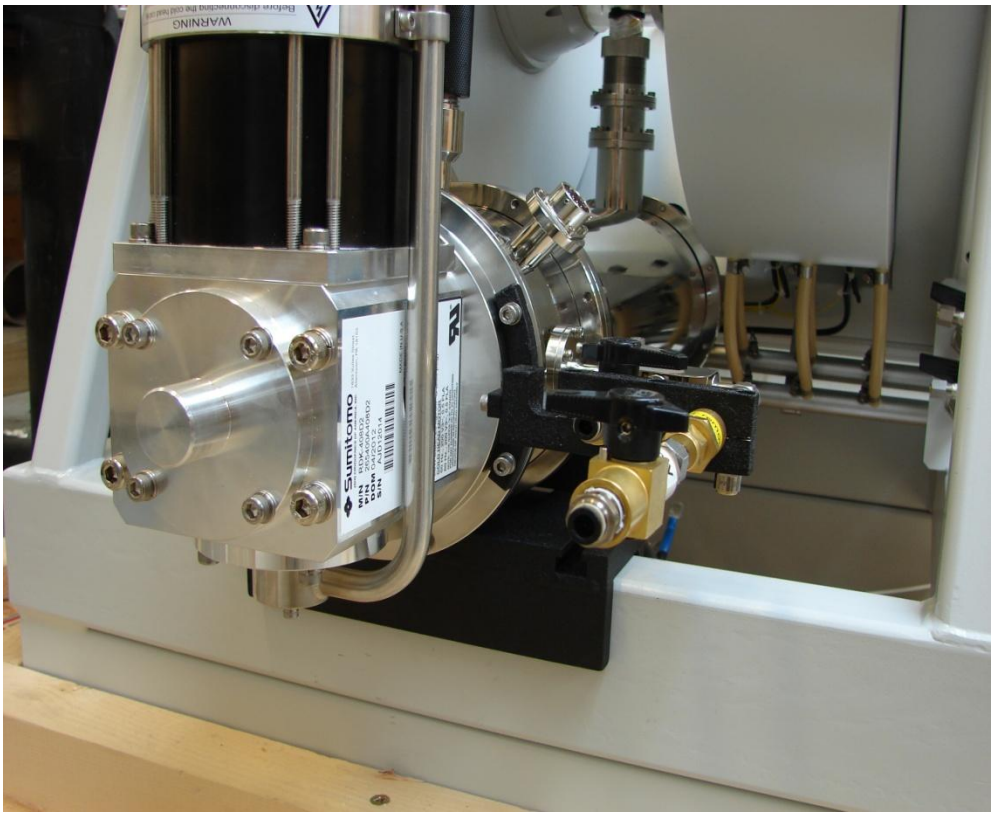
Cold Edge technologies

OWNER'S MANUAL

"where the cooler….



"….meets the interface."

WaveGuide EPR System

www.coldedgetech.com | techsupport@coldedgetech.com

Notes, Notices and Warnings

Three types of special warnings – notes, notices, and warnings – are used in each section of the Wave Guide Interface manual. They appear as follows and serve the purposes stated.

- NOTE: A NOTE indicates important information or additional items of information that help you make better use of your Interface.
- NOTICE: A NOTICE indicates either potential damage to hardware and tells you how to avoid the problem.
- WARNING: A WARNING calls attention to actions or conditions which can result in personal injury or injury to others.

All notes, notices, and warnings appear in the text where they are applicable.

Contents

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Introduction

The Wave Guide Interface serves as a mate between the cryocooler and the customer's research equipment. The interface is normally customer specific and is designed around equipment that the researcher has in place. Most of the design is concentrated around the researcher's sample. Therefore, the size of the sample is critical for the design of the interface. The interface generally consists of a few parts which include the radiation shield, sample holder, temperature instrumentation, and vacuum shroud. Each part of the interface is critical in helping the researcher achieve his or her desired experimental results.

