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8060A
Digital Multimeter

Instruction Manual

P/N 632661
March 1982
Rev.3, 1/88
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Rev. 6/81

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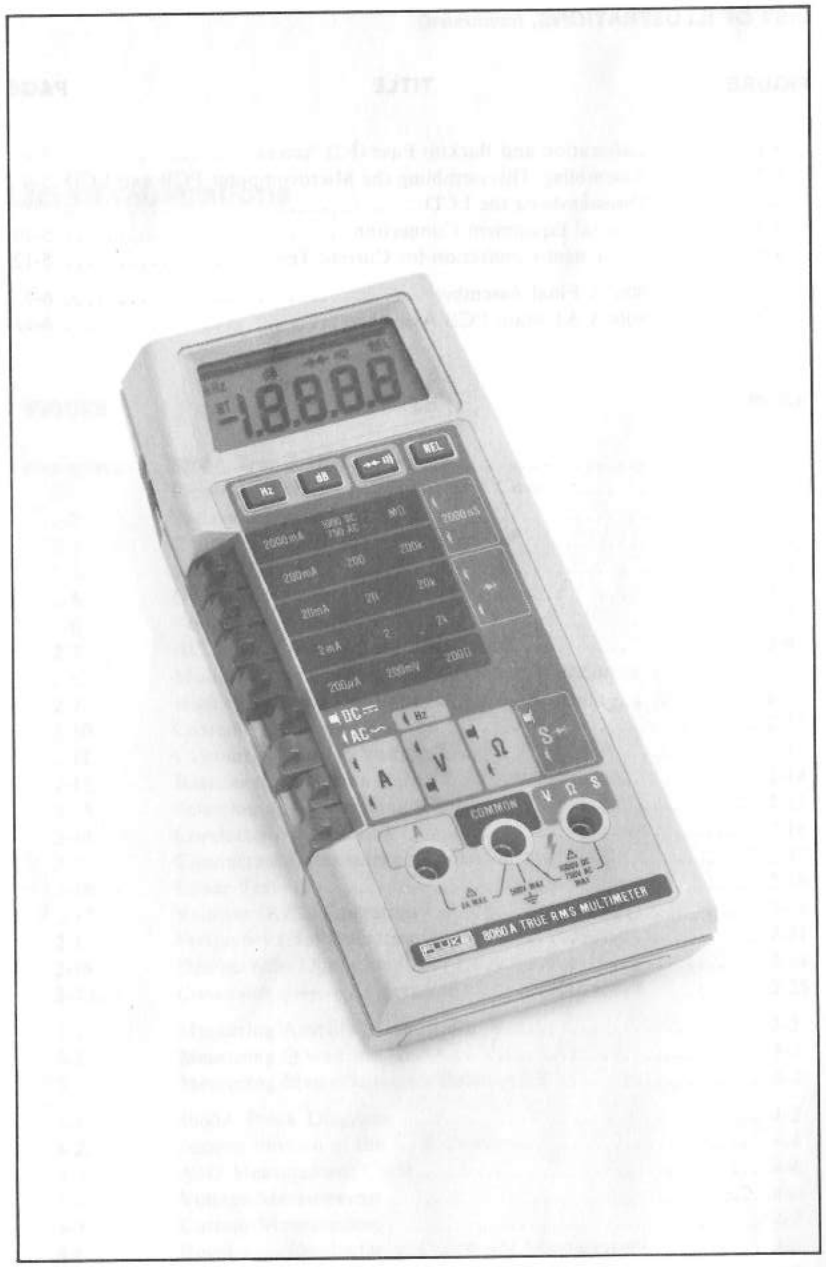
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Model 8060A Digital Multimeter

Section 1
Introduction and Specifications

1-1. INTRODUCTION

Your John Fluke Model 8060A is a handheld, microcomputer-based 4-1/2 digit multimeter that is ideally suited for use in the field, laboratory, shop or home. The 8060A has all the features that have become accepted standards for quality handheld multimeters, as well as some new features that have not been offered before in a handheld multimeter. New features include the following:

- True rms measurements for ac signals up to 100 kHz.
- Frequency measurements up to 200 kHz.
- Voltage measurements in dBm referenced to 600Ω or in dB relative to an operator-selected reference voltage.
- Resistance measurements up to 300 MΩ.
- Ability to store any input signal as an offset or relative reference value.

Other features include:

- FUNCTIONS:

  All standard DMM measurement functions, such as ac and dc volts and ac and dc current, as well as resistance, conductance, continuity, and diode test.

- RANGES:

  Leading zero suppression.

  Automatic polarity.

  Overrange indication.

  Protection from overloads and transients up to 6 kV.

  Dual-slope integration a/d conversion to ensure noise-free measurements.

Autoranging MΩ resistance range (to 300 MΩ), as well as four fixed resistance ranges from 200Ω to 200 kΩ.

- OPERATOR CONVENIENCE:

  4-1/2 digit Liquid Crystal Display.

  Software-controlled self-test routines for quick verification of internal circuitry and operation.

- POWER:

  170 hours of continuous operation can be expected from a 9V alkaline battery (NEDA 1604).

  Low battery voltage is automatically detected and displayed. The low battery indication, BT, appears on the display when about 20% of the battery life remains.

  Ordinary line operation is possible using a Fluke Model A81 Battery Eliminator.

A full line of accessories is available to enhance the capabilities of the 8060A.

1-2. SPECIFICATIONS

The specifications for the 8060A are listed in Table 1-1.

Table 1-1. 8060A Specifications

ELECTRICAL

The following specifications are based on a one-year calibration cycle, an operating temperature of 18 to 28°C (64 to 82°F) and a relative humidity not exceeding 80%.

DC Voltage

RANGE	RESOLUTION	ACCURACY ±(% of reading + no. of digits)
200 mV	.01 mV	0.04% + 2
2 V	.1 mV	
20 V	1 mV	0.05% + 2
200 V	10 mV	
1000 V	100 mV	

RESPONSE TIME ..... 1 second maximum, to rated accuracy within selected range.

INPUT IMPEDANCE ..... 10 MΩ nominal

NORMAL MODE NOISE REJECTION ..... >60 db at 50 Hz or 60 Hz

COMMON MODE NOISE REJECTION ..... >120 dB at dc, >90 dB at 50 Hz and 60 Hz (1 kΩ imbalance)

OVERLOAD PROTECTION ..... 1000V dc or peak ac continuous, except 20 seconds maximum on 200 mV and 2V ranges above 300V dc or rms.

DC Voltage, High Impedance Mode

All specifications are the same as for the dc voltage mode except the following (only 200 mV and 2V ranges are available):

RANGE	RESOLUTION	ACCURACY ±(% of reading + no. of digits)
200 mV	.01 mV	0.05% + 2
2V	.1 mV	

INPUT IMPEDANCE ..... >1,000 MΩ, typically 10,000 MΩ

OVERLOAD PROTECTION ..... 300V dc or rms continuous, 20 seconds maximum 300V to 1000V dc or peak ac.

Table 1-1. 8060A Specifications (cont)

DC Voltage, dB Mode

Measurements are made in dBm referenced to 600Ω or relative dB. All specifications are the same as for dc voltage except the following:

DYNAMIC RANGE ..... With full .01 dB resolution, 99.79 dB. Total specified dynamic range is 136.22 dB (160 μV to 1000V).

RESOLUTION AND ACCURACY ..... Depends on linear dc count (count refers to the display in dc volts independent of the decimal points - see table below).

ACCURACY		
dBm Ref. 600Ω	Range	Tolerance
-74 to -56 (160 μV to 1.27 mV)	200 mV	±1 dB
-55.6 to -37.6 (1.28 mV to 10.23 mV)	200 mV	±.2 dB
-37.58 to -31.77 (10.24 mV to 19.99 mV)	200 mV	±.04 dB
-31.76 to -11.76 (20 mV to -199.99 mV)	200 mV	±.04 dB
-11.76 to 8.24 (.2V to 1.9999V)	2V	±.04 dB
8.24 to 28.24 (2.000V to 19.999V)	20V	±.04 dB
28.24 to 48.24 (20.00V to 199.99V)	200V	±.04 dB
48.24 to 62.22 (200.0 to 1000V	1000V	±.04 dB

LINEAR COUNTS	RESOLUTION	ACCURACY
19,999 to 1024	.01 dB	±.04 dB
1023 to 128	.1 dB	±.2 dB
127 to 16	1 dB	± 1 dB

Table 1-1. 8060A Specifications (cont)

AC Voltage (True RMS, AC-Coupled)

RANGES ..... 200 mV, 2V, 20V, 200V, 750V

ACCURACY ..... ±(% of reading + no. of digits). See table below:

INPUT VOLTAGE	RESOLUTION	RANGE	20 Hz to 45 Hz	45 Hz to 1 kHz	1 kHz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz
10.0 to 199.99 mV	.01 mV	200 mV	1% +10	0.2% +10	0.2% +20	0.5% +40	1% +100	3% +200
.1000 to 1.9999V	.1 mV	2V		0.5% +10	0.5% +20	1% +40	2% +100	
1.000 to 19.999V	1 mV	20V						
10.00 to 199.99V	10 mV	200V						
100.0 to 499.9V	100 mV	750V	Not Specified		Not Specified			
500.0 to 750.0V				1% +10				

AC Voltage (cont.)

INPUT IMPEDANCE ..... 10 MΩ shunted by <100 pF

COMMON MODE NOISE REJECTION ..... >60 dB at 50 Hz and 60 Hz (1 kΩ imbalance)

CREST FACTOR RANGE . 1:1 to 3:1

RESPONSE TIME ..... Five seconds maximum to rated accuracy within selected range, 12 seconds to rated accuracy from an overload.

OVERLOAD PROTECTION ..... 750V rms or 1000V peak continuous except 20 seconds maximum on the 200 mV range above 300V rms or 300V dc. Input not to exceed a volt-hertz product of 10^7 (for example, 200V at 50 kHz).

Table 1-1. 8060A Specifications (cont)

AC Voltage, dB Mode (True RMS, AC-Coupled)

Measurements are made in dBm referenced to 600Ω or relative dB. All specifications are the same as for ac voltage except the following:

DYNAMIC RANGE ..... With full .01 dB resolution, 97.30 dBm. Total specified dynamic range is 109.72 dBm (2.45 mV to 750.0V ac rms).

RESOLUTION ..... Depends on number of linear ac counts (count refers to the actual number on the display independent of the decimal point. See table below).

