# Model K49
Disk Drive Thermal Conditioning System

Operation and Maintenance Manual

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# Table of Contents

# Disk Drive Thermal Conditioning System

## 1. Background

This report documents the installation, operation and maintenance procedures for the Disk Drive Thermal Conditioning System, Pond Engineering Number K49. Information contained in this manual is proprietary to Pond Engineering Laboratories 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 K49

**Figure 1** shows the general configuration of the system and indicates the location of service points discussed later in this manual.
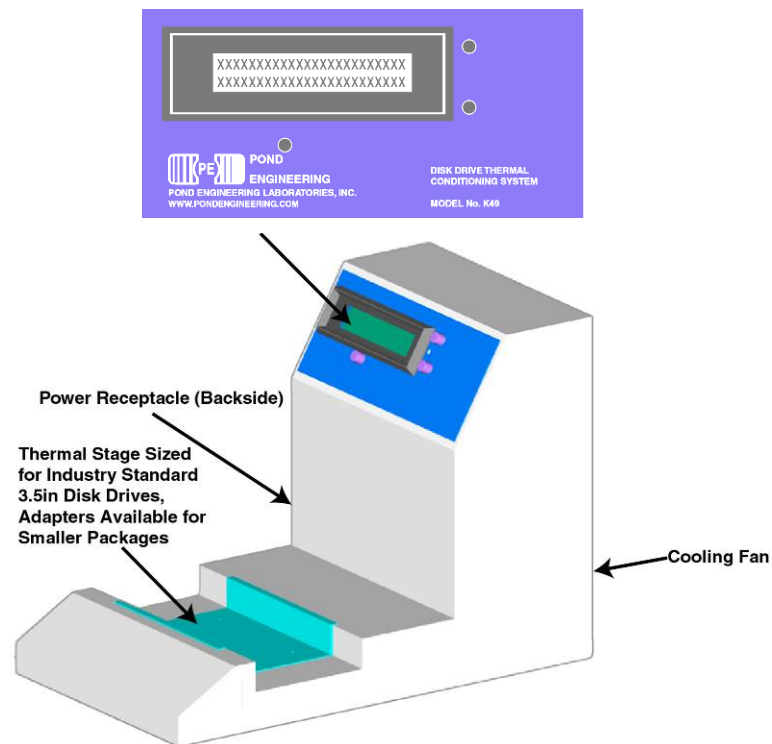


**Figure 1 - System General Layout**

The K49 provides a stable and uniform temperature environment for the bench top testing of disk drives over a range of temperatures from –5.0°C to 75.0°C. The system supports industry-standard 3.5-in disk drives. Adapters for smaller drives are available from Pond Engineering. The system comes standard with RS-232 and USB Type B remote communication interface to integrate the unit into an automatic test system. An optional feature includes IEEE-488 communication. As shown in **Figure 1**, the controller panel is located on a sloping surface at the front of the outer chassis of the system. The operator interface includes three front panel switches and a 2 line by 24 characters Liquid Crystal Display (LCD).

**Figure 2 - Front Panel Layout**

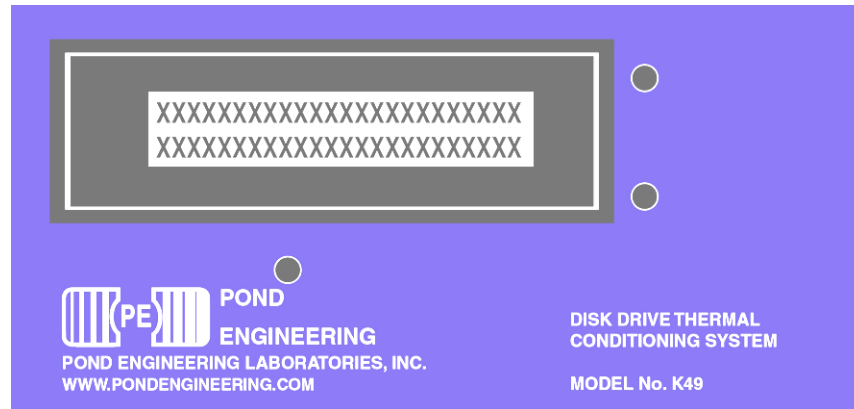In normal operating mode, this display presents the current temperature set point and the measured thermal stage temperature on the first and second lines of the display, respectively. Measurements are taken at approximately 3-second intervals and the lower line of the display (measured stage temperature) is updated following each measurement. Additional controller functions (communication ports, diagnostic information, sensor calibration etc.) are accessed in Command Functions mode, through the display and switches, as outlined in later sections.

Also provided with the system is a foam cover for the thermal stage. The cover should be used to minimize condensation on the drive and improve system performance at temperatures below room temperature.

****** Note: The K49 should always be operated on a level surface with clearance at the rear of the unit to allow free air flow. Failure to do so can prevent proper operation of the heat pipe cooling system and can damage the system. ******

## 2.1  K49P Variant

An optional configuration, Model Number K49P, provides the additional capability to control pressure altitude in the range of -500 to 12,500 feet pressure altitude. This optional configuration requires the external provision of 30 psig compressed dry instrument air and vacuum at a pressure not to exceed 100 Torr (0.13 bar); push to connect bulkhead fittings (5/32" (4mm) O.D.) are provided at the rear of the cabinet for these connections. All temperature control functions are identical to the K49 model. Information on K49P specific operations are given as part of the following sections in the order in which the system presents those options and are marked as **K49P Variant**.

