

FLUKE®

5500A Multi-Product Calibrator

*Extended Specifications
2005*



5500A Specifications

The following paragraphs detail specifications for the 5500A Calibrator. The specifications are valid after allowing a warm-up period of 30 minutes, or twice the time the 5500A has been turned off. For example, if the 5500A 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 $t_{cal} \pm 5\text{ }^{\circ}\text{C}$ (t_{cal} is the ambient temperature when the 5500A was calibrated), the temperature coefficient is less than 0.1 times the 90-day specifications per $^{\circ}\text{C}$ (limited to $0\text{ }^{\circ}\text{C}$ to $50\text{ }^{\circ}\text{C}$). These specifications also assume the 5500A Calibrator is zeroed every seven days or when the ambient temperature changes more than $5\text{ }^{\circ}\text{C}$. (See "Zeroing the Calibrator" in Chapter 4 of the 5500A Operator Manual.)

Also see additional specifications later in this chapter for information on extended specifications for ac voltage and current. The dimensional outline for the 5500A Calibrator is shown in Figure A.

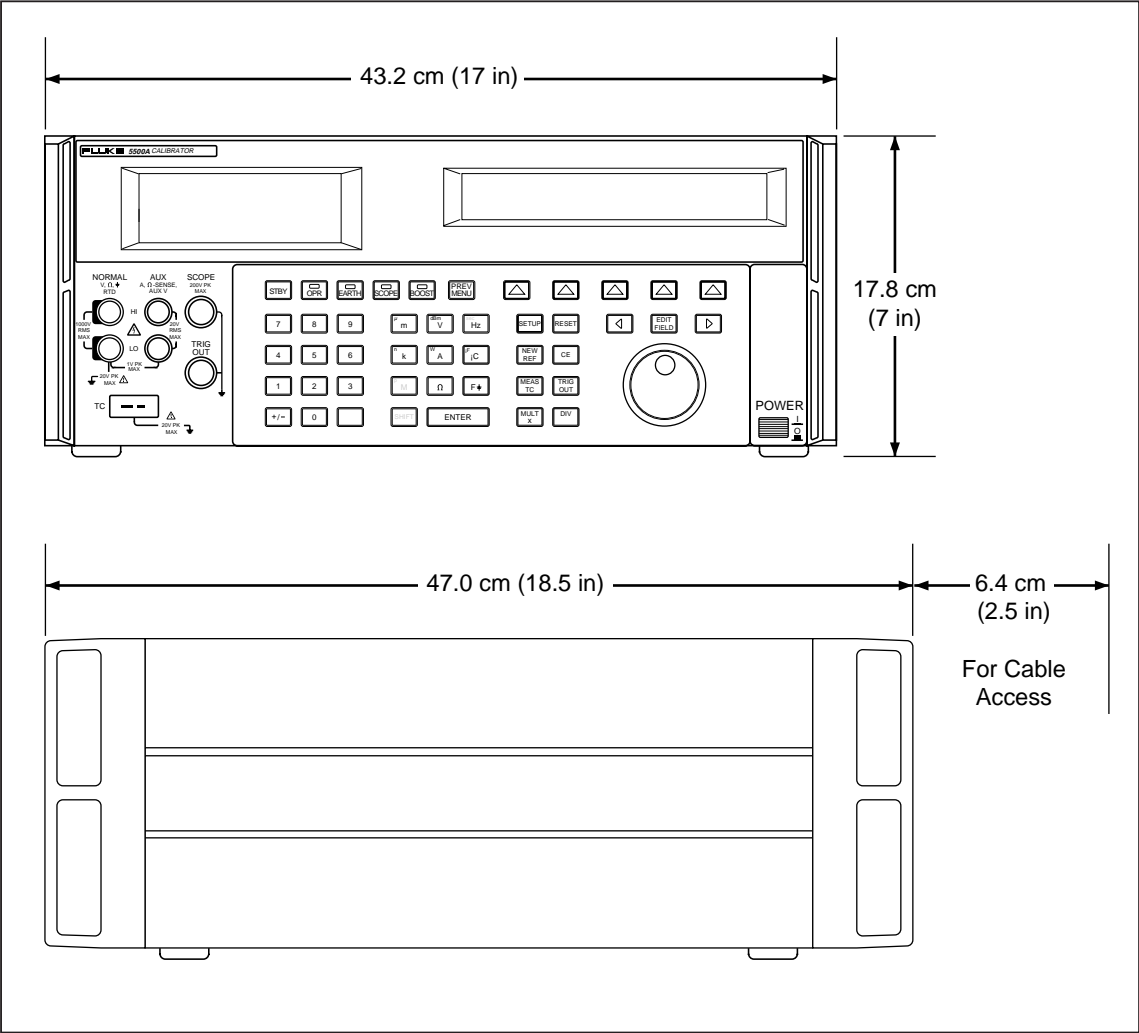


Figure A. 5500A Calibrator Dimensional Outline

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General Specifications

| | |
|---|---|
| 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, 5725A Amplifier |
| Temperature Performance | <ul style="list-style-type: none"> Operating: 0 °C to 50 °C Calibration (tcal): 15 °C to 35 °C Storage: -20 °C to 70 °C |
| Temperature Coefficient | Temperature Coefficient for temperatures outside tcal +5 °C is 0.1X/ °C of the 90-day specification (or 1-year, as applicable) per °C. |
| Relative Humidity ^[1] | <ul style="list-style-type: none"> Operating: <80 % to 30 °C, <70 % to 40 °C, <40 % to 50 °C Storage: <95 %, non-condensing |
| Altitude | <ul style="list-style-type: none"> Operating: 3,050 m (10,000 ft) maximum Non-operating: 12,200 m (40,000 ft) maximum |
| Safety | Complies with IEC 1010-1 (1992-1); ANSI/ISA-S82.01-1994; CAN/CSA-C22.2 No. 1010.1-92 |
| Analog Low Isolation | 20 V |
| EMC | Designed to comply with FCC Rules Part 15; VFG 243/1991. If used in areas with Electromagnetic fields of 1 to 3 V/m, 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) from direct contact to the binding posts. Good static aware practices should be followed when handling this and other pieces of electronic equipment. |
| Line Power | <ul style="list-style-type: none"> 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 |
| Power Consumption | 5500A Calibrator, 300 VA; 5725A Amplifier, 750 VA |
| Dimensions | 5500A Calibrator: <ul style="list-style-type: none"> Height: 17.8 cm (7 in), standard rack increment, plus 1.5 cm (0.6 in) for feet on bottom of unit Width, 43.2 cm (17 in), standard rack width Depth: 47.3 cm (18.6 in) overall 5725A Amplifier: Height, 13.3 cm (5.25 in), standard rack increment, plus 1.5 cm (0.6 in) for feet on bottom of unit Width, 43.2 cm (17 in), standard rack width Depth, 63.0 cm (24.8 in) overall. |
| Weight (without options) | 5500A Calibrator, 22 kg (49 lb); 5725A Amplifier 32 kg (70 lb) |
| Absolute Uncertainty Definition | The 5500A 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 5500A for the temperature range indicated. |
| Specification Confidence Interval | 99 % |
| [1] After long periods of storage at high humidity, a drying out period (with the power on) of at least one week may be required. | |

