

MicrostatHe

MicrostatHe Rectangular Tail

OptistatCF-V

Revision 6

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1 Important Information

1.1 Introduction to this manual

This manual is part of the product that you have bought. Please keep it for the whole life of the product and make sure that you incorporate any amendments which might be sent to you. If you sell or give away the product to someone else, please give them the manual too.

1.2 Safety requirements

Please refer to the booklet *Safety Matters*, which has been supplied with the system. This includes information about the properties of liquid nitrogen and liquid helium, and detailed recommendations about the precautions you should take. It is your responsibility to ensure your own safety, and the safety of the people working around you.

1.3 Important Health and Safety Notice

Important Health and Safety Notice

When returning components for service or repair it is essential that the item is shipped together with a signed declaration that the product has not been exposed to any hazardous contamination or that appropriate decontamination procedures have been carried out so that the product is safe to handle.

1.4 Conventions used in this manual

The following conventions have been followed in this manual:

- Danger:** Indicates that the hazard may cause death or severe injury if the instructions are not followed carefully.
- Warning:** Indicates that the hazard may cause injury.
- Caution:** Indicates that the hazard may cause damage to equipment.
- Note:** Something that needs to be brought to the customer's attention.
- Tip:** Indicates a helpful hint that may be of use to the customer.

1.5 Important information

Warning

Before you operate this equipment you must make sure that you are aware of the precautions necessary to ensure your own safety. We supply a separate booklet called *Safety Matters* with the system. Please read it carefully so that you fully understand the hazards you may encounter when using cryogenics.

Oxford Instruments cannot accept responsibility for damage to the system caused by failure to observe the correct procedures laid down in this manual. The warranty may be affected if the system is misused, or the recommendations in this handbook are not followed.

Temperature and voltage limits

If you have bought a cryostat and temperature controller together from Oxford Instruments the temperature controller will have been set up in the factory:

- To prevent you from accidentally exceeding the maximum safe operating temperature of the cryostat
- To limit the maximum heater voltage to a safe level

If you are planning to use an existing temperature controller, or a power supply or controller made by another manufacturer, you should take the same precautions. The recommended values for the 'Heater Voltage Limit' and the 'Temperature Limit (T_{HOT})' are given with the test results for the cryostat.

Warning **If you do not safeguard the system it is possible to cause serious damage.**

1.6 Disposal and recycling instructions

Before disposing of this equipment, it is important to check with the appropriate local organisations to obtain advice on local rules and regulations about disposal and recycling.

You **must** contact Oxford Instruments NanoScience Customer Support (giving full product details) before any disposal begins.

2 Introduction

2.1 Introduction to this manual

This manual is intended for use with the MicrostatHe (standard and rectangular tail options) and OptistatCF-V cryostats. They are described in the same manual because the procedure for operation is identical for each cryostat.

Both versions of the MicrostatHe are continuous flow cryostats designed principally to allow a sample to be cooled to a low temperature and studied with an optical microscope. The special window arrangement for the standard MicrostatHe allows the sample to be brought close to the objective lens of a microscope. The Rectangular Tail MicrostatHe has a rectangular or square tail to provide a short working distance through four windows.

Each cryostat may be operated in any orientation (although the performance is likely to be reduced if it is inverted). The sample is mounted in vacuum, and cooled by conduction. The sample temperature is continuously variable between 3.8 K and 500 K.

The OptistatCF-V cryostat is also a continuous flow cryostat, which uses the same cooling unit as the MicrostatHe. This cryostat has four radial window ports and one axial port with optical access of f/0.9.

This manual is designed to describe the system and explain how to operate it with the Oxford Instruments ITC temperature controller. You can run the cryostat manually if a temperature controller is not available, but it is difficult to obtain good temperature control. We recommend that you read this manual carefully before you try to operate the system. With practice you will find the best way to use the system for your own special application

2.2 Continuous flow cryostats

Continuous flow cryostats do not have an internal reservoir to store a supply of cryogen. The liquid is supplied from a separate storage vessel through an insulated transfer tube. The transfer tube delivers the liquid helium to a heat exchanger close to the sample space. The gas returning from the heat exchanger then cools the radiation shield and flows out of the cryostat. A thermometer and heater are mounted on the heat exchanger, and these can be used with a temperature controller to balance the cooling power of the cryogen and to control the temperature of the sample.

Either liquid helium or liquid nitrogen can be used in these cryostats. Temperatures down to about 77 K can be reached using liquid nitrogen, but even at these temperatures better temperature stability can be achieved using liquid helium. If liquid helium is used, it is possible to maintain a temperature below 4.2 K continuously using the standard gas flow pump (GF4) and controller (VC31). Lower temperatures can be achieved using a larger pump such as the EPS25 rotary pump.

Figure 1 illustrates the overall system configuration when the cryostat is run using an LLT or GFS transfer tube. The system can also be run using a TTL transfer tube, in which case the pump is attached to a port provided for the purpose on the cryostat. Figure 1 shows a transfer tube with an auto needle valve, but a manual needle valve can also be used.

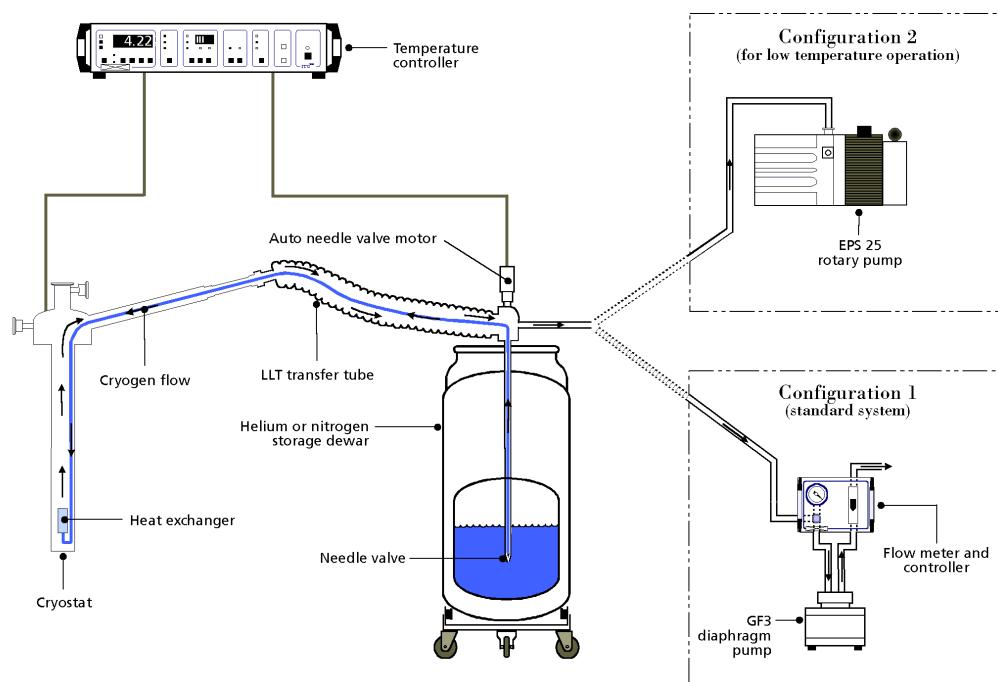


Figure 1 Configurations for continuous flow cryostat systems

2.3 Description of the cryostat

Figure 2 shows the main parts of the standard MicrostatHe and Figure 4 those for the Rectangular Tail option. Figure 4 is a drawing of the cooling unit of the cryostat together with both the MicrostatHe and OptistatCF-V tails.

