Model K23XR

Primary Metrology Comparison Furnace

Operation and Maintenance Manual

by
Pond Engineering Laboratories, Inc.
2401 South County Road 21
Berthoud, CO 80513
(303) 651-1678
www.pondengineering.com

Rev. 5/3/2006

POND ENGINEERING
Pond Engineering Laboratories, Inc.
www.pondengineering.com

POND ENGINEERING
Pond Engineering Laboratories, Inc.
www.pondengineering.com

Primary Metrology Furnace System

1. Background

This report documents the operation and maintenance procedures for the Primary Metrology Furnace system, Pond Engineering Model Number K23XR. 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. Any other use is prohibited. An electronic copy of this manual along with the Pond Engineering GPIB Driver is on the CD-ROM included with the manual.

2. General Information and Operating Procedures

General configuration of the Primary Metrology Furnace is shown in the diagram below and is intended to give the reader a better understanding of the overall system layout as well as specifying the location of the control switches and service points discussed later in this manual.

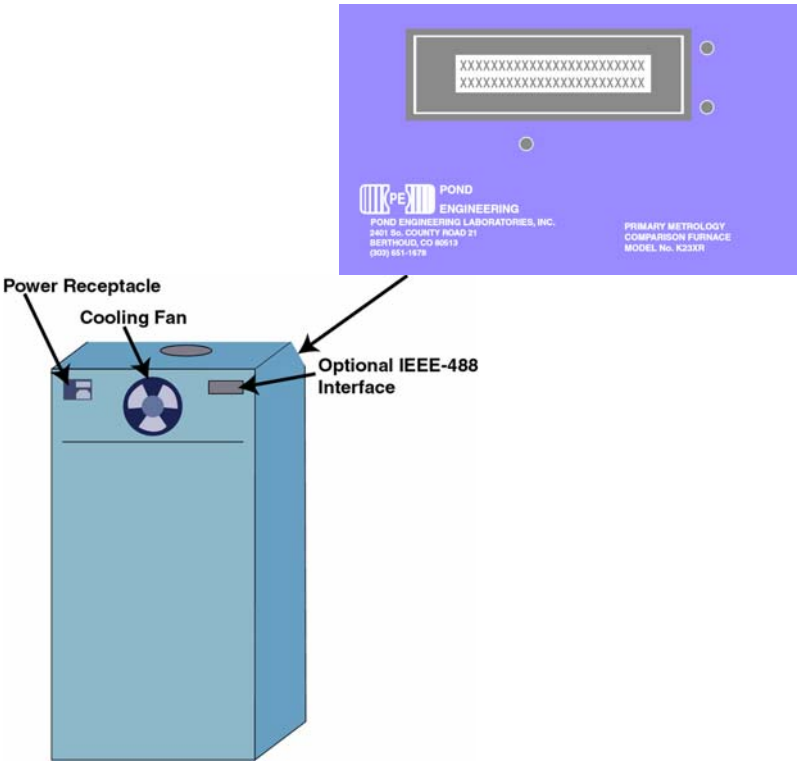


Figure 1 - System General Layout

As shown in Figure 1, the three interactive control switches and 2 line by 24 character Liquid Crystal Display (LCD) are located on the sloping front panel of the Primary Metrology Furnace. The Furnace is designed for use with Primary Fixed Point Cells or the optional Comparison Blocks (standard configuration allows seven thermometers to be compared) for calibrations within the range of 220°C to 1000°C. The furnace may be configured with an optional IEEE-488 or RS-232 remote interface, which allows it to be used as part of a highly automated calibration system.

Interior access to the system cabinet is provided by a removable back panel attached to the frame by button head screws. CAUTION: High voltage is present inside the furnace cabinet even when the power switch is in the off position.

All user interfacing is accomplished through three front panel switches and a 2 line by 24 character Liquid Crystal Display (LCD) located on the front panel of the cabinet, as shown in Figure 2.

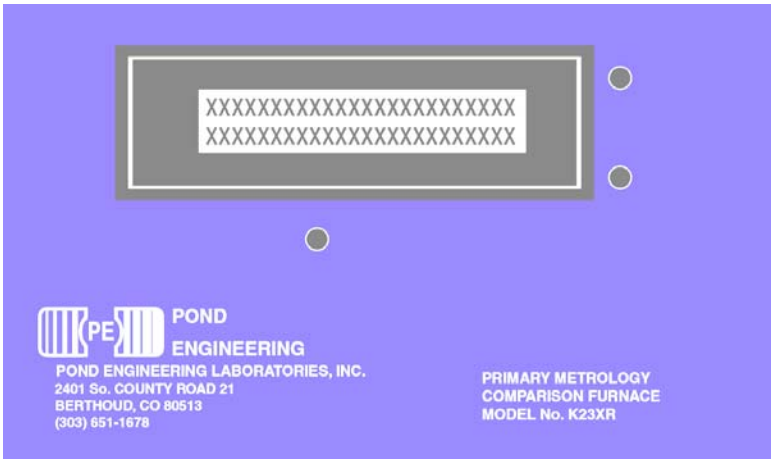


Figure 2 - Front Panel Layout

3. System Controller

Interactive controller software provides simplicity in the system controls while maintaining the flexibility necessary to accommodate optional features. The user interface, including LCD and switches, provides access to all system functions and variables through a set of "COMMAND FUNCTIONS". Explanatory prompts, displayed on the LCD, explain user options and give directions for all user actions necessary to set up the system, edit configurations and operate the system manually. The following sections provide a detailed outline of each "COMMAND FUNCTION" and the software prompts and user actions that accompany them.

Because of the multitude of functions 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. (The labels attached to the switches in Figure 3 are for the benefit of the reader in understanding references to switches throughout this manual. Such labels do not appear on the device front panel.)

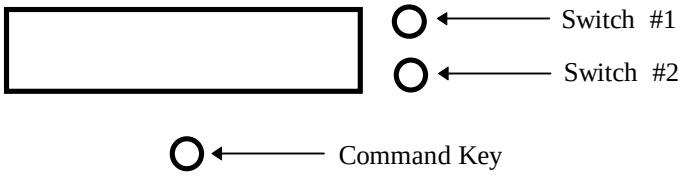


Figure 3 - Front Panel Switch Layout

3.1. Normal Operating Mode

During normal operating mode, the system controller displays both the current setpoint and most recent temperature reading taken from the core. Measurements are taken at approximately 3 second intervals and the lower line of the display is updated following 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 in order to access the "COMMAND FUNCTIONS" portion of the program.

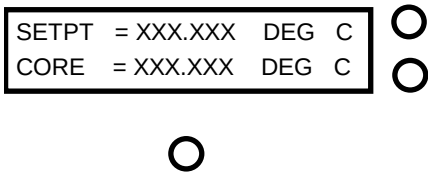


Figure 4 - Normal Operating Mode Display

3.2. The Command Functions

In order to perform the functions necessary for operation, the user must leave the normal operating mode and enter the "COMMAND FUNCTIONS" mode. This is accomplished by depressing the Command Key and holding it down for a period of 2-3 seconds. As the key is pressed, the words "COMMAND FUNCTIONS" will be immediately displayed on the lower line of the LCD. 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 should press and hold the Command Key until the words "COMMAND FUNCTIONS" disappear (approximately three seconds) and then release the key.

