KEITHLEY
A Tektronix Company

Model 2002

Multimeter Specifications

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This document contains the complete specifications for the Model 2002. Every effort has been made to make these specifications complete by characterizing its performance under the variety of conditions encountered in production, engineering, and research.

The Model 2002 provides transfer, 24-hour, 90-day, 1-year, and 2-year specifications, with full specifications for the 90-day, 1-year, and 2-year intervals. This allows the operator to use 90-day, 1-year, or 2-year recommended calibration intervals, depending upon the level of accuracy needed. As a general rule, the 2-year performance of the Model 2002 exceeds the 90-day, 180-day, and 1-year specifications of a 6½-digit DMM.

ABSOLUTE ACCURACY

All dc and ac specifications are given as relative accuracies. To obtain absolute accuracies, the absolute uncertainties of the calibration sources must be added to the relative accuracies. The absolute uncertainties for the calibration sources used during Keithley factory calibration are given in a table included in the specifications. The source uncertainty of the operator may be different.

TYPICAL ACCURACIES

Accuracy can be specified as typical or warranted. All specifications shown are warranted unless specifically noted. Almost 99 percent of the Model 2002 specifications are warranted specifications. In some cases, it is not possible to obtain sources to maintain traceability on the performance of every unit in production on some measurements (for example, high-voltage, high-frequency signal sources with enough accuracy do not exist). These values are listed as typical.

2002 SPECIFIED CALIBRATION INTERVALS

Measurement function	24 hour[1]	90 day[2]	1 year[2]	2 year[2]
DC volts	•	•	•	•
DC volts peak spikes		•	•	•
AC volts RMS		•[3]	•[3]	•[3]
AC volts peak		•	•	•
AC volts average		•[3]	•[3]	•[3]
AC volts crest factor		•	•	•
Ohms	•	•	•	•
DC current	•	•	•	•
DC in-circuit current		•	•	•
AC current		•	•	•
Frequency		•	•	•
Temperature (thermocouple)		•	•	•
Temperature (RTD)	•	•	•	•

[1] For T_{CAL} ± 1 °C.
[2] For T_{CAL} ± 5 °C.
[3] For ± 2 °C of last ac self-calibration.

Specifications are subject to change without notice.

DC VOLTS

DCV INPUT CHARACTERISTICS AND ACCURACY
ENHANCED ACCURACY[4] – 10 PLC, DFILT 10

Range	Full scale	Resolution	Input resistance	Relative accuracy ± (ppm of reading + ppm of range)					Temperature coefficient ± (ppm of reading + ppm of range) / °C Outside T_{CAL} ± 5 °C
				Transfer[5]	24 hours[6]	90 days[7]	1 year[7]	2 years[7]	
200 mV[8]	± 210.0 mV	1 nV	> 100 GΩ	0.4 + 1.5	3.5 + 3	15 + 8	19 + 9	23 + 10	2 + 1.8
2 V[8]	± 2.10 V	10 nV	> 100 GΩ	0.2 + 0.15	1.2 + 0.3	6 + 0.8	10 + 0.9	14 + 1	0.2 + 0.18
20 V	± 21.0 V	100 nV	> 100 GΩ	0.1 + 0.05	1.2 + 0.1	6 + 0.15	10 + 0.15	14 + 0.15	0.3 + 0.02
200 V	± 210.0 V	1 µV	10 MΩ ± 1%	0.5 + 0.08	5 + 0.4	14 + 2	22 + 2	30 + 2	1.5 + 0.3
1000 V[9]	± 1100.0 V	10 µV	10 MΩ ± 1%	1 + 0.05	5 + 0.08	14 + 0.4	22 + 0.4	30 + 0.4	1.5 + 0.06

DC voltage uncertainty: = ± [(ppm of reading) × (measured value) + (ppm of range) × (range used)] / 1,000,000.

% accuracy: = (ppm accuracy) / 10,000.

1 ppm of range: = 20 counts for ranges up to 200 V and 10 counts on 1000 V range at 7½-digits.

NORMAL ACCURACY[10] – 1PLC, DFILT OFF

Range	Full scale	Resolution	Input resistance	Relative accuracy ± (ppm of reading + ppm of range)				Temperature coefficient ± (ppm of reading + ppm of range) / °C Outside T_{CAL} ± 5 °C
				24 hours[6]	90 days[7]	1 year[7]	2 years[7]	
200 mV[8]	± 210.0 mV	10 nV	> 100 GΩ	3.5 + 6	15 + 11	19 + 12	23 + 13	2 + 1.8
2 V[8]	± 2.10 V	100 nV	> 100 GΩ	1.2 + 0.6	6 + 1.1	10 + 1.2	14 + 1.3	0.2 + 0.18
20 V	± 21.0 V	1 µV	> 100 GΩ	3.2 + 0.35	8 + 0.4	12 + 0.4	16 + 0.4	0.3 + 0.02
200 V	± 210.0 V	10 µV	10 MΩ ± 1%	5 + 1.2	14 + 2.8	22 + 2.8	30 + 2.8	1.5 + 0.3
1000 V[9]	± 1100.0 V	100 µV	10 MΩ ± 1%	5 + 0.4	14 + 0.7	22 + 0.7	30 + 0.7	1.5 + 0.06

[4] Specifications are for 10 power line cycles, synchronous autozero, 10-reading repeat digital filter, autorange off, except as noted.
[5] Specifications apply for 20-reading repeat digital filter, T_{REF} ± 0.5 °C (T_{REF} is the initial ambient temperature), and for measurements within ten percent of the initial measurement value and within 10 minutes of the initial measurement time.
[6] For T_{CAL} ± 1 °C, following 4-hour warmup. T_{CAL} is ambient temperature at calibration (23 °C at the factory). Add 0.5 ppm of reading uncertainty if the unit is power cycled during this interval.
[7] For T_{CAL} ± 5 °C, following 4-hour warmup.
[8] Take care to minimize thermal offsets due to operator cables.
[9] Add 20 ppm × $(V_{IN}/1000\ V)^2$ additional uncertainty for inputs above 200 V, except in transfer accuracy specifications.
[10] Specifications are for 1 power line cycle, normal autozero, digital filter off, autorange off.

SPEED AND ACCURACY

Accuracy[4,11] 90 days **± (ppm of reading + ppm of range + ppm of range RMS noise[12])**						
Range	10 PLC, DFILT on, 10 readings	10 PLC, DFILT off	1 PLC, DFILT on, 10 readings	1 PLC, DFILT off	0.1 PLC, DFILT off	0.01 PLC,[13] DFILT off
200 mV [8]	15 + 8 + 0	15 + 8 + 0.5	15 + 8 + 0.7	15 + 8 + 1	25 + 10 + 13	100 + 200 + 15
2 V [8]	6 + 0.8 + 0	6 + 0.8 + 0.05	6 + 0.8 + 0.07	6 + 0.8 + 0.1	7 + 1 + 1.3	130 + 200 + 3
20 V	6 + 0.15 + 0	6 + 0.15 + 0.03	7 + 0.15 + 0.05	8 + 0.15 + 0.08	15 + 0.5 + 0.7	130 + 200 + 3
200 V	14 + 2 + 0	14 + 2 + 0.1	14 + 2 + 0.15	14 + 2 + 0.25	15 + 2 + 1	130 +200 + 3
1000 V [9]	14 + 0.4 + 0	14 + 0.4 + 0.05	14 + 0.4 + 0.05	14 + 0.4 + 0.1	15 + 0.5 + 0.5	90 + 200 + 2

PLC = Power line cycles. DFILT = Digital filter.

