ATF
NOV. 2008

IRLabs

Infrared Laboratories

Advanced Components for Advanced Research

Detectors	Dewars	Electronics
Cameras	Refrigerators	Optics
	IR Emission Microscopes	

SPECIAL OPERATING INSTRUCTIONS

SUPPORT ROD ADJUSTMENT PROCEDURE

Proper adjustment of the three support rods is extremely important as the optical alignment and thermal integrity of the system are affected. The following procedure is recommended:

1) Unpack the dewar and remove the shipping hardware according to the enclosed unpacking instructions.

2) Gradually tighten the 6-32 nuts on the support rods until the cold work surface appears to be centered within the radiation shield.

3) With the window of the dewar removed, check the alignment of the optical path. The optics on the cold work surface should be centered within the baffle tube.

4) Insert the filter wheel control rod to insure that it is on line to engage the coupler. Make any necessary adjustments.

5) Once the optical components are aligned and the support rods tightened, attach the radiation shield lid. Make sure the "W" stamped on the lid is lined up with the one stamped on the shield rim.

6) Attach the bottom plate of the dewar, making sure that:
   a) the o-ring is seated properly and free of any debris and
   b) the numbers stamped into the plate line up with those on the dewar case.

7) Check that the optical path is well centered in the window hole in the dewar case. Adjustments are made by re-positioning the plates on the radiation shield lid that receive the support pins on the bottom plate. When everything looks right, re-attach the window. The dewar is now ready for pumping.

BOLOMETER SYSTEM TROUBLESHOOTING

There are three main components in the system to check: the bolometer/load resistor circuit, the cooled JFET module, and the preamplifier. Performing these series of checks should isolate the problem of no (or low) output signal.

1) WITH SYSTEM AT ROOM TEMPERATURE
   a) Connect an ohmmeter to the BNC jack marked "BIAS TEST" on the preamplifier box (all switches should be in the OFF position). The resistance should be the value of the load resistor. This is normally 10 MΩ for 4.2K bolometers and 20MΩ for 1.6K units.
   b) Connect a voltmeter to the BNC jack marked "Vs" and turn the main power on. The value should be between 0.6 and 2.0 volts and stable. If you are running two bolometers from one preamplifier, check both switch positions.

2) WITH SYSTEM COOLED TO OPERATING TEMPERATURE
   a) Repeat step 1a above. With the bolometer cold, its impedance should be in the megaohm range, so the total resistance at BIAS TEST should be 15-25 MΩ depending on background conditions.
   b) Repeat step 1b above. The values at Vs should be similar, but lower.
   c) Check that the voltage at Vs changes when the "BIAS ON" switch is turned on. The change should be large for a 4.2K bolometer, small (but measurable) for a 1.6K bolometer.
   d) Connect the "OUTPUT" of the preamplifier to an oscilloscope. Select a scale of 20mV/division. White noise should be visible and stable. Turn the "INPUT ON" switch on. After a few seconds, the white noise on the scope should be greater and somewhat jittery (for a 4.2K bolometer). If the window of the dewar is exposed to the room, wave a hot soldering iron in front of it (your hand is OK also). The signal on the scope should react quite dramatically. For a 1.6K bolometer, the same should be true except the reaction to the motion at the window will be much less severe.

If the window of the dewar is not exposed, place your finger over the liquid helium fill port for a second and release it. This should give the same effect.

DUAL SILICON BOLOMETER SYSTEM

BOLOMETERS, CONE OPTICS, FILTERS

The two silicon bolometers, Units **3310** and **3311**, have been mounted in a side-looking configuration with optical axis at 90º spacing in conjunction with cooled Winston cone optics, filters, baffling, electronics and vacuum window.

Detector #3310

The Silicon Bolometer, Unit #3310 (4.2K operation), has been mounted in a side-looking configuration in conjunction with a Winston cone collector, far-infrared cut-on type filters and outer vacuum window. The bolometer itself is of the composite type and features a small Silicon element thermally bonded to a suitably blackened 2.5 mm diameter diamond absorber mounted in a cylindrical cavity. The absorbing layer thickness has been especially selected to minimize fringing effect. The mounting block in turn is bolted to an "L" type bracket which supports the cone exit aperture. The Winston cone features an entrance aperture of 12.7 mm at a focal ratio of 2.44 and an exit aperture of 2.4 mm and has been gold plated to prevent tarnish and improve thermal properties.

The outer vacuum window is wedged white polyethylene.

Detector #3311

The Silicon Bolometer, Unit #3311 (4.2K operation), has been mounted in a side-looking configuration in conjunction with a Winston cone collector, far-infrared cut-on type filters and outer vacuum window. The bolometer itself is of the composite type and features a small Silicon element thermally bonded to a suitably blackened 2.5 mm diameter diamond absorber mounted in a cylindrical cavity. The absorbing layer thickness has been especially selected to minimize fringing effect. The mounting block in turn is bolted to an "L" type bracket which supports the cone exit aperture. The Winston cone features an entrance aperture of 12.7 mm at a focal ratio of 2.44 and an exit aperture of 2.4 mm and has been gold plated to prevent tarnish and improve thermal properties.

The outer vacuum window is wedged white polyethylene.

PREAMPLIFIER

Two Model LN-6C preamplifiers, **#3235** and **3236**, wired for use with the two bolometer detectors have been provided. The LN-6C preamplifiers have been modified to provide three level switchable gains of 1000, 200 and 50.

The LN-6C preamplifier features a dual J-FET first stage mounted on the cold plate. One lead of the bolometer has been brought out to a solder terminal on the rear of the mount with wiring as shown on the cold module diagram. The other lead has been grounded directly to the substrate.

CONFIRMATION OF BOLOMETER CHARACTERISTICS

Confirmation of the bolometer D-C characteristics have been complicated somewhat by the addition of the cooled 1st stage. A suggested procedure is as follows:

1) Remove bias from the bolometer by placing the "bias on" switch in the off position.

2) Connect a 0-40 V well-filtered D-C power supply to the "bias test".

3) Connect a high impedance voltmeter to BNC jack "Vs".

4) With the power supply at "0" volts, measure the offset on "Vs". This reading (approx. 0.8 V) should then be subtracted from all further readings to yield E(B) volts.

5) The current I'B (μa) may then be compared with the data given on the test data sheet for each filter position.

6) Values of I(B) and E(B) may then be compared with the data given on the test data sheet for each filter position.

The 1st stage "J-FET" mounted on the cold plate is configured in a "TIA" mode and requires operating temperature of 60K or more. This is accomplished by mounting the unit at the end of a fiberglass insulating stalk and using a heater resistor to maintain a small current flow. Allow about 15 minutes for thermal equilibrium of the J-FET after power is applied.

DEWAR AND WIRING

The dewar is an Infrared Laboratories Model HDL-5 liquid helium dewar **#4002**. All metal on the cold surface is gold-plated O.F.H.C. copper with the exception of the cone which is gold-plated nickel. The detector wiring consists of 5 mil constantan which comes out to a ten-pin connector on the dewar case.

Excessive frequency-dependent noise can generally be traced to loose or broken supports. These should be tightened modestly tight to prevent the interior can from shaking in relation to the radiation shield or outer case.

The personnel of Infrared Laboratories, Inc. stand ready to assist you if the occasion arises. Please do not hesitate to call on us if you have any problems or questions.

heats dissip.

BOLOMETER CHARACTERISTICS

DATE TESTED: 10/28/2008

UNIT#: 3310

AREA: 2.5mm diameter diamond

FILTER: C103 (103 μm 20% Tx, CUT ON)

TEMP. [K]: 4.2

G [μW/K]=	12.63
Ro [MΩ]=	13.1
S [V/W]=	2.73E+05
NEP[W/Hz$^{1/2}$]=	1.87E-13

DC LOAD CURVE DATA

R-load [MΩ] 10

Vbias[V]	Vs[V]	Eb [V]	Ib [μA]
0.0	0.779	0.000	0.000
1.0	1.347	0.568	0.043
2.0	1.863	1.084	0.092
4.0	2.726	1.947	0.205
6.0	3.416	2.637	0.336
8.0	3.974	3.195	0.481
10.0	4.443	3.664	0.634
12.0	4.841	4.062	0.794
14.0	5.178	4.399	0.960
16.0	5.475	4.696	1.130
18.0	5.736	4.957	1.304
20.0	5.965	5.186	1.481
25.0	6.438	5.659	1.934
30.0	6.799	6.020	2.398
35.0	7.082	6.303	2.870
40.0	7.306	6.527	3.347

NOISE: Vn [nV/Hz$^{1/2}$]

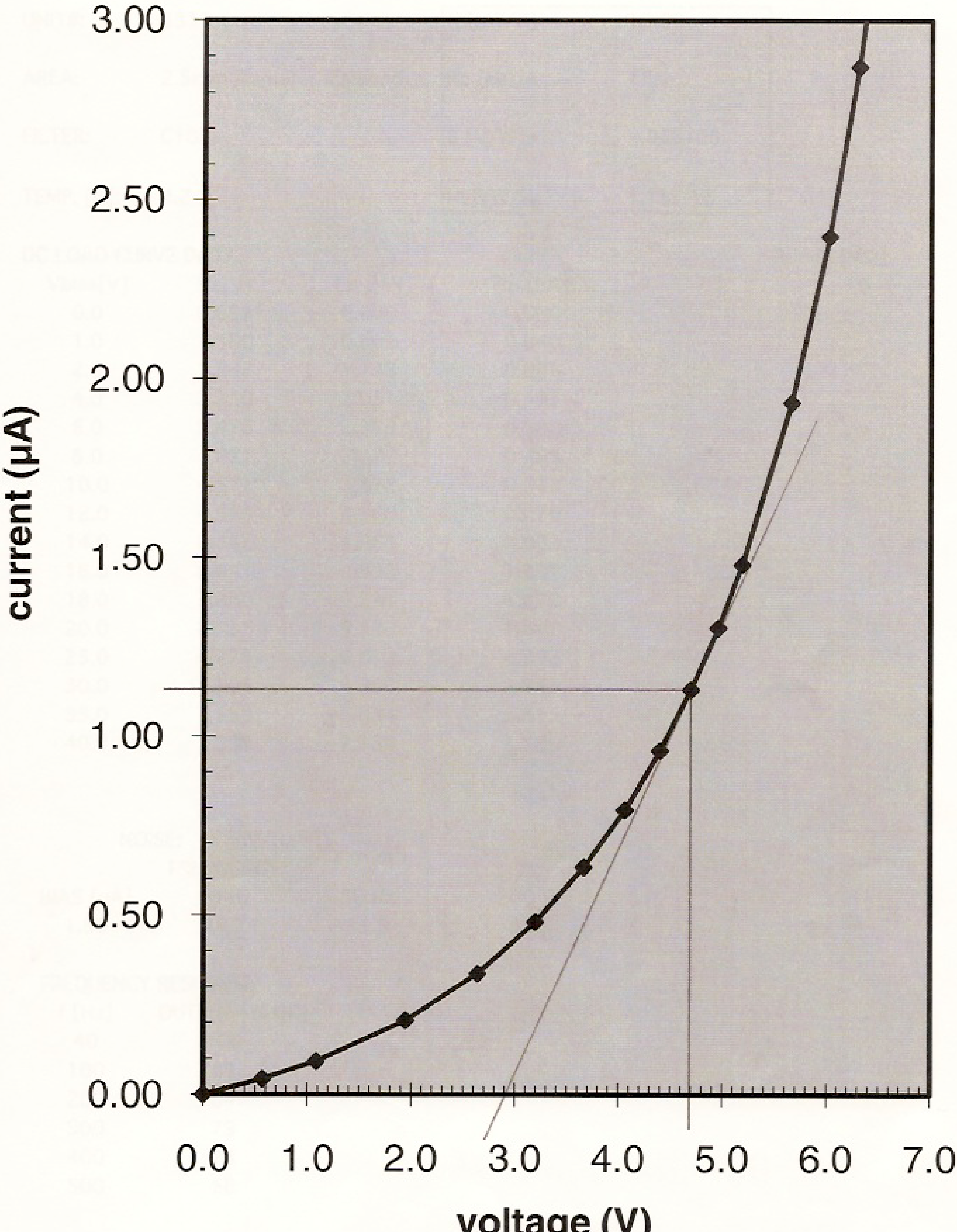
FREQUENCY

BIAS [μA]	20 Hz	80 Hz	200 Hz
1.50	74.9	51.2	37.2

FREQUENCY RESPONSE

f [Hz]	OUTPUT [% DC]
40	100
100	90
200	84
300	76
400	65
500	58

#3310 4.2K



current (μA)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
voltage (V)

