Model K61

Wide Range Liquid Bath

Operation and Maintenance Manual

by

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Model K61
Wide Range Liquid Bath

2. Introduction

This manual documents the installation, operation and maintenance procedures for the Pond Engineering Model K61 Wide Range Liquid Bath. 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.

2.1 Safety Information

Throughout the manual, the following terms will be used and should be taken under advisement by the user to ensure safety of the user and to prevent damage to the instruments.

WARNING: Notifies user of possible actions and conditions that may pose harm and hazard to the user.

CAUTION: Notifies user of possible actions and conditions that may pose potential damage to the instrument.

NOTE: Notifies user of helpful information to improve convenience and increase ease of instrument use.

2.2 General Information

The K61 Wide Range Liquid Bath consists of two self-contained well chambers housed in a single cabinet with a single controller. The system is designed for use in the calibration of a variety of temperature measurement devices across the temperature range of -80ºC to +300ºC. Power is supplied to the system through the upper back panel utilizing a standard IEC modular power cord. The system is factory configured to accept 100-120 VAC, 10A and can be field configured to accept 200-240 VAC, 7.5A input. See **Section 4.2.6** for details.

The cold well utilizes a free piston stirling cooler in conjunction with a heater block to provide the cooling power and control necessary for operation at temperatures from -80°C to +70°C. Incorporated in the cold well is a vapor envelope and desiccant to prevent potentially damaging condensation. The hot well utilizes a similar heater block with passive cooling to cover the range of +50°C to +300°C. Temperature stability is achieved by utilizing a cascaded dual-loop PID control. Vertical temperature uniformity is achieved by the utilization of an impeller driven by a magnetically coupled wet rotor brushless DC motor to produce a bottom-stirred coaxial flow system without the requirement for mechanical shaft seals.

Figure 1 shows the flow pattern created by the K61 during normal operation. This ensures uniformity of ±0.03°C or better within the active calibration volume over the entire operating temperature range of the bath. Both wells require approximately 2.6 liters of fluid to operate properly and provide a fluid depth to allow probe immersion of greater than 300mm. The K61 has a well opening with a diameter of approximately 65mm, which can accept up to four units under test (UUT) plus a standard external reference.

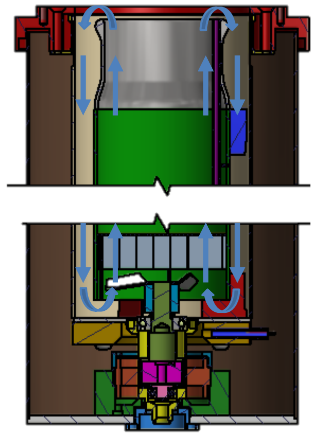


Figure 1 - Coaxial Flow Diagram

The K61 Wide Range Liquid Bath may be user-configured to display and control in either °C or °F (see **Section 6.2.4.1** for details), and can accommodate a wide variety of temperature measurement instruments including, but not limited to:

- Platinum Resistance Thermometers (PRTs)
- Resistance Temperature Detectors (RTDs)
- Thermistors
- Thermocouple probes
- Dial Thermometers
- Liquid-in-Glass Thermometers

The K61 Wide Range Liquid Bath cabinet is 92cm high, 51cm deep and 46cm wide and is fitted with wheels so it can be transported to different locations within the calibration laboratory.

2.3 Theory of Operation

The K61 Wide Range Liquid Bath utilizes a single controller to accomplish control for both the hot and cold calibration wells with one well active at any given time. The active well is selected by the user via the front panel interface. The bath temperature is monitored and controlled through a dual-loop control utilizing nominal 100Ω platinum resistance thermometer (PRT) sensors as the internal control probes. The sensor for the primary loop is embedded in the heater block of each well providing rapid response time, and the sensor for the secondary loop is an external probe that must be moved by the user to the well currently in use. This dual-loop control provides temperature stability of ±0.015°C or better over a 30 minute window.

Figure 2 shows the general configuration of the system and provides a reference for location of connection and service points discussed later in this manual.

As shown in **Figure 2**, the controller front panel is located on a sloping surface at the front of the outer chassis of the system. The system is designed primarily to provide a stable and uniform temperature environment for the calibration of temperature measurement devices over the range of -80ºC to +300ºC. The controller provides for calibration at any setpoint in that range and enables easy switching between hot and cold wells. Optional features include USB or RS-232 remote interfaces to allow operation of the system as part of an integrated automatic test system.

Cabinet Front Cabinet Rear

Figure 2 - General System Layout

The operator interface consists of three front panel switches and a 2-line by 24-character Liquid Crystal Display (LCD) on the system front panel, as shown in **Figure 3,** which provide access to all functions of the unit as well as diagnostics information.

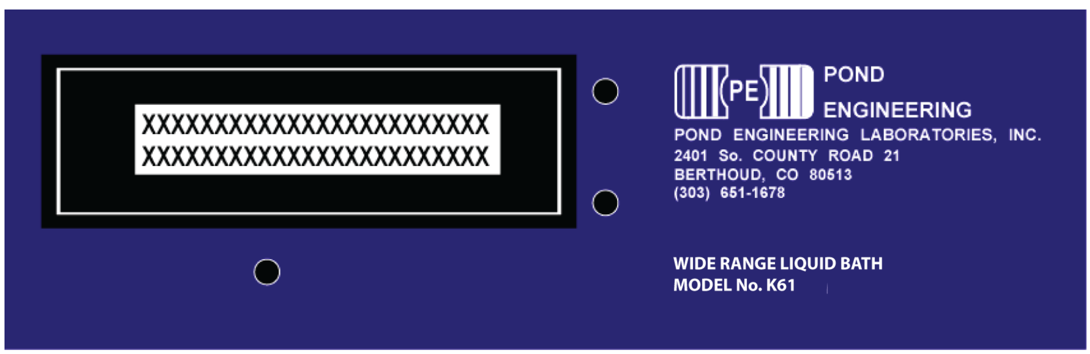


Figure 3 - Front Panel Layout

During operation, this display indicates the active well using a directional arrow (==> or <==) and presents the current temperature setpoint for the controller on the top line of the display. The bottom line displays the measured calibration volume temperature. Measurements are taken at approximately 1-second intervals and the lower line of the display is updated following each measurement, indicating the measured calibration volume temperature. Additional controller functions (for the purpose of providing diagnostic information, sensor calibration etc.) are accessed in Command Functions mode, through display and switches, as outlined in the following sections.

2.3.1 Specifications

Range	-80ºC to +300ºC Cold well : -80ºC to +70ºC Hot well : +50ºC to 300ºC
Stability	± 0.015°C or better within a 30 minute window
Vertical Uniformity	± 0.03°C or better
Fluid Heating Rate	≈ 2.5°C/ minute from 25ºC to 50ºC ≈ 1.0°C/ minute from 50ºC to 150ºC ≈ 0.3°C/ minute from 150ºC to 300ºC
Fluid Cooling Rate	≈ 0.5°C/ minute from 70ºC to -30ºC ≈ 0.25°C/ minute from -30ºC to -80ºC
Stabilization Time	≈ 30 minutes
Well Volume	2 Wells @ ≈ 2.6 liters ea., total ≈ 5.2 liters
Immersion Depth	≥300mm
User Interface	2-line x 24-character LCD with 3 push-button switches
Display Resolution	0.01°C or 0.01°F
Control Heater	Hot Well: 370 Watts Cold Well: 120 Watts, Stirling Cooler Capacity: 120 Watts @ 25°C
Well Access Opening	65mm (2.56 in) Diameter
Cabinet Dimensions	92cm H x 51cm D x 46cm W
Weight	≈ 59 kg (130 lb.)
Power	100-120 VAC - Factory Default 200-220 VAC 50/60 Hz nominal NOTE: The system is internally switchable for operation at either of these two voltages.
System Fuse	10A 150V slow blow (100-120 VAC Operation) 7.5A 250V slow blow (200-220 VAC Operation) – (Not supplied by factory)
Interface Package	USB, RS-232 (optional)

3. Environmental Conditions

3.1 Bath Environment

In order to guarantee the performance levels specified elsewhere in this manual, the Model K61 Wide Range Liquid Bath should be operated in a room ambient temperature of 10 to 30°C (50 to 86°F), with relative humidity not to exceed 50% non-condensing. The K61 is for indoor use only and should not be operated in an excessively dirty or dusty environment.