NOISE REJECTION (DB)[14]

Speed (number of power line cycles)	**AC and dc CMRR[15]**		**AC NMRR**		
	Line sync on[16]	**Internal trigger**	**Line sync on,[16] 25 readings DFILT on**	**Line sync on,[16] DFILT off**	**Internal trigger, DFILT off**
PLC ≥ 1	140	120	90	80	60
PLC < 1	90	60	60	45	0

Effective noise is reduced by a factor of 10 for every 20 dB of noise rejection (140 dB reduces effective noise by 10,000,000:1).

CMRR is rejection of undesirable ac or dc signal between LO and protective earth (safety ground). NMRR is rejection of undesirable power line related ac signal between HI and LO.

KEITHLEY FACTORY CALIBRATION UNCERTAINTY

Range	**ppm of reading**
200 mV	3.2
2 V	3.2
20 V	2.6
200 V	2.6
1000 V	2.6

Factory calibration uncertainty represents traceability to the National Institute of Standards and Technology (NIST). This uncertainty is added to relative accuracy specifications to obtain absolute accuracies. The 200 mV and 2 V range uncertainties are equal to the uncertainty of the 2 V calibration source. The 20 V, 200 V, and 1000 V range uncertainties are equal to the uncertainty of the 20 V calibration source.

[11] For T_{CAL} ± 5 °C, normal autozero. Calculate 1-year or 2-year accuracy by applying the same speed accuracy ppm changes to the 1-year or 2-year base accuracy.
[12] Typical values. Peak-to-peak noise equals 6 times RMS noise.
[13] In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.
[14] For line frequency ± 0.1%.
[15] Applies for 1 kΩ imbalance in the LO lead. For 400 Hz operation, subtract 10 dB. For the 200 V and 1000 V ranges, subtract 20 dB.
[16] For noise synchronous to the line frequency.

DCV READING RATES[17,22]

PLC	Measurement aperture	Bits	Default digits	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with time stamp to IEEE-488[18]	
				Autozero off	Autozero on	Autozero off	Autozero on	Autozero off	Autozero on
10	167 ms (200 ms)	29	8½	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	33.4 ms (40 ms)	27	7½	29 (25)	9 (7.6)	29 (24)	9 (7.4)	27 (22)	9 (7.4)
1	16.7 ms (20 ms)	26	7½	56 (48)	47 (40)	55 (45)	46 (38)	50 (41)	42 (34)
0.2	3.34 ms (4 ms)	23	6½	235 (209)	154 (137)	225 (200)	146 (130)	152 (135)	118 (105)
0.1	1.67 ms (2 ms)	22	6½	318 (305)	173 (166)	308 (295)	168 (161)	181 (174)	121 (116)
0.02	334 µs (400 µs)	20	5½	325 (325)	179 (179)	308 (308)	173 (173)	182 (182)	124 (124)
0.01	167 µs (167 µs)	19	4½	390 (390)	186 (186)	365 (365)	182 (182)	201 (201)	125 (125)
0.01[13]	167 µs (167 µs)	19	4½	2000 (2000)	—	2000 (2000)	—	—	—

Linearity: < 0.1 ppm of range typical, < 0.35 ppm maximum.

Zero stability: Typical maximum variation in 1 hour, T_{REF} ± 0.5 °C, 7½-digits resolution, 10-reading digital filter, synchronous autozero.

Range	1 PLC	10 PLC
200 mV[8]	± 60 counts	± 40 counts
2 V[8]	± 6 counts	± 4 counts
20 V	± 4 counts	± 1 count
200 V	± 5 counts	± 2 counts
1000 V	± 2 counts	± 1 count

Input bias current: < 100 pA at 25 °C.

Settling characteristics: < 50 µs to 10 ppm of step size for the 200 mV to 20 V ranges; < 1 ms to 10 ppm of step size for the 200 V and 1000 V ranges. Reading settling times are affected by source impedance and cable dielectric absorption characteristics.

Autoranging: Autoranges up at 105% of range, down at 10% of range.

[17] For on-scale readings, no trigger delays, internal trigger, digital filter off, normal autozero, display off, SREAL format. These rates are for 60 Hz and 50 Hz. Rates for 400 Hz equal those for 50 Hz.
[18] Using internal buffer.

DCV PEAK SPIKES MEASUREMENT

REPETITIVE SPIKES ACCURACY[19] 90 **DAYS**, 1 **YEAR** OR 2 YEARS, T_{CAL} ± 5 °C ± (% OF READING + % OF RANGE)

Range	0 kHz to 1 kHz[20]	1 kHz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 500 kHz	500 kHz to 750 kHz	750 kHz to 1 MHz	Temperature coefficient ± (% of reading + % of range) / °C outside T_{CAL} ± 5 °C
200 mV	0.08 + 0.7	0.09 + 0.7	0.1 + 0.7	0.15 + 0.7	0.25 + 0.7	1.0 + 0.7	2.5 + 0.7	5.5 + 0.7	9 + 0.7	0.002 + 0.03
2 V	0.08 + 0.3	0.09 + 0.3	0.1 + 0.3	0.15 + 0.3	0.25 + 0.3	1.0 + 0.3	2.5 + 0.3	5.5 + 0.3	9 + 0.3	0.002 + 0.03
20 V	0.1 + 0.7	0.11 + 0.7	0.14 + 0.7	0.19 + 0.7	0.25 + 0.7	1.0 + 0.7	2.5 + 0.7	5.5 + 0.7	9 + 0.7	0.004 + 0.03
200 V[21]	0.1 + 0.3	0.11 + 0.3	0.14 + 0.3	0.19 + 0.3	0.25 + 0.3	1.0 + 0.3[22]	2.5 + 0.3[22]	5.5 + 0.3[22]	9 + 0.3[22]	0.004 + 0.03
1000 V[21]	0.12 + 0.6	0.16 + 0.6	0.2 + 0.6	0.25 + 0.6[22]	0.5 + 0.6[22]	—	—	—	—	0.01 + 0.02
Max % of range	± 125 %	± 125 %	± 125 %	± 125 %	± 125 %	± 125 %	± 125 %	± 100 %	± 75 %	—

Default measurement resolution: 3½-digits.
Maximum input: ± 1100 V peak value, 2×10^7 V·Hz (for inputs above 20 V).
Nonrepetitive spikes: 10% of range per µs typical slew rate.
Spike width: Specifications apply for spikes ≥ 1 µs.
Range control: In multiple display mode, voltage range is the same as dc V range.
Spikes measurement window: Default is 100 ms per reading (settable from 0.1 s to 9.9 s in primary display mode).
Input characteristics: Same as ACV input characteristics.
Spikes display: Access as multiple display on dc volts. First option presents positive peak spikes and highest spike since reset. Second option presents negative spikes and lowest spike. Highest and lowest spike can be reset by pressing the DCV function button. Third option displays the maximum and minimum levels of the input signal. Spike displays are also available through CONFIG-ACV-ACTYPE as primary displays.

AC VOLTS

AC magnitude: RMS or average; peak and crest factor measurements also available.

ACV INPUT CHARACTERISTICS

RMS range	Peak input	Full scale RMS	Resolution	Input impedance	Temperature coefficient[23] ± (% of reading + % of range) / °C outside T_{CAL} ± 5 °C
200 mV	1 V	210.0 mV	100 nV	1 MΩ ± 2% with < 140 pF	0.004 + 0.001
2 V	8 V	2.10 V	1 µV	1 MΩ ± 2% with < 140 pF	0.004 + 0.001
20 V	100 V	21.0 V	10 µV	1 MΩ ± 2% with < 140 pF	0.006 + 0.001
200 V	800 V	210.0 V	100 µV	1 MΩ ± 2% with < 140 pF	0.006 + 0.001
750 V	1100 V	775.0 V	1 mV	1 MΩ ± 2% with < 140 pF	0.012 + 0.001

AC voltage uncertainty = ± [(% of reading) × (measured value) + (% of range) × (range used)] / 100.

PPM accuracy = (% accuracy) × 10,000.

