FLUKE®
Calibration

9102S
Dry-Well Calibrator

User's Guide

2005 Rev. 1, 4/20

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

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Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product’s specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

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Before You Start

The Fluke Calibration 9102S Dry-Well Calibrator (the Product or the Calibrator) is a small portable instrument for quick on-site checks and calibration of thermocouple and RTD temperature probes. The Product is small enough to use in the field, and accurate enough to use in the lab. Calibrations may be done over a range of -10 °C to 122 °C (14 °F to 252 °F). Temperature display and setpoint resolution are 0.1 °.

The Product features:

- A controlled temperature block with two calibration insert sleeves
- Rapid heating and cooling
- Prop stand
- Handle strap
- RS-232 interface capability
- +12 V dc battery option

Built-in programmable features include:

- Temperature scan rate control
- Eight set-point memory
- Adjustable readout in °C or °F

The temperature is accurately controlled by Fluke Calibration's digital controller. The controller uses a precision platinum RTD as a sensor and controls the well temperature with transistor-driven thermoelectric devices.

The LED front panel shows the current well temperature. Use the control buttons to set temperature to any desired temperature within the Product's range. Multiple fault protection devices ensure user and Product safety and protection.

The Product is portable, low cost, and easy to operate. Through proper use and maintenance, the Product provides continued accurate calibration of temperature sensors and devices. The user should be familiar with the safety guidelines and operating procedures of the calibrator as described in this manual and the *Safety Information* that ships with the Product.

Contact Fluke Calibration

To contact Fluke Calibration, call one of the following telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: (65) 6799-5588
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

To see product information and download the latest manual supplements, visit Fluke Calibration's website at www.flukecal.com.

To register your product, visit http://flukecal.com/register-product.

Safety Information

A **Warning** identifies conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

General Safety Information is located in the printed *Safety Information* document that ships with the Product. It can also be found online at www.Flukecal.com. More specific safety information is listed where applicable.

Service Information

Contact an authorized Fluke Calibration Service Center if the Product needs calibration or repair during the warranty period. Please have Product information such as the purchase date and serial number ready when you schedule a repair.

Specifications and Environmental Conditions

Specifications

Table 1. Specifications

Range	-10 °C to 122 °C (14 °F to 252 °F) at an ambient of 23 °C
Accuracy	±0.25 °C
Stability	±0.05 °C
Resolution	0.1 °C or °F
Well-to-Well Uniformity	±0.2 °C with sensors of similar size at equal depths within wells
Heating Times	ambient to 100 °C: 10 minutes
Stabilization	7 minutes
Cooling Times	ambient to 0 °C: 10 minutes
Well Depth	102 mm (4 inches)
Removable Inserts	See *Accessories*
Power Requirements **Power Rates**	 100 to 240 V ac, 50/60 Hz, 90 VA; or 12 V dc, 2.6 A
Size	100 mm H x 152 mm W x 175 mm D (4 in x 6 in x 6.9 in)
Environmental Conditions **Operation Temperature Range** **Ambient Relative Humidity** **Ambient Pressure** **Altitude**	 5 to 50 °C (41 to 122 °F) 0 to 80 % RH for temperatures up to 30 ºC, 0 to 50 % RH for temperatures 30 to 50 °C 75 kPa to 106 kPa <2000 m
Weight	4 lb (1.8 kg)
Safety	Mains IEC 61010-1: Overvoltage Category II, Pollution Degree 2 Additional IEC 61010-2-010 (Heating)
Electromagnetic Compatibility (EMC)	International..... IEC 61326-1: Basic Electromagnetic Environment CISPR 11: Group 1, Class A *Group 1: Equipment has intentionally generated and/or uses conductively-coupled radio frequency energy that is necessary for the internal function of the equipment itself.* *Class A: Equipment is suitable for use in all establishments other than domestic and those directly connected to a low-voltage power supply network that supplies buildings used for domestic purposes. There may be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted and radiated disturbances.* *Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.* *Emissions that exceed the levels required by CISPR 11 can occur when the equipment is connected to a test object.* *The equipment may not meet the immunity requirements of this standard when test leads and/or test probes are connected.* Korea (KCC) ..... Class A Equipment (Industrial, Broadcasting, & Communication Equipment) *Class A: Equipment meets requirements for industrial electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and not to be used in homes.* USA (FCC)..... 47 CFR 15 subpart B. This product is considered an exempt device per clause 15.103.

Environmental Conditions

Although the Product has been designed for optimum durability and trouble-free operation, it must be handled with care.

⚠Caution

To avoid damaging the Product:

- **Do not operate the Product in an excessively dusty or dirty environment.**
- **Minimize vibrations in the calibration environment.**
- **Use the Product indoors only.**

For Maintenance and cleaning recommendations, see *Maintenance*.

Quick Start

Make sure to read the dry-out period text in the Safety Information that comes with the Product.

Unpacking

Unpack the Product carefully and inspect it for any damage that may have occurred during shipment. If there is shipping damage, notify the carrier immediately.

Verify that the following components are present:

- 9102S Dry-well Calibrator
- Mains Power Cable
- User's Guide with Report of Calibration
- RS-232 Cable
- 3102-3 Insert, 3/16 in
- 3102-4 Insert, 1/4 in
- Insert Removal Tool

AC Power Operation

Plug the mains power cable of the Product into a mains outlet of the proper voltage, frequency, and current capability. Refer to *Unpacking* and *Specifications*, for power details. Turn on the dry-well using the switch on the rear panel. The dry-well turns on and heats to the previously-programmed temperature set-point. The front-panel display indicates the actual dry-well temperature.

DC Power Operation

The Product has a dc power option. The dc option requires a power source that delivers 12 V dc at 3 A.

⚠Warning

A fire may occur if a short circuit occurs along the input cord and no protective devices are on the dc input source. For short-circuit protection using a battery, a fuse is required at the battery terminals.

The dc power socket is on the rear panel of the Product near the ac power jack. The Product accepts a 7/32 inch diameter, two-conductor dc power plug such as Switchcraft® PN 760. Observe the correct polarity as shown in Figure 1. The outside conductor is positive and the inside is negative. The ac power switch on the rear panel does not switch the dc power.

