Model K28M

Gallium Melting Point Cell Maintenance System
Operation and Maintenance Manual

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Gallium Melting Point Maintenance System

1. Background

This report documents operating and maintenance procedures for the Gallium Melting Point Cell Maintenance System, Pond Engineering Number K28. Information contained in this manual is considered by Pond Engineering Laboratories to be proprietary and is provided for use exclusively by the purchaser for instructional and maintenance purposes relative to the hardware delivered, any other use is prohibited.

2. General Information and Operating Procedures

Figure 1, below, shows the general configuration of the Gallium Melting Point Maintenance System (K28M). These diagrams provide a better visualization of the K28M's appearance, as well as a point of reference in location and use of the control switches and service points discussed later in this manual.
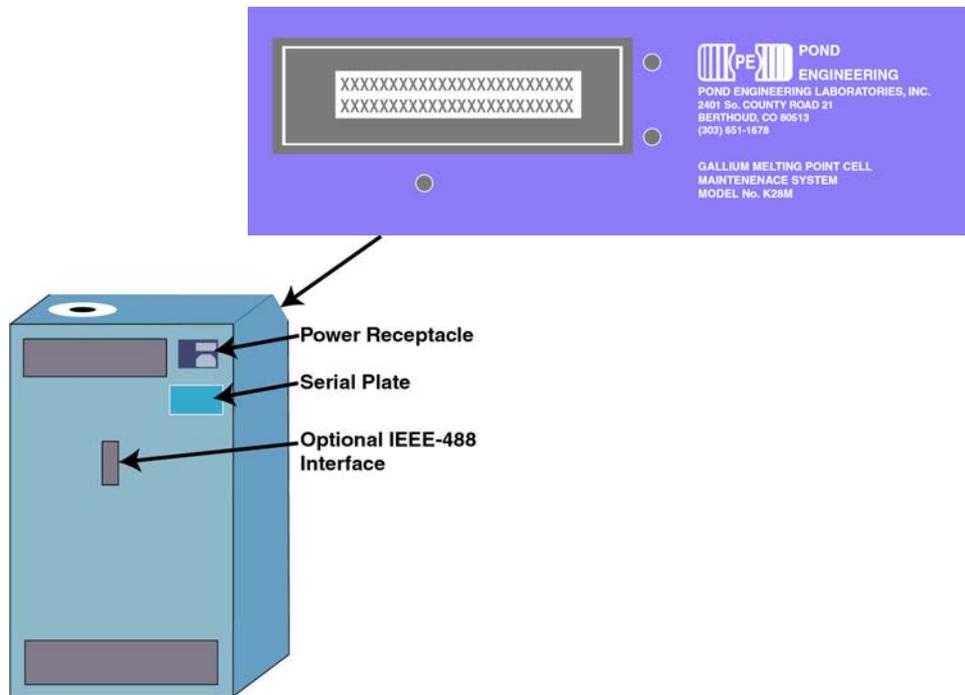
Figure 1 - General Layout

As shown in **Figure 1**, the controller front panel is located on a sloping surface at the front of the outer chassis. The Gallium Melting Point Maintenance System is designed to provide a stable and uniform temperature environment for the preparation and maintenance of triple point conditions inside Pond Engineering model K28C Gallium Melting Point Cells. It accommodates one SPRTs in an arrangement of one central well 0.312" diameter and approximately 13" deep.

Optional features include:

1. An IEEE-488 or RS-232 interface to allow operation of the Gallium Melting Point Maintenance System as part of an integrated automatic calibration system.

2. An internal system clock to allow unattended initiation of the system's automatic preparation cycle at a user selected time and date.

3. A thermometer preheat/ inner melt formation system.

These optional features are available as factory installable options. Interior access to the system cabinet is provided by a removable back panel attached to the frame by button head screws at the periphery of the panel.

Installation of a cell is accomplished by attaching the cell top to the cell using the compression fitting on the underside of the cell top and sliding the cell assembly downward into the core until the cell top is seated on the top surface of the Maintenance System. In this procedure the cell is suspended by the top of the central well and is not in intimate thermal contact with any portion of the Maintenance System core, greatly extending the usable life of a melt. Additional detail regarding cell installation and removal is provided in later sections of this manual.