0.015% of range = 30 counts for ranges up to 200 V and 113 counts on 750 V range at 5½ digits.

[19] Specifications apply for sine wave input with a 10-reading digital filter. If no filter is used, add 0.25% of range typical uncertainty.
[20] Specifications assume ac + dc coupling for frequencies below 200 Hz. Below 20 Hz add 0.1% of reading additional uncertainty.
[21] Add 0.001% of reading × $(V_{IN}/100\ V)^2$ additional uncertainty for inputs above 100 V.
[22] Typical values.

LOW FREQUENCY MODE RMS[24] 90 days, 1 year or 2 years, ± 2 °C from last ac self-calibration, for 1% to 100% of range,[25] ± (% of reading + % of range)

Range	1 Hz to 10 Hz[22]	10 Hz to 50 Hz	50 Hz to 499 Hz	501 Hz to 2 kHz	2 kHz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 200 kHz	0.2 MHz to 1 MHz	1 MHz to 2 MHz
200 mV	0.09 + 0.015	0.06 + 0.015	0.035 + 0.015	0.03 + 0.02	0.02 + 0.02	0.025 + 0.02	0.05 + 0.02	0.3 + 0.015	0.75 + 0.025	2 + 0.1	5 + 0.2
2 V	0.09 + 0.015	0.04 + 0.015	0.025 + 0.015	0.02 + 0.02	0.02 + 0.02	0.025 + 0.02	0.05 + 0.02	0.3 + 0.015	0.75 + 0.025	2 + 0.1	5 + 0.2
20 V	0.1 + 0.015	0.06 + 0.015	0.035 + 0.015	0.03 + 0.015	0.04 + 0.015	0.05 + 0.015	0.07 + 0.015	0.3 + 0.015	0.75 + 0.025	4 + 0.2	7 + 0.2[22]
200 V[26]	0.1 + 0.015	0.05 + 0.015	0.03 + 0.015	0.03 + 0.015	0.04 + 0.015	0.05 + 0.015	0.07 + 0.015	0.3 + 0.015	0.75 + 0.025[22]	4 + 0.2[22]	—
750 V[26]	0.13 + 0.015	0.09 + 0.015	0.05 + 0.015	0.05 + 0.015	0.06 + 0.015	0.08 + 0.015	0.1 + 0.015[22]	0.5 + 0.015[22]	—	—	—

NORMAL MODE RMS[24] 90 days, 1 year or 2 years, ± 2 °C from last AC self-calibration, for 1% to 100% of range[25], ± (% of reading + % of range)

Range	20 Hz to 50 Hz	50 Hz to 100 Hz	0.1 kHz to 2 kHz	2 kHz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 200 kHz	0.2 MHz to 1 MHz	1 MHz to 2 MHz
200mV	0.25 + 0.015	0.07 + 0.015	0.02 + 0.02	0.02 + 0.02	0.025 + 0.02	0.05 + 0.02	0.3 + 0.015	0.75 + 0.025	2 + 0.1	5 + 0.2
2V	0.25 + 0.015	0.07 + 0.015	0.02 + 0.02	0.02 + 0.02	0.025 + 0.02	0.05 + 0.02	0.3 + 0.015	0.75 + 0.025	2 + 0.1	5 + 0.2
20V	0.25 + 0.015	0.07 + 0.015	0.03 + 0.015	0.04 + 0.015	0.05 + 0.015	0.07 + 0.015	0.3 + 0.015	0.75 + 0.025	4 + 0.2	7 + 0.2[22]
200V[26]	0.25 + 0.015	0.07 + 0.015	0.03 + 0.015	0.04 + 0.015	0.05 + 0.015	0.07 + 0.015	0.3 + 0.015	0.75 + 0.025[22]	4 + 0.2[22]	—
750V[26]	0.25 + 0.015	0.1 + 0.015	0.05 + 0.015	0.06 + 0.015	0.08 + 0.015	0.1 + 0.015[22]	0.5 + 0.015[22]	—	—	—

DB ACCURACY RMS ± DB, 90 days, 1 year or 2 years, T_{CAL} ± 5 °C, reference = 1 V, autoranging, low frequency mode, ac + dc coupling

Input	1 Hz to 100 Hz	0.1 Hz to 30 kHz	30 kHz to 100 kHz	100 kHz to 200 kHz	0.2 MHz to 1 MHz	1 MHz to 2 MHz
–54 dB to –40 dB (2 mV to 10 mV)	0.230	0.225	0.236	0.355	—	—
–40 dB to –34 dB (10 mV to 20 mV)	0.036	0.031	0.041	0.088	—	—
–34 dB to 6 dB (20 mV to 2 V)	0.023	0.018	0.028	0.066	0.265	0.630
6 dB to 26 dB (2 V to 20 V)	0.024	0.024	0.028	0.066	0.538	0.820[22]
26 dB to 46 dB (20 V to 200 V)	0.024	0.024	0.028	0.066[22]	0.538[22]	—
46 dB to 57.8 dB (200 V to 775 V)	0.018	0.021	0.049[22]	—	—	—

[23] Temperature coefficient applies to RMS and average readings. For frequencies above 100 kHz, add 0.01% of reading / °C to temperature coefficient.
[24] Specifications apply for sinewave input, ac + dc coupling, 1 power line cycle, autozero on, digital filter off, following 55-minute warmup.
[25] For 1% to 5% of range below 750 V range, and for 1% to 7% of 750 V range, add 0.01% of range uncertainty. For inputs from 200 kHz to 2 MHz, specifications apply above 10% of range.
[26] Add 0.001% of reading × $(V_{IN}/100\ V)^2$ additional uncertainty for inputs above 100 V_{RMS}.

ACV READING RATES[22,27]

PLC	Measurement aperture	Bits	Default digits	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with timestamp to IEEE-488[18]	
				Autozero off	Autozero on	Autozero off	Autozero on	Autozero off	Autozero on
10	167 ms (200 ms)	29	6½	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	33.4 ms (40 ms)	27	5½	29 (25)	9 (7.6)	28 (23)	9 (7.4)	26 (21)	9 (7.4)
1	16.7 ms (20 ms)	26	5½	56 (48)	47 (40)	52 (43)	44 (36)	48 (39)	40 (33)
0.2	3.34 ms (4 ms)	23	5½	145 (129)	110 (98)	131 (117)	100 (88)	102 (91)	79 (70)
0.1	1.67 ms (2 ms)	22	5½	150 (144)	112 (108)	132 (127)	101 (97)	102 (98)	80 (77)
0.02	334 µs (400 µs)	20	5½	150 (150)	115 (115)	132 (132)	103 (103)	102 (102)	80 (80)
0.01	167 µs (167 µs)	19	4½	382 (382)	116 (116)	251 (251)	103 (103)	163 (163)	80 (80)
0.01[13]	167 µs (167 µs)	19	4½	2000 (2000)	—	2000 (2000)	—	—	—

ACV CREST FACTOR MEASUREMENT[28]

Crest factor: = Peak ac / RMS ac.

Crest factor resolution: 3 digits.

Crest factor accuracy: Peak ac uncertainty + ac normal mode RMS uncertainty.

Measurement time: 100 ms + RMS measurement time.

Input characteristics: Same as ac V input.

Crest factor frequency range: 20 Hz to 1 MHz.

Crest factor display: Access as multiple display on ac volts.

AC COUPLING

For ac-only coupling, add the following percentage of reading:

	1 Hz to 10 Hz	10 Hz to 20 Hz	20 Hz to 50 Hz	50 Hz to 100 Hz	100 Hz to 200 Hz
Normal mode (RMS, average)	—	—	0.41	0.07	0.015
Low frequency mode (RMS)	0.1	0.01	0	0	0

For low frequency mode below 200 Hz, specifications apply for sine wave inputs only.

