

Appendix E

Helium Recondenser Controller Option

The LM-510 can be configured with a Helium Recondenser Controller installed in Channel 2. It is designed to monitor pressure in a cryostat containing liquid helium and helium vapor that is equipped with helium reliquifier, and to add heat to the system as needed to maintain an optimal pressure for recondensing. Also, when properly configured, it prevents system contamination by maintaining positive pressure in the cryostat.

E.1 Helium Recondenser Controller (HRC) Specifications

Pressure Sensor	Factory configurable for 0-5V or 4-20mA 0 to 14.7 psi calibrated range typical Reads to -1.8 psi typical
Heater Power	0 to 10 Watts
Heater Compliance	0 to 12 Volts
Analog Outputs:	
Pressure	4-20mA for 0 to 15 PSI
Heater Power	4-20mA for 0 to 10 Watts
Compliance	9 Volts
Current sense resistor	less than 450 ohms
Internal excitation – no external supply is used with the analog output	

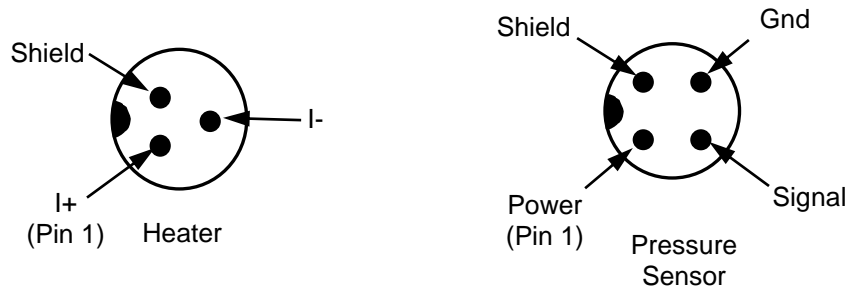
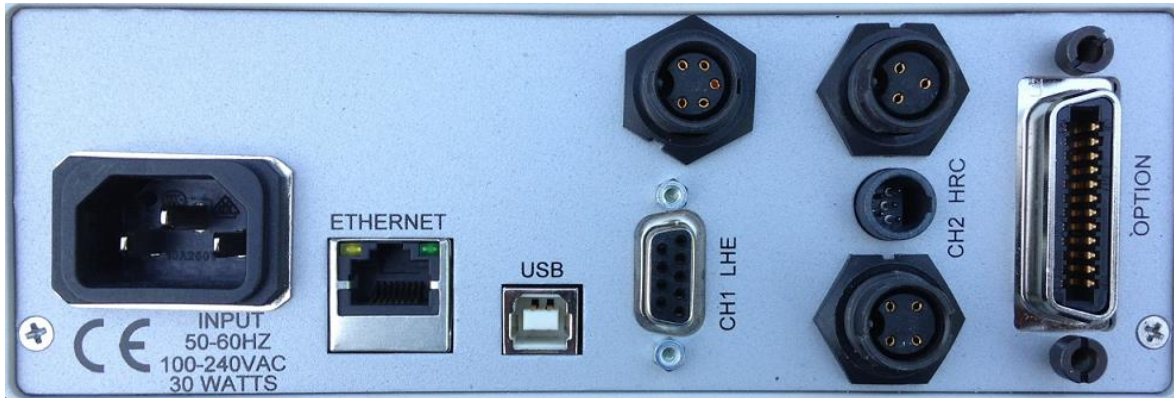
E.2 Setup

The Helium Recondenser Controller card is installed by the factory in channel 2 with a Liquid Helium Level Monitor card in channel 1.

E.2.1 Connections

Connections are made to the rear panel as shown in Figure E-1. The analog output connector is shown in E.4.0.

Figure E-1 HRC Rear Panel



E.2.2 Calibration

The HRC card comes fully calibrated from the factory. The pressure sensor offset and gain may be adjusted in the HRC menu if desired. It is recommended that only the offset be adjusted unless the pressure sensor is removed from the system so that test pressures can be applied. Refer to Section E.3.1.7 for further details.

