Model 2001 Specifications

The following pages contain the complete specifications for the 2001. 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 2001 provides 5-minute, 1-hour, 24-hour, 90-day, 1-year, and 2-year specifications, with full specifications for the 90-day, 1-year and 2-year specifications. This allows the user to utilize 90-day, 1-year, or 2-year recommended calibration intervals, depending upon the level of accuracy desired. As a general rule, the 2001's 2-year performance exceeds a 5½-digit DMM's 90-day, 180-day or 1-year specifications. 6½- or 7½-digit performance is assured using 90-day or 1-year specifications.

ABSOLUTE ACCURACY

To minimize confusion, *all 90-day, 1-year and 2-year 2001 specifications are absolute accuracy*, traceable to NIST based on factory calibration. Higher accuracies are possible, based on your calibration sources. For example, calibrating with a 10V primary standard rather than a 20V calibrator will reduce calibration uncertainty, and can thereby improve total 2001 accuracy for measurements up to 50% of range. Refer to the 2001 calibration procedure for details.

TYPICAL ACCURACIES

Accuracy can be specified as typical or warranted. All specifications shown are warranted unless specifically noted.

Almost 99% of the 2001'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). Since these values cannot be verified in production, the values are listed as typical.

2001 SPECIFIED CALIBRATION INTERVALS

MEASUREMENT FUNCTION	24 HOUR[1]	90 DAY[2]	1 YEAR[2]	2 YEAR[2]
DC Volts	•	•	•	•
DC Volts Peak Spikes		•[3]	•	•
AC Volts rms		•[3]	•	•
AC Volts Peak		•[3]	•	•
AC Volts Average		•[3]	•	•
AC Volts Crest Factor		•[3]	•	•
Ohms	•	•	•	•
DC Current	•	•	•	•
DC In-Circuit Current		•	•	•
AC Current		•[3]	•	•
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.

DCV INPUT CHARACTERISTICS AND ACCURACY

RANGE	FULL SCALE	RESOLUTION	DEFAULT RESOLUTION	INPUT RESISTANCE	ACCURACY[1] ±(ppm of reading + ppm of range) 5 Minutes[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]	±210.00000	10 nV	100 nV	>10 GΩ	3 + 3	10 + 6	25 + 6	37 + 6	50 + 6	3.3 +1.5
2 V	±2.1000000	100 nV	1 µV	>10 GΩ	2 + 1.5	7 + 2	18 + 2	25 + 2	32 + 2	2.6 +0.15
20 V	±21.000000	1 µV	10 µV	>10 GΩ	2 + 1.5	7 + 4	18 + 4	24 + 4	32 + 4	2.6 +0.7
200 V	±210.00000	10 µV	100 µV	10 MΩ ±1%	2 + 1.5	13 + 3	27 + 3	38 + 3	52 + 3	4.3 +1
1000 V	±1100.0000	100 µV	1 mV	10 MΩ ±1%	10 + 1.5	17 + 6	31 + 6	41 + 6	55 + 6	4.1 +1

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

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

1PPM OF RANGE = 2 counts for ranges up to 200V, 1 count on 1000V range at 6½ digits.

SPEED AND ACCURACY[5] 90 Days

RANGE	ACCURACY ±(ppm of reading+ppm of range+ppm of range rms noise[10]) 1PLC DFILT On, 10 Readings	1PLC DFILT Off	0.1PLC DFILT Off	0.01PLC[11] DFILT Off
200 mV [4]	25+6+0	25+6+0.6	25+30+10	100+200+15
2 V	18+2+0	18+2+0.2	18+25+1	130+200+3
20 V	18+4+0	18+4+0.3	18+20+0.5	130+200+3
200 V	27+3+0	27+5+0.3	27+20+0.8	130+200+3
1000 V	31+6+0	31+6+0.1	31+21+0.5	90+200+2

PLC = power line cycle; DFILT = digital filter

NOISE REJECTION (dB)

SPEED (Number of Power Line Cycles)	AC and DC CMRR[6] Line Sync On[7]	Internal Trigger[8]	AC NMRR Line Sync On[7] 25-Reading DFILT On	Line Sync On[7] DFILT Off	Internal Trigger[8] DFILT Off
NPLC = 10	140	120	90	80	60
NPLC ≥ 1	140	120	90	80	60
NPLC < 1	60	50	30	20	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 AC signal between HI and LO.

DCV READING RATES[9,10]

200mV, 2V, 200V Ranges

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	Auto Zero On
10	167 ms (200 ms)	28	7½	6 (5.1)	2 (1.7)	6	2 (1.6)	6 (4.1)	2 (1.6)
2	33.4 ms (40 ms)	26	7½	30 (25)	9 (7.6)	28 (23)	9 (7.3)	27 (22)	8 (7.2)
1	16.7 ms (20 ms)	25	6½	58 (48)	44 (34)	54 (45)	41 (32)	49 (41)	37 (30)
0.2	3.34 ms (4 ms)	22	6½	214 (186)	127 (112)	183 (162)	104 (101)	140 (126)	88 (85)
0.1	1.67 ms (2 ms)	21	5½	272 (272)	150 (148)	228 (225)	129 (123)	156 (153)	100 (96)
0.02	334 µs (400 µs)	19	5½	284 (287)	156 (155)	230 (230)	136 (134)	158 (156)	104 (103)
0.01	167 µs (167 µs)	16	4½	417 (417)	157 (157)	317 (317)	137 (134)	198 (198)	105 (103)
0.01[11]	167 µs (167 µs)	16	4½	2000 (2000)		2000 (2000)			

20V, 1000V Ranges

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	Auto Zero On
10	167 ms (200 ms)	28	7½	6 (5.1)	2 (1.7)	6	2 (1.6)	6	2 (1.6)
2	33.4 ms (40 ms)	26	7½	30 (25)	9 (8.2)	28 (23)	9 (7.8)	27 (22)	9 (7.7)
1	16.7 ms (20 ms)	25	6½	57 (48)	42 (38)	54 (45)	43 (35)	48 (41)	39 (32)
0.2	3.34 ms (4 ms)	22	6½	201 (186)	102 (113)	173 (162)	102 (99)	129 (127)	84 (83)
0.1	1.67 ms (2 ms)	21	5½	201 (201)	126 (116)	175 (173)	105 (105)	129 (128)	86 (86)
0.02	334 µs (400 µs)	19	5½	227 (227)	129 (129)	178 (178)	114 (114)	138 (138)	90 (90)
0.01	167 µs (167 µs)	16	4½	422 (422)	130 (130)	333 (333)	117 (117)	199 (199)	95 (95)
0.01[11]	167 µs (167 µs)	16	4½	2000 (2000)		2000 (2000)			

SETTLING CHARACTERISTICS: <500µs to 10ppm of step size. Reading settling times are affected by source impedance and cable dielectric absorption characteristics. Add 10ppm of range for first reading after range change.