AC + DC COUPLING

For dc > 20% of ac RMS voltage, apply the following additional uncertainty, multiplied by the ratio (dc / total RMS). Applies to RMS and average measurements.

Range	% of reading	% of range
200 mV, 20 V	0.05	0.1
2 V, 200 V, 750 V	0.07	0.01

[27] For on-scale readings, no trigger delays, internal trigger, digital filter off, normal autozero, display off, SREAL format. These rates are for 60 Hz and 50 Hz. Rates for 400 Hz equal those for 50 Hz. Applies for normal RMS and average mode. Low frequency RMS mode rate is typically 0.2 readings per second.

[28] Subject to peak input voltage specification.

AVERAGE ACV MEASUREMENT

Normal mode RMS specifications apply from 10% to 100% of range, for 20 Hz to 1 MHz. Add 0.025% of range uncertainty for 50 kHz to 100 kHz, 0.05% of range uncertainty for 100 kHz to 200 kHz, and 0.5% of range uncertainty for 200 kHz to 1 MHz.

HIGH CREST FACTOR ADDITIONAL ERROR ± (% OF READING)

Applies to RMS measurements.

Crest factor	1 to 2	2 to 3	3 to 4	4 to 5
Additional error	0	0.1	0.2	0.4

ACV PEAK VALUE MEASUREMENT[19]

Repetitive peak accuracy, ± (% of reading + % of range), 90 days, 1 year or 2 years, T_{CAL} ± 5 °C

Range	20 Hz to 1 kHz[29]	1 kHz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 500 kHz	500 kHz to 750 kHz	750 kHz to 1 MHz	Temperature coefficient ± (% of reading + % of range) / °C outside T_{CAL} ± 5 °C
200 mV	0.08 + 0.7	0.09 + 0.7	0.1 + 0.7	0.15 + 0.7	0.25 + 0.7	1.0 + 0.7	2.5 + 0.7	5.5 + 0.7	9 + 0.7	0.002 + 0.03
2 V	0.08 + 0.3	0.09 + 0.3	0.1 + 0.3	0.15 + 0.3	0.25 + 0.3	1.0 + 0.3	2.5 + 0.3	5.5 + 0.3	9 + 0.3	0.002 + 0.03
20 V	0.1 + 0.7	0.11 + 0.7	0.14 + 0.7	0.19 + 0.7	0.25 + 0.7	1.0 + 0.7	2.5 + 0.7	5.5 + 0.7	9 + 0.7	0.004 + 0.03
200 V[26]	0.1 + 0.3	0.11 + 0.3	0.14 + 0.3	0.19 + 0.3	0.25 + 0.3	1.0 + 0.3[22]	2.5 + 0.3[22]	5.5 + 0.3[22]	9 + 0.3[22]	0.004 + 0.03
750 V[26]	0.12 + 0.6	0.16 + 0.6	0.2 + 0.6	0.25 + 0.6[22]	0.5 + 0.6[22]	—	—	—	—	0.01 + 0.02
Valid % of range[30]	10% to 400%	10% to 400%	10% to 400%	10% to 350%	10% to 350%	10% to 250%	10% to 150%	10% to 100%	7.5% to 75%	—

Default measurement resolution: Four digits.

Nonrepetitive peak: 10% of range per µs typical slew rate for single spikes.

Peak width: Specifications apply for all peaks ≥ 1 µs.

Peak measurement window: 100 ms per reading.

Maximum input: ± 1100 V peak, 2×10^7 V·Hz (for inputs above 20 V).

Settling characteristics:

Normal mode (RMS, avg.):
< 300 ms to 1% of step change.
< 450 ms to 0.1% of step change.
< 500 ms to 0.01% of step change.

Low frequency Mode (RMS):
< 5 s to 0.1% of final value

Common mode rejection: For 1 kΩ imbalance in either lead: > 60 dB for line frequency ± 0.1%.

Maximum Volt-Hz product: 2×10^7 V·Hz (for inputs above 20 V).

Autoranging: Autoranges up at 105% of range, down at 10% of range.

[29] AC peak specifications assume ac + dc coupling for frequencies below 200 Hz.
[30] For overrange readings 200% to 300% of range, add 0.1% of reading uncertainty. For 300% to 400% of range, add 0.2% of reading uncertainty.

OHMS

TWO-WIRE AND FOUR-WIRE OHMS

Range	Full scale	Resolution	Current source[31]	Open circuit[22]	Maximum HI lead resistance[32]	Maximum LO lead resistance[32]	Maximum offset compensation[33]
20 Ω	21.0 Ω	100 nΩ	7.2 mA	5 V	50 Ω	10 Ω	± 0.2 V
200 Ω	210.0 Ω	1 µΩ	960 µA	5 V	200 Ω	100 Ω	± 0.2 V
2 kΩ	2.1 kΩ	10 µΩ	960 µA	5 V	200 Ω	150 Ω	–0.2 V to +2 V
20 kΩ	21.0 kΩ	100 µΩ	96 µA	5 V	1.5 kΩ	1.5 kΩ	–0.2 V to +2 V
200 kΩ	210.0 kΩ	1 mΩ	9.6 µA	5 V	1.5 kΩ	1.5 kΩ	—
2 MΩ	2.10 MΩ	10 mΩ	1.9 µA	6 V	1.5 kΩ	1.5 kΩ	—
2 MΩ[34]	21.0 MΩ	100 mΩ	1.4 µA[35]	14 V	—	—	—
20 MΩ[34]	210.0 MΩ	1 Ω	1.4 µA[35]	14 V	—	—	—
1 GΩ[34]	1.050 GΩ	10 Ω	1.4 µA[35]	14 V	—	—	—

KEITHLEY FACTORY CALIBRATION UNCERTAINTY

Range	ppm of reading
20 Ω	29.5
200 Ω	7.7
2 kΩ	6.4
20 kΩ	7.8
200 kΩ	7.3
2 MΩ	14.9
20 MΩ	14.9
200 MΩ	14.9
1 GΩ	14.9

Factory calibration uncertainty represents traceability to NIST. This uncertainty is added to relative accuracy specifications to obtain absolute accuracies.

The 20 Ω to 2 MΩ range uncertainties are equal to the uncertainty of the respective calibration sources.

The 20 MΩ, 200 MΩ, and 1 GΩ range uncertainties are equal to the uncertainty of the 2 MΩ calibration source.

[31] Current source has an absolute accuracy of ± 5%.
[32] Refers to source lead resistance. Sense lead resistance is limited only by noise considerations. For best results, limit it to 1.5 kΩ.
[33] Offset compensation voltage + source current × measured resistance must be less than source current × resistance range selected.
[34] For 2-wire mode under 50% relative humidity. Additional 0.0075% for 20 MΩ, 200 MΩ for 0.2%, and 1.75% for the 1 GΩ range when operating between 45% to 50%.
[35] Current source is paralleled with a 10 MΩ resistance.

ENHANCED ACCURACY[36] 10 PLC, offset comp. on, DFILT 10

Range	Transfer[5]	24 hours[37]	Relative accuracy ± (ppm of reading + ppm of range)			Temperature coefficient ± (ppm of reading + ppm of range) / °C outside T_{CAL} ± 5 °C
			90 days[7]	1 year[7]	2 years[7]	
20 Ω	2.5 + 3	5 + 4.5	15 + 6	17 + 6	20 + 6	2.5 + 0.7
200 Ω	2.5 + 2	5 + 3	15 + 4	17 + 4	20 + 4	2.5 + 0.5
2 kΩ	1.3 + 0.2	2.5 + 0.3	7 + 0.4	9 + 0.4	11 + 0.4	0.8 + 0.05
20 kΩ	1.3 + 0.2	2.5 + 0.3	7 + 0.4	9 + 0.4	11 + 0.4	0.8 + 0.05
200 kΩ	2.5 + 0.4	5.5 + 0.5	29 + 0.8	35 + 0.9	40 + 1	3.5 + 0.18
2 MΩ	5 + 0.2	12 + 0.3	53 + 0.5	65 + 0.5	75 + 0.5	7 + 0.1
20 MΩ[34]	15 + 0.1	50 + 0.2	175 + 0.6	250 + 0.6	300 + 0.6	20 + 0.1
200 MΩ[34]	50 + 0.5	150 + 1	500 + 3	550 + 3	600 + 3	80 + 0.5
1 GΩ[34]	250 + 2.5	2250 + 5	3500 + 15	3550 + 15	3600 + 15	400 + 2.5

Resistance uncertainty: = ± [(ppm of reading) × (measured value) + (ppm of range) × (range used)] / 1,000,000.

