

Model K23M / K23MR

Metrology Furnace
Operation and Maintenance Manual

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Metrology Furnace System

1. Background

This report documents the installation, operating and maintenance procedures for the Metrology Furnace system. Information contained in this manual is considered by Pond Engineering Laboratories to be proprietary and is provided for use exclusively by the purchaser for instructional and maintenance purposes relative to the hardware delivered and any other use is prohibited.

2. General Information and Operating Procedures

Figure 1 below, shows the general configuration of the Metrology Furnace system and provides the reader a better visualization of its appearance, as well as a point of reference in location and use of the control switches and service points discussed later in this manual.

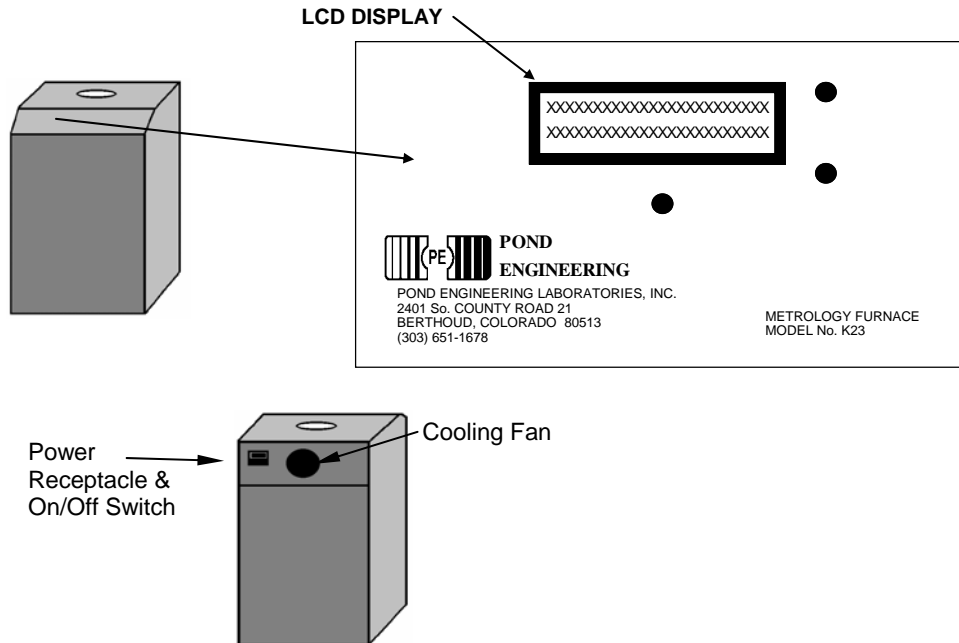


Figure 1 - System General Layout

As shown in Figure 1, the controller front panel is located on a sloping surface at the front of the outer chassis of the Metrology Furnace. The Metrology Furnace is designed to provide a stable and uniform temperature environment for the preparation and maintenance of Indium, Tin, and Zinc fixed point cells. It provides three preheat wells 0.312" (7.9 mm) inside diameter and approximately 16" deep.

Optional features include an Isothermal Block, IEEE-488 and RS 232 interface. Either interface can be installed at the factory to allow operation of the Metrology Furnace system as part of an integrated automatic calibration system. The Isothermal Block is used to provide a uniform and stable environment for the comparison of up to four thermometers.



Interior access to the system cabinet is provided by four removable panels attached to the frame by button head screws at the periphery of the panels. Any or all of the four cover panels may be removed for inspection and service without disconnecting any system cabling.

Installation of a cell is accomplished by carefully sliding the cell assembly downward into the furnace core until the cell is resting on the bottom of the core. Pond Engineering suggests the use of a cushion to protect the cell from coming in direct contact with the aluminum core.

Operator interface is provided by three front panel switches (keys) and a 2 line by 24 character Liquid Crystal Display (LCD) located in the front panel of the Metrology Furnace system as shown in Figure 2 below.

