2002 Multimeter

Specifications

The following pages contain the complete specifications for the 2002. Every effort has been made to make these specifications complete by characterizing its performance under the variety of conditions often encountered in production, engineering, and research.

The 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 utilize 90-day, 1-year, or 2-year recommended calibration intervals, depending upon the level of accuracy desired. As a general rule, the 2002's 2-year performance exceeds a 6½-digit DMM's 90-day, 180-day, or 1-year specifications.

Absolute Accuracy

All DC 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's factory calibration are included in the specifications. The uncertainties of the operator's sources may be different.

All AC specifications are given as absolute accuracies.

Typical Accuracies

Accuracy can be specified as typical or warranted. All specifications shown are warranted unless specifically noted. Almost 99% of the 2002's 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 (e.g., high-voltage, high-frequency signal sources with sufficient 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-cal.

2002 Multimeter

DC Volts

DCV Input Characteristics and Accuracy

Enhanced Accuracy[1] – 10PLC, DFILT 10

Range	Full Scale	Resolution	Input Resistance	Relative Accuracy ±(ppm of reading + ppm of range) Transfer[12]	24 Hours[2]	90 Days[3]	1 Year[3]	2 Years[3]	Temperature Coefficient ±(ppm of reading + ppm of range)/°C Outside T_{CAL} ±5°C
200 mV[4]	±210.000000	1 nV	>100 GΩ	0.4 + 1.5	3.5 + 3	15 + 8	19 + 9	23 + 10	2 + 1.8
2 V[4]	±2.10000000	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	±21.0000000	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	±210.000000	1 µV	10 MΩ ±1%	0.5 + 0.08	5 + 0.4	14 + 2	22 + 2	30 + 2	1.5 + 0.3
1000 V[13]	±1100.00000	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.
1ppm of Range = 20 counts for ranges up to 200V and 10 counts on 1000V range at 7½ digits.

Normal Accuracy[14] – 1PLC, DFILT off

Range	Full Scale	Resolution	Input Resistance	Relative Accuracy ±(ppm of reading + ppm of range) 24 Hours[2]	90 Days[3]	1 Year[3]	2 Years[3]	Temperature Coefficient ±(ppm of reading + ppm of range)/°C Outside T_{CAL} ±5°C
200 mV[4]	±210.00000	10 nV	>100 GΩ	3.5 + 6	15 + 11	19 + 12	23 + 13	2 + 1.8
2 V[4]	±2.1000000	100 nV	>100 GΩ	1.2 + 0.6	6 + 1.1	10 + 1.2	14 + 1.3	0.2 + 0.18
20 V	±21.000000	1 µV	>100 GΩ	3.2 + 0.35	8 + 0.4	12 + 0.4	16 + 0.4	0.3 + 0.02
200 V	±210.00000	10 µV	10 MΩ ±1%	5 + 1.2	14 + 2.8	22 + 2.8	30 + 2.8	1.5 + 0.3
1000 V[13]	±1100.0000	100 µV	10 MΩ ±1%	5 + 0.4	14 + 0.7	22 + 0.7	30 + 0.7	1.5 + 0.06

Speed and Accuracy 90 Days

Range	10PLC DFILT On, 10 Readings	10PLC DFILT Off	1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC DFILT Off	0.01PLC[11] DFILT Off
	Accuracy[1,5] ±(ppm of reading+ppm of range+ppm of range rms noise[10])					
200 mV[4]	15 + 8 + 0	15 + 8 + 0.5	15 + 8 + 0.7	15 + 8 + 1	25 + 10 + 13	100 + 200 + 15
2 V[4]	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[13]	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)[8]

Speed (Number of Power Line Cycles)	AC and DC CMRR[6] Line Sync On[7]	AC and DC CMRR[6] Internal Trigger	AC NMRR Line Sync On[7] 25 Readings DFILT On	AC NMRR Line Sync On[7] DFILT Off	AC NMRR Internal Trigger DFILT Off
PLC ≥ 1	140	120	90	80	60
PLC < 1	90	60	60	50	0

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

CMRR is rejection of undesirable AC or DC signal between LO and earth. 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 NIST. This uncertainty is added to relative accuracy specifications to obtain absolute accuracies. The 200mV and 2V range uncertainties are equal to the uncertainty of the 2V calibration source. The 20V, 200V, and 1000V range uncertainties are equal to the uncertainty of the 20V calibration source.

DCV Reading Rates[9,10]

PLC	Measurement Aperture	Bits	Default Digits	Readings/Second to Memory Autozero Off	Readings/Second to Memory Autozero On	Readings/Second to IEEE-488[15] Autozero Off	Readings/Second to IEEE-488[15] Autozero On	Readings/Second with Time Stamp to IEEE-488[15] Autozero Off	Readings/Second with Time Stamp to IEEE-488[15] 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[11]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

DC Volts (cont'd)

Linearity <0.1ppm of range typical, <0.2ppm maximum.

