FLUKE®
Hart Scientific®

1594A/1595A Super-Thermometer

User's Guide

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Limited Warranty & Limitation of Liability

Each product from Fluke Corporation ("Fluke") is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year(s) for the thermometer. 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 Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any other product, which in Fluke's opinion, has been misused, altered, neglected, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption. Fluke does not warrant calibrations on the Super-Thermometer.

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

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1 Before you start

1.1 Symbols used

Table 1 lists the symbols that may be used on the instrument or in this manual and the meaning of each symbol.

Table 1 *Symbols*

Symbol	Description	Symbol	Description
	AC (Alternating Current)		PE Ground
	AC-DC		Hot Surface (Burn Hazard)
	Battery		Read the User's Guide (Important Information)
	Complies with European Union directives		Off
	DC		On
	Double Insulated		Standby Indication
	Electric Shock		Canadian Standards Association
	Fuse		C-TICK Australian EMC mark
	Ground		The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) mark.

1.2 Safety information

This instrument is compliant to EN 61010-1 {2nd Edition}, and CAN/CSA 22.2 No 61010.1-04, Pollution Degree 2. This instrument is designed for indoor use only. 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.

1.2.1 WARNINGS

- **DO NOT** use this unit in environments other than those listed in the User's Guide.
- Follow all safety guidelines listed in the User's Guide.
- Calibration equipment should only be used by trained personnel.
- This instrument can measure extreme temperatures. Precautions must be taken to prevent personal injury or damage to objects. Probes may be extremely hot or cold. Cautiously handle probes to prevent personal injury. Carefully place probes on a heat/cold resistant surface or rack until they reach room temperature.
- **DO NOT** operate near flammable materials.
- Use only a grounded AC mains supply of the appropriate voltage to power the instrument.

- **DO NOT** connect an AC mains supply that does not match the voltage setting on the back of the unit.
- **DO NOT** use this instrument in combination with any probe (PRT or thermistor) to measure the temperature or resistance of any device where the probe might come in contact with a conductor that is electrically energized. Severe electric shock, personal injury, or death may occur.
- DO NOT position this instrument in a manner where it is difficult to reach the power cord or power entry module mains switch. When rack mounting the instrument, ensure the rack power cord and mains supply switch are accessible.

1.2.2 CAUTIONS

- If the instrument is dropped, struck, or handled in a way that causes internal or external physical damage, immediately unplug the instrument, discontinue use, and contact a Fluke Authorized Service Center for repair. Do not attempt to disassemble or repair the instrument. Refer repairs or replacement of components to a Fluke Authorized Service Center.
- **DO NOT** connect AC voltage to any input terminal on the instrument. Permanent damage to the instrument will result.

1.3 Authorized service centers

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

Fluke Corporation

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 Introduction and specifications

2.1 Introduction

The Hart Scientific family of Super-Thermometers long ago established the standard for easy-to-use, precision temperature measurement instrumentation. Laboratories worldwide have selected the Super-Thermometer not only for the assurance of achieving high-quality results, but also for the innovative features that increase productivity in the lab. The Hart Scientific 1594A and 1595A Super-Thermometers continue this legacy adding new patent pending measurement technology and features that truly are best in class. Below is a summary of key capabilities and features.

- Typical 1595A accuracy 0.2 ppm (0.05 mK), 1594A accuracy 0.8 ppm (0.2 mK)
- Sample rates as fast as 1 second
- Measures SPRTs, HTPRTs, PRTs, and thermistors
- Four input channels on the front panel accept most probe terminations with the patented DWF, gold-plated, tellurium-copper, quick-connect terminals
- Configurable standby current for each input channel minimizes self-heating transients when scanning between channels
- Two input channels on the back panel, dedicated for external standard resistors, keep the front panel inputs free for Reference Thermometers or Standard Resistors and UUTs
- Channel Select Keys above each input channel change color to indicate whether a channel is actively measuring, in standby, or inactive—pressing a channel key activates the selected channel
- Temperature-controlled internal reference resistors allow for traceable temperature and absolute resistance measurements in ambient conditions from 15 °C to 30 °C
- Patent pending, Ratio Self-Calibration performs a linearity check or calibration of the Super-Thermometer ratio accuracy without the need of any external equipment
- Automated Zero-Power Measurement allows for determination and/or cancellation of a thermometer's self-heating error
- Updated computer interface with USB control, RS-232, and IEEE-488 included as standard
- Ethernet connection allows for remote view of the Super-Thermometer's display from a web browser
- USB memory device on the front panel to accommodate data logging, transfer of probe parameters, and storage and retrieval of Super-Thermometer user configurations
- VGA output allows the Super-Thermometer's screen to be displayed on a VGA monitor
- Selectable operating language: English, Chinese, Japanese, Spanish, French, German, or Russian
- Intuitive User Interface makes the Super-Thermometer easy to configure and use right out of the box

2.2 Specifications

2.2.1 General

Current best practices in metrology require uncertainty analyses to be in compliance with the ISO *Guide to the Expression of Uncertainty in Measurement* (often referred to as the "GUM"). For convenience, the specifications in this section are listed in $k = 2$ (95%) coverage and in $k = 3$ (99%) coverage to allow the user to easily apply the specifications in an uncertainty analysis.

The following specifications apply after the standard warm-up period of 30 minutes. The Super-Thermometer is designed to measure with accuracy and stability without the need for internal auto-cal or zeroing routines. To realize the full potential of measurement ability, accepted metrology practices such as the use of proper wiring should be adhered to. In addition, it is important to ensure that the instrument is correctly set up.

The specifications are divided into three categories: primary specifications, ancillary specifications, and general specifications.

Primary specifications: the core set of measurement accuracy specifications of the Super-Thermometer. They are guaranteed for performance verification at the 99% confidence level.

Ancillary specifications: additional specifications that help the user understand more of the uncertainties involved in measurement. Since they may be subject to the application and setting in which the Super-Thermometer is used, they are not guaranteed for performance verification but should be considered typical.