The sample is mounted in vacuum on a heat exchanger, and optical access to the sample is available through the windows. The sample space and radiation shields are thermally insulated from the room temperature surroundings by the outer vacuum chamber (OVC). This space is pumped to a high vacuum before the cryostat is cooled down but it is protected against accidental build up of high pressures by a pressure relief valve.

Up to two windows can be fitted to the Microstat. Each window is permanently bonded into the OVC flange, which is shaped to allow the sample to be mounted as close as possible to the inside surface of the window. It also allows a typical optical microscope objective lens turret to be rotated without withdrawing the microscope objective.

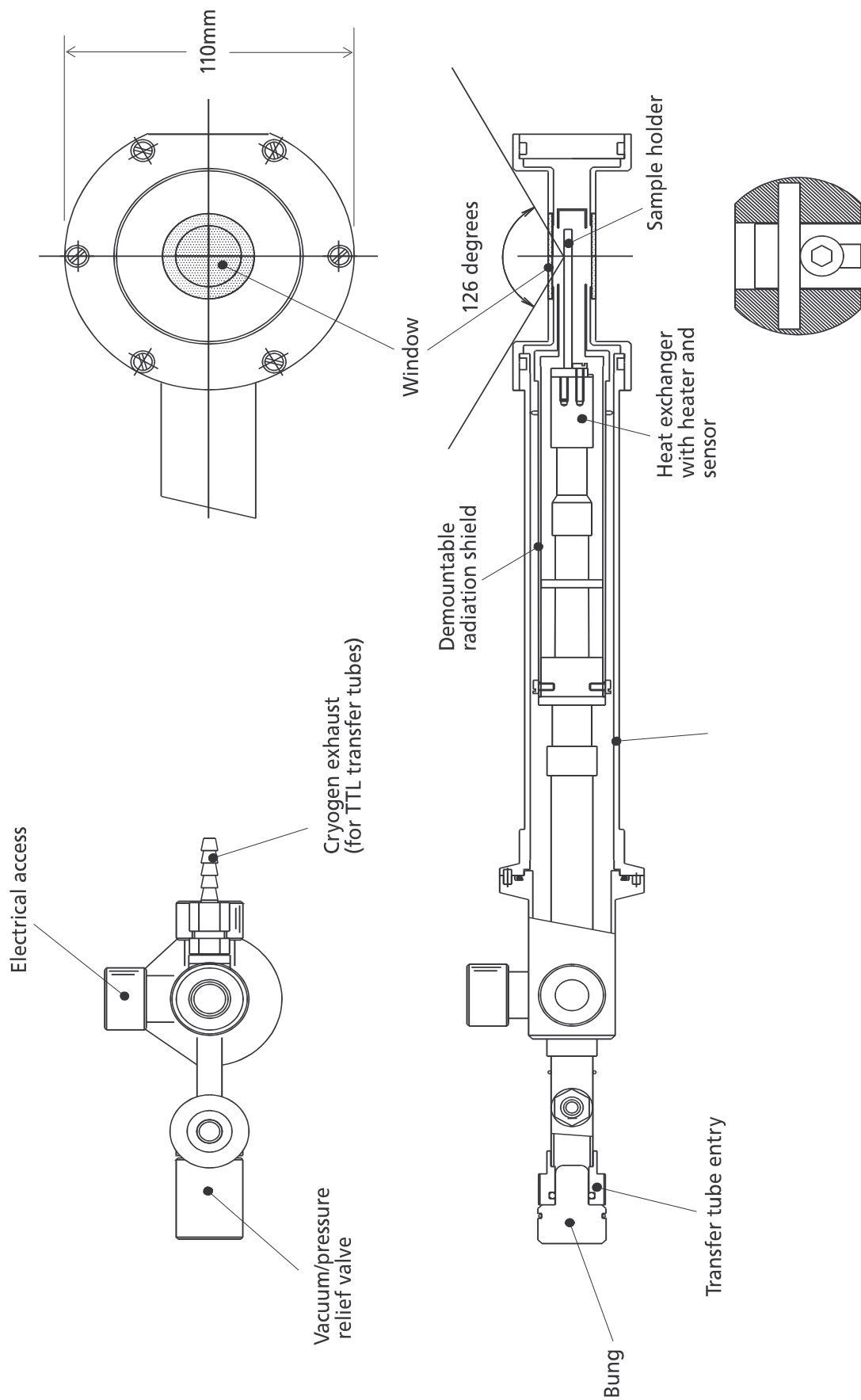


Figure 2 Diagram of the MicrostatHe cryostat

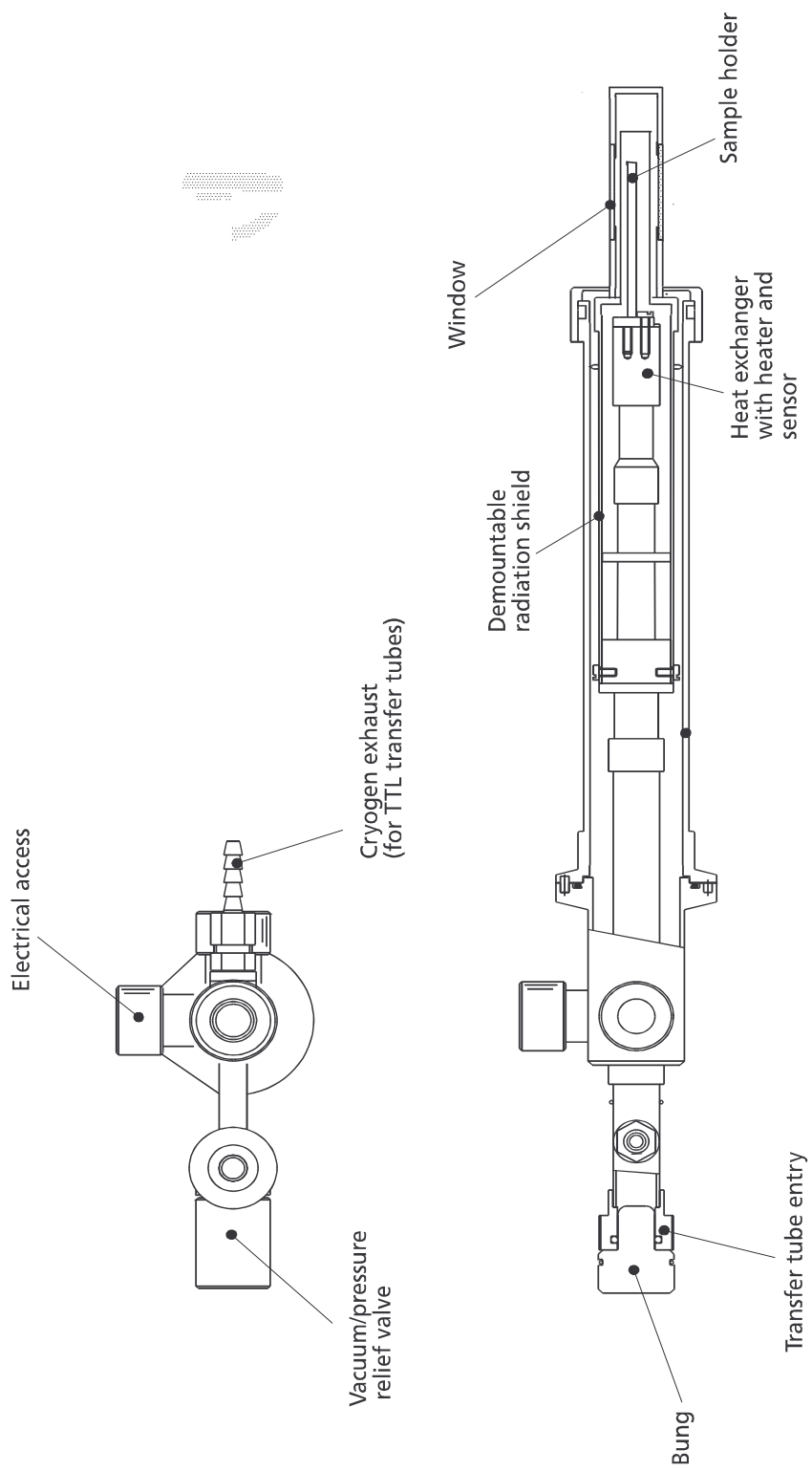


Figure 3 Diagram of the MicrostatHe with Rectangular Tail

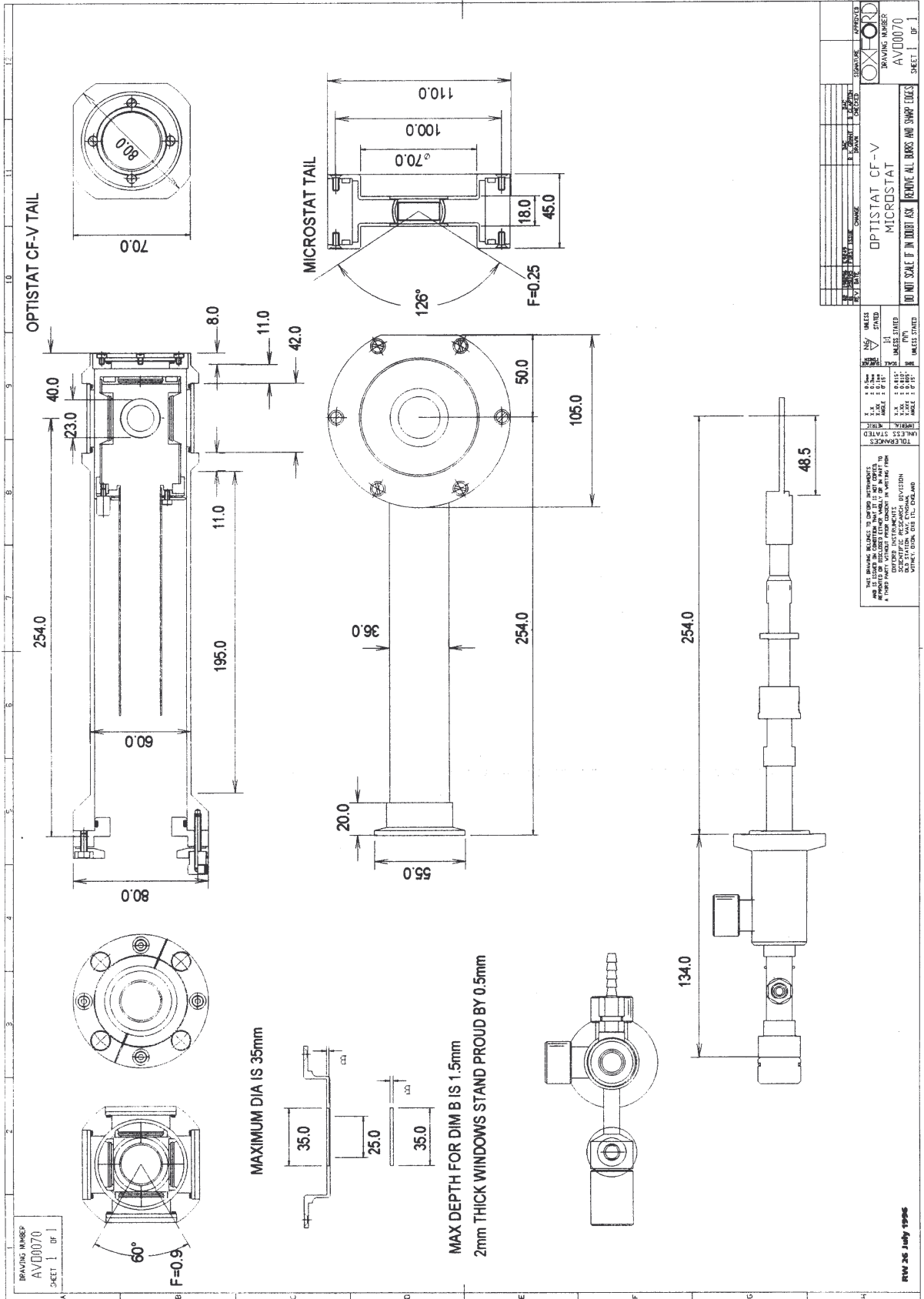


Figure 4 Drawing of cooling unit and cryostat tails

2.4 The cryogen transfer tube

Two types of transfer tube are available for the cryostats: TTL and LLT. The GFS is an older design; it is identical in its use to the LLT, except that it is not recommended for low temperature operation (configuration 2 in Figure 1). They are described fully in separate manuals.