Beyond adapting to the researchers interests and needs, the interface also serves as intricate part to helping the cryocooler achieve its best results. One of the interface parts is the radiation shield which helps reflect radiant heat loads from not only the researcher's sample, but also from the Cold Head. Any heat that is intercepted by the Cold Head impacts the ultimate performance. The vacuum shroud also helps the Cold Head by introducing a vacuum insulator between room temperature external ambient air, and the much lower temperature of the Cold Head. This vacuum insulator keeps the Cold Head free of ice.

The vacuum level of the interface can also be critical to the researcher's experiments. Each interface is designed with O-ring seals and can safely achieve upwards of 10-6 Torr levels of vacuum pressure.

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Principles of Operation

The design of the sample area is generally customer specific and depending on what research needs to be done the interface can provide different forms of cooling. In Wave Guide testing, space, specific materials, and fast cooling methods are key components for the system to work for the researchers needs. For this reason, the Wave Guide interface provides a thin vacuum jacketed glass sample space, in which cold helium gas is passes over the sample. The cold helium gas is provided from an external gas cylinder, which cools through heat exchangers mounted to the cooling stages of the Cold Head inside the interface. Cold helium gas passing directly over the sample allows for fast cooling methods, because the sample can be changed in and out of the gas stream through the top of the glassware without having to break vacuum and allow the system to warm back up to room temperature. The vacuum jacketed glassware has a very low magnetic signature that doesn't interfere with the magnetic poles that the sample sits between.

Strategically placed temperature instrumentation is used to accurately measure the temperature of the sample and accurately control the temperature region of the researcher's experiment. Depending on the range of temperature, and the sample environment, specific diodes or sensors are used. In magnetic fields, cernox is a sensor of choice because the sensor is designed to work in 1T magnetic environments without interfering with the magnetic signature.

A radiation shield is placed over the Cold Head, heat exchangers, and instrumentation to cut down on any radiative heat load that will change the sample's temperature.

The vacuum shroud is then placed over the Cold Head and will act as an insulator between the Cold Head and ambient room temperature. The shroud will ensure that ice does not build up on the cooler.

Once these items are assembled to the Cold Head of the Cryocooler system, the rest is up to the Cryocooler. The Cryocooler will cool the sample to a specified temperature range.

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Component Description

Radiation Shield – helps remove radiant heat load from your sample.

Vacuum Shroud – insulates the Cold Head from room temperature. A variety of designs were engineered to readily adapt to standard laboratory experiments. Most shrouds are designed custom specific to handle the researcher's experiments. The vacuum shroud is equipped with a vacuum port, multiple instrumentation ports, and a relief valve.

Glass Sample Area – used to hold and examine your sample.

Instrumentation – one or multiple sensors, diodes, or thermocouples used to accurately measure the temperature of your sample. Most instrumentation is customer specific depending on the experiments temperature range and environment. The instrumentation sometimes includes extra leads used later by the researcher for specialized testing of his or her sample. **Cernox sensors are used in this particular interface due to the magnetic signature in the customers' experiments.**

Temperature Controller – It inputs temperature readings of your strategically placed sensors, diodes, or thermocouples. It also has features that can be used to control the temperature of your sample region. This instrument can be externally programmed as part of an automation setup.

Cryocooler - this is the engine of the system. It consists of a cold head, a compressor, and flex lines that allow the gas to travel from the compressor to the cold head.

> **Cold Head -** this is the cooling part of the Cryocooler system. It removes heat from the compressors incoming gas by expansion through an internal displacer. The displacer is filled with regenerative material that also helps with the cooling of the gas.
> **Compressor-** is part of the cryocooler system which cycles helium gas to and from the cold head. It contains an absorber which is used to filter out impurities from the gas which may cause cool down problems for the cold head.

Vacuum Pump – used to insulate the Interface from the cryocooler. For the standard O-ring Interface a small mechanical pump can be used to pull 10E-3 Torr of vacuum. For the UHV Interface a turbo pump is used to pull vacuum in a much higher range.

