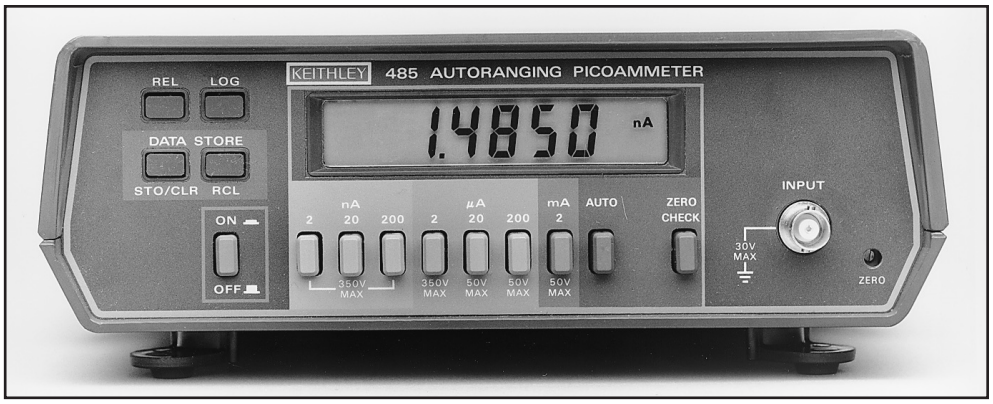
480 and 485 Picoammeters

- 100fA sensitivity
- 200µV maximum voltage burden
- Analog output
- Log I readings
- Optional IEEE-488 interface



ACCESSORIES AVAILABLE

OUTPUT OPTIONS

4853	IEEE-488 Interface (485)

CABLES

4801	Low Noise BNC Input Cable, 1.2m (4 ft)
4802-10	Low Noise BNC Input Cable, 3m (10 ft), unterminated
4803	Low Noise Cable Kit

ADAPTER

4804	Male BNC to Female Triax Adapter

RACK MOUNT KITS

1010	Single Rack Mount Kit
1017	Dual Rack Mount Kit

POWER

1758	Rechargeable Battery Pack (485)

See page A-231 for descriptions of all accessories.

The Model 485 Autoranging Picoammeter provides 100fA sensitivity with 4½-digit resolution in a low-cost, highly sensitive, easy-to-use instrument. The 485 measures DC current on seven ranges covering 10 decades from 100fA to 2mA. The input can withstand overloads as high as 1000V (with 100kΩ limiting resistor) for flexibility in a wide range of applications in test, research, and student labs. An analog output linearly converts the incoming current to voltage for hard copy output or control loop applications.

In addition to 100fA sensitivity, the 485 has both excellent accuracy and low voltage burden. One-year accuracy on the most sensitive range is an impressive 0.4%. The 485's input voltage drop (burden) is actively constrained by feedback techniques to less than 200µV. Thus the 485 makes high accuracy current measurements even in circuits with very low source voltages.

The 485 has several features that facilitate measuring low current. In the autorange mode, the 485 maximizes resolution. The REL button makes readings relative to the baseline (the reading prior to touching the button). The LOG button converts the display to the logarithm (base 10) of the absolute value of the measured current. Digital calibration is performed from the front panel or over the bus.

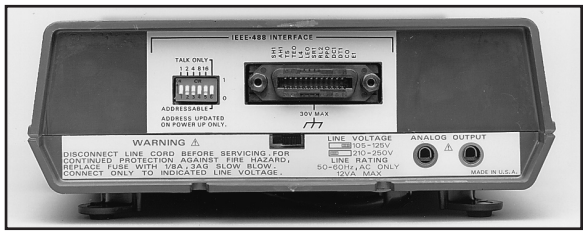
A 100-point data store buffer collects and stores measurements at one of six automatic reading rates from three per second to one per hour, or manually with the STORE button. Minimum and maximum readings are continuously updated at three per second in the data store mode.

Addition of the Model 4853 IEEE-488 Interface to the 485 provides fully programmable computer control. For isolation from the power line or for portability, the 485 can be battery powered with the Model 1758 Rechargeable Battery Pack.