It is necessary to provide clearance around the instrument to allow sufficient air circulation and access to side cabinet doors. There should be a distance of approximately 5 inches from the back of the cabinet to the nearest wall to allow air flow. A fume hood or other adequate ventilation system should be used to remove any vapors given off by hot bath fluid. Silicone oils require additional ventilation to prevent an oily, dirty environment. Keep flammable materials away from the bath when operating at high temperature.

3.2 Equilibration Period

The system must be allowed to equilibrate in normal room conditions for a minimum of 2 hours prior to operation after any of the following events:

- Initial use
- System transport
- Storage in humid/semi-humid environments
- Storage in temperatures greater than 10°C above or below room ambient

4. Getting Started

4.1 Unpacking

NOTE: Upon receipt of the shipment, inspect the unopened package and check for signs of damage on the exterior of the shipping material. Carefully unpack the bath and check for both external and internal damage of the Wide Range Liquid Bath and its accompanying accessories. If anything is damaged, contact the carrier immediately.

Supplied with the system are the following components:

1. Model K61 Wide Range Liquid Bath.
2. 1 gallon container with 3.78 liters of Methanol calibration fluid with associated MSDS
3. 1 gallon container with 3.78 liters of Water/Glycol calibration fluid with associated MSDS
4. 1 gallon container with 3.0 liters of Clearco PSF-50cSt Silicone Oil calibration fluid with associated MSDS
5. 1 gallon container with 3.0 liters of Clearco DPDM-400cSt Silicone Oil calibration fluid with associated MSDS
6. K61 Accessory Kit containing:
   - 6.1. 1 Power Cord
   - 6.2. 1 Inner Well Assembly
   - 6.3. 1 Rotor Assembly
   - 6.4. 1 Control Probe
   - 6.5. 1 Drip Containment Tray
   - 6.6. 3 Spare Desiccant Capsules
   - 6.7. Operation and Maintenance Manual
   - 6.8. Quick Reference Card

4.2 Bath Preparation, Filling, & Power Configuration

4.2.1 Installing the Rotor

Carefully place the rotor into the well. Once it is down into the bearing pocket, the magnets inside the rotor will cause it to pull down into the bearing seats. The impeller should then be able to be manually spun. **Figure 4** shows how the rotor fits into the bottom of the outer well.

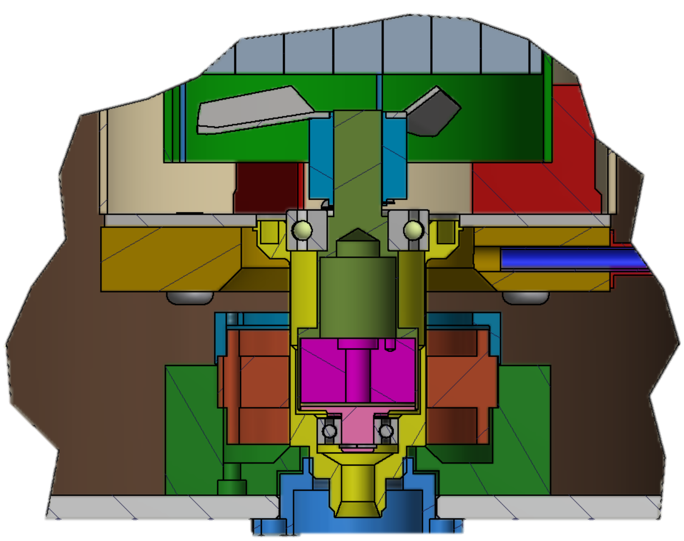


Figure 4 - Installed Rotor Position

4.2.2 Installing the Inner Well Assembly

Carefully place the inner well into the outer well. Make sure that the lower 3 fins (located towards the bottom of the inner well) do not hit the impeller but are lined up in the spaces between the impeller blades. The 3 fins on the inner well should be resting on the bottom of the outer well.

NOTE: It is convenient to orient the inner well so the system control probe well tube is closest to the rear of cabinet. This allows for easier access to the calibration well for inserting subsequent probes.

Once inserted, slide the inner well stabilizer to the tensioned position. This will prevent the inner well from rattling/moving during operation of the system. The inner well stabilizer should be disengaged prior to removal of the inner well assembly.

4.2.3 Installing the Control Probe

Place the control probe into the system control probe well tube. Connect the plug into the back of cabinet and tighten until snug.

4.2.4 Preparing Bath Fluids

Open the side cabinet door to access the drain valve for the active well. When viewed from the front of the cabinet, the cold well is located on the left and the drain valve for the cold well is located inside the left side cabinet door. The hot well is located on the right and the drain valve for the hot well is located inside the right side cabinet door. Make sure the drain valve is in the closed position and a container suitable for holding the desired fluid is placed under the overflow drain line before proceeding. The label located under the drain valve indicates the OPEN and CLOSED valve positions. **Figure 5** shows an example of an open and closed valve on the hot well.

OPEN

CLOSED

Figure 5 - Drain Valve Positions

WARNING: Prior to filling the bath with fluid, the user MUST ensure the drain valve is closed and a suitable container is located under the overflow drain line.

The K61 is equipped with a removable drip containment tray that has alignment holes for ease of installation. These holes should line up with two of the nuts on the rear set of casters, and the front edge of the tray should be just behind the base of the stirling cooler. The drip containment tray is designed to fit two 1-gallon containers similar to those provided with the K61 bath fluids, and will help to keep the cabinet cleaner, as it can be easily removed and cleaned.

NOTE: It is convenient to place absorbent material (i.e. paper towels) in the bottom of the drip tray before inserting the bath fluid containers.

4.2.5 Filling Well with Bath Fluid

Fill the well with suitable fluid for the desired temperature range. See **Section 5.5.2** for more information regarding individual bath fluid temperature ranges and recommended quantities.

4.2.5.1 Recommended Fluid Levels

The fluid levels listed below are measured down from the top edge of the inner well assembly. They are measured with the system powered off and the fluids at room temperature. These levels can also be found on the Quick Reference Card.

- K61BF_101-Methanol: 10-20mm
- K61BF_201-Ethylene Glycol/Water: 25-35mm
- K61BF_301-Silicone Fluid 50cSt: 30-40mm
- K61BF_401-DPDM-400: 35-45mm

4.2.6 Connecting the System to Power

After determining the desired input voltage, ensure the system is properly configured to accept that voltage. The K61 has been factory configured to run on 100-120 Volts AC, and is fitted with 10 Amp fuses. The voltage selector switch can be accessed through the right side cabinet door, as shown in **Figure 6**. Connect the system to the desired AC power source using the supplied or other suitable IEC power cord. If the system is reconfigured for operation at 200-220 VAC, the user should install 7.5A 250V slow blow fuses (not included from factory) in place of the 10A fuses shipped in the system. **Figure 2** shows the location of the fuse holder.

