FLUKE®
Calibration

9009
Industrial Dual-Block Calibrator

User's Guide

February 2013 Rev. 1, 3/22

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Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

Fluke Europe B. V.
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

11/99

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Introduction

The Fluke Calibration 9009 Industrial Dual-Block Calibrator (the Product, calibrator, or instrument) is a portable instrument/bench-top temperature calibrator. Use the Product to calibrate thermocouple and RTD temperature probes. The Product is small enough to use in the field, and accurate enough to use in the lab. With an ambient temperature of -15 °C (5 °F), calibrate over a range of -15 °C to 350 °C (5 °F to 622 °F). The resolution of the display is 0.1 degrees.

The Product features:

- Two independently controlled temperature blocks
- Rapid heating and cooling
- Interchangeable multiple hole probe sleeves
- Convenient integrated carrying case
- RS-232 interface

Built in programmable features include applicable to both the hot and cold blocks):

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

The temperature of each well is accurately controlled by a precision controller. The controller uses a precision platinum RTD as a sensor and controls the well temperature with a solid-state relay (triac) driven heater.

The LED front panel (display) continuously shows the current well temperature. Set the temperature with the control keys to any desired temperature within the specified range. Multiple fault protection devices ensure user and Product safety and protection.

Note

When one of the temperature blocks is accessed through the front panel, the other temperature block control panel is not accessible. Always push **EXIT** *to exit the control panel in use.*

Safety Information

General Safety Information is in the printed *Safety Information* document that shipped with the Product or online at www.Flukecal.com. More specific safety information is listed in this manual where applicable.

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 device under test (DUT).

⚠ Cautions

To avoid possible damage to the Product, follow these guidelines:

- **Never introduce any foreign material into the well.**
- **Do not change the values of the calibration constants from the factory set values. The correct setting of these parameters is important to the safety and proper operation of the Product.**
- **Do not slam the probe stems into the well. This type of action can cause a shock to the sensor and affect the calibration.**
- **Always use a ground fault interrupt device.**
- **The Product is a precision instrument. Although it has optimum durability and trouble-free operation, it must be handled with care.**
- **Most probes have handle temperature limits. Be sure that the probe handle temperature limit is not exceeded in the air above the instrument.**
- **The instrument and any thermometer probes used with it are sensitive instruments that can be easily damaged. Always handle these devices with care. Do not allow them to be dropped, struck, stressed, or overheated.**
- **Components and heater lifetimes can be shortened by continuous high temperature operation.**
- **If a mains supply power fluctuation occurs, immediately turn off the Product. Power bumps from brown-outs and black-outs can damage the instrument. Wait until the power has stabilized before re-energizing the Product.**

Contact Fluke Calibration

Fluke Corporation operates worldwide. For local contact information, go to our website: www.flukecal.com

To register your product, view, print, or download the latest manual or manual supplement, go to our website.

Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090

+1-425-446-5500
info@flukecal.com

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

Complete specifications are located in the printed Safety Information document that came with the Product.

Quick Start

The subsequent sections detail how to get the Product ready for use.

Unpack the Product

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 these components are present:

- 9009 Industrial Dual-Block Calibrator
- *9009 Safety Information*
- Two 3102-3 4.76 mm (3/16 in) and two 3102-4 6.35 mm (1/4 in) Inserts
- Power Cord
- Report of Calibration with calibration label
- RS-232 Cable
- Insert Removal Tool

Set Up

To set up the Product:

1. Place the Product on a flat surface with at least 457 mm (18 in) of clearance above the instrument.
2. Plug the power cord into a grounded mains outlet.
   Make sure that the nominal voltage corresponds to that indicated on the Product, see the specifications in the printed Safety Information.
3. Check that the well is clear of any foreign objects, dirt, and grit and carefully insert the probe sleeves into the wells.
   Do not drop the sleeve in the well. Probe sleeve holes should be of the smallest diameter possible while still allowing the probe to slide in and out easily. Sleeves with various hole sizes are available from Fluke Calibration. Insert the sleeve with the small tong hole positioned upward.
4. Power on the Product.
   Toggle the switch on the power entry module (PEM). The fan blows air through the Product and the display illuminates after 3 seconds. The calibrator heats or cools to the previously programmed temperature set-point. The front panel displays indicate the actual calibrator temperature. After a brief self test, the Product begins normal operation.