ORDERING INFORMATION

485	Autoranging Picoammeter
485/1758	Autoranging Picoammeter with Rechargeable Battery Pack
485/4853	Autoranging Picoammeter with IEEE-488 Interface
480	Picoammeter
480/1788	Picoammeter with Rechargeable Battery Pack

These products are available with an **Extended Warranty.** See section C for complete ordering information.



MODEL 480

- LED display
- 1pA resolution
- Analog output
- Optional battery power

The Model 480 is an easy-to-use, sensitive ammeter that resolves 1pA at a low price. Simple controls, LED display, shielded BNC input, high normal mode rejection, and excellent overload specifications make it easy to use. The 480 measures DC current from 1pA per digit (2nA full range) to 2mA, with 3½-digit precision. Seven ranges cover the full span of low-current measurements. The input is simply connected to the circuit under test, the appropriate range selected, and the current read from the LED display.

QUESTIONS?

1-800-552-1115 (U.S. only)

Call toll free for technical assistance, product support or ordering information.

480 and 485 Picoammeters

MODEL 485

RANGE	RESOLUTION	ACCURACY (1 Year) 18°-28°C ±(%rdg + counts)*	ANALOG RISE TIME (10%–90%)	NORMAL MODE REJECTION RATIO (50 or 60Hz)	MAXIMUM CONTINUOUS INPUT**
2 nA	100 fA	0.4 + 4	60 ms	70 dB	350 V DC
20 nA	1 pA	0.4 + 1	60 ms	70 dB	350 V DC
200 nA	10 pA	0.2 + 1	6 ms	65 dB	350 V DC
2 µA	100 pA	0.15 + 1	3 ms	65 dB	350 V DC
20 µA	1 nA	0.1 + 1	3 ms	65 dB	50 V DC
200 µA	10 nA	0.1 + 1	1 ms	65 dB	50 V DC
2 mA	100 nA	0.1 + 1	1 ms	55 dB	50 V DC

*When properly zeroed. **With no limiting resistance: 1000V DC with external 100kΩ series resistance.

MODEL 480

RANGE	RESOLUTION	ACCURACY (1 Year) 18°-28°C ±(%rdg + counts)*	ANALOG RISE TIME (10%–90%)	NORMAL MODE REJECTION RATIO (50 or 60Hz)	MAXIMUM CONTINUOUS INPUT**
2 nA	1 pA	0.8 + 4	70 ms	70 dB	600 V DC
20 nA	10 pA	0.8 + 3	70 ms	70 dB	600 V DC
200 nA	100 pA	0.5 + 3	7 ms	60 dB	600 V DC
2 µA	1 nA	0.5 + 3	7 ms	60 dB	600 V DC
20 µA	10 nA	0.5 + 3	4 ms	50 dB	75 V DC
200 µA	100 nA	0.5 + 3	1 ms	50 dB	75 V DC
2 mA	1 µA	0.5 + 3	1 ms	50 dB	20 V DC

*Up to 70% R.H.

INPUT VOLTAGE BURDEN: <200µV.

RANGING: 480: Manual. **485:** Manual or autoranging.

AUTORANGING TIME (485): Average 250ms per range change.

SETTLING TIME AT DISPLAY: <1 second to within 2 counts on fixed range.

CONVERSION PERIOD: 485: 300ms. **480**: 400ms.

TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.1 × applicable accuracy specification)/°C.

MAXIMUM COMMON MODE VOLTAGE: 30V rms, DC to 60Hz sine wave.

ANALOG OUTPUT (485): Output Voltage: +1V = –10000 counts, except +100mV = –10000 counts on 2nA range. **Output Resistance:** 1kΩ.

ANALOG OUTPUT (480): Output Voltage: 1V = 1000 counts. **Output Resistance:** 1kΩ.

REL (485): Pushbutton allows zeroing of on-range readings. Allows relative readings to be made with respect to baseline value. Front panel annunciator indicates REL mode.

DATA STORE and MIN/MAX (485): 100 reading storage capacity; records data at one of six selectable rates from 3 readings/second to 1 reading/hour, or by manual triggering. Also detects and stores maximum and minimum readings continuously while in the DATA STORE mode.

