FLUKE®

Calibration

5502E
Multi-Product Calibrator

Extended Specifications

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 tcal ±5 °C (tcal 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 ±1 °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 (tcal)** ..... **15 °C to 35 °C**
- **Storage** ..... **-20 °C to +70 °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 tcal ±5 °C is 10 % of the stated specification per °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 ±300 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 Ω Performance not specified above 3 V/m. This instrument may be susceptible to electro-static 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: ±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 ±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 %

FLUKE®
Calibration

Detailed Specifications

DC Voltage

Range	Absolute Uncertainty, tcal ± 5 °C ±(% of output + µV)		Stability	Resolution (µV)	Max Burden [1]
	90 Day	1 Year	24 hours, ± 1 °C ±(ppm of output + µV)		
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 µV/°C and 1 mV/°C modes [2]					
0 to 329.9999 mV	0.005 + 3	0.006 + 3	5 + 1	0.1	10 Ω

[1] Remote sensing is not provided. Output resistance is < 5 mΩ for outputs ≥ 0.33 V. The AUX output has an output resistance of <1 Ω. TC simulation has an output impedance of 10 Ω ± 1 Ω.

[2] TC simulating and measuring are not specified for operation in electromagnetic fields above 0.4 V/m.

Range	Noise	
	Bandwidth 0.1 Hz to 10 Hz p-p ±(ppm of output + floor in µV)	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 ±5 °C ±(% of output +µA)		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	0.013 + 0.05	0.01 µA	10	
0 to 32.9999 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 °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 32.9999 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

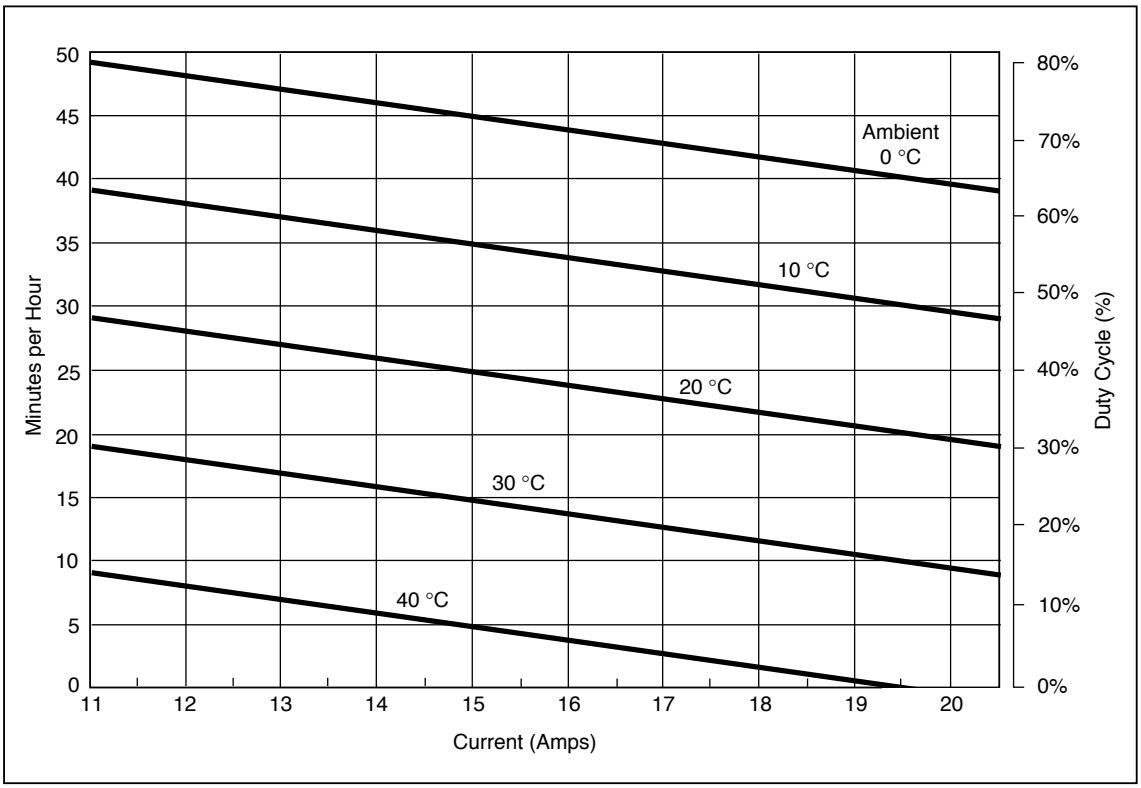

Figure 1. Allowable Duration of Current >11 A

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 Ω + 5 μV / 1 mA = (0.002 + 0.005) Ω = 0.007 Ω.

[3] Do not exceed the largest current for each range. For currents lower than shown, the floor adder increases by $Floor_{(new)} = Floor_{(old)} \times I_{min}/I_{actual}$. For example, a 50 μA stimulus measuring 100 Ω has a floor specification of: 0.0014 Ω x 1 mA/50 μA = 0.028 Ω, 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, tcal ±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	

[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 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.