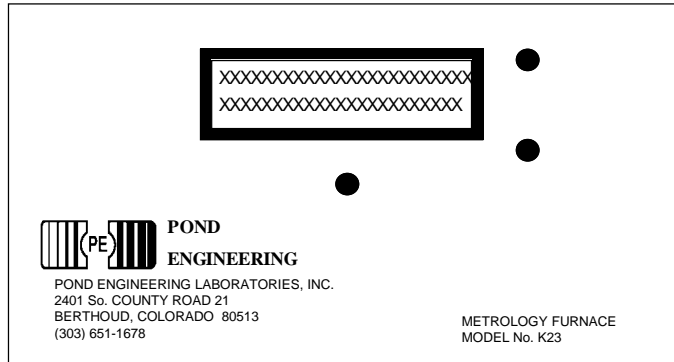


Figure 2 - Front Panel Layout

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 three second intervals and the lower line of the display is updated following measurement, indicating the measured core temperature. Additional controller functions (for the purpose of providing diagnostic information, access to variables, etc.) are accessed through the use of the front panel switches and messages presented by the LCD display as outlined in the following sections.

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 a 24 character by 2 line Liquid Crystal Display (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 is provided in the following text and figures, providing a detailed description of prompts and user actions necessary to set up the system, edit configurations and operate the system manually.

Because of the multitude of functions which each switch will be called upon to 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 3 below are for the benefit of the reader in understanding the documentation herein. Such labels do not appear on the device front panel.)



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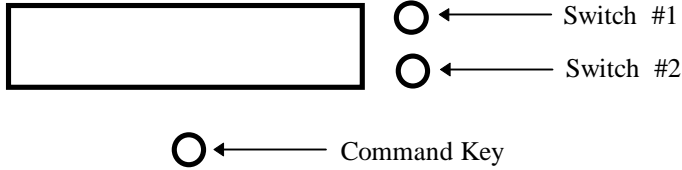


Figure 3 - Front Panel Switch Layout

3.1. Normal Operating Mode

In normal operation, the Metrology Furnace controller will continuously display the current temperature setpoint for the controller and the measured core temperature on the first and second lines of the display, as shown in Figure 4 below. Measurements are taken at approximately three second intervals and the lower line of the display updated following measurement. This information is removed from the display when the user presses and holds the “Command Key” for a period of two to three seconds which allows entry to the “COMMAND FUNCTIONS” portion of the program.

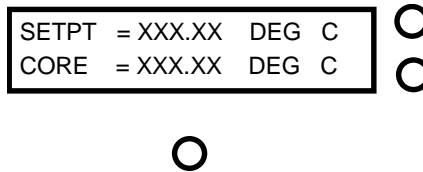


Figure 4 - Normal Operating Mode Display

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 and 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 and then the operator must release the key.

The system has been designed such that control functions operate normally even when the user is accessing the control functions.

3.2.1. Change Setpoint

The first command function accessed is “CHANGE SETPOINT TEMPERATURE.” This function allows the user to change the setpoint to one of three user adjustable memory setpoint temperatures or manually adjust the setpoint temperature. Manual adjustment of the setpoint temperature may be accomplished within the range of 90.00 to 500.00 (660 for MR) degrees C. As shown in Figure 5, the “YES” is located adjacent to the top switch, which we 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 6 will be presented on the LCD.

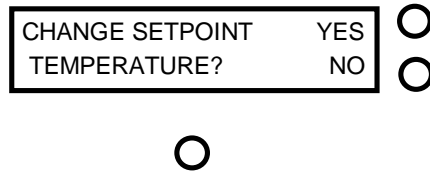


Figure 5 - Setpoint Access Prompt

The system controller is equipped with three “SETPOINT” memory temperatures. The user may choose to select the memory setpoint temperatures by pressing the corresponding “YES” switch. A “NO” selection will advance the system to the next memory setpoint. A “NO” response to all of the three memory setpoint temperatures will allow the user to change the setpoint manually, as shown in Figure 7 below.