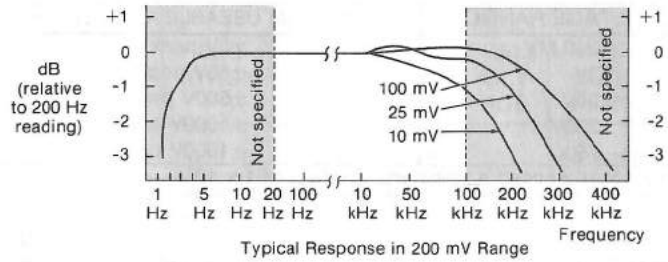
LINEAR COUNTS*	RESOLUTION
19,999 to 1024 1023 to 128 127 to 16	.01 dB .1 dB 1 dB
*Not specified below 245 counts.	

ACCURACY ..... See table below:

dBm REF. 600Ω	RANGE	20 Hz to 45 Hz	45 Hz to 10 kHz	10 kHz to 30 kHz	30 kHz to 50 kHz	50 kHz to 100 kHz
-50.0 to -37.6 (2.45 mV to 10.23 mV)	200 mV	0.5 dB	1.0 dB	3.0 dB	Not Specified	
-37.58 to -31.76 (10.24 mV to 20.00 mV)	200 mV	0.20 dB		0.50 dB	1.00 dB	2.20 dB
-31.76 to -11.76 (20 mV to 199.99 mV)	200 mV	0.10 dB* 0.15 dB		0.15 dB* 0.30 dB	0.30 dB* 0.65 dB	0.50 dB* 1.20 dB
-11.76 to 8.24 (.2000V to 1.9999V)	2V					
8.24 to 28.24 (2.000V to 19.999V)	20V					
28.24 to 48.24 (20.00V to 199.99V)	200V	1 kHz				
48.24 to 59.72 (200.0V to 750.0V	750V	0.5 dB	Not Specified			
*Specification applies above 8000 linear counts.						

Table 1-1. 8060A Specifications (cont)

AC Voltage, dB Mode (cont.)

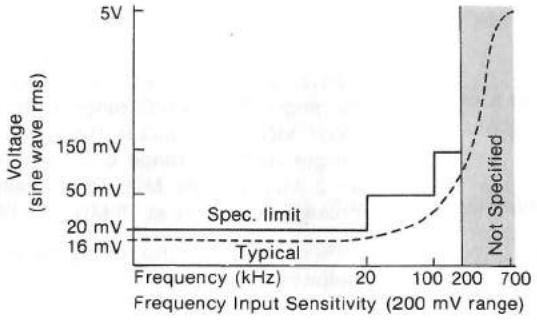


Typical Response in 200 mV Range

Frequency

FREQUENCY RANGE (Fully Autoranging)	RESOLUTION	ACCURACY ±(% of reading + no. of digits)
200 Hz 2000 Hz 20 kHz 200 kHz	.01 Hz .1 Hz 1 Hz 10 Hz	.05% + 1

INPUT SIGNAL	SENSITIVITY (based on sine wave V rms)
12 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 200 kHz	20 mV or 10% of voltage range* 50 mV or 25% of voltage range* 150 mV or 75% of voltage range*
*Whichever value is greater	



Frequency Input Sensitivity (200 mV range)

Table 1-1. 8060A Specifications (cont)

Frequency (cont.)

AC VOLTAGE RANGE	MAXIMUM USEABLE AC VOLTAGE*
200 MV	±5V peak
2V	±50V peak
20V	±500V peak
200V	±1000V peak
750	±1000V peak

*Signal not to exceed a volt-hertz product of 1×10^7.

INPUT CHARACTERISTICS ..... AC-coupled, 10 MΩ shunted by <100 pF

OVERLOAD PROTECTION . 759V rms or 1000V peak continuous except 20 seconds maximum on the 200 mV range above 300V rms or 300V dc. Input not to exceed a volt-hertz product of 10^7 (for example, 200V at 50 kHz).

EXTENDED FREQUENCY

Selection ..... Enabled by holding down Hz button at power on.

Range ..... 12 Hz to 700 kHz, typically.

Resolution ..... 100 Hz above 200 kHz.

Accuracy ..... ±(.05% of reading + 2 digits)

Sensitivity (sine wave V rms) ..... Typically 100 mV at 200 kHz increasing to 4.5V at 700 kHz in the 200 mV range. Will measure a TTL signal (50% duty cycle) to 420 kHz, typically.

Resistance

RANGES ..... 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, autoranging MΩ. The MΩ range extends from .0001 MΩ to 300 MΩ in three autoranged ranges. Upscale range changes are made at 2 MΩ and 20 MΩ. Downscale range changes are made at 19 MΩ and 1.9 MΩ.

ACCURACY ..... ±(% of reading + no. of digits). See table below.

Table 1-1. 8060A Specifications (cont)

Resistance (cont.)

RANGE		RESOLUTION	ACCURACY	FULL-SCALE VOLTAGE	MAX CURRENT	OPEN CIRCUIT VOLTAGE
200Ω		0.01Ω	(0.07%+2+.02Ω)	<250 mV	<1.1 mA	<4.8V
2 kΩ		0.1Ω	(0.07%+2)		<150 μA	<1.5V
20 kΩ		1Ω	(0.07%+2)		<15 μA	
200 kΩ		10Ω	(0.07%+2)		<1.5 μA	
MΩ	0-1.9999 MΩ	100Ω	(0.15%+2)	<2.5V	<2.5 μA	<2.5V
	2-19.99 MΩ	10 kΩ	(0.2%+3)			
	20-99.9MΩ	100 kΩ	(1%+3)			
	100-300MΩ	1 MΩ	(2%+3)			
AUTORANGING KΩ		0.1Ω TO 1 kΩ	(0.2%+5)		<1.0 mA	

RESPONSE TIME ..... Two seconds maximum to rated accuracy for all ranges except MΩ. For MΩ, 8 seconds maximum.

OVERLOAD PROTECTION ..... 500V dc or rms ac for all ranges.

Conductance

RANGE ..... 2000 nS (equivalent to a resistance range from 500 kΩ to 10,000 MΩ)

RESOLUTION ..... 0.1 nS

ACCURACY ..... ±(0.5% of reading + 20 digits)

OPEN CIRCUIT VOLTAGE ..... <1.5V

OVERLOAD PROTECTION ..... 500V dc or rms ac

Table 1-1. 8060A Specifications (cont)

Continuity

RANGES ..... All resistance ranges

THRESHOLD ..... Nominally 10% of range (for example, 20Ω in the 200Ω range) for 200Ω, 2 kΩ, 20 kΩ, 200 kΩ ranges. Nominally 20 kΩ in MΩ range.

DISPLAY INDICATION ... Horizontal bar across the top of the display and/or 2.667 kHz tone. Indication is present for a minimum of 200 ms.

RESPONSE TIME ..... 50 μs maximum (10 μs typical)

OVERLOAD PROTECTION ..... 500V dc or rms ac

Diode Test

RANGE 2V

TEST CURRENT ..... 1 mA (±10%) Nominal

ACCURACY ..... ±(0.05% of reading + 2 digits)

RESPONSE TIME ..... 2 seconds maximum

OVERLOAD PROTECTION ..... 500V dc or rms ac

DC Current

RANGE	RESOLUTION	ACCURACY ±(% of reading + no. of digits)	BURDEN VOLTAGE
200 μA	.01 μA	0.2% + 2	.3V maximum
2 mA	.1 μA		.3V maximum
20 mA	1 μA	0.3% + 2	.3V maximum
200 mA	10 μA		.3V maximum
2000 mA	100 μA		.9V maximum

OVERLOAD PROTECTION ..... 2A/250V fuse (operator replaceable) in series with 3A/600V fuse (service personnel replaceable).

AC Current (True RMS Responding, AC-Coupled

ACCURACY ..... ±(% of reading + no. of digits). See table below:

Table 1-1. 8060A Specifications (cont)

DC Current (cont.)

INPUT CURRENT	RESOLUTION	RANGE	20 Hz to 45 Hz	45 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 30 kHz
10 to 199.99 μA	0.01 μ	200 μA	1%+10	0.75%+10	2%+20	2%+40
.1 to 1.9999 mA	0.1 μA	2 mA				
1 to 19.999 mA	1 μA	20 mA				
10 to 199.99 mA	10μA	200 mA			Not Specified	
100 to 1999.9 mA	100 μA	2000 mA				

BURDEN VOLTAGE ..... 0.3V rms maximum except 2000 mA range, 0.9V rms maximum.

OVERLOAD PROTECTION ..... 2A/250V fuse (operator replaceable) in series with 3A/600V fuse (service personnel replaceable).

Relative

SELECTION ..... When the REL button is pushed, the input applied at that time is stored as a zero reference point. Subsequent readings indicate deviations (±) from the reference point.

ACCURACY ..... Error does not exceed the sum of the errors of the reference reading and the subsequent reading.

GENERAL

Maximum Common Mode Voltage ..... 500V dc or ac rms

Display Update Rate ..... 2.5 readings/second for all functions except frequency and dB. For frequency, 1 reading/second. For dB, 1.4 readings/second.

Table 1-1. 8060A Specifications (cont)

GENERAL (cont.)	
Display	4½ digit duplex LCD (19,999 count), leading zero suppression, autopolarity.
Display Annunciators	BT (low battery indicator), Hz or kHz (frequency unit), dB (dB function enabled), REL (relative function enabled). ⊣⊢ and ıı)) (continuity function enabled), and ═══ (bar indicates continuity detected).
A/D Converter	Dual-slope converter
Power	Single standard 9V battery (NEDA 1604), or Fluke A-81 Battery Eliminator option available for 100, 115, or 230V ac operation.
Battery Life	Typically 170 hours with an alkaline battery. BT appears on display when approximately 20% of battery life remains.
Size	180 mm L x 86 mm W x 45 mm H (7.1" L x 3.4" W x 1.8" H)
Weight	.41 kg (14.5 oz.)
Shock and Vibration	MIL-T-28800B
ENVIRONMENTAL	
Operating Temperature	0 to 50°C
Storage Temperature	-35 to +60°C
Accuracy Temperature Coefficient	0.1 x the applicable accuracy specification per °C (plus the initial 23°C specification) for 0 to 18°C and 28 to 50°C.
Relative Humidity	0 to 80% R.H. from 0 to +35°C, 0 to 70% from +35°C to +50°C, except 0 to 70% R.H. for MΩ range above 20 MΩ.

Section 2
Operating Instructions

2-1. INTRODUCTION

This section describes how to make measurements with your 8060A. Even though you may have used a multimeter before, we suggest that you take the time to read this material carefully so that you can take full advantage of the wide variety of measurement functions offered by the 8060A.

2-2. UNPACKING YOUR INSTRUMENT

Your instrument was shipped with two test leads (one red and one black), a 9V battery, and this manual. Check the shipment carefully and immediately contact the place of purchase if anything is missing or damaged in shipment.