Operator interface is provided by three front panel switches and a 2 line by 24 character Liquid Crystal Display (LCD) located in the front panel of the Gallium Melting Point Maintenance System as shown in below.
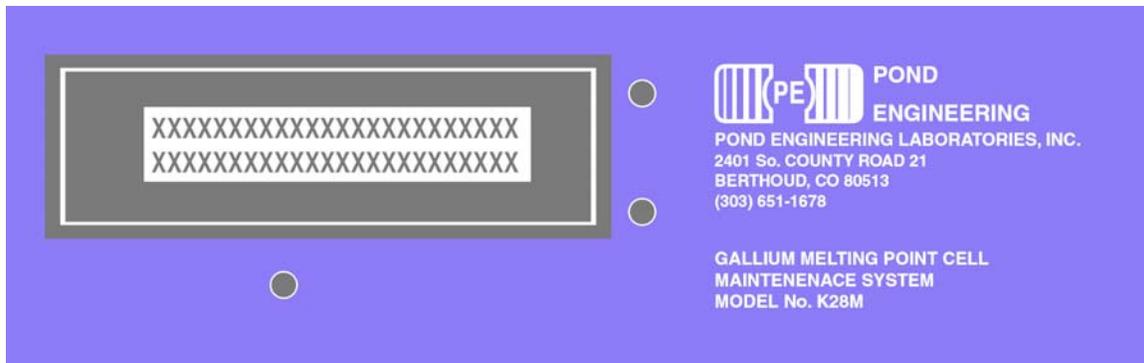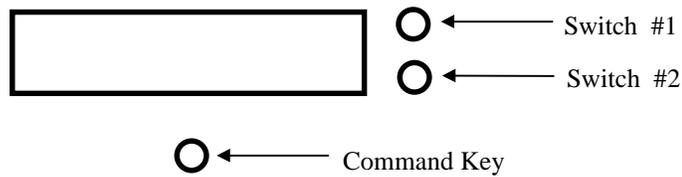

Figure 2 - Front Panel Layout

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

3. System Controller

All commands to the system are accessed through the liquid crystal display (LCD). The three switches allow the user to make changes to the system settings. An outline of changing system settings, editing configurations, and display types are provided in the following text and figures.

Because of the multitude of functions that each switch will be called upon to perform, all "labeling" of the switches is provided by the software program and presented to the user via the LCD. (The labels attached to the switches in **Figure 3** below are only for the benefit of the reader in understanding the documentation. These labels do not appear on the device front panel.)

Figure 3 - Front Panel Switch Layout

3.1 Timer Operating Mode

The Timer Operating Mode is designed to aid the process of setting up a twenty-four hour cycle that allows automatic preparation of a new melt every day. The three-step cycle consists of preparation of the cell for melting, melting the cell, and freezing the cell. Please note that while in the Timer Operating Mode, all command functions are accessible as explained in *3.3 The "COMMAND FUNCTIONS"*.

3.1.1 The Twenty-Four Hour Cycle

An example of the twenty-four hour cycle is shown in **Figure 4**. All times in the cycle are based on a twenty-four hour clock where times earlier than 12:00 are in the morning while times greater than 12:00 are in the afternoon and evening. For the example that is shown in **Figure 4** at 4:00 in the morning the system will begin preparing the system for melting, at 7:00 the system will begin melting, and at 14:00 (or 2:00pm) the system will begin to refreeze the cell. Each stage of the cycle is represented by a "Timer Mode". The three Timer Modes, one, two and three, correspond to and use the setpoint temperatures stored in memory location one, two, and three, respectively.
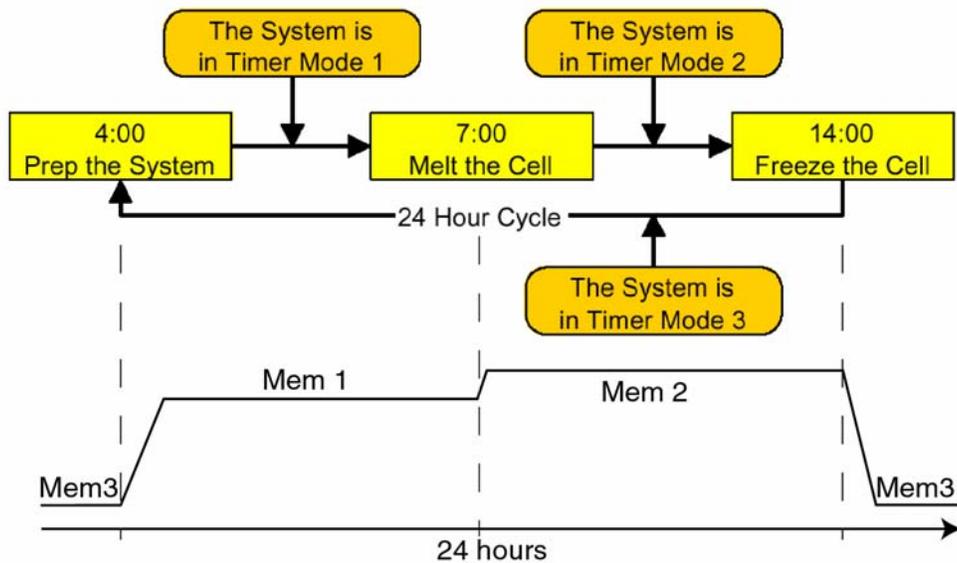
Figure 4 - Timer Cycle 1

