FLUKE®
Hart Scientific®

9132

Portable IR Calibrator
User's Guide

Rev. 672501 ENG

Limited Warranty & Limitation of Liability

Each product from Fluke Corporation, Hart Scientific Division ("Hart") is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year for the Portable IR Calibrator. The warranty period begins on the date of the shipment. Parts, product repairs, and services are warranted for 90 days. The warranty extends only to the original buyer or end-user customer of a Hart authorized reseller, and does not apply to fuses, disposable batteries or to any other product, which in Hart's opinion, has been misused, altered, neglected, or damaged by accident or abnormal conditions of operation or handling. Hart 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. Hart does not warrant that software will be error free or operate without interruption. Hart does not warrant calibrations on the Portable IR Calibrator.

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

To obtain warranty service, contact your nearest Hart authorized service center or send the product, with a description of the difficulty, postage, and insurance prepaid (FOB Destination), to the nearest Hart authorized service center. Hart assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Hart determines that the failure was caused by misuse, alteration, accident or abnormal condition or operation or handling, Hart will provide an estimate or 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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1 Before You Start

1.1 Introduction

The Hart Scientific 9132 Portable IR Calibrator may be used as a portable instrument or bench top temperature calibrator for calibrating point IR thermometers. The 9132 is small enough to use in the field, and accurate enough to use in the lab. Calibrations may be done over a range of 50°C to 500°C (122°F to 932°F). Temperature display and setability resolution of the 9132 is 0.1 degrees.

The instrument features:

- Rapid heating and cooling
- Hand strap
- RS-232 interface capability

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 Hart's digital controller. The controller uses a precision platinum RTD as a sensor and controls the well temperature with a solid state relay (triac) driven heater.

For improved uncertainties, a 0.125" external reference thermometer may be used in the calibration probe hole at the top of the instrument. When using an external reference thermometer, the unit accuracy, stability, and ambient temperature effects on the surface can be minimized.

The LED front panel continuously shows the current temperature. The temperature may be easily set with the control buttons to any desired temperature within the specified range. The instrument's multiple fault protection devices insure user and instrument safety and protection.

The 9132 calibrator was designed for portability, low cost, and ease of operation. Through proper use the instrument will provide 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 user guide.

1.2 Symbols Used

Table 1 lists the International Electrical Symbols. Some or all of these symbols may be used on the instrument or in this manual.

Table 1 *Symbols*

Symbol	Description
	AC (Alternating Current)
	AC-DC
	Battery
	Complies with European Union directives
	DC
	Double Insulated
	Electric Shock
	Fuse
	PE Ground
	Hot Surface (Burn Hazard)
	Read the User's Guide (Important Information)
	Off
	On

Symbol	Description
	Canadian Standards Association
CAT II	OVERVOLTAGE (Installation) CATEGORY II, Pollution Degree 2 per IEC1010-1 refers to the level of Impulse Withstand Voltage protection provided. Equipment of OVERVOLTAGE CATEGORY II is energy-consuming equipment to be supplied from the fixed installation. Examples include household, office, and laboratory appliances.
	C-TIC Australian EMC mark
	The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) mark.

1.3 Safety Information

Use this instrument only as specified in this manual. Otherwise, the protection provided by the instrument may be impaired.

The following definitions apply to the terms “Warning” and “Caution”.

- “WARNING” identifies conditions and actions that may pose hazards to the user.
- “CAUTION” identifies conditions and actions that may damage the instrument being used.

1.3.1 WARNINGS

To avoid personal injury, follow these guidelines.

- **BURN HAZARD – DO NOT** touch the IR target surface of the unit.The temperature of the IR target surface is the same as the actual temperature shown on the display. If the unit is set at 500°C and the display reads 500°C, the target surface is 500°C.The top sheet metal of the instrument may exhibit extreme temperatures for areas close to the IR target surface. **DO NOT** turn off the unit at temperatures higher than 100°C. This could create a hazardous situation. Select a set-point less than 100°C and allow the unit to cool before turning it off.
- **DO NOT** operate this unit without a properly grounded, properly polarized power cord.
- **DO NOT** connect this unit to a non-grounded, non-polarized outlet.
- **HIGH VOLTAGE** is used in the operation of this equipment. **SEVERE INJURY OR DEATH** may result if personnel fail to observe safety precautions. Before working inside the equipment, turn the power off and disconnect the power cord.
- Always replace the fuse with one of the same rating, voltage, and type.
- This instrument is intended for indoor use only.
- Overhead clearance is required. **DO NOT** place this instrument under a cabinet or other structure.

- **DO NOT** use this unit for any application other than calibration work.
- **DO NOT** use this unit in environments other than those listed in the user's guide.
- **DO NOT** operate near flammable materials.
- Use of this instrument at **HIGH TEMPERATURES** for extended periods of time requires caution.
- Completely unattended high temperature operation is not recommended for safety reasons.
- Before initial use, after transport, and anytime the dry-well has not been energized for more than 10 days, the calibrator must be energized for a dry-out period of 1 to 2 hours before it can be assumed to meet all of the safety requirements of the IEC1010-1.
- The instrument can generate extreme temperatures. Precautions must be taken to prevent personal injury or damage to objects.
- Use only a grounded AC mains supply of the appropriate voltage to power the instrument. Refer to Section 3.1, Specifications for power details.
- The instrument is equipped with operator accessible system fuses. If a fuse blows, it may be due to a power surge or failure of a component. Replace the fuse once. If the fuse blows a second time, it is likely caused by failure of a component part. If this occurs, contact an Authorized Hart Scientific Service Center (see Section). Always replace the fuse with one of the same rating, voltage, and type. Never replace the fuse with one of a higher current rating.
- Follow all safety guidelines listed in the user's manual.
- Calibration Equipment should only be used by Trained Personnel.

