DESERT CRYOGENICS

a Division of Lake Shore Cryotronics, Inc.

HFTTP4 Integrated Horizontal Field Superconducting Magnet Probe Stations

A. Description

The integrated-magnet probe station utilizes a standard TT-Prober base and manipulated X-Y-Z stages with a superconducting Helmholtz Pair magnet and a special continuous-transfer refrigeration assembly. This refrigerator consists of a split-helium supply and three coaxial stages, which are: the sample stage, the magnet stage, and the radiation shield stage. The sample stage is a 24.9 mm diameter copper cylinder. A heating element of resistive wire is wound around the stage for temperature control above base temperature. Chucks are affixed to the sample stage by three M2.5 - 0.45 × 6 mm screws, and the chucks have an M3 - 0.5 threaded hole provided for lifting. The helium supply enters the standard bayonet to the refrigerator and splits, with one path continuing unregulated to the magnet stage. After cooling the magnet stage, this helium cools the radiation shield then exhausts through an NW 16 fitting on the side of the bayonet. The other path passes through the helium control valve, to the sample stage, then exhausts through an NW 25 fitting under the chamber. A micrometer knob under the chamber operates the helium control valve. This allows the magnet stage to remain near 4.2 K while the temperature of the sample stage can be varied from 4.2 K to 30 K using the valve and heater. If the magnetic field is not required, the sample stage temperature can be varied from 4.2 K to 325 K. The system uses standard ZN50 probes with non-magnetic brass dowel pins in place of the standard stainless steel pins. Electrical connections for the high current leads of the magnet are made through a convenient jack attached to the underside of the base plate sharing the microscope mounting screws.

B. Operation

The procedures for operating the manipulated stages, microscope/vision system, probes, and chucks are similar to the standard system. Only differences from the standard system are described in this addendum.

Sample Cooldown and Magnet Energization

1. Close helium control valve (under chamber) to establish zero (**DO NOT OVER-TORQUE – VALVE IS DELICATE**)
2. Open helium control valve 6 turns.
3. Close transfer-line foot valve to establish zero.
4. Open transfer-line foot valve 8 turns.
5. Insert transfer-line in Dewar and pressurize Dewar to 6 or 7 psi (0.4 to 0.47 atm).
6. Cool until magnet stage temperature reaches 4 K to 5 K.
7. Continue cooling until radiation shield temperature reaches 15 K to 20 K (normally an additional 10 minutes).
8. Close helium control valve slowly until sample stage temperature starts to rise.
9. Open helium control valve 1 to 1.5 turns from this point. Sample stage temperature should be stable at 4.2 K.
10. Decrease Dewar pressure to 5 psi (0.34 atm.).
11. Verify that the temperatures are stable.
12. Magnet current can now be ramped to desired field. (**SEE MAGNET AND POWER SUPPLY MANUALS**)

Controlling Sample Stage from 4.2 K to 30 K (with Magnetic Field ON)

1. Cool system as described above in ‘Sample Cooldown and Magnet Energization.’
2. Enter a setpoint in the temperature controller for the desired sample stage temperature. (**CAUTION: CURRENT TO THE SAMPLE STAGE HEATER MUST BE LIMITED TO 0.25 A**)
3. If the heating power is insufficient, the helium flow to the sample stage can be reduced using the helium control valve.

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Controlling Sample Stage from 30 K to 325 K (with Magnetic Field OFF)

1. Ramp magnet current to zero.
2. Enter a set point in the temperature controller for the desired sample stage temperature. **(CAUTION: CURRENT TO THE SAMPLE STAGE HEATER MUST BE LIMITED TO 0.25 A)**
3. Reduce Dewar pressure, transfer-line foot valve setting, and helium control valve setting as necessary to achieve set point and conserve helium.

C. Electrical Connections

The chamber bottom contains a standard 19-pin feedthrough for wiring to the temperature sensors and heaters. Also on the chamber bottom are a feedthrough for the magnet high-current leads and a 6-pin feedthrough for the magnet voltage taps.

Sensor and Heater Connections

Sensors are included for all three stages of the refrigerator. The sample stage and magnet stage use GaAlAs diode sensors (Lake Shore Model TG-120-SD, calibrated) and the radiation shield uses a silicon diode sensor (Lake Shore Model DT-670-CU, uncalibrated).

The sample stage is heated by a 100 Ω, wire-wound heater. ***Current must be limited to 0.25 A to prevent damage to the heater wire.*** The magnet stage and radiation shield stage both have 50 V, 25 Ω, 100 W heaters. Each of these is made up of two 50 Ω heaters in parallel.

The following Table 1 shows the pinouts for the control and readout cables of the system. As originally configured, the cables are designed to ground the vacuum shroud, which forms an electrical Faraday cage around the sample, to the chassis of the temperature controller. Independent of the provided cabling arrangement, there is always precisely one ground connection. In many experimental arrangements, however, the vacuum shroud may optimally be connected to a different ground. In this case, it is best to disconnect the ground connection to the controller chassis in order to avoid multiple and potentially conflicting grounds. To disconnect the ground to the controller chassis, unplug the round, green single banana connector.