Another example of how the cycle functions is shown in **Figure 5**. This cycle differs slightly from the previous in that the times of each process have been shifted. The exact process is as follows: at 10:00 begin to prepare the cell for melting; at 18:00 begin to melt the cell, at 7:00 the following day begin to freeze the cell. If the next transition time in the cycle is less than the current time, the system will wait until the 24 hour clock rolls over and reaches the specified time to change the Timer Mode.
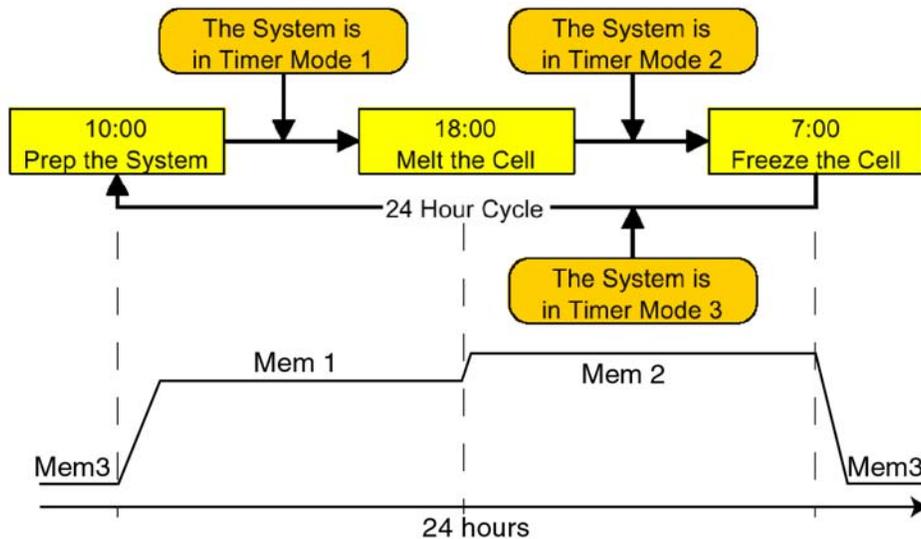
Figure 5 - Timer Cycle 2

3.1.2 Setting the Transition Times and Corresponding Temperature Values

To change the transition times within the cycle see section *3.3.5 Access Vars Array* to change variables **15**, **16** and **17** which correspond to Timer Mode 1 start time, Timer Mode 2 start time, and Timer Mode 3 start time respectively. Please use discretion when setting the times. Timer Mode 1's start time follows Timer Mode 3, Timer Mode 2's follows Timer Mode 1, and Timer Mode 3's start time follows Timer Mode 2. Examples of setting the times can be seen in **Figure 4** and **Figure 5**.

To set the Timer Mode temperature setpoints please see section *3.3.3 Adjust Memory Setpoint Temperatures*. The Timer uses the values stored at these locations in sequential order (Memory 1, then Memory 2, then Memory 3, then Memory 1...) as it moves through the cycle. Pond Engineering recommends to leave Memory 1 set to prepare the cell for melting, Memory 2 set to melt the cell, and Memory 3 set to freeze the cell. Please use discretion when setting the temperature values so that the mercury cell can physically prepare for melting, melt, and freeze when the system changes to the respective Timer Mode.

> Note: Section *3.1 Timer* and its subsections assumes that Memory 1 is set to prepare the cell for melting, Memory 2 is set to melt the cell, and Memory 3 is set to the freeze the cell. Please refer to the list of variables in section *3.3.5 Access Vars Array* to reference the factory-initialized values.

3.1.3 Powering Up the System

If the timer function is enabled, the system will prompt for the correct time, based on a twenty-four hour clock, during startup, **Figure 6**. The correct time must be entered so that the system may correctly set up sequential system operations.

```
TIME = 10:30 (24 HR)       UP     ◯
          PRESS V TO SET    DN     ◯
```
◯

Figure 6 – Time Setup

To set the time use Switch #1 to increment the digit indicated by the cursor, Switch #2 to decrement the digit, and the "Command Key" to move to the next digit. The time will be stored to memory as soon as the cursor is moved past the last digit with the "Command Key". If a mistake was made while entering the time, simply power the system "OFF" and then "ON" again to re-enter the time.

> Note: If the Timer Mode has been saved to 0, or disabled, the Time Setup prompt will not be displayed upon power up. Refer to section *3.1.4 Enabling/ Disabling the Timer* to re-enable the timer if desired.

Once the correct time is entered, the LCD will change to the display shown in **Figure 7**. The top line shows the current setpoint, in degrees C, followed by the current time. The bottom line shows the current core temperature, in degrees C, followed by the time to switch the setpoint to the next Timer Mode. Measurements of the core temperature and updating the display are done in approximately 3-second intervals.

```
SETPT  =  -30.10  C    10:35     ◯
CORE   =  -31.46  C    20:00     ◯
```
◯

Figure 7 - Timer Operation

> Note: If the Timer Mode, at startup, is set to a mode where the next transition time is less than the current mode's time, the system will wait until the twenty-four hour clock rolls over and reaches the specified time to switch to the next mode as discussed in 3.1.1 *The Twenty-Four Hour Cycle.*

3.1.4 Enabling/ Disabling the Timer

The Timer Function is enabled when the Timer Mode is set to 1, 2, or 3. If the Timer Mode is set to 0, the Timer function will become disabled and consequentially will not prompt for the correct time when powering on.