Electrical Specifications

DC Voltage Specifications

| Range | Absolute Uncertainty, tcal ± 5 °C ± (% of output + μV) | | | | Stability 24 hours, ± 1 °C | Resolution μV | Maximum Burden ^[1] |
|---|---|------|--------|------|-------------------------------|------------------|----------------------------------|
| | 90 days | | 1 year | | ± (ppm output + μV) | | |
| 0 to 329.9999 mV | 0.005 | 3 | 0.006 | 3 | 5 ppm + 1 | 0.1 | 50 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 | 0.004 | 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 |
| Auxiliary Output (dual output mode only) ^[2] | | | | | | | |
| 0 to 329.999 mV | 0.03 | 350 | 0.04 | 350 | 30 + 100 | 1 | 5 mA |
| 0.33 to 3.3 V | 0.03 | 350 | 0.04 | 350 | 30 + 100 | 10 | 5 mA |
| [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. | | | | | | | |
| [2] Two channels of dc voltage output are provided. | | | | | | | |

| Range | Noise | |
|--|---|----------------------------|
| | Bandwidth 0.1 to 10 Hz p-p $\pm (\text{ppm output} + \mu\text{V})$ | Bandwidth 10 to 10 kHz rms |
| 0 to 329.9999 mV | 1 μV | 4 μV |
| 0 to 3.299999 V | 10 μV | 50 μV |
| 0 to 32.99999 V | 100 μV | 600 μV |
| 30 to 329.9999 V | 10 ppm + 1 mV | 20 mV |
| 100 to 1020.000 V | 10 ppm + 5 mV | 20 mV |
| Auxiliary Output (dual output mode only) ^[1] | | |
| 0 to 329.999 mV | 5 μV | 20 μV |
| 0.33 to 3.3 V | 20 μV | 200 μV |
| [1] Two channels of dc voltage output are provided. | | |

DC Current Specifications

| Range | Absolute Uncertainty, tcal ± 5 °C ± (% of output + μA) | | | | Resolution | Compliance Voltage | Maximum Inductive Load |
|--|--|------|--------|------|------------|-----------------------------|------------------------------|
| | 90 days | | 1 year | | | | |
| 0 to 3.29999 mA | 0.010 | 0.05 | 0.013 | 0.05 | 0.01 μA | 4.5 V | 1 μH |
| 0 to 32.9999 mA | 0.008 | 0.25 | 0.01 | 0.25 | 0.1 μA | 4.5 V | 200 μH |
| 0 to 329.999 mA | 0.008 | 3.3 | 0.01 | 3.3 | 1 μA | 4.5 to 3.0 V ^[1] | 200 μH |
| 0 to 2.19999 A | 0.023 | 44 | 0.03 | 44 | 10 μA | 4.5 to 3.4 V ^[2] | 200 μH |
| 0 to 11 A | 0.038 | 330 | 0.06 | 330 | 100 μA | 4.5 to 2.5 V ^[3] | 200 μH |
| 5725A Amplifier | | | | | | | |
| 0 to 11 A | 0.03 | 330 | 0.04 | 330 | 100 | 4 V | 400 μH |
| <div>[1] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -5.05*Io+4.67. The highest compliance voltage is limited to 4.5 V.</div> <div>[2] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -0.588*Io+4.69. The highest compliance voltage is limited to 4.5 V.</div> <div>[3] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -0.204*Io+4.75. The highest compliance voltage is limited to 4.3 V.</div> | | | | | | | |

| Ranges | Noise | |
|------------------------|----------------------------------|----------------------------------|
| | Bandwidth 0.1 to 10 Hz p-p | Bandwidth 10 to 10 kHz rms |
| 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 2.19999 A | 20 μA | 1 mA |
| 0 to 11 A | 200 μA | 10 mA |
| 5725A Amplifier | | |
| 0 to 11 A | ± 25 ppm of output + 200 nA | 2 mA |

Resistance Specifications

| Range ^[1] | Absolute Uncertainty, tcal ± 5 °C ± (% of output + Ω) ^[2] | | | | Resolution Ω | Allowable Current ^[4] |
|----------------------|---|----------------------|--------|----------------------|-----------------|-------------------------------------|
| | 90 days | | 1 year | | | |
| 0 to 10.99 Ω | 0.009 | 0.008 ^[3] | 0.012 | 0.008 ^[3] | 0.001 | 1 to 125 mA |
| 11 to 32.999 Ω | 0.009 | 0.015 ^[3] | 0.012 | 0.015 ^[3] | 0.001 | 1 to 125 mA |
| 33 to 109.999 Ω | 0.007 | 0.015 ^[3] | 0.009 | 0.015 ^[3] | 0.001 | 1 to 70 mA |
| 110 to 329.999 Ω | 0.007 | 0.015 ^[3] | 0.009 | 0.015 ^[3] | 0.001 | 1 to 40 mA |
| 330 Ω to 1.09999 kΩ | 0.007 | 0.06 | 0.009 | 0.06 | 0.01 | 250 μA to 18 mA |
| 1.1 to 3.29999 kΩ | 0.007 | 0.06 | 0.009 | 0.06 | 0.01 | 250 μA to 5 mA |
| 3.3 to 10.9999 kΩ | 0.007 | 0.6 | 0.009 | 0.6 | 0.1 | 25 μA to 1.8 mA |
| 11 to 32.9999 kΩ | 0.007 | 0.6 | 0.009 | 0.6 | 0.1 | 25 μA to 0.5 mA |
| 33 to 109.999 kΩ | 0.008 | 6 | 0.011 | 6 | 1 | 2.5 μA to 0.18 mA |
| 110 to 329.999 kΩ | 0.009 | 6 | 0.012 | 6 | 1 | 2.5 μA to 0.05 mA |
| 330 kΩ to 1.09999 MΩ | 0.011 | 55 | 0.015 | 55 | 10 | 250 nA to 0.018 mA |
| 1.1 to 3.29999 MΩ | 0.011 | 55 | 0.015 | 55 | 10 | 250 nA to 5 μA |
| 3.3 to 10.9999 MΩ | 0.045 | 550 | 0.06 | 550 | 100 | 25 nA to 1.8 μA |
| 11 to 32.9999 MΩ | 0.075 | 550 | 0.1 | 550 | 100 | 25 nA to 0.5 μA |
| 33 to 109.999 MΩ | 0.4 | 5500 | 0.5 | 5500 | 1000 | 2.5 nA to 0.18 μA |
| 110 to 330 MΩ | 0.4 | 16500 | 0.5 | 16500 | 1000 | 2.5 nA to 0.06 μA |

[1]

Continuously variable from 0 to 330 MΩ.

[2]

Applies for COMP OFF (to the 5500A Calibrator front panel NORMAL terminals) and 2-wire and 4-wire compensation.

[3]

The floor adder is improved to 0.006 Ω (0 to 10.99 Ω range) and 0.010 Ω (11 to 329.999 Ω) if the 5500A Calibrator is zeroed (ohms zero or instrument zero) within 8 hours and temperature is ±1 °C of zeroing ambient temperature.

[4]

Do not exceed the largest current for each range. For currents lower than shown, the floor adder increases by Floor(new) = Floor(old) x Imin/Iactual. For example, a 100 μA stimulus measuring 100 Ω has a floor uncertainty of 0.01 Ω x 1 mA/100 μA = 0.1 Ω.

| Range | Maximum Voltage ^[1] | Maximum Lead Resistance ^[2] |
|--------------------------------------|--------------------------------|--|
| 0 to 10.99 Ω | 1.37 | <3.2 |
| 11 to 32.999 Ω | 4.12 | <3.2 |
| 33 to 109.999 Ω | 7.7 | <3.2 |
| 110 to 329.999 Ω | 13.2 | <3.2 |
| 330 Ω to 1.09999 k Ω | 19.8 | <6 |
| 1.1 to 3.29999 k Ω | 16.5 | <6 |
| 3.3 to 10.9999 k Ω | 19.8 | <6 |
| 11 to 32.9999 k Ω | 16.5 | <6 |
| 33 to 109.999 k Ω | 19.8 | <6 |
| 110 to 329.999 k Ω | 16.5 | (n/a 110 k Ω and above) |
| 330 k Ω to 1.09999 M Ω | 19.8 | |
| 1.1 to 3.29999 M Ω | 16.5 | |
| 3.3 to 10.9999 M Ω | 19.8 | |
| 11 to 32.9999 M Ω | 16.5 | |
| 33 to 109.999 M Ω | 19.8 | |
| 110 to 330 M Ω | 19.8 | |

[1] This is for the largest resistance for each range. The maximum voltage for other values is I_{max} (highest value of Allowable Current above) multiplied by Rout.