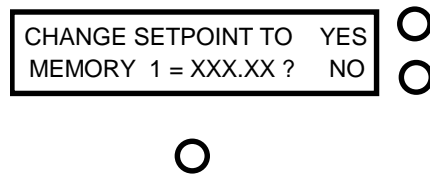


Figure 6 - Memory Setpoint Change Prompt

The 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 “COMMAND” key, located directly below the LCD, is used to advance the cursor to each of the digits. The current number presented on the display is used by the system controller as the current setpoint even while in the command functions mode.

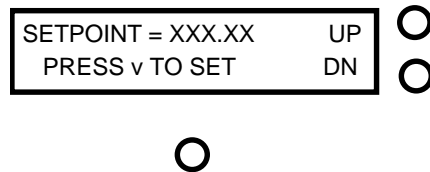


Figure 7 - Manual Setpoint Change Prompt

As the cursor is scrolled past the hundredths 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

The second command function accessed is “ADJUST SYSTEM VARIABLES.” This command function is provided to allow user examination and adjustment of the system variables used by the controller.

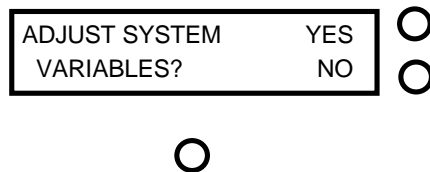


Figure 8 - System Variable Access Prompt

Pressing the switch by the display “YES” will allow access to the first system variable by presenting the message shown in Figure 9, while responding with a “NO” command will terminate the function.

3.2.2.1. *Adjust System Memory Setpoint Temperatures*

The first variable accessed by the adjust system variables function is “MEMORY 0” as shown in Figure 9. The “MEMORY 0” variable is the system startup setpoint. Responding “YES” to the prompt will allow the user to adjust the setpoint as shown prompted in Figure 10, a “NO” response will access the next memory setpoint.

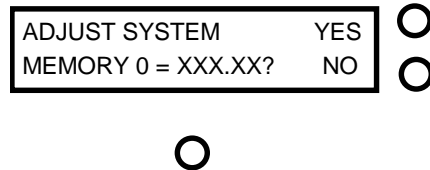


Figure 9- System Memory Setpoint Prompt

The adjustment of “MEMORY 0” may be accomplished by using the two switches on the side corresponding the labels “UP” and “DN” displayed on the LCD shown in Figure 10. The “COMMAND” key, located directly below the LCD, is used to advance the cursor to each of the digits.

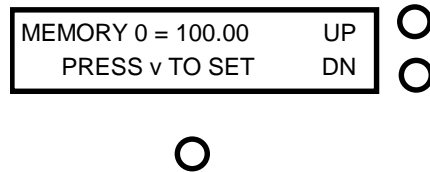


Figure 10 - Adjust System Memory Setpoint Prompt

As the cursor is scrolled past the hundredths 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 command function as described in the following section.

3.2.2.2. *Adjust 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 the core or a cell in the furnace. Adjustment is accessed by displaying the messages shown in Figure 11 below.

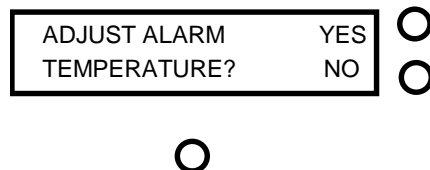


Figure 11 - Adjust Alarm Temperature Access Prompt

Responding “YES” to the prompt will allow user access to the “ADJUST ALARM TEMPERATURE” 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.

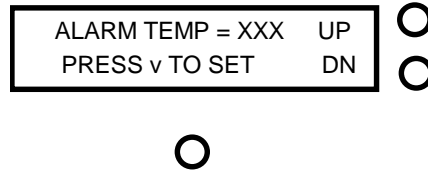


Figure 12 - Alarm Temperature Adjust Prompt

Modification of the variable is accomplished by pressing the two switches to the right of the LCD. The command key 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 12 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the “DN” will cause it to be decremented by one. The range of the variable is 90 - 505 (665 for MR) degrees C. As the cursor passes the last digit the value is stored as a temporary system variable, provided the desired alarm temperature falls within the allowable range. An attempt to set the alarm temperature to a value outside the given range will cause no change in alarm temperature to take place and the next variable access function will be started.