ZERO STABILITY: Typical variation in zero reading, 1 hour, T_{REF} ±1°C, 6½-digit default resolution, 10-reading digital filter:

Range	ZERO STABILITY 1 Power Line Cycle Integration	10 Power Line Cycle Integration
2V – 1000V	±3 counts	±2 counts
200 mV	±5 counts	±3 counts

ISOLATED POLARITY REVERSAL ERROR: This is the portion of the instrument error that is seen when high and low are reversed when driven by an isolated source. This is not an additional error—it is included in the overall instrument accuracy spec. **Reversal Error:** <2 counts at 10V input at 6½ digits, 10 power line cycles, 10-reading digital filter.

INPUT BIAS CURRENT: <100pA at 25°C.

LINEARITY: <1ppm of range typical, <2ppm maximum.

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

DC VOLTS NOTES

1. Specifications are for 1 power line cycle, Auto Zero on, 10-reading digital filter, except as noted.
2. For T_{CAL} ±1°C, following 55-minute warm-up. T_{CAL} is ambient temperature at calibration, which is 23°C from factory.
3. For T_{CAL} ±5°C, following 55-minute warm-up. Specifications include factory traceability to US NIST.
4. When properly zeroed using REL function.
5. For T_{CAL} ±5°C, 90-day accuracy. 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.
7. For noise synchronous to the line frequency.
8. For line frequency ±0.1%.
9. See Operating Speed section for additional detail. For DELAY=0, internal trigger, digital filter off, display off (or display in "hold" mode). Aperture is reciprocal of line frequency. These rates are for 60Hz and (50Hz).
10. Typical values.
11. In burst mode, display off. Burst mode requires Auto Zero refresh (by changing resolution or measurement function) once every 24 hours.
12. DCV Transfer Stability typical applications are standard cell comparisons and relative accuracy measurements. Specs apply for 10 power line cycles, 20-reading digital filter, autozero on with type synchronous, fixed range following 2-hour warm-up at full scale to 10% of full scale, at T_{REF} ± 1°C (T_{REF} is the initial ambient temperature). Specifications on the 1000V range are for measurements within 5% of the initial measurement value and following measurement settling.

DCV PEAK SPIKES MEASUREMENT

REPETITIVE SPIKES ACCURACY[1] 90 Days, ±2°C from last AC self-cal ±(% 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} ±2°C
200 mV	0.08+0.7	0.08+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	0.08+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	0.09+0.7	0.1 +0.7	0.12+0.7	0.17+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]	0.09+0.3	0.1 +0.3	0.12+0.3	0.17+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]	0.1 +0.6	0.13+0.6	0.16+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%	

REPETITIVE SPIKES ACCURACY[1] 1 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.

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	DEFAULT RESOLUTION	INPUT IMPEDANCE	TEMPERATURE COEFFICIENT[2] ±(% of reading + % of range) / °C Outside T_{CAL} ±5°C
200 mV	1 V	210.0000	100 nV	1 µV	1MΩ ±2% with <140pF	0.004 + 0.001
2 V	8V	2.100000	1 µV	10 µV	1MΩ ±2% with <140pF	0.004 + 0.001
20 V	100 V	21.00000	10 µV	100 µV	1MΩ ±2% with <140pF	0.006 + 0.001
200 V	800 V	210.0000	100 µV	1 mV	1MΩ ±2% with <140pF	0.006 + 0.001
750 V	1100 V	775.000	1 mV	10 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, ±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	0.04+0.015	0.03+0.015	0.03+0.015	0.03+0.015	0.035+0.015	0.05+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
2 V	0.09+0.015	0.04+0.015	0.03+0.015	0.03+0.015	0.03+0.015	0.035+0.015	0.05+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
20 V	0.1 +0.015	0.05+0.015	0.04+0.015	0.04+0.015	0.06+0.015	0.08 +0.015	0.1 +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	0.04+0.015	0.04+0.015	0.06+0.015	0.08 +0.015	0.1 +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	0.08+0.015	0.08+0.015	0.09+0.015	0.12 +0.015	0.15+0.015[5]	0.5+0.015[5]			

LOW FREQUENCY MODE RMS[1] 1 or 2 Years, T_{CAL} ±5°C 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	0.11+0.015	0.06+0.015	0.05+0.015	0.05+0.015	0.05 +0.015	0.05+0.015	0.06+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
2 V	0.11+0.015	0.06+0.015	0.05+0.015	0.05+0.015	0.05 +0.015	0.05+0.015	0.06+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
20 V	0.12+0.015	0.07+0.015	0.06+0.015	0.06+0.015	0.085+0.015	0.12+0.015	0.13+0.015	0.3+0.015	0.75+0.025	4+0.2	7+0.2[5]
200 V[4]	0.12+0.015	0.07+0.015	0.06+0.015	0.06+0.015	0.085+0.015	0.12+0.015	0.13+0.015	0.3+0.015	0.75+0.025[5]	4+0.2[5]	
750 V[4]	0.15+0.015	0.11+0.015	0.1 +0.015	0.1 +0.015	0.13 +0.015	0.18+0.015	0.22+0.015[5]	0.5+0.015[5]			

AC VOLTS (cont'd)

NORMAL MODE RMS[1] 90 Days, ±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	0.03+0.015	0.03+0.015	0.035+0.015	0.05+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
2 V	0.25+0.015	0.07+0.015	0.03+0.015	0.03+0.015	0.035+0.015	0.05+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
20 V	0.25+0.015	0.07+0.015	0.04+0.015	0.06+0.015	0.08 +0.015	0.1 +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	0.04+0.015	0.06+0.015	0.08 +0.015	0.1 +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	0.08+0.015	0.09+0.015	0.12 +0.015	0.15+0.015[5]	0.5+0.015[5]			