BOLOMETER CHARACTERISTICS

DATE TESTED: 10/28/2008

UNIT#:	3311
AREA:	2.5mm diameter diamond
FILTER:	C103
TEMP. [K]:	4.2

G [μW/K]=	13.09
Ro [MΩ]=	15.1
S [V/W]=	2.91E+05
NEP[W/Hz$^{1/2}$]=	1.15E-13

DC LOAD CURVE DATA

R-load [MΩ] 10

Vbias[V]	Vs[V]	Eb [V]	Ib [μA]
0.0	0.699	0.000	0.000
1.0	1.300	0.601	0.040
2.0	1.842	1.143	0.086
4.0	2.750	2.051	0.195
6.0	3.478	2.779	0.322
8.0	4.071	3.372	0.463
10.0	4.571	3.872	0.613
12.0	4.999	4.300	0.770
14.0	5.365	4.666	0.933
16.0	5.691	4.992	1.101
18.0	5.980	5.281	1.272
20.0	6.237	5.538	1.446
25.0	6.778	6.079	1.892
30.0	7.205	6.506	2.349
35.0	7.553	6.854	2.815
40.0	7.838	7.139	3.286

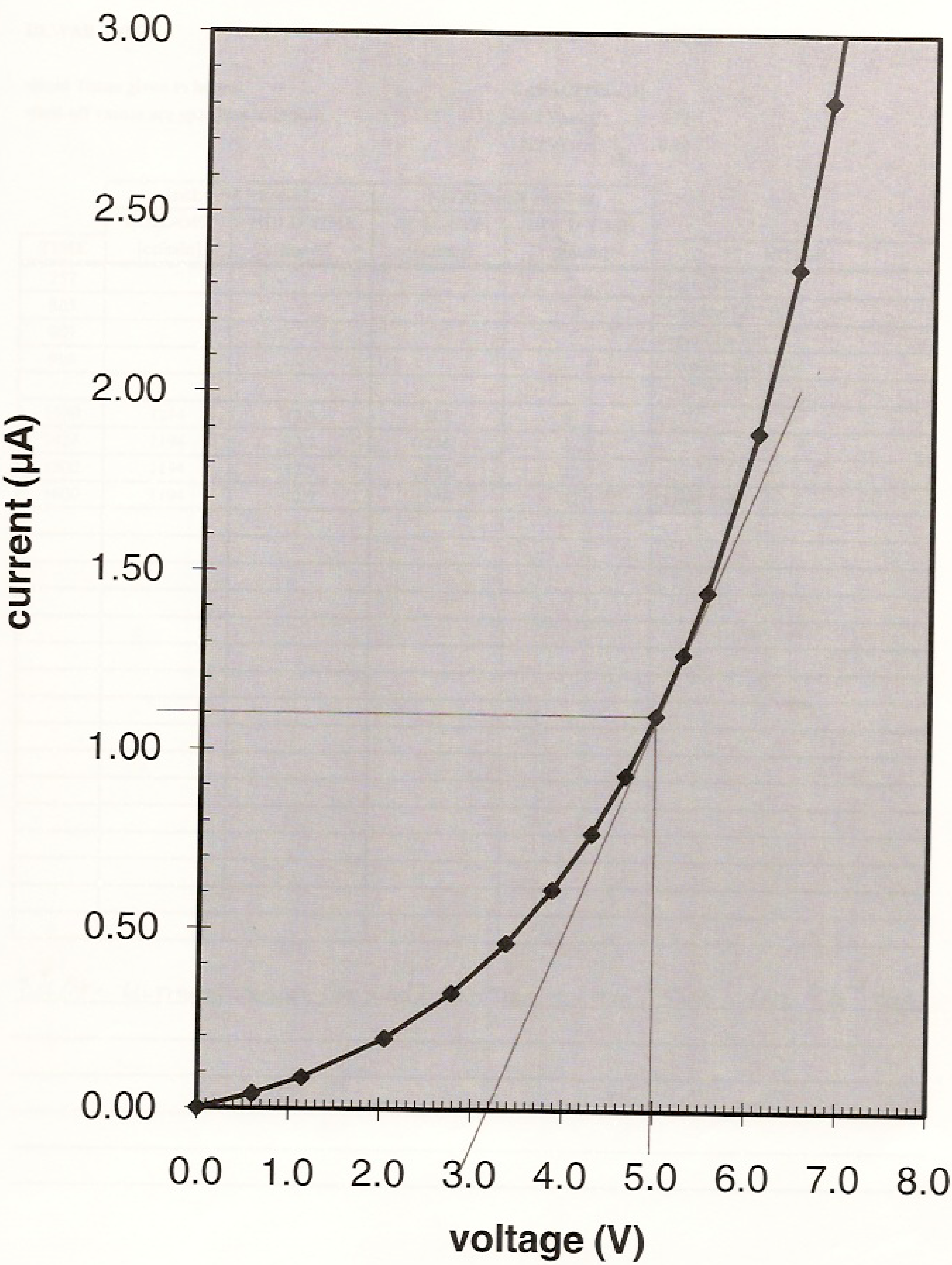
NOISE: Vn [nV/Hz$^{1/2}$]

	FREQUENCY		
BIAS [μA]	20 Hz	80 Hz	200 Hz
1.50	48.7	33.5	32.3

FREQUENCY RESPONSE

f [Hz]	OUTPUT [% DC]
40	100
100	89
200	84
300	79
400	74
500	68

#3311 4.2K



3.00
2.50
2.00
1.50
1.00
0.50
0.00
current (μA)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
voltage (V)

IRLabs
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CRYOGENIC TEST DATA

CUSTOMER: Brookehaven

DATE: 10/30/2008

DEWAR TYPE: HDL-5

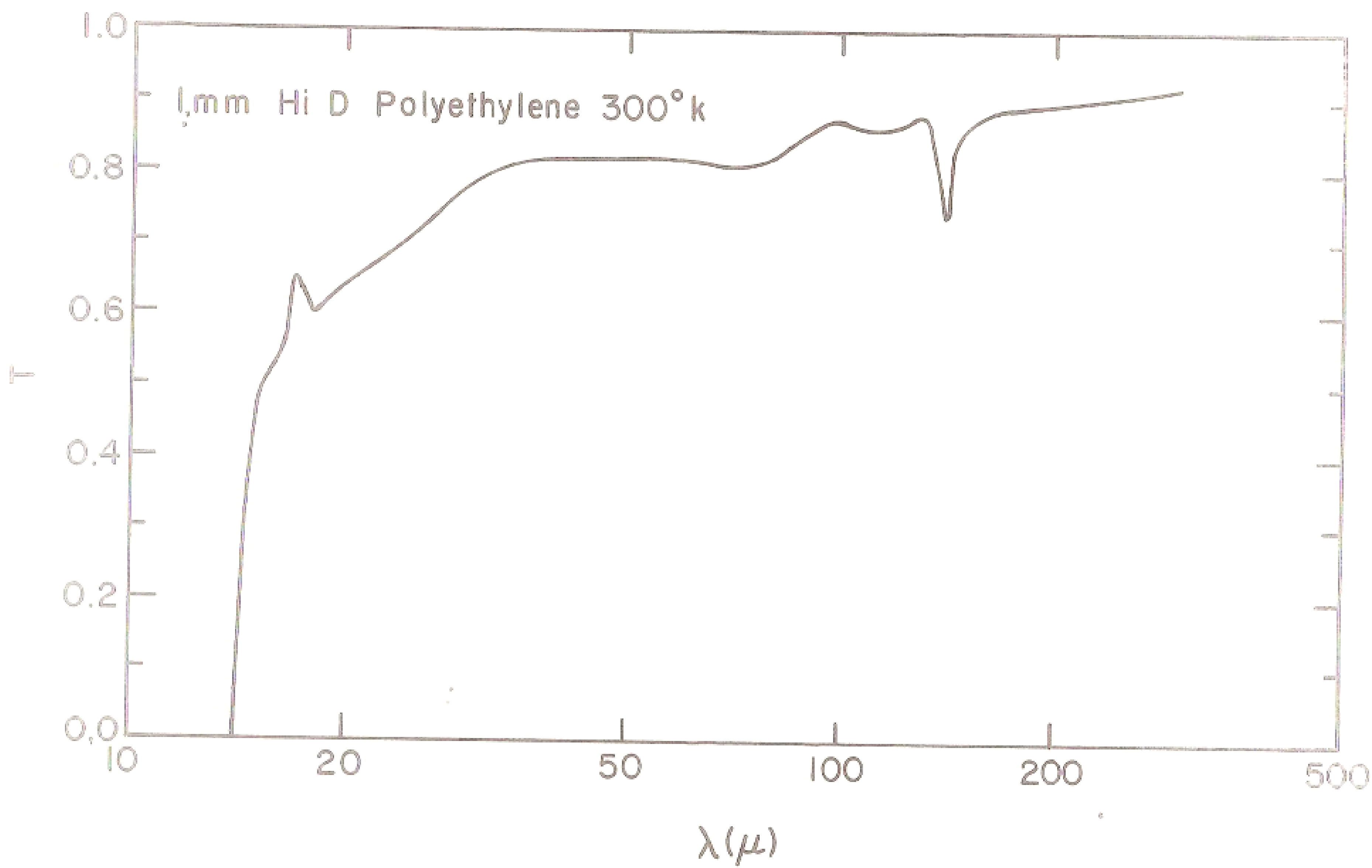
SERIAL #: BRNLSF11Z(4002)

•Hold Times given in hours.
•Boil-off values are specified in cc/min.

CAPACITIES [l]
LHe Vessel: 1.22
LN2 Vessel: 0.90

	HELIUM VESSEL		NITROGEN VESSEL		
TIME	BOIL-OFF [cc/min]	HOLD TIME [hours]	BOIL-OFF [cc/min]	HOLD TIME [hours]	NOTES
757					Begin LN2 Fill
803					Complete LN2 Fill
907					Begin LHe Fill
913					Complete LHe Fill
1330	1244	12.4	202	51.5	
1424	1194	12.9	246	42.3	
1500	1194	12.9	246	42.3	
1600	1194	12.9	246	42.3	Steady state

11/6/08 - ULTIMATE VACUUM (AT TURBO), ROOM TEMP ~ 1×10^{-6} TORR, LN2 $\lesssim 10^{-7}$ TORR.


1,mm Hi D Polyethylene 300°k
1.0
0.8
0.6
0.4
0.2
0.0
T
10
20
50
100
200
500
λ(μ)

DEWAR NOTES AND INSTRUCTIONS

1. Unpacking Instructions

This dewar has been carefully packed for shipment. The following steps are necessary to remove the shipping hardware and prepare the dewar for normal use.

