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FLUKE®

Calibration

9118A

Calibration Furnace

Users Manual

September 2012

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LIMITED WARRANTY AND LIMITATION OF LIABILITY

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Introduction

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury, read all safety information before you use the Product.

The Product is used to calibrate Platinum Resistance Thermometers (PRTs), fiber optic sensors, and thermocouples to a maximum temperature of 1200 °C.

How to Contact Fluke

To contact Fluke Calibration, call one of these telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

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

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

Safety Information

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

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury:

- **Read all safety information before you use the Product.**
- **Carefully read all instructions.**

- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Do not use the Product around explosive gas, vapor, or in damp or wet environments.
- Use this Product indoors only.
- Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.
- Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.
- Connect one end of the supplied ground wire to the protective earth ground terminal on the rear panel and the other end to an earth ground.
- Make sure the ground conductor in the mains power cord is connected to a protective earth ground. Disruption of the protective earth could put voltage on the chassis that could cause death.
- Do not put the Product where access to the mains power cord is blocked.
- Make sure that the Product is grounded before use.
- Do not use an extension cord or adapter plug.
- Do not use and disable the Product if it is damaged.
- Make sure the power cord does not touch with hot parts of the Product.
- Do not use the Product if it operates incorrectly.
- Make sure that the space around the Product meets minimum requirements.
- Do not keep the Product in operation and unattended at high temperatures.
- Use caution when you install and remove probes and inserts from the Product. They can be hot.
- Do not put the Product on a flammable surface and keep a fire extinguisher nearby.
- Do not set anything on top of the Product. Very high temperatures can cause the ignition of flammable materials.

- **Applicable personal protective equipment must be worn when you move hot temperature probes or do work near the furnace apertures.**
- **Do not use the Product for applications other than calibration work.**
- **The Product must only be used by approved personnel.**
- **Do not touch surfaces near the well access port. They can be very hot.**
- **Do not touch the insulation material in the Product. The insulation material can cause mild mechanical irritation with skin, eyes, and upper respiratory system. If it gets on your skin, flush area and wash gently. Do not rub or scratch exposed skin. If it gets into your eyes, flush abundantly with water. Do not rub eyes. If the nose and throat become irritated, move to a dust-free area and blow nose. If symptoms continue, get medical advice.**
- **Do not put the Product in a corner or cause a blockage behind the Product.**
- **Do not use fluids to clean out the well. Fluids in the Product can cause damage.**
- **Do not put unwanted material into the probe protection tube or hole of the insert. Fluids in the Product can cause damage.**
- **Only change calibration constant values from the factory set values when you calibrate the Product. These values are important in the safe operation of the Product.**
- **Read and understand the operation before you turn on the Product.**
- **Do not operate the Product in wet, oily, dusty, or dirty environments.**
- **Make sure the probe handle temperature does not go above its limit.**

⚠ Caution

To prevent damage to the Product:

- **Operate the Product at room temperature. See specifications.**
- **Make sure there is a minimum of 45 cm clearance around the Product.**

- **Be careful with thermometer probes. Do not drop, stress, or let them become too hot.**
- **Do not operate the Product without the control probes correctly connected and put into the furnace. The furnace does not operate correctly without the control probes.**
- **Make sure the main probe and zone probe are connected to the correct connector.**
- **Turn off the furnace when a mains supply power fluctuation occurs. Turn on the furnace only when the mains power is stable.**
- **Make sure that all reference sensors used with the furnace are specified for the temperature range of the furnace.**
- **Do not disconnect the Product from the mains while the furnace temperature is above 80 °C.**

The symbols on the Product and in this manual are shown in Table 1.

Table 1. Symbols

Symbol	Description	Symbol	Description
	Risk of Danger, Important information. See Manual.		Hazardous Voltage
	Caution. Hot surface.		Protective Earth Ground
	USB connection		Conforms to European Union directives
	Conforms to relevant North American Safety Standards		Conforms to relevant Australian EMC requirements
	This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product. Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.		

Installation

Unpack and Inspection

Carefully unpack the Product and check for all parts. If there is damage, tell the shipper immediately and make a claim. The parts included are:

- 9118A Calibration Furnace
- Type-S Thermocouples (2 each)
- Protection Tubes (2 each)
- TC Support Bracket
- Getting Started Manual
- Users Manual CD-ROM
- Ground Wire
- Serial Cable
- USB Cable

Placement

For best results, choose a location to setup the Product where room temperature changes are minimum. To safely remove heat, put the Product in a position with a minimum of 45 cm of free air space around it.

Dry-Out Period

Before initial use, after transport, or the Product has not been energized for more than 10 days, turn on the Product for a minimum of 2 hours.

If the Product is wet or was in a wet environment, remove moisture before you turn on the Product.

How to Move the Product

Warning

To prevent personal injury, use proper techniques to lift the Product.

When you lift the Product, bend your knees and lift with your legs. Before you move the Product, let it cool to ambient temperatures and remove the control and cutout thermocouples and all objects in the furnace well. To safely move the Product, two people are necessary. Put one person in the front and one person at the rear of the Product. Carefully put your hands under the Product and lift in unison.

Product Components

As shown in Figure 1, the two primary components of the Product are the furnace and the controller.

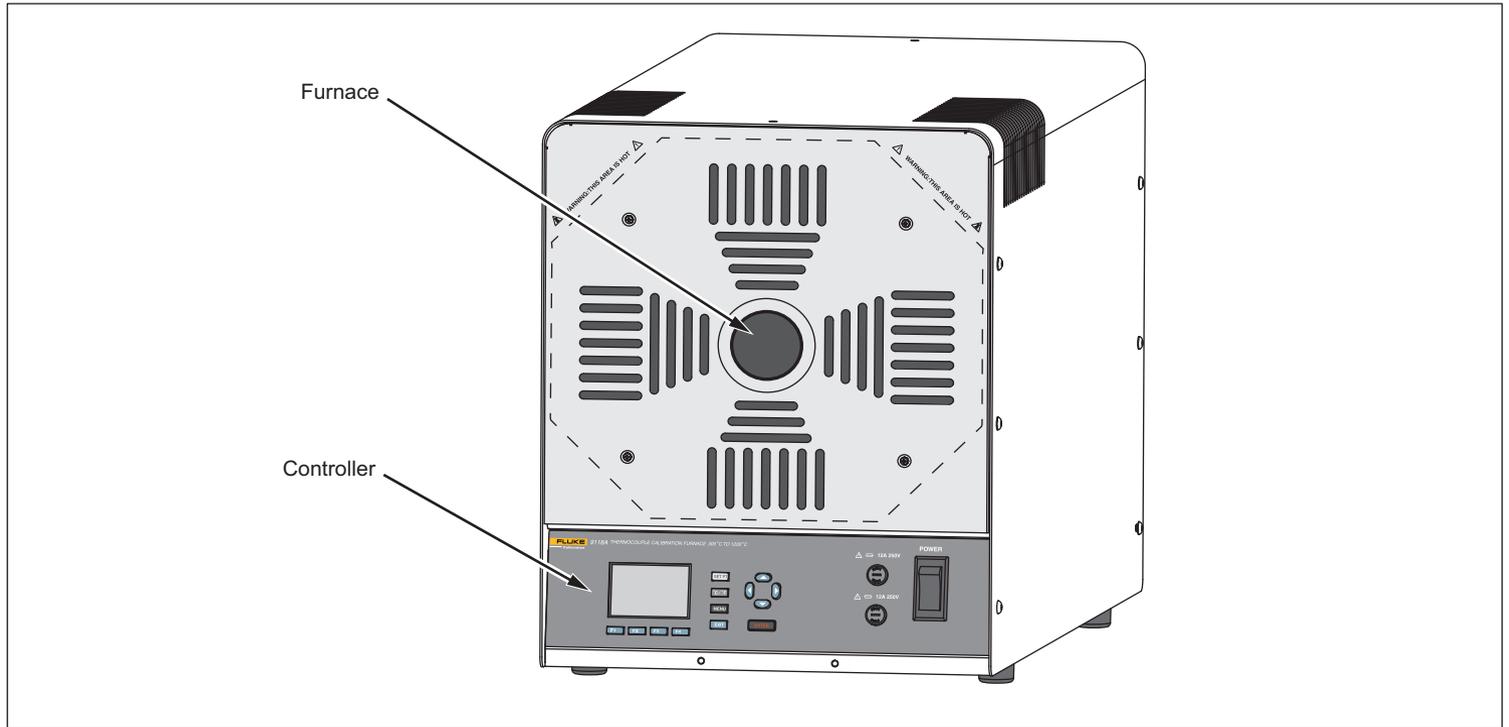


Figure 1. 9118A Calibration Furnace

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Front-Panel Controls

Figure 2 shows the front-panel controls of the Product and Table 2 is a list of control descriptions.

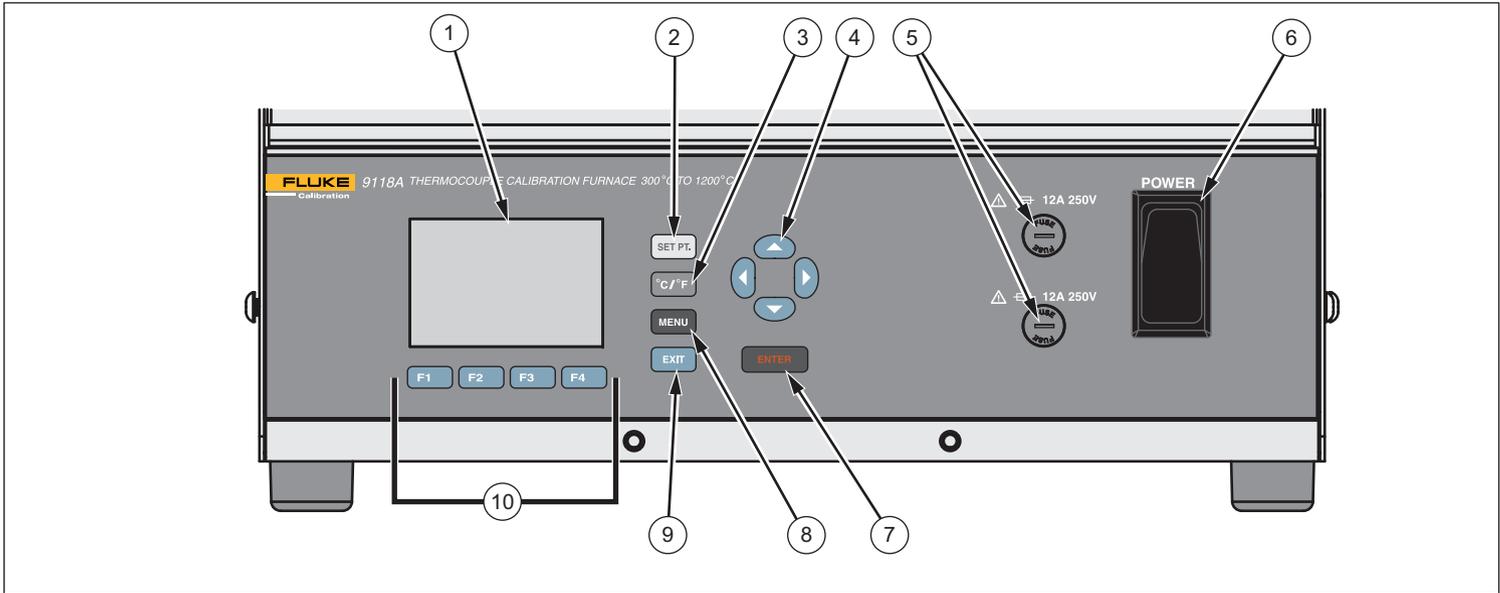


Figure 2. Front-Panel Controls

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Table 2. Front-Panel Controls

Item	Description	Item	Description
①	LCD Display	⑥	Mains power switch
③	Set a temperature setpoint into the Product.	⑦	Used to set a value into the Product and choose a menu.
③	Sets the Product to show temperatures in Celsius or Fahrenheit.	⑧	Menu button shows the main menu in the display.
④	Moves through menus and adjusts numbers.	⑨	Exits the menu shown in the display and moves to the previous menu.
⑤	Furnace fuses	⑩	Softkeys (F1 through F4) are used to select the function that shows in the display above the softkey.

