KEITHLEY

Model 2002

Multimeter Specifications

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This document contains 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 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 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 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's factory calibration are given in a table included in the specifications. The uncertainties of the operator's sources may be different.

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.

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DC VOLTS

DCV INPUT CHARACTERISTICS AND ACCURACY
Enhanced Accuracy[4] – 10PLC, 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
				Transfer[5]	24 Hours[6]	90 Days[7]	1 Year[7]	2 Years[7]	Outside T_{CAL} ±5°C
200mV[8]	±210.0mV	1nV	>100GΩ	0.4 + 1.5	3.5 + 3	15 + 8	19 + 9	23 + 10	2 + 1.8
2V[8]	±2.10V	10nV	>100GΩ	0.2 + 0.15	1.2 + 0.3	6 + 0.8	10 + 0.9	14 + 1	0.2 + 0.18
20V	±21.0V	100nV	>100GΩ	0.1 + 0.05	1.2 + 0.1	6 + 0.15	10 + 0.15	14 + 0.15	0.3 + 0.02
200V	±210.0V	1µV	10MΩ ±1%	0.5 + 0.08	5 + 0.4	14 + 2	22 + 2	30 + 2	1.5 + 0.3
1000V[9]	±1100.0V	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) x (measured value) + (ppm of range) x (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[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
				24 Hours[6]	90 Days[7]	1 Year[7]	2 Years[7]	Outside T_{CAL} ±5°C
200mV[8]	±210.0mV	10nV	>100GΩ	3.5 + 6	15 + 11	19 + 12	23 + 13	2 + 1.8
2V[8]	±2.10V	100nV	>100GΩ	1.2 + 0.6	6 + 1.1	10 + 1.2	14 + 1.3	0.2 + 0.18
20V	±21.0V	1µV	>100GΩ	3.2 + 0.35	8 + 0.4	12 + 0.4	16 + 0.4	0.3 + 0.02
200V	±210.0V	10µV	10MΩ ±1%	5 + 1.2	14 + 2.8	22 + 2.8	30 + 2.8	1.5 + 0.3
1000V[9]	±1100.0V	100µV	10MΩ ±1%	5 + 0.4	14 + 0.7	22 + 0.7	30 + 0.7	1.5 + 0.06

SPEED AND ACCURACY

Range	Accuracy [4,11] 90 DAYS ±(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 DFILT Off	0.01PLC[13] DFILT Off
200mV[8]	15 + 8 + 0	15 + 8 +0.5	15 + 8 + 0.7	15 + 8 + 1	25 + 10 + 13	100 + 200 + 15
2V[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
20V	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
200V	14 + 2 + 0	14 + 2+ 0.1	14 + 2+ 0.15	14 + 2 + 0.25	15 + 2 + 1	130 +200 + 3
1000V[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

[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, TREF ± 0.5°C (TREF is the initial ambient temperature), and for measurements within 10% of the initial measurement value and within 10 minutes of the initial measurement time.
[6] 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.
[7] For T_{CAL} ±5°C, following 4-hour warm-up.
[8] Care must be taken to minimize thermal offsets due to operator cables.
[9] Add 20ppm × $(V_{IN}/1000V)^2$ additional uncertainty for inputs above 200V, except in transfer accuracy specifications
[10] Specifications are for 1 power line cycle, normal autozero, digital filter off, autorange off.
[11] 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.
[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 1kΩ imbalance in the LO lead. For 400Hz operation, subtract 10dB. For the 200V and 1000V ranges, subtract 20dB.
[16] For noise synchronous to the line frequency.

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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
200mV	3.2
2V	3.2
20V	2.6
200V	2.6
1000V	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[17,22]

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

Linearity: <0.1ppm of range typical, <0.2ppm 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
200mV[8]	± 60 counts	± 40 counts
2V[8]	± 6 counts	± 4 counts
20V	± 4 counts	± 1 count
200V	± 5 counts	± 2 counts
1000V	± 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.

[17] 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.
[18] Using Internal Buffer.

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DCV PEAK SPIKES MEASUREMENT

REPETITIVE SPIKES ACCURACY[19] 90 Days, 1 Year or 2 Years, T_{CAL} ±5°C ±(% of reading+% of range)

Range	0–1kHz[20]	1kHz–10kHz	10kHz–30kHz	30kHz–50kHz	50kHz–100kHz	100kHz–300kHz	300kHz–500kHz	500kHz–750kHz	750kHz–1MHz	Temperature Coefficient ±(% of reading +% of range)/°C Outside TCAL ±5°C
200mV	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
2V	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
20V	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
200V[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
1000V[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: ±1100V peak value, $2x10^7$V·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.

