

# **Model K22**

Primary Metrology Comparison Cryostat  
Operation and Maintenance Manual

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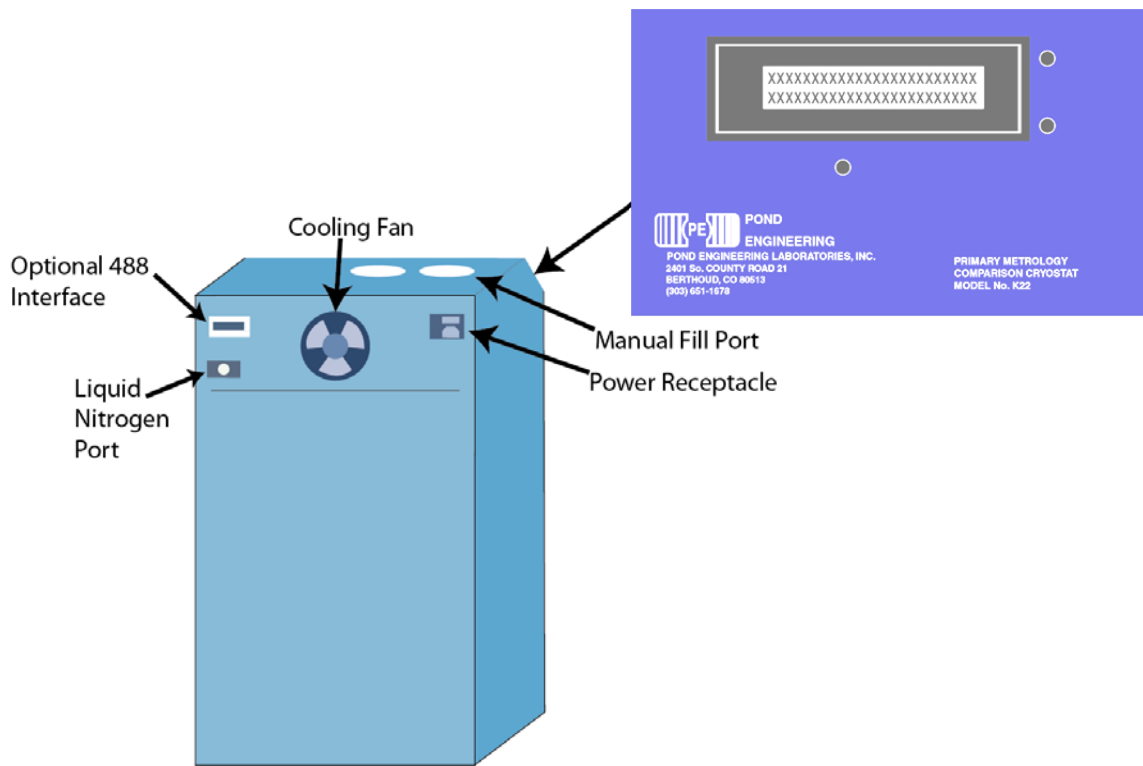
# Primary Metrology Comparison Cryostat

## 1. Background

This report documents the installation, operating and maintenance procedures for the Primary Metrology Comparison Cryostat, Pond Engineering Number K22. Pond Engineering Laboratories considers information contained in this manual to be proprietary and is provided for use by the purchaser exclusively for instructional and maintenance purposes; any other uses are prohibited.

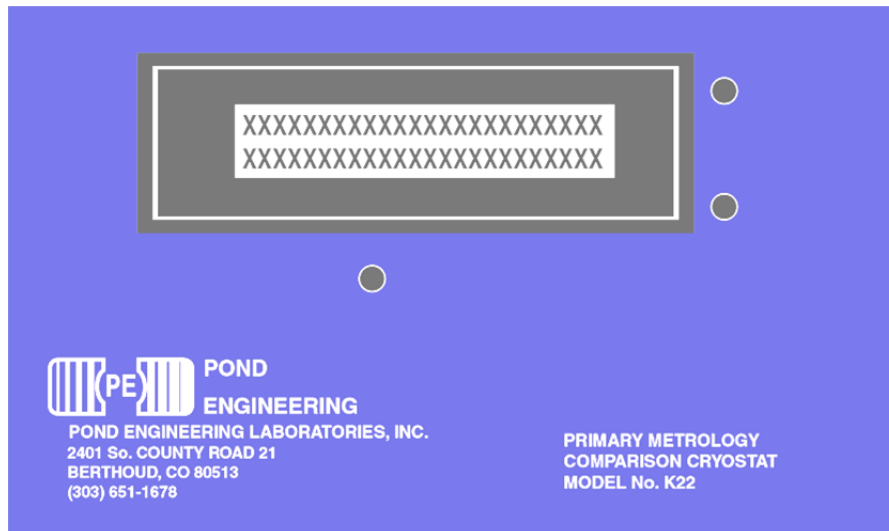
## 2. General Information and Operating Procedures

Figure 1, below, shows the general configuration of the cryostat and provides a better visualization of its appearance, as well as, a reference for location of service points discussed later in this manual.



**Figure 1 - System General Layout**

As shown in Figure 1, the controller front panel is located on a sloping surface at the front of the outer chassis of the Cryostat. The Cryostat is designed to provide an extremely stable and uniform temperature environment for the comparison calibration of Standard Platinum Resistance Thermometers (SPRT's) over a range of  $-190^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ . The Cryostat accommodates up to seven SPRT's in an arrangement of seven 0.315" wells inside diameter and 16 inches deep. The temperature stability of the lower seven inches of the center well is maintained within  $\pm 0.0005^{\circ}\text{C}$  with six peripheral wells, uniform to each other within  $0.0001^{\circ}\text{C}$ . Optional features include an IEEE-488 interface that is installed at the factory to allow operation of the Cryostat as part of an integrated automatic calibration system. The Cryostat has four panels attached to the cabinet frame via button head screws. By removing these panels, one may gain access to the inner system components. The operator interface is provided by three front panel switches, and a 2 line by 24 character Liquid Crystal Display (LCD).