[3] For currents >11 A, Floor specification is 10000 µA within 30 seconds of selecting operate. For operating times >30 seconds, the floor specification is 5000 µA.

[4] Subject to compliance voltages limits.

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 ±(% 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 μF	0.19 + 1 nF	0.25 + 1 nF	100 pF	10 to 600 Hz	1.5 kHz	2 kHz
1.1 to 3.2999 μF	0.19 + 3 nF	0.25 + 3 nF	100 pF	10 to 300 Hz	800 Hz	1 kHz
3.3 to 10.999 μF	0.19 + 10 nF	0.25 + 10 nF	1 nF	10 to 150 Hz	450 Hz	650 Hz
11 to 32.999 μF	0.30 + 30 nF	0.40 + 30 nF	1 nF	10 to 120 Hz	250 Hz	350 Hz
33 to 109.99 μF	0.34 + 100 nF	0.45 + 100 nF	10 nF	10 to 80 Hz	150 Hz	200 Hz
110 to 329.99 μF	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 μF	0.45 + 1 μF	100 nF	0 to 20 Hz	45 Hz	65 Hz
1.1 to 3.2999 mF	0.34 + 3 μF	0.45 + 3 μF	100 nF	0 to 6 Hz	30 Hz	40 Hz
3.3 to 10.999 mF	0.34 + 10 μF	0.45 + 10 μF	1 μF	0 to 2 Hz	15 Hz	20 Hz
11 to 32.999 mF	0.7 + 30 μF	0.75 + 30 μF	1 μF	0 to 0.6 Hz	7.5 Hz	10 Hz
33 to 110.00 mF	1.0 + 100 μF	1.1 + 100 μF	10 μF	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 μF and 100 mA for 1.1 μF 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]	
		90 Day	1 Year
B	600 to 800	0.42	0.44
	800 to 1000	0.34	0.34
	1000 to 1550	0.30	0.30
	1550 to 1820	0.26	0.33
C	0 to 150	0.23	0.30
	150 to 650	0.19	0.26
	650 to 1000	0.23	0.31
	1000 to 1800	0.38	0.50
	1800 to 2316	0.63	0.84
E	-250 to -100	0.38	0.50
	-100 to -25	0.12	0.16
	-25 to 350	0.10	0.14
	350 to 650	0.12	0.16
	650 to 1000	0.16	0.21
J	-210 to -100	0.20	0.27
	-100 to -30	0.12	0.16
	-30 to 150	0.10	0.14
	150 to 760	0.13	0.17
	760 to 1200	0.18	0.23
K	-200 to -100	0.25	0.33
	-100 to -25	0.14	0.18
	-25 to 120	0.12	0.16
	120 to 1000	0.19	0.26
	1000 to 1372	0.30	0.40

TC Type [1]	Range °C [2]	Absolute Uncertainty Source/Measure tcal ±5 °C ± °C [3]	
		90 Day	1 Year
L	-200 to -100	0.37	0.37
	-100 to 800	0.26	0.26
	800 to 900	0.17	0.17
N	-200 to -100	0.30	0.40
	-100 to -25	0.17	0.22
	-25 to 120	0.15	0.19
	120 to 410	0.14	0.18
	410 to 1300	0.21	0.27
R	0 to 250	0.48	0.57
	250 to 400	0.28	0.35
	400 to 1000	0.26	0.33
	1000 to 1767	0.30	0.40
S	0 to 250	0.47	0.47
	250 to 1000	0.30	0.36
	1000 to 1400	0.28	0.37
	1400 to 1767	0.34	0.46
T	-250 to -150	0.48	0.63
	-150 to 0	0.18	0.24
	0 to 120	0.12	0.16
	120 to 400	0.10	0.14
U	-200 to 0	0.56	0.56
	0 to 600	0.27	0.27

[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		600 to 630	0.09	0.11
	-80 to 0	0.05	0.05	Pt 385, 1000 Ω	-200 to -80	0.03	0.03
	0 to 100	0.07	0.07		-80 to 0	0.03	0.03
	100 to 300	0.08	0.09		0 to 100	0.03	0.04
	300 to 400	0.09	0.10		100 to 260	0.04	0.05
	400 to 630	0.10	0.12		260 to 300	0.05	0.06
Pt 3916, 100 Ω	-200 to -190	0.25	0.25		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	PtNi 385, 120 Ω (Ni120)	-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
	400 to 600	0.08	0.10				
	600 to 630	0.21	0.23				
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 ±5 °C	Max Voltage Resolution
Normal Channel (Single Output Mode)			
1.0 to 33 mV	0.01 to 9.99 Hz	±(5.0 % of output +0.5 % 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 ±5 °C, ±(% of output + % 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	

[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.

[2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM.

[3] Uncertainty for Truncated Sine outputs is typical over this frequency band.

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	

[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.

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

[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.

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 µs	<10 µs to 1 % of final value	<2 %	1 % to 99 % <3.3 V p-p. 0,01 Hz to 100 kHz	±(0.02 % of period + 100 ns), 50 % duty cycle ±(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 ±(% 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	
	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 ±5 °C ±(% of output + % 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	
	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	
	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