Figure 6 - Voltage Selector Switch Location

5. System Operation

5.1 Safety Information

5.1.1 Flashpoint Hazard

It is important to exercise EXTREME caution when operating the bath at elevated temperatures. The fluid temperature in the bath can easily exceed the flashpoint of many materials commonly found in the lab. Before inserting anything into the well, ensure that it is completely free of any substance that could flash (water, alcohol, etc.) when exposed to the bath temperature. Additionally, any object placed over or near the well should also be of a material suitable for use at the operating temperature. Pay particular attention to the physical properties of the fluids in use. Ensure that the fluid is being used within its recommended operating range. Failure to do these things can cause serious injury and/or damage to the instrument.

5.2 Bath Operation

CAUTION: Read **Section 4.2** before using. Incorrect handling of the machinery can damage the bath and could result in injury.

5.2.1 Bath Preparation, Filling, and Power Configuration

Refer to **Section 4.2** for instructions on how to fill the bath and prepare it for operation.

CAUTION: Do not move a bath filled with fluid. Empty the calibration wells before repositioning.

5.2.2 Bath Startup

NOTE: Instructions for starting up the system can also be found on the Quick Reference Card.

Once the bath has been filled and configured for the correct voltage, the power can be switched on. The power switch is located adjacent the power cord, on the upper back panel of the unit. On power-up, the system will prompt the user to select which well to activate, as shown in **Figure 7**. Well selection is accomplished by pressing the corresponding switch, according to the on-screen labeling.

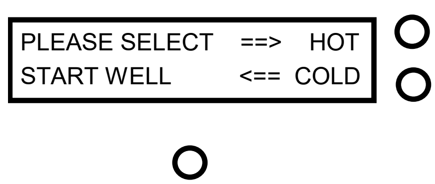


Figure 7 - Well Selection Prompt

As a protection against software or hardware fault and user error, the bath is programmed with both a primary and secondary alarm temperature function. This protects the cabinet and hardware from excessive temperatures and, most importantly, protects the bath fluids from being heated beyond the safe operating temperature preventing hazardous vaporization, breakdown, or ignition of the liquid. After a start well has been selected, the user is prompted to set the primary alarm temperature. The primary alarm temperature is also configurable by accessing the COMMAND FUNCTIONS through the front panel interface. The primary alarm temperature must always be set at least 10ºC (18°F) below the upper temperature limit of high-temperature calibration fluids or 10ºC above the lower temperature limit of low-temperature calibration fluids and no more than 10ºC above or below the upper and lower temperature limits of the bath. Refer to **Section 6.2.4.2** for information on how to change the alarm temperatures.

WARNING: Check to make sure the primary alarm is adjusted to suit the fluid characteristics. ENSURE the primary alarm is set 10°C (18°F) below the Flashpoint of the bath fluid selected.

During initial cooldown, it may be necessary to temporarily establish a higher alarm temperature until the system is able to cool the fluid to below the appropriate alarm temperature.

Once the alarms have been set, the prompt shown in **Figure 8** will appear on the LCD, asking the user to verify that the control probe is in the active well. Once the user has verified and responded to the prompt, the system will start to control the selected well to the default setpoint for that well. The LCD will indicate which well is currently active, as well as display the well setpoint and the current well temperature. If needed, the well setpoint can be changed through the Command Functions, as described in **Section 6.2.2** of this manual.

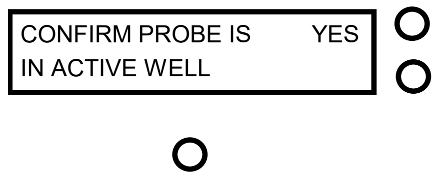


Figure 8 - Probe Confirmation Prompt

5.2.3 Achieving Adequate Circulation

It may be necessary to adjust the stir motor speed to obtain the circulation needed to maintain well uniformity. Once the fluid temperature is within 20°C (32°F) of the setpoint, adjust the motor speed to achieve a fluid height of 3-5mm over the top of the inner well assembly. The motor speed can be set in the range of 300 to 1000 RPM. See **Section 6.2.3** for information on how to change the motor speed.

NOTE: Generally, operation at the low end of a fluid's operating temperature range will require a motor speed near the high end of the speed range. Conversely, operation at the high end of a fluid's operating temperature range will require a motor speed near the low end of the speed range.

5.3 Calibration Procedure

5.3.1 Compatible Measurement Instruments

The K61 Wide Range Liquid Bath can accommodate a variety of temperature measurement instruments including, but not limited to:

- Platinum Resistance Thermometers (PRTs)
- Resistance Temperature Detectors (RTDs)
- Thermistors
- Thermocouple probes
- Dial Thermometers
- Liquid-in-Glass Thermometers

5.3.2 Comparison Calibration

CAUTION: Always make sure that probes are completely dry before inserting into a hot liquid. Some high temperature calibration fluids react violently to water and other liquids.

Use the system controller to select the appropriate well (hot or cold) and program the setpoint for the calibration. Ensure the calibration fluid in the well is appropriate for the setpoint temperature, and that the well is properly filled. Insert the reference probe into the calibration well. Then insert the UUT into the calibration well. After insertion, allow adequate time for the probes to settle and the temperature of the calibration volume to stabilize.

Upon removal from the calibration well, probes should be wiped with a clean, soft cloth after they have come to room temperature on a heat-resistant surface or rack.

CAUTION: Allow all units under test to come to room temperature before cleaning or inserting them into a calibration well.

For best results:

- Place the UUT as close as feasibly possible (but not touching) the reference probe in the bath
- Ensure the probes are not in contact with any calibration well surfaces
- Insert both probes to the same depth in the calibration fluid
- Ensure immersion depth is at least 20x the diameter of the UUT + the sensor length
- When calibrating over a wide temperature range, start at the highest temperature and progress down to the lowest temperature
- Use a heat shield, if necessary, to protect probe handles

5.3.3 Calibration of Multiple Probes

The K61 Wide Range Liquid Bath can accommodate up to 4 UUTs in addition to the external reference probe. Fully loading the bath with probes increases the time required for the temperature to stabilize after inserting the probes. Use the reference probe to ensure that the temperature has stabilized before starting calibration.

5.4 Shutting Down the System

The shutdown procedure for the K61 Wide Range Liquid Bath is initiated from within the "Command Functions". Refer to **Section 6.2.6** for more information. Information on how to drain the wells can be found in **Section 5.5.3**.

5.5 Maintenance

5.5.1 Care and Cleaning

CAUTION: Disconnect power from the bath before performing any maintenance. Empty both calibration wells and carefully remove the inner well(s) and stirring mechanism(s) before using any detergents, degreasers or solvents.

If the outside of the bath becomes soiled, it may be wiped clean with a damp cloth and mild detergent. Do not use harsh chemicals or abrasives on the surface, which may damage the finish.

When using silicon oil, the bath will require periodic maintenance during normal operation due to the vaporization of the oil, which will condense on the surface of the unit and, if not removed, can potentially build up enough to affect the performance and lifetime of the system. How often and how long the bath is operated at higher temperatures determines how often the maintenance will be needed. Simply wipe down the oily areas of the bath with a soft cloth sprayed with mild degreaser. Do not spray the degreaser directly on the bath. Repeat the process as often as necessary to keep the oil from collecting on the bath.

Due to eventual migration of water vapor into the vapor envelope around the cold well, it is necessary to periodically check and/or replace the rechargeable desiccant capsule. These capsules can be recharged by placing them in an airtight container with other, larger desiccants or with a molecular sieve. The desiccant can be accessed through the left side cabinet door. The desiccant itself is inside a black plastic cartridge near the bottom of the cold well, as shown in **Figure 9**. Unscrew the cartridge to check the desiccant. **Figure 10** shows the appearance of both dry and saturated desiccant packs.