External Helium Gas Bottle – is used as a cooling source between the cold head and the interface. Helium gas should be 99.999% pure. The bottle must have a 2 stage regulator that regulates 2500 psi to 0-2 psi for regulating 0.5 psi pressure in the low vibe interface. You can use a less precise gauge such as a needle valve and finer adjustment pressure gauge, but you will have to constantly regulate the 0.5 psi pressure throughout the entire cool down period. The 2 stage regulator will allow you to set the 0.5 psi pressure without maintaining it manually.

Specifications:

Model#	Type	2nd stage capacity		1st stage capacity		Highest Temp.	Cool down Time
		50 Hz	**60 Hz**	**50 Hz**	**60 Hz**		
4K Cryocoolers							
SHI							
RDK-408D2	4K GM	1.0W @ 4.2K	1.0W @ 4.2K	40W @ 43K	50W @ 43K	325K	<60 min. to 4.2K
10K Cryocoolers							
SHI							
CH-204 / DE-204	10K GM	6.7W @20K	8.1W @20K	13.5W @80K	16.2W @80K	350K	30 min. to 20K
CH-210	10K GM	6W @20K	6W @20K	110W @77K	110W @77K	350K	35min. To 20K
CH-210 N	6.5K GM	7 W @20K	7.5W @20K	86W @77K	88.5W @77K	350K	30 min to 20K

- NOTE: The information provided above is for the bare cooler only. Any additional mass that is added such as a sample holder, sample, instrumentation, etc. will add to these specifications.

- NOTE: The performance of the 2nd stage for a CH-210 and SDRK-408 increases with a heat load on the 1st Stage

- NOTE: The capacity data will improve during the interface cool down because of the added load of the heat exchangers on the 1st stage.

Orientation:

Any position, system will be mounted horizontally in to the magnet

Materials:

Non-Magnetic 304 Stainless Steel
OFHC Copper
Brass
Soft and Hard Solder
560 Braise

Operating Pressures:

Vacuum Pressure:

Standard O-ring => 10E-6 Torr is achievable with any O-ring design, however, 10E-3 Torr vacuum is all that is needed to properly insulate the system.

Relief Pressure:

All interfaces are designed with a 1 psi relief valve in case pressure would build up in the vacuum shroud. A 150 psi relief valve is added to the gas supply circuitry to protect the sample from over pressure.

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Unpacking

The Wave Guide Interface components are normally shipped assembled in the same carton as the Cold Head. Below is a table of the packaging size and content for your convenience.

Packaging	Contents
40 x 24 x 40	CH-210, CH-210N, SDRK- 408 Coolers with Bruker Wave Guide interface and Oxford Mercury Controller
28 X 28 X 7	¾" x 10, 20, or 30 ft Helium Gas Lines, Installation Kit, Misc. Items
24 X 26 X 32	F-70 Compressor

- NOTE: The above packaging is for a standard Bruker Wave Guide interface, as per CE drawing p/n 120108 (10K WG), and p/n 120110 (4K WG).

- NOTICE: Handle the Cold Head carefully so the instrument leads are not bent or broken. **Shipping cap should always be used when the system is not in use. The shipping cap is vacuum sealed so vacuum can be pumped on the interface when not in use to keep the system clean.**

- NOTICE: The interface is put on the Cold Head before shipping to ensure the safe arrival of the Cryocooler. The interface is much more durable and can withstand more of the hardships of shipping.

- NOTICE: Please check that all parts are present from factory. Refer to the packing list for an itemized bill of material. If any part is missing, or you are unsure about parts that was sent please contact the service department (techsupport@coldedgetech.com) with questions.

- NOTE: Please keep all packaging so that the system can be returned for maintenance or repairs with proper packing requirements. COLDEDGE Tech will not be held responsible for damaged shipments if it is not packaged properly.

