

**FLUKE®**

**116**

True-rms Multimeter

**Users Manual**

PN 2538688

July 2006, Rev. 1, 2/07

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# True-rms Multimeter

## **Introduction**

The Fluke **Model 116**, is a battery-powered, true-rms multimeter (hereafter "the Meter") with a 6000-count display and a bar graph.

This meter meets CAT III IEC 61010-1 2<sup>nd</sup> Edition standards. The IEC 61010-1 2<sup>nd</sup> Edition safety standard defines four measurement categories (CAT I to IV) based on the magnitude of danger from transient impulses. CAT III meters are designed to protect against transients in fixed-equipment installations at the distribution level.

## **Contacting Fluke**

To contact Fluke, call:

USA: 1-888-99-FLUKE (1-888-993-5853)

Canada: 1-800-36-FLUKE (1-800-363-5853)

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Singapore +65-738-5655

Anywhere in the world: +1-425-446-5500

Visit Fluke's web site at [www.fluke.com](http://www.fluke.com).

Register your Meter at [register.fluke.com](http://register.fluke.com).

## **Unsafe Voltage**

To alert you to the presence of a potentially hazardous voltage, the  $\text{⚡}$  symbol is displayed when the Meter measures a voltage  $\geq 30$  V or a voltage overload (OL) condition. When making frequency measurements  $>1$  kHz, the  $\text{⚡}$  symbol is unspecified.

**Safety Information**

A "⚠️⚠️ **Warning**" statement identifies hazardous conditions and actions that could cause bodily harm or death.










A "⚠️ **Caution**" statement identifies conditions and actions that could damage the Meter or the equipment under test.

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

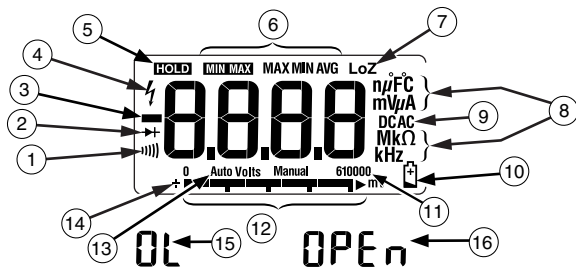
- **Use the Meter only as specified in this manual or the protection provided by the Meter might be impaired.**
- **Do not use the Meter or test leads if they appear damaged, or if the Meter is not operating properly.**
- **Always use proper terminals, switch position, and range for measurements.**
- **Verify the Meter's operation by measuring a known voltage. If in doubt, have the Meter serviced.**
- **Do not apply more than the rated voltage, as marked on Meter, between terminals or between any terminal and earth ground.**
- **Use caution with voltages above 30 V ac rms, 42 V ac peak, or 60 V dc. These voltages pose a shock hazard.**
- **Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, or capacitance.**
- **Do not use the Meter around explosive gas or vapor.**
- **When using test leads or probes, keep your fingers behind the finger guards.**
- **Only use test leads that have the same voltage, category, and amperage ratings as the meter and that have been approved by a safety agency.**
- **Remove test leads from Meter before opening the battery door or Meter case.**

- **Comply with local and national safety requirements when working in hazardous locations.**
- **Use proper protective equipment, as required by local or national authorities when working in hazardous areas.**
- **Avoid working alone.**
- **Use only the replacement fuse specified or the protection may be impaired.**
- **Check the test leads for continuity before use. Do not use if the readings are high or noisy.**
- **Do not use the Auto Volts function to measure voltages in circuits that could be damaged by this function's low input impedance ( $\approx 3 \text{ k}\Omega$ ).**

#### Symbols

	AC (Alternating Current)		Battery (Low battery when shown on display.)
	DC (Direct Current)		Double Insulated
	Hazardous voltage		Important Information; Refer to manual
	Earth ground		AC and DC
	Do not dispose of this product as unsorted municipal waste. Contact Fluke or a qualified recycler for disposal.		



Display



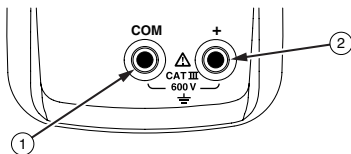
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No.	Symbol	Meaning
①	)	The Meter function is set to Continuity.
②	→	The Meter function is set to Diode Test
③	-	Input is a negative value.
④	⚡	⚠ Unsafe voltage. Measured input voltage $\geq 30$ V, or voltage overload condition (OL).
⑤	<b>HOLD</b>	Display hold enabled. Display freezes present reading.

