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# **8840A**

*DIGITAL MULTIMETER*

# **Instruction Manual**

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Table 1-1. Specifications

**DC VOLTAGE**

**Input Characteristics**

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		INPUT RESISTANCE
		5½ DIGITS	4½ DIGITS*	
200 mV	199.999 mV	1 µV	10 µV	≥10,000 MΩ
2V	1.99999V	10 µV	100 µV	≥10,000 MΩ
20V	19.9999V	100 µV	1 mV	≥10,000 MΩ
200V	199.999V	1 mV	10 mV	10 MΩ
1000V	1000.00V	10 mV	100 mV	10 MΩ

\*4½ digits at the fastest reading rate.

**Accuracy**

NORMAL (S) READING RATE ..... ±(% of Reading + Number of Counts).

RANGE	24 HOUR 23±1°C <sup>1</sup>	90 DAY 23±5°C	1 YEAR 23±5°C
200 mV <sup>2</sup>	0.003 + 3	0.007 + 4	0.008 + 4
2V	0.002 + 2	0.004 + 3	0.005 + 3
20V	0.002 + 2	0.005 + 3	0.006 + 3
200V	0.002 + 2	0.005 + 3	0.006 + 3
1000V	0.003 + 2	0.005 + 3	0.007 + 3

<sup>1</sup> Relative to calibration standards.

<sup>2</sup> Using Offset control.

MEDIUM AND FAST RATES: ..... In medium rate, add 2 counts to number of counts. In fast rate, use 2 counts for the number of counts.

**Operating Characteristics**

TEMPERATURE COEFFICIENT ..... <±(0.0006% of Reading + 0.3 Count) per °C from 0°C to 18°C and 28°C to 50°C.

MAXIMUM INPUT ..... 1000V dc or peak ac on any range.

NOISE REJECTION ..... Automatically optimized at power-up for 50, 60, or 400 Hz.

RATE	READINGS/ SECOND <sup>1</sup>	FILTER	NMRR <sup>2</sup>	PEAK NM SIGNAL	CMRR <sup>3</sup>
S	2.5	Analog & Digital	>98 dB	20V or 2x FS <sup>4</sup>	>140 dB
M	20	Digital	>45 dB	1x FS	>100 dB
F	100	None	—	1x FS	>60 dB

<sup>1</sup> Reading rate with internal trigger and 60 Hz power line frequency. See "Reading Rates" for more detail.

<sup>2</sup> Normal Mode Rejection Ratio, at 50 or 60 Hz ±0.1%. The NMRR for 400 Hz ±0.1% is 85 dB in S rate and 35 dB in M rate.

<sup>3</sup> Common Mode Rejection Ratio at 50 or 60 Hz ±0.1%, with 1 kΩ in series with either lead. The CMRR is >140 dB at dc for all reading rates.

<sup>4</sup> 20 volts or 2 times Full Scale whichever is greater, not to exceed 1000V.

Table 1-1. Specifications (cont)

**TRUE RMS AC VOLTAGE (OPTION -09)**  
**Input Characteristics**

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		INPUT IMPEDANCE
		5½ DIGITS	4½ DIGITS*	
200 mV	199.999 mV	1 µV	10 µV	1 MΩ shunted by <100 pF
2V	1.99999V	10 µV	100 µV	
20V	19.9999V	100 µV	1 mV	
200V	199.999V	1 mV	10 mV	
700V	700.00V	10 mV	100 mV	

\*4½ digits at the fastest reading rate.

**Accuracy**

NORMAL (S) READING RATE ..... ±(% of Reading + Number of Counts).  
 For sinewave inputs ≥10,000 counts<sup>1</sup>.

FREQUENCY (Hz)	24 HOURS <sup>2</sup> 23±1°C	90 DAY 23±5°C	1 YEAR 23±5°C
20-45	1.2 + 100	1.2 + 100	1.2 + 100
45-100	0.3 + 100	0.35 + 100	0.4 + 100
100-20k	0.07 + 100	0.14 + 100	0.16 + 100
20k-50k	0.15 + 120	0.19 + 150	0.21 + 200
50k-100k	0.4 + 300	0.5 + 300	0.5 + 400

<sup>1</sup> For sine-wave inputs between 1,000 and 10,000 counts, add to Number of Counts 100 counts for frequencies 20 Hz to 20 kHz, 200 counts for 20 kHz to 50 kHz, and 500 counts for 50 kHz to 100 kHz.

<sup>2</sup> Relative to calibration standards.

MEDIUM AND FAST READING RATES ... In medium rate, add 50 counts to number of counts. In fast rate the specifications apply for sinewave inputs ≥1000 counts and >100 Hz.

