

**FLUKE®**

# 45

Dual Display Multimeter

## Users Manual

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# Chapter 1

## Introduction

### **Introducing the Fluke 45 Dual Display Multimeter**

#### *Note*

*This manual contains information and warnings that must be followed to ensure safe operation and retain the meter in safe condition.*

#### **⚠ Warning**

**To avoid electric shock or injury, read the "multimeter safety" sheet preceding Chapter 2 before using the meter.**

The Fluke 45 Dual Display Multimeter (also referred to as "the meter") is a 4<sup>1</sup>/<sub>2</sub>-digit (30,000 count) meter with a 5-digit (100,000 count) high resolution mode. The meter is designed for bench-top, field service, and system applications. Complete specifications are provided in Appendix A.

With the (optional) IEEE-488 computer interface installed, the meter is fully programmable for use on the IEEE Standard 488.1 interface bus(1987). The meter is also designed in compliance with supplemental standard IEEE-488.2 (1987).

Some features provided by the meter are:

- A dual, vacuum fluorescent, display that allows two properties of an input signal to be displayed at the same time. (e.g., ac voltage in one display and frequency in the other).
- Remote operation via the RS-232 interface (included) or the IEEE-488 interface (optional).
- True rms ac
- (AC + DC) rms, calculated
- Frequency measurements to greater than 1 MHz
- 1  $\mu$ V sensitivity in volts dc
- Decibels with variable reference impedance and audio power measurement capability.
- A compare mode to determine if a measurement is within, above, or below a designated range.

- 100,000, 30,000, and 3,000 selectable count resolution, with display reading speeds of 2.5, 5, and 20 readings per second (rps), respectively.
- Built-in self-tests with closed-case calibration (no internal calibration adjustments).

## Options and Accessories

Two options are available. These options can be installed in the meter at the factory or by the customer on site:

- The IEEE-488 Interface (Option -O5K) provides full programmability, and automated calibration. The IEEE-488 computer interface command set is identical to the RS-232 interface commands wherever possible.
- The Battery Kit (Option -01 K) consists of a rechargeable, 8 V, lead-acid battery, with battery bracket and charger assembly. The battery has a typical operating time of eight hours and is fully operable at ambient temperatures between 0 and 50 °C. For complete battery specifications, refer to Appendix A.

Available accessories are listed and described in Table 1-1.

**Table 1-1. Accessories**

| Model       | Description   |
|-------------|---|
| C40         | Soft carrying case. Provides padded protection for the meter. Includes a pocket for the manual and pouch for the test leads and line cord.  |
| M00-200-634 | Rackmount Kit. Allows meter to be mounted on either the right or left side of a standard 19-inch rack.  |
| RS40        | RS-232 terminal interface cable. Connects the Fluke 45 to any terminal or printer with properly configured DTE connector (DB-25 socket), including an IBM PC <sup>®</sup> , IBM PC/XT <sup>®</sup> or IBM PS/2 (models 25, 30, 50, P60, 70, and 80).                  |
| RS41        | RS-232 modem cable. Connects the Fluke 45 to a modem with properly configured DB-25 male pin connector.   |
| S45         | QuickStart <sup>™</sup> , a PC software package, simplifies operation of the Fluke 45 when using the RS-232 computer interface. Readings are recorded in files that can be accessed by Lotus 1-2-3 <sup>®</sup> , dBase III <sup>®</sup> and other graphics packages. |
| Y8021       | Shielded IEEE-488 one-meter (39.4 inches) cable, with plug and jack at each end.  |
| Y8022       | Shielded IEEE-488 two-meter (78.8 inches) cable, with plug and jack at each end.  |
| Y8023       | Shielded IEEE-488 four-meter (13 feet) cable, with plug and jack at each end.   |

## Where to go from Here

This manual has been organized to assist you in getting started quickly. It is not necessary for you to read the entire manual before using the meter effectively. However, we recommend that you do so in order to use your meter to its full advantage.

Begin by scanning the Table of Contents to familiarize yourself with the organization of the manual. Then, read Chapter 2, "GETTING STARTED". Refer to the appropriate chapter of the manual as needed. The contents of each chapter are summarized below.

### Chapter 1: Introduction

Introduces the Fluke 45 Dual Display Multimeter, describing its features, options, accessories, and users manual.

**Chapter 2: Getting started**

Explains how to prepare the meter for operation and get started quickly taking basic measurements from the front panel.

**Chapter 3: Operating the meter from the front panel**

Provides a complete description of each operation that can be performed using the push-buttons on the front panel. Chapter 3 is organized so that related operations and functions are grouped together.

**Chapter 4: Applications**

Describes how to use the meter in more advanced operations and sophisticated applications. Assumes a basic knowledge of the meter and front panel operations.

**Chapter 5: Operating the Meter using the Computer Interface**

Describes how to connect the meter to a terminal or host and operate it via the RS-232-C or (optional) IEEE-488 interface. Assumes a basic knowledge of the meter and front panel operations.

**Chapter 6: Maintenance**

Describes how to perform basic maintenance and repairs (e.g., replacing fuses) and how to order replacement parts. Complete service and repair procedures are contained in the "Fluke 45 Dual Display Multimeter Service Manual" (P/N 856042).

**Appendices**

- A. Specifications
- B. ASCII/ IEEE-488 Bus Codes
- C. IEEE-488.2 Device Documentation Requirements



# MULTIMETER SAFETY

The Fluke 45 Dual Display Multimeter has been designed and tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus. This manual contains information and warnings which must be followed to ensure safe operation and retain the meter in safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

The meter is designed for IEC 664, Installation Category II use. It is designed for use in circuits with a VA rating of <4800 VA.

Some common international electrical symbols used in this manual are shown below.

|   |                          |   |   |
|---|--------------------------|---|---|
| ~ | AC - ALTERNATING CURRENT | ⚡ | DANGEROUS VOLTAGE                                       |
| ≡ | DC - DIRECT CURRENT      | ⏚ | EARTH GROUND  |
| ⎓ | EITHER AC OR DC CURRENT  | ⚠ | SEE EXPLANATION IN MANUAL                               |
| ⊞ | FUSE                     | ⊞ | DOUBLE INSULATION FOR PROTECTION AGAINST ELECTRIC SHOCK |

Before using the meter, read the following safety information carefully. In this manual, "**WARNING**," is reserved for conditions and actions that pose hazard(s) to the user; "**CAUTION**," is reserved for conditions and actions that may damage your meter.

## ⚠ WARNING TO AVOID ELECTRICAL SHOCK OR OTHER INJURY:

- Avoid working alone
- Follow all safety procedures for equipment being tested.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Be sure the meter is in good operating condition.
- Select the proper function for your measurement.
- To avoid electrical shock, use caution when working above 60V dc or 30V ac RMS.
- Disconnect the live test lead before disconnecting the common test lead.
- Disconnect the power and discharge high-voltage capacitors before testing in  $\Omega$  and  $\rightarrow$  (|)|).
- When making a current measurement, turn the circuit power off before connecting the meter in the circuit.
- Check meter fuses before measuring transformer secondary or motor winding current. (See Section 6, MAINTENANCE.) An open fuse may allow high voltage build-up, which is potentially hazardous.
- Use clamp-on probes when measuring circuits exceeding 10 amps.
- When servicing the meter, use only the replacement parts specified.
- Do not allow meter to be used if it is damaged or if its safety is impaired.





# Chapter 2

## Getting Started

### Introduction

Chapter 2 explains how to prepare the meter for operation, discusses general operating features, and walks you through the basics of taking some common measurements.

### Getting Started

#### Unpacking and Inspecting the Meter

Carefully remove the meter from its shipping container and inspect it for possible damage or missing items. If the meter is damaged or something is missing, contact the place of purchase immediately. Save the container and packing material in case you have to return the meter.

#### Front Panel and Rear Panel

The front panel (shown in Figure 2-1.) has three main elements: the input terminals on the left, the primary and secondary displays, and the pushbuttons. The pushbuttons are used to select major functions, ranging operations, and function modifiers. These elements are described in detail in Chapter 3.

The rear panel (shown in Figure 2-2) contains the power-line cord connector, an RS-232 interface connector, a cutout for the (optional) IEEE-488 interface connector, a serial number label, and a line fuse. (For fuse testing and replacement procedures, refer to Chapter 6.) *Rotate the rear feet 180 degrees before using the meter.*

#### Adjusting the Handle

For bench-top use, the handle can be positioned to provide two viewing angles. To adjust its position, pull the ends out to a hard stop (about 1/4-inch on each side) and rotate it to one of the four stop positions shown in Figure 2-3. To remove the handle, adjust it to the vertical stop position and pull the ends all the way out.

#### Line Power

##### **⚠Warning**

**To avoid shock hazard, connect the instrument power cord to a power receptacle with earth ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.**