## True-rms Multimeter Display

No.	Symbol	Meaning
⑥	<b>MIN MAX</b> <b>MAX MIN AVG</b>	MIN MAX AVG mode enabled. Maximum, minimum, average or present reading displayed
⑦	<b>LoZ</b>	The Meter is measuring voltage or capacitance with a low input impedance.
⑧	<b>nμ°F°C mVμA</b> <b>MkΩ kHz</b>	Measurement units.
⑨	<b>DC AC</b>	Direct current or alternating current
⑩		Battery low warning.
⑪	<b>610000 mV</b>	Indicates the Meter's range selection.
⑫	<b>(Bar graph)</b>	Analog display.
⑬	<b>Auto Volts</b> <b>Auto</b> <b>Manual</b>	The Meter is in the Auto Volts function. Auto ranging. The Meter selects the range for best resolution. Manual ranging. User sets the Meter's range.
⑭	<b>+</b>	Bar graph polarity
⑮	<b>OL</b>	 The input is too large for the selected range.
⑯	<b>OPEn</b>	Thermocouple missing or defective when Temperature function is selected.

### Terminals



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No.	Description
①	Common (return) terminal for all measurements.
②	Input terminal for measuring voltage, continuity, resistance, capacitance, frequency, temperature, microamps and testing diodes..

Error Messages	
<b>bAtt</b>	Battery must be replaced before the Meter will operate.
<b>CAL Err</b>	Calibration required. Meter calibration is required before the Meter will operate.
<b>EEP<sub>r</sub> Err</b>	Internal error. The Meter must be repaired before it will operate.
<b>F I I D Err</b>	Internal error. The Meter must be repaired before it will operate.




## True-rms Multimeter Rotary Switch Positions

### Rotary Switch Positions






Switch Position	Measurement Function
<b>AUTO-V</b> LoZ	Automatically selects ac or dc volts based on the sensed input with a low impedance input.
$\tilde{V}^{Hz}$ Hz (button)	AC voltage from 0.06 to 600 V. Frequency from 5 Hz to 50 kHz.
$\bar{V}$	DC voltage from 0.001 V to 600 V.
$m\tilde{V}$	AC voltage from 6.0 to 600 mV, dc-coupled. DC voltage from 0.1 to 600 mV.
$\Omega$	Ohms from 0.1 $\Omega$ to 40 M $\Omega$ .
$\text{    }$	Continuity beeper turns on at <20 $\Omega$ and turns off at >250 $\Omega$ .
$\text{⌋}$	Temperature from -40 °C to 400 °C (-40 °F to 752 °F) with K-type thermocouple
$\text{⤵}$	Diode Test. Displays OL above 2.0 V.
$\text{⤵}$	Farads from 1 nF to 9999 $\mu$ F.
$\mu\bar{A}$	DC current from 0.1 to 600 $\mu$ A. AC current from 6.0 to 600 $\mu$ A. DC-coupled.
Note: All ac functions and Auto-V LoZ are true-rms. AC voltage is ac-coupled. Auto-V LoZ, AC mV and AC $\mu$ A are dc coupled.	

### Battery Saver ("Sleep Mode")

The Meter automatically enters "Sleep mode" and blanks the display if there is no function change, range change or button press for 20 minutes. Pressing any button or turning the rotary switch awakens the Meter. To disable the Sleep mode, hold down the  button while turning the Meter on. The Sleep mode is always disabled in the MIN MAX AVG mode.

### MIN MAX AVG Recording Mode

The MIN MAX AVG recording mode captures the minimum and maximum input values (ignoring overloads), and calculates a running average of all readings. When a new high or low is detected, the Meter beeps.



- Put the Meter in the desired measurement function and range.
- Press  to enter MIN MAX AVG mode.
- **MIN MAX** and MAX are displayed and the highest reading detected since entering MIN MAX AVG is displayed.
- Press  to step through the low (MIN), average (AVG), and present readings.
- To pause MIN MAX AVG recording without erasing stored values, press . **HOLD** is displayed.
- To resume MIN MAX AVG recording, press  again.
- To exit and erase stored readings, press  for at least one second or turn the rotary switch.

### Display HOLD



**To avoid electric shock, when Display HOLD is activated, be aware that the display will not change when you apply a different voltage.**

In the Display HOLD mode, the Meter freezes the display.