The TTL transfer tube is a low loss vacuum insulated transfer tube suitable for use with liquid helium or liquid nitrogen.

Caution: If you are using a TTL transfer tube, make sure that you do not unscrew the dewar leg completely, as this would change the original factory settings. If you do accidentally remove this leg, refer to the transfer tube manual, which describes the procedure for resetting it.

The LLT transfer tube is designed for ultra low loss performance. The cold exhaust gas from the cryostat flows along the tube, shielding the incoming liquid from room temperature thermal radiation. The LLT 600 and 700 are used for manual control, and the LLT 650 and 750 are automated versions, which allow the gas flow rate to be optimised automatically, using the ITC range of temperature controllers.

2.5 The gas flow pump and flow controller

The Oxford Instruments GF4 gas flow pump is used to promote the flow through the cryostat. It is an oil-free diaphragm pump with a nominal displacement of 42 litres per minute. The air leak rate is guaranteed to be less than $10 \text{ cm}^3/\text{minute}$. This pump is described fully in a separate manual.

The VC31 gas flow controller is used to control the flow of gas through the cryostat. It includes a flow meter (calibrated for helium gas) and a pressure gauge, so that the flow can be monitored.

3 Unpacking and preparation

3.1 Unpacking the system

Carefully remove the cryostat and all the accessories from the packing case, and check the packing list to make sure that you have found all of the components. Examine the system to make sure that it has not been damaged since it left the factory. If you find any signs of damage please contact Oxford Instruments immediately.

To run this system you need the following components:

- The cryostat: MicrostatHe, MicrostatHe with Rectangular tail or OptistatCF-V
- Liquid helium or liquid nitrogen storage dewar
- Cryogen transfer tube (TTL or LLT) and suitable adapter for storage dewar
- Polythene tube (7 mm inner diameter) for the gas exhaust
- High vacuum pumping system to evacuate the OVC occasionally
- Oil-free diaphragm pump (GF4), or EPS25 rotary pump for low temperature operation
- Gas flow controller (VC31) and pumping lines
- Temperature controller (ITC 502 or ITC 503)

3.2 Preparing the system for operation

Choose a suitable position to operate the cryostat safely, and if necessary arrange for it to be supported so that it cannot accidentally fall. Use Figure 2 to help you to locate the services and controls on the top plate of the cryostat.

3.2.1 Evacuating the outer vacuum chamber (OVC)

The OVC has to be pumped to high vacuum to make sure that it gives the required thermal insulation. When the system is new, all of the materials inside the vacuum space are likely to outgas quickly, and this will affect the quality of the vacuum. This does not mean that the system is leaking, just that the new materials are being cleaned by the vacuum. The OVC should be pumped thoroughly before each cooldown, especially when the cryostat is new.

Connect the pumping system to the cryostat vacuum valve on the entry arm of the cryostat. We recommend that you use a diffusion pump or turbo-molecular pump, backed by a rotary pump, and fitted with a cold trap which helps the system to pump water vapour. Typically, you should pump the OVC until the pressure at the pump is 10^{-4} or 10^{-5} mbar. If the system is badly contaminated with water vapour, the gas ballast facility on the rotary pump should be used.

3.2.2 Evacuating the transfer tube

The transfer tube vacuum space has a separate evacuation valve similar to that on the cryostat, and the high vacuum pumping system can be connected to it directly.

3.2.3 Exhaust gas connections

If you are using a TTL transfer tube on the system, the exhaust gas is taken from the port on the cryostat entry arm. It does not flow back through the transfer tube.

If you have an LLT or GFS transfer tube, the exhaust port on the cryostat arm is closed, and the gas flows along the transfer tube to the exhaust port.

For standard operation (configuration 1 in Figure 1), a piece of polythene tube is used to connect the exhaust port on the cryostat or transfer tube to the VC31 gas flow controller. The other connections should be made as shown in Figure 5 or Figure 6 (depending whether you are using a TTL or LLT transfer tube) for continuous operation with the GF4 pump and VC31 controller. The exhaust line from the VC31 can either be connected to a helium recovery system or vented to the atmosphere.

For low temperature operation with the LLT transfer tube (configuration 2 in Figure 1), remove the "Christmas tree" spigot clamped to the NW16 fitting (Klein flange) on the transfer tube exhaust port. Attach a pumping line directly to this fitting, and attach the other end to the EPS25 rotary pump. Make sure that an oil-mist filter is attached to the exhaust of the pump. The outlet of the oil-mist filter can either be connected to a helium recovery system or vented to the atmosphere

3.2.4 Electrical connections to the temperature controller

The ITC temperature controller should be connected to the cryostat as shown in Figure 5 or Figure 6. The cable should usually be connected to the "sensor 1" socket on the temperature controller. If your transfer tube has an automatic needle valve, connect the needle valve cable to the "Auxiliary" socket on the back panel of the ITC. Check that the mains voltage selector on the temperature controller is correct for your local power supply, and connect it to the mains. Switch on the temperature controller, and press the SENSOR button until Sensor 1 LED is lit. The main display should then show the code for the sensor fitted to the cryostat. The correct code is shown in the test results sheet. The calibration in the temperature controller has been set up for the thermometer in the cryostat. If the code displayed is incorrect, please refer to the temperature controller manual.

3.2.5 Loading the sample and making electrical connections

The sample is mounted on the heat exchanger within the OVC; the OVC and radiation shield have to be removed to change the sample. The procedure for changing samples is given in section 4.5.