NORMAL MODE RMS[1] 1 or 2 Years, T_{CAL} ±5°C 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	0.08+0.015	0.05+0.015	0.05 +0.015	0.05+0.015	0.06+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
2 V	0.25+0.015	0.08+0.015	0.05+0.015	0.05 +0.015	0.05+0.015	0.06+0.015	0.3+0.015	0.75+0.025	2+0.1	5+0.2
20 V	0.25+0.015	0.08+0.015	0.06+0.015	0.085+0.015	0.12+0.015	0.13+0.015	0.3+0.015	0.75+0.025	4+0.2	7+0.2[5]
200 V[4]	0.25+0.015	0.08+0.015	0.06+0.015	0.085+0.015	0.12+0.015	0.13+0.015	0.3+0.015	0.75+0.025[5]	4+0.2[5]	
750 V[4]	0.27+0.015	0.11+0.015	0.1 +0.015	0.13 +0.015	0.18+0.015	0.22+0.015[5]	0.5+0.015[5]			

dB ACCURACY RMS ±dB, 90 Days, 1 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 10 mV)	0.230	0.225	0.236	0.355		
–40 to–34 dB (10 mV to 20 mV)	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]

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	READINGS/SECOND TO MEMORY Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	READINGS/SECOND TO IEEE-488 Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero On
10	167 ms (200 ms)	28	6½	6 (5.1)	2 (1.7)	2	2 (1.6)	2	2 (1.5)
2	33.4 ms (40 ms)	26	5½	30 (24)	9 (7.9)	28 (23)	9 (7.6)	27 (22)	9 (7.5)
1	16.7 ms (20 ms)	25	5½	57 (48)	38 (35)	53 (45)	36 (33)	48 (41)	34 (30)
0.1	1.67 ms (2 ms)	21	5½	136 (136)	70 (70)	122 (122)	64 (64)	98 (98)	56 (56)
0.01	167 µs (167 µs)	16	4½	140 (140)	71 (71)	127 (127)	66 (66)	99 (99)	58 (58)
0.01[8]	167 µs (167 µs)	16	4½	2000 (2000)		2000 (2000)			

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/AC 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 for 50kHz–100kHz, 0.05% of range for 100kHz–200kHz, and 0.5% of range for 200kHz–1MHz.

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.

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).

AC VOLTS (cont'd)

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: 2×10^7 V•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, digital filter off, following 55 minute warm-up.
2. Temperature coefficient applies to rms or 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% to 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 DELAY=0, digital filter off, display off (or display in "hold" mode). Internal Trigger, Normal mode. See Operating Speed section for additional detail. Aperture is reciprocal of line frequency. These rates are for 60Hz and (50Hz). Applies for rms and average mode. Low frequency mode rate is typically 0.2 readings per second.
7. For overrange readings 200–300% of range, add 0.1% of reading. For 300–400% of range, add 0.2% of reading.
8. In burst mode, display off. Burst mode requires Auto Zero 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.

OHMS

TWO-WIRE AND FOUR-WIRE OHMS (2W and 4W Ohms Functions)[13]

RANGE	FULL SCALE	RESOLUTION	DEFAULT RESOLUTION	CURRENT[1] SOURCE	OPEN CIRCUIT[12]	MAXIMUM LEAD RESISTANCE[2]	MAXIMUM OFFSET COMPENSATION[3]	TEMPERATURE COEFFICIENT ±(ppm of reading + ppm of range)/°C Outside T_{CAL} ±5°
20 Ω	21.000000	1 µΩ	10 µΩ	9.2 mA	5 V	1.7 Ω	±0.2 V	8 + 1.5
200 Ω	210.00000	10 µΩ	100 µΩ	0.98 mA	5 V	12 Ω	±0.2 V	4 + 1.5
2 kΩ	2100.0000	100 µΩ	1 mΩ	0.98 mA	5 V	100 Ω	–0.2 V to +2 V	3.0 + 0.2
20 kΩ	21.000000	1 mΩ	10 mΩ	89 µA	5 V	1.5 kΩ	–0.2 V to +2 V	4 + 0.2
200 kΩ	210.00000	10 mΩ	100 mΩ	7 µA	5 V	1.5 kΩ		11 + 0.2
2 MΩ [4]	2.1000000	100 mΩ	1 Ω	770 nA	5 V	1.5 kΩ		25 + 0.2
20 MΩ [4]	21.000000	1 Ω	10 Ω	70 nA	5 V	1.5 kΩ		250 + 0.2
200 MΩ [4]	210.00000	10 Ω	100 Ω	4.4 nA	5 V	1.5 kΩ		4000 + 10
1 GΩ [4]	1.0500000	100 Ω	1 kΩ	4.4 nA	5 V	1.5 kΩ		4000 + 10

RESISTANCE ACCURACY[5] ±(ppm of reading + ppm of range)

RANGE	24 Hours[6]	90 Days[7]	1 Year[7]	2 Years[7]
20 Ω	29 + 7	52 + 7	72 + 7	110 + 7
200 Ω	24 + 7	36 + 7	56 + 7	90 + 7
2 kΩ	22 + 4	33 + 4	50 + 4	80 + 4.5
20 kΩ	19 + 4	32 + 4	50 + 4	80 + 4.5
200 kΩ	20 + 4.5	72 + 4.5	90 + 4.5	130 + 5
2 MΩ [4]	50 + 4.5	110 + 4.5	160 + 4.5	230 + 5
20 MΩ [4]	160 + 4.5	560 + 4.5	900 + 4.5	1100 + 5
200 MΩ [4]	3000 + 100	10000 + 100	20000 + 100	30000 + 100
1 GΩ [4]	9000 + 100	20000 + 100	40000 + 100	60000 + 100

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

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

1PPM OF RANGE = 2 counts for ranges up to 200MΩ and 1 count on 1GΩ range at 6½ digits.