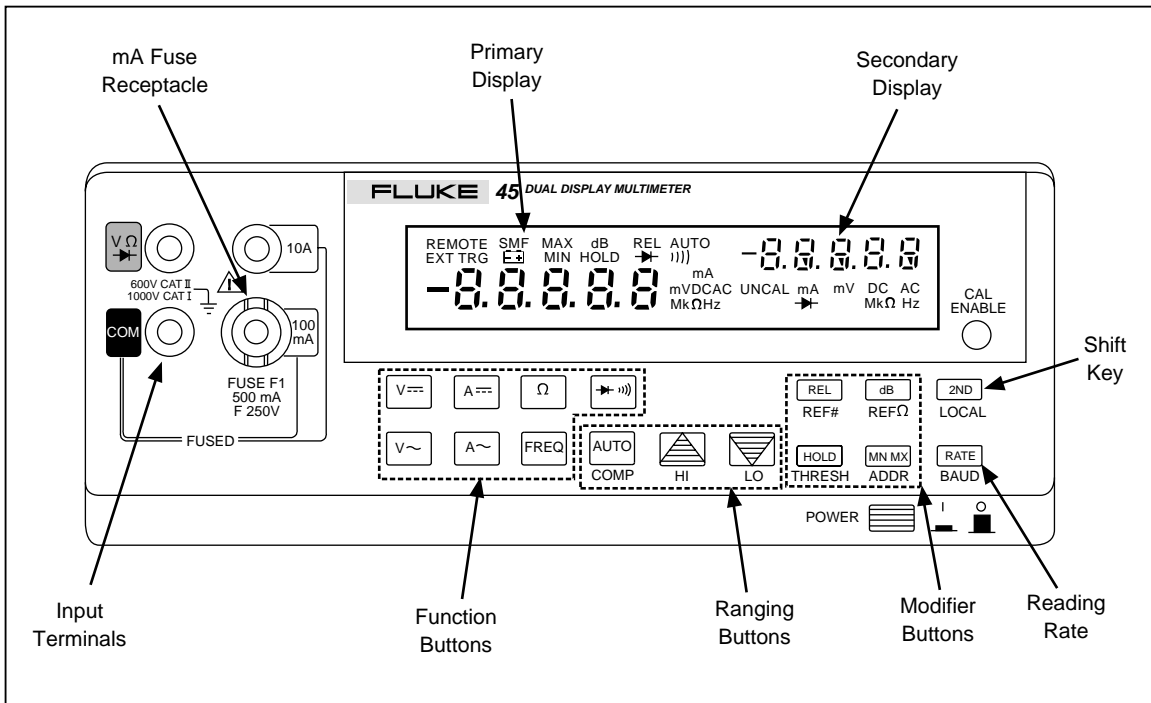


Figure 2-1. Front Panel

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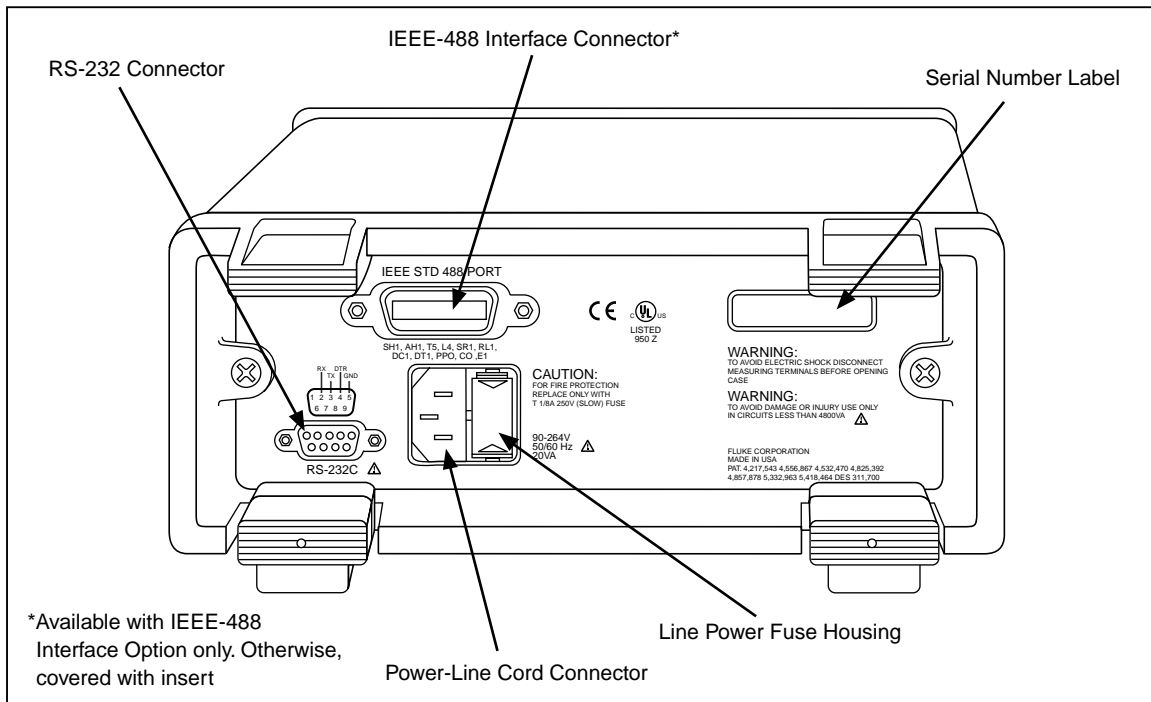


Figure 2-2. Rear Panel

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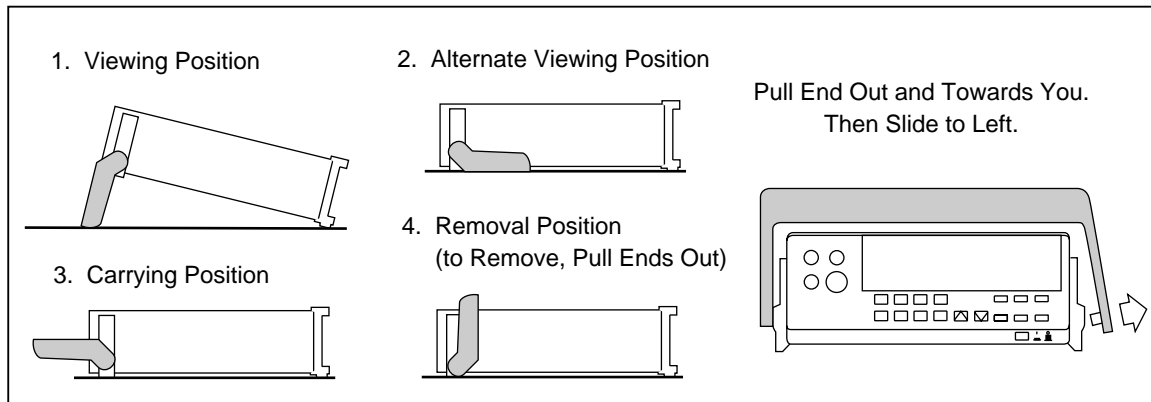


Figure 2-3. Adjusting Handle

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If you have not already done so, plug the line cord into the connector on the rear of the meter. The meter will operate on any line voltage between 90 V ac and 264 V ac without adjustment, and any frequency between 45 and 440 Hz. However, it is only warranted to meet published specifications at 50/60 Hz.

## Turning the Meter on

To turn the meter on, press in the green, POWER button located on the lower-right of the front panel. If the meter is being operated under battery power and you turn the meter off, you must wait five seconds before turning the meter back on. If you do not, the meter will not power-up.

When the meter is turned on, the primary and secondary displays light for about 4 seconds while the instrument performs an internal self-test of its digital circuitry. These tests check RAM, ROM, A/D, calibration, and the display. The meter has passed all tests and is ready for normal operation if an error code is not displayed. However, if an error is detected, the meter will still attempt to operate. (Refer to "Self-Test Diagnostics and Error Codes" in Chapter 6.)

If any front panel button other than **POWER** is held down while the power-up sequence is in progress, the entire display stays on until another button is pressed. Then, the powerup sequence continues.

After the meter completes the power-up sequence, it assumes the power-up measurement configuration stored in non-volatile memory. The power-up configuration set at the factory is shown in Table 3-13. (To change the power-up configuration, refer to "Changing the Power-Up Configuration" in Chapter 3.)

## Using the Pushbuttons

The pushbuttons on the front panel select meter functions and operations. A summary of basic pushbutton operations is shown in Figure 2-4.

Pushbuttons can be used in three ways. You can:

- Press a single button to select a function or operation.  
EXAMPLE: Press **MODE** to select volts ac for the primary display.
- Press a combination of buttons, one after the other.

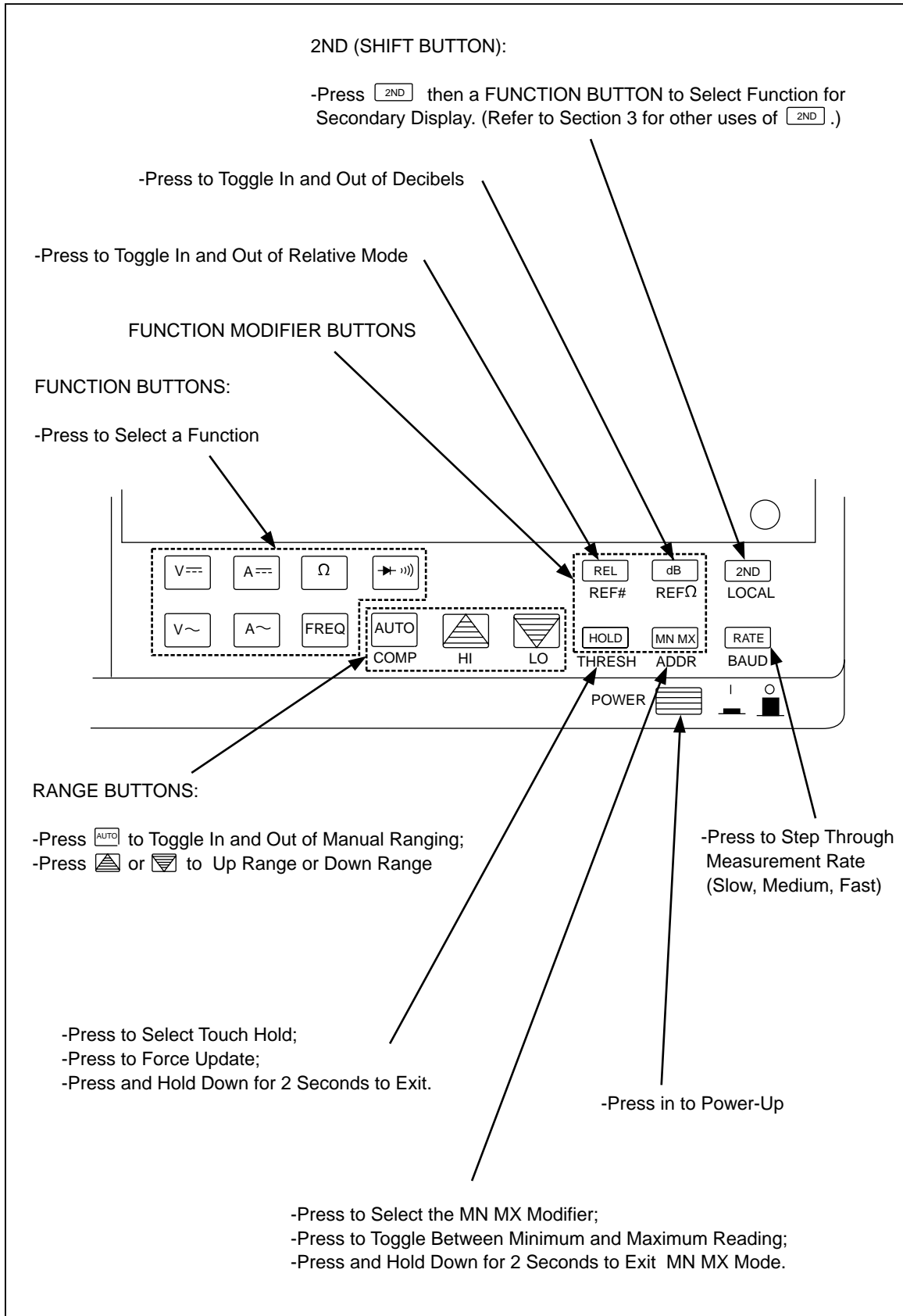


Figure 2-4. Summary of Basic Pushbutton Operations

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EXAMPLE: Press **AC** to select volts ac for the primary display, then press **dB** to select the decibels modifier.

- Press multiple buttons simultaneously.

EXAMPLE: Press **AC** and **DC** simultaneously to select true rms volts ac + volts dc (calculated) in the primary display.

For more details on the uses of each button, refer to Chapter 3, "OPERATING THE METER FROM THE FRONT PANEL."

## Selecting a Measurement Range

Measurement ranges can be selected automatically by the meter in "autorange" or manually by the user. In the autorange mode, the meter selects the appropriate range for the measurement reading.