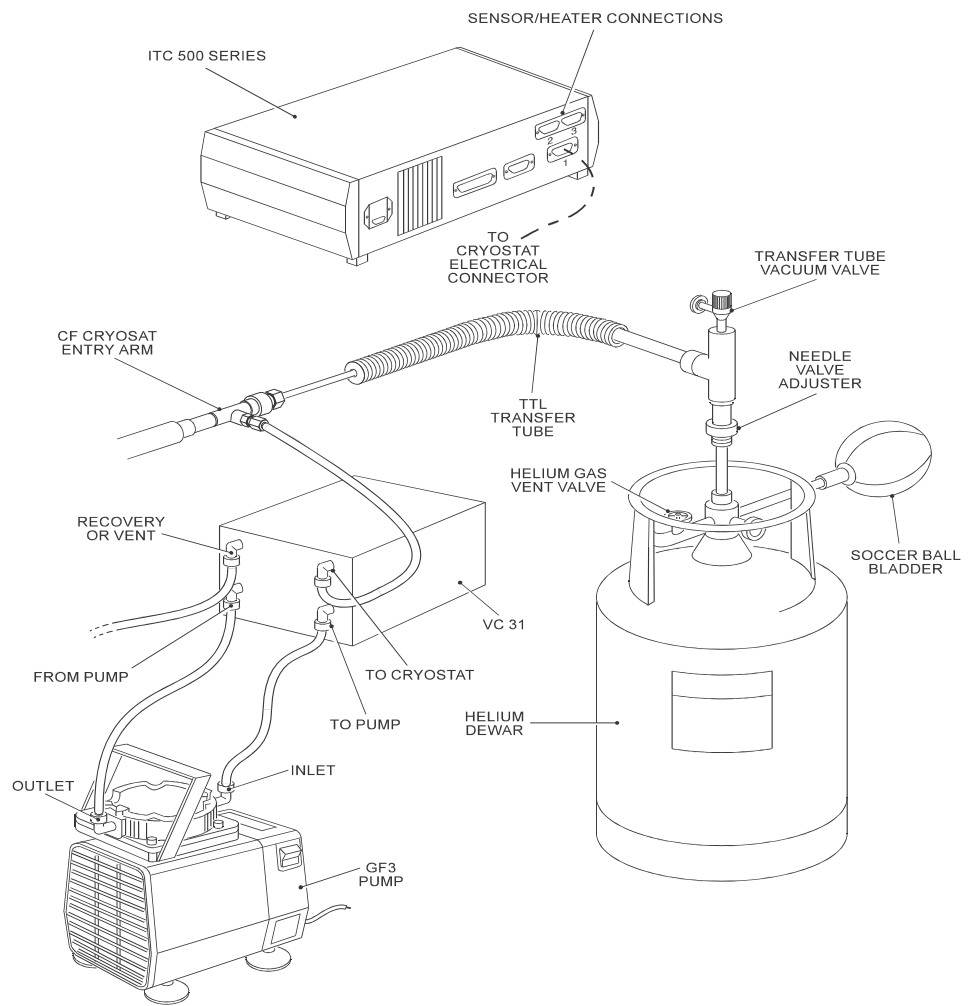


Figure 5 Cryogen, exhaust gas and electrical connections (TTL transfer tubes)

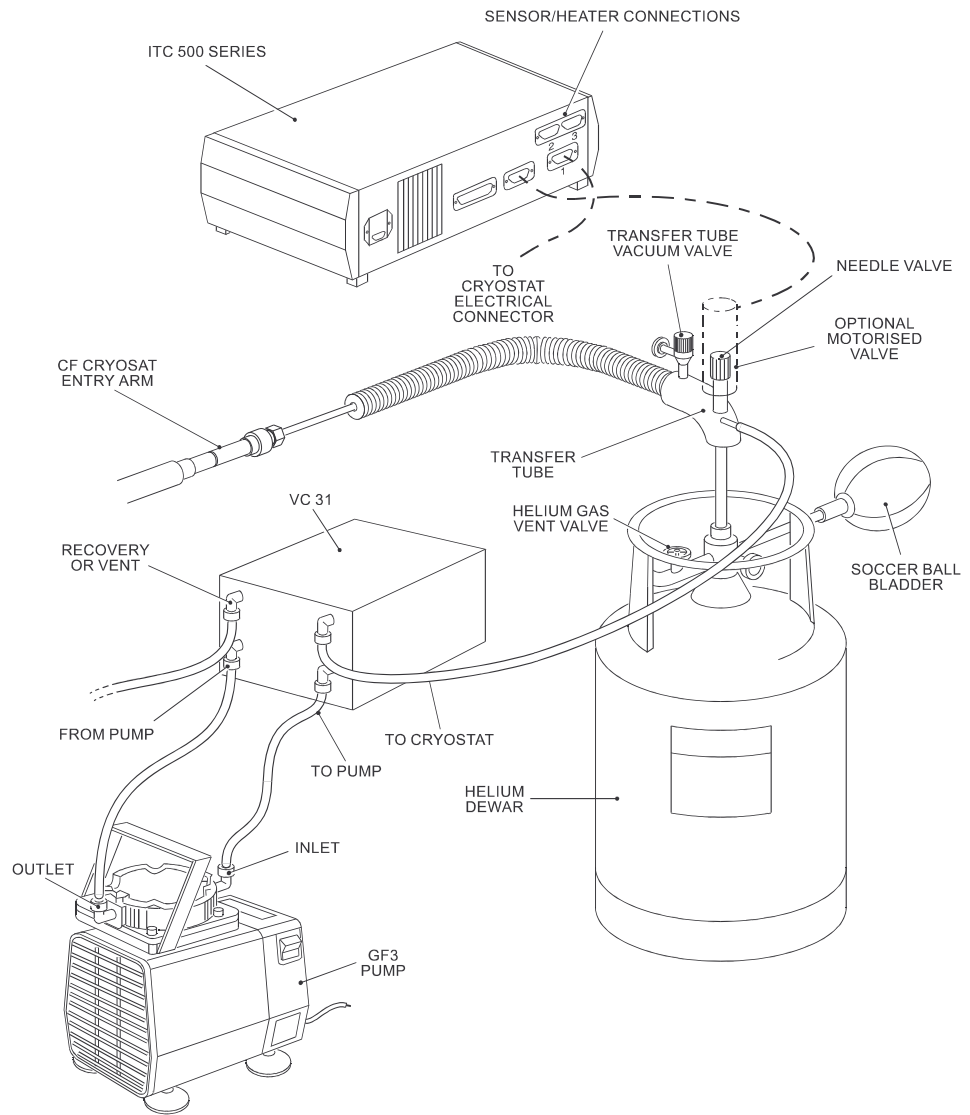


Figure 6 Cryogen, exhaust gas and electrical connections (LLT transfer tubes)

4 Running the system

The following procedure assumes that you are using liquid helium with the system. The cryostats can also be used with liquid nitrogen but some of the techniques are different. Please see section 4.8 for details.

4.1 Cooldown

Ensure that the cryostat's OVC and the transfer tube have recently been pumped to high vacuum. Connect the system together as described in Section 3.2. Set the 'set temperature' of the temperature controller to below 4.2 K, by pressing and holding the SET button, and using RAISE/LOWER to adjust the set point shown on the main display.