% accuracy: = (ppm accuracy) / 10,000.

1 ppm of range: = 20 counts for ranges up to 200 MΩ and 10 counts on 1 GΩ range at 7½ digits.

SPEED AND ACCURACY

Accuracy[11, 38] 90 days ± (ppm of reading + ppm of range + ppm of range RMS noise[12])						
Range	10 PLC DFILT on, 10 readings	10 PLC DFILT off	1 PLC DFILT on, 10 readings	1 PLC DFILT off	0.1 PLC[39] DFILT off	0.01 PLC[39,13] DFILT off
20 Ω	15 + 11 + 0	15 + 11 + 0.5	15 + 13 + 0.5	15 + 13 + 1	15 + 16 + 25	110 + 200 + 35
200 Ω	15 + 8 + 0	15 + 8 + 0.5	17 + 8 + 0.5	17 + 8 + 1	17 + 10 + 15	110 + 200 + 35
2 kΩ	7 + 0.8 + 0	7 + 0.8 + 0.05	8 + 0.8 + 0.07	8 + 0.8 + 0.2	8 + 1 + 2	130 + 230 + 5
20 kΩ	7 + 0.8 + 0	7 + 0.8 + 0.1	8 + 0.8 + 0.1	9 + 0.8 + 0.2	40 + 1 + 2	130 + 230 + 5
200 kΩ	29 + 0.8 + 0	29 + 0.8 + 0.1	31 + 0.8 + 0.1	34 + 0.8 + 0.2	250 + 1 + 2	—
2 MΩ	55 + 0.5 + 0	53 + 0.5 + 0.1	58 + 0.5 + 0.1	68 + 0.5 + 0.2	750 + 0.7 + 2	—
20 MΩ[34]	175 + 0.6 + 0	175 + 0.6 + 0	175 + 0.6 + 0	200 + 0.6 + 0	—	—
200 MΩ[34]	500 + 3 + 0	510 + 3 + 0	510 + 3 + 0	550 + 3 + 0	—	—
1 GΩ[34]	3500 + 15 + 0	3600 + 15 + 0	3600 + 15 + 0	4000 + 15 + 0	—	—

PLC = Power line cycles. DFILT = Digital filter.

[36] Specifications are for 10 power line cycles, 10-reading repeat digital filter, synchronous autozero, autorange off, 4-wire mode, offset compensation on (for 20 Ω to 20 kΩ ranges), except as noted.
[37] For T_{CAL} ± 1 °C, following 4-hour warmup. T_{CAL} is ambient temperature at calibration (23 °C at the factory).
[38] Specifications are for 1 power line cycle, normal autozero, digital filter off, autorange off, 4-wire mode, offset compensation off, except as noted.
[39] Ohms measurements at rates lower than 1 power line cycle are subject to potential noise pickup. Take care to provide adequate shielding.

2-WIRE ACCURACY ± (PPM of range)

Range	Additional uncertainty (inside T_{CAL} ± 5 °C)	Temperature coefficient (outside T_{CAL} ± 5 °C)
20 Ω	300 ppm	70 ppm / °C
200 Ω	30 ppm	7 ppm / °C
2 kΩ	3 ppm	0.7 ppm / °C

NORMAL ACCURACY[38] 1 PLC, offset comp. off, DFILT off

Relative accuracy ± (ppm of reading + ppm of range)					Temperature coefficient ± (ppm of reading + ppm of range) / °C
Range	24 hours[37]	90 days[7]	1 year[7]	2 years[7]	outside T_{CAL} ± 5 °C
20 Ω	5 + 12	15 + 16	17 + 17	20 + 19	2.5 + 2.5
200 Ω	7 + 8	17 + 11	19 + 12	22 + 13	2.5 + 1.8
2 kΩ	3.5 + 1.1	8 + 1.4	10 + 1.5	12 + 1.6	0.8 + 0.18
20 kΩ	4.5 + 1.1	9 + 1.4	11 + 1.5	13 + 1.6	0.8 + 0.18
200 kΩ	11 + 1.1	34 + 1.4	40 + 1.5	45 + 1.6	3.5 + 0.18
2 MΩ	27 + 0.9	68 + 1.1	80 + 1.1	90 + 1.1	7 + 0.1
20 MΩ[34]	75 + 0.2	200 + 0.6	275 + 0.6	325 + 0.6	20 + 0.1
200 MΩ[34]	200 + 1	550 + 3	600 + 3	650 + 3	80 + 0.5
1 GΩ[34]	2750 + 5	4000 + 15	4050 + 15	4100 + 15	400 + 2.5

Settling characteristics: Preprogrammed settling delay times are for < 500 pF external circuit capacitance. Reading settling times are affected by source impedance and cable dielectric absorption characteristics.

Ohms voltage drop measurement: Available as a multiple display.

Autoranging: Autoranges up at 105% of range and down at 10% of range.

2-WIRE RESISTANCE READING RATES[17, 22]

PLC	Measurement aperture	Bits	Default digits	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with timestamp to IEEE-488[18]	
				Autozero off	Autozero on	Autozero off	Autozero on	Autozero off	Autozero on
10	167 ms (200 ms)	29	8½	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	33.4 ms (40 ms)	27	7½	29 (25)	9 (7.6)	29 (24)	9 (7.4)	27 (22)	9 (7.4)
1	16.7 ms (20 ms)	26	7½	56 (48)	47 (40)	55 (45)	46 (38)	50 (41)	42 (34)
0.2[39]	3.34 ms (4 ms)	23	6½	222 (197)	156 (139)	220 (196)	148 (132)	156 (139)	107 (95)
0.1[39]	1.67 ms (2 ms)	22	6½	330 (317)	176 (169)	305 (293)	166 (159)	157 (151)	110 (106)
0.02[39]	334 µs (400 µs)	20	5½	330 (330)	182 (182)	305 (305)	172 (172)	160 (160)	113 (113)
0.01[39]	167 µs (167 µs)	19	4½	384 (384)	186 (186)	352 (352)	172 (172)	179 (179)	123 (123)
0.01[13,39]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

4-WIRE RESISTANCE READING RATES[22, 17]

PLC	Measurement aperture	Bits	Default digits	Readings or readings with timestamp per second to memory or IEEE-488[18]			
				Autozero off, offset comp. off	Autozero off, offset comp. on	Autozero on, offset comp. off	Autozero on, offset comp. on
10	167 ms (200 ms)	29	8½	6 (5)	3 (2.5)	2 (1.6)	1 (0.8)
2	33.4 ms (40 ms)	27	7½	27 (22)	13 (10.7)	9 (7.4)	4 (3.5)
1	16.7 ms (20 ms)	26	7½	50 (41)	25 (20)	42 (34)	20 (16)
0.2[39]	3.34 ms (4 ms)	23	6½	154 (137)	76 (68)	115 (102)	54 (48)
0.1[39]	1.67 ms (2 ms)	22	6½	184 (176)	92 (88)	123 (118)	63 (60)
0.02[39]	334 µs (400 µs)	20	5½	186 (186)	107 (107)	126 (126)	72 (72)
0.01[39]	167 µs (167 µs)	19	4½	211 (211)	107 (107)	133 (133)	72 (72)