General specifications: general specifications such as measurement range, environmental operating range, dimensions, etc.

2.2.2 Primary specifications

Resistance ratio accuracy

Resistance ratio accuracy is the ability of the Super-Thermometer to measure the ratio of two resistances, Rx/Rs. It is determined primarily by the linearity of the measurement circuit. The following specifications apply for resistance ratios measured with a reference resistor of 25 Ω or 100 Ω using a measurement current of 0.5 mA to 2.0 mA. Other reference resistors are specified using a factor as explained in the following specification table. Performance verification is guaranteed for 99% confidence level specifications within the specified operating temperature range of 15°C to 30°C. The listed uncertainties are in terms of parts-per-million (ppm) of reading unless stated otherwise.

Table 2 *Resistance ratio accuracy specifications*

Ratio range	1594A accuracy (ppm of reading)	1595A accuracy (ppm of reading)
95% confidence level, 1-year		
0.95 to 1.05	0.24 ppm	0.06 ppm
0.5 to 0.95, 1.05 to 2.0	0.64 ppm	0.16 ppm
0.25 to 0.5, 2.0 to 4.0	0.8 ppm	0.2 ppm
0.0 to 0.25	2.0×10^{-07} †	5.0×10^{-8} †
4.0 to 10.0	2.0 ppm	0.5 ppm
99% confidence level, 1-year		
0.95 to 1.05	0.3 ppm	0.075 ppm
0.5 to 0.95, 1.05 to 2.0	0.8 ppm	0.2 ppm
0.25 to 0.5, 2.0 to 4.0	1.0 ppm	0.25 ppm
0.0 to 0.25	2.5×10^{-7} †	6.3×10^{-8} †
4.0 to 10.0	2.5 ppm	0.63 ppm
†Specifications are in terms of absolute ratio		
All specifications listed in this table apply when using a 25 Ω or 100 Ω reference resistor. Multiply stated specifications by a factor of 2 when using a 10 Ω reference resistor with sensing current between 1 and 5 mA, and a factor of 10 when using a 1 Ω reference resistor with sensing current between 5 and 20 mA. When using a 10 kohm reference resistor, internal or external, use the Absolute Resistance Accuracy specification in Table 4.		

Resistor Stability

Resistor stability characterizes the ability of the instrument to accurately compare two similar resistances within some time period using the internal resistors as references. The following specifications apply using the given reference resistor and excitation current and for a one-minute average. The specifications assume typical laboratory conditions, which do not include transportation and large ambient temperature fluctuations.

Resistance stability is determined by the short-term stability of the internal reference resistors and control stability of the temperature stabilizing block. It does not include measurement noise.

Table 3 *Resistor stability specifications*

Resistor (Rs)	Accuracy (ppm of reading)	
	24 hours	**30 days**
1 Ω	5 ppm	10 ppm
10 Ω	0.5 ppm	2 ppm
25 Ω	0.25 ppm	1 ppm
100 Ω	0.2 ppm	1 ppm
10 kΩ	0.25 ppm	1 ppm

Absolute resistance accuracy

Absolute resistance accuracy is the ability of the instrument to measure absolute resistance, Rx, using the internal reference resistors. The following specifications apply using the given reference resistor, Rs, and excitation current.

The 1-year specifications include calibration uncertainty, reference resistor drift, ambient temperature sensitivity, resistance ratio uncertainty, and measurement noise using 1-minute average and a 2-second sample period (n = 30).

Performance verification is guaranteed for 99% confidence level, 1-year specifications within the specified operating temperature range of 15°C to 30°C, maintaining a calibration interval of 6 months for the first year and 1 year thereafter.

Table 4 *Absolute resistance accuracy specifications*

Resistance range (Rs, current)	Accuracy (ppm of reading)
95% confidence level, 1-year	
0 Ω to 1.2 Ω (1 Ω, 10 mA)	Greater of 40 ppm or 0.000012 Ω
0 Ω to 12 Ω (10 Ω, 3 mA)	Greater of 10 ppm or 0.000024 Ω
0 Ω to 120 Ω (25 Ω, 1 mA)	Greater of 5 ppm or 0.000024 Ω
0 Ω to 400 Ω (100 Ω, 1 mA)	Greater of 4 ppm or 0.00008 Ω
0 Ω to 10 kΩ (10 kΩ, 10 μA)	Greater of 5 ppm or 0.000012 kΩ
10 kΩ to 40 kΩ (10 kΩ, 10 μA)	8 ppm
40 kΩ to 100 kΩ (10 kΩ, 2 μA)	20 ppm
100 kΩ to 500 kΩ (10 kΩ, 1 μA)	80 ppm
99% confidence level, 1-year	
0 Ω to 1.2 Ω (1 Ω, 10 mA)	Greater of 50 ppm or 0.000015 Ω
0 Ω to 12 Ω (10 Ω, 3 mA)	Greater of 13 ppm or 0.00003 Ω
0 Ω to 120 Ω (25 Ω, 1 mA)	Greater of 6.3 ppm or 0.00003 Ω
0 Ω to 400 Ω (100 Ω, 1 mA)	Greater of 5 ppm or 0.0001 Ω
0 kΩ to 10 kΩ (10 kΩ, 10 μA)	Greater of 6.3 ppm or 0.000015 kΩ
10 kΩ to 40 kΩ (10 kΩ, 10 μA)	10 ppm
40 kΩ to 100 kΩ (10 kΩ, 2 μA)	25 ppm
100 kΩ to 500 kΩ (10 kΩ, 1 μA)	100 ppm

Measurement current accuracy

Measurement current accuracy is guaranteed to meet the following specifications. The specifications are stated as percent of selected current or in absolute mA.