**Note: The system has been designed such that control functions operate normally even

when the user is accessing the command functions.

3.2.1. Change Setpoint Temperature

First on the menu of command functions is the query "CHANGE SETPOINT TEMPERATURE?" This function allows the user to quickly and easily change the system controller setpoint.

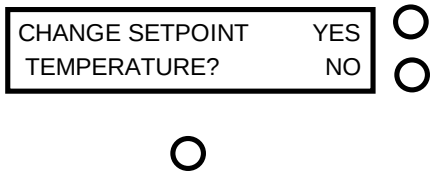


Figure 5 - Set point Access Prompt

As shown in Figure 5, 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 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.

Setpoints can be changed to one of three "memory setpoints" stored in the system, or adjusted manually. The three "memory setpoints" allow the user to customize their system by entering the three most frequently used setpoints for quick, efficient access. Adjusting memory setpoints is discussed in section 3.2.2.1.

The user may select one of 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.

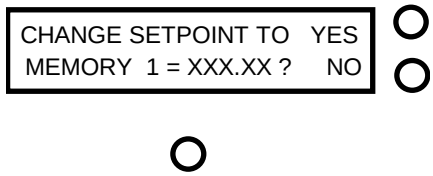


Figure 6 - Memory Setpoint Change Prompt

Changing the setpoint to a temperature not pre-programmed into the system memory is accomplished through the LCD interface. The setpoint may be any value within the range of 220.00°C to 1000.00°C. To change the setpoint value, simply use switches labeled "UP" and "DN" located on the right side of the LCD. Pressing the switch adjacent to the "UP" prompt will cause the value of the selected digit to be increased by one, while pressing the switch adjacent to

the "DN" prompt will cause it to be decreased by one. The Command Key, located directly below the LCD, is used to advance the cursor to each of the digits. As the cursor is scrolled past the last digit, setpoint adjustment is completed and the user is advanced to the next Command Function as described in the following section.

The setpoint temperature presented on the display is used by the system controller only after the cursor is moved past the least significant figure.

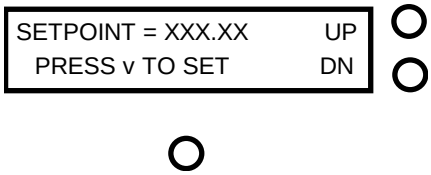


Figure 7 - Manual Setpoint Change Prompt

3.2.2. Adjust System Variables

After the setpoint has been confirmed or adjusted, the system will automatically advance to the next "COMMAND FUNCTION", "ADJUST SYSTEM VARIABLES?" This function allows the user to review and adjust both the system variables used by the controller and the calibration variables involving core temperature measurement.

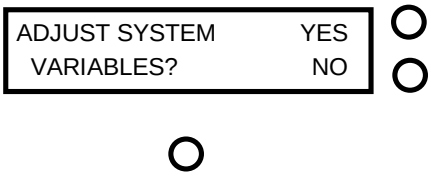


Figure 8 - System Variable Access Prompt

Pressing the upper switch labeled "YES" will allow access to the first system variable, and the message shown in Figure 9 will appear. Responding "NO" will skip over the system variables and advance to the next command function.

3.2.2.1. Adjust Memory Setpoint Temperatures

The first variable accessed by the "ADJUST SYSTEM VARIABLES" function is the "Memory 0", as shown in Figure 9. Responding "YES" to the prompt will allow the user to adjust the system start-up setpoint (default setpoint temperature displayed when the system is started). A "NO" response will advance the system to the next memory setpoint.

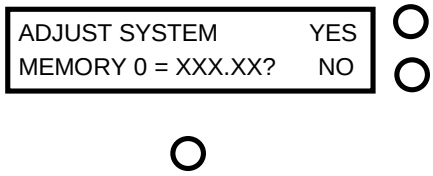


Figure 9 - Adjust Setpoint Memory Prompt

The system start-up setpoint, "MEMORY 0", may be adjusted 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. Pressing either switch once will move the value selected up or down by increments of one respectively. As the cursor is scrolled past the last digit, current memory setpoint adjustment is completed and the user is advanced to the next memory setpoint. When all memory setpoint adjustments have been made, the system advances to the next Command Function as described in the following section.

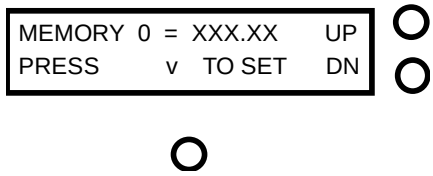


Figure 10 - Adjust System Memory Setpoint Prompt

3.2.2.2. Adjust Alarm Temperature

When the system is advanced past the "ADJUST MEMORY SETPOINTS" command, the next variable is accessed. The "ALARM TEMPERATURE" variable allows the user to determine the temperature at which the controller turns off the heater to prevent overheating the core or cell in the furnace. Function is accessed through the prompt shown in Figure 10.

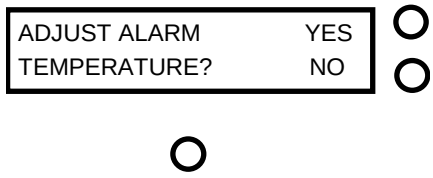


Figure 11 - Adjust Alarm Temperature Access Prompt

Responding "YES" to the prompt will allow the user to modify the variable as described below, while a "NO" response will allow access to the next system variable in the sequence, as described in the following section (3.2.2.3).

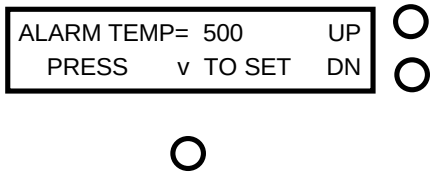


Figure 12 - Alarm Temperature Adjust Prompt

Modification of this variable is accomplished by pressing the two switches on the right of the LCD. Pressing the switch adjacent to the "UP" prompt will cause the value of the selected digit to be increased by one, while pressing the switch adjacent to the "DN" prompt will cause it to be decreased by one. The range of the variable is 240°C to 1120°C. The command key located directly below the LCD is used to advance the cursor to each of the digits. As the cursor passes the last digit, the value is stored as a temporary system variable.

3.2.2.3. Adjust Control Gradient

In this furnace, the gradient setting controls the difference in temperature between the main and guard zones. Adjustments made to the control gradient raise or lower the temperature of the guard zone. This feature is particularly important in situations where the cell must be melted from a specific area (i.e.: the top or bottom) for proper calibrations. To skip this variable, press Switch #2 adjacent to the NO response. To access this variable, simply press the switch adjacent to the YES prompt on the LCD. At this point the prompt in Figure 14 will appear.