3.2.2.3. *Adjust Control Gradient*

The control gradient is the setpoint temperature difference between the core and the guard zone. A positive setting indicates the guard zone temperature setpoint is higher than the core setpoint. A negative setting indicates the guard zone temperature setpoint is lower than the core setpoint. One possible use of this adjustment is to minimize axial temperature gradients in the core. A “YES” response to the prompt below allows changes to the guard zone temperature setpoint relative to the system setpoint.

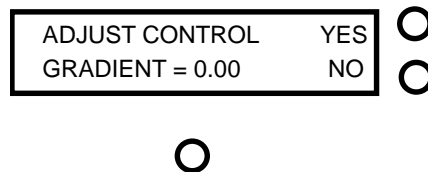


Figure 13 - Gradient Control Access Prompt

Responding with a “NO” to the prompt will cause no change in temperature gradient to take place and the next variable access function will be started. A “YES” response will allow the user to change the temperature gradient setting as shown in Figure 14 below.

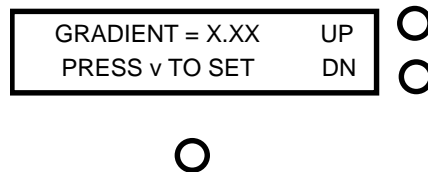


Figure 14 - Gradient Adjust Prompt

The adjustment of “GRADIENT” may be accomplished by using the two switches on the side corresponding the labels “UP” and “DN” displayed on the LCD shown in Figure 10. The “COMMAND” key, located directly below the LCD, is used to advance the cursor to each of the

digits. Pressing the switch adjacent to the “UP” prompt will cause the value of the digit to be incremented by one and pressing the switch adjacent to the “DN” will cause the variable to be decremented by one. As the cursor is scrolled past the hundredths digit, the gradient adjustment is completed and the user is allowed access to the next function. This variable has a range from -9.99 - 9.99 degrees C.

3.2.2.4. *Adjust GPIB Address (Only meaningful if IEEE-488 option installed)*

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 Furnace 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 15 - 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 16 - 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.

3.2.2.5. *Change Secondary Alarm Temperature*

The next variable accessed by this function is the secondary alarm temperature. This is a setpoint temperature used by a separate safety system that drops power to the heater power supply if reached or exceeded. Once tripped, this alarm can only reset by doing a POR (power on reset). It is recommended that this value be set higher than the (primary) Alarm Temperature. Adjustment is accessed by displaying the messages shown in Figure 16 below.

CHANGE SECONDARY	YES	<input type="radio"/>
ALARM TEMPERATURE?	NO	<input type="radio"/>



Figure 17 - Change Secondary Alarm Temperature Access Prompt

Responding “YES” to the prompt will allow user access to the “CHANGE SECONDARY ALARM TEMPERATURE” 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.

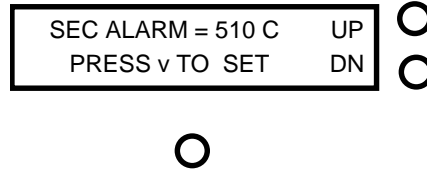


Figure 18 - Secondary Alarm Temperature Adjust Prompt

Modification of the variable is accomplished by pressing the two switches to the right of the LCD. The command key 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 18 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the “DN” will cause it to be decremented by one. The range of the variable is 90 - 510 degrees C. As the cursor passes the last digit the value is stored as a temporary system variable, provided the desired secondary alarm temperature falls within the allowable range.

3.2.2.6. Access Vars Array

This function allows access to variables stored in the system’s memory. It is strongly recommended that before responding “YES” , that a careful review of what each variable represents be conducted (see chart below). It is strongly recommended that only experienced users familiar with this system and its limitations exercise this option.

****DO NOT ADJUST VARS ARRAY WITHOUT FIRST CONSULTING FACTORY!!!** Doing so can cause severe damage to the furnace 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.