To manually select a range, press **MAN** to toggle in (and out) of the manual ranging mode, or press **UP** or **DOWN**. In the manual range mode, press **UP** or **DOWN** to up range or down range to the desired range. For more details on ranging, refer to "Ranging" in Chapter 3.

## Automatic Input Terminal Selection

If current (ac or dc) is being measured in the autorange mode and there is no input on the 100 mA terminal, the meter switches automatically between the 100 mA and 10 A input terminals looking for a signal. A front panel annunciator indicates that the meter is in the mA range while the meter attempts to select the correct input terminal.

When a signal is detected at either input terminal, the display updates with the measurement results. If an input signal is not found on either input terminal, a measurement is taken on the mA terminal.

Automatic input terminal selection is disabled when the meter is in the manual ranging mode. Use the **MAN** and **UP** buttons to select the appropriate current input terminal and range.

## Taking Some Basic Measurements

### **⚠ Warning**

**Read "Multimeter Safety" before operating this meter.**

The following procedures describe the basics of taking common measurements from the front panel. These procedures are provided for the user who needs to get started quickly, but does not want to read the rest of the manual at this time. However, in order to take full advantage of your meter, you should read the remainder of this manual carefully and completely.

### **⚠ Warning**

**To avoid electrical shock or damage to the meter, do not apply more than the rated voltage between any terminal and earth ground. The meter is protected against overloads up to the limits shown in Table 3-1. Exceeding these limits poses a hazard to the meter and operator.**

### Measuring Voltage, Resistance, or Frequency

To measure voltage, resistance, or frequency, press the desired function button and connect the test leads as shown in Figure 2-5. The meter will select the appropriate range in the autorange mode, and an annunciator on the display will indicate measurement units.

#### Note

*After measuring high voltage to 1000 V dc, errors may occur when making measurements with 1 to 10  $\mu$ V resolution. Allow up to two minutes prior to making low-level measurements.*

### Measuring Current

To measure current, insert the test leads in the 100 mA input terminal for currents up to 100 mA or in the 10 A input terminal for higher current. Press  or  and connect the test leads as shown in Figure 2-6 and described in the following procedure:

1. Turn off power in the circuit to be measured.
2. Break the circuit (on the ground side to minimize the common mode voltage), and place the meter in series at that point. (To measure current without breaking the circuit, use a current clamp.)
3. Turn on power to the circuit, and read the display. The meter will select the appropriate range automatically, and an annunciator on the display will indicate the units of the measurement value shown.
4. Turn off power to the circuit and disconnect the meter from the tested circuit.

#### Note

*After measuring high current using the 10 A input, thermal voltages are generated that may create errors when making low-level (high sensitivity) dc measurements of volts, current, or ohms. To make the most accurate measurements, allow up to ten minutes for the thermals to settle out.*

### Diode/Continuity Testing

Diode and continuity tests are performed by a diode test function with a continuity beeper that can be turned on and off.

The continuity test determines whether a circuit is intact (i.e., has a resistance less than about 30  $\Omega$ ). The meter detects continuity for intervals as brief as 50  $\mu$ s. The continuity test function cannot be selected for the secondary display.

To perform a continuity test, press  , and connect the test leads as shown in Figure 2-7. The beeper emits a single beep when the input drops below +0.8 V (approximately 1 k $\Omega$ ), and emits a continuous tone when the input goes below +25 mV (approximately 30  $\Omega$ ).

The diode test measures the forward voltage of a semiconductor junction (or junctions) at approximately 0.7 mA. Readings are displayed in the 3 V range at the medium and fast measurement rates. "OL" is displayed for voltages above +2.5 V. If the diode test is performed at the slow reading rate, readings are displayed in millivolts on the 1000 mV (1 V) range.

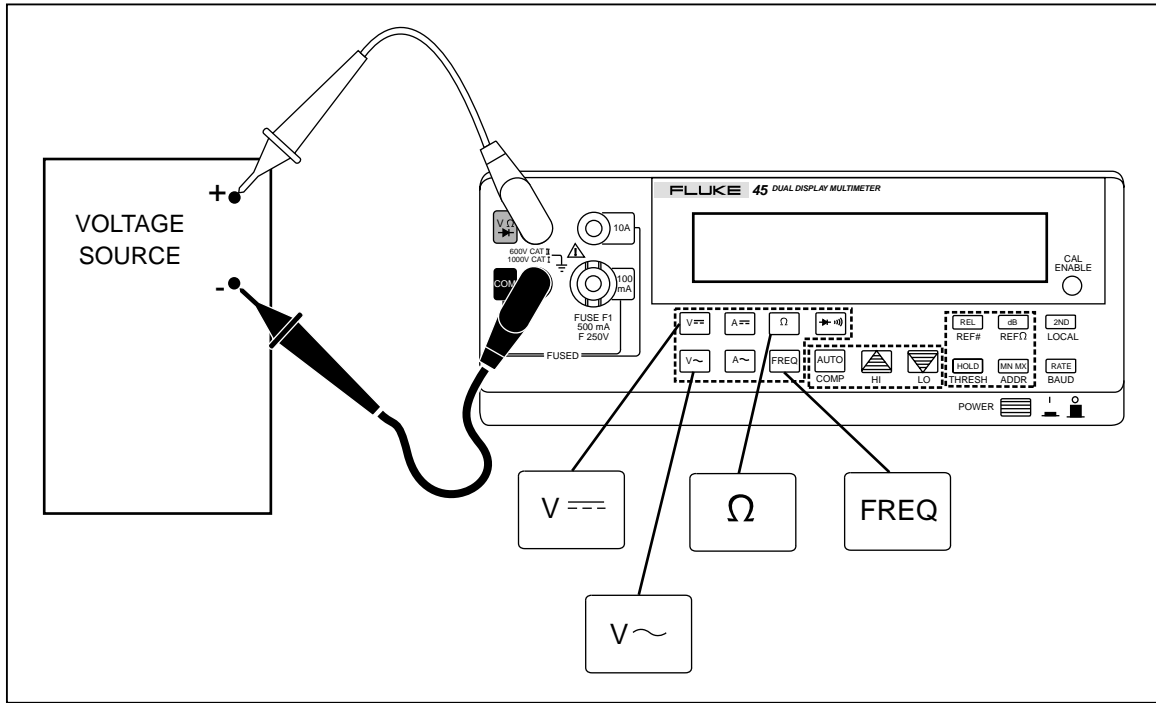


Figure 2-5. Measuring Voltage, Resistance, or Frequency

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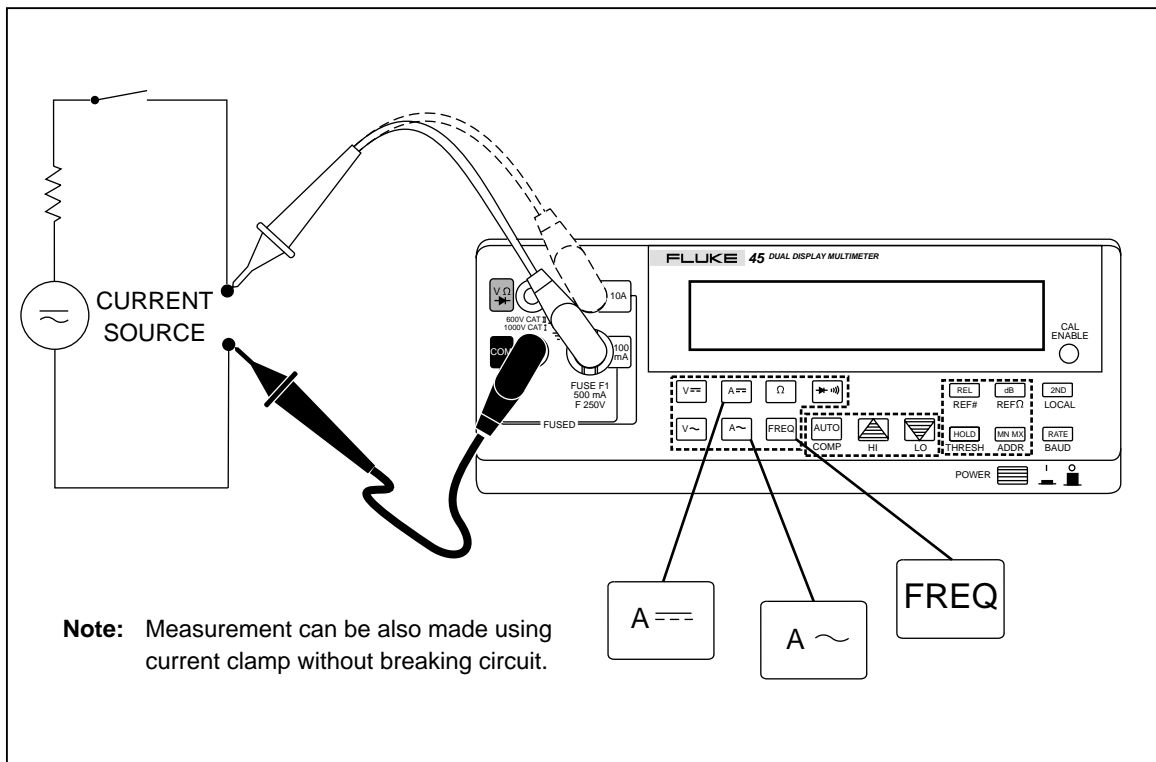


Figure 2-6. Measuring Current or Frequency

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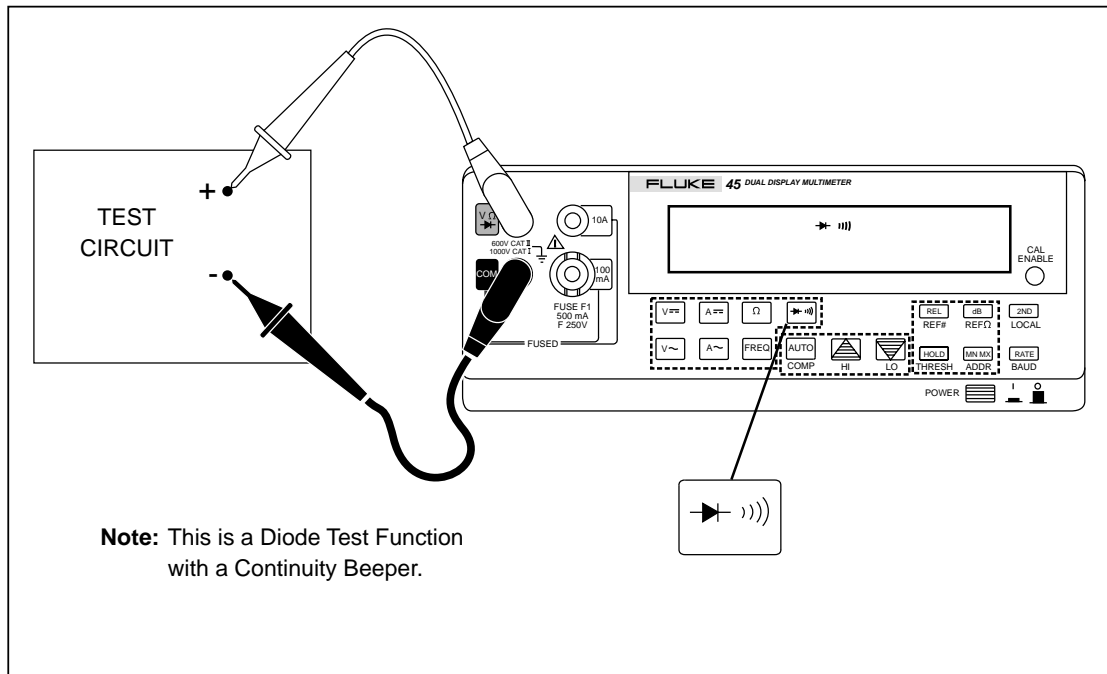