## 2.2  K49X Variant

Another optional configuration is the K49X which has two-stage thermoelectrics providing higher heat pumping capacity to the stage. The minimum and maximum temperature set-points have been adjusted in the K49X allowing a range of temperatures from -15°C to 85°C. All other Command Functions and operating procedures are identical to the K49.

# 3. System Controller

In an effort to maintain simplicity while providing the flexibility to accommodate optional features, the operator interface is based largely on interactive software control. The software prompts the user through a set of COMMAND FUNCTIONS, including; CHANGE SETPOINT TEMPERATURE and ADJUST SYSTEM VARIABLES. The software displays messages on the LCD to direct the user through each command function using the three front panel switches. This manual includes an outline of the user interface and a detailed description of prompts along with instructions on how to edit system configurations and operate the system manually. 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. The labels attached to the switches in **Figure 3**, below, are for the benefit of the reader in understanding the notation in this manual. Such labels do not appear on the device.
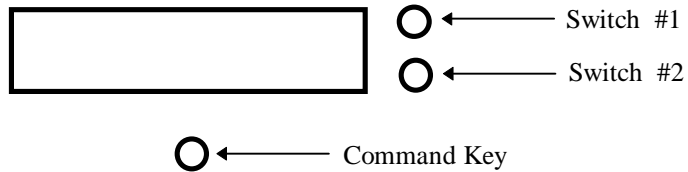


**Figure 3 - Front Panel Switch Layout**

## 3.1 Normal Operating Mode

During normal operation, the system controller continuously displays the set point temperature and the current measured thermal stage temperature, as shown in **Figure 4**. Measurements are taken at approximately 3-second intervals, the lower line of the display being updated following the measurement. This information is removed from the display when the user accesses the COMMAND FUNCTIONS portion of the program by pressing, and holding, the "Command Key" for a period of 2-3 seconds. Pressing Switch 1 or Switch 2 while in the normal operating mode will increment or decrement, respectively, the set point by the increment variable (initially set to 5 degrees). Pressing and holding either of these keys will cause the display to scroll to the high or low limits.
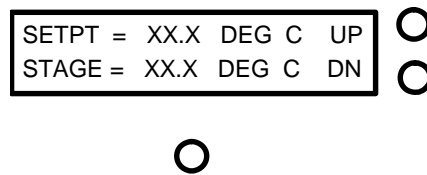


```
SETPT = XX.X  DEG  C   UP
STAGE = XX.X  DEG  C   DN
```

**Figure 4 - Normal Operating Mode Display**

**K49P Variant:** If the system is equipped with the optional pressure altitude controls, pressing (and releasing in less than a period of 2-3 seconds), the "Command Key" will cause the controller to toggle between the pressure and temperature screen.

```
ALT SETPT =  XXXXX  FT  UP
PRESS ALT =  XXXXX  FT  DN
```
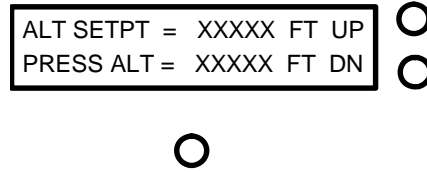
**Figure 5 - Normal Operating Mode Display for K49P Variant**

While displaying the pressure screen, pressing Switch 1 or Switch 2 while in the normal operating mode will increment or decrement, respectively, the pressure altitude set point by the increment variable. Pressing and holding either of these keys will cause the display to scroll to the high or low limits. Both temperature and pressure altitude are actively controlled regardless of the state of the normal operating mode display.

## 3.2  The "Command Functions"

In order to perform system configuration functions, the user must leave the normal operating mode and enter COMMAND FUNCTIONS.  To do this, depress and hold the Command Key.  As the key is pressed, the words COMMAND FUNCTIONS will appear immediately on the lower line of the display.  If the key is released, the unit returns to normal operating mode. 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 Set point Temperature

The first command function is CHANGE SETPOINT TEMPERATURE.  Through this function, the user may manually adjust the set point temperature within the range of –5.0 to 75.0°C (**K49X Variant**: -15.0 to 85.0°C) .   As shown in **Figure 6**, 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 user selects NO, the program will present the next function.

```
CHANGE SETPOINT      YES
  TEMPERATURE?       NO
```
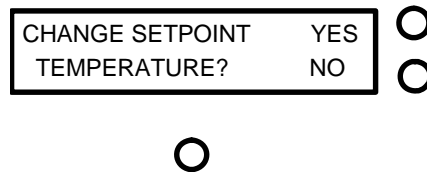
**Figure 6 - Temperature Set point Access Prompt**