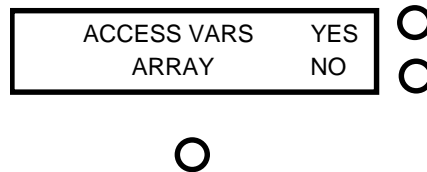


Figure 19 - Access Variables Array Prompt

Responding “YES” will cause Figure 20 to appear. This is to warn the user of the danger that could occur if this function is not used properly. Press Switch #1 to continue or Switch #2 to exit to the next function.

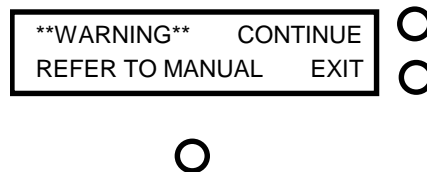


Figure 20 - Warning Prompt

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

VAR 0 = XXX.XXXX	UP
PRESS v TO SET	DN




Figure 21 - Variable 0 Adjustment Prompt

Scrolling through the variables is accomplished by pressing 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 21 will cause the value of the selected digit to increment one, while pressing the switch adjacent to the “DN” will cause it to be decremented 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.**

Following is a list of the variables and their locations:

#	Variable \Description	Default Values	Recommend Range
0	Setpoint Temperature	100.0000 degrees C	90-500 degrees C
1	Memory 0 Setpoint Temperature	100.0000 degrees C	90-500 degrees C
2	Memory 1 Setpoint Temperature	156.0000 degrees C	90-500 degrees C
3	Memory 2 Setpoint Temperature	232.0000 degrees C	90-500 degrees C
4	Memory 3 Setpoint Temperature	419.0000 degrees C	90-500 degrees C
5	Alarm Temperature	505.0000 degrees C	90-505 degrees C
6	GPIO Primary Address	6.0000	1.0000-30.0000
7	Gradient Along Core	0.0000	-9.99-9.99 degrees C
10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		
20	ACCESS CODE for protected vars 766.3	0	

****Protected Variables****

21	Proportional 1 Gain	2.0000	1.0000-4.0000
22	Integral 1 Gain	.1	0.0025-.200
23	Derivative 1 Gain	-50.0000	-100.0000- -25.0000
24	Number of core temperature read	70	
25	Number of shell temperature read	70	
26	Number of guard temperature read	70	
27	Integral increment maximum	0.3000	
28	Second Control Group Limit	10.0000	
30	Proportional 2 Gain	20.0000	10.0000-40.0000
31	Integral 2 Gain	0.0200	0.0100-0.1600
32	Derivative 2 Gain	-300.0000	-600.000- -150.0000
33	Integral 2 Increment Maximum per ISR	0.1000	
34	Core Drift rate threshold	0	
35	Proportional 2 Limit	10.0000	
36	Integral 2 Limit	10.0000	
40	Vars initial check	23.0300	
47	Proportional 2	(current reading)	
48	Integral 2	(current reading)	
49	Derivative 2	(current reading)	
59	Average Core Temperature	(current reading)	
60	Core Temperature	(current reading)	
61	Shell Temperature	(current reading)	
62	Guard Temperature	(current reading)	
63	Core Sensor Resistance	(current reading)	
64	Shell Sensor Resistance	(current reading)	
65	Guard Sensor Resistance	(current reading)	
66	Proportional Signal	(current reading)	
67	Integral Signal	(current reading)	
68	Derivative Signal	(current reading)	

3.2.3. Save Changes to Variables

Here the user is given the opportunity to save the newly established system variables to non-volatile RAM. 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 RAM within the system controller. System variables stored in non-volatile RAM are utilized to establish the values for the system variables the next time the system is turned on.

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



Figure 22 - Save Variables Prompt

Responding “NO” to this prompt causes the system to exit the function without saving the variables to non-volatile RAM, 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 in non-volatile RAM, the newly established values would be lost and the system would utilize the default values previously stored when re-started. 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 it appears.

3.2.4. 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 control function to allow display of “DIAGNOSTIC INFORMATION” by answering “YES” to the command function prompt shown in Figure 3.