Table 5 *Measurement current accuracy specifications*

Current Range	Accuracy
99% confidence level, 1-year	
0.001 mA to 0.005 mA	0.00005 mA
0.005 mA to 0.02 mA	1 %
0.02 mA to 0.2 mA	0.5 %
0.2 mA to 2 mA	0.2 %
2 mA to 20 mA	0.5 %

2.2.3 Ancillary specifications

Temperature measurement noise

Temperature measurement noise indicates typical measurement noise in temperature measurements. The specifications below are given for averages taken over a period of 1 minute with a 2-second sample rate. The effect of noise may be reduced for longer averages or may be greater for shorter averages.

Noise performance is dependent upon many conditions. Some of the most important things to consider are the type of thermometer, setup, and environmental conditions such as electromagnetic interference.

Due to the subjective nature of measurement noise, it is not a guaranteed specification. The specifications listed in the table below are obtainable in a typical laboratory environment. It is important that the user make their own evaluation of measurement noise in the application and environment where the Super-Thermometer is used.

Table 6 *Temperature measurement noise specifications*

Conditions (Rs, Current)	Standard error of the mean, °C
Typical performance	
25 Ω SPRT at 0°C (25 Ω, 1.0 mA)	0.00002
25 Ω SPRT at 420°C (25 Ω, 1.0 mA)	0.00006
100 Ω PRT at 0°C (100 Ω, 1.0 mA)	0.00001
100 Ω PRT at 420°C (100 Ω, 1.0 mA)	0.00003
10 kΩ Thermistor at 25°C (10 kΩ, 10 mA)	0.000003

Relative measurement current accuracy

Zero-power resistance values are calculated based on measurements taken at two levels of excitation current that differ by a factor of 1.4142. Only the portions of the errors in the currents that are uncorrelated contribute to error in the zero-power resistance value.

The following specifications may be used to estimate the contribution of current error in zero-power resistance measurements.

Table 7 *Relative measurement current specifications*

Range	Relative Accuracy, mA
99% confidence level	
0.001 mA to 0.1 mA	0.0008
0.1 mA to 2 mA	0.003
2 mA to 20 mA	0.03

2.2.4 General Specifications

Table 8 *General Specifications*

Warm-up period	30 minutes
Measurement range	0 Ω to 500 kΩ
Measurement current range	0.001 mA to 20 mA
Measurement current reversal interval: **Sample period of 1 second or 2 seconds** **Sample period of 5 second or 10 seconds**	 0.2 second 1.2 second
Standby current range	0.001 mA to 2 mA
AC power	100 V to 230 V (± 10 %) 50 or 60 Hz
Fuse Rating	2 A – T – 250 V
Specified operating temperature	15 °C to 30 °C
Absolute operating temperature	5 °C to 40 °C
Storage temperature	0 °C to 40 °C
Operating relative humidity, 5°C to 30°C	10 % to 70 %
Operating relative humidity, 30°C to 40°C	10 % to 50 %
Storage relative humidity	0 % to 95 %, non-condensing
Maximum operating altitude	3000 m
Dimensions: **Height** **Width** **Depth (with handles)** **Depth (without handles)** **Weight**	 147 mm (5.8 in) 439 mm (17.3 in) 447 mm (17.6 in) 406 mm (16.0 in) 7.3 kg (16.0 lb)

3 Preparation for operation

3.1 Unpacking and inspection

The Super-Thermometer is shipped in a container designed to prevent damage during shipping. Inspect the contents of the container for damage and immediately report any damage to the shipping company. Instructions for inspection are included in the shipping container.

Table 9 *Optional accessories*

Item	Model or part number
Rack Mount Kit	1594-RMKT
2590 Scanner	2590
Case	1594-CASE
Carry-handle Kit	1594-HNDL
Extended range test report	1994 (1594A), 1995 (1595A)

3.2 Instruction Manuals

The Super-Thermometer instruction manual set is shipped on CD. The set includes:

- 1594A/1595A Super-Thermometer User's Guide
- 1594A/1595A Super-Thermometer Technical Guide

The 1594A/1595A Super-Thermometer User's Guide contains instructions for unpacking and setting up the instrument. Specifications and an overview of Super-Thermometer operation are also included. The User's Guide is available in the following languages: English, Chinese, Spanish, Japanese, German, French, and Russian.

The 1594A/1595A Super-Thermometer Technical Guide contains complete information for setting up and operating the Super-Thermometer. It also includes instructions for remote operation, calibration and maintenance. The Technical Guide is available in English only.

For ordering a replacement instruction manual CD contact your local Fluke representative or service center. All manuals are available online for download in PDF format.

3.3 Line voltage and fuses

CAUTION: *To prevent possible damage to the instrument, verify the correct fuse is installed for the selected line voltage setting.*

The correct line power fuse and line voltage range was installed at the factory per the configuration that was ordered. However, it is important to verify the correct fuse value and line voltage setting. The fuse is accessible on the rear panel in the PEM (Power Entry Module). The line voltage setting is shown in the PEM window (see Figure 1 on next page) and see Section 2.2, Specifications, on page 5 for the fuse rating.

To check or replace the fuse and to verify or change the line voltage setting, refer to Figure 1 on next page and proceed as follows:

1. Disconnect line power.
2. Observe what line voltage setting is displayed in the PEM window. If it is correct, the fuse assembly will be re-inserted in the same orientation it is removed. Otherwise, it will need to be rotated 180° before re-insertion.
3. Open the fuse compartment by inserting a screwdriver blade in the slot located at the top of the fuse compartment and open the PEM door.
4. Use the screwdriver blade to pry out the fuse block by inserting the blade in the slot located at the top of the fuse block.
5. Remove the fuses from the assembly for replacement or verification. Be sure the correct fuses are installed.
6. Reinstall the fuse assembly by pushing it back into the PEM while ensuring that the correct line voltage label is shown in the PEM window. Close the PEM door so it locks in place.

