

FLUKE®

Calibration

5502E

Multi-Product Calibrator

Getting Started

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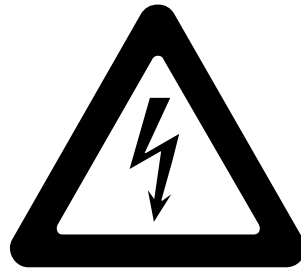
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Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

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

OPERATOR SAFETY SUMMARY

WARNING



HIGH VOLTAGE

is used in the operation of this equipment

LETHAL VOLTAGE

may be present on the terminals, observe all safety precautions!

To prevent electrical shock hazard, the operator should not electrically contact the output HI or sense HI terminals or circuits connected to these terminals. During operation, lethal voltages of up to 1020 V ac or dc may be present on these terminals.

When the nature of the operation permits, keep one hand away from equipment to reduce the hazard of current flowing through vital organs of the body.

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Getting Started

Introduction

Warning

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

This manual gives the feature differences between the 5502A and the 5502E. Use this manual in conjunction with the 5502A Operators manual.

All instructions in the 5502A Operators Manual apply to the 5502E except as noted below.

- The DC and AC Power (Simultaneous Voltage and Current outputs) functions are not applicable to the 5502E.
- The Dual Voltage (Simultaneous Voltage/Voltage output) function is not applicable to the 5502E.
- The Phase function is not applicable to the 5502E.
- The Harmonics function is not applicable to the 5502E.
- The rear panel 10 MHz Reference IN and OUT connectors are not functional. The terminals are for service only.
- The 300 MHz and 600 MHz options are not compatible with the 5502E.

The 5502E does not have SCOPE and TRIG OUT terminals. The SCOPE and TRIG OUT buttons are on the front panel of the 5502E, but they are non-functional and beep when pushed.

The Product in Figure 1 can be configured to source:

- DC voltage from 0 V to ± 1020 V.
- AC voltage from 1 mV to 1020 V, with output from 10 Hz to 500 kHz.
- AC current from 29 μ A to 20.5 A, with variable frequency limits.
- DC current from 0 to ± 20.5 A.
- Resistance values from a short circuit to 1100 M Ω .
- Capacitance values from 220 pF to 110 mF.
- Simulated output for eight types of Resistance Temperature Detectors (RTDs).
- Simulated output for 11 types of thermocouples.

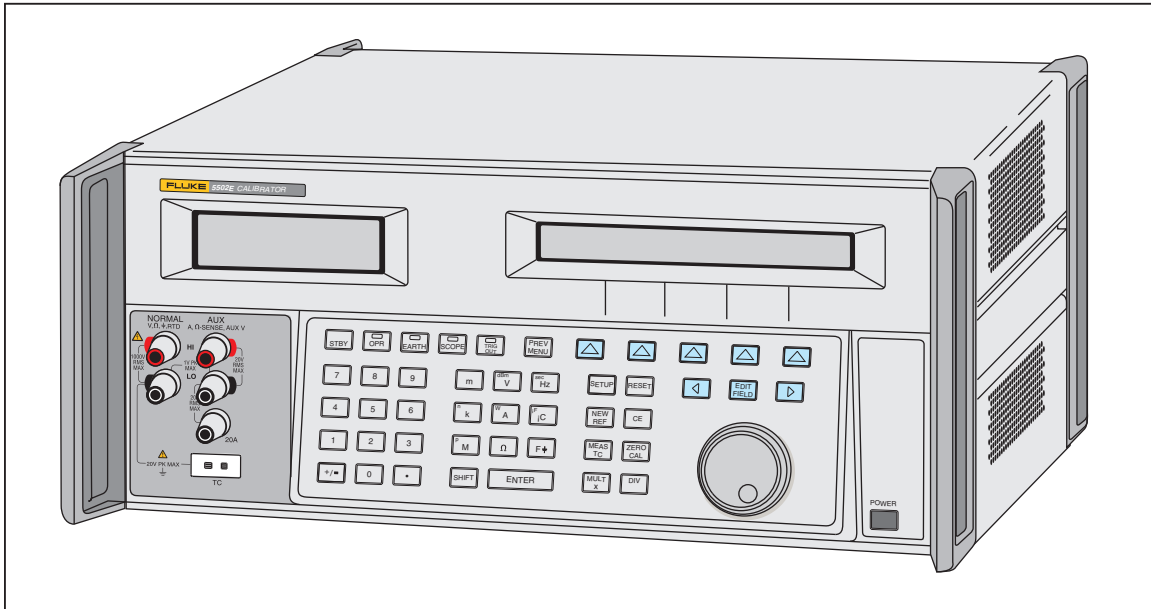


Figure 1. 5502E Multi-Product Calibrator

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Calibrator features include:

- Automatic meter error calculation, with reference values that you can select.
- **MULT** and **DIV** keys that change the output value to predetermined values for various functions.
- Programmable entry limits. These limits do not let you go above preset output limits.
- Voltage and current that can be output at the same time, to an equivalent of 20.9 kW.
- The power to output two voltages at the same time.
- Extended bandwidth mode outputs multiple waveforms down to 0.01 Hz, and sine waves to 2 MHz.
- A Standard IEEE-488 (GPIB) interface that complies with ANSI/IEEE Standards 488.1-1987 and 488.2-1987.
- A EIA Standard RS-232 serial data interface to print, show, or move internally stored calibration constants, and for remote control of the 5502E.
- A pass-through RS-232 serial data interface to send data to the Unit Under Test (UUT).

Safety Information

In this manual, 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:







- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Carefully read all instructions.
- Do not use the Product around explosive gas, vapor, or in damp or wet environments.
- Use this Product indoors only.
- Do not touch voltages > 30 V ac rms, 42 V ac peak, or 60 V dc.
- Do not use the Product if it operates incorrectly.
- Do not use and disable the Product if it is damaged.
- Do not use test leads if they are damaged. Examine the test leads for damaged insulation, exposed metal, or if the wear indicator shows. Check test lead continuity.
- Use only cables with correct voltage ratings.
- Connect the common test lead before the live test lead and remove the live test lead before the common test lead.
- Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.
- 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.
- Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.
- Do not connect directly to mains.
- Do not use an extension cord or adapter plug.
- For safe operation and maintenance of the Product, make sure that the space around the Product meets minimum requirements.

This Calibrator complies with:

- ANSI/ISA-61010-1 (82.02.01)
- CAN/CSA C22.2 No. 61010-1-04
- ANSI/UL 61010-1:2004
- EN 61010-1:2001
- ANSI/IEEE Standards 488.1-1987 and 488.2-1987.

Symbols used in this manual and on the Product are in Table 1.

Table 1. Symbols

Symbol	Description	Symbol	Description
CAT I	IEC Measurement Category I – CAT I is for measurements not directly connected to mains. Maximum transient Overvoltage is as specified by terminal markings.		Conforms to relevant North American Safety Standards.
CE	Conforms to European Union directives.		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.
	Risk of Danger. Important information. See manual.		Hazardous voltage
	Earth ground		Conforms to relevant Australian EMC requirements.

Contact Fluke Calibration

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

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- 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>.

Overload Protection

The Calibrator supplies reverse-power protection, fast output disconnection, and/or fuse protection on the output terminals for all functions.

Reverse-power protection prevents damage to the calibrator from occasional, accidental, normal-mode, and common-mode overloads to a maximum of ± 300 V peak. It is not intended as protection against frequent (systematic and repeated) abuse. Such abuse will cause the Calibrator to fail.



For volts, ohms, capacitance, and thermocouple functions, there is fast output disconnection protection. This protection senses applied voltages higher than 20 volts on the output terminals. It quickly disconnects the internal circuits from the output terminals and resets the calibrator when such overloads occur.

For current and aux voltage functions, user replaceable fuses supply protection from overloads applied to the Current/Aux Voltage output terminals. The fuses are accessed by an access door on the bottom of the calibrator. You must use replacement fuses of the same rating and type specified in this manual, or the protection supplied by the Calibrator will be compromised.

Operation Overview

The Calibrator can be operated at the front panel or remotely with the RS-232 or IEEE-488 ports. For remote operations, software is available to integrate Product operation into a wide variety of calibration requirements.

Local Operation

Typical local operations include front-panel connections to the UUT, and then manual keystroke entries at the front panel to put the Calibrator in the necessary output mode.  and  make it easy to step up or down at the push of a key. You can also examine Calibrator specifications at the push of two buttons. The backlit LCD is easy to read from many different angles and can be read in dim or bright light. The large, easy-to-read keys are color-coded and give tactile feedback.

Remote Operation (RS-232)

There are two rear-panel serial data RS-232 ports: SERIAL 1 FROM HOST, and SERIAL 2 TO UUT (see Figure 2). Each port is dedicated to serial-data communications to operate and control the Product during calibration procedures. For complete information on remote operation, see Chapter 5 of the Operators Manual.

The SERIAL 1 FROM HOST serial data port connects a host terminal or personal computer (PC) to the Calibrator. To send commands to the Calibrator: enter commands from a terminal (or a PC running a terminal program), write your own procedures with BASIC, or use optional Windows-based software such as MET/CAL Plus.

The SERIAL 2 TO UUT serial data port connects a UUT to a PC or terminal with the 5502A (see Figure 2). This “pass-through” configuration removes the requirement for two COM ports at the PC or terminal. A set of four commands control the operation of the SERIAL 2 TO UUT serial port. See Chapter 6 for a discussion of the UUT_ commands.

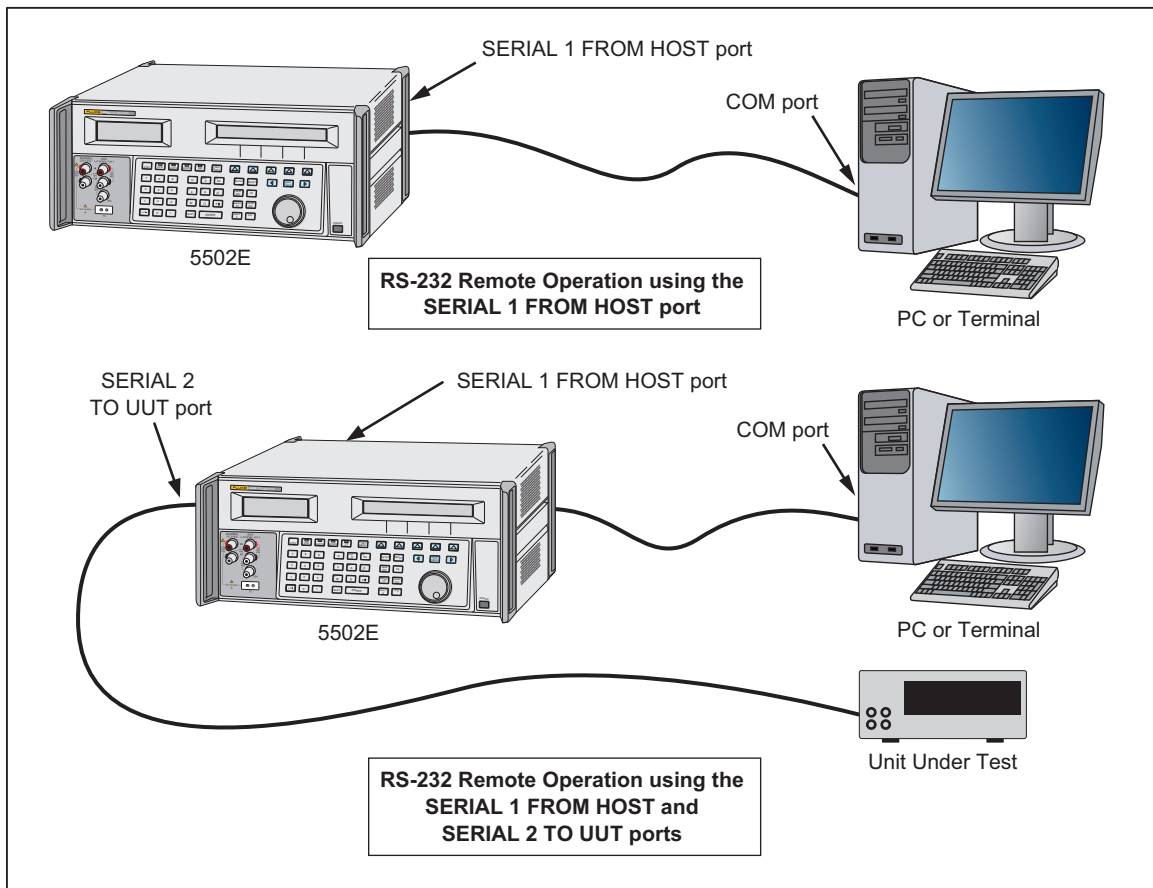


Figure 2. RS-232 Remote Connection

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Remote Operation (IEEE-488)

The rear-panel IEEE-488 port is a fully programmable parallel interface bus that complies with standard IEEE-488.1 and supplemental standard IEEE-488.2. When the Calibrator is used by remote control of an instrument controller, the Calibrator operates exclusively as a “talker/listener.” You can write your own programs with the IEEE-488 command set or run the optional Windows-based MET/CAL Plus software. See Chapter 6 of the Operators Manual for a discussion of the commands available for IEEE-488 operation.