2

Set-up

1. Remove the shipping cap and replace with Bruker's Wave Guide glassware.

   - NOTE: The system is shipped under vacuum. To remove the shipping cap you will need to open the vacuum valve and evacuate.

   - NOTE: Apply a small amount of Apezion N grease around the brass bushing and "hour glass" piece. This will help to keep the gas flow over the sample.

   - NOTE: Cover the glassware before installing into the magnet with protective outer sleeve. Install each part of the sleeve individually to make sure o-rings are making a good seal around the glassware.

2. Mount the Cooler Front End Bracket to the Interface. Replace the (4) M5 screws with the screws provided with the bracket.

3. Secure the bracket mounts to the magnet.

   a.) Bolt the Cooler Interface block to the bracket mount on the front of the magnet using the (2) M8 bolts provided.
   b.) Mount the Rear bracket base to the back bottom cross bar of the magnet. Tighten the (2) M8 bolts to secure to the magnet frame.
   c.) Using the M10 threaded rods with square nut, slide the square nuts into the slot on the rear bracket mount.
   d.) Place the Support Bracket on the bolts and tighten fast to the rear bracket mount.

   - NOTE: The Support Bracket can be adjusted for height if needed by adjusting the hex nuts to the desired height.

4. Securely mount the Cold Head to the stand to support the weight of the interface.

   - NOTE: Insert the Cold Head into the magnet, such that the Cooler Front End Bracket sits on the Cooler Interface block (use the M5 bolts to secure it), and the Cold Head motor base is supported on the Rear Bracket assembly.

   - NOTE: Once the cold head is properly supported in the stand, securely fasten the cold head to the stand using the strap provided. Simply tighten the strap to the Rear Bracket assembly. It should be tight enough such that the cold head is not freely moving.

   - NOTE: The stand can be adjusted for height by the M10 rods on the back rear bracket, and the M5 screws on the interface block in the front of the magnet.

5. Insert a glass sample tube into the Wave Guide glassware

- NOTE: Once the glass tubing is inserted into the sample space, slide the top hat piece of the Wave Guide glassware over the sample tube. Hand-tighten the fitting so that it vacuum seals the glassware to the rest of the system.
- NOTICE: Do not over-tighten the fitting you can risk breaking the glass tube.

6. Connect a temperature controller to the interface.

- NOTE: The controller cable is labeled to match the sensor curves.
- Install the Heater Block/Heater connector into the MB sensor slot on the Oxford Mercury Controller. Install the Gas connector into the DB.6 slot on the Oxford Controller.

- Please note that the sensor curves are pre-installed and paired with the proper heater.

7. Connect the vacuum pump to the NW25 port on the Interface, turn the pump on and begin evacuating the Vacuum Shroud.

- **NOTICE: This system should be run with a turbo molecular pump ONLY.**

IF YOU ARE USING A RECIRCULATION SYSTEM, please refer to APPENDIX A of this manual for further instructions using the Recirculator.

8. Connect the GAST pump (provided) **INLET** to the **PUMP IN** on the Flow Assembly via 6mm tubing provided (cut to length as needed). Then connect the **RETURN** on the Flow Assembly to the **RETURN** on the interface. Open the needle valve and turn on the GAST pump to begin evacuating the internal exchangers.

- **NOTE: The Flow Assembly is a good tool to help check for leaks on the glass ware. Once connected as directed above, close the needle valve. If the vacuum maintains it is safe to conclude the glassware is leak tight. If the vacuum degrades check the glassware for leaks before continuing.**

Cool Down Operation

Evacuation of the Vacuum Shroud:

The Interface may take 30 minutes to 1 hour to pull to the vacuum level needed. As suggested in the Set-up section of the manual, it is always good practice to check the rate of rise before turning the system on to cool down.

- NOTE: Never turn the system on before 10E-3 Torr of vacuum is achieved. The Interface will ice up inside the shroud and your cool down time will be impacted significantly.