Figure 1 *PEM (Power Entry Module)*

3.4 Connecting to Line Power

WARNING: *To avoid electrical shock, connect the factory supplied three-prong line power cord to a properly grounded power outlet. Do not use a two-prong adapter or extension cord that will break the ground connection.*

After the line voltage setting and correct fuse are verified, connect the instrument to a properly grounded three-prong outlet using the provided line voltage cord.

3.5 Placement and Rack Mounting

In general, place the Super-Thermometer in an area free of drafts and excessive electrical noise. Refer to the specifications for environmental requirements.

The Super-Thermometer is designed to be used on a bench-top or installed in a standard width rack with the optional rack mount kit. For bench-top use it is equipped with hinged, non-slip feet. For rack mount instructions, refer to the rack mount kit instruction manual.

4 Features

4.1 Introduction

The Super-Thermometer has been designed with several features that help make setup and operation as simple as possible while still providing many measurement capabilities. This section describes the front and rear panel features as well as the menu system. Please read this section before operating the instrument.

4.2 Front panel features

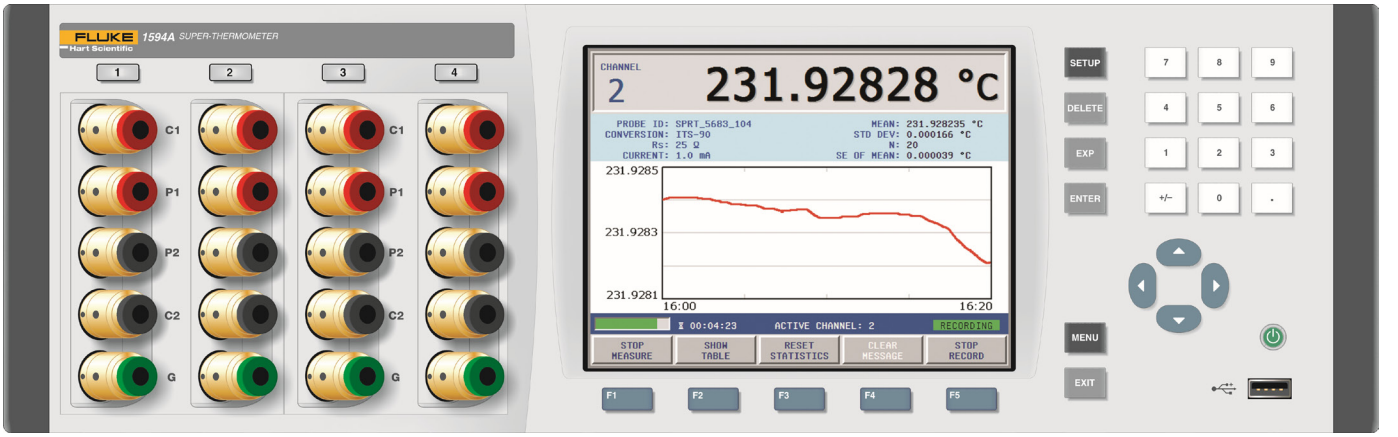


Figure 2 *Front view*

4.2.1 Measurement inputs

Four measurement inputs, channels 1 through 4, are located on the front panel. Some key points concerning the measurement inputs are:

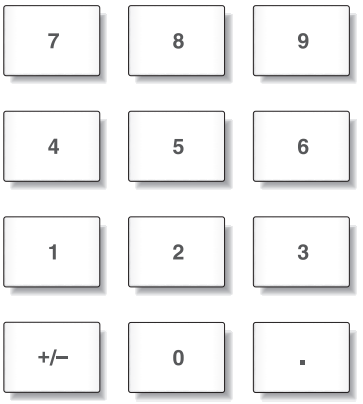
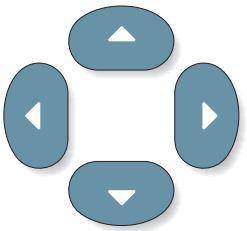
- Current (C1, C2), Potential (P1, P2), and Guard (G) terminals are labeled to facilitate correct connection (Figure 7 on page 24).
- Channels 2 and 4 can also be used as reference resistor (Rs) inputs.

4.2.2 USB connection

The USB port on the front panel allows a formatted USB memory device to be connected to the Super-Thermometer for saving measurements and settings. The memory device must be Linux compatible and formatted with the FAT32 file system.

4.2.3 Front panel keys

Table 10 *Front panel key descriptions*

	The Power Standby key turns off the display and disables the front panel keys, sending the system into standby. Power remains applied to some internal components such as the resistor oven. When the system is brought out of standby by pressing the Power Standby Key, it is not necessary to wait the 30-minute warm-up period.
	The numeric keys consist of the digits 0 through 9, sign (+/-), and decimal point (.). These keys are used for entering numeric values.
	The arrow keys are used to move the cursor on the display and to navigate lists
	The SETUP key is used to directly access the Channel Setup menu for quick and easy measurement configuration.
	The DELETE key is used to delete alpha-numeric characters
	The EXP key is used when entering an exponential number for example: 1.0 E-04
	The ENTER key is used to save a change or to select an item. When an item is changed, ENTER must be pressed otherwise the item reverts to its original value upon exiting.
	The MENU key is used to go directly to the Main Menu screen.
	The EXIT key is used to exit from a menu or setting. Pressing EXIT will leave an edit without saving the changes. When entering a number, if EXIT is pressed and held, the entire number is deleted and the cursor is moved to the leftmost place in the number field.
	The Function Keys are located below the display and are used to execute the function displayed directly above them. Function keys are used to select menu options and in certain cases they are used to toggle a setting shown on the display.
	Pressing any of the four Channel Select Keys will automatically activate the selected channel and illuminate the Channel Select Key in green. If a channel is in standby mode, the Channel Select Key is illuminated in amber. If a channel is inactive,the Channel Select Key is clear.

Front panel display

The Front Panel Display is shown in Figure 3 on this page. The display screen is used to show all measurements, menus and configuration information.