If reshipment is necessary, please use the original shipping container. If the original container is not available, be sure that adequate protection is provided to prevent damage during shipment. It is recommended that the instrument be surrounded by at least three inches of shock-absorbing material in the shipping container.

2-3. BATTERY INSTALLATION OR REPLACEMENT

The 8060A is designed to operate on a single, common, inexpensive 9V battery (NEDA 1604). When you receive the instrument, the battery will not be installed. Once the battery is installed, you can expect a typical operating life of up to 170 hours with an alkaline battery, or 80 hours with a carbon-zinc battery. When the battery has exhausted about 80% of its useful life the BT indicator will appear at the far left of the display. Your instrument will continue to operate properly for at least 24 hours with an alkaline battery after BT first appears on the display. The 8060A also may be operated from a standard ac power line outlet when used with the optional A81 Battery Eliminator (refer to Section 7 for a description). Use the following procedure to install or replace the battery:

WARNING

TO AVOID ELECTRICAL SHOCK, TURN OFF THE INSTRUMENT AND REMOVE THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE BATTERY.

1. Set the 8060A power switch to OFF.

2. Remove test leads from external connections and from the 8060A input terminals.

3. Turn the instrument over and use your thumbs to pry off the battery cover as shown in Figure 2-1.

4. Slide the battery out of the compartment as shown in Figure 2-2.

5. Carefully pull the battery clip free from the battery terminals (if replacing the battery) and attach the new battery.

6. Slide the battery and its leads into the compartment and slide the cover into place.

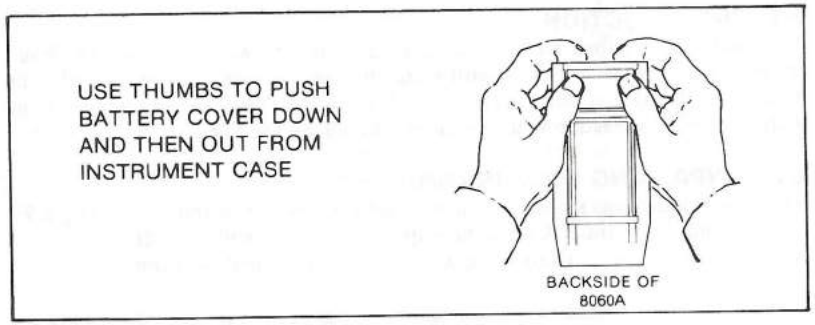


Figure 2-1. Removal of Battery Compartment Cover

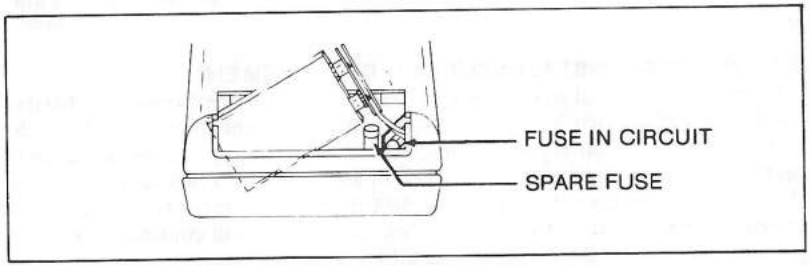


Figure 2-2. Battery Removal and Fuses

You can measure the voltage of your battery by using the following procedure:

1. Select the dc voltage function and the 20V range (refer ahead to Figure 2-6 if necessary).

2. Locate the opening for the battery eliminator jack on the right side of the instrument to the right of the display. Touch the red (VΩS) probe tip

to the side contact (not the center pin). Be sure you do not short the battery by shorting the side contact to the center pin. Battery voltage should be between 5.2V to 10V for proper operation. If the voltage is less, the battery should be replaced.

2-4. FUSE REPLACEMENT

When you installed the battery, you probably noticed two fuses at the right side of the battery compartment (refer to Figure 2-2 or examine your instrument). The fuse at the far right is F1. Fuse F1, 2A/250V, protects the current input from an input overload. The other fuse is a spare fuse for F1. When you purchase your instrument, F1 should be installed and the spare fuse should be in one of the two slots next to it. The larger slot is for the American-style fuse, and the smaller slot is for the European-style fuse (either style fuse fits in the installation compartment).

If you need to replace F1, use the tip of a test lead to push the fuse forward from the end and then up to relase. Replace F1 with the appropriate 2A/250V fuse; American-style: fast-acting, type AGX2, 1/4 x 1", John Fluke 376582; European-style: 5 x 20 mm, John Fluke 460972.

There is another fuse, F2, 3A/600V, which also protects the current input. The instrument cover must be removed to replace F2. This procedure is described in Section 5 and should only be done by a person qualified to service the instrument.

The following steps provide a quick and easy way to ckeck the condition of both fuses F1 and F2:

1. Select the resistance function and the 2 kΩ range (look ahead to Figure 2-12 if necessary).

2. Touch the red test lead tip to the A input jack so that the VΩS input and the A input are shorted together.

3. If the display reads .1000 ± .0100 kΩ, both fuses are good.

4. If the display reads OL, one or both fuses needreplacement.

2-5. PHYSICAL FEATURES

Before you begin using your 8060A, we suggest you take a few minutes to familiarize yourself with the instrument. All of the externally accessible features are shown in Figure 2-3 and described in Table 2-1. The front panel and the display are also described in the following paragraphs.

2-6. Front Panel

The front panel of the 8060A is designed to make function and range selection easy. The symbols and colors on the panel indicate which switches to push or buttons to press to select the function you want. Details are provided later with the description of each function.

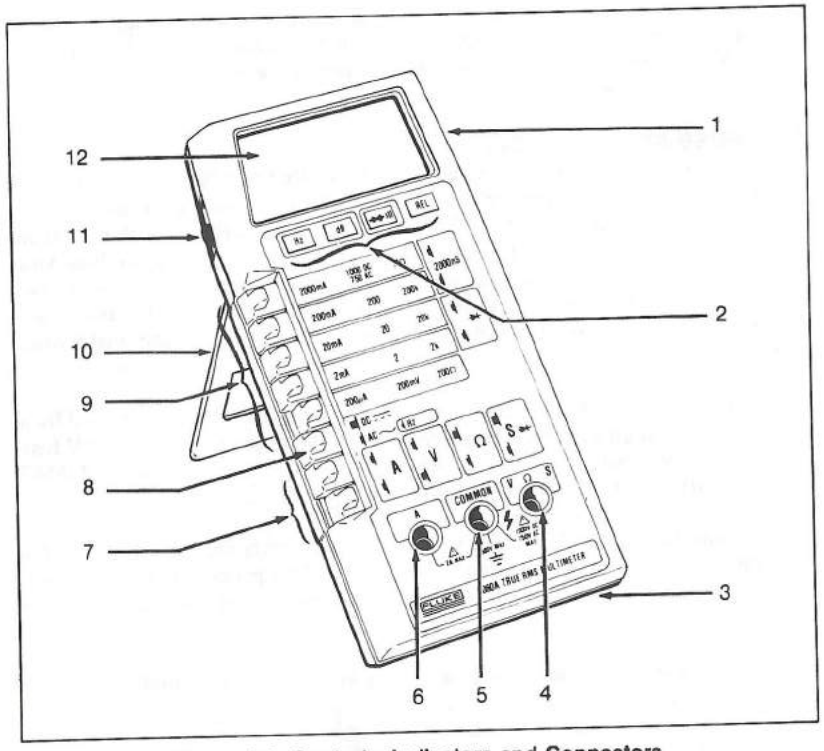


Figure 2-3. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators and Connectors

ITEM NO.	NAME	FUNCTION
1	Battery Eliminator Connector	External input power connector for use with the A81 Battery Eliminator accessory.
2	Function Buttons: Hz, dB, ◂◂ ıılı, REL	Push buttons that toggle on or toggle off the 'secondary' functions: frequency, dB, visible or audible continuity, or relative. These functions are selected in conjunction with the primary measurement functions (see items 7 and 8).
3	Battery Compartment and Cover	Cover for the 9V battery and the current fuse F1.

Table 2-1. Controls, Indicators and Connectors (cont)

ITEM NO.	NAME	FUNCTION
4	V Ω S Input Connector	Protected test lead connector used as the high input for all voltage, conductance, resistance, continuity, frequency measurements and diode test. All test lead connectors accept standard or safety-designed banana plugs.
5	COMMON Input Connector	Protected test lead connector used as the low or common input for all measurements.
6	A Input Connector	Protected test lead connector used as the high input for current measurements.
7	Function Switches: A,V,Ω,S ⊣◂	Interlocked switches that are used in conjunction with the input connectors to select the measurement functions. Pushing one switch releases the other, or both may be pushed together.
8	AC/DC Function Switch	Push-on/push-off switch is used to select ac or dc for current or voltage measurements. (Does not affect selection of diode test, resistance, or conductance functions).
9	Range Switches	Interlocked switches that are used to select ranges. Pushing a switch selects the corresponding range and releases other switch depressions. Also used to select conductance and the diode test.
10	Tilt Bail	A fold-out stand. The bail may also be removed (press in one of the legs at the hinge of the bail) and reinserted from the top as a hook for hanging the instrument.
11	Power Switch	Slide switch for turning instrument on or off.
12	Display	4½ digit LCD display (19999 maximum) with decimal point, minus sign, overrange, Hz, dB, continuity and relative indicators.

2-7. Display

The 8060A provides measurement results on the 4-1/2 digit LCD display (refer to Figure 2-4 or your instrument). The decimal point is placed automatically. Symbols in the upper portion of the display indicate when one of the secondary functions is enabled. The unit for the autoranging frequency measurements is displayed automatically as Hz or kHz. The units for all the other measurements are indicated by the range switch that is pushed in. Leading zeroes are not displayed.

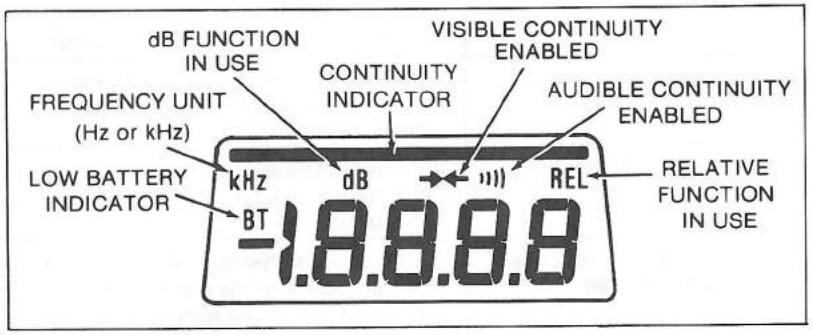


Figure 2-4. 8060A Display

If you are taking a measurement and the OL symbol appears on the display (Figure 2-5), an overrange condition is indicated, meaning that the input is higher than the range selected. You should select a higher range for the measurement. The OL symbol does not necessarily mean that the instrument is being exposed to a damaging input condition. For example, when measuring resistance, an open input will cause OL to appear.