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



Figure 23 - Diagnostics Mode Display Prompt

If the system is currently displaying “DIAGNOSTIC INFORMATION”, the prompt will be modified as shown in Figure 24 to allow the user to toggle back to the “NORMAL DISPLAY” mode.

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



Figure 24 - Normal Mode Display Prompt

The “DIAGNOSTIC INFORMATION” display presents an array of numeric information for system diagnostics for each of the system control loops; the Core, Shell and Guard. An example of the Control loop diagnostic information is shown in Figure 25.

483.00	10.00	-3.89	==> C	○
133.89	-10.00	-3.9	S,G	○



Figure 25 - Core Control Loop Diagnostics Display

The information presented by this display is as follows. Top row left to right: current core temperature setpoint, core proportional signal, core derivative signal. Bottom row left to right: measured core temperature, core integrator, offset temperature passed to shell control loop.

Pressing the lower of the two side buttons (Switch 1 & 2) on the display will allow the user to toggle between the core, shell, and the guard control loop diagnostics display. An example of a shell control loop diagnostics display is shown in Figure 26.

478.5	56.30	-6.9	==> S	○
140.88	28.00	28.0	G,C	○



Figure 26 - Shell Control Loop Diagnostics Display

The information presented by the shell control loop diagnostics display is as follows. Top row left to right: current shell setpoint, shell proportional signal, shell derivative signal. Bottom row left to right: Measured shell temperature, shell integrator, shell drive voltage.

483.00	06.41		==> G	○
163.15	32.00	28.00	C,S	○



Figure 27 - Guard Control Loop Diagnostics Display

The information presented by the guard control loop diagnostics display is as follows. Top row left to right: current guard setpoint, guard proportional signal. Bottom row left to right: Measured guard temperature, guard integrator, guard drive voltage.

**** 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.

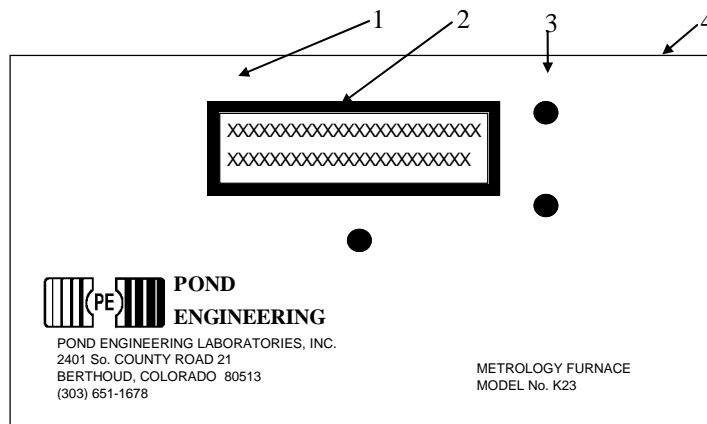
After completing all of the command functions as described above, the system will again return to the normal operating mode, presenting the normal display or diagnostic display information as selected.

4. System Hardware Description

A brief description of system hardware is provided in this section as a reference to aid the user in providing 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.