E.3 Operation and Menus

The Main Display is shown in Figure E-2 and the HRC Menu in figure E-3. The pressure is shown in blue unless the alert levels set in the menu are violated which cause the pressure to be displayed in red. The maximum heater power is set in the menu, and the bar to the right of the pressure shows the heater power. Full scale is the maximum heater power from the menu setting. "Heater

Disabled” will be displayed in red above the pressure reading if the heater is disabled in the menu. “Heater Fault” will be displayed if the heater is disconnected or shorted. Note that a partial short or high resistance heater may only be detected by observing heater power output is low when high heater power is required.

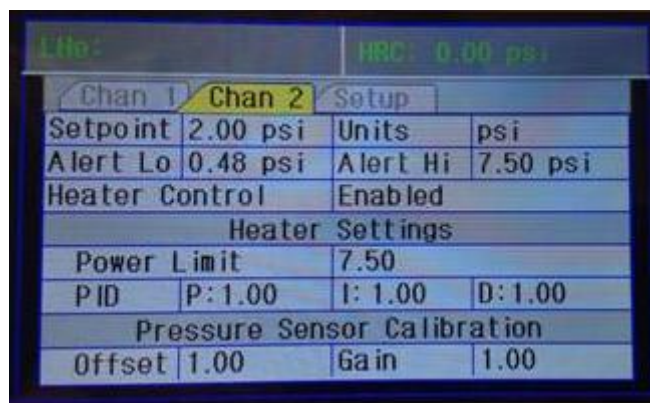
Figure E-2 HRC Main Display



E.3.1 Menu Settings

General menu operation is introduced in sections 4.1 and 4.2 of this manual. Please refer to those sections if needed.

Figure E-3 HRC Menu



E.3.1.1 Setpoint

The pressure setpoint is the target pressure used to control heater output. A PID algorithm is used to adjust heater output when the heater is enabled.

E.3.1.2 Units

Pressure may be displayed in pounds per square inch (psi) or bars.

E.3.1.3 Alert Settings

If the measured pressure is between the Alert Lo and Alert Hi settings, the pressure displayed in the main display will be in blue. If outside the range it will be displayed in red.

E.3.1.4 Heater Control

The heater may be enabled or disabled in the menu. This allows pressure to be monitored during cool-down without adding heat to the system.

E.3.1.5 Power Limit

The PID algorithm that controls heater output calculates error functions based on both target pressure and maximum heater power. If the pressure error causes the maximum heater power to be exceeded, the algorithm will start limiting the heater power to the power limit entered in the menu. If this setting is not needed for operation, it may be left at the maximum value of 10.0 Watts.

E.3.1.6 PID

Conventional PID parameters are provided if fine tuning of the PID algorithm is desired. Default settings are shown in Figure E-2

E.3.1.7 Pressure Sensor Offset and Gain

If recalibration of the pressure sensor is required, the capability to adjust offset and gain is provided. This calibration may be performed by removing pressure from the sensor and adjusting the offset to obtain a zero reading. The factory calibrates gain by setting the gain to 1.0, applying 14 psi to the sensor, observing the measured pressure, and calculating the appropriate gain:

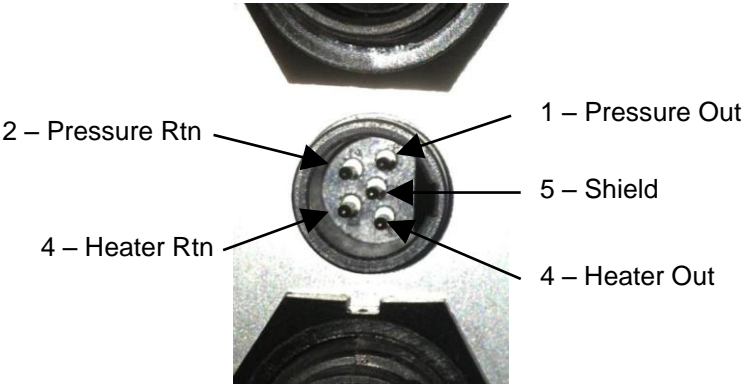
$$\text{Gain} = 14.0 / (\text{measured pressure})$$

The factors may also be determined observing the displayed pressure at two known pressures and solving the resulting linear equations for gain and offset.