Figure 2-7. Continuity Testing

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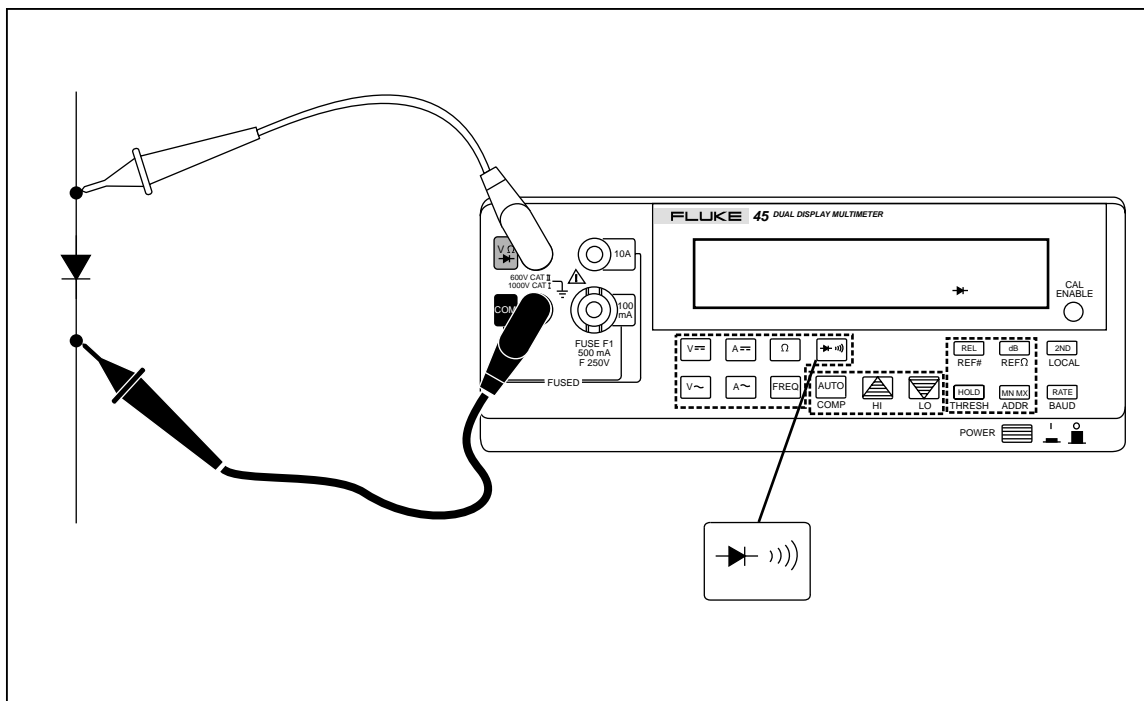





Figure 2-8. Diode Testing

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To perform a diode or transistor junction test, press  to select the diode/continuity function. (Each press of  turns the continuity beeper on and off.) Then connect the test leads across the diode as shown in Figure 2-8. Notice how the test leads are placed. Reversing the polarity will reverse-bias the diode.

### **Operating the Meter Under Battery Power (Optional)**

The meter can be powered by an 8 V, lead-acid battery. The battery module consists of a battery, battery bracket, and battery charger circuit assembly. The battery is rechargeable, requires no maintenance, and is fully operable at ambient temperatures between 0 and 50 °C. Refer to Appendix A for specifications.

The battery has a typical operating time of eight hours. When less than 1/2-hour of battery life remains,  turns on. If you turn the meter off when it is being operated under battery power, you must wait five seconds before turning the meter back on. Otherwise the meter will not power-up.

To maintain a fully charged battery (and maximize battery life), always recharge the battery after the meter has been operated on battery power. To recharge the battery, plug the meter into line power and turn the meter off. It will take approximately 16 hours to fully recharge a discharged battery with the meter turned off.

The battery remains fully charged as long as the meter is connected to line power. You need not be concerned about over-charging the battery. Do not store the battery for extended periods in a discharged state. Always fully charge the battery before storage and at least once every six months during storage. If the meter has been stored for a long period with the battery installed, fully recharge the battery before using the meter on battery power.

### **Rack Mounting**

You can mount the meter in a standard 19-inch rack using the M00-200-634 Rack Mount Kit. The rear feet can be rotated to clear a narrow rack space.

To install the rack mount kit, refer to the instructions provided with it.



# Chapter 3

## Operating the Meter From the Front Panel

### Introduction

Chapter 3 explains how to operate the meter from the front panel. Refer to Chapter 4 for information concerning specific applications. Chapter 5 provides instructions on how to operate the meter using the computer interface (RS-232 or IEEE-488).

### Front Panel Operations

The following operations can be performed from the front panel:

- Select a measurement function (volts dc, volts ac, current dc, current ac, resistance, frequency, and diode/continuity test) for the primary and secondary display.
- Take a measurement and display a reading.
- Select the manual or autorange mode (AUTO).
- Manually select a measurement range for the primary display.
- Select function modifiers that cause the meter to display relative readings (REL), minimum or maximum values (MN MX), or decibels (dB), or to enter the Touch Hold mode (HOLD) to hold a reading on the primary display.
- Change the measurement rate (slow, medium, fast).
- Set the dB reference resistance (REF  $\Omega$ ).
- Take a measurement and compare (COMP) it against a tolerance range (HI, LO, or PASS).
- Use the "editor" to select from option lists, to enter a relative base, or to enter a HILO range for the compare (COMP) mode.
- Configure the computer interface (RS-232 or IEEE-488).
- Take an audio power reading.
- Send measurements directly to a printer or terminal through the RS-232 interface (RS-232 print-only mode).

These and other front panel operations are described in the remainder of Chapter 3.

## Display

The meter has a 5-digit, vacuum-fluorescent, dual display. This display shows measurement readings, annunciators, and messages. The annunciators indicate measurement units and the meters operating configuration.

The dual display allows you to see two properties (e.g., volts ac and frequency) of the input signal you are measuring. Readings are taken and displayed in an alternating fashion. That is, a reading is taken of one property of the input and sent to a display; then a reading of the other property is taken and sent to the other display. (For more detail, see "How the Meter makes Dual Display Measurements" in Chapter 4.)

The display flashes when a measurement exceeds 1000 V dc or 750 V ac, the maximum rated input level. If an input exceeds the full scale value of the selected range, the overload annunciator (OL) is displayed.

### Primary Display

The primary display (shown in Figure 3-1) consists of the larger digits and annunciators (see Figure 3-2) and is located on the left side of the front panel. Readings using the relative (REL), minimum maximum (MN MX), Touch Hold (HOLD), or decibels (dB) modifiers can be shown on the primary display only.

### Secondary Display

The secondary display consists of a set of smaller digits on the right side of the dual display (see Figure 3-3).

Press  to turn the secondary display on and off. A series of five dashes is shown in the secondary display when the secondary display has been turned on but a function has not yet been selected.

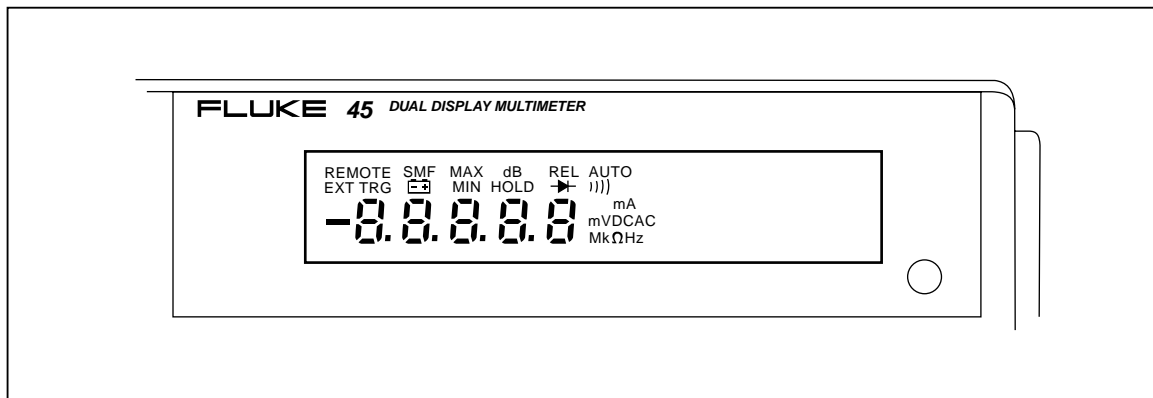


Figure 3-1. Primary Display

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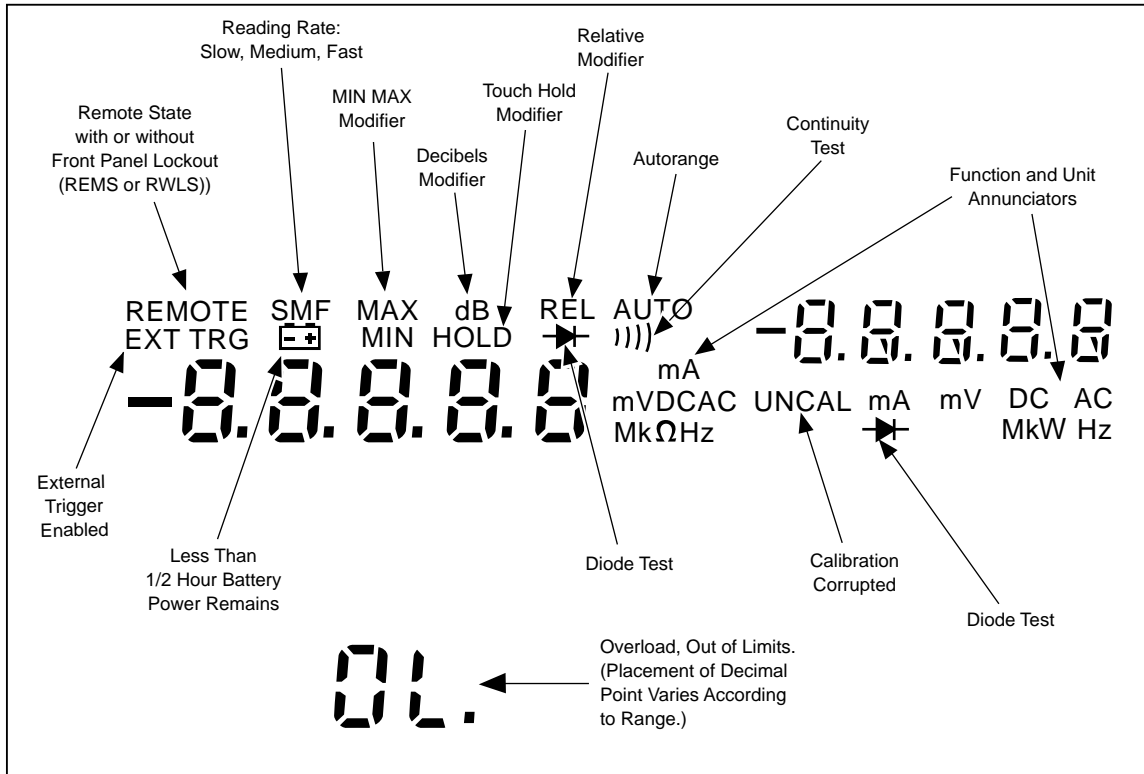