Unpack and Inspection

The calibrator is shipped in a container to prevent damage. Examine the calibrator carefully for damage and immediately report damage to the shipper. Instructions for inspection and claims are included in the shipping container.

When you unpack the calibrator, make sure that you have all the standard equipment in Table 2. Examine the shipping list to make sure other items that you purchased are included. Refer to the “Accessories” section in Chapter 8 of the Operators Manual for more information. Report missing items to the point of purchase or to the nearest Fluke Calibration Service Center (see “Contact Fluke Calibration”). A performance test is in the “Maintenance” section of Chapter 7 in the Operators Manual.

If you ship the calibrator to Fluke Calibration, use the initial container. If it is not available, you can get a new container from Fluke Calibration with the Calibrator model and serial number.

Table 2. Standard Equipment

Item	Model or Part Number
Calibrator	5502E
Mains Power Cord	See Table 3 and Figure 4
<i>5502E Getting Started Manual</i>	4238530
<i>5502A Operators Manual on CD-ROM</i>	4155227

Select Line Voltage

The Calibrator comes from the factory configured for the line voltage typically applicable for the country of purchase, or as specified at the time of your purchase order. You can operate the Calibrator from one of four line-voltage settings: 100 V, 120 V, 200 V, and 240 V (47 Hz to 63 Hz). To verify the line-voltage setting, note the voltage setting that you can see through the window in the power-line fuse compartment cover (Figure 3). The permitted line-voltage variation is 10 % above or below the line-voltage setting.

To change the line-voltage setting, complete the following procedure:

Warning

To prevent possible electrical shock, fire, or personal injury, disconnect line power.

1. To open the fuse compartment, put a screwdriver blade in the tab on the left side of the compartment and pry until it can be removed.
2. To remove the line-voltage selector assembly, hold the line-voltage indicator tab with pliers and pull it straight out of its connector.
3. Turn the line-voltage selector assembly to the necessary voltage and reinsert.
4. Make sure to use the correct fuse for the selected line voltage (100 V/120 V, use 5 A/250 V slow blow, 220 V/240 V, use 2.5 A/250 V slow blow). To install the fuse compartment, push it into position until the tab locks.

Connect to Line Power

Warning

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

- **Do not use a two-conductor mains power cord unless you install a protective ground wire to the Product ground terminal before you operate the Product.**
- **Do not use an extension cord or adapter plug.**

Make sure that the Product is grounded before use. The calibrator is shipped with the correct line-power plug for the country of purchase. If it is necessary to use a different type, refer to Table 3 and Figure 4 for a list and illustration of the line-power plug types available from Fluke Calibration.

After you make sure that the line voltage selection is set correctly and that the correct fuse for that line voltage is installed, connect the calibrator to a correctly-grounded three-prong outlet.

Select Line Frequency

The calibrator is shipped from the factory for nominal operation at 60 Hz line frequency. If you use 50 Hz line voltage, reconfigure the Calibrator for optimal performance at 50 Hz. To do this:

1. From the front panel, go into SETUP, INSTMT SETUP, OTHER SETUP.
2. Push the softkey below MAINS to change the selection to 50 Hz.
3. Store the change.

After a correct instrument warmup (on for 30 minutes or longer), you must zero the complete instrument again. See the section on “Zero the Calibrator” in Chapter 4 of the Operators Manual.

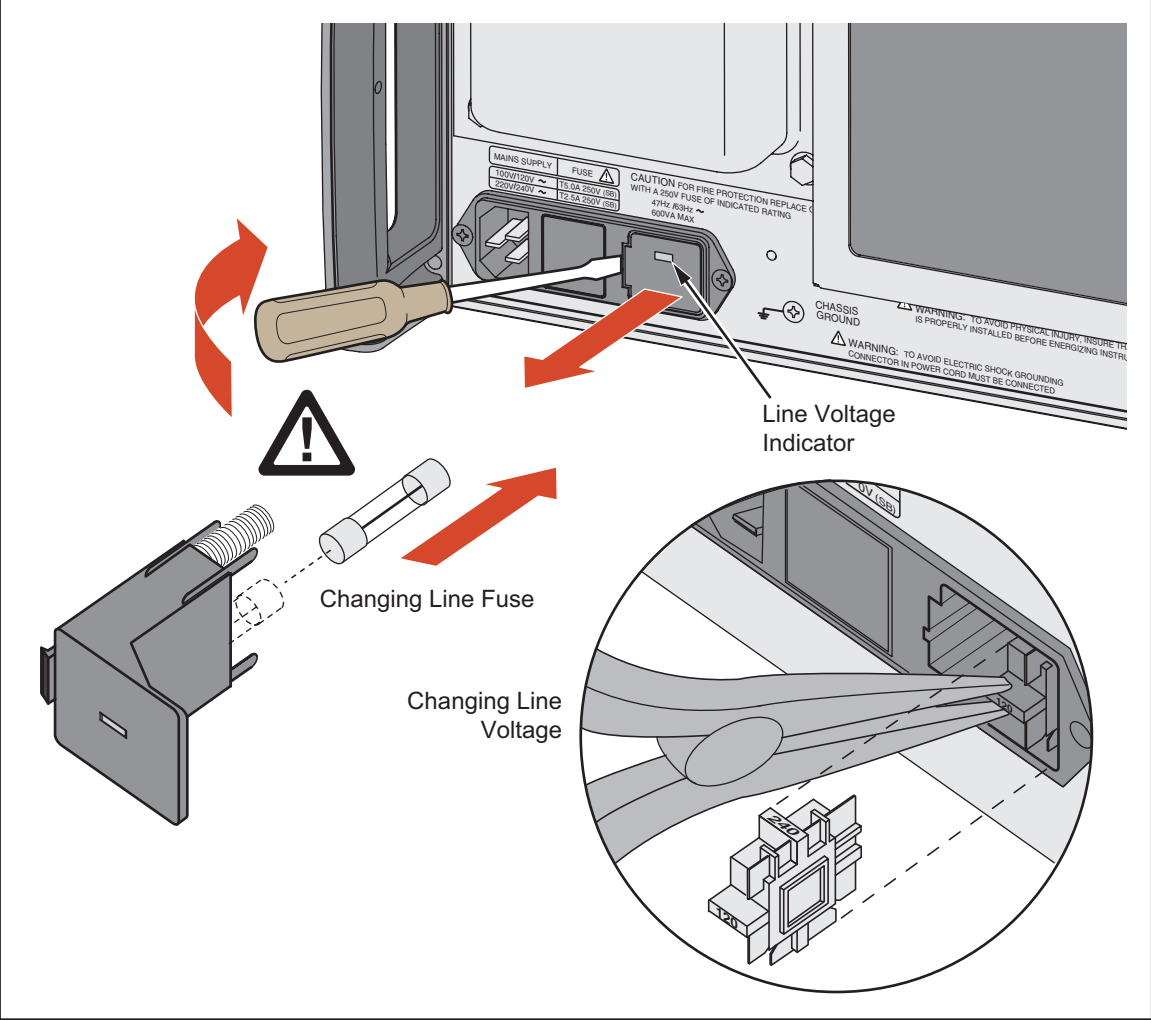


Figure 3. Access the Fuse and Select Line Voltage

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Table 3. Mains-Power Cord Types Available from Fluke Calibration

Type	Voltage/Current	Fluke Calibration Option Number
North America	120 V/15 A	LC-1
North America	240 V/15 A	LC-2
Universal Euro	220 V/15 A	LC-3
United Kingdom	240 V/13 A	LC-4
Switzerland	220 V/10 A	LC-5
Australia	240 V/10 A	LC-6
South Africa	240 V/5 A	LC-7

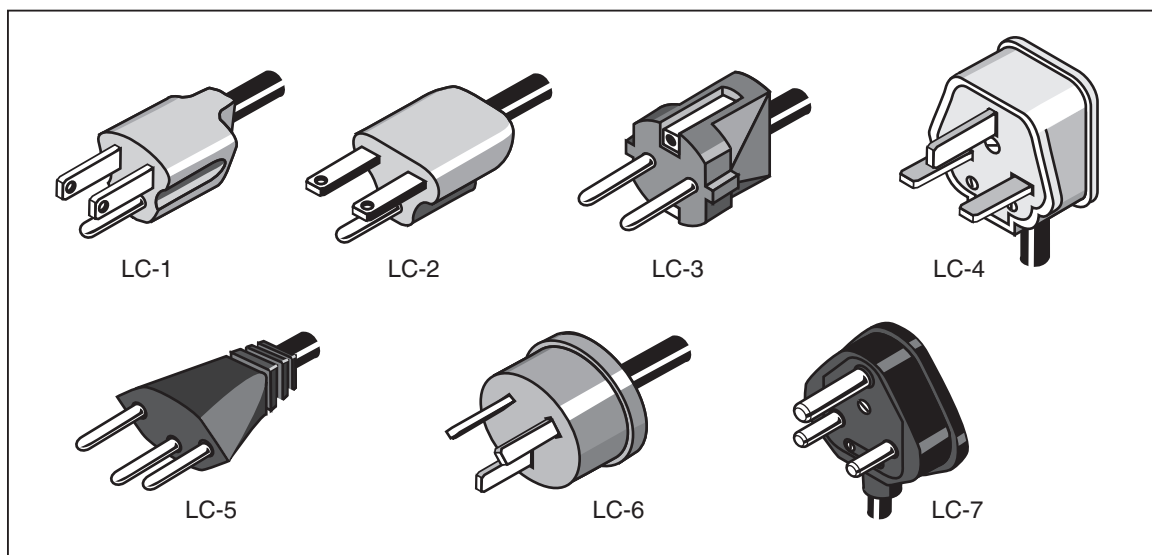


Figure 4. Mains-Power Cord Types Available from Fluke Calibration

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Placement

You can put the Product on a bench top or install it in a standard-width 24 inch (61 cm) depth equipment rack. For bench-top use, the Calibrator has a non-slip feet. To install the Calibrator in an equipment rack, use the 5502A Rack-Mount Kit, Model Y5537. Instructions to install the Calibrator into a rack come with the kit.

Airflow Considerations

⚠⚠ Warning

For safe operation and maintenance of the Product, make sure that the space around the Product meets minimum requirements.

Baffles put cool air from the fan into the chassis to internally dissipate heat when the Calibrator is in operation. The accuracy and dependability of all internal parts of the calibrator are enhanced by a cool internal temperature. You can increase the life of the Calibrator and enhance its performance by these rules:

- The area around the air filter must be a minimum 3 inches from close walls or rack enclosures.
- The exhaust perforations on the sides of the Calibrator must be clear of blockage.
- The air that gets to the Calibrator must be at room temperature. Make sure the exhaust air from other instruments does not enter into the fan inlet.
- Clean the air filter after 30 days or more frequently if the calibrator is operated in a dusty environment. (See the “Maintenance” chapter of the Operators Manual for instructions to clean the air filter.)