NONSINUSOIDAL INPUTS ..... For nonsinusoidal inputs ≥10,000 counts with frequency components ≤100 kHz, add the following % of reading to the accuracy specifications.

FUNDAMENTAL FREQUENCY	CREST FACTOR		
	1.0 TO 1.5	1.5 TO 2.0	2.0 TO 3.0
45 Hz to 20 kHz	0.05	0.15	0.3
20 Hz to 45 Hz and 20 kHz to 50 kHz	0.2	0.7	1.5

**Operating Characteristics**

MAXIMUM INPUT ..... 700V rms, 1000V peak or 2 x 10<sup>7</sup> Volts-Hertz product (whichever is less) for any range.

Table 1-1. Specifications (cont)

TEMPERATURE COEFFICIENT .....  $\pm$ (% of Reading + Number of Counts) per °C, 0°C to 18°C and 28°C to 50°C.

FOR INPUTS	FREQUENCY IN HERTZ		
	20-20k	20k-50k	50k-100k
$\geq 10,000$ counts	0.019 + 9	0.021 + 9	0.027 + 10
$\geq 1,000$ counts	0.019 + 12	0.021 + 15	0.027 + 21

COMMON MODE REJECTION ..... >60 dB at 50 or 60 Hz with 1 k $\Omega$  in either lead.

**CURRENT**

**Input Characteristics**

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION	
		5½ DIGITS	4½ DIGITS*
2000 mA	1999.99 mA	10 $\mu$ A	100 $\mu$ A

\*4½ digits at the fastest reading rate.

**DC Accuracy**

NORMAL (S) READING RATE .....  $\pm$ (% of Reading + Number of Counts).

	90 DAYS 23 $\pm$ 5°C	1 YEAR 23 $\pm$ 5°C
$\leq 1A$	0.04 + 4	0.05 + 4
>1A	0.1 + 4	0.1 + 4

MEDIUM AND FAST READING RATES ... In medium reading rate, add 2 counts to number of counts. In fast reading rate, use 2 counts for number of counts.

**AC Accuracy (Option -09)**

NORMAL (S) READING RATE .....  $\pm$ (% of Reading + Number of Counts).  
1 Year, 23 $\pm$ 5°C, for sinewave inputs  $\geq 10,000$  counts.

FREQUENCY IN HERTZ		
20-45	45-100	100-5k*
2.0 + 200	0.5 + 200	0.4 + 200

\*Typically 20 kHz

Table 1-1. Specifications (cont)

MEDIUM AND FAST READING RATES ... In medium rate, add 50 counts to number of counts. In fast reading rate, for sinewave inputs  $\geq 1000$  counts and frequencies  $> 100$  Hz, the accuracy is  $\pm(0.2\%$  of reading + 30 counts).

NONSINUSOIDAL INPUTS ..... For nonsinusoidal inputs  $\geq 10,000$  counts with frequency components  $\leq 100$  kHz, add the following % of reading to the accuracy specifications.

FUNDAMENTAL FREQUENCY	CREST FACTOR		
	1.0 TO 1.5	1.5 TO 2.0	2.0 TO 3.0
45 Hz to 5 kHz	0.05	0.15	0.3
20 Hz to 45 Hz	0.2	0.7	1.5

**Operating Characteristics**

TEMPERATURE COEFFICIENT ..... Less than 0.1 x accuracy specification per °C from 0°C to 18°C and 28°C to 50°C.

MAXIMUM INPUT ..... 2A dc or rms ac. Protected with 2A, 250V fuse accessible at front panel, and internal 3A, 600V fuse.

BURDEN VOLTAGE ..... 1V dc or rms ac typical at full scale.

**RESISTANCE**

**Input Characteristics**

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		CURRENT THROUGH UNKNOWN
		5½ DIGITS	4½ DIGITS*	
200Ω	199.999Ω	1 mΩ	10 mΩ	1 mA
2 kΩ	1.99999 kΩ	10 mΩ	100 mΩ	1 mA
20 kΩ	19.9999 kΩ	100 mΩ	1Ω	100 μA
200 kΩ	199.999 kΩ	1Ω	10Ω	10 μA
2000 kΩ	1999.99 kΩ	10Ω	100Ω	5 μA
20 MΩ	19.9999 MΩ	100Ω	1 kΩ	0.5 μA

\*4½ digits at the fastest reading rate.