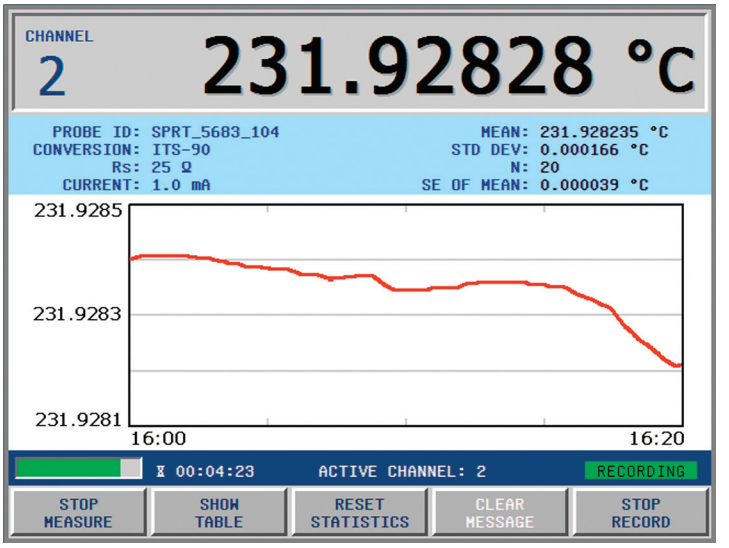


Figure 3 *Front panel display*

The default display language is English. The display can be shown in the following language options: English, Chinese, Spanish, Japanese, German, French, and Russian.

The display language can be changed in the User Settings screen. The User settings screen is displayed, in English (regardless of language setting), when using a shortcut key sequence that is entered from the Measurement screen. In the Measurement screen (press and hold the EXIT key to return to the Measurement screen), press and release the ENTER key and then press the SETUP key. Use the Up/Down arrow keys to select the LANGUAGE configuration field and then use the Left/Right arrow keys to choose the intended language. Pressing the ENTER key saves the new selection.

For all other display configuration settings, see the Display Menu section of the Technical Guide.

4.3 Rear panel features

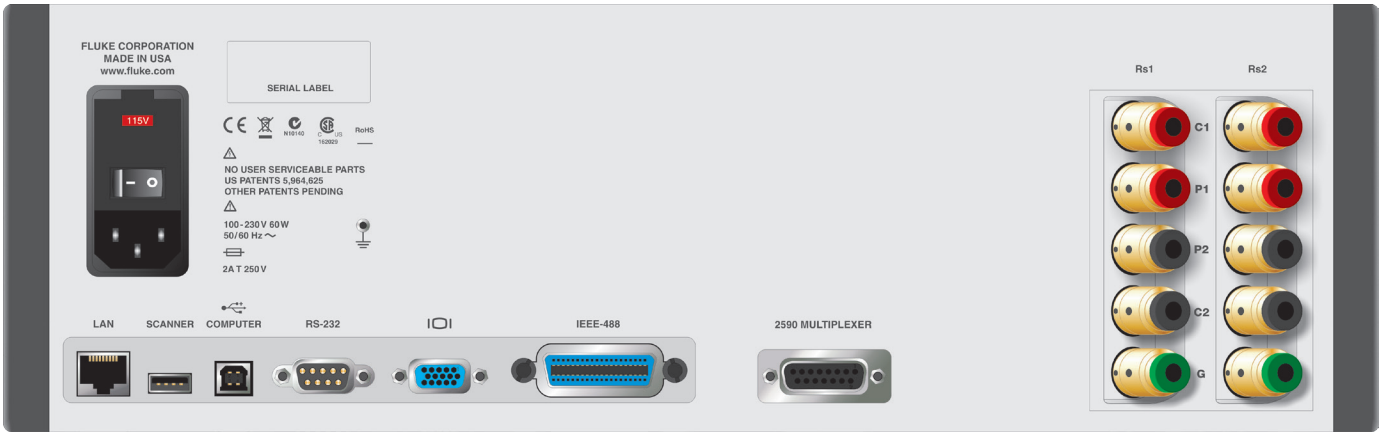


Figure 4 *Rear view*

External resistor inputs

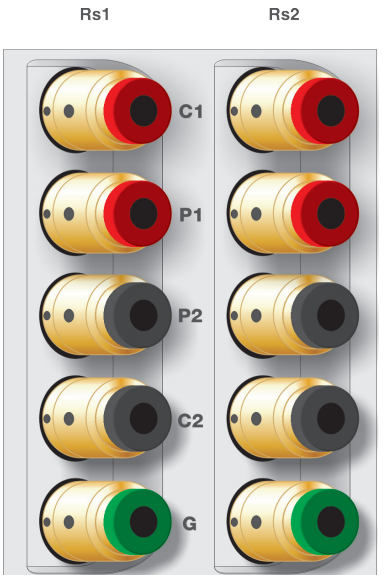


Figure 5 *External resistor inputs*

The Rs1 and Rs2 external reference resistor connections are located on the rear panel. The Current (C1, C2), Potential (P1, P2) and Guard (G) terminals are labeled to facilitate proper connection (see Figure 7 on page 24).

4.3.1 Scanner connection

The 2590 Scanner connection is a 15-pin socket located on the back panel. It is used to control an optional scanner. Refer to the scanner manual for connection and setup instructions.

4.3.2 Future peripheral connection

SCANNER

A USB peripheral port is intended for future peripheral control.

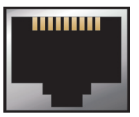
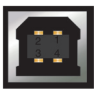
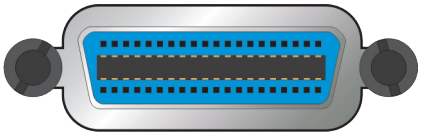
Note: *This port is NOT used for external memory connection. For external memory via USB see Section 4.2.2, USB connection, on page 13 and Figure 2 on page 13.*

4.3.3 Remote Operation Connections

The Super-Thermometer comes equipped with several remote operation connections. See Table 11 on this page for the remote operation connection descriptions.