Figure 3-2. Display Annunciators

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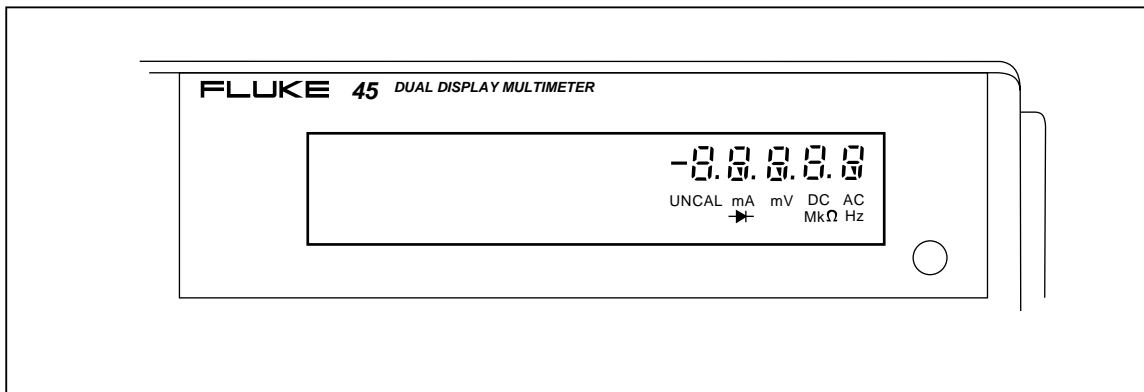


Figure 3-3. Secondary Display

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If the secondary display has been turned on, press a function button (white) to select a measurement function for the secondary display. The reading in the primary display will not be affected. When the secondary display is active, pressing any function button turns off the secondary display and selects that function on the primary display. To turn the secondary display off without affecting the primary display, press  twice.

*Note*

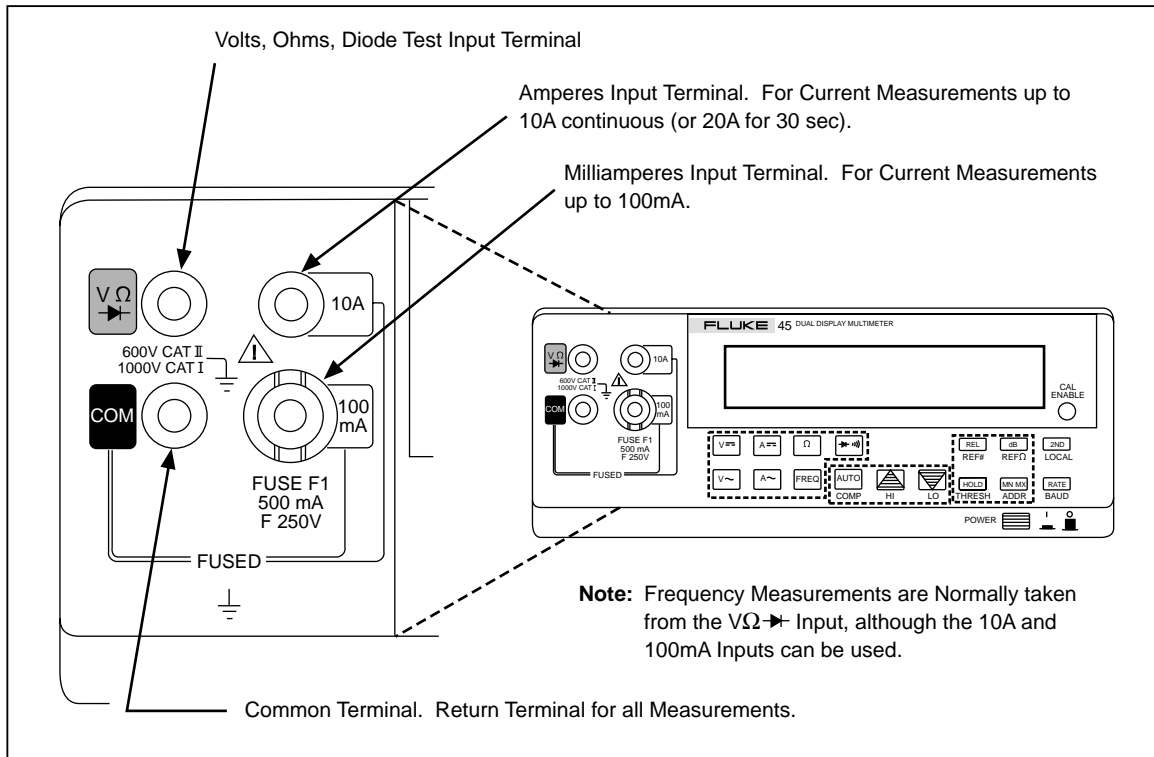
*If you press , only a diode test voltage reading will be shown in the secondary display; continuity is restricted to the primary display.*

Neither function modifiers (REL, dB, HOLD, and MN MX) nor the manual range mode can be selected in the secondary display. Measurement ranges in the secondary display are always selected through autoranging.

## Input Terminals

The input terminals, shown in Figure 3-4, are located on the left of the front panel.

The meter is protected against overloads up to the limits shown in Table 3-1. Exceeding these limits poses a hazard to both the meter and operator.



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Figure 3-4. Input Terminals

Table 3-1. Input Limits

| FUNCTION      | INPUT TERMINALS       | MAXIMUM INPUT  |
|---------------|-----------------------|--|
|               | V and COM             | 1000V dc   |
| and FREQ      | V and COM             | 750V ac rms, 1000V peak, $2 \times 10^7$ V-Hz normal mode, or $1 \times 10^6$ V-Hz common mode (whichever is less) |
| mA and FREQ   | 100 mA and COM        | 300 mA dc or ac rms  |
| and FREQ      | 10A and COM           | 10A dc or ac rms (or 20A dc or ac rms for 30 sec. Max)   |
|               | V and COM             | 500V dc or ac rms on all ranges  |
|               | V and COM             | 500V dc or ac rms  |
| All Functions | Any terminal to earth | 1000V dc or peak ac  |

### Selecting a Measurement Function

Press a function button (white), shown in Figure 3-5, to select a measurement function. To select ac + dc total rms readings, press and , or and , simultaneously.

When you select a function, annunciators turn on to indicate the function selected. If a reading is shown on the secondary display when a function button is pressed, the secondary display will be turned off.

Ranges and full scale values are summarized in Table 3-2 for voltage, Table 3-3 for current, Table 3-4 for ohms, and Table 3-5 for frequency.

### Ranging



Ranging operations are performed using the , , and buttons (see Figure 3-6).

### Autoranging

When you are in the autorange mode, the AUTO annunciator is lit.

In autorange, the meter automatically selects the next higher range when a reading is greater than full scale. If no higher range is available, "OL" (overload) is displayed on the primary or secondary display. The meter automatically selects a lower range when a reading is less than approximately 9 % of full scale.



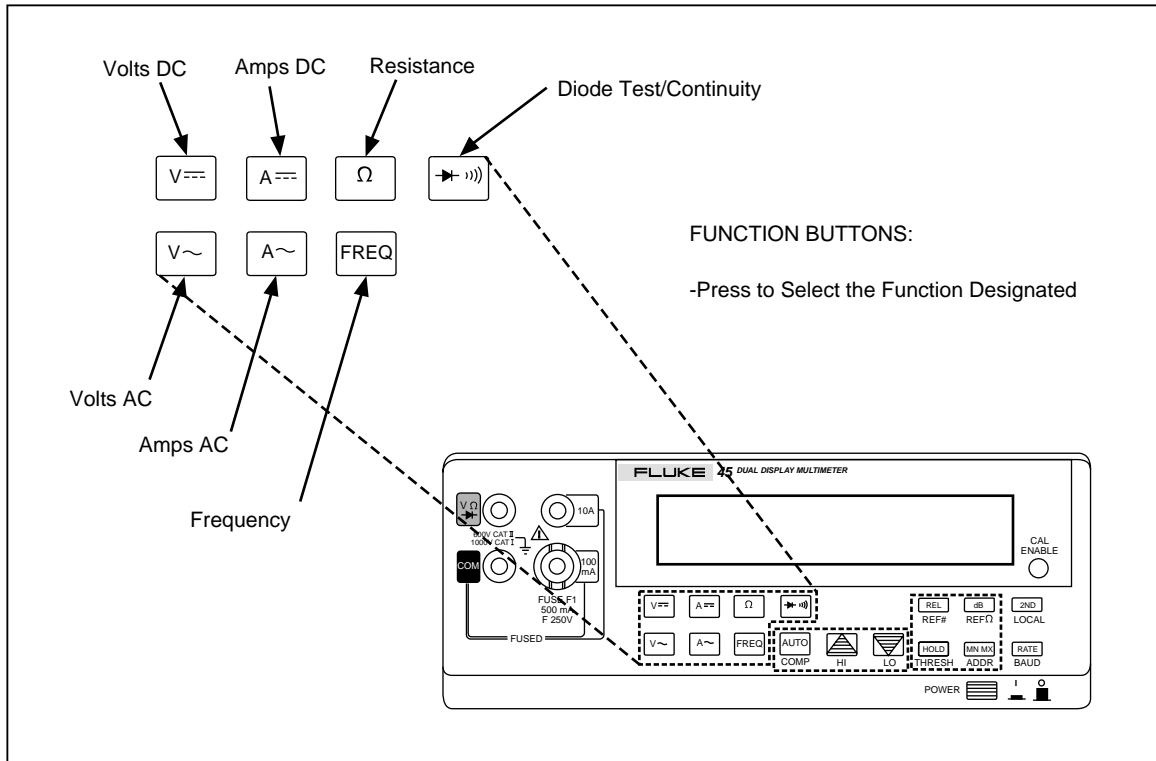


Figure 3-5. Function Selection Buttons

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Table 3-2. Voltage Ranges and Full Scale Values

| Fast Reading Rate |            | Medium Reading Rate |            | Slow Reading Rate |            |
|-------------------|------------|---------------------|------------|-------------------|------------|
| Range             | Full Scale | Range               | Full Scale | Range             | Full Scale |
| 300 mV            | 300.0 mV   | 300 mV              | 300.00 mV  | 100 mV            | 99.999 mV  |
| 3 V               | 3.000 V    | 3 V                 | 3.0000 V   | 1000 mV           | 999.99 mV  |
| 30 V              | 30.00 V    | 30 V                | 30.000 V   | 10 V              | 9.9999 V   |
| 300 V             | 300.0 V    | 300 V               | 300.00 V   | 100 V             | 99.999 V   |
| 1000 V*           | 1000 V*    | 1000 V*             | 1000.0 V*  | 1000 V*           | 999.99 V*  |