1. Press  to activate Display HOLD. (**HOLD** is displayed.)
2. To exit and return to normal operation, press  or turn the rotary switch.

### Backlight



Press  to toggle the backlight on and off. The backlight automatically turns off after 40 seconds. To disable backlight auto-off, hold down  while turning the Meter on.

### Manual and Autoranging

The Meter has both Manual and Autorange modes.


- In the Autorange mode, the Meter selects the range with the best resolution.
- In the Manual Range mode, you override Autorange and select the range yourself.

When you turn the Meter on, it defaults to Autorange and **Auto** is displayed.

1. To enter the Manual Range mode, press . **Manual** is displayed.
2. In the Manual Range mode, press  to increment the range. After the highest range, the Meter wraps to the lowest range.

#### Note

*You cannot manually change the range in the MIN MAX AVG or Display HOLD modes.*






*If you press  while in MIN MAX AVG or Display Hold, the Meter beeps twice, indicating an invalid operation, and the range does not change.*

3. To exit Manual Range, press  for at least 1 second or turn the rotary switch. The Meter returns to Autorange and **Auto** is displayed.

### Power-Up Options

To select a Power-Up Option, hold down the button indicated in the following table while turning the Meter on.

Power-Up Options are canceled when you turn the Meter off and when sleep mode is activated.

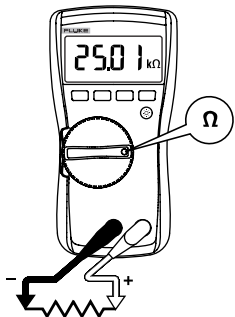
Button	Power-Up Options
	Turns on all display segments.
	Disables beeper. bEEP is displayed when enabled.
	Enables low impedance capacitance measurements. LCAP is displayed when enabled. See page 14.
	Disables automatic power-down ("Sleep mode"). PoFF is displayed when enabled.
	Disables auto backlight off. LoFF is displayed when enabled.

### Making Basic Measurements

The figures on the following pages show how to make basic measurements.

When connecting the test leads to the circuit or device, connect the common (**COM**) test lead before connecting the live lead; when removing the test leads, remove the live lead before removing the common test lead.

### Measuring Resistance

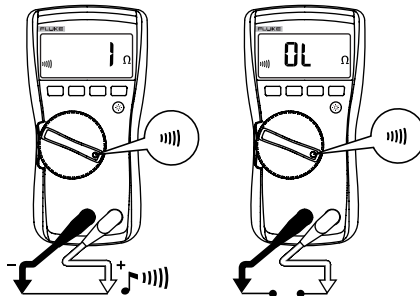


**Warning**

To avoid electric shock, injury, or damage to the Meter, disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes, or capacitance.

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### Testing for Continuity



**Note**

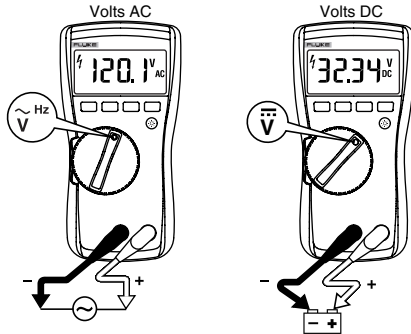
The continuity function works best as a fast, convenient method to check for opens and shorts. For maximum accuracy in making resistance measurements, use the Meter's resistance ( $\Omega$ ) function.

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# True-rms Multimeter

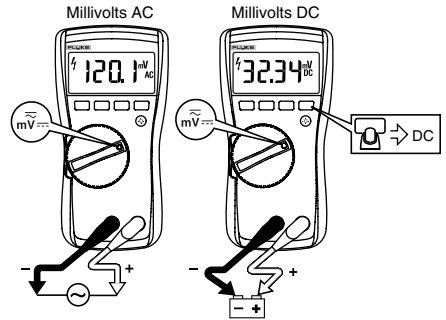
## Making Basic Measurements

### Measuring AC and DC Voltage



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### Measuring AC and DC Millivolts



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### Using Auto Volts Selection

With the function switch in the  $\text{AUTO-V}$  position, the Meter automatically selects a dc or ac voltage measurement based on the input applied between the + and COM jacks.

