FLUKE®

# 80 Series III

Multimeters

**Getting Started**

English
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# Lifetime Limited Warranty

Each Fluke 20, 70, 80, 170 and 180 Series DMM will be free from defects in material and workmanship for its lifetime. As used herein, “lifetime” is defined as seven years after Fluke discontinues manufacturing the product, but the warranty period shall be at least ten years from the date of purchase. This warranty does not cover fuses, disposable batteries, damage from neglect, misuse, contamination, alteration, accident or abnormal conditions of operation or handling, including failures caused by use outside of the product’s specifications, or normal wear and tear of mechanical components. This warranty covers the original purchaser only and is not transferable.

For ten years from the date of purchase, this warranty also covers the LCD. Thereafter, for the lifetime of the DMM, Fluke will replace the LCD for a fee based on then current component acquisition costs.

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If the product is defective, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Fluke will pay return transportation for product repaired or replaced in-warranty. Before making any non-warranty repair, Fluke will estimate cost and obtain authorization, then invoice you for repair and return transportation.

THIS WARRANTY IS YOUR ONLY REMEDY. NO OTHER WARRANTIES, SUCH AS FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSED OR IMPLIED. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY. AUTHORIZED RESELLERS ARE NOT AUTHORIZED TO EXTEND ANY DIFFERENT WARRANTY ON FLUKE’S BEHALF. Since some states do not allow the exclusion or limitation of an implied warranty or of incidental or consequential damages, this limitation of liability may not apply to you. If any provision of this warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.


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# *Table of Contents*

# Introduction

### ⚠Warning

**Read "Safety Information" before you use the meter.**

Except where noted, the descriptions and instructions in this manual apply to Series III Models 83, 85, 87, and 87/E multimeters. Model 87 is shown in all illustrations.

# Safety Information

This meter complies with:

- EN61010.1:1993
- ANSI/ISA S82.01-1994
- CAN/CSA C22.2 No. 1010.1-92
- 1000 V Overvoltage Category III, Pollution Degree 2
- UL3111-1

Use the meter only as specified in this manual, otherwise the protection provided by the meter may be impaired.

In this manual, a **Warning** identifies conditions and actions that pose hazards to the user. A **Caution** identifies conditions and actions that may damage the meter or the equipment under test.

International symbols used on the meter and in this manual are explained in Table 1.

### ⚠Warning

**To avoid possible electric shock or personal injury, follow these guidelines:**

- **Do not use the meter if it is damaged. Before you use the meter, inspect the case. Look for cracks or missing plastic. Pay particular attention to the insulation surrounding the connectors.**
- **Make sure the battery door is closed and latched before you operate the meter.**
- **Replace the battery as soon as the battery indicator (+▬) appears.**
- **Remove test leads from the meter before you open the battery door.**
- **Inspect the test leads for damaged insulation or exposed metal. Check the test leads for continuity. Replace damaged test leads before you use the meter.**
- **Do not use the meter if it operates abnormally. Protection may be impaired. When in doubt, have the meter serviced.**
- **Do not operate the meter around explosive gas, vapor, or dust.**

- **Use only a single 9 V battery, properly installed in the meter case, to power the meter.**
- **When servicing the meter, use only specified replacement parts.**

**Caution**

**To avoid possible damage to the meter or to the equipment under test, follow these guidelines:**

- **Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, or capacitance.**
- **Use the proper terminals, function, and range for your measurements.**
- **Before measuring current, check the meter's fuses.**

To protect yourself, use the following guidelines:

- Use caution when working with voltages above 30 V ac rms, 42 V ac peak, or 60 V dc. Such voltages pose a shock hazard.
- When using the probes, keep your fingers behind the finger guards.
- Connect the common test lead before you connect the live test lead. When you disconnect test leads, disconnect the live test lead first.
- Avoid working alone.
- When measuring current, turn off circuit power before connecting the meter in the circuit. Remember to place the meter in series with the circuit.

## *Contacting Fluke*

To contact Fluke, call one of the following telephone numbers:

USA: 1-888-99-FLUKE (1-888-993-5853)
Canada: 1-800-36-FLUKE (1-800-363-5853)
Europe: +31 402-675-200
Japan: +81-3-3434-0181
Singapore: +65-738-5655
Anywhere in the world: +1-425-446-5500

Or, visit Fluke's Web site at www.fluke.com.

**Table 1. International Electrical Symbols**

| | | | |
|---|---|---|---|
| ~ | AC (Alternating Current) | ⏚ | Earth ground |
| ⎓ | DC (Direct Current) | | Fuse |
| ≂ | AC or DC | CE | Conforms to European Union directives |
| ⚠ | Refer to the manual for information about this feature. | SP® | Conforms to relevant Canadian Standards Association directives |
| | Battery | ⧈ | Double insulated |
| TÜV PRODUCT SERVICE GS geprüfte Sicherheit | Inspected and licensed by TÜV Product Services. | | |

## *Your Meter's Features*

Tables 2 through 5 briefly describe your meter's features. You can find more detailed information about the features in the Users Manual (on the CD-ROM).

**Table 2. Inputs**

| Terminal | Description |
|---|---|
| A | Input for 0 A to 10.00 A current measurements |
| mA μA | Input for 0 μA to 400 mA current measurements |
| COM | Return terminal for all measurements |
| V Ω⇥ | Input for voltage, continuity, resistance, diode, capacitance, frequency, and duty cycle measurements |

**Table 3. Rotary Switch Positions**

| Switch Position | Function |
|---|---|
| Ṽ | AC voltage measurement |
| V̿ | DC voltage measurement |
| mV̿ | 400 mV dc voltage range |
| ))) Ω ⊣⊢ | ))) Continuity test |
| | Ω Resistance measurement |
| | ⊣⊢ Capacitance measurement |
| ⊣▶⊢ | Diode test |
| mA<br>A | DC or AC current measurements from 0 mA to 10.00 A |
| µA | DC or AC current measurements from 0 µA to 4000 µA |

**Table 4. Pushbuttons**

| Button | Function | Button Function |
|---|---|---|
| (Blue button) | ))))Ω⊣⊢ | Selects capacitance. |
| | mA/A, µA | Switches between dc and ac current. |
| | Power-up | Disables automatic power-off feature. |
| MIN MAX | Any switch position | Starts recording of minimum and maximum values. Steps the display through MIN, MAX, AVG (average), and present readings. |
| | Power-up | Enables high-accuracy 1-second response time for MIN MAX recording. |
| RANGE | Any switch position | Switches between the ranges available for the selected function. To return to autoranging, hold the button down for 1 second. |
| | | Manually selecting a range causes the meter to exit the Touch Hold®, MIN MAX, and REL (relative) modes. |
| | Power-up | For servicing purposes only. |
| HOLD | Any switch position | Touch Hold captures the present reading on the display. When a new, stable reading is detected, the meter beeps and displays the new reading. |
| | MIN MAX recording | Stops and starts recording without erasing recorded values. |
| | Frequency counter | Stops and starts the frequency counter. |

**Table 4. Pushbuttons (cont.)**

| Button | Function | Button Function |
|---|---|---|
| ☼ Model 87: yellow button<br>☼ Models 83, 85: gray button | Any switch position | Turns the backlight on and off.<br>For Model 87, hold the yellow button down for one second to enter the 4-1/2 digit mode. To return to the 3-1/2 digit mode, hold the button down only until all display segments turn on (about one second). |
| ))))) | Continuity ))))Ω⊣⊢<br>MIN MAX recording<br>Power-up | Turns the continuity beeper on and off.<br>On Model 87, switches between 250 µs and 100 ms or 1 s response times.<br>Disables the beeper for all functions. |
| REL Δ (Relative mode) | Any switch position<br>Power-up | Stores the present reading as a reference for subsequent readings. The display is zeroed, and the stored reading is subtracted from all subsequent readings.<br>For Models 83 and 85, enables zoom mode for the bar graph. |
| Hz | Any switch position<br>Power-up | Starts the frequency counter.<br>Press again to enter duty cycle mode.<br>Provides >4000 MΩ input impedance for the 400 mV dc range. |

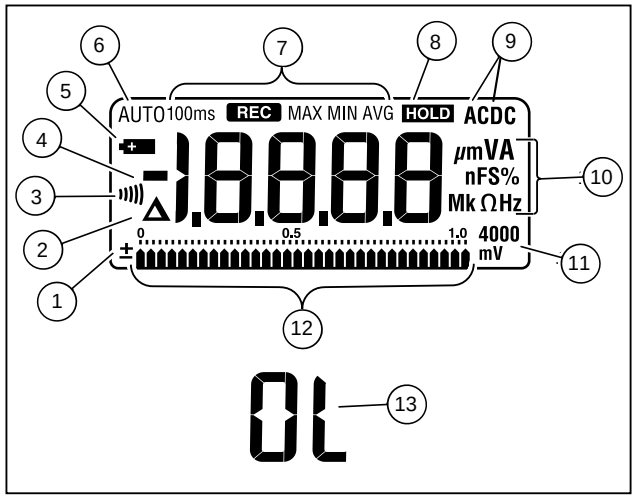


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**Figure 1. Display Features (Model 87 Shown)**