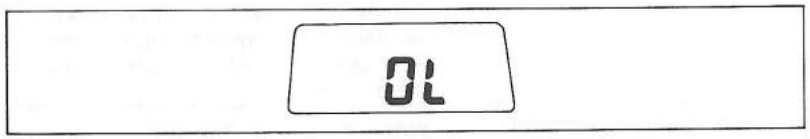


Figure 2-5. Overrange Indicator

2-8. SIGNAL INPUT LIMITS

CAUTION

Exceeding the maximum input overload limits can damage your instrument.

Before you begin to use your 8060A, it is important to note the maximum inputs that may be applied to the instrument. Table 2-2 presents the maximum inputs that are allowed for each function, range, and input terminal.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE COMMON INPUT TERMINAL TO ANY SOURCE MORE THAN 500 VOLTS DC OR RMS AC ABOVE EARTH GROUND.

Table 2-2. Input Overload Limits

FUNCTION	INPUT TERMINALS	MAXIMUM INPUT LIMIT
AC Voltage, AC dB, Frequency	VΩS and COMMON	750V rms or 1000V peak continuous except 20 seconds maximum on the 200 mV range above 300V dc or ac rms.
DC Voltage, DC dB	VΩS and COMMON	1000V dc or peak ac continuous except 20 seconds maximum on the 200 mV and 2V ranges above 300V dc or ac rms.
AC or DC Current	A and COMMON	2A maximum, fuse protected to 600V dc or ac rms.
Resistance, Conductance, Diode Test, and Continuity	VΩS and COMMON	500V dc or ac rms

2-9. OPERATION

The following paragraphs describe the power-on self-test, and how to operate your 8060A in each of the seven primary functions or the four secondary functions.

2-10. Power-On Self-Test

To turn on your instrument, locate the green switch on the left side of the instrument and slide it forward. Whenever you turn on the instrument, the 8060A automatically performs a self-test to make sure the display and the microcomputer are functioning properly. If everything is functioning properly, all the LCD segments in the display will turn on (Figure 2-4). After about one or two seconds, the display will go blank briefly before responding to switch selections.

If the LCD segments do not all turn on during the self-test, or if the instrument does not clear the display after the test and then respond to switch selections, something is probably wrong with the instrument. Try the test again, and if it fails, have a qualified person refer to Section 5. If there is no display when you turn on the instrument, check the battery and battery connections. You will find that if you turn off your instrument and then immediately turn it back on, a random assortment of LCD segments may be displayed. This is normal. After about a second the instrument should turn on all the LCD segments as usual during the self-test.

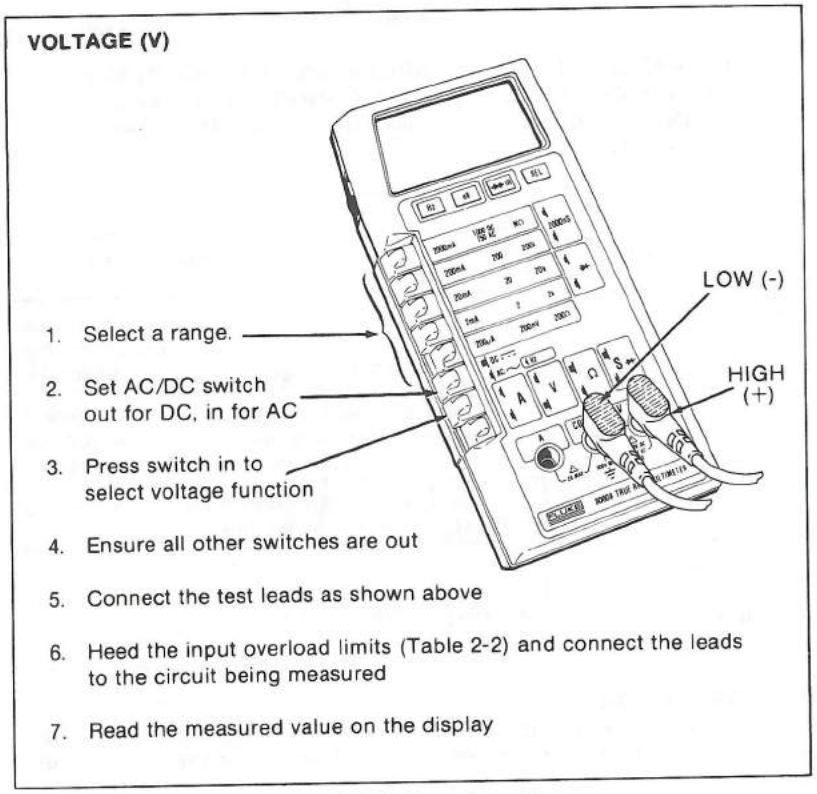


Figure 2-6. Voltage Operation

2-11. AC/DC Voltage (V)

Selection of the ac or dc voltage (V) functions is described in Figure 2-6. The 8060A offers five ac and five dc voltage ranges: 200mV, 2V, 20V, 200V, and 750V ac/1000V dc. All ranges present a 10 MΩ input impedance, which is shunted by <100pF in ac voltage measurements.

2-12. TRUE RMS MEASUREMENT

One of the most useful features of the 8060A is the direct measurement of true rms or effective ac voltages and ac currents. Mathematically, rms is defined as the square root of the sum of the squares of the ac and dc components. In physical terms, rms is equivalent to the dc value that dissipates the same amount of heat in a resistor as the original waveform. The reason that rms is so valuable is that it greatly simplifies the analysis of complex ac signals. Since rms is the dc equivalent to the original waveform, it can be used in the relationships derived from Ohm's law (E = I x R), and it provides a reliable basis for comparing dissimilar waveforms.

Most meters in use today have average-responding ac converters rather than true rms ac converters like the 8060A. Usually the gain in average-responding meters is adjusted so that the reading gives the rms value, provided the input signal is a harmonic-free sinusoid. However, if the signal is not sinusoidal, the average-responding meter does not give correct rms readings.

The 8060A ac converter actually calculates the rms value through analog computation. This means that 8060A readings are accurate rms values not only for harmonic-free sinusoids, but also for mixed frequencies, modulated signals, square waves, sawtooths, 10%-duty-cycle rectangular pulses, etc.

2-13. AC-COUPLED AC MEASUREMENTS

Input signals are ac-coupled in the ac functions. One of the major advantages of ac-coupling is that ripple measurements can be made on power supplies, phone lines, etc. Ripple measurements cannot be made with dc-coupling. Remember, however, that when the 8060A measures signals with the ac voltage function, the reading on the display does not include the dc component (if it exists). For example, consider the waveform in Figure 2-7. The ac voltage function will measure the ac rms component. The dc voltage function will measure the dc component. To obtain the total rms value for such a waveform, first measure the ac and dc values separately, then calculate the total rms value using the formula given in Figure 2-7.

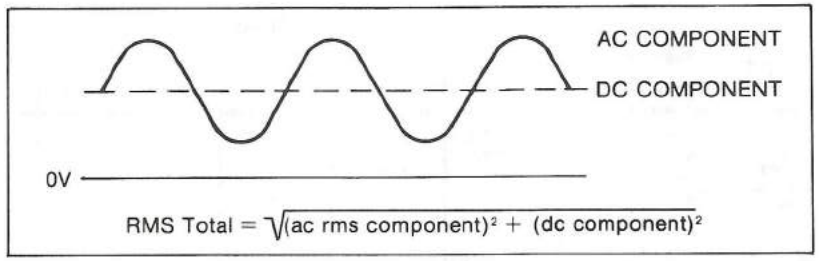


Figure 2-7. AC and DC Waveform Components

2-14. WAVEFORM COMPARISON AND CONVERSION

Figure 2-8 shows the relationship between common waveforms and the display readings for the 8060A and average-responding meters. Figure 2-8 also illustrates the relationship between ac and dc measurements for ac-coupled meters. For example, consider the first waveform, a 1.414V (0-pk) sinewave. Both the 8060A and the rms-calibrated average-responding meter display the correct rms reading of 1.000V (the dc component equals 0). However, consider the 1.414V (0-pk) rectified square wave. Both types of meters correctly measure the dc component (0.707V). But only the 8060A correctly measures the ac component (0.707V). The average-responding meter measures 0.785V, which amounts to a 5.6% error in the total rms measurement calculated from the ac and dc components.

AC COUPLED INPUT WAVEFORM	PEAK VOLTAGES		DISPLAY READINGS			DC AND AC TOTAL RMS
			AC COMPONENT ONLY		DC COMPONENT ONLY	TRUE RMS = $\sqrt{ac^2 + dc^2}$
	PK-PK	0-PK	RMS CAL*	8060A		
SINE	2.828	1.414	1.000	1.000	0.000	1.000
RECTIFIED SINE (FULL WAVE)	1.414	1.414	0.421	0.435	0.900	1.000
RECTIFIED SINE (HALF WAVE)	2.000	2.000	0.764	0.771	0.636	1.000
SQUARE	2.000	1.000	1.110	1.000	0.000	1.000
RECTIFIED SQUARE	1.414	1.414	0.785	0.707	0.707	1.000
RECTANGULAR PULSE	2.000	2.000	2.22K	2K	2D	$2\sqrt{D}$
TRIANGLE SAWTOOTH	3.464	1.732	0.960	1.000	0.000	1.000

RMS CAL IS THE DISPLAYED VALUE FOR AVERAGE RESPONDING METERS THAT ARE CALIBRATED TO DISPLAY RMS FOR SINE WAVES

Figure 2-8. Multiplication Factors for Converting Waveforms

Since average-responding meters have been in use for so long, you may have accumulated test or reference data based on them. The conversion factors in Figure 2-8 should help you convert between the two measurement methods.