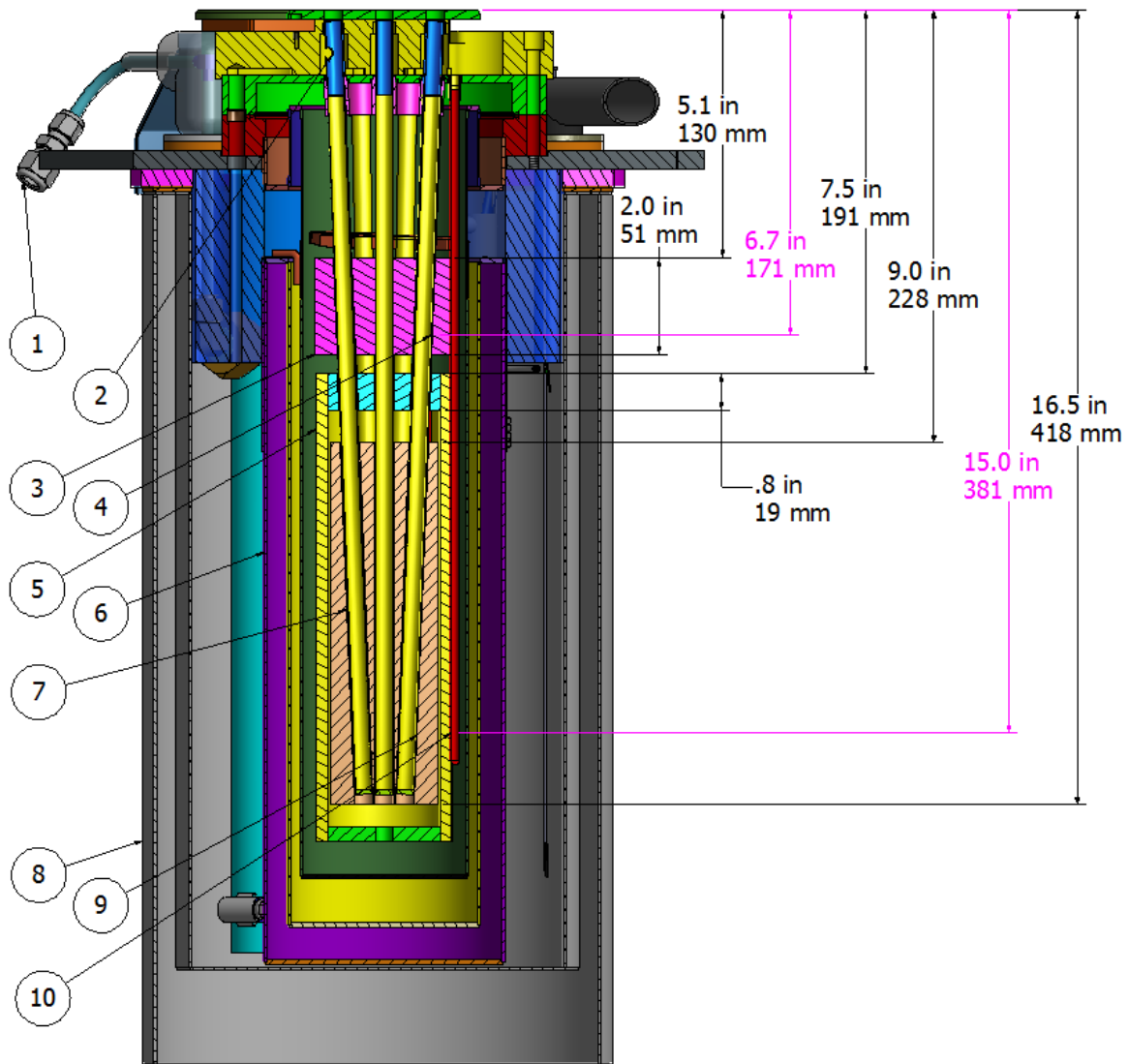


**Figure 2 - Front Panel Layout**

In the normal operating mode this display presents the current temperature setpoint for the controller and the measured core temperature on the first and second lines of the display, respectively. Measurements are taken at approximately 3-second intervals and the lower line of the display is updated following the measurement, indicating the measured core temperature. Additional controller functions (for the purpose of providing diagnostic information, sensor calibration etc.) are accessed through the use of the front panel switches and messages presented by the LCD display as outlined in the following sections.

## **2.1 Theory of Operation**

The Model K22 Primary Comparison Cryostat has been designed to provide a stable uniform thermal environment for the comparison of multiple thermometers. It is optimized for use with long stem Standard Platinum Resistance Thermometers over the range from the triple point of water to the triple point of argon. One center well and six peripheral wells extend from the top of the cabinet into the isothermal core to allow insertion of multiple thermometers. The peripheral wells are oriented approximately 2.2 degrees off-axis to minimize the physical separation of the sensing end of the thermometers while still allowing room for the larger diameter cable / thermometer stem junctions near the top of the cabinet.



**Figure 3 – Unit Cross Section**

Liquid nitrogen contained in an internal storage dewar (8) is used as an expendable refrigerant to cool the apparatus. Provisions are made to allow automatic filling of the internal storage dewar from an external pressurized dewar through tube connection (1). Heaters are provided on both the guard block (3) and shell zone (5) to allow heat to be added under microprocessor control to regulate the temperature of the guard and shell zones as measured by 100 Ohm prt sensors (4, 9, 10) (dimensioned shown in magenta to center of sensing element). A cascaded PID control is used to regulate the temperature of the core zone (7) by directly controlling the temperature of the shell zone with the setpoint of the shell zone control loop being established by the cascade PID control loop associated with the core zone. Substantially better temperature stability is achieved by thermally decoupling the shell from the core block and using the cascade PID loop to control the core temperature.

Gaseous nitrogen from the LN2 boil off is ducted to areas surrounding each thermometer well (2) in order to purge the area around each well and prevent condensation of moisture or other atmospheric gasses in the thermowells. LN2 is pumped to ports near the top of the intermediate dewar (6) where a wick is used to distribute the LN2 uniformly over the outer envelope of the intermediate dewar providing better stability

with varying LN2 levels in the internal storage dewar. Operation over the range of -151 degrees C and below is achieved by flooding the intermediate dewar, allowing LN2 to directly contact the core envelope tube and increase the coupling between the guard and shell zones with the LN2 expendable refrigerant.

