2182 Nanovoltmeter Specifications

Volts Specifications (20% over range)

CONDITIONS: 1PLC with 10 reading digital filter or 5PLC with 2 reading digital filter.

CHANNEL 1 RANGE	RESOLUTION	INPUT RESISTANCE	ACCURACY: ±(ppm of reading + ppm of range) (ppm = parts per million) (e.g., 10ppm = 0.001%) 24 Hour[1] T_{CAL} ±1°C	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C
10.000000 mV[2, 3, 4]	1 nV	>10 GΩ	20 + 4	40 + 4	50 + 4	60 + 4	(1 + 0.5)/°C
100.00000 mV	10 nV	>10 GΩ	10 + 3	25 + 3	30 + 4	40 + 5	(1 + 0.2)/°C
1.0000000 V	100 nV	>10 GΩ	7 + 2	18 + 2	25 + 2	32 + 3	(1 + 0.1)/°C
10.000000 V	1 µV	>10 GΩ	2 + 1[5]	18 + 2	25 + 2	32 + 3	(1 + 0.1)/°C
100.00000 V[4]	10 µV	10 MΩ ±1%	10 + 3	25 + 3	35 + 4	52 + 5	(1 + 0.1)/°C
CHANNEL 2[6, 10]							
100.00000 mV	10 nV	>10 GΩ	10 + 6	25 + 6	30 + 7	40 + 7	(1 + 1)/°C
1.0000000 V	100 nV	>10 GΩ	7 + 2	18 + 2	25 + 2	32 + 3	(1 + 0.5)/°C
10.000000 V	1 µV	>10 GΩ	2 + 1[5]	18 + 2	25 + 2	32 + 3	(1 + 0.5)/°C

CHANNEL 1/CHANNEL 2 RATIO: Ratio accuracy = accuracy of selected Channel 1 range + accuracy of selected Channel 2 range.

($V1_{t1} - V1_{t2}$)/2 (DELTA): Delta accuracy = accuracy of selected Channel 1 range.

DC Noise Performance[7] (DC noise expressed in volts peak-to-peak)

Response time = time required for reading to be settled within noise levels from a stepped input, 60Hz operation.

CHANNEL 1 RESPONSE TIME	NPLC, FILTER	RANGE 10mV	100mV	1V	10V	100V	NMRR[8]	CMRR[9]
25.0 s	5, 75	6 nV	20 nV	75 nV	750 nV	75 µV	110 dB	140 dB
4.0 s	5, 10	15 nV	50 nV	150 nV	1.5 µV	75 µV	100 dB	140 dB
1.0 s	1, 18	25 nV	175 nV	600 nV	2.5 µV	100 µV	95 dB	140 dB
667 ms	1, 10 or 5, 2	35 nV	250 nV	650 nV	3.3 µV	150 µV	90 dB	140 dB
60 ms	1, Off	70 nV	300 nV	700 nV	6.6 µV	300 µV	60 dB	140 dB
CHANNEL 2[10]								
25.0 s	5, 75	—	150 nV	200 nV	750 nV	—	110 dB	140 dB
4.0 s	5, 10	—	150 nV	200 nV	1.5 µV	—	100 dB	140 dB
1.0 s	1, 10 or 5, 2	—	175 nV	400 nV	2.5 µV	—	90 dB	140 dB
85 ms	1, Off	—	425 nV	1 µV	9.5 µV	—	60 dB	140 dB

Voltage Noise vs. Source Resistance[11]

(DC noise expressed in volts peak-to-peak)

SOURCE RESISTANCE	NOISE	ANALOG FILTER	DIGITAL FILTER
0 Ω	6 nV	Off	100
100 Ω	8 nV	Off	100
1 kΩ	15 nV	Off	100
10 kΩ	35 nV	Off	100
100 kΩ	100 nV	On	100
1 MΩ	350 nV	On	100

Temperature (Thermocouples)[12]

(Displayed in °C, °F, or K. Accuracy based on ITS-90, exclusive of thermocouple errors.)