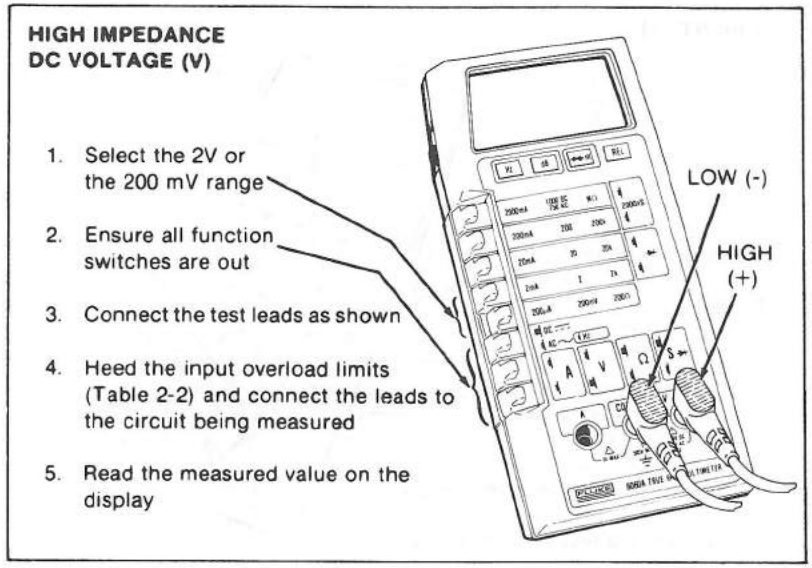


Figure 2-9. High Impedance DC Voltage

2-15. HIGH IMPEDANCE DC VOLTAGE

Occasionally you may want to make dc voltage measurements in high impedance circuitry where even the 10 MΩ input impedance for the normal dc voltage function could load the circuit and cause significant errors. For example, a 10 MΩ input impedance causes a 0.1% error when measuring the voltage across the 10 kΩ leg of a 90 kΩ over 10 kΩ voltage divider. The 8060A offers a >1,000 MΩ (typically >10,000 MΩ) input impedance dc voltage function which greatly reduces this error.

Figure 2-9 describes how to select the high input impedance dc voltage function (the ac voltage function does not operate in this mode). Notice that all of the function switches must be out to select this function. Either the 2V or the 200 mV range may be selected. Refer to Section 3 for more applications of this function, including a technique for using the 8060A as an electrometer tc measure extremely low currents.

NOTE

When taking measurements in the high impedance dc voltage function, do not select any ranges except the 2V or 200 mV ranges. Measurement in other ranges will result in erroneous readings.

NOTE

When the high impedance dc voltage function is selected and no input is applied, noise from the environment (such as rf or power line noise) may cause the 8060A to display OL (overrange).

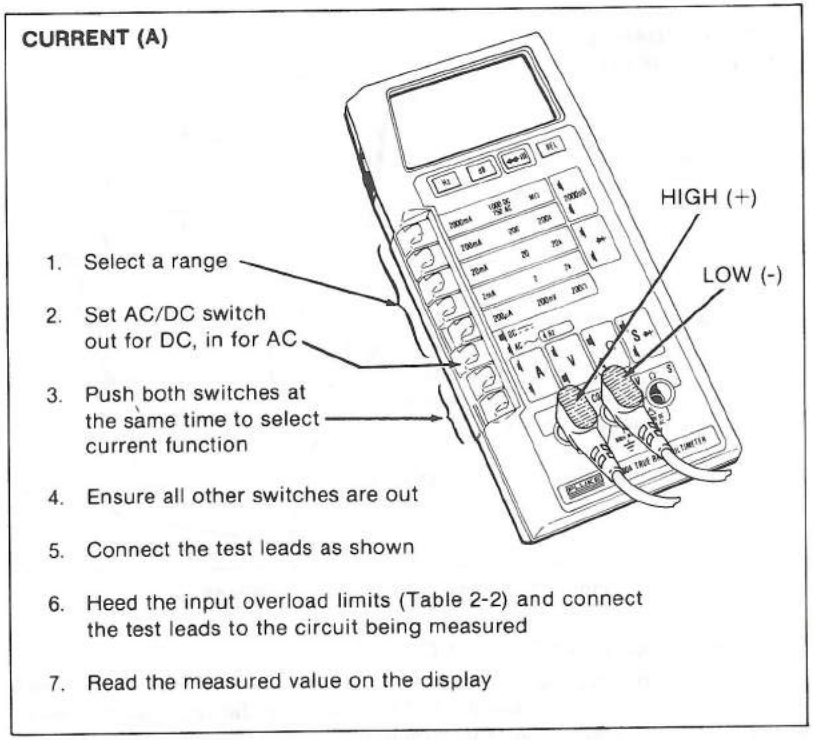


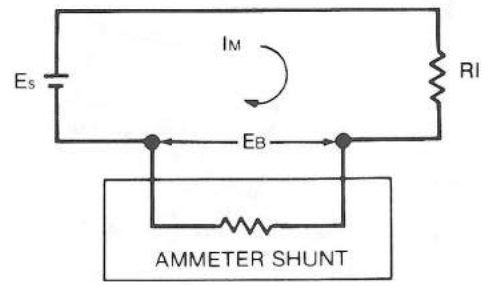
Figure 2-10. Current Operation

2-16. AC/DC Current (A)

Selection of the ac or dc current (A) function is described in Figure 2-10. The 8060A offers five ac (true rms ac-coupled) and five dc current ranges: 200 μA, 2 mA, 20 mA, 200 mA, 2000 mA. Each range is protected by a 2A/250V fuse in series with a 3A/600V fuse.

When a meter is placed in series with a circuit to measure current, you may have to consider an error caused by the voltage drop across the meter (in this case, across the protective fuses and current shunts). This voltage drop is called the burden voltage. The maximum full-scale burden voltages for the 8060A are 0.3V for the four lowest ranges and 0.9V for the highest range.

These voltage drops can affect the accuracy of a current measurement if the current source is unregulated and the resistance of the shunt and fuses represents a significant part (1/1000 or more) of the source resistance. If burden voltage does present a problem, you can calculate the error by using the formula in Figure 2-11. You can minimize this error by selecting the highest current range that provides the necessary resolution.



Es = Source voltage
Rl = Load resistance + Source resistance
Im = Measured current (display reading in amps)
Eb = Burden voltage (calculated)
Eb = meas. current [(200/current range in mA) +.35]

ERROR:

Error in % = 100 x Eb/(Es - Eb)
Error in A = (Eb x Im)/(Es - Eb)

EXAMPLE:

Es = 15V
Rl = 100 kΩ
Im = 148.51 μA (.14851 mA)

$Eb = 148.51 \times 10^{-6} \times [(200/.2) + .35]$

$= 148.51 \times 10^{-6} \times 1000.35 = 148.56$ mV

Max. error in % = 100 x [148.56 mV/(15V - .14856V)] = 1.0003%

Add this to the range spec. accuracy:

Max. error in % = 1.0003% ±(.2% + 2 digits)

Max. error in A = (148.56 mV x 148.51 μA)/(15000 mV - 148.56 mV)

= 1.486 μA

Add 1.486 μA to the reading for correct current

Figure 2-11. Calculating Burden Voltage Error

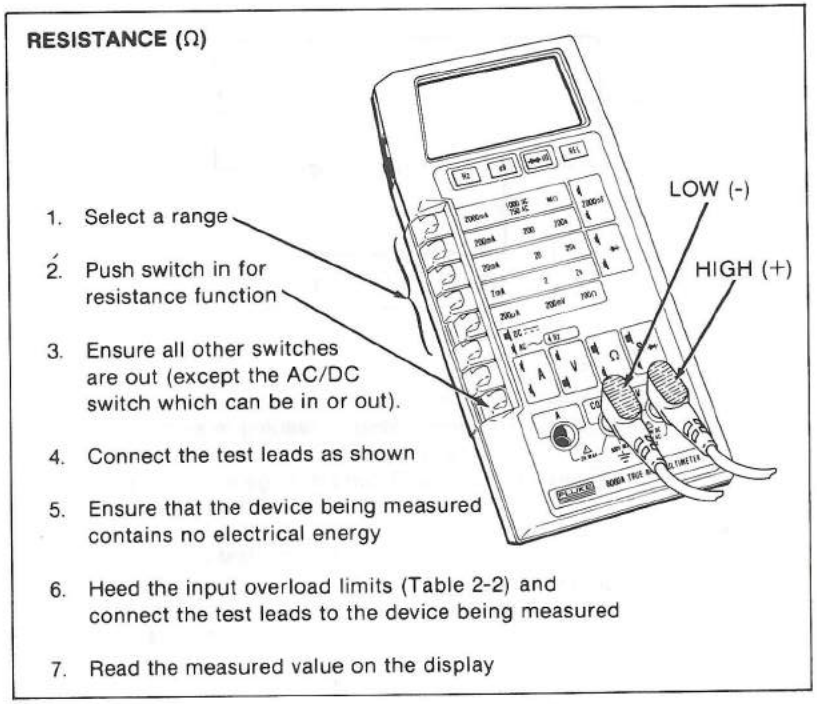


Figure 2-12. Resistance Operation

2-17. Resistance (Ω)

Selection of the resistance function is described in Figure 2-12. There are four fixed ranges (200Ω, 2 kΩ, 20 kΩ, 200 kΩ) plus the autoranging MΩ range consisting of three ranges: 2 MΩ, 20 MΩ, and 300 MΩ.

In all fixed resistance ranges (200Ω to 200 kΩ), the test voltage is less than that required to turn on most semiconductor junctions. This feature, sometimes referred to as "low power" ohms, aids in troubleshooting by allowing you to measure resistors independent of the effects of in-circuit transistors and diodes. For the fixed ranges the maximum full scale voltage across the circuit being measured is less than 250 mV. The autoranging MΩ ranges have enough voltage to turn on semiconductor junctions (maximum 2.5V full scale), but the current is very low (2.2 μA maximum).

Resistance measurements for all ranges are made using a two-wire ratiometric technique. This means that test lead resistance may affect the accuracy in the 200Ω range. You can correct this error by shorting the test leads together, reading the test lead resistance, and then subtracting it from resistance readings. The most convenient way to do this is with the relative function as described later in this section. This technique is also useful for removing the 0.02Ω error factor in the 200Ω range (refer to resistance specifications in Section 1).

2-18. AUTORANGING MEGOHMS

When the autoranging MΩ range is selected, the 8060A automatically selects the range appropriate for the measurement. The measurement resolution decreases in the two higher MΩ ranges as shown in Table 2-3. Readings made at the crossover points between ranges are microcomputer-stabilized by an offset in the upscale and downscale directions. Range changes are made at 2.00 MΩ and 20.00 MΩ as readings go upscale, or at 19.0 MΩ and 1.90 MΩ as readings go downscale.