Remotely view the Super-Thermometer's display in a web browser via the LAN connection. This connection also allows limited control of the Super-Thermometer (start/stop measurement, reset statistics, clear alert message, start/stop recording).

Table 11 *Remote operation connections*

Connection	Description
LAN 	Ethernet connector that allows connection to a network for controlling the instrument and transmitting measurements
 COMPUTER 	USB port that allows the instrument to be controlled as a USB peripheral from a computer
RS-232 	9-pin subminiature D type serial port that can be used to control the instrument via RS-232
IEEE-488 	IEEE-488 Input/Output that is compatible with IEEE-488 interface and the IEC 625 Bus for controlling the instrument

4.3.4 Line voltage connection

Figure 6 *Power Entry Module*

The PEM (Power Entry Module) located on the rear panel connects the Super-Thermometer to line voltage. It contains the Line Voltage Power Switch, the Line Voltage Fuses, and the Line Voltage Selector. See the Line Voltage and Fuses section for configuration and connection instructions.

4.3.5 Earth ground connection

The Earth Ground Connection is provided to allow connection to earth ground. This connection can help improve measurement noise. It is not intended to replace the ground connection provided through the line voltage cord.

4.4 Menu system features

The Super-Thermometer menus and screens are designed to help the user quickly and easily set up the instrument for measurement while also providing many configuration options. It is important to note that some function keys are located in multiple locations in the menu system for ease of use. See the complete menu structure in section 3.5.

The following are descriptions of the primary menus and screens. Refer to the Technical Guide for in-depth information regarding the menus and screens.

4.4.1 User settings screen

- Helps the user configure the device settings
- First screen displayed upon initial power-up from factory
- Can be recalled from the Measurement screen (see Section 4.4.2, Measurement screen, on this page) by pressing and releasing ENTER, then pressing SETUP

4.4.2 Measurement screen

- Displayed upon power-up (except first time from factory)
- Contains function keys and display options needed for typical measurement functions
- Can be recalled from any other screen by pressing and holding the EXIT key
- Can be set to Data Graph or Data Table mode

4.4.3 Main menu screen

- Contains the menus and screens needed for configuration of the Super-Thermometer and its measurements.
- Directly accessed from any screen by pressing the MENU key.

4.4.4 Channel setup screen

- Contains the function keys needed to allow the user to quickly configure measurements including the setup of measurement channels and assigning of probe definitions.
- Directly accessed from any screen by pressing the SETUP key.

4.4.5 Menu navigation tips

The following are some tips for using the Super-Thermometer menus and screens:

- Function Keys are used to select menus and functions and in some cases to toggle settings.
- The EXIT key is used to exit a screen or menu and allows the user to leave an edit without saving.
- Menus and screens contain help text that clarify the purpose of the menu or screen.
- When a field requires alpha-numeric character input, an alpha-numeric interface opens automatically upon pressing ENTER while the field is selected.
- Some screens may be password protected. If the password is required, a special password screen will appear. More information concerning password protection is found in the System Menu section of the Technical Guide.

4.5 Menu structure

MAIN MENU (**MENU** key)

CHANNEL SETUP (**SETUP** key)

| ASSIGN PROBE (see PROBE MENU below)

| CHANNEL SETTINGS

| | SET UP Rs

| | ASSIGN RESISTOR

| | DEFINE RESISTOR

| | | ADD RESISTOR

| | | EDIT RESISTOR

| | | READ RESISTOR

| | MANAGE RESISTORS

| | READ FILE

| | WRITE FILE

| | MOVE UP

| | MOVE DOWN

| | DELETE RESISTOR

| ON/OFF

| MEASURE MENU (see MEASURE MENU below)

PROBE MENU

- ADD PROBE
- COPY PROBE
- EDIT PROBE
  - TEST CALCULATION
- READ PROBE
- MANAGE PROBES
  - READ FILE
  - WRITE FILE
  - MOVE UP
  - MOVE DOWN
  - DELETE PROBE

MEASURE MENU

- SCAN SETTINGS
- TIMING SETTINGS
- DIGITAL FILTER
- RECORDING MENU
  - RECORDING SETTINGS
  - VIEW DATA
  - READ FILE
  - WRITE FILE
  - ERASE DATA
- ZERO-POWER MEASUREMENT

DISPLAY MENU

- USER SETTINGS
- FIELD SETTINGS
- STATISTICS SETTINGS
- GRAPH SETTINGS
- TEMPERATURE UNIT

SYSTEM MENU

- TIME DATE
- REMOTE INTERFACE
  - SERIAL
  - USB
  - NETWORK
  - IEEE-488
  - ERRORS
- CONFIG
  - STORE CONFIG

- | RECALL CONFIG
- | DELETE CONFIG
- | RESTORE DEFAULT
- | UPDATE FIRMWARE
- PASSWORD
- CALIBRATION
  - SYSTEM TEST
  - CURRENT TEST
  - RATIO CALIBRATION
  - RESISTANCE CALIBRATION

CALIBRATION PARAMETERS

5 Getting started

5.1 Powering on the Super-Thermometer

CAUTION: *Before powering the Super-Thermometer on, ensure that the line voltage selection is set properly. Refer to Section 3.3, Line voltage and fuses, on page 11 for instructions.*

Power the Super-Thermometer on by setting the power switch located on the back panel to the On position. After power is on, pressing the Power Standby switch on the front panel puts the system into hibernation, leaving key components such as the resistor oven powered on.

The first time the unit is powered on, the User Settings screen will be displayed after startup. Later in the section it will be explained how this feature is turned off so the Measurement screen is displayed when the unit is powered on.

5.2 User settings screen

The User Settings screen allows the user to configure system settings such as language, temperature measurement resolution, screen saver settings and alarms. As mentioned previously, the User Settings screen is the first displayed upon the first power-up. This feature can be turned off by the user after the user settings have been configured.