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Table 1

19-Pin	Function	Cable, Pair, Color[a]	Connector
A	Sample TG V+	1, 1, red	6-pin, 4
B	Sample TG V–	1, 1, black	6-pin, 2
C	Sample TG I+	1, 2, white	6-pin, 5
D	Sample TG I–	1, 2, green	6-pin, 1
N/C	Cable Shield	1, shield	6-pin, 3
E	Sample Heater+	2, 1, red	Banana +
F	Sample Heater –	2, 1, black	Banana –
Connector body	Ground	2, shield	Single green banana[b]
G	Magnet Stage TG V+	3, 1, red	6-pin, 4
H	Magnet Stage TG V–	3, 1, black	6-pin, 2
J	Magnet Stage TG I+	3, 2, white	6-pin, 5
K	Magnet Stage TG I–	3, 2, green	6-pin, 1
N/C	Cable Shield	3, shield	6-pin, 3
L	Radiation Shield Stage SD V+	4, 1, red	6-pin, 4
M	Radiation Shield Stage SD V–	4, 1, black	6-pin, 2
N	Radiation Shield Stage SD I+	4, 2, white	6-pin, 5
P	Radiation Shield Stage SD I–	4, 2, green	6-pin, 1
N/C	Cable Shield	4, shield	6-pin, 3
R	Shield Heater	5, 1, red	Banana +[c]
S	Shield Heater	5, 1, black	Banana –
Connector body	Ground	5, shield	Single green banana[b]
T	Magnet Heater	6, 1, red	Banana +[c]
U	Magnet Heater	6, 1, black	Banana –
Connector body	Ground	5, shield	Single green banana[b]
V	Not used		

[a] *In control cable*

[b] *Drain wire connected to single banana, which plugs into chassis next to heater output of controller. The other end of the drain wire is connected to the body of the 19-pin mating connector. This connects the Faraday cage (vacuum shroud) of the system to the chassis ground of the controller. See the discussion above to determine if this connection should be left in place or broken.*

[c] *Dual banana to auxiliary analog programmable power supply.*

Legend for Tables 1 and 2

- TG = GaAlAs diode thermometer
- SD = silicon diode thermometer
- Sample stage heater = 100 Ω, 25 V, 0.25 A limit
- Magnet stage heater = 25 Ω, 100 W, 50 V
- Shield heater = 25 Ω, 100 W, 50 V
- N/C = No Connection

Magnet Connections

The high current flexible cables go from the power supply to a large plug. The mating connection is attached to the underside of the prober base. From this jack, solid copper leads go to the conflat-type feedthrough on the chamber bottom. To make or break the large cable connection, push or pull straight in line with the connector.

A detailed description of the connection to the magnet voltage taps follows in Table 2.

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Table 2

6-Pin	Function	Wire Color[a]	Power Supply
A	Not used		
B	Not used		
C	Not used		
D	Not used		
E	Magnet V+	1, 1, red	“Mag.V in +”
F	Magnet V–	1, 1, black	“Mag.V in –”

[a] *In control cable*

D. Precautions and Safety Considerations

All precautions and safety considerations related to the standard system as described on page iv of this manual still apply. In addition, the following warnings from the magnet manual apply:

8.0 SYSTEM SAFETY PRECAUTIONS

8.1 NEVER DISCONNECT THE CURRENT LEADS WHEN THE MAGNET IS CHARGED. A POTENTIAL FATAL VOLTAGE (KILOVOLTS) WILL OCCUR THAT CAN CAUSE SEVERE INJURY OR DEATH

8.2 NEVER TOUCH THE CURRENT LEADS WHILE THE MAGNET IS ENERGIZED. ALWAYS USE A 30 kV INSULATED TOOL. (Lineman’s high voltage gloves)

8.3 NEVER OPERATE THE MAGNET WITH INSUFFICIENT LIQUID HELIUM LEVEL.

8.4 NEVER OPERATE THE VAPOR COOLED CURRENT LEADS WITHOUT HELIUM GAS FLOWING.

8.5 KEEP FERROMAGNETIC MATERIALS THAT MAY BE ATTRACTED BY THE STRONG MAGNETIC FIELD AWAY FROM THE DEWAR.

8.6 ALWAYS WEAR PROTECTIVE CLOTHING WHEN WORKING WITH CRYOGENIC LIQUIDS AND GASES.

8.7 DO NOT USE CRYOGENIC GASES IN CONFINED SPACES. THE AREA SHOULD BE WELL VENTILATED. A MAGNET QUENCH RESULTS IN THE HELIUM LIQUID BEING CONVERTED TO GAS. THIS COULD BE UP TO 750 TIMES THE LIQUID VOLUME. IF THE ROOM IS SMALL AND NOT WELL VENTILATED FOR THIS OCCURANCE, ASPHYXIATION COULD RESULT.

8.8 WATCHES AND CREDIT CARDS CAN BE DAMAGED BY THE HIGH MAGNETIC FIELDS.

8.9 INTENSE MAGNETIC FIELDS CAN CAUSE SERIOUS INJURY PEOPLE WITH PACEMAKERS, MAGNETIC IMPLANTS, AND NEUROSTIMULATORS. POST WARNING SIGNS OF POTENTIAL DANGER. A SIGN IS SUPPLIED WITH THIS MANUAL.

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