Checking the shroud for leaks before running the system is also good practice. Spray all joints with Isopropanol and watch for a spike in vacuum. If spraying Isopropanol over any joint causes a spike in vacuum, you know that you have a small leak. Re-grease o-rings and recheck.

- NOTE: Any debris on the O-ring or inside the O-ring groove will certainly cause a leak path and will be noticeable as this particular vacuum level.

Purging the Interface

Before turning the system on you will need to purge the interface to remove any air that is trapped inside the glass sample area.

Ready the external gas cylinder to supply a ~100 psi/7bar/69KPa of pressure.

- NOTICE: To safely and properly regulate the gas flow, you will need a two stage regulator. The first stage will be for the high pressure inside the cylinder. Depending on the size of the gas cylinder this stage could have to regulate up to 3000 psi. The second stage should be for finer pressure adjustment (0-200 psi).

Connect the gas cylinder to the 6mm quick connect tube fitting on the **SUPPLY** of interface. Open the **RETURN**/exhaust valve ***FIRST*** followed by the **SUPPLY** valve.

- **NOTE: The quick connect fittings are designed to accept 6mm plastic tubing without having to wrench or tighten the fitting. Simply push the plastic tubing into the fitting until it can go no further. To check if it is inserted correctly, try to pull the tubing away from the connector. If it is connected correctly you will not be able to remove the tube without pressing shoulder part of the connector.**

- **NOTE: To remove the tubing, press the shoulder part of the connector completely flush with the connector and pull the tube away from the connector.**

Once all the **SUPPLY** connections are made*, purge the system for an hour before starting the interface*. **This will help to push any air or contaminates out of the exchangers and greatly reduce the chances of a gas blockage during cool down.**

- **NOTICE: If you open the supply valve on the WG before the return you will blow the glassware out of the system.**

Cool Down:

When you have completed the set-up section of this manual, and are ready to cool down your sample, turn on the Cryocooler following the instructions provided in the manual.

NOTE: Follow the Cryocooler's manual for instructions on how to install the Cold Head, Compressor, Gas Lines, and make all necessary electrical connections.

NOTICE: Make sure that you are properly following the electrical specifications for the compressor.

WARNING: Follow all of your research facility's safety instructions when working with electrical components to avoid electrical shock.

WARNING: Be sure the work area is well ventilated when working with helium or nitrogen. They can cause suffocation.

Once the compressor is turned on, you will here the Cryocooler begin to start pumping. The Cryocooler will take approximately 60 minutes to cool down depending on the model (some will take longer, some may require less time). Depending on the mass of your sample, it may take more time for the Cryocooler to cool the sample. Remember in this particular interface the Cryocooler is cooling specially engineered heat exchangers, and the gas purge through the heat exchangers are cooling the sample, so it is normal for the system to take longer than the cooler specs provided earlier in the manual.

If you are using a turbo pump, closing off the vacuum is not necessary continue pumping while the system is running for optimal vacuum performance.

Continue purging the helium at ~100 psi (7bar, 69KPa) of pressure throughout the entire cooling process. You will notice that the sample temperature will significantly lag the heater block temperature until the system is <100K in which the sample temperature will rapidly speed up.

- NOTE: The WaveGuide system has a certain sweet spot pressure for the JT effect (~100 psi/7bar/690KPa for the 4K, and ~120 psi/8bar/830KPa for the 10K) to work at optimal conditions.

- **NOTE: It is best to measure the flow of the system on the exhaust/return side of the system. The optimal flow of the helium purge (~100 psi/7bar/69KPa) through the system is 5Lpm @ min temp.**

- NOTICE: Never run the heater while the Cryocooler is in ambient conditions. You will cause harm to the Cold Head.

Controlling the gas purge

The gas purge can run at a variety of different settings according to the temperature you would like to run the system, and the amount of flow you want at the sample.

Generally the system should start with 100 psi/7bar/690KPa, however, at temperature set points above minimum temperature you may have to change the pressure to control the temperature delta at the sample.