E.4.0 Analog Outputs

Analog outputs are provided to allow the calibrated pressure and heater power to be monitored without using one of the computer interfaces. Accuracy does not suffer significantly since calibrated 12 bit resolution is provided for each 4-20mA output.

Figure E-4 HRC Analog Outputs



The 4-20 mA analog outputs do not require an external power source. An internal 12V source is used which provides approximately 9V compliance which allows a sense resistor of up to 450 ohms to be used in the receiver. This shows a typical implementation:



E.5.0 Computer Interface Command Reference

The following HRC commands supplement the command set provided in Appendix A.

Command	Available	Description
HEAT	HRC Operate	Enable/Disable HRC heater
HEAT?	HRC Operate	Query HRC heater enable status
HLIM	HRC Operate	Set heater power limit
HLIM?	HRC Operate	Query heater power limit
MEAS?	Operate	Query pressure and heater power
PCAL	HRC Operate	Calibrate pressure sensor offset
PSET	HRC Operate	Set target operating pressure
PSET?	HRC Operate	Query target operating pressure

Command Reference

HEAT Enable/Disable HRC heater
Availability: HRC Operate Mode
Command Syntax: HEAT <ON, OFF>
Example: HEAT ON
Default Parameter: None **Parameter Range:** ON, OFF
Description: The **HEAT** command enables or disables the HRC heater.
Related Commands: HEAT?

HEAT? Query HRC heater enable status
Availability: Operate Mode
Command Syntax: HEAT?
Example: HEAT?
Response: <ON, OFF>
Response Example: ON
Description: The **HEAT?** query returns ON if the heater is enabled or OFF if the heater is disabled. If the heater is turned off due to the system being above the target operating pressure when the heater is enabled, ON will still be returned.
Related Commands: HEAT

HLIM Set heater power limit
Availability: Operate Mode
Command Syntax: HLIM <Power Limit>
Example: HLIM 3.25
Default Parameter: N/A **Parameter Range:** 0.1 to 10.0
Description: The **HLIM** command sets the maximum heater power to the limit provided.
Related Commands: HLIM?

HLIM? Query heater power limit
Availability: Operate Mode
Command Syntax: HLIM?
Example: HLIM?
Response: <Power Limit> <Units>
Response Example: 3.25 Watts
Description: The **HLIM?** query returns the heater power limit.
Related Commands: HLIM

MEAS? Query last completed measurement on selected channel
Availability: Operate Mode
Command Syntax: MEAS? [Channel #]
Example: MEAS? 2
Default Parameter: Default Channel (See CHAN) **Parameter Range:** 1 to 2
Response: <Pressure> <Units> <Heater Power> W
Response Example: 3.125 psi 2.487 W (example for HRC channel)
Description: The **MEAS?** query returns the latest measurement in the present units for the selected channel.
Related Commands: CHAN, CHAN?, MEAS, *STB?

PCAL Calibrate pressure sensor offset
Availability: Operate Mode
Command Syntax: PCAL <Calibrated Pressure>
Example: PCAL 2.250
Default Parameter: N/A **Parameter Range:** 0.0 to 14.0
Description: The **PCAL** command adjusts the pressure sensor calibration offset such that present pressure results in the calibrated pressure provided as a parameter to the command.

Related Commands:

PSET Set target operating pressure
Availability: Operate Mode
Command Syntax: PSET <Pressure>
Example: PSET 2.500
Default Parameter: N/A **Parameter Range:** 0.15 to 14.25
Description: The **PSET** command sets the target operating pressure to the value provided.
Related Commands: PSET?

PSET? Query target operating pressure
Availability: Operate Mode
Command Syntax: PSET?
Response: <Target Operating Pressure> <Units>
Response Example: 2.500 psi
Description: The **PSET?** query returns the target operating pressure in the present units.
Related Commands: PSET