TYPE	RANGE	RESOLUTION	ACCURACY 90 Day/1 Year 23° ±5°C Relative to Simulated Reference Junction
J	–200 to +760°C	0.001 °C	±0.2 °C
K	–200 to +1372°C	0.001 °C	±0.2 °C
N	–200 to +1300°C	0.001 °C	±0.2 °C
T	–200 to +400°C	0.001 °C	±0.2 °C
E	–200 to +1000°C	0.001 °C	±0.2 °C
R	0 to +1768°C	0.1 °C	±0.2 °C
S	0 to +1768°C	0.1 °C	±0.2 °C
B	+350 to +1820°C	0.1 °C	±0.2 °C

Operating Characteristics[13, 14]

60Hz (50Hz) Operation

FUNCTION	DIGITS	READINGS/s	PLCs
DCV Channel 1, Channel 2, Thermocouple	7.5	3 (2)	5
	7.5[17, 19]	6 (4)	5
	6.5[18, 19]	18 (15)	1
	6.5[18, 19, 20]	45 (36)	1
	5.5[17, 19]	80 (72)	0.1
	4.5[16, 17, 19]	115 (105)	0.01
Channel 1/Channel 2 (Ratio), ($V1_{t1} - V1_{t2}$)/2 (Delta), Scan	7.5	1.5 (1.3)	5
	7.5[17, 19]	2.3 (2.1)	5
	6.5[18]	8.5 (7.5)	1
	6.5[18, 20]	20 (16)	1
	5.5[17]	30 (29)	0.1
	4.5[17]	41 (40)	0.01

System Speeds[13, 15]

RANGE CHANGE TIME:[14] <40 ms (<50 ms).

FUNCTION CHANGE TIME:[14] <45 ms (<55 ms).

AUTORANGE TIME:[14] <60 ms (<70 ms).

ASCII READING TO RS-232 (19.2K Baud): 40/s (40/s).

MAX. INTERNAL TRIGGER RATE:[16] 120/s (120/s).

MAX. EXTERNAL TRIGGER RATE:[16] 120/s (120/s).

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Measurement Characteristics

A-D LINEARITY: 0.8ppm of reading + 0.5ppm of range.

FRONT AUTOZERO OFF ERROR: 10mV - 10V: Add ±(8ppm of range + 500µV) for <10 minutes and ±1°C.

AUTOZERO OFF ERROR

10mV: Add ±(8ppm of range + 100nV) for <10 minutes and ±1°C.
100mV–100V: Add ±(8ppm of range + 10µV) for <10 minutes and ±1°C.

NOTE: Offset voltage error does not apply for Delta Mode.

INPUT IMPEDANCE

10mV–10V: >10GΩ, in parallel with <1.5nF.
100V: 10MΩ ±1%.

INPUT BIAS CURRENT: <50pA DC at 23°C.

COMMON MODE CURRENT: <50nA p-p at 50Hz or 60Hz.

INPUT PROTECTION: 150V peak to any terminal. 70V peak Channel 1 LO to Channel 2 LO.

CHANNEL ISOLATION: >10GΩ.

EARTH ISOLATION: 350V peak, >10GΩ and <150pF any terminal to earth. Add 35pF/ft with Model 2107 Low Thermal Input Cable.

Analog Output

MAXIMUM OUTPUT: ±1.2V.

ACCURACY: ±(0.1% of output + 1mV).

OUTPUT RESISTANCE: 1kΩ ±5%.

GAIN: Adjustable from 10^{-9} to 10^{6}. With gain set to 1, a full range input will produce a 1V output.

OUTPUT REL: Selects the value of input that represents 0V at output. The reference value can be either programmed value or the value of the previous input.

Triggering and Memory

WINDOW FILTER SENSITIVITY: 0.01%, 0.1%, 1%, 10%, or full scale of range (none).

READING HOLD SENSITIVITY: 0.01%, 0.1%, 1% or 10% of reading.

TRIGGER DELAY: 0 to 99 hours (1ms step size).

EXTERNAL TRIGGER DELAY: 2ms + <1ms jitter with auto zero off, trigger delay = 0.

MEMORY SIZE: 1024 readings.

Math Functions

Rel, Min/Max/Average/Std Dev/Peak-to-Peak (of stored reading), Limit Test, %, and mX+b with user defined units displayed.

Remote Interface

Keithley 182 emulation.

GPIB (IEEE-488.2) and RS-232C.

SCPI (Standard Commands for Programmable Instruments).

GENERAL SPECIFICATIONS

POWER SUPPLY: 100V/120V/220V/240V ±10%.

LINE FREQUENCY: 45Hz to 66Hz and 360Hz to 440Hz, automatically sensed at power-up.