- NOTE: Tweaking the gas pressures will not hurt the cooler. These values are suggested, however, you may find that a certain pressure works better than others.

- NOTICE: **The system MUST maintain some positive pressure during cool down and a minimum flow rate of 0.5Lpm.** Failure to do so will cause a blockage in the exchangers. No physical damage is done, however, you will need to warm the cooler back to room temp and begin testing again if this occurs.

Changing a sample:

Unlike a sample in vacuum system, the EPR interface allows the user to quickly change samples without having to warm the system up and break vacuum to get to the sample area. The sample is usually inside of a small test tube that gets inserted into the Ultra-Torr fitting at the end of the glass sample area.

To change a sample, close the needle valve on the Flow Assembly so that you will not pull moisture into the system. Loosen the Top Hat fitting on the protective glassware outer sleeve and slide the test tube out. Make sure that a new sample is inserted immediately, or that a blank tube is inserted until the new sample is ready. **DO NOT leave the glass sample area exposed without a test tube for a long period of time, or the glass will frost and start to ice up.**
While changing a sample it is important to have a purge of helium at all times so that an ice plug does not form in the system.

- **NOTICE: The Flow Assembly relief valve should pop and allow all overpressure of helium to evacuate the system during the sample change.**

Temperature control:

- **NOTICE: Please refer to the proper temperature controller's manual for basic temperature control.**

Controlling the temperature accurately at the sample will be dependent on the heaters power adjustment supplied by the controller, and control of the gas flow.

ColdEdge has found that make adjustment to the pressure during the heating process greatly helps the stability of the system. ColdEdge recommends using less flow at higher set points to accurately stabilize the temperature.

A heater block is added to the system AFTER the JT to heat the gas flow into the sample. A sensor has been added to control the heater block**. This is the recommended sensor for controlling the temperature of the sample.**

Because this heater is not attached to the cooler rather it heats the gas stream as it passes through, it will only take a small amount of power (<7Watts) to control the temperature from 4K-300K.

Shut Down:

Once all your experimental measurements are made, you can close off the SUPPLY side valve (and remove the helium purge), BUT allow the RETURN/exhaust side to remain open and run the GAST pump while the system is sitting idle. Keep the glassware closed to moisture.

Follow the manual for shutting down the cryocooler.

NOTICE: Make sure you turn the heater off on the controller before shutting down the Cryocooler.

Allow the cold head to warm up on its own. Opening the vacuum while the system is still cold will cause it to ice up, potentially damaging the sensors. Once it warms above 200K, you may purge the vacuum with nitrogen to speed the warm up process.

NOTE: For faster warm up, you can use the temperature controller to heat the system up to room temperature. If you decide to heat the system up like this, again, make sure the Cryocooler is running at all times. Allow the heat to stabilize for 15 or 20 minutes at room temperature then shut the temperature controller down along with the Cryocooler.

You may keep a small gas purge while the system is warming to room temperature. This will assure that moisture does not collect in the heat exchangers.

Once the system reaches room temperature close both valves, and keep glassware closed to prevent moisture/air from entering the system.

- NOTE: An inline filter on the external plumbing has been added, along with cold filters on the plumbing inside the system, to prevent debris from entering the exchanger.

- **NOTICE: It is critical to keep moisture from entering the system both before and during the experimental runs. A small amount can cause issues. Always use 99.999% (Ultra Pure) Helium when running and/or purging the system.**

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Maintenance

Sample Space Glassware

If the vacuum jacketed glassware in the sample space should be broken or damaged, it can easily be changed by unscrewing the knurled aluminum fitting that holds the housing that accepts the glass tubing samples. Once removed, the vacuum jacketed glassware will be exposed. The glassware is sealed on a series of o-rings inside the extension piece of the vacuum shroud. Simply pull the glassware towards you.

- NOTE: The Quartz Dewar Assembly comes apart in (2) pcs so that you have better access to the entire glassware section, including the o-rings.