(1) Invert the dewar in a suitable stand for ease of inspection.

(2) Remove all protective tape and packing from the dewar bottom.

(3) Remove all screws from the anodized aluminum shipping plate across the bottom of the dewar. The following order is suggested. First, remove the 4-40 (M-3 for metric dewars) socket head screws securing the 1/4-20 slotted screws. Then remove the1/4-20 slotted screws by holding the 1/4" nut under the shipping plate with a finger and unscrewing the slotted screw. Remove the two 4-40 (M-3 for metric dewars) slotted screws that secure the shipping plate to the outer shield. Lastly, remove the four 8-32 (M-4 for metric dewars) socket screws that affix the shipping plate to the dewar case.

(4) Remove the 5/8" square aluminum blocks from the cold work surface inside the dewar by removing the four 4-40 (M-3 for metric dewars) slotted screws securing each shipping block.

(5) With the shipping plate and shipping blocks removed, carefully inspect the cold work surface and radiation shield for any apparent shipping damage. If your dewar is not equipped with rigid supports, check to make sure none of the support rods are broken.

(6) Install the radiation shield bottom cover using the 4-40 slotted screws (M-3 for metric dewars) provided. Make sure to line up the "W" on the bottom cover with the one on the shield. (The W indicates the location of the weld in the radiation shield.)

(7) Install the bottom plate of the dewar using the 8-32 socket head screws (M-4 for metric dewars) provided. Make sure to line up the stamped number on the bottom plate with the one on the side of the dewar case. For dewars without rigid supports, inspect the bottom plate and make sure the Kel-F support pins are not

damaged, and make sure they are properly aligned with the holes in the radiation shield cover when installing the dewar bottom plate.

(8) Turn the dewar right-side-up (so it is resting with the fill ports upward) and remove the neck rod by unscrewing the nut and knurled knob and lifting the rod straight out.

Your dewar is now ready to use according to the instructions provided by Infrared Laboratories, Inc.

Please keep the shipping hardware in a safe place. It may be necessary to use it if the dewar is transported. Damage to the internal structure of the dewar can occur if the shipping plate is not used.

If any problems arise with the unpacking or operation of your dewar system, do not hesitate to call Infrared Laboratories, Inc. at (520) 622-7074.

2. Model HDL-5 Helium Dewar

The HDL-5 helium dewar features a liquid nitrogen cooled radiation shield to provide extended helium hold times of up to 90 hours at 4.2 K. When pumped, temperatures as low as 1.4 K may be obtained with hold times in the 40 hour range. These features, in addition to the large cold work area and the rugged, all-metal construction, provides the experimentalist with a versatile aid in those cryogenic applications requiring temperatures in the range 1.4 - 4.2 K.

The achievement of the above hold times necessitates a few precautions when installing equipment within the dewar. The 90 hour helium hold time is roughly equivalent to a heat input of 3.5 milliwatts. This is, of course, with all ports closed, but with all supports in place. If a 1 cm^2 aperture is opened in the radiation shield and no solid angle restrictions are placed on the incoming radiation, then an additional heat load of about 50 milliwatts is introduced in the cold area, seriously degrading the hold time. This problem can be alleviated to a large extent by the following means:

(1) Keep the number of holes in the radiation shield to a minimum and of a minimum diameter.

(2) Filters can be placed over the entrance port in the radiation shield if the system spectral response will allow. For example, a quartz filter would reduce the 300 K background by about 90%.

(3) Baffling on the radiation shield entrance port can be utilized if the system optical parameters allow. A short section of blackened tubing will reduce the entrance cone of radiation appreciably.

(4) If rigid supports are not installed, the cold work surface is centered inside the radiation shield and supported by rods fabricated from Kel-F and hollowed out to minimize heat leakage. One spare rod is furnished with each dewar, and additional rods are available from Infrared Laboratories, Inc.

(5) All wiring from the cold work area to the outer electrical plug should be of small diameter (#36-40) and of low-loss material (Constantan or Manganin are very good). Infrared Laboratories can furnish small quantities of #40 Teflon-insulated Constantan wire at no charge if desired.

(6) All material mounted on the cold work surface should be clean with the mounting surfaces in intimate contact. Poor contact will introduce a virtual heat leak with mounted equipment never quite attaining the bath temperature. The use of vented screws is recommended.

The dewar helium and nitrogen capacities are presented in the included Cryogenic Test Data sheet, along with representative hold times. Degradation of these hold times will occur under any of the following conditions:

(1) Poor vacuum caused by a case air leak. Introduction of liquid helium into the inner chamber will provide a low pressure in the vacuum space. A case air leak, in addition to causing an excess helium leak, will degrade the vacuum, especially in the outer chamber surrounding the nitrogen container.

(2) The two pins centering the radiation shield in the outer case have been hollowed out to minimize heat leak; if additional contact is added, then a special effort should be made to reduce the cross-sectional area.

(3) A wrapping of heavy-duty aluminum foil has been placed over various surfaces of the outer case, radiation shield, and inner helium and nitrogen containers. This serves to reduce surface emissivity and increases the nitrogen hold time by about 20% and the helium hold time by about 15%.

(4) All interior surfaces of the dewar should be kept as clean as possible and a vacuum maintained within the dewar vacuum space.

Most components to be cooled can be mounted on the cold work surface through the dewar bottom opening; however, if it becomes necessary to disassemble the dewar to facilitate mounting components, then the following procedure should be followed:

NOTE: All wiring to the exterior connectors on the case will have to be unsoldered before the case can be removed.

(1) Invert the dewar in a suitable stand to facilitate ease of access.

(2) Remove the dewar bottom plate and the radiation shield bottom plate after bringing the guard vacuum to atmospheric pressure.

(3) Stand the dewar upright on a clean surface, loosen and remove the eight bolts holding the main dewar body.

(4) Very carefully remove the inner assembly by lifting it out of the dewar outer case; replace this inner assembly on the dewar stand.

(5) Remove the 12 screws holding the radiation shield to its mount; also remove the three nuts holding the radiation shield standoffs. The radiation shield can now be removed by gently prying upward, being very careful not to exert any sideways thrust. The neck tubing is 0.006" wall thickness stainless steel tubing and is fairly fragile.

(6) The cold work surface is now exposed and can be utilized to its full diameter. To reassemble, simply reverse the above procedure.

If it becomes necessary to drill additional mounting holes in the cold work surface, then the neck tube shipping rod should be re-installed to reduce the possibility of neck tube damage. Holes should be no deeper than 0.250", as the plate thickness is 0.350", tapering to 0.325" at the center.

It is important that the helium pumping device with its built-in safety features be utilized whenever possible. The heat transfer in the neck tube of the dewar is such that it is fairly easy for an ice plug to form in the neck tube itself. The pumping device eliminates this problem by allowing a proper path for the gas to escape.

3. Shipping Hardware

It is very important that the shipping hardware be retained for possible future use (for example, sending the dewar back for repairs or upgrades, transporting the dewar to other facilities, etc.). The shipping hardware secures the internal cryogen vessels and radiation shield so that damage does not occur to these and other fragile components during transport. Each kit is made specific for each dewar, so please keep the hardware in a safe place in case it is needed.

If the shipping hardware is misplaced and a replacement is required, it will have to be purchased by the user for our minimum order charge (currently $150.00). Infrared Laboratories, Inc. will no longer loan or supply replacement kits on any other basis.

4. Pumping the Guard Vacuum

In order to prevent condensation and icing, as well as to ensure reasonably long cryogen hold times, it is imperative that a dewar have an adequate guard vacuum. The interior of the dewar must be evacuated or the water vapor in the atmosphere, and also other substances with boiling points higher than that of nitrogen, will condense on all the cold parts of the dewar, including mirrors, detectors, filters, etc. Even if the dewar has enough of a vacuum to prevent condensation inside the dewar, just a small amount of contamination of the guard vacuum will allow heat transfer from the ~300 Kelvin case to the cold cryogen vessels. This will always result in seriously degraded hold time.

To pump a guard vacuum on a dewar requires a pump capable of pressures down to around 10 mTorr. Although a conventional mechanical pump is sufficient, a turbo pump would be preferable. A pressure gauge reading in the mTorr range is also essential.

(1) Attach the dewar to the pump with a section of rubber hose or an Ultra-Torr fitting. Make sure that the vacuum valve on the dewar is closed.

(2) Turn on the mechanical pump and open the pump valve to pump out the hose attached to the dewar. Allow the pressure gauge to stabilize before proceeding to the next step.

(3) SLOWLY open the dewar vacuum valve. Watch the pressure gauge carefully to see when the pressure jumps, indicating that the valve is starting to open. Continue to open the valve slowly enough so the pressure gauge does not jump wildly to atmospheric pressure. This slow pump-out is done to protect the contents of the dewar from pressure gradients which can cause damage to fragile filters, or cause the foil lining in the dewar to bulge out from the case and shield.

(4) Once the dewar valve is fully open, allow the pump to evacuate the dewar to below 100 mTorr. This may take from a couple minutes to a few hours, depending on the size of the dewar and the amount

of contamination inside the dewar. Heating the case with a heat gun may help drive off any residue of solvents, oils, or water still inside the dewar.

(5) Valve the dewar onto a diffusion pump, if one is available. Make sure the pump's cold trap is filled with liquid nitrogen. If no diffusion pump is available, continue pumping with the mechanical pump. An ideal guard vacuum is at or below 5 mTorr, but pressures below 15 mTorr are adequate.

(6) Fill dewar with liquid nitrogen according to fill instructions. Upon filling with nitrogen, the operator may notice the pressure drop to below 1 mTorr. This is normal, and is due to the rapid removal of vapors within the dewar as they condense onto the cold vessel.

NOTE: It is recommended that the dewar be left on the diffusion pump during filling. Infrared Laboratories nitrogen dewars use charcoal getter to absorb outgas materials and maintain a high vacuum, but the charcoal only becomes effective at temperatures below 150 K. For this reason, it is best to remove nitrogen dewars from the diffusion pump only after they have been filled with LN_2.

Helium dewars do not require charcoal getter because of the cryopumping action of the liquid helium at 4.2 K. However, helium dewars should be left on a diffusion pump during pre-cooling to prevent build-up of excess outgas materials within the guard vacuum. The dewar can be removed from the pump to empty out the LN_2 prior to transfer of LHe.

Because the guard vacuum is so important, every Infrared Laboratories dewar is leak checked and filled with cryogens at the factory to ensure proper operation. However, if the dewar is disassembled by the operator, the potential exists that an O-ring may be contaminated or damaged. If a dewar does not pump down properly, it may have a leak.

A leak can be located by selectively squirting small amounts of acetone on the suspected joints on the dewar, i.e. the connectors, valve, bottom plate, while the dewar is on the mechanical pump. (Take care not to get acetone on fragile windows.) If a leaking spot is hit with acetone, the pressure gauge will jump slightly, then slowly return to where it was before. If an O-ring joint is suspected, careful removal and inspection may reveal a metal chip or a hair in the groove. Cleaning and regreasing of the O-ring and groove should solve this problem. Other leaks may not be as obvious. If you have a persistent leak or other problem, do not hesitate to call Infrared Laboratories, Inc. at (520) 622-7074.

5. Liquid Nitrogen Filling Instructions

The following instructions are to aid the user in transferring liquid nitrogen into an Infrared Laboratories, Inc. dewar. Only persons with experience in handling LN_2 should transfer the liquids. Failure to follow proper procedures could cause severe injuries. Please read the following instructions completely and refer to them until becoming familiar with the operations of the dewar.