Instruction Manuals

The 5502E Manual Set includes:

- *5502A Operators Manual* on included CD-ROM (PN 4155227)
- *5502E Getting Started* (PN 4238530)

One of each manual above comes with the instrument. Refer to the Fluke Calibration Catalog or speak to a Fluke Calibration sales representative (see “Contact Fluke Calibration”) if more printed copies are necessary. The manuals are also available on the Fluke Calibration website.

5502E Getting Started Manual

This *5502E Getting Started* contains a brief introduction to the 5502E Manual Set, instructions on how to get your calibrator prepared for operation and a complete set of specifications.

5502A Operators Manual

The *5502A Operators Manual* supplies complete information to install the Calibrator and operate it from the front-panel keys and in remote configurations. The manual also has a glossary of calibration, specifications, and error-code information. The Operators Manual includes:

- Installation
- Controls and features, front-panel operation
- Remote operation (IEEE-488 bus or serial port remote control)
- Serial port operation (print, show, or transfer data, and setup for serial port remote control)
- Operator maintenance, with verification and calibration procedures
- Accessories
- SC600 and SC300 oscilloscope calibration options

General Specifications

The following tables list the 5502E specifications. All specifications are valid after allowing a warm-up period of 30 minutes, or twice the time the 5502E has been turned off. (For example, if the 5502E has been turned off for 5 minutes, the warm-up period is 10 minutes.)

All specifications apply for the temperature and time period indicated. For temperatures outside of $t_{cal} \pm 5^\circ\text{C}$ (t_{cal} is the ambient temperature when the 5502E was calibrated), the temperature coefficient as stated in the General Specifications must be applied.

The specifications also assume the Calibrator is zeroed every seven days or whenever the ambient temperature changes more than 5°C . The tightest ohms specifications are maintained with a zero cal every 12 hours within $\pm 1^\circ\text{C}$ of use.

Also see additional specifications later in this chapter for information on extended specifications for ac voltage and current.

Warmup Time	Twice the time since last warmed up, to a maximum of 30 minutes.
Settling Time	Less than 5 seconds for all functions and ranges except as noted.
Standard Interfaces	IEEE-488 (GPIB), RS-232
Temperature	
Operating	0°C to 50°C
Calibration (t_{cal})	15°C to 35°C
Storage	-20°C to $+70^\circ\text{C}$; The DC current ranges 0 to 1.09999 A and 1.1 A to 2.99999 A are sensitive to storage temperatures above 50°C . If the 5502E is stored above 50°C for greater than 30 minutes, these ranges must be re-calibrated. Otherwise, the 90 day and 1 year uncertainties of these ranges double.
Temperature Coefficient	Temperature coefficient for temperatures outside of $t_{cal} \pm 5^\circ\text{C}$ is 10 % of the stated specification per $^\circ\text{C}$.
Relative Humidity	
Operating	<80 % to 30°C , <70 % to 40°C , <40 % to 50°C
Storage	<95 %, non-condensing. After long periods of storage at high humidity, a drying-out period (with power on) of at least one week may be required.
Altitude	
Operating	3,050 m (10,000 ft) maximum
Non-operating	12,200 m (40,000 ft) maximum
Safety	Complies with EN/IEC 61010-1:2001, CAN/CSA-C22.2 No. 61010-1-04, ANSI/UL 61010-1:2004;
Output Terminal Electrical Overload Protection	Provides reverse-power protection, immediate output disconnection, and/or fuse protection on the output terminals for all functions. This protection is for applied external voltages up to $\pm 300\text{ V}$ peak.
Analog Low Isolation	20 V normal operation, 400 V peak transient
EMC	Complies with EN/IEC 61326-1:2006, EN/IEC 61326-2-1:2006 for controlled EM environments under the following conditions. If used in areas with Electromagnetic fields of 1 to 3 V/m from 0.08-1GHz, resistance outputs have a floor adder of $0.508\ \Omega$ Performance not specified above 3 V/m. This instrument may be susceptible to electrostatic discharge (ESD) to the binding posts. Good static awareness practices should be followed when handling this and other pieces of electronic equipment. Additionally this instrument may be susceptible to electrical fast transients on the mains terminals. If any disturbances in operation are observed, it is recommended that the rear panel chassis ground terminal be connected to a known good earth ground with a low inductance ground strap. Note that a mains power outlet while providing a suitable ground for protection against electric shock hazard may not provide an adequate ground to properly drain away conducted rf disturbances and may in fact be the source of the disturbance. This instrument was certified for EMC performance with data I/O cables not in excess of 3m.
Line Power	Line Voltage (selectable): 100 V, 120 V, 220 V, 240 V Line Frequency: 47 Hz to 63 Hz Line Voltage Variation: $\pm 10\%$ about line voltage setting. For optimal performance at full dual outputs (e.g. 1000 V, 20 A) choose a line voltage setting that is $\pm 7.5\%$ from nominal.

Power Consumption 600 VA
Dimensions (HxWxL) 17.8 cm x 43.2 cm x 47.3 cm (7 in x 17 in x 18.6 in) Standard rack width and rack increment, plus 1.5 cm (0.6 in) for feet on bottom of unit.
Weight (without options) 22 kg (49 lb)
Absolute Uncertainty Definition The 5502E specifications include stability, temperature coefficient, linearity, line and load regulation, and the traceability of the external standards used for calibration. You do not need to add anything to determine the total specification of the 5502E for the temperature range indicated.
Specification Confidence Level 99 %

Detailed Specifications

DC Voltage

Range	Absolute Uncertainty, tcal $\pm 5\text{ }^\circ\text{C}$ $\pm(\%$ of output + $\mu\text{V})$		Stability	Resolution (μV)	Max Burden ^[1]
	90 Day	1 Year	24 hours, $\pm 1\text{ }^\circ\text{C}$ $\pm(\text{ppm of output} + \mu\text{V})$		
0 to 329.9999 mV	0.005 + 3	0.006 + 3	5 + 1	0.1	65 Ω
0 to 3.299999 V	0.004 + 5	0.005 + 5	4 + 3	1	10 mA
0 to 32.99999 V	0.004 + 50	0.005 + 50	4 + 30	10	10 mA
30 to 329.9999 V	0.0045 + 500	0.0055 + 500	4.5 + 300	100	5 mA
100 to 1020.000 V	0.0045 + 1500	0.0055 + 1500	4.5 + 900	1000	5 mA
TC Simulate and Measure in Linear 10 $\mu\text{V}/^\circ\text{C}$ and 1 $\text{mV}/^\circ\text{C}$ modes ^[2]					
0 to 329.999 mV	0.005 + 3	0.006 + 3	5 + 1	0.1	10 Ω
<p>[1] Remote sensing is not provided. Output resistance is < 5 mΩ for outputs $\geq 0.33\text{ V}$. The AUX output has an output resistance of <1 Ω. TC simulation has an output impedance of 10 $\Omega \pm 1\text{ }^\circ\text{C}$.</p> <p>[2] TC simulating and measuring are not specified for operation in electromagnetic fields above 0.4 V/m.</p>					

Range	Noise	
	Bandwidth 0.1 Hz to 10 Hz p-p $\pm(\text{ppm of output} + \text{floor in } \mu\text{V})$	Bandwidth 10 Hz to 10 kHz rms
0 to 329.9999 mV	0 + 1	6 μV
0 to 3.299999 V	0 + 10	60 μV
0 to 32.99999 V	0 + 100	600 μV
30 to 329.9999 V	10 + 1000	20 mV
100 to 1020.000 V	10 + 5000	20 mV

DC Current

Range	Absolute Uncertainty, tcal $\pm 5^\circ\text{C}$ $\pm(\% \text{ of output } + \mu\text{A})$		Resolution	Max Compliance Voltage V	Max Inductive Load mH
	90 Day	1 Year			
0 to 329.999 μA	0.012 + 0.02	0.015 + 0.02	1 nA	10	400
0 to 3.29999 mA	0.010 + 0.05	0.010 + 0.05	0.01 μA	10	
0 to 32.99999 mA	0.008 + 0.25	0.010 + 0.25	0.1 μA	7	
0 to 329.999 mA	0.008 + 3.3	0.010 + 2.5	1 μA	7	
0 to 1.09999 A	0.023 + 44	0.038 + 44	10 μA	6	
1.1 to 2.99999 A	0.030 + 44	0.038 + 44	10 μA	6	
0 to 10.9999 A (20 A Range)	0.038 + 500	0.060 + 500	100 μA	4	
11 to 20.5 A ^[1]	0.080 + 750 ^[2]	0.10 + 750 ^[2]	100 μA	4	

[1] Duty Cycle: Currents <11 A may be provided continuously. For currents >11 A, see Figure 1. The current may be provided Formula $60 - T - I$ minutes any 60 minute period where T is the temperature in $^\circ\text{C}$ (room temperature is about 23°C) and I is the output current in amperes. For example, 17 A, at 23°C could be provided for $60 - 23 - 17 = 20$ minutes each hour. When the 5502E is outputting currents between 5 and 11 amps for long periods, the internal self-heating reduces the duty cycle. Under those conditions, the allowable "on" time indicated by the formula and Figure 1 is achieved only after the 5502E is outputting currents <5 A for the "off" period first.

[2] Floor specification is 1500 μA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 750 μA .

Range	Noise	
	Bandwidth 0.1 Hz to 10 Hz p-p	Bandwidth 10 Hz to 10 kHz rms
0 to 329.999 μA	2 nA	20 nA
0 to 3.29999 mA	20 nA	200 nA
0 to 32.99999 mA	200 nA	2.0 μA
0 to 329.999 mA	2000 nA	20 μA
0 to 2.99999 A	20 μA	1 mA
0 to 20.5 A	200 μA	10 mA