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

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

Polarity Reversal Error This is the portion of the instrument error that is seen when HI and LO are reversed. This is not an additional error—it is included in the overall instrument accuracy specification. **Reversal Error:** <4 counts at 10V input at 7½ digits, 10 power line cycles, synchronous autozero, 10-reading repeat digital filter.

Input Bias Current <100pA at 25°C.

Settling Characteristics <50µs to 10ppm of step size for the 200mV–20V ranges. <1ms to 10ppm of step size for the 200V and 1000V 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.

DC Volts Notes

1. Specifications are for 10 power line cycles, synchronous autozero, 10-reading repeat digital filter, autorange off, except as noted.
2. For T_{CAL} ±1°C, following 4-hour warm-up. 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.
3. For T_{CAL} ±5°C, following 4-hour warm-up.
4. Care must be taken to minimize thermal offsets due to operator cables.
5. For T_{CAL} ±5°C, normal autozero. 1-year or 2-year accuracy can be found by applying the same speed accuracy ppm changes to the 1-year or 2-year base accuracy.
6. Applies for 1kΩ imbalance in the LO lead. For 400Hz operation, subtract 10dB. For the 200V and 1000V ranges, subtract 20dB.
7. For noise synchronous to the line frequency.
8. For line frequency ±0.1%.
9. For on-scale readings, no trigger delays, internal trigger, digital filter off, normal autozero, display off, SREAL format. These rates are for 60Hz and (50Hz). Rates for 400Hz equal those for 50Hz.
10. Typical values. Peak-to-peak noise equals 6 times rms noise.
11. In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.
12. Specifications apply for 20-reading repeat digital filter, T_{REF} ± 0.5°C (T_{REF} is the initial ambient temperature), and for measurements within 10% of the initial measurement value and within 10 minutes of the initial measurement time.
13. Add 20ppm × $(V_{IN}/1000V)^2$ additional uncertainty for inputs above 200V, except in transfer accuracy specifications.
14. Specifications are for 1 power line cycle, normal autozero, digital filter off, autorange off.
15. Using Internal Buffer.

DCV Peak Spikes Measurement

Repetitive Spikes Accuracy [1] **90 Days, 1 Year or 2 Years, T_{CAL} ±5°C ±(% of reading+% of range)**

Range	0–1kHz[4]	1kHz–10kHz	10kHz–30kHz	30kHz–50kHz	50kHz–100kHz	100kHz–300kHz	300kHz–500kHz	500kHz–750kHz	750kHz–1MHz	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[3]	0.1 +0.3	0.11+0.3	0.14+0.3	0.19+0.3	0.25+0.3	1.0+0.3[2]	2.5+0.3[2]	5.5+0.3[2]	9+0.3[2]	0.004+0.03
1000 V[3]	0.12+0.6	0.16+0.6	0.2 +0.6	0.25+0.6[2]	0.5 +0.6[2]					0.01 +0.02
Max. % of Range	±125%	±125%	±125%	±125%	±125%	±125%	±125%	±100%	±75%	

Default Measurement Resolution 3½ digits.

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

Non-Repetitive Spikes 10% of range per µs typical slew rate.

Spike Width Specifications apply for spikes ≥1µs.

Range Control In Multiple Display mode, voltage range is the same as DCV range.

Spikes Measurement Window Default is 100ms per reading (settable from 0.1 to 9.9s 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 DCV function button. Third option displays the maximum and minimum levels of the input signal. Spikes displays are also available through CONFIG-ACV-ACTYPE as primary displays.

DCV Peak Spikes Notes

1. Specifications apply for 10-reading digital filter. If no filter is used, add 0.25% of range typical uncertainty.
2. Typical values.
3. Add 0.001% of reading × $(V_{IN}/100V)^2$ additional uncertainty for inputs above 100V.
4. Specifications assume AC+DC coupling for frequencies below 200Hz. Below 20Hz add 0.1% of reading additional uncertainty.

2002 Multimeter

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[2] ±(% of reading + % of range) / °C Outside T_{CAL} ±5°C
200 mV	1 V	210.0000	100 nV	1MΩ ±2% with <140pF	0.004 + 0.001
2 V	8 V	2.100000	1 µV	1MΩ ±2% with <140pF	0.004 + 0.001
20 V	100 V	21.00000	10 µV	1MΩ ±2% with <140pF	0.006 + 0.001
200 V	800 V	210.0000	100 µV	1MΩ ±2% with <140pF	0.006 + 0.001
750 V	1100 V	775.000	1 mV	1MΩ ±2% with <140pF	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 200V and 113 counts on 750V range at 5½ digits.