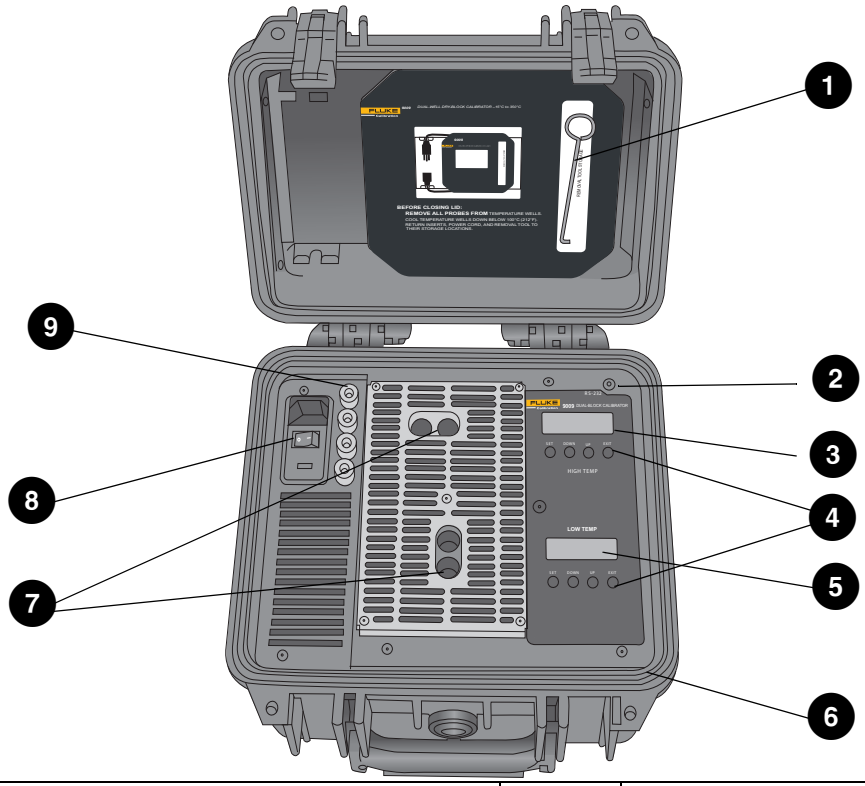
Parts and Controls

This section describes the Product and its parts.

Top Panel (Lid Open)

See Table 1 for the top panel parts.

Table 1. Top Panel



Number	Description	Number	Description
❶	Storage inside the lid for power cord and insert removal tool.	❻	O-ring seal keeps Calibrator protected and sealed from moisture during transit.
❷	Serial Port. A three-conductor jack to interface the calibrator to a computer or terminal with serial RS-232 communications.	❼	Constant Temperature Block Assemblies. Calibrate two sensors at once or use one well for a reference thermometer. See *Constant Temperature Block* for additional details.

Table 1. Top Panel (cont.)

Number	Description	Number	Description
❸	Hot Display. Both displays not only shows the set and actual temperatures but also shows various calibrator functions, settings, and constants. The display shows temperatures in units according to the selected scale °C or °F. The High Temp and Low Temp displays are labeled.	❽	PEM. The power switch is located on the PEM. The PEM also houses the fuse.
❹	Controller Keypad. Use the four-button keypad control buttons to set the calibrator temperature set-point, access and set other operating parameters, and access and set calibration parameters. Each display has their own button set. Set the control temperature 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** - Shows the next parameter in the menu stores parameters to the displayed value. **DOWN** - Decrements the displayed value of parameters. **UP** - Increment the displayed value. **EXIT** - Exits a function and skips to the next function. Any changes made to the displayed value are ignored.		
❺	Cold Display	❾	Insert Storage.Store up to four inserts here.

Power Cord (not shown) - The removable power cord inlet plugs into an IEC grounded socket on the PEM.

Constant Temperature Block

The high temperature *Block* is made of bronze and the cold temperature *Block* is made of aluminum. The Block provides a constant and accurate temperature environment for the sensor under calibration (see Figure 1). A 0.5 in diameter well may be used for sensors of that size or may be sleeved down with various sized probe sleeves. Heaters are strategically placed in the block assembly to provide even heat to the sensor. A high-temperature platinum control RTD is embedded at the base of the block assembly to sense and control the temperature of the block. The entire assembly is suspended in an air-cooled chamber thermally isolated from the chassis and electronics.

⚠Warning

The block vent cover can be very hot due to the fan blowing upward.

Accessories

The inserts in this section are available for the Product. Inserts may be used with either the hot or cold temperature wells.

Figure 1. Constant Temperature Block

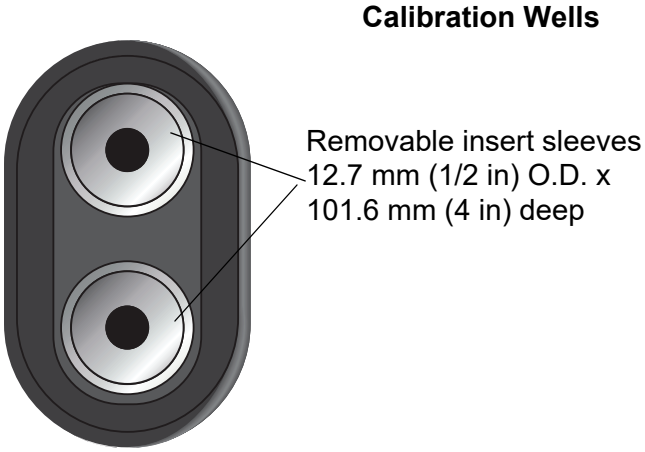


Table 2. Accessories

Model	Description
3102-0	Blank Insert
3102-1	1.6 mm (1/16 in) Insert
3102-2	3.2 mm (1/8 in) Insert
3102-3	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 in) Insert
3102-7	11.1 mm (7/16 in) Insert
3102-8	4.0 mm (5/32 in) Insert