The following fields are displayed in the User Settings screen:

LANGUAGE- sets the language in which the menus and screens are displayed. The options are ENGLISH, CHINESE, JAPANESE,SPANISH, GERMAN, FRENCH, and RUSSIAN. ENGLISH is the default option.

DATE FORMAT- sets the format used to display dates on the screen. Available options are YYYY-MM-DD, MM-DD-YYYY, and DD/MM/YYYY. The default option is YYYY-MM-DD. This setting has no effect on communications commands and responses, recorded data, or library files.

DECIMAL FORMAT- sets the decimal character used in decimal numbers on the display. Available options are period (.) and comma (,). The default option is (.). This setting has no effect on communications commands and responses, recorded data, or library files.

TEMPERATURE RESOLUTION- sets the desired number of decimal places that appear in displayed temperature measurements. Available options are 0.1 through 0.000001. The default option is 0.00001. The actual number of decimal places of displayed temperatures may be reduced for large numbers. This setting has no effect on communications commands and responses, recorded data, or library files. The resolution of displayed resistances and resistance ratios is fixed at the maximum practical resolution.

SCREEN SAVER ENABLE- enables or disables the screen saver. If Screen Saver Enable is OFF, the display will remain on indefinitely. Enabling the screen saver saves power and extends the lifetime of the display. The default option is OFF.

SCREEN SAVER DELAY- sets the screen saver delay time. Available options are 5 min, 10 min, 15 min, 30 min, 45 min, 1 hr, and 2 hr. The default option is 1 hr.

DISPLAY BRIGHTNESS- sets the brightness of the display backlight. Available options are 50 %, 60 %, 70 %, 80 %, 90 %, and 100 %. The default option is 100 %. Reducing the display brightness saves power and extends the lifetime of the display.

ITS-90 SUBRANGE WARNING- enables (ON) or disables (OFF) the warning message that appears at the bottom of the Measurement Screen when a probe's measured temperature exceeds its ITS-90 subrange by more than 10°C. The default option is ON.

Rs DUE WARNING- enables (ON) or disables (OFF) the warning message that appears at the bottom of the Measurement screen when the due date of a resistor in the Resistor Library is past. The default option is OFF.

WARNING BEEP- enables (ON) or disables (OFF) the audio indication that accompanies warning messages. The default option is ON.

KEYPAD BEEP- enables (ON) or disables (OFF) the audio indication that accompanies each key-press. The default option is ON.

START-UP HELP- determines whether the User Settings screen appears automatically after power-on. When the settings is ON the User Settings screen will appear every time the power is switched on. If the setting is OFF the Measurement screen will appear instead. The default option is ON.

NOTE: *The following apply only the first time the unit is powered-on from the factory:*

Pressing the NEXT (F1) function key continues to the Time and Date screen allowing the user to enter the system Time, Date and Daylight Saving settings with the following configuration fields:

TIME- is the time of the system clock. It is always in 24-hour format.

DATE- is the date of the system clock. It appears in the format determined by the Date Format setting (see Section 5.2, User settings screen, on page 23).

DAYLIGHT SAVING- determines whether the system clock is automatically adjusted at the beginning and end of the Daylight Saving period. Options are OFF, NORTH AMERICA, and EUROPE.

The user settings sequence is completed by selecting the NEXT (F1) function key at which point the user is prompted to allow the user settings screen to be displayed upon power-up. After making the selection, the Channel Setup screen is shown to help the user set up a measurement.

5.3 Connecting a probe or resistor

CAUTION: *Incorrect sensing current can damage a probe or resistor. Before connecting a device to the Super-Thermometer ensure that the sensing current setting does not exceed the limit of the device.*

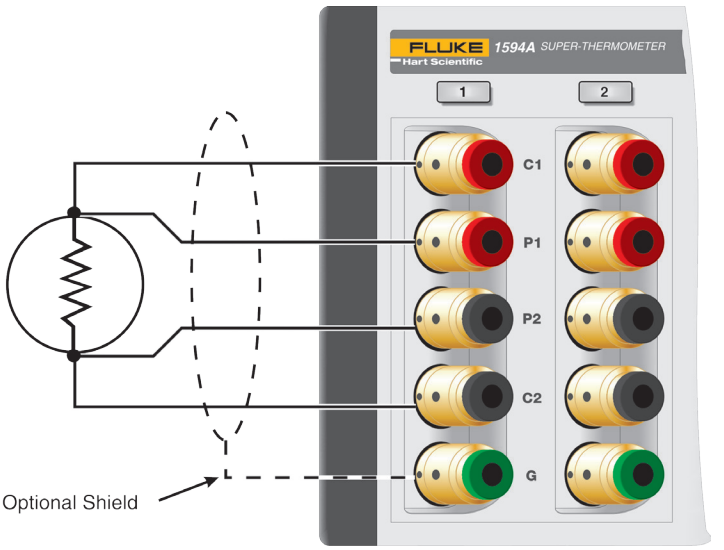


Figure 7 *Input wiring*

The Super-Thermometer measurement inputs are equipped with patented gold-plated DWF connectors. These connectors are spring-loaded to provide constant contact pressure with measurement connections and they require little maintenance.

The DWF connectors are designed to accept spade connectors (by pressing the connector open), bare wire (inserted in one of the side holes while pressing the connector open), and banana jacks (inserted in the front). For best results, always use wires and connectors that are clean and free of corrosion and oxidation.

The DWF connectors are labeled with C1, C2 (current connections) and P1, P2 (measurement potential connections). The guard connector is labeled with a “G” and is used for connecting to a probe or resistor guard or shield. The guard connection may help reduce measurement noise.

Connect a probe or resistor, as specified by the device’s manufacturer, to any one of the four measurement channels located on the front panel. To prevent the possibility of applying too much current, suspend measurement sampling and configure the channel before making the connection.