[2] Maximum lead resistance for no additional error in 2-wire COMP.

AC Voltage (Sine Wave) Specifications

| Range | Frequency | Absolute Uncertainty, tcal ± 5 °C ± (% of output + μV) | | | | Resolution | Max Burden ^[1] |
|-------------------|-----------------|---|--------|--------|--------|------------|--|
| | | 90 days | | 1 year | | | |
| 1.0 to 32.999 mV | 10 to 45 Hz | 0.20 | 20 | 0.35 | 20 | 1 μV | 50 Ω |
| | 45 Hz to 10 kHz | 0.11 | 20 | 0.15 | 20 | | |
| | 10 to 20 kHz | 0.15 | 20 | 0.2 | 20 | | |
| | 20 to 50 kHz | 0.19 | 20 | 0.25 | 20 | | |
| | 50 to 100 kHz | 0.26 | 33 | 0.35 | 33 | | |
| | 100 to 500 kHz | 0.75 | 60 | 1 | 60 | | |
| 33 to 329.999 mV | 10 to 45 Hz | 0.19 | 50 | 0.25 | 50 | 1 μV | 50 Ω |
| | 45 Hz to 10 kHz | 0.04 | 20 | 0.05 | 20 | | |
| | 10 to 20 kHz | 0.08 | 20 | 0.1 | 20 | | |
| | 20 to 50 kHz | 0.12 | 40 | 0.16 | 40 | | |
| | 50 to 100 kHz | 0.17 | 170 | 0.24 | 170 | | |
| | 100 to 500 kHz | 0.53 | 330 | 0.7 | 330 | | |
| 0.33 to 3.29999 V | 10 to 45 Hz | 0.11 | 250 | 0.15 | 250 | 10 μV | 10 mA |
| | 45 Hz to 10 kHz | 0.02 | 60 | 0.03 | 60 | | |
| | 10 to 20 kHz | 0.06 | 60 | 0.08 | 60 | | |
| | 20 to 50 kHz | 0.10 | 300 | 0.14 | 300 | | |
| | 50 to 100 kHz | 0.17 | 1700 | 0.24 | 1700 | | |
| | 100 to 500 kHz | 0.38 | 3300 | 0.5 | 3300 | | |
| 3.3 to 32.9999 V | 10 to 45 Hz | 0.11 | 2500 | 0.15 | 2500 | 100 μV | 10 mA |
| | 45 Hz to 10 kHz | 0.03 | 600 | 0.04 | 600 | | |
| | 10 to 20 kHz | 0.06 | 2600 | 0.08 | 2600 | | |
| | 20 to 50 kHz | 0.14 | 5000 | 0.19 | 5000 | | |
| | 50 to 100 kHz | 0.17 | 17000 | 0.24 | 17000 | | |
| 33 to 329.999 V | 45 Hz to 1 kHz | 0.04 | 6.6 mV | 0.05 | 6.6 mV | 1 mV | 5 mA, except 20 mA for 45 to 65 Hz |
| | 1 to 10 kHz | 0.06 | 15 | 0.08 | 15 | | |
| | 10 to 20 kHz | 0.07 | 33 | 0.09 | 33 | | |
| 330 to 1020 V | 45 Hz to 1 kHz | 0.04 | 80 mV | 0.05 | 80 mV | 10 mV | 2 mA, except 6 mA for 45 to 65 Hz |
| | 1 to 5 kHz | 0.15 | 100 | 0.20 | 100 | | |
| | 5 to 10 kHz | 0.15 | 500 | 0.20 | 500 | | |

AC Voltage (Sine Wave) Specifications (cont.)

| Range | Frequency | Absolute Uncertainty, tcal ± 5 °C ± (% of output + μV) | | | | Resolution | Maximum Burden ^[1] |
|---|----------------|---|-------|--------|-------|------------|-------------------------------|
| | | 90 days | | 1 year | | | |
| 5725A Amplifier | | | | | | | |
| 100 to 1020 V | 45 Hz to 1 kHz | 0.04 | 80 mV | 0.05 | 80 mV | 10 mV | 50 mA |
| | 1 to 20 kHz | 0.06 | 100 | 0.08 | 100 | | 70 mA |
| | 20 to 30 kHz | 0.08 | 100 | 0.10 | 100 | | 70 mA |
| 100 to 750 V | 30 to 100 kHz | 0.38 | 500 | 0.5 | 500 | | 70 mA |
| Auxiliary Output [dual output mode only] ^[2] | | | | | | | |
| 10 to 329.999 mV | 10 to 20 Hz | 0.15 | 370 | 0.2 | 370 | 1 μV | 5 mA |
| | 20 to 45 Hz | 0.08 | 370 | 0.1 | 370 | | |
| | 45 Hz to 1 kHz | 0.08 | 370 | 0.1 | 370 | | |
| | 1 to 5 kHz | 0.15 | 450 | 0.2 | 450 | | |
| | 5 to 10 kHz | 0.3 | 450 | 0.4 | 450 | | |
| 0.33 to 3.29999 V | 10 to 20 Hz | 0.15 | 450 | 0.2 | 450 | 10 μV | 5 mA |
| | 20 to 45 Hz | 0.08 | 450 | 0.1 | 450 | | |
| | 45 Hz to 1 kHz | 0.07 | 450 | 0.09 | 450 | | |
| | 1 to 5 kHz | 0.15 | 1400 | 0.2 | 1400 | | |
| | 5 to 10 kHz | 0.3 | 1400 | 0.4 | 1400 | | |
| <div>[1] Remote sensing is not provided. Output resistance is < 5 mΩ for outputs ≥ 0.33 V. The AUX output resistance is < 1 Ω. The maximum load capacitance is 500 pF, subject to the maximum burden current limits.</div> <div>[2] There are two channels of voltage output. The maximum frequency of the dual output is 10 kHz.</div> | | | | | | | |

AC Voltage (Sine Wave) Specifications (cont.)

| Range | Frequency | Maximum Distortion and Noise 10 Hz to 5 MHz Bandwidth \pm (% output + μ V) |
|--|-----------------|--|
| 1.0 to 32.999 mV | 10 to 45 Hz | 0.15 % + 90 μ V |
| | 45 Hz to 10 kHz | 0.035 + 90 μ V |
| | 10 to 20 kHz | 0.06 + 90 μ V |
| | 20 to 50 kHz | 0.15 + 90 μ V |
| | 50 to 100 kHz | 0.25 + 90 μ V |
| | 100 to 500 kHz | 0.3 + 90 μ V |
| 33 to 329.999 mV | 10 to 45 Hz | 0.15 % + 90 μ V |
| | 45 Hz to 10 kHz | 0.035 + 90 μ V |
| | 10 to 20 kHz | 0.06 + 90 μ V |
| | 20 to 50 kHz | 0.15 + 90 μ V |
| | 50 to 100 kHz | 0.20 + 90 μ V |
| | 100 to 500 kHz | 0.20 + 90 μ V |
| 0.33 to 3.29999 V | 10 to 45 Hz | 0.15 % + 200 μ V |
| | 45 Hz to 10 kHz | 0.035 + 200 μ V |
| | 10 to 20 kHz | 0.06 + 200 μ V |
| | 20 to 50 kHz | 0.15 + 200 μ V |
| | 50 to 100 kHz | 0.20 + 200 μ V |
| | 100 to 500 kHz | 0.20 + 200 μ V |
| 3.3 to 32.9999 V | 10 to 45 Hz | 0.15 % + 2 mV |
| | 45 Hz to 10 kHz | 0.035 + 2 mV |
| | 10 to 20 kHz | 0.08 + 2 mV |
| | 20 to 50 kHz | 0.2 + 2 mV |
| | 50 to 100 kHz | 0.5 + 2 mV |
| 33 to 329.999 V | 45 Hz to 1 kHz | 0.15 % + 10 mV |
| | 1 to 10 kHz | 0.05 + 10 mV |
| | 10 to 20 kHz | 0.6 + 10 mV |
| 330 to 1000 V | 45 Hz to 1 kHz | 0.15 % + 30 mV |
| | 1 to 10 kHz | 0.07 + 30 mV |
| 5725A Amplifier | | |
| 100 to 1000 V | 45 Hz to 1 kHz | 0.07 % |
| | 1 to 20 kHz | 0.15 % |
| | 20 to 30 kHz | 0.3 % |
| 100 to 750 V | 30 to 100 kHz | 0.4 % |
| Auxiliary Output (dual output mode only) 10 Hz to 100 kHz Bandwidth | | |
| 10 to 329.999 mV | 10 to 20 Hz | 0.2 % + 200 μ V |
| | 20 to 45 Hz | 0.06 + 200 μ V |
| | 45 Hz to 1 kHz | 0.08 + 200 μ V |
| | 1 to 5 kHz | 0.3 + 200 μ V |
| | 5 to 10 kHz | 0.6 + 200 μ V |
| 0.33 to 3.29999 V | 10 to 20 Hz | 0.2 % + 200 μ V |
| | 20 to 45 Hz | 0.06 + 200 μ V |
| | 45 Hz to 1 kHz | 0.08 + 200 μ V |
| | 1 to 5 kHz | 0.3 + 200 μ V |
| | 5 to 10 kHz | 0.6 + 200 μ V |