2-WIRE ACCURACY[7] ±(ppm of range)

RANGE	20 Ω	200 Ω	2 kΩ
ADDITIONAL UNCERTAINTY (inside T_{CAL} ± 5°C)	300 ppm	30 ppm	3 ppm
TEMPERATURE COEFFICIENT (outside T_{CAL} ±5°C)	70ppm/°C	7ppm/°C	0.7ppm/°C

SPEED AND ACCURACY[9] 90 Days

RANGE	ACCURACY ±(ppm of reading+ppm of range+ppm of range rms noise[12]) 1PLC[11] DFILT Off	0.1PLC[11] DFILT Off	0.01PLC[8,11] DFILT Off
20 Ω	52+ 7+0.6	52+ 30+10	110+200+ 35
200 Ω	36+ 7+0.6	36+ 30+10	110+200+ 35
2 kΩ	33+ 4+0.2	33+ 24+ 1	130+230+ 5
20 kΩ	32+ 4+0.2	32+ 24+ 2	130+230+ 5
200 kΩ	72+ 4.5+0.5	72+ 25+ 4	150+300+ 10
2 MΩ [4]	110+ 4.5+ 2	110+ 25+15	150+300+150
20 MΩ [4]	560+ 4.5+ 5	560+ 30+20	560+300+150
200 MΩ [4]	10,000+100+ 40	10,000+120+80	10,000+700+250
1 GΩ [4]	20,000+100+ 40	20,000+120+80	20,000+700+250

PLC = Power Line Cycles. DFILT = Digital Filter.

SETTLING CHARACTERISTICS: For first reading following step change, add the total 90-day measurement error for the present range. Pre-programmed settling delay times are for <200pF external circuit capacitance. For 200MΩ and 1GΩ ranges, add total 1 year errors for first reading following step change. Reading settling times are affected by source impedance and cable dielectric absorption characteristics.

OHMS MEASUREMENT METHOD: Constant current.

OFFSET COMPENSATION: Available on 20Ω – 20kΩ ranges.

OHMS VOLTAGE DROP MEASUREMENT: Available as a multiple display.

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

OHMS (cont'd)

2-WIRE RESISTANCE READING RATES[10,12] 20Ω, 200Ω, 2kΩ, and 20kΩ Ranges

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	READINGS/SECOND TO MEMORY Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	READINGS/SECOND TO IEEE-488 Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero On
10	167 ms (200 ms)	28	7½	6 (5.1)	2 (1.7)	5 (4)	2 (1.6)	5 (4)	2 (1.6)
2	33.4 ms (40 ms)	26	7½	30 (25)	8 (7.1)	28 (23)	8 (6.8)	27 (22)	8 (6.7)
1	16.7 ms (20 ms)	25	6½	58 (48)	40 (34)	53 (45)	37 (32)	49 (41)	35 (31)
0.2[11]	3.34 ms (4 ms)	22	6½	219 (189)	109 (97)	197 (162)	97 (87)	140 (129)	79 (74)
0.1[11]	1.67 ms (2 ms)	21	5½	300 (300)	126 (118)	248 (245)	112 (108)	164 (163)	89 (88)
0.02[11]	334 µs (400 µs)	19	5½	300 (300)	130 (130)	249 (249)	114 (114)	165 (165)	91 (91)
0.01[11]	167 µs (167 µs)	16	4½	421 (421)	135 (135)	306 (306)	114 (114)	189 (189)	92 (92)
0.01[8,11]	167 µs (167 µs)	16	4½	2000 (2000)		2000(2000)			

2-WIRE RESISTANCE READING RATES[10,12] 20MΩ Range

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	READINGS/SECOND TO MEMORY Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero On
10	167 ms (200 ms)	28	7½	6 (5.1)	1 (0.8)	2 (1.8)	1 (0.8)
2	33.4 ms (40 ms)	26	7½	30 (25)	1 (0.8)	16(14.5)	1 (0.8)
1	16.7 ms (20 ms)	25	6½	58 (48)	4 (3.8)	25 (22)	4 (3.5)
0.1[11]	1.67 ms (2 ms)	21	5½	300 (296)	5 (5)	43 (39)	5 (4.7)
0.02[11]	334 µs (400 µs)	19	5½	300 (300)	5 (5)	43 (43)	5 (5)
0.01[11]	167 µs (167 µs)	16	4½	412 (412)	5 (5)	43 (43)	5 (5)

4-WIRE RESISTANCE READING RATES[10,12] Any Range

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS or READINGS WITH TIME STAMP/SECOND TO MEMORY or IEEE-488, AUTO ZERO ON Offset Comp. Off	Offset Comp. On
10	167 ms (200 ms)	28	7½	2 (1.6)	0.6 (0.5)
2	33.4 ms (40 ms)	26	7½	7 (6.1)	2 (1.6)
1	16.7 ms (20 ms)	25	6½	12 (11.6)	3 (3.7)
0.1[11]	1.67 ms (2 ms)	21	5½	20 (20)	6 (6)
0.01[11]	167 µs (167 µs)	16	4½	21 (21)	7 (7)

OHMS NOTES

1. Current source is typically ±9% absolute accuracy.
2. Total of measured value and lead resistance cannot exceed full scale.
3. Maximum offset compensation 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 1 power line cycle, 10 reading digital filter, Auto Zero on, 4-wire mode, offset compensation on (for 20Ω to 20kΩ ranges).
6. For T_{CAL} ±1°C, following 55 minute warm-up. T_{CAL} is ambient temperature at calibration (23°C at the factory).
7. For T_{CAL} ±5°C, following 55-minute warm-up. Specifications include traceability to US NIST.
8. In burst mode, display off. Burst mode requires Auto Zero refresh (by changing resolution or measurement function) once every 24 hours.
9. For T_{CAL} ±5°C, 90-day accuracy. 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 DELAY=0, digital filter off, internal trigger, display off. Aperture is reciprocal of line frequency. These rates are for 60Hz and (50Hz). Speed for 200kΩ range is typically 10% slower than 20kΩ range; speed for 2MΩ range is typically 3 times faster than 20MΩ range; speed for 1GΩ range is typically 30%–50% as fast as 20MΩ range. See Operating Speed section for additional detail.
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.
13. When measuring resistance of inductive loads, the inductance of that load must be 10mH or less.

DC AMPS

DCI INPUT CHARACTERISTICS AND ACCURACY[4]

RANGE	FULL SCALE	RESOLUTION	DEFAULT RESOLUTION	MAXIMUM BURDEN VOLTAGE[6]	ACCURACY[1] ±(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 µA	210.00000	10 pA	100 pA	0.25 V	63 + 25	300 + 25	500 + 25	1350 + 25	58 + 7
2 mA	2.1000000	100 pA	1 nA	0.31 V	64 + 20	300 + 20	400 + 20	750 + 20	58 + 5
20 mA	21.000000	1 nA	10 nA	0.4 V	65 + 20	300 + 20	400 + 20	750 + 20	58 + 5
200 mA	210.00000	10 nA	100 nA	0.5 V	96 + 20	300 + 20	500 + 20	750 + 20	58 + 5
2 A	2.1000000	100 nA	1 µA	1.5 V	500 + 20	600 + 20	900 + 20	1350 + 20	58 + 5

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

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

10PPM OF RANGE = 20 counts at 6½ digits.