6 Making measurements

6.1 Introduction

The Super-Thermometer has been designed to allow quick and easy measurement setup while providing flexible measurement options. A measurement setup varies with the type of measurement being performed. The purpose of the following sections is to guide the user through the setup of typical measurements. Refer to the Technical Guide for more detailed information concerning measurement setup.

6.2 Temperature measurement

The following are the steps for setting up and performing a temperature measurement:

1. Press and hold the EXIT key to go to the Measurement screen.
2. If necessary, suspend measurement by pressing the START/STOP MEASUREMENT (F1) function key located in the Measurement screen.
3. Connect a temperature probe to one of the measurement input channels.
4. Press the SETUP key to open the channel setup screen. Use the Up/Down arrow keys to highlight the channel where the probe is connected. Scanner channels, if available, are identified with a S1 (scanner 1) or a S2 (scanner 2) prefix added to the channel number.
5. Once the channel is highlighted, use the following steps to assign a probe definition to the selected channel:
    a. Select the ASSIGN PROBE (F1) function key to open the Probe Library.
    b. Scroll through the list of probe definitions using the Up/Down arrow keys. If the desired probe definition has not been previously entered, select ADD PROBE (F1) to begin the process of creating a probe definition (see the Probe Menu section in the Technical Guide for more information).
    c. When the desired probe definition is highlighted, press the ENTER key to assign the selected probe definition to the highlighted channel.
6. Select the CHANNEL SETTINGS (F2) function key to configure the measurement channel. Use the following steps to configure the channel:
    a. Select the desired reference resistor (Rs) to be used for the measurement. Use Table 12 on the next page as a guide for the selection.
    b. Verify the correct sensing current has been selected.
    c. Determine whether standby current (used to self-heat the probe sensor when channel is not being measured) is to be On or Off.
    d. Select the desired measurement calculation. The options are RESISTANCE (to output the probe's resistance only), RATIO (to output the ratio of the probe's resistance versus the reference resistor), and TEMPERATURE (only if calibration coefficients were entered in the probe definition).
    e. Press the EXIT key to move back to the Channel Setup screen.
7. If the desired measurement channel is set to Off, use the On/Off (F3) function key to toggle the channel to On.
8. If necessary, select the MEASURE MENU (F4) function key to configure settings such as channel scanning, measurement timing, digital filter settings, measurement recording, and zero-power measurement. Otherwise, press the EXIT key twice (or press and hold the EXIT key) to go to the Measurement screen.
9. In the Measurement screen, select the START MEASURE (F1) function key to start measurement sampling.

After measurement has started, use the SHOW TABLE/GRAPH (F2) function key to toggle between a measurement data table screen and a data graph screen. All other measurement options and settings are explained in full detail in the Technical Guide.

Table 12 *Recommended Reference Resistors and Sensing Current*

Probe Type	Reference Resistance	Sensing Current
25 Ω SPRT	25 Ω	1.0 mA
100 Ω PRT or RTD	100 Ω	1.0 mA
2.5 Ω SPRT	10 Ω	5.0 mA
0.25 Ω SPRT	1 Ω	14.14 mA
1000 Ω PRT or RTD	10 kΩ	0.05 mA
Thermistors, 2 kΩ to 10 kΩ	10 kΩ	0.01 mA

6.3 Ratio Measurement

The ratio measurement is the fundamental measurement from which the resistance and temperature measurements are derived. It is simply the ratio (Rx/Rs) between an unknown resistance (Rx) and a reference resistor (Rs). To configure the Super-Thermometer for a ratio measurement, follow the steps listed in Section 6.2, Temperature measurement, on page 27 except select the RATIO option in step 6.d.

6.4 Using an External Resistor

The Super-Thermometer is equipped with a set of internal resistors. If needed, up to four external resistors can be connected using Rs1 and Rs2 inputs on the back panel and Ch2 and Ch4 inputs on the front panel. Use the following instructions for connecting and measuring with an external resistor:

1. Suspend measurement by going to the Measurement Screen and pressing the STOP MEASUREMENT (F1) function key.
2. Connect a reference resistor using one of the Rs inputs. Ensure the current and potential connections are correct.
3. Go to the Add Resistor screen by using the following steps:
    a. Press the SETUP key to open the Channel Setup screen.
    b. Select the CHANNEL SETTINGS (F2) function key.
    c. Select the SETUP RS (F1) function key.
    d. Select the DEFINE RESISTOR (F2) function key.
    e. Select the ADD RESISTOR (F1) function key.
4. Enter a unique ID in the ID field. Pressing the ENTER key will open the Alpha-Numeric Interface for text entry.
5. Enter the resistance value of the resistor in the RESISTANCE VALUE field.

CAUTION: *The Resistance Value field is used in measurement for the calculation of the Rx resistance. Entering this value incorrectly will cause measurement error.*

6. Set the maximum measurement current allowed for the reference resistor.
7. If necessary, enter the calibration date and due date for the external reference resistor. The Super-Thermometer will use the due date to warn the user when the resistor is due for calibration.
8. Select the SAVE (F1) function key to save the definition.
9. Press the EXIT key to go up one menu to the Set Up Rs screen. Use the Up/Down arrow keys to highlight the Rs input to which the external resistor is connected.
10. Select the ASSIGN RESISTOR (F1) function key to open the list of defined reference resistors. Use the Up/Down arrow keys to highlight the resistor's definition. Press the ENTER key to assign the resistor to the selected Rs input.
11. Now, when selecting the reference resistor in Section 6.2, Temperature measurement, on page 27, step 6.a, the newly entered external resistor will appear as an option.

7 Maintenance

Avoid operating the instrument in excessively wet, oily, dusty, or dirty 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 that may damage the paint or plastic.

- The instrument should be handled with care. Avoid knocking, dropping, or vibrating the instrument.
- This instrument is tested and calibrated at the factory. Continued regular testing and calibration is recommended.
- Routinely check the ratio accuracy using the Ratio Self-Calibration function.

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