AC Current (Sine Wave) Specifications

| Range | Frequency | Absolute Uncertainty, tcal ± 5 °C ± (% of output + μA) | | | | Resolution | Compliance Voltage | Max Inductive Load |
|---------------------|-----------------|---|------|--------|------|------------|-------------------------------------|------------------------------|
| | | 90 days | | 1 year | | | | |
| | | | | | | | | |
| 0.029 to 0.32999 mA | 10 to 20 Hz | 0.19 | 0.15 | 0.25 | 0.15 | 0.01 μA | 3.0 V rms | 1 μH |
| | 20 to 45 Hz | 0.09 | 0.15 | 0.125 | 0.15 | | | |
| | 45 Hz to 1 kHz | 0.09 | 0.25 | 0.125 | 0.25 | | | |
| | 1 to 5 kHz | 0.30 | 0.15 | 0.4 | 0.15 | | | |
| | 5 to 10 kHz | 0.94 | 0.15 | 1.25 | 0.15 | | | |
| 0.33 to 3.2999 mA | 10 to 20 Hz | 0.15 | 0.3 | 0.2 | 0.3 | 0.01 μA | 3.0 V rms | 1 μH |
| | 20 to 45 Hz | 0.08 | 0.3 | 0.1 | 0.3 | | | |
| | 45 Hz to 1 kHz | 0.08 | 0.3 | 0.1 | 0.3 | | | |
| | 1 to 5 kHz | 0.15 | 0.3 | 0.2 | 0.3 | | | |
| | 5 to 10 kHz | 0.45 | 0.3 | 0.6 | 0.3 | | | |
| 3.3 to 32.999 mA | 10 to 20 Hz | 0.15 | 3 | 0.2 | 3 | 0.1 μA | 3.0 V rms | 200 μH, 10 to 500 Hz |
| | 20 to 45 Hz | 0.08 | 3 | 0.1 | 3 | | | 1 μH, 500 Hz to 10 kHz |
| | 45 Hz to 1 kHz | 0.07 | 3 | 0.09 | 3 | | | |
| | 1 to 5 kHz | 0.15 | 3 | 0.2 | 3 | | | |
| | 5 to 10 kHz | 0.45 | 3 | 0.6 | 3 | | | |
| 33 to 329.99 mA | 10 to 20 Hz | 0.15 | 30 | 0.2 | 30 | 1 μA | 3.0 to 2.0 V rms ^[1] | 200 μH, 10 to 500 Hz |
| | 20 to 45 Hz | 0.08 | 30 | 0.1 | 30 | | | 5 μH, 500 Hz to 10 kHz |
| | 45 Hz to 1 kHz | 0.07 | 30 | 0.09 | 30 | | | |
| | 1 to 5 kHz | 0.15 | 30 | 0.2 | 30 | | | |
| | 5 to 10 kHz | 0.45 | 30 | 0.6 | 30 | | | |
| 0.33 to 2.19999 A | 10 to 45 Hz | 0.15 | 300 | 0.2 | 300 | 10 μA | 3.0 to 2.0 V rms ^[2] | 200 μH, 45 to 500 Hz |
| | 45 Hz to 1 kHz | 0.08 | 300 | 0.1 | 300 | | | 5 μH, 500 Hz to 5 kHz |
| | 1 to 5 kHz | 0.7 | 300 | 0.75 | 300 | | | |
| 2.2 to 11 A | 45 to 65 Hz | 0.05 | 2000 | 0.06 | 2000 | 100 μA | 2.8 to 1.25 V rms ^[3] | 200 μH, 45 to 65 Hz |
| | 65 to 500 Hz | 0.08 | 2000 | 0.10 | 2000 | | | 1 μH, 65 Hz to 1 kHz |
| | 500 Hz to 1 kHz | 0.25 | 2000 | 0.33 | 2000 | | | |

AC Current (Sine Wave) Specifications (cont.)

| Range | Frequency | Absolute Uncertainty, $t_{cal} \pm 5\text{ }^{\circ}\text{C}$ \pm (% of output + μA) | | | | Resolution | Compliance Voltage | Max Inductive Load |
|--|-----------------|---|-------|--------|-------|------------|--------------------|--------------------|
| | | 90 days | | 1 year | | | | |
| 5725A Amplifier | | | | | | | | |
| 1.5 to 11 A | 45 Hz to 1 kHz | 0.08 | 100 | 0.1 | 100 | 100 | 3 | 400 μH |
| | 1 to 5 kHz | 0.19 | 5000 | 0.25 | 5000 | | | |
| | 5 to 10 kHz | 0.75 | 10000 | 1 | 10000 | | | |
| <div>[1] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -3.37*Io+3.11. The highest compliance voltage is limited to 3.0 V.</div> <div>[2] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -0.535*Io+3.18. The highest compliance voltage is limited to 3.0 V.</div> <div>[3] The actual voltage compliance (Vc) is a function of current output (Io), and is given by the formula: Vc = -0.176*Io+3.19. The highest compliance voltage is limited to 2.8 V.</div> | | | | | | | | |
| Range | Frequency | Maximum Distortion and Noise 10 Hz to 100 kHz Bandwidth \pm (% output + μA) | | | | | | |
| 0.02 to 0.32999 mA | 10 to 20 Hz | 0.15 + 1.0 μA | | | | | | |
| | 20 to 45 Hz | 0.1 + 1.0 μA | | | | | | |
| | 45 Hz to 1 kHz | 0.05 + 1.0 μA | | | | | | |
| | 1 to 5 kHz | 0.5 + 1.0 μA | | | | | | |
| | 5 to 10 kHz | 1.0 + 1.0 μA | | | | | | |
| 0.33 to 3.2999 mA | 10 to 20 Hz | 0.15 + 1.5 μA | | | | | | |
| | 20 to 45 Hz | 0.06 + 1.5 μA | | | | | | |
| | 45 Hz to 1 kHz | 0.02 + 1.5 μA | | | | | | |
| | 1 to 5 kHz | 0.5 + 1.5 μA | | | | | | |
| | 5 to 10 kHz | 1.2 + 1.5 μA | | | | | | |
| 3.3 to 32.999 mA | 10 to 20 Hz | 0.15 + 5 μA | | | | | | |
| | 20 to 45 Hz | 0.05 + 5 μA | | | | | | |
| | 45 Hz to 1 kHz | 0.07 + 5 μA | | | | | | |
| | 1 to 5 kHz | 0.3 + 5 μA | | | | | | |
| | 5 to 10 kHz | 0.7 + 5 μA | | | | | | |
| 33 to 329.99 mA | 10 to 20 Hz | 0.15 + 50 μA | | | | | | |
| | 20 to 45 Hz | 0.05 + 50 μA | | | | | | |
| | 45 Hz to 1 kHz | 0.07 + 50 μA | | | | | | |
| | 1 to 5 kHz | 0.2 + 50 μA | | | | | | |
| | 5 to 10 kHz | 0.4 + 50 μA | | | | | | |
| 0.33 to 2.19999 A | 10 to 45 Hz | 0.2 + 500 μA | | | | | | |
| | 45 Hz to 1 kHz | 0.1 + 500 μA | | | | | | |
| | 1 to 5 kHz | 1.4 + 500 μA | | | | | | |
| 2.2 to 11 A | 45 to 65 Hz | 0.2 + 3 mA | | | | | | |
| | 65 to 500 Hz | 0.1 + 3 mA | | | | | | |
| | 500 Hz to 1 kHz | 0.4 + 3 mA | | | | | | |
| 5725A Amplifier | | | | | | | | |
| 1.5 to 11 A | 45 Hz to 1 kHz | 0.05 + 1 mA | | | | | | |
| | 1 to 5 kHz | 0.12 + 1 mA | | | | | | |
| | 5 to 10 kHz | 0.5 + 1 mA | | | | | | |