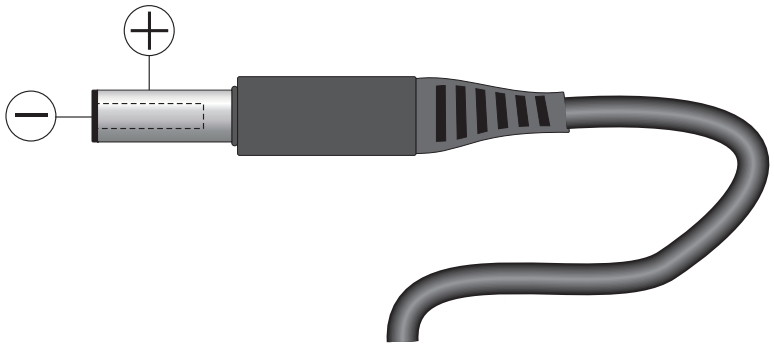

Figure 1. 12 V dc Power Source Polarity

Setup

Place the Product on a flat surface with at least 6 inches of free space around the Product. Always leave enough clearance in front of the Product to allow for safe and easy insertion and removal of probes. The prop stand may be swung down to raise the front of the Product from a horizontal position. Plug the power cord into a grounded mains outlet. Observe that the nominal voltage corresponds to that indicated on the Product.

Turn on the power to the Product with the power switch. The fan begins to quietly blow air through the Product and the controller display illuminates after 3 seconds. After a brief self-test the Product begins normal operation. If the unit fails to operate, check the power connection.

The display shows the well temperature and the well heater brings the temperature of the well to the set-point temperature.

After Product use, allow the well to cool by setting the temperature to 25 °C and then wait 1/2 hour before you turn off the Product.

Parts and Controls

The user should become familiar with the Product and its parts (See Figure 2 and Figure 3).

Rear Panel

Mains power cable - The removable mains power cable attaches to the rear of the Product. It plugs into a standard 115 V ac (optional 230 V ac) grounded socket.

DC Power Jack - The Product can be used with a dc power source. The dc input jack requires 12 V and 2.6 A. See Figure 2, ❶ for pinout.

Power Switch - The power switch is located on the rear of the Product. The switch is either on or off. The on position is for normal operation. The off position disconnects power to the entire unit.

Fan - The Product has a variable speed fan. Under certain circumstances, the fan may turn off. The fan shuts off at 100 °C and above. Slots at the top and around the corners of the Product are provided for airflow. The area around the Product must be kept clear to allow for adequate ventilation. The air is directed from the front to the back. Allow 6 inches of open space around the Product to allow adequate ventilation.

RS-232 - The RS-232 serial port provides a means for connecting the Product to a computer or a printer using the included serial cable.

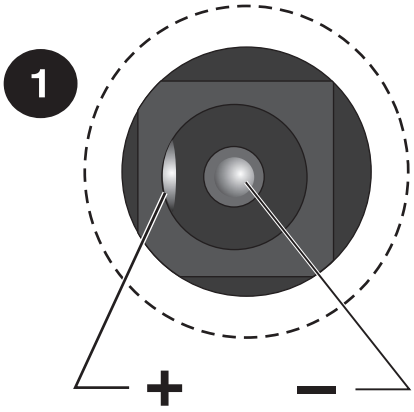

Figure 2. Back Panel

Front Panel

⚠Caution

Always leave enough clearance in front of the calibrator to allow for safe and easy installation and removal of probes.

Figure 3. Front Panel

Strap - A strap is provided to aid the user in carrying the Product in one hand. Slide your hand into position and secure using the loop and hook fastener for a tight fit. Be careful when you carry the Product while using the strap as inserts can fall out of the wells when tipped forward. Inspect the strap periodically for wear.

Well Block - Located on the middle of the front panel are the well openings where probes may be inserted into the well. The block accepts temperature sensors up to 12.7 mm (1/2 in) in diameter. The wells can be made to accept probes of smaller than 12.7 mm (1/2 in) diameter by using optional inserts. Probes should fit snugly into the wells for best results.

Display - The digital display not only shows set and actual temperatures but also indicates various Product functions, settings, and constants. The display shows temperatures in units according to the selected scale °C or °F.

Controller Keypad - The four button keypad allows easy setting of the set-point temperature. The control buttons (**SET**, ▼, ▲, and **EXIT**) are used to set the Product temperature set-point, access, and set other operating parameters, and access and set calibration parameters.

Setting the control temperature is done directly in degrees of the current scale. It can be set to one-tenth of a degree Celsius or Fahrenheit.

The functions of the buttons are:

SET – Used to display the next parameter in the menu and to store parameters to the displayed value.

▼ (down arrow) – Used to decrement the displayed value of parameters.

▲ (up arrow) – Used to increment the displayed value.

EXIT – Used to exit a function and to skip to the next function. Any changes made to the displayed value are ignored.

Accessories

Table 2 lists optional inserts and a carrying case by model number.

Table 2. Accessories

Model	Description
3102-0	Blank Insert
3102-1	1.6 mm (1/16 in) Insert
3102-2	3.2 mm (1/8 in) Insert
3102-8	4.0 mm (5/32 in) Insert
3102-3	4.8 mm (3/16 in) Insert
3102-4	6.4 mm (1/4 in) Insert
3102-5	7.9 mm (5/16 in) Insert
3102-6	9.5 mm (3/8 mm) Insert
3102-7	11.1 mm (7/16 mm) Insert
9308	Rugged Carrying Case

Call your local Fluke Calibration representative for current pricing.

General Operation

Set the Temperature

You can enter temperature set-points from the front panel. *Temperature Set-point* explains how to program set-points. To set the temperature set-point on the Product using the front-panel keys:

1. Press **SET** twice to access the set-point value.
2. Press ▲ or ▼ to change the set-point value.
3. Press **SET** to program in the new set-point.
4. Press and hold **EXIT** to return to the temperature display.

When the set-point temperature is changed the controller switches the well heater on or off to raise or lower the temperature. The displayed well temperature gradually changes until it reaches the set-point temperature. The well may require another 5 to 10 minutes to reach the set-point depending on the span. Another 5 to 10 minutes is required to stabilize within ±0.05°C of the set-point.