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 7** will be presented on the LCD. Manual adjustment of the SETPOINT is accomplished using the two switches corresponding to the labels UP and DN displayed on the LCD.  The cursor starts in the tens position. Choosing UP will cause the value to increase by 10 until it reaches a maximum of 75 degrees C.  Choosing DN will cause the value to decrease by 10 until it reaches -5 degrees C. The COMMAND switch, located directly below the LCD, is used to advance the cursor through the remaining digits.  The number presented on the display is applied as the current set point as soon as the cursor passes the last digit.
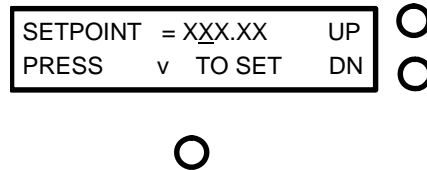
```
SETPOINT  = XXX.XX      UP
PRESS      v   TO SET    DN
```

**Figure 7 - Manual Temperature Set point Change Prompt**

Once the cursor scrolls past the last digit, set point adjustment is complete and the user may access the next Command Function, described in the following section.

### 3.2.2  Change Set point Pressure Altitude (K49P Variant only)

This function allows the user to establish a set point altitude in 100 foot increments. The input value is limited to values in the range of -500 to 12,500 feet. This function is presented as in **Figure 8.**
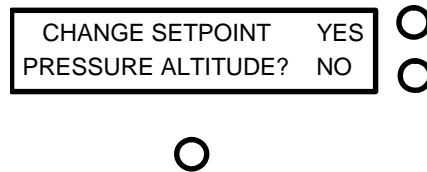
```
 CHANGE SETPOINT     YES
PRESSURE ALTITUDE?   NO
```

**Figure 8 - Pressure Altitude Set point Access Prompt**

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 9** - Manual Pressure Altitude Set point Change Prompt will be presented on the LCD. Manual adjustment of the PRESSURE ALTITUDE SETPOINT is accomplished using the two switches corresponding to the labels UP and DN displayed on the LCD.  The cursor starts in the ten thousands position. Choosing UP will cause the value to increase by 10,000 feet until it reaches a maximum of 12,500 feet.  Choosing DN will cause the value to decrease by 10,000 until it reaches -500 feet. The COMMAND switch, located directly below the LCD, is used to advance the cursor through the remaining digits.  The number presented on the display is applied as the current set point as soon as the cursor passes the hundreds digit.
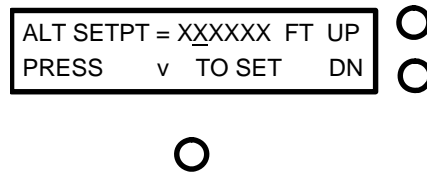
```
ALT SETPT = XXXXXX  FT  UP
PRESS       v   TO SET    DN
```

**Figure 9 - Manual Pressure Altitude Set point Change Prompt**

### 3.2.3 Adjust System Variables

This command function allows user examination and adjustment of the system variables used by the controller.
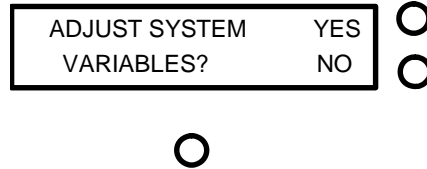
| ADJUST SYSTEM | YES |
| VARIABLES? | NO |

**Figure 10 - System Variables Access Prompt**

Pressing the switch labeled YES will allow access to the first system variable, shown in **Figure 11**, while responding NO will terminate the function and allow the user access to the next COMMAND FUNCTION.

### 3.2.3.1 Set USB (RS232) Port as Active Port

The first variable accessed is SET_____ AS ACTIVE PORT. This variable is dependent on which communication type is currently in use either USB or RS232. Pressing the switch labeled YES will activate the port that is currently not in use which will be the port named in the prompt. Pressing the switch labeled NO will move to the next variable leaving the current port active. The default port as shipped from the factory is RS232 and may be changed by pressing yes to this prompt and then saving the variables.

| SET USB PORT AS | YES |
| ACTIVE PORT? | NO |
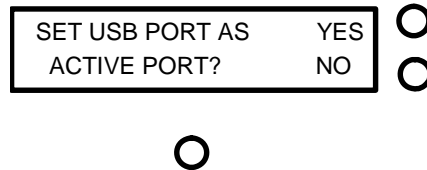
**Figure 11 - Set Active Port Prompt**

### 3.2.3.2 Adjust Startup Temperature Set point

The second variable accessed is TEMPERATURE MEMORY 0 shown in **Figure 12**. The TEMPERATURE MEMORY 0 variable is the system startup set point temperature. Responding YES to the prompt allows the user to adjust the set point as shown in **Figure 13**, a NO response accesses the next system variable described in the following section.

| ADJUST TEMPERATURE | YES |
| MEMORY 0 = XXX.XX ? | NO |
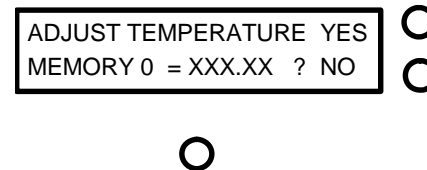
**Figure 12 - Temperature Memory Set point Prompt**

The adjustment of MEMORY 0 (power-up set point) is accomplished through the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in **Figure 13**. The COMMAND key, located directly below the LCD, is used to advance the cursor to each of the digits.

```
┌─────────────────────────────┐
│ MEMORY  0  = XXX.XX     UP   │   O
│ PRESS      v  TO SET    DN   │   O
└─────────────────────────────┘
                                    O
```

**Figure 13 - Adjust System Memory Set point Prompt**

As the cursor is scrolled past the last digit, memory set point adjustment is completed and the user is allowed access to the next system variable, as described in the following section.