Capacitance Specifications

| Range | Absolute Uncertainty, tcal ± 5 °C ± (% of output + nF) | | | | Resolution | Frequency | |
|-------------------|---|------|--------|------|------------|---------------|---------------------------|
| | 90 days | | 1 year | | | Allowed | Typical for <1 % Error |
| 0.33 to 0.4999 nF | 0.38 | 0.01 | 0.5 | 0.01 | 0.1 pF | 50 to 1000 Hz | 10 kHz |
| 0.5 to 1.0999 nF | 0.38 | 0.01 | 0.5 | 0.01 | 0.1 pF | 50 to 1000 Hz | 10 kHz |
| 1.1 to 3.2999 nF | 0.38 | 0.01 | 0.5 | 0.01 | 0.1 pF | 50 to 1000 Hz | 10 kHz |
| 3.3 to 10.999 nF | 0.38 | 0.01 | 0.5 | 0.01 | 1 pF | 50 to 1000 Hz | 10 kHz |
| 11 to 32.999 nF | 0.19 | 0.1 | 0.25 | 0.1 | 1 pF | 50 to 1000 Hz | 10 kHz |
| 33 to 109.99 nF | 0.19 | 0.1 | 0.25 | 0.1 | 10 pF | 50 to 1000 Hz | 10 kHz |
| 110 to 329.99 nF | 0.19 | 0.3 | 0.25 | 0.3 | 10 pF | 50 to 1000 Hz | 10 kHz |
| 0.33 to 1.0999 μF | 0.19 | 1 | 0.25 | 1 | 100 pF | 50 to 1000 Hz | 5 kHz |
| 1.1 to 3.2999 μF | 0.26 | 3 | 0.35 | 3 | 100 pF | 50 to 1000 Hz | 2 kHz |
| 3.3 to 10.999 μF | 0.26 | 10 | 0.35 | 10 | 1 nF | 50 to 400 Hz | 1.5 kHz |
| 11 to 32.999 μF | 0.30 | 30 | 0.40 | 30 | 1 nF | 50 to 400 Hz | 800 Hz |
| 33 to 109.99 μF | 0.38 | 100 | 0.50 | 100 | 10 nF | 50 to 200 Hz | 400 Hz |
| 110 to 329.99 μF | 0.50 | 300 | 0.70 | 300 | 10 nF | 50 to 100 Hz | 200 Hz |
| 330 to 1.1 mF | 1 | 300 | 1 | 300 | 100 nF | 50 to 100 Hz | 150 Hz |

Specifications apply to both dc charge/discharge capacitance meters and ac RCL meters.

The output is continuously variable from 330 pF to 1.1 mF.

For all ranges, the maximum charge and discharge current is 150 mA pk or 30 mA rms. The peak voltage is 4 V, except the 330 μF to 1.1 mF range is limited to 1 V. The maximum lead resistance for no additional error in 2-wire COMP mode is 10 Ω.

Temperature Calibration (Thermocouple) Specifications

| TC Type ^[1] | Range (°C) ^[2] | Absolute Uncertainty Source/Measure, tcal ± 5 °C, ± (°C) ^[3] | |
|--|---------------------------|---|--------|
| | | 90 days | 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 |
| K | 760 to 1200 | 0.18 | 0.23 |
| | -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 |
| L | -200 to -100 | 0.37 | 0.37 |
| | -100 to 800 | 0.26 | 0.26 |
| | 800 to 900 | 0.17 | 0.17 |
| | -200 to -100 | 0.30 | 0.40 |
| N | -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 |
| | 0 to 250 | 0.48 | 0.57 |
| R | 250 to 400 | 0.28 | 0.35 |
| | 400 to 1000 | 0.26 | 0.33 |
| | 1000 to 1767 | 0.30 | 0.40 |
| | 0 to 250 | 0.47 | 0.47 |
| S | 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 |
| <p>The 10 µV/ °C linear output mode has the same uncertainty as the 300 mV dc range.</p> <p>Applies to both simulated thermocouple output and thermocouple measurement.</p> <p>[1] Temperature standard ITS-90 or IPTS-68 is selectable.</p> <p>[2] Resolution is 0.01 °C.</p> <p>[3] Does not include thermocouple error.</p> | | | |

Temperature Calibration (RTD) Specifications

| 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 days | 1 year | | | 90 days | 1 year | | | |
| Pt 395, 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 | 600 to 630 | 0.09 | 0.11 | | | |
| | -80 to 0 | 0.05 | 0.05 | | -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 | | | | | | | |
| <div>[1] Resolution is 0.003 °C.</div> <div>[2] Applies for COMP OFF (to the 5500A Calibrator front panel NORMAL terminals) and 2-wire and 4-wire compensation.</div> <div>[3] Based on MINCO Application Aid No. 18.</div> | | | | | | | | | | |

DC Power Specification Summary

| | Voltage Range | Absolute Uncertainty, $t_{cal} \pm 5\text{ }^{\circ}\text{C}$, \pm (% of Watts output) ^[1] | | | |
|---|-----------------|--|-----------------|-----------------|-----------------|
| | | 5500A Calibrator Current Range | | | |
| | | 3.3 to 8.999 mA | 9 to 32.999 mA | 33 to 89.99 mA | 90 to 329.99 mA |
| 90 days | 33 mV to 1020 V | 0.03 | 0.02 | 0.03 | 0.02 |
| 1 year | 33 mV to 1020 V | 0.04 | 0.03 | 0.04 | 0.03 |
| | | | | | |
| | Voltage Range | 0.33 to 0.8999 A | 0.9 to 2.1999 A | 2.2 to 4.4999 A | 4.5 to 11 A |
| 90 days | 33 mV to 1020 V | 0.07 | 0.05 | 0.08 | 0.06 |
| 1 year | 33 mV to 1020 V | 0.08 | 0.06 | 0.12 | 0.09 |
| | | | | | |
| | Voltage Range | 5725A Amplifier Current Range | | | |
| | | 1.5 to 4.4999 A | 4.5 to 11 A | | |
| | | | | | |
| 90 days | 33 mV to 1020 V | 0.09 | 0.07 | | |
| 1 year | 33 mV to 1020 V | 0.10 | 0.08 | | |
| ^[1] To determine dc power uncertainty with more precision, see the individual "DC Voltage Specifications" and "DC Current Specifications" and "Calculating Power Uncertainty." | | | | | |