To re-enable the Timer, refer to *3.3.5 Access Vars Array* to become familiar with how to use the Vars Array. Change variable **19** to Timer Mode 1, 2, or 3 to indicate the current mode in the twenty-four hour cycle. Save the changes to the variables and power "OFF" the system and then power it "ON" to set the correct time and start the cycle.

3.2 Normal Operating Mode

In normal operation, with the Timer disabled (Timer Mode is set to 0), the Mercury Triple Point Cell Maintenance System controller will continuously display the current temperature setpoint for the controller and the measured core temperature on the first and second lines of the display, as shown in **Figure 8**. Measurements are taken at approximately 3-second intervals and the lower line of the display is updated following measurement. This information is removed from the display when the user presses and holds the

"Command Key" for a period of 2 to 3 seconds which allows entry to the "COMMAND FUNCTIONS" portion of the program.

```
┌────────────────────────────┐
│ SETPT  = -XX.XX   DEG  C   │  ◯
│ CORE   = -XX.XX   DEG  C   │  ◯
└────────────────────────────┘

              ◯
```
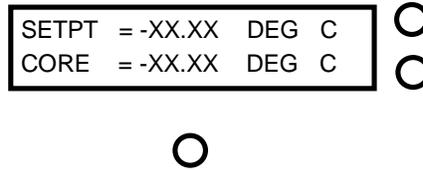
Figure 8 - Normal Operating Mode Display

3.3 The "COMMAND FUNCTIONS"

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

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

3.3.1 Adjust Setpoint

The purpose of this function is to allow the user to adjust the Setpoint Temperature of the system controller within the range of 15.00 °C to 35.00 °C. As shown in **Figure 9**, the "YES" is adjacent to the top switch, which we identified earlier in Error! Reference source not found. as "Switch #1".   The "NO" is adjacent to the switch identified as "Switch #2". If the "NO" selection is made, the program will continue on to allow access to the next function. However, if the user selects "YES" by pressing the corresponding switch, the display shown in **Figure 10** will be presented on the LCD.

```
┌────────────────────────────┐
│ CHANGE SETPOINT      YES   │  ◯
│ TEMPERATURE?         NO    │  ◯
└────────────────────────────┘

              ◯
```
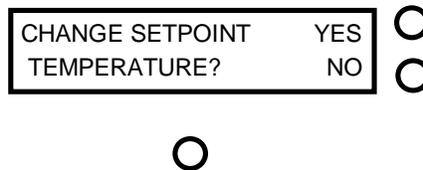
Figure 9 - Setpoint Access Prompt

The system controller is equipped with three memory "SETPOINT" temperatures. The user may choose to select the memory setpoint temperatures by pressing the corresponding "YES" switch. A "NO" selection will advance the system to the next memory setpoint. A "NO" response to all of the three memory setpoint temperatures will allow the user to change the setpoint manually.

```
┌────────────────────────────┐
│ CHANGE SETPOINT TO   YES   │  ◯
│  MEMORY  1 = XX.XX ?   NO  │  ◯
└────────────────────────────┘

              ◯
```
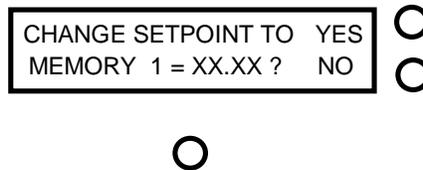
Figure 10 - Memory Setpoint Change

Manual adjustment of the "SETPOINT" may be accomplished by using the two switches on the side corresponding to the labels "UP" and "DN" displayed on the LCD. The "COMMAND" switch, located directly below the LCD, is used to advance the cursor to each of the digits. The current number presented on the display is used by the system controller as the current setpoint even while in the command functions mode.

```
┌─────────────────────────┐   ○
│  SETPOINT = XX.XX    UP │
│  PRESS v TO SET     DN  │   ○
└─────────────────────────┘
              ○
```
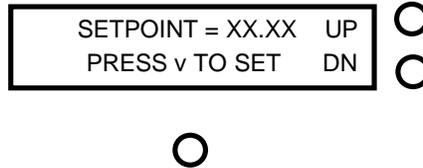
Figure 11 - Manual Setpoint Adjust Prompt

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

3.3.2 Adjust System Variables

This command function is provided to allow user examination and adjustment of the system variables used by the controller as well as the calibration variables for the system core temperature measurements.

```
┌─────────────────────────┐   ○
│  ADJUST SYSTEM     YES  │
│   VARIABLES?        NO  │   ○
└─────────────────────────┘
              ○
```
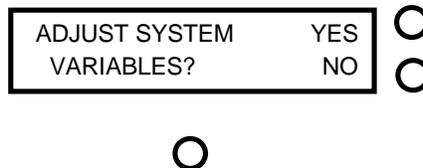
Figure 12 - System Variable Access Prompt

Pressing the switch by the display "YES" will allow access to the first system variable by presenting the messages shown in **Figure 13**, while responding with a "NO" command will terminate the function and the user is allowed access to the next Command Function.