LOG (485): Displays logarithm (base 10) of the absolute value of the measured current (examples: –3.000 = ±1mA; –6.301 = ±0.5µA).

IEEE BUS IMPLEMENTATION (485 OPTION 4853)

MULTILINE COMMANDS: DCL, SDC, GET, GTL, UNT, UNL, SPE, SPD.

UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.

INTERFACE FUNCTIONS: SH1, AH1, T5, TE0, L4, LE0, SR1, RL2, PP0, DC1, DT1, C0, E1.

PROGRAMMABLE PARAMETERS: Range, Zero Check, REL, LOG, Trigger, Calibration, EOI, SRQ, Status, Output Format, Terminator.

GENERAL

DISPLAY:

485: 4½-digit LCD, 0.5 in height; polarity, range, and status indication.

480: Four 0.5 in LED digits with appropriate decimal point and polarity indication.

OVERRANGE INDICATION: 485: "OL" displayed. **480:** Display blinks all zeros above 1999 counts.

CONNECTORS: Input: BNC. **Analog Output:** Banana jacks.

OPERATING ENVIRONMENT: 0°–50°C, <70% RH up to 35°C; linearly derate 3% RH/°C up to 50°C.

STORAGE ENVIRONMENT: –25° to 60°C.

POWER: 105–125V or 210–250V (switch selected), 90–110V available, 50–60Hz, 12VA (20VA on 480).

DIMENSIONS, WEIGHT: 85mm high × 235mm wide × 275mm deep (3½ in × 9¼ in × 10¾ in). Net weight 1.8kg (4 lb).

VOLTAGE BURDEN CAN CAUSE ERRORS AT ANY CURRENT LEVEL

The voltage burden is the terminal voltage of an ammeter. An ideal ammeter will not alter the current flowing in a circuit when connected in place of a conductor. Thus, it must have zero resistance and therefore zero voltage burden.

*Digital multimeters use the shunt ammeter technique shown in **Figure 1** to measure current. The measurement method is to develop a voltage across a sensing resistor. The resistor is chosen such that 200mV corresponds to the maximum current reading on a selected range. The voltage burden specification is the 200mV developed across the sensing resistor.*

Figure 1

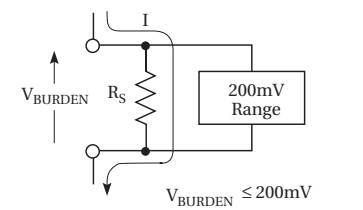
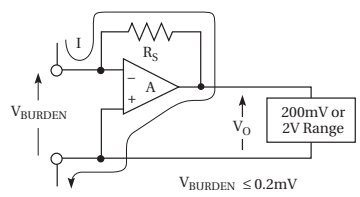


Figure 2

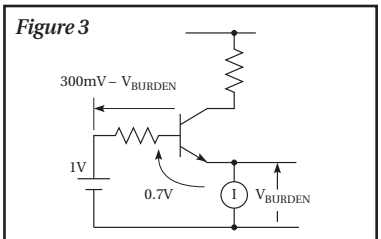


*Feedback picoammeters such as the 480/485 and Keithley electrometers use a technique in which the voltage burden is the input voltage of an op amp, as shown in **Figure 2**.*

The output voltage of the op amp is precisely related to the input current. Since input voltage is output voltage divided by op amp gain (typically 100,000), the voltage burden is only microvolts. Maximum specified voltage burden of the 480/485 is only 0.2mV.

*An example of the problems caused by high voltage burden is shown in **Figure 3.** In measuring the emitter current of a transistor, the DMM causes a very significant error (200mV out of 300mV) while the 480/485 voltage burden creates negligible error (0.2mV out of 300mV). Even though the basic measurement is well within the range of a DMM, the 480/485 makes a more accurate measurement since, due to its low voltage burden, the 480/485 is much closer to an ideal ammeter.*

Figure 3



Ideal Ammeter: V_{BURDEN} = 0
= 0% error

480/485: V_{BURDEN} ≤ 0.2mV
≤ 0.07% error

DMM: V_{BURDEN} ≤ 200mV
≤ 67% error