General Operation

Change Display Units

The temperature units are factory defaulted to Celsius. To change to Fahrenheit or back to Celsius:

1. Push **SET** and **UP** simultaneously. The temperature display changes units.

Or

1. Push **SET** three times to store the changes.

`Un= C`

2. Push **UP** or **DOWN** to change units.
3. Push **SET** to store the changes.

Set the Temperature

Temperature Set-point explains how to set the calibrator temperature set-point with the front panel keys. Briefly, the procedure is:

1. Push **SET** twice to access the set-point value.
2. Push **UP** or **DOWN** to change the set-point value.
3. Push **SET** to store the new set-point.
4. Push **EXIT** to return to the temperature display.

When the set-point temperature changes, the heater switches on or off to raise or lower the temperature. The well temperature gradually changes until it reaches the set-point temperature. The well can require 5 minutes to 10 minutes to reach the set-point, depending on the span. Another 5 minutes to 10 minutes is required to stabilize within ±0.1 °C of the set-point. Ultimate stability can take 15 minutes to 20 minutes more of stabilization time.

Controller Operation

Use the front panel to monitor the well temperature, set the temperature set-point in degrees C or F, monitor the heater output power, adjust the controller proportional band, and program the calibration parameters, operating parameters, and serial interface configuration. Operation of the functions and parameters are shown in the flowchart in Figure 2. Copy this chart for reference.

Note

When you use one set of control buttons, the other set is disabled.

Well Temperature

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

`100.0 C` Well temperature in degrees Celsius

Push **Exit** to access the temperature display function from any function.

Temperature Set-point

Set the temperature set-point to any value within the range and resolution as given in the specifications. Do not exceed the safe upper temperature limit of any device inserted into the well.

To set the temperature, select the set-point memory and adjust the set-point value.

Programmable Set-points

The controller stores eight set-point temperatures in memory. Quickly recall the set-points to conveniently set the calibrator to a previously-programmed temperature set-point.

To set the temperature, select the set-point memory first. Push **SET** to access this function from the temperature display function. The number of the current set-point memory shows at the left on the display followed by the current set-point value.

100.0 C	Well temperature in degrees Celsius
Push **SET**	Access set-point memory
1 100.	Set-point memory is currently set to 1 101 °C

To change the set-point memory push **UP** or **DOWN**.

4 300.	New set-point memory is 4 300 °C

Push **SET** to accept the new selection and access the set-point value.

Set-point Value

To adjust the set-point after you select the set-point memory, push **SET**.

4 200.	Set-point 4 value in °C

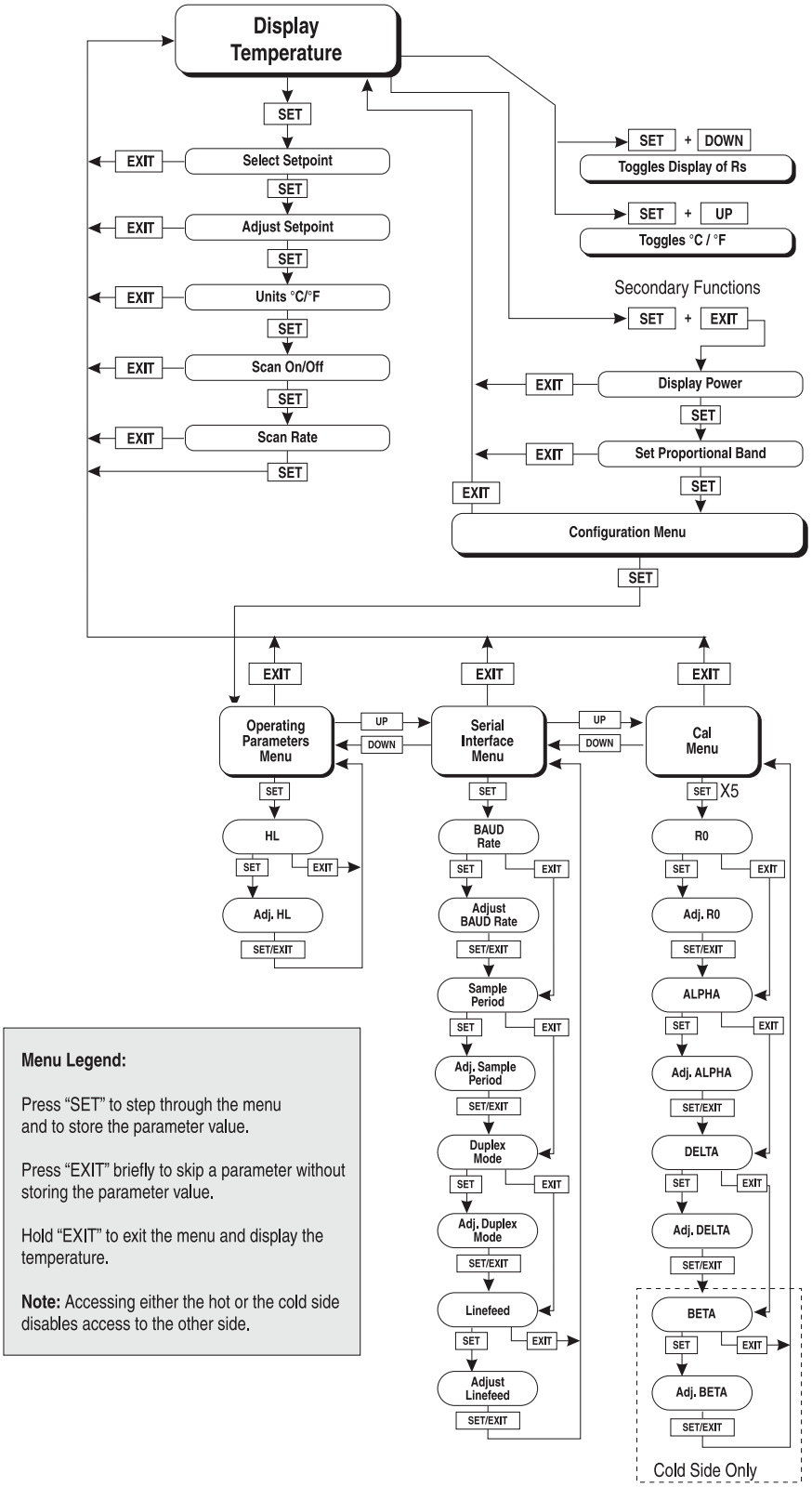
If the set-point value is correct, push **EXIT** to show the well temperature. Push **SET** and then push **UP** or **DOWN** to adjust the set-point value.