Rear-Panel Connections

Figure 3 shows the rear-panel connections of the Product and Table 3 is a list of connector descriptions.

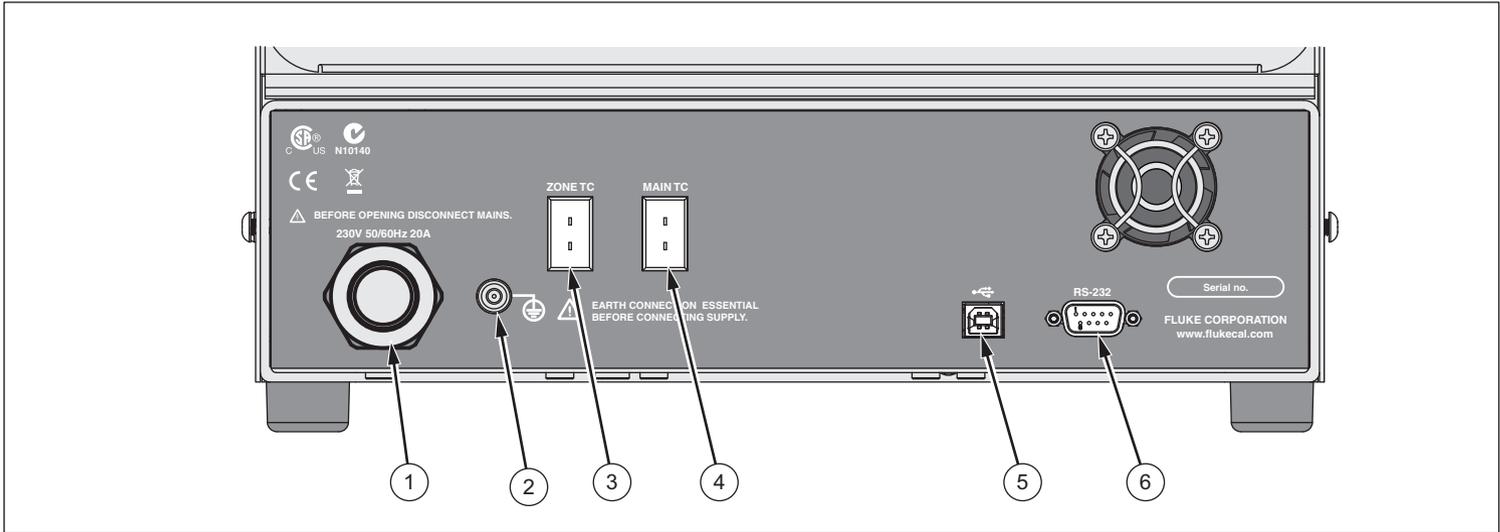


Figure 3. Rear-Panel Connections

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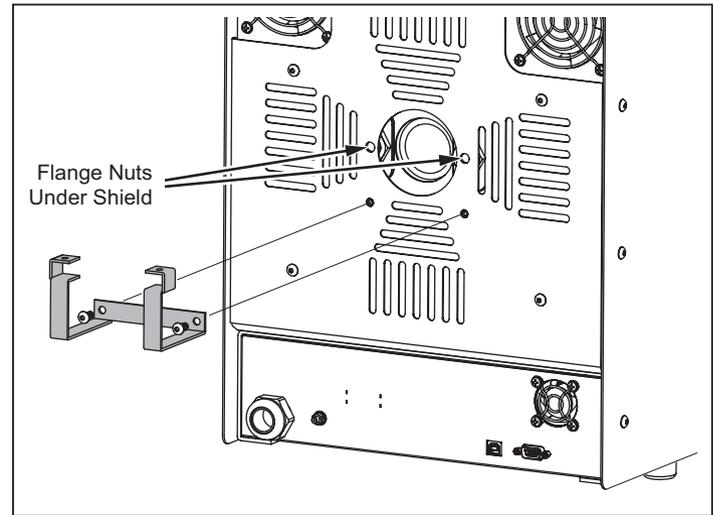
Table 3. Rear-Panel Connections

Item	Description	Item	Description
①	Mains power cord	④	Main thermocouple input jack
②	Protective Earth Terminal	⑤	USB connector
③	Zone thermocouple input jack	⑥	RS-232 connector

Protection Tube and Support Bracket Installation

To install the two protection tubes and thermocouple (TC) support bracket:

1. Remove five socket-head screws that hold the rear shield in position.
2. Put the long protection tube into the flange nut for the main control thermocouple.
3. Put the short protection tube into the flange nut for the zone control thermocouple.
4. Attach the rear shield with the five socket-head screws removed in step 1.
5. Attach the TC support bracket to the rear of the Product with the two socket-head screws supplied. See Figure 4.



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Figure 4. Thermocouple Support Bracket Installation

Probe Installation

Note

When you put the temperature control probes into their applicable guide tube, make sure the end surface of the probe handle is aligned with the edge of the TC support bracket.

Two thermocouples are used as temperature control probes. These probes are put into the rear of the furnace and held in position with the TC support bracket.

To install the control probes:

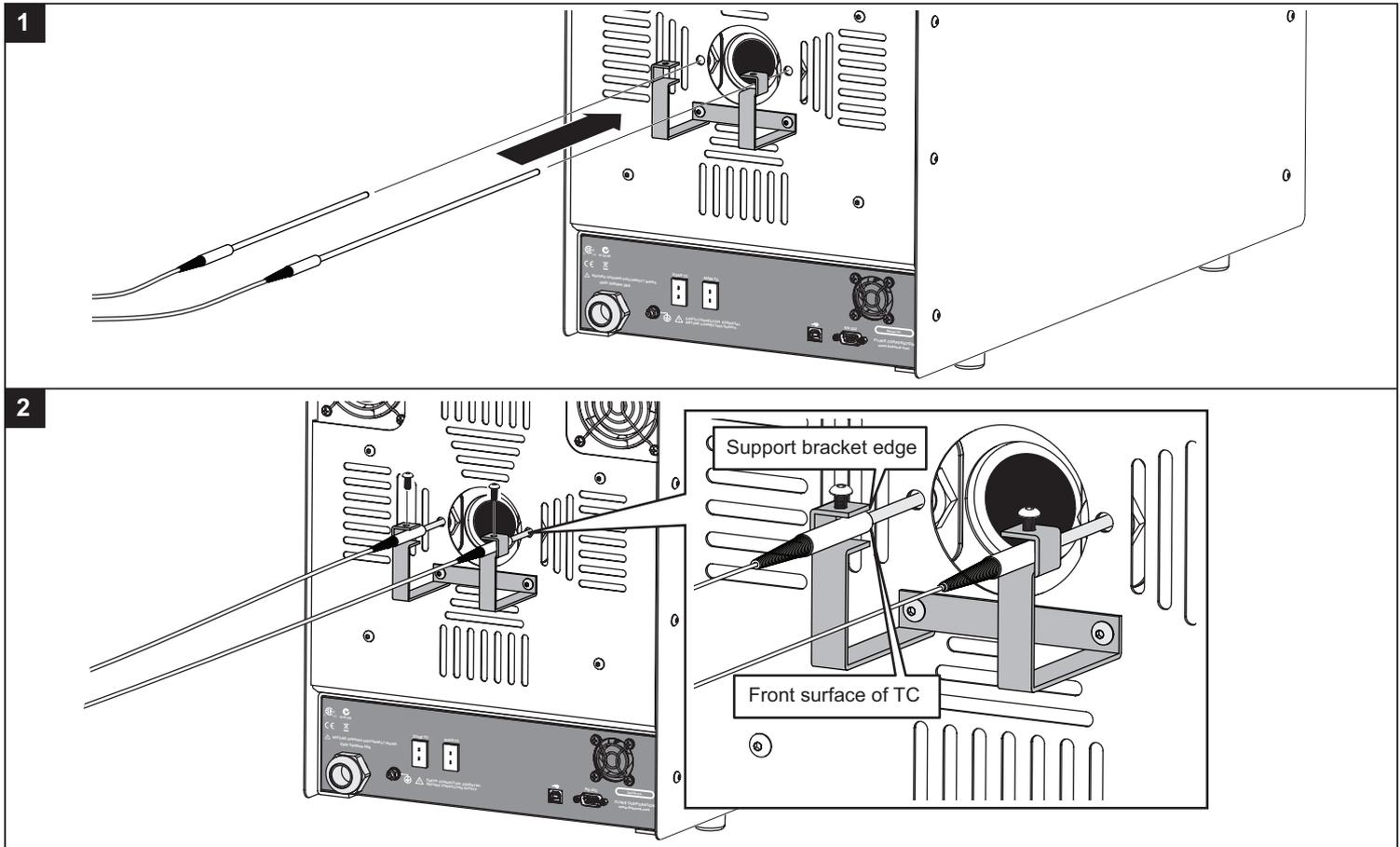
1. Put the long probe into the **MAIN TC** tube on the rear panel of the furnace.
2. Align the end surface of the thermocouple handle with the front edge of the bracket. See Figure 5.
3. Tighten the bracket screw to hold the thermocouple in position.
4. Connect the cable of the long probe to the **MAIN TC** connector on the rear panel.

Caution

To prevent damage to the thermocouple, do not tighten the screw too much.

5. Put the short probe into the **ZONE TC** tube on the rear panel of the furnace.
6. Align the end surface of the thermocouple handle with the front edge of the bracket. See Figure 5.

7. Tighten the bracket screw to hold the thermocouple in position.
8. Connect the cable of the short probe to the **ZONE TC** connector on the rear panel.



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Figure 5. Control Thermocouple Insertion

Connect to Mains Power

⚠⚠ Warning

For safe operation and maintenance of the product, remove moisture from the Product before you connect to mains power. Fluke Calibration recommends the Product be put in a low humidity temperature chamber at 50 °C for 4 hours or more.

Connect the supplied ground wire between the protective earth terminal on the rear panel and earth ground. Use the 2.5 meter power cord to connect the Product to a 230 V ac outlet rated for 20 amps.