Before any dewar can be filled, it must have an adequate guard vacuum. Inadequate guard vacuums cause degraded hold-times, cryogen waste, and poor thermal performance. Refer to the section of the manual that discusses pumping a guard vacuum.

Once the dewar is pumped, it is ready to be cooled or "pre-cooled" with liquid nitrogen. For helium dewars, pre-cooling is an important step that greatly reduces the amount of liquid helium used during transfer.

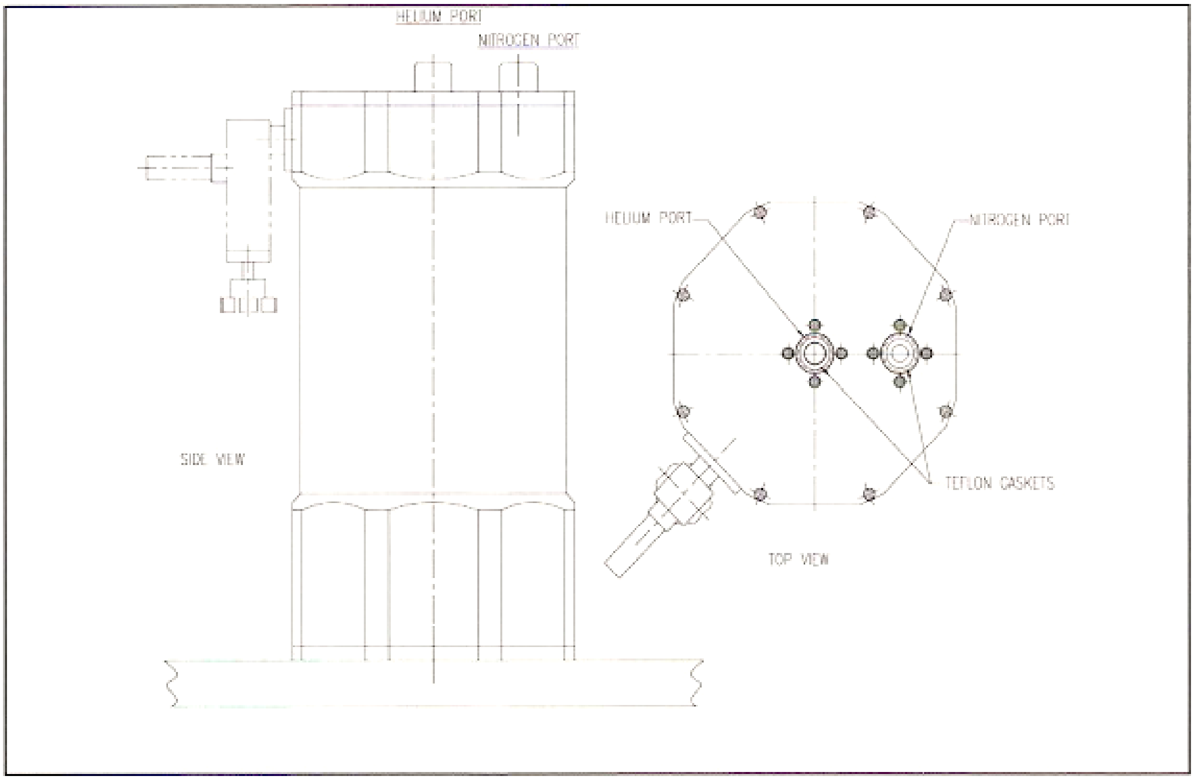


FIGURE 1 – Orientation of Dewar for Filling

(1) Make sure that all control rods (for filter wheels, heat switches, etc.) are retracted so that unnecessary heat will not be injected into the dewar.

(2) Place the dewar upright with the fill ports in the upward direction. Make sure that the Teflon gasket is properly seated into the Helium fill port (the inner vessel for Nitrogen dewars), Figure 1.

(3) Insert the liquid nitrogen fill device, Figure 2, into the Helium fill port and tighten the knurled knob, Figure 3. The raised edge of the fill device should seal on the Teflon gasket.

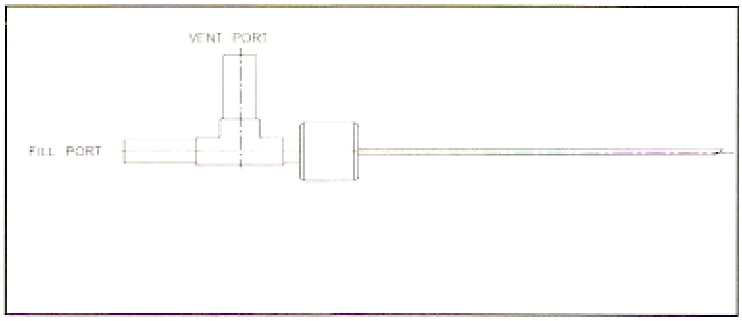


FIGURE 2 – Nitrogen Fill Device

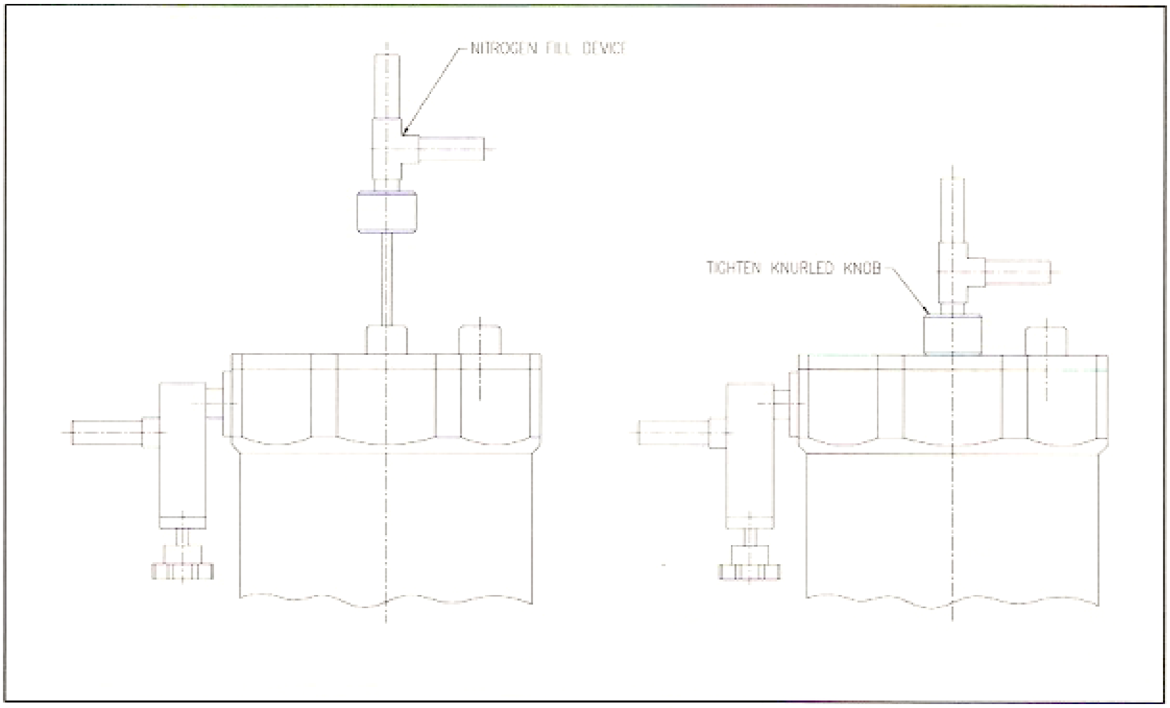


FIGURE 3 -- Installing the Nitrogen Fill Device

(4) Connect a hose suitable for liquid nitrogen service to the fill tube port that extends out axially from the dewar, Figure 4. Surgical tubing of 5/16" ID works well and is easy to use.

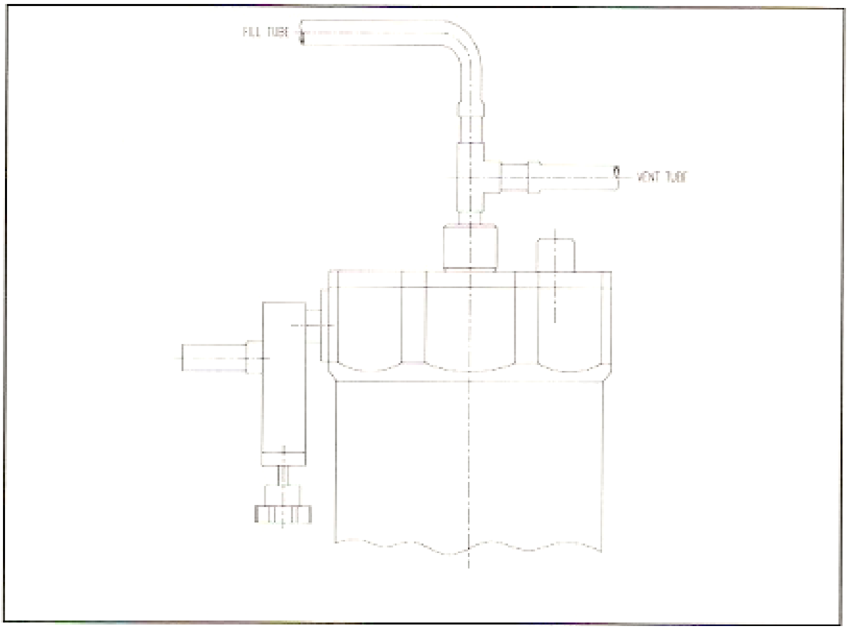


FIGURE 4 -- Filling the Helium (inner) Vessel

(5) Optional. Attach a section of surgical tubing to the fill vent tube, the tube which extends out radially from the filling attachment (see Figure 4). This is done to direct the cold vent gas and, eventually, liquid away from people and sensitive equipment.

(6) Connect the fill hose to a pressurized storage dewar of liquid nitrogen. Open the supply valve to allow the liquid nitrogen to flow into the test dewar. Keep filling the test dewar until there is a steady stream of liquid nitrogen flowing from the vent port. Depending on the size of the dewar, this step should take from 3-20 minutes.

(7) Shut off the supply valve and allow the hoses to thaw. Once the hoses are again bendable, remove both of them from the filling attachment. The attachment can be removed at this time. The dewar inner vessel is now "pre-cooling." Pre-cooling times vary depending on the amount of cooled mass inside the dewar. Refer to the cryogenic test data for your individual dewar to determine the optimum pre-cool time for your dewar.

(8) Insert the nitrogen fill device into the nitrogen fill port, making sure it goes to the bottom of the nitrogen vessel (Figure 5).