DC AMPS

DCI INPUT CHARACTERISTICS AND ACCURACY

Range	Full scale	Resolution	Maximum burden voltage[40]	Relative accuracy ± (ppm of reading + ppm of range)				Temperature coefficient[41] ± (ppm of reading + ppm of range) / °C outside T_{CAL} ± 5 °C
				24 hours[42]	90 days[43]	1 year[43]	2 years[43]	
200 µA	210.0 µA	10 pA	0.25 V	50 + 6	275 + 25	350 + 25	500 + 25	50 + 5
2 mA	2.10 mA	100 pA	0.3 V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
20 mA	21.0 mA	1 nA	0.35 V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
200 mA	210.0 mA	10 nA	0.35 V	75 + 5	300 + 20	375 + 20	525 + 20	50 + 5
2 A	2.10 A	100 nA	1.1 V	350 + 5	750 + 20	750 + 20	1000 + 20	300 + 5

DC current uncertainty: = ± [(ppm reading) × (measured value) + (ppm of range) × (range used)] / 1,000,000.

% accuracy: = (ppm accuracy) / 10,000.

5 ppm of range: = 10 counts at 6½ digits.

DCI READING RATES[17, 22]

PLC	Measurement aperture	Bits	Default digits	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with timestamp to IEEE-488[18]	
				Autozero off	Autozero on	Autozero off	Autozero on	Autozero off	Autozero on
10	167 ms (200 ms)	29	7½	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	33.4 ms (40 ms)	27	7½	29 (25)	9 (7.6)	29 (24)	9 (7.4)	27 (22)	9 (7.4)
1	16.7 ms (20 ms)	26	6½	56 (48)	47 (40)	55 (45)	46 (38)	50 (41)	42 (34)
0.2	3.34 ms (4 ms)	23	6½	222 (197)	157 (140)	209 (186)	150 (133)	156 (139)	113 (100)
0.1	1.67 ms (2 ms)	22	5½	334 (321)	178 (171)	310 (298)	168 (161)	186 (178)	124 (119)
0.02	334 µs (400 µs)	20	5½	334 (334)	184 (184)	310 (310)	174 (174)	187 (187)	127 (127)
0.01	167 µs (167 µs)	19	4½	387 (387)	186 (186)	355 (355)	176 (176)	202 (202)	128 (128)
0.01[13]	167 µs (167 µs)	19	4½	2000 (2000)	—	2000 (2000)	—	—	—

[40] Actual maximum burden voltage = (maximum burden voltage) × ($I_{MEASURED}/I_{FULL\ SCALE}$).
[41] Specifications are for 1 power line cycle, autozero on, 10-reading repeat digital filter.
[42] For T_{CAL} ± 1°C, following 55-minute warmup. T_{CAL} is ambient temperature at calibration (23°C at the factory).
[43] For T_{CAL} ± 5°C, following 55-minute warmup.

SPEED AND ACCURACY

ACCURACY[41,11] 90 Days **± (ppm of reading + ppm of range + ppm of range RMS noise[12])**				
Range	**1 PLC DFILT on, 10 readings**	**1 PLC DFILT off**	**0.1 PLC DFILT off**	**0.01 PLC[13] DFILT off**
200 µA	275 + 25 + 0	275 + 25 + 0.5	300 + 25 + 50	300 + 200 + 80
2 mA	275 + 20 + 0	275 + 20 + 0.5	300 + 20 + 50	300 + 200 + 80
20 mA	275 + 20 + 0	275 + 20 + 0.5	300 + 20 + 50	300 + 200 + 80
200 mA	300 + 20 + 0	300 + 20 + 0.5	325 + 20 + 50	325 + 200 + 80
2 A	600 + 20 + 0	600 + 20 + 0.5	625 + 20 + 50	625 + 200 + 80

PLC = Power line cycles. DFILT = Digital filter.

KEITHLEY FACTORY CALIBRATION UNCERTAINTY

Range	**ppm of reading**
200 µA	43
2 mA	40
20 mA	55
200 mA	162
2 A	129

Factory calibration uncertainty represents traceability to NIST. This uncertainty is added to relative accuracy specifications to obtain absolute accuracies. The 20 Ω to 2 MΩ range uncertainties are equal to the uncertainty of the respective calibration sources. The 20 MΩ, 200 MΩ, and 1 GΩ range uncertainties are equal to the uncertainty of the 2 MΩ calibration source.

Settling characteristics: < 500 µs to 50 ppm of step size. Reading settling times are affected by source impedance and cable dielectric absorption characteristics.

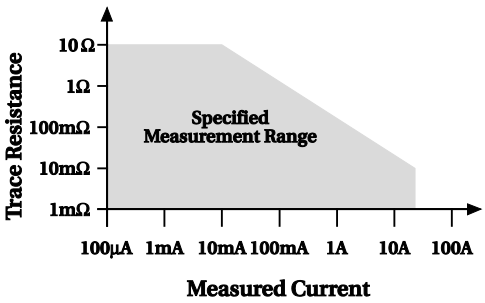
Maximum allowable input: 2.1 A, 250 V.

Overload protection: 2 A, 250 V fuse, accessible from front (for front input) and rear (for rear input).

Autoranging: Autoranges up at 105% of range, down at 10% of range.

DC IN-CIRCUIT CURRENT

Measurement range chart



The dc in-circuit current measurement function allows you to measure the current through a wire or a circuit board trace without breaking the circuit.

When the in-circuit current measurement function is selected, the Model 2002 first performs a 4-wire resistance measurement, then a voltage measurement, and displays the calculated current.

TYPICAL RANGES
Current: 100 µA to 12 A.
Trace resistance: 1 mΩ to 10 Ω.
Voltage: ± 200 mV maximum across trace.
Speed: Four measurements/second at 1 power line cycle.
Accuracy: ± (5% + 500 µA). For 1 power line cycle, autozero on, 10-reading digital filter, T_{CAL} ± 5 °C, 90 days, 1 year or 2 years.

AC AMPS

AC magnitude: RMS or average.

ACI INPUT CHARACTERISTICS

RMS range	Peak input	Full scale RMS	Resolution	Maximum burden voltage[40]	Temperature coefficient ± (% of reading + % of range) / °C outside T_{CAL} ± 5 °C
200 µA	1 mA	210.0 mA	100 pA	0.35 V	0.01 + 0.001
2 mA	10 mA	2.10 mA	1 nA	0.45 V	0.01 + 0.001
20 mA	100 mA	21.0 mA	10 nA	0.5 V	0.01 + 0.001
200 mA	1 A	210.0 A	100 nA	0.5 V	0.01 + 0.001
2 A	2 A	2.10 A	1 µA	1.5 V	0.01 + 0.001

ACI ACCURACY[24, 44]

90 days, 1 year or 2 years, T_{CAL} ± 5 °C, for 5% to 100% of range, ± (% of reading + % of range)

Range	20 Hz to 50 Hz	50 Hz to 200 Hz	200 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 30 kHz[22]	30 kHz to 50kHz[22]	50 kHz to 100 kHz[22]
200 µA	0.35 + 0.015	0.2 + 0.015	0.4 + 0.015	0.5 + 0.015			
2 mA	0.3 + 0.015	0.15 + 0.015	0.12 + 0.015	0.12 + 0.015	0.25 + 0.015	0.3 + 0.015	0.5 + 0.015
20 mA	0.3 + 0.015	0.15 + 0.015	0.12 + 0.015	0.12 + 0.015	0.25 + 0.015	0.3 + 0.015	0.5 + 0.015
200 mA	0.3 + 0.015	0.15 + 0.015	0.12 + 0.015	0.15 + 0.015	0.5 + 0.015	1 + 0.015	3 + 0.015
2 A	0.35 + 0.015	0.2 + 0.015	0.3 + 0.015	0.45 + 0.015[45]	1.5 + 0.015	4 + 0.015	—

AC current uncertainty: = ± [(% of reading) × (measured value) + (% of range) × (range used)] / 100.