Low Frequency Mode rms[1]

90 Days, 1 Year or 2 Years, ±2°C from last AC self-cal, for 1% to 100% of range[3], ±(% of reading + % of range)

Range	1–10Hz[5]	10–50Hz	50–100Hz	0.1–2kHz	2–10kHz	10–30kHz	30–50kHz	50–100kHz	100–200kHz	0.2–1MHz	1–2MHz
200 mV	0.09+0.015	0.06+0.015	0.035+0.015	0.03+0.01	0.02+0.01	0.025+0.01	0.05+0.01	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+0.01	0.02+0.01	0.025+0.01	0.05+0.01	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[5]
200 V[4]	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[5]	4+0.2[5]	
750 V[4]	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[5]	0.5+0.015[5]			

Normal Mode rms[1]

90 Days, 1 Year or 2 Years, ±2°C from last AC self-cal, for 1% to 100% of range[3], ±(% of reading + % of range)

Range	20–50Hz	50–100Hz	0.1–2kHz	2–10kHz	10–30kHz	30–50kHz	50–100kHz	100–200kHz	0.2–1MHz	1–2MHz
200 mV	0.25+0.015	0.07+0.015	0.02+0.01	0.02+0.01	0.025+0.01	0.05+0.01	0.3+0.015	0.75+0.025	2+0.1	5+0.2
2 V	0.25+0.015	0.07+0.015	0.02+0.01	0.02+0.01	0.025+0.01	0.05+0.01	0.3+0.015	0.75+0.025	2+0.1	5+0.2
20 V	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[5]
200 V[4]	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[5]	4+0.2[5]	
750 V[4]	0.25+0.015	0.1 +0.015	0.05+0.015	0.06+0.015	0.08 +0.015	0.1 +0.015[5]	0.5+0.015[5]			

dB Accuracy rms

±dB, 90 Days, 1 Year or 2 Years, T_{CAL} ±5°C, Reference=1V, Autoranging, Low Frequency Mode, AC+DC Coupling

Input	1–100Hz	0.1–30kHz	30–100kHz	100–200kHz	0.2–1MHz	1–2MHz
–54 to–40 dB (2 mV to 10mV)	0.230	0.225	0.236	0.355		
–40 to–34 dB (10 mV to 20mV)	0.036	0.031	0.041	0.088		
–34 to 6 dB (20 mV to 2 V)	0.023	0.018	0.028	0.066	0.265	0.630
6 to 26 dB (2 V to 20 V)	0.024	0.024	0.028	0.066	0.538	0.820[5]
26 to 46 dB (20 V to 200 V)	0.024	0.024	0.028	0.066[5]	0.538[5]	
46 to 57.8 dB (200 V to 775 V)	0.018	0.021	0.049[5]			

ACV Reading Rates [5,6]

PLC	Measurement Aperture	Default Bits	Default Digits	Readings/Second to Memory Autozero Off	Readings/Second to Memory Autozero On	Readings/Second to IEEE-488[12] Autozero Off	Readings/Second to IEEE-488[12] Autozero On	Readings/Second with Time Stamp to IEEE-488[12] Autozero Off	Readings/Second with Time Stamp to IEEE-488[12] 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[8]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

AC Volts (cont'd)

ACV Crest Factor Measurement [11]

Crest Factor	= Peak AC / rms AC.
Crest Factor Resolution	3 digits.
Crest Factor Accuracy	Peak AC uncertainty + AC normal mode rms uncertainty.
Measurement Time	100ms plus rms measurement time.
Input Characteristics	Same as ACV input.
Crest Factor Frequency Range	20Hz – 1MHz.
Crest Factor Display	Access as multiple display on AC volts.

AC Coupling

For AC only coupling, add the following % of reading:

	1–10Hz	10–20Hz	20–50Hz	50–100Hz	100–200Hz
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 200Hz, 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
200mV, 20V	0.05	0.1
2V, 200V, 750V	0.07	0.01

Average ACV Measurement

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

High Crest Factor Additional Error ±(% of reading)

Applies to rms measurements.

Crest Factor	1 – 2	2 – 3	3 – 4	4 – 5
Additional Error	0	0.1	0.2	0.4

ACV Peak Value Measurement [10]

Repetitive Peak Accuracy, ±(% of reading + % of range), 90 Days, 1 Year or 2 Years, T_{CAL} ±5°C

Range	20Hz–1kHz[9]	1kHz–10kHz	10kHz–30kHz	30kHz–50kHz	50kHz–100kHz	100kHz–300kHz	300kHz–500kHz	500kHz–750kHz	750kHz–1MHz	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 [4]	0.1 +0.3	0.11+0.3	0.14+0.3	0.19+0.3	0.25+0.3	1.0+0.3[5]	2.5+0.3[5]	5.5+0.3[5]	9+0.3[5]	0.004 + 0.03
750 V [4]	0.12+0.6	0.16+0.6	0.2 +0.6	0.25+0.6[5]	0.5 +0.6[5]					0.01 + 0.02
Valid % of Range[7]	10–400%	10–400%	10–400%	10–350%	10–350%	10–250%	10–150%	10–100%	7.5–75%	

Default Measurement Resolution	4 digits.
Non-Repetitive Peak	10% of range per µs typical slew rate for single spikes.
Peak Width	Specifications apply for all peaks ≥1µs.
Peak Measurement Window	100ms per reading.
Maximum Input	±1100V peak, 2×10^7V·Hz (for inputs above 20V).