\* 750V for volts ac

**Table 3-3. Current Ranges and Full Scale Values**

| Fast Reading Rate |            | Medium Reading Rate |            | Slow Reading Rate |            |
|-------------------|------------|---------------------|------------|-------------------|------------|
| Range             | Full Scale | Range               | Full Scale | Range             | Full Scale |
| 30 mA             | 30.00 mA   | 30 mA               | 30.000 mA  | 10 mA             | 9.9999 mA  |
| 100 mA            | 100.0 mA   | 100 mA              | 100.00 mA  | 100 mA            | 99.999 mA  |
| 10 A              | 10.00 A*   | 10 A                | 10.000 A*  | 10 A              | 9.9999 A   |

\* 20 A for maximum of 30 seconds

**Table 3-4. Ohms Ranges and Full Scale Values**

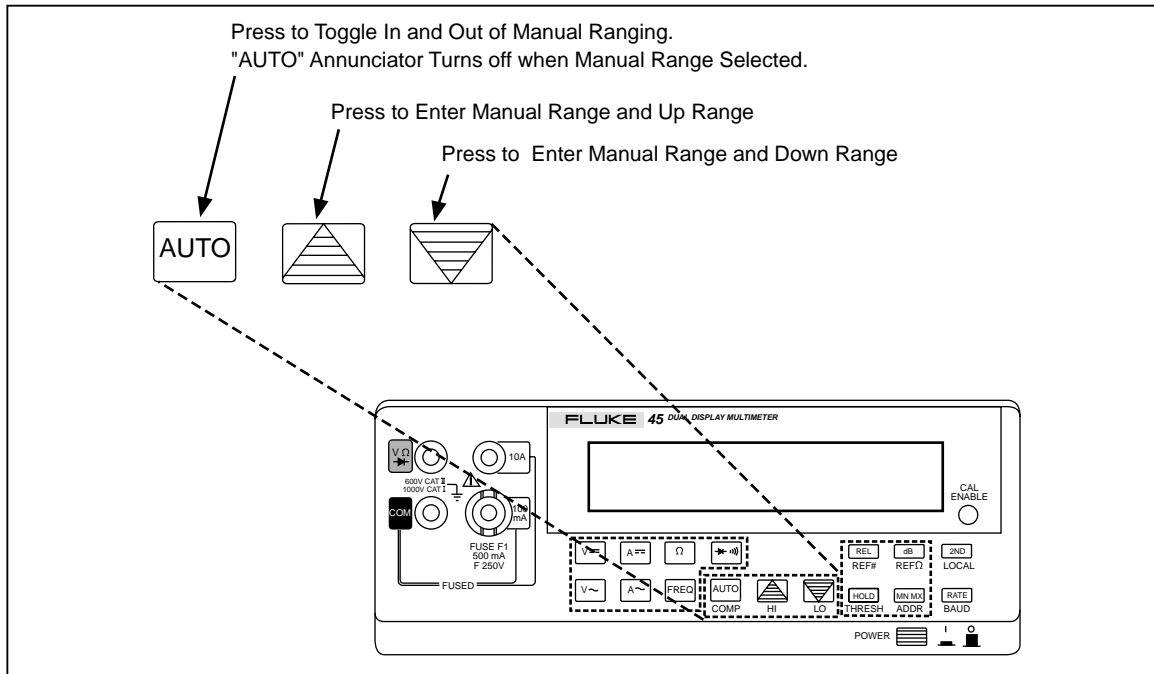
| Fast Reading Rate |            | Medium Reading Rate |            | Slow Reading Rate |             |
|-------------------|------------|---------------------|------------|-------------------|-------------|
| Range             | Full Scale | Range               | Full Scale | Range             | Full Scale* |
| 300 Ω             | 300.0 Ω    | 300 Ω               | 300.00 Ω   | 100 Ω             | 98.000 Ω    |
| 3 kΩ              | 3.000 kΩ   | 3 kΩ                | 3.0000 kΩ  | 1000Ω             | 980.00 Ω    |
| 30 kΩ             | 30.00 kΩ   | 30 kΩ               | 30.000 kΩ  | 10 kΩ             | 9.8000 kΩ   |
| 300 kΩ            | 300.0 kΩ   | 300 kΩ              | 300.00kΩ   | 100 kΩ            | 98.000 kΩ   |
| 3 MΩ              | 3.000 MΩ   | 3 MΩ                | 3.0000 MΩ  | 1000 kΩ           | 980.00 kΩ   |
| 30 MΩ             | 30.00 MΩ   | 30 MΩ               | 30.000 MΩ  | 10 MΩ             | 9.8000 MΩ   |
| 300 MΩ            | 300 MΩ     | 300 MΩ              | 300.0 MΩ   | 100 MΩ            | 98.0 MΩ**   |

\*Typical  
 \*\* Because of the method used to measure resistance, the 100 M (slow) and 300 M (medium and fast) ranges cannot measure below 3.125 M and 20 M respectively. "UL" (Underload) is shown on the display for resistances below these nominal points, and the computer interface outputs "+1 E-9".

**Table 3-5. Frequency Ranges and Full Scale Values (Slow and Medium\*)**

| Range    | Full Scale |
|----------|------------|
| 1000 Hz  | 999.99 Hz  |
| 10 kHz   | 9.9999 kHz |
| 100 kHz  | 99 999 kHz |
| 1000 kHz | 999.99 kHz |
| 1 MHz    | 9.9999 MHz |


\* Fast (F) reading rate has one digit of resolution less.






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

Figure 3-6. Range Selection Buttons

### Manual Ranging

Press  to toggle in and out of manual ranging. The range you are in when you enter the manual range mode becomes the selected range.

In manual range, the meter remains in the selected range regardless of input. Press  to toggle back to autoranging. Manual ranging can only be performed on readings shown on the primary display; the secondary display always autoranges.

Press  to up range. If the  is pressed when the meter is still in autorange, manual ranging is selected, the AUTO annunciator turns off, and the next higher range is selected (if there is one).



Press  to down range. If the  is pressed when the meter is still in autorange, manual ranging is selected, the AUTO annunciator turns off, and the next lower range is selected (if there is one).

### Measuring Frequency

**(FREQ)**

#### Frequency Ranging

Frequency measurements from 5 Hz to > 1 MHz are automatically ranged so that a frequency measurement is always displayed with maximum resolution.

If the frequency function (FREQ) is selected in the primary display, press the  or  to manually select a range. (Manual ranging is not allowed in the secondary display.) If you select a frequency range manually, frequency measurements that exceed the full scale value of that range cause "OL" (overload) to be displayed. Refer to Table 3-5 for frequency ranges and full scale values.

### Frequency Measurement Rates

The rate at which frequency measurements are taken is a factor of the frequency being measured (see Table 3-6).

When the frequency function has been selected, pressing   has no effect on the frequency update rate.

**Table 3-6. Frequency Measurement Rates**

| Frequency  | Reading Rate |
|------------|--------------|
| @ > 150 Hz | 1.8/sec      |
| @ 100 Hz   | 1.6/sec      |
| @ 60 Hz    | 1.3/sec      |
| @ 15 Hz    | 1/1.2sec     |
| @10Hz      | 1/1.7sec     |
| @5Hz       | 1/3.2 sec    |

### Measuring Frequency of Current (100 mA and 10A) Inputs

Frequency measurements are always taken using the ac input circuitry of the meter. Normally, measurements are taken on the   input terminal. However, frequency measurements can also be taken on current inputs. *If frequency is to be measured using a current input, ac current must be selected in the primary display and frequency must be selected in the secondary display.*

When the ac current function in a mA range is selected in the primary display and frequency is selected as the secondary display function, the frequency of the current at the 100 mA terminal will be measured. Similarly, when the ac current function in the 10 A range is selected for the primary display and frequency is selected in the secondary display, the frequency of the current at the 10 A input terminal is measured.

### Frequency Sensitivity Selection

Before a frequency measurement is started, the amplitude of the input signal is sampled and the optimum ac range is selected automatically. For most applications, therefore, the user need not be concerned with setting the measurement sensitivity for stable frequency readings.

However, if necessary, measurement sensitivity can be selected manually. To do so, use the dual display as described in the following procedure:

1. Power-up the meter and press   or   to select an ac voltage or current function in the primary display.
2. Press  ,  , or   to manually select an ac measurement range.
3. Press   then press   to select the frequency function in the secondary display.

All frequency measurements on the secondary display will be taken on the selected ac range.

The maximum input voltage that may be applied on any ac measurement range for reliable frequency measurements is listed in Table 3-7.

The minimum signal for a stable frequency measurement varies depending on the frequency and waveform being measured.

**Table 3-7. Maximum Sinewave Inputs for Frequency Measurements**

| Range  | Maximum Input Voltage |
|--------|-----------------------|
| 300 mV | 1 V rms               |
| 3 V    | 6 V rms               |
| 30 V   | 60 V rms              |
| 300 V  | 750 V rms             |
| 750 V  | 750 V rms             |

The input signal sensitivity is listed under the frequency specifications in Appendix A. These values are based on sine waveforms. The signal level must be increased for lower crest factor inputs (the crest factor is the ratio of the peak voltage to the ac rms voltage of the waveform). If the input signal is below the required level, the frequency will be displayed as zero. If the measurements are unstable, the input signal may be near the threshold level.

### Selecting A Function Modifier

(REL), (dB), (HOLD), (MN MX)

Selecting a function modifier (see Figure 3-7) causes the meter to perform an action on an input (e.g., convert to decibels or compare to another value) before a reading is displayed. Function modifiers can be used in combination. (See "Using Function Modifiers in Combination," later in Chapter 3.)

To use a function modifier, press a function button to select a primary function, then press a function modifier button (or buttons). Modified readings are shown only on the primary display.

After a function modifier has been selected, pressing any (white) function button turns off all modifiers, causes the secondary display to go blank, and returns unmodified readings to the primary display.