Ppm accuracy: = (% accuracy) × 10,000.

0.015% of range: = 30 counts at 5½ digits.

ACI READING RATES[17, 22]

PLC	Measurement aperture	Bits	Default digits	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with timestamp to IEEE-488[18]	
				Autozero off	Autozero on	Autozero off	Autozero on	Autozero off	Autozero on
10	167 ms (200 ms)	29	6½	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	33.4 ms (40 ms)	27	5½	29 (25)	9 (7.6)	28 (23)	9 (7.4)	27 (22)	9 (7.4)
1	16.7 ms (20 ms)	26	5½	56 (48)	47 (40)	53 (43)	44 (36)	47 (38)	40 (33)
0.2	3.34 ms (4 ms)	23	5½	163 (145)	102 (91)	139 (124)	100 (89)	95 (84)	74 (66)
0.1	1.67 ms (2 ms)	22	5½	163 (156)	104 (100)	139 (133)	101 (97)	95 (91)	75 (72)
0.02	334 µs (400 µs)	20	5½	163 (163)	107 (107)	139 (139)	103 (103)	95 (95)	76 (76)
0.01	167 µs (167 µs)	19	4½	384 (384)	110 (110)	253 (253)	103 (103)	164 (164)	76 (76)
0.01[13]	167 µs (167 µs)	19	4½	2000 (2000)	—	2000 (2000)	—	—	—

[44] Add 0.005% of range uncertainty for current above 0.5 A RMS for self-heating.
[45] If signals greater than 1.5 A_{RMS} have been present, add an additional 0.05% of reading error until thermal stability has been restored (< 8 minutes).

AC COUPLING

For ac-only coupling, add the following % of reading:

	20 Hz to 50 Hz	50 Hz to 100 Hz	100 Hz to 200 Hz
RMS, average	0.55	0.09	0.015

AC + DC COUPLING

For dc > 20% of ac RMS voltage, apply the following additional uncertainty, multiplied by the ratio (dc / total RMS).

	% of reading	% of range
RMS, average	0.05	0.1

HIGH CREST FACTOR ADDITIONAL ERROR ± (% of reading)

Applies to RMS measurements.

Crest factor	1 to 2	2 to 3	3 to 4	4 to 5
Additional error	0	0.1	0.2	0.4

AVERAGE ACI MEASUREMENT

RMS specifications apply for 10% to 100% of range.

Settling characteristics: < 300ms to 1% of step change.
< 450ms to 0.1% of step change.
< 500ms to 0.01% of step change.

Autoranging: Autoranges up at 105% of range, down at 10% of range.

FREQUENCY COUNTER

FREQUENCY / PERIOD INPUT CHARACTERISTICS AND ACCURACY 90 days, 1 year, or 2 years

Input	Frequency range[46]	Period range	Resolution	Minimum signal level[47]			Maximum input	Trigger level	Accuracy ± (% of reading)
				1 Hz to 1 MHz	1 Hz to 5 MHz	5 MHz to 15 MHz			
AC voltage	1 Hz to 15 MHz	67 ns to 1 s	5 digits	60 mV	60 mV	400 mV	1100 V peak[46]	0 V to 600 V	0.03
AC current	1 Hz to 1 MHz	1 µs to 1 s	5 digits	150 µA	—	—	1 A peak	0 V to 600 mA	0.03

Time base: 7.68 MHz ± 0.01%, 0 °C to 55 °C.

Reading time: 420 ms maximum.

Voltage input impedance: 1 MΩ ± 2% with < 140 pF.

Trigger level adjustment: Trigger level is adjustable in 0.5% of range steps to ± 60% of range in real time using the up and down range buttons.

Frequency ranging: Autoranging from Hz to MHz.

Frequency coupling: AC only.

[46] Subject to 2×10^7 V·Hz product (for inputs above 20 V).
[47] Valid for the lowest range. For each range increase, multiply these numbers by 10. Signals in RMS.

TEMPERATURE (RTD)

Range	Resolution	4-wire accuracy[48]			
		24 hours[49]	90 days[7]	1 year[7]	2 years[7]
–100 °C to +100 °C	0.001 °C	± 0.016 °C	± 0.020 °C	± 0.021 °C	± 0.022 °C
–200 °C to +630 °C	0.001 °C	± 0.061 °C	± 0.066 °C	± 0.068 °C	± 0.070 °C
–148 °F to +212 °F	0.001 °F	± 0.029 °F	± 0.036 °F	± 0.038 °F	± 0.040 °F
–328 °F to +1166 °F	0.001 °F	± 0.110 °F	± 0.119 °F	± 0.122 °F	± 0.126 °F

RTD type: 100 Ω platinum, DIN 43760, 4-wire. ITS-90 (PT100, D100, F100) and IPTS-68 (PT385, PT3916).

Sensor current: 960 µA (pulsed).

Temperature coefficient: ± 0.001 °C / °C or ± 0.002 °F / °C outside T_{CAL} ± 5 °C.

Maximum source HI lead resistance: 200 Ω.

Maximum source LO lead resistance: 100 Ω.

RTD TEMPERATURE READING RATES[17, 22] (2-wire or 4-wire)

Readings or readings with timestamp per second to memory or IEEE-488		
PLC	Autozero off	Autozero on
10	3 (2.5)	1 (0.8)
2	12 (10)	4 (3.3)
1	20 (16)	17 (13)
0.1	51 (49)	41 (39)
0.01	58 (58)	46 (46)

TEMPERATURE (THERMOCOUPLE)

Thermocouple type	Range	Resolution	Accuracy[50]
J	–200 °C to +760 °C	0.001 °C	± 0.5 °C
K	–200 °C to +1372 °C	0.001 °C	± 0.5 °C
T	–200 °C to +400 °C	0.001 °C	± 0.5 °C
E	–200 °C to +1000 °C	0.001 °C	± 0.6 °C
R	0 °C to +1768 °C	0.001 °C	± 3 °C
S	0 °C to +1768 °C	0.001 °C	± 3 °C
B	+350 °C to +1820 °C	0.001 °C	± 5 °C

TC TEMPERATURE READING RATES[22, 51]

PLC	Readings per second to memory		Readings per second to IEEE-488[18]		Readings per second with timestamp to IEEE-488[18]	
	Autozero Off	Autozero On	Autozero Off	Autozero On	Autozero Off	Autozero On
10	6 (5)	2 (1.7)	6 (5)	2 (1.6)	6 (5)	2 (1.6)
2	29 (25)	9 (7.6)	29 (24)	9 (7.4)	27 (22)	9 (7.4)
1	57 (48)	47 (40)	56 (46)	46 (38)	50 (41)	42 (34)
0.1	131 (126)	107 (103)	100 (96)	84 (81)	83 (80)	72 (69)
0.01	168 (168)	112 (112)	121 (121)	89 (89)	96 (96)	74 (74)

[48] Specifications are for 10 power line cycles, autozero on, 10-reading repeat digital filter, 4-wire mode. Exclusive of RTD probe errors.
[49] For T_{CAL} ± 1 °C, following 4-hour warmup.
[50] Relative to external 0 °C reference junction; exclusive of thermocouple errors. Junction temperature may be external. Applies for 90 days, 1 year or 2 years, T_{CAL} ± 5 °C.
[51] For on-scale readings, no trigger delays, digital filter off, display off, normal autozero, internal trigger, SREAL format. These rates are for 60 Hz and 50 Hz. Rates for 400 Hz equal those for 50 Hz. Typical values.