220.00	New set-point value

When the controller reaches the desired set-point value, push **SET** to accept the new value and to access the temperature scale units selection. If you push **EXIT** instead of **SET**, any changes made to the set-point are ignored.

Push **SET**	Accept new set-point value

Figure 2. Controller Operation Flowchart



Temperature Scale Units

See *Temperature Scale Units*.

Scan

Set and enable the scan rate so that when the set-point is changed the Product heats or cools at a specified rate (degrees per minute) until it reaches the new set-point. With the scan disabled the Product heats or cools at the maximum possible rate.

Scan Control

Control the scan with the scan on/off function that appears in the main menu after the set-point function.

`Sc=OFF` Scan function off

Push **UP** or **DOWN** to toggle the scan on or off.

`Sc=On` Scan function on

Push **SET** to accept the present setting and continue.

Scan Rate

The next function in the main menu is the scan rate. Set the scan rate from .1 °C/min to 99.9 °C/min. The maximum scan rate, however, is limited by the natural heating or cooling rate of the instrument. This 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 C of F per minute, depending on the selected units.

`Sr= 10.0` Scan rate in °C/min

Push **UP** or **DOWN** to change the scan rate.

`Sr= 2.0` New scan rate

Push **SET** to accept the new scan rate and continue.

Secondary Menu

Access less-used functions with the secondary menu. To access the secondary menu, push **SET** and **EXIT** simultaneously, then release. The first function in the secondary menu is the heater power display. (See Figure 2.)

Heater Power

The temperature controller controls the temperature of the well by pulsing the heater on and off. The total power 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. Monitor the percent heater power to know how stable the well temperature is. With good control stability the percent heating power should not fluctuate more than ±1 % within 1 minute.

Note

For the Cold Side, negative numbers indicate the well is being cooled. When the display reads, -100 P, the well is being cooled at maximum power. When the display reads, 0 P, the well is neither heating nor cooling. When the display reads, 100 P, the well is being heated at maximum power.

For the hot side, when the display reads, 0 P, maximum cooling is occurring (no heater power is applied). The power percentage is never negative on the hot side.

Access the heater power display in the secondary menu. Push **SET** and **EXIT** simultaneously and release. Heater power shows as a percentage of full power.

100.0C	Well temperature
Push **SET** and **EXIT**	Access heater power in secondary menu
SEC	Flashes for secondary menu, then shows the heater power
13.0 P	Heater power in percent

To exit out of the secondary menu, push and hold **EXIT**. To continue to the proportional band setting function, push **EXIT** momentarily or **SET**.

Proportional Band

In a proportional controller such as this, 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, heater power is reduced, which consequently tends to lower the temperature. In this way, the temperature is maintained at a constant temperature.

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 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. The proportional band width is easily adjusted from the front panel. Set the width to discrete values in degrees C or F, which depends on the selected units. The proportional band adjustment is accessed within the secondary menu. Push **SET** and **EXIT** to enter the secondary menu and show the heater power. Then push **SET** to access the proportional band.

Push **SET** and **EXIT**	Access heater power in secondary menu
SEC	Flashes for secondary menu, then shows the heater power
13.0 P	Heater power in percent
Push **SET**	Access proportional band
ProP	Flashes ProP and the current setting
4.1	Proportional band setting

To change the proportional band, push **UP** or **DOWN**.