Close the needle valve on the transfer tube fully, and open it by six turns as described below:

TTL transfer tubes

Rotate the black nut anti-clockwise (when viewed from above) until it is closed. Then open the needle valve by no more than six turns by rotating the knurled nut in the opposite direction. If you rotate the nut further, the thread will be disengaged and the factory setting will be lost.

LLT transfer tubes

Rotate the handle clockwise to close the valve. Open it by six turns.

If the transfer tube has been supplied with the cryostat it should fit the system without any modification. If not, you may need to remove a PTFE washer from the transfer tube arm (this washer is required for some other standard cryostats, not for this one). If the washer is fitted the transfer tube may not fit into the cryostat, or it may restrict the cryogen flow and the cryostat may not cool down properly.

The pumping system should have been connected as described earlier. Open the needle valve on the VC31 fully, by turning it anti-clockwise. Switch on the GF4 pump.

Warning: **Make sure that you have taken the necessary precautions to ensure your own safety and the safety of other people working near you.**

Slowly lower the dewar leg of the transfer tube into the liquid helium. Some liquid will be used to cool the leg, and the dewar exhaust must be open to allow this gas to escape. However, you can use some of it to pre-cool the inner tube of the transfer tube and the cryostat if you lower the leg slowly enough. If you try to cool the leg too quickly a large amount of liquid will be wasted, and you could be burnt by the cold gas.

As soon as the dewar leg has been loaded into the liquid helium, push the other end into the entry arm of the cryostat and engage the nut on the transfer tube arm with the thread on the cryostat arm and tighten it. The cryostat heat exchanger and sample should now cool steadily. The cryostat typically cools to 4.2 K within 40 minutes.

4.2 Operation below 4.2 K

Temperatures lower than 4.2 K are achieved by lowering the pressure in the heat exchanger. Since the pumping speed of any pump is limited, this can only be achieved by limiting the rate at which helium is supplied, using the needle valve in the transfer tube. The specifications or test results for the cryostat give the temperatures which can be achieved using the GF4 diaphragm pump and using the EPS25 rotary pump. The dependence of temperature on flow rate for a given pump is illustrated in Figure 7. It is important for continuous operation at low temperatures that the cryostat is not running in single shot mode, i.e. with a pool of excess liquid helium in the heat exchanger. To prevent this, you should use the following procedure.

Put the heater control and the gas flow control of the ITC temperature controller into MANUAL mode, with zero heater voltage. When the cryostat has reached 4.2 K (point A in Figure 7), close the needle valve on the transfer tube. The temperature will probably fall immediately, because liquid helium in the heat exchanger is being boiled off. After at most a few minutes the liquid will have boiled away, and the temperature will start to rise.

At this point, open the needle valve about a quarter turn. The temperature should stabilise below about 20 K (at point C). Now open the needle valve in very small increments, waiting for the temperature to stabilise after each change. As you do this, the temperature will fall, until you reach the base temperature of the system (point B).

Now select the desired SET temperature on the ITC, and switch the ITC heater control to AUTO.

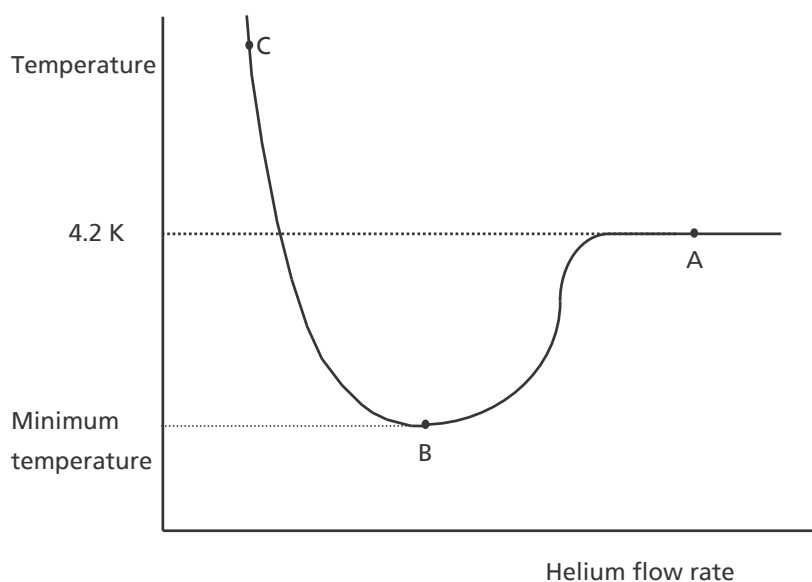


Figure 7 Temperature vs Helium flow rate, for a cryostat running in continuous flow conditions, zero heater voltage

4.3 Temperature control above 4.2 K

4.3.1 Introduction

You can control the temperature of the heat exchanger between 4.2 K and 500 K using a temperature controller. The flow of liquid helium and the heater power have to be adjusted to reach the required set point. The ITC502 or ITC503 temperature controller is used to control the heater power automatically, and adjusts the power to maintain the set temperature. These temperature controllers are three term controllers. The temperature control is optimised by setting the best values for:

- Proportional band (P)
- Integral action time (I)
- Derivative action time (D)

The values given in the test results for the system are suitable to give good stability. If you want to improve the stability further you may be able to do this by adjusting the three terms slightly. The autotune facility on the ITC503 can be used to optimise these values, and the auto PID feature can be set up to allow the temperature controller to choose the best values for the three terms to suit the set temperature. The procedure for optimising the PID values and control theory are given in the ITC manual.

4.3.2 Controlling at a 'set temperature'

Check that the cryostat has been connected to the temperature controller as described in section 3.2. Select the channel on the temperature controller corresponding to the sensor, which will be used to control the system, and ensure that the light on the heater control panel corresponds to the control sensor.

Set the required 'set temperature' by pressing and holding the SET button on the temperature controller, and using the RAISE/LOWER buttons to adjust the value shown on the main display. Set the PID values and the cryogen flow rate to those shown for the nearest temperature in the test results. Press the AUTO button once, and the temperature controller should adjust the heater output to warm the heat exchanger to the 'set temperature'.

It is not necessary to cool the cryostat to 4.2 K before you set the required 'set temperature'. If the temperature controller is set to the required temperature at the beginning of the cooldown, the cryostat should cool to the set temperature and the temperature controller should then hold it at this point.

You should then optimise the flow of liquid helium so that the heater output of the temperature controller is not too high. In general, the flow should be reduced until the steady heater output is at a suitable level. If you are using an Auto LLT system it will optimise the flow and heater voltage automatically for you. As a guide, if you are optimising the flow manually the heater voltage should typically be as follows

- 3 to 5 volts when the system is working in the region 4.2 K to 20 K
- 8 to 12 volts when it is working below 300 K
- greater than 8 volts when it is working above 300 K

4.3.3 Operation above room temperature

Pump the OVC continuously to maintain the required high vacuum. You can now control the system at a 'set temperature' as described in section 4.3.2.