Settling Characteristics	**Normal Mode (rms, avg.)**	<300ms to 1% of step change <450ms to 0.1% of step change <500ms to 0.01% of step change
	Low Frequency Mode (rms)	<5s to 0.1% of final value
Common Mode Rejection	For 1kΩ imbalance in either lead: >60dB for line frequency ±0.1%.	
Maximum Volt·Hz Product	2×10^7V·Hz (for inputs above 20V).	
Autoranging	Autoranges up at 105% of range, down at 10% of range.	

AC Volts Notes

1 Specifications apply for sinewave input, AC + DC coupling, 1 power line cycle, autozero on, digital filter off, following 55-minute warm-up.

2 Temperature coefficient applies to rms and average readings. For frequencies above 100kHz, add 0.01% of reading/°C to temperature coefficient.

3 For 1% to 5% of range below 750V range, and for 1% to 7% of 750V range, add 0.01% of range uncertainty. For inputs from 200kHz to 2MHz, specifications apply above 10% of range.

4 Add 0.001% of reading × $(V_{IN}/100V)^2$ additional uncertainty above 100V rms.

5 Typical values.

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

7 For overrange readings 200–300% of range, add 0.1% of reading uncertainty. For 300–400% of range, add 0.2% of reading uncertainty.

8 In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.

9 AC peak specifications assume AC + DC coupling for frequencies below 200Hz.

10 Specifications apply for 10-reading digital filter. If no filter is used, add 0.25% of range typical uncertainty.

11 Subject to peak input voltage specification.

12 Using Internal Buffer.

2002 Multimeter

Ohms

Two-Wire and Four-Wire Ohms

Range	Full Scale	Resolution	Current Source[1]	Open Circuit[12]	Maximum HI Lead Resistance[2]	Maximum LO Lead Resistance[2]	Maximum Offset Compensation[3]
20 Ω	21.0000000	100 nΩ	7.2 mA	5 V	50 Ω	10 Ω	±0.2 V
200 Ω	210.000000	1 µΩ	960 µA	5 V	200 Ω	100 Ω	±0.2 V
2 kΩ	2100.00000	10 µΩ	960 µA	5 V	200 Ω	150 Ω	–0.2 V to +2 V
20 kΩ	21.0000000	100 µΩ	96 µA	5 V	1.5 kΩ	1.5 kΩ	–0.2 V to +2 V
200 kΩ	210.000000	1 mΩ	9.6 µA	5 V	1.5 kΩ	1.5 kΩ	
2 MΩ	2.10000000	10 mΩ	1.9 µA	6 V	1.5 kΩ	1.5 kΩ	
20 MΩ[4]	21.0000000	100 mΩ	1.4 µA[13]	14 V			
200 MΩ[4]	210.000000	1 Ω	1.4 µA[13]	14 V			
1 GΩ[4]	1.05000000	10 Ω	1.4 µA[13]	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
2MΩ	14.9
20MΩ	14.9
200MΩ	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 20Ω - 2MΩ range uncertainties are equal to the uncertainty of the respective calibration sources.

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

Enhanced Accuracy[5] 10PLC, Offset comp. on, DFILT 10

Range	Relative Accuracy ± (ppm of reading + ppm of range) Transfer[14]	24 Hours[6]	90 Days[7]	1 Year[7]	2 Years[7]	Temperature Coefficient ± (ppm of reading + ppm of range) / °C Outside T_{CAL} ±5°C
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[4]	15 + 0.1	50 + 0.2	175 + 0.6	250 + 0.6	300 + 0.6	20 + 0.1
200 MΩ[4]	50 + 0.5	150 + 1	500 + 3	550 + 3	600 + 3	80 + 0.5
1 GΩ[4]	250 + 2.5	750 + 5	2000 + 15	2050 + 15	2100 + 15	400 + 2.5

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

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

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

Speed and Accuracy 90 Days

RANGE	Accuracy[9,15] ±(ppm of reading + ppm of range + ppm of range rms noise[12]) 10PLC DFILT On, 10 Readings	10PLC DFILT Off	1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC[11] DFILT Off	0.01PLC[8,11] 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[4]	175 + 0.6 + 0	175 + 0.6 + 0	175 + 0.6 + 0	200 + 0.6 + 0		
200 MΩ[4]	500 + 3 + 0	510 + 3 + 0	510 + 3 + 0	550 + 3 + 0		
1 GΩ[4]	2000 + 15 + 0	2100 + 15 + 0	2100 + 15 + 0	2500 + 15 + 0		

PLC = Power Line Cycles. DFILT = Digital Filter.