How to Turn on the Product

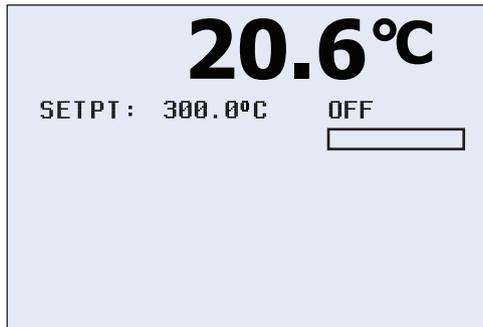
Push the “I” side of the power switch, on the front panel of the Product. The screen shown in Figure 6 shows in the display while the Product does a self test.



qrs001.bmp

Figure 6. Power-Up Screen

When the self test is complete and no errors are sensed, the screen shown in Figure 7 shows in the display. The Product is in a standby mode. You must set a setpoint temperature to start control of the furnace. See the “Adjust Furnace Temperature” section to learn how to start the temperature control of the furnace.



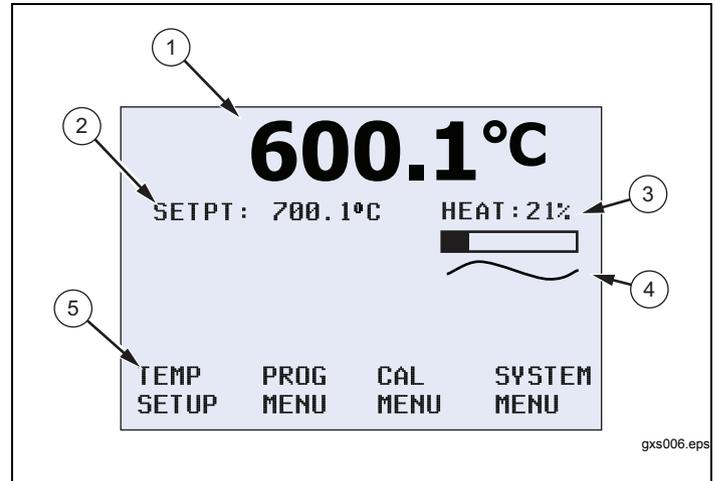
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Figure 7. Main Screen

Display

Table 4 is a list of display elements with descriptions.

Table 4. Display Elements



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Item	Description
①	Furnace temperature
②	Setpoint temperature
③	Heat/Cool Status
④	Stability Indicator ( = stable,  = unstable)
⑤	Softkey functions

Setup

Set the Language

Text in the LCD display can be set to show in a different language. To set the language:

1. Push **MENU**.
2. Push the softkey below **System Menu**.
3. Push the softkey below **Display Menu**.
4. Push **◀** or **▶** to scroll through the languages.
5. When your language is shown in the display, push **ENTER**.

To toggle between the set language and English, push **F1** and **F2** at the same time.

Set Display Contrast

With the main screen shown in the display, push **☰** to decrease display contrast. Push **☷** to increase display contrast.

Operation

Warning

For safe operation and maintenance of the product:

- **Energize the Product for a 2 hour dry-out period before use, if the Product was:**
 - **In transport**

- **In a humid or semi-humid storage environment**
- **Not energized for more than 10 days**
- **Remove moisture from the Product before you connect to mains power. Fluke Calibration recommends the Product be put in a low humidity temperature chamber at 50 °C for 4 hours or more. While the Product dries, do not assume the Product complies with all safety standards.**
- **Put temperature probes you remove from the Product on a heat resistant rack or surface until they are safe to touch.**
- **Keep a minimum of 45 cm clearance from the front, left, and right sides. Keep 150 cm from the top of the Product.**

The front-panel controls let you set the parameters of the Product and monitor its performance. You can also set the parameters of the communication interface. Four softkeys are used to navigate through the menus of the Product. The menus let you setup the Product and change system parameters as necessary.

How to Set Parameters in the Product

There are two methods to set a parameter in the Product. You can set a parameter from a list of values or in the case of numerical values, set a parameter with the cursor keys.

Value List

An example where you select from a list of values is the preset selection.

1. From the main screen, push **SET PT.**
2. Push the softkey below **SELECT PRESET** in the display.

As shown in Figure 8, the number 1 is highlighted to the right of **PRESET:**.

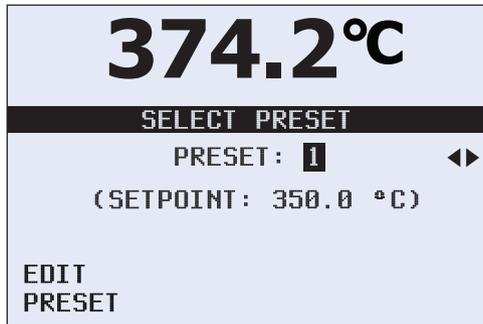


Figure 8. Preset Selection

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3. To change the preset number, push **▲** and **▼** to scroll through the preset numbers.

4. Push **ENTER** when the correct preset number is shown in the display.

This is the selection method for value lists.

Set Number Value

An example where you set a number is where you set the setpoint temperature.

1. From the main screen, push **SET PT.**
2. Push **ENTER**.

As shown in Figure 9, the left most digit in the **SETPOINT** temperature is highlighted.

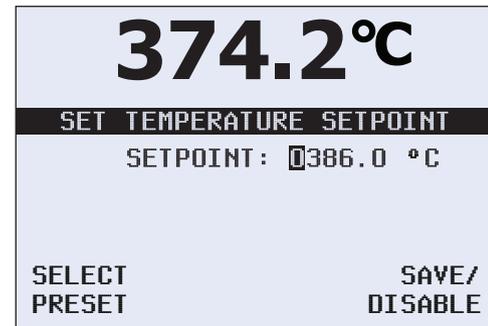


Figure 9. SETPOINT Temperature

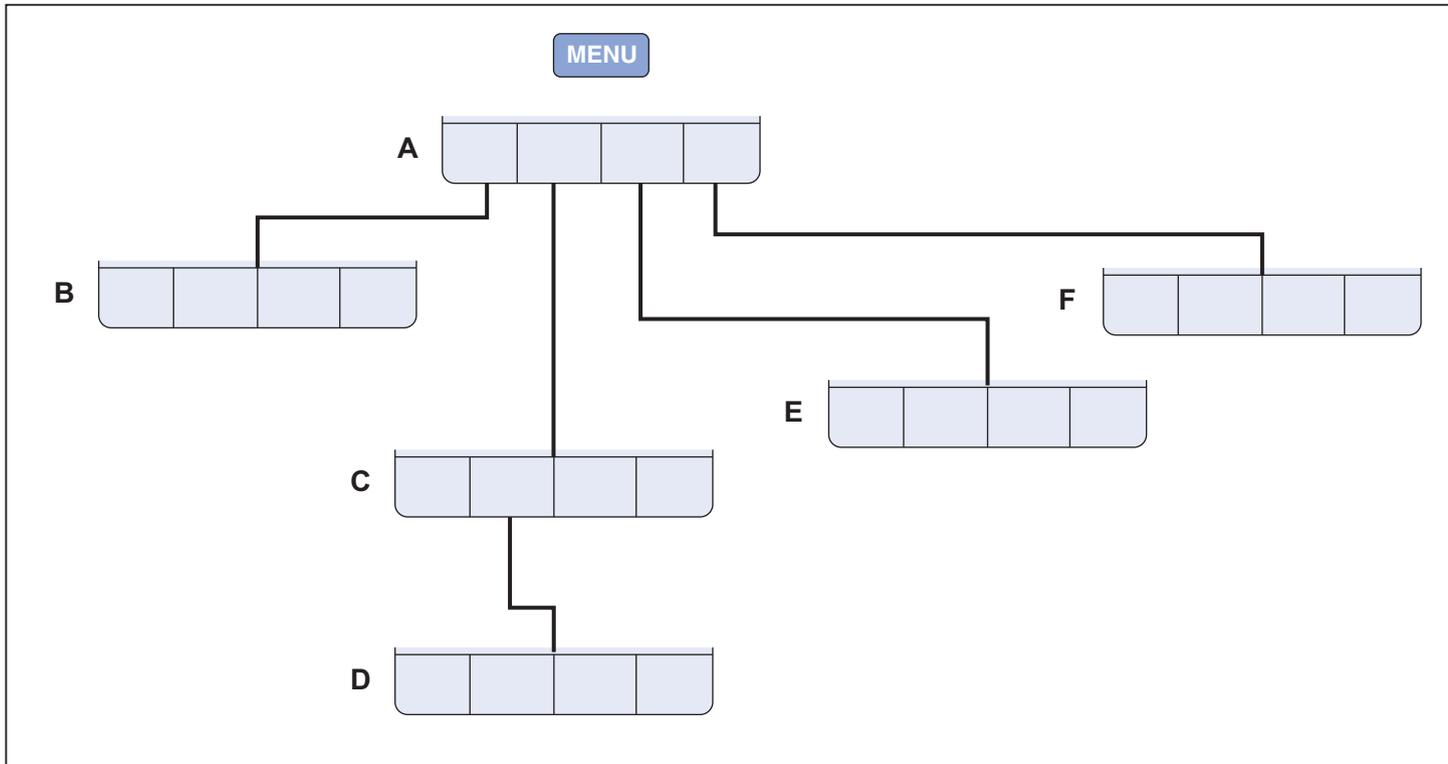
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3. Push  or  to increase or decrease the highlighted digit.
4. Push  to move the highlight to the next digit.
5. Do steps 3 and 4 again for each digit in the number.
6. After all digits are set, push **ENTER**.