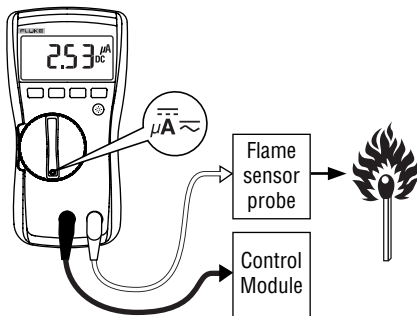
This function also sets the Meter's input impedance to approximately  $3 \text{ k}\Omega$  to reduce the possibility of false readings due to ghost voltages.

With the function switch in the  $\text{mV}$  position, the Meter measures ac plus dc millivolts. Press  $\text{DC}$  to switch the Meter to dc millivolts.

**Measuring AC and DC Current****⚠ Warning**

To avoid personal injury or damage to the Meter:

- Never attempt to make an in-circuit current measurement when the open-circuit potential to earth is > 600 V.
- Use the proper switch position and range for your measurement.



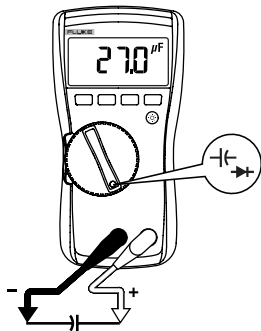
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To measure flame rectification circuits:

1. Turn the function switch to  $\mu\text{A} \sim$ .
2. Connect the Meter between the flame sensor probe and the control module.
3. Turn heating unit on and record  $\mu\text{A}$  measurement.

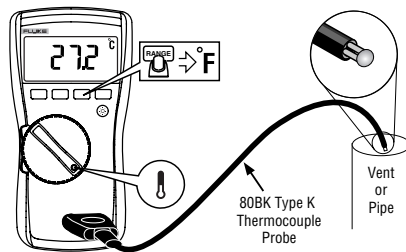
## True-rms Multimeter Making Basic Measurements

### Measuring Capacitance



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### Measuring Temperature



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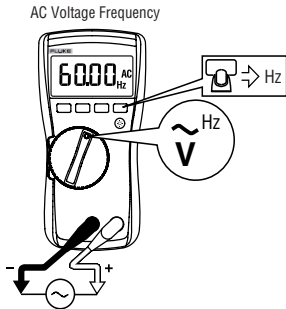
### **⚠ ⚠ Warning**

**To avoid risk of electric shock, do NOT connect 80BK to live circuits.**

## Measuring Frequency

### **⚠⚠ Warning**

To avoid electrical shock, disregard the bar graph for frequencies >1 kHz. If the frequency of the measured signal is >1 kHz, the bar graph and  $\zeta$  are unspecified.



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The Meter measures the frequency of a signal by counting the number of times the signal crosses a trigger level each second. The trigger level is 0 V for all ranges.

1. Press  $\square$  to turn the frequency measurement function on and off. Frequency works with ac volts only.
2. In frequency, the bar graph and range annunciator indicate the AC voltage present.
3. Select progressively lower ranges using manual ranging for a stable reading.

## Making Low Impedance Capacitance Measurements

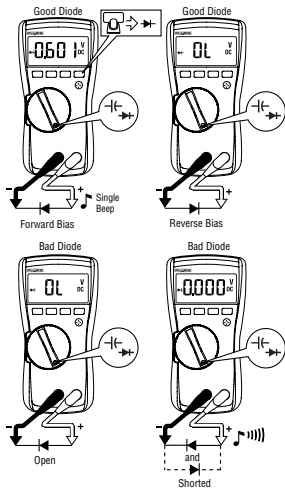
For making capacitance measurements on cables with ghost voltage, hold **RANGE** while turning on the Meter to switch the Meter into LoZ, (low input impedance) Capacitance mode. In this mode, capacitance measurements will have a lower accuracy and lower dynamic range. This setting is not saved when the Meter is turned off or goes into sleep mode.



# True-rms Multimeter

## Making Low Impedance Capacitance Measurements

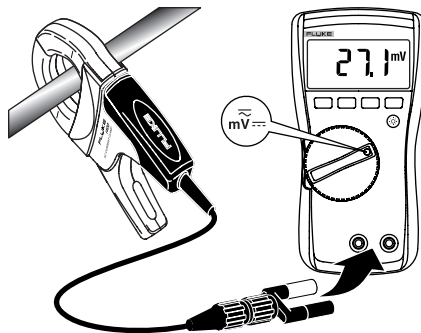
### Testing Diodes



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### Measuring Current above 600 $\mu\text{A}$

The millivolt and voltage function of the Meter can be used with an optional mV/A output Current Probe to measure currents that exceed the rating of the Meter. Make sure the Meter has the correct function, AC or DC, selected for your current probe. Refer to a Fluke catalog or contact your local Fluke representative for compatible current clamps.