DCI READING RATES[5,9]

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	READINGS/SECOND TO MEMORY Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	READINGS/SECOND TO IEEE-488 Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero On
10	167 ms (200 ms)	28	7½	6 (5.1)	2 (1.7)	6 (4.8)	2 (1.6)	6 (4.8)	2 (1.6)
2	33.4 ms (40 ms)	26	7½	30 (24)	10 (8.2)	28 (23)	9 (7.8)	27 (22)	9 (7.7)
1	16.7 ms (20 ms)	25	6½	57 (48)	45 (38)	53 (45)	41 (35)	48 (41)	40 (32)
0.2	3.34 ms (4 ms)	22	6½	217 (195)	122 (111)	186 (168)	109 (98)	135 (125)	88 (85)
0.1	1.67 ms (2 ms)	21	5½	279 (279)	144 (144)	234 (229)	123 (123)	158 (156)	99 (98)
0.02	334 µs (400 µs)	19	5½	279 (279)	148 (148)	234 (234)	130 (130)	158 (158)	101 (101)
0.01	167 µs (167 µs)	16	4½	298 (298)	150 (150)	245 (245)	132 (132)	164 (164)	102 (102)
0.01[7]	167 µs (167 µs)	16	4½	2000 (2000)		2000 (2000)			

DC AMPS (cont'd)

SPEED AND ACCURACY[8] 90 Days

RANGE	ACCURACY ±(ppm of reading+ppm of range+ppm of range rms noise[9]) 1PLC DFILT Off	0.1PLC DFILT Off	0.01PLC[7] DFILT Off
200 µA	300+25+0.3	300+50+8	300+200+80
2 mA	300+20+0.3	300+45+8	300+200+80
20 mA	300+20+0.3	300+45+8	300+200+80
200 mA	300+20+0.3	300+45+8	300+200+80
2 A	600+20+0.3	600+45+8	600+200+80

PLC = Power Line Cycle. DFILT = Digital Filter.

SETTLING CHARACTERISTICS: <500µs to 50ppm of step size. Reading settling times are affected by source impedance and cable dielectric absorption characteristics. Add 50ppm of range for first reading after range change.

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, Auto Zero on, 10 reading digital filter.
2. For T_{CAL} ± 1°C, following 55 minute warm-up.
3. For T_{CAL} ± 5°C, following 55 minute warm-up. Specifications include traceability to US NIST.
4. Add 50 ppm of range for current above 0.5A for self heating.
5. For DELAY=0, digital filter off, display off. Internal trigger. Aperture is reciprocal of line frequency. These rates are for 60Hz and (50Hz). See Operating Speed section for additional detail.
6. Actual maximum voltage burden = (maximum voltage burden) × ($I_{MEASURED}/I_{FULL\ SCALE}$).
7. In burst mode, display off. Burst mode requires Auto Zero refresh (by changing resolution or measurement function) once every 24 hours.
8. For T_{CAL} ±5°C, 90-day accuracy. 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. Typical values.

DC IN-CIRCUIT CURRENT

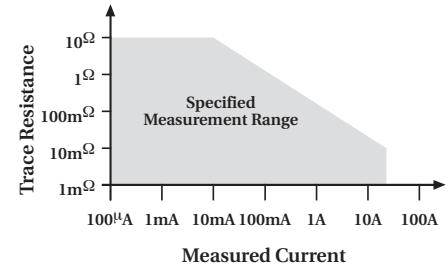
The DC in-circuit current measurement function allows a user to measure the current through a wire or a circuit board trace without breaking the circuit.

When the In-Circuit Current Measurement function is selected, the 2001 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 typical.
Voltage:	±200mV max. across trace.
Speed:	4 measurements/second at 1 power line cycle.
Accuracy:	±(5% + 2 counts). For 1 power line cycle, Auto Zero on, 10 reading digital filter, T_{CAL}±5°C, after being properly zeroed. 90 days, 1 year or 2 years.

MEASUREMENT RANGE CHART



AC AMPS

AC magnitude: RMS or Average.

ACI INPUT CHARACTERISTICS

RMS RANGE	PEAK INPUT	FULL SCALE RMS	RESOLUTION	DEFAULT 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	1 nA	0.25 V	0.01 + 0.001
2 mA	10 mA	2.100000	1 nA	10 nA	0.31 V	0.01 + 0.001
20 mA	100 mA	21.00000	10 nA	100 nA	0.4 V	0.01 + 0.001
200 mA	1 A	210.0000	100 nA	1 µA	0.5 V	0.01 + 0.001
2 A	2 A	2.100000	1 µA	10 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.

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/AC rms).

	% of Reading	% of Range
rms, Average	0.05	0.1

AC AMPS (cont'd)

ACI READING RATES[3,4]

NPLC	MEASUREMENT APERTURE	BITS	DEFAULT DIGITS	READINGS/SECOND TO MEMORY Auto Zero Off	READINGS/SECOND TO MEMORY Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	READINGS/SECOND TO IEEE-488 Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero On
10	167 ms (200 ms)	28	6½	6 (5.1)	2 (1.7)	6 (4.9)	2 (1.6)	6 (4.8)	2 (1.6)
2	33.4 ms (40 ms)	26	5½	30 (25)	9 (7.9)	28 (23)	9 (7.6)	27 (22)	9 (7.5)
1	16.7 ms (20 ms)	25	5½	57 (48)	39 (35)	53 (45)	37 (33)	49 (41)	34 (30)
0.1	1.67 ms (2 ms)	21	5½	157 (136)	70 (70)	123 (123)	62 (62)	107 (107)	56 (53)
0.01	167 µs (167 µs)	16	4½	156 (136)	70 (70)	140 (140)	63 (63)	113 (113)	56 (56)
0.01[6]	167 µs (167 µs)	16	4½	2000 (2000)		2000 (2000)			

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.

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.

AC AMPS NOTES

1. Specifications apply for sinewave input, AC+DC coupling, 1 power line cycle, 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 DELAY=0, digital filter off, display off, internal trigger. Aperture is reciprocal of line frequency. These rates are for 60Hz and (50Hz).
5. Actual maximum voltage burden = (maximum voltage burden) × ($I_{MEASURED}/I_{FULL\ SCALE}$).
6. In burst mode, display off. Burst mode requires Auto Zero refresh (by changing resolution or measurement function) once every 24 hours.