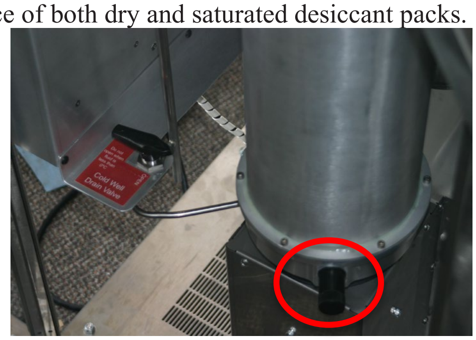


Figure 9 - Desiccant Cartridge Location

Dry Saturated

Figure 10 - Dry and Saturated Desiccants

5.5.2 Calibration Fluid Selection and Maintenance

For optimum performance, select calibration fluids with:

- Viscosity less than 10 centistokes at fluid operating temperature, for increased response time, temperature control and stability. Fluids with viscosity higher than 50 centistokes at fluid operating temperature are not recommended for use in this bath.
- Low specific heat, for increased heating and cooling rates.
- High thermal conductivity for increased uniformity and decreased settling time
- Low thermal expansion to prevent overflow and splashing
- High electrical resistivity for minimizing electrical leakage (i.e.: for the calibration of bare temperature sensors)
- Long fluid lifetime. Many fluids degrade over time through vaporization, water absorption, gelling, or chemical break-down. Note that degradation becomes significant near the upper temperature limit of many fluids, substantially reducing the fluid's lifetime.
- Minimal safety and environmental concerns such as burns, fire, and toxic fumes.

Pond Engineering has available for use with the K61 Wide Range Liquid Bath 1 gallon containers of the following recommended calibration fluids and their respective minimum quantities needed for use within the specified temperature ranges:

- K61BF_101 - 3.78 liters of Methanol for use between -80°C and -10°C,
- K61BF_201 - 3.78 liters of Water / Glycol for use between -20°C and +70°C,
- K61BF_302* - 3.0 liters of Silicone oil (Clearco PSF-50cSt) for use between +50°C and +150°C,
- K61BF_402* - 3.0 liters of Silicone oil (Clearco DPDM-400cSt) for use between +140°C and +300°C

*Full gallon quantities available on request – contact Pond Engineering for details

WARNING: High-temperature calibration fluids can present risk of burns, fire and toxic fumes. Use appropriate safety equipment.

Periodically check the calibration fluid to ensure that the fluid level has not dropped below the recommended fluid level. Changes in the fluid level can affect the stability of the bath. Calibration fluid lifetime varies by composition. Particular attention should be paid to the viscosity of the fluid. A significant change in the viscosity can indicate that the fluid is contaminated, being used outside of its temperature limits, contains ice particles, or is close to chemical breakdown. Users should familiarize themselves with the characteristics of new calibration fluid in the bath and set a regular maintenance schedule (at least monthly for the first year of operation) so that such changes are noticed before they compromise the performance of the bath.

5.5.3 Draining/Changing Calibration Fluids

To drain the calibration fluid out of the K61, it is necessary that the system be powered off, and the temperature of the fluid must be within a certain threshold. For the cold well, the fluid must be warmer than 0°C (32°F). For the hot well, the bath fluid must be cooler than 100°C (212°F). These temperature thresholds have been printed on the valve labels for quicker reference.

CAUTION: Opening the valve when the fluid is outside of the temperature threshold can cause irreversible damage to the valve, and may cause the system to be inoperable.

WARNING: Draining hot bath fluids can cause burns if allowed to contact skin. Exercise caution when draining hot fluids.

After draining the bath, the well should be rinsed with isopropyl alcohol and drained into a separate container to minimize cross-contamination of bath fluids. Make sure all traces of the rinsing agent have been flushed out of the system before attempting to run it. This can be done by either flushing some of the new bath fluid through the lines to remove excess rinsing agent, or by blowing compressed air through the lines.

WARNING: Failure to remove all traces of the rinsing agent could result in a violent reaction at higher operating temperatures.

5.5.4 Calibrating the Bath

Factory calibration is accomplished by recording the external probe measured resistance (Var. 57) at the triple point of water, -80°C, -40°C, +100°C, and +200°C and calculating ITS-90 coefficients as outlined below.

It may be necessary to periodically calibrate the bath to improve temperature setpoint accuracy. Calibration of the K61 Wide Range Liquid Bath may be accomplished by comparison calibration to a user-supplied external reference utilizing a triple point of water resistance (Var. 8) and a standard ITS-90 2-point calibration both above and below zero (Vars 9-12). The calibration variable numbers can also be found in **Section 6.2.4.5**.

6. System Controller

Detailed descriptions of the controller function and system setup are provided in this section. In an effort to maintain simplicity, while providing the flexibility to accommodate optional features, the operator interface is based largely on user-interactive software control. The software prompts the user through a set of COMMAND FUNCTIONS, including CHANGE ACTIVE WELL, CHANGE SETPOINT TEMPERATURE, CHANGE STIRRING MOTOR SPEED, ADJUST SYSTEM VARIABLES, DISPLAY DIAGNOSTIC INFORMATION, and SHUT DOWN ACTIVE WELL.

The software displays messages on the LCD to direct the user stepwise through each command function using the three front panel switches surrounding the LCD.

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 11**, below, are for the benefit of the reader in understanding the notation in this manual. Such labels do not appear on the device front panel.

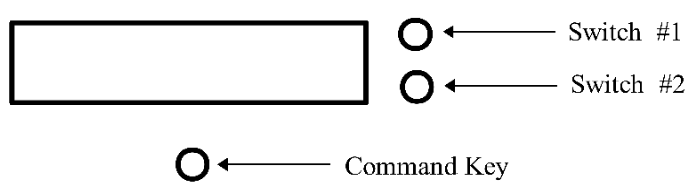


Figure 11 - Front Panel Switch Layout

6.1 Normal Operating Mode

During normal operation, the system controller continuously indicates the active well (cold to the left, hot to the right), and displays both the setpoint temperature (top line) and the current measured bath temperature (bottom line), as shown in **Figure 12**. Measurements are taken by the internal control sensor at approximately 1-second intervals and the lower line of the display is updated following the measurement.

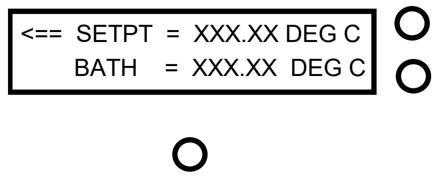


Figure 12 - Normal Operating Mode Display

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.

6.2 The "Command Functions"

In order to perform system configuration functions, the user must leave the normal operating mode (though normal system operation continues) and enter the COMMAND FUNCTIONS. To do this, the user should 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 normal operation screen will return and normal operation will continue. In order to proceed to "Command Functions", the operator must press and hold the "Command Key" until the words COMMAND FUNCTIONS disappear, at which time the operator may release the key.

NOTE: The system has been designed such that control functions operate normally even when the user is accessing the command functions. If the system is equipped with the optional USB or RS-232 interface capability, serial commands will not work until the system is returned to normal operating mode. Attempting to send remote interface commands while in COMMAND FUNCTIONS will cause a remote interface error that will clear itself in 10 to 30 seconds.

6.2.1 Change Active Well

The first command function accessed is CHANGE ACTIVE WELL. Through this function, the user may toggle the system controller between cold and hot wells to perform calibrations along the full operating temperature range of the system.