### 3. System Controller

In an effort to provide simplicity, while maintaining flexibility to accommodate optional features, the operator interface is based largely on user interactive software control. The software provides prompts to the user through a set of COMMAND FUNCTIONS, including ADJUST SETPOINT TEMPERATURE, and ADJUST SYSTEM VARIABLES. In a user-interactive manner, the software displays messages on the LCD to prompt the user as necessary to perform all command functions through the use of the three front panel switches surrounding the LCD. An outline of the user interface, a detailed description of prompts, how to edit configurations and operate the system manually are explained in this manual. Because of the multitude of functions that each switch will perform, all “labeling” of the switches is provided by the system software and presented to the user via the LCD display. The labels attached to the switches in Figure 5, below, are for the benefit of the reader in understanding the documentation herein. Such labels do not appear on the device front panel.

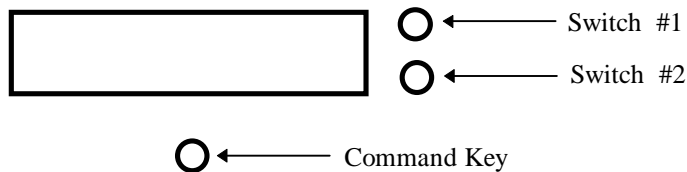


Figure 4 - Front Panel Switch Layout

#### 3.1 Normal Operating Mode

In normal operation, the Cryostat controller will continuously display the setpoint temperature and the current measured core temperature, as shown in Figure 6. Measurements are taken at approximately 3-second intervals and the lower line of the display updated following the measurement. This information is removed from the display when the user presses and holds the “Command Key” for a period of 2 to 3 seconds which allows entry to the COMMAND FUNCTIONS portion of the program.

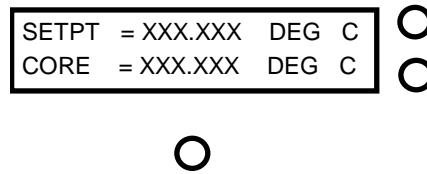


Figure 5 - Normal Operating Mode Display

#### 3.2 The “Command Functions”

In order to perform the many functions necessary, the user must leave the normal operating mode and enter COMMAND FUNCTIONS. To do this, the user should depress and hold the Command Key. As the key is pressed, the words COMMAND FUNCTIONS will be immediately displayed on the lower line of the display. If the key is released the normal operation screen will again be displayed and normal operation will continue. In order to proceed to “Command Functions”, the operator must press and hold the “Command Key” until the words COMMAND FUNCTIONS disappear at which time the operator may release the key.

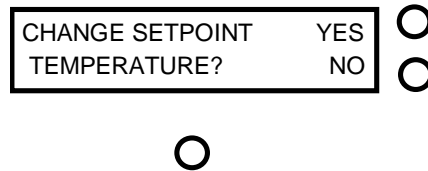
**\*\*Note: The system has been designed such that control functions operate normally even when the user is accessing the command functions. The IEEE-488 commands will not work however, until the**

system is returned to normal operating mode. Attempting to send 488 commands while in COMMAND FUNCTIONS will cause a 488 error that will clear itself in 10 to 30 seconds.

### 3.2.1 Change Setpoint

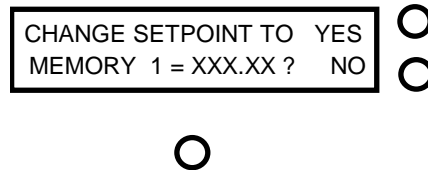
The first command function accessed is CHANGE SETPOINT TEMPERATURE. This function is provided to either change the setpoint to one of three user defined memory setpoint temperatures or to manually adjust the setpoint temperature. Manual adjustment of the Setpoint Temperature may be accomplished within the range of -190.00 to 50.00°C. As shown in Figure 7, the YES is located adjacent to the top switch, which was identified earlier in Figure 3 as “Switch #1”. The NO is adjacent to the switch identified as “Switch #2”. If the NO selection is made, the program will continue on to allow access to the next function.

If the user selects YES by pressing the corresponding switch, the display shown in Figure 8 will be presented on the LCD.



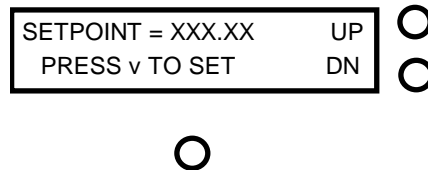
**Figure 6 - Setpoint Access Prompt**

The system controller is equipped with three memory SETPOINT temperatures (MEMORY 1 - MEMORY 3). The user may choose to select one of the memory setpoint temperatures by pressing the corresponding YES switch.



**Figure 7 - Memory Setpoint Change Prompt**

A NO selection will advance the system to the next memory setpoint. A NO response to all three memory setpoint temperatures will allow the user to change the setpoint manually, as shown in Figure 9. Manual adjustment of the SETPOINT may be accomplished by using the two switches on the side corresponding to the labels UP and DN displayed on the LCD. The cursor starts in the hundred’s position. Choosing UP will cause the value to increase by 100 until it reaches a maximum of 50 degrees C. Choosing DN will cause the value to decrease by 100 until it reaches -190 degrees C. The COMMAND switch, located directly below the LCD, is used to advance the cursor to the ten’s digit and so on. The number presented on the display is used as the current setpoint as soon as one advances the cursor past the last digit.

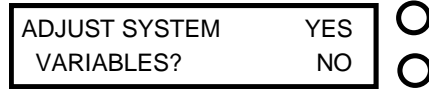


**Figure 8 - Manual Setpoint Change Prompt**

Once the cursor is scrolled past the last digit, setpoint adjustment is completed and the user is allowed access to the next Command Function as described in the following section.

### 3.2.2 Adjust System Variables

This command function is provided to allow user examination and adjustment of the system variables used by the controller.

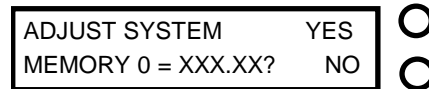


**Figure 9 - System Variables Access Prompt**

Pressing the switch by the display YES will allow access to the first system variable by presenting the messages shown in Figure 11, while responding with a NO command will terminate the function.