3.3.3 Adjust Memory Setpoint Temperatures

The first variable accessed by the ADJUST SYSTEM VARIABLES function is " Memory 0" as shown in **Figure 13**.

```
┌─────────────────────────┐   ○
│ ADJUST SYSTEM      YES  │
│ MEMORY 0 = XX.XX?   NO  │   ○
└─────────────────────────┘
              ○
```
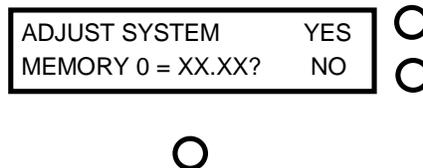
Figure 13 - System Memory Setpoint Prompt

The "Memory 0" variable is the system startup setpoint. Responding "YES" to the prompt will allow the user to adjust the setpoint, a "NO" response will access the next memory setpoint.

```
MEMORY 0 = XX.XX      YES     O
PRESS v TO SET        NO      O
                              O
```
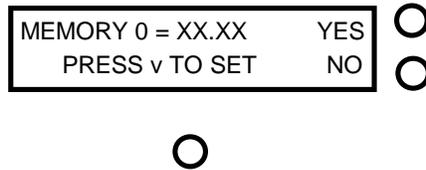
Figure 14 - Adjust Memory Setpoint Prompt

Modification of the variable is accomplished by pressing the two switches to the right of the LCD. The command key located directly below the LCD, is used to advance the cursor to each of the digits. Pressing the switch adjacent to the "UP" prompt shown in **Figure 14** will cause the value of the selected digit to increment one, while pressing the switch adjacent to the "DN" will cause it to be decremented by one. As the cursor is scrolled past the last digit, memory setpoint adjustment is completed and the user is allowed access to the next memory setpoint. When all memory setpoint adjustments have been presented, the system advances to the next system variable as described in the following section.

3.3.4 Calibration of Core Sensors

The next variables presented are calibration variables, or the offset between the actual temperature of the core and the measured value for each of the two core sensors.

These variables may be examined or adjusted by responding "YES" to the prompt shown in **Figure 15**. A "NO" response will conclude the function and allow the user to move to the next routine as described in the following section.
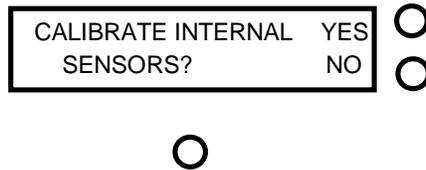
```
CALIBRATE INTERNAL   YES    O
SENSORS?             NO     O
                            O
```

Figure 15 - Calibration Access prompt

Upon of entering the calibration routine the drive voltages to the system core are disabled and the prompt shown in **Figure 16** is displayed.

```
ALLOW SYSTEM TO COME TO   O
ROOM TEMPERATURE      OK  O
                          O
```
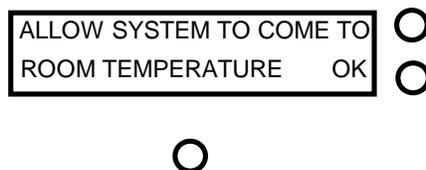
Figure 16 - Calibration Adjust Prompt

The system must come to room temperature for the calibration to occur. A gallium cell and a check SPRT must be placed into the system while waiting for the system to come to room temperature. The time it takes to reach room temperature may take from 20 minutes to 2 hours depending on conditions. After the system has reached room temperature and the entire core is stable, press the switch labeled "OK" to access the prompt in **Figure 17**.

```
CORE = 25.33 DEG. C    UP     O
PRESS  v TO SET    DN          O

                O
```
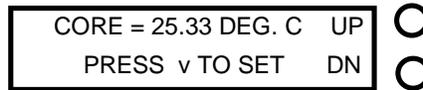
Figure 17 - Core Offset Adjust Prompt

One can modify the main core offset variable being applied to the measured value by entering the calibrated temperature measured in the cell by the user at this time. Modification of the variable is accomplished by pressing the two switches to the right of the LCD. Pressing the switch adjacent to the "UP" prompt will cause the value of the variable to be incremented by one hundredth. Pressing the switch adjacent to the "DN" will cause the variable to be decremented by one hundredth. The system will continually update the measured value, apply the current offset, and display the corrected value so all changes are reflected in the display as they occur. After the desired value has been established by incrementing or decrementing the values as described above, pressing the Command Key causes the value to be stored as a temporary system variable and the calculated offset values can be (MAN)ually modified if desired as shown in **Figure 18**.

```
MAIN OFFSET = 1.09   MAN     O
TE OFFSET = 0.26      USE     O

                O
```
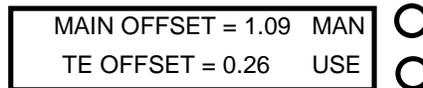
Figure 18 - Manual Core Offset