**Accuracy**

NORMAL (S) READING RATE .....  $\pm(\%$  of Reading + Number of Counts)<sup>1</sup>

RANGE	24 HOUR 23±1°C <sup>2</sup>	90 DAY 23±5°C	1 YEAR 23±5°C
200Ω	0.004 + 3	0.011 + 4	0.014 + 4
2 kΩ	0.0028 + 2	0.01 + 3	0.013 + 3
20 kΩ	0.0028 + 2	0.01 + 3	0.013 + 3
200 kΩ	0.0028 + 2	0.01 + 3	0.013 + 3
2000 kΩ	0.023 + 3	0.027 + 3	0.028 + 3
20 MΩ	0.023 + 3	0.043 + 4	0.044 + 4

<sup>1</sup> Using Offset control.

<sup>2</sup> Relative to calibration standards.

Table 1-1. Specifications (cont)

**Accuracy, cont**

MEDIUM AND FAST READING RATES ... In medium rate, add 2 counts to the number of counts for the 200Ω through 200 kΩ ranges and 3 counts for the 2000 kΩ and 20 MΩ ranges. In fast reading rate, use 3 counts for the number of counts for the 200Ω range, and 2 counts for all other ranges.

**Operating Characteristics**

TEMPERATURE COEFFICIENT ..... Less than 0.1 x accuracy specification per °C from 0°C to 18°C and 28°C to 50°C.  
 MEASUREMENT CONFIGURATION ..... 2-wire or 4-wire.  
 OPEN CIRCUIT VOLTAGE ..... Less than 6.5V on the 200Ω through 200 kΩ ranges. Less than 13V on the 2000 kΩ and 20 MΩ ranges.  
 INPUT PROTECTION ..... To 300V rms.

**READING RATES**

READING RATES WITH INTERNAL TRIGGER ..... (readings per second).

RATE	POWER LINE FREQUENCY*		
	50 HZ	60 HZ	400 HZ
S	2.08	2.5	2.38
M	16.7	20	19.0
F	100	100	100

\*Sensed automatically at power-up.

**AUTOMATIC SETTling TIME DELAY**

Time in milliseconds from single trigger to start of A/D conversion, Autorange off.

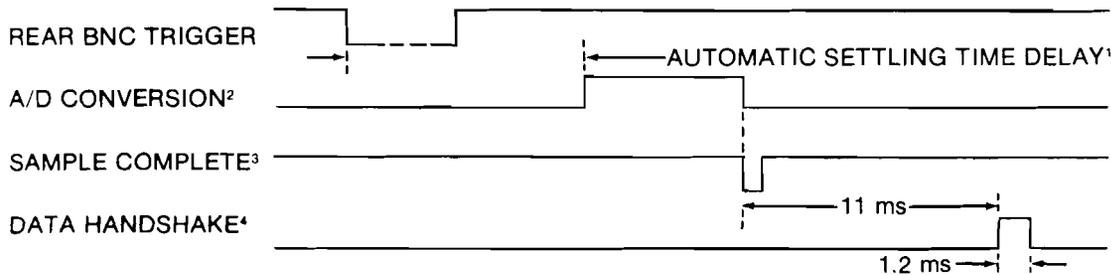
FUNCTION	RANGE	READING RATE			NUMBER OF COUNTS FROM FINAL VALUE <sup>1</sup>
		S	M	F	
VDC	200 mV	342	61	9	5
	2V-1000V	342	17	9	5
VAC	All	551	551	551	30 (Note 2)
mA DC	2000 mA	342	17	9	5
mA AC	2000 mA	551	551	551	30 (Note 2)
Ohms	200Ω	394	105	17	5
	2 kΩ	322	17	13	5
	20 kΩ	342	17	13	5
	200 kΩ	141	121	21	5
	2000 kΩ	141	101	81	10
	20 MΩ	1020	964	723	30

1. Difference between first reading and final value for an in-range step change coincident with trigger.
2. For slow reading rate. 50 counts for medium rate; 10 counts for fast rate.

Table 1-1. Specifications (cont)

**EXTERNAL TRIGGER TIMING CHARACTERISTICS**

The following diagram shows the nominal timing for the various processes which take place between an external trigger and data sent out on the IEEE-488 interface. Delays will vary if a second trigger comes before the data handshake is complete.



NOTES: 1. Time from single trigger to start of A/D conversion. (See "Automatic Settling Time Delay" on previous page.) If the delay is disabled by using the T3 or T4 command, then the delay is 1 ms ±150 μs. When the 8840A is triggered with an IEEE-488 command (GET or ?), the automatic settling time delay begins after the trigger command has been processed and recognized.