1.3.2 CAUTIONS

- DO NOT plug the unit into 230V if the heater switches and fuse holder read 115V. This action will cause the fuses to blow and may damage the instrument.
- Components and heater lifetime can be shortened by continuous high temperature operation.
- DO NOT use fluids to clean the target surface.
- 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 calibrator.
- DO use a ground fault interrupt device.
- Operate the instrument in room temperatures between 5 and 50°C. (41–122° F). Allow sufficient air circulation by leaving at least 6 inches of space between the instrument and nearby objects.
- The instrument is a precision instrument. Although is has been designed for optimum durability and trouble free operation, it must be handled with care. Always carry the unit in an upright position. The convenient fold-up handle allows one hand carrying. The instrument should not be operated in excessively wet, oily, dusty, or dirty environments. Do not operate near flammable materials.
- Before initial use, after transport, and anytime the dry-well has not been energized for a "dry-out" period of 1-2 hours before it can be assumed to meet all of the safety requirements of the IEC 1010-1.

- If a main supply power fluctuation occurs, immediately turn off the instrument. Wait until the power has stabilized before re-energizing the instrument.

1.4 Authorized Service Centers

Please contact one of the following authorized Service Centers to coordinate service on your Hart product:

Fluke Corporation, Hart Scientific Division

799 E. Utah Valley Drive
American Fork, UT 84003-9775
USA

Phone: +1.801.763.1600
Telefax: +1.801.763.1010
E-mail: support@hartscientific.com

Fluke Nederland B.V.

Customer Support Services
Science Park Eindhoven 5108
5692 EC Son
NETHERLANDS

Phone: +31-402-675300
Telefax: +31-402-675321
E-mail: ServiceDesk@fluke.nl

Fluke Int'l Corporation

Service Center - Instrimpex
Room 2301 Sciteck Tower
22 Jianguomenwai Dajie
Chao Yang District
Beijing 100004, PRC
CHINA

Phone: +86-10-6-512-3436
Telefax: +86-10-6-512-3437
E-mail: xingye.han@fluke.com.cn

Fluke South East Asia Pte Ltd.

Fluke ASEAN Regional Office
Service Center
60 Alexandra Terrace #03-16
The Comtech (Lobby D)
118502
SINGAPORE

Phone: +65 6799-5588
Telefax: +65 6799-5588
E-mail: antng@singa.fluke.com
When contacting these Service Centers for support, please have the following information available:

- Model Number
- Serial Number
- Voltage
- Complete description of the problem

2 Specifications and Environmental Conditions

2.1 Specifications

Table 2 *Specifications*

Range	50°C to 500°C (122°F to 932°F)
Accuracy	±0.5°C at 100°C (±0.9°F at 212°F) ±0.65°C at 300°C (±1.2°F at 572°F) ±0.8°C at 500°C (±1.4°F at 932°F)
Stability	±0.1°C at 100°C (±0.18 at 212°F) ±0.15°C at 300°C (±0.27 at 572°F) ±0.3°C at 500°C (±0.54 at 932°F)
Target Size	2.25" (57 mm)
Resolution	0.1°C or °F
Display	LED, °C or °F, switchable
Heating Times	30 minutes to max (50 0176C to 500°C)
Cooling Times	30 minutes (500°C to 100°C)
Stabilization Time	10 minutes
Target Emissivity	0.95 (±0.02 from 8 to 14μM)
Aperture Diameter	2.25" (57mm)
Computer Interface	RS-232 interface included with Model 9930 Interface-*it* control software
Power	115 VAC (±10%), 3 A or 230 VAC (±10%), 1.5 A, 50/60 Hz, switchable, 340 W
Size	4" H x 6" W x 7" D (102 x 152 x 178 mm)
Weight	4 lb. (1.8 kg)

Temperature differences between the IR surface and the reference probe are calculated as shown in the graph in Figure 1.

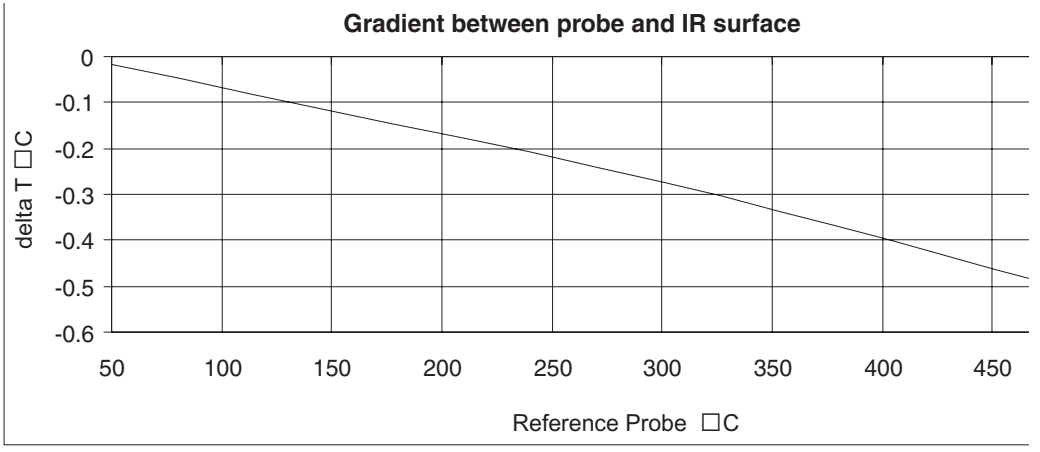

Figure 1 *Temperature Gradient Between Probe and IR Target Surface*

NOTE: *As the calibrator temperature increases, the difference between the temperature sensed by the reference thermometer and the temperature of the face of the target increases.*