Table 2-3. Resistance Function Autoranges and Resolution

RANGE			RESOLUTION	NO. OF DIGITS POSSIBLE IN READING
MΩ Auto-Range	2 MΩ		100Ω	4½
	20 MΩ		10 kΩ	3½
	300 MΩ	20 to 99.9 MΩ	100 kΩ	3
		100 to 300 MΩ	1 MΩ	3
kΩ Auto-Range	2 kΩ 20 kΩ		0.1Ω 10Ω	4½ 3½
	300 kΩ	20 to 99.9 kΩ	100Ω	3
		100 to 299 kΩ	1 kΩ	3

2-19. AUTORANGING KILOHMS

Although it is not indicated on the front panel, there is an additional autoranging range available: the autoranging kΩ range, which consists of 2 kΩ, 20 kΩ, and 300 kΩ ranges. To select this range, you must simultaneously press the MΩ and the 200Ω switches as shown in Figure 2-13. Like the autoranging MΩ ranges, the autoranging kΩ ranges have enough voltage to turn on semiconductor junctions. Note that the use of the relative function with the autoranging kΩ ranges is restricted to the autoranging kΩ ranges. Refer to the description of the relative function for more information. The autoranging kΩ has the same decrease in resolution (see Table 2-3) and the same display hysteresis as the autoranging MΩ.

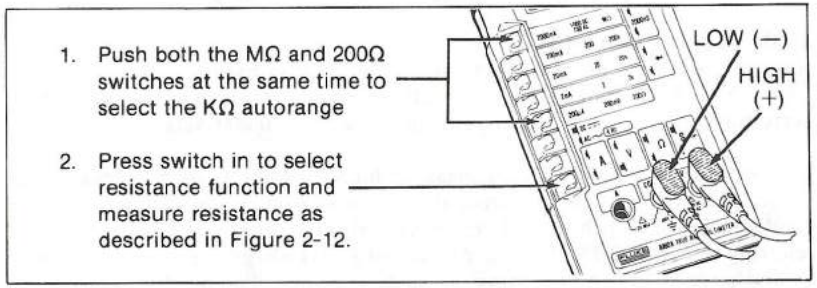
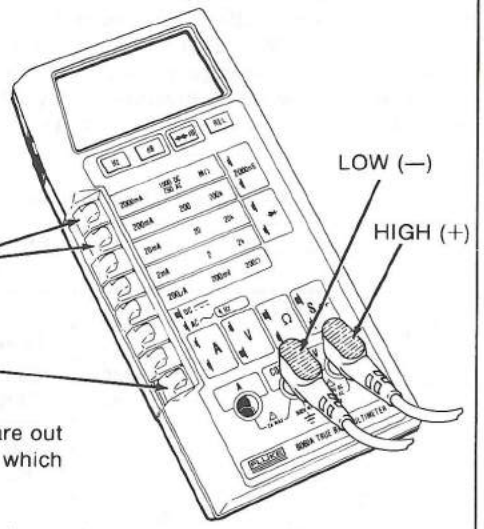


Figure 2-13. Selection of Autoranging Kilohms

CONDUCTANCE (S)



1. Push both switches simultaneously to set range.
2. Press switch in for conductance function.
3. Ensure all other switches are out (except the AC/DC switch which can be in or out).
4. Connect the test leads as shown above.
5. Ensure that the device being measured contains no electrical energy.
6. Heed the input overload limits (Table 2-2) and connect the test leads to the device being measured (connect the test lead from the V Ω S input to the + lead of polarized capacitors for leakage measurements).
7. Read the measured value on the display.

Figure 2-14. Conductance Operation

2-20. Conductance (S)

Selection of the conductance function is described in Figure 2-14. The range is 2000 nS (nS = nanosiemens or 10^{-9} siemens, 1 siemen = $1/\Omega$) which corresponds to a resistance range from 500 kΩ to 10,000 MΩ.

Conductance is a good way to measure high resistances, such as leakages in diodes, capacitors, pcbs, or insulators. For example, you can measure the conductance of a pcb and then convert the measurement to resistance by referring to Figure 2-15. If you are measuring the leakage of a capacitor, be sure to discharge it first by shorting its leads together. The positive (+) lead of polarized capacitors should be connected to the VΩS input.

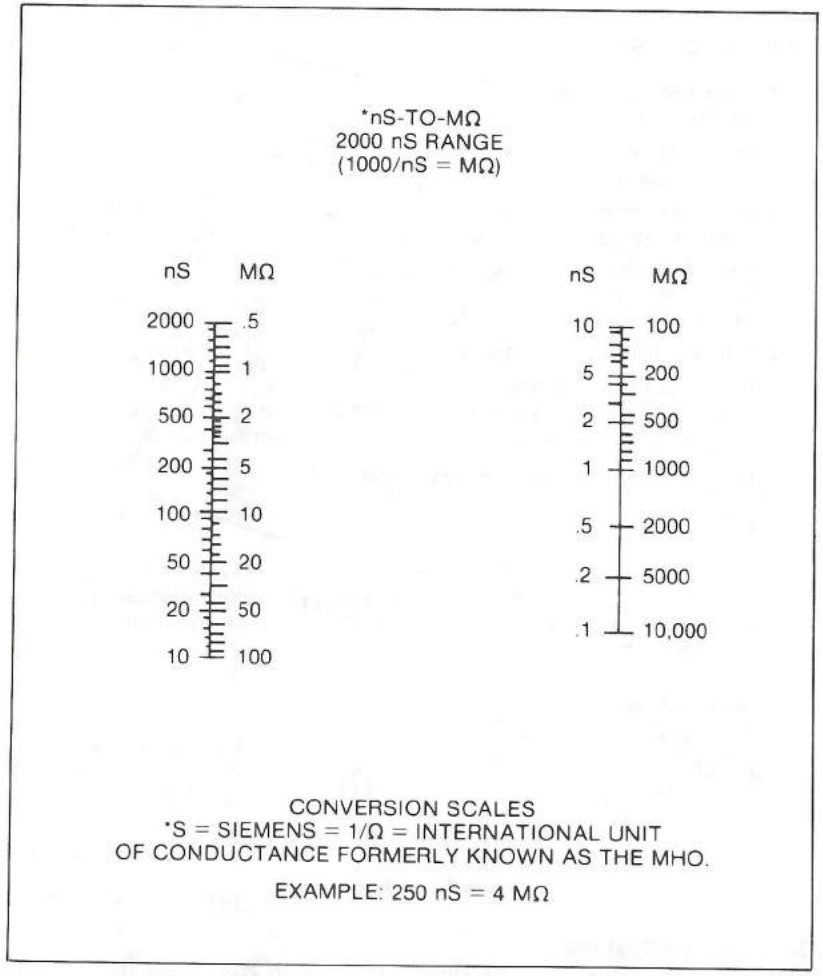


Figure 2-15. Conductance/Resistance Conversion

You may encounter situations where conductance is more convenient to measure than resistance. For example, the resistance of a photodiode is inversely proportional to the available light, i.e. as light increases, resistance decreases. This might be confusing if you want to examine the response of the component over a range of values. However, since conductance is the reciprocal of resistance, photodiode conductance is directly proportional to available light. As light increases, conductance increases. It might be easier to examine the photodiode response in terms of conductance, and then convert the measurements to resistance values if desired.

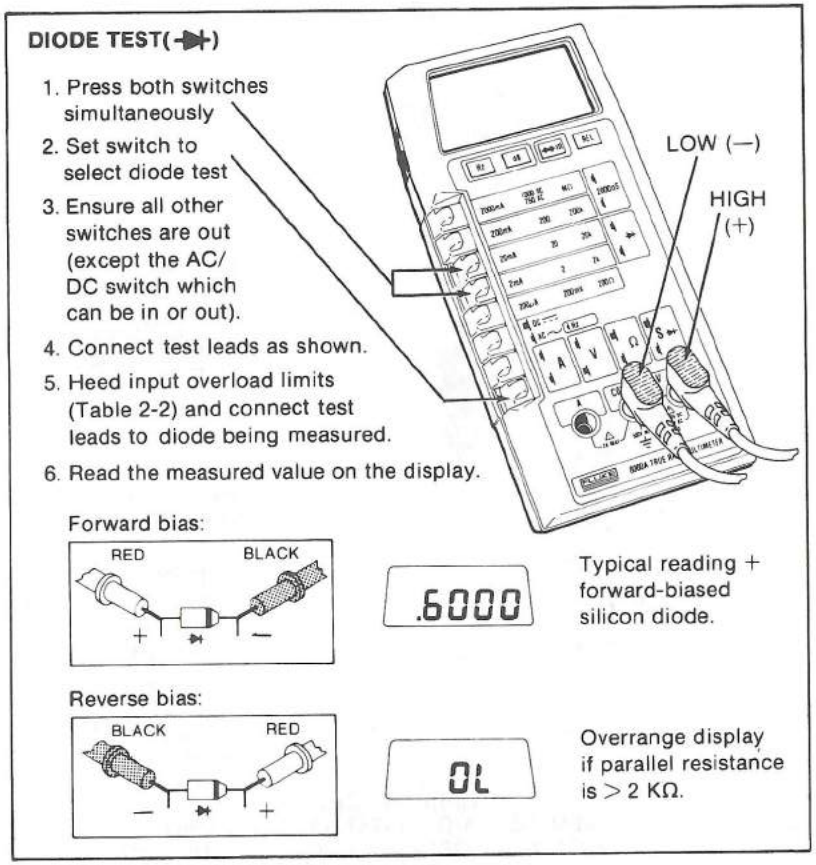


Figure 2-16. Diode Test

2-21. Diode Test (⊣▶⊢)

Selection of the diode test is described in Figure 2-16. Notice how the test leads are placed to forward-bias or reverse-bias the diode in the figure.

The diode test measures the forward voltage of a semiconductor junction (or junctions) at a 1 mA test current. Readings are displayed in the 2V range, with OL displayed for voltages greater than 2V. For a silicon diode, the typical forward voltage at 1 mA is about 0.6V. A reverse-biased semiconductor junction should display the overrange (OL) indicator provided that any resistance parallel to the junction is greater than 2 kΩ.

A quick way to check for shorted or open junctions is to reverse the test leads. If the junction indicates the same in-scale reading both directions, it is probably shorted. If the junction indicates an overrange both directions, it is open.

