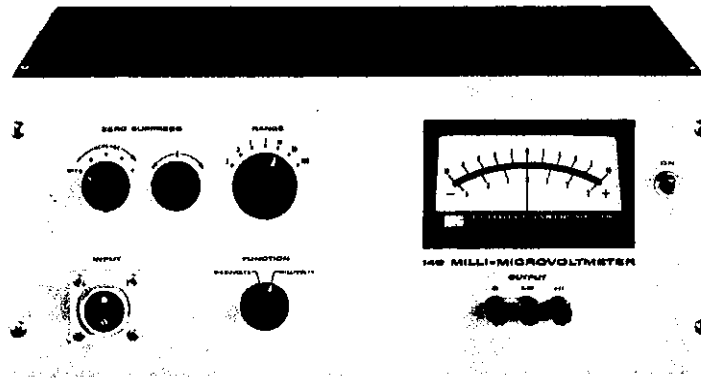


# MODEL 149

# NANOVOLTMETER



## specifications, model 149

**RANGE:** 0.1 microvolt ( $10 \times 10^{-8}$  volt) full scale to 100 millivolts on zero-center meter. 13 overlapping ranges in 1x and 3x steps.

**ACCURACY:**  $\pm 3\%$  of full scale on all ranges exclusive of noise and drift.

**ZERO DRIFT:** Less than 10 nanovolts per hour or less than 30 nanovolts in any 8-hour period after approximately 2-hour warm-up with reasonably constant ambient temperature. Long-term drift is non-cumulative.

**INPUT NOISE (with input shorted):** Less than 0.6 nanovolt rms (3 nanovolts peak-to-peak) on most sensitive range.

### INPUT CHARACTERISTICS:

Range	Input Resistance Greater than	Maximum Source Resistance <sup>1</sup>
0.1 $\mu$ V	10 k $\Omega$	100 $\Omega$
0.3 $\mu$ V	30 k $\Omega$	300 $\Omega$
1.0 $\mu$ V	100 k $\Omega$	1 k $\Omega$
3.0 $\mu$ V	300 k $\Omega$	3 k $\Omega$
10.0 $\mu$ V	1 M $\Omega$	10 k $\Omega$
30.0 $\mu$ V	3 M $\Omega$	30 k $\Omega$
100 $\mu$ V and above	10 M $\Omega$	30 k $\Omega$

Note: <sup>1</sup>Source resistances higher than the recommended maximum will increase noise and rise time.

**LINE FREQUENCY REJECTION:** Greater than 50:1 on the most sensitive range. (Ratio of impressed peak-to-peak line frequency voltage at input to indicated dc voltage.)

**ISOLATION:** Circuit ground to chassis ground: Approximately  $10^8$  ohms shunted by 0.05 microfarad. Circuit ground may be floated up to  $\pm 400$  volts with respect to chassis ground.

### RISE TIME (10% to 90%):

**0.1-microvolt Range:** Less than 2 seconds when source resistance is less than 10% of maximum; 4 seconds using maximum source resistance.

**0.3-microvolt to 100-millivolt Ranges:** Less than 1 second when source resistance is less than 10% of maximum; 2 seconds using maximum source resistance.

**ZERO SUPPRESSION:** Up to at least 1 millivolt on the microvolt ranges and up to at least 10 millivolts on the millivolt ranges. Stability is such that 100 times full scale may be suppressed.

### RECORDER OUTPUT:

**Output:**  $\pm 10$  volts dc at up to 5 milliamperes for full-scale meter deflection.

**Resistance:** Less than 10 ohms within the amplifier pass band.

**Gain:** 10 volts/Range setting in volts

**Noise:** Input noise times gain plus modulation products.

**Modulation Products:** Less than 2% peak-to-peak of full scale with input shorted.

**CONNECTORS:** Input: Special connector. Front Output: Binding posts. Rear Output: Amphenol 80-PC2F.

**POWER:** 105-125 or 210-250 volts, 60 Hz, 50 watts. 50-Hz models available.

**DIMENSIONS, WEIGHT:** 7" high x 19" wide x 13" deep; net weight, 24 pounds.

**ACCESSORIES SUPPLIED:** Model 1501 Low Thermal Input Cable with alligator clips; mating output connector; length of low-thermal solder.