FREQUENCY COUNTER

FREQUENCY/PERIOD INPUT CHARACTERISTICS AND ACCURACY 90 Days, 1 Year, or 2 Years

	FREQUENCY RANGE[1]	PERIOD RANGE	DEFAULT RESOLUTION	MINIMUM SIGNAL LEVEL 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

MEASUREMENT TECHNIQUE: Unique pulse count/time count at overflow.

TIME BASE: 7.68MHz ± 0.01%, 0°C to 55°C.

READING TIME: 420ms maximum.

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 2×10^7 V • Hz product (for inputs above 20V).

TEMPERATURE (RTD)

RANGE	RESOLUTION	4-WIRE ACCURACY[3] 1 Hour[2]	90 Days	1 Year	2 Years
–100° to +100°C	0.001°C	±0.005°C	±0.05°C	±0.08°C	±0.12°C
–200° to +630°C	0.001°C	±0.005°C	±0.12°C	±0.14°C	±0.18°C
–212° to +180°F	0.001°F	±0.009°F	±0.09°F	±0.15°F	±0.22°F
–360° to +1102°F	0.001°F	±0.009°F	±0.15°F	±0.18°F	±0.33°F

RTD TYPE: 100Ω platinum; DIN 43 760 or IPTS-68, alpha 0.00385, 0.00390, 0.003916, or 0.00392, 4-wire.

MAXIMUM LEAD RESISTANCE (each lead): 12Ω (to achieve rated accuracy).

SENSOR CURRENT: 1mA (pulsed).

COMMON MODE REJECTION: <0.005°C/V at DC, 50Hz, 60Hz and 400Hz, (100Ω imbalance, LO driven).

TEMPERATURE COEFFICIENT: ±(0.0013% + 0.005°C)/°C or ±(0.0013% + 0.01°F)/°C outside T_{CAL} ±5°C.

RTD TEMPERATURE READING RATES[1] (2- or 4-Wire)

NPLC	READINGS or READINGS WITH TIME STAMP/SECOND TO MEMORY or IEEE-488 Auto Zero Off	Auto Zero On
10	1 (1)	1 (1)
2	5 (4.3)	4 (3.6)
1	7 (6.5)	6 (5.5)
0.1	12 (10.8)	9 (9)
0.01	12 (12)	10 (10)

TEMPERATURE (Thermocouple)

THERMOCOUPLE TYPE	RANGE	DEFAULT RESOLUTION	ACCURACY[4]
J	–200° to + 760°C	0.1°C	±0.5°C
K	–200° to +1372°C	0.1°C	±0.5°C
T	–200° to + 400°C	0.1°C	±0.5°C
E	–200° to +1000°C	0.1°C	±0.6°C
R	0° to +1768°C	1 °C	±3 °C
S	0° to +1768°C	1 °C	±3 °C
B	+350° to +1820°C	1 °C	±5 °C

TC TEMPERATURE READING RATES[1]

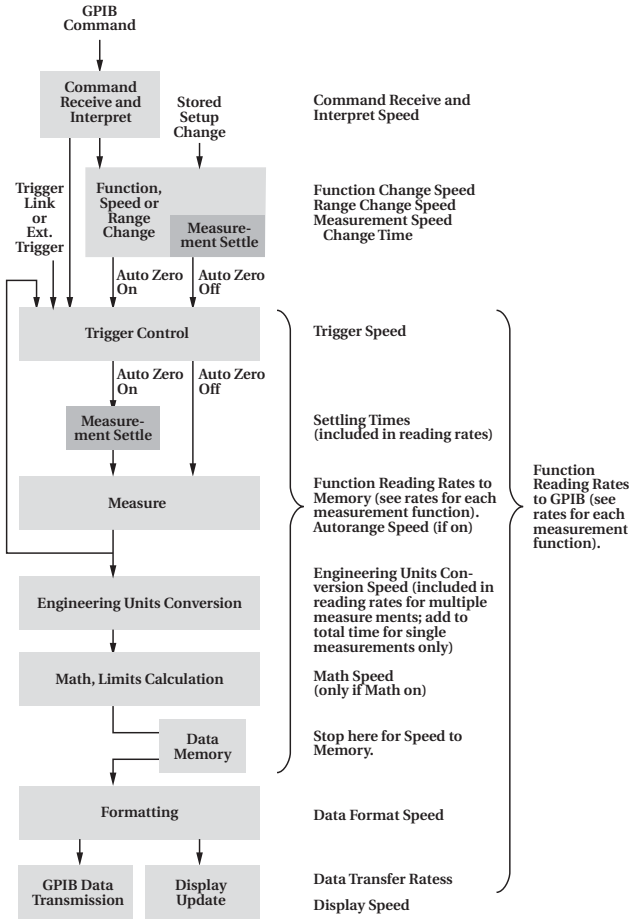
NPLC	READINGS/SECOND TO MEMORY Auto Zero Off	Auto Zero On	READINGS/SECOND TO IEEE-488 Auto Zero Off	Auto Zero On	READINGS/SECOND WITH TIME STAMP TO IEEE-488 Auto Zero Off	Auto Zero On
10	6 (5.1)	2 (1.7)	4 (3.4)	2 (1.4)	4 (3.4)	2 (1.4)
2	30 (25)	9 (7.6)	28 (23)	9 (7.3)	27 (22)	8 (7.2)
1	57 (48)	43 (37)	53 (45)	40 (32)	49 (41)	37 (30)
0.1	139 (139)	95 (95)	126 (123)	85 (84)	99 (99)	72 (72)
0.01	177 (177)	98 (98)	156 (156)	87 (87)	119 (119)	73 (73)

TEMPERATURE NOTES

1. Typical speeds for Auto Zero on. For DELAY=0, digital filter off, display off, internal trigger. Rates are for 60Hz and (50Hz).
2. For ambient temperature ±1°C, measured temperature ±10°C, 10-reading digital filter.
3. Excluding probe errors. T_{CAL} ±5°C.
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.

OPERATING SPEED

The following diagram illustrates the factors that determine a DMM's reading rate.