4.4 Warming up the system

Switch off the gas flow pump. After a few seconds the pressure in the helium flow circuit will rise to approximately the pressure of the storage dewar, and the transfer tube can be removed from the cryostat. Immediately fit the special pressure relief valve (supplied with the system) into the cryostat so that it is not contaminated with ice (condensed from the air). This could block the transfer tube next time it is cooled down.

If you do not need to warm the system quickly it may be left to warm up naturally. If you want to warm it more quickly allow a small volume of dry nitrogen gas into the OVC to break the vacuum. You can use the sample space heater to help warm the cryostat.

4.5 Changing samples

Warm the cryostat to room temperature, as described in Section 4.4. The OVC and part of the radiation shield have to be removed from the cryostat to change samples. This can be done as described in Section 5.2, when the sample has been replaced, re-assemble the cryostat and evacuate the OVC. Proceed to cool the system down as described earlier.

4.6 Sample holders

Various sample holders are available for use with the cryostat. One is a solid flat holder covering the entire clear aperture. Several small samples may be mounted on this sample holder, so that measurements can be taken on all of them without having to warm the cryostat to change samples.

The other sample holder is designed for transmission measurements. It has a 12.5 mm diameter aperture, and includes a sample retaining clamp.

4.7 Adjusting the sample position

The sample holder can be adjusted to allow the sample to be positioned as close as possible to the inside of the OVC window. This adjustment has to be made before the radiation shield and OVC are fitted. Take care to ensure that neither the sample nor the sample holder touch the radiation shield, or the OVC (or window).

Figure 2 shows an end view of the cold finger with the sample holder and its retaining screw.

To adjust the position of the sample holder the screw should be loosened, this will allow the holder to be slid up and down.

The sample holder is located in a groove in the cold finger, which prevents it from being rotated during adjustment.

4.8 Operating with liquid nitrogen

The cryostat can also be operated with liquid nitrogen instead of liquid helium. The basic operating procedure is the same as that for helium, but there are a few differences.

- a) The flow gauge on the VC31 is calibrated for helium gas, so it will not give the correct flow reading for nitrogen gas. If the calibration is important, you could use a VC41 instead.
- b) The cooldown time is greater with nitrogen.
- c) **If you pump the liquid nitrogen to a pressure below 150 mbar you may freeze it and block the cryostat. This is possible with either GF4 or EPS25 pumps.**
- d) It is more difficult to control the temperature of the sample, and specification is typically changed to ± 0.2 K. It is particularly difficult to control the temperature below 90 K, because liquid collects in the sample space heat exchanger and boils intermittently.
- e) Liquid nitrogen is not cold enough to cryopump air effectively, so it more difficult to maintain a good vacuum in the OVC and transfer tube. It may be necessary to pump the OVC and transfer tube continuously because the warm surfaces outgas slightly. Surfaces cooled by liquid helium would freeze this gas and maintain the vacuum.
- f) It is best to use the minimum flow possible to get good stability at low temperatures, (especially below 100 K). If you find that the temperature seems stable for a short time and then it suddenly becomes unstable, try to reduce the flow. Change the flow rate slowly, (typically 1% per minute), so that any liquid that has collected in the sample space heat exchanger has time to boil away before you make another change.
- g) When you find the optimum flow rate for 77.3 K this should be suitable for the whole temperature range. Increase it if you want to cool down more quickly, but as you approach 77.3 K reduce the flow again so that the cryostat is not filled with liquid.
- h) If you are using an LLT or GFS transfer tube with an automatic needle valve it is best to run it with the gas flow control in MANUAL mode. Since liquid nitrogen is much less expensive than liquid helium there is little advantage to be gained by reducing the consumption. When the gas flow control is in AUTO mode it may change the flow rate too rapidly, and good stability may never be achieved.
- i) The PID settings on the temperature controller may be different from those given in the test results. Typically the P and I values should be increased slightly.

5 Maintenance

If you carry out a few simple procedures your cryostat will give you years of reliable operation.

5.1 Rubber 'O' rings

Whenever you remove part of the cryostat or if you suspect that there is a leak on the system check the 'O' ring on the OVC and transfer tube entry arm for cuts or abrasions. If you find a damaged ring, replace it.

5.2 Removing the OVC and radiation shield

The OVC and radiation shield must be removed if you want to:

- Change the samples
- Modify or repair the wiring
- Repair mechanical damage

Warm the cryostat to room temperature and then open the OVC valve to allow air into the system. (Use dry nitrogen gas, if there is any chance that the internal parts of the cryostat are still cold, and then wait until it is warm before opening the OVC.)

If the blue part of the OVC is fixed to the microscope stage it is not necessary to remove it. Referring to Figure 2 or Figure 3 for guidance, release the NW40 clamp and withdraw the cooling unit from the OVC.

This gives access to the radiation shield, this is removed by loosening the four screws and pulling the shield. The holes in the shield have been slotted so the retaining screws do not need to be removed.

The sample holder, cold finger and wiring are now accessible.

To remove the sample holder the retaining screw needs to be loosened, as with the radiation shield there is no need to remove the screw as the sample holder has been slotted.

Before re-assembling check the 'O' ring is clean, undamaged and lightly greased.

The cold finger has two tapped holes to allow the sample holder to be turned over to face either window. The OVC has a pin which locates in either one of two holes in the NW40 of the cooling unit to ensure it is replaced with the sample holder parallel to the window surface.

5.3 Window replacement on the Optistat^{CF-V}

If you need to clean the windows, they can all be removed as follows.

5.3.1 Outer windows

Carefully remove the four nylon window retaining screws. The outer windows are shown in Figure 8. If the cryostat is turned over, the window will fall out. Clean it with a suitable lens cleaner and lens tissue. Before the window is replaced, check the 'O' ring, clean and grease it lightly with vacuum grease. The windows should be carefully tested for leaks with a mass spectrometer leak detector if one is available. However, some window materials (for example polythene, Mylar, and aluminised Mylar) are porous to helium gas at room temperature, and cannot be leak tested in this way.

5.3.2 Radiation shield windows

The radiation shield windows are held in place by wire clips as shown in Figure 9. Carefully prise the clip out of the window frame, and turn the cryostat over to let the window drop out. When you replace the window you should apply a thin layer of grease to the mounting surface to improve thermal contact, as shown in Figure 9. Apiezon N grease is suitable. The window should not be loose in the mount. The pressure from the wire clip should be sufficient to make sure that the window is cooled properly.