Change the Display Units

This Product can display temperature in Celsius or Fahrenheit. The temperature units are shipped from the factory set to Celsius. There are two ways to change to Fahrenheit or back to Celsius:

1. Press **SET** and ▲ simultaneously. The temperature display changes units.

or

1. Press **SET** three times from the temperature display to show

Un= C

2. Press the ▲ or ▼ key to change units.
3. Press **SET** to save the setting or **EXIT** to continue without changing the setting.

Operation

This section discusses how to operate the Product using the front-control panel. Use the front panel to monitor the well temperature, set the temperature set-point, monitor the heater output power, adjust the controller proportional band, and program the Product. Operation of the functions and parameters are shown in Figure 4. This chart may be copied for reference.

In the subsequent discussion, a button with the word **SET** or **EXIT** inside, a ▲, or ▼, indicates the panel button, while the dotted box indicates the display reading. Explanations of the button or display readings are to the right of each button or display value.

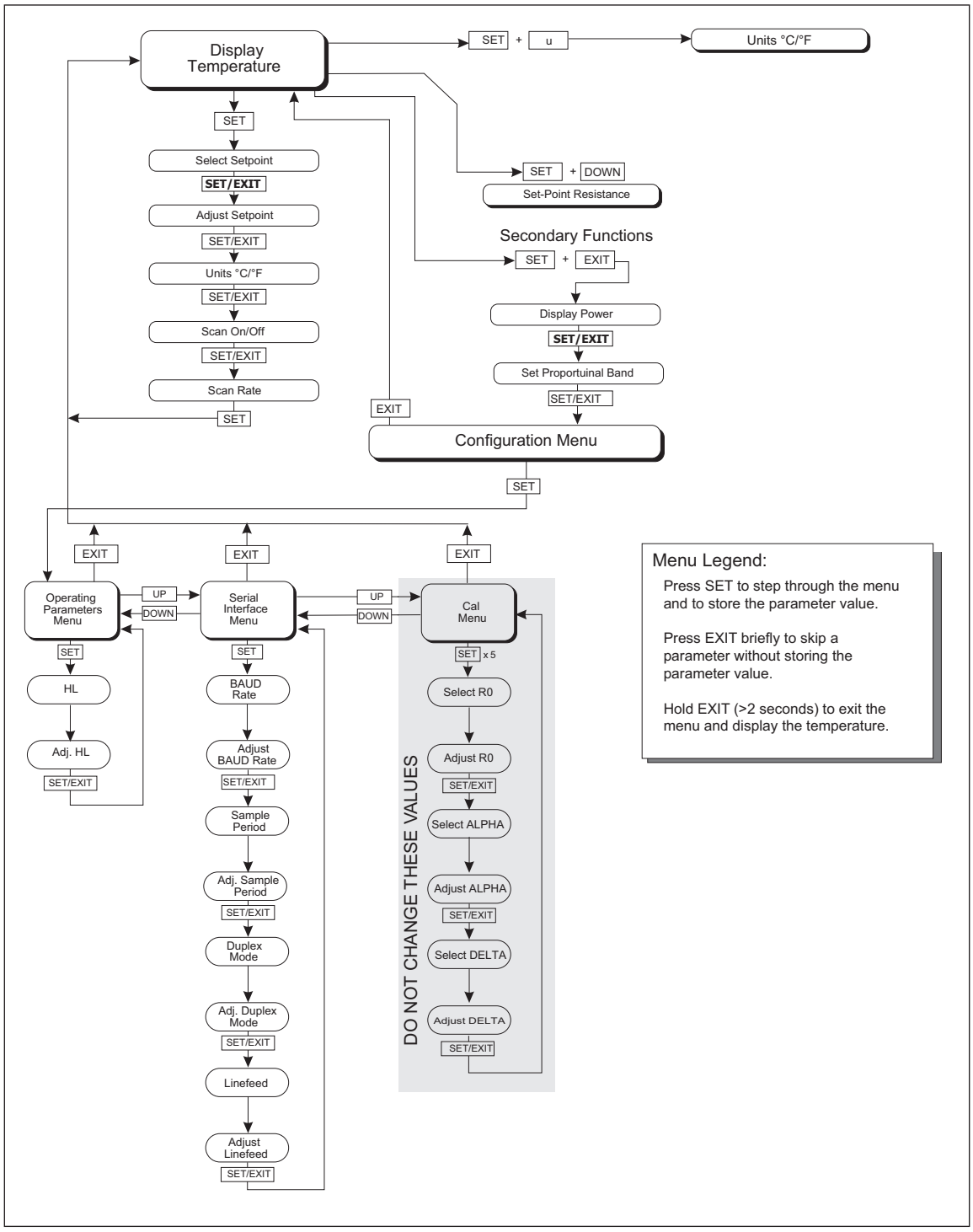

Figure 4. Operational Flowchart

Well Temperature

The display allows direct viewing of the actual well temperature. This temperature value is normally shown on the display. The units of the temperature value (C or F) are displayed at the right. For example,

100.0 C *Well temperature in degrees Celsius*

The temperature display function may be accessed from any other function by holding and releasing **EXIT**.

Temperature Set-point

The temperature set-point can be set to any value within the range and with resolution as given in the specifications. Be careful not to exceed the safe upper temperature limit of any device inserted into the well.

Setting the temperature involves selecting the set-point memory and adjusting the set-point value.

Programmable Set-points

The controller stores 8 set-point temperatures in memory. The set-points can be quickly recalled to conveniently set the Product to a previously-programmed temperature set-point.

To set the temperature, press **SET** to access set-point memory. The number of the set-point memory location currently being used appears at the left on the display followed by the current set-point value. Use ▲ and ▼ to select a new set-point memory location.

100.0 C *Well temperature in degrees Celsius*

Access set-point memory

1 100. *Set-point memory 1 location, 100 °C currently used*

To change to another set-point memory location, press the up or down arrow.

4 50. *New set-point memory 4 location, 50 °C*

Press **SET** to accept the new selection and access the set-point value. Press **EXIT** to continue and to ignore any changes.

Accept selected set-point memory

Set-point Value

The set-point value may be adjusted after selecting the set-point memory and pressing **SET**.