Softkey Menus

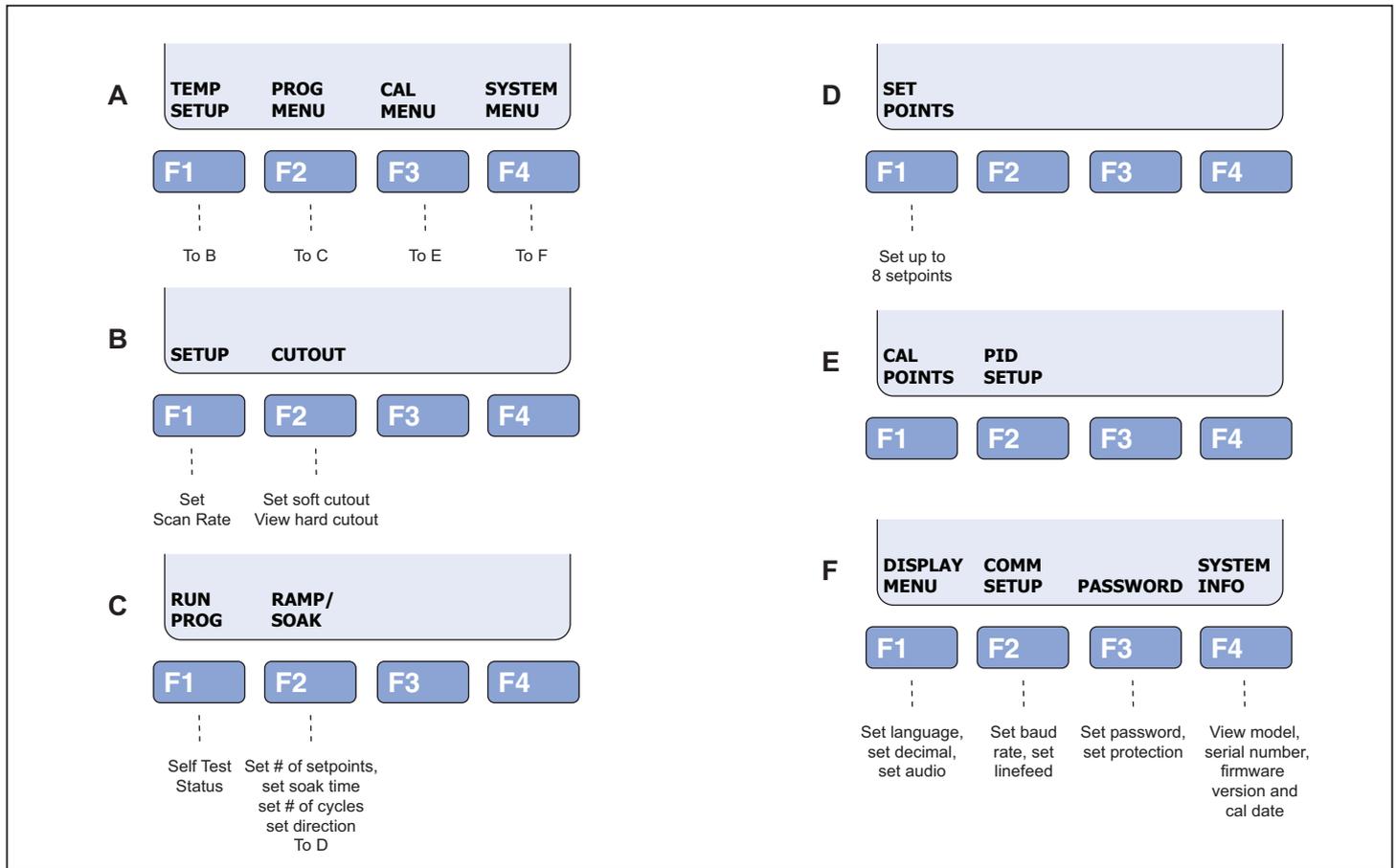
The softkeys are identified in Table 2. The softkeys are used with the front-panel **MENU** key. The functions of the four softkeys are identified by label information shown directly above each key.

A group of softkey labels is a menu. A group of connected menus makes a menu tree. Figure 10 shows the menu-tree structure for the Product. Figure 11 shows each menu in the menu tree.



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Figure 10. Softkey Menu Tree



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Figure 11. Menu Softkey Displays

Temperature (TEMP) Setup Menu

Push the softkey under **TEMP SETUP** to set the scan rate and cutout parameters.

Scan Rate

The **SCAN RATE** parameter sets the rate at which the Product increases or decreases the temperature to a new setpoint. The scan rate can be set between 0.1 °C to 80.0 °C/minute.

Note

The maximum scan rate is the natural rate the Product heats and cools. This is less than the maximum scan rate parameter value.

Cutout

In the cutout menu, there are two parameters: soft and hard cutout. The Product has an adjustable cutout device that turns off power to the heat source if the temperature is higher than a set value.

Use the soft cutout parameter to cut out at the high temperature limit of the probes under calibration. Fluke Calibration recommends you set the cutout 5 °C to 10 °C below the high temperature limit of the probe under test.

When the cutout opens, the Product shows **CUTOUT** in the display, turns off power to the heater, and sets the Product to cool. The Product stays in the cutout condition until the temperature drops below the cutout temperature and the Product is reset by the operator.

To reset the Product after the temperature drops below the cutout value:

1. Push **SET PT.**.
2. Push **ENTER**. If it is necessary to change the setpoint temperature, use the cursor buttons to change the value.
3. Push **ENTER** again.

The **HARD CUTOUT** parameter is set at the factory and is not user settable. This menu selection only lets you see the cutout value.

Program (PROG) Menu

Push the softkey under **PROG** to show the **RAMP/SOAK** and **RUN PROG** menus.

RAMP/SOAK Menu

The RAMP/SOAK feature lets the user program setpoint temperatures and set the time the Product holds the temperature at each setpoint. The Product automatically heats or cools to the programmed setpoint and holds that temperature for the specified time.

The **NO. SETPOINTS** parameter is used to set the number of different temperatures the ramp/soak function will use in the program. You can set a maximum of eight temperature setpoints.

The **SOAK TIME** parameter is used to set the number of minutes each setpoint temperature is held before it changes to the subsequent setpoint. Soak time starts when the temperature is stable.

The **NO. CYCLES** parameter is used to set how many times the setpoint sequence is to be done again.

The **DIRECTION** parameter is used to set how the setpoints sequence before the sequence is done again. When set to →, the Product does the setpoints in one direction from 1 to 8. If set to ↻, it does the setpoints from 1 to 8 and then back to 1 before the sequence is done again.

RUN PROG Function

Use the RUN PROG function to start and stop the test set up through the RAMP/SOAK menu. With the TEST STATUS parameter highlighted, push **Q** or **D** to change the test status and push **ENTER**. When set to RUN, the furnace uses the values set through the RAMP/SOAK menu to control the furnace. When the furnace does all the values in the RAMP/SOAK parameters, the status changes to OFF. To stop a test, set the parameter to OFF.

Calibration (CALIB) Menu

Note

Calibration parameters must be correct for the Product to operate correctly.

The **CALIB** menu lets you get access to the calibration points constants and the controller parameters.

Calibration (CAL) Points Menu

When you push the **CAL POINTS** softkey, the product prompts you for a numeric password. You must know the password before you can change a calibration point.

There are 12 calibration points: Zone 1 (300), Skew 1 (300), Temp 1 (300), Zone 2 (700), Skew 2 (700), Temp 2 (700), Zone 3 (1000), Skew 3 (1000), Temp 3 (1000), Zone 4 (1200), Skew 4 (1200), and Temp 4 (1200).

The TEMP parameter adjusts the actual temperature at the midpoint location for the applicable set-point temperature, but does not change the temperature gradient. The ZONE parameter increases or decreases the temperatures in the outer areas of the access tube for an applicable setpoint temperature. The curvature of the temperature profile is adjusted, and does not have an effect on the temperature at the midpoint location or the slope of the temperature profile at the midpoint location. The SKEW parameter adjusts the slope of the temperature profile at the midpoint location for the applicable setpoint temperature. This increases the temperature of one end of the access tube and decreases the temperature of the opposite end.

PID Setup Menu

The **PID SETUP** menu is used to set controller parameters.

The **TEMP PB** parameter is the main proportional band and the gain that the proportional-integral-derivative (PID) controller uses for control.

The **TEMP INT** parameter lets you set the time the controller uses for control. The time is in seconds.

The **TEMP DER** parameter lets you set the derivative time the controller uses for control. The time is in seconds.

System Menu

The **SYSTEM** menu lets you get access to the display menu to set the language, set the type of decimal character, and turn off and turn on key audio. The communication setup parameters, password, and system information are also available through this menu.

Display (DISP) Menu

The **LANGUAGE** parameter is used to set the language used in the display.

The **DECIMAL** parameter is used to set the decimal character to a period or a comma.

The **KEY AUDIO** parameter is used to turn off and turn on the audio feedback when a key is pushed.

Communications (COMM) Setup Menu

The **BAUD RATE** parameter lets you set the baud rate for the RS-232 communications port.

The **LINEFEED** parameter turns on and turns off the line feed character sent across the RS-232 communications port.

Password Setup Menu

The **PASSWORD** menu lets you set the user password and set the level of protection for specified parameters. A password is necessary to access the password menu.

The **USER PASSWORD** parameter is used to set the password for the system that is used to access some menus. The password is a four-digit number where each digit is a number from 1 to 9. The default password is "1234".

The **PROTECTION** parameter sets the level of password protection in the Product. If set to HIGH, then a password is necessary to access the Cutout menu, Ramp/Soak menu, CALIB (Calibration) menu, and PROG menu. When set to LOW, only CALIB and PROG menus are password protected.

System Information (INFO) Menu

The **SYSTEM INFO** menu is a view only menu. This menu shows the Product model number, serial number, firmware version, and the calibration date.

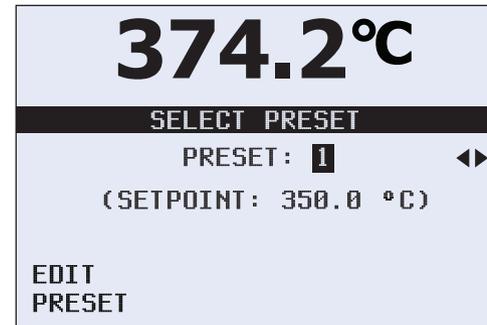
Adjust Furnace Temperature

There are two methods to adjust the furnace temperature. You can recall a preset temperature or set a temperature setpoint manually. The term “setpoint” refers to the temperature the furnace goes to and holds.

Set the Furnace Temperature with a Preset

The Product stores eight preset setpoint temperatures. You can set each preset setpoint as necessary. To set the setpoint to a preset temperature:

1. Push **SET PT**.
2. Push the softkey below **SELECT PRESET**.
3. Push **◀** or **▶** to move between presets (1 through 8). In Figure 12, the temperature of the preset is shown in the display.



gxs111.eps

Figure 12. Preset Selection

4. With a preset number highlighted, push **ENTER**.

Note

*If the Product is in standby mode, you must push **ENTER** again to start the furnace.*

Set the Furnace Temperature Manually

To adjust the furnace temperature manually:

1. Push **SET PT.**.
2. Push **ENTER**.
3. Push **▲** to increase the temperature or push **▼** to decrease the setpoint temperature.

Note

When you push the up or down key momentarily, the setpoint temperature moves by one step. Push and hold the key and the setpoint temperature increases or decreases until the key is released.

4. Push **ENTER** to save the setpoint temperature and start the furnace.

Note

After a maximum of 5 seconds, the furnace starts to heat or cool to the setpoint temperature.

The actual temperature is the measured temperature in the furnace and lags the setpoint temperature. The lag interval is the time necessary to increase or decrease the temperature of the center of the furnace.

How to Stop the Furnace Heat Cycle

To stop the furnace heat cycle:

1. With the main screen in the display, push **SET PT.**.
2. Push the softkey below **SAVE/DISABLE**.

The heat or cool procedure stops and the Product is set to standby mode.

Change a Preset Temperature

You can set the temperature of the eight presets. To change a preset temperature:

1. Push **SET PT.**.
2. Push the softkey below **SELECT PRESET**.
3. Push **▲** or **▼** to scroll to the preset to change.
4. Push the softkey below **EDIT PRESET**. As shown in Figure 13, the temperature of the selected preset is highlighted in the display.

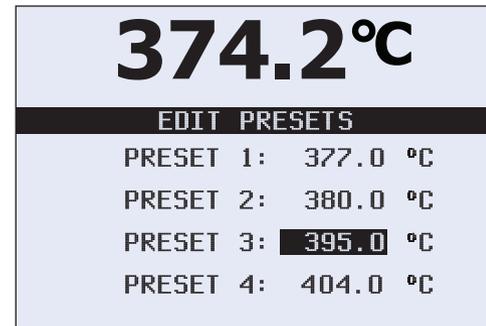


Figure 13. Change Preset Temperature

gxs112.eps

5. Push **ENTER**.
6. The highlight moves to the most significant digit of the temperature.
7. Push **▲** or **▼** to change the digit.
8. Push **▶** to move the highlight to the next digit.
9. Do steps 7 and 8 again until all digits are set.
10. Push **ENTER** to set the preset value.