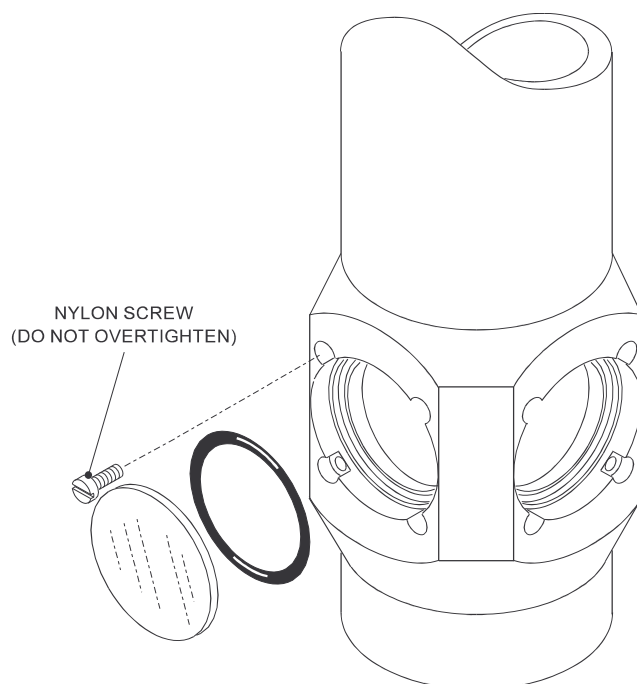


Figure 8 'O' ring sealed outer windows

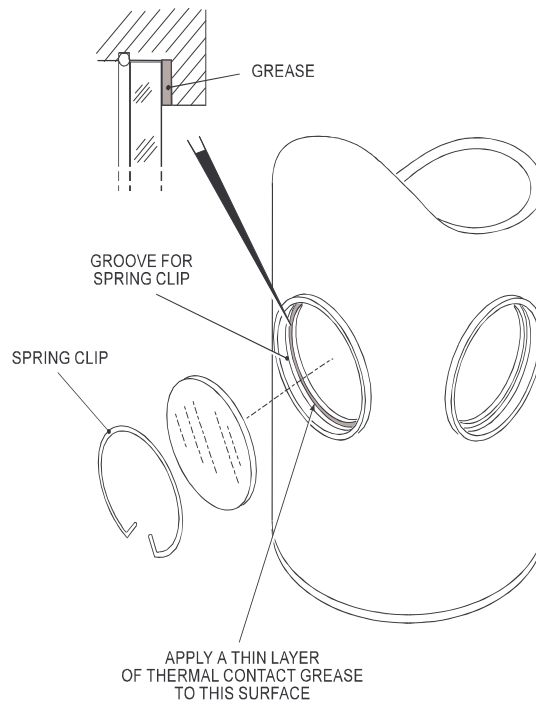


Figure 9 Radiation shield windows

6 Electrical connections on the cryostat

The standard cryostat is fitted with a ten pin seal toward the top of the cooling unit. This is used for the connection to the cold finger. The seal is held in place by the black knurled nut. Do not remove it unless you need to gain access to the wiring.

6.1 Wiring for sample

Additional connectors may have been fitted to the cryostat if you requested them. The wires to the sample should be thermally anchored to the cryostat to make sure that too much heat is not introduced to the sample through the wiring.

6.2 Standard wiring for a MicrostatHe with a rhodium iron resistor

As standard, the heat exchanger is fitted with a rhodium iron resistor (set up for four wire measurement) and two heaters. Detailed information about the thermometer is given after page 3.

Pin	Function	
A)	Heat exchanger heater (Watlow Firerod cartridge)
B)	
C	V+	Heat exchanger sensor
D	V-	
E	I+	
F	I-	

6.2.1 Checking the wiring

A resistance meter can be used to check the wiring of the cryostat. You should expect to measure the following values. These readings may be affected if the cryostat is damp or if your fingers are in contact with one or more of the pins.

Pins	Expected resistance
A to B	40 Ω approx.
C to D	27 Ω approx.
C to E	< 15 Ω
C to F	27 Ω approx.
E to F	27 Ω approx.
A to C	> 1 M Ω
A to ground	> 1 M Ω
C to ground	> 1 M Ω

7 Troubleshooting

The following table shows the most common faults. Refer also to the fault-finding table in the transfer tube manual.

Symptom	Diagnosis and suggestions
<p>Cryostat OVC cannot be pumped to high vacuum</p> <p>Or</p> <p>Water condenses on the cryostat body when it is cold</p>	<p>Check the cryostat OVC for leaks. In particular check:</p> <ul style="list-style-type: none"> • Cryostat top plate seals • OVC seals (dry, dirty or damaged 'O' rings) <p>If there is no leak there may be too much moisture in the OVC and it should be pumped with a rotary pump, with the gas ballast valve open.</p>
<p>Cryostat will not cool down</p>	<p>Check whether there is any flow of gas through the system, using the gauge on the VC31. If not see the transfer tube manual.</p>
<p>Poor temperature stability</p>	<p>Check that the PID settings on the temperature controller and the cryogen flow rate are as suggested in the test results.</p>
<p>Cryostat cannot be warmed up.</p> <p>or</p> <p>Heater not working</p>	<p>Check that the 'set temperature' is higher than the present sample temperature, or switch the heater on manually.</p> <p>Check that the high temperature limit of the temperature controller has not been exceeded, (as indicated by the message "Hot 1" on the display).</p> <p>Check that the heater voltage limit on the temperature controller is high enough.</p> <p>Check that the heater is not open circuit by checking from pin A to pin B. If so the wiring will have to be repaired.</p>

Symptom	Diagnosis and suggestions
Cryostat will not reach specified minimum temperature	<p>Check that the heater is switched off.</p> <p>Check that the flow rate is high enough, and that there is sufficient liquid in the storage dewar.</p> <p>Check the connections to the thermometer and make sure that it is working properly and in good thermal contact with the cryogen flow.</p> <p>Check that you have not added too much heavy wiring to the sample holder, introducing a high heat load.</p> <p>Check the quality of the vacuum in the OVC.</p> <p>Check the vacuum in the transfer tube.</p> <p>Check the cryostat for mechanical damage. Warm it to room temperature and remove the OVC to check whether the radiation shield touches the sample holder or OVC.</p> <p>Check that the radiation shield has been fitted correctly.</p> <p>Check that the sample or sample holder are not touching the radiation shield or OVC.</p>
Sensor not reading correctly	Check the wiring