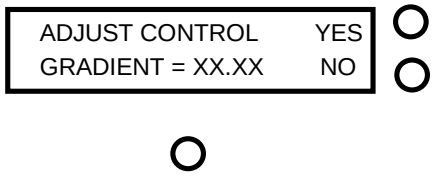


Figure 13 - Adjust Control Gradient Prompt

The control gradient may be adjusted using the two switches corresponding to the labels UP and DN displayed on the LCD. The Command Key is used to advance the cursor to each of the digits. Pressing either switch once will move the selected value up or down by increments of one respectively. As the cursor is scrolled past the last digit, control gradient adjustment is completed and the new setting is stored as a temporary system variable.

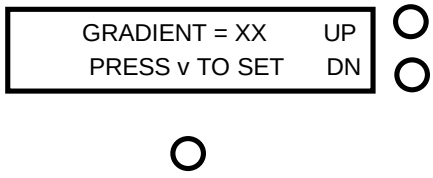


Figure 14 - Control Gradient Adjust Prompt

3.2.2.4. Adjust GPIB Address

The next variable presented, "ADJUST GPIB ADDRESS", is the parameter that determines the address at which the system can be accessed over the IEEE-488 Interface Bus. The message shown in Figure 15 will appear if the IEEE-488 Interface option is installed in the system hardware.

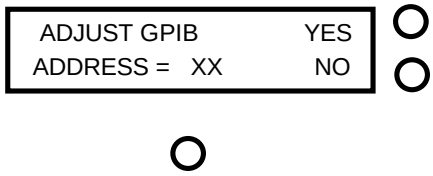


Figure 15 - IEEE-488 Address Adjust Prompt

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

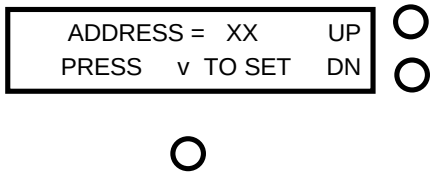


Figure 16 - Address Adjust Prompt

The "YES" response directs the user to the display shown in Figure 16. The IEEE-488 instrument address is adjusted using the two switches on the right side of the LCD. Pressing the switch adjacent to the "UP" prompt will cause the value of the selected digit to increase by one, while pressing the switch adjacent to the "DN" prompt will cause it to decrease by one. This variable can be set to any whole number within the range of 1 to 30. The Command Key, located directly below the LCD, is used to advance the cursor to each of the digits. As the cursor passes the last digit, the value is stored as a temporary system variable and the system advances to the next function.

3.2.2.5. Access Vars Array

The second part of the "COMMAND FUNCTIONS" allows the user to adjust those variables stored in the system's memory. It is strongly recommended that before responding "YES" to the prompt shown in Figure 17, the user review carefully 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 could cause severe damage to the furnace and could be very dangerous!

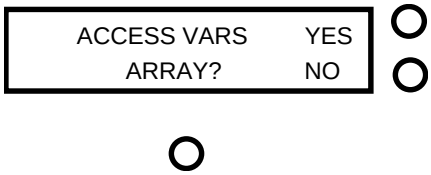


Figure 17 - Access Variables Array Prompt

Responding "YES" to the variables access prompt will automatically cause the "WARNING PROMPT" to be displayed. This message is intended to warn and remind the user of damage that could occur if this function is not used properly. Press Switch #1 to continue or Switch #2 to exit to the next function.

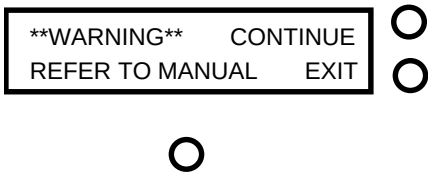


Figure 18 - Warning Prompt

If the user chooses to "CONTINUE" and view/adjust the system variables, the display shown in Figure 19 will appear. The system variables are numbered not labeled and include many of the variables which have specific adjustment routines described above. Please refer to the chart below for complete descriptions of each of the variables, their function and recommended range.

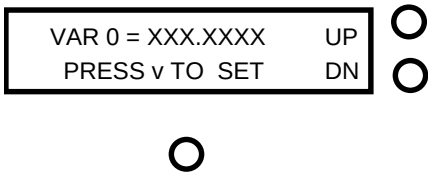


Figure 19 - Variable 0 Adjustment Prompt

To examine and adjust a certain variable, scroll through the list using the two switches to the right of the LCD, labeled "UP" and "DN". To begin adjusting a variable, press the Command Key, located below the LCD. This switch also serves to advance the cursor from one digit to the next. Pressing the switch adjacent to the "UP" prompt will cause the value of the selected digit to be increased by one, while pressing the switch adjacent to the "DN" prompt will cause it to be decreased by one. As the cursor passes the last digit the value is stored as a temporary system variable.

> ****WARNING**** Variable entries are not limited to the recommended range by the software; setting values outside the recommended ranges can result in permanent damage to the system.

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

REF#	Variable \Description	Default Values	Recommend Range
0	Setpoint Temperature	232.0000 °C	220-1000 °C
1	Memory 0 Setpoint Temperature	232.0000 °C	220-1000 °C
2	Memory 1 Setpoint Temperature	232.0000 °C	220-1000 °C
3	Memory 2 Setpoint Temperature	660.0000 °C	220-1000 °C
4	Memory 3 Setpoint Temperature	962.0000 °C	220-1000 °C
5	Alarm Temperature	970.0000 °C	240-1020 °C
6	GPIB Primary Address	6	1-30
7	Gradient (Linear)	0.0	As necessary for Calibrations
8	Guard Coefficient D	0.0	As necessary for Calibrations
9	Guard W at Aluminum	3.376	As necessary for Calibrations
10	RTPW for Core Sensor	100.00	As necessary for Calibrations
11	Core A Coefficient	0.0	As necessary for Calibrations
12	Core B Coefficient	0.0	As necessary for Calibrations
13	Core C Coefficient	0.0	As necessary for Calibrations
14	Core D Coefficient	0.0	As necessary for Calibrations
15	Core W at Aluminum	3.3760	As necessary for Calibrations
16	Guard RTPW	100.00	As necessary for Calibrations
17	Guard A Coefficient	0.0	As necessary for Calibrations
18	Guard B Coefficient	0.0	As necessary for Calibrations
19	Guard C Coefficient	0.0	As necessary for Calibrations
20	ACCESS CODE for protected variables	0.0000	Consult Factory for Access
Protected Variables			
21	Proportional 1 Gain	20.0	10.00- 40.00
22	Integral 1 Gain	0.05	0.02-0.10
23	Derivative 1 Gain	-300.0	-150.0000- -600.0000
24	Proportional 2 Gain	6.0000	
25	Integral 2 Gain	NA	
26	Derivative 2 Gain	NA	
27	Integral increment maximum	0.0400	
28	Integral hold off limit	1.0000	
29	Time of hold after condition	10.0000	
30	Integral one power slope		
31	Integral one power intercept		
32	Prop 2 limit	10.0000	
33	Integral 2 Limit	10.0000	
34	Integral 2 increment max per ISR	0.0100	
35	Derivative 2 Limit	10.0000	
37	Core PID2	0.0000	
38	Comparison Block Drift		
40	Variable initial check	34.5200	
41	Guard Calibration Flag		
48	Guard Proportional Gain		