Note

*If the preset you edited is not number 8, then the highlight moves to the subsequent preset. You can push **ENTER** to edit that preset. If the edited preset is number 8, then the screen goes back to the select preset screen.*

Probe Insertion

Caution

To prevent possible damage to probes, make sure all probes put into the furnace are rated for the temperature range used in the calibration procedure.

Note

Fluke Calibration recommends you use a metal and/or ceramic fiber surface or container to set hot probes on.

For the best stable temperature and minimum gradient, put sample probes into the full depth of the well. Variations in

equipment, probe dimension, and configuration can have an effect on temperature stability and gradients.

Note

A solid (unstirred) mass, as in a furnace, can have heat loss through the probe stem. The loss changes between probes and temperatures.

Cutouts

The Product has five cutout functions: soft cutout, hard cutout, chassis thermostat cutout, TC and heater cutout, and fan fault cutout. Only the soft cutout can be set through the user interface.

Soft Cutout

The soft cutout prevents damage to the Product and temperature probes. Use the soft cutout to turn off power to the furnace so the probes do not become too hot.

The temperature at which the soft cutout turns off power to the furnace can be set through the user interface. See the Temperature Setup Menu section to learn how to set the soft cutout temperature. Set the cutout temperature to ± 10 °C of the temperature limit of the equipment under calibration.

When the soft cutout turns off power to the furnace, **CUTOUT** shows in the display. The Product stays in this condition until the temperature of the furnace goes below the cutout temperature and the setpoint is set again.

Hard Cutout

The Hard Cutout disables the heaters if the control thermocouples sense that the furnace temperature is above a factory-set limit. It also cuts out if a control thermocouple is open-circuit or disconnected.

The hard cutout temperature is set at the factory and can be seen through the user interface. This is not a user-accessible parameter. When the hard cutout turns off power to the furnace, the temperature must decrease a few degrees below the hard cutout temperature to reset.

Chassis Thermostat Cutout

The Chassis Thermostat Cutout turns off power if the chassis temperature is too hot. The power stays off until the temperature of the chassis decreases a few degrees below the cutout temperature. This is not a user-accessible adjustment.

Fan Fault Cutout

The Fan Fault Cutout turns off power to the furnace when a fan fails. The furnace stays off until the fan is repaired.

TC or Heater Fault Cutout

The TC Fault Cutout turns off power to the furnace when the product senses there is a problem with a control probe or a heater. This protects the Product when a control probe comes out of its socket or a wire in one of the

probes opens. This cutout also turns off the furnace if it is in the heat mode and the temperature of the furnace does not increase. When this cutout turns off furnace power, **TC OR HEATER FAULT!** shows in the display. The probe or heater must be repaired or replaced to reset this cutout.

Remote Operation

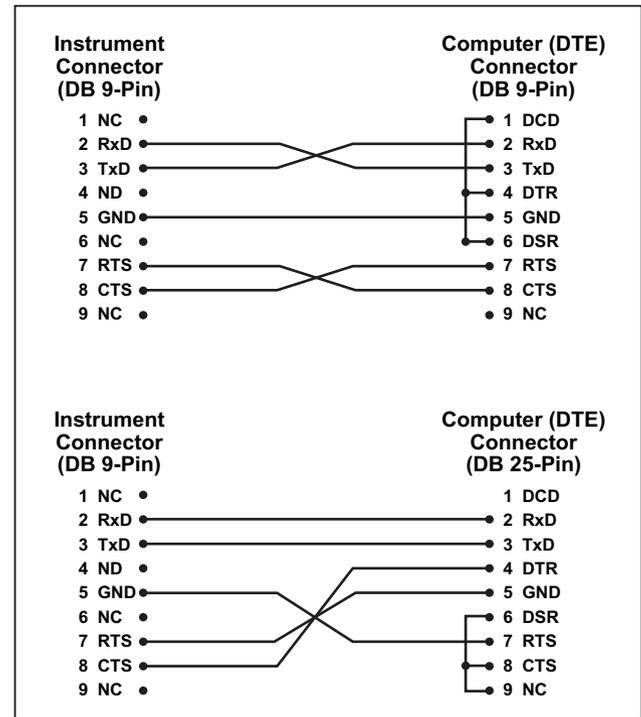
Remote operation of the Product from a PC or computer is done with commands through the remote interface. The command set will let you set setpoint temperatures, monitor furnace temperature, get measurement data, and control furnace operation. This section contains the procedures to set up, configure, and operate the Product through the remote interface.

The Product is controlled with Standard Commands and Programmable Instruments (SCPI) commands. The SCPI command set and how the Product implements those commands is included in the SCPI Commands section of this manual.

Digital Communication Interface

There is an RS-232C and USB interface on the rear panel of the Product. See Table 3. To prevent noise on the signal wires, use a shielded low-resistance cable between the Product and PC.

Figure 14 shows the cable connections that connects the PC to the Product. The connections shown in the figure are for a DB 9-pin connector and DB 25-pin connector on the PC.



gxs005.eps

Figure 14. RS-232 Cable Connections

To use the USB interface for remote operation, you must install a driver on the PC. The driver is found on the 9118A CD-ROM.

To get an up-to-date USB driver, go to <http://www.ftdichip.com/Drivers/VCP.thm>.

How to Configure the Digital Interface

To control the Product with a PC, you must set the parameters of the digital interface in the Product. To set the interface parameters:

1. Push **MENU**.
2. Push the softkey below **SYSTEM MENU**.
3. Push the softkey below **COMM SETUP**.
4. Set the RS-232 parameters to the values as the parameter values for the PC interface.

Input Terminators

An input terminator is a character sent by the PC that identifies the end of a string. When the Product receives an input terminator, it does the command preceding the terminator character.

Applicable terminators are:

- LF (Line Feed)
- CR (Carriage Return)
- CR LF (Carriage Return/Line Feed)

In some instances, a terminator is automatically sent at the end of an output string from the PC.

SCPI Commands

This section gives all SCPI commands recognized by the Product with their description and syntax rules.

Commands by Function or Group

Table 5 is a list of commands grouped by Calibration, Main Screen, Program, Setup, System, and Temperature.

Table 5. Commands by Function or Group

Group	Screen Parameter	Command	Password Group	Read/Write
Calibration – Controller	TEMP PB	SOUR:LCON:PBAN	Unconditional	R/W
	TEMP INT	SOUR:LCON:INT	Unconditional	R/W
	TEMP DER	SOUR:LCON:DER	Unconditional	R/W
Calibration – Heat Source	TEMP 1	SOUR:SENS:CAL:PAR1	Unconditional	R/W
	TEMP 2	SOUR:SENS:CAL:PAR2	Unconditional	R/W
	TEMP 3	SOUR:SENS:CAL:PAR3	Unconditional	R/W
	TEMP 4	SOUR:SENS:CAL:PAR4	Unconditional	R/W
	GRAD 1	SOUR:SENS:CAL:ZONE1	Unconditional	R/W
	GRAD 2	SOUR:SENS:CAL:ZONE2	Unconditional	R/W
	GRAD 3	SOUR:SENS:CAL:ZONE3	Unconditional	R/W
	GRAD 4	SOUR:SENS:CAL:ZONE4	Unconditional	R/W
	SKEW 1	SOUR:SENS:CAL:SKEW1	Unconditional	R/W
	SKEW 2	SOUR:SENS:CAL:SKEW2	Unconditional	R/W
	SKEW 3	SOUR:SENS:CAL:SKEW3	Unconditional	R/W
	SKEW 4	SOUR:SENS:CAL:SKEW4	Unconditional	R/W
	None	SOUR:SENS:TEMP1	Unconditional	R
	None	SOUR:SENS:TEMP2	Unconditional	R
	None	SOUR:SENS:TEMP3	Unconditional	R

Table 5. Commands by Function or Group (cont.)

Group	Screen Parameter	Command	Password Group	Read/Write
Main Screen	(none)	SOUR:SENS:DATA	N/A	R
	SETPT	SOUR:SPO	N/A	R/W
	HEAT %	OUTP1:DATA	N/A	R
	(none)	OUTP2:DATA	N/A	R
	ENABLE	OUTP1:STAT	N/A	R/W
Program – Run	TEST STATUS	PROG:STAT	N/A	R/W
Program - Setup	TEST ID	PROG:IDEN	N/A	R/W
Ramp & Soak	RAMP/SOAK SETUP	PROG:SEQ:CAT	N/A	R
	SETPOINT n	PROG:SEQ:PAR SPO _n	Conditional	R/W
	SOAK TIME	PROG:SEQ:PAR DWEL	Conditional	R/W
	SETPOINTS	PROG:SEQ:PAR POIN	Conditional	R/W
	NO CYCLES	PROG:SEQ:PAR CYCL	Conditional	R/W
	PASS TOLERANCE	PROG:SEQ:PAR PTOL	Conditional	R/W
	DIRECTION	PROG:SEQ:PAR DIR	Conditional	R/W
	SETPOINT 1	SOUR:LIST:SPO1	N/A	R/W
	SETPOINT 2	SOUR:LIST:SPO2	N/A	R/W
	SETPOINT 3	SOUR:LIST:SPO3	N/A	R/W
SETPOINT 4	SOUR:LIST:SPO4	N/A	R/W	

Table 5. Commands by Function or Group (cont.)

Group	Screen Parameter	Command	Password Group	Read/Write
Ramp & Soak (cont.)	SETPOINT 5	SOUR:LIST:SPO5	N/A	R/W
	SETPOINT 6	SOUR:LIST:SPO6	N/A	R/W
	SETPOINT 7	SOUR:LIST:SPO7	N/A	R/W
	SETPOINT 8	SOUR:LIST:SPO8	N/A	R/W
Setup – Communications	BAUD RATE	SYST:COMM:SER:BAUD	N/A	R/W
	LINEFEED	SYST:COMM:SER:LIN	N/A	R/W
Setup – Display	LANGUAGE	SYST:LANG	N/A	R/W
	DECIMAL	SYST:DEC:FORM	N/A	R/W
	KEY AUDIO	SYST:BEEP:KEYB	N/A	R/W
Setup – Password	PASSWORD (Disable)	SYST:PASS:CDIS	Unconditional	W
	PASSWORD (Enable)	SYST:PASS:CEN	Unconditional	W
Status	(none)	SYST:PASS:CEN:STAT	N/A	R
	USER PASSWORD	SYST:PASS:NEW	Unconditional	W
	PROTECTION	SYST:PASS:PROT	N/A	R/W
Setup – Date/Time	DATE	SYST:DATE	Unconditional	R/W
System – Setup	°C/°F	UNIT:TEMP	N/A	R/W
Heat Enable	(none)	OUTP:STAT	N/A	R/W
	(none)	SYST:KLOC	Conditional	R/W

Table 5. Commands by Function or Group (cont.)