10.0	New proportional band setting

To accept and store the new setting push **SET**. Push **EXIT** to continue without storing the new value.

Controller Configuration

The controller has several configuration and operating options and calibration parameters which are programmable through the front panel. To access these, push **SET** from the secondary menu after the proportional band. The display shows Config and then PAr for the first of three sets of configuration parameters- operating parameters, serial interface parameters, and calibration parameters. To select the menus, push **UP** and **DOWN** and then push **SET** (see Figure 2).

Operating Parameters

The operating parameters menu is indicated by,

PAr	Operating parameters menu

Push **SET** to enter the menu. The operating parameters menu contains the HL (High Limit) parameter which adjusts the upper set-point temperature. The factory default and maximum are set to 350 C. For safety, adjust the HL down to restrict the maximum temperature set-point.

HL	Flashes HL, then shows the current value
H=350	Current HL setting

Adjust the HL parameter with **UP** or **DOWN**.

H=300	New HL setting

Push **SET** to accept the new temperature limit.

Serial Interface Parameters

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

SErIAL Serial RS-232 interface parameters menu

The serial interface parameters menu contains parameters which determine the operation of the serial interface. These controls only apply to instruments fitted with the serial interface. The parameters in the menu are: BAUD rate, sample period, duplex mode, and linefeed. Push **SET** to enter the menu.

Serial Interface Setup

Before operation, first set up the serial interface by programming the BAUD rate and other configuration parameters. Program these parameters within the serial interface menu. The serial interface parameters menu is outlined in Figure 2.

To enter the serial parameter programming mode:

1. Push **EXIT** while you push **SET**, and then release to enter the secondary menu.
2. Push **SET** repeatedly until the display reads PAr.
3. Push **UP** until the serial interface menu is indicated with Serial.

Push **SET** to enter the serial parameter menu. The BAUD rate, the sample rate, the duplex mode, and the linefeed parameter are in the serial interface parameters menu.

BAUD Rate

The BAUD rate setting determines the serial communications transmission rate.

The BAUD rate parameter is indicated by,

bAUd Flashes bAUd and then displays the setting

2400 b Current BAUD rate

The BAUD rate of serial communications is programmable to 300 BAUD, 600 BAUD, 1200 BAUD, **2400 BAUD** (default), 4800 BAUD, or 9600 BAUD. Use **UP** or **DOWN** to change the BAUD rate value.

4800 b New BAUD rate

Push **SET** to set the BAUD rate to the new value or **EXIT** to abort the operation and skip to the next parameter in the menu.

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 instrument transmits the current measurement over the serial interface approximately every 5 seconds. The automatic sampling is disabled with a sample period of 0.

SPEr Flashes SPEr and then displays the current setting

SP= 1 Current sample period (seconds)

Adjust the value with **UP** or **DOWN** and then use **SET** to store the sample rate to the displayed value. **EXIT** does not store the new value.

SP= 60 New sample period

Duplex Mode

The duplex mode can be set to full duplex or half duplex. With full duplex, any commands received by the calibrator with the serial interface will be immediately echoed or transmitted back to the device of origin. With half duplex, the commands will be executed but not echoed. The duplex mode parameter is indicated by,

dUPL	Flashes dUPL and then displays the setting
d=FULL	Current duplex mode setting

The mode may be changed with **UP** or **DOWN** and **SET**.

d=HALF	New duplex mode setting

Linefeed

Linefeed enables (on) or disables (off) transmission of a linefeed character (LF, ASCII 10) after transmission of any carriage-return.

LF	Flashes LF and then displays the setting
LF= On	Current linefeed setting

The mode may be changed with **UP** or **DOWN** and **SET**.

LF= OFF	New linefeed setting

Calibration Parameters

The controller gives access to a number of the Product calibration constants: R0, ALPHA, DELTA, and BETA (cold side only). These values are set at the factory and should 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 so that if the controller memory fails, the user may restore these values to the factory settings. Keep a list of these constants and their settings with the manual. These constants and their settings are on the Report of Calibration that is shipped with the instrument.

⚠ 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 and proper operation of the Product.

The calibration parameters menu is indicated by:

CAL	Calibration parameters menu

Push **SET** five times to enter the menu.

The calibration parameters R0, ALPHA, DELTA, and BETA (cold side only) characterize the resistance-temperature relationship of the platinum control sensor. These parameters may be adjusted by an experienced user to improve the accuracy of the calibrator.

The calibration parameter name flashes on the display and the Product shows the current value. The value of the parameter may be changed with **UP** and **DOWN**. After the Product reaches the desired value, push **SET** to set the parameter to the new value. To skip and ignore any changes you have made, push **EXIT**.

R0

This probe parameter refers to the resistance of the control probe at 0 °C (32 °F). The value of this parameter is set at the factory for best instrument accuracy.