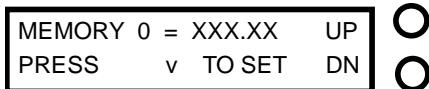
#### 3.2.2.1 Adjust Memory Temperatures

The first variable accessed is MEMORY 0 as shown in Figure 11. The MEMORY 0 variable is the system startup setpoint temperature. Responding YES to the prompt will allow the user to adjust the setpoint as shown in Figure 12, a NO response will access the remaining three memory setpoint temperatures (MEMORY 1 - MEMORY 3). A NO response to all four memory setpoint temperatures accesses the next system variable described in the following section.



**Figure 10 - System Memory Setpoint Prompt**

The adjustment of MEMORY 0 may be accomplished by using the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in Figure 12. The COMMAND switch, located directly below the LCD, is used to advance the cursor to each of the digits.



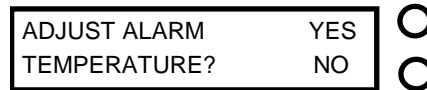
**Figure 11 - Adjust System Memory Setpoint Prompt**

Modification of the variable is accomplished by pressing either of the two switches to the right of the LCD. Pressing the switch adjacent to the UP prompt shown in Figure 12 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the DN will cause it to decrement one. As the cursor is scrolled past the last digit, memory setpoint adjustment is completed and the user is allowed access to the next memory setpoint. When all memory setpoint adjustments have been presented, the system advances to the next system variable as described in the following section.

#### 3.2.2.2 Change Primary Alarm Temperature

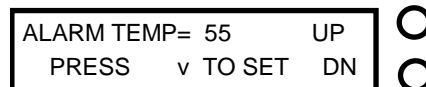
The next variable accessed by this function is ALARM TEMPERATURE, the temperature at which the controller turns off the heater drive to prevent overheating of the core.





**Figure 12 - Change Primary Alarm Temperature Access Prompt**

Responding YES to the prompt will allow user access to the variable modification function as described below, while a NO response will allow access to the next system variable in the sequence, as described in the following section.



**Figure 13 - Primary Alarm Temperature Adjust Prompt**

Modification of the variable is accomplished by pressing either of the two switches to the right of the LCD. The command switch located directly below the LCD is used to advance the cursor to each of the digits. Pressing the switch adjacent to the UP prompt shown in Figure 15 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the DN will cause it to decrement one. The range of the variable is -3.0 to 50.0 °C. As the cursor passes the last digit the value is stored as a temporary system variable.

If for any reason the measured core temperature exceeds the primary alarm temperature the following display will appear.

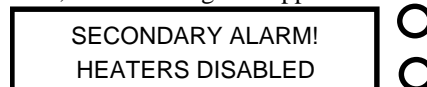


**Figure 14 - Primary Alarm Display**

When the primary alarm is exceeded the system immediately shuts off all power to the core heaters. The user must press Switch 2 in order to exit the above display and return the system to normal operation.

**\*\*Note: The Cryostat is provided with an isolated secondary alarm. The secondary alarm is provided to prevent a catastrophic system failure.**

This alarm is a failsafe device to prevent the system from overheating or overfilling the shell with liquid nitrogen. When this alarm is activated, the following will appear on the display.



**Figure 15 - Secondary Alarm**

When this alarm is activated the fan will stop, the liquid nitrogen valve will close, and the heaters will be disabled. This alarm can only be cleared by turning the system off and then back on again.

### 3.2.2.3 Set IEEE - 488 Address

The next variable presented is, SET IEEE-488 ADDRESS, the parameter that determines the address at which the system can be accessed over the IEEE-488 Buss. This is an optional accessory to the Cryostat system that will not be accessed if not installed. Please skip this section if the IEEE-488 feature has not been installed.

ADJUST GPIB	YES	<input type="radio"/>
ADDRESS = X	NO	<input type="radio"/>



**Figure 16 - IEEE-488 Address Adjust Prompt**

This variable may be examined or adjusted by the user by responding YES to the prompt, while a NO response will allow access to the next Command Function in the sequence as described in the following section.

ADDRESS = X	UP	<input type="radio"/>
PRESS v TO SET	DN	<input type="radio"/>



**Figure 17 - Address Adjust Prompt**

Here the user has the ability to choose the address at which the IEEE-488 can be located as shown in Figure 17. The adjustment of address may be accomplished by using either of the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in Figure 17. This variable can be set within the range of 1 to 30. The COMMAND switch, located directly below the LCD, is used to advance the cursor to each of the digits. Pressing the switch adjacent to the UP prompt shown in Figure 17 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the DN will cause it to decrement one. As the cursor passes the last digit the value is stored as a temporary system variable.

### 3.2.2.4 Access Vars Array

This function allows access to variables stored in the system's memory. It is strongly recommended that before responding YES one carefully reviews what each variable represents (see chart below). Only experienced users familiar with this system and its limitations should exercise this option.

**\*\*DO NOT ADJUST VARS ARRAY WITHOUT FIRST CONSULTING FACTORY!!!** Doing so can cause severe damage to the Cryostat and could be very dangerous! If the message UNABLE TO LOAD VARIABLES should appear on the front panel display call Pond Engineering immediately for service.

ACCESS VARS	YES	<input type="radio"/>
ARRAY?	NO	<input type="radio"/>



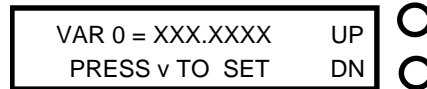
**Figure 18 - Access Variables Array Prompt**

Responding YES will cause Figure 19 to appear. This is to warn the user of the danger if this function is not used properly. Press Switch #1 to continue or Switch #2 to exit to the next function.



**Figure 19 - Warning Prompt**

Variables can be viewed and changed as shown below. The variables are not labeled. Please refer to the following chart for information about each variable.



**Figure 20 - Variable 0 Adjustment Prompt**

Scrolling through the variables is accomplished by pressing either of the two switches to the right of the LCD, the switch adjacent to UP increments the variable number and the switch adjacent to DN decrements it. The command key located directly below the LCD is used to start the adjustment of the selected variable by advancing the cursor through the digits. Pressing the switch adjacent to the UP prompt shown in Figure 20 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the DN will cause it to decrement by one. As the cursor passes the last digit the value is stored as a temporary system variable. **\*\*WARNING\*\* Software checking is not done for these entries and inputting values outside the recommended ranges can result in permanent damage to the system if utilized for operating the system.**

The following is a list of the variables and their locations.