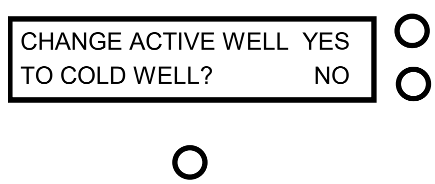


Figure 13 – Calibration Well Toggle Prompt

As shown in **Figure 13**, the YES is located adjacent to the top switch, which was identified earlier in **Figure 11** as "Switch #1". The NO is adjacent to the switch identified as "Switch #2". If the NO selection is made, the program will present the next function.

CAUTION: Changing the active well by selecting YES to this prompt will immediately toggle controller function to the currently inactive well. Never switch active wells while a calibration is in process.

CAUTION: When the active well is changed, the control probe must be inserted into the active well. Failure to do so could result in damage to the system.

6.2.2 Change Setpoint

The next command function accessed is CHANGE SETPOINT TEMPERATURE. Through this function, the user may manually adjust the setpoint temperature within the range of -80ºC to +70ºC if the cold well is active and +50ºC to +300ºC if the hot well is active. As shown in **Figure 14**, the YES is located adjacent to the top switch, which was identified earlier in **Figure 11** as "Switch #1". The NO is adjacent to the switch identified as "Switch #2". If the NO selection is made, the program will present the next function.

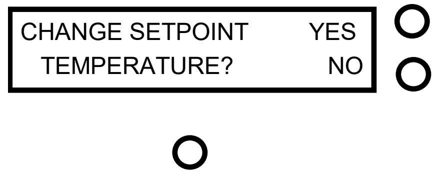


Figure 14 - Setpoint Access Prompt

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 15** will be presented on the LCD.

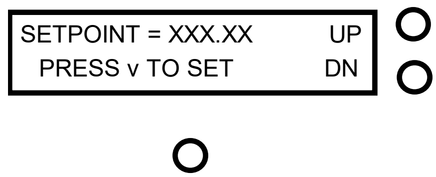


Figure 15 - Setpoint Change Prompt

Adjustment of the SETPOINT is accomplished using the two switches on the side corresponding to the labels UP and DN displayed on the LCD. The cursor starts in the hundred's position. Choosing UP will cause the setpoint value to increase by 100 until it reaches the maximum setpoint for the selected well. Choosing DN will cause the value to decrease by 100 until it reaches the minimum setpoint for the selected well. The COMMAND switch, located directly below the LCD, is used to set the value of the hundreds digit and advance the cursor to the ten's digit and so on. The number presented on the display is used as the current setpoint as soon as the user advances the cursor past the last digit.

NOTE: The range of setpoint temperatures available is contingent on which well is currently active. To program setpoints below +50ºC, ensure that the cold well is selected. To program setpoints above +70ºC, ensure that the hot well is selected.

If units are set to display as degrees Fahrenheit, setpoint adjustment is also done in degrees Fahrenheit.

Once the cursor is scrolled past the last digit, setpoint adjustment is complete and the user is presented the next Command Function as described in the following section.

6.2.3 Change Stirring Motor Speed

The next command function accessed is CHANGE STIRRING MOTOR SPEED. Through this function, the user may adjust the speed of the calibration fluid stirring motor. As shown in **Figure 16**, the YES is located adjacent to the top switch, which was identified earlier in **Figure 11** as "Switch #1". The NO is adjacent to the switch identified as "Switch #2". If the NO selection is made, the program will present the next function.

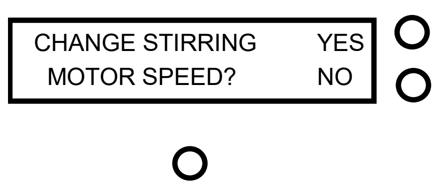


Figure 16 – Motor Speed Access Prompt

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 17** will be presented on the LCD.

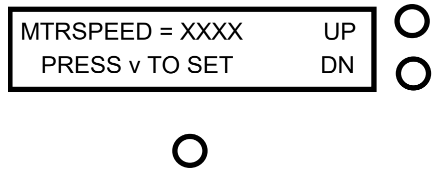


Figure 17 - Motor Speed Change Prompt

Adjustment of the MTRSPEED is accomplished using the two switches on the side corresponding to the labels UP and DN displayed on the LCD. The cursor starts in the hundred's position. Choosing UP will cause the motor setpoint value to increase by 100 until it reaches a maximum of 1000 rpm. Choosing DN will cause the value to decrease by 100 until it reaches 300 rpm. The COMMAND switch, located directly below the LCD, is used to set the value of the hundred's digit and advance the cursor to the ten's digit and so on. The number presented on the display is used as the current motor speed as soon as the user exits the Command Functions.

Once the cursor is scrolled past the last digit, motor speed adjustment is complete and the user is presented the next Command Function as described in the following section.

6.2.4 Adjust System Variables

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

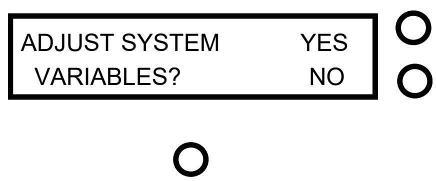


Figure 18 - System Variables Access Prompt

Pressing the switch labeled YES will allow access to the first system variable, shown in **Figure 19**, while responding NO will terminate the function and allow the user access to the next Command Function, DISPLAY DIAGNOSTIC INFORMATION.

6.2.4.1 Configure Display Units

Figure 19 – Degrees F Display Prompt

Responding YES to the prompt in **Figure 19** allows the user to choose whether the system displays setpoint and measured bath temperatures in Degrees Celsius or Degrees Fahrenheit. Since the K61 Wide Range Liquid Bath is programmed to display temperatures in Degrees C by default, the default for this command function is to prompt the user to switch the system to display Degrees F. Responding NO will allow the user access to the next system variable, discussed in the next section.

If the system is currently configured to display in Degrees F, the prompt will appear as shown below in **Figure 20**, allowing the user to toggle between the two units of measure.

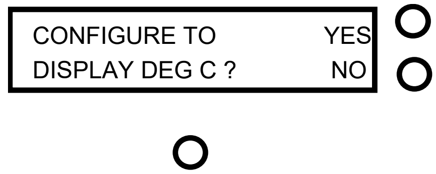


Figure 20 – Degrees C Display Prompt

6.2.4.2 Change Alarm Temperature

The next command function accessed is CHANGE ALARM TEMPERATURE. Through this function, the user may manually adjust the primary alarm temperature (the point at which the system shuts down to protect the integrity of the calibration fluid and/or the safety of users) within the range of -90ºC to +330ºC. As shown in **Figure 21**, the YES is located adjacent to the top switch, which was identified earlier in **Figure 11** as “Switch #1”. The NO is adjacent to the switch identified as “Switch #2”. If the NO selection is made, the program will present the next function.

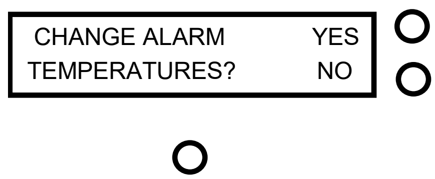


Figure 21 – Alarm Temperature Access Prompt

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 22** will be presented on the LCD.

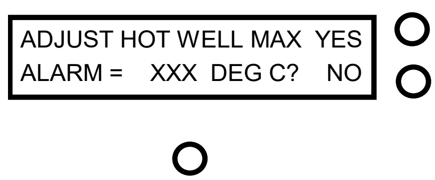


Figure 22 – Hot Well Max Temperature Alarm Adjust Prompt

If the user selects YES by pressing the corresponding switch, the display shown in **Figure 23** will be presented on the LCD.

