

# **Agilent 34410A/11A 6 ½ Digit Multimeter**

## **User's Guide**



**Agilent Technologies**

# Notices

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## Software Revision

This guide is valid for the firmware that was installed in the instrument at the time of manufacture. However, upgrading the firmware may add or change product features. For the latest firmware and documentation, go to the product page at:

[www.agilent.com/find/34410A](http://www.agilent.com/find/34410A)

or

[www.agilent.com/find/34411A](http://www.agilent.com/find/34411A)

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## Safety Notices

### CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

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### WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

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## Safety Information

Do not defeat power cord safety ground feature. Plug in to a grounded (earthed) outlet.

Do not use product in any manner not specified by the manufacturer.

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

### Safety Symbols



Earth Ground



Chassis Ground



Risk of electric shock



Refer to manual for additional safety information

**CAT II (300V)** IEC Measurement Category II. Inputs may be connected to mains (up to 300 VAC) under Category II overvoltage conditions.

### WARNING

**Main Power and Test Input Disconnect: Unplug instrument from wall outlet, remove power cord, and remove all probes from all terminals before servicing. Only qualified, service-trained personnel should remove the cover from the instrument.**

### WARNING

**Line and Current Protection Fuses: For continued protection against fire, replace the line fuse and the current-protection fuse only with fuses of the specified type and rating.**

### WARNING

**Front/Rear Switch: Do not change the position of the Front/Rear switch on the front panel while signals are present on either the front or rear set of terminals. The switch is not intended as an active multiplexer. Switching while high voltages or currents are present may cause instrument damage and lead to the risk of electric shock.**

### WARNING

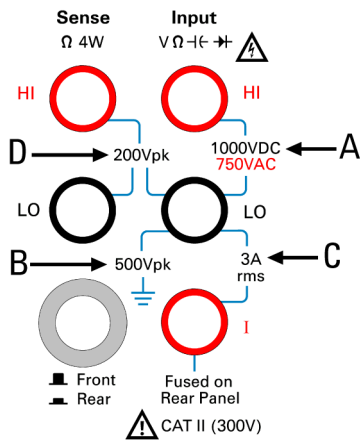
**IEC Measurement Category II. The HI and LO input terminals may be connected to mains in IEC Category II installations for line voltages up to 300 VAC. To avoid the danger of electric shock, do not connect the inputs to mains for line voltages above 300 VAC. See "IEC Measurement Category II Overvoltage Protection" on the following page for further information.**

### WARNING

**Protection Limits: To avoid instrument damage and the risk of electric shock, do not exceed any of the Protection Limits defined in the following section.**

## Protection Limits

The Agilent 34410A/11A Digital Multimeter provides protection circuitry to prevent damage to the instrument and to protect against the danger of electric shock, provided the Protection Limits are not exceeded. To ensure safe operation of the instrument, do not exceed the Protection Limits shown on the front and rear panel, and defined below:



**Note:** The front-panel terminals are shown above. The rear-panel terminals are identical. The Front/Rear switch selects the terminal set to be used. *Do not operate this switch while signals are present on the front or rear terminals.* The current-protection fuse is on the rear panel.

## Input Terminal Protection Limits

Protection Limits are defined for the input terminals:

**Main Input (HI and LO) Terminals.** The HI and LO input terminals are used for voltage, resistance, capacitance, and diode test measurements. Two Protection Limits are defined for these terminals:

**HI to LO Protection Limit.** The Protection Limit from HI to LO ("A" in the figure at left) is 1000 VDC or 750 VAC, which is also the maximum voltage measurement. This limit can also be expressed as 1000 Vpk maximum.

**LO to Ground Protection Limit.** The LO input terminal can safely "float" a maximum of 500 Vpk relative to ground. This is Protection Limit "B" in the figure.

As is implied by the above limits, the Protection Limit for the HI input terminal is a maximum of 1500 Vpk relative to ground.

**Current Input Terminal.** The current input ("I") terminal has a Protection Limit of 3A (rms) maximum current flowing from the LO input terminal. This is Protection Limit "C" in the figure. Note that the current input terminal will be at approximately the same voltage as the LO terminal.

**Note:** The current-protection circuitry includes a fuse on the rear panel. To maintain protection, replace this fuse only with a fuse of the specified type and rating.

## Sense Terminal Protection Limits

The HI and LO sense terminals are used only for four-wire resistance and temperature measurements (" $\Omega$  4W"). The Protection Limit is 200 Vpk for all of the terminal pairings ("D" in the figure):

- LO sense to LO input.
- HI sense to LO input.
- HI sense to LO sense.

**Note:** The 200 Vpk limit on the sense terminals is the Protection Limit. Operational voltages in resistance measurements are much lower — less than 10 V in normal operation.

## IEC Measurement Category II Overvoltage Protection

To protect against the danger of electric shock, the Agilent 34410A/11A Digital Multimeter provides overvoltage protection for line-voltage mains connections meeting **both** of the following conditions:

The HI and LO input terminals are connected to the mains under Measurement Category II conditions, defined below, **and**

The mains are limited to a maximum line voltage of 300 VAC.

IEC Measurement Category II includes electrical devices connected to mains at an outlet on a branch circuit. Such devices include most small