- NOTICE: **DO NOT** push or use any type of tools on the glassware. This will break the tubing.

- NOTICE: Be aware of the smaller "hourglass" tube that sits inside the vacuum jacketed tube that holds the sensor in place. **This piece tends to fall off once the vacuum jacketed glassware is removed.**

Make sure the OUTSIDE of the new vacuum jacketed glassware is greased slightly with vacuum grease before it is inserted back into position.

Removing Blockages

Small blockages may occur if moisture becomes trapped inside the exchangers. To avoid this make sure that you induce a small purge ***AT ALL TIMES*** while the system is operating.

If a small blockage occurs, allow the system to warm to room temperature. Purge the interface with nitrogen (best case) or helium for 30 minutes. While purging, connect a plastic tube to the exhaust side (make sure the supply valve is open) and dip the tubing into a beaker of water to assure that you have flow moving through the system.

- NOTE: If you do not see flow, make sure that the sample well is completely shut off, such that it is not escaping through the glassware.

If the blockage still occurs, remove the sample tube and pressurize the exchangers with up to > 100 psi to try and force the debris/contaminates through the exchangers and out of the sample well.

Once there is flow through the system, continue the purge for at least 1 hr while pumping with the GAST pump on the RETURN/exhaust side. Make sure the glassware is closed off so that no moisture is allowed to enter the system.

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Troubleshooting

This list is meant for logical solutions to problems that could be occurring. If there is a problem that's occurring that is not on this list, or you are not having success diagnosing the problem please contact the COLDEDGE service department immediately.

Problem	Cause	Corrective Action
Interface isn't making Minimum temperature	helium purge is not sufficient	100 psi/7bar/69KPa is required. Verify 5Lpm Flow
	Insufficient vacuum shielding in the Vacuum Shroud	System must be pumped to 10E-3 Torr before operating the system.
	Instrumentation not properly set	Check connections according to the manual. Verify sensor curves and sensor type. Refer to manual for help.
	Improper flow at Sample	Grease Brass Bushing and Hour glass piece. Make sure sample glass tube is seated on hour glass piece properly.
	Sensor not thermally placed at the sample	Make sure that the sensor is directly over the gas nozzle
System taking longer than 60 minutes to cool	Helium purge is insufficient	100 psi/7bar/69KPa is required.
Shroud icing or sweating	Vacuum leak	Check joints and oring sealing areas for leaks. One method to try is by spraying isopropanol around the joints

		and oring areas and watching the vacuum gauge for a rise. If the vacuum rises you found a leak point.
Sensors reading “--/---,” “Tover, Tunder,” or “1.2K”	Sensors grounded	Verify that the sensors are not touching a screw or some other part of the cryostat that is grounded out.
	Sensor curve not Selected	Refer to the manual in Section 4 (Set-up) for help
	Controller cable connections not properly connected	Refer to the manual in section 4 (Set-up) for help

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Ordering Parts

Parts can be ordered directly from COLDEDGE Technologies. All parts are stocked and ready for shipment. Ordering parts can be done via the following:

Purchase Orders

If you choose to order using a purchase order, contact a COLDEDGE representative for a quote.

Be sure that a purchase order for parts includes the following information:

- The quantity desired, part number, and part description.
- The shipping address and the desired method of shipping.
- A purchase order number and the Companies billing address.
- A contact name with either a phone number or email address.

Purchase orders through COLDEDGE Technologies have net terms of 30 days.

Online Orders-COMING SOON!

Ordering parts can now be made easy by ordering through COLDEDGE Technologies online shopping store.

Simply click on the service tab and then click on the product that you require parts for. On each products page, there is a full list of parts with a picture helping identify the specific parts you might require. Click on the part to add to your shopping cart of items.

To checkout you will need a major credit card, either Visa or Mastercard. Enter your credit card information and your desired shipping method.

Items ordered before 4 pm will be shipped that day.