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
200mV	1V	210.0mV	100nV	1MΩ ±2% with <140pF	0.004 + 0.001
2V	8V	2.10V	1µV	1MΩ ±2% with <140pF	0.004 + 0.001
20V	100V	21.0V	10µV	1MΩ ±2% with <140pF	0.006 + 0.001
200V	800V	210.0V	100µV	1MΩ ±2% with <140pF	0.006 + 0.001
750V	1100V	775.0V	1mV	1MΩ ±2% with <140pF	0.012 + 0.001

AC Voltage Uncertainty = ±[(% of reading) x (measured value) + (% of range) x (range used)] / 100.

PPM Accuracy = (% accuracy) x 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[24] 90 Days, 1 Year or 2 Years, ±2°C from last AC self-cal, for 1% to 100% of range[25], ±(% of reading + % of range)

Range	1–10Hz[22]	10–50Hz	50–499Hz	501Hz–2kHz	2–10kHz	10–30kHz	30–50kHz	50–100kHz	100–200kHz	0.2–1MHz	1–2MHz
200mV	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
2V	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
20V	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]
200V[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]	
750V[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]			

[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 200Hz. Below 20Hz add 0.1% of reading additional uncertainty.
[21] Add 0.001% of reading × $(V_{IN}/100V)^2$ additional uncertainty for inputs above 100V.
[22] Typical values.
[23] Temperature coefficient applies to RMS and average readings. For frequencies above 100kHz, 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 warm-up.
[25] 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.
[26] Add 0.001% of reading × $(V_{IN}/100V)^2$ additional uncertainty for inputs above 100V RMS.

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NORMAL MODE RMS[24] 90 Days, 1 Year or 2 Years, ±2°C from last AC self-cal, for 1% to 100% of range[25], ±(% 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
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, TCAL ±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 –40dB (2mV to 10mV)	0.230	0.225	0.236	0.355		
–40 to –34dB (10mV to 20mV)	0.036	0.031	0.041	0.088		
–34 to 6dB (20mV to 2V)	0.023	0.018	0.028	0.066	0.265	0.630
6 to 26dB (2V to 20V)	0.024	0.024	0.028	0.066	0.538	0.820[22]
26 to 46dB (20V to 200V)	0.024	0.024	0.028	0.066[22]	0.538[22]	
46 to 57.8dB (200V to 775V)	0.018	0.021	0.049[22]			

ACV READING RATES[22,27]

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

[27] 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.

[28] Subject to peak input voltage specification.

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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[19]

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

Range	20Hz–1kHz[29]	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
200mV	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
2V	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
20V	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
200V[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
750V[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]	10–400%	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, $2x10^7$V·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 x 10^7V·Hz (for inputs above 20V).

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

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]
20Ω	21.0Ω	100nΩ	7.2mA	5V	50Ω	10Ω	±0.2 V
200Ω	210.0Ω	1µΩ	960µA	5V	200Ω	100Ω	±0.2 V
2kΩ	2100.0kΩ	10µΩ	960µA	5V	200Ω	150Ω	–0.2 V to +2 V
20kΩ	21.0kΩ	100µΩ	96µA	5V	1.5kΩ	1.5kΩ	–0.2 V to +2 V
200kΩ	210.0kΩ	1mΩ	9.6µA	5V	1.5kΩ	1.5kΩ	
2MΩ	2.10MΩ	10mΩ	1.9µA	6V	1.5kΩ	1.5kΩ	
2MΩ[34]	21.0MΩ	100mΩ	1.4µA[35]	14V			
20MΩ[34]	210.0MΩ	1Ω	1.4µA[35]	14V			
1GΩ[34]	1.050GΩ	10Ω	1.4µA[35]	14V			

[29] AC peak specifications assume AC + DC coupling for frequencies below 200Hz.
[30] For overrange readings 200–300% of range, add 0.1% of reading uncertainty. For 300–400% of range, add 0.2% of reading uncertainty.
[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, it is suggested that it be limited to 1.5kΩ.
[33] Offset compensation voltage plus source current times measured resistance must be less than source current times resistance range selected.
[34] For 2-wire mode.
[35] Current source is paralleled with a 10MΩ resistance.