#	Variable \Description	Default Values	Recommend Range
0	Setpoint Temperature	0.0000 degrees C	-190 to 50 degrees C
1	Memory 0 Setpoint Temperature	0.0000 degrees C	-190 to 50 degrees C
2	Memory 1 Setpoint Temperature	-38.8300 degrees C	-190 to 50 degrees C
3	Memory 2 Setpoint Temperature	-110.0000 degrees C	-190 to 50 degrees C
4	Memory 3 Setpoint Temperature	-189.3400 degrees C	-190 to 50 degrees C
5	Alarm Temperature	100.0000 degrees C	0 to 100 degrees C
6	GPIB Primary Address	6.0000	1.0000-30.0000
7	Gradient For Guard	0	±5 degrees C
10	Guard RTPW	See 6. Calibration Log	
11	Guard A Coefficient Above Zero	See 6. Calibration Log	
12	Guard B Coefficient Below Zero	See 6. Calibration Log	
13	Core RTPW	See 6. Calibration Log	
14	Core A Coefficient Above Zero	See 6. Calibration Log	
15	Core B Coefficient Below Zero	See 6. Calibration Log	
16	Shell RTPW	See 6. Calibration Log	
17	Shell A Coefficient Above Zero	See 6. Calibration Log	
18	Shell B Coefficient Below Zero	See 6. Calibration Log	
19	System Status		
20	ACCESS CODE for protected variables	0.0000	Call Factory

### 3.2.2.5 Save Changes to Variables

The user can now save the newly established system variables as the power-up default values. As mentioned earlier, the newly established system variables are stored as temporary system variables at this point, responding YES to this prompt causes the variables to be stored in non-volatile memory within the system controller to be utilized as the system variables the next time the system is turned on.

SAVE CHANGES TO	YES	<input type="radio"/>
VARIABLES?	NO	<input type="radio"/>



**Figure 21 - Save Variables Prompt**

Responding NO to this prompt causes the system to exit the function without saving the variables to non-volatile memory, allowing the user to temporarily establish new values for the system variables without permanently altering the default values. If the power were to be shut off or interrupted before the new information was stored into the non-volatile memory, the newly established values would be lost and the system would utilize the default values previously stored in non-volatile memory for the system variables at the time power was restored to the system. Following verification of performance of the newly established variable values, they may be stored by entering the ADJUST SYSTEM VARIABLES routine and responding YES to the SAVE CHANGES prompt when presented.

### 3.2.3 Diagnostics Display Mode Select

Here the user is given the opportunity to choose which set of information is presented by the display during operation. Two choices are presented, NORMAL DISPLAY and DIAGNOSTIC INFORMATION. The NORMAL DISPLAY mode is always presented upon system power up and is changed through this command function, to allow display of DIAGNOSTIC INFORMATION answer YES to the command function prompt shown in Figure 22.

DISPLAY DIAGNOSTIC	YES	<input type="radio"/>
INFORMATION?	NO	<input type="radio"/>



**Figure 22 - Diagnostics Mode Display Prompt**

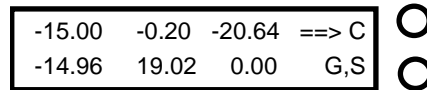
If the system is currently displaying DIAGNOSTIC INFORMATION, the prompt will be modified to allow the user to toggle back to the NORMAL DISPLAY mode by answering YES to the command function prompt shown in Figure 23.

CHANGE TO NORMAL	YES	<input type="radio"/>
DISPLAY?	NO	<input type="radio"/>



**Figure 23 - Normal Mode Display Prompt**

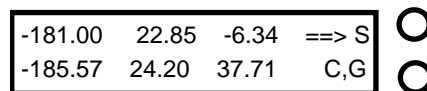
The DIAGNOSTIC INFORMATION display presents an array of numeric information for system diagnostics for the core, shell and guard system control loops.



**Figure 24 - Core Loop Diagnostics Display**

The information presented by the core loop diagnostics display is as follows. Top row left to right: current setpoint, core proportional signal, core derivative signal. Bottom row left to right: measured core temperature, core integrator signal, and core PID sum.

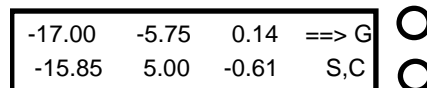
Pressing the button opposite the letters “G,S” on the display will allow the user to scroll to the next diagnostics display. An example of a second loop diagnostics display is shown in the figure below.



**Figure 25 - Shell Loop Diagnostics Display**

The information presented by this display is as follows. Top row from left to right: shell setpoint, shell proportional signal, shell derivative signal. Bottom row left to right: measured shell temperature, shell integrator signal, shell PID sum.

Pressing the button opposite the letters “C,G” on the display will allow the user to scroll to the next diagnostics display. An example of a core loop diagnostics display is shown in the figure below.



**Figure 26 - Guard Loop Diagnostics Display**

The information presented by the guard loop diagnostics display is as follows. Top row left to right: current setpoint, guard loop proportional signal, guard loop derivative signal. Bottom row left to right: measured core temperature, guard loop integrator signal, and guard loop PID sum.

**\*\*Note: Once the DIAGNOSTIC INFORMATION mode has been entered the display will only present the diagnostic information; normal display mode can be obtained through the COMMAND FUNCTIONS options as described above.**

After completing all of the command functions as described above, the Metrology Cryostat system will again return to the normal operating mode as described earlier.

## 4. Operating the Cryostat Using a Remote Interface

If the Cryostat has been equipped with an IEEE-488 Remote Interface any host computer that can be set up as a system controller may be used to operate the Cryostat over the interface. Pond Engineering has software available for reading the Cryostat variables by an IBM compatible or Macintosh computer with a National Instruments 488 interface card. Custom software packages are also available to integrate the

Cryostat into an automated lab. The system variables that can be accessed over the 488 and the command set recognized by the Cryostat are listed below.

#### **4.1 System Variable List**

Please refer to section 3.2.2.4 *Access Vars Array* for a list of the system variables.