2.2 Environmental Conditions

Although the instrument has been designed for optimum durability and trouble-free operation, it must be handled with care. The instrument should not be operated in an excessively dusty or dirty environment. Maintenance and cleaning recommendations can be found in the Maintenance section of this manual.

The instrument operates safely under the following conditions:

- temperature range: 5-35°C (41-95°F)
- ambient relative humidity: 15-50%
- pressure: 75kPa – 106kPa
- mains voltage within ±10% of nominal
- vibrations in the calibration environment should be minimized
- altitudes less than 2,000 meters

3 Quick Start

3.1 Unpacking

Unpack the calibrator 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:

- 9132 Calibrator
- Power Cord
- User's Guide
- Serial Cable
- 9930 Software

3.2 Set Up

Place the calibrator on a flat surface with at least 6 inches of free space around the instrument. The prop may be swung down to raise the front of the instrument from a horizontal position. Plug the power cord into a grounded mains outlet. Observe that the nominal voltage corresponds to that indicated on the back of the calibrator.

Turn on the power to the calibrator by toggling the power switch on. The fan should begin quietly blowing air through the instrument and the controller display should illuminate after 3 seconds. After a brief self-test the controller should begin normal operation. If the unit fails to operate please check the power connection.

The heater will start operating to bring the temperature of the calibrator to the set-point temperature and the display will begin to show the actual target temperature.

3.3 Power

Plug the dry-well power cord into a mains outlet of the proper voltage, frequency, and current capability. Refer to Specifications for power details. Turn the dry-well on using the rear panel "POWER" switch. The dry-well will turn on and begin to heat to the previously programmed temperature set-point. The front panel LED display will indicate the actual dry-well temperature.

3.4 Setting the Temperature

Section 8.2 explains in detail how to set the temperature set-point on the calibrator using the front panel keys. The procedure is summarized here.

1. Press "SET" twice to access the set-point value.
2. Press "UP" or "DOWN" to change the set-point value.
3. Press "SET" to program in the new set-point.
4. Press "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 5 to 10 minutes to reach the set-point depending on the span. Another 5 to 10 minutes is required to stabilize within ±0.1°C of the set-point. Ultimate stability may take 15 to 20 minutes more of stabilization time.

4 Parts and Controls

The user should become familiar with the calibrator and its parts.

4.1 Back Panel

The back panel (Figure 2) consists of the power cord inlet, power switch, heater voltage switch, serial port, and fan.

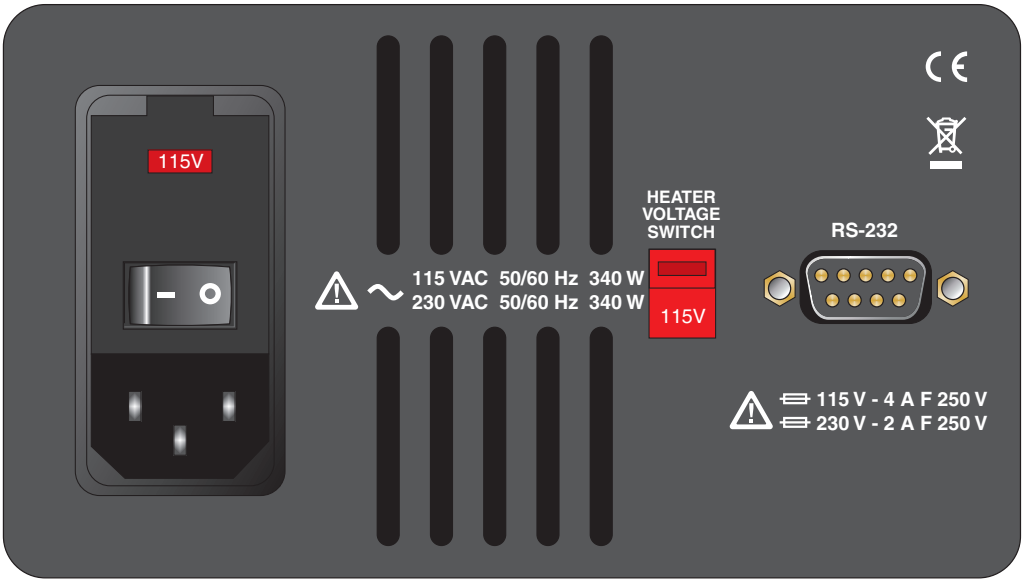

Figure 2 *Back Panel*

Power Inlet – At the rear of the calibrator is the removable power cord inlet that plugs into an IEC grounded socket.

Power Switch – The power switch is located on the power entry module (PEM). The PEM also houses the fuses and the dual voltage selector. The PEM and Heater Voltage Switch (see below) allow the unit to be field switchable for 115 VAC (±10%) or 230 VAC (±10%) operation.