It is recommended that any new offsets resulting from a calibration be recorded in a log similar to the log provided at the end of this manual. The information in **Figure 18** displays the offset values being applied to the main sensor and the thermoelectric sensor respectively. The prompts allow manual adjustment of these offset values ("MAN") or "USE" these values as the calibration offsets. If "USE" is selected the system will move to the next option discussed in the following section. A "MAN" will display the prompt shown in **Figure 19**.

```
MAIN OFFSET =  1.09    UP     O
PRESS  v TO SET    DN          O

                O
```

Figure 19 - Manual Main Core Offset Adjustment

The adjustment of "MAIN OFFSET" may be accomplished by using the two switches on the side of the LCD corresponding the labels "UP" and "DN." The command switch, 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 main core offset adjustment is completed and thermoelectric offset can then be changed. After completing the adjustment to the thermoelectric offset, the system advances to the next command function as described in the following section.

3.3.5 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 20** one carefully reviews what each variable represents (see the following table). It is strongly recommended that only experienced users familiar with this system and its limitations exercise this option.

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

```
┌─────────────────────────────┐   O
│  ACCESS VARS      YES        │
│  ARRAY?           NO         │   O
└─────────────────────────────┘

            O
```
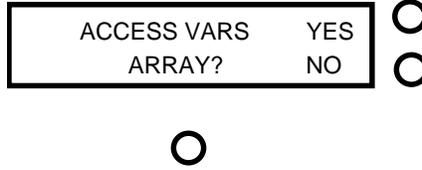
Figure 20 - Access Variables Array Prompt

Responding YES will cause **Figure 21** 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.

```
┌─────────────────────────────┐   O
│  **WARNING**     CONTINUE    │
│  REFER TO MANUAL    EXIT     │   O
└─────────────────────────────┘

            O
```

Figure 21 - Warning Prompt

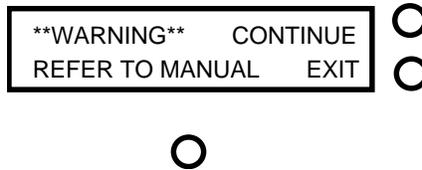Variables can be viewed and changed as shown below. The variables are not labeled. Please refer to the following chart for information about each variable.

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

            O
```
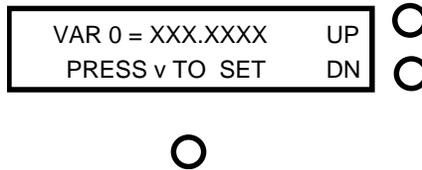
Figure 22 - Variable 0 Adjustment Prompt

Scrolling through the variables is accomplished by pressing either of the two switches to the right of the LCD, the switch adjacent to UP increments the variable number and the switch adjacent to DN decrements it. The command key located directly below the LCD is used to start the adjustment of the selected variable by advancing the cursor through the digits. Pressing the switch adjacent to the UP prompt shown in **Figure 22** will cause the value of the selected digit to increment one, while pressing the switch adjacent to the DN will cause it to decrement by one. As the cursor passes the last digit the value is stored as a temporary system variable.

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

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

#	Variable \Description	Default Values	Recommend Range
0	Setpoint Temperature	35.0000 degrees C	15.00 to 35.00 degrees C
1	Gradient along Core	0.0 degrees C	-2.0 to +2.0 degrees C
2	Unused		
3	Memory 0 Setpoint Temperature	35.0000 degrees C	15.00 to 35.00 degrees C
4	Memory 1 Setpoint Temperature	29.5000 degrees C	15.00 to 35.00 degrees C
5	Memory 2 Setpoint Temperature	30.1000 degrees C	15.00 to 35.00 degrees C
6	Memory 3 Setpoint Temperature	15.0000 degrees C	15.00 to 35.00 degrees C
7	GPIB Primary Address	6.0000	1.0000-30.0000
9	Thermoelectric Offest	See *6. Calibration Log*	
10	Main Outer Shell Offset	See *6. Calibration Log*	
14	Time counter calibration - percent	104.400	
15	Time of day to shift to prep mode - HH.MM	4.3001	0.00 – 23.59
16	Time of day to shift to melt mode - HH.MM	6.0001	0.00 – 23.59
17	Time of day to shift to freeze mode - HH.MM	20.0001	0.00 – 23.59
19	Current Timer Mode: 0 = Disable Auto Prep 1 = Preparation Mode, use Mem1 2 = Melt Mode, use Mem2 3 = Freeze Mode, use Mem3	0.0000	
20	ACCESS CODE for protected variables	0.0000	Call Factory

Protected Variables

#	Variable \Description	Default Values	Recommend Range
21	Outer shell temperature in degrees C		
22	Measured guard temperature in degrees C		
29	System status Variable		
24	Initialization Variable – Code Version		
42	Configuration Variable- 488 Interface		
51	Main Proportional Signal		
52	Main Integral		
53	Thermoelectric integral		
54	Thermoelectric Proportional Signal		
55	Main Heater Voltage		
56	Thermoelectric Heater Voltage		
60	Timer hours	10.0000	
61	Timer minutes	30.0001	
62	Timer seconds	0.0000	
63	Time of day counter - 24 hour time HH.MMSS	(current reading)	
64	Flag to indicate whether next_day_flag has been set		1= yes, 0 = no

3.3.6 Save changes to Variables

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