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### Using the Bargraph

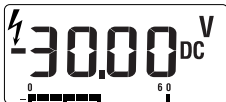
The bar graph is like the needle on an analog meter. It has an overload indicator (▶) to the right and a polarity indicator (+) to the left.

Because the bar graph updates much faster than the digital display, the bar graph is useful for making peak and null adjustments.

The bar graph is disabled when measuring capacitance and temperature. In frequency, the bar graph and range annunciator indicates the underlying voltage up to 1 kHz.

*The number of segments indicates the measured value and is relative to the full-scale value of the selected range.*

In the 60 V range, for example (see below), the major divisions on the scale represent 0, 15, 30, 45, and 60 V. An input of -30 V turns on the negative sign and the segments up to the middle of the scale.

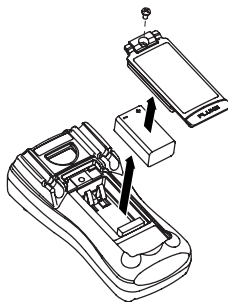


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### Maintenance

Maintenance of the Meter consists of replacing the battery and cleaning the case.

### Replacing the Battery



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**⚠ ⚠ Warning**

**To avoid shock, injury, or damage to the Meter, remove test leads from the Meter before opening the case or battery door.**

To remove the battery door for battery replacement:

1. Remove the test leads from the Meter.
2. Remove the battery door screw.
3. Use the finger recess to lift the door slightly.
4. Lift the door straight up to separate it from the case.

The battery fits inside the battery door, which is then inserted into the case, bottom edge first, until it is fully seated. Do not attempt to install the battery directly into the case.

5. Install and tighten battery door screw.


***Cleaning***

Wipe the case with a damp cloth and mild detergent. **Do not use abrasives, isopropyl alcohol, or solvents to clean the case top or lens/window.** Dirt or moisture in the terminals can affect readings.

**General Specifications**

Accuracy is specified for 1 year after calibration, at operating temperatures of 18 °C to 28 °C, with relative humidity at 0 % to 90 %.

Extended specifications are available at [www.Fluke.com](http://www.Fluke.com).

<b>Maximum voltage between any terminal and earth ground</b> .....	600 V
<b>Surge Protection</b> .....	6 kV peak per IEC 61010-1600V CAT III, Pollution Degree 2
<b>Display</b> .....	Digital: 6,000 counts, updates 4/sec
.....	Bar Graph: 33 segments, updates 32/sec
<b>Temperature</b> .....	Operating: -10 °C to + 50 °C
	Storage: -40 °C to + 60 °C
<b>Temperature Coefficient</b> .....	0.1 x (specified accuracy)/°C (<18 °C or >28 °C)
<b>Operating Altitude</b> .....	2,000 meters
<b>Battery</b> .....	9 Volt Alkaline, NEDA 1604A / IEC 6LR61
<b>Battery Life</b> .....	Alkaline: 400 hours typical, without backlight
<b>Safety Compliances</b> .....	Complies with ANSI/ISA 82.02.01 (61010-1) 2004, CAN/CSA-C22.2 No 61010-1-04, UL 6101B (2003) and IEC/EN 61010-1 2 <sup>nd</sup> Edition for measurement Category III, 600 V, Pollution Degree 2, EMC EN61326-1
<b>Certifications</b> .....	UL, C, CSA, TÜV,  (N10140), VDE

**True-rms Multimeter**  
**General Specifications**

**IP Rating** (dust and water protection) .....IP42

**Table 1. Accuracy Specifications**

Function	Range	Resolution	Accuracy ± ([% of Reading] + [Counts])	
DC millivolts	600.0 mV	0.1 mV	0.5 % + 2	
DC Volts	6.000 V	0.001 V	0.5 % + 2	
	60.00 V	0.01 V		
	600.0 V	0.1 V		
			DC, 45 to 500 Hz	500 Hz to 1 kHz
Auto-V LoZ <sup>[1]</sup> True-rms	600.0 V	0.1 V	2.0 % + 3	4.0 % + 3
			45 to 500 Hz	500 Hz to 1 kHz
AC millivolts <sup>[1]</sup> True-rms	600.0 mV	0.1 mV	1.0 % + 3	2.0 % + 3
AC Volts <sup>[1]</sup> True-rms	6.000 V	0.001 V	1.0 % + 3	2.0 % + 3
	60.00 V	0.01 V		
	600.0 V	0.1 V		

Table 1 Accuracy Specifications (cont.)