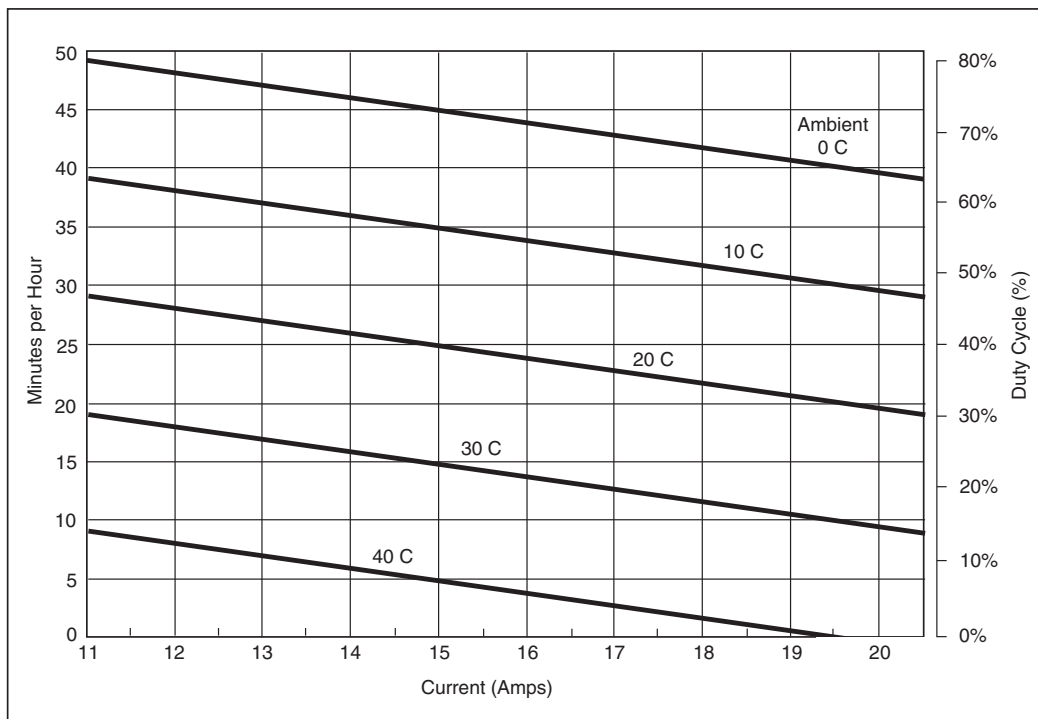


Figure 5. Allowable Duration of Current >11 A

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Resistance

Range ^[1]	Absolute Uncertainty, tcal ±5 °C ±(% of output + floor) ^[2]				Resolution (Ω)	Allowable Current ^[3] (A)
	% of output		Floor (Ω) Time and temp since ohms zero cal			
	90 Day	1 Year	12 hrs ±1 °C	7 days ±5 °C		
0 to 10.999 Ω	0.009	0.012	0.001	0.01	0.001	1 mA to 125 mA
11 to 32.999 Ω	0.009	0.012	0.0015	0.015	0.001	1 mA to 125 mA
33 to 109.999 Ω	0.007	0.009	0.0014	0.015	0.001	1 mA to 70 mA
110 to 329.999 Ω	0.007	0.009	0.002	0.02	0.001	1 mA to 40 mA
330 to 1.09999 kΩ	0.007	0.009	0.002	0.02	0.01	1 mA to 18 mA
1.1 to 3.29999 kΩ	0.007	0.009	0.02	0.2	0.01	100 μA to 5 mA
3.3 to 10.9999 kΩ	0.007	0.009	0.02	0.1	0.1	100 μA to 1.8 mA
11 to 32.9999 kΩ	0.007	0.009	0.2	1	0.1	10 μA to .5 mA
33 to 109.999 kΩ	0.008	0.011	0.2	1	1	10 μA to 0.18 mA
110 to 329.999 kΩ	0.009	0.012	2	10	1	1 μA to 50 μA
330 kΩ to 1.09999 MΩ	0.011	0.015	2	10	10	1 μA to 18 μA
1.1 to 3.29999 MΩ	0.011	0.015	30	150	10	250 nA to 5 μA
3.3 to 10.9999 MΩ	0.045	0.06	50	250	100	250 nA to 1.8 μA
11 to 32.9999 MΩ	0.075	0.1	2500	2500	100	25 nA to 500 nA
33 to 109.999 MΩ	0.4	0.5	3000	3000	1000	25 nA to 180 nA
110 to 329.999 MΩ	0.4	0.5	100000	100000	1000	2.5 nA to 50 nA
330 to 1100.00 MΩ	1.2	1.5	500000	500000	10000	1 nA to 13 nA

[1] Continuously variable from 0 Ω to 1.1 GΩ.

[2] Applies for 4-WIRE compensation only. For 2-WIRE and 2-WIRE COMP, add 5 μV per amp of stimulus current to the floor specification. For example, in 2-WIRE mode, at 1 kΩ the floor specification within 12 hours of an ohms zero cal for a measurement current of 1 mA is: $0.002 \Omega + 5 \mu\text{V} / 1 \text{ mA} = (0.002 + 0.005) \Omega = 0.007 \Omega$.

[3] Do not exceed the largest current for each range. For currents lower than shown, the floor adder increases by $\text{Floor}_{(\text{new})} = \text{Floor}_{(\text{old})} \times I_{\text{min}}/I_{\text{actual}}$. For example, a 50 μA stimulus measuring 100 Ω has a floor specification of: $0.0014 \Omega \times 1 \text{ mA}/50 \mu\text{A} = 0.028 \Omega$, assuming an ohms zero calibration within 12 hours.

AC Voltage (Sine Wave)

Range	Frequency	Absolute Uncertainty, tcal ±5 °C ±(% of output + μV)		Resolution	Max Burden	Max Distortion and Noise 10 Hz to 5 MHz Bandwidth ±(% of output + floor)
		90 Day	1 Year			
1.0 to 32.999 mV	10 Hz to 45 Hz	0.120 + 20	0.150 + 20	1 μV	65 Ω	0.15 + 90 μV
	45 Hz to 10 kHz	0.080 + 20	0.100 + 20			0.035 + 90 μV
	10 kHz to 20 kHz	0.120 + 20	0.150 + 20			0.06 + 90 μV
	20 kHz to 50 kHz	0.160 + 20	0.200 + 20			0.15 + 90 μV
	50 kHz to 100 kHz	0.300 + 33	0.350 + 33			0.25 + 90 μV
	100 kHz to 500 kHz	0.750 + 60	1.000 + 60			0.3 + 90 μV ^[1]
33 mV to 329.999 mV	10 Hz to 45 Hz	0.042 + 20	0.050 + 20	1 μV	65 Ω	0.15 + 90 μV
	45 Hz to 10 kHz	0.029 + 20	0.030 + 20			0.035 + 90 μV
	10 kHz to 20 kHz	0.066 + 20	0.070 + 20			0.06 + 90 μV
	20 kHz to 50 kHz	0.086 + 40	0.100 + 40			0.15 + 90 μV
	50 kHz to 100 kHz	0.173 + 170	0.230 + 170			0.2 + 90 μV
	100 kHz to 500 kHz	0.400 + 330	0.500 + 330			0.2 + 90 μV ^[1]
0.33 V to 3.29999 V	10 Hz to 45 Hz	0.042 + 60	0.050 + 60	10 μV	10 mA	0.15 + 200 μV
	45 Hz to 10 kHz	0.028 + 60	0.030 + 60			0.035 + 200 μV
	10 kHz to 20 kHz	0.059 + 60	0.070 + 60			0.06 + 200 μV
	20 kHz to 50 kHz	0.083 + 60	0.100 + 60			0.15 + 200 μV
	50 kHz to 100 kHz	0.181 + 200	0.230 + 200			0.2 + 200 μV
	100 kHz to 500 kHz	0.417 + 900	0.500 + 900			0.2 + 200 μV ^[1]
3.3 V to 32.9999 V	10 Hz to 45 Hz	0.042 + 800	0.050 + 800	100 μV	10 mA	0.15 + 2 mV
	45 Hz to 10 kHz	0.025 + 600	0.030 + 600			0.035 + 2 mV
	10 kHz to 20 kHz	0.064 + 600	0.070 + 600			0.08 + 2 mV
	20 kHz to 50 kHz	0.086 + 600	0.100 + 600			0.2 + 2 mV
	50 kHz to 100 kHz	0.192 + 2000	0.230 + 2000			0.5 + 2 mV
33 V to 329.999 V	45 Hz to 1 kHz	0.039 + 3000	0.050 + 3000	1 mV	5 mA, except 20 mA for 45 Hz to 65 Hz	0.15 + 10 mV
	1 kHz to 10 kHz	0.064 + 9000	0.080 + 9000			0.05 + 10 mV
	10 kHz to 20 kHz	0.079 + 9000	0.090 + 9000			0.6 + 10 mV
	20 kHz to 50 kHz	0.096 + 9000	0.120 + 9000			0.8 + 10 mV
	50 kHz to 100 kHz	0.192 + 80000	0.240 + 80000			1 + 10 mV
330 V to 1020 V	45 Hz to 1 kHz	0.042 + 20000	0.050 + 20000	10 mV	2 mA, except 20 mA for 45 to 65 Hz	0.15 + 30 mV
	1 kHz to 5 kHz	0.064 + 20000	0.080 + 20000			0.07 + 30 mV
	5 kHz to 10 kHz	0.075 + 20000	0.090 + 20000			0.07 + 30 mV

[1] Max Distortion for 100 kHz to 200 kHz. For 200 kHz to 500 kHz, the maximum distortion is 0.9 % of output + floor as shown.
Note
Remote sensing is not provided. Output resistance is <5 mΩ for outputs ≥0.33 V. The maximum load capacitance is 500 pF, subject to the maximum burden current limits.

AC Current (Sine Wave)

Range	Frequency	Absolute Uncertainty, tc _{al} ±5 °C ±(% of output + μA)		Compliance adder ±(μA/V)	Max Distortion and Noise 10 Hz to 100 kHz BW ±(% of output + floor)	Max Inductive Load μH
		90 Day	1 Year			
LCOMP Off						
29 to 329.99 μA	10 to 20 Hz	0.16 + 0.1	0.2 + 0.1	0.05	0.15 + 0.5 μA	200
	20 to 45 Hz	0.12 + 0.1	0.15 + 0.1	0.05	0.10 + 0.5 μA	
	45 Hz to 1 kHz	0.1 + 0.1	0.125 + 0.1	0.05	0.05 + 0.5 μA	
	1 to 5 kHz	0.25 + 0.15	0.3 + 0.15	1.5	0.50 + 0.5 μA	
	5 to 10 kHz	0.6 + 0.2	0.8 + 0.2	1.5	1.00 + 0.5 μA	
	10 to 30 kHz	1.2 + 0.4	1.6 + 0.4	10	1.20 + 0.5 μA	
0.33 to 3.29999 mA	10 to 20 Hz	0.16 + 0.15	0.2 + 0.15	0.05	0.15 + 1.5 μA	200
	20 to 45 Hz	0.1 + 0.15	0.125 + 0.15	0.05	0.06 + 1.5 μA	
	45 Hz to 1 kHz	0.08 + 0.15	0.1 + 0.15	0.05	0.02 + 1.5 μA	
	1 to 5 kHz	0.16 + 0.2	0.2 + 0.2	1.5	0.50 + 1.5 μA	
	5 to 10 kHz	0.4 + 0.3	0.5 + 0.3	1.5	1.00 + 1.5 μA	
	10 to 30 kHz	0.8 + 0.6	1.0 + 0.6	10	1.20 + 0.5 μA	
3.3 to 32.9999 mA	10 to 20 Hz	0.15 + 2	0.18 + 2	0.05	0.15 + 5 μA	50
	20 to 45 Hz	0.075 + 2	0.09 + 2	0.05	0.05 + 5 μA	
	45 Hz to 1 kHz	0.035 + 2	0.04 + 2	0.05	0.07 + 5 μA	
	1 to 5 kHz	0.065 + 2	0.08 + 2	1.5	0.30 + 5 μA	
	5 to 10 kHz	0.16 + 3	0.2 + 3	1.5	0.70 + 5 μA	
	10 to 30 kHz	0.32 + 4	0.4 + 4	10	1.00 + 0.5 μA	
33 to 329.999 mA	10 to 20 Hz	0.15 + 20	0.18 + 20	0.05	0.15 + 50 μA	50
	20 to 45 Hz	0.075 + 20	0.09 + 20	0.05	0.05 + 50 μA	
	45 Hz to 1 kHz	0.035 + 20	0.04 + 20	0.05	0.02 + 50 μA	
	1 to 5 kHz	0.08 + 50	0.10 + 50	1.5	0.03 + 50 μA	
	5 to 10 kHz	0.16 + 100	0.2 + 100	1.5	0.10 + 50 μA	
	10 to 30 kHz	0.32 + 200	0.4 + 200	10	0.60 + 50 μA	
0.33 to 1.09999 A	10 to 45 Hz	0.15 + 100	0.18 + 100		0.20 + 500 μA	2.5
	45 Hz to 1 kHz	0.036 + 100	0.05 + 100		0.07 + 500 μA	
	1 to 5 kHz	0.5 + 1000	0.6 + 1000	[2]	1.00 + 500 μA	
	5 to 10 kHz	2.0 + 5000	2.5 + 5000	[3]	2.00 + 500 μA	
1.1 to 2.99999 A	10 to 45 Hz	0.15 + 100	0.18 + 100		0.20 + 500 μA	2.5
	45 Hz to 1 kHz	0.05 + 100	0.06 + 100		0.07 + 500 μA	
	1 to 5 kHz	0.5 + 1000	0.6 + 1000	[2]	1.00 + 500 μA	
	5 to 10 kHz	2.0 + 5000	2.5 + 5000	[3]	2.00 + 500 μA	
3 to 10.9999 A	45 to 100 Hz	0.05 + 2000	0.06 + 2000		0.2 + 3 mA	1
	100 Hz to 1 kHz	0.08 + 2000	0.10 + 2000		0.1 + 3 mA	
	1 kHz to 5 kHz	2.5 + 2000	3.0 + 2000		0.8 + 3 mA	
11 to 20.5 A ^[1]	45 to 100 Hz	0.1 + 5000	0.12 + 5000		0.2 + 3 mA	1
	100 Hz to 1 kHz	0.13 + 5000	0.15 + 5000		0.1 + 3 mA	
	1 to 5 kHz	2.5 + 5000	3.0 + 5000		0.8 + 3 mA	

[1] Duty Cycle: Currents <11 A may be provided continuously. For currents >11 A, see Figure 1. The current may be provided 60-T-I minutes any 60 minute period where T is the temperature in °C (room temperature is about 23 °C) and I is the output current in amps. For example, 17 A, at 23 °C could be provided for 60-17-23 = 20 minutes each hour. When the 5502E is outputting currents between 5 and 11 amps for long periods, the internal self-heating reduces the duty cycle. Under those conditions, the allowable "on" time indicated by the formula and Figure 1 is achieved only after the 5502E is outputting currents <5 A for the "off" period first.