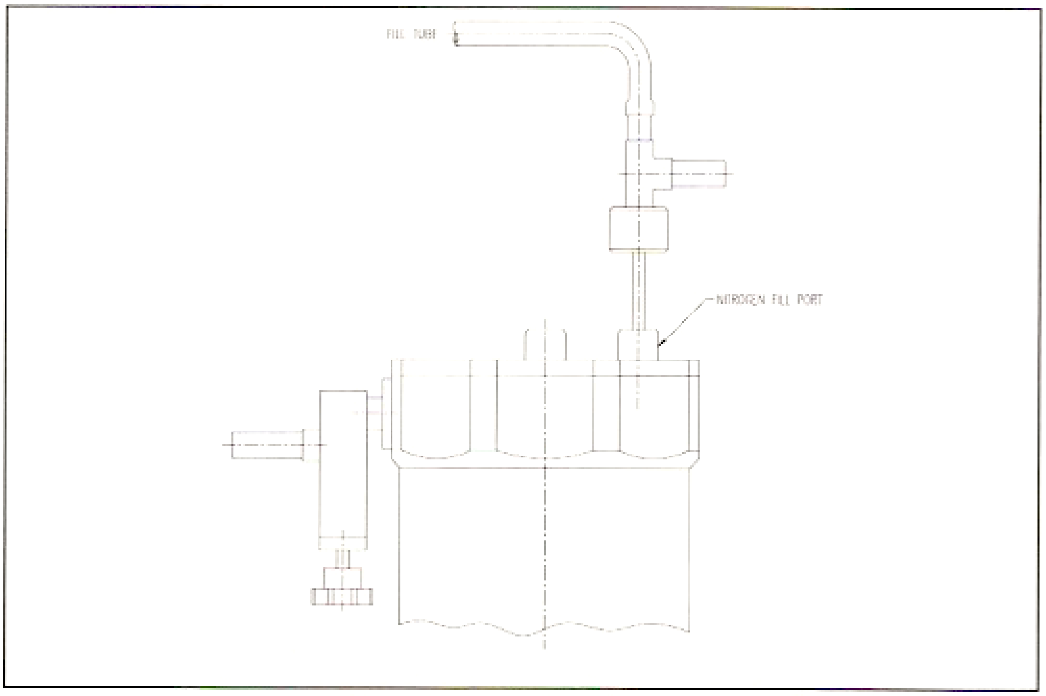


FIGURE 5 -- Filling the Nitrogen Vessel

(9) Connect the hose from the supply dewar to the fill tube. Turn on the flow. The flow may tend to force the fill device out of the fill port until the hose freezes. Hold the fill device in place until it stiffens.

(10) Shut off liquid supply when the dewar is full. Remove the fill device when the hose thaws.

At this point, both the helium (inner) and nitrogen (outer) vessels should be full of liquid nitrogen. All the internal components are being cooled to liquid nitrogen temperature. Liquid nitrogen only dewars should be allowed to reach equilibrium before running a detector. Liquid helium dewars should be allowed to cool to liquid nitrogen temperature. Once this "pre-cooling" is completed, the helium vessel needs to be emptied of nitrogen and filled with liquid helium.

The following steps outline the procedure for preparing the dewar for the transfer of liquid helium. It is assumed that the operator is familiar with the use of vacuum insulated transfer tubes and liquid helium storage dewars.

(11) Reinsert the fill device and connect a hose to the vent port. The hose should be connected to the port that is perpendicular to the fill tube, Figure 6. Connect the other end of the hose to a pressurized source of dry nitrogen gas with a supply pressure greater than 20 psig. A liquid nitrogen storage container may be used.

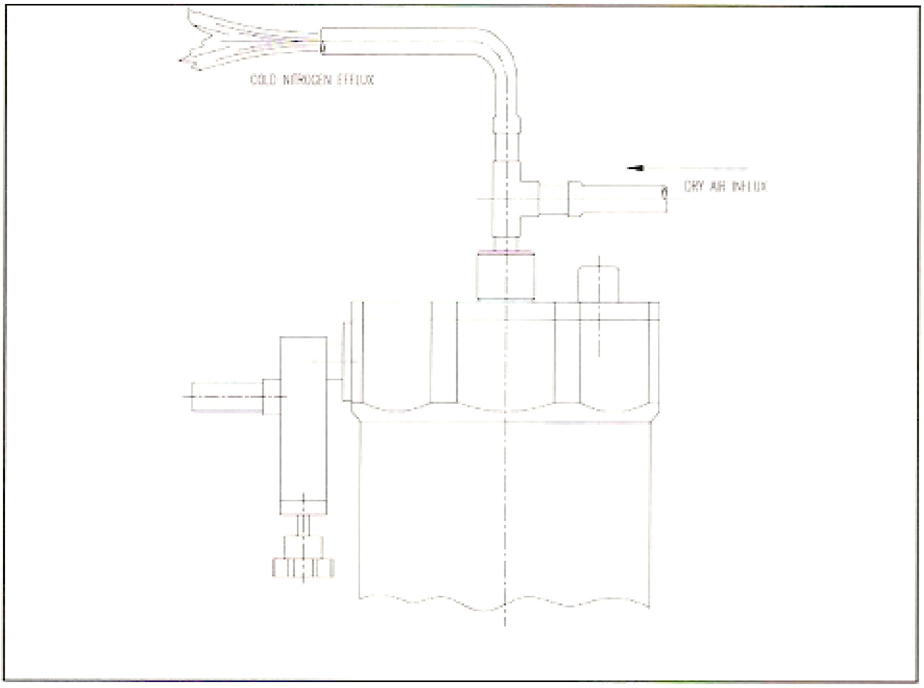


FIGURE 6--Blowing Out Liquid Nitrogen from Helium (inner) Vessel

(12) Slowly open the valve of the gas supply to force the liquid nitrogen out of the vessel. The liquid will exit rapidly from the fill tube port that is axial to the dewar (see Figure 6). A hose may be attached to this port to direct the liquid nitrogen away from people and sensitive instruments, and into an insulated container for reuse.

(13) Continue to blow out the liquid nitrogen until only gas is seen exiting the port. It is advised that you continue to run gas through the vessel for about 30 seconds to make sure that all the liquid nitrogen is expelled or vaporized. Any residual liquid nitrogen left in the vessel could cause problems during liquid helium transfer: the nitrogen will solidify at liquid helium temperature, possibly clogging the transfer tube, and using excess helium for cooling.

(14) When all the liquid nitrogen is removed, loosen the knurled knob and remove the fill port. The dewar is now ready for liquid helium. Instructions for helium transfer are included for helium dewars.

Another method for emptying a dewar of cryogens is to simply invert it so the liquid can run out the port. This is a practical method for small dewars, but difficult for large, heavy dewars. Inverting also allows both vessels to be emptied at the same time, which is an advantage when warming up the dewar. When emptying for a helium transfer, however, the nitrogen vessel will have to be refilled.

Some dewars exhibit peculiar characteristics such as spitting up liquid nitrogen during or just after filling. Some dewars are simply difficult to fill for various reasons. If you have any questions or problems with your dewar, do not hesitate to call Infrared Laboratories, Inc. at (520) 622-7074.

6. Liquid Helium Transfer

NOTE: The usual precautions for handling cryogenic liquids should be followed.*

After evacuation of the case to about 1 milliTorr (1 micron), the dewar should be pre-cooled with liquid nitrogen. A minimum pre-cooling time of thirty (30) minutes should be used, however, pre-cooling for several hours reduces the consumption of helium.

Before transferring liquid helium, all pre-coolant must be removed, either by pouring out the liquid or by transferring it. The helium transfer tube should be flushed with helium gas and slowly inserted into the storage dewar. Sealing the top of the storage dewar traps the evolving helium gas and starts to build up pressure which vents through the transfer tube. When the tube is touching the bottom of the storage dewar, an overpressure of approximately 0.25 - 0.5 psi of helium gas should be maintained. As the transfer tube cools, it should be inserted into the experimental dewar until it almost touches bottom. Rapid efflux of cold vapor continues for several minutes until liquid begins to collect. A sudden drop in blow-off signals that the liquid is collecting. At a pressure of 0.5 psi, a 1.2 liter dewar should fill in about 2 minutes. When liquid reaches the restricted neck, a sudden plume of very cold gas signals that the transfer is complete. The pressure applied to the storage dewar is released and the transfer tube withdrawn. Do not fail to cap the storage dewar or to turn off the supply of helium gas when transfer is complete.

A normal transfer will consume about 2.5 liters of liquid helium and will last about 5 minutes. It is normal for the initial boil-off to be readily visible. As the radiation shield cools, this visible plume will gradually disappear.

NOTE: The power to the preamplifier should be turned on just after the liquid helium transfer is complete to avoid freezing out the JFET on the cold plate.

* One of the several standard textbooks on this subject is Cryogenic Engineering by Russell B. Scott, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1959.

7. Pumping on the Liquid Helium Bath

At sea level, liquid helium boils at 4.2 K. By reducing the vapor pressure above the liquid helium bath, temperatures down to 1.2 K may be attained. Below the lambda point, 2.17 K, liquid helium becomes a superfluid and is quite stable. Figure 7 shows a typical pumping system for pumping on a liquid helium bath.

A slow pumpdown conserves helium. A good indicator is the temperature of the pumping fixture. A small buildup of frost on the fixture is normal, however if frost begins to form on the hose attached to the fixture you are going a bit fast. After about an hour, the lambda point of 38 mm Hg should be reached. Once through the transition, the throttle valve can be opened and equilibrium can be reached in about 15 minutes. This recommended pumpdown time can be shortened to perhaps 45 minutes, but going too fast may simply pump all the liquid helium out of the dewar.

In some pumping systems, thermo-mechanical oscillations may occur and cause the liquid helium to be rapidly consumed. This problem can be solved by increasing or decreasing the diameter of various sections of the system tubing.

A word of caution about air leaks in the pumping system: if air leaks into the plumbing, it will freeze in the neck tube. If the neck tube becomes blocked, the dewar can build up pressure and rupture! Test for air leaks beforehand and always use the safety feature built into the pumping fixture. The re-entrant tube prevents complete blockage of the neck should an air leak be present (see the separate enclosure entitled "Safety Hazards").

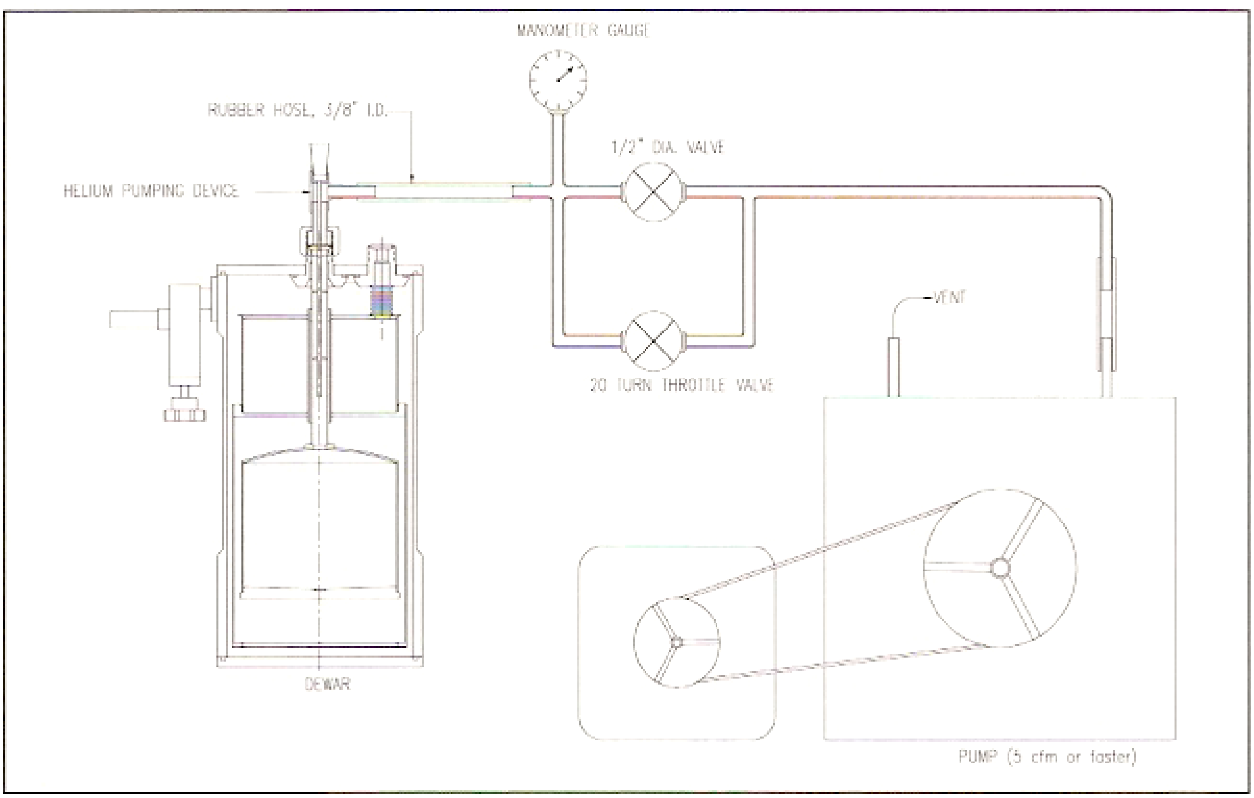


FIGURE 7 – Typical Arrangement for Pumping on the Liquid Helium Bath

8. SAFETY HAZARDS: Ice Plug Formation in the Neck of the Helium Vessel

If an ice plug forms in the neck tube of the helium vessel, the result is extreme pressure buildup and eventually deformation or even rupture. A safety device/pumping attachment has been included with the dewar to reduce the possibility of this occurring. This device should be used even if the helium bath is not going to be pumped on.

