181/Nanovoltmeter

Bench/Systems

- **10nV sensitivity**
- **10nV/°C stability (typical)**
- **μP controlled**
- **5½—6½-digit resolution**
- **Fully programmable**
- **Standard IEEE-488 interface**
- **Pushbutton zero**

10nV sensitivity. The 181 was designed to provide useable 10nV sensitivity. A proprietary JFET input amplifier provides the ultra-low noise and high linearity required for this application.

The 181 should not be confused with μP DMMs that average microvolt readings, then display "nanovolts". The 181 is optimized for nanovolt measurements.

Stability. The 181's zero stability is typically 10nV/°C for ambient temperature rates of change of less than 2°C/hr.

Rapid response with low noise. Nanovoltmeter users have always requested an instrument with conflicting design parameters: fast response to a step input and low noise response to a DC or slowly varying input. The μP has allowed Keithley to offer a discontinuous digital filter, acting on the rate of input change, to provide both fast response and low noise performance.

When a large input change is sensed with damping "out", the μP switches off its 3-pole digital filter to allow a fast reading update which will be within 25 digits of final value. The filter is then switched on for low noise settling to the final value.

For a slowly varying signal, damping "in" is optimum. This allows the instrument to track the signal in a continuous manner by keeping its 3-pole digital filter "in" at all times.

Other Features.

- The readout can be expanded from 5½-digit to 6½-digit resolution by depressing the HI RES pushbutton. 6½ digits are always available on the IEEE-488 bus.
- All front panel controls are programmable.
- Front panel annunciator lamps continuously update instrument status. This is particularly helpful in systems applications.
- The isolated analog output is provided. This output can be set to represent either the three least significant decades or the three most significant decades of the displayed reading.
- The mV Input connector is manufactured with special Low Thermal EMF materials to minimize zero shifts and offsets.
- The Zero control also serves as a baseline suppression, since all readings displayed are the difference between the stored baseline and the actual voltage.

DC VOLTS

RANGE	5½-DIGIT RESOLUTION	ACCURACY ±(%rdg + digits) 24 HR., 22°-24°C	ACCURACY ±(%rdg + digits) 1 YR., 18°-28°C	TEMPERATURE COEFFICIENT ±(%rdg+digits)/°C 0°-18°C & 28°-35°C	INPUT RESISTANCE	MAXIMUM ALLOWABLE INPUT	NMRR (LINE FREQUENCY)
2mV	10 nV	0.006% + 5 d*	0.015% + 5d*	0.002 % + 3 d	> 1 GΩ	120V**	> 90dB
20mV	100 nV	0.006% + 2 d*	0.015% + 2d*	0.002 % + 0.5d	> 1 GΩ	120V**	> 80dB
200mV	1 μV	0.006% + 2 d	0.015% + 2d	0.002 % + 0.2d	> 1 GΩ	120V**	> 80dB
2 V	10 μV	0.004% + 1.5d	0.007% + 2d	0.0007% + 0.2d	> 1 GΩ	1000V	> 60dB
20 V	100 μV	0.004% + 1.5d	0.01 % + 2d	0.0008% + 0.2d	10MΩ	1000V	> 60dB
200 V	1mV	0.004% + 1.5d	0.01 % + 2d	0.0008% + 0.2d	10MΩ	1000V	> 60dB
1000 V	10mV	0.005% + 1.5d	0.01 % + 2d	0.0012% + 0.2d	10MΩ	1000V	> 60dB

CMRR: 160dB on mV ranges, 140dB on V ranges; at DC and line frequency (50 or 60Hz).

*When properly zeroed.
**10 seconds maximum; 35V rms continuous.

IEEE-488 BUS IMPLEMENTATION:

Multiline Commands: DCL, LLO, SDC, GET.
Uniline Commands: IFC, REN, EOI, SRQ, ATN.

PROGRAMMABLE PARAMETERS:
Front Panel Controls: Range, Filter, Zero, Damping, Hi Resolution.
Internal Parameters: SRQ Response, Trigger Modes, Data Terminators

ADDRESS MODES: Talk-Only and Addressable.

TRIGGER MODES:
One Shot: Updates output buffer once at first valid conversion after trigger on TALK and/or GET.
Continuous: Updates output buffer at all valid conversions after trigger.

GENERAL

NOISE: Less than 30nV p-p on lowest range with Filter on.

INPUT CAPACITANCE: 5000pF on mV ranges.

SETTLING TIME: 0.5 sec. to within 25 digits of final reading with Filter on, Damping off.

FILTER: 3-pole digital; RC = .5, 1 or 2 seconds depending on range.

CONVERSION SPEED: 4 readings/second.

DISPLAY: Seven 13mm (0.5 in.) LED digits with appropriate decimal point and polarity.

OVERLOAD INDICATION: Display indicates polarity and OFLO.

ANALOG OUTPUT:
Accuracy: ±(.15% of displayed reading + 1mV).
Time Constant: 400ms.
Level: ±2V full scale on all ranges; X1 or X1000 gain.

ISOLATION: Input LO to output LO or power line ground: 1400V peak, 5 × 10^5V•Hz, greater than 10^{10}Ω paralleled by 1500pF.

WARMUP: 1 hour to rated accuracy when properly zeroed.

ENVIRONMENTAL LIMITS:
Operating: 0°C to 35°C, 0% to 80% relative humidity.
Storage: −25°C to 65°C.

POWER: 105-125V or 210-250V (internal switch selected), 50-60Hz, 30V•A maximum.

INPUT CONNECTORS: Special low thermal for 200mV and lower ranges. Binding posts for 2V to 1000V ranges.

DIMENSIONS, WEIGHT: 127mm high × 216mm wide × 359mm deep (5" × 8½" × 14¼"). Net weight 3.85kg (8½ lbs.).