AC Power (45 Hz to 65 Hz) Specification Summary, PF=1

| Voltage Range | | Absolute Uncertainty, tcal \pm 5 °C, \pm (% of Watts output) ^[1] | | | |
|--|------------------|---|-----------------|-----------------|-----------------|
| | | Current Range | | | |
| | | 3.3 to 8.999 mA | 9 to 32.999 mA | 33 to 89.99 mA | 90 to 329.99 mA |
| 5500A Calibrator | | | | | |
| 90 days | 33 to 329.999 mV | 0.30 | 0.20 | 0.25 | 0.20 |
| | 330 mV to 1020 V | 0.20 | 0.12 | 0.20 | 0.12 |
| 1 year | 33 to 329.999 mV | 0.40 | 0.25 | 0.35 | 0.25 |
| | 330 mV to 1020 V | 0.25 | 0.15 | 0.25 | 0.15 |
| 5725A Amplifier | | | | | |
| 90 days | 100 to 1020 V | 0.20 | 0.12 | 0.20 | 0.12 |
| 1 year | 100 to 1020 V | 0.25 | 0.15 | 0.25 | 0.15 |
| | | 0.33 to 0.8999 A | 0.9 to 2.1999 A | 2.2 to 4.4999 A | 4.5 to 11 A |
| 5500A Calibrator | | | | | |
| 90 days | 33 to 329.999 mV | 0.25 | 0.20 | 0.25 | 0.20 |
| | 330 mV to 1020 V | 0.20 | 0.12 | 0.18 | 0.12 |
| 1 year | 33 to 329.999 mV | 0.35 | 0.25 | 0.35 | 0.25 |
| | 330 mV to 1020 V | 0.25 | 0.15 | 0.20 | 0.15 |
| 5725A Amplifier | | | | | |
| 90 days | 100 to 1020 V | 0.20 | 0.12 | 0.18 | 0.12 |
| 1 year | 100 to 1020 V | 0.25 | 0.15 | 0.20 | 0.15 |
| | | 1.5 to 4.4999 A | | 4.5 to 11 A | |
| 5500A Calibrator | | | | | |
| 90 days | 33 to 329.999 mV | 0.25 | | 0.20 | |
| | 330 mV to 1020 V | 0.15 | | 0.12 | |
| 1 year | 33 mV to 1020 V | 0.35 | | 0.25 | |
| | 330 mV to 1020 V | 0.20 | | 0.15 | |
| [1] To determine uncertainty with more precision, see "Calculating Power Uncertainty." | | | | | |

Power and Dual Output Limit Specifications

| Frequency | Voltages (NORMAL) | Currents | Voltages (AUX) | Power Factor (PF) |
|--|--------------------------------|---------------------|--------------------------------|----------------------|
| DC | 0 to ± 1020 V | 0 to ± 11 A | 0 to ± 3.3 V | — |
| 10 to 45 Hz | 33 mV to 32.9999 V | 3.3 mA to 2.19999 A | 10 mV to 3.3 V | 0 to 1 |
| 45 to 65 Hz | 33 mV to 1020 V | 3.3 mA to 11 A | 10 mV to 3.3 V | 0 to 1 |
| 65 to 500 Hz | 330 mV to 1020 V | 33 mA to 2.19999 A | 100 mV to 3.3 V | 0 to 1 |
| 65 to 500 Hz | 3.3 V to 1020 V | 33 mA to 11 A | 100 mV to 3.3 V | 0 to 1 |
| 500 Hz to 1 kHz | 330 mV to 1020 V | 33 mA to 11 A | 100 mV to 3.3 V | 1 |
| 1 to 5 kHz | 3.3 V to 1020 V ^[1] | 33 mA to 2.19999 A | 100 mV to 3.3 V ^[1] | 1 |
| 5 to 10 kHz | 3.3 V to 1020 V ^[2] | 33 mA to 329.99 mA | 1 V to 3.3 V ^[2] | 1 |
| <p>[1] In dual volts, voltage is limited to 3.3 to 500 V in the NORMAL output.</p> <p>[2] In dual volts, voltage is limited to 3.3 to 250 V in the NORMAL output.</p> <ul style="list-style-type: none"> The range of voltages and currents shown in "DC Voltage Specifications," "DC Current Specifications," "AC Voltage (Sine Waves) Specifications," and "AC Current (Sine Wave) Specifications" are available in the power and dual output modes (except minimum current for ac power is 0.33 mA). However, only those limits shown in this table are specified. See "Calculating Power Uncertainty" to determine the uncertainty at these points. The phase adjustment range for dual ac outputs is 0 to ± 179.99 degrees. The phase resolution for dual ac outputs is 0.02 degree. | | | | |

Phase Specifications

| 1-Year Absolute Uncertainty, tcal ± 5 °C, (ΔΦ Degrees) | | | | |
|--|--------------|-----------------|------------|-------------|
| 10 to 65 Hz | 65 to 500 Hz | 500 Hz to 1 kHz | 1 to 5 kHz | 5 to 10 kHz |
| 0.15 ° [1] | 0.9 ° [2] | 2.0 ° [3] | 6 ° | 10 ° |
| [1] For 33 to 1000 V output, burden current <6 mA. For 6 to 20 mA burden current (33 to 330 V), the phase uncertainty is 0.4 degree. [2] For 33 to 1000 V output, burden current <2 mA. For 2 to 5 mA burden current (33 to 330 V), the phase uncertainty is 1.5 degrees. [3] For 33 to 1000 V output, burden current <2 mA. For 2 to 5 mA burden current (33 to 330 V), the phase uncertainty is 5 degrees. | | | | |

| Phase (Φ) Watts Degrees | Phase (Φ) VARs Degrees | PF | Power Uncertainty Adder due to Phase Error % | | | | |
|--|------------------------------|-------|--|--------------|-----------------|------------|-------------|
| | | | 10 to 65 Hz | 65 to 500 Hz | 500 Hz to 1 kHz | 1 to 5 kHz | 5 to 10 kHz |
| 0 | 90 | 1.000 | 0.00 | 0.01 | 0.06 | 0.55 | 1.52 |
| 5 | 85 | 0.996 | 0.02 | 0.15 | | | |
| 10 | 80 | 0.985 | 0.05 | 0.29 | | | |
| 15 | 75 | 0.966 | 0.07 | 0.43 | | | |
| 20 | 70 | 0.940 | 0.10 | 0.58 | | | |
| 25 | 65 | 0.906 | 0.12 | 0.74 | | | |
| 30 | 60 | 0.866 | 0.15 | 0.92 | | | |
| 35 | 55 | 0.819 | 0.18 | 1.11 | | | |
| 40 | 50 | 0.766 | 0.22 | 1.33 | | | |
| 45 | 45 | 0.707 | 0.26 | 1.58 | | | |
| 50 | 40 | 0.643 | 0.31 | 1.88 | | | |
| 55 | 35 | 0.574 | 0.37 | 2.26 | | | |
| 60 | 30 | 0.500 | 0.45 | 2.73 | | | |
| 65 | 25 | 0.423 | 0.56 | 3.38 | | | |
| 70 | 20 | 0.342 | 0.72 | 4.33 | | | |
| 75 | 15 | 0.259 | 0.98 | 5.87 | | | |
| 80 | 10 | 0.174 | 1.49 | 8.92 | | | |
| 85 | 5 | 0.087 | 2.99 | 17.97 | | | |
| 90 | 0 | 0.000 | — | — | | | |
| To calculate exact ac Watts power adders due to phase uncertainty for values not shown, use the following formula: | | | | | | | |
| $Adder(\%) = 100(1 - \frac{Cos(\Phi + \Delta\Phi)}{Cos(\Phi)}) .$ | | | | | | | |
| For example: for a PF of .9205 (Φ = 23) and a phase uncertainty of ΔΦ = 0.15, the ac Watts power adder is: | | | | | | | |
| $Adder(\%) = 100(1 - \frac{Cos(23+.15)}{Cos(23)}) = 0.11\% .$ | | | | | | | |

Calculating Power Uncertainty

Overall uncertainty for power output in Watts (or VARs) is based on the root sum square (rss) of the individual uncertainties in percent for the selected voltage, current, and power factor parameters:

$$\text{Watts uncertainty} \quad U_{\text{power}} = \sqrt{U_{\text{voltage}}^2 + U_{\text{current}}^2 + U_{\text{PFadder}}^2}$$

$$\text{VARs uncertainty} \quad U_{\text{VARs}} = \sqrt{U_{\text{voltage}}^2 + U_{\text{current}}^2 + U_{\text{VARsadder}}^2}$$

Because there are an infinite number of combinations, you should calculate the actual ac power uncertainty for your selected parameters. The method of calculation is best shown in the following examples (using 90-day specifications):

Example 1 Output: 100 V, 1 A, 60 Hz, Power Factor = 1.0 ($\Phi=0$)

Voltage Uncertainty Uncertainty for 100 V at 60 Hz is 0.04 % + 6.6 mV, totaling:
100 V x .0004 = 40 mV added to 6.6 mV = 46.6 mV. Expressed in percent:
46.6 mV/100 V x 100 = 0.047 % (see "AC Voltage (Sine Wave) Specifications").