Before attaching the safety device, check the teflon washer at the neck tube opening. If it shows signs of excessive wear, or no longer fits in the groove properly, replace it. The safety device can then be inserted and screwed on hand tight, followed by another quarter to half turn with pliers. Check the rubber stopper to insure that it is firmly seated (a very light coat of vacuum grease can be applied if necessary). If pumping is to follow, make sure there are no leaks in the pumping manifold, hose, etc.

When pumping on the helium bath, it is important to monitor the bath pressure closely. If the pressure suddenly drops, or the rubber stopper repeatedly pops out it is a sign that an ice plug has formed. If this happens, discontinue pumping immediately, remove safety device and insert a 1/4" heated copper rod down the neck tube to clear the ice plug (it may be necessary to do this several times before the plug is cleared).

When it is time for the helium bath to be returned to atmospheric pressure, use a source of dry helium gas (if one is available) to fill the pumping line instead of room air. This will reduce the chance of ice plug formation. If the dewar is to be kept cold after pumping, retransfer liquid helium immediately after returning bath to atmospheric pressure and reattach safety device. If the dewar is to be warmed at this time, invert the dewar to remove cryogens. **NEVER REMOVE LIQUID HELIUM FROM DEWAR BY BLOWING OUT WITH COMPRESSED AIR**. Always invert the dewar until all the helium has run out, then compressed air can be used for warming.

9. SAFETY HAZARDS: Guard Vacuum Failure

If the guard vacuum fails, the result is a large quantity of room air being sucked into the vacuum space. This is indicated by a large increase in helium boil off (or if pumping on the bath, a large increase in bath pressure). As the dewar warms, the trapped room air expands and can cause damage to the cryogen vessels and other internal components.

Guard vacuum failure should be dealt with by putting the dewar back on a vacuum pump and leaving it on while the dewar warms. The cause of the failure should then be investigated and corrected before cooling the dewar again.

Silicon Bolometer

Instruction Manual

Infrared Laboratories
1808 E. 17th Street
Tucson, AZ 85719

Table of Contents

General Description

A complete detector system consists of three main parts: the detector mounted on a copper substrate, the liquid helium dewar, and the preamplifier. The preamplifier is bolted directly to the side of the dewar case and is powered by an internal battery supply. This system is mechanically rugged and can be operated under a wide range of environmental conditions and in any attitude within a few degrees of horizontal. The usual precautions for handling cryogenic liquids should be followed.* The case of the dewar is evacuated to forepump pressure (approximately 1 μ) before use. After periods of several weeks, it may be necessary to re-evacuate the case. Access to the detector work surface is obtained by removing the bottom plate of the dewar, which is sealed with an O-ring, and then removing the bottom plate of the radiation shield. A system of internal supports is provided to allow accurate alignment of the cooled surface with respect to the outer case. These supports are the most fragile components in the system. Excessive mechanical shock may fracture one or more of the supports. In order to minimize the possibility of such damage in shipment, the following precautions have been taken. The two bottom plates have been removed and a rigid clamp attached in their place with the internal supports partially loosened. It is necessary to remove the clamp and tighten the internal supports to produce the desired alignment. The two bottom plates may then be replaced according to the enclosed instructions. The case can then be evacuated to forepump pressure and the dewar cooled for operation.

Cooling the Dewar

After evacuation of the case to forepump pressure, the dewar should be pre-cooled with liquid nitrogen or liquid air. A minimum pre-cooling time of five minutes should be used; however, pre-cooling for several hours reduces the consumption of helium.

Before transferring liquid helium, all pre-coolant must be removed, either by pouring out the liquid or by transferring it. The helium transfer tube should be flushed with helium gas and slowly inserted into the storage dewar. Sealing the top of the storage dewar traps the evolving helium gas and starts to build up pressure which vents through the transfer tube. When the tube is touching the bottom of the storage dewar, an overpressure of approximately $^1/_4$ - $^1/_2$ psi of helium gas should be maintained. As the transfer tube cools, it should be inserted into the experimental dewar until it almost touches bottom. Rapid efflux of cold vapor for several minutes until liquid begins to collect. A sudden drop in blow-off signals that the liquid is collecting. At a pressure of $^1/_2$ psi, the 1.2 liter dewar should fill in about 2 minutes. When liquid reaches the restricted neck, a sudden plume of very cold gas signals that the transfer is complete. The pressure applied to the

* One of several standard textbooks on this subject is Cryogenic Engineering by Russell B. Scott, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1959.

storage dewar is released and the tube withdrawn. Do not fail to cap the storage dewar or to turn off the supply of helium gas when transfer is complete.

A normal transfer will consume about 2.5 liters of liquid helium for the HD-3, 5 liters for the HD-3(8), and will last about 5 minutes. It is normal for the initial boil-off to be readily visible. As the radiation shield cools, this visible plume will gradually disappear.

Pumping on the Dewar

At sea level, liquid helium boils at 4.2 K. Most bolometers will be operated below the lambda point of liquid helium at 2.17 K. In the superfluid state, liquid helium is quite stable.

By reducing the vapor pressure above the liquid, temperatures down to 1.2 K may be attained. 1.8 K corresponds to a vapor pressure of about 14 mm Hg, a very desirable operating point. Figure 1 shows the pumping system used for this purpose.

A slow pump-down conserves helium. A good indicator is the temperature of the pumping fitting. If ice forms on the outside you are going a bit fast. After about 45 minutes, the lambda point at 38 mm Hg should be reached. Once through the transition, the throttle valve can be opened and equilibrium can be reached in about 15 minutes. This recommended period of 1 hour can be shortened to perhaps 30 minutes, but going too fast may simply pump all the helium out of the dewar.

In some pumping systems, thermo-mechanical oscillations may occur and rapidly consume the liquid helium. This problem is always solvable by increasing or decreasing the diameter of various sections of the system tubing. This is an annoyance which fortunately is not too common.

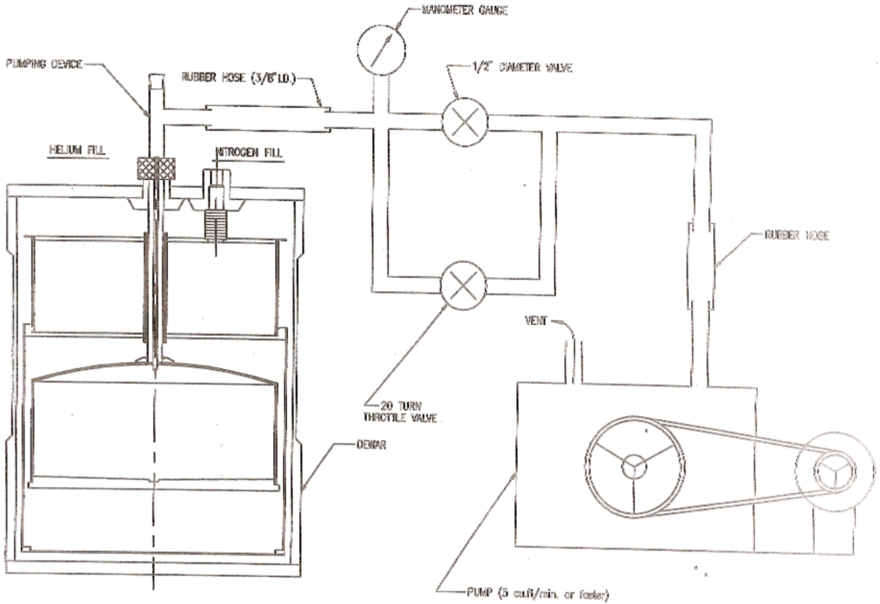


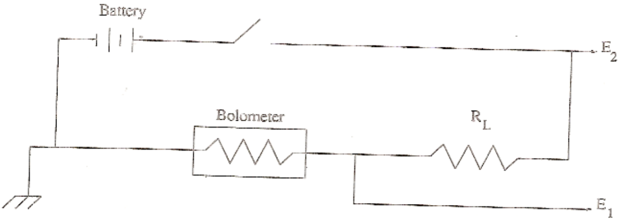
FIGURE 1: PUMPING SYSTEM

A word of caution about air leaks in the pumping system: if air leaks into the plumbing, it will freeze in the neck tube. If the neck tube becomes blocked, the dewar can build up pressure and rupture! Test for air leaks beforehand and always use the safety feature built into the pumping fitting. The re-entrant tube prevents complete blockage of the neck should an air leak be present.

Recommended Test Procedures

D.C. Load Curve

With bath stabilized at operating temperature and instruments connected as shown in Figure 2, the E.I. characteristic may be measured. The input impedance of the voltmeter used to measure E_1 should be more than 10 times R_o, the bolometer resistance. The current, I_B, is simply $(E_2 - E_1) / R_L$. A typical load curve is shown in Figure 3.



Note: E_2 varied from 0 to R_L / I_B (Max.)
E_1 is measured by high impedance voltmeter

Figure 2: Load Curve Setup

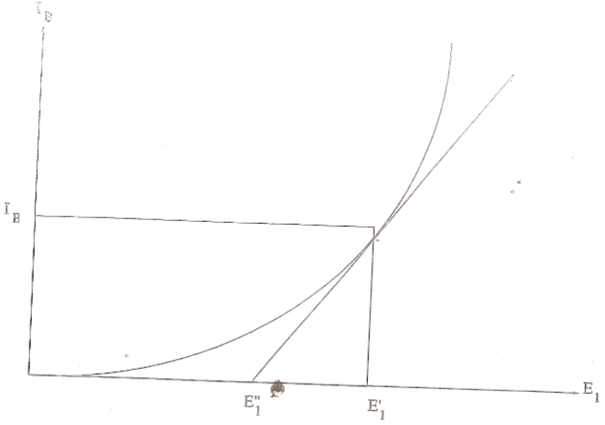


Figure 3: Load Curve

Frequency Response

If a bright source can be placed close enough to the window, the arrangement of Figure 4 may be used where the oscilloscope responds to D.C. If higher gain is needed, A.C. coupling must be used. The preamplifier, for example, could be utilized with a low gain oscilloscope. In any case, it is necessary to be certain that the true D.C. signal level has been measured, i.e. the A.C. response must be low enough to allow extrapolation to zero frequency. If the bolometer is properly constructed, it will have a single time constant and its frequency response will be as illustrated in Figure 5a. If, however, there are two time constants, with one very long, the result may resemble Figure 5b. Note that the oscilloscope input impedance must be large relative to the load resistor R_L to avoid loading of the circuit.