REF#	Variable \Description	Default Values	Recommend Range
49	Guard Integral Gain		
50	Guard Derivative Gain		
57	Average Guard Temperature	Current Reading	
58	System status variable	0.0	
59	Average Core Temperature	Current Reading	
60	Core Temperature	Current Reading	
61	Comparison Block Temperature		
62	Guard Temperature	Current Reading	
63	Core Sensor Resistance	Current Reading	
65	Guard Resistance	Current Reading	
66	Proportional Signal	Current Reading	
67	Integral Signal	Current Reading	
68	Derivative Signal	Current Reading	
Variables Accessible by Remote Only			
72	Guard Proportional signal	Current Reading	
73	Guard Integral signal	Current Reading	
74	Guard Derivative signal	Current Reading	
75	Flag to indicate external control		
76	Temperature written by external system		

3.2.2.6. Save changes to Variables

The prompt in Figure 20 allows the operator to 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 only at this point. Responding "YES" to this prompt causes the variables to be stored in non-volatile memory within the system controller. The saved variables will then be used by default when the system is restarted and the values used previously on start-up are replaced and cannot be recovered.

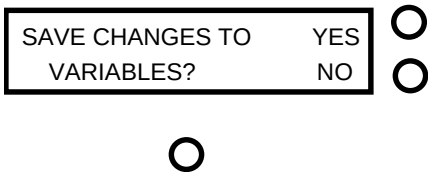


Figure 20 - Save Variables Prompt

Responding "NO" to the prompt in Figure 20 causes the system to exit the "COMMAND FUNCTIONS" without saving the variables to non-volatile memory. This allows the user to temporarily establish new values for the system variables without permanently altering the default values. If the power was to be shut off or interrupted before the new information was stored in the non-volatile memory, the newly established values would be lost and the system would utilize the default values upon being restarted. Following verification that the newly

established variable values perform to satisfaction, they may be stored by entering the "ADJUST SYSTEM VARIABLES" routine, stepping through the prompts and responding "YES" to the "SAVE CHANGES" prompt.

3.2.2.7. Display Mode Select

When the user completes variable adjustments, the system returns to normal operating mode. Before exiting the "COMMAND FUNCTIONS", two options are presented, "NORMAL DISPLAY" and "DIAGNOSTIC INFORMATION". This choice determines how information will be displayed upon leaving the COMMAND FUNCTIONS. "NORMAL DISPLAY" mode is the default and will be displayed on system power-up. The display mode may be temporarily changed by responding "YES" to the prompt below.

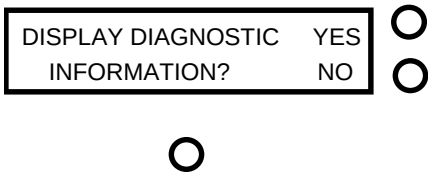


Figure 21 - Diagnostics Mode Display Prompt

If the system is currently displaying "DIAGNOSTIC INFORMATION", the prompt will be modified as shown below to make the option of "NORMAL DISPLAY" mode available. Selection can be made by answering "YES" to the command function prompt.

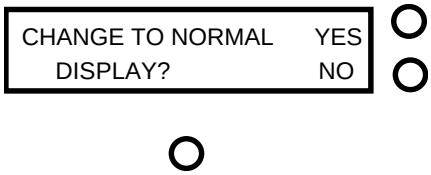


Figure 22 - Normal Mode Display Prompt

The "DIAGNOSTIC INFORMATION" display presents an array of numeric information for system diagnostics for the "CORE" zone and the "GUARD" zone. An example of the core diagnostic information is shown in Figure 23.

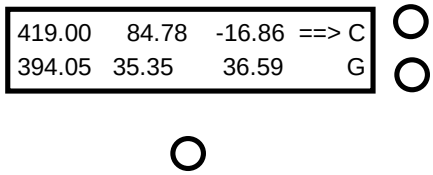


Figure 23 - Core Diagnostics Display

The information presented in this display is as follows:

Top row from left to right:core setpoint....core proportional signal.....core derivative signal

Bottom row left to right:....core temperature....core integrator signal....core zone heater voltage.

Pressing the button opposite the letter "G" on the display will allow the user to scroll to the next diagnostics display.

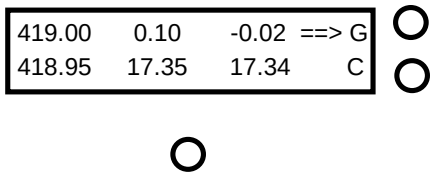


Figure 24 - Guard Diagnostics Display

The information presented by the guard diagnostics is as follows:

Top row left to right:....guard zone setpoint....guard proportional signal....guard derivative signal

Bottom row left to right:...guard temperature...guard integrator signal....guard zone heater 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 option as described above.

4. System Use with Comparison Block

Care needs to be taken when removing and inserting the comparison block from and into the furnace. Included with the block is block handle which is used in removing the comparison block from the system. Shown below is the layout of the comparison block and its operation.

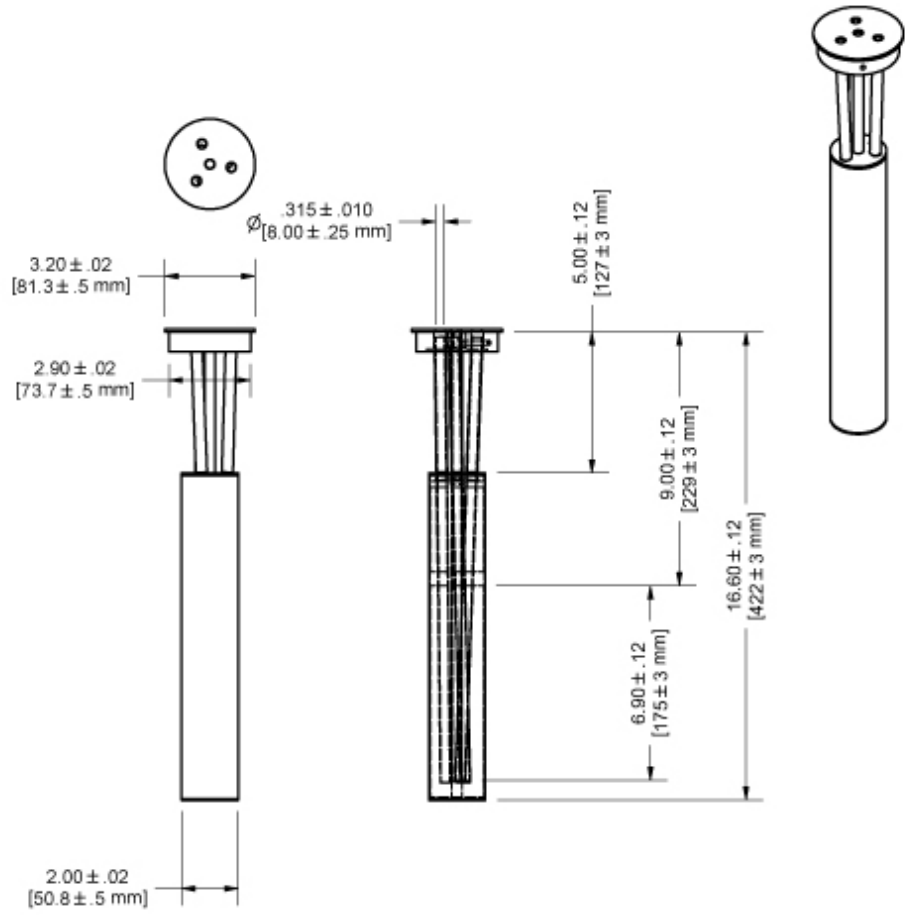


Figure 25 – K23XB Comparison Block Diagram

4.1. Removing or Inserting Comparison Block

To operate the handle, insert it in the center well. **WARNING: DO NOT put the handle in any other well as it was cause serious damage to the block.** After inserting the handle, pull up slightly on the black knob and turn clockwise to tighten down. Pull the comparison block out by the handle. To remove the handle from the comparison block turn the knob counter clockwise to loosen and pull handle straight up out of the block.

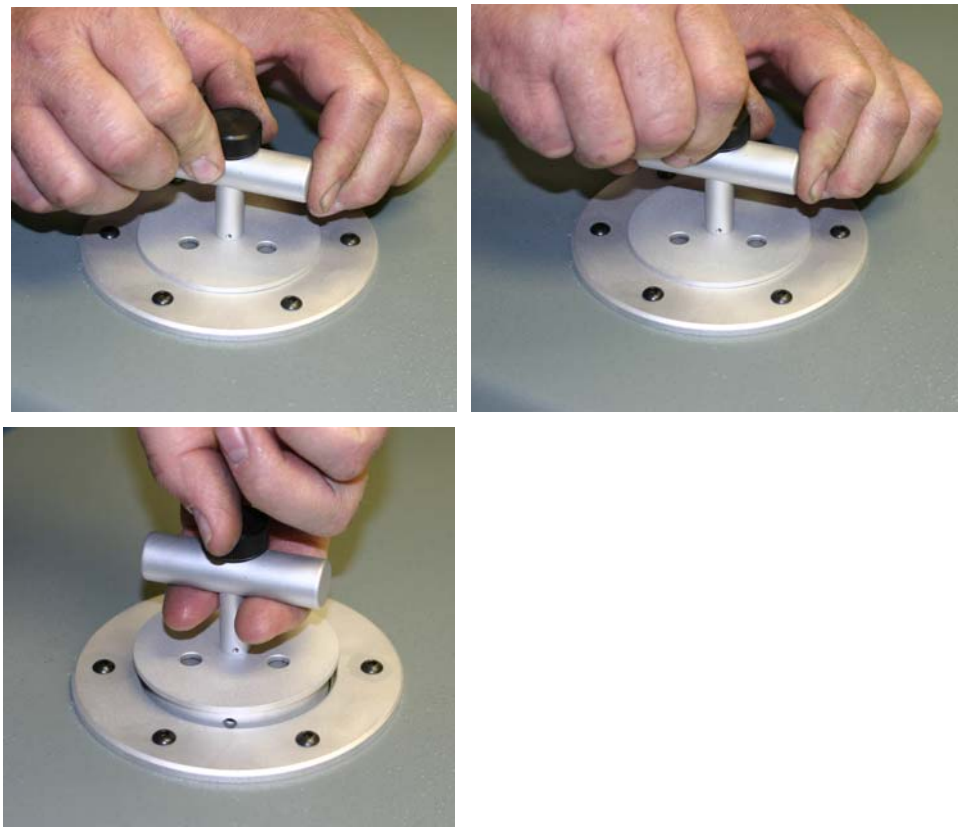


Figure 26 - Insert handle, lift slightly on knob, screw tight, and lift straight up to remove.

5. Remote Interface Commands

If the Temperature Calibration Furnace has been equipped with the optional IEEE-488 Remote Interface, any host computer which can be set up as a system controller may be used to operate the Calibration Furnace over the interface. Pond Engineering has software available for interfacing with the furnace variables using an IBM compatible or Macintosh computer with a National Instruments 488 interface card. Custom software packages are also available to integrate the furnace as part of an automated lab. The system variables which can be accessed over the 488 interface, and the command set recognized by the furnace can be found in section

3.2.2.5. Access Vars Array. Also included on the CD-ROM is a copy of Pond Engineering's GPIB Communication software, see section 5.1 for operation.

5.1. Pond Engineering GPIB Software

Included on the CD-ROM is a copy of the Pond Engineering GPIB Communication Software. This makes the ease of the command set of just pointing to the variable and setting the variable to read or right.

5.1.1. Installation

To begin the installation insert the CD-ROM into a windows x86 PC, let the auto run start and click on *Install Pond Engineering GPIB Driver*. Alternatively you can go to D:\ PEL GPIB Driver Setup.exe and double click the icon to start the installation where D is your CD-ROM drive. From there follow the prompts to install the software.

5.1.2. Usage

To start the software go to Start – Program Files – Pond Engineering GPIB Driver. The screen should look like this.

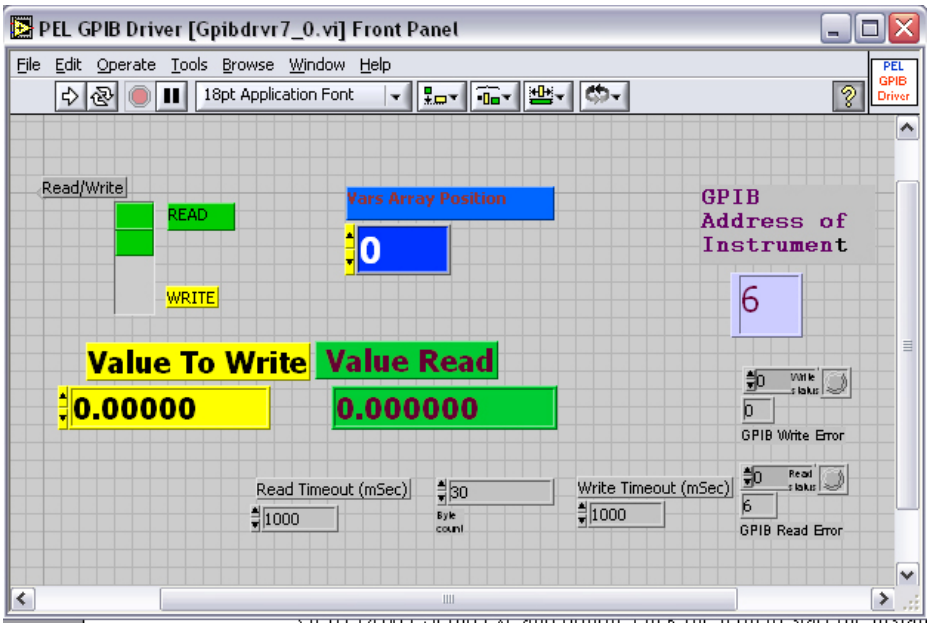


Figure 27 - PEL GPIB Screen

From here you can select the Variable Number (blue) in which you wish to change/read, select Read or Write (Yellow), and run the program to receive or write the value. (Note: the variable numbers are on page 11-12 of this manual) The values read will show in the green Value Read box, those you wish to write you enter in the yellow Value to Write box. To run the program each time you push the arrow button in the upper left part of the toolbar. If you need to change the timeout, byte count, or GPIB Address you can do so here in the indicated windows.

5.2. Primary Metrology Furnace Command Set

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

5.2.1. Read System Variable

The "READ" command, called by sending an "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 furnace will wait to be addressed as a talker to return the data over the bus. The furnace has a one second write time-out, thus the controller in charge must read from the furnace within one second after sending the "R" command to receive data. For example: If the user wants to see the value stored as the system's alarm temperature, the user would send the character string: R05. The controller in charge would then address the furnace as a talker and wait for the data to be returned.

**Note: Control of the Furnace core remains the highest priority even when the furnace is in remote mode and may put off responding to 488 commands for as long as 500ms.

For Example, having been addressed as a talker, the furnace will return the text string +4.300000e+02(space)05 as soon as it is not performing control functions. This indicates that the value 430 (°C) is the current value for Variable 05 (the Alarm Temperature). Values returned are always in the above scientific format followed by a space and address number for the given value.

5.2.2. Write System Variable

The "WRITE" command, executed 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 be decimal with at least 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 300 °C, the user would send: W05,300 and the alarm temperature variable would then be set to 300 °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 users 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 variable. 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 variable was received by the furnace correctly. This is especially important when setting the RTPW's and calibration coefficients, since an errant RTPW or coefficient may cause the furnace to overheat and damage the core.

5.2.3. Remote Mode

After receiving a command over the 488 Buss, the furnace enters remote mode. In remote mode the LCD will display the message shown in Figure 28.

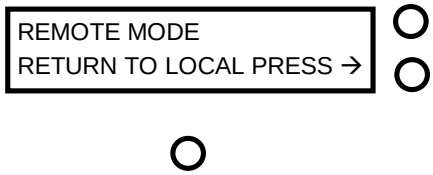


Figure 28 - Remote Mode Display

In remote mode, the system will only respond to the return to local switch (switch #2). After returning to local control the system will respond normally to all switches.

5.2.4. External Feedback Control Variables

It is important to remember that cell temperature is a function of both guard and main zone temperatures. In order to control axial gradients, the guard zone control temperature must be set to different values depending on the type of cell, comparison block and thermometer being used. As a general guideline, a change of 1°C in Guard temperature changes the cell temperature by approximately 0.2°C while the core temperature remains constant. When using a comparison block, this effect may be easily compensated for using the External Feedback function included

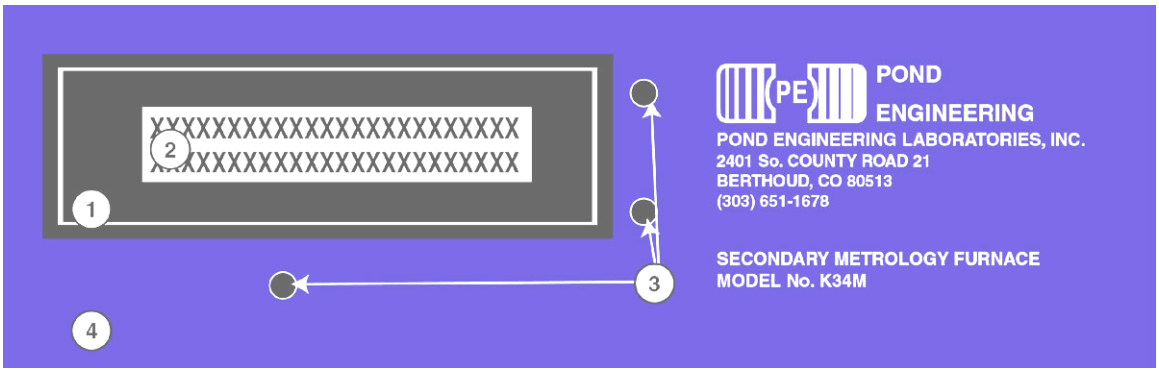
as part of the IEEE-488 remote interface option. In effect, this allows the furnace to accept feedback from a calibrated working standard directly in the comparison block. When operating in this mode, the temperature as measured by the working standard is written back to the furnace controller, allowing the furnace to compensate by adjusting the setpoint temperature until the working standard indicates stability at the setpoint temperature. For example, if the system setpoint is 232°C, and the gradient variable (factory default: 5°C) is set to 10°C, the temperature of the block would be 1°C higher than the setpoint. Using the External Feedback option, the working standard temperature would be written to the furnace indicating a block temperature of 233°C. The furnace uses this temperature as an input to a cascaded Proportional, Integral, Derivative (PID) control loop to adjust the furnace setpoint 1°C lower, causing the comparison block to stabilize at the intended setpoint with the full accuracy of the working standard.

This feature is controlled by variables 75 and 76, described earlier in *3.2.2.5. Access Vars Array*, Variable 75 is used as a flag. Only when this variable is set to a value of 1.0 will the system look to receive a temperature input from the external thermometer. The temperature measured by the external thermometer may be written to variable 76 and will be used by the furnace controller to modify the furnace core setpoint to achieve a comparison block temperature (as measured by the working standard) equal to the current system setpoint. This modification of the core control temperature is internally limited to 10 °C. It is recommended that the external temperature be updated at least every 60 seconds in order to allow proper operation of the control system. Shorter update periods (as short as 10 seconds) provide better system performance. Only when variable 75 is active will an external temperature feedback be utilized. On power up, variable 75 is set to 0.0, disabling operation of this feature.