Current Uncertainty Uncertainty for 1 A is 0.08 % + 300 μ A, totaling:
1 A x .0008 = 800 μ A added to 300 μ A = 1.1 mA. Expressed in percent:
1.1 mA/1 A x 100 = 0.11 % (see "AC Current (Sine Waves) Specifications").

PF Adder Watts Adder for PF = 1 ($\Phi=0$) at 60 Hz is 0 % (see "Phase Specifications").

$$\text{Total Watts Output Uncertainty} = U_{\text{power}} = \sqrt{0.047^2 + 0.11^2 + 0^2} = 0.12\%$$

Example 2 Output: 100 V, 1 A, 400 Hz, Power Factor = 0.5 ($\Phi=60$)

Voltage Uncertainty Uncertainty for 100 V at 400 Hz is 0.04 % + 6.6 mV, totaling:
100 V x .0004 = 40 mV added to 6.6 mV = 46.6 mV. Expressed in percent:
46.6 mV/100 V x 100 = 0.047 % (see "AC Voltage (Sine Wave) Specifications").

Current Uncertainty Uncertainty for 1 A is 0.08 % + 300 μ A, totaling:
1 A x .0008 = 800 μ A added to 300 μ A = 1.1 mA. Expressed in percent:
1.1 mA/1 A x 100 = 0.11 % (see "AC Current (Sine Wave) Specifications").

PF Adder Watts Adder for PF = 0.5 ($\Phi=60$) at 400 Hz is 2.73 % (see "Phase Specifications").

$$\text{Total Watts Output Uncertainty} = U_{\text{power}} = \sqrt{0.047^2 + 0.11^2 + 2.73^2} = 2.73\%$$

VARs When the Power Factor approaches 0.0, the Watts output uncertainty becomes unrealistic because the dominant characteristic is the VARs (volts-amps-reactive) output. In these cases, calculate the Total VARs Output Uncertainty, as shown in example 3:

Example 3 Output: 100 V, 1 A, 60 Hz, Power Factor = 0.0872 ($\Phi=85$)

Voltage Uncertainty Uncertainty for 100 V at 60 Hz is 0.04 % + 6.6 mV, totaling:
100 V x .0004 = 40 mV added to 6.6 mV = 46.6 mV. Expressed in percent:
46.6 mV/100 V x 100 = 0.047 % (see "AC Voltage (Sine Wave) Specifications").

Current Uncertainty Uncertainty for 1 A is 0.08 % + 300 μ A, totaling:
1 A x .0008 = 800 μ A added to 300 μ A = 1.1 mA. Expressed in percent:
1.1 mA/1 A x 100 = 0.11 % (see "AC Current (Sine Wave) Specifications").

VARs Adder VARs Adder for $\Phi=85$ at 60 Hz is 0.02 % (see "Phase Specifications").

$$\text{Total VARs Output Uncertainty} = U_{\text{VARs}} = \sqrt{0.047^2 + 0.11^2 + 0.02^2} = 0.12\%$$

Additional Specifications

The following paragraphs provide additional specifications for the 5500A 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 5500A 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. (See Chapter 4, Front Panel Operations in the 5500A Operator Manual.)

Frequency Specifications

| Frequency Range | Resolution | 1-Year Absolute Uncertainty, $t_{cal} \pm 5\text{ °C}$ | Jitter |
|--|------------|--|-----------------|
| 0.01 - 119.99 Hz | 0.01 Hz | 25 ppm, $\pm 1\text{ mHz}$ | 2 μs |
| 120.0 - 1199.9 Hz | 0.1 Hz | 25 ppm, $\pm 1\text{ mHz}$ | 2 μs |
| 1.200 - 11.999 kHz | 1.0 Hz | 25 ppm, $\pm 1\text{ mHz}$ ^[1] | 2 μs |
| 12.00 - 119.99 kHz | 10 Hz | 25 ppm, $\pm 15\text{ mHz}$ | 140 ns |
| 120.0 - 1199.9 kHz | 100 Hz | 25 ppm, $\pm 15\text{ mHz}$ | 140 ns |
| 1.200 - 2.000 MHz | 1 kHz | 25 ppm, $\pm 15\text{ mHz}$ | 140 ns |
| [1] $\pm (25\text{ ppm} + 15\text{ mHz})$ above 10 kHz | | | |

Harmonics (2nd to 50th) Specifications

| Fundamental Frequency ^[1] | Voltages NORMAL Terminals | Currents | Voltages AUX Terminals | Amplitude Uncertainty |
|--|------------------------------|---------------------|---------------------------|--|
| 10 to 45 Hz | 33 mV to 32.9999 V | 3.3 mA to 2.19999 A | 10 mV to 3.3 V | Same % of output as the equivalent single output, but twice the floor adder. |
| 45 to 65 Hz | 33 mV to 1020 V | 3.3 mA to 11 A | 10 mV to 3.3 V | |
| 65 to 500 Hz | 33 mV to 1020 V | 33 mA to 11 A | 100 mV to 3.3 V | |
| 500 to 1 kHz | 330 mV to 1020 V | 33 mA to 11 A | 100 mV to 3.3 V | |
| 1 to 5 kHz | 3.3 to 1020 V | 33 mA to 2.19999 A | 100 mV to 3.3 V | |
| Phase uncertainty for harmonic outputs is 1 degree, or the phase uncertainty shown in "Phase Specifications" for the particular output, whichever is greater. For example, the phase uncertainty of a 400 Hz fundamental output and 10 kHz harmonic output is 10 degrees (from "Phase Specifications"). Another example, the phase uncertainty of a 60 Hz fundamental output and a 400 Hz harmonic output is 1 degree. | | | | |
| [1] The maximum frequency of the harmonic output is 10 kHz. For example, if the fundamental output is 5 kHz, the maximum selection is the 2nd harmonic (10 kHz). All harmonic frequencies (2nd to 50th) are available for fundamental outputs between 10 and 200 Hz. | | | | |

Example of determining Amplitude Uncertainty in a Dual Output Harmonic Mode

What are the amplitude uncertainties for the following dual outputs?

NORMAL (Fundamental) Output:

100 V, 100 HzFrom "AC Voltage (Sine Wave) Specifications" the single output specification for 100 V, 100 Hz, is 0.015 % + 2 mV. For the dual output in this example, the specification is 0.015 % + 4 mV as the 0.015 % is the same, and the floor is twice the value (2 x 2 mV).

AUX (50th Harmonic) Output:

100 mV, 5 kHz.....From "AC Voltage (Sine Wave) Specifications" the auxiliary output specification for 100 mV, 5 kHz, is 0.15 % + 450 mV. For the dual output in this example, the specification is 0.15 % + 900 mV as the 0.15 % is the same, and the floor is twice the value (2 x 450 mV).