### 3.2.3.3  Adjust Startup Pressure Set Point (K49P Variant only)

The third variable accessed is ALTITUDE MEMORY 0 shown in **Figure 14**. The ALTITUDE MEMORY 0 variable is the system startup set point pressure. Responding YES to the prompt allows the user to adjust the set point as shown in **Figure 15**, a NO response accesses the next system variable described in the following section.

```
┌─────────────────────────────┐
│ ADJUST ALTITUDE        YES   │   O
│ MEMORY 0 = XXXXXX FT?  NO    │   O
└─────────────────────────────┘
                                    O
```
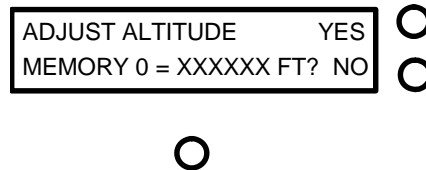
**Figure 14 - Altitude Memory Set point Prompt**

The adjustment of MEMORY 0 (power-up set point) is accomplished through the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in **Figure 15**. The COMMAND key, located directly below the LCD, is used to advance the cursor to each of the digits.
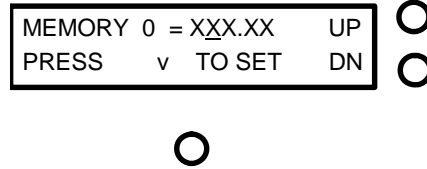
```
┌─────────────────────────────┐
│ MEMORY 0  = XXXXXX FT  UP    │   O
│ PRESS      v  TO SET    DN   │   O
└─────────────────────────────┘
                                    O
```

**Figure 15 - Adjust System Memory Set point Prompt**

As the cursor is scrolled past the hundreds digit, memory set point adjustment is completed and the user is allowed access to the next system variable, as described in the following section.

## 3.2.3.4  Access Vars Array

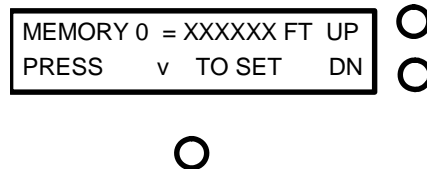This function allows access to variables stored in the system's memory.  It is strongly recommended that before responding YES, one carefully reviews what each variable represents (see chart below).  It is also strongly recommended that only experienced users familiar with this system and its limitations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

**\*\*DO NOT ADJUST VARS ARRAY WITHOUT FIRST CONSULTING FACTORY!!!**  Doing so can cause severe damage to the system 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.
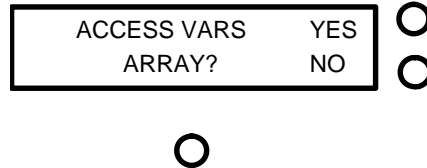
```
ACCESS VARS     YES      ◯
ARRAY?          NO       ◯
```
◯

**Figure 16 - Access Variables Array Prompt**

Responding YES will cause the prompt in **Figure 17** to appear.  This is to remind the user of the potential consequences of improper use of this function.  Press Switch #1 to continue or Switch #2 to exit to the next function.
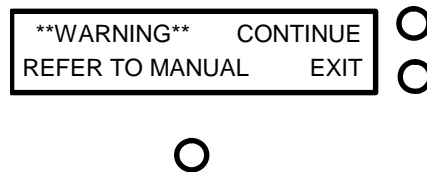
```
**WARNING**     CONTINUE    ◯
REFER TO MANUAL      EXIT    ◯
```
◯

**Figure 17 - Warning Prompt**

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

```
VAR  0  =  XXX.XXXXX  UP      ◯
PRESS      v  TO SET     DN    ◯
```
◯
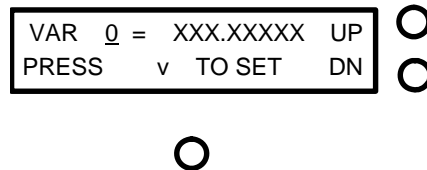
**Figure 18 - Variable 0 Adjustment Prompt**

To scroll through the variables, press 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.

Once a variable has been selected, 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 decrement by one. As the cursor passes the last digit, the value is stored as a temporary system variable.