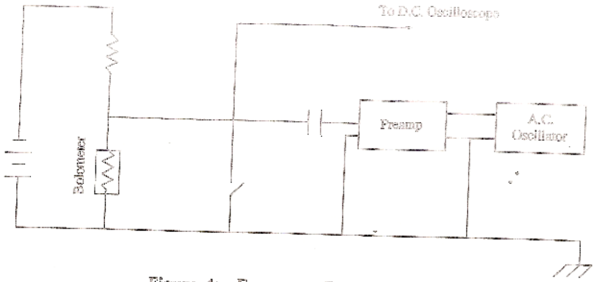


Figure 4: Frequency Response Setup

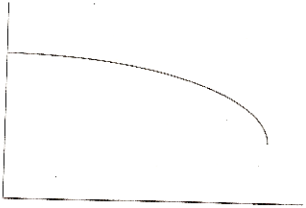


Figure 5a: Frequency Response (Single τ)

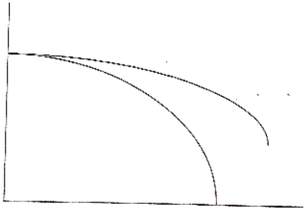


Figure 5b: Frequency Response (Double τ)

<u>Response Versus Bias Current</u>

The A.C. output should be measured for various bias currents up to the highest used in the load curve and well beyond the value which produces maximum output.

Absolute Noise Measurement

This is the most important measurement to be undertaken here. It verifies that the bolometer is working properly and that no serious degradations are occurring in the detector or associated equipment. A number of difficulties may arise, although the following procedures are intended to avoid most of the common problems encountered in noise measurements.

(a) In the frequency range of interest, 10 to 1000 Hz, a number of narrowband filter systems are available. Any filter may be used here if its effective $Q \approx \Delta f / f \geq 10$. Narrow bandwidths are undesirable since if $\Delta f < 1$ cps, inconveniently long measuring times become necessary. An inexpensive filter is available from Infrared Laboratories as model NM-2. In choosing the frequencies to be used the power line fundamental and its harmonics should be avoided. We usually employ the following set of frequencies: 10, 20, 40, 80, 160, 320, 640 Hz.

(b) The voltmeter need not be of the true rms variety since it will be calibrated on noise very similar to that we wish to measure. A linear amplifier may be needed between the filter and the voltmeter to increase its sensitivity to about 0.1 mv rms full scale.

(c) It is necessary that the preamplifier have noise performance equivalent to our standard model; the circuit and a brief description are included.

(d) After connecting the apparatus as shown in Figure 6, checks must be made to eliminate all interference from power line or other sources. With preamp input shorted or connected to the detector, the waveform on the oscilloscope must be free of ripple or other signals such as partially rectified r.f. coming from nearby transmitters. Ground loops, lack of a good ground, proximity to transformers in oscilloscopes or other equipment, or poor shielding between detector and preamplifier are common causes of extraneous pick-up.

Figure 6: Noise Measurement Setup

(e) Once the setup is free of interference, it may be calibrated by placing across the input several resistors of known value. Johnson noise produced by the resistors can be calculated from:

$$V_n = (4kTR\Delta f)^{1/2} \quad \text{Volts/Hz}^{1/2}$$

where

k = Boltzmann's constant = 1.38×10^{-23}

T = temperature in Kelvins

R = resistance in Ω

Δ = bandwidth of the filter in Hz

Wirebound types are recommended. The resulting data should be plotted as follows:

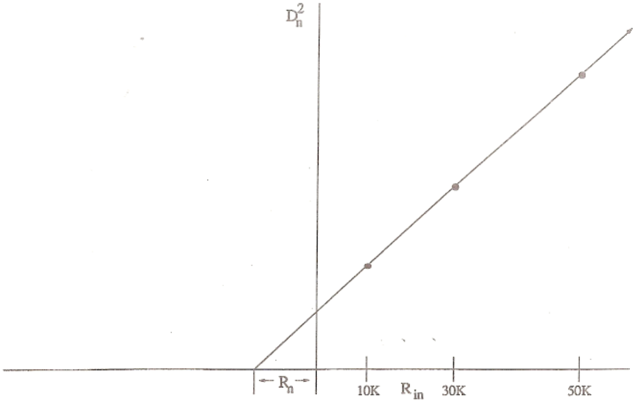


Figure 7: Noise Calibration

This procedure should be followed for each frequency to be used. In addition to calibrating the noise meter, it determines the value of R_N, the noise equivalent resistance of the pre-amplifier.

(f) Detector noise may now be measured as a function of I_B. Values of I_B should be chosen from zero to the highest value on the load curve. Various small batteries can be selected for this purpose. A word of caution on installation of the bias battery is in order: first, always solder leads to each battery to avoid noisy contacts; second, keep heat to a minimum necessary for proper joints to avoid damaging the battery; and last, more than one battery is usually tried to insure that the battery is not noisy itself. If all is well, the zero bias noise should just equal the calculated value for R_0 and T_0. Optimum value of detector impedance decreases as the current increases and this can offset the increasing current noise. These measurements should be carried out for various frequencies including the chosen chopping frequency.

Microphonics and pump noise can complicate the problem of ascertaining true detector noise. Even if the window is blocked off, the slightest motion of the inner parts of the dewar can produce random fluctuation in background. The dewar has been constructed to minimize this problem. Also, our preamplifier is relatively nonmicrophonic. Pump noise arises when surges in the vapor pressure of the helium bath are large enough to produce temperature fluctuations of the detector. A good test is to suddenly shut off the pump and monitor the noise. Only under rare circumstances have we encountered pump noise, but this problem is eliminated by the insertion of a reservoir in the pumping line to smooth out the pumping oscillations.

T_0	Bath Temperature
R_0 (Ω)	Bolometer Resistance
I_B (amp)	Bias Current
E_1 (volt)	Voltage Across Bolometer
R_L (Ω)	Load Resistor, usually cooled
E_2 (volt)	Bias Supply Voltage
S_O (volt/watt)	Maximum Responsivity
$P_O = I_B E_1$ (watt)	Bias Power at Maximum Responsivity
G (watt/K)	Thermal Conductance
T (sec)	Thermal Time Constant
f_0 (Hz)	Chopping Frequency
V_N (volt/$Hz^{1/2}$)	rms Noise Voltage
NEP (watt/$Hz^{1/2}$)	Noise Equivalent Power
A (cm^2)	Active Area of Detector (one surface)
D* (cm-$Hz^{1/2}$/watt)	Detectivity
R_N (Ω)	Noise Equivalent Resistance

$S_O = 0.7\,(R_0/T_0G)^{1/2}$

$NEP = 2T_0(kG)^{1/2}$

$P0 = 0.1T_0G$

$S = E_1{}''/(2I_B{}'E_1{}')$

LN-6C PREAMPLIFIER

The LN-6C preamplifier is a low-noise voltage amplifier employing remote first stage electronics. By placing the first amplifier stage near the detector on the cold surface, microphonic and excess input capacitance are greatly reduced. This preamplifier is ideally suited to Infrared thermal sensors such as bolometers operating from 0.3K to 4.2K at very high impedance. The J230 JFET remote amplifier along with its thin film heater are mounted on a thin-wall fiberglass thermal insulator, allowing 77K operation of the FET even when the module is mounted to a low-temperature cold plate. Power dissipation to the cold surface is less than 1mW. The system load resistor is thermally sunk to the liquid Helium surface to minimize its Johnson noise, and a small (#40) constantan wire connects it to the remote amplifier module. Bias on the detector is conveniently switched from the preamplifier enclosure and a BIAS TEST BNC jack allows monitoring of the applied bias as well as providing an input for external bias. Load curves can be measured conveniently at test points provided on the side of the box. Power is supplied by two internal 9 volt batteries and continuous operation up to 100 hours is standard.

SPECIFICATIONS

First Stage	Remote at cold surface
Voltage Gain	200/1000 ± 5 percent (switched)
Input Impedance	$>1 \times 10^{13}\Omega$
Output Impedance	<500 ohms
Frequency Response	0.75Hz to 30 KHz
Maximum Output	± 7V
Power Requirements	± 9V (Batteries included) @ ± 3mA
Shorted Input Noise	$<5nV/Hz^{1/2}$
Bias Voltage	Switched, to suit application
Size	6 1/2" x 3" x 4" wide
Weight	Approx. 2 pounds

LN-6C PREAMPLIFIER
OPERATING INSTRUCTIONS

1. Initial Inspection

After unpacking the preamplifier, remove the four lid screws and inspect to see that two 9V Alkaline batteries are in place and are connected properly into their battery snaps. It will be necessary to have the lid removed to attach the unit to a dewar or other device containing the detector. Check to see that the preamplifier power is turned off, and that the bias and input switches are off.

2. Attaching Preamplifier

With the lid removed, attach the preamplifier to the dewar with two 8-32 screws near the connector cut-out at the rear of the box. Some installations will offer a tapped hole to match the clearance hole near the base of the two batteries at the top of the box. The standard clearance hole is for an 8-32 screw. Plug the electrical connector (preamplifier input connector) into the appropriate jack and replace the lid.

Note: REFER TO 6. IF WIRING OF THE COLD MODULE IS TO BE DONE BY THE CUSTOMER.

3. Normal Operation

Check to see that the bias is correctly set for the particular detector being used. See detector data sheet and section f. in the *ABSOLUTE NOISE MEASUREMENT* section of the system write-up for details of bias selection. Measurement of the bias voltage is performed at the ***BIAS TEST*** BNC jack with the ***BIAS*** switch in the ON position.

Bring the detector to normal operating temperature and turn the preamplifier power (***INPUT*** switch off). White noise should be seen at the ***OUTPUT*** BNC jack. An oscilloscope or spectrum analyzer can be used to measure this noise. The D.C. level at this jack should be less than 250mV (which is a measure of the D.C. offset of the output amplifier only). This value should change by a factor of 5 when the ***GAIN*** switch is changed from 1000 to 200. A.C. noise at this point should be 4.5×10^{-9} V/Hz$^{1/2}$ or less at 20Hz (referred to the preamplifier input).

Turn the INPUT switch on and allow 60 seconds for stabilization of the circuitry before making measurements. Signals as large as +7.5mV at the preamplifier input @ GAIN = 1000 may be accommodated without saturation of the preamplifier.

4. Cold Module Operation

Under normal operation, the cold module is "self-starting" due to the heater resistor(which dissipates about one milliwatt) cemented to the active end (top) of the cold module. Since JFET electrical conduction diminishes at temperatures below 60K, this heater insures adequate temperature rise, even from a low temperature "cold start", and also causes thermal equilibrium to take place in a short time, usually less than 1/2 hour.

5. Detector Load Curve Measurement

Since the detector lead is not brought out directly, measurement of the load curve requires monitoring of the cold JFET source. This is done at the V_S BNC jack. Values for this source voltage depend upon the particular JFET being used, but are normally in the range 0.75V to 1.5V when the JFET is cold. Room temperature values normally are in the range 0.95V to 1.9V. Note that these values are measured with the ***BIAS*** switch in the OFF position. This source voltage represents an offset and must be subtracted from subsequent measured voltages to obtain a normal load curve. Bias for the load curve measurement is applied to the ***BIAS TEST*** BNC jack with the ***BIAS*** switch turned off.

The usual formula gives the detector current:

$$ID = \frac{V - V_B}{R_L}$$

ID=detector current
V=bias voltage applied at bias test BNC jack
V_B=detector voltage(minus source voltage at zero bias)
R_L=value of load resistor in ohms

6. Cold Module Installation

Refer to drawing and notes supplied. The low thermal conductance tube, which connects the lower part of the module (mounted to cold surface) to the active end, is very fragile; great care should be taken to insure that no forces or torques are applied to this tube during installation. Constantan and Manganin wire are available from the factory.