[2] For compliance voltages greater than 1 V, add 1 mA/V to the floor specification from 1 to 5 kHz.

[3] For compliance voltages greater than 1 V, add 5 mA/V to the floor specification from 5 to 10 kHz.

AC Current (Sine Wave) (cont.)

Range	Frequency	Absolute Uncertainty, tcal ±5 °C ±(% of output + μA)		Max Distortion and Noise 10 Hz to 100 kHz BW ±(% of output + floor)	Max Inductive Load
		90 Day	1 Year		
LCOMP On					
29 to 329.99 μA	10 to 100 Hz	0.20 + 0.2	0.25 + 0.2	0.1 + 1.0 μA	400 μH
	100 Hz to 1 kHz	0.50 + 0.5	0.60 + 0.5	0.05 + 1.0 μA	
330 μA to 3.29999 mA	10 to 100 Hz	0.20 + 0.3	0.25 + 0.3	0.15 + 1.5 μA	
	100 Hz to 1 kHz	0.50 + 0.8	0.60 + 0.8	0.06 + 1.5 μA	
3.3 to 32.9999 mA	10 to 100 Hz	0.07 + 4	0.08 + 4	0.15 + 5 μA	
	100 Hz to 1 kHz	0.18 + 10	0.20 + 10	0.05 + 5 μA	
33 to 329.999 mA	10 to 100 Hz	0.07 + 40	0.08 + 40	0.15 + 50 μA	
	100 Hz to 1 kHz	0.18 + 100	0.20 + 100	0.05 + 50 μA	
330 mA to 2.99999 A	10 to 100 Hz	0.10 + 200	0.12 + 200	0.2 + 500 μA	
	100 to 440 Hz	0.25 + 1000	0.30 + 1000	0.25 + 500 μA	
3.3 A to 20.5 A ^[1]	45 to 100 Hz	0.10 + 2000 ^[2]	0.12 + 2000 ^[2]	0.1 + 0 μA	400 μH ^[4]
	100 to 440 Hz	0.80 + 5000 ^[3]	1.00 + 5000 ^[3]	0.5 + 0 μA	
<p>[1] Duty Cycle: Currents <11 A may be provided continuously. For currents >11 A, see Figure 1. The current may be provided 60-T-I minutes any 60 minute period where T is the temperature in °C (room temperature is about 23 °C) and I is the output current in amps. For example, 17 A, at 23 °C could be provided for 60-17-23 = 20 minutes each hour. When the 5502E is outputting currents between 5 and 11 amps for long periods, the internal self-heating reduces the duty cycle. Under those conditions, the allowable "on" time indicated by the formula and Figure 1 is achieved only after the 5502E is outputting currents <5 A for the "off" period first.</p> <p>[2] For currents >11 A, Floor specification is 4000 μA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 2000 μA.</p> <p>[3] For currents >11 A, Floor specification is 1000 μA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 5000 μA.</p> <p>[4] Subject to compliance voltages limits.</p>					

Range	Resolution μA	Max Compliance Voltage V rms ^[1]
29 to 329.99 μA	0.01	7
0.33 to 3.29999 mA	0.01	7
3.3 to 32.9999 mA	0.1	5
33 to 329.999 mA	1	5
0.33 to 2.99999 A	10	4
3 to 20.5 A	100	3
[1] Subject to specification adder for compliance voltages greater than 1 V rms.		

Capacitance

Range	Absolute Uncertainty, tcal ± 5 °C \pm (% of output + floor) ^{[1] [2] [3]}		Resolution	Allowed Frequency or Charge-Discharge Rate		
	90 Day	1 Year		Min and Max to Meet Specification	Typical Max for <0.5 % Error	Typical Max for <1 % Error
220.0 to 399.9 pF	0.38 + 0.01 nF	0.5 + 0.01 nF	0.1 pF	10 Hz to 10 kHz	20 kHz	40 kHz
0.4 to 1.0999 nF	0.38 + 0.01 nF	0.5 + 0.01 nF	0.1 pF	10 Hz to 10 kHz	30 kHz	50 kHz
1.1 to 3.2999 nF	0.38 + 0.01 nF	0.5 + 0.01 nF	0.1 pF	10 Hz to 3 kHz	30 kHz	50 kHz
3.3 to 10.999 nF	0.19 + 0.01 nF	0.25 + 0.01 nF	1 pF	10 Hz to 1 kHz	20 kHz	25 kHz
11 to 32.999 nF	0.19 + 0.1 nF	0.25 + 0.1 nF	1 pF	10 Hz to 1 kHz	8 kHz	10 kHz
33 to 109.99 nF	0.19 + 0.1 nF	0.25 + 0.1 nF	10 pF	10 Hz to 1 kHz	4 kHz	6 kHz
110 to 329.99 nF	0.19 + 0.3 nF	0.25 + 0.3 nF	10 pF	10 Hz to 1 kHz	2.5 kHz	3.5 kHz
0.33 to 1.0999 μ F	0.19 + 1 nF	0.25 + 1 nF	100 pF	10 to 600 Hz	1.5 kHz	2 kHz
1.1 to 3.2999 μ F	0.19 + 3 nF	0.25 + 3 nF	100 pF	10 to 300 Hz	800 Hz	1 kHz
3.3 to 10.999 μ F	0.19 + 10 nF	0.25 + 10 nF	1 nF	10 to 150 Hz	450 Hz	650 Hz
11 to 32.999 μ F	0.30 + 30 nF	0.40 + 30 nF	1 nF	10 to 120 Hz	250 Hz	350 Hz
33 to 109.99 μ F	0.34 + 100 nF	0.45 + 100 nF	10 nF	10 to 80 Hz	150 Hz	200 Hz
110 to 329.99 μ F	0.34 + 300 nF	0.45 + 300 nF	10 nF	0 to 50 Hz	80 Hz	120 Hz
0.33 to 1.0999 mF	0.34 + 1 μ F	0.45 + 1 μ F	100 nF	0 to 20 Hz	45 Hz	65 Hz
1.1 to 3.2999 mF	0.34 + 3 μ F	0.45 + 3 μ F	100 nF	0 to 6 Hz	30 Hz	40 Hz
3.3 to 10.999 mF	0.34 + 10 μ F	0.45 + 10 μ F	1 μ F	0 to 2 Hz	15 Hz	20 Hz
11 to 32.999 mF	0.7 + 30 μ F	0.75 + 30 μ F	1 μ F	0 to 0.6 Hz	7.5 Hz	10 Hz
33 to 110.00 mF	1.0 + 100 μ F	1.1 + 100 μ F	10 μ F	0 to 0.2 Hz	3 Hz	5 Hz

[1] The output is continuously variable from 220 pF to 110 mF.
 [2] Specifications apply to both dc charge/discharge capacitance meters and ac RCL meters. The maximum allowable peak voltage is 3 V. The maximum allowable peak current is 150 mA, with an rms limitation of 30 mA below 1.1 μ F and 100 mA for 1.1 μ F and above.
 [3] The maximum lead resistance for no additional error in 2-wire COMP mode is 10 Ω .

Temperature Calibration (Thermocouple)

TC Type [1]	Range °C [2]	Absolute Uncertainty Source/Measure tcal ±5 °C ± °C [3]		TC Type [1]	Range °C [2]	Absolute Uncertainty Source/Measure tcal ±5 °C ± °C [3]	
		90 Day	1 Year			90 Day	1 Year
B	600 to 800	0.42	0.44	L	-200 to -100	0.37	0.37
	800 to 1000	0.34	0.34		-100 to 800	0.26	0.26
	1000 to 1550	0.30	0.30		800 to 900	0.17	0.17
	1550 to 1820	0.26	0.33	N	-200 to -100	0.30	0.40
C	0 to 150	0.23	0.30		-100 to -25	0.17	0.22
	150 to 650	0.19	0.26		-25 to 120	0.15	0.19
	650 to 1000	0.23	0.31		120 to 410	0.14	0.18
	1000 to 1800	0.38	0.50		410 to 1300	0.21	0.27
	1800 to 2316	0.63	0.84	R	0 to 250	0.48	0.57
E	-250 to -100	0.38	0.50		250 to 400	0.28	0.35
	-100 to -25	0.12	0.16		400 to 1000	0.26	0.33
	-25 to 350	0.10	0.14		1000 to 1767	0.30	0.40
	350 to 650	0.12	0.16	S	0 to 250	0.47	0.47
650 to 1000	0.16	0.21	250 to 1000		0.30	0.36	
J	-210 to -100	0.20	0.27		1000 to 1400	0.28	0.37
	-100 to -30	0.12	0.16	1400 to 1767	0.34	0.46	
	-30 to 150	0.10	0.14	T	-250 to -150	0.48	0.63
	150 to 760	0.13	0.17		-150 to 0	0.18	0.24
760 to 1200	0.18	0.23	0 to 120		0.12	0.16	
K	-200 to -100	0.25	0.33		120 to 400	0.10	0.14
	-100 to -25	0.14	0.18	U	-200 to 0	0.56	0.56
	-25 to 120	0.12	0.16		0 to 600	0.27	0.27
	120 to 1000	0.19	0.26				
	1000 to 1372	0.30	0.40				

[1] Temperature standard ITS-90 or IPTS-68 is selectable.
TC simulating and measuring are not specified for operation in electromagnetic fields above 0.4 V/m.

[2] Resolution is 0.01 °C

[3] Does not include thermocouple error

Temperature Calibration (RTD)

RTD Type	Range °C ^[1]	Absolute Uncertainty tcal ±5 °C ± °C ^[2]		RTD Type	Range °C ^[1]	Absolute Uncertainty tcal ±5 °C ± °C ^[2]	
		90 Day	1 Year			90 Day	1 Year
Pt 385, 100 Ω	-200 to -80	0.04	0.05	Pt 385, 500 Ω	-200 to -80	0.03	0.04
	-80 to 0	0.05	0.05		-80 to 0	0.04	0.05
	0 to 100	0.07	0.07		0 to 100	0.05	0.05
	100 to 300	0.08	0.09		100 to 260	0.06	0.06
	300 to 400	0.09	0.10		260 to 300	0.07	0.08
	400 to 630	0.10	0.12		300 to 400	0.07	0.08
	630 to 800	0.21	0.23		400 to 600	0.08	0.09
Pt 3926, 100 Ω	-200 to -80	0.04	0.05	Pt 385, 1000 Ω	-200 to -80	0.03	0.03
	-80 to 0	0.05	0.05		-80 to 0	0.03	0.03
	0 to 100	0.07	0.07		0 to 100	0.03	0.04
	100 to 300	0.08	0.09		100 to 260	0.04	0.05
	300 to 400	0.09	0.10		260 to 300	0.05	0.06
Pt 3916, 100 Ω	-200 to -190	0.25	0.25	PtNi 385, 120 Ω (Ni120)	300 to 400	0.05	0.07
	-190 to -80	0.04	0.04		400 to 600	0.06	0.07
	-80 to 0	0.05	0.05		600 to 630	0.22	0.23
	0 to 100	0.06	0.06		-80 to 0	0.06	0.08
	100 to 260	0.06	0.07	0 to 100	0.07	0.08	
	260 to 300	0.07	0.08	100 to 260	0.13	0.14	
	300 to 400	0.08	0.09	Cu 427 10 Ω ^[3]	-100 to 260	0.3	0.3
Pt 385, 200 Ω	-200 to -80	0.03	0.04				
	-80 to 0	0.03	0.04				
	0 to 100	0.04	0.04				
	100 to 260	0.04	0.05				
	260 to 300	0.11	0.12				
	300 to 400	0.12	0.13				
	400 to 600	0.12	0.14				
	600 to 630	0.14	0.16				

[1] Resolution is 0.003 °C
 [2] Applies for COMP OFF (to the 5502E Calibrator front panel NORMAL terminals) and 2-wire and 4-wire compensation.
 [3] Based on MINCO Application Aid No. 18

Additional Specifications

The subsequent paragraphs provide additional specifications for the 5502E Calibrator ac voltage and ac current functions. These specifications are valid after allowing a warm-up period of 30 minutes, or twice the time the 5502E has been turned off. All extended range specifications are based on performing the internal zero-cal function at weekly intervals, or when the ambient temperature changes by more than 5 °C.