4 50. *Set-point 4 value in °C*

If the set-point value does not need to be changed, press and hold **EXIT** to resume displaying the well temperature. To change the set-point value, press **SET** and then press ▲ or ▼.

60. *New set-point value*

When the desired set-point value is reached, press **SET** to accept the new value and access the temperature scale units selection. If **EXIT** is pressed, any changes made to the set-point are ignored.

Accept new set-point value

To change temperature units, see *Change the Display Units*.

Scan

The scan rate can be set and enabled so that when the set-point is changed the dry-well heats or cools at a specified rate (degrees per minute) until it reaches the new set-point. With the scan disabled the dry-well heats or cools at the maximum possible rate.

Scan Control

The scan is controlled with the scan on/off function that appears in the main menu after the temperature scale units.

Sc *Sc flashes for one second and then the current scan setting displays*

OFF *Scan function off*

Press ▲ or ▼ to toggle the scan on or off.

On *Scan function on*

Press **SET** to accept the present setting and continue. Press **EXIT** to cancel.

S *Accept scan setting*

Scan Rate

The scan rate can be set from 0.1 to 99.9 °C/min. The maximum scan rate, however, is actually limited by the natural heating or cooling rate of the Product. This rate is often <100 °C/min, especially when cooling.

The scan rate function appears in the main menu after the scan control function. The scan rate units are in degrees Celsius per minute, regardless of the selected units.

Sr	*Sr flashes for one second and then the current scan rate setting displays*
0.1	*Scan rate in °C/min*

Press ▲ or ▼ to change the scan rate.

2.0	*New scan rate*

Press **SET** to accept the new scan rate and continue. Press **EXIT** to cancel.

S	*Accept scan rate*

Set-point Resistance

The set-point resistance is the resistance the Product is trying to make the control sensor achieve and is calculated in the firmware using the set-point temperature. This value is not directly adjustable but is recalculated when the set-point temperature is changed. The set-point resistance is used to perform a calibration adjustment using the Callendar-Van Dusen R versus T curve fit (see *Calibration and Adjustment Procedure*). The Product must be at temperature and stable prior to taking the set-point resistance reading. The set-point resistance displays by pressing the **SET** and ▼ simultaneously. The set-point resistance is displays as follows:

SrES	*SrES flashes for two seconds and then the whole number of the current set-point resistance setting displays*
99.	*Whole number portion of the set-point resistance flashes for two seconds and then the fraction portion of the current set-point resistance setting is displayed*
.222	*Fraction portion of the current set-point resistance setting*

The set-point resistance is 99.222.

Secondary Menu

Functions which are used less often are accessed within the secondary menu. The secondary menu is accessed by pressing **SET** and **EXIT** simultaneously and then releasing. The first function in the secondary menu is the heater power display (see Figure 4).

Heater Power

The temperature controller controls the temperature of the well by pulsing the heater on and off. The total power being applied to the heater is determined by the duty cycle or the ratio of heater on time to the pulse cycle time. By knowing the amount of heating, the user can tell if the calibrator is heating up to the set-point, cooling down, or controlling at a constant temperature. Monitoring the percent heater power allows the user to know the stability of the well temperature. With good control stability the percent heating power should not fluctuate more than ±5 % within one minute.

The heater power display is accessed in the secondary menu. Press **SET** and **EXIT** simultaneously and release. The heater power displays as a percentage of full power.

100.0 C	*Well temperature*
SET + EXIT	*Access heater power in secondary menu*
SEC	*Flashes SEC for secondary menu and then displays the heater power*
12.0P	*Heater power in percent*

To exit out of the secondary menu, press **EXIT**. To continue on to the proportional band setting function press **SET**.

Proportional Band

In a proportional controller such as this, the heater output power is proportional to the well temperature over a limited range of temperatures around the set-point. This range of temperature is called the proportional band. At the bottom of the proportional band, the heater output is 100 %. At the top of the proportional band, the heater output is 0. Thus, as the temperature rises the heater power is reduced, which consequently tends to lower the temperature back down. In this way the temperature is maintained at a constant level.

The temperature stability of the well and response time depend on the width of the proportional band. If the band is too wide, the well temperature deviates excessively from the set-point due to varying external conditions. This is because the power output changes very little with temperature and the controller cannot respond very well to changing conditions or noise in the system. If the proportional band is too narrow, the temperature may swing back and forth because the controller overreacts to temperature variations. For best control stability, the proportional band must be set for the optimum width.

The proportional band width is set at the factory as printed on the Report of Calibration. The proportional band width may be altered by the user if desired to optimize the control characteristics for a particular application.

The proportional band width is easily adjusted from the front panel. The width may be set to discrete values in degrees C or F depending on the selected units. The proportional band adjustment is accessed within the secondary menu. Press **SET** and **EXIT** to enter the secondary menu and show the heater power. Then press **SET** to access the proportional band.

SET + EXIT	*Access heater power in secondary menu*
SEC	*Flashes SEC for secondary menu and then displays the heater power*
12.0P	*Heater power in percent*
SET	*Access proportional band*
PrOP	*Flashes prop and then displays the setting*
4.1	*Proportional band setting*

To change the proportional band press ▲ or ▼.

10.0	*New proportional band setting*

To accept the new setting press **SET**. Press **EXIT** to continue without storing the new value.

SET	*Accept the new proportional band setting*

Controller Configuration

The Product has a number of configuration and operating options and calibration parameters which are programmable from the front panel. These are accessed from the secondary menu after the proportional band function by pressing **SET**. Press **SET** again to enter the first of three sets of configuration parameters — operating parameters, serial interface parameters, and calibration parameters. The menus are selected with ▲ and ▼ and then pressing **SET**.

Operating Parameters

The operating parameters menu is indicated by:

PAr	*Operating parameters menu*

The operating parameters menu contains the High Limit parameter.

High Limit

The High Limit parameter adjusts the upper set-point temperature. The factory default and maximum are set to 125 °C (257 °F). The minimum setting is 50 °C (122 °F). For safety, a user can adjust the High Limit down so the maximum temperature set-point is restricted.

HL	*Flashes HL and then displays the setting*
125	*Flashes the current value and then displays the value for adjustment*
125	*Current High Limit setting*

Press ▲ or ▼ to adjust the setting.