**Table 5. Display Features**

| Number | Feature | Indication |
|---|---|---|
| ① | ± | Polarity indicator for the analog bar graph. |
| ② | △ | Relative (REL) mode is active. |
| ③ | ))) | The continuity beeper is on. |
| ④ | − | Indicates negative readings. In relative mode, this sign indicates that the present input is less than the stored reference. |
| ⑤ | + | The battery is low. ⚠**Warning: To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears.** |
| ⑥ | **AUTO** | The meter is in autorange mode and automatically selects the range with the best resolution. |
| ⑦ | **100 ms REC MAX MIN AVG** | Indicators for minimum-maximum recording mode. |
| ⑧ | **HOLD** | Touch Hold is active. |
| ⑨ | **AC DC** | Indicator for ac or dc voltage or current. AC voltage and current is displayed as an rms (root mean square) value. |
| ⑩ | **A, μA, mA** | A: Amperes (amps). The unit of current.<br>μA: Microamp. 1 x $10^{-6}$ or 0.000001 amperes.<br>mA: Milliamp. 1 x $10^{-3}$ or 0.001 amperes. |

**Table 5. Display Features (cont.)**

| Number | Feature | Indication |
|---|---|---|
| | **V, mV** | V: Volts. The unit of voltage.<br>mV: Millivolt. 1 x $10^{-3}$ or 0.001 volts. |
| | **μF, nF** | F: Farad. The unit of capacitance.<br>μF: Microfarad. 1 x $10^{-6}$ or 0.000001 farads.<br>nF: Nanofarad. 1 x $10^{-9}$ or 0.000000001 farads. |
| | **nS** | S: Siemen. The unit of conductance.<br>nS: Nanosiemen. 1 x $10^{-9}$ or 0.000000001 siemens. |
| | **%** | Percent. Used for duty cycle measurements. |
| | **Ω, MΩ, kΩ** | Ω: Ohm. The unit of resistance.<br>MΩ: Megohm. 1 x $10^{6}$ or 1,000,000 ohms.<br>kΩ: Kilohm. 1 x $10^{3}$ or 1000 ohms. |
| | **Hz, kHz, MHz** | Hz: Hertz. The unit of frequency.<br>kHz: Kilohertz. 1 x $10^{3}$ or 1000 hertz.<br>MHz: Megahertz. 1 x $10^{6}$ or 1,000,000 hertz. |
| ⑪ | **4000 mV** | Displays the currently selected range. |
| ⑫ | Analog bar graph | Provides an analog indication of the present inputs. |
| ⑬ | **OL** | The input (or the relative value when in relative mode) is too large for the selected range. For duty cycle measurements OL is displayed when the input signal stays high or low. |

### Power-Up Options

Holding a button down while turning the meter on activates a power-up option. Table 4 includes the power-up options available. These options are also listed on the back of the meter.

### Automatic Power-Off

The meter automatically turns off if you do not turn the rotary switch or press a button for 30 minutes. To disable automatic power-off, hold down the blue button while turning the meter on. Automatic power-off is always disabled in MIN MAX recording mode.

### Input Alert™ Feature

If a test lead is plugged into the **mA/μA** or **A** terminal, but the rotary switch is not correctly set to the **mA/μA** or **A** position, the beeper warns you by making a chirping sound. This warning is intended to stop you from attempting to measure voltage, continuity, resistance, capacitance, or diode values when the leads are plugged into a current terminal. *Placing the probes across (in parallel with) a powered circuit when a lead is plugged into a current terminal can damage the circuit you are testing and blow the meter's fuse.* This can happen because the resistance through the meter's current terminals is very low, so the meter acts like a short circuit.

## Analog Bar Graph

The analog bar graph functions like the needle on an analog meter, but without the overshoot. The bar graph is updated 40 times per second. Because the graph responds 10 times faster than the digital display, it is useful for making peak and null adjustments and observing rapidly changing inputs.