ALPHA

This probe parameter refers to the average sensitivity of the probe between 0 °C (32 °F) and 100 °C (212 °F). The value of this parameter is set at the factory for best instrument accuracy.

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 instrument accuracy.

BETA (Low Temp Only)

This probe parameter characterizes the low temperatures. The value of this parameter is set at the factory for best instrument accuracy.

Digital Communication Interface

The calibrator can communicate with and can be controlled by other equipment through the digital serial interface. This allows the user to set the set-point temperature, monitor the temperature, and access any of the other controller functions, all with remote communications equipment. Communications commands are summarized in Figure 3.

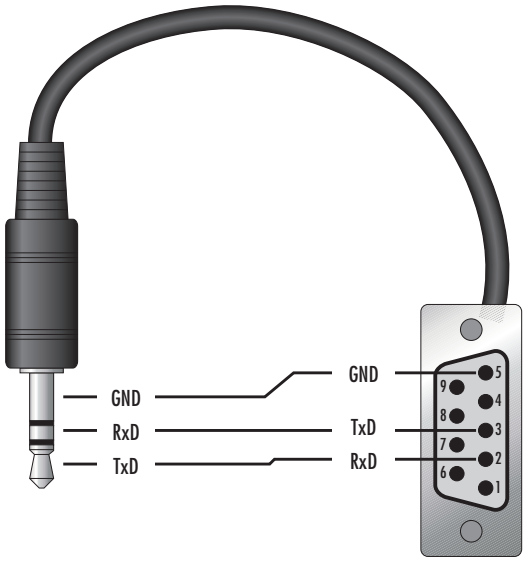
Serial Communications

The calibrator has an RS-232 serial interface that allows serial digital communications over fairly long distances. Use a serial interface to access any of the functions, parameters, and settings discussed in *Serial Communications* except for the BAUD rate setting. The protocol for serial communications is eight data bits, one stop bit, no parity, and no flow control.

Wiring

The three-conductor jack for the serial port is located on the top of the Product. Figure 3 shows the pin-out of this connector and suggested cable wiring. The TxD line on one side connects to the RxD line on the other and vice-versa. To reduce the possibility of electrical interference, shield the serial cable with low resistance between the connector and the shield.

Figure 3. Serial Cable Wiring



Serial Operation

Once the cable has been attached and the interface set up properly, the controller immediately begins to transmit temperature readings at the programmed rate. Serial communications uses 8 data bits, one stop bit, and no parity. The set-point and other commands can be sent through the serial interface to set the temperature set-point and view or program the various parameters. The interface commands are discussed in *Interface Commands*. All commands are ASCII character strings terminated with a carriage-return character (CR, ASCII 13).

Interface Commands

Note

When you send a command, preface the command with either a C: (cold side) or H: (hot side). If the C: or H: are left off, the returned value is for the hot side.

The various commands to access calibrator functions through the digital interface are listed in this section (see Table 3). These commands are used with the RS-232 serial interface. Terminate the commands with a carriage-return character. The interface makes no distinction between upper- and lower-case letters, hence either can be used. Commands can be abbreviated to the minimum number of letters which determines a unique command. A command may be used to either set a parameter or display a parameter depending on whether there is a value sent with the command following a = character. For example, **s** <CR > returns the current set-point and **s** =**150.0**<CR> sets the set-point to 150.0 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*, can 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 will simply be ignored. Backspace (BS, ASCII 8) may be used to erase the previous character. A terminating CR is implied with all commands.

Table 3. Controller Communications Commands

Command Description	Command Format[1]	Command Example[2]	Returned	Returned Example	Acceptable Values
Display Temperature					
Read current set-point	s[etpoint]	s	set: 999.99 {C or F}	set: 150.00 C	-
Set current set-point	s[etpoint]=n	s=350	-	-	Instrument Range
Read temperature	t[emperature]	t	t{h or c}: 9999.99 {C or F}	th: 55.66 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:12.4C/min	-
Set scan rate	sr[ate]=n	sr=1.1	-	-	.1 to 99.9
Secondary Menu					
Read proportional band setting	pr[opband]	pr	pb: 999.9	pb: 15.9	-
Set proportional band to *n*	pr[opband]=n	pr=8.83	-	-	Depends on Configuration
Read heater power (duty cycle)	po[wer]	po	po: 999.9	po: 1.3	-
Configuration Menu					
Operating Parameters Menu					
Read High Limit	hl	hl	hl:999	hl:350	
Set High Limit	hl=*n*	hl=350			Cold 25 to 126, Hot 50 to 350
Serial Interface Menu					
Read serial sample setting	sa[mple]	sa	sa: 9	sa: 1	-
Set serial sampling setting to *n* seconds	sa[mple]=n	sa=0	-	-	0 to 999
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	-	-	-

Table 5. Controller Communications Command (cont.)