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KEITHLEY FACTORY CALIBRATION UNCERTAINTY

Range	ppm of reading
20Ω	29.5
200Ω	7.7
2kΩ	6.4
20kΩ	7.8
200kΩ	7.3
2MΩ	14.9
20MΩ	14.9
200MΩ	14.9
1GΩ	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[36] 10PLC, 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
			90 Days[7]	1 Year[7]	2 Years[7]	Outside T_{CAL} ±5°C
20Ω	2.5 + 3	5 + 4.5	15 + 6	17 + 6	20 + 6	2.5 + 0.7
200Ω	2.5 + 2	5 + 3	15 + 4	17 + 4	20 + 4	2.5 + 0.5
2kΩ	1.3 + 0.2	2.5 + 0.3	7 + 0.4	9 + 0.4	11 + 0.4	0.8 + 0.05
20kΩ	1.3 + 0.2	2.5 + 0.3	7 + 0.4	9 + 0.4	11 + 0.4	0.8 + 0.05
200kΩ	2.5 + 0.4	5.5 + 0.5	29 + 0.8	35 + 0.9	40 + 1	3.5 + 0.18
2MΩ	5 + 0.2	12 + 0.3	53 + 0.5	65 + 0.5	75 + 0.5	7 + 0.1
20MΩ[34]	15 + 0.1	50 + 0.2	175 + 0.6	250 + 0.6	300 + 0.6	20 + 0.1
200MΩ[34]	50 + 0.5	150 + 1	500 + 3	550 + 3	600 + 3	80 + 0.5
1GΩ[34]	250 + 2.5	750 + 5	2000 + 15	2050 + 15	2100 + 15	400 + 2.5

Resistance Uncertainty: = ±[(ppm of reading) x (measured value) + (ppm of range) x (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

Accuracy[11, 38] 90 Days ±(ppm of reading+ppm of range+ppm of range RMS noise[12])						
RANGE	10PLC DFILT On, 10 Readings	10PLC DFILT Off	1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC[39] DFILT Off	0.01PLC[39, 13] DFILT Off
20Ω	15+11+0	15+11+0.5	15+13+0.5	15+13+1	15+16+25	110+200+35
200Ω	15+8+0	15+8+0.5	17+8+0.5	17+8+1	17+10+15	110+200+35
2kΩ	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
20kΩ	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
200kΩ	29+0.8+0	29+0.8+0.1	31+0.8+0.1	34+0.8+0.2	250+1+2	
2MΩ	55+0.5+0	53+0.5+0.1	58+0.5+0.1	68+0.5+0.2	750+0.7+2	
20MΩ[34]	175+0.6+0	175+0.6+0	175+0.6+0	200+0.6+0		
200MΩ[34]	500+3+0	510+3+0	510+3+0	550+3+0		
1GΩ[34]	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)
20Ω	300ppm	70ppm/°C
200Ω	30ppm	7ppm/°C
2kΩ	3ppm	0.7ppm/°C

[36] 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.
[37] For T_{CAL} ±1°C, following 4-hour warm-up. 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. Care must be taken to provide adequate shielding.

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NORMAL ACCURACY[38]

1PLC, 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
20Ω	5+12	15+16	17+17	20+19	2.5+2.5
200Ω	7+8	17+11	19+12	22+13	2.5+1.8
2kΩ	3.5+1.1	8+1.4	10+1.5	12+1.6	0.8+0.18
20kΩ	4.5+1.1	9+1.4	11+1.5	13+1.6	0.8+0.18
200kΩ	11+1.1	34+1.4	40+1.5	45+1.6	3.5+0.18
2MΩ	27+0.9	68+1.1	80+1.1	90+1.1	7+0.1
20MΩ[34]	75+0.2	200+0.6	275+0.6	325+0.6	20+0.1
200MΩ[34]	200+1	550+3	600+3	650+3	80+0.5
1GΩ[34]	1250+5	2500+15	2550+15	2600+15	400+2.5

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[17,22]

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

4-WIRE RESISTANCE READING RATES[22,17]