2. A/D conversion time is dependent on the reading rate and power-line frequency:

RATE	A/D CONVERSION TIME (ms)		
	50 Hz	60 Hz	400 Hz
S	472	395	414
M	52	45	47
F	7	7	7

3. Sample Complete is a 2.5 μs pulse which indicates that the analog input may be changed for the next reading.

4. When talking to a fast controller.

**GENERAL**

- COMMON MODE VOLTAGE ..... 1000V dc or peak ac, or 700V rms ac from any input to earth.
- TEMPERATURE RANGE ..... 0 to 50°C operating, -40 to 70°C storage.
- HUMIDITY RANGE ..... 80% RH from 0 to 35°C, 70% to 50°C.
- WARMUP TIME ..... 1 hour to rated specifications.
- POWER ..... 100, 120, 220, or 240V ac ±10% (250V ac maximum), switch selectable at rear panel. 50, 60, or 400 Hz, automatically sensed at power-up. 20 VA maximum.
- VIBRATION ..... Meets requirements of MIL-T-28800C for Type III, Class 3, Style E equipment.
- PROTECTION ..... ANSI C39.5 and IEC 348, Class 1.
- SIZE ..... 8.9 cm high, 21.6 cm wide, 37.1 cm deep (3.47 in high, 8.5 in wide, 14.4 in deep).
- WEIGHT ..... Net, 3.4 kg (7.5 lb); shipping, 5.0 kg (11 lb).
- INCLUDED ..... Line cord, test leads, Instruction/Service Manual, IEEE-488 Quick Reference Guide, (Option -05 only), and instrument performance record.
- IEEE-488 INTERFACE FUNCTION ..... Option allows complete control and data output capability, and supports the following interface function subsets: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1, PP0, and C0.

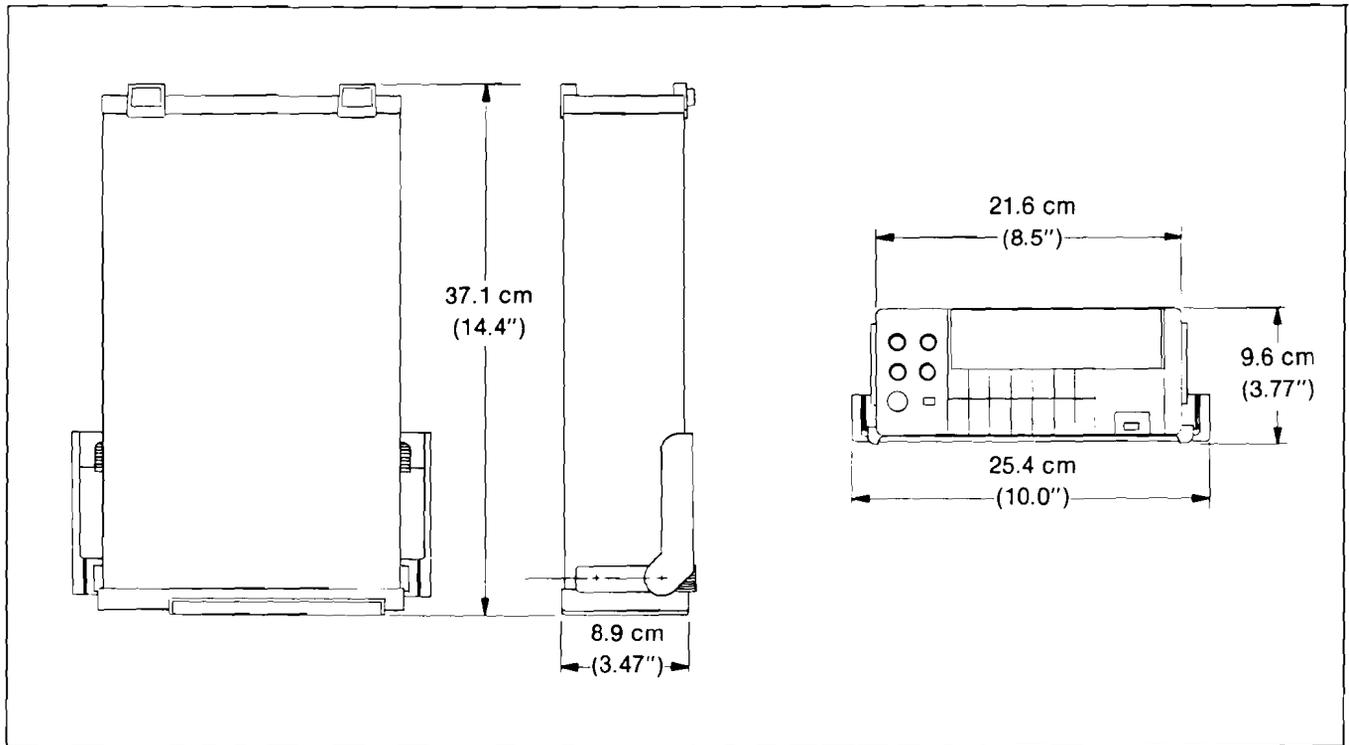


Figure 1-1. External Dimensions