### Model 87 Bar Graph

Model 87's bar graph consists of 32 segments. The position of the pointer on the display represents the last three digits of the digital display. For example, for inputs of 500 Ω, 1500 Ω, and 2500 Ω, the pointer is near 0.5 on the scale. If the last three digits are 999, the pointer is at the far right of the scale. As the digits increment past 000, the pointer wraps back to the left side of the display. The polarity indicator at the left of the graph indicates the polarity of the input.

### Models 83 and 85 Bar Graph

The bar graph on Models 83 and 85 consists of 43 segments. The number of lit segments is relative to the full-scale value of the selected range. The polarity indicator at the left of the graph indicates the polarity of the input. For example, if the 40 V range is selected, the "4" on the scale represents 40 V. An input of -30 V would

light the negative sign and the segments up to the "3" on the scale.

If the input equals or exceeds the 4096 counts on a manually-selected range, all segments are lit and ▶ appears to the right of the bar graph. The graph does not operate with the capacitance or frequency counter functions.

The bar graph on Models 83 and 85 also has a zoom function, as described under "Zoom Mode".

## 4-1/2 Digit Mode (Model 87)

On a Model 87 meter, pressing the yellow button for one second causes the meter to enter the high-resolution, 4-1/2 digit mode. Readings are displayed at 10 times the normal resolution with a maximum display of 19,999 counts. The display is updated once per second. The 4-1/2 digit mode works in all modes except capacitance and the 250 µs and 100 ms MIN MAX modes.

To return to the 3-1/2 digit mode, press the yellow button only until all of the display segments turn on (about one second).

## MIN MAX Recording Mode

The MIN MAX mode records minimum and maximum input values. When the inputs go below the recorded minimum value or above the recorded maximum value, the meter beeps and records the new value. This mode can be used to capture intermittent readings, record maximum readings while you are away, or record readings while you are operating the equipment under test and cannot watch the meter. MIN MAX mode can also calculate an average of all readings taken since the MIN MAX mode was activated. To use MIN MAX mode, refer to the functions in Table 6.

Response time is the length of time an input must stay at a new value to be recorded. A shorter response time captures shorter events, but with decreased accuracy. Changing the response time erases all recorded readings. Models 83 and 85 have 100 millisecond and 1 second response times; Model 87 has 1 second, 100 millisecond, and 250 µs (peak) response times. The 250 µs response time is indicated by "1 ms" on the display.

The 100 millisecond response time is best for recording power supply surges, inrush currents, and finding intermittent failures. This response time follows the update time of the analog display.

The high-accuracy 1 second response time has the full accuracy of the meter and is best for recording power supply drift, line voltage changes, or circuit performance

while line voltage, temperature, load, or some other parameter is being changed.

The true average value (AVG) displayed in the 100 ms and 1 s modes is the mathematical integral of all readings taken since you started recording. The average reading is useful for smoothing out unstable inputs, calculating power consumption, or estimating the percent of time a circuit is active.

**Table 6. MIN MAX Functions**

| Button | MIN MAX Function |
|---|---|
| MIN MAX | Enter MIN MAX recording mode. The meter is locked in the range displayed before you entered MIN MAX mode. (Select the desired measurement function and range before entering MIN MAX.) The meter beeps each time a new minimum or maximum value is recorded. |
| MIN MAX<br>(While in MIN MAX mode) | Scroll through minimum (MIN), maximum (MAX), and average (AVG) values. |
| )))))<br>PEAK MIN MAX | Model 87 only: Select 100 ms or 250 µs response time. (The 250 µs response time is indicated by "1 ms" on the display.) Stored values are erased. The present and AVG (average) values are not available when 250 µs is selected. |
| HOLD | Stop recording without erasing stored values. Press again to resume recording. |
| MIN MAX<br>(hold for 1 second) | Exit MIN MAX mode. Stored values are erased. The meter stays in the selected range. |
| Hold down MIN MAX<br>while turning the meter on | Select 1 s high-accuracy response time. See text under "MIN MAX Recording Mode" for more explanation. MIN MAX readings for the frequency counter are recorded only in the high-accuracy mode. |

## Touch Hold ® Mode

### ⚠Warning

**The Touch Hold mode will not capture unstable or noisy readings. Do not use Touch Hold mode to determine that circuits are without power.**

The Touch Hold mode captures the present reading on the display. When a new, stable reading is detected, the meter beeps and displays the new reading. To enter or exit Touch Hold mode, press HOLD .

## Relative Mode

Selecting relative mode ( REL Δ ) causes the meter to zero the display and store the present reading as the reference for subsequent measurements. The meter is locked into the range selected when you pressed REL Δ . Press REL Δ again to exit this mode.

In relative mode, the reading shown is always the difference between the present reading and the stored reference value. For example, if the stored reference value is 15.00 V and the present reading is 14.10 V, the display shows -0.90 V.

On Model 87, the relative mode does not change the operation of the analog display. Selecting relative mode on a Model 83 or 85 meter causes the bar graph to enter Zoom mode. In zoom mode, the center of the graph represents zero and the sensitivity of the bar graph increases by a factor of 10.

**Table 7. Replacement Parts**

| Item | Description | PN | Quantity |
|---|---|---|---|
| BT1 | Battery, 9 V | 614487 | 1 |
| F1 ⚠ | Fuse, 0.440 A, 1000 V, FAST | 943121 | 1 |
| F2 ⚠ | Fuse, 11 A, 1000 V, FAST | 803293 | 1 |
| H1 | Screw, Case | 832246 | 3 |
| MP1 | Foot, Non-Skid | 824466 | 2 |
| MP2 | O-Ring, Input Receptacle | 831933 | 1 |
| TM1 | CD-ROM (contains Users Manual) | 1611720 | 1 |
| TM2 | Getting Started Manual | 1611712 | 1 |
| TM3 | Quick Reference Guide, Fluke 80 Series III | 688168 | 1 |
| TM4 | Service Manual | 688645 | Optional |
| ⚠To ensure safety, use exact replacement only. | | | |

## *Specifications*

**Maximum Voltage between any Terminal and Earth Ground:** 1000 V rms

⚠**Fuse Protection for mA or µA inputs:** 44/100 A, 1000 V FAST Fuse

⚠**Fuse Protection for A input:** 11 A, 1000 V FAST Fuse

**Display:** Digital: 4000 counts updates 4/sec; (Model 87 also has 19,999 counts in 4½-digit mode, updates 1/sec.). Analog: updates 40/sec. Frequency: 19,999 counts, updates 3/sec at >10 Hz. Model 87: 4 x 32 segments (equivalent to 128); Models 83, 85: 43 segments.

**Temperature:** Operating: -20°C to +55°C; Storage: -40°C to +60°C

**Altitude:** Operating: 2000 m; Storage: 10,000 m

**Temperature Coefficient:** 0.05 x (specified accuracy)/ °C (<18°C or >28°C)

**Electromagnetic Compatibility:** In an RF field of 3 V/m total accuracy = specified accuracy except: Models 85,87: Total Accuracy = Specified Accuracy + 0.4% of range above 800 MHz (µADC only). (mVAC and µAAC unspecified). Model 83: Total Accuracy = Specified Accuracy + 5% of range above 300 MHz (µADC only). (VDC unspecified).

**Relative Humidity:** 0% to 90% (0°C to 35°C); 0% to 70% (35°C to 55°C)

**Battery Type:** 9 V zinc, NEDA 1604 or 6F22 or 006P

**Battery Life:** 400 hrs typical with alkaline (with backlight off)

**Shock Vibration:** Per MIL-T-28800 for a Class 2 instrument

**Size (HxWxL):** 1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)

**Size with Holster and Flex-Stand:** 2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)

**Weight:** 12.5 oz (355 g)

**Weight with Holster and Flex-Stand:** 22.0 oz (624 g)

**Safety:** Complies with ANSI/ISA S82.01-1994, CSA 22.2 No. 1010.1:1992 to 1000 V Overvoltage Category III. UL listed to UL3111-1. Licensed by TÜV to EN61010-1.

**Table 8. Models 85 and 87 AC Voltage Function Specifications**

| Function | Range | Resolution | Accuracy[1] | | | |
|---|---|---|---|---|---|---|
| | | | **50 Hz - 60 Hz** | **45 Hz - 1 kHz** | **1 kHz - 5 kHz** | **5 kHz - 20 kHz[2]** |
| $\tilde{V}$ [3] | 400.0 mV | 0.1 mV | ±(0.7% + 4) | ±(1.0% + 4) | ±(2.0% + 4) | ±(2.0% + 20) |
| | 4.000 V | 0.001 V | ±(0.7% + 2) | ±(1.0% + 4) | ±(2.0% + 4) | ±(2.0% + 20) |
| | 40.00 V | 0.01 V | ±(0.7% + 2) | ±(1.0% + 4) | ±(2.0% + 4) | ±(2.0% + 20) |
| | 400.0 V | 0.1 V | ±(0.7% + 2) | ±(1.0% + 4) | ±(2.0% + 4)[4] | unspecified |
| | 1000 V | 1 V | ±(0.7% + 2) | ±(1.0% + 4)[5] | unspecified | unspecified |

1. Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18°C to 28°C, with relative humidity up to 90%, for a period of one year after calibration. For Model 87 in the 4 ½-digit mode, multiply the number of least significant digits (counts) by 10. AC conversions are ac-coupled and valid from 5% to 100% of range. Models 85 and 87 are true rms responding. AC crest factor can be up to 3 at full scale, 6 at half scale. For non-sinusoidal wave forms add -(2% Rdg + 2% full scale) typical, for a crest factor up to 3.
2. Below 10% of range, add 6 counts.
3. Models 85 and 87 are true rms responding meters. When the input leads are shorted together in the ac functions, the meters display a reading (typically <25 counts) that is caused by internal amplifier noise. The accuracy on Models 85 and 87 is not significantly affected by this internal offset when measuring inputs that are within 5% to 100% of the selected range. When the rms value of the two values (5% of range and internal offset) is calculated, the effect is minimal as shown in the following example where 20.0 = 5% of 400 mV range, and 2.5 is the internal offset: RMS = SQRT[$(20.0)^2$ + $(2.5)^2$] = 20.16. If you use the REL function to zero the display when using the ac functions, a constant error that is equal to the internal offset will result.
4. Frequency range: 1 kHz to 2.5 kHz.
5. Below 10% of range, add 16 counts.

**Table 9. Model 83 AC Voltage Function Specifications**

| Function | Range | Resolution | Accuracy[1] | | |
|---|---|---|---|---|---|
| | | | **50 Hz - 60 Hz** | **45 Hz - 1 kHz** | **1 kHz - 5 kHz** |
| $\tilde{V}$[2] | 400.0 mV | 0.1 mV | ±(0.5% + 4) | ±(1.0% + 4) | ±(2.0% + 4) |
| | 4.000 V | 0.001 V | ±(0.5% + 2) | ±(1.0% + 4) | ±(2.0% + 4) |
| | 40.00 V | 0.01 V | ±(0.5% + 2) | ±(1.0% + 4) | ±(2.0% + 4) |
| | 400.0 V | 0.1 V | ±(0.5% + 2) | ±(1.0% + 4) | ±(2.0% + 4)[3] |
| | 1000 V | 1 V | ±(0.5% + 2) | ±(1.0% + 4) | unspecified |

1. See the first sentence in Table 8 for a complete explanation of accuracy.
2. Below a reading of 200 counts, add 10 counts.
3. Frequency range: 1 kHz to 2.5 kHz.

**Table 10. DC Voltage, Resistance, and Conductance Function Specifications**

| Function | Range | Resolution | Accuracy[1] | | |
|---|---|---|---|---|---|
| | | | **Model 83** | **Model 85** | **Model 87** |
| V ⎓ | 4.000 V | 0.001 V | ±(0.1% + 1) | ±(0.08% + 1) | ±(0.05% + 1) |
| | 40.00 V | 0.01 V | ±(0.1% + 1) | ±(0.08% + 1) | ±(0.05% + 1) |
| | 400.0 V | 0.1 V | ±(0.1% + 1) | ±(0.08% + 1) | ±(0.05% + 1) |
| | 1000 V | 1 V | ±(0.1% + 1) | ±(0.08% + 1) | ±(0.05% + 1) |
| mV ⎓ | 400.0 mV | 0.1 mV | ±(0.3% + 1) | ±(0.1% + 1) | ±(0.1% + 1) |
| Ω | 400.0 Ω | 0.1 Ω | ±(0.4% + 2)[2] | ±(0.2% + 2)[2] | ±(0.2% + 2)[2] |
| | 4.000 kΩ | 0.001 kΩ | ±(0.4% + 1) | ±(0.2% + 1) | ±(0.2% + 1) |
| | 40.00 kΩ | 0.01 kΩ | ±(0.4% + 1) | ±(0.2% + 1) | ±(0.2% + 1) |
| | 400.0 kΩ | 0.1 kΩ | ±(0.7% + 1) | ±(0.6% + 1) | ±(0.6% + 1) |
| | 4.000 MΩ | 0.001 MΩ | ±(0.7% + 1) | ±(0.6% + 1) | ±(0.6% + 1) |
| | 40.00 MΩ | 0.01 MΩ | ±(1.0% + 3) | ±(1.0% + 3) | ±(1.0% + 3) |
| nS | 40.00 nS | 0.01 nS | ±(1.0% + 10) | ±(1.0% + 10) | ±(1.0% + 10) |

1. See the first sentence in Table 8 for a complete explanation of accuracy.
2. When using the REL Δ function to compensate for offsets.