PLC	Measurement Aperture	Bits	Default Digits	Readings or Readings with Time Stamp/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	167ms (200ms)	29	8½	6 (5)	3 (2.5)	2 (1.6)	1 (0.8)
2	33.4ms (40ms)	27	7½	27 (22)	13 (10.7)	9 (7.4)	4 (3.5)
1	16.7ms (20ms)	26	7½	50 (41)	25 (20)	42 (34)	20 (16)
0.2[39]	3.34ms (4ms)	23	6½	154 (137)	76 (68)	115 (102)	54 (48)
0.1[39]	1.67ms (2ms)	22	6½	184 (176)	92 (88)	123 (118)	63 (60)
0.02[39]	334µs (400µs)	20	5½	186 (186)	107 (107)	126 (126)	72 (72)
0.01[39]	167µs (167µs)	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
				24 Hours[42]	90 Days[43]	1 Year[43]	2 Years[43]	Outside T_{CAL} ±5°C
200µA	210.0µA	10pA	0.25V	50 + 6	275 + 25	350 + 25	500 + 25	50 + 5
2mA	2.10mA	100pA	0.3V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
20mA	21.0mA	1nA	0.35V	50 + 5	275 + 20	350 + 20	500 + 20	50 + 5
200mA	210.0mA	10nA	0.35V	75 + 5	300 + 20	375 + 20	525 + 20	50 + 5
2A	2.10A	100nA	1.1V	350 + 5	600 + 20	750 + 20	1000 + 20	50 + 5

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

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

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

[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 warm-up. T_{CAL} is ambient temperature at calibration (23°C at the factory).
[43] For T_{CAL} ± 5°C, following 55-minute warm-up.

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DCI READING RATES[17,22]

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

SPEED AND ACCURACY

ACCURACY[41, 11] 90 Days ±(ppm of reading+ppm of range+ppm of range RMS noise[12])				
Range	1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC DFILT Off	0.01PLC[13] DFILT Off
200µA	275+25+0	275+25+0.5	300+25+50	300+200+80
2mA	275+20+0	275+20+0.5	300+20+50	300+200+80
20mA	275+20+0	275+20+0.5	300+20+50	300+200+80
200mA	300+20+0	300+20+0.5	325+20+50	325+200+80
2A	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
200µA	43
2mA	40
20mA	55
200mA	162
2A	129

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.

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

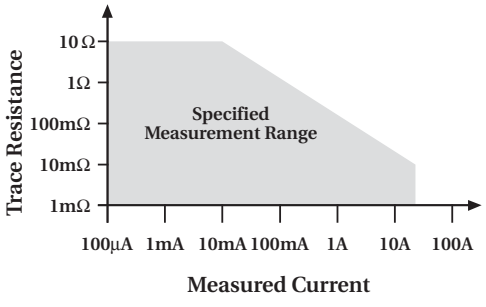
Maximum Allowable Input: 2.1A, 250V.

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 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.

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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
200µA	1mA	210.0mA	100pA	0.35V	0.01 + 0.001
2mA	10mA	2.10mA	1nA	0.45V	0.01 + 0.001
20mA	100mA	21.0mA	10nA	0.5V	0.01 + 0.001
200mA	1A	210.0A	100nA	0.5V	0.01 + 0.001
2A	2A	2.10A	1µA	1.5V	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	20Hz–50Hz	50Hz–200Hz	200Hz–1kHz	1kHz–10kHz	10kHz–30kHz[22]	30kHz–50kHz[22]	50kHz–100kHz[22]
200µA	0.35 + 0.015	0.2 + 0.015	0.4 + 0.015	0.5 + 0.015			
2mA	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
20mA	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
200mA	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
2A	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) x (measured value) + (% of range) x (range used)] / 100.
ppm Accuracy: = (% accuracy) x 10,000.
0.015% of Range: = 30 counts at 5½ -digits.

ACI READING RATES[17, 22]

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

[44] Add 0.005% of range uncertainty for current above 0.5A RMS for self-heating.

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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

	Frequency Range[45]	Period Range	Resolution	Minimum Signal Level[46]			Maximum Input	Trigger Level	Accuracy ±(% of reading)
				1Hz–1MHz	1–5MHz	5–15MHz			
AC Voltage Input	1Hz–15 MHz	67ns – 1s	5 digits	60mV	60mV	400mV	1100V pk[45]	0–600V	0.03
AC Current Input	1Hz– 1 MHz	1µs – 1s	5 digits	150µA			1A 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 only.

TEMPERATURE (RTD)

Range	Resolution	4-Wire Accuracy[47]			
		24 Hours[48]	90 Days[7]	1 Year[7]	2 Years[7]
–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[17,22] (2- or 4-Wire)

Readings or Readings with Time Stamp/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)

[45] Subject to 2×10^7V·Hz product (for inputs above 20V).
[46] Valid for the lowest range. For each range increase, multiply these numbers by 10.
[47] Specifications are for 10 power line cycles, autozero on, 10 reading repeat digital filter, 4-wire mode. Exclusive of RTD probe errors.
[48] For T_{CAL} ± 1°C, following 4-hour warm-up.