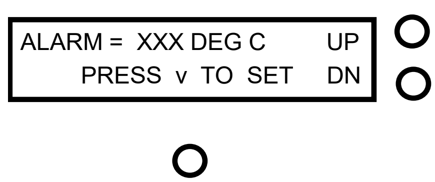


Figure 23 - Hot Well Max Alarm Adjustment Screen

Adjustment of the ALARM TEMP is accomplished using the two switches on the side corresponding to the labels UP and DN displayed on the LCD. The cursor starts in the hundred’s position. Choosing UP will cause the alarm value to increase by 100 until it reaches its maximum. Choosing DN will cause the value to decrease by 100 until it reaches its minimum. The maximum and minimum alarm setpoints for the cold well are -85°C and +75°C respectively. The maximum alarm setpoint for the hot well is +305°C. The COMMAND switch, located directly below the LCD, is used to set the value of the hundred’s digit and advance the cursor to the ten’s digit and so on. The number presented on the display is used as the current alarm temperature as soon as the user advances the cursor past the last digit.

WARNING: For the safety of the user, the alarm temperature should always be set to AT LEAST 10ºC below the flash point for the calibration fluid in use, and AT LEAST 10ºC above the freezing point of the calibration fluid when the cold well is active.

NOTE: If units are set to display in Fahrenheit, alarm adjustments are also done in Fahrenheit.

Once the cursor is scrolled past the last digit, alarm temperature adjustment is complete and the user is allowed to modify or accept the remaining alarm parameters. Once all alarms have been accepted or modified, the user is presented the next Command Function as described in the following section.

6.2.4.3 Adjust Startup Setpoint

The next variable accessed is the POWER-ON or system startup setpoint temperature, as shown in **Figure 24**. Responding YES to the prompt allows the user to adjust the setpoint as shown in **Figure 25**, a NO response accesses the next system variable described in the following section.

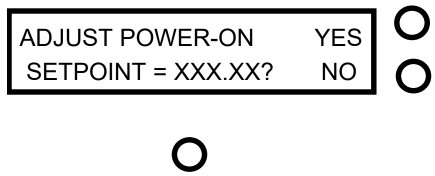


Figure 24 - Startup Setpoint Prompt

The adjustment of the STARTUP (the initial setpoint on power up) is accomplished through the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in **Figure 25**. 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 allowed access to the next system variable, as described in the following section.

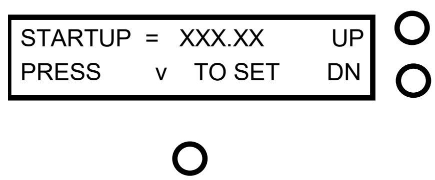


Figure 25 - Adjust Startup Setpoint Prompt

NOTE: If units are set to display as degrees Fahrenheit, startup setpoint adjustment is also done in degrees Fahrenheit.

6.2.4.4 Adjust Startup Motor Speed

The next variable accessed is the MOTOR SPEED STARTUP or system startup motor speed, as shown in **Figure 26**. Responding YES to the prompt allows the user to adjust the motor speed as shown in **Figure 27**, a NO response accesses the next system variable described in the following section.

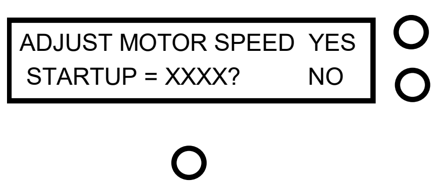


Figure 26 – Motor Startup Speed Prompt

The adjustment of the STARTUP (the initial motor speed on power up) is accomplished through the two switches on the side corresponding to the labels UP and DN displayed on the LCD shown in **Figure 27**. 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, motor speed adjustment is completed and the user is allowed access to the next system variable, as described in the following section.

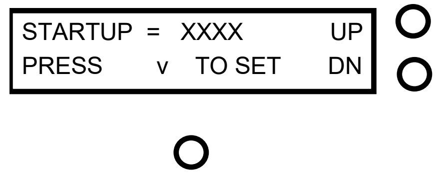


Figure 27 - Adjust Motor Startup Speed Prompt

6.2.4.5 Access Vars Array

This function allows access to variables stored in the system's memory. It is strongly recommended that before responding YES to the prompt in **Figure 28**, 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.

CAUTION: **DO NOT** adjust Vars Array without first consulting factory!

Adjusting variables without an accurate understanding of each of them 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 [(303)-651-1678] immediately for service.

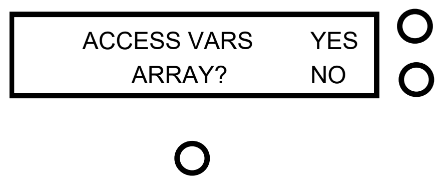


Figure 28 - Access Variables Array Prompt

Responding YES to the prompt in **Figure 28** will cause the prompt in **Figure 29** to appear. This is to warn the user of the danger if this function is not used properly. Press Switch #1 to continue or Switch #2 to exit to the next function.

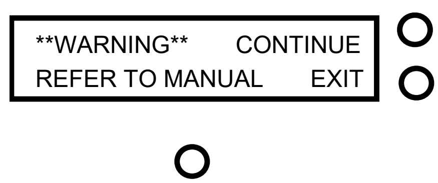


Figure 29 - Warning Prompt

If CONTINUE is selected, variables will be presented in series as shown in **Figure 30** and can be changed as described below. The variables are presented by number and are not text labeled. Please refer to **Table 1** for information about each variable.

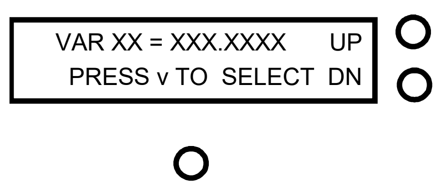


Figure 30 - Variable Adjustment Prompt

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 30 will cause the value of the selected digit (of the variable value) 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.

CAUTION: Software limit checking is not done for these entries and inputting values outside the recommended ranges can result in permanent damage to the system if utilized for operating the system.

The following is a list of commonly accessed system variables and their locations.

Table 1 - Commonly Accessed Variables

#	Variable \ Description	Default Values	Recommended Range
0	Current Well Setpoint Temperature (°C)	N/A	-80°C to +300°C
1	Motor Speed Setpoint (RPM)	N/A	300 RPM to 1000 RPM
2	System Startup Setpoint (°C)	75°C	-80°C to +300°C
3	System Startup Well	1 (Hot Well)	0 (Cold Well) 1 (Hot Well)
4	Startup Motor Speed Setpoint (RPM)	800 RPM	300 RPM to 1000 RPM
5	Cold Well Primary High Alarm (°C)	75°C	75°C MAX
6	Cold Well Primary Low Alarm (°C)	-100°C	-100°C MIN
7	Hot Well Primary High Alarm (°C)	155°C	305°C MAX
8	Probe TPW Resistance (Ω)	See Calibration Log	95Ω to 105Ω
9	A Coefficient Above Zero	See Calibration Log	N/A
10	B Coefficient Above Zero	See Calibration Log	N/A
11	A Coefficient Below Zero	See Calibration Log	N/A
12	B Coefficient Below Zero	See Calibration Log	N/A
13	Temperature Units	0 (°C)	0 (°C) 1 (°F)

6.2.4.6 Save Changes to Variables

Having scrolled through the available system variables and made adjustments as desired, 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 the prompt in **Figure 31** causes the variables to be stored in non-volatile memory within the system controller to be utilized as the system variables the next time the system is turned on.