#### **4.2 Cryostat Command Set**

The command set for the Cryostat is outlined in the following paragraphs. The commands are issued from the host computer that acts as the controller. The Cryostat acting as the slave listens when addressed as a listener, talks when addressed as a talker, and does not issue a service request (SRQ).

##### **4.2.1 Read System Variable**

The “READ “ command, called by sending a “R” (upper or lower case) followed by the two digit address of the variable, enables the user to read or interrogate the current values for system variables. The syntax for the read command is “Rxx”, where xx is the address of the variable to interrogate. The address must be two digits in length, therefore addresses less than 10 MUST HAVE LEADING ZEROS.

After receiving a read command, the Cryostat will wait to be addressed as a talker to return the data at the read location over the bus. The Cryostat has a one-second-write timeout, thus the controller in charge must read from the Cryostat within one second after sending the R command to receive data. For example: If the user wants to see the value stored as the systems alarm temperature, the user would send the character string:

```
R05<cr>
```

The controller in charge would then address the Cryostat as a talker and wait for the data to be returned.

**\*\*Note: The Cryostat must maintain control of the Cryostat core as the highest priority and may put off responding to 488 commands for as long as 500ms. The Cryostat being addressed as a talker and not in the control cycle would return the alarm temperature (variable address 05), as follows:**

```
+4.300000e+02(space)05
```

**The values returned are always in the above scientific format followed by a space and address number for the given value.**

##### **4.2.2 Write System Variable**

The “WRITE” command, called by sending a “W” (upper or lower case) followed by the two digit address, a comma, and the desired new value, enables the user to write or set the values for system variables. The syntax for the write command is “Wxx,(value)”, where xx is the address of the variable and (value) is the new desired value for the variable. The format for (value) must have a positive or negative sign followed by a decimal number with at most seven significant digits not to exceed 15 digits in length.

For example: If the user wants to change the value stored as the alarm temperature to -25.345 °C, the user would send:

```
W05,-25.345<cr>
```

and the alarm temperature variable would then be set to -25.345°C.

**\*\*Note: As variables are written to the system the new value is immediately used by the system.**

**However this new value is not stored as a permanent system variable until the user saves the variable using the “Save variables” command through the front panel. IMPORTANT! SAVING CHANGED VARIABLES WILL PERMANENTLY CHANGE THE SYSTEMS VARIABLES. Pond Engineering strongly recommends the user keep a log of any changed variables. Also, Pond Engineering is in no way responsible for any damage caused by the failure to use these commands properly. DO NOT set a variable outside the recommended range.**

In order to maintain flexibility the only variables that are limit checked are the Setpoint variables and the Alarm variables. All other variables can be set to any value received over the 488. Extreme caution must

be used when setting any variable over the 488. The user should read back any variable after setting it to insure the Cryostat received the variable correctly. This is especially important when setting the calibration RTPW and calibration coefficients, since an errant RTPW or coefficient may cause the Cryostat to overheat and damage the Cryostat core.

## 5. Handling and Maintenance

### 5.1 System Maintenance

The Primary Metrology Comparison Cryostat (k22) is designed and fabricated to require minimal periodic maintenance. The following information is provided to guide the user in maintaining the system. Care should be taken to avoid accumulation of excessive moisture in the thermometer wells or in the system dewar. After each use when significant moisture accumulation is observed, the system setpoint should be set to 50.0 °C and the system allowed to remain stable at this temperature for 2 hours or more to drive off excessive moisture.

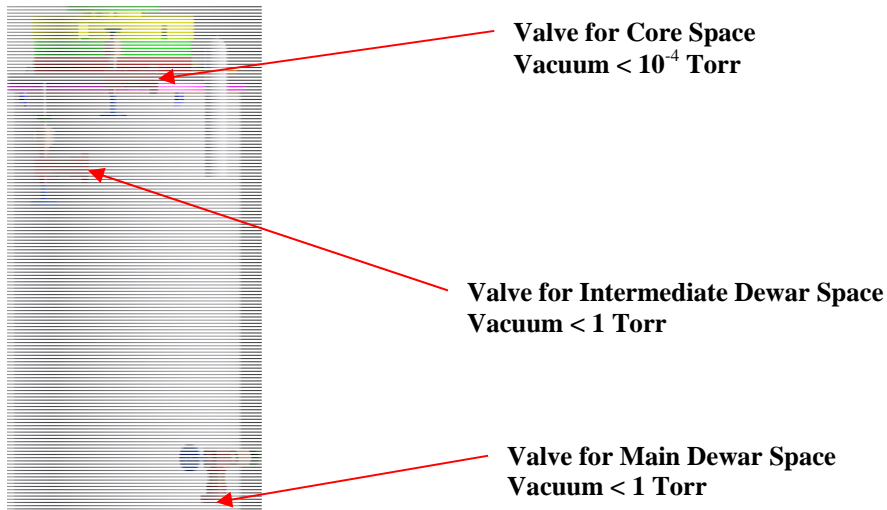
#### 5.1.1 Cleaning

Exterior surfaces of the cabinet are coated with a durable polyurethane coating which is not affected by most solvents and cleaning agents. It is recommended that exterior surfaces be cleaned with alcohol or a mild commercial cleaning agent.

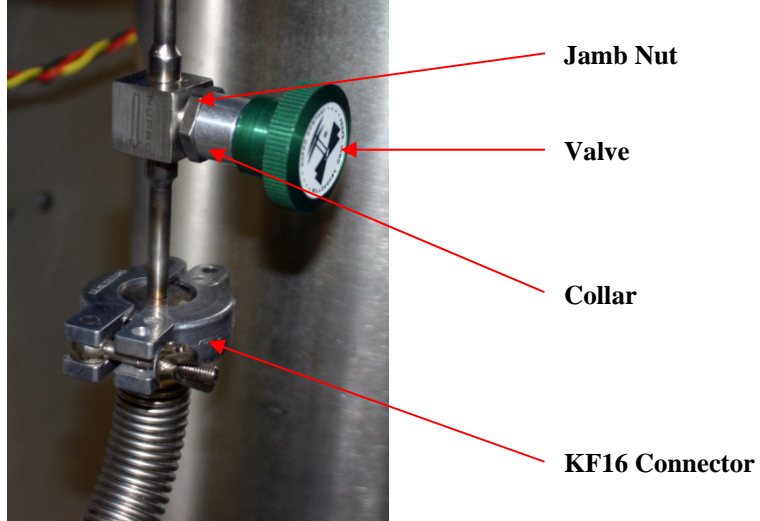
#### 5.1.2 Evacuation Procedures

#### 5.1.3 Evacuation Procedures

Under normal operation, the system should maintain an adequate vacuum level each vacuum space as indicated in the figure below for several years. If considerable condensation on the exterior of the main dewars outer envelope or unusually instabilities are notices, the dewar may be evacuated using the following procedure. An external high vacuum pump (capable of pumping to  $10^{-5}$  Torr or lower) and appropriate connecting lines to mate with the KF 16 flange vacuum fittings are needed.