CAUTION: Use only low thermal conductance wire if it becomes necessary to connect the module active end to lower temperature areas. Failure to do so will cause overcooling of the module during operation and possible malfunction of the JFET (not permanent).

7. Maintenance

The only maintenance required under normal conditions is replacement of the power supply batteries. To do this, turn the preamplifier off and remove the lid. Note that this unit is equipped with integral snap/holder assemblies which are epoxied in place. Careful use of a small screwdriver will aid in prying the batteries loose from these snap-in sockets. Remove & replace the batteries with Alkaline 9V units-- other types will have shorter life, except for certain re-chargeable Nickel-Cadmium cells. On units with the integral holder, simply snap the new batteries in place.

Normal battery life will exceed 75 hours of continuous operation.

8. Troubleshooting (requires D.C. voltmeter with input impedance of 10 megohms or greater)

In case of difficulty, use the following procedure to isolate a fault. Always check power supply batteries before beginning. Acceptable range is $\pm$8.0V to $\pm$9.4 V.

A. Short input (INPUT switch in OFF position)
B. Turn power on & GAIN to 1000
C. Measure D.C. voltage at OUTPUT BNC jack
   1) If value is 0 $\pm$ 250mV, go to E.
   2) If value is outside this range, go to D.
D. Measure D.C. voltage at TP2 (refer to board layout sketch
   1) If value is 0 $\pm$ 250 mV, Op 12 (or 2nd OP-27 on late units) is probably faulty

2) If value is outside this range, Op 27 first amplifier has probably failed. (Note: Grounding TP2 with a test lead should cause the output voltage at BNC jack to be 0 ± 250 mV).

E. Measure voltage at TP1 or Vs BNC jack

1) If value is 1 ± .4 volts, trouble is probably in the detector load resistor circuit.

2) If value is outside this range, be sure that sufficient time has elapsed after amplifier turn-on to allow start-up of the JFET module (See Section 4). Check bias voltage to see if it is in the correct range. Start-up is not required if the dewar is at ambient temperature.

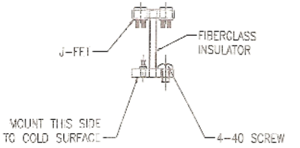
Note: Dewar may be either cold or warm to diagnose faults using the above procedure.

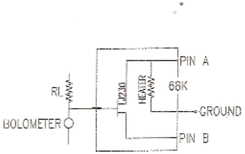
F. Consult factory if difficulty persists.

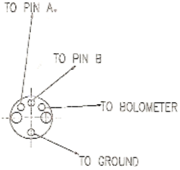
9. Spare Parts

A complete stock of spare parts for immediate shipment is maintained at the factory for this unit, both at the component and subsystem levels.

LN6/C COLD MODULE







6 PIN CONNECTOR

A DRAIN
B SOURCE
C BIAS
D
E GROUND
F

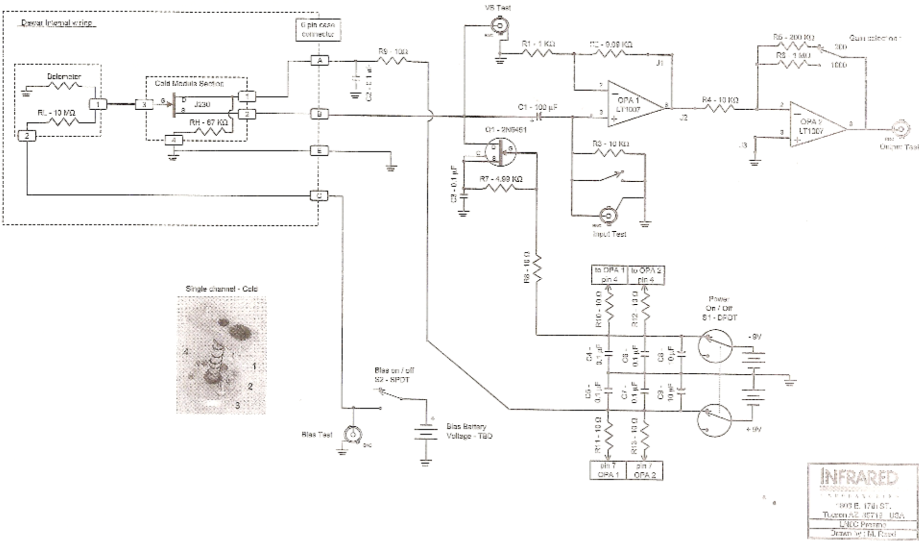
Notes for installation

1. Use constantan or Mangnin wire (#30 or smaller) to connect module to connector.

2. Load resistor should be mounted on cold surface as close to the detector as possible.

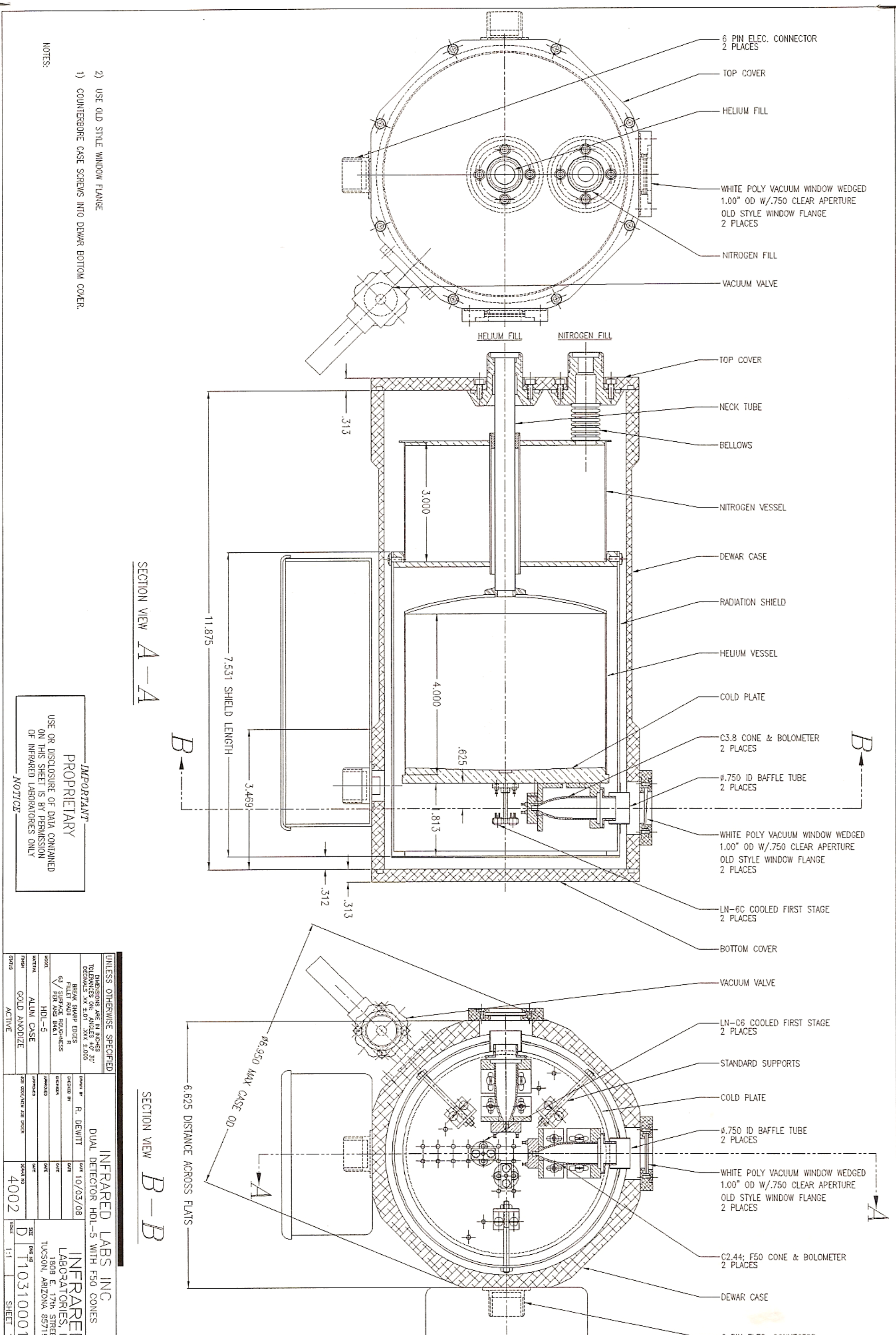
3. The G1 lead from the cold module to junction of RL & Det should be kept as short as possible. Cement this lead to the cold surface to avoid microphonics.

LN6C Preamp and Dewar Internal Components



4/27/04

Page 3 - schematic


FILE T1031000 1A BROOKHAVEN HDL5 4002 MODEL (1).PDF
6 PIN ELEC. CONNECTOR
2 PLACES
TOP COVER
HELIUM FILL
WHITE POLY VACUUM WINDOW WEDGED
1.00" OD W/.750 CLEAR APERTURE
OLD STYLE WINDOW FLANGE
2 PLACES
NITROGEN FILL
VACUUM VALVE
HELIUM FILL
NITROGEN FILL
TOP COVER
NECK TUBE
BELLOWS
NITROGEN VESSEL
DEWAR CASE
RADIATION SHIELD
HELIUM VESSEL
COLD PLATE
C3.8 CONE & BOLOMETER
2 PLACES
ø.750 ID BAFFLE TUBE
2 PLACES
WHITE POLY VACUUM WINDOW WEDGED
1.00" OD W/.750 CLEAR APERTURE
OLD STYLE WINDOW FLANGE
2 PLACES
LN-6C COOLED FIRST STAGE
2 PLACES
BOTTOM COVER
.313
3.000
11.875
7.531 SHIELD LENGTH
4.000
.625
3.469
.813
.312
.313
SECTION VIEW A-A
B
B
VACUUM VALVE
LN-C6 COOLED FIRST STAGE
2 PLACES
STANDARD SUPPORTS
COLD PLATE
ø.750 ID BAFFLE TUBE
2 PLACES
WHITE POLY VACUUM WINDOW WEDGED
1.00" OD W/.750 CLEAR APERTURE
OLD STYLE WINDOW FLANGE
2 PLACES
C2.44: F50 CONE & BOLOMETER
2 PLACES
DEWAR CASE
6 PIN ELEC. CONNECTOR
MOUNTED WITH LN6C PREAMP
2 PLACES
ø6.950 MAX CASE OD
6.625 DISTANCE ACROSS FLATS
SECTION VIEW B-B
A
A
NOTES:
1) COUNTERBORE CASE SCREWS INTO DEWAR BOTTOM COVER.
2) USE OLD STYLE WINDOW FLANGE
IMPORTANT
PROPRIETARY
USE OR DISCLOSURE OF DATA CONTAINED
ON THIS SHEET IS BY PERMISSION
OF INFRARED LABORATORIES ONLY
NOTICE
UNLESS OTHERWISE SPECIFIED
MODEL HDL-5
MATERIAL ALUM CASE
FINISH GOLD ANODIZE
STATUS ACTIVE
DRAWN BY R. DEWITT
DATE 10/03/08
INFRARED LABS INC
DUAL DETECTOR HDL-5 WITH F50 CONES
4002
INFRARED
LABORATORIES, INC.
1808 E. 17th STREET
TUCSON, ARIZONA 85719 USA
SIZE D
DWG NO T1031000 1A
REV. —
SCALE 1:1
SHEET 1 OF 1