```
┌────────────────────────────┐  ○
│ SAVE CHANGES TO     YES │
│ VARIABLES?          NO  │  ○
└────────────────────────────┘
              ○
```

Figure 23 - Save Variables Prompt

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

3.3.7 Diagnostics Display Mode Select

Here the user is given the opportunity to choose which set of information is presented by the display during operation. Two choices are presented, "NORMAL DISPLAY" and "DIAGNOSTIC INFORMATION". The "NORMAL DISPLAY" mode is always presented upon system power up and is changed through this control function to allow display of "DIAGNOSTIC INFORMATION" by answering "YES" to the command function prompt shown in **Figure 24**.

```
┌────────────────────────────┐  ○
│ DISPLAY DIAGNOSTIC   YES │
│ INFORMATION?         NO  │  ○
└────────────────────────────┘
              ○
```

Figure 24 - Diagnostics Mode Display Prompt

If the system is currently displaying "DIAGNOSTIC INFORMATION", the prompt will be modified as shown in **Figure 25** to allow the user to toggle back to the "NORMAL DISPLAY" mode.

```
┌────────────────────────────┐  ○
│ CHANGE TO NORMAL     YES │
│ DISPLAY?             NO  │  ○
└────────────────────────────┘
              ○
```

Figure 25 - Normal Mode Display Prompt

The "DIAGNOSTIC INFORMATION" display presents an array of numeric information for system diagnostics for each of the system control loops; the "M"ain zone and the "T"hermoelectric zone. An example of the main zone diagnostic information is shown below in **Figure 26**.

```
┌────────────────────────────┐  ○
│ 34.00    61.20    ==> M │
│ 33.09     4.00        T │  ○
└────────────────────────────┘
              ○
```

Figure 26 - Main Diagnostics Display

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The information presented by this display is as follows. Top row left to right: current setpoint, main zone proportional signal. Bottom row left to right: current main core measured temperature, main zone integrator.

Pressing the button opposite the letter "T" on the display will allow the user to toggle between the main diagnostics display and the thermoelectric diagnostics display. An example of a thermoelectric diagnostic display is shown in **Figure 27**.