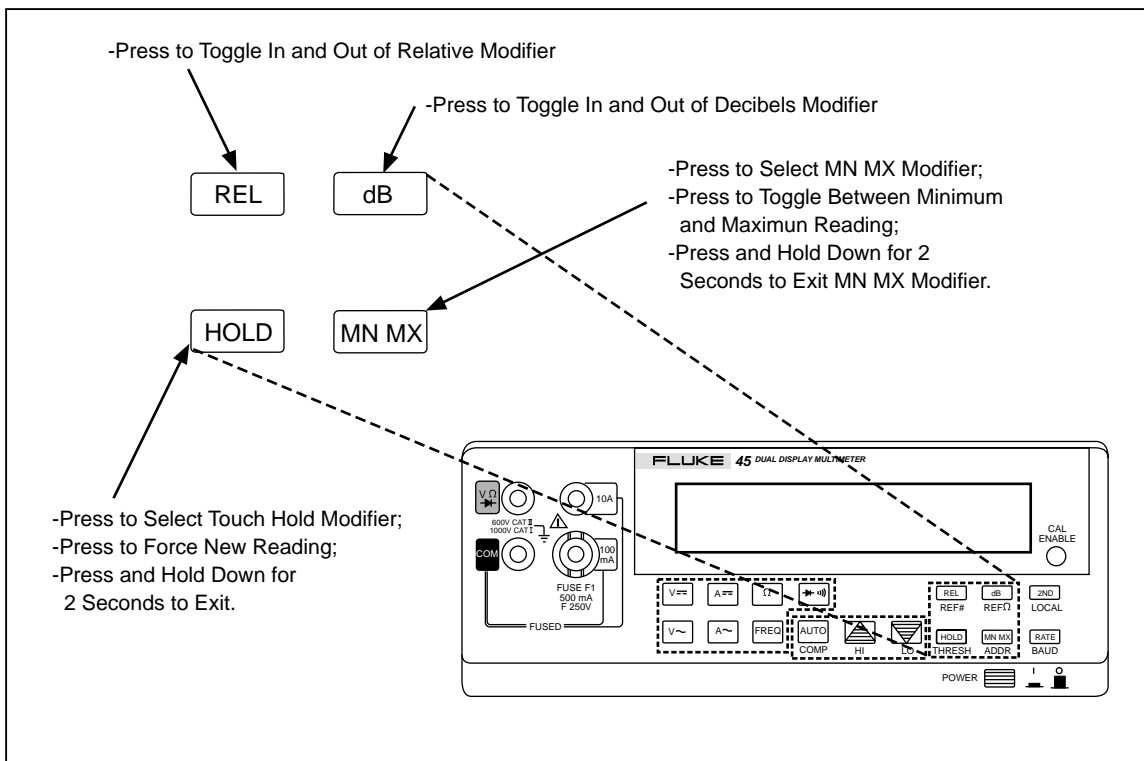


Figure 3-7. Function Modifier Selection Buttons

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### REL (Relative Readings) Modifier

When the relative modifier (REL) is selected, the reading on the primary display is always the difference between the relative base and an input measurement. For example, if the relative base is 15.000 V, and the present reading is 14.100 V, the display will show -0.900.

### Warning

**To avoid electrical shock or damage to the meter, note that a relative reading may not indicate the presence of dangerous voltages at the input connectors or test leads.**

Press **REL** to toggle in and out of the relative modifier. When the relative modifier is selected: the last valid reading is stored as the relative base, the primary display zeroes out, and "0.000" is shown on the primary display. (The secondary display is unaffected.)

To edit the relative base, use the number editor as described in "Using the Number Editor" later in Chapter 3).

### Note

*The relative modifier cannot be selected if the display shows "OL" or is blank. (The display would be blank, for example, because of external triggering or range changes.)*

Selecting the relative modifier **REL** turns off autoranging and locks in the present range. Make sure you are in the correct range before selecting the relative modifier. If you press **REL** or **dB** after the relative modifier has been selected, you will automatically exit **REL**.

When you are in REL, the relative base can be shown in the secondary display by pressing **REF** and, while holding it down, pressing **REF**. Now, whenever the relative

modifier is selected, the relative base is shown in the secondary display. To turn off this feature, press **MODE** and, while holding it down, press **MODE**.

### **dB (Decibels and Audio Power) Modifier**

The decibels modifier takes a voltage measurement, converts it to dBm (measure of decibels relative to one milliwatt), and displays the result on the primary display.

Press **MODE** to toggle in and out of the decibels modifier. When the decibels modifier is selected, "dB" is shown on the primary display.

Decibels can be selected only when a voltage function is selected on the primary display (volts ac, volts dc, or volts ac + dc). Decibels are always displayed in a single, fixed range with 0.01 dB resolution. However, the basic measurement itself (e.g. volts ac) autoranges.

A voltage measurement is converted to dBm using the following formula:

$$\text{dBm} = 10 \cdot \log \left( 1000 \cdot \frac{\text{value}^2}{\text{reference impedance}} \right)$$

where "value" is the measurement value. The reference impedance can be set to any of 21 reference impedances listed in Table 3-8 by using the list editor as described in "Using the List Editor" later in Chapter 3.

**Table 3-8. Reference Impedances in Ohms**

|       |     |     |
|-------|-----|-----|
| 8000  | 300 | 93  |
| 1200  | 250 | 75  |
| 1000* | 150 | 50  |
| 900   | 135 | 16† |
| 800   | 125 | 8†  |
| 600   | 124 | 4†  |
| 500   | 110 | 2†  |

\* Voltage annunciator lit  
† Audio power readings possible

To access the reference impedance list, press **MODE** then press **REF** (REF ). The reference impedance currently selected is displayed, along with the db and annunciators. Press **UP** or **DOWN** to scroll to the desired value, then press **ENTER** to select a reference impedance and return the primary display to the measurement function. Press any function (white) or modifier (light grey) button to exit the reference impedance list without selecting a new value.

Setting the dB reference resistance to 16, 8, 4, or 2 ohms allows you to use the meter to calculate audio power. After the reference resistance has been set to 16, 8, 4, or 2 ohms, press **MODE** twice to select the audio power modifier. "POWER" will be shown on the secondary display.

The following equation is used to make a power calculation:

$$\text{Audio power} = \frac{\text{Volts}}{\text{reference resistance}}$$

where volts is the measurement value.

### **HOLD (Touch Hold) Modifier**

The Touch Hold modifier allows you to take a measurement and "hold" that measurement on the display. This feature can be particularly advantageous in difficult or hazardous circumstances when you might want to keep your eyes fixed on the probes, and then read the display when it is safe or convenient to do so. When a new, stable reading is detected, a beep is emitted, and the display is automatically updated.

Press **⇨** to select the Touch Hold modifier. When Touch Hold is selected, "HOLD" is shown in the primary display. In Touch Hold, each press of **⇨** forces a new reading to be displayed. To exit Touch Hold, press down **⇨** for two seconds.

If you are in the autorange mode when Touch Hold is selected, you will autorange to the correct range. If you are in the manual range mode, you will enter Touch Hold in the selected (fixed) range you were in when Touch Hold was selected.

The Touch Hold modifier can be combined with the MN MX modifier to hold and update only when a new minimum or maximum value is detected. Pressing **⇨** less than two seconds when Touch Hold has been selected forces the display to update.

The meter allows you some choice when it comes to determining the minimum response level needed for Touch Hold to capture and display a measurement. You can choose among three Touch Hold sensitivity levels:

- Level 1 (5 % of range)
- Level 2 (7 % of range)
- Level 3 (8 % of range)

To change this level, press **⇨**, then press **⇨**. The number "1," "2," "3" appears on the primary display. Press **⇨** or **⇨** to step to the desired sensitivity level. Then press **⇨** to set the level and return the primary display. You can return to the primary display without changing the sensitivity level by pressing any button except **⇨**, **⇨**, or **⇨**.

### **MN MX (Minimum Maximum) Modifier**

The MN MX modifier causes the meter to store the minimum and maximum inputs measured since the MN MX modifier was selected.

Press **⇨** to select the MN MX modifier. When the MN MX modifier is first selected, the minimum and maximum values are set to the displayed reading and the "MIN" annunciator lights. Press **⇨** again to display the maximum reading (and the "MAX" annunciator). Each subsequent press of the **⇨** button toggles between the minimum and maximum measurements taken. To exit the MN MX modifier, press and hold down the **⇨** button for two seconds.

Selecting the MN MX modifier turns off autoranging and locks in the present range. Make sure you are in the correct range before selecting the MN MX modifier. If you press **⇨** or **⇨** after MN MX has been selected, you will automatically exit the MN MX modifier.

To observe the quantity being measured without resetting the stored MN MX values, use the secondary display by pressing **⇨**, then select the same measurement function that is selected for the primary display.

### **Using Function Modifiers in Combination**

The meter allows you to use multiple function modifiers (dB, REL, HOLD, MN MX) simultaneously. The selected modifiers are evaluated in the following order: HOLD, dB, MN MX, and REL. That is, the meter first looks for a stable measurement for Touch



Hold, then converts the measurement to decibels, then determines if the measurement is either a new minimum or maximum value, and then subtracts the relative base from the measurement.

When using multiple modifiers, the order in which modifiers are selected is important. For example, if **MIN** is pressed when you are in the MN MX, either the minimum or maximum value (which ever is currently displayed) becomes the relative base. Pressing **MAX** again as the next action causes the meter to display the difference between the minimum and maximum value. If, on the other hand, **REL** is pressed when you are in REL, the difference between the relative base and the minimum or maximum value (depending on what was displayed) is shown.

### Selecting A Measurement Rate (Rate)

The meter takes measurements at one of three, user-selectable rates: slow, medium, and fast. Rate selection allows you to maximize either measurement speed or noise rejection, which affects accuracy (see Table 3-9). The rate selected is indicated by "S," "M," "F" (slow, medium, or fast, respectively) in the primary display.

Press **MODE**, located in the lower-right corner of the front panel, to step through measurement rates. The selected rate applies to all basic measurements, except frequency. (When frequency is measured, the rate is a factor of the frequency being measured (see Table 3-6), and pressing **MODE** has no effect on the frequency update rate.)

**Table 3-9. Display Measurement Rates for Single Function Measurements**

| Measurement Rate | Digits | Display Counts | Results Per Second |
|------------------|--------|----------------|--------------------|
| Slow             | 5      | 99,999*        | 2-1/2              |
| Medium           | 4-1/2  | 30,000         | 5                  |
| Fast             | 3-1/2  | 3,000          | 20                 |

\* All ranges and functions except ohms will display up to 99999. Ohms displays up to 98000 (typical).

### Using the **2ND** Button

Pressing **2ND** (located on the lower-right of the front panel) causes the next button pushed to perform a second level operation.

A second level operation can be selected by:

- Pressing **2ND** then pressing another button (or buttons);
- Pressing and holding down **2ND** and pressing another button;

The second level operation available on a pushbutton is engraved below it on the front panel and enclosed in parentheses in Table 3-10. (The LOCAL function associated with **2ND** operates only when the meter is in REMS [remote without front panel lockout]. See Table 5-15 in Chapter 5.)