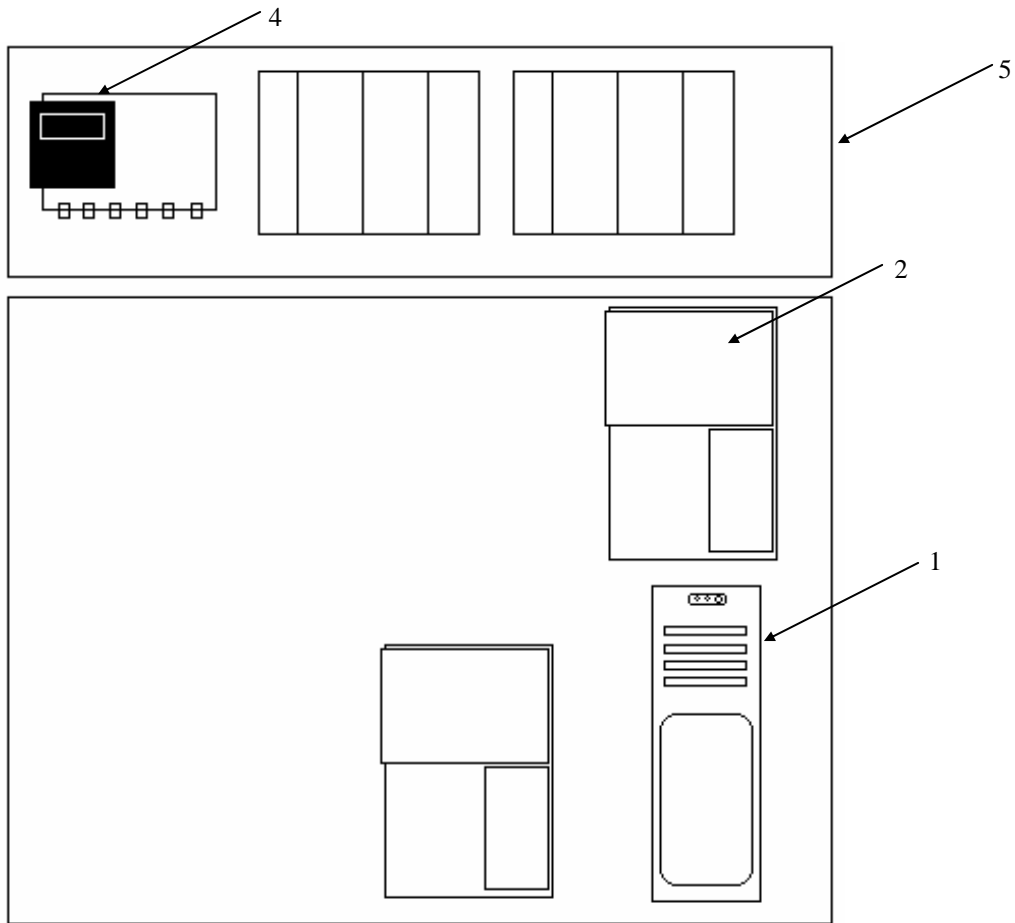
Exterior surfaces of the Metrology Furnace have been coated with a durable polyurethane coating which is not affected by most solvents and cleaning agents. It is recommended that exterior surfaces be cleaned with alcohol or a mild commercial cleaning agent.

4.1. Front Panel



<u>REF. #</u>	<u>NAME</u>	<u>MAKE</u>	<u>MODEL</u>
1	Die Cast Metal Bezel	JMJ Technical Products, Inc.	1-458
2	24X2 Dot Matrix LCD Module DMC Series	Optrex	DMC20261
3	Miniature Push-button panel Mount SPDT Switches - 3 each - with Caps for Miniature Switches	Eaton Cutler-Hammer	PS1-100Q
4	Engraved Laminate Front Panel Electronics Chassis	Eaton Cutler-Hammer Pond Engineering	W-KN-17 K18-FP4.2.