```
┌─────────────────────────┐   ◯
│  34.00    17.22      M   │
│  25.38    3.00    ==> T  │   ◯
└─────────────────────────┘
```

◯

Figure 27 - Thermoelectric Diagnostics Display

The information presented by the thermoelectric diagnostics display is as follows. Top row left to right: thermoelectric setpoint, thermoelectric proportional. Bottom row left to right: current measured thermoelectric temperature, thermoelectric integrator.

Again the button opposite the letter "T" toggles between the thermoelectric and main diagnostics display.

> NOTE: Once the "DIAGNOSTIC INFORMATION" mode has been entered the display will only present the diagnostic information; normal display mode can be obtained through the "COMMAND FUNCTIONS" options as previously explained.

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

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4. System Hardware Description

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

4.1 Front Panel
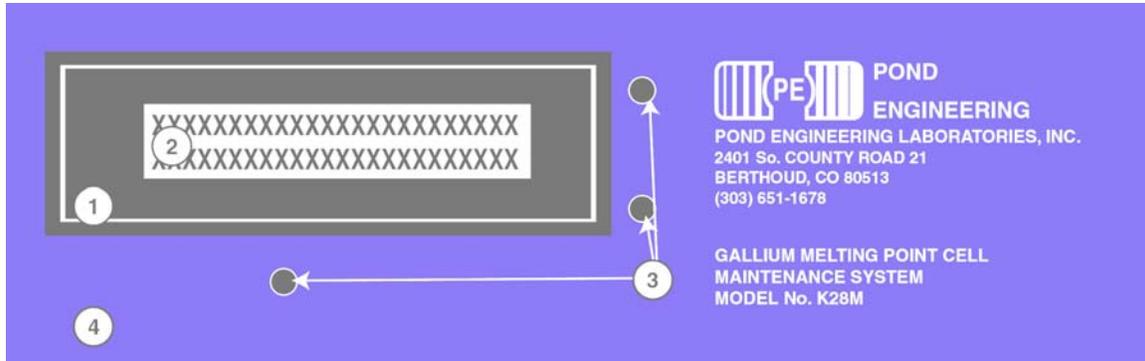
REF. #	NAME	MAKE	MODEL
1	Die Cast Metal Bezel	JMJ Technical Products, Inc.	1-458
2	24X2 Dot Matrix LCD Module DMC Series	Optrex	DMC20261
3	Miniature Push-button panel Mount SPDT Switches - 3 each - with	Eaton Cutler-Hammer	PS1-100Q
	Caps for Miniature Switches	Eaton Cutler-Hammer	W-KN-17
4	Engraved Laminate Front Panel	Pond Engineering	K28-FP

4.2 Electronics Chassis/ Back Panel
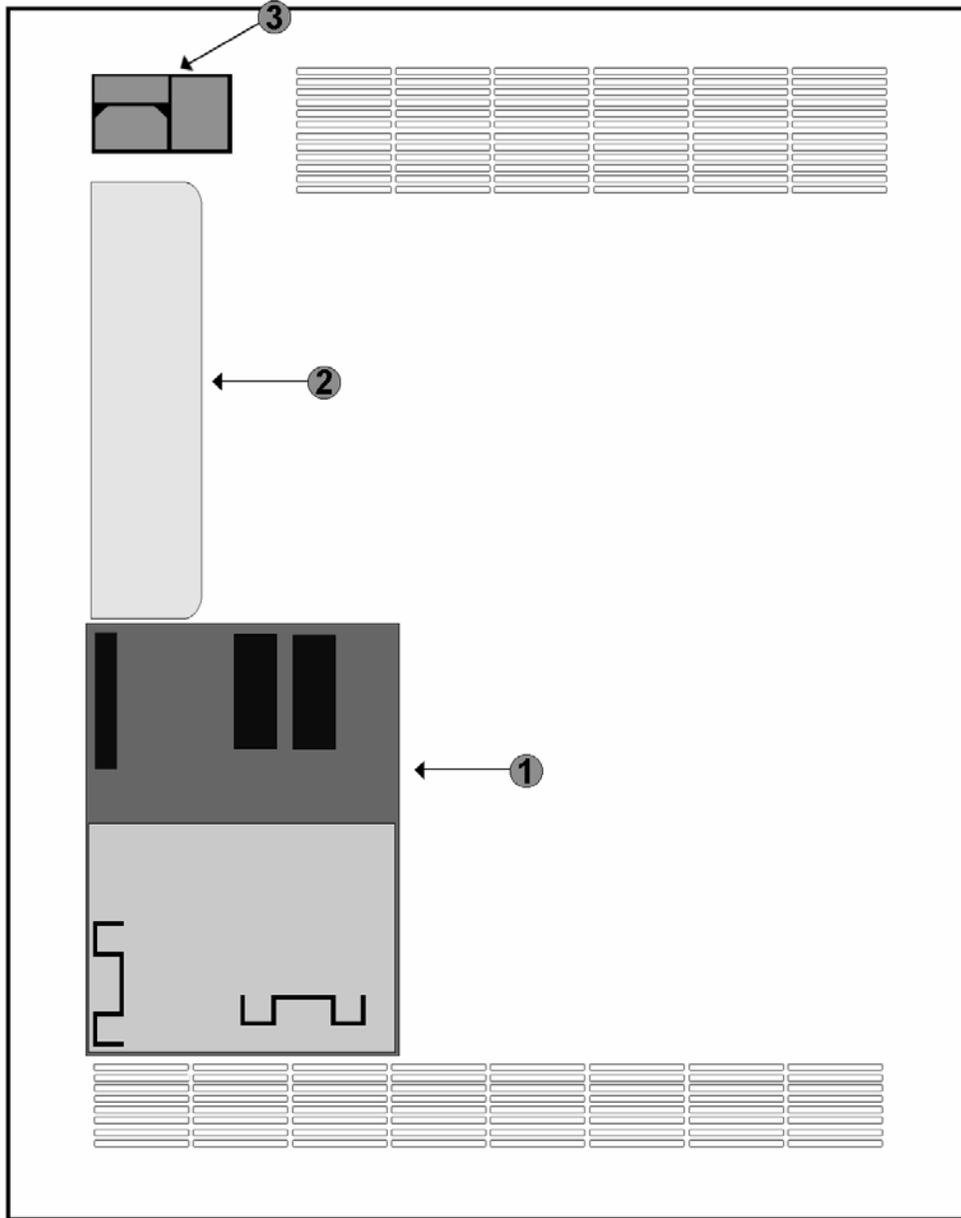
REF. #	NAME	MAKE	MODEL
1	Microprocessor/Controller	Pond Engineering Labs.	K28M-400
2	Power Supply	Power-One Inc.	MAP55-4002
3	System ON/OFF Switch	Power Dynamics	42R37

4.3 Schematic

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5. Calibration Record

Main:	Date:	Thermo.:	Date:	Comments: