# INTRODUCTION AND SPECIFICATIONS

## Table 1-1. Specifications

### DC VOLTAGE

**Input Characteristics**

<table>
<thead>
<tr>
<th>RANGE</th>
<th>FULL SCALE 5½ DIGITS</th>
<th>RESOLUTION</th>
<th>INPUT RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5½ DIGITS</td>
<td>4½ DIGITS²</td>
</tr>
<tr>
<td>200 mV</td>
<td>199.999 mV</td>
<td>1 µV</td>
<td>10 µV</td>
</tr>
<tr>
<td>2 V</td>
<td>1.99999 V</td>
<td>10 µV</td>
<td>100 µV</td>
</tr>
<tr>
<td>20 V</td>
<td>19.9999 V</td>
<td>100 µV</td>
<td>1 mV</td>
</tr>
<tr>
<td>200 V</td>
<td>199.999 V</td>
<td>1 mV</td>
<td>10 mV</td>
</tr>
<tr>
<td>1000 V</td>
<td>1000.00 V</td>
<td>10 mV</td>
<td>100 mV</td>
</tr>
</tbody>
</table>

*4½ digits at the fastest reading rate.*

### Accuracy

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

<table>
<thead>
<tr>
<th>RANGE</th>
<th>24 HOUR 23±1°C¹</th>
<th>90 DAY 23±5°C</th>
<th>1 YEAR 23±5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 mV²</td>
<td>0.003 + 3</td>
<td>0.007 + 4</td>
<td>0.008 + 4</td>
</tr>
<tr>
<td>2 V</td>
<td>0.002 + 2</td>
<td>0.004 + 3</td>
<td>0.005 + 3</td>
</tr>
<tr>
<td>20 V</td>
<td>0.002 + 2</td>
<td>0.005 + 3</td>
<td>0.006 + 3</td>
</tr>
<tr>
<td>200 V</td>
<td>0.002 + 2</td>
<td>0.005 + 3</td>
<td>0.006 + 3</td>
</tr>
<tr>
<td>1000 V</td>
<td>0.003 + 2</td>
<td>0.005 + 3</td>
<td>0.007 + 3</td>
</tr>
</tbody>
</table>

¹ Relative to calibration standards.
² 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.

<table>
<thead>
<tr>
<th>RATE</th>
<th>READINGS/ SECOND¹</th>
<th>FILTER</th>
<th>NMRR²</th>
<th>PEAK NM SIGNAL</th>
<th>CMRR³</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>2.5</td>
<td>Analog &amp; Digital                  &gt;98 dB</td>
<td>20 V or 2x FS⁴</td>
<td>&gt;140 dB</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>20</td>
<td>Digital                                    &gt;45 dB</td>
<td>1x FS</td>
<td>&gt;100 dB</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>100</td>
<td>None                                        —</td>
<td>1x FS</td>
<td>&gt;60 dB</td>
<td></td>
</tr>
</tbody>
</table>

¹ Reading rate with internal trigger and 60 Hz power line frequency. See “Reading Rates” for more detail.
² 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.
³ 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.
⁴ 20 volts or 2 times Full Scale whichever is greater, not to exceed 1000V.
TRUE RMS AC VOLTAGE (OPTION -09)

### Input Characteristics

<table>
<thead>
<tr>
<th>RANGE</th>
<th>FULL SCALE 5½ DIGITS</th>
<th>RESOLUTION 5½ DIGITS</th>
<th>RESOLUTION 4½ DIGITS*</th>
<th>INPUT IMPEDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 mV</td>
<td>199.999 mV</td>
<td>1 μV</td>
<td>10 μV</td>
<td>1 MΩ shunted</td>
</tr>
<tr>
<td>2 V</td>
<td>1.999999 V</td>
<td>10 μV</td>
<td>100 μV</td>
<td>by</td>
</tr>
<tr>
<td>20 V</td>
<td>19.99999 V</td>
<td>100 μV</td>
<td>1 mV</td>
<td>&lt;100 pF</td>
</tr>
<tr>
<td>200 V</td>
<td>199.999 V</td>
<td>1 mV</td>
<td>10 mV</td>
<td></td>
</tr>
<tr>
<td>700 V</td>
<td>700.000 V</td>
<td>10 mV</td>
<td>100 mV</td>
<td></td>
</tr>
</tbody>
</table>

*4½ digits at the fastest reading rate.

### Accuracy

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

For sinewave inputs ≥10,000 counts:

<table>
<thead>
<tr>
<th>FREQUENCY (Hz)</th>
<th>24 HOURS² 23±1°C</th>
<th>90 DAY 23±5°C</th>
<th>1 YEAR 23±5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-45</td>
<td>1.2 + 100</td>
<td>1.2 + 100</td>
<td>1.2 + 100</td>
</tr>
<tr>
<td>45-100</td>
<td>0.3 + 100</td>
<td>0.35 + 100</td>
<td>0.4 + 100</td>
</tr>
<tr>
<td>100-20k</td>
<td>0.07 + 100</td>
<td>0.14 + 100</td>
<td>0.16 + 100</td>
</tr>
<tr>
<td>20k-50k</td>
<td>0.15 + 120</td>
<td>0.19 + 150</td>
<td>0.21 + 200</td>
</tr>
<tr>
<td>50k-100k</td>
<td>0.4 + 300</td>
<td>0.5 + 300</td>
<td>0.5 + 400</td>
</tr>
</tbody>
</table>

¹ 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.

² 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.

<table>
<thead>
<tr>
<th>FUNDAMENTAL FREQUENCY</th>
<th>CREST FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0 TO 1.5</td>
</tr>
<tr>
<td>45 Hz to 20 kHz</td>
<td>0.05</td>
</tr>
<tr>
<td>20 Hz to 45 Hz and 20 kHz to 50 kHz</td>
<td>0.2</td>
</tr>
</tbody>
</table>

### Operating Characteristics

MAXIMUM INPUT ................. 700V rms, 1000V peak or 2 x 10⁷ Volts-Hertz product (whichever is less) for any range.
TEMPERATURE COEFFICIENT ............ ±(% of Reading + Number of Counts) per °C, 0°C to 18°C and 28°C to 50°C.

<table>
<thead>
<tr>
<th>FOR INPUTS</th>
<th>FREQUENCY IN HERTZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20-20k</td>
</tr>
<tr>
<td>≥10,000 counts</td>
<td>0.019 + 9</td>
</tr>
<tr>
<td>≥1,000 counts</td>
<td>0.019 + 12</td>
</tr>
</tbody>
</table>

COMMON MODE REJECTION ............ >60 dB at 50 or 60 Hz with 1 kΩ in either lead.

CURRENT
Input Characteristics

<table>
<thead>
<tr>
<th>RANGE</th>
<th>FULL SCALE 5½ DIGITS</th>
<th>RESOLUTION 5½ DIGITS</th>
<th>4½ DIGITS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 mA</td>
<td>1999.99 mA</td>
<td>10 µA</td>
<td>100 µA</td>
</tr>
</tbody>
</table>

*4½ digits at the fastest reading rate.

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

<table>
<thead>
<tr>
<th></th>
<th>90 DAYS 23±5°C</th>
<th>1 YEAR 23±5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1A</td>
<td>0.04 + 4</td>
<td>0.05 + 4</td>
</tr>
<tr>
<td>&gt;1A</td>
<td>0.1 + 4</td>
<td>0.1 + 4</td>
</tr>
</tbody>
</table>

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 ............ ±(% of Reading + Number of Counts).
1 Year, 23±5°C, for sinewave inputs ≥10,000 counts.

<table>
<thead>
<tr>
<th>FREQUENCY IN HERTZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-45</td>
</tr>
<tr>
<td>2.0 + 200</td>
</tr>
</tbody>
</table>

*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 \(\pm(0.2\% \text{ of reading} + 30\) counts).

NONSENUSOIDAL INPUTS ............... For nonsinusoidal inputs \(\geq 10,000\) counts with frequency components \(<100\) kHz, add the following % of reading to the accuracy specifications.

| FUNDAMENTAL FREQUENCY | CREST FACTOR
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0 TO 1.5</td>
</tr>
<tr>
<td>45 Hz to 5 kHz</td>
<td>0.05</td>
</tr>
<tr>
<td>20 Hz to 45 Hz</td>
<td>0.2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>RANGE</th>
<th>FULL SCALE 5½ DIGITS</th>
<th>RESOLUTION 5½ DIGITS</th>
<th>4½ DIGITS*</th>
<th>CURRENT THROUGH UNKNOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200Ω</td>
<td>199.999Ω</td>
<td>1 mΩ</td>
<td>10 mΩ</td>
<td>1 mA</td>
</tr>
<tr>
<td>2 kΩ</td>
<td>1.99999 kΩ</td>
<td>10 mΩ</td>
<td>100 mΩ</td>
<td>1 mA</td>
</tr>
<tr>
<td>20 kΩ</td>
<td>19.999 kΩ</td>
<td>100 mΩ</td>
<td>1Ω</td>
<td>100 μA</td>
</tr>
<tr>
<td>200 kΩ</td>
<td>199.99 kΩ</td>
<td>1Ω</td>
<td>10Ω</td>
<td>10 μA</td>
</tr>
<tr>
<td>2000 kΩ</td>
<td>1999.99 kΩ</td>
<td>10Ω</td>
<td>100Ω</td>
<td>5 μA</td>
</tr>
<tr>
<td>20 MΩ</td>
<td>19.9999 MΩ</td>
<td>100Ω</td>
<td>1 kΩ</td>
<td>0.5 μA</td>
</tr>
</tbody>
</table>

*4½ digits at the fastest reading rate.

Accuracy

NORMAL (S) READING RATE .......... \(\pm(\% \text{ of Reading} + \text{Number of Counts})^1\)

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

^1 Using Offset control.

^2 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).

<table>
<thead>
<tr>
<th>RATE</th>
<th>POWER LINE FREQUENCY*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 Hz</td>
</tr>
<tr>
<td>S</td>
<td>2.08</td>
</tr>
<tr>
<td>M</td>
<td>16.7</td>
</tr>
<tr>
<td>F</td>
<td>100</td>
</tr>
</tbody>
</table>

*Sensed automatically at power-up.

### AUTOMATIC SETTLING TIME DELAY

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

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>RANGE</th>
<th>READING RATE</th>
<th>NUMBER OF COUNTS FROM FINAL VALUE*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>M</td>
</tr>
<tr>
<td>VDC</td>
<td>200 mV</td>
<td>342</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>2V-1000V</td>
<td>342</td>
<td>17</td>
</tr>
<tr>
<td>VAC</td>
<td>All</td>
<td>551</td>
<td>551</td>
</tr>
<tr>
<td>mA DC</td>
<td>2000 mA</td>
<td>342</td>
<td>17</td>
</tr>
<tr>
<td>mA AC</td>
<td>2000 mA</td>
<td>551</td>
<td>551</td>
</tr>
<tr>
<td>Ohms</td>
<td>200Ω</td>
<td>394</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>2 kΩ</td>
<td>322</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>20 kΩ</td>
<td>342</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>200 kΩ</td>
<td>141</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>2000 kΩ</td>
<td>141</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>20 MΩ</td>
<td>1020</td>
<td>964</td>
</tr>
</tbody>
</table>

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.
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.

![Diagram of trigger timing](image)

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:

<table>
<thead>
<tr>
<th>RATE</th>
<th>50 Hz</th>
<th>60 Hz</th>
<th>400 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>472</td>
<td>395</td>
<td>414</td>
</tr>
<tr>
<td>M</td>
<td>52</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>F</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

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 I.
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).
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

37.1 cm (14.4"")

21.6 cm (8.5"")

9.6 cm (3.77"")

25.4 cm (10.0"")

8.9 cm (3.47"")