100	*New High Limit setting*

To accept the new setting, press **SET**. Press **EXIT** to continue without storing the new value.

SET	*Accept the new High Limit setting*

Serial Interface Parameters

The serial RS-232 interface parameters menu is indicated by:

SErL	*Serial RS-232 interface parameters menu*

Press **SET** to enter the menu. The serial interface parameters menu contains parameters which determine the operation of the serial interface. The parameters in the menu are: baud rate, sample period, duplex mode, and linefeed.

Baud Rate

The baud rate is the first parameter in the menu. The baud rate setting determines the serial communications transmission rate.

The baud rate parameter is indicated by::

bAUd	*Flashes bAUd for one second and then displays the setting*
2400b	*Current baud rate*

The BAUD rate of the serial communications may be programmed to 300, 600, 1200, 2400 (default), 4800, or 9600 BAUD. Use the up or down arrows to change the BAUD rate value.

4800 b	*New baud rate*

Press **SET** to accept the new setting or **EXIT** to abort the operation and skip to the next parameter in the menu.

Sample Period

The next parameter in the serial interface parameter menu is the sample period. The sample period is the time period in seconds between temperature measurements transmitted from the serial interface. If the sample rate is set to 5, the Product transmits the current measurement over the serial interface approximately every five seconds. The automatic sampling is disabled with a sample period of 0. The sample period is indicated by:

SPEr	*Flashes for one second and then the serial sample period setting displays*
1	*Current sample period (seconds)*

Adjust the value with ▲ or ▼.

60	*New sample period*

Press **SET** to accept the new setting or **EXIT** to abort the operation and skip to the next parameter in the menu.

Duplex Mode

The next parameter is the duplex mode. The duplex mode may be set to full duplex or half duplex. With full duplex any commands received by the Product through the serial interface are immediately echoed or transmitted back to the device of origin. With half duplex the commands are executed but not echoed. The duplex mode parameter is indicated by:

dUPL	Flashes for one second and then the serial duplex mode setting displays
FULL	*Current duplex mode setting*

The mode may be changed with ▲ or ▼.

HALF	*New duplex mode setting*

Press **SET** to accept the new setting or **EXIT** to abort the operation and skip to the next parameter in the menu.

Linefeed

The final parameter in the serial interface menu is the linefeed mode. This parameter enables (on) or disables (off) transmission of a linefeed character (LF, ASCII 10) after transmission of any carriage-return. The linefeed parameter is indicated by:

LF	*Flashes for one second and then the serial linefeed setting displays*
On	*Current linefeed setting*

The mode may be changed with ▲ or ▼.

OFF	*New linefeed setting*

Press **SET** to accept the new setting or **EXIT** to abort the operation and skip to the next parameter in the menu.

Calibration Parameters

The operator of the Product controller has access to a number of the calibration constants: R0, ALPHA, and DELTA. These values are set at the factory and must not be altered. The correct values are important to the accuracy and proper and safe operation of the Product. Access to these parameters is available to the user so that in the event that the controller memory fails the user may restore these values to the factory settings. The user should have a list of these constants and their settings with the Product manual.

⚠Caution

DO NOT change the values of the Product calibration constants from the factory set values. The correct setting of these parameters is important to the safety, proper operation, and performance of the Product.

The calibration parameters menu is indicated by:

CAL *Calibration parameters menu*

Press **SET** five times to enter the menu. The calibration parameters menu contains the parameters, Hard Cutout, R0, ALPHA, and DELTA, which characterize the resistance-temperature relationship of the platinum control sensor. These parameters may be adjusted to improve the accuracy of the Product.

The calibration parameters are accessed by pressing **SET** after the name of the parameter displays. The value of the parameter may be changed using ▲ or ▼. After the desired value is reached, press **SET** to set the parameter to the new value. Press **EXIT** to skip a parameter and ignore any changes that may have been made.

R0

This probe parameter refers to the resistance of the control probe at 0 °C. The value of this parameter is set at the factory for best Product accuracy. The value ranges from 95 to 105. For values greater than 100.000, the display does not show the hundreds placement. For values less than 100.000, the display shows the entire value. The R0 parameter is indicated by:

r0 *Flashes for one second and then the R0 setting displays*

00.014 *Current R0 setting (100.014)*

To change the R0 setting, press ▲ or ▼.

99.999 *New R0 setting*

To accept the new setting, press **SET**. Press **EXIT** to continue without storing the new value.

SET *Accept the new R0 setting*

ALPHA

This probe parameter refers to the average sensitivity of the probe between 0 and 100 °C. The value of this parameter is set at the factory for best Product accuracy.

ALPhA	*Flashes for one second and then the ALPHA setting displays*
38530	*Current ALPHA setting*

To change the ALPHA setting, press ▲ or ▼.

38600	*New ALPHA setting*

To accept the new setting, press **SET**. Press **EXIT** to continue without storing the new value.

SET	*Accept the new ALPHA setting*

DELTA

This probe parameter characterizes the curvature of the resistance-temperature relationship of the sensor. The value of this parameter is set at the factory for best Product accuracy.

DELtA	*Flashes for one second and then the DELTA setting displays*
0.0000	*Current DELTA setting*

To change the DELTA setting, press ▲ or ▼

0.1000	*New DELTA setting*

To accept the new setting, press **SET**. Press **EXIT** to continue without storing the new value.

SET	*Accept the new DELTA setting*

Digital Communication Interface

This Product can communicate with and be controlled by other equipment through the digital serial interface.

With a digital interface, the Product may be connected to a computer or other equipment. This allows the user to set the set-point temperature, monitor the temperature, and access any of the other controller functions, all using remote communications equipment. Communications commands are summarized in Table 3.

RS-232 Connection

The three-conductor jack for the serial port is located on the back of the Product. One serial cable is included. Additional or longer cables, of 3 m or less, can be constructed by following the wiring diagram shown in Figure 5.

Note

The TxD line on one side connects to the RxD line on the other and vice-versa. To reduce the possibility of electrical interference, the serial cable should be shielded with low resistance between the connector and the shield and should not be much longer than is necessary. The protocol for serial communications is 8 data bits, 1 stop bit, and no parity. Use no flow control. Set the linefeed to ON (all carriage returns are followed by a linefeed (LF, ASCII 10)), and the duplex to HALF, disabling echo.