**Table 3-10. Button Operations**

| Pushbuttons      | Operations  |
|------------------|---|
| then             | Show volts ac reading in secondary display  |
| then             | Show volts dc reading in secondary display  |
| then             | Show amperes ac reading in secondary display  |
| then             | Show amperes dc reading in secondary display  |
| then             | Show ohms reading in secondary display  |
| then             | Show Hz reading in secondary display  |
| then             | Show diode test reading in secondary display  |
| then<br>(COMP)   | Compare mode in primary display. (See "Using the Compare Function" in Chapter 3, below.)  |
| then<br>(LO)     | Edit Compare mode low point. (See "Using the Compare Function" in Chapter 3, below.)  |
| then<br>(Hi)     | Edit Compare mode high point. (See "USING THE COMPARE FUNCTION" in Chapter 3, below)  |
| and<br>(LO)      | Store value on primary display as LO compare point (See "USING THE COMPARE FUNCTION" in Chapter 3, below.)                                |
| and<br>(HI)      | Store value on primary display as HI compare point (See "USING THE COMPARE FUNCTION" in Chapter 3, below.)                                |
| then<br>(REF #)  | Edit relative base. (See "Using the List and Number Editor" in Chapter 3 below.)  |
| and              | Toggle display of relative base in secondary display.   |
| then<br>(THRESH) | Select Touch Hold sensitivity threshold   |
| then<br>(REF )   | Select dB reference impedance.  |
| then<br>(ADDR)   | Select computer interface address for IEEE-488 operations or RS-232 print only rate. (See also "RS-232 Print-Only Mode" in Chapter 5.)    |
| then<br>(BAUD)   | Select RS-232 baud rate or "IEEE" to enable an installed IEEE-488 interface.  |
| Then             | Turn off secondary display, leaving primary display unaffected.   |
| and              | Store present operating configuration of meter as power-up configuration. (See "Changing the Power-Up Configuration" later in Chapter 3.) |
| and              | Display software version.   |

## Using The Compare (Comp) Function

The compare function (COMP) provides an easy way to determine if a reading falls within a designated range of values. In the compare mode, the meter displays a reading in the primary display and indicates in the secondary display if that value is lower (LO) than, higher (HI) than, or within a range (PASS) you selected.

The compare function can be used with any other function modifier — i.e., REL, MN MX, HOLD, or dB.

Before selecting the compare function, set the high and low points of the tolerance range that a reading will be compared against. This can be done in three ways:

- Set the high and low compare points to the present reading by pressing and holding down **MEM**, and then pressing either **HI** or **LO**.

The value presently displayed becomes either the high or low point. If the display is blank, the meter emits a beep and previously set high or low point remains unchanged.

OR

- Use the number editor, as described under "Using the Number Editor" later in Chapter 3. (Before entering the number editor, be sure you are in the appropriate range.)

The decimal point and input range are fixed according to the range in the editor.

OR

- Use the computer interface commands COMPHI and COMPLO to set the high and low compare points remotely. (Refer to Chapter 5 and Table 5-13.)

To select the compare function, press **MEM**, then press **COMP**. When COMP is first selected, Touch Hold is also activated (and annunciated). Before a stable value is detected, two dashes are shown in the secondary display. When a stable value is detected, the meter emits a beep, the reading is displayed in the primary display, and "HI", "LO", or "PASS" is shown in the secondary display. If the value is either HI or LO, the meter emits a second beep. (If the reading is near zero, only two dashes are shown in the secondary display.)

Touch Hold can be turned off by pressing and holding down **MEM** for longer than one second. The secondary display then updates each time a new reading is taken, but a beep is not sounded.

## The List and Number Editors

Two editors can be invoked from the front panel:

- The "list editor" allows you to scroll through and select from a list of options.
- The "number editor" allows you to edit or enter a numeric value.

"Editing" is performed in the primary display. The normal operation of the meter is interrupted when either editor is invoked.

If a computer interface command is received by the meter during editing, the edit is aborted, and the meter returns to normal operation. The item being edited is not changed.

**Using the List Editor**

Use the list editor to select an option from a list. Table 3-11 summarizes the options available through the list editor.

To use the list editor, proceed as follows:

1. Press **ENTER**.
2. Press the appropriate modifier button, as indicated in Table 3-11, to call the list editor on an options list.

The option currently selected is shown in the primary display and an annunciator, indicating the option list, is shown in the secondary display.

3. Press **LEFT** or **RIGHT** to step through the list. (Holding down either button for longer than two seconds causes it to scroll.)
4. As you step through the list, only the selected option is shown in normal intensity (bright), all others are dimmed. When the desired option is shown, press **ENTER** to select it. The selected option is then displayed in normal intensity.

To abort the operation, press any button except **ENTER**, **LEFT**, and **RIGHT**. When the option selection operation is aborted, the editor is exited, and the meter resumes normal operation.

For example, to set the decibel reference impedance to 16:

1. Press **ENTER**, then press **MODE**.  
 “ ”, “dB”, and the reference impedance are shown in the primary display.
2. Press and hold down **LEFT** to scroll to 16. (If the refernce impedance is less than 16, press and hold down **RIGHT**.) Each option other than the selected reference impedance is dimmed. Also, since power can be selected with this reference, "POWER" is shown in the secondary display.

Table 3-11. Options Available Through List Editor

| To Set  | Pushbuttons                      | Options   | Annunciator                             |
|---|----------------------------------|---|---|
| Touch Hold Minimum Response Level                                     | then<br>(THRESH)                 | "1" (5 % of range);<br>"2" (7 % of range); or   | "HOLD"<br>"3" (8% of range)             |
| Decibel Reference Impedance in Ohms                                   | then<br>(REF #)                  | 2, 4,8,16,50,75,93,<br>110,124,125,135,150,<br>250, 300,500,600, 800,<br>900,1000,1200, or 8000 | "dB" and " ";<br>also "V" when<br>1000Ω |
| RS-232 Baud Rate  | then<br>(BAUD)                   | 300,600,1200,2400,<br>4800, or 9600   | "baud"                                  |
|   | Parity options list<br>displayed | "E" (even), "O" (odd),<br>"no" (none)   | "PAR" for parity                        |
|   | Echo Mode                        | On or Off   | "Echo" and "On"<br>or "OFF"             |
| IEEE-488 Address(If<br>IEEE-488 Interface<br>Installed and selected.) | then<br>(ADDR)                   | Valid addresses between<br>0-30   | "IEEE"                                  |
| RS-232 PrintOnly<br>Mode (If RS-232<br>Interface Selected)            | then<br>(ADDR)                   | 1,2,5,10,20,50,100, 200,<br>500,1000,2000,<br>5000,10000,20000, or<br>50000                     | "PRINT"                                 |
| Trigger Type  | and<br>simultaneously            | 1,2,3,4, 5 (See Table 5-<br>14.)  | "tri"                                   |

- When you have scrolled to 16, press **16** to set the dB reference impedance. "16" now becomes bright, indicating that it is the selected value.

This dB reference will remain selected until you change it (as described above), turn the meter off, or reset the meter to the power-up configuration by pressing and holding down **16** during power-up. (See "Changing the Power-Up Configuration" later in Chapter 3.)

### Using the Number Editor

Use the number editor to set the relative base, or the low (LO) and high (HI) points for compare (COMP) operations (see "Using the Compare Function" earlier in Chapter 3).

To use the number editor, proceed as follows:

- To invoke the desired number editor, press **16** then press **1**, **2**, or **3** (REF #). See Table 3-12

Table 3-12. Number Editor Options

| Pushbuttons  | Number Editor Invoked On    |
|--------------|-----------------------------|
| then (LO)    | Low Point for Compare Mode  |
| then (Hi)    | High Point for Compare Mode |
| then (REF #) | Relative Base               |

The last number entered (or, in REL, the last measured value) is shown with the left most digit displayed in normal intensity and the remaining digits dim. (If the number is negative, the minus sign is dim.) Related annunciators are lit, and "EDIT" is shown in the secondary display.

2. Press **←** to step the bright digit through numbers between 0 and 9. Holding down causes this digit to scroll continuously.

Press **→** to select the digit to be edited. Each press of **→** causes the digit to the right to be selected and go bright, while causing the previously selected digit to go dim. When the right most digit has been selected, the next press of **→** selects the sign: if the sign is positive, the negative annunciator flashes bright dim; if the sign is negative, the negative annunciator is bright. **→** will toggle the sign between positive and negative.

3. Any time during editing, you can store a selected value by pressing **ENTER**.
4. To abort the edit and return the meter to normal operation, press any button except **←**, **→**, and **ENTER**.

## Power-Up Configuration

### Factory Settings of Power-Up Configuration

When the meter is turned on and completes the power-up sequence, it assumes its power-up configuration. The power-up configuration set at the factory is shown in Table 3-13.

The IEEE-488 address, the RS-232 baud rate, parity, echo, and print-only rate are not changed when power is cycled off and on. These parameters remain as set until changed by the user.

### Changing the Power-Up Configuration

You can change the power-up configuration to one that more closely meets your needs and preferences. Any combination of meter parameters can become the power-up configuration.


To save any configuration in which the meter is operating, press **ENTER** and, while holding it down, press **←**. The following parameters are saved:

- Measurement function and initial range on primary display.
- Measurement function and initial range on secondary display.

Table 3-13. Power-Up Configuration Set at Factory

| Parameter                                    | Configurations                             |
|--|--|
| Function Setting                             | DC volts                                   |
| Range Mode                                   | Autorange                                  |
| Reading Rate                                 | Medium (30,000 counts @ 5 readings/second) |
| Touch Hold Sensitivity Level                 | Level "2" (1 to 2 % of Range)              |
| Reference Impedance (for dB)                 | 600 ohms                                   |
| High/Low Values for Compare (COMP) Mode      | 0  |
| Minimum and Maximum values in MN MX Modifier | 0  |
| Relative Base                                | 0  |
| Relative Base in Secondary Display           | Disabled                                   |
| Trigger Type                                 | Internal                                   |

- Range mode on primary display (manual or autorange).
- Measurement rate ("S" (slow) "M" (medium) or "F" (fast)).
- Dual display status (active or inactive).
- Any combination of selected function modifiers (MIN or MAX, HOLD, dB or dB POWER, REL, and COMP).
- Touch Hold sensitivity level ("1", "2", or "3").
- dB reference impedance (see Table 3-8 for available values).
- Last recorded minimum and maximum values for MN MX modifier.
- Last recorded relative base.
- Relative base shown in secondary display (enabled or disabled).
- Last HI-LO settings in compare mode.
- Trigger type (see Table 5-3 for available trigger types).
- Echo (on or off)

To restore the power-up configuration to the factory settings and erase any user-defined configuration, press and hold down , while turning the meter on. The meter beeps when the factory settings are restored.

## Calibration

The CAL ENABLE button is located in the lower-right corner of the display. Press and Hold for three seconds to enable calibration. The meter allows for closed case calibration using reference sources. See the *Fluke 45 Dual Display Multimeter Service Manual* (P/N 856042) for calibration procedures.