Frequency

Frequency Range	Resolution	1-Year Absolute Uncertainty, tcal ±5 °C ±(ppm + mHz)	Jitter
0.01 to 119.99 Hz	0.01 Hz	25 + 1	2 μs
120.0 to 1199.9 Hz	0.1 Hz	25 + 1	2 μs
1.2 to 11.999 kHz	1 Hz	25 + 1	2 μs
12 to 119.99 kHz	10 Hz	25 + 15	140 ns
120.0 to 1199.9 kHz	100 Hz	25 + 15	140 ns
1.2 to 2.000 MHz	1 kHz	25 + 15	140 ns

AC Voltage (Sine Wave) Extended Bandwidth

Range	Frequency	1-Year Absolute Uncertainty tcal $\pm 5^\circ\text{C}$	Max Voltage Resolution
Normal Channel (Single Output Mode)			
1.0 to 33 mV	0.01 to 9.99 Hz	$\pm(5.0\% \text{ of output} + 0.5\% \text{ of range})$	Two digits, e.g., 25 mV
34 to 330 mV			Three digits
0.4 to 33 V			Two digits
0.3 to 3.3 V	500.1 kHz to 1 MHz	-10 dB at 1 MHz, typical	Two digits
	1.001 to 2 MHz	-31 dB at 2 MHz, typical	

AC Voltage (Non-Sine Wave)

Triangle Wave & Truncated Sine Range, p-p ^[1]	Frequency	1-Year Absolute Uncertainty, tcal $\pm 5^\circ\text{C}$, $\pm(\% \text{ of output} + \% \text{ of range})$ ^[2]	Max Voltage Resolution
Normal Channel (Single Output Mode)			
2.9 to 92.999 mV	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz ^[3]	5.0 + 0.5	
93 to 929.999 mV	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz ^[3]	5.0 + 0.5	
0.93 to 9.29999 V	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz ^[3]	5.0 + 0.5	
9.3 to 93 V	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz ^[3]	5.0 + 0.5	
	45 Hz to 1 kHz	0.25 + 0.25	
1 to 10 kHz	5.0 + 0.5		
<p>[1] To convert p-p to rms for triangle wave, multiply the p-p value by 0.2886751. To convert p-p to rms for truncated sine wave, multiply the p-p value by 0.2165063.</p> <p>[2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM.</p> <p>[3] Uncertainty for Truncated Sine outputs is typical over this frequency band.</p>			

AC Voltage (Non-Sine Wave) (cont.)

Square Wave Range (p-p) ^[1]	Frequency	1-Year Absolute Uncertainty, tcal ±5 °C, ±(% of output + % of range) ^[2]	Max Voltage Resolution
Normal Channel (Single Output Mode)			
2.9 to 65.999 mV	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz	5.0 + 0.5	
66 to 659.999 mV	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz	5.0 + 0.5	
0.66 to 6.59999 V	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz	5.0 + 0.5	
6.6 to 66.0000 V	0.01 to 10 Hz	5.0 + 0.5	Two digits on each range
	10 to 45 Hz	0.25 + 0.5	Six digits on each range
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 20 kHz	0.5 + 0.25	
	20 to 100 kHz	5.0 + 0.5	
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz ^[3]	5.0 + 0.5	
<p>[1] To convert p-p to rms for square wave, multiply the p-p value by 0.5. [2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM.</p>			

AC Voltage, DC Offset

Range ^[1] (Normal Channel)	Offset Range ^[2]	Max Peak Signal	1-Year Absolute Uncertainty, tcal ±5 °C ^[3] ±(% of dc output + floor)
Sine Waves (rms)			
3.3 to 32.999 mV	0 to 50 mV	80 mV	0.1 + 33 μV
33 to 329.999 mV	0 to 500 mV	800 mV	0.1 + 330 μV
0.33 to 3.29999 V	0 to 5 V	8 V	0.1 + 3300 μV
3.3 to 32.9999 V	0 to 50 V	55 V	0.1 + 33 mV
Triangle Waves and Truncated Sine Waves (p-p)			
9.3 to 92.999 mV	0 to 50 mV	80 mV	0.1 + 93 μV
93 to 929.999 mV	0 to 500 mV	800 mV	0.1 + 930 μV
0.93 to 9.29999 V	0 to 5 V	8 V	0.1 + 9300 μV
9.3 to 93.0000 V	0 to 50 V	55 V	0.1 + 93 mV
Square Waves (p-p)			
6.6 to 65.999 mV	0 to 50 mV	80 mV	0.1 + 66 μV
66 to 659.999 mV	0 to 500 mV	800 mV	0.1 + 660 μV
0.66 to 6.59999 V	0 to 5 V	8 V	0.1 + 6600 μV
6.6 to 66.0000 V	0 to 50 V	55 V	0.1 + 66 mV
<p>[1] Offsets are not allowed on ranges above the highest range shown above. [2] The maximum offset value is determined by the difference between the peak value of the selected voltage output and the allowable maximum peak signal. For example, a 10 V p-p square wave output has a peak value of 5 V, allowing a maximum offset up to ± 50 V to not exceed the 55 V maximum peak signal. The maximum offset values shown above are for the minimum outputs in each range. [3] For frequencies 0.01 to 10 Hz, and 500 kHz to 2 MHz, the offset uncertainty is 5 % of output, ±1 % of the offset range.</p>			

AC Voltage, Square Wave Characteristics

Risetime @ 1 kHz Typical	Settling Time @ 1 kHz Typical	Overshoot @ 1 kHz Typical	Duty Cycle Range	Duty Cycle Uncertainty
<1 μ s	<10 μ s to 1 % of final value	<2 %	1 % to 99 % <3.3 V p-p. 0.01 Hz to 100 kHz	\pm (0.02 % of period + 100 ns), 50 % duty cycle \pm (0.05 % of period + 100 ns), other duty cycles from 10 % to 90 %

AC Voltage, Triangle Wave Characteristics (typical)

Linearity to 1 kHz	Aberrations
0.3 % of p-p value, from 10 % to 90 % point	<1 % of p-p value, with amplitude >50 % of range

AC Current (Non-Sine Wave)

Triangle Wave & Truncated Sine Wave Range p-p	Frequency	1-Year Absolute Uncertainty tcal ± 5 °C \pm (% of output + % of range)	Max Current Resolution
0.047 to 0.92999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
0.93 to 9.29999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
9.3 to 92.9999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
93 to 929.999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.5	
	1 to 10 kHz	10 + 2	
0.93 to 8.49999 A ^[2]	10 to 45 Hz	0.5 + 1.0	Six digits
	45 Hz to 1 kHz	0.5 + 0.5	
	1 to 10 kHz	10 + 2	
8.5 to 57 A ^[2]	45 to 500 Hz	0.5 + 0.5	Six digits
	500 Hz to 1 kHz	1.0 + 1.0	
^[1] Frequency limited to 1 kHz with LCOMP on. ^[2] Frequency limited to 440 Hz with LCOMP on.			

AC Current (Non-Sine Wave) (cont.)

Square Wave Range p-p	Frequency	1-Year Absolute Uncertainty tcal $\pm 5^\circ\text{C}$ $\pm(\% \text{ of output} + \% \text{ of range})$	Max Current Resolution
0.047 to 0.65999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
0.66 to 6.59999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
6.6 to 65.9999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.25	
	1 to 10 kHz	10 + 2	
66 to 659.999 mA ^[1]	10 to 45 Hz	0.25 + 0.5	Six digits
	45 Hz to 1 kHz	0.25 + 0.5	
	1 to 10 kHz	10 + 2	
0.66 to 5.99999 A ^[2]	10 to 45 Hz	0.5 + 1.0	Six digits
	45 Hz to 1 kHz	0.5 + 0.5	
	1 to 10 kHz	10 + 2	
6 to 41 A ^[2]	45 to 500 Hz	0.5 + 0.5	Six digits
	500 Hz to 1 kHz	1.0 + 1.0	
[1] Frequency limited to 1 kHz with LCOMP on. [2] Frequency limited to 440 Hz with LCOMP on.			

AC Current, Square Wave Characteristics (typical)

Range	LCOMP	Risetime	Settling Time	Overshoot
I < 6 A @ 400 Hz	off	25 μs	40 μs to 1 % of final value	<10 % for <1 V Compliance
3 A & 20 A Ranges	on	100 μs	200 μs to 1 % of final value	<10 % for <1 V Compliance

AC Current, Triangle Wave Characteristics (typical)

Linearity to 400 Hz	Aberrations
0.3 % of p-p value, from 10 % to 90 % point	<1 % of p-p value, with amplitude >50 % of range

Performance Tests

To make sure that the Product is in specification, use Tables 4 through 12. The tables are for approved metrology personnel who have access to a standards laboratory that has the correct equipment to test calibration equipment of this level of accuracy. The tables show the recommended test points and the permitted maximum and lower limits for each point. The limits were calculated by adding or subtracting the 90-day specification from the output value. There is no built-in factor for measurement uncertainty. These performance tests replace those found in the 5502A Operators Manual and only apply to the 5502E.

Table 4. Verification Tests for DC Voltage (Normal)

Range	Output	Lower Limit	Upper Limit
329.9999 mV	0.0000 mV	-0.0030 mV	0.0030 mV
329.9999 mV	329.0000 mV	328.9805 mV	329.0194 mV
329.9999 mV	-329.0000 mV	-329.0194 mV	-328.9805 mV
3.299999 V	0.000000 V	-0.000005 V	0.000005 V
3.299999 V	1.000000 V	0.9999855 V	1.000045 V
3.299999 V	-1.000000 V	-1.000045 V	-0.999955 V
3.299999 V	3.290000 V	3.2899863 V	3.290136 V
3.299999 V	-3.290000 V	-3.290136 V	-3.2898638 V
32.99999 V	0.00000 V	-0.00005 V	0.00005 V
32.99999 V	10.00000 V	9.99955 V	10.00045 V
32.99999 V	-10.00000 V	-10.00045 V	-9.99955 V
32.99999 V	32.90000 V	32.89863 V	-32.90136 V
32.99999 V	-32.90000 V	32.90136 V	-32.89863 V
329.9999 V	50.0000 V	49.9972 V	50.0027 V
329.9999 V	329.0000 V	328.9846 V	329.0153 V
329.9999 V	-50.0000 V	-50.0027 V	-49.9972 V
329.9999 V	-329.0000 V	-329.0153 V	-328.9846 V
1000.000 V	334.000 V	333.983 V	334.016 V
1000.000 V	900.000 V	899.958 V	900.042 V
1000.000 V	1020.000 V	1019.952 V	1020.047 V
1000.000 V	-334.000 V	-334.016V	-333.983 V
1000.000 V	-900.000 V	-900.042 V	-899.958 V
1000.000 V	-1020.000 V	-1020.047 V	-1019.952 V

Table 5. Verification Tests for DC Current (AUX)