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**\*\*WARNING\*\* Software checking is not done for these entries and inputting values outside the recommended ranges can result in permanent damage to the system.**

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

| # | Variable \Description | Default Values | Recommended Range |
|---|---|---|---|
| 0 | Current Setpoint Temperature (Deg. C) | Saved Value for Variable 3 | -5 to 75 (-15 to 85 for K49X) degrees C |
| 1 | Current Setpoint Pressure Altitude (100's of feet) | Saved Value for Variable 2 | -5.00 to 125.00 100's of feet |
| 2 | Startup Setpoint Pressure Altitude (100's of feet) | 25.0 | -5.00 to 125.00 100's of feet |
| 3 | Startup Setpoint Temperature (Deg. C) | 25.0 | -5 to 75 (-15 to 85 for K49X) degrees C |
| 7 | GPIB Primary Address | 6.0000 | 1.0000-30.0000 |
| 10 | Current Measured Stage Temperature (Deg. C) | | -5 to 75 (-15 to 85 for K49X) degrees C |
| 12 | Set point Increment (Deg. C) | 5.0 | 1 to 75 (1 to 85 for K49X) degrees C |
| 20 | ACCESS CODE for protected variables | 0.0000 | Call Factory |
| 22 | Pressure Altitude Set point Increment (100's of feet) | 5.0 | 1.0 to 125.00 |

### 3.2.3.5  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 will cause 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.



**Figure 19 - Save Variables Prompt**

Responding NO to this prompt exits 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 was 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.

### 3.2.4  Diagnostics Display Mode Select

Here, the user is given the opportunity to toggle between two sets of information for display during normal operating mode. The NORMAL DISPLAY mode is always presented upon system power up and is changed through this command function to allow display of DIAGNOSTIC INFORMATION by answering YES to the command function prompt shown in **Figure 20**.



**Figure 20 - 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 21**.

```
CHANGE TO NORMAL    YES    O
DISPLAY?            NO     O
                           O
```

**Figure 21 - Normal Mode Display Prompt**

The DIAGNOSTIC INFORMATION display presents an array of numeric information for system diagnostics for the Primary and Secondary system control loops.

```
45.0    45.0   - 0.2      T     O
        45.1    7.5      7.3    O
                                O
```

**Figure 22 - Diagnostics Display**

The information presented by this display in temperature mode is as follows.

|  |  |  |  |
|---|---|---|---|
| **TOP ROW** | Thermal Stage Controller Set point | Controller Proportional Signal | *T* |
| **BOTTOM ROW** | Measured Thermal Stage Temperature | Controller Integrator Signal | Stage Controller PID sum |

The information presented by this display in pressure altitude mode is as follows for the **K49P Variant**.

|  |  |  |  |
|---|---|---|---|
| **TOP ROW** | Press. Altitude Controller Set point | Controller Proportional Signal | *P* |
| **BOTTOM ROW** | Measured Chamber Press. Altitude | Controller Integrator Signal | Control Valve Drive Voltage |

Note: Once the DIAGNOSTIC INFORMATION mode has been entered the display will only present the diagnostic information; return to normal display mode through the COMMAND FUNCTIONS options as described above. Although the UP and DN labels are not presented, the two switches on the right-hand side will still increment or decrement the set points as described earlier.

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

# 4. Operating the System Using a Remote Interface

The standard system can communicate with a remote computer via RS-232 or USB Type-B. A driver must be installed on the host computer in order to communicate using USB as outlined in **4.1 Downloading Driver for USB Communication**.

If the system comes 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 system over the interface. Pond Engineering has software available for reading the system variables by an IBM compatible or Macintosh computer with a National Instruments 488 interface card. Custom software packages are also available to integrate the system into an automated lab. The system variables accessed over the 488 and the command set recognized by the system are listed below.

## 4.1 Downloading Driver for USB Communication

The driver for the USB communication can be found on the disc that came with the system; file name is K49_USB_Driver_W7&XP. If the USB port is not the active port set it to be active as outlined in **3.2.3.1Set USB (RS232) Port as Active Port**. When the system is plugged in to the host computer via USB the new hardware wizard should automatically start. If the wizard does not start the new hardware can be found under *Devices and Printers* on the start menu. The name of the device is POND CDC/USB. Locate this device and double click the icon. On the Properties dialog box select the *Hardware* tab, click the *Properties* button. This will open a second Properties Dialog box. On this dialog box click the *Change settings* button. Click the *Driver* tab at the top and click *Update Driver*. Select *Browse my computer for driver software* or *Install from a list or specific location,* navigate to the CD and select the file. A warning will pop up saying the driver has not been verified by Windows click *Install this driver software anyway*. Each system has a unique serial number that the computer will recognize so each individual system will have to have a driver downloaded for it. This allows for multiple units to be connected to the same computer at the same time. Once the installation finishes the icon for the unit will be named *Pond Comm Port (COM#).* Each subsequent system will have the next highest number in place of the # sign.

## 4.2 System Variable List

Please refer to section **3.2.3.4** for a list of the system variables.

## 4.3 System Command Set

The command set for the system is outlined in the following paragraphs. The commands are issued from the host computer that acts as the controller. The K49 system, acting as the slave, listens when addressed as a listener, talks when addressed as a talker, and does not issue service requests (SRQ). The command set, variable list, and syntax is the same for the Serial interface or the IEEE-488 interface option.