AC Voltage (Sine Wave) Extended Bandwidth Specifications

| Range | Frequency | 1-Year Absolute Uncertainty, tcal $\pm 5^{\circ}\text{C}$, \pm (% of output + % of range) | | Maximum Voltage Resolution |
|-------------------------------------|------------------|--|------------|----------------------------|
| | | % Output | % Range | |
| Normal Channel (Single Output Mode) | | | | |
| 1.0 to 33 mV | 0.01 to 10 Hz | 5.0 % | 0.5 % | Two digits, e.g., 25 mV |
| 34 to 330 mV | | | | Three digits |
| 0.4 to 3.3 V | | | | Two digits |
| 4 to 33 V | | | | Two digits |
| 0.3 to 3.3 V | 10 to 500 kHz | (See AC Voltage (Sine Waves) Specifications) | | |
| | 500 kHz to 1 MHz | -8 dB at 1 MHz, typical | Two digits | |
| | 1 to 2 MHz | -32 dB at 2 MHz, typical | | |
| Auxiliary Output (Dual Output Mode) | | | | |
| 10 to 330 mV | 0.01 to 10 Hz | 5.0 % | 0.5 % | Three digits |
| 0.4 to 3.3 V | | | | Two digits |
| | 10 to 10 kHz | (See AC Voltage (Sine Wave) Specifications) | | |

AC Voltage (Non-Sine Wave) Specifications

| Triangle Wave & Truncated Sine Range p-p ^[1] | Frequency | 1-Year Absolute Uncertainty, tcal ± 5 °C, ± (% of output + % of range) ^[2] | | Maximum Voltage Resolution |
|---|------------------------------|---|---------|----------------------------|
| | | % Output | % Range | |
| 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 |
| 93 to 929.999 mV | 10 to 45 Hz | 0.25 | 0.5 | Six digits on each range |
| 0.93 to 9.29999 V | 45 Hz to 1 kHz | 0.25 | 0.25 | |
| 9.3 to 92.9999 V | 1 to 20 kHz | 0.5 | 0.25 | |
| | 20 to 100 kHz ^[3] | 5.0 | 0.5 | |
| Auxiliary Output (Dual Output Mode) | | | | |
| 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 |
| 0.93 to 9.29999 V | 45 Hz to 1 kHz | 0.25 | 0.25 | |
| | 1 to 10 kHz | 5.0 | 0.5 | |
| <div>[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.</div> <div>[2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM.</div> <div>[3] Uncertainty for truncated sine outputs is typical over this frequency band.</div> | | | | |

| Square Wave Range p-p ^[1] | Frequency | 1-Year Absolute Uncertainty, tcal ± 5 °C ± (% of output + % of range) ^[2] | | Maximum Voltage Resolution |
|--|----------------|--|---------|-------------------------------|
| | | % Output | % Range | |
| 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 |
| 66 to 659.999 mV | 10 to 45 Hz | 0.25 | 0.5 | Six digits on each range |
| 0.66 to 6.59999 V | 45 Hz to 1 kHz | 0.25 | 0.25 | |
| 6.6 to 65.9999 V | 1 to 20 kHz | 0.5 | 0.25 | |
| | 20 to 100 kHz | 5.0 | 0.5 | |
| Auxiliary Output (Dual Output Mode) | | | | |
| 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 |
| 0.66 to 6.59999 V | 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 square wave, multiply the p-p value by .5000000. | | | | |
| [2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM. | | | | |

AC Voltage, DC Offset Specifications

| Range ^[1] (Normal Channel) | Offset Range ^[2] | Max Peak Signal | 1-Year Absolute Offset Uncertainty, tcal ± 5 °C ^[3] ± (% Output (dc) + μV) |
|--|-----------------------------|--------------------|---|
| 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 92.9999 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 65.9999 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.</p> <p>[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.</p> <p>[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

| Rise Time @ 1 kHz Typical | Settling Time @ 1 kHz Typical | Overshoot @ 1 kHz Typical | Duty Cycle Range | Duty Cycle Uncertainty ^[1] |
|--|--------------------------------------|---------------------------------|--|--|
| <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 (0.8 % of period +140 ns) for frequencies >10 kHz; + (0.8 % of period + 2 μ s) for frequencies \leq 10 kHz. |
| [1] For duty cycles of 10.00 % to 90.00 %. | | | | |

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 (Sine Wave) Extended Bandwidth Specifications

| Range | Frequency | 1-Year Absolute Uncertainty, tcal \pm 5 $^{\circ}$ C, \pm (% of output + % of range) | | Maximum Current Resolution |
|-----------------------------|---------------|--|---------|-------------------------------|
| | | % Output | % Range | |
| All current ranges, <330 mA | 0.01 to 10 Hz | 5.0 | 0.5 | 2 digits each range |
| | 10 to 10 kHz | (See AC Current (Sine Wave) Specifications) | | |

AC Current (Non-Sine Wave) Specifications

| Triangle Wave & Truncated Sine Wave Ranges ^[1] | Frequency | 1-Year Absolute Uncertainty, tcal $\pm 5^{\circ}\text{C}$, $\pm (\% \text{ of output} + \% \text{ of range})$ ^[2] | Maximum Current Resolution |
|--|-----------------|---|----------------------------|
| 2.9 to 92.999 mA | 0.01 to 10 Hz | $5.0 + 0.5$ | Two digits, e.g., 75 mA |
| | 10 to 45 Hz | $0.25 + 0.5$ | Six digits on each range |
| | 45 Hz to 1 kHz | $0.25 + 0.25$ | |
| | 1 to 10 kHz | $0.25 + 0.5$ | |
| 93 to 929.999 mA | 0.01 to 10 Hz | $5.0 + 0.5$ | Two digits |
| | 10 to 45 Hz | $0.25 + 0.5$ | Six digits on each range |
| | 45 Hz to 1 kHz | $0.25 + 0.5$ | |
| | 1 to 10 kHz | $5.0 + 1.0$ | |
| 0.93 to 2.19 A | 10 to 45 Hz | $5.0 + 1.0$ | Two digits |
| | 45 Hz to 1 kHz | $0.5 + 0.5$ | Six digits on each range |
| | 1 to 5 kHz | $5.0 + 1.0$ | |
| 2.2 to 11 A | 45 to 500 Hz | $2.0 + 0.5$ | Two digits on each range |
| | 500 Hz to 1 kHz | $5.0 + 1.0$ | Six digits on each range |
| 2.9 to 65.999 mA | 0.01 to 10 Hz | $5.0 + 0.5$ | Two digits, e.g., 50 mA |
| | 10 to 45 Hz | $0.25 + 0.5$ | Six digits on each range |
| | 45 Hz to 1 kHz | $0.25 + 0.25$ | |
| | 1 to 10 kHz | $0.25 + 0.5$ | |
| 66 to 659.999 mA | 0.01 to 10 Hz | $5.0 + 0.5$ | Two digits |
| | 10 to 45 Hz | $0.25 + 0.5$ | Six digits on each range |
| | 45 Hz to 1 kHz | $0.25 + 0.5$ | |
| | 1 to 10 kHz | $5.0 + 1.0$ | |
| 0.66 to 2.19 A | 10 to 45 Hz | $5.0 + 1.0$ | Two digits |
| | 45 Hz to 1 kHz | $0.5 + 0.5$ | Six digits on each range |
| | 1 to 5 kHz | $5.0 + 1.0$ | |
| 2.2 to 11 A | 45 to 500 Hz | $2.0 + 0.5$ | Two digits on each range |
| | 500 Hz to 1 kHz | $5.0 + 1.0$ | Six digits on each range |
| [1] All waveforms are p-p output ranges. | | | |
| [2] Uncertainty is stated in p-p. Amplitude is verified using an rms-responding DMM. | | | |

AC Current, Square Wave Characteristics (typical)

| Range | Rise Time | Settling Time | Overshoot |
|---------------------------------------|------------------|--|-------------------------------|
| $I < 4.4 \text{ A @ } 400 \text{ Hz}$ | 25 μs | 40 μs to 1 % of final value | <10 % for loads <100 Ω |

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 |



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