Group	Screen Parameter	Command	Password Group	Read/Write
System – Information	(none)	SYST:ERR	N/A	R
	(all)	*IDN	N/A	R
	(none)	*CLS	N/A	W
	(none)	*OPT	N/A	R
	FW VER	SYST:CODE:VERS	N/A	R
Temperature – Cutout	HARD CUTOUT	SOUR:PROT:HCUT	N/A	R
	SOFT CUTOUT	SOUR:PROT:SCUT:LEV	Conditional	R/W
Reset	(none)	SOUR:PROT:CLEA	N/A	W
Trip State	(none)	SOUR:PROT:TRIP	N/A	R
Temperature – Setup	SCAN RATE	SOUR:RATE	N/A	R/W
Monitor Temperature	CJC Temperature	SOUR:SENS:DATA	N/A	R
	Monitor TC	SOUR:SENS:DATA	N/A	R

Alphabetic List of Commands

In this section, commands are shown alphabetically. Each command is shown with its long and short form. For each command there is a description, one or more examples, and a parameter range when applicable.

Note

In this section, square brackets ([]) show optional keywords or parameters. Braces ({ }) enclose parameters inside a command string. Triangle brackets (< >) show that you must replace the parameter with a value. Some commands use upper and lower case letters. You must use all the uppercase letters in a command. The lowercase letters are optional. The “|” is used as a separator between optional parameter values in a command.

All commands used with the Product are sequential. Each command is completed before a subsequent command is processed.

All commands that are not recognized by the Product cause an error message to show in the error queue. A command can be rejected with an error if the command is misspelled, has incorrect syntax, and/or has invalid parameters.

***CLS**

Clears all status registers.

Example: *CLS

Response: None

***IDN?**

Gets manufacturer, model number, serial number and firmware version of the product.

Example: *IDN?

Response: FLUKE, 9118A, 0, 4.03

***OPT?**

Gets product configuration or reference functionality.

Example: *OPT?

Response: 1 Reference hardware is enabled. (0 = disabled)

OUTPut:STATus <n>

Sets or gets the main heat output on or off.

Parameters: n = ON or 1 Turn on main heat.
 OFF or 0 Turn off main heat.

Example: OUTP:STAT 1 Turn on main heat.

OUTPut:STATus?

Gets the main heat output on or off.

Example: `OUTP:STAT?`

Response: `0` Main heat output is off. (1 = on)

OUTP[n]:DATA?

Gets the duty cycle of a heater duty cycle in percent.

Parameters: `n` 1 to 3 1 = main heater output (default), 2 = zone heater output, 3 = balance heater output.

Example: `OUTP:DATA?`

Response: `18.0` Main heater output duty cycle is 18 %.

Example: `OUTP2:DATA?`

Response: `57.0` Zone heater output duty cycle is 57.0 %.

PROGram:IDEN [quoted string]

Sets the program identifier.

Parameters: `string` = 1 to 12 characters (0 - 9, A - Z, '-'). Default = "0"

Example: `IDEN? "TEST-1"`

PROGram:IDEN? <quoted string>

Gets the program identifier.

Example: `IDEN?`

Response: `TEST-1`

PROGram:SEQ:PAR? <Par>

Get a parameter from the ramp/soak test.

Parameters: Par = SPO[x] x = 1 to 8 setpoint number. Default = 1. Gets setpoint temperature for the setpoint number.

DWEL Gets soak time

POIN Gets the number of setpoints in the ramp/soak test.

CYCL Gets the number of times the ramp/soak test is to be repeated.

DIR Gets the direction of how the setpoints will be done in the test. See DIRECTION in the Ramp/Soak Menu section.

Example: PROG:SEQ:PAR? SPO2 Gets the setpoint temperature for setpoint number 2.

PROGram:STATus <n>

Sets the execution state for the selected program.

Parameters: n = RUN or 1 Start the selected program.

OFF or 0 Stop the selected program. (Default)

Example: PROG:STAT 1 Starts the selected program.

PROGram:STATus?

Sets or gets the execution state for the selected program.

Example: PROG:STAT?

Response: 0 The selected program is stopped.

SOURce:LCON:DER <n>

Sets the main control derivative time in seconds.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: n 0.0 to 99.9 seconds.

Example: SOUR:LCON:DER 5

SOURce:LCON:DER?

Gets the main control derivative time in seconds.

Example: SOUR:LCON:DER?

Response: 1.5 The main zone derivative time is 1.5 seconds.

SOURce:LCON:INT <n>

Sets the main control loop integral time in seconds.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameter: n = 10.0 to 999.9 seconds.

Example: SOUR:LCON:INIT 10

SOURce:LCON:INT?

Gets the main control loop integral time in seconds.

Example: SOUR:LCON:INIT?

Response: 20.0 The main control loop integral time is 20.0 seconds.

SOURce:LCON:PBAN <n>

Sets the main control proportional band in °C which the PID controller uses for main zone control.

Parameters: n = 1.0 to 199.9 °C

Example: SOUR:LCON:PBAN 7

SOURce:LCON:PBAN?

Gets the main control proportional band in °C which the PID controller uses for main zone control.

Example: SOUR:LCON:PBAN?

Response: 1.5 The main control loop proportional band is 1.5 °C.

SOURce:LIST:SPO<i> <n>

Sets the temperature value for a preset setpoint in the RAMP/SOAK menu.

Parameters: i = Setpoint number (1 to 8)

n = Setpoint temperature.

Example: SOUR:LIST:SPO6 700.00 Sets setpoint number 6 to 700.00 degrees.

SOURce:LIST:SPO<i>?

Gets the temperature value for a preset setpoint in the RAMP/SOAK menu.

Example: SOUR:LIST:SPO4?

Response: 400.0 The setpoint temperature for setpoint 4 is 400.0 degrees.

SOURce:PROT:HCUT?

Gets the hard cutout temperature setpoint in °C or °F.

Example: SOUR:PROT:HCUT?

Response: 140 The hard cutout temperature is set to 140 °C.

SOURce:PROT:CLEA

Resets the cutout to enable the Product.

Example: SOUR:PROT:CLEA

Response: None

If the furnace goes above the maximum temperature, the cutout circuit will trip. The Product does not heat or cool until the cutout condition is cleared.

SOURce:PROT:SCUT:LEV <n>

Sets the soft cutout temperature.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: n = 25.00 to 1220.00 degrees.

Example: SOUR:PROT:SCUT:LEV 450 Sets the soft cutout to 450 degrees.

SOURce:PROT:SCUT:LEV?

Gets the soft cutout temperature.

Example: SOUR:PROT:SCUT:LEV?

Response: 1000 Soft cutout temperature is set to 1000 degrees.

SOURce:PROT:TRIP?

Gets the cutout trip state.

Example: SOUR:PROT:TRIP?

Response: 0 Cutout not tripped (1 = cutout tripped).

SOURce:RATE <n>

Sets the control temperature rate of change (scan rate) in °C or °F per minute.

Parameters: n = 0.10 to 500.00 degrees per minute. Default = 100.00

Example: SOUR:RATE 1.26 Sets the scan rate to 1.26 degrees per minute.

SOURce:RATE?

Gets the control temperature rate of change (scan rate) in °C or °F per minute.

Example: SOUR:RATE?

Response: 0.531 The scan rate is set to 0.531 degrees per minute. The response to this command starts out high and decreases as the temperature gets nearer to the setpoint temperature.

SOURce:SENS:CAL:ZONE <x> <n>

Sets the axial gradient adjustment parameter.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: x = 1 to 4 (1 = ZONE1, 2 = ZONE2, 3 = ZONE3, 4 = ZONE4)

n = -10.0 to 10.0 as a temperature offset in °C.

Example: SOUR:SENS:CAL:ZONE2 0.08

SOURce:SENS:CAL:ZONE <x>?

Gets the axial gradient adjustment parameter.

Example: SOUR:SENS:CAL:ZONE2?

Response: 0.05 Axial gradient adjustment is 0.05.

SOURce:SENS:CAL:PAR<x> [n]

Sets a control temperature calibration parameter.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: x = 1 to 3 (1 = PAR1 = TEMP 1, 2 = PAR2 = TEMP 2, 3 = PAR3 = TEMP 3, 4 = TEMP 4)
n = -50.00 to +50.00 (Default = 0.000)

Example: SOUR:SENS:CAL:PAR2 0.02 Set the calibration parameter to 0.02 for main control.

SOURce:SENS:CAL:PAR<x>?

Gets a control temperature calibration parameter.

Example: SOUR:SENS:CAL:PAR2?

Response: 0.0 The calibration parameter #2 is set to 0.0.

SOURce:SENS:CAL:TEMP[n]?

Gets the temperature of a calibration parameter. This temperature is fixed and is in degrees Celsius.

Parameter: n = 1 to 3 (1 = TEMP1, 2 = TEMP2, 3 = TEMP3). Default = 1

Example: SOUR:SENS:CAL:TEMP1?

Response: 300 The temperature value of the TEMP1 parameter is 300 °C.

SOURce:SENS:CAL:SKEW<x> <n>

Sets an axial compensation adjustment parameter.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: x = 1 to 4 (1 = SKEW1, 2 = SKEW2, 3 = SKEW3, 4 = SKEW4)

SOURce:SPO [n]

Sets the control setpoint.

Parameters: n = 300.00 to 1200.00 degrees Celsius (Default = 300.00).

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Example: SOUR:SPO 400.00 Sets the setpoint temperature to 400.00 degrees.

SOURce:SPO?

Gets the control setpoint.

Example: SOUR:SPO?

Response: 300.00 Setpoint temperature is set to 300.00 degrees.

SYSTem:BEEP:KEYB [n]

Sets the state of the keyboard beep function.

Parameters: n = ON or 1 Turn on keyboard beep. (Default)
OFF or 0 Turn off keyboard beep.

Example: SYST:BEEP 1 Turn on keyboard beep.

SYSTem:BEEP:KEYB?

Gets the state of the keyboard beep function.

Example: SYST:BEEP?

Response: 0 keyboard beep is off. (1 = on)

SYSTem:CODE:VERS?

Gets the version of the firmware.

Example: `SYST:CODE:VERS?`

Response: `1.10` The version of firmware is 1.10.

SYSTem:COMM:SER:BAUD [baud]

Sets the baud rate of the serial interface.

Parameters: `baud = 1200, 2400, 4800, 9600, 19200, 38400` (Default = 9600)

Example: `SYST:COMM:BAUD 2400` Sets the baud rate of the serial interface to 2400.

SYSTem:COMM:SER:BAUD?

Gets the baud rate of the serial interface.

Example: `SYST:COMM:BAUD?`

Response: `1200` The baud rate of the serial interface is set to 1200.

SYSTem:COMM:SER:LIN [n]

Sets the use of a line feed character at the end of data sent out the serial interface.

Parameters: `n = ON or 1` Turn on line feed character.

`OFF or 0` Turn off line feed character. (Default)

Example: `SYST:COMM:SER:LIN 1` Turn on line feed character.

SYSTem:COMM:SER:LIN?

Gets the use of a line feed character at the end of data sent out the serial interface.

Example: `SYST:COMM:SER:LIN?`

Response: `0` Line feed character is not used at the end of data form the serial interface.

SYSTem:DATE <date>

Sets the system date.

Parameters: date = yyyy, mm, dd yyyy = four digit number for year, mm = two digit number for month, dd = two digit number for day.

Example: SYST:DATE 2012,05,24 Sets the system date to May 24, 2012.

SYSTem:DATE?

Gets the system date.