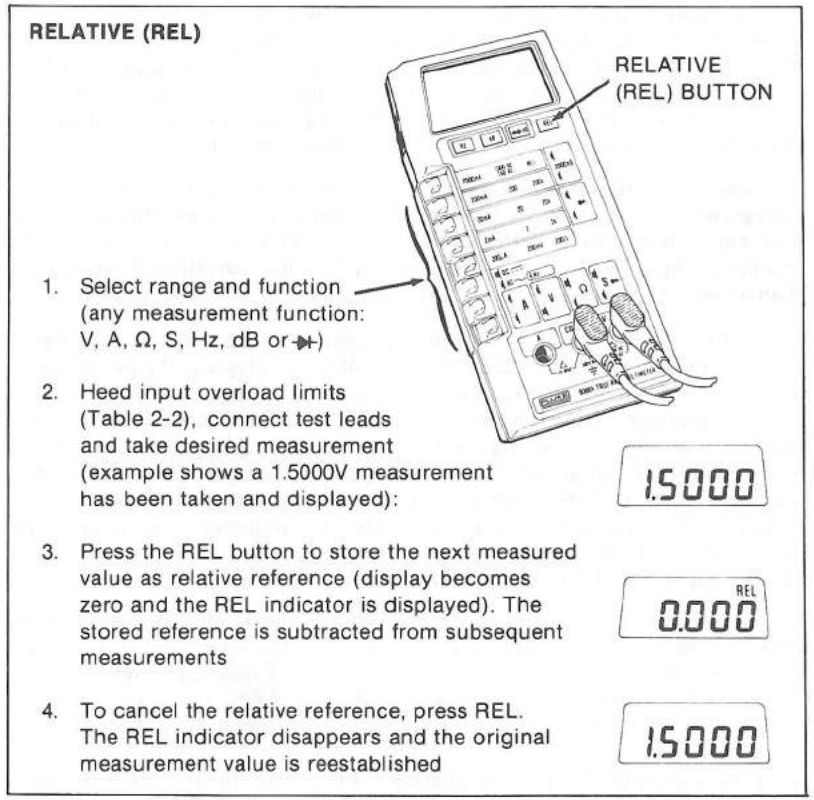


Figure 2-17. Relative (REL) Operation

2-22. Relative (REL)

The relative function allows you to store any reading as an offset or relative reference value. When you press the REL button, the REL indicator appears in the upper right corner of the display, and the 8060A stores the next measurement in a register along with the function and range. Subsequent measurements are displayed as the difference between the measured value and the stored relative reference (refer to Figure 2-17).

For example, if a reading of 1.0000V dc is displayed when the REL button is pressed (the display will read 0.0000 after REL is pressed), subsequent readings will have 1.0000 subtracted from them. If the next measurement is 1.2700V dc, the reading displayed will be .2700. If the next measurement is 0.8500V dc, the reading displayed will be –.1500. You may cancel the relative reference by pressing the REL button (the REL indicator disappears from the display), by turning the instrument off, or by storing a relative reference with another function.

If you change ranges, the relative reference is automatically multiplied or divided by the appropriate power of ten before being subtracted from the measurement. If you change functions, the REL indicator disappears and the relative reference is stored with the original function. When you reselect the function, the relative reference is restored (the REL indicator reappears) unless a new relative reference was established in another function.

The relative function may be used with all the measurement functions: ac or dc voltage, ac or dc dB, ac or dc current, resistance, conductance, diode test, and frequency. When used with continuity, the relative function stores the accompanying resistance readings. Note that the input overload limits are not changed by the use of the relative function.

Another thing to be aware of when using relative reference is that the range of possible readings is still subject to the limits of the display and the 19999 counts of the analog-to-digital (a/d) converter, regardless of the relative reference. For example, suppose the instrument is in the dc voltage function with the 20V range selected, and you store a relative reference of 15V. The maximum positive relative voltage reading that can be displayed without overranging is 4.999V, which is actually a 19.999V input signal. Any input signal greater than 19.999V exceeds the 19999 counts of the a/d converter. The minimum (negative) voltage reading that may be displayed without overranging is –19.999V, which is a –4.999V input signal. You can avoid this situation by selecting a higher range.

Remember that even though the REL indicator appears on the display almost instantaneously after the REL button is pressed, the relative reference is not stored until the next measurement takes place. For most functions, the time between measurements is about 0.4 seconds (frequency measurements occur every second, and dB measurements occur about every 1.4 seconds).

A typical way to use the relative reference is to correct for test lead resistance. Although test lead resistance is usually very small (typically0.5 to 5Ω), it can be significant when measuring low resistances. To correct for it, select the desired resistance range, short the test leads together, and press the REL button. The REL indicator will appear and the display will read zero. The 8060A will automatically subtract the stored test lead resistance from subsequent measurements. Other common applications for relative reference include: offset nulling (dc and ac voltage or current), amplifier matching (dB), power line frequency deviation (Hz), diode and transistor matching (diode test), resistor matching (Ω), and voltage deviation (ac and dc voltage).

NOTE

The use of the relative function with the autoranging kΩ ranges is restricted to the autoranging kΩ ranges. If you take a reference reading within the autoranging kΩ range and then use it as a reference outside autoranging kΩ, or use a reference reading taken outside autoranging kΩ within autoranging kΩ, errors will result. There is no restriction on the use of the relative function with the fixed resistance ranges or with autoranging MΩ.

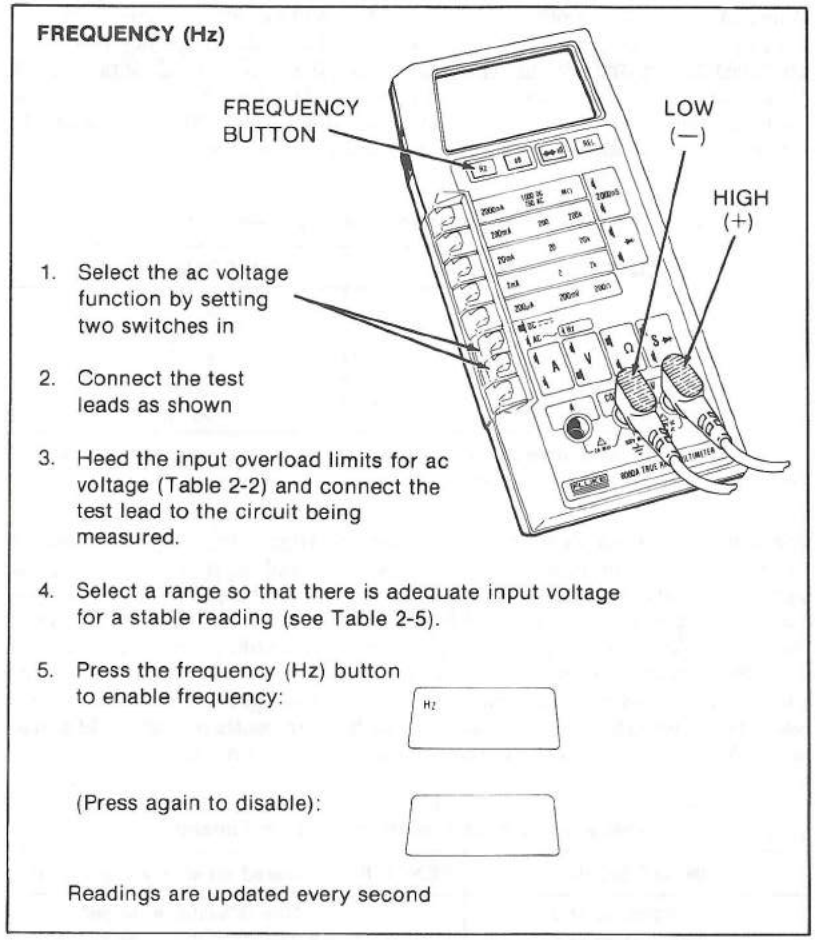


Figure 2-18. Frequency (Hz) Operation

2-23. Frequency (Hz)

The selection of the frequency function is described in Figure 2-18. Frequency selection is cancelled if you select a different function (resistance or ac voltage dB, for example).

The frequency function is fully autoranging over four ranges: 200 Hz, 2000 Hz, 20 kHz, and 200 kHz. Depending on the frequency of the ac input signal, the 8060A automatically selects the proper range and displays the appropriate measurement unit, either Hz or kHz. Frequencies less than 12.2 Hz are not measured reliably, and frequencies greater than 199.99 kHz cause the OL overrange indicator to appear.

When you press the Hz button to select the frequency function, the Hz indicator appears in the display almost immediately, and the first frequency reading is displayed within one second. The 8060A has a one-second reading rate for all ranges (except for frequencies between 12 and 16 Hz, which respond in 1 to 1.3s), including the .01 Hz and .1 Hz resolution readings in the 200 Hz and 2000 Hz range. The resolution for each range is listed in Table 2-4.

Table 2-4. Frequency Function Autoranges and Resolution

FREQUENCY RANGE	RESOLUTION
200 Hz	.01 Hz
2000 Hz	.1 Hz
20 kHz	1 Hz
200 kHz	10 Hz
>200 kHz Extended Range*	100 Hz
*Extended range enabled by holding down the Hz button at power-on.	

The minimum input signal that is required to trigger the frequency counter varies, depending on the ac voltage range selected and the frequency. The input signal sensitivity is listed in Table 2-5. The values are based on rms sine waves. You must increase the signal level for lower crest factor input signals (the crest factor is the ratio of the peak voltage to the ac rms voltage of a waveform) or non-50% duty-cycle signals. If the input signal is below the required level, the 8060A will display 0.00 Hz, and will not take readings. If you find that your readings are unstable, the input signal may be near the threshold level for that range. You can correct this by selecting a lower ac volts range.

Table 2-5. Sensitivity for the Frequency Function

INPUT SIGNAL	SENSITIVITY (based on sine wave V rms)
12 Hz to 20 kHz	20 mV or 10% of voltage range*
20 kHz to 100 kHz	50 mV or 25% of voltage range*
100 kHz to 200 kHz	150 mV or 75% of voltage range*
*Whichever value is greater	

The maximum input voltage that may be applied depends on the ac voltage range. The maximum inputs are listed in Table 2-6.

CAUTION

No voltage overrange indication is given when the 8060A is measuring frequency. To prevent possible instrument damage, do not exceed 750V ac rms or a volt-hertz product of 1 x 10^7 when measuring frequency.

Table 2-6. Maximum Input Voltages for the Frequency Function

AC VOLTAGE RANGE	MAXIMUM USEABLE AC VOLTAGE*
200 mV	±5V peak
2V	±50V peak
20V	±1000V peak
200V	±1000V peak
750V	±1000V peak
*Signal not to exceed a volt-hertz product of 1 x 10^7.	

In addition to the four usual frequency ranges, there is an extended frequency range that may be enabled. To enable the extended frequency range, hold down the Hz button as you turn on the instrument. After the power-on self-test has been completed (the display is .8.8.8.8), release the Hz button. Now when you select the frequency function, the autoranging can extend beyond the 200 kHz range. The 200 mV ac voltage range is recommended for frequencies above 200 kHz. Normally this frequency range is not enabled because of loss of sensitivity above 200kHz, but typically you can measure 420 kHz TTL level signals (50% duty cycle). When the instrument is turned off, the extra range is disabled.

2-24. Decibel (dB)

The selection of dB is described in Figure 2-19. Like frequency, dB is automatically cancelled if you select another function (resistance or frequency, for example).