Heater Voltage Switch – To be used only when changing the input voltage. (See Section 7.2 for instructions on changing the input voltage.)

CAUTION: *Do not plug the unit into 230 V if the heater switches and fuse holder read 115 V. This action will cause the fuses to blow and may damage the instrument.*

Serial Port – A DB-9 male connector is present for interfacing the calibrator to a computer or terminal with serial RS-232 communications.

Fan – The fan inside the calibrator has two speeds and runs continuously when the unit is being operated to provide cooling for the instrument. The fan runs slow for heating and maintaining operation and runs fast for rapid cooling. Slots are provided for airflow. The area around the calibrator must be kept clear to allow adequate ventilation. The airflow is directed out the front and can be extremely hot.

4.2 Front Panel

The front panel (Figure 3) consists of the controller display, controller keypad, and target assembly.

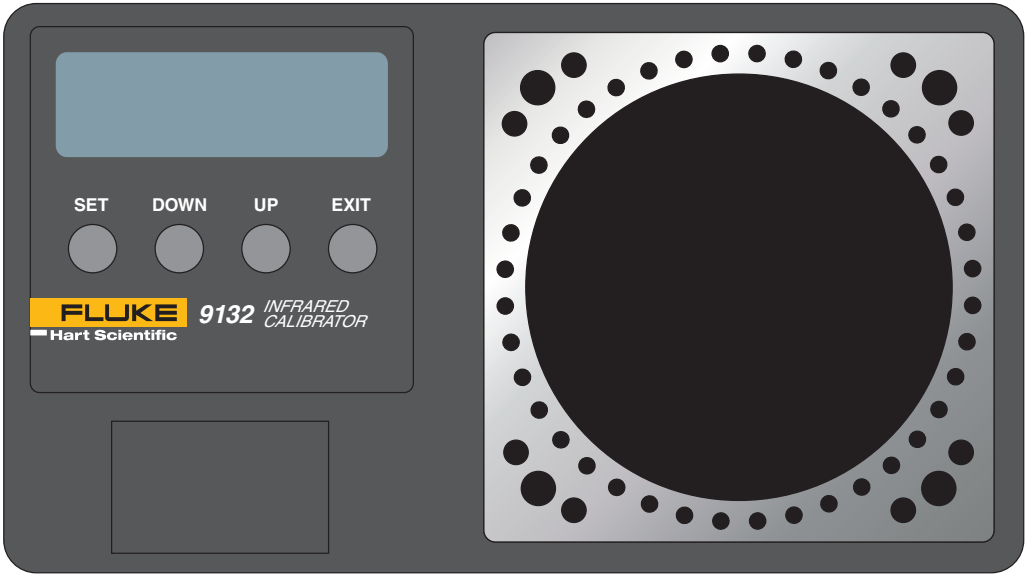

Figure 3 *Front Panel*

Controller Display – The digital display displays set and actual temperatures and various calibrator 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, DOWN, UP, and EXIT) are used to set the calibrator 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. The control temperature can be set to one-tenth of a degree Celsius or Fahrenheit.

The functions of the buttons are as follows:

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

DOWN – Used to decrement the displayed value of parameters.

UP – 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.

Target Assembly – The target assembly is 57 mm (2.25 in) in diameter and has an emisivity of 0.95.

5 General Operation

5.1 Changing Display Units

The Model 9132 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 as described below.

1. Press the “SET” and “UP” simultaneously. The units are changed.

Or

1. Press the “SET” key three times from the temperature display to show Un = C
2. Press the “UP” or “DOWN” key to change units.

5.2 Switching to 230 V Operation

The 9132 is switchable from 115 V ac to 230 V ac 50/60 Hz. Switching the voltage can change the calibration. Therefore, we recommend that the instrument be calibrated after the voltage is switched. To change from 115 V ac to 230 V ac follow the steps below.

1. Unplug the instrument.
2. With a small straight slot screwdriver remove the fuse holder located on the rear panel.
3. Replace the two 4 amps fuses with 2 amp 250 V fuses.
4. Replace the fuse holder with the “230V” in the display window.
5. Using the same straight slot screwdriver, move the heater switch to display “230V”. See the back panel drawing in Figure 2 on page 11.

NOTE: *If the heater switch and the fuse holder do not both read 230 V when complete, the unit will either not heat or only heat at a fraction of its capacity. If not done properly, the unit could become damaged and void the calibration and warranty. Use 4 amp fuses for 115 V and 2 amp fuses for 230 V only.*

CAUTION: *Do not plug the unit into 230 V if the heater switches and fuse holder read 115 V. This action will cause the fuses to blow and may damage the instrument.*

6 Controller Operation

This chapter discusses in detail how to operate the instrument temperature controller using the front control panel. Using the front panel key-switches and LED display the user may 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 on page . This chart may be copied for reference.

In the following discussion a button with the word SET, UP, EXIT or DOWN inside indicates the panel button while the LED type text indicates the display reading. Explanation of the button or display reading are to the right of each button or display value.

6.1 Well Temperature

The digital LED display on the front panel allows direct viewing of the actual well temperature. This temperature value is what is normally shown on the display. The units, C or F, of the temperature value 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 pressing the "EXIT" button.

6.2 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 one of the eight set-points in memory and then adjusting the set-point value.