**Table 11. Current Function Specifications**

| Function | Range | Resolution | Accuracy[1] | | | Burden Voltage (typical) |
|---|---|---|---|---|---|---|
| | | | Model 83[2] | Model 85[3, 4] | Model 87[3, 4] | |
| **mA** | 40.00 mA | 0.01 mA | ±(1.2% + 2)[6] | ±(1.0% + 2)[6] | ±(1.0% + 2) | 1.8 mV/mA |
| **A~** | 400.0 mA | 0.1 mA | ±(1.2% + 2)[6] | ±(1.0% + 2)[6] | ±(1.0% + 2) | 1.8 mV/mA |
| (45 Hz to 2 kHz) | 4000 mA | 1 mA | ±(1.2% + 2)[6] | ±(1.0% + 2)[6] | ±(1.0% + 2) | 0.03 V/A |
| | 10.00 A[5] | 0.01 A | ±(1.2% + 2)[6] | ±(1.0% + 2)[6] | ±(1.0% + 2) | 0.03 V/A |
| **mA** | | | | | | |
| **A⎓** | 40.00 mA | 0.01 mA | ±(0.4% + 4) | ±(0.2% + 4) | ±(0.2% + 4) | 1.8 mV/mA |
| | 400.0 mA | 0.1 mA | ±(0.4% + 2) | ±(0.2% + 2) | ±(0.2% + 2) | 1.8 mV/mA |
| | 4000 mA | 1 mA | ±(0.4% + 4) | ±(0.2% + 4) | ±(0.2% + 4) | 0.03 V/A |
| | 10.00 A[5] | 0.01 A | ±(0.4% + 2) | ±(0.2% + 2) | ±(0.2% + 2) | 0.03 V/A |

1. See the first sentence in Table 8 for a complete explanation of accuracy.
2. AC conversion for Model 83 is ac coupled and calibrated to the rms value of a sinewave input.
3. AC conversions for Models 85 and 87 are ac coupled, true rms responding, and valid from 5% to 100% of range.
4. See note 3 in Table 8.
5. ⚠ 10 A continuous; 20 A for 30 seconds maximum; >10 A: unspecified.
6. Below a reading of 200 counts, add 10 counts.

**Table 11. Current Function Specifications (continued)**

| Function | Range | Resolution | Accuracy[1] | | | Burden Voltage (typical) |
|---|---|---|---|---|---|---|
| | | | Model 83[2] | Model 85[3, 4] | Model 87[3, 4] | |
| **μA ∼** (45 Hz to 2 kHz) | 400.0 μA | 0.1 μA | ±(1.2% + 2)[5] | ±(1.0% + 2)[5] | ±(1.0% + 2) | 100 μV/μA |
| | 4000 μA | 1 μA | ±(1.2% + 2)[5] | ±(1.0% + 2)[5] | ±(1.0% + 2) | 100 μV/μA |
| **μA⎓** | 400.0 μA | 0.1 μA | ±(0.4% + 4) | ±(0.2% + 4) | ±(0.2% + 4) | 100 μV/μA |
| | 4000 μA | 1 μA | ±(0.4% + 2) | ±(0.2% + 2) | ±(0.2% + 2) | 100 μV/μA |

1. See the first sentence in Table 8 for a complete explanation of accuracy.
2. AC conversion for Model 83 is ac coupled and calibrated to the rms value of a sinewave input.
3. AC conversions for Models 85 and 87 are ac coupled, true rms responding, and valid from 5% to 100% of range.
4. See note 3 in Table 8.
5. Below a reading of 200 counts, add 10 counts.

**Table 12. Capacitance and Diode Function Specifications**

| Function | Range | Resolution | Accuracy[1] |
|---|---|---|---|
| ⊣⊢ | 5.00 nF<br>0.0500 µF<br>0.500 µF<br>5.00 µF | 0.01 nF<br>0.0001 µF<br>0.001 µF<br>0.01 µF | ±(1% + 3)<br>±(1% + 3)<br>±(1% + 3)<br>±(1.9% + 3) |
| ⊣▶⊢ | 3.000 V | 0.001 V | ±(2% + 1) |

1. With a film capacitor or better, using Relative mode to zero residual. See the first sentence in Table 8 for a complete explanation of accuracy.