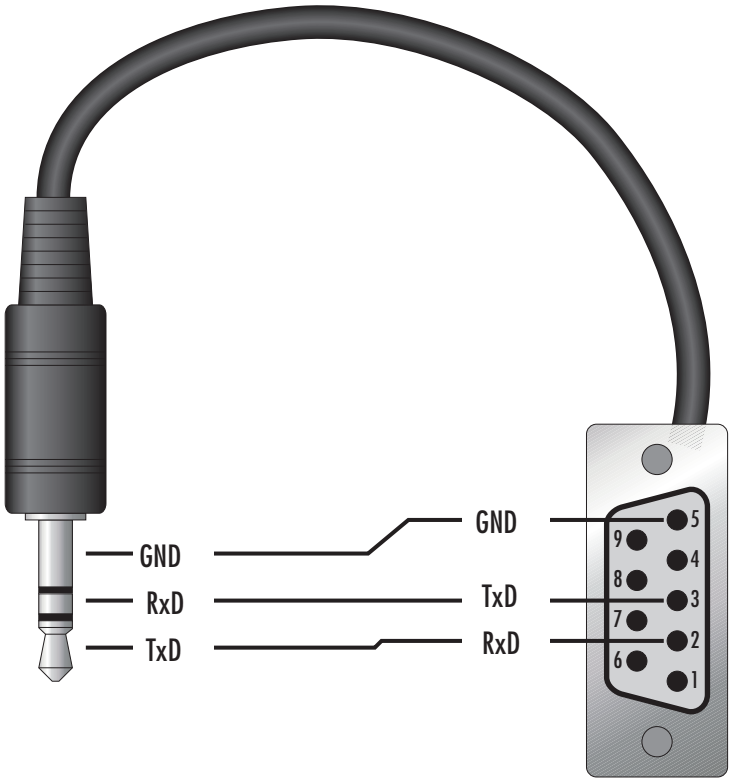

Figure 5. Serial Cable Wiring

The serial port can be used to transmit measurements to a computer or printer or to change settings of the Product from a computer. A full list of commands is in *Interface Commands*.

Commands sent to the Product must end with an EOS character which is a carriage return (CR, ASCII 13) or linefeed character (LF, ASCII 10). Commands can be sent with upper or lower case letters. Data returned from the Product end with a carriage return. If the linefeed setting is on, a linefeed is also sent after the carriage return.

Interface Commands

Use the digital interface and commands shown in Table 3 to access Product functions. These commands are used with the RS-232 serial interface. The commands are terminated with a carriage-return character (CR, ASCII 13). The interface makes no distinction between upper and lower case letters, so either may be used. Commands may be abbreviated to the minimum number of letters which determines a unique command. A command may be used to either set a parameter or to show a parameter depending on whether or not a value is sent with the command following a "=" character. For example, "s" returns the current set-point and "s=120.0" sets the set-point to 120.0 degrees.

In the list of commands in Table 3, characters or data within brackets, "[" and "]", are optional for the command. A slash, "/", denotes alternate characters or data. Numeric data, denoted by "n", may be entered in decimal or exponential notation. Characters are shown in lower case although upper case may be used. Spaces may be added within command strings and are simply ignored. Backspace (BS, ASCII 8) may be used to erase the previous character. A terminating carriage return (CR, ASCII 13) is implied with all commands.

Table 3. Controller Communications Commands

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Display Temperature					
Read current set-point	s[etpoint]	s	set: 999.99 {C or F}	set: 75.00 C	
Set current set-point to n	s[etpoint]=n t[emperature]=*n*	s=100 t=100			-10 to 122 °C 14 to 252 °F
Read temperature	t[emperature]	t	t: 999.9 {C or F}	t: 55.6 C	
Read temperature units	u[nits]	u	u: x	u: C	
Set temperature units:	**u[nits]=c/f**				C or F
Set temperature units to Celsius	u[nits]=c	u=c			
Set temperature units to Fahrenheit	u[nits]=f	u=f			
Read scan mode	sc[an]	sc	sc: {ON or OFF}	sc: ON	
Set scan mode	sc[an]=on/off	sc=on			ON or OFF
Read scan rate	sr[ate]	sr	srat: 99.9 {C or F}/min	srat:12.4 C/min	
Set scan rate	sr[ate]=n	sr=1.1			0.1 to 99.9 °C 0.2 to 179.8 °F
Secondary Menu					
Read proportional band setting	pr[op-band]	pr	pb: 999.99999	pb: 15.9	
Set proportional band to *n*	pr[op-band]=n	pr=8.83			0.1 to 30 °C 0.2 to 54 °F
Read heater power (duty cycle)	po[wer]	po	po: 999.9	po: 6.5	
Configuration Menu					
Operating Parameters Menu					
Read High Limit	hl[imit]	hl	hl: 9999	hl: 125	
Set High Limit	hl[imit]=n	hl=100			50 to 125 °C 122 to 257 °F
Serial Interface Menu					
Read serial sample setting	sa[mple]	sa	sa: 99999	sa: 1	
Set serial sampling setting to *n* seconds	sa[mple]=n	sa=0		0 to 10,000	

Table 3. Controller Communications Commands (cont.)

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Set serial duplex mode:	**du[plex]=f[ull]/ h[alf]**			FULL or HALF	
Set serial duplex mode to full	du[plex]=f[ull]	du=f			
Set serial duplex mode to half	du[plex]=h[alf]	du=h			
Set serial linefeed mode:	**lf[eed]=on/of[f]**			ON or OFF	
Set serial linefeed mode to on	lf[eed]=on	lf=on			
Set serial linefeed mode to off	lf[eed]=of[f]	lf=of			
Calibration Menu					
Read R0 calibration parameter	r[0]		r0: 999.999	r0: 100.7	
Set R0 calibration parameter to *n*	r[0]=n	r=100.7			95.0 to 105.0
Read ALPHA calibration parameter	al[pha]	al	al: 9.99999999	al: 0.003865	
Set ALPHA calibration parameter to *n*	al[pha]=n	al=0.003865			0.002 to 0.006
Read DELTA calibration parameter	de[lta]	de		de: 1.50	
Set DELTA calibration parameter	de[lta]=n	de=1.37	de: 9.99999		0.0–3.0v
Miscellaneous Other Commands					
Read firmware version number	*ver[sion]	*ver	ver.9999x,9.99	ver.9102S,1.10	
Read structure of all commands	h[elp]	h	list of commands		
Read ALL operating parameters	all	all	list of parameters		
Read set-point	*sr	*sr	999.999 ohms	100.123 ohms	

Legend: [] Optional command data
{} Returns either information
n Numeric data supplied by user
9 Numeric data returned to user
x Character data returned to user

Note: When DUPLEX is set to FULL and a command is sent to READ, the command is returned followed by a carriage return and linefeed. Then the value is returned as indicated in the RETURNED column.