### 4.3.1 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 system will wait to be addressed as a talker to return the data at the read location over the bus. The system has a one-second-write timeout, thus the controller in charge must read from the system (addressing the system as a talker) 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 current set point, the user would send the character string:

"R00" "ENTER"

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

**\*\*Note: Control of the system core remains the highest priority and the system may put off responding to 488 commands for as long as 500ms if they interrupt a control cycle. The system being addressed as a talker and not in the control cycle would return the current set point temperature (variable address 00), as follows:**
**+4.300000e+02(space)00**
**The values returned are always in the above scientific format followed by a space and address number for the given value.**

### 4.3.2  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 of the set point temperature to 25.34 °C, the user would send:
"W00,+25.34" "ENTER"
The set point temperature would then be set to 25.34°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 given in the table in 3.2.3.3*

All variables can be set to any value received over the 488.  Use extreme caution when setting any variable over the 488.  The user should read back any variable after setting it to insure the system 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 system to overheat and damage the core.

## 4.4  Serial Interface Hardware Description

Hardware connection to the serial interface is provided at a 9 pin D Sub connector on the rear panel of the system. Communication over the serial interface is accomplished asynchronously at 9600 baud with no hardware flow control. Pin out and connection to standard PC serial ports is shown in **Figure 23**.
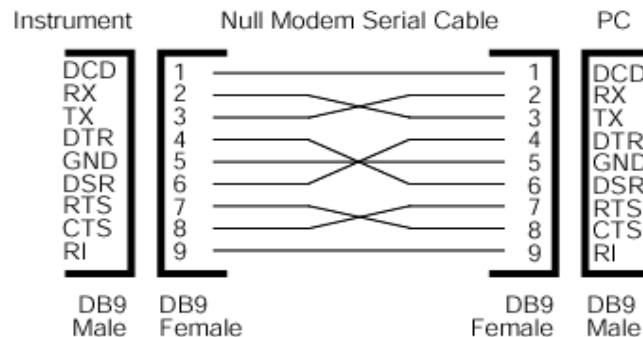


**Figure 23 - Serial Interface Connection**

## 4.5 Serial Interface Example

Communication with the system is accomplished using the Windows utility application HyperTerminal. HyperTerminal can be opened using pre-configured sessions found on the disc received with the unit. These are named K49_USB.ht and K49_232.ht for USB or RS232 connection respectively. Another option is to create your own session as outlined in Figure 24 - Connecting with HyperTerminal and Figure 25 - HyperTerminal Communication Example.
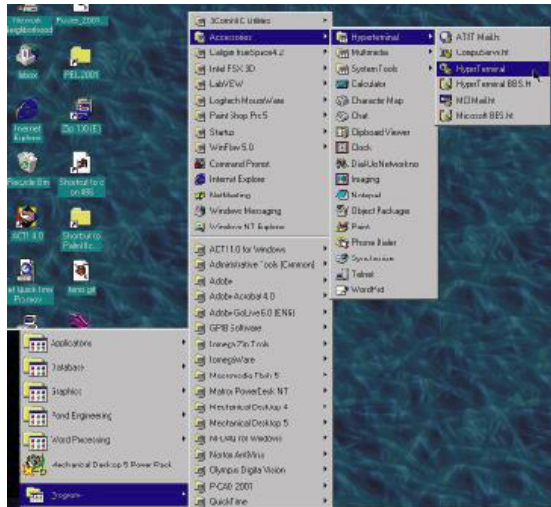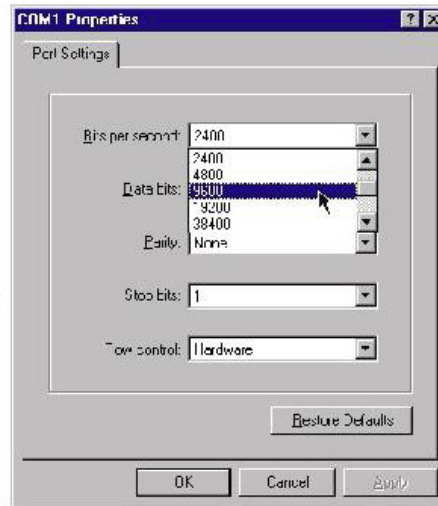
Access Hyperterminal by clicking the Windows Start button and following the paths shown at left.