6. System Hardware Description

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

6.1. Front Panel

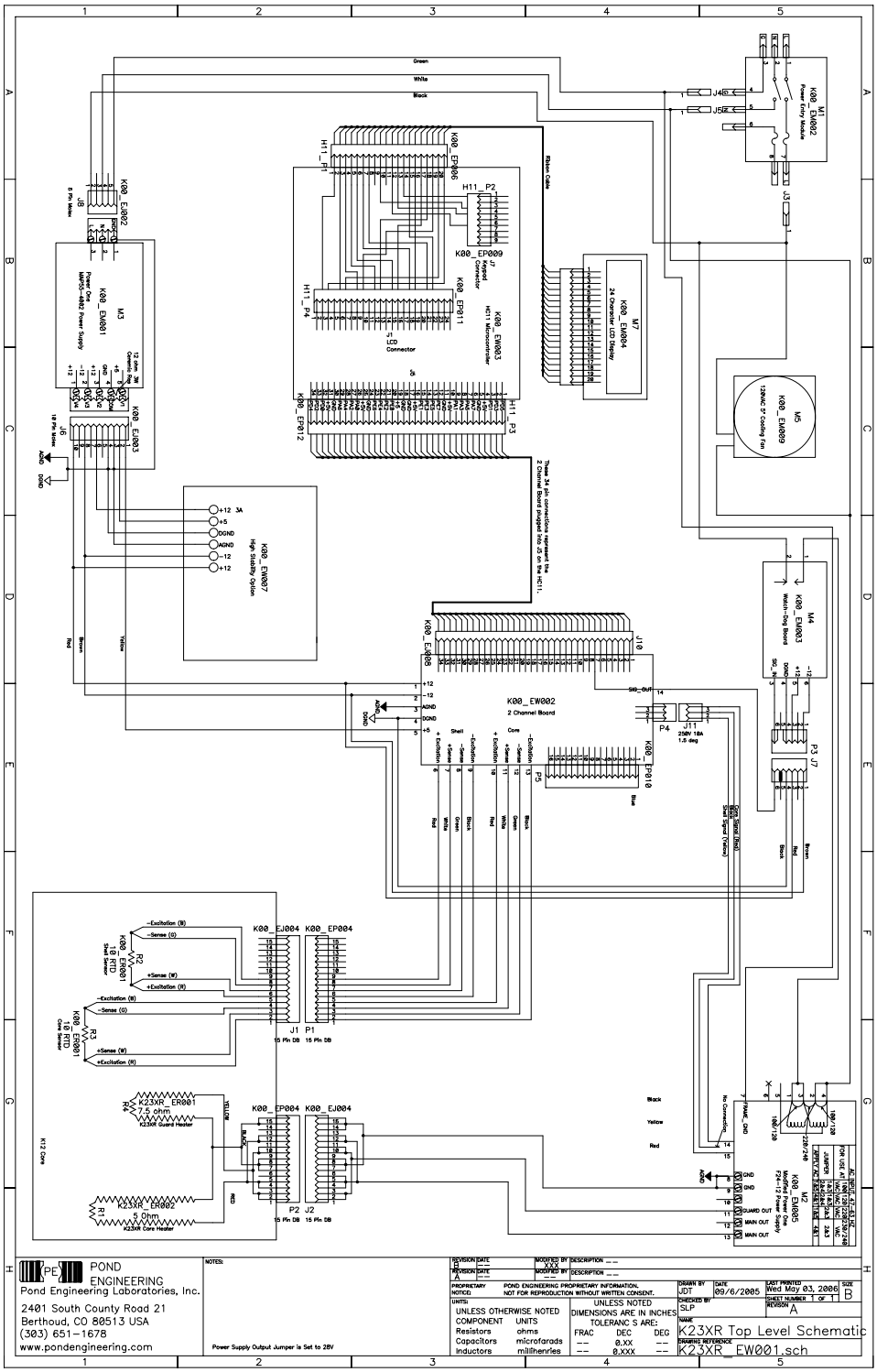


REF.#	NAME	MAKE /MODEL
1	Die Cast Metal Bezel	JMJ Technical Products Inc/1-458
2	24X2 Dot Matrix LCD Module	DMC Series Optrex/ DMC20261
3	Switches,3 each, with Caps	Eaton Cutler-Hammer/W-KN 17
4	Engraved Laminate Front Panel	Pond Engineering /K23X-FP

6.2. Electronics Chassis/ Back Panel

REF.#	NAME	MAKE /MODEL
1	Microprocessor/Controller	Pond Engineering Labs. K23XR -400
2	Computer Power Supply	Power-One Inc. MAP55-4002
3	Main Power Supply	Pond Engineering Labs. K34-HE24-7.2-A
4	Fan	Comair Rotron FE12B3
5	Optional 488 connector	Pond Engineering 488-connector

6.3. Top Level Schematic



7. Maintenance

7.1. Periodic Maintenance

Caution – HOT Surfaces. Periodically you may clean the painted surfaces with a mild non abrasive cleaner such as glass cleaner. You may also use alcohol or a soap and water mixture to remove any dirt or dust from the painted surface.

Also it is important to check for dust accumulation on the Fan and Heat sink and remove as necessary. You may do this with a low pressure air source, such as a pressurized air canister.

7.2. Core Vacuum Level

If the drive voltage is creeping up or the system has the inability to reach high set point then this indicates in increase in gas pressure in the core. If this occurs then maintenance needs to be done to the core vacuum level. **WARNING: DO NOT place insulation on top of the furnace!!** As this will cause serious, irreparable damage to the core.

Operation at temperatures above 660°C will give about 50 hrs of operation until the core needs maintenance. This number will decrease with operations at higher temperatures, particularly with a system that has not been in service for a long period.