Command Description	Command Format[1]	Command Example[2]	Returned	Returned Example	Acceptable Values
Calibration Parameters Menu					
Read R0 calibration parameter	r[0]	r	r0: 999.999	r0: 100.578	-
Set R0 calibration parameter to *n*	r[0]=n	r=100.324	-	-	100 to 105
Read ALPHA calibration parameter	al[pha]	al	al: 9.9999999	al: 0.0038573	-
Set ALPHA calibration parameter to *n*	al[pha]=n	al=0.0038433	-	-	.002 to 006
Read DELTA calibration parameter	de[lta]	de	de:9.99999	de: 1.507	-
Set DELTA calibration parameter	de[lta]=n	de=1.3742	-	-	0.5 to 1.9
Read BETA calibration parameter	be[ta]	be	Be:9.999	be:-0.342	-25 to 25
Set BETA calibration parameter	be[ta]=n	be=0.342	-	-	-
Miscellaneous					
Read firmware version number	*ver[sion]	*ver	ver.9999,9.99	ver.9009,1.21	-
Read structure of all commands	h[elp]	h	list of commands	-	-
Read ALL operating parameters	all	all	list of parameters	-	-

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.

[1] Preface all commands with either C: (for cold side) or H: (for hot side). If the C: or H: is left off, the returned value is for the hot side.
[2] The returned command has either C or an H before the colon depending on which side was queried.

Calibrate a Single Probe

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 you complete Product operation, set the temperature to 25 °C for one-half hour to allow the well to cool before switching the power off.

Insert the probe to be calibrated into the Product well. 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, the probe may be compared to the calibrator display temperature. The display temperature should be stable to within 0.1 °C (32.18 °F) for best results.

⚠ Caution

Never introduce any foreign material into the well. Fluids can leak into the calibrator and damage the calibrator or binding and damage to your probe.

Calibrator 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 calibrator. However, actual heat losses will vary with design of the thermometer probes inserted into the calibrator. 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 will be stable to 0.1 °C within 5 minutes of reaching the set-point temperature. Ultimate stability is achieved 10 minutes to 20 minutes after the Product reaches the set temperature.

If you insert another cold probe into a well, this requires another period of stabilizing, depending on the magnitude of the disturbance and the required accuracy. For example, if you insert a .25-in diameter room temperature probe at 300 °C, it takes 5 minutes to be within 0.1 °C of its settled point and takes 10 minutes to achieve maximum stability.

To speed up the calibration process, know how soon to make the measurement. Make typical measurements at the desired temperatures with the test probes under test to establish these times.

Calibration

Note

Consider this procedure a general guideline. Each laboratory must 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 equipment and environment of the laboratory.

You may want to calibrate the Product to improve the temperature set-point accuracy. To adjust calibration, adjust the controller probe calibration constants R0, ALPHA, DELTA, and BETA (cold side) so that the temperature of the Product as measured with a standard thermometer agrees more closely with the set-point. The thermometer used must be able to measure the well temperature with higher accuracy than the desired accuracy of the Product. Use a good thermometer and this calibration procedure to calibrate the Product to an accuracy of better than 0.5 °C up to 100 °C.

Calibration Points

When you calibrate the Product, adjust R0, ALPHA, DELTA, and BETA (cold side) to minimize the set-point error at each of three different Product temperatures. Any three reasonably separated temperatures can be used for the calibration. Improved results can be obtained for shorter ranges when you use temperatures that are just within the most useful operating range of the Product. The farther apart the calibration temperatures, the larger will be the calibrated temperature range, but the calibration error will also be greater over the range. Choosing a range of 50 °C to 90 °C may allow the calibrator to have a better accuracy of maybe ±0.2 °C over that range, but outside that range the accuracy may be only ±1.5 °C.

Calibration Procedure

Follow these steps for the calibration procedure:

1. Choose the set-points to use in the calibration of the R0, ALPHA, DELTA, and BETA parameters. These set-points are generally -15 °C, 0 °C, 60 °C, and 110 °C (5 °F, 32 °F, 140 °F, and 230 °F) but other set-points can be used.
2. Set the calibrator to the low set-point. When the Product reaches the set-point and the display is stable, wait about 15 minutes and then take a reading from the thermometer. Sample the set-point resistance by holding down **SET** and pushing **DOWN**. Write these values down as T_1 and R_1 respectively.
3. Repeat step 2 for the other set-points and record them as T_1, R_1, T_2, R_2, T_3, R_3, T_4, and R_4 respectively.
4. Use the recorded data to calculate new values for R0, ALPHA, DELTA, BETA parameters with the equations given below.

Compute DELTA

$A = [T_4 - T_3]$

$B = [T_3 - T_2]$

$$C = \left[\frac{T_4}{100}\right]\left[1 - \frac{T_4}{100}\right] - \left[\frac{T_3}{100}\right]\left[1 - \frac{T_3}{100}\right]$$

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

$E = R_4 - R_3$

$F = R_3 - R_2$

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

Where:

T_{1-4} – Measured temperature using thermometer.