COMMAND RECEIVE AND INTERPRET SPEED

	FASTEST	TYPICAL	SLOWEST
Time per character	0.16 ms	0.28 ms	0.66 ms
Characters per second	6250	3751	1515

TYPICAL COMMAND TIMES Command	Receive and Interpret Time	Rate (per second)
SENSE1:VOLTAGE:AC: RESOLUTION MAXIMUM	9.4 ms	106
VOLT:AC:RES:MAX	4.1 ms	243
SENSE1:FUNC 'VOLT:AC"	6.3 ms	158
RESISTANCE:RANGE:UPPER 1E9	9.0 ms	111
STATUS:QUEUE:CLEAR	5.1 ms	196
STAT:QUE:CLE	3.1 ms	322
*TRG	1.2 ms	833

MEASUREMENT SPEED CHANGE TIMES[1,2]

Typical delay before first reading after making a speed change.

FUNCTION	From	To	AUTO ZERO OFF Time	AUTO ZERO ON Time
DCV, DCI, ACI	Any	≤ 0.1 PLC	66 ms	44 ms
	Any	1 PLC	190 ms	140 ms
	Any	10 PLC	1540 ms	1195 ms
ACV	Any	≤ 0.1 PLC	120 ms	100 ms
	Any	1 PLC	250 ms	197 ms
	Any	10 PLC	1600 ms	1250 ms
Ohms (2-wire)	Any	≤ 0.1 PLC	69 ms	57 ms
	Any	1 PLC	195 ms	170 ms
	Any	10 PLC	1540 ms	1370 ms
Ohms (4-wire)	Any	≤ 0.1 PLC	110 ms	46 ms
	Any	1 PLC	240 ms	165 ms
	Any	10 PLC	1590 ms	1370 ms
TC Temperature	Any	≤ 0.1 PLC	80 ms	55 ms
	Any	1 PLC	195 ms	170 ms
	Any	10 PLC	1545 ms	1370 ms

FUNCTION CHANGE SPEED[1]

FROM Function	TO Function	Range(s)	AUTO ZERO OFF TIME	AUTO ZERO OFF RATE (per second)	AUTO ZERO ON TIME	AUTO ZERO ON RATE (per second)
Any	DCV	200mV, 2V	8.1 ms	120	36 ms	27
		20V	8.1 ms	120	8.6 ms	110
		200V	24 ms	40	52 ms	19
		1000V	11 ms	160	10.2 ms	190
Any	ACV	Any	563 ms	1.8	563 ms	1.8
Any except ACI	DCI	200µA, 2mA, 20mA	4.5 ms	220	5.1 ms	190
		200mA, 2A	6.0 ms	160	6.6 ms	150
ACI		Any	21.1 ms	45	22 ms	45
Any	ACI	Any	521 ms	1.9	521 ms	1.9
Any	Ohms (2-wire)	20Ω, 200Ω, 2kΩ, 20kΩ	6.0 ms	165	34 ms	29
		200kΩ	26 ms	38	61 ms	16
		2MΩ	95 ms	10.5	425 ms	2.4
		20MΩ	265 ms	4	690 ms	1.4
		200MΩ, 1GΩ	366 ms	3	5.5 ms	180
Any	Ohms (4-wire)	20Ω, 200Ω, 2kΩ, 20kΩ	12 ms	140	34.1 ms	29
		200kΩ	26 ms	38	60 ms	16
Any except ACI and Ohms	Frequency[8]	Any	61 ms	16	60 ms	17
ACI, Ohms (4-wire)		Any	79 ms	12	75 ms	13
Ohms (2-wire)		Any	418 ms	2	416 ms	2
Any	RTD Temp. (2-wire)	Any	6.0 ms	165	33 ms	30
	RTD Temp. (4-wire)	Any	11.5 ms	150	37 ms	27
	TC Temp.	Any	8.0 ms	125	35 ms	28

OPERATING SPEED (cont'd)

RANGE CHANGE SPEED[1]

FUNCTION	From	To	AUTO ZERO OFF TIME	AUTO ZERO OFF RATE (per second)	AUTO ZERO ON TIME	AUTO ZERO ON RATE (per second)
DCV	200mV, 2V	20V	4.5 ms	220	3.1 ms	190
	200V, 1000V	20V	8.0 ms	120	8.6 ms	110
	200mV, 2V, 20V	200mV, 2V, 20V	4.5 ms	220	36 ms	27
	200V, 1000V	200mV, 2V	8.0 ms	120	38 ms	26
	200mV, 2V, 20V	200V	24 ms	41	52 ms	19
	1000V	200V	9 ms	110	37 ms	27
	Any	1000V	11 ms	165	10.1 ms	190
ACV	Any	Any	563 ms	1.8	563 ms	1.8
DCI	Any	200µA, 2mA, 20mA	4.5 ms	220	5.2 ms	190
		200mA, 2A	6.0 ms	160	6.6 ms	150
ACI	Any	Any	525 ms	1.9	525 ms	1.9
Ohms (2-wire)	Any	20Ω, 200Ω, 2kΩ, 20kΩ	6.0 ms	160	34 ms	29
	Any	200kΩ	26 ms	38	66 ms	15
	Any	2MΩ	95 ms	10	420 ms	2.3
	Any	20MΩ	265 ms	3.7	690 ms	1.4
	Any	200MΩ, 1GΩ	366 ms	2.7	5.5 ms	180
Ohms (4-wire)	Any	20Ω, 200Ω, 2kΩ, 20kΩ	8 ms	160	34 ms	29
	Any	200kΩ	26 ms	38	66 ms	16

TRIGGER SPEED (External Trigger or Trigger-Link)

	Auto Zero On	Auto Zero Off
Trigger Latency:	1.2 ms typical	2 µs
Trigger Jitter:		±0.5 µs

ENGINEERING UNIT CONVERSION SPEED

Included in reading times for multiple measurements; add to total time for single measurements only.

CONFIGURATION	TIME	RATE (per second)
DCV	2.4 ms	416
DCV, Filter on	2.4 ms	416
DCV, Relative on	2.5 ms	400
DCV, Ratio on	3.7 ms	270
ACV	5.3 ms	188
ACV, Relative on	5.3 ms	188
ACV, Filter on	6.8 ms	147
ACV, dB	9.4 ms	106
ACV, dBm	17.3 ms	57

DISPLAY SPEED

Display updated at up to 20 times per second. Display update can be suspended by holding the display (press ENTER) or setting Display Enable Off from GPIB.