Test Probe Calibration

For optimum accuracy and stability, allow the Product to warm up for 10 minutes after power-up and then allow adequate stabilization time after reaching the set-point temperature. After completing operation of the calibrator, allow the well to cool by setting the temperature to 25 °C for one-half hour before turning off the power.

Calibrate a Single Probe

Insert the probe to be calibrated into the well of the Product. The probe should fit snugly into the calibrator probe sleeve yet should not be so tight that it cannot be easily removed. Avoid any dirt or grit that may cause the probe to jam into the sleeve. For best results, insert the probe to the full depth of the well. Once the probe is inserted into the well, allow adequate stabilization time to allow the test probe temperature to settle as described above. Once the probe has settled to the temperature of the well, compare it to the displayed Product temperature. The displayed temperature should be stable to within ±0.05 °C for best results.

⚠Caution

Never allow foreign material into the wells of the block. Fluids and other materials can damage the Product causing binding and damage to your probe.

Dry-well Characteristics

There is a temperature gradient vertically in the test well. The heater has been applied to the block in such a way as to compensate for nominal heat losses out of the top of the dry-well. However, actual heat losses vary with temperature and the design of the thermometer probes inserted into the Product. For best results, insert probe to full depth of well.

Stabilization and Accuracy

The stabilization time of the Product depends on the conditions and temperatures involved. Typically, the test well stabilizes to ±0.05 °C within 7 minutes of reaching the set-point temperature as indicated by the display. Maximum stability is achieved 10 to 20 minutes after reaching the set temperature.

Depending on the magnitude of the disturbance and the required accuracy, inserting a cold probe into a warm well requires another stabilization period. For example, inserting a 0.25 inch diameter room temperature probe into a sleeve at 120 °C takes 7 minutes to be within ±0.05 °C of its settled point and might take 15 minutes to achieve maximum stability.

Speeding up the calibration process can be accomplished by knowing how soon to make the measurement. Fluke Calibration recommends that typical measurements be made at the desired temperatures with the desired test probes to establish these times.

Calibration and Adjustment Procedure

Note

This procedure is a general guideline. Each laboratory should write their own procedure based on their equipment and their quality program. Each procedure should be accompanied by an uncertainty analysis also based on the laboratory's equipment and environment.

Use the instructions in this section to calibrate and adjust the Product. Calibration is done by measuring the Product temperature with a calibrated reference thermometer fully inserted with a snug fit in the Product measurement well. Adjustment is done by adjusting the controller calibration constants R0, ALPHA, and DELTA so that the temperature of the Product, as measured with the reference thermometer, agrees more closely with the set-point. The reference thermometer used must be able to measure the Product temperature with higher accuracy than the accuracy of the Product.

Calibration Points

Fluke Calibration recommends calibrating the Product over the entire operating range at enough temperature points to evaluate Product accuracy and to be able to adjust the Product, if needed. At least three reasonably-separated temperature points are required to adjust the Product. Improved results can be obtained for shorter ranges when using temperatures that are just within the most useful operating range of the Product. The farther apart the calibration temperatures, the greater the calibrated temperature range. However, the calibration error is also greater over the range. For example, if 10 °C to 100 °C is the calibration range, the Product may achieve an accuracy of ±0.25 °C over the range 10 °C to 100 °C. Choosing a range of 50 °C to 100 °C may allow the Product to have a better accuracy of maybe ±0.2 °C over the range 75 °C to 105 °C but outside that range the accuracy may be only ±0.25 °C.

Calibration Procedure

1. Choose the desired calibration points. At a minimum, three points are needed to calculate new calibration parameters R0, ALPHA, and DELTA. Typically, adjustment is based on measurements at 2 °C, 50 °C, and 100 °C but other temperature points can also be used.
2. Set the Product to the lowest calibration point. When the Product reaches the calibration point and the display is stable, wait at least 15 minutes and then take a reading from the reference thermometer (T_1). View and then record the Product control sensor resistance by holding down **SET** and pressing ▼ (R_1). Calculate the difference between the reference thermometer reading and the Product displayed set-point to evaluate Product error.
3. Repeat step 2 for the remaining calibration points measuring in order of increasing temperature. When the other two adjustment points are measured, record T_2 and R_2 and T_3 and R_3 respectively.
4. If adjustment is needed, use the recorded results to calculate new values for the R0, ALPHA, and DELTA.

Compute DELTA

$$A = T_3 - T_2$$

$$B = T_2 - T_1$$

$$C = \left[\frac{T_3}{100}\right]\left[1 - \frac{T_3}{100}\right] - \left[\frac{T_2}{100}\right]\left[1 - \frac{T_2}{100}\right]$$

$$D = \left[\frac{T_2}{100}\right]\left[1 - \frac{T_2}{100}\right] - \left[\frac{T_1}{100}\right]\left[1 - \frac{T_1}{100}\right]$$

$$E = R_3 - R_2$$

$$F = R_2 - R_1$$

$$delta = \frac{AF - BE}{DE - CF}$$

T_{1-3} - Measured temperature using the reference thermometer.