Example: SYST:DATE?

Response: 2012,11,30 The system date is set to November 30, 2012.

SYSTem:DEC:FORM [n]

Sets the decimal format.

Parameters: n = 0 – period (Default)
1 – comma

Example: SYST:DEC:FORM 1 Sets the decimal format to comma.

SYSTem:DEC:FORM?

Gets the decimal format.

Example: SYST:DEC:FORM?

Response: 0 Decimal format is set to period.

SYSTem:KLOC <n>

Sets the status of the front-panel keypad lock.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: n = 1 – Lock keypad.
 0 – Unlock keypad. (Default)

Example: SYST:KLOC 1 Locks the keyboard.

SYSTem:KLOC?

Gets the status of the front-panel keypad lock.

Example: SYST:KLOC?

Response: 0 Keypad is unlocked.

SYSTem:LANG <lang>

Sets the display language.

Parameters: lang = 1 – English
 7 – Chinese

Example: SYST:LANG 7 Sets the display language to Chinese.

SYSTem:LANG?

Gets the display language.

Example: SYST:LANG?

Response: 1 The display language is set to English.

SYSTem:PASS:CDIS

Disable access to commands with password protection.

Example: SYST:PASS:CDIS

This command has no response.

SYSTem:PASS:CEN [n]

Enables access to commands with password protection.

Parameters: n = 0000 to 9999. If the n parameter is left out, then the default password of 1234 is used.

Example: SYST:PASS:CEN 1045 Disables password protection on commands where a password is necessary to set them. Password protection remains disabled until SYST:PASS:CDIS is used or you turn off power to the Product.

This command has no response.

SYSTem:PASS:CEN:STAT?

Gets the access state of password protected commands.

Example: SYST:PASS:CEN:STAT?

Response: 0 Cannot change commands with password protection. A response of 1 means password commands can be set by the applicable command. Use the SYST:PASS:CEN command to set the password protection parameter.

SYSTem:PASS:NEW <n>|DEF

Sets the system password.

Note

This command has password protection. Use the SYST:PASS:CEN command first before you use this command to set this value.

Parameters: n = 0000 to 9999

DEF Sets the password to 1234.

Example: SYST:PASS:NEW 1045 Sets the password to 1045.

This command has no response.

SYSTem:PASS:PROT <n>

Sets the password protection level.

Parameters: n = 0 – Low
1 – High

Example: SYST:PASS:PROT 1 Sets the password protection level to high.

SYST:PASS:PROT?

Gets the password protection level.

Example: SYST:PASS:PROT?

Response: 0 The password protection level is low.

UNIT:TEMP [n]

Sets the display temperature units.

Parameters: n = C – Centigrade (Default)
F - Fahrenheit

Example: UNIT:TEMP C Sets the display temperature units to Centigrade.

UNIT:TEMP?

Gets the display temperature units.

Example: UNIT:TEMP?

Response: F Display temperature units is set to Fahrenheit.

Maintenance

Warning

To prevent possible electrical shock, fire, or personal injury:

- Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.
- Use only specified replacement parts.
- Have an approved technician repair the Product.

Caution

To prevent possible damage to the Product:

- Do not use fluids to clean the well.
- Do not use harsh chemicals on the Product surfaces.
- Do an over-temperature cutout test a minimum of one time in a 6 month period.
- Make sure the well is clean and clear of unwanted material.
- Use the National Safety Council decontamination steps when hazardous material is spilt on or in the Product.

Fluke Calibration recommends that you do an axial uniformity test when you receive the Product and at 6 month intervals. See the Furnace Calibration section.

Cutout Test

Fluke Calibration recommends you do a minimum of one cutout test in 6 months. To do a cutout test:

1. Push **SET PT.**
2. Set the setpoint temperature to 400 °C and let the furnace temperature become stable.
3. Push **ENTER**.
4. Push **MENU**.
5. Push the softkey below **TEMP SETUP**.
6. Push the softkey below **CUTOUT**.
7. Set the soft cutout to 300 °C.

The cutout indicator on the front panel illuminates and the furnace stops the heat cycle. If the cutout does not stop the heat cycle, the Product must be repaired.

8. Set the soft cutout temperature to 1240 °C.

How to Clean the Product

Clean the Product surfaces with a damp cloth and mild detergent. Make sure liquids do not go into the Product.

Note

Before you clean or decontaminate the Product with a procedure not recommended by Fluke Calibration, speak with a service center associate for more information.

Furnace Calibration

The furnace calibration procedure in this manual is a general guideline. Each calibration laboratory must write a procedure for their calibration equipment and quality program. Do an uncertainty analysis with the laboratory equipment and environment.

Note

To get answers to furnace calibration questions, talk to a Fluke Calibration associate. See the How to Contact Fluke section.

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury, have an approved technician calibrate the Product.

A technician who does the furnace calibration procedure must know the data in this Users manual.

Calibration Terminology

As Found Data: Data measured on the UUT before it is adjusted.

As Left Data: Data measured on the UUT after it is adjusted.

Environment Conditions

Furnace calibration must be done in an environment with a temperature of $23\text{ }^{\circ}\text{C} \pm 4\text{ }^{\circ}\text{C}$ and relative humidity below 60 %.

Calibration Equipment

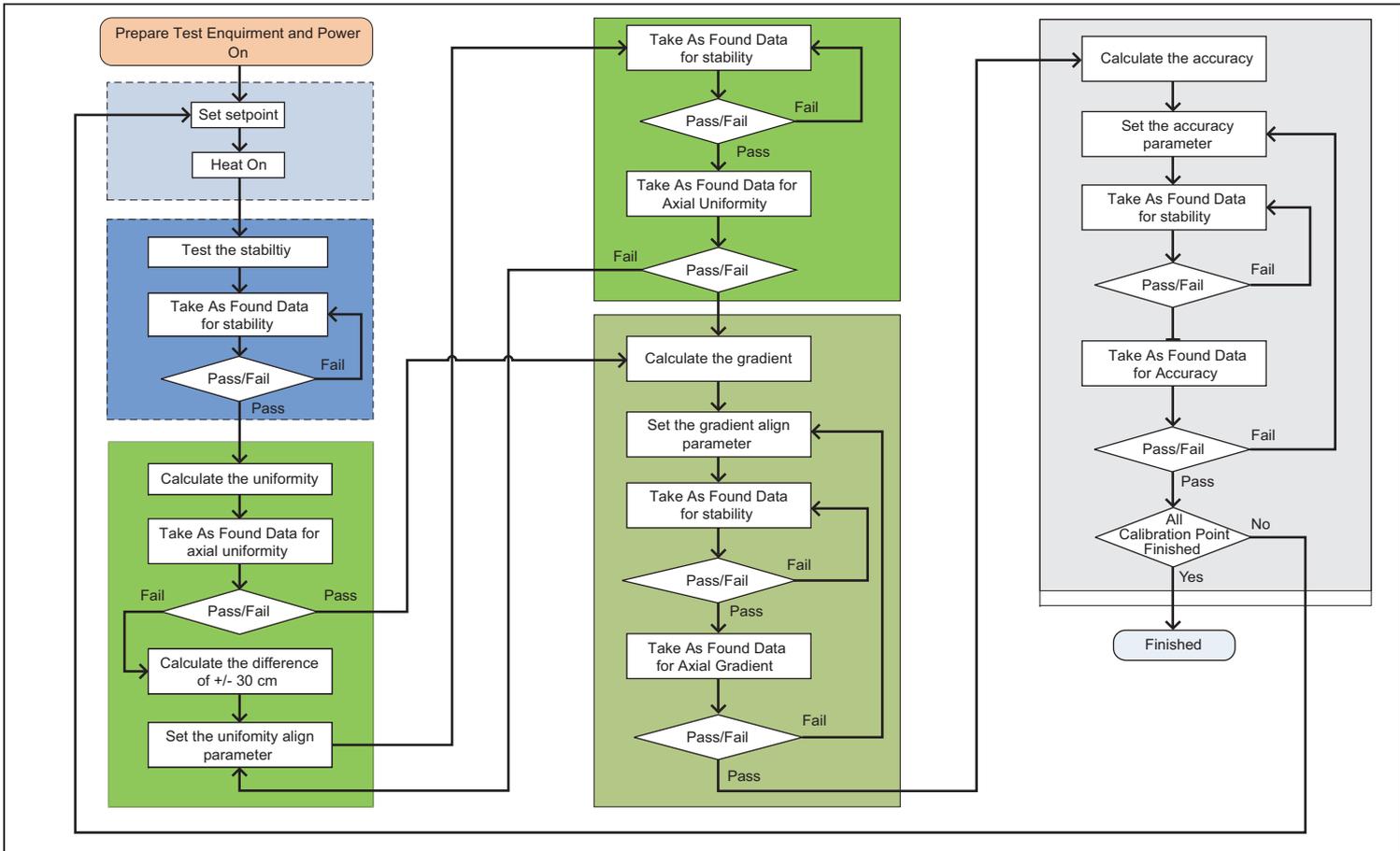
Table 6 is a list of equipment necessary for a furnace calibration.

Table 6. Calibration Equipment

Equipment	Specifications
Ice Point	0.05 °C accuracy 0.02 °C stability
Thermocouple Readout	0.25 °C accuracy
Thermocouples	S or R type 1 °C @ 1200 °C

Calibration

Product calibration uses a stability test, uniformity test, and adjustment, followed by an accuracy test and adjustment. All tests and adjustments are done at different temperatures across the range of the Product. Figure 15 is a flow chart of the furnace calibration procedure.



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Figure 15. Furnace Calibration Flow Chart

Table 7 is a list of Furnace calibration tests and adjustments.