Assign a name to the communication session as shown in the window below (eg. "test")
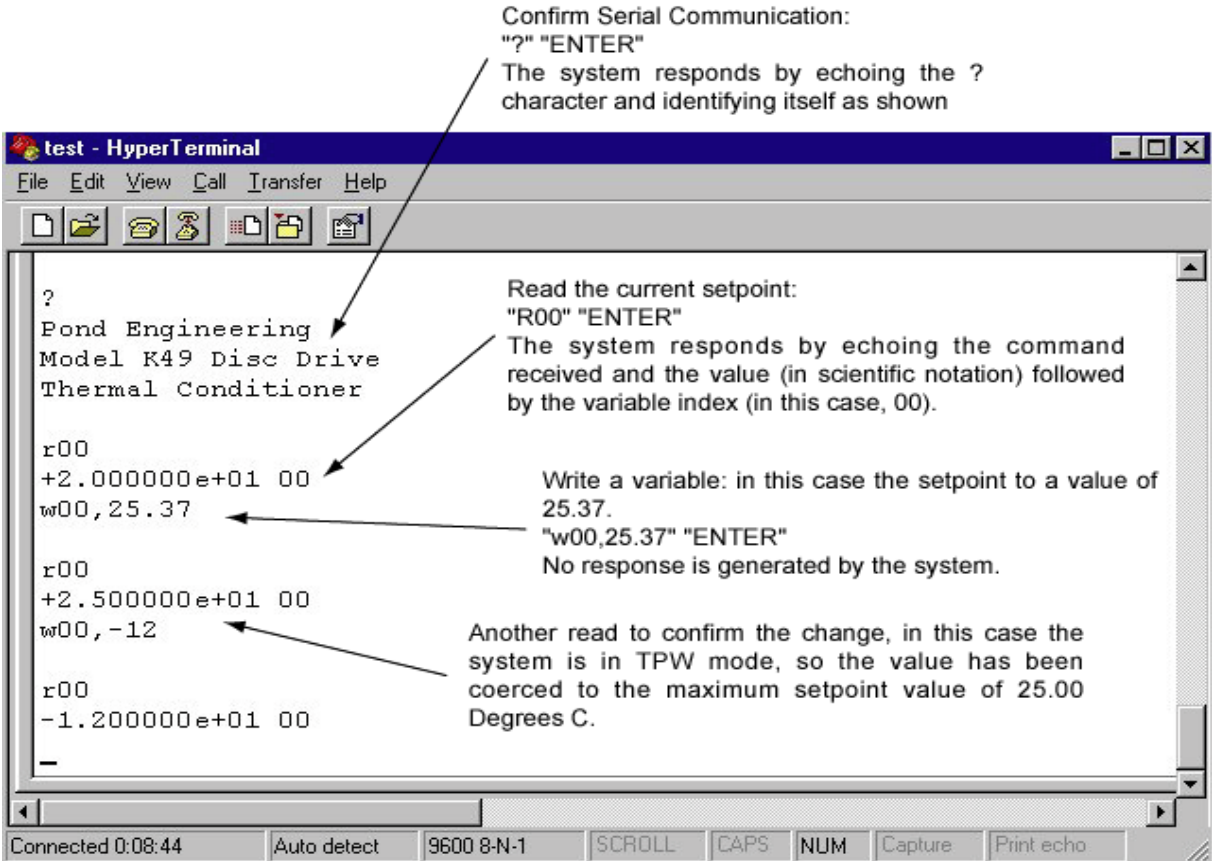
Verify that the COM PORT the system is connected to is the one selected in the window shown at left, then click OK.

Confirm (or select) the "Bits per second" or baud rate of 9600 from the pull-down menu and click OK

**Figure 24 - Connecting with HyperTerminal**

When the connection has been established, communicate with the system as in the following example;



Confirm Serial Communication:
"?" "ENTER"
The system responds by echoing the ? character and identifying itself as shown

Read the current setpoint:
"R00" "ENTER"
The system responds by echoing the command received and the value (in scientific notation) followed by the variable index (in this case, 00).

Write a variable: in this case the setpoint to a value of 25.37.
"w00,25.37" "ENTER"
No response is generated by the system.

Another read to confirm the change, in this case the system is in TPW mode, so the value has been coerced to the maximum setpoint value of 25.00 Degrees C.

**Figure 25 - HyperTerminal Communication Example**

# 5. 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 that significant maintenance or repair is required, contact Pond Engineering before replacing or modifying major system components.
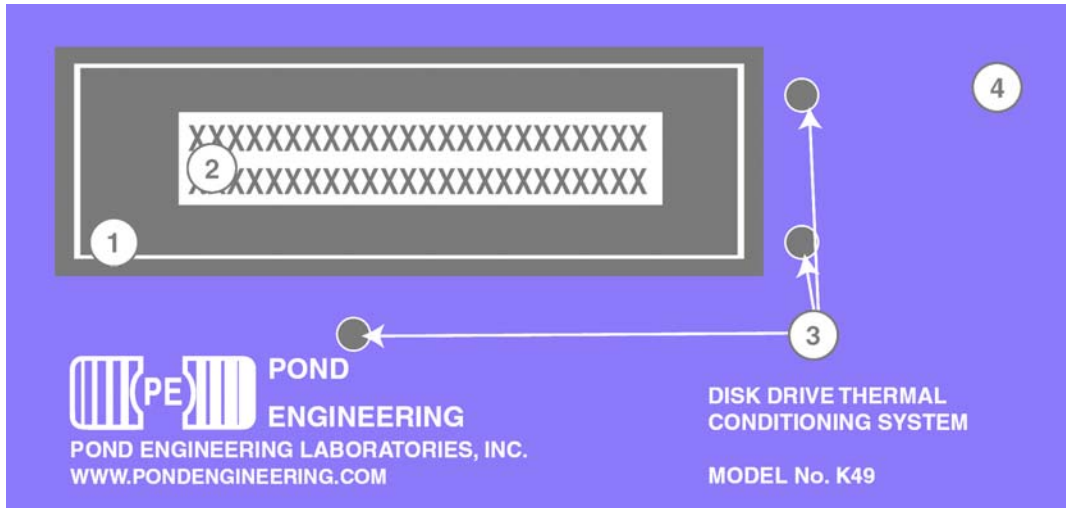
## 5.1 Front Panel