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[15] 1PLC, Offset comp. off, DFILT off

RANGE	Relative Accuracy ± (ppm of reading + ppm of range) 24 Hours[6]	90 Days[7]	1 Year[7]	2 Years[7]	Temperature Coefficient ± (ppm of reading + ppm of range)/°C 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[4]	75 + 0.2	200 + 0.6	275 + 0.6	325 + 0.6	20 + 0.1
200 MΩ[4]	200 + 1	550 + 3	600 + 3	650 + 3	80 + 0.5
1 GΩ[4]	1250 + 5	2500 + 15	2550 + 15	2600 + 15	400 + 2.5

Ohms (cont'd)

Settling Characteristics Pre-programmed settling delay times are for <500pF 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, down at 10% of range.

2-Wire Resistance Reading Rates[10,12]

PLC	Measurement Aperture	Bits	Default Digits	Readings/Second to Memory Autozero Off	Readings/Second to Memory Autozero On	Readings/Second to IEEE-488[16] Autozero Off	Readings/Second to IEEE-488[16] Autozero On	Readings/Second with Time Stamp to IEEE-488[16] Autozero Off	Readings/Second with Time Stamp to IEEE-488[16] 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[11]	3.34 ms (4 ms)	23	6½	222 (197)	156 (139)	220 (196)	148 (132)	156 (139)	107 (95)
0.1[11]	1.67 ms (2 ms)	22	6½	330 (317)	176 (169)	305 (293)	166 (159)	157 (151)	110 (106)
0.02[11]	334 µs (400 µs)	20	5½	330 (330)	182 (182)	305 (305)	172 (172)	160 (160)	113 (113)
0.01[11]	167 µs (167 µs)	19	4½	384 (384)	186 (186)	352 (352)	172 (172)	179 (179)	123 (123)
0.01[8,11]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

4-Wire Resistance Reading Rates[10,12]

PLC	Measurement Aperture	Bits	Default Digits	Readings or Readings with Time Stamp/Second to Memory or IEEE-488[16]: 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[11]	3.34 ms (4 ms)	23	6½	154 (137)	76 (68)	115 (102)	54 (48)
0.1[11]	1.67 ms (2 ms)	22	6½	184 (176)	92 (88)	123 (118)	63 (60)
0.02[11]	334 µs (400 µs)	20	5½	186 (186)	107 (107)	126 (126)	72 (72)
0.01[11]	167 µs (167 µs)	19	4½	211 (211)	107 (107)	133 (133)	72 (72)

Ohms Notes

1 Current source has an absolute accuracy of ± 5%.

2 Refers to source lead resistance. Sense lead resistance is limited only by noise considerations. For best results, it is suggested that it be limited to 1.5kΩ.

3 Offset compensation voltage plus source current times measured resistance must be less than source current times resistance range selected.

4 For 2-wire mode.

5 Specifications are for 10 power line cycles, 10-reading repeat digital filter, synchronous autozero, autorange off, 4-wire mode, offset compensation on (for 20Ω to 20kΩ ranges), except as noted.

6 For T_{CAL} ±1°C, following 4-hour warm-up. T_{CAL} is ambient temperature at calibration (23°C at the factory).

7 For T_{CAL} ±5°C, following 4-hour warm-up.

8 In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.

9 For T_{CAL} ±5°C, normal autozero. 1-year and 2-year accuracy can be found by applying the same speed accuracy ppm changes to the 1-year or 2-year base accuracy.

10 For on-scale readings, no trigger delays, digital filter off, internal trigger, normal autozero, display off, SREAL format. These rates are for 60Hz and (50Hz). Rates for 400Hz equal those for 50Hz.

11 Ohms measurements at rates lower than 1 power line cycle are subject to potential noise pickup. Care must be taken to provide adequate shielding.

12 Typical values. Peak-to-peak noise equals 6 times rms noise.

13 Current source is paralleled with a 10MΩ resistance.

14 Specifications apply for 20-reading repeat digital filter, T_{REF} ± 0.5°C (T_{REF} is the initial ambient temperature), and for measurements within 10% of the initial measurement value and within 10 minutes of the initial measurement time.

15 Specifications are for 1 power line cycle, normal autozero, digital filter off, autorange off, 4-wire mode, offset compensation off, except as noted.

16 Using Internal Buffer.

DC Amps

DCI Input Characteristics and Accuracy

Range	Full Scale	Resolution	Maximum Burden Voltage[6]	Relative Accuracy[1] ±(ppm of reading + ppm of range) 24 Hours[2]	90 Days[3]	1 Year[3]	2 Years[3]	Temperature Coefficient[1] ±(ppm of reading + ppm of range)/°C Outside T_{CAL} ±5°C
200 µA	210.00000	10 pA	0.25 V	50 + 6	275 + 25	350 + 25	500 + 25	50 + 5
2 mA	2.1000000	100 pA	0.3 V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
20 mA	21.000000	1 nA	0.35 V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
200 mA	210.00000	10 nA	0.35 V	75 + 5	300 + 20	375 + 20	525 + 20	50 + 5
2 A	2.1000000	100 nA	1.1 V	350 + 5	600 + 20	750 + 20	1000 + 20	50 + 5

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

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

5ppm of Range = 10 counts at 6½ digits.