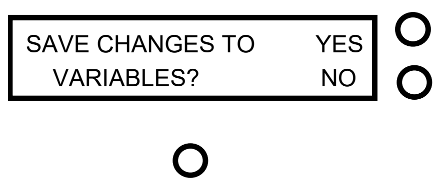


Figure 31 - Save Variables Prompt

Responding NO to the prompt in **Figure 31** causes the system to exit the function without saving the variables to non-volatile memory, allowing the user to temporarily establish new values for the system variables without permanently altering the default values.

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.

NOTE: If the power is interrupted before the new information is stored into the non-volatile memory, the newly established values are lost and the system will utilize the default values previously stored in non-volatile memory when power is restored to the system.

NOTE: Restarting the system will restore the default system variable settings as long as the changes have not been saved.

6.2.5 Diagnostics Display Mode Select

In this command function, the user is given the opportunity to choose which set of information is presented by the display during normal operating mode. Two choices are available; NORMAL DISPLAY and DIAGNOSTIC INFORMATION. Since the K61 Wide Range Liquid Bath defaults to NORMAL DISPLAY mode, the default for this command function is to prompt the user to switch the system to display DIAGNOSTIC INFORMATION. The user can configure the system to display DIAGNOSTIC INFORMATION by answering YES to the command function prompt shown in **Figure 32**.

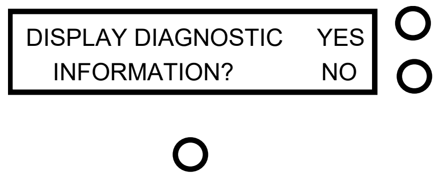


Figure 32 - Diagnostics Mode Display Prompt

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 33**.

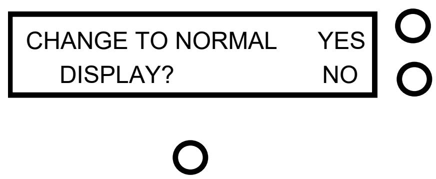


Figure 33 - Normal Mode Display Prompt

The DIAGNOSTIC INFORMATION display presents an array of numeric information for system diagnostics. There are three separate screens available in the diagnostics display mode: Primary Control Loop (BTH), Secondary Control Loop (BLK), and System (SYS). The user can cycle through these screens by using the button labeled in **Figure 11** as “Switch #2”. The far right column on the display indicates the active screen and the next screen which will be displayed upon pressing “Switch #2”, on the first and second lines, respectively.

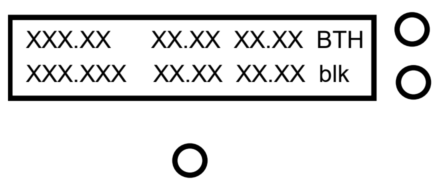


Figure 34 – Heater Block Diagnostics Screen

The information presented by the display shown in **Figure 34** is described below.

Primary Control Loop Diagnostics				
	Left Position	**Center Left Position**	**Center Right Position**	**Right Position**
Top Row	Bath Controller Setpoint (ºC)	Controller Proportional Signal (ºC)	Controller Derivative Signal (ºC)	BTH
Bottom Row	Measured Bath Temperature (ºC)	Controller Integrator Signal (ºC)	Offset Between Controller and Heater Block Setpoints (ºC)	blk

Secondary Control Loop Diagnostics				
	Left Position	**Center Left Position**	**Center Right Position**	**Right Position**
Top Row	Heater Block Controller Setpoint (ºC)	Controller Proportional Signal (V)	Controller Derivative Signal (V)	BLK
Bottom Row	Measured Heater Block Temperature (ºC)	Controller Integrator Signal (V)	Drive Voltage to Heater (V)	sys

System Diagnostics				
	Left Position	**Center Left Position**	**Center Right Position**	**Right Position**
Top Row	Motor Speed Setpoint (RPM)	Alarm Code	Inactive Well Temperature (°C)	SYS
Bottom Row	Measured Motor Speed (RPM)	Stirling Drive Voltage (1-5V)	Motor Duty (Unitless)	bth

NOTE: Once the DIAGNOSTIC INFORMATION mode has been entered the display will only present the diagnostic information; the user can return to normal display mode through the COMMAND FUNCTIONS options as described above.

6.2.6 Shut down Active Well

This command function is utilized to prepare the system for disconnecting the power. This involves disabling the heaters and/or the stirling cooler to prevent the system from being damaged. When this command is accessed, the system displays the prompt shown in **Figure 35**.

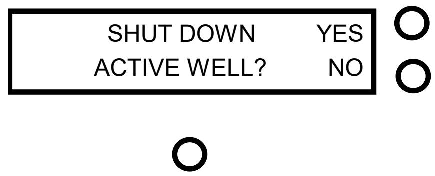


Figure 35 - Well Shutdown Prompt

6.2.6.1 Hot Well Shutdown

If the hot well is the active well, answering "YES" to this prompt will disable the output to the well heaters. The system will then alert the user that it is ready to be powered down by displaying the message shown in **Figure 36**. At this point, the user can safely flip the main power switch to the "OFF" position.

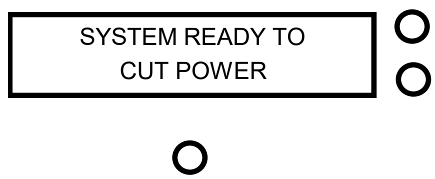


Figure 36 - Ready to Power Down

6.2.6.2 Cold Well Shutdown

If the cold well is the active well, answering "YES" to the shutdown prompt will disable the output to the well heaters, as well as begin to ramp down the stirling cooler power. While the stirling is shutting down, the front panel will show a countdown, as depicted in **Figure 37**. Once the stirling has had adequate time to shut down, the system will alert the user that it is ready by displaying the message shown in **Figure 36**. At this point, the user can safely flip the main power switch to the "OFF" position.

CAUTION: Shutting the system down with the stirling cooler active could cause damage to the system.

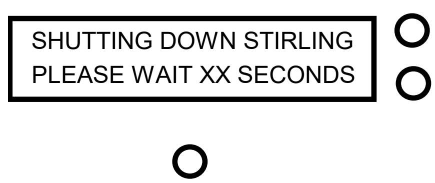


Figure 37 - Stirling Countdown

After stepping through all of the command functions as described above the system will automatically return to the normal operating mode described in **Section 6.1**.

6.3 System Alarms

The K61 Wide Range Liquid Bath is equipped with several alarms to aid in protecting the system against damage. Each alarm has an associated alarm code that is displayed once the alarm is triggered. If multiple alarms are triggered, the displayed alarm code will be the sum of the individual alarm codes. **Table 2** contains a brief description of the system alarm codes.

Table 2 - Alarm Code Descriptions

Alarm Code	Description
0	No Alarm – Normal Operating Mode
1	Primary Alarm
2	Secondary Alarm
4	Well Heating Alarm
8	Motor Fault
16	Inactive Well Heating

6.3.1 Hard-Reset Alarms

Two of the system alarms are hard-reset alarms, and can only be cleared by cycling the power to the system. If a hard-reset alarm is set, the system will trip a watchdog circuit, disabling power output to the heaters. The system will also display the message shown in **Figure 38** with the alarm code and the current bath temperature on the first and second lines respectively. This section provides more information about these alarms and their potential causes.

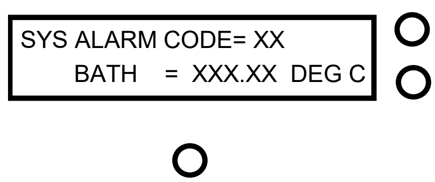


Figure 38 – Hard-Reset Alarm Message

6.3.1.1 Secondary Alarm

The secondary alarm is programmed to 5ºC above and 50ºC below the upper and lower temperature limits of the bath; 305ºC and -130ºC respectively. If the temperature in the calibration well exceeds either of these limits, the system will automatically shut down the heater and stirling cooler drives.