**Figure 27 – Valves and Vacuum Space**



**Figure 28 - Vacuum Connector Assembly**

1. Connect to the external vacuum pump and evacuate line to  $10^{-3}$  Torr or lower.
2. Loosen valve jamb nut approximately  $\frac{1}{2}$  turn, by turning the nut counter-clockwise with an appropriate wrench. Loosen nut back and slide collar back.



**Figure 29 - Loosen Jamb Nut**

3. Slowly open valve 1 turn counter-clockwise, valve will then be open .



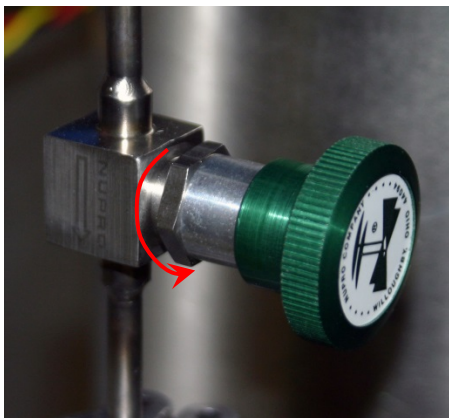


**Figure 30 – Open Valve**

4. Pump on core until  $10^{-5}$  torr achieved at pumping system
5. Close the valve tightly by turning the knob clockwise, slide collar towards valve, tighten jamb nut against collar.



**Figure 31 – Close Valve**



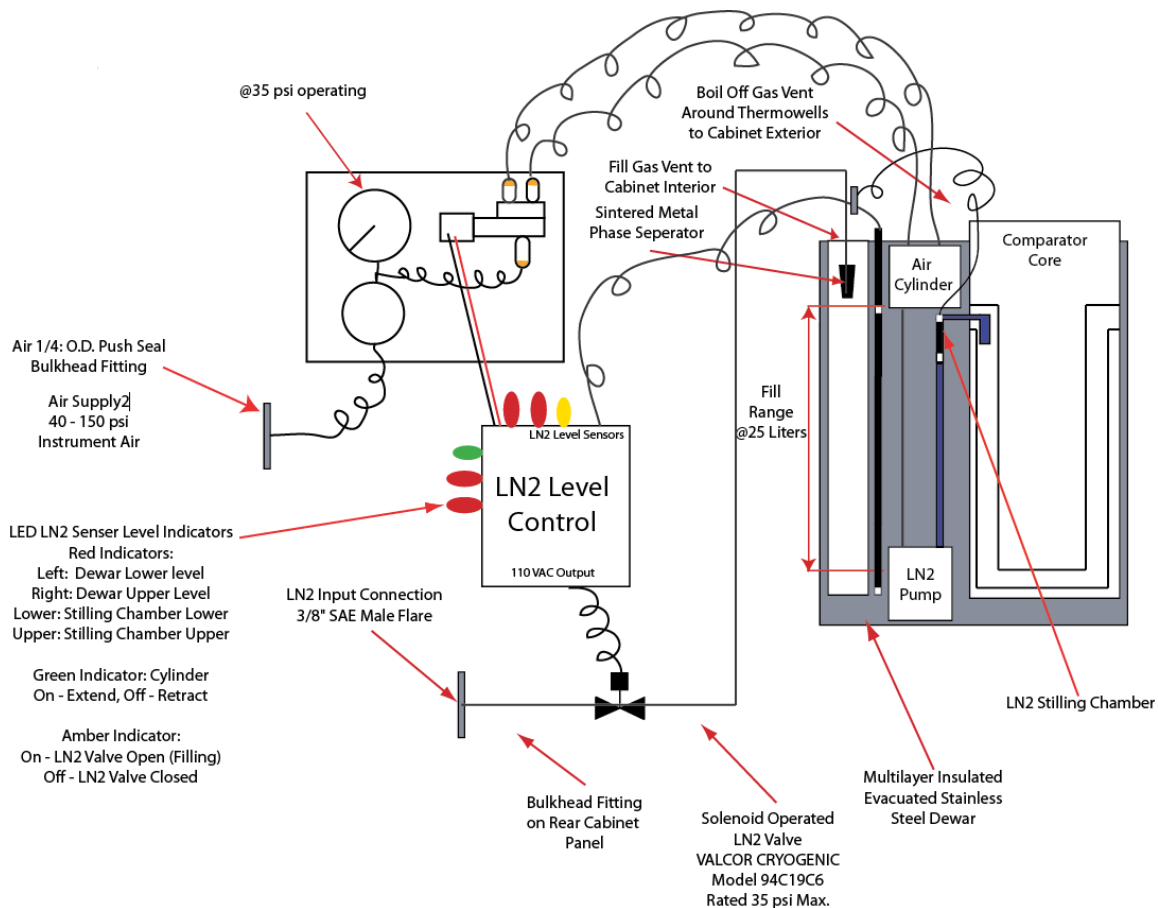
**Figure 32 - Tighten Jamb Nut**

6. Remove external high vacuum pump

## 6. System Hardware Description

A brief description of system hardware is provided in this section as a reference to aid the user with periodic maintenance of the system. In the event significant maintenance or repair is required, it is recommended that Pond Engineering be contacted prior to replacing or modifying major system components.

### 6.1 Liquid Nitrogen Level Controls



**Note:** Pond Engineering recommends a maximum input pressure of 15lbs. A valve should be used to adjust the flow rate of LN2 entering the system.