DC Amps (cont'd)

DCI Reading Rates[4,5]

PLC	Measurement Aperture	Bits	Default Digits	Readings/Second to Memory Autozero Off	Readings/Second to Memory Autozero On	Readings/Second to IEEE-488[9] Autozero Off	Readings/Second to IEEE-488[9] Autozero On	Readings/Second with Time Stamp to IEEE-488[9] Autozero Off	Readings/Second with Time Stamp to IEEE-488[9] 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[7]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

Speed and Accuracy 90 Days

Range	1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC DFILT Off	0.01PLC[7] DFILT Off
	ACCURACY[1,8] ±(ppm of reading+ppm of range+ppm of range rms noise[4])			
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 uncertainties for each range are equal to the uncertainty of the respective calibration sources.

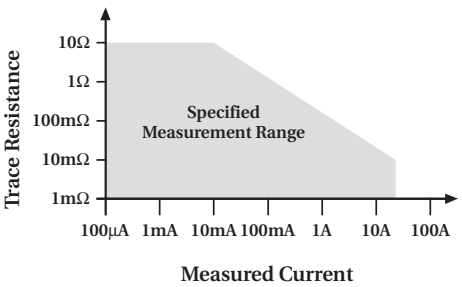
Settling Characteristics	<500µs to 50ppm of step size. Reading settling times are affected by source impedance and cable dielectric absorption characteristics.
Maximum Allowable Input	2.1A, 250V.
Overload Protection	2A fuse (250V), accessible from front (for front input) and rear (for rear input).
Autoranging	Autoranges up at 105% of range, down at 10% of range.

DC Amps Notes

1 Specifications are for 1 power line cycle, autozero on, 10-reading repeat digital filter.
2 For T_{CAL} ± 1°C, following 55-minute warm-up. T_{CAL} is ambient temperature at calibration (23°C at the factory).
3 For T_{CAL} ± 5°C, following 55-minute warm-up.
4 Typical values. Peak-to-peak noise equals 6 times rms noise.
5 For on-scale readings, no trigger delays, internal trigger, digital filter off, normal autozero, display off, SREAL format. These rates are for 60Hz and (50Hz). Rates for 400Hz equal those for 50Hz.
6 Actual maximum burden voltage = (maximum burden voltage) × ($I_{MEASURED}/I_{FULL\ SCALE}$).
7 In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.
8 For T_{CAL} ±5°C, normal autozero. 1-year and 2-year accuracy can be found by applying the same speed accuracy ppm changes to the 1-year or 2-year base accuracy.
9 Using Internal Buffer.

DC In-Circuit Current

Measurement Range Chart



The DC in-circuit current measurement function allows a user 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 2002 will first perform a 4-wire resistance measurement, then a voltage measurement, and will display the calculated current.

TYPICAL RANGES

Current	100µA to 12A.
Trace Resistance	1mΩ to 10Ω.
Voltage	±200mV max. across trace.
Speed	4 measurements/second at 1 power line cycle.
Accuracy	±(5% + 500µA). 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[5]	Temperature Coefficient ±(% of reading + % of range)/°C Outside T_{CAL} ±5°C
200 µA	1 mA	210.0000	100 pA	0.35 V	0.01 + 0.001
2 mA	10 mA	2.100000	1 nA	0.45 V	0.01 + 0.001
20 mA	100 mA	21.00000	10 nA	0.5 V	0.01 + 0.001
200 mA	1 A	210.0000	100 nA	0.5 V	0.01 + 0.001
2 A	2 A	2.100000	1 µA	1.5 V	0.01 + 0.001

ACI Accuracy [1,2]

90 Days, 1 Year or 2 Years, T_{CAL} ±5°C, for 5% to 100% of range, ±(% of reading + % of range)

Range	20Hz–50Hz	50Hz–200Hz	200Hz–1kHz	1kHz–10kHz	10kHz–30kHz[3]	30kHz–50kHz[3]	50kHz–100kHz[3]
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	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 [3,4]

PLC	Measurement Aperture	Bits	Default Digits	Readings/Second to Memory Autozero Off	Readings/Second to Memory Autozero On	Readings/Second to IEEE-488[7] Autozero Off	Readings/Second to IEEE-488[7] Autozero On	Readings/Second with Time Stamp to IEEE-488[7] Autozero Off	Readings/Second with Time Stamp to IEEE-488[7] 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[6]	167 µs (167 µs)	19	4½	2000 (2000)		2000 (2000)			

AC Coupling

For AC only coupling, add the following % of reading:

	20–50Hz	50–100Hz	100–200Hz
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 – 2	2 – 3	3 – 4	4 – 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.

AC Amps Notes

1 Specifications apply for sinewave input, AC+DC coupling, 1 power line cycle, autozero on, digital filter off, following 55-minute warm-up.
2 Add 0.005% of range uncertainty for current above 0.5A rms for self-heating.
3 Typical values.
4 For on-scale readings, no trigger delays, digital filter off, normal autozero, display off, internal trigger, SREAL format. These rates are for 60Hz and (50Hz). Rates for 400Hz equal those for 50Hz.
5 Actual maximum burden voltage = (maximum burden voltage) × ($I_{MEASURED}$/$I_{FULL\ SCALE}$).
6 In burst mode, display off. Burst mode requires autozero refresh (by changing resolution or measurement function) once every 24 hours.
7 Using Internal Buffer.