OPERATING SPEED

FUNCTION CHANGE SPEED[52]

Typical delay before measurement initiation after making a function change.

From function	To function	Range	Time
Any except 4-wire resistance, Temperature	DCV	Any	4.6 ms
4-wire resistance, Temperature		Any	7.6 ms
Any	ACV	Any	574 ms
AC Voltage, DC Voltage, 2-wire resistance, Frequency	DCI	Any	7.1 ms
4-wire resistance, Temperature		Any	10 ms
AC Current		Any	22 ms
Any	ACI	Any	523 ms
Any except 4-wire resistance, Temperature	2WΩ	20 Ω to 2 kΩ	4.7 ms
		20 kΩ	15 ms
		200 kΩ	27 ms
		2 MΩ	103 ms
		20 MΩ	153 ms
		200 MΩ, 1 GΩ	253 ms
4-wire resistance, Temperature	2WΩ	20 Ω to 2 kΩ	7.7 ms
		20 kΩ	18 ms
		200 kΩ	30 ms
		2 MΩ	105 ms
		20 MΩ	157 ms
		200 MΩ, 1 GΩ	256 ms
Any	4WΩ	20 Ω to 2 kΩ	7.7 ms
		20 kΩ	18 ms
		200 kΩ	30 ms
		2 MΩ	105 ms
Any except AC Voltage and AC Current	Freq[53]	Any	60 ms
AC Voltage and AC Current		Any	573 ms
Any	Temp	Any	7.6 ms

[52] For display off, 0.01 power line cycles, autorange off, digital filter off, autozero on, offset compensation off. Display on may impact time by 3% worst-case. To eliminate this impact, press **ENTER (hold)** to freeze display.
[53] Based on 100 kHz input frequency.

RANGE CHANGE SPEED[52]

Typical delay before measurement initiation after making a range change.

Function	From	To	Time
DC voltage	Any	Any	5.2 ms
AC voltage	Any	Any	559 ms
DC current	Any	Any	7.6 ms
AC current	Any	Any	503 ms
2-wire resistance	Any	20 Ω to 2 kΩ	5.2 ms
	Any	20 kΩ	15 ms
	Any	200 kΩ	27 ms
	Any	2 MΩ	103 ms
	Any	20 MΩ	153 ms
	Any	200 MΩ, 1 GΩ	253 ms
4-wire resistance	Any	20 Ω to 2 kΩ	5.2 ms
	Any	20 kΩ	15 ms
	Any	200 kΩ	27 ms
	Any	2 MΩ	103 ms

TRIGGER SPEED (EXTERNAL TRIGGER OR TRIGGER-LINK)

	Autozero off	Autozero on
Trigger latency	< 2 µs	1.2 ms typical
Trigger jitter	± 0.5 µs	—

GPIB DATA FORMATTING TRANSMISSION TIME[54]

	Readings only		Readings with timestamp	
Format	**Time**	**Readings per second**	**Time**	**Readings per second**
DREAL (double precision real)	0.51 ms	1961	3.1 ms	323
SREAL (single precision real)	0.38 ms	2632	3.3 ms	303
ASCII	6.2 ms	161	10.2 ms	98

[54] Average time for 1000 readings, byte order swapped, display off.

SINGLE FUNCTION SCAN SPEED[55] (INTERNAL SCANNER)

	DCV (20 V)		2WΩ (2 kΩ)		4WΩ (2 kΩ)		ACV		Frequency		TC temperature		RTD temperature (2-wire)	
TYPE	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**	**Time per chan.**	**Rate (chan./ second)**
Ratio or delta[56] (2 channels)	8.2 ms	122	8.5 ms	118	18.8 ms	53	—	—	—	—	—	—	—	—
Fast scan (using solid state channels)	8.2 ms	122	6.3 ms	159	—	—	501 ms	2	559 ms	1.8	12.8 ms	78	—	—
Normal scan	14 ms	71	11.4 ms	88	14.4 ms	69	506 ms	2	564 ms	1.8	17.2 ms	58	43 ms	23

MAXIMUM INPUT LEVELS

	Rated input[57]	Overload recovery time
HI to LO	± 1100 V	< 900 ms
HI sense to LO	± 350 V_{PK} 250 V RMS	< 900 ms
LO sense to LO	± 150 V_{PK} 100 V RMS	< 900 ms
I input to LO	2 A, ± 250 V (fused)	—
HI to earth	± 1600 V	< 900 ms
LO to earth	± 500 V	—

DELAY AND TIMER

Timestamp	**Resolution:** 1 µs. **Accuracy:** ± 0.01% of elapsed time ± 1 µs. **Maximum:** 2,100,000.000000 seconds (24 days, 7 hours).
Delay time	**(Trigger edge to reading initiation)** **Maximum:** 999,999.999 seconds (11 days, 14 hours). **Resolution:** 1 ms. **Jitter:** ± 1 ms.
Timer	**(Reading initiation to reading initiation)** **Maximum:** 999,999.999 seconds (11 days, 14 hours). **Resolution:** 1 ms. **Jitter:** ± 1 ms.

[55] For on-scale readings, no trigger delays, display off, 0.01 power line cycles, autorange off, digital filter off, offset compensation off, autozero off.
[56] Ratio and delta functions output one value for each pair of measurements.
[57] For voltages between other terminals, these ratings can be added.

IEEE-488 BUS IMPLEMENTATION

Implementation: IEEE-488.2, SCPI-1991.0.
Multiline commands: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.
Uniline commands: IFC, REN, EOI, SRQ, ATN.
Interface commands: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

DIGITAL I/O

Connector type: 8-pin, D-subminiature.
Input: One pin, TTL compatible.
Outputs: Four pins. Open collector, 30 V maximum pull-up voltage, 100 mA maximum sink current, 10 Ω output impedance.
Control: Direct control by output or set real time with limits.

GENERAL SPECIFICATIONS AND STANDARDS COMPLIANCE[58]

Power	**Voltage:** 90 V to 134 V and 180 V to 250 V, universal self-selecting. **Frequency:** 50 Hz, 60 Hz, or 400 Hz, self-identifying at power-up. **Consumption:** < 55 VA.
Environmental	**Operating temperature:** 0 °C to 45 °C. **Storage temperature:** – 40 °C to 70 °C. **Humidity:** 80% relative humidity, 0 °C to 35 °C.
Calibration	**Type:** Software. No manual adjustments required. **Sources:** Two dc voltages, six resistances, and five dc currents. All other functions calibrated (adjusted) from these sources and a short circuit. No ac calibrator required for adjustment. **Average time to perform:** Forty minutes for comprehensive calibration, six minutes for ac-only calibration.
Physical	**Case dimensions:** 90 mm high × 214 mm wide × 369 mm deep (3½ in. × 8½ in. × 14½ in.). **Working dimensions:** From front of case to rear, including power cord and IEEE-488 connector, 381 mm (15.0 in.) **Net weight:** < 4.2 kg (< 9.2 lb). **Shipping weight:** < 9.1 kg (< 20 lb).
Approvals	**EMI/RFI:** EU EMC Directive. **Safety:** EU Low-Voltage Directive.
Accessories supplied	The unit is shipped with line cord, high-performance modular test leads, optional slot cover, and full calibration data.

EXTENDED MEMORY/NONVOLATILE MEMORY OPTIONS

DATA STORAGE

Model	Size (bytes)	4½-digit	6½-digit with timestamp	Type	Setup storage	
					Number	Type
2002	8 k	2,027	404	Volatile	1	Nonvolatile
2002/MEM1	32 k	6,909	1,381	Nonvolatile	5	Nonvolatile
2002/MEM2	128 k	29,908	5,980	Nonvolatile	10	Nonvolatile

These are the minimum sizes to expect.

[58] MIL-PRF-28800F Type III, Class 5, Style E applies.