6.2.1 Programmable Set-points

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

To set the temperature one must first select the set-point memory. This function is accessed from the temperature display function by pressing "SET". The number of the set-point memory currently being used is shown at the left on the display followed by the current set-point value.

100.0 C *Well temperature in degrees Celsius*

Access set-point memory

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

To change to another set-point memory press "UP" or "DOWN".

4. 300. *New set-point memory 4, 300°C*

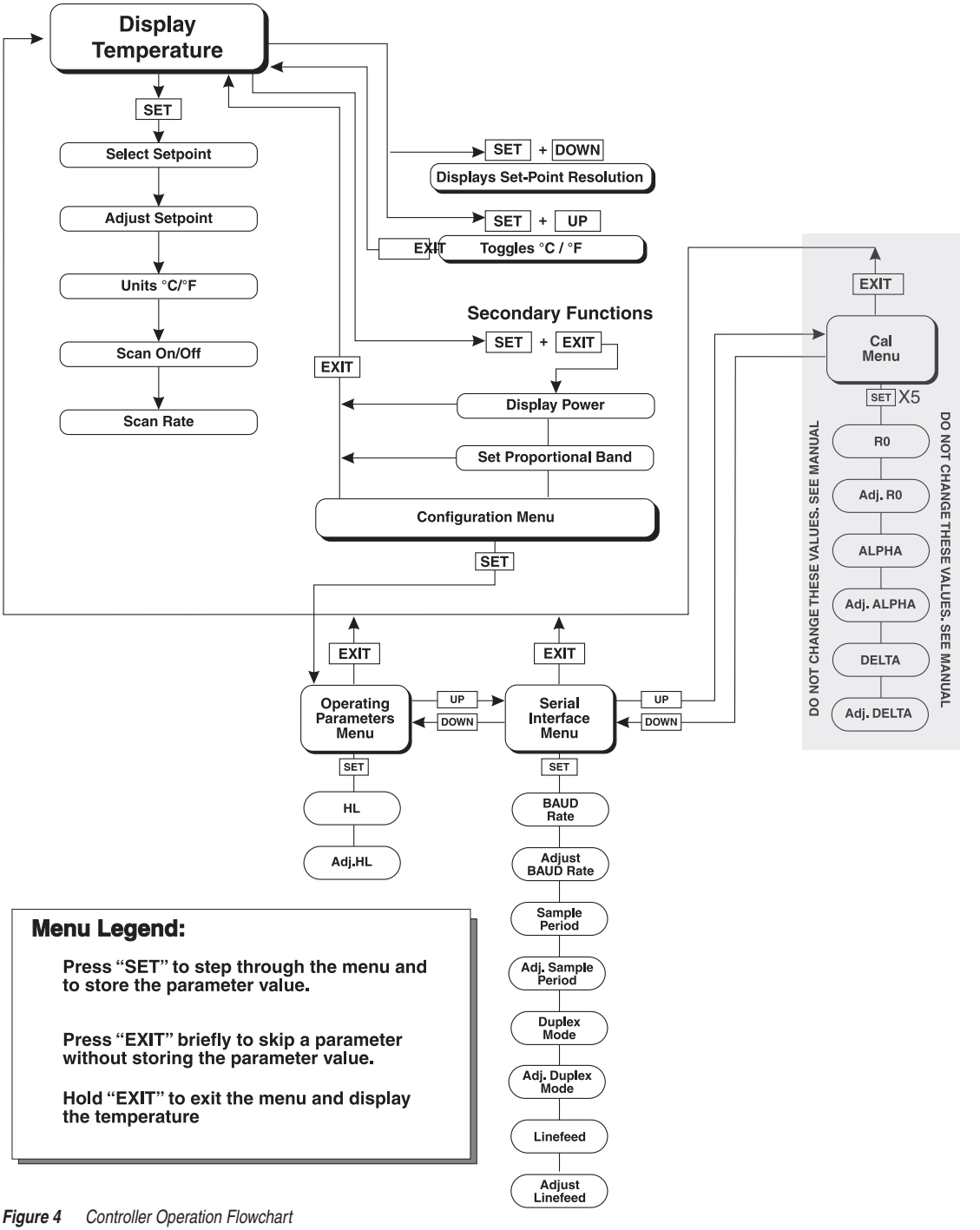

Figure 4 *Controller Operation Flowchart*

Press “SET” to accept the new selection and access the set-point value.

Accept selected set-point memory.

6.2.2 Set-point Value

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

4. 200. *Set-point 4 value in °C*

If the set-point value need not be changed then press “EXIT” to resume displaying the well temperature. To change the set-point value, press “SET” and then press “UP” or “DOWN”.

220.0 *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 instead then any changes made to the set-point will be ignored.

Accept new set-point value

6.3 Temperature Scale Units

The temperature scale units of the controller maybe set by the user to degrees Celsius (°C) or Fahrenheit (°F). The units are used in displaying the well temperature, set-point, and proportional band.

Press “SET” after adjusting the set-point value to change display units.

Un=C *Scale units currently selected*

Press “UP” or “DOWN” to change the units.

Un=F *New units selected*

6.4 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.

6.4.1 Scan Control

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

Sc=OFF *Scan function off*

Press “UP” or “DOWN” to toggle the scan on or off.

Sc=On *Scan function on*

Press "SET" to accept the present setting and continue.

SET *Accept scan setting*

6.4.2 Scan Rate

The next function in the main menu is the scan rate. The scan rate can be set from .1 to 99.9°C/min. The maximum scan rate however is actually limited by the natural heating or cooling rate of the instrument. This is often less than 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 per minute.

Sr = 10.0 *Scan rate in °C/min*

Press "UP" or "DOWN" to change the scan rate.

Sr = 2.0 *New scan rate*

Press "SET" to accept the new scan rate and continue.

SET *Accept scan rate*

6.5 Set-point Resistance

To display the Set-point Resistance, press the "SET" and "DOWN" keys simultaneously when the temperature is displayed. When the "SET" and "DOWN" keys are released the temperature is again displayed. This value is used to calibrate the unit and is not adjustable.

6.6 Temperature Scale Units

To toggle between °C and °F, press the "SET" and "UP" keys simultaneously when the temperature is displayed.

6.7 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.

6.8 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 lets the user know how stable the well temperature is. With good control stability the percent heating power should not fluctuate more than ±1% within one minute.

The heater power display is accessed in the secondary menu. Press “SET” and “EXIT” simultaneously and release. The heater power is displayed 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 and hold the “EXIT” button. To continue on to the proportional band setting function press “SET”.

6.9 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 fairly 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 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 to about 25.0°C. The user may alter the proportional band width if he desires to optimize the control characteristics for a particular application. However, we recommend the proportional band be changed only by knowledgeable personnel.

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 can be 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 for secondary menu and then displays the proportional band setting*

4.1 *Proportional band setting*

To change the proportional band press "UP" or "DOWN".

10.0 *New proportional band setting*

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

Accept the new proportional band setting

6.10 Controller Configuration

The controller has a number of configuration and operating options and calibration parameters, which are programmable via the front panel. These are accessed from the secondary menu after the proportional band function by pressing "SET". Pressing "SET" again enters the first of three sets by configuration parameters – calibration parameters, operating parameters and serial interface parameters. The menus are selected using the "UP" and "DOWN" keys and then pressing "SET".

6.11 Operating Parameters

The operating parameters menu is indicated by,

PAr *Operating parameters menu*

The operating parameters menu contains the High Limit parameter. The High Limit parameter adjusts the upper set-point temperature. The factory default and maximum are set to 126 °C. For safety, a user can adjust the High Limit parameter down so the maximum temperature set-point is restricted.

Press "SET" to enable adjustment of the High Limit parameter.

HL *Flashes* HL *and then displays the setting*

H=126 *Current HL setting*

Adjust the HL parameter using "UP" or "DOWN".

H=90 *New High Limit setting*

Press "SET" to accept the new High Limit parameter.

6.12 Serial Interface Parameters

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

SErIAL *Serial RS-232 interface parameters menu*

Press "UP" 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.

6.12.1 Baud Rate

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

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

The baud rate of the serial communications may be programmed to 300, 600, 1200, 2400, 4800, or 9600 baud. Use “UP” or “DOWN” to change the baud rate value.

4800 b	*New baud rate*

Press “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.

6.12.2 Sample Period

The sample period is the next parameter in the serial interface parameter menu. 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 five seconds. The automatic sampling is disabled with a sample period of 0.

SPEr	*Flashes SPEr and then displays the setting*
SP= 1	*Current sample period (seconds)*

Adjust the value with “UP” or “DOWN” and then use “SET” to set the sample rate to the displayed value. Press “EXIT” to continue without changes.

SP= 60	*New sample period*

6.12.3 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 are 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*

Adjust the setting using “UP” or “DOWN” and pressing “SET”.

d=HALF	*New duplex mode setting*

6.12.4 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 LF and then displays the setting*
LF= On	*Current linefeed setting*

Adjust the setting using “UP” or “DOWN” and pressing “SET”.

LF=OFF	*New linefeed setting*

6.13 Calibration Parameters

The operator of the instrument controller has access to a number of the calibration constants namely 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 instrument. 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 instrument manual.

CAUTION: *DO NOT change the values of the instrument calibration constants from the factory set values. The correct setting of these parameters is important to the safety and proper operation of the instrument.*

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, 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 calibrator.

The name of the parameter flashes on the display and then the value is displayed. The value of the parameter may be changed using the “UP” and “DOWN” buttons. After the desired value is reached press “SET” to set the parameter to the new value. Pressing “EXIT” causes the parameter to be skipped ignoring any changes that may have been made.

6.13.1 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 instrument accuracy.

6.13.2 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 instrument accuracy.

6.13.3 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.

7 Digital Communications

The calibrator is capable of communicating with and being controlled by other equipment through the digital serial interface.

With a digital interface the instrument 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 on page .

7.1 Serial Communications

The calibrator is installed with an RS-232 serial interface that allows serial digital communications over fairly long distances. With the serial interface the user may access any of the functions, parameters and settings discussed in Section 8 with the exception of the baud rate setting.

7.2 Wiring

The serial communications cable attaches to the calibrator through the D-9 connector at the back of the instrument. Figure 5 shows the pin-out of this connector and suggested cable wiring. The serial cable should be shielded. If the unit is used in a heavy industrial setting the shielded cable must be limited to **one** meter.

7.2.1 Setup

Before operation the serial interface must first be set up by programming the baud rate and other configuration parameters. These parameters are programmed within the serial interface menu. The serial interface parameters menu is outlined in Figure on page .