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TEMPERATURE (THERMOCOUPLE)

Thermocouple Type	Range	Resolution	Accuracy[49]
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[22,50]

PLC	Readings/Second to Memory		Readings/Second to IEEE-488[18]		Readings/Second with Time Stamp 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)

OPERATING SPEED

FUNCTION CHANGE SPEED[51]

Typical delay before measurement initiation after making a function change.

From Function	To Function	Range	Time
Any except 4WΩ, Temp	DCV	Any	4.6ms
4WΩ, Temp		Any	7.6ms
Any	ACV	Any	574ms
ACV, DCV, 2WΩ, Freq	DCI	Any	7.1ms
4WΩ, Temp		Any	10ms
ACI		Any	22ms
Any	ACI	Any	523ms
Any except 4WΩ, Temp	2WΩ	20Ω to 2kΩ	4.7ms
		20kΩ	15ms
		200kΩ	27ms
		2MΩ	103ms
		20MΩ	153ms
		200MΩ, 1GΩ	253ms
4WΩ, Temp	2WΩ	20Ω to 2kΩ	7.7ms
		20kΩ	18ms
		200kΩ	30ms
		2MΩ	105ms
		20MΩ	157ms
		200MΩ, 1GΩ	256ms
Any	4WΩ	20Ω to 2kΩ	7.7ms
		20kΩ	18ms
		200kΩ	30ms
		2MΩ	105ms
Any except ACV, ACI	Freq[52]	Any	60ms
ACV, ACI		Any	573ms
Any	Temp	Any	7.6ms

[49] 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.
[50] 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.
[51] 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.
[52] Based on 100kHz input frequency.

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RANGE CHANGE SPEED[51]

Typical delay before measurement initiation after making a range change.

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

TRIGGER SPEED (EXTERNAL TRIGGER OR TRIGGER-LINK)

	Autozero Off	Autozero On
Trigger Latency:	< 2µs	1.2ms typical
Trigger Jitter:	± 0.5µs	

GPIB DATA FORMATTING TRANSMISSION TIME[53]

Format	Readings Only		Readings with Time Stamp	
	Time	Rdg./s	Time	Rdg./s
DREAL (Double precision real)	0.51ms	1961	3.1ms	323
SREAL (Single precision real)	0.38ms	2632	3.3ms	303
ASCII	6.2ms	161	10.2ms	98

SINGLE FUNCTION SCAN SPEED[54] (INTERNAL SCANNER)

	DCV (20V)		2WΩ (2kΩ)		4WΩ (2kΩ)		ACV		Freq		TC Temp		RTD Temp (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[55] (2 channels)	8.2ms	122	8.5ms	118	18.8ms	53								
Fast Scan (using solid state channels)	8.2ms	122	6.3ms	159			501ms	2	559ms	1.8	12.8ms	78		
Normal Scan	14ms	71	11.4ms	88	14.4ms	69	506ms	2	564ms	1.8	17.2ms	58	43ms	23

[53] Average time for 1000 readings, byte order swapped, display off.
[54] For on-scale readings, no trigger delays, display off, 0.01 power line cycles, autorange off, digital filter off, offset compensation off, autozero off.
[55] Ratio and delta functions output one value for each pair of measurements.

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MAXIMUM INPUT LEVELS

	Rated Input[56]	Overload Recovery Time
HI to LO	±1100V	< 900ms
HI Sense to LO	± 350V pk 250V RMS	< 900ms
LO Sense to LO	± 150V pk 100V RMS	< 900ms
I Input to LO	2A, ± 250V (fused)	—
HI to Earth	±1600V	< 900ms
LO to Earth	± 500V	

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.

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.

GENERAL SPECIFICATIONS AND STANDARDS COMPLIANCE[57]

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.

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.

[56] For voltages between other terminals, these ratings can be added.
[57] MIL-PRF-28800F Type III, Class 5, Style E applies.

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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.).

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, operator's manual, option slot cover, and full calibration data.

EXTENDED MEMORY/NON-VOLATILE MEMORY OPTIONS

DATA STORAGE						
					Setup Storage	
Model	Size (Bytes)	4½-Digit	6½-Digit with Time Stamp	Type	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.