R_{1-3} - Value of set-point resistance from the display. (Press **SET** and ▼ at the same time.)

where

T_1 and **R_1** are the measured temperature and set-point resistance at 2.0 °C

T_2 and **R_2** are the measured temperature and set-point resistance at 50.0 °C

T_3 and **R_3** are the measured temperature and set-point resistance at 100.0 °C

Compute R0 and ALPHA

$$a_1 = T_1 + delta\left[\frac{T_1}{100}\right]\left[1 - \frac{T_1}{100}\right]$$

$$a_3 = T_3 + delta\left[\frac{T_3}{100}\right]\left[1 - \frac{T_3}{100}\right]$$

$$rzero = \frac{R_3 a_1 - R_1 a_3}{a_1 - a_3}$$

$$alpha = \frac{R_1 - R_3}{R_3 a_1 = R_1 a_3}$$

delta is the new value of DELTA computed above.

Program the new values for DELTA (delta), R0 (rzero), and ALPHA (alpha) into the dry-well with the following steps.

1. Press **SET** and **EXIT** at the same time. Press **SET** until 5. PAR displays. and then press ▲ until CAL displays.
2. Press **SET** five times to enter the menu.
3. Press **SET** and ▲ or ▼ until the correct numerical setting displays. Press **SET** to accept the new value.
4. Repeat step 3. for ALPHA and DELTA.
5. Press **EXIT** to show the displayed temperature.

Accuracy and Repeatability

Compare the error observed at each calibration point with the Product accuracy specification to determine accuracy performance. If the Product is adjusted, repeat the calibration procedure to verify accuracy performance at all required temperature points. Repeatability can be verified by repeating a temperature point, preferably one that is at the midpoint of the desired operating range, by first measuring it in a sequence as temperature increases then measuring it again as temperature decreases from the maximum operating temperature. The difference between the upward measurement and the downward measurement is an indication of repeatability.

Maintenance

- With proper care the Product requires very little maintenance. Avoid operating the Product in an oily, wet, dirty, or dusty environment.
- If the outside of the Product becomes soiled, wipe it clean with a damp cloth and mild detergent. Do not use harsh chemicals on the surface which may damage the paint.
- It is important to keep the well of the calibrator clean and clear of any foreign matter. Do not use fluid to clean out the well.
- Use a commercially available plastic or felt brush, of appropriate diameter for a tight fit without any fluid, to clean the well. Complete the cleaning process by using cotton swabs and air to remove any debris.
- Inserts should be cleaned periodically. For cold dry-wells operating below 0 °C, you should always clean the inserts after operating the unit at or below 0 °C. Use emery cloth or other similar material to clean the outside of the inserts. Ensure that the inserts are wiped clean of any debris loosened in the buffing process. Periodic cleaning of the outside of the inserts ensures easy insertion and removal of the inserts from the well.
- Handle the Product with care. Avoid knocking or dropping the Product.
- Do not drop the probe stems into the well, and avoid any other mechanical shock to the sensor.
- If a hazardous material is spilled on or inside the equipment, take the appropriate decontamination steps as outlined by the national safety council with respect to the material.
- If the mains supply cable becomes damaged, replace it with a cord with the appropriate gauge wire for the current of the Product. If there are any questions, call an Authorized Service Center (see *Contact Fluke Calibration*) for more information.
- Before using any cleaning or decontamination method except those recommended by Fluke Calibration, users should check with an Authorized Service Center to be sure that the proposed method will not damage the equipment.
- If the Product is used in a manner not in accordance with the Product design, the operation of the dry-well may be impaired or safety hazards may arise.

Troubleshooting Problems, Possible Causes, and Solutions

This section contains information on troubleshooting, CE Comments, and a wiring diagram.

In the event that the Product appears to function abnormally, this section may help to find and solve the problem. Several possible problem conditions are described along with likely causes and solutions. If a problem arises, please read Table 4 carefully and attempt to understand and solve the problem. If the problem cannot otherwise be solved, contact an Authorized Service Center (see *Contact Fluke Calibration* for assistance. Be sure to have the model number, serial number, voltage, and problem description available.

Table 4. Troubleshooting

Problem	Possible Causes and Solutions
Incorrect temperature reading	**Incorrect R0, ALPHA, and DELTA parameters.** Find the value for R0, ALPHA, and DELTA on the Report of Calibration. Reprogram the parameters into the Product (see *Calibration Parameters*). Allow the Product to stabilize and verify the accuracy of the temperature reading. **Controller locked up.** The controller may have locked up due to a power surge or other aberration. Initialize the system by performing the Factory Reset Sequence. **Factory Reset Sequence.** Hold **SET** and **EXIT** down simultaneously while powering up the Product. The Product display shows '-init-,' the model number, and the firmware version. Each of the controller parameters and calibration constants must be reprogrammed. The values can be found on the Report of Calibration (see *Calibration Parameters*).
The Product heats or cools too quickly or too slowly	**Incorrect scan and scan rate settings.** The scan and scan rate settings may be set to unwanted values. Check the Scan and Scan Rate settings. The scan may be off (if the unit seems to be responding too quickly). The scan may be on with the Scan Rate set low (if unit seems to be responding too slowly). **Improper line voltage.** Verify the bottom of the unit matches the source voltage.
Unstable display	**Wait.** Allow the Product to stabilize for a few minutes. **Proportional band may be incorrect.** Refer to the proportional band on the Report of Calibration.

Table 4. Troubleshooting

Problem	Possible Causes and Solutions
The display shows and error code	**Controller problem.** The error messages signify problems with the controller. Err 1 - a RAM error Err 2 - a NVRAM error Err 3 - a Structure error Err 4 - an ADC setup error Err 5 - an ADC ready error Err 6 – a defective control sensor Err 7 – a heater error Initialize the system by performing the Factory Reset Sequence described above.
Temperature cannot be set above a certain point	Incorrect High Limit parameter. The High Limit parameter may be set below 125 °C. Check this value as described in *Operating Parameters*.
Display is reading incorrectly	The Product was turned off at high temperatures and reenergized too quickly. Turn off the Product until the display is completely off and then reenergize.
Display flickers when the Product is turned off	This is normal operation and is more prevalent at high temperatures due to Seebeck Coefficient of the thermoelectric cooling devices. Some time is required to fully discharge the switching power supply and to complete the power off cycle.
The Product does not reach temperature	The specifications for the Product include an ambient temperature of 23 °C. If the ambient temperature is >23 °C, the Product may not be able to reach the lowest specified temperature. Check the temperature if the Product does not reach maximum temperature.