2002 Multimeter

Frequency Counter

Frequency/Period Input Characteristics and Accuracy

90 Days, 1 Year, or 2 Years

	Frequency Range[1]	Period Range	Resolution	Minimum Signal Level[2] 1Hz–1MHz	1–5MHz	5–15MHz	Maximum Input	Trigger Level	Accuracy ±(% of reading)
AC Voltage Input	1Hz–15 MHz	67 ns – 1 s	5 digits	60 mV	60 mV	350 mV	1100 V pk[1]	0–600V	0.03
AC Current Input	1Hz– 1 MHz	1 µs – 1 s	5 digits	150 µA			1 A pk	0–600mA	0.03

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

Reading Time 420ms maximum.

Voltage Input Impedance 1MΩ ± 2% with <140pF.

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 + DC or AC only.

Frequency Notes

1 Subject to 2×10^7V·Hz product (for inputs above 20V).

2 Valid for the lowest range. For each range increase, multiply these numbers by 10.

Temperature (RTD)

Range	Resolution	4-Wire Accuracy[5] 24 Hours[2]	90 Days[3]	1 Year[3]	2 Years[3]
–100° to +100°C	0.001°C	±0.016°C	±0.020°C	±0.021°C	±0.022°C
–200° to +630°C	0.001°C	±0.061°C	±0.066°C	±0.068°C	±0.070°C
–148° to +212°F	0.001°F	±0.029°F	±0.036°F	±0.038°F	±0.040°F
–328° to +1166°F	0.001°F	±0.110°F	±0.119°F	±0.122°F	±0.126°F

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

Sensor Current 960µA (pulsed).

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

Maximum Source HI Lead Resistance 200Ω.

Maximum Source LO Lead Resistance 100Ω.

RTD Temperature Reading Rates[1] (2- or 4-Wire)

PLC	Readings or Readings with Time Stamp/Second to Memory or IEEE-488 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[4]
J	–200° to + 760°C	0.001°C	±0.5°C
K	–200° to +1372°C	0.001°C	±0.5°C
T	–200° to + 400°C	0.001°C	±0.5°C
E	–200° to +1000°C	0.001°C	±0.6°C
R	0° to +1768°C	0.001°C	±3 °C
S	0° to +1768°C	0.001°C	±3 °C
B	+350° to +1820°C	0.001°C	±5 °C

TC Temperature Reading Rates[1]

PLC	Readings/Second to Memory Autozero Off	Autozero On	Readings/Second to IEEE-488[6] Autozero Off	Autozero On	Readings/Second with Time Stamp to IEEE-488[6] 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)

Temperature Notes

1 For on-scale readings, no trigger delays, digital filter off, display off, normal autozero, internal trigger, SREAL format. These rates are for 60Hz and (50Hz). Rates for 400Hz equal those for 50Hz. Typical values.

2 For T_{CAL} ± 1°C, following 4-hour warm-up.

3 For T_{CAL} ± 5°C, following 4-hour warm-up.

4 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.

5 Specifications are for 10 power line cycles, autozero on, 10 reading repeat digital filter, 4-wire mode. Exclusive of RTD probe errors.

6 Using Internal Buffer.

Operating Speed

Function Change Speed[1]

Typical delay before measurement initiation after making a function change.

From Function	To Function	Range	Time
Any except 4WΩ, Temp	DCV	Any	4.6 ms
4WΩ, Temp		Any	7.6 ms
Any	ACV	Any	574 ms
ACV, DCV, 2WΩ, Freq	DCI	Any	7.1 ms
4WΩ, Temp		Any	10 ms
ACI		Any	22 ms
Any	ACI	Any	523 ms
Any except 4WΩ, Temp	2WΩ	20Ω to 2kΩ	4.7 ms
		20kΩ	15 ms
		200kΩ	27 ms
		2MΩ	103 ms
		20MΩ	153 ms
		200MΩ, 1GΩ	253 ms
4WΩ, Temp	2WΩ	20Ω to 2kΩ	7.7 ms
		20kΩ	18 ms
		200kΩ	30 ms
		2MΩ	105 ms
		20MΩ	157 ms
		200MΩ, 1GΩ	256 ms
Any	4WΩ	20Ω to 2kΩ	7.7 ms
		20kΩ	18 ms
		200kΩ	30 ms
		2MΩ	105 ms
Any except ACV, ACI	Freq[5]	Any	60 ms
ACV, ACI		Any	573 ms
Any	Temp	Any	7.6 ms

Range Change Speed[1]

Typical delay before measurement initiation after making a range change.