Table 7. Furnace Calibration Tests and Adjustments

No.	Test Name	Test Points (°C)	Notes
1	Stability Test	300, 700, 1000, 1200	As Found/As Left data to verify the temperature stability – can be done with other tests at same nominal setpoints.
2	Axial Uniformity Test	300, 700, 1000, 1200	As Found data – use data for initial uniformity adjustment
3	Axial Uniformity Adjustment	300, 700, 1000, 1200	Adjust the zone and skew parameters to set axial uniformity to the specification
4	Axial Uniformity Test	300, 700, 1000, 1200	As Left data to verify the temperature uniformity.
5	Accuracy Test	300, 700, 1000, 1200	As Found test data – use to adjust the accuracy
6	Accuracy Adjustment	300, 700, 1000, 1200	Adjusts the TEMP calibration parameters to set the accuracy to the specification
7	Accuracy Test	300, 700, 1000, 1200	As Left data to verify the accuracy

To do Product Calibration:

1. Connect the test equipment as shown in Figure 16.

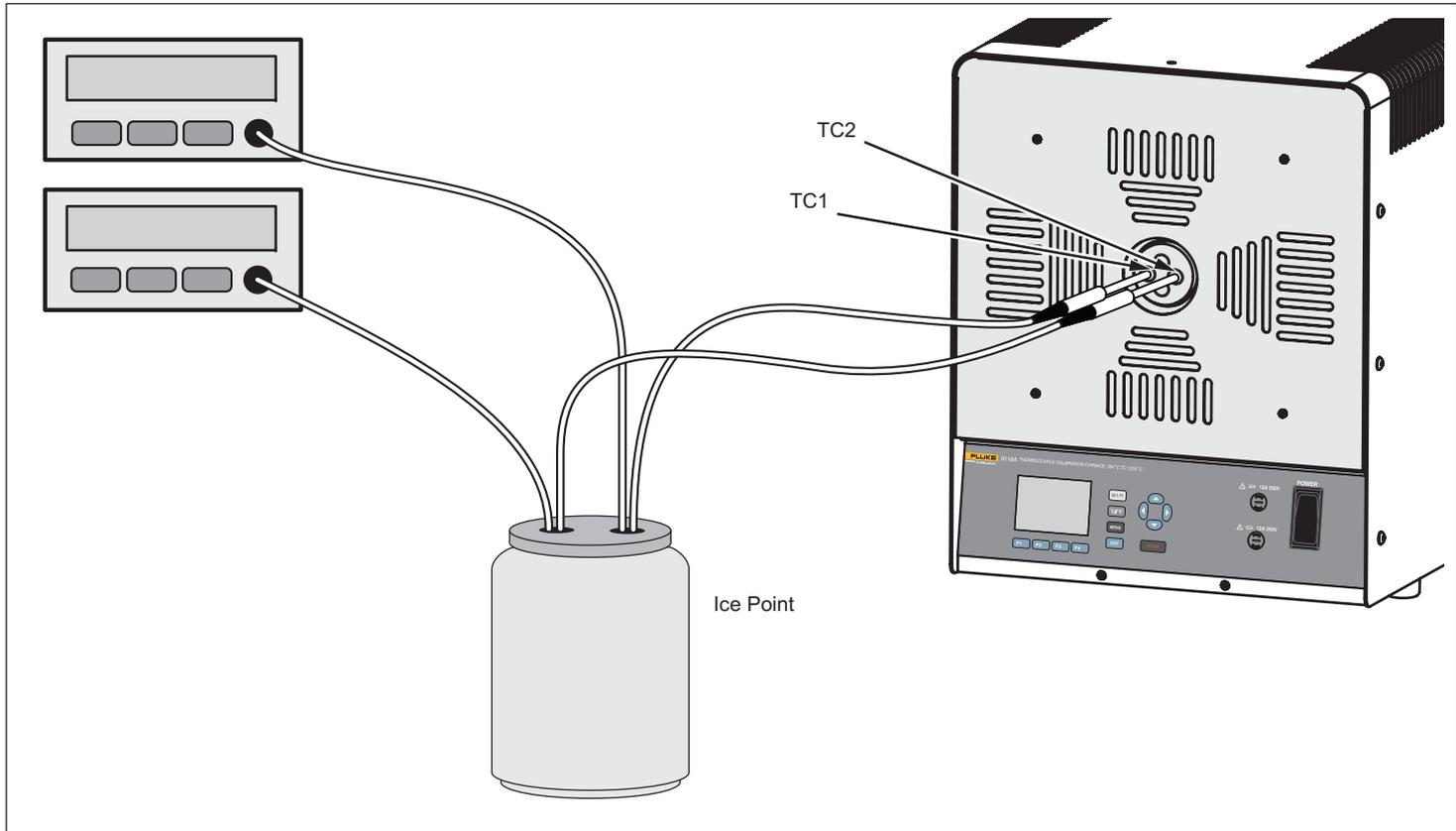


Figure 16. Test Equipment Connections

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Note

In the steps that follow, start the calibration procedure at the lowest temperature (300 °C) and move up the range to 1200 °C.

2. Set the Product to one of the setpoint temperatures in Table 8.

Stability Test

The 7 steps that follow find the As Found and As Left data for stability.

3. Push **ENTER** to start the furnace.
4. Put the test thermocouple (TC1) at the center of the furnace (zero reference).
5. Stabilization time starts after one hour when the stability indicator shows the furnace temperature is stable.
6. After the stabilization time, record the temperature on the readout for TC1 at 1 minute intervals for 30 minutes.
7. Calculate 2σ (2 times the standard deviation) of the 30 recorded measurements.
8. Compare the calculated 2σ with the value in the stability column of Table 8.

Table 8. Stability Test Data

Setpoint (°C)	Stabilization Time (min)	Samples	Stability 2σ Limit ($\pm^\circ\text{C}$)
300	60	30	0.2
700	60	30	0.2
1000	60	30	0.2
1200	60	30	0.2

If the test fails, do steps 6 through 8 again. If it fails a second time, repair the instability.

9. Record the result.

Axial Uniformity

The 11 steps that follow make up the axial uniformity test and the formulae to calculate the SKEW and ZONE parameter values. The new values are put into the Product to correct for axial temperature gradients.

Note

The axial uniformity test must be done before the axial uniformity adjustment.

10. Move test thermocouple TC2 to one of the positions shown in Table 9.
11. Let the thermocouple soak for a minimum of 5 minutes at this position.
12. Record the temperature for TC1 and TC2 in Table 9.

13. Do steps 10 through 12 again for each position in Table 9.

Note

Let the Product soak for 5 minutes after you move TC2.

Table 9. Axial Uniformity Test

	TC2 Position from Furnace Center (mm)				
	-30	-10	0	10	30
TC1					
TC2					
Difference					

14. Calculate the temperature difference relative to the center position for each position of TC2 in Table 9 and record it in the Table.

$$Difference_{(x)} = (TC2_{(x)} - TC1_{(x)}) - (TC2_{(0)} - TC1_{(0)})$$

15. Calculate a gradient value for the 30 and -30 positions of TC2 with:

$$Gradient_{(x)} = TC2_{(x)} - TC1_{(x)}$$

X = TC2 Position at 30 mm and -30 mm

16. Calculate the slope value with:

$$Slope = Gradient_{(+30)} - Gradient_{(-30)}$$

17. Calculate the SKEW value with:

$$SKEW_{n(new)} = SKEW_{n(old)} + A \times (Slope)$$

18. Table 10 shows the value for A at each of the temperature setpoints.

Table 10. Skew Correction Values

Setpoint (°C)	A Value
300	1.02
700	1.35
1000	4.67
1200	5.30

19. Put the $SKEW_{n(new)}$ value into the Product through the front panel or RS-232 port. Table 11 is a list of temperature setpoints and the RS-232 command and front-panel name for the SKEW parameters.

Table 11. SKEW Parameter

Setpoint (°C)	Parameter	
	RS-232 Command	Front Panel
300	SOUR:SENS:CAL:SKEW1	SKEW (300)
700	SOUR:SENS:CAL:SKEW2	SKEW (700)
1000	SOUR:SENS:CAL:SKEW3	SKEW (1000)
1200	SOUR:SENS:CAL:SKEW4	SKEW (1200)

20. Let the Product soak for 30 minutes after you put in the SKEW value.
21. Do steps 10 through 13 again to make sure axial uniformity is equal to or less than the specification. The difference between the maximum and minimum values in the difference row of Table must be between +0.5 °C and -0.5 °C.
22. Calculate a curve value for the 0, 30 and -30 positions of TC2 with:

$$\text{Curve} = \frac{(\text{Gradient}_{(0)} - \text{Gradient}_{(+30)}) + (\text{Gradient}_{(0)} - \text{Gradient}_{(-30)})}{2}$$

23. Calculate the ZONE value with:

$$\text{ZONE}_{n(\text{new})} = \text{ZONE}_{n(\text{old})} + B \times (\text{Curve})$$

Table 12 shows the value for B at each temperature setpoint.

Table 12. Zone Correction Values

Setpoint	B Value
300	1.5
700	2.4
1000	3.3
1200	4.2

24. Put the ZONE_{n(new)} value into the Product through the front panel or RS-232 port. Table 13 is a list of

temperature setpoints and the RS-232 command and front-panel name for the ZONE parameters.

Table 13. ZONE Parameter

Setpoint (°C)	Parameter	
	RS-232 Command	Front Panel
300	SOUR:SENS:CAL:ZONE1	ZONE (300)
700	SOUR:SENS:CAL:ZONE2	ZONE (700)
1000	SOUR:SENS:CAL:ZONE3	ZONE (1000)
1200	SOUR:SENS:CAL:ZONE4	ZONE (1200)

25. Let the Product soak for 30 minutes after you put in the ZONE value.
26. Do steps 10 through 14 again to make sure axial uniformity is equal to or less than the specification. If the Product does not satisfy the specification, do steps 15 through 25 again with the new axial uniformity values.

Accuracy Test

Note

Make sure TC1 is at the midpoint in the access tube (0 MM) when you do an accuracy test.

To do an accuracy test:

1. Set the Product to a setpoint temperature in Table 14.

2. Wait for the stability indicator to show the furnace temperature is stable.
3. Record TC1 measurements for 1 minute.
4. Calculate the average of all measurements.
5. Calculate accuracy with:

$$\text{Accuracy} = TC1 - \text{setpoint temperature}$$
6. The accuracy must be less than or equal to ± 5 °C. If not, do an accuracy adjustment.
7. Do steps 1 through 6 for each setpoint temperature in Table 14.

Accuracy Adjustment

To do an accuracy adjustment:

1. Calculate the new $TEMP_n$ parameter with:

$$Temp_{n(new)} = Temp_{n(old)} - \text{Accuracy}$$
2. Put the $TEMP_{n(new)}$ value into the Product through the front panel or RS-232 port. Table 14 is a list of temperature setpoints and the RS-232 command and front-panel name for the TEMP parameters.

Table 14. Accuracy Parameter

Setpoint (°C)	Parameter	
	RS-232 Command	Front Panel
300	SOUR:SENS:CAL:PAR1	TEMP (300)
700	SOUR:SENS:CAL:PAR2	TEMP (700)
1000	SOUR:SENS:CAL:PAR3	TEMP (1000)
1200	SOUR:SENS:CAL:PAR4	TEMP (1200)

3. Let the Product soak for 30 minutes after you put in the SKEW value.
4. Do steps 1 through 6 of the accuracy test.

To complete the calibration of the Product, do a stability test, axial uniformity test, and accuracy test to make sure the Product is equal to or less than the specifications for each setpoint.

Specifications

All accuracy specifications except temperature are for a period of 1 year after calibration, at 13 °C to 33 °C.

Temperature

Operating	5 °C to 40 °C
Storage	-20 °C to 70 °C
Humidity	80 % maximum for temperatures <31 °C, decreasing linearly to 50 % at 40 °C

Altitude.....<2000 m

Furnace Temperature Range300 °C to 1200 °C

Uniformity

Radial (14 mm radius from geometry central point)	±0.5 °C
Axial (±30 mm axial length from geometry central point)	±0.25 °C

Note

The peak of the temperature profile is ±10 mm from the furnace axial midpoint.

Stability (within 30 minutes)	±0.2 °C
Set-Point Accuracy	±5 °C
Stabilization Time	2 hours from ambient to 1200 °C
Heater Power.....	4000 watts at 230 V ac
Power Requirements	230 V ac (±10 %), 50/60 Hz, 20 A
Display	LCD, White/black
Resolution.....	0.1 °C

⚠ Fuses

System.....	20 A, 250 V circuit breaker
Main Heater.....	F 12 A, 250 V
Zone Heater.....	F 12 A, 250 V
Size (H x W x L).....	400 mm x 337 mm x 700 mm
Weight without package	30 kg (without thermal block)

Cal Power

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