4.2. Electronics Chassis

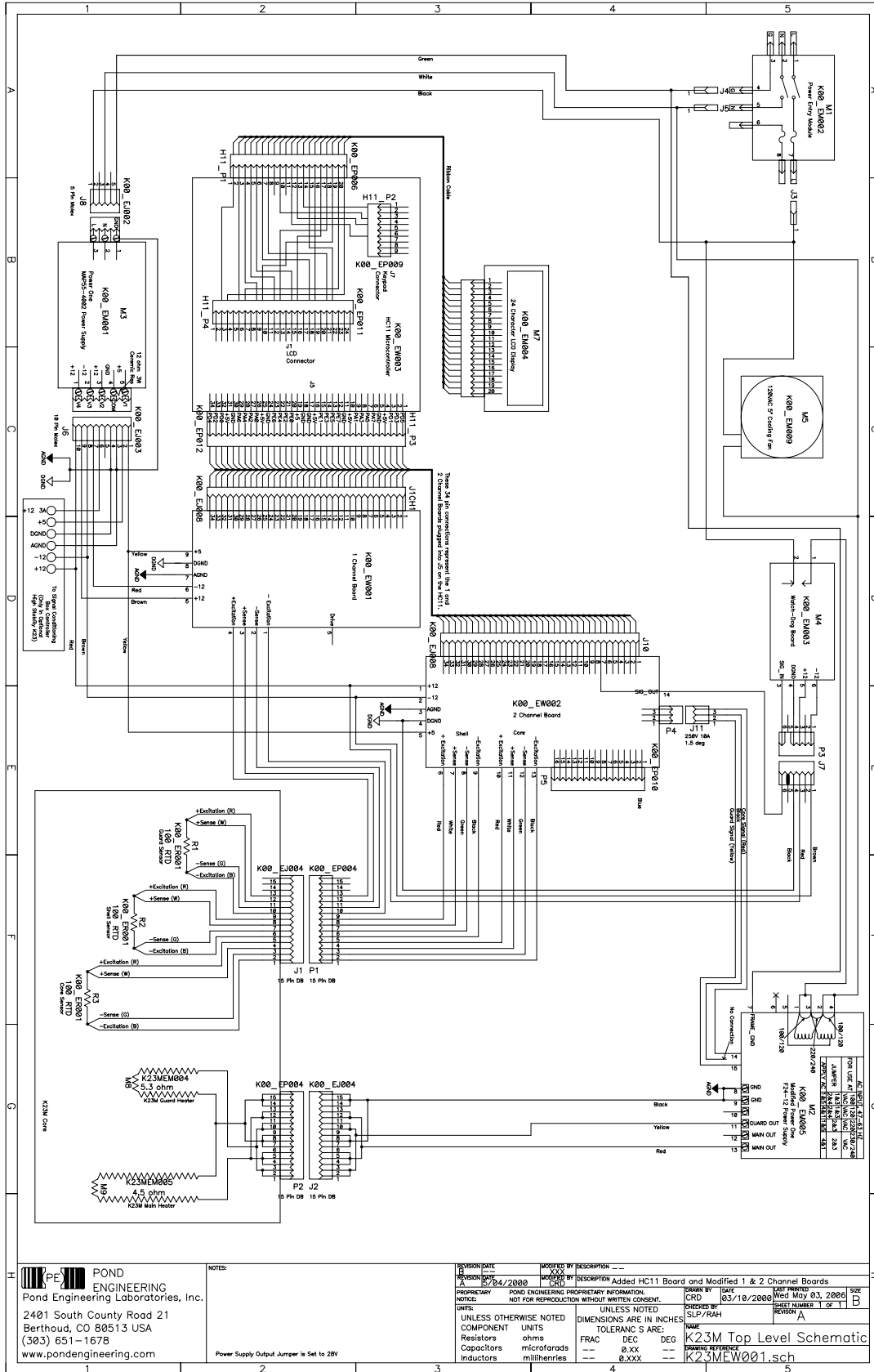


<u>REF.#</u>	<u>NAME</u>	<u>MAKE</u>	<u>MODEL</u>
1	Power Supply	Power-One Inc.	MAP55-4002
2	Microprocessor/Controller	Pond Engineering Labs.	K23-PRIMARY
3	Microprocessor/Controller	Pond Engineering Labs.	K23-SAFETY
4	System ON/OFF Switch	Power Dynamics	42R37
5	Power Supply	Pond Engineering Labs.	F24-12-A

4.3. Power Input

Power Cord 10A/240AC (60HZ) NEMA 6 -15P
 Fuse 6A / 250V (fuse in power receptacle)

4.4 Top Level Schematic



5. Calibration Record

#	Variable \Description	Factory Values	Comments
10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		

#	Variable \Description	Values	Comments
10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		

10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		

10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		

10	RTPW for Core Sensor		
11	A Coefficient		
12	B Coefficient		
13	C Coefficient		
14	RTPW for Shell Sensor		
15	A Coefficient		
16	B Coefficient		
17	C Coefficient		
18	RTPW for Guard Sensor		