**Figure 26 - Front Panel Hardward**

| REF. # | NAME | MAKE | MODEL |
|---|---|---|---|
| 1 | Die Cast Metal Bezel | Pond Engineering | K00_H005 |
| 2 | LCD Display | Pond Engineering | K00_A001_1 |
| 3 | Push Button Switch Cap | Pond Engineering | K00_EH006 |
| 4 | Engraved Laminate Front Panel | Pond Engineering | K49-H001 |

## 5.2 Power Input

| NAME | MAKE | MODEL |
|---|---|---|
| Power Cord | Pond Engineering | K00_E002 |

## 5.3 Electronics Chassis

| NAME | MAKE | MODEL |
|---|---|---|
| Power Supply(100-240V,4A) | Pond Engineering | K00_EM007 |
| Microprocessor/Controller | Pond Engineering | K00_A005 |
| System ON/OFF Switch | Pond Engineering | K00_E001 |

## 5.4 Temperature Control

| NAME | MAKE | MODEL |
|---|---|---|
| Core | Pond Engineering | K49_A010 |

# 6. Top Level Schematic
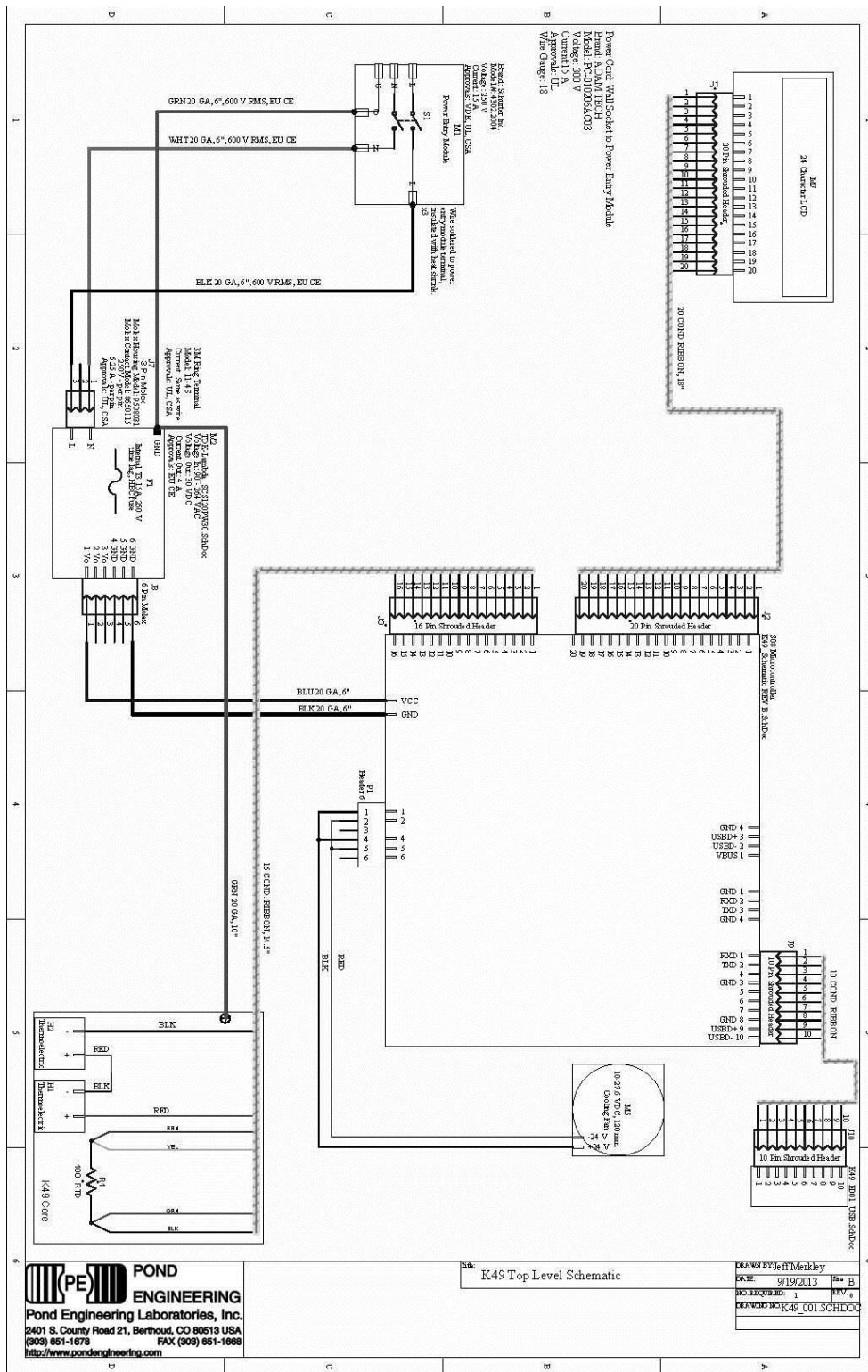


**Figure 27 - Top Level Schematic**

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## 7. Calibration Log

| Date | STAGE | RTPW | Coef. A Above | Coef. A Below | By Whom |
|------|-------|------|---------------|---------------|---------|
| For Factory Calibration see Calibration Report | | | | | |
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