Conditions that can cause this alarm to trigger include:

- The probe is not properly installed
- Mechanical failure of the heater control hardware

6.3.1.2 Inactive Well Heating Alarm

The inactive well heating alarm is programmed to prevent power from being applied to the heaters in the inactive well. This prevents the inactive well from reaching temperatures harmful to the system and to the user. This alarm will trigger in the event of excessive heating in the inactive well, and will protect the system from any further damage.

Conditions that can cause this alarm to trigger include:

- Mechanical failure of the heater control hardware
- External heat source in inactive well

If the alarm is repeatedly triggered, please contact Pond Engineering for instructions on how to resolve this issue.

6.3.2 Soft-Reset Alarms

The other three system alarms are soft-reset alarms, and can be cleared from the front panel of the system. If a soft-reset alarm has been triggered, the system will display the message shown in **Figure 39** with the alarm code and the current bath temperature on the first and second lines respectively. The display also has the letters "CLR" adjacent to the switch labeled in **Figure 11** as "Switch #1". Pressing this switch will clear all soft-reset alarms that have been triggered, and the system will return to normal operation.

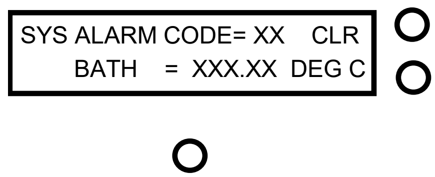


Figure 39 - Soft-Reset Alarm Message

NOTE: Soft-reset alarms cannot be cleared if a hard-reset alarm has also been triggered. The user must cycle power to the system to clear all alarms.

6.3.2.1 Primary Alarm

This alarm is triggered if the bath temperature exceeds any of the user-defined alarm temperatures. If the primary alarm is triggered, power to the heaters and stirling cooler is shut off and the bath cools or heats. The display switches to show the soft-reset alarm message and the bath heats or cools until it is a few degrees above or below the low or high alarm setpoint temperature, respectively.

6.3.2.2 Motor Fault

In the event that the motor does not function properly, the system will trigger the motor fault alarm. The K61 is configured to make several attempts to start the motor. If it is not successful in starting the motor, the system will display the soft-reset alarm message. The user should investigate the motor starting issue, and may need to shut down the system.

Conditions that can cause this alarm to trigger include:

- The rotor is not properly installed
- Foreign objects in vicinity of impeller blades
- Foreign objects and/or residue in bearings/bearing pockets

6.3.2.3 Well Heating Alarm

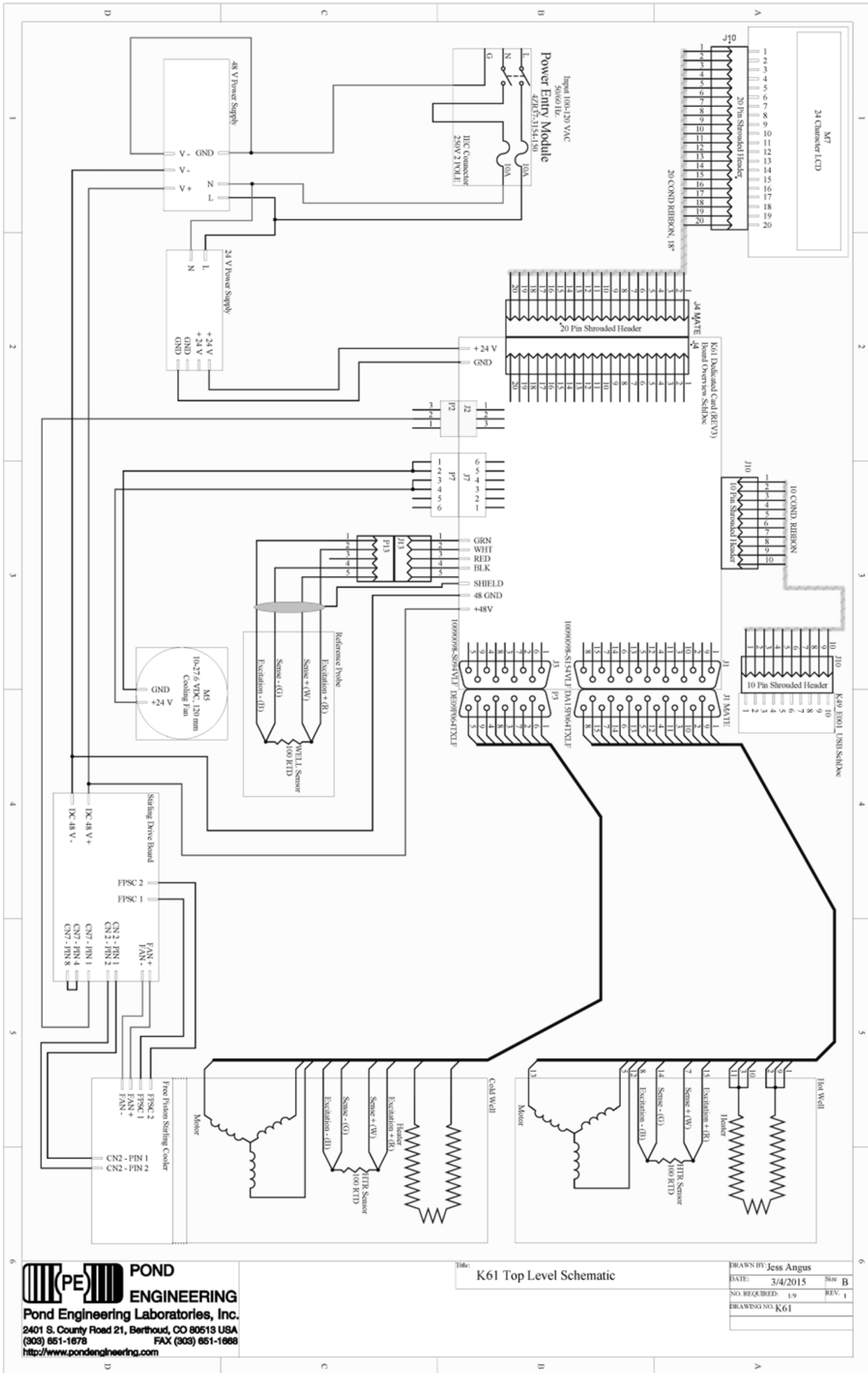
The well heating alarm will be triggered if the system fails to detect a rise in bath temperature with the heaters at full power, preventing potential damage to the system.

Conditions that can cause this alarm to trigger include:

- The probe is properly installed, but not in the active well
- Adding cooler fluid to a well as it is heating
- Starting the hot well from room temperature with high viscosity fluids. (i.e. K61BF_401)
- Mechanical failure of the well switching hardware
- Alarm configuration inadequate for use with bath fluid

The alarm may be cleared by pressing the button labeled in **Figure 11** as "Switch #1". Heater power is restored for a period of approximately 80 seconds after the alarm is cleared. The alarm will be triggered again if the fault condition persists. If the alarm is repeatedly triggered, please contact Pond Engineering for instructions on how to resolve this issue.

7. Top Level Schematic



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8. Control Probe Calibration Log

System S/N:__________ Probe S/N:__________

Date	Cal By (Initials)	RTPW (Ohms)	Coef. A Above	Coef. B Above	Coef. A Below	Coef. B Below	Comments