7.2.1. Evacuation Procedures

1. Connect to external high vacuum pump (10^{-5} Torr or lower) with KF 16 Connector provided inside left side cover.

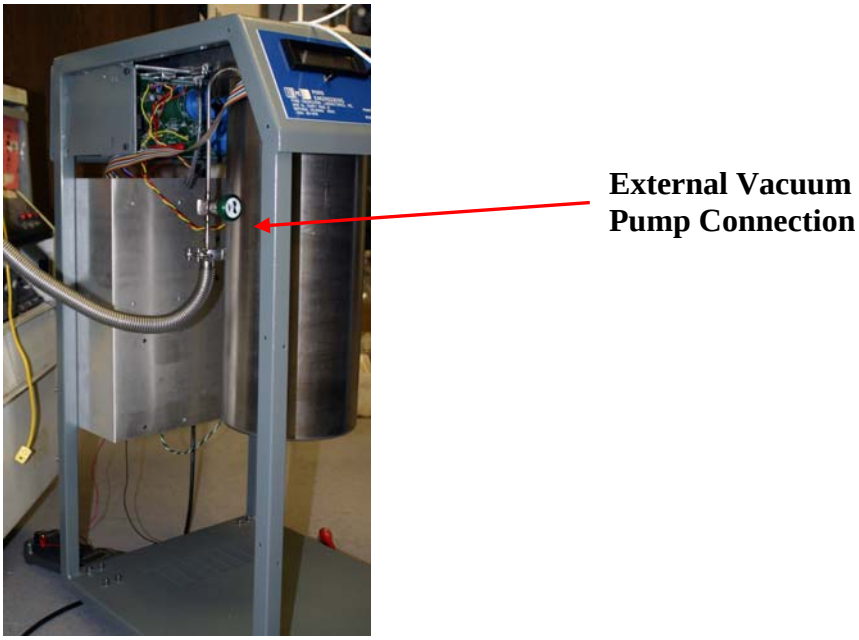


Figure 29 - K23XR with panel removed

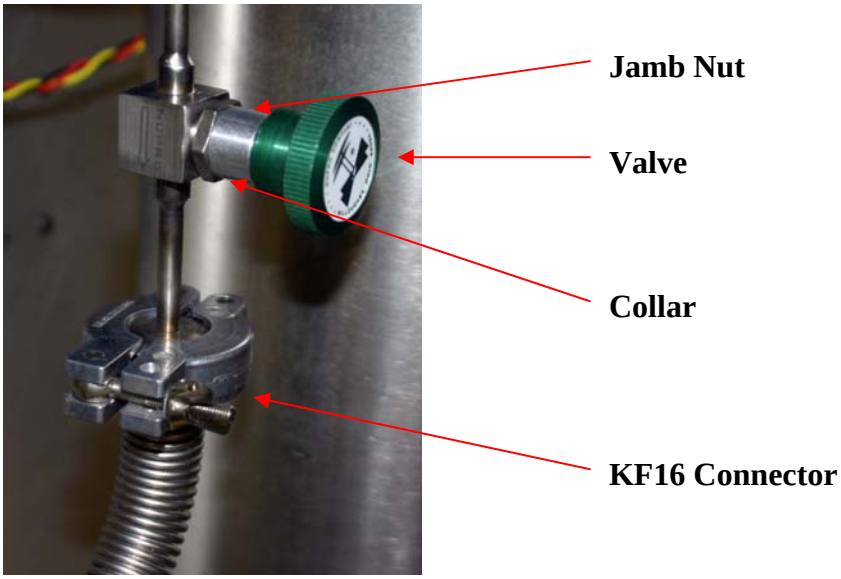


Figure 30 - Vacuum Connector Assembly

2. **Evacuate line to 10^{-3} Torr or lower**
3. Loosen valve jamb nut, by taking crescent wrench and moving counter-clockwise. Loosen nut back and slide collar back

Figure 31 - Remove Jamb Nut

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

Figure 32 - Loosen Knob

5. Pump on core until 10^{-5} torr achieved at pumping system

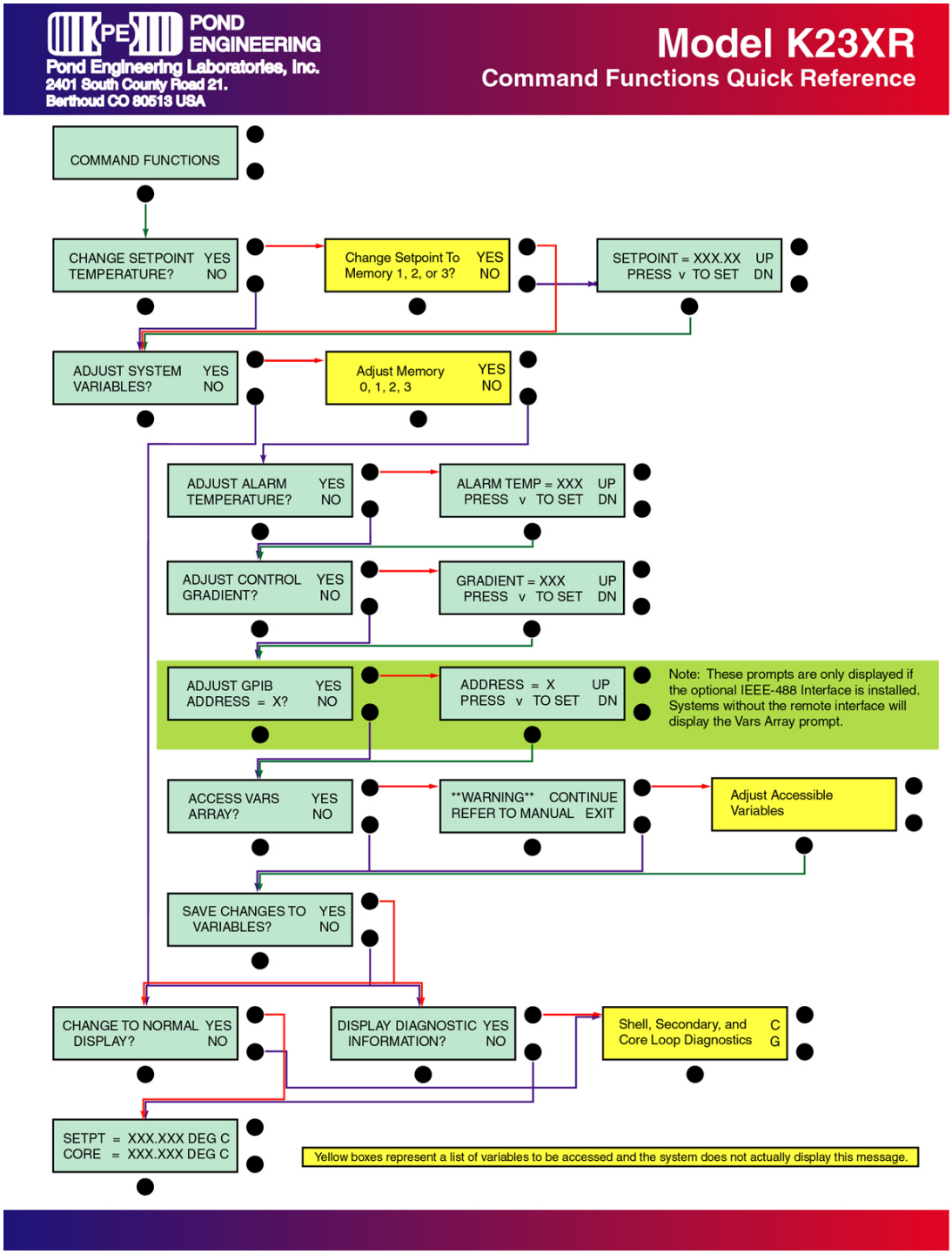
6. Shut valve tightly clockwise, slide collar towards valve, tighten nut against valve

Figure 33 - Tighten Knob

Figure 34 - Tighten Jamb Nut

7. Remove external high vacuum pump
8. Continuous pumping may be necessary with a new system when operating at higher temperatures

8. K23XR Command Functions Flowchart



9. Calibration Record

The factory calibrated values are outlined in the chart below. Please feel free to make copies of the chart on the following page for use in your lab calibrations.

Date:			
REF#	**Variable \Description**	**Factory Values**	**Comments**
10	RTPW for Core Sensor		
11	Core A Coefficient		
12	Core B Coefficient		
13	Core C Coefficient		
14	Core D Coefficient		
15	Core W at Aluminum		
16	RTPW for Guard Sensor		
17	Guard A Coefficient		
18	Guard B Coefficient		
19	Guard C Coefficient		
8	Guard D Coefficient		
9	Guard W at Aluminum		

POND ENGINEERING
Pond Engineering Laboratories, Inc.
www.pondengineering.com

K23XR Calibration Record

Date:			
REF#	**Variable/Description**	**Values**	**Comments**
10	RTPW for Core Sensor		
11	Core A Coefficient		
12	Core B Coefficient		
13	Core C Coefficient		
14	Core D Coefficient		
15	Core W at Aluminum		
16	RTPW for Guard Sensor		
17	Guard A Coefficient		
18	Guard B Coefficient		
19	Guard C Coefficient		
8	Guard D Coefficient		
9	Guard W at Aluminum		
Date:			
REF#	**Variable/Description**	**Values**	**Comments**
10	RTPW for Core Sensor		
11	Core A Coefficient		
12	Core B Coefficient		
13	Core C Coefficient		
14	Core D Coefficient		
15	Core W at Aluminum		
16	RTPW for Guard Sensor		
17	Guard A Coefficient		
18	Guard B Coefficient		
19	Guard C Coefficient		
8	Guard D Coefficient		
9	Guard W at Aluminum		