When dB is selected, the 8060A microcomputer converts ac or dc voltage readings to the dBm equivalent (decibels above or below one milliwatt). The standard reference impedance is 600Ω. You can make dB measurements independent of the reference impedance by using the relative function in conjunction with the dB function. You can also modify the reference impedance by applying and storing a voltage equivalent to 0 dBm referenced to the desired impedance. Refer to Section 3 for details.

Note that the 8060A performs a 'bridging' measurement when measuring dBm, which assummes the reference load is part of the system. When making 'terminating' measurements (such as testing a phone line without a phone connected) be sure to apply the proper load to the 8060A. For example, if you are making a terminating dBm measurement in a 600Ω system with 50V maximum signal levels, place a 600Ω 5 watt resistor across the 8060A input terminals.

The ac dB dynamic range is from -50.0 to 59.72 dBm (109.72 dBm total). The dc dB dynamic range is from -74 to 62.22 dBm (136.22 dBm total). For readings greater than approximately 5% of full-scale for the voltage range selected, the resolution is .01 dB. Below approximately 5% of scale, resolution drops off to .1 dB, and below approximately 0.6% of scale, resolution is 1 dB. Anytime blank digits appear to the right of the decimal point, it is an indication that resolution has fallen off and you need to select a lower range.

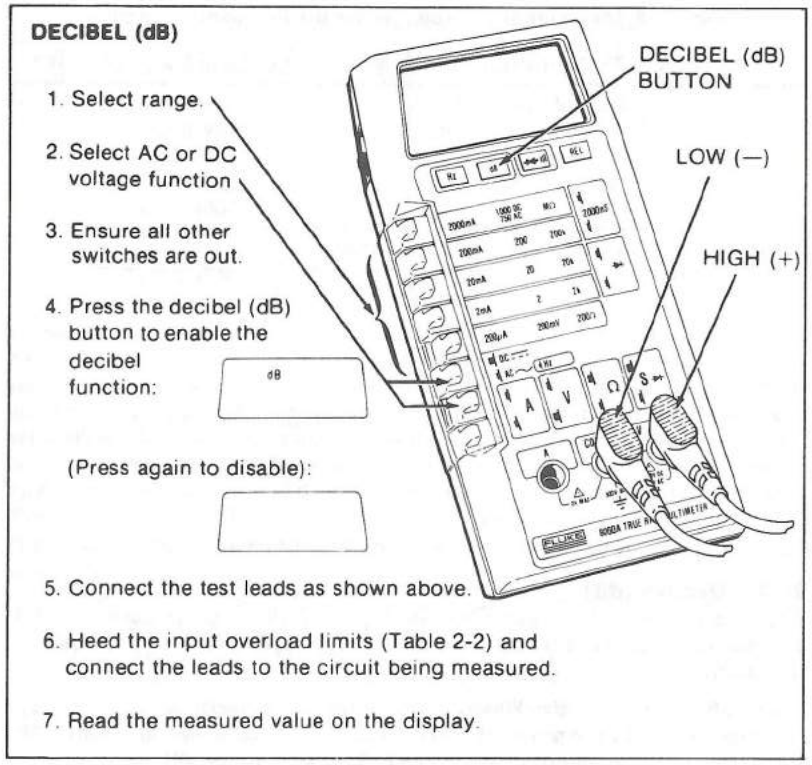


Figure 2-19. Decibel (dB) Operation

2-25. dBV

dBV is defined as dB relative to 1 volt, independent of load impedance. This measurement is commonly used in the audio industry as a convenient reference for log weighted measurements such as noise, sensitivity, and level. The 8060A uses the ratio self-test to "fool" the microcomputer into thinking it has 1V present at the meter input, and then uses the pseudo 1V as the 0 dB relative reference. Use the following procedure to make dBV measurements:

1. Turn the 8060A power switch off.

2. Select Volts, AC, 2V range.

3. Turn the power switch on while holding down the continuity button. When the .8.8.8.8 display appears, the power-on self test is complete.

4. Release the continuity button. The display should now read -.9990 to -1.0010. The instrument is now in the ratio self-test mode.

5. Push the dB button. The display should read 2.21 dB to 2.22 dB.

6. Push the REL button. The display should read 0.00 dB REL.

7. Push the continuity button again to cancel the ratio self-test.

The meter will now make all subsequent dB measurements in dBV as long as the power remains on and the REL button is not used again. All other meter functions can be used without losing the dBV function.

2-26. Continuity ( ))

To select the continuity function, first select the resistance function and then press the))) button under the display. The))) button functions like a three-position switch: the first button press enables visible continuity (the indicator is displayed), the second button press enables audible continuity (the))) indicator is displayed), and the third button press cancels continuity selection (the))) indicator disappears). The selection of continuity is summarized in Figure 2-20.

When continuity is detected, visible continuity is indicated by the long bar across the top of the display. Audible continuity (if enabled) is indicated by the tone emitted from the instrument.

Continuity is a quick check to verify whether circuit connections are intact. The continuity detection threshold is typically <10% of the resistance range selected for the fixed ranges (i.e. continuity is detected if resistance is less than 20Ω in the 200Ω range, less than 200Ω in the 2 kΩ range, etc.). The detection threshold is <20Ω for the autoranging kΩ range, and <20 kΩ for the autoranging MΩ range.

The 8060A can detect continuity for intervals as brief as 50 μs (typcially as brief as 10 μs). It extends the visible or audible indication to a minimum of 200 ms to make it easy for you to see or hear the results. Note that while continuity is enabled, the 8060A still makes resistance measurements and displays the readings.

2-27. INITIAL CHECK-OUT PROCEDURE

Here is an easy procedure you can use to verify that your 8060A is operating properly for most functions. All you need to perform these tests are the test leads and access to a standard wall socket. Remember that you are not trying to verify the instrument accuracy, but are simply confirming that the functions work. Performance tests and calibration adjustments are presented in Section 5. If the instrument passes the self-test when the instrument is first turned on, then the display and the microcomputer are working properly.

1. DC VOLTAGE - Select the dc voltage function and the 20V range. Read the battery voltage by touching the probe tip from the lead connected to the VΩS jack to the side contact (not the center pin) in the opening for the battery eliminator jack on the right side of the instrument.

Be careful not to short the battery by connecting the side contact to the center pin. Battery voltage should read 5.2V to 10V. If the voltage is less than 5.2V, the battery should be replaced.

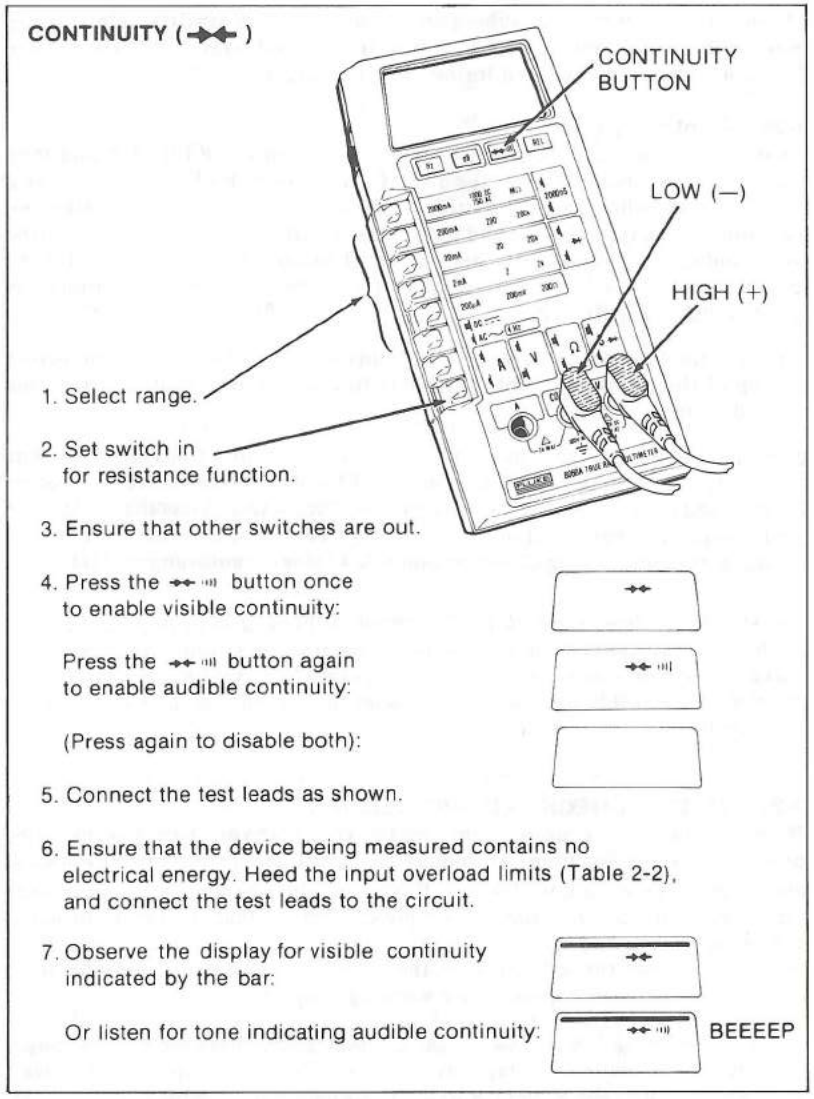


Figure 2-20. Continuity (→◄◄) Operation

WARNING

THE LOCAL LINE VOLTAGE IS MEASURED IN THE FOLLOWING STEP. BE CAREFUL NOT TO TOUCH THE PROBE TIPS WITH YOUR FINGERS, OR TO ALLOW THE PROBE TIPS TO CONTACT EACH OTHER.

2. AC VOLTAGE, dB, FREQUENCY - Select the ac voltage function and the 200V range. Take note of the preceding warning and insert the probe tips into a standard wall socket. The display should read the local line voltage.

Now push the dB button. The display should read the line voltage in dB.

Now push the Hz button. The display should read the frequency of the line voltage. Carefully remove the probe tips from the wall socket.

3. RESISTANCE, CONTINUITY, CONDUCTANCE, DIODE TEST - Select the resistance function and the 2 kΩ range. Touch the red (VΩS) probe tip to the A jack so the VΩS input is shorted to the A input (this is the fuse check procedure from Section 2-4). The display should read .1000 ±.0100 kΩ (neglecting lead resistance).

Push the →◄◄ ·ıı) button twice to enable the visible and audible continuity. You should see the bar in the display and hear the tone.

Select the diode test (with the VΩS and A inputs still shorted together). The display should read .0102 ±.0015V.

Select the conductance function (with the VΩS and A inputs still shorted together). The instrument should indicate overrange (OL). Remove the connection between the inputs. The instrument should indicate 0.0 ±1.0.

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