**Table 13. Frequency Counter Specifications**

| Function | Range | Resolution | Accuracy[1] |
|---|---|---|---|
| Frequency<br>(0.5 Hz to 200 kHz,<br>pulse width >2 µs) | 199.99<br>1999.9<br>19.999 kHz<br>199.99 kHz<br>>200 kHz | 0.01 Hz<br>0.1 Hz<br>0.001 kHz<br>0.01 kHz<br>0.1 kHz | ±(0.005% + 1)<br>±(0.005% + 1)<br>±(0.005% + 1)<br>±(0.005% + 1)<br>unspecified |

1. See the first sentence in Table 8 for a complete explanation of accuracy.

**Table 14. Frequency Counter Sensitivity and Trigger Levels**

| Input Range[1] | Minimum Sensitivity (RMS Sinewave) | | Approximate Trigger Level |
|---|---|---|---|
| | 5 Hz - 20 kHz | 0.5 Hz - 200 kHz | (DC Voltage Function) |
| 400 mV dc | 70 mV (to 400 Hz) | 70 mV (to 400 Hz) | 40 mV |
| 400 mV dc | 150 mV | 150 mV | — |
| 4 V | 0.3 V | 0.7 V | 1.7 V |
| 40 V | 3 V | 7 V (≤140 kHz) | 4 V |
| 400 V | 30 V | 70 V (≤14.0 kHz) | 40 V |
| 1000 V | 300 V | 700 V (≤1.4 kHz) | 400 V |
| **Duty Cycle Range** | **Accuracy** | | |
| 0.0 to 99.9% | Within ±(0.05% per kHz + 0.1%) of full scale for a 5 V logic family input on the 4 V dc range.<br>Within ±((0.06 x Voltage Range/Input Voltage) x 100%) of full scale for sine wave inputs on ac voltage ranges. | | |

1. Maximum input for specified accuracy = 10X Range or 1000 V.

**Table 15. Electrical Characteristics of the Terminals**

| Function | Overload Protection[1] | Input Impedance (nominal) | Common Mode Rejection Ratio (1 kΩ unbalance) | | Normal Mode Rejection | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| V⎓ | 1000 V rms | 10 MΩ<100 pF | >120 dB at dc, 50 Hz or 60 Hz | | >60 dB at 50 Hz or 60 Hz | | | | | |
| mV⎓ | 1000 V rms | 10 MΩ<100 pF | >120 dB at dc, 50 Hz or 60 Hz | | >60 dB at 50 Hz or 60 Hz | | | | | |
| V~ | 1000 V rms | 10 MΩ<100 pF (ac-coupled) | >60 dB, dc to 60 Hz | | | | | | | |
| | | **Open Circuit Test Voltage** | **Full Scale Voltage** | | **Typical Short Circuit Current** | | | | | |
| | | | **To 4.0 MΩ** | **40 MΩ or nS** | **400 Ω** | **4 k** | **40 k** | **400 k** | **4 M** | **40 M** |
| Ω | 1000 V rms | <1.3 V dc | <450 mV dc | <1.3 V dc | 200 µA | 80 µA | 12 µA | 1.4 µA | 0.2 µA | 0.2 µA |
| ⏩⏪ | 1000 V rms | <3.9 V dc | 3.000 V dc | | 0.6 mA typical | | | | | |

1. $10^6$ V Hz max

**Table 16. MIN MAX Recording Specifications**

| Model | Nominal Response | Accuracy |
|---|---|---|
| 83 | 100 ms to 80% | Specified accuracy ±12 counts for changes >200 ms in duration (±40 counts in ac with beeper on) |
| | 1 s | Same as specified accuracy for changes >2 seconds in duration (±40 counts in ac with beeper on) |
| 85, 87 | 100 ms to 80%<br>(DC functions) | Specified accuracy ±12 counts for changes >200 ms in duration |
| | 120 ms to 80%<br>(AC functions) | Specified accuracy ±40 counts for changes >350 ms and inputs >25% of range |
| | 1 s | Same as specified accuracy for changes >2 seconds in duration |
| | 250 µs<br>(Model 87 only) | Specified accuracy ±100 counts for changes >250 µs in duration<br>(± 250 digits typical for mV, 400 µA dc, 40 mA dc, 4000 mA dc) |