To enter the serial parameter programming mode press “SET” and “EXIT” simultaneously to enter the secondary menu. Press “SET” repeatedly until the display reads PAr. Press “UP” until the serial interface menu is indicated with SERIAL. Finally press “SET” to enter the serial parameter menu. In the serial interface parameters menu are the baud rate, the sample rate, the duplex mode, and the linefeed parameter.

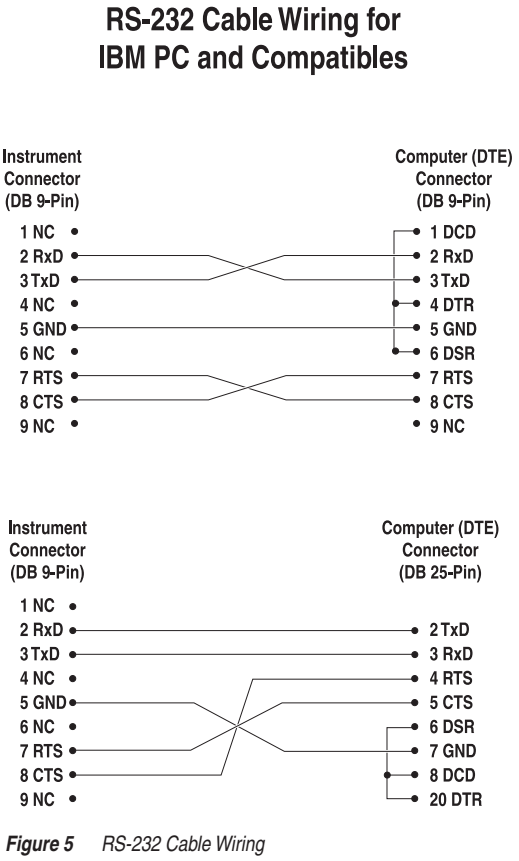

Figure 5 *RS-232 Cable Wiring*

7.2.1.1 Baud Rate

The baud rate is the first parameter in the menu. The display prompts with the baud rate parameter by showing "bAUd". Press "SET" to choose to set the baud rate. The current baud rate value is displayed. The baud rate may be programmed to 300, 600, 1200, 2400, 4800, or 9600 baud. The baud rate is pre-programmed to 1200 baud. Use "UP" or "DOWN" to change the baud rate value. Press "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.

7.2.1.2 Sample Period

The sample period is the next parameter in the menu and prompted with SPER. 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 five seconds. The automatic sampling is disabled with a sample period of 0. Press "SET" to choose to set the sample period. Adjust the period with "UP" or "DOWN" and then use "SET" to set the sample rate to the displayed value.

7.2.1.3 Duplex Mode

The next parameter is the duplex mode indicated with DUPL. The duplex mode may be set to half duplex (HALF) or full duplex (FULL). With full duplex any commands received by the thermometer via 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 default setting is full duplex. The mode may be changed using "UP" or "DOWN" and pressing "SET".

7.2.1.4 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, ASCII10) after transmission of any carriage-return. The default setting is with linefeed on. The mode may be changed using "UP" or "DOWN" and pressing "SET".

7.2.2 Serial Operation

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

7.3 Interface Commands

The various commands for accessing the calibrator functions via the digital interfaces are listed in this section (see Table 3). These commands are used with the RS-232 serial interface. The commands are terminated with a carriage-return character. The interface makes no distinction between upper and lower case letters, hence 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 display a parameter depending on whether or not a value

is sent with the command following a “=”. For example, “s=150.0” sets the set-point to 150.0 degrees.

In the following list of commands, 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 will simply be ignored. Backspace (BS, SCII 8) may be used to erase the previous character. A terminating CR is implied with all commands.

Table 3 *Serial Commands*

Command Description	Command Format	Command Example	Returned	Returned Example	Acceptable Values
Display Temperature					
Read current set-point	s[etpoint]	s	set: 999.9 {C or F}	set: 100.00 C	
Set current set-point to n	s[etpoint]=n	s=200.0			Instrument Range
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	scan: {ON or OFF}	scan: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: 1.0	
Configuration Menu					
Operating Parameters Menu					
Read high limit	hl	hl	hl:999	hl:126	
Set high limit	hl=n	hl=90			0–126
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			
Calibration 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			90 to 110
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 .005
Read DELTA calibration parameter	de[lta]	de	de:9.99999	de: 1.507	

8 Calibration Procedure

Sometimes the user may want to calibrate the instrument to improve the temperature set-point accuracy. Calibration is done by adjusting the controller probe calibration constants **R0, ALPHA, and DELTA** so that the temperature of the dry-well 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 dry-well. By using a good thermometer and following this procedure the dry-well can be calibrated to an accuracy of better than 0.8°C over its full range.

8.1 Calibration Points

In calibrating the instrument, **R0, ALPHA, and DELTA** are adjusted to minimize the set-point error at each of three different dry-well temperatures. Any three reasonably separated temperatures may be used for the calibration. Improved results can be obtained for shorter ranges when using temperatures that are just within the most useful operating range of the dry-well. The farther apart the calibration temperatures, the larger the calibrated temperature range is, but the calibration error is greater over the range. If, for instance, 150°C to 350°C is chosen as the calibration range then the calibrator may achieve an accuracy of say ±0.3°C over the range 150 to 350°C. Choosing a range of 200°C to 300°C may allow the calibrator to have a better accuracy of maybe ±0.2°C over the range 175 to 325°C but outside that range the accuracy may be only ±0.5°C.