**ACCESSORIES AVAILABLE:** (Also see page 45.)

Model 1483 Low-Thermal Connection Kit	\$ 90
Model 1484 Refill Kit	\$ 35
Model 1491 End Frames: adapts unit for bench use	\$ 20
Model 1498 Low-Thermal Shorting Plug	\$ 30
Model 1501 Low-Thermal Input Cable (extra)	\$ 25
Model 1502 Low-Thermal Input Cable: 10', bare copper leads	\$ 25
Model 1503 Low-Thermal Solder	\$ 7

**PRICES:** (For export pricing see inside front cover.)

Model 149 Milli-microvoltmeter (60 Hz; Rack) \$ 975

Model 149 Milli-microvoltmeter (50 Hz) \$ 1004

# specifications, model 150B

## AS A VOLTMETER AND NULL DETECTOR:

**RANGE:** 0.3 microvolt ( $3 \times 10^{-7}$  volt) full scale to 1 volt on a zero-center meter. 14 overlapping ranges in 1x and 3x steps.

### ACCURACY:

**Meter:**  $\pm 2\%$  of full scale on all ranges.

**1-Volt Output Terminals:**  $\pm 1\%$ .

**100-Millivolt Output Terminals:** Adjustable to  $\pm 1\%$ .

Note: Accuracy specifications exclude noise and drift.

**ZERO DRIFT:** Less than 0.1 microvolt per 24 hours after 1-hour warm-up with reasonably constant ambient temperature. Long-term drift is non-cumulative.

**INPUT NOISE:** With input shorted, less than 5 nanovolts rms (25 nanovolts peak-to-peak) on the most sensitive range.

With 10,000-ohm source resistance, less than 14 nanovolts rms (70 nanovolts peak-to-peak) on the most sensitive range.

### INPUT RESISTANCE

Range	Input Resistance Greater than	Maximum Source <sup>1</sup> Resistance
0.3 $\mu$ V	1 M $\Omega$	10 k $\Omega$
1 $\mu$ V	3 M $\Omega$	30 k $\Omega$
3 $\mu$ V	10 M $\Omega$	100 k $\Omega$
10 $\mu$ V	30 M $\Omega$	300 k $\Omega$
30 $\mu$ V and above	100 M $\Omega$	1 M $\Omega$

Note: <sup>1</sup>Source resistance higher than the recommended maximum will increase noise and rise time.

**ZERO SHIFT WITH SOURCE RESISTANCE:** Less than  $10^{-10}$  volt per ohm.

**LINE FREQUENCY REJECTION<sup>1</sup>:** A voltage of power line frequency which is 75 dB (p-p/dc) greater than full scale affects reading less than 2% on the most sensitive range (decreasing to 60 dB on the 10-microvolt range and to 20 dB on the 1-volt range).

**COMMON MODE REJECTION<sup>1</sup>:** Greater than 180 dB at line frequency or dc.

**RISE TIME (10% to 90%)<sup>1</sup>:** Using up to 1000 ohms source resistance, less than 0.5 second on the 30-microvolt and higher ranges, increasing to 3 seconds on the 0.3-microvolt range. Using maximum source resistance up to 100 kilohms, rise times increase to approximately 3 seconds on the 30-microvolt and higher ranges, 6 seconds on the 10-microvolt and lower ranges.

**ZERO SUPPRESSION:** Up to 10 millivolts available. Stability is such that 100 times full scale may be suppressed.

## AS AN AMMETER:

**RANGE:**  $3 \times 10^{-10}$  ampere full scale to  $10^{-3}$  ampere on zero-center meter. 14 overlapping ranges in 1x and 3x steps.

### ACCURACY:

**Meter:**  $\pm 3\%$  of full scale on all ranges.

**1-Volt Output Terminals:**  $\pm 2\%$ .

**100-Millivolt Output Terminals:** Adjustable to  $\pm 2\%$ .

Note: Accuracy specifications exclude noise and drift.

**ZERO DRIFT:**  $\pm 2 \times 10^{-11}$  ampere per 24 hours after 1-hour warm-up.

**INPUT NOISE:** Less than  $3 \times 10^{-12}$  ampere peak-to-peak on the most sensitive range.

**INPUT VOLTAGE DROP:** 100 microvolts on nanoampere ranges, 1 millivolt on microampere ranges.

**INPUT RESISTANCE:** On the microampere ranges, the input resistance is equal to  $10^{-3}$  divided by the range in amperes. On the nanoampere ranges, it is equal to  $10^{-4}$  divided by the range in amperes.

<sup>1</sup>Note: All specifications are measured with filter in. With filter out, rise times for any source resistance up to maximum are less than 0.5 second on the 30-microvolt and higher ranges, increasing to 3 seconds on the 0.3-microvolt range. With filter out, the rejection ratios are reduced about 30 dB.

## GENERAL:

**ISOLATION:** Circuit ground to chassis ground: Greater than  $10^9$  ohms shunted by 0.001 microfarad. Circuit ground may be floated up to  $\pm 400$  volts with respect to chassis ground. On battery operation, may be completely isolated from power line and ground.