POWER CONSUMPTION: 22VA.

OPERATING ENVIRONMENT: Specified for 0° to 50°C. Specified to 80% RH at 35°C.

MAGNETIC FIELD DENSITY: 10mV range 4.0s response noise tested to 500 gauss.

STORAGE ENVIRONMENT: –40° to 70°C.

WARRANTY: 3 years.

SAFETY: Complies with European Union Directive 73/23/EEC (low voltage directive); meets EN 61010-1 safety standard. Installation category I.

EMC: Complies with European Union Directive 89/336/EEC (CE marking requirement), FCC part 15 class B, CISPR 11, IEC 801-2, IEC-801-3, IEC 801-4.

VIBRATION: MIL-T-28800E Type III, Class 5.

WARM-UP: 2.5 hours to rated accuracy.

DIMENSIONS: Rack Mounting: 89mm high × 213mm wide × 370mm deep (3.5 in × 8.375 in × 14.563 in). Bench Configuration (with handles and feet): 104mm high × 238mm wide × 370mm deep (4.125 in × 9.375 in × 14.563 in).

SHIPPING WEIGHT: 5kg (11 lbs).

Accessories Supplied

2107-4: Low Thermal Input Cable with spade lugs, 1.2m (4 ft).

User manual, service manual, contact cleaner, line cord, alligator clips.

Accessories Available

2107-30: Low Thermal Input Cable with spade lugs, 9.1m (30 ft)
2182-KIT: Low Thermal Connector with strain relief
2188: Low Thermal Calibration Shorting Plug
4288-1: Single Fixed Rack Mount Kit
4288-2: Dual Fixed Rack Mount Kit
7007-1: Shielded GPIB Cable, 1m (3.2 ft)
7007-2: Shielded GPIB Cable, 2m (6.5 ft)
7009-5: Shielded RS-232 Cable, 1.5m (5 ft)
8501-1: Trigger-Link Cable, 1m (3.2 ft)
8501-2: Trigger-Link Cable, 2m (6.5 ft)
8502: Trigger-Link Adapter to 6 female BNC connectors
8503: Trigger-Link Cable to 2 male BNC connectors

Notes

1. Relative to calibration accuracy.
2. With Analog Filter on, add 20ppm of reading to listed specification.
3. When properly zeroed using REL function. If REL is not used, add 100nV to the range accuracy.
4. Specifications include the use of ACAL function. If ACAL is not used, add 9ppm of reading/°C from T_{CAL} to the listed specification. T_{CAL} is the internal temperature stored during ACAL.
5. For 5PLC with 2-reading Digital Filter. Use ±(4ppm of reading + 2ppm of range) for 1PLC with 10-reading Digital Filter.
6. Channel 2 must be referenced to Channel 1. Channel 2 HI must not exceed 125% (referenced to Channel 1 LO) of Channel 2 range selected.
7. Noise behavior using 2188 Low Thermal Short after 2.5 hour warm-up. ±1°C. Analog Filter off. Observation time = 10× response time or 2 minutes, whichever is less.
8. For L_{SYNC} On, line frequency ±0.1%. If L_{SYNC} Off, use 60dB.
9. For 1kΩ unbalance in LO lead. AC CMRR is 70dB.
10. For Low Q mode On, add the following to DC noise and range accuracy at stated response time: 200nV p-p @ 25s, 500nV p-p @ 4.0s, 1.2µV p-p @ 1s, and 5µV p-p @ 85ms.
11. After 2.5 hour warm-up, ±1°C, 5PLC, 2 minute observation time, Channel 1 10mV range only.
12. For Channel 1 or Channel 2, add 0.3°C for external reference junction. Add 2°C for internal reference junction.
13. Speeds are for 60Hz (50Hz) operation using factory defaults operating conditions (*RST). Autorange Off, Display Off, Trigger Delay = 0, Analog Output off.
14. Speeds include measurements and binary data transfer out the GPIB. Analog Filter On, 4 readings/s max.
15. Auto Zero Off, NPLC = 0.01.
16. 10mV range, 80 readings/s max.
17. Sample count = 1024, Auto Zero Off.
18. For L_{SYNC} On, reduce reading rate by 15%.
19. For Channel 2 Low Q mode Off, reduce reading rate by 30%.
20. Front Auto Zero Off, Auto Zero Off.

HW 7/30/01
Rev. D