Function	Range	Resolution	Accuracy $\pm$ ([% of Reading] + [Counts])
Continuity	600 $\Omega$	1 $\Omega$	Beeper on < 20 $\Omega$ , off > 250 $\Omega$ ; detects opens or shorts of 500 $\mu$ s or longer.
Ohms	600.0 $\Omega$	0.1 $\Omega$	0.9 % + 2
	6.000 k $\Omega$	0.001 k $\Omega$	0.9 % + 1
	60.00 k $\Omega$	0.01 k $\Omega$	0.9 % + 1
	600.0 k $\Omega$	0.1 k $\Omega$	0.9 % + 1
	6.000 M $\Omega$	0.001 M $\Omega$	0.9 % + 1
40.00 M $\Omega$	0.01 M $\Omega$	5 % + 2	
Diode test	2.000 V	0.001 V	0.9 % + 2
Capacitance	1000 nF	1 nF	1.9 % + 2
	10.00 $\mu$ F	0.01 $\mu$ F	1.9 % + 2
	100.0 $\mu$ F	0.1 $\mu$ F	1.9 % + 2
	9999 $\mu$ F	1 $\mu$ F	100 $\mu$ F - 1000 $\mu$ F: 1.9 % + 2 > 1000 $\mu$ F: 5 % + 20
Lo-Z Capacitance	1 nF to 500 $\mu$ F		10% + 2 typical
Temperature (Type K Thermocouple)	-40 $^{\circ}$ C to 400 $^{\circ}$ C	0.1 $^{\circ}$ C	1 % + 10 <sup>[2]</sup>
	-40 $^{\circ}$ F to 752 $^{\circ}$ F	0.2 $^{\circ}$ F	1 % + 18 <sup>[2]</sup>

## True-rms Multimeter General Specifications

**Table 1 Accuracy Specifications (cont.)**

Function	Range	Resolution	Accuracy ± ([% of Reading] + [Counts])
AC $\mu$ Amps True-rms <sup>[1]</sup> (45 Hz to 1 kHz)	600.0 $\mu$ A	0.1 $\mu$ A	1.5 % + 3 (2.5 % + 3 >500 Hz)
DC $\mu$ Amps	600.0 $\mu$ A	0.1 $\mu$ A	1.0 % + 2
Hz (V input) <sup>[3]</sup>	99.99 Hz 999.9 Hz 9.999 kHz 50.00 kHz	0.01 Hz 0.1 Hz 0.001 kHz 0.01 kHz	0.1 % + 2

**Notes:**

- [1] All AC ranges except Auto-V LoZ are specified from 1 % to 100% of range. Auto-V LoZ is specified from 0 V. Because inputs below 1 % of range are not specified, it is normal for this and other true-rms meters to display non-zero readings when the test leads are disconnected from a circuit or are shorted together. For volts and  $\mu$ A, crest factor of  $\leq 3$  at 4000 counts, decreasing linearly to 1.5 at full scale. AC volts is ac-coupled. Auto-V LoZ, AC mV, and AC  $\mu$ A are dc-coupled.
- [2] Temperature uncertainty (accuracy) does not include the error of the thermocouple probe.
- [3] Frequency is ac coupled and specified from 5 Hz to 50 kHz.

Table 2. Input Characteristics

Function	Input Impedance (Nominal)	Common Mode Rejection Ratio (1 k $\Omega$ Unbalanced)		Normal Mode Rejection
Volts AC	>5 M $\Omega$ <100 pF	>60 dB at dc, 50 or 60 Hz		
Volts DC	>10 M $\Omega$ <100 pF	>100 dB at dc, 50 or 60 Hz		>60 dB at 50 or 60 Hz
Auto-V LoZ	~3 k $\Omega$ <500 pF	>60 dB at dc, 50 or 60 Hz		
	<b>Open Circuit Test Voltage</b>	<b>Full Scale Voltage</b>		<b>Short Circuit Current</b>
Ohms	<2.7 V dc	<b>To 6.0 M<math>\Omega</math></b>	<b>40 M<math>\Omega</math></b>	<350 $\mu$ A
		<0.7 V dc	<0.9 V dc	
Diode Test	<2.7 V dc	2.000 V dc		<1.2 mA