MATH AND LIMITS CALCULATION SPEED[1]

CALCULATION	NOMINAL TIME	NOMINAL RATE (per second)	MAXIMUM TIME
mX + b	0.35 ms	2850	0.44 ms
Percent	0.60 ms	1660	0.64 ms
Limits[6]	0.35 ms	2850	0.37 ms
None	0.07 ms		0.08 ms

GPIB DATA FORMATTING TRANSMISSION TIME[3]

FORMAT	READINGS ONLY Time	READINGS ONLY Rdg./s	READINGS WITH TIME STAMP Time	READINGS WITH TIME STAMP Rdg./s
DREAL (Double precision real)	0.30 ms	3330	2.0 ms	500
SREAL (Single precision real)	0.37 ms	2710	2.1 ms	475
ASCII	3.9 ms	255	8.2 ms	120

SINGLE FUNCTION SCAN SPEED[4] (Internal Scanner)

TYPE	DCV (20V)[7] Time per Chan.	DCV (20V)[7] Rate (Chan./second)	2-Wire Ohms (2kΩ)[7] Time per Chan.	2-Wire Ohms (2kΩ)[7] Rate (Chan./second)	4-Wire Ohms (2kΩ)[7] Time per Chan.	4-Wire Ohms (2kΩ)[7] Rate (Chan./second)	ACV Time per Chan.	ACV Rate (Chan./second)	Frequency Time per Chan.	Frequency Rate (Chan./second)	TC Temperature Time per Chan.	TC Temperature Rate (Chan./second)	RTD Temperature (2-Wire) Time per Chan.	RTD Temperature (2-Wire) Rate (Chan./second)
Ratio or Delta[5] (2 channels)	4 ms	250	4.4 ms	230	18.5 ms	54								
Fast Scan (using solid state channels)	5.5 ms	181	7 ms	140			520 ms	1.9	958 ms	1	13.8 ms	72		
Normal Scan	10.3 ms	97	12.1 ms	80	21 ms	47	532 ms	1.8	974 ms	1	18 ms	55	95 ms	10

MIXED FUNCTION SCAN SPEED[1] (Internal Scanner)

SCAN CONFIGURATION (Channels)	Average Time/ Channel	Average Rate (Channel/s)
5 chan. DCV, 5 chan. 2wΩ	20 ms	50
3 DCV, 3 2wΩ, 4 TC	22 ms	45
5 2wRTD, 5 TC	60 ms	17
5 2wΩ, 5 2wRTD	60 ms	17
9 DCV, 1 ACV	73 ms	13
2 DCV, 1 ACV, 2 2wΩ, 1 4wΩ	122 ms	8
5 DCV, 5 Freq.	490 ms	2
3 DCV, 3 ACV, 2 4wΩ	220 ms	5

OPERATING SPEED NOTES

1. With Display off, 1 power line cycle, autorange off, filter off, triggers halted. Display on may impact time by 3% worst case. To eliminate this impact press ENTER (hold) to lock out display from front panel.
2. Based on using 20V, 2kΩ, 200mA ranges.
3. Auto Zero off, using 386SX/16 computer, average time for 1000 readings, byte order swapped, front panel disabled.
4. Typical times for 0.01 power line cycle, autorange off, Delay=0, 100 measurements into buffer.
5. Ratio and delta functions output one value for each pair of measurements.
6. Time to measure, evaluate limits, and set digital outputs are found by summing measurement time with limits calculation time.
7. Auto Zero off.
8. Based on 100kHz input frequency.

DELAY AND TIMER

TIME STAMP

Resolution: 1µs.
Accuracy: ±0.01% ±1µs.
Maximum: 2,100,000.000 000 seconds (24 days, 20 hours).

DELAY TIME (Trigger edge to reading initiation)

Maximum: 999,999.999 seconds (11 days, 12 hours).
Resolution: 1ms.
Jitter: ±1ms.

TIMER (Reading initiation to reading initiation)

Maximum: 999,999.999 seconds (11 days, 12 hours).
Resolution: 1ms.
Jitter: ±1ms.

NOTE: To find measurement speed, see each measurement section.

MAXIMUM INPUT LEVELS

	RATED INPUT[1]		OVERLOAD RECOVERY TIME
HI to LO	±1100V pk		< 900 ms
HI Sense to LO	± 350V pk	250V rms	< 900 ms
LO Sense to LO	± 350V pk	250V rms	< 900 ms
I Input to LO	2A, ± 250V	(fused)	—
HI to Earth	±1600V		< 900 ms
LO to Earth	± 500V		

1. For voltages between other terminals, these ratings can be algebraically 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.

GENERAL SPECIFICATIONS AND STANDARDS COMPLIANCE

POWER

Voltage: 90–134V and 180–250V, universal self-selecting.
Frequency: 50Hz, 60Hz, or 400Hz self-identifying.
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.

NORMAL CALIBRATION

Type: Software. No manual adjustments required.
Sources: 2 DC voltages (2V, 20V) and 2 resistances (19k and 1M). Different calibration source values are allowed. All other functions calibrated (adjusted) from these sources and a short circuit. No AC calibrator required for adjustment.

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 (<20lbs.).

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.
Reliability: MIL-T-28800E[1].
Maintainability: MIL-T-28800E[1].
MTTR: <90 minutes (includes disassembly and assembly, excludes recalibration). MTTR is Mean Time To Repair.
MTBF, Estimated: >75,000 hours (Bellcore method). MTBF is Mean Time Between Failure.
MTTC: <20 minutes for normal calibration. <6 minutes for AC self-calibration. MTTC is Mean Time To Calibrate.
Process: MIL-STD 45662A and BS5750.

ACCESSORIES SUPPLIED

The unit is shipped with line cord, high performance modular test leads, user's manual, option slot cover, and full calibration data. A personal computer startup package is available free.

Note 1: For MIL-T-28800E, applies to Type III, Class 5, Style E.

EXTENDED MEMORY / NON-VOLATILE MEMORY OPTIONS

	DATA STORAGE				SETUP STORAGE	
MODEL	SIZE (Bytes)	4½-Digit	6½-Digit w/Time Stamp	Type	Number	Type
2001	8k	2,027	404	volatile	1	non-volatile
2001/MEM1	32k	6,909	1,381	non-volatile	5	non-volatile
2001/MEM2	128k	29,908	5,980	non-volatile	10	non-volatile

These are the minimum sizes to expect.

Specifications subject to change without notice.