8.2 Calibration Procedure

1. Choose three set points to use in the calibration of the R0, ALPHA, and DELTA parameters. These set points are generally 50.0°C, 250°C, and 500.0°C but other set points may be used if desired or necessary.
2. Set the calibrator to the low set-point. When the instrument reaches the set-point and the display is stable, wait 15 minutes or so and then take a reading from the thermometer. Sample the set-point resistance by holding down the SET key and pressing the DOWN key. Write these values down as T_1 and R_1 respectively.
3. Repeat step 2 for the other two set points recording them as T_2 and R_2 and T_3 and R_3 respectively.
4. Using the recorded data, calculate new values for the R0, ALPHA, and DELTA parameters using the following equations.

8.2.1 Compute DELTA

$$A = T_3 - T_2$$

$$B = T_2 - T_1$$

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

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

$$E = R_3 - R_2$$

$$F = R_2 - R_1$$

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

$\mathbf{T_{1\text{-}3}}$ - Measured temperature using a thermometer

$\mathbf{R_{1\text{-}3}}$ – Value of the set-point resistance from the display. (Press SET and DOWN at the same time.)

Where:

$\mathbf{T_1}$ and $\mathbf{R_1}$ are the measured temperature and resistance at 50.0°C

$\mathbf{T_2}$ and $\mathbf{R_2}$ are the measured temperature and resistance at 200.0°C

$\mathbf{T_3}$ and $\mathbf{R_3}$ are the measured temperature and resistance at 350.0°C

8.2.2 Compute R0 and ALPHA

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

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

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

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

Where:

delta is the new value of DELTA computed above

Program the new values for DELTA (delta), R0 (rzero) & ALPHA (alpha) into the instrument using the following steps.

1. Press the SET and EXIT keys at the same time and then press SET until R0 is displayed.
2. Press SET then use the UP or DOWN keys until the correct numerical setting is displayed. Press SET to accept the new value.
3. Repeat step 2 for ALPHA and DELTA.

8.2.3 Accuracy and Repeatability

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

9 Maintenance

- The calibration instrument has been designed with the utmost care. Ease of operation and simplicity of maintenance have been a central theme in the product development. Therefore, with proper care the instrument should require very little maintenance. Avoid operating the instrument in dirty or dusty environments.
- If the outside of the instrument becomes soiled, it may be wiped clean with a damp cloth and mild detergent. Do not use harsh chemicals on the surface, which may damage the paint.
- The calibrator should be handled with care. Avoid knocking or dropping the calibrator.
- If the mains supply cord becomes damaged, replace it with a cord with the appropriate gauge wire for the current of the instrument. If there are any questions, call an Authorized Hart Scientific Service Center (see Section) for more information.
- Before using any cleaning or decontamination method except those recommended by Hart, users should check with an Authorized Hart Scientific Service Center (see Section) to be sure that the proposed method will not damage the equipment.
- If the instrument is used in a manner not in accordance with the equipment design, the operation of the instrument may be impaired or safety hazards may arise.

10 Troubleshooting

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

10.1 Troubleshooting Problems, Possible Causes, and Solutions

In the event that the instrument 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 this section carefully and attempt to understand and solve the problem. If the problem cannot otherwise be solved, contact an Authorized Service Center (see Section 1.4). Be sure to have the model number, serial number, and voltage of your instrument available.

Table 4 *Troubleshooting Problems*

Problem	Possible Causes and Solutions
Incorrect temperature reading	**Incorrect R0, ALPHA, and DELTA parameters.** Find the values for R0, ALPHA, and DELTA on the Report of Calibration that was shipped with the instrument (or from subsequent calibrations of the instrument). Reprogram the parameters into the 9132 memory (see Section 6.13, Calibration Parameters). Allow the instrument 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 the SET and EXIT buttons down at the same time while powering up the instrument. After the instrument displays -init-, release the buttons. The display shows -init-, then displays 9132, and then displays the firmware version. After performing the master reset sequence, all of the configuration parameters are reset to their default values. Reprogram the R0, ALPHA, and DELTA parameters into the 9132 memory (see Section 6.13, Calibration Parameters) and any other applicable configuration parameters. Allow the instrument to stabilize and verify the accuracy of the temperature reading.
Blank display after mains power applied	**Blown fuse.** A fuse may have blown due to a power surge or failure of a component. Replace the fuse once. If the fuse blows a second time, it is likely caused by the failure of a component. Always replace the fuse with one of the same rating, voltage, and type. Never replace the fuse with one of a higher current rating.
The Instrument 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).
The display shows any of the following: Err 1, Err 2, Err 3, Err 4, Err 5, Err 6, or Err 7	**Controller problem.** The error messages signify the following 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 describe above.
Temperature cannot be set above a certain point	**Incorrect High Limit parameter.** The High Limit parameter may be set below 500°C. Check this value as described in Section 6.11, Operating Parameters.

10.2 Comments

11.2.1

10.2.1 EMC Directive

Hart Scientifics' equipment has been tested to meet the European Electromagnetic Compatibility Directive (EMC Directive, 89/336/EEC). The Declaration of Conformity for your instrument lists the specific standards to which the unit was tested.

11.2.2

10.2.2 Low Voltage Directive (Safety)

In order to comply with the European Low Voltage Directive (73/23/EEC), Hart Scientific equipment has been designed to meet the IEC 1010-1 (EN 61010-1) and the IEC 1010-2-010 (EN 61010-2-010) standards.