#### 6.1.1 LN2 Level LED Indicators

There are 6 LED indicators on the LN2 control board on the electronics chassis. The red LED's are used to indicate the upper and lower levels of the LN2. As shown in Figure 33 the red LED's in line with the amber are used to indicate the level of LN2 inside the main Dewar. The red LED's in line with the green indicate the fill level of the stilling chamber. When the red LED's are illuminated the respective sensor is submerged in LN2.

The Dewar's fill sensor indicators: The farthest left red LED indicates the lowest level of LN2 the unit needs to properly control. The red indicator to the right illuminates when the LN2 has reached the max fill

point. The amber LED indicates whether the auto LN2 fill valve is open and filling the chamber (LED is on) or closed (LED is off).

The stilling chambers sensor indicators: The lower red LED indicates the lower sensor; once this LED illuminates after the initial fill it should remain on until the unit is turned off. The lower sensor indicates that the LN2 pump is continuously dispersing LN2 around the intermediate Dewar. The upper red indicator

## **6.2 Front Panel**

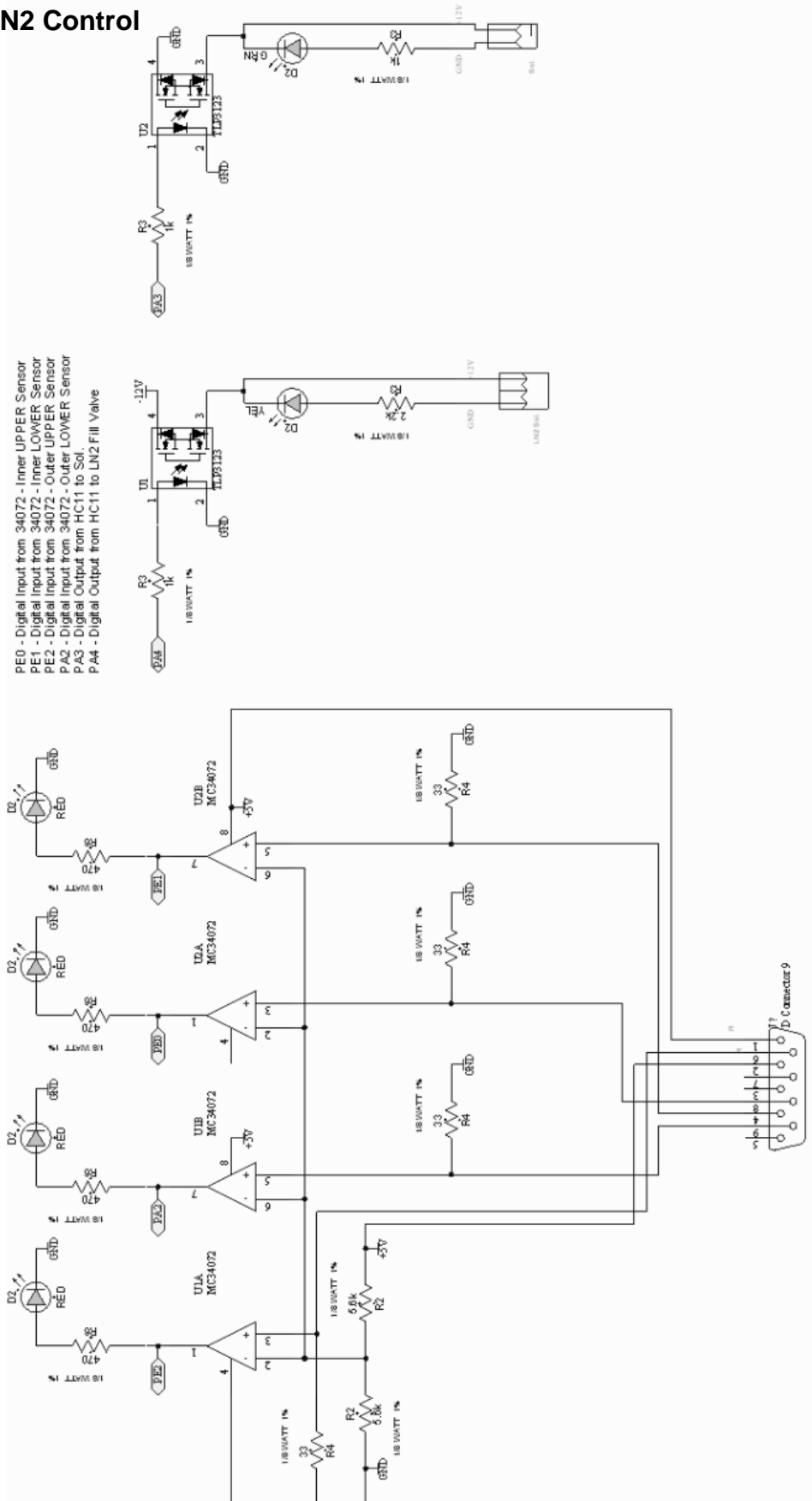
<b>REF. #</b>	<b>NAME</b>	<b>MAKE</b>	<b>MODEL</b>
1	Die Cast Metal Bezel	JMJ Technical Products, Inc.	1-458
2	24X2 Dot Matrix LCD Module DMC Series	Optrex	DMC20261
3	Miniature Pushbutton panel Mount SPDT Switches - 3 each – with Caps for Miniature Switches	Eaton Cutler-Hammer Eaton Cutler-Hammer	PS1-100Q W-KN-17
4	Engraved Laminate Front Panel	Pond Engineering	K22-FP

## **6.3 Power Input**

<b>NAME</b>	<b>MAKE</b>	<b>MODEL</b>
Power Cord	10A/220AC (50/60HZ)	NEMA 5 -15P

## **6.4 Schematics**

### 6.4.1 LN2 Control



## 6.4.2 Top Level



## 7. Calibration Log

<u>Date</u>		<u>RTPW</u>	<u>Coef. A &lt; 0</u>	<u>Coef. B &lt; 0</u>
	CORE			
	SHELL			
	GUARD			
	CORE			
	SHELL			
	GUARD			
	CORE			
	SHELL			
	GUARD			
	CORE			
	SHELL			
	GUARD			
	CORE			
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	CORE			
	SHELL			
	GUARD			