R_{1-4} – Value of R from display of Product (push **SET** and **DOWN** simultaneously.)

where

T_1 and R_1 are the measured temperature and resistance at -15 °C

T_2 and R_2 are the measured temperature and resistance at 0 °C

T_3 and R_3 are the measured temperature and resistance at 60 °C

T_4 and R_4 are the measured temperature and resistance at 110 °C

Compute R0 & ALPHA

$$a_1 = T_2 + delta\left[\frac{T_2}{100}\right]\left[1 - \frac{T_2}{100}\right]$$

$$a_3 = T_4 + delta\left[\frac{T_4}{100}\right]\left[1 - \frac{T_4}{100}\right]$$

$$rzero = \frac{R_4 a_1 - R_2 a_3}{a_1 - a_3}$$

$$alpha = \frac{R_2 - R_4}{R_4 a_1 - R_2 a_3}$$

Where:

delta is the new value of DELTA computed above.

Compute BETA (Cold Side Only)

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

$$y = \left[\frac{T_1}{100}\right]$$

$$beta = \frac{1}{(alpha)(x)(y^3)} + \frac{T_1}{(x)\ (y)} - \frac{delta}{y^2} - \frac{\frac{R_1}{rzero}}{(alpha)(x)(y^3)}$$

Where:

T and R are the measured resistance at -15 °C.

alpha, rzero, and delta are the new values of ALPHA, R0, and DELTA calculated above.

Program the new values for DELTA (delta), R0 (rzero), ALPHA (alpha) and BETA (cold side only) into the calibrator with these steps:

1. Push the **SET** and **EXIT** simultaneously and then push **SET** until R0 shows.
2. Push **SET** then use the **UP** or **DOWN** keys until the correct numerical setting shows.
3. Pus **SET** to accept the new value.
4. Repeat step 2 for ALPHA, DELTA, and BETA (cold side only).

Accuracy and Repeatability

Check the accuracy of the Product at various points over the calibrated range. If the Product does not pass specification at all set-points, repeat the *Calibration Procedure*.

Maintenance

With proper care, the Product requires very little maintenance. Refer to *Safety Information*.

- If the outside of the instrument becomes soiled, wipe it clean with a damp cloth and mild detergent. Do not use harsh chemicals on the surface which can damage the paint.
- Keep the well of the calibrator clean and clear of any foreign matter. Do not use fluid to clean out the well.
- Handle the Product with care. Avoid knocking or dropping the instrument.
- If a hazardous material is spilled on or inside the Product, take the appropriate decontamination steps as outlined by the national safety council with respect to the material.
- Periodically buff the removable probe sleeves clean to prevent dust and carbon material build up.
- If a sleeve is dropped, examine the sleeve for deformities before you insert it into the well. If there is any chance of jamming the sleeve in the well, file or grind off the protuberance.
- Do not slam the probe stems into the well. This can cause a shock to the sensor.
- If a hazardous material is spilled on or inside the Product, take the appropriate decontamination steps as outlined by the national safety council with respect to the material.
- If the mains supply cord becomes damaged, replace it with a cord with the appropriate gauge wire for the current of the Product. If there are any questions, see *Service Information*.
- Before the use of any cleaning or decontamination method except those recommended by Fluke Calibration, check with an Authorized Service Center to be sure that the proposed method does not damage the Product.

Troubleshooting Problems, Possible Causes, and Solutions

If the Product functions abnormally, Table 4 may help to find and solve the problem. Several possible problem conditions are described along with likely causes and solutions. Please read this section carefully and attempt to understand and solve the problem. If the problem cannot otherwise be solved, contact an Authorized Service Center (see *Service Information*). Be sure to have the model number and serial number of the Product available.

Table 4. Troubleshooting

Problem	Possible Causes and Solutions
Incorrect temperature reading	Power the Product on and watch the display. If the first number shown is less than -0005-, the Product has been re-initialized. Do the Master Reset Sequence to initialize the system as described in the problem, Controller locks up.
The display is off	Check the fuses. Check that the power cord is plugged in and connected to the Product.
The Product heats slowly	Check the Scan and Scan Rate settings. The Scan may be on with the Scan Rate set low.
Controller locks up	Initialize the system with the Master Reset Sequence. If the Product repeats the error code, contact an Authorized Service Center. Master Reset Sequence: The Master Reset must be done on the cold side. However, both the cold and the hot sides are reset. Hold **SET** and **EXIT** down (on the cold side) at the same time while you power up the Product. The screen shows -init-, the Product model number, and the version of the software. The Product needs to be reprogrammed on both the hot and the cold side for R0, ALPHA, and DELTA, and on the cold side for BETA in the calibration menu. These numbers can be found on the Report of Calibration that was shipped with the Product.

Table 4. Troubleshooting (cont.)

Problem	Possible Causes and Solutions
Temperature readout is not the actual temperature of the well	**Possible RF energy emission.** With the Product stable, slowly rotate the Product. If no change occurs, the Product may need to be calibrated. If so, contact a service center. If the display changes more than twice the normal display deviation, another Product in the area could be emitting RF energy. Move the Product to a different location and rotate the Product again. If the temperature is correct in this new area or deviates differently than the first are, RF energy is present in the room. If you must perform the test in the affected area, use the comparison test to eliminate any possible errors.