Function	From	To	Time
DCV	Any	Any	5.2 ms
ACV	Any	Any	559 ms
DCI	Any	Any	7.6 ms
ACI	Any	Any	503 ms
2WΩ	Any	20Ω to 2kΩ	5.2 ms
	Any	20kΩ	15 ms
	Any	200kΩ	27 ms
	Any	2MΩ	103 ms
	Any	20MΩ	153 ms
	Any	200MΩ, 1GΩ	253 ms
4WΩ	Any	20Ω to 2kΩ	5.2 ms
	Any	20kΩ	15 ms
	Any	200kΩ	27 ms
	Any	2MΩ	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[2]

Format	Readings Only Time	Readings Only Rdg./s	Readings with Time Stamp Time	Readings with Time Stamp Rdg./s
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

Single Function Scan Speed[3] *(Internal Scanner)*

TYPE	DCV (20V) Time per Chan.	DCV (20V) Rate (Chan./second)	2WΩ (2kΩ) Time per Chan.	2WΩ (2kΩ) Rate (Chan./second)	4WΩ (2kΩ) Time per Chan.	4WΩ (2kΩ) Rate (Chan./second)	ACV Time per Chan.	ACV Rate (Chan./second)	Freq Time per Chan.	Freq Rate (Chan./second)	TC Temp Time per Chan.	TC Temp Rate (Chan./second)	RTD Temp (2-Wire) Time per Chan.	RTD Temp (2-Wire) Rate (Chan./second)
Ratio or Delta[4] (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

Operating Speed Notes

1 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.

2 Using 386/33 computer, average time for 1000 readings, byte order swapped, display off.

3 For on-scale readings, no trigger delays, display off, 0.01 power line cycles, autorange off, digital filter off, offset compensation off, autozero off.

4 Ratio and delta functions output one value for each pair of measurements.

5 Based on 100kHz input frequency.

2002 Multimeter

Maximum Input Levels

	Rated Input[1]		Overload Recovery Time
HI to LO	±1100V		< 900 ms
HI Sense to LO	± 350V pk	250V rms	< 900 ms
LO Sense to LO	± 150V pk	100V rms	< 900 ms
I Input to LO	2A, ± 250V	(fused)	—
HI to Earth	±1600V		< 900 ms
LO to Earth	± 500V		

Note 1: 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, 30V maximum pull-up voltage, 100mA maximum sink current, 10Ω output impedance.
Control	Direct control by output or set real-time with limits.

Delay and Timer

Time Stamp	**Resolution:** 1µs.
	Accuracy: ±0.01% of elapsed time ± 1µs.
	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: 1ms.
	Jitter: ±1ms.
Timer	**(Reading initiation to reading initiation)**
	Maximum: 999,999.999 seconds (11 days, 14 hours).
	Resolution: 1ms.
	Jitter: ±1ms.

General Specifications and Standards Compliance

Power	**Voltage:** 90–134V and 180–250V, universal self-selecting.
	Frequency: 50Hz, 60Hz, or 400Hz, self-identifying at power-up.
	Consumption: <55VA.
Environmental	**Operating Temperature:** 0°C to 50°C.
	Storage Temperature: –40°C to 70°C.
	Humidity: 80% R.H., 0°C to 35°C, per MIL-T-28800E[1] Para 4.5.5.1.2.
Calibration	**Type:** Software. No manual adjustments required.
	Sources: 2 DC voltages, 6 resistances, and 5 DC currents. All other functions calibrated (adjusted) from these sources and a short circuit. No AC calibrator required for adjustment.
	Average Time to Perform: 40 minutes for comprehensive calibration, 6 minutes for AC-only calibration.
Process	MIL-STD 45662A.
Physical	**Case Dimensions:** 90mm high × 214mm wide × 369mm deep (3½ in. × 8½ in. × 14½ in.).
	Working Dimensions: From front of case to rear including power cord and IEEE-488 connector: 15.0 inches.
	Net Weight: <4.2kg (<9.2 lbs.).
	Shipping Weight: <9.1kg (<20 lbs.).
Standards	**EMI/RFI:** Conforms to VDE 0871B (per Vfg 1046/1984), IEC 801-2. Meets FCC part 15 Class B, CISPR-22 (EN55022).
	Safety: Conforms to IEC348, CAN/CSA-C22.2. No. 231, MIL-T-28800E[1]. Designed to UL1244.
Accessories Supplied	The unit is shipped with line cord, high performance modular test leads, operator's manual, option slot cover, and full calibration data.
Note 1	For MIL-T-28800E, applies to Type III, Class 5, Style E.

Extended Memory/Non-Volatile Memory Option

	DATA STORAGE					
Model	**Size (Bytes)**	**4½-Digit**	**6½-Digit with Time Stamp**	**Type**	**Setup Storage Number**	**Type**
2002	8k	2,027	404	volatile	1	non-volatile
2002/MEM1	32k	6,909	1,381	non-volatile	5	non-volatile
2002/MEM2	128k	29,908	5,980	non-volatile	10	non-volatile

These are the minimum sizes to expect.