### RECORDER OUTPUT (1 volt):

**Output:**  $\pm 1$  volt at up to 1 milliampere for full-scale meter deflection on any range.

**Resistance:** Less than 5 ohms within the amplifier pass band.

**Noise:** Input noise times gain plus modulation products.

**Modulation Products:** Less than 4% peak-to-peak of full scale with input shorted.

### RECORDER OUTPUT (100 millivolts):

**Output:**  $\pm 100$  millivolts adjustable over a 10% span for full-scale meter deflection on any range.

**Resistance:** Less than 1000 ohms.

**Noise:** Input noise times gain plus modulation products.

**Modulation Products:** Less than  $\frac{1}{2}\%$  peak-to-peak of full scale with input shorted.

Using this output, rise time is at least one second on any range.

**CONNECTORS:** Input: Special Keithley Model 1485. Output: Amphenol 80PC2F.

### POWER:

**Line Operation:** 105-125 or 210-250 volts (switch selected), 60 Hz, 25 watts. 50-Hz models available.

**Battery Operation:** Rechargeable nickel-cadmium 6-volt battery pack. Over 9 hours continuous operation from full charge; recharges in less than 16 hours from built-in charging circuit.

**DIMENSIONS, WEIGHT:** 7" high x 8 $\frac{3}{4}$ " wide x 10" deep; net weight, 16 pounds.

**ACCESSORIES SUPPLIED:** Model 1506 Low-Thermal Input Cable: 4' low-thermal triaxial cable, alligator clips. Mating output connector. Length of low-thermal solder. Internally mounted nickel-cadmium battery pack, Model 1489.

**ACCESSORIES AVAILABLE:** (Many of the following accessories are described on page 45.)

- Model 1503 Low-Thermal Solder . . . . . \$ 7
- Model 1506 Low-Thermal Input Cable (extra) . . . . . \$ 35
- Model 1507 Low-Thermal Input Cable: 4', low-thermal triaxial cable, copper spade lugs . . . . . \$ 35
- Model 1483 Low-Thermal Connection Kit . . . . . \$ 90
- Model 1484 Refill Kit . . . . . \$ 35
- Model 1485 Female Low-Thermal Input Connector . . . . . \$ 15
- Model 1486 Male Low-Thermal Input Connector . . . . . \$ 15
- Model 1488 Low-Thermal Shorting Plug . . . . . \$ 30
- Model 1489 Replacement Battery Pack . . . . . \$ 50
- Model 1534 Special Low-Thermal Triaxial Cable: 10' length . . . . . \$ 15
- Model 2603 Low-Thermal Calibration Cable: 4', for use with Model 140, 147, 148 or 150B . . . . . \$ 30
- Model 4006 Rack Mounting Kit: adapts Model 150B for standard 7" x 19" rack mounting. . . . . \$ 30
- Model 4007 Dual Rack Mounting Kit: adapts two Model 150Bs or any two 7" high Keithley half-rack models for side-by-side 7" x 19" rack mounting. . . . . \$ 30
- Model 260 Nanovolt Source (see page 48) . . . . . \$565
- Model 370 Recorder (see page 64) . . . . . \$735

**PRICES:** (For export pricing see inside front cover.)

- Model 150B Microvolt Ammeter (60 Hz, Bench) . . . . . \$895
- Model 150B Microvolt Ammeter (50 Hz) . . . . . \$922

REPORT ON CHANGE IN SPECIFICATIONS

MODEL 149

Distribution: J. Keithley, T. Brick, A. Oliverio, A. Kaplan, W. Allen, C. Cech, R. Nowac, M. Moore, A. Kronenwetter, D. Bartos, Dr. Cath, J. Yeager, T. Davies, G. Herron, J. Butler, S. Sarkisian, R. Streetz, D. Sutphin, E. Kifer, R. Erdman, W. Nichols, T. Sheridan, Engrg. File

The following change was approved by the Catalog Specifications Review Committee at the time the 1970-71 catalog was written and took effect on distribution of the catalog.

Change: ACCURACY: (page 36 of old catalog)  
from:  $\pm 2\%$  of full scale on all ranges exclusive of noise and drift.  
to: ACCURACY: (page 38 of new catalog)  
 $\pm 3\%$  of full scale on all ranges exclusive of noise and drift.

Reason: It was felt that the change would produce negligible sales decreases while effecting considerable manufacturing economies for a net gain in profit.

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ACTION

Manufacturing: Set up manufacturing procedures as necessary to achieve the revised specification. Give notice of the change to applicable personnel in tech check-out and repair.

Engineering: Note revision and change any applicable drawings for instrument or its parts.

Sales: Issue notice of change to entire worldwide sales organization.

Change 149 ad to reflect revision if necessary.

Change 149 manual and any other applicable manuals to reflect revision.

Change any other literature as reprinted to reflect revision.

AMP/bk  
9/8/70