Range	Output	Lower Limit	Upper Limit
329.999 μ A	0.000 μ A	-0.020 μ A	0.020 μ A
329.999 μ A	190.000 μ A	189.957 μ A	190.043 μ A
329.999 μ A	-190.000 μ A	-190.043 μ A	-189.957 μ A
329.999 μ A	329.000 μ A	328.941 μ A	329.059 μ A
329.999 μ A	-329.000 μ A	-329.059 μ A	-328.941 μ A
3.29999 mA	0.00000 mA	-0.00005 mA	0.00005 mA
3.29999 mA	1.90000 mA	1.89976 mA	1.90024 mA
3.29999 mA	-1.90000 mA	-1.90020 mA	-1.89980 mA
3.29999 mA	3.29000 mA	3.28969 mA	3.29031 mA
3.29999 mA	-3.29000 mA	-3.29031 mA	-3.28969 mA
32.9999 mA	0.0000 mA	-0.00025 mA	0.00025 mA
32.9999 mA	19.0000 mA	18.9982 mA	19.0018 mA
32.9999 mA	-19.0000 mA	-19.0018 mA	-18.9982 mA
32.9999 mA	32.9000 mA	32.8971 mA	32.9029 mA
32.9999 mA	-32.9000 mA	-32.9029 mA	-32.8971 mA
329.999 mA	0.000 mA	-0.0033 mA	0.0033 mA
329.999 mA	190.000 mA	189.982 mA	190.018 mA
329.999 mA	-190.000 mA	-190.018 mA	-189.982 mA
329.999 mA	329.000 mA	328.971 mA	329.029 mA
329.999 mA	-329.000 mA	-329.029 mA	-328.971 mA
2.99999 A	0.00000 A	-0.00004 A	0.00004 A
2.99999 A	1.09000 A	1.08979 A	1.09021 A
2.99999 A	-1.09000 A	-1.09021 A	-1.08962 A
2.99999 A	2.99000 A	2.98906 A	2.99094 A
2.99999 A	-2.99000 A	-2.99094 A	-2.98906 A
20.5000 A	0.0000 A	-0.0005 A	0.0005 A
20.5000 A	11.0000 A	10.9953 A	11.0046 A
20.5000 A	-11.0000 A	-11.0046 A	10.9953 A
20.5000 A	20.0000 A	19.9833 A	20.0168 A
20.5000 A	-20.0000 A	-20.0168 A	-19.9833 A

Table 6. Verification Tests for Resistance

Range	Output	Lower Limit	Upper Limit
10.999 Ω	0.000 Ω	-0.0010 Ω	0.0010 Ω
10.999 Ω	2.000 Ω	1.9989 Ω	2.0011 Ω
10.999 Ω	10.900 Ω	10.8980 Ω	10.9019 Ω
32.999 Ω	11.900 Ω	11.8974 Ω	11.9025 Ω
32.999 Ω	19.000 Ω	18.9967 Ω	19.0032 Ω
32.999 Ω	30.000 Ω	29.9958 Ω	30.0042 Ω
109.999 Ω	33.000 Ω	32.9962 Ω	33.0037 Ω
109.999 Ω	109.000 Ω	108.9909 Ω	109.0090 Ω
329.999 Ω	119.000 Ω	118.9896 Ω	119.0103 Ω
329.999 Ω	190.000 Ω	189.9847 Ω	190.0153 Ω
329.999 Ω	300.000 Ω	299.9770 Ω	300.0230 Ω
1.09999 k Ω	0.33000 k Ω	0.329749 k Ω	0.330251 k Ω
1.09999 k Ω	1.09000 k Ω	1.089921 k Ω	1.090078 k Ω
3.29999 k Ω	1.19000 k Ω	1.189896 k Ω	1.190103 k Ω
3.29999 k Ω	1.90000 k Ω	1.899847 k Ω	1.900153 k Ω
3.29999 k Ω	3.00000 k Ω	2.999770 k Ω	3.000230 k Ω
10.9999 k Ω	3.30000 k Ω	3.29974 k Ω	3.30025 k Ω
10.9999 k Ω	10.9000 k Ω	10.89921 k Ω	10.90078 k Ω
32.9999 k Ω	11.9000 k Ω	11.89896 k Ω	11.90103 k Ω
32.9999 k Ω	19.0000 k Ω	18.99847 k Ω	19.00153 k Ω
32.9999 k Ω	30.0000 k Ω	29.99977 k Ω	30.00230 k Ω

Table 6. Verification Tests for Resistance (cont.)

Range	Output	Lower Limit	Upper Limit
109.999 kΩ	33.000 kΩ	32.9971 kΩ	33.0028 kΩ
109.999 kΩ	109.000 kΩ	108.9910 kΩ	109.0089 kΩ
329.999 kΩ	119.000 kΩ	118.9872 kΩ	119.0127 kΩ
329.999 kΩ	190.000 kΩ	189.9809 kΩ	190.0191 kΩ
329.999 kΩ	300.000 kΩ	299.9710 kΩ	300.0290 kΩ
1.09999 MΩ	0.33000 MΩ	0.329961 MΩ	0.330038 MΩ
1.09999 MΩ	1.09000 MΩ	1.089878 MΩ	1.090121 MΩ
3.29999 MΩ	1.19000 MΩ	1.189839 MΩ	1.190160 MΩ
3.29999 MΩ	1.90000 MΩ	1.899761 MΩ	1.900239 MΩ
3.29999 MΩ	3.00000 MΩ	2.999640 MΩ	3.000360 MΩ
10.9999 MΩ	3.3000 MΩ	3.29846 MΩ	3.30153 MΩ
10.9999 MΩ	10.9000 MΩ	10.89504 MΩ	10.90495 MΩ
32.9999 MΩ	11.9000 MΩ	11.88857 MΩ	11.91142 MΩ
32.9999 MΩ	19.0000 MΩ	18.98325 MΩ	19.01675 MΩ
32.9999 MΩ	30.0000 MΩ	29.99750 MΩ	30.02500 MΩ
109.999 MΩ	33.000 MΩ	32.8650 MΩ	33.1350 MΩ
109.999 MΩ	109.000 MΩ	108.5610 MΩ	109.4390 MΩ
329.999 MΩ	119.000 MΩ	118.4240 MΩ	119.5760 MΩ
329.999 MΩ	290.000 MΩ	288.7400 MΩ	291.2600 MΩ
1100.00 MΩ	400.00 MΩ	394.700 MΩ	405.300 MΩ
1100.00 MΩ	640.00 MΩ	631.820 MΩ	648.180 MΩ
1100.00 MΩ	1090.00 MΩ	1076.420 MΩ	1103.580 MΩ

Table 7. Verification Tests for AC Voltage (Normal)

Range	Output	Frequency	Lower Limit	Upper Limit
32.999 mV	3.000 mV	45 Hz	2.977 mV	3.022 mV
32.999 mV	3.000 mV	10 kHz	2.977 mV	3.022 mV
32.999 mV	30.000 mV	9.5 Hz	28.350 mV	31.650 mV,
32.999 mV	30.000 mV	10 Hz	29.944 mV	30.056 mV
32.999 mV	30.000 mV	45 Hz	29.956 mV	30.044 mV
32.999 mV	30.000 mV	1 kHz	29.956 mV	30.044 mV
32.999 mV	30.000 mV	10 kHz	29.956 mV	30.044 mV
32.999 mV	30.000 mV	20 kHz	29.944 mV	30.056 mV
32.999 mV	30.000 mV	50 kHz	29.932 mV	30.068 mV
32.999 mV	30.000 mV	100 kHz	29.877 mV	30.123 mV
32.999 mV	30.000 mV	450 kHz	29.715 mV	30.285 mV
329.999 mV	33.000 mV	45 Hz	32,970 mV	33.029 mV
329.999 mV	33.000 mV	10 kHz	32.970 mV	33.029 mV
329.999 mV	300.000 mV	9.5 Hz	283.350 mV	316.650 mV
329.999 mV	300.000 mV	10 Hz	299.917 mV	300.083 mV
329.999 mV	300.000 mV	45 Hz	299.893 mV	300.107 mV
329.999 mV	300.000 mV	1 kHz	299.983 mV	300.107 mV
329.999 mV	300.000 mV	10 kHz	299.983 mV	300.107 mV
329.999 mV	300.000 mV	20 kHz	299.782 mV	300.218 mV
329.999 mV	300.000 mV	50 kHz	299.702 mV	300.298 mV
329.999 mV	300.000 mV	100 kHz	299.311 mV	300.689 mV
329.999 mV	300.000 mV	500 kHz	298.470 mV	301.530 mV
3.29999 V	0.33000 V	45 Hz	0.32984 V	0.33015 V
3.29999 V	0.33000 V	10 kHz	0.32984 V	0.33015V
3.29999 V	3.00000 V	9.5 Hz	2.83500 V	3.16500 V
3.29999 V	3.00000 V	10 Hz	2.99868 V	3.00132 V
3.29999 V	3.00000 V	45 Hz	2.99910 V	3.00090 V
3.29999 V	3.00000 V	1 kHz	2.99910V	3.00090 V
3.29999 V	3.00000 V	10 kHz	2.99910 V	3.00090 V
3.29999 V	3.00000 V	20 kHz	2.99817 V	3.00183 V
3.29999 V	3.00000 V	50 kHz	2.99745 V	3.00255 V

Table 7. Verification Tests for AC Voltage (Normal) (cont.)

Range	Output	Frequency	Lower Limit	Upper Limit
3.29999 V	3.00000 V	100 kHz	2.99437 V	3.00563V
3.29999 V	3.00000 V	450 kHz	2.98659 V	3.01340 V
3.29999 V	3.29000 V	1 MHz	2.250 V ^[1]	
32.9999 V	3.3000 V	45 Hz	3.2985 V	3.3014 V
32.9999 V	3.3000 V	10 kHz	3.2985 V	3.3014 V
32.9999 V	30.0000 V	9.5 Hz	28.3500 V	31.6500 V
32.9999 V	30.0000 V	10 Hz	29.9866 V	30.0134V
32.9999 V	30.0000 V	45 Hz	29.9919 V	30.0081 V
32.9999 V	30.0000 V	1 kHz	29.9919 V	30.0081 V
32.9999 V	30.0000 V	10 kHz	29.9919 V	30.0081 V
32.9999 V	30.0000 V	20 kHz	29.9802 V	30.0198 V
32.9999 V	30.0000 V	50 kHz	29.9736 V	30.0264 V
32.9999 V	30.0000 V	90 kHz	29.9404 V	30.0596 V
329.999 V	33.000 V	45 Hz	32.984 V	33.015 V
329.999 V	33.000 V	10 kHz	32.969 V	33.030V
329.999 V	300.000 V	45 Hz	299.880 V	300.120 V
329.999 V	300.000 V	1 kHz	299.880 V	300.120 V
329.999 V	300.000 V	10 kHz	299.799 V	300.201 V
329.999 V	300.000 V	18 kHz	299.754 V	300.246 V
329.999 V	300.000 V	50 kHz	299.703 V	300.297 V
329.999 V	200.000 V	100 kHz	199.536 V	200.464 V
1020.00 V	330.00 V	45 Hz	329.84 V	330.15 V
1020.00 V	330.00 V	10 kHz	329.73 V	330.26 V
1020.00 V	1000.00V	45 Hz	999.56 V	1000.44 V
1020.00 V	1000.00 V	1 kHz	999.56 V	1000.44 V
1020.00 V	1000.00 V	5 kHz	999.349 V	1000.66 V
1020.00 V	1000.00 V	8 kHz	999.23 V	1000.77 V
1020.00 V	1020.00 V	1 kHz	1019.55 V	1020.44 V
1020.00 V	1020.00 V	8 kHz	1019.21 V	1020.78 V

[1] Typical specification is -24 dB at 2 MHz

Table 8. Verification Tests for AC Current

Range	Output	Frequency	Lower Limit	Upper Limit
329.99 μ A	33.00 μ A	1 kHz	32.87 μ A	33.13 μ A
329.99 μ A	33.00 μ A	10 kHz	32.60 μ A	33.40 μ A
329.99 μ A	33.00 μ A	30 kHz	32.20 μ A	33.80 μ A
329.99 μ A	190.00 μ A	45 Hz	189.71 μ A	190.29 μ A
329.99 μ A	190.00 μ A	1 kHz	189.71 μ A	190.29 μ A
329.99 μ A	190.00 μ A	10 kHz	188.66 μ A	191.34 μ A
329.99 μ A	190.00 μ A	30 kHz	187.32 μ A	192.68 μ A
329.99 μ A	329.00 μ A	10 Hz	328.37 μ A	329.63 μ A
329.99 μ A	329.00 μ A	45 Hz	328.57 μ A	329.43 μ A
329.99 μ A	329.00 μ A	1 kHz	328.57 μ A	329.43 μ A
329.99 μ A	329.00 μ A	5 kHz	328.03 μ A	329.97 μ A
329.99 μ A	329.00 μ A	10 kHz	326.83 μ A	331.17 μ A
329.99 μ A	329.00 μ A	30 kHz	324.65 μ A	333.35 μ A
3.2999 mA	0.3300 mA	1 kHz	0.3296 mA	0.3304 mA
3.2999 mA	0.3300 mA	5 kHz	0.3293 mA	0.3307 mA
3.2999 mA	0.3300 mA	30 kHz	0.3268 mA	0.3332 mA
3.2999 mA	1.9000 mA	1 kHz	1.8983 mA	1.9017 mA
3.2999 mA	1.9000 mA	10 kHz	1.8921 mA	1.9079 mA
3.2999 mA	1.9000 mA	30 kHz	1.8842 mA	1.9158 mA
3.2999 mA	3.2900 mA	10 Hz	3.2846 mA	3.2954 mA
3.2999 mA	3.2900 mA	45 Hz	3.2872 mA	3.2928 mA
3.2999 mA	3.2900 mA	1 kHz	3.2872 mA	3.2928 mA
3.2999 mA	3.2900 mA	5 kHz	3.2845 mA	3.2955 mA
3.2999 mA	3.2900 mA	10 kHz	3.2765 mA	3.3035 mA
3.2999 mA	3.2900 mA	30 kHz	3.2631 mA	3.3169 mA
32.999 mA	3.3000 mA	1 kHz	3.297 mA	3.303 mA
32.999 mA	3.3000 mA	5 kHz	3.296 mA	3.304 mA
32.999 mA	3.3000 mA	30 kHz	3.285 mA	3.315 mA
32.999 mA	19.0000 mA	1 kHz	18.991 mA	19.009 mA
32.999 mA	19.0000 mA	10 kHz	18.967 mA	19.033 mA

Table 8. Verification Tests for AC Current (cont.)

Range	Output	Frequency	Lower Limit	Upper Limit
32.999 mA	19.0000 mA	30 kHz	18.935 mA	19.065 mA
32.999 mA	32.9000 mA	10 Hz	32.849 mA	32.951 mA
32.999 mA	32.9000 mA	1 kHz	32.886 mA	32.914 mA
32.999 mA	32.9000 mA	5 kHz	32.877 mA	32.923 mA
32.999 mA	32.9000 mA	10 kHz	32.844 mA	32.956 mA
32.999 mA	32.9000 mA	30 kHz	32.791 mA	33.009 mA
329.99 mA	33.0000 mA	1 kHz	32.97 mA	33.03 mA
329.99 mA	33.0000 mA	5 kHz	32.92 mA	33.08 mA
329.99 mA	33.0000 mA	30 kHz	32.69 mA	33.31 mA
329.99 mA	190.0000 mA	1 kHz	189.91 mA	190.09 mA
329.99 mA	190.0000 mA	10 kHz	189.60 mA	190.40 mA
329.99 mA	190.0000 mA	30 kHz	189.19 mA	190.81 mA
329.99 mA	329.0000 mA	10 Hz	328.49 mA	329.51 mA
329.99 mA	329.0000 mA	45 Hz	328.86 mA	329.14 mA
329.99 mA	329.0000 mA	1 kHz	328.86 mA	329.14 mA
329.99 mA	329.0000 mA	5 kHz	328.69 mA	329.31 mA
329.99 mA	329.0000 mA	10 kHz	328.37 mA	329.63 mA
329.99 mA	329.0000 mA	30 kHz	327.75 mA	330.25 mA
2.99999 A	0.33000 A	1 kHz	0.32978 A	0.33022 A
2.99999 A	0.33000 A	5 kHz	0.32735 A	0.33265 A
2.99999 A	0.33000 A	10 kHz	0.31840 A	0.34160 A
2.99999 A	1.09000 A	10 Hz	1.08827 A	1.09174 A
2.99999 A	1.09000 A	45 Hz	1.08951 A	1.09049 A
2.99999 A	1.09000 A	1 kHz	1.08951 A	1.09049 A
2.99999 A	1.09000 A	5 kHz	1.08355 A	1.09645 A
2.99999 A	1.09000 A	10 kHz	1.06320 A	1.11680A
2.99999 A	2.99000 A	10 Hz	2.98542 A	2.99459 A
2.99999 A	2.99000 A	45 Hz	2.98840 A	2.99160 A
2.99999 A	2.99000 A	1 kHz	2.98840 A	2.99160 A
2.99999 A	2.99000 A	5 kHz	2.97405 A	3.00595 A

Table 8. Verification Tests for AC Current (cont.)

Range	Output	Frequency	Lower Limit	Upper Limit
2.99999 A	2.99000 A	10 kHz	2.92520 A	3.05480 A
20.5000 A	3.3000 A	500 Hz	3.2954 A	3.3046 A
20.5000 A	3.3000 A	1 kHz	3.2954 A	3.3046 A
20.5000 A	3.3000 A	5 kHz	3.2155 A	3.3845 A
20.5000 A	11.0000 A	45 Hz	10.9840A	11.0160 A
20.5000 A	11.0000 A	65 Hz	10.9840 A	11.0160A
20.5000 A	11.0000 A	500 Hz	10.9807 A	11.0193 A
20.5000 A	11.0000 A	1 kHz	10.9807 A	11.0193 A
20.5000 A	11.0000 A	5 kHz	10.7200 A	11.2800A
20.5000 A	20.0000 A	45 Hz	19.9750 A	20.0250 A
20.5000 A	20.0000 A	65 Hz	19.9750 A	20.0250 A
20.5000 A	20.0000 A	500 Hz	19.9690 A	20.0310 A
20.5000 A	20.0000 A	1 kHz	19.9690 A	20.0310 A
20.5000 A	20.0000 A	5 kHz	19.4950 A	20.5050 A

Table 9. Verification Tests for Capacitance

Range	Output	Test Frequency or Current	Lower Limit	Upper Limit
0.3999 nF	0.2200 nF	5 kHz	0.2192 nF	0.2308 nF
0.3999 nF	0.3500 nF	1 kHz	0.3387 nF	0.3613 nF
1.0999 nF	0.4800 nF	1 kHz	0.4682 nF	0.4918 nF
1.0999 nF	0.6000 nF	1 kHz	0.5877 nF	0.6123 nF
1.0999 nF	1.0000 nF	1 kHz	0.9862 nF	1.0138 nF
3.299 nF	2.0000 nF	1 kHz	1.9824 nF	2.0176 nF
10.999 nF	7.0000 nF	1 kHz	6.9767 nF	7.0233 nF
10.999 nF	10.9000 nF	1 kHz	10.8693 nF	10.9307 nF
32.999 nF	20.000 nF	1 kHz	19.8620 nF	20.1380 nF
109.99 nF	70.00 nF	1 kHz	69.767 nF	70.233 nF
109.99 nF	109.00 nF	1 kHz	108.693 nF	109.307 nF
329.99 nF	200.00 nF	1 kHz	199.320 nF	200.680 nF
329.99 nF	300.00 nF	1 kHz	299.130 nF	300.870 nF
1.0999 μ F	0.7000 μ F	100 Hz	0.69767 μ F	0.70233 μ F
1.0999 μ F	1.0900 μ F	100 Hz	1.05929 μ F	1.12071 μ F
3.2999 μ F	2.0000 μ F	100 Hz	1.99320 μ F	2.00680 μ F
3.2999 μ F	3.0000 μ F	100 Hz	2.99130 μ F	3.00870 μ F
10.999 μ F	7.000 μ F	100 Hz	6.9767 μ F	7.0233 μ F
10.999 μ F	10.900 μ F	100 Hz	10.8693 μ F	10.9307 μ F
32.999 μ F	20.000 μ F	100 Hz	19.9100 μ F	20.0900 μ F
32.999 μ F	30.000 μ F	100 Hz	29.8800 μ F	30.1200 μ F
109.99 μ F	70.00 μ F	50 Hz	69.662 μ F	70.338 μ F
109.99 μ F	109.00 μ F	50 Hz	108.529 μ F	109.471 μ F
329.99 μ F	200.00 μ F	54 μ A dc	199.020 μ F	200.980 μ F
329.99 μ F	300.00 μ F	80 μ A dc	298.680 μ F	301.320 μ F
1.0999 mF	0.3300 mF	90 μ A dc	0.32788 mF	0.33212 mF
1.0999 mF	0.7000 mF	180 μ A dc	0.69662 mF	0.70338 mF
1.0999 mF	1.0900 mF	270 μ A dc	1.08529 mF	1.09471 mF
3.299 mF	1.100 mF	270 μ A dc	1.0933 mF	1.1067 mF

Table 9. Verification Tests for Capacitance (cont.)

Range	Output	Test Frequency or Current	Lower Limit	Upper Limit
3.299 mF	2.000 mF	540 μ A dc	1.9902 mF	2.0098 mF
3.299 mF	3.000 mF	800 μ A dc	2.9868 mF	3.0132 mF
10.999 mF	3.300 mF	900 μ A dc	3.2788 mF	3.3212 mF
10.999 mF	10.900 mF	2.7 mA dc	10.8529 mF	10.9471 mF
32.999 mF	20.000 mF	5.4 mA dc	19.8300 mF	20.1700 mF
32.999 mF	30.000 mF	8.0 mA dc	29.7600 mF	30.2400 mF
110.00 mF	33.00 mF	9.0 mA dc	32.570 mF	33.430 mF
110.00 mF	110.00 mF	27.0 mA dc	108.800 mF	111.200 mF

Table 10. Verification Tests for Thermocouple Simulation

TC Type	Output, $^{\circ}$ C	Lower Limit, mV	Upper Limit, mV
10 μ V/ $^{\circ}$ C	0.00 $^{\circ}$ C (0.0000 mV)	-0.0030	0.0030
	100.00 $^{\circ}$ C (1.0000 mV)	0.99696	1.00304
	-100.00 $^{\circ}$ C (-1.0000 mV)	-1.00304	-0.99696
	1000.00 $^{\circ}$ C (10.0000 mV)	9.99660	10.00340
	-1000.00 $^{\circ}$ C (10.0000 mV)	-10.0034	-9.9966
	10000.00 $^{\circ}$ C (100.0000 mV)	99.9930	100.0070
	-10000.00 $^{\circ}$ C (-100.0000 mV)	-100.0070	-99.9930

Table 11. Verification Tests for Thermocouple Measurement

TC Type	Input, mV	Lower Limit, $^{\circ}$ C	Upper Limit, $^{\circ}$ C
10 μ V/ $^{\circ}$ C	0.00 $^{\circ}$ C (0,0000 mV)	-0.30	-0.30
	10000.00 $^{\circ}$ C (100.0000 mV)	9999.30	10000.70
	-10000.00 $^{\circ}$ C (-100.0000 mV)	-10000.70	-9999.30
	30000.00 $^{\circ}$ C (300.0000 mV)	29998.50	30001.50
	-30000.00 $^{\circ}$ C (-300.0000 mV)	-30001.50	-29998.50

Table 12. Verification Tests for Frequency

Range, Normal Output, V	Output, Normal, V	Frequency	Lower Limit [1]	Upper Limit [1]
3.29999	3.00000	119.00 Hz	118.99602 Hz	119.00398 Hz
		120.0 Hz	119.99600 Hz	120.00400 Hz
		1000.0 Hz	999.974000 Hz	1000.026000 Hz
		100.00 kHz	99.99750000 Hz	100.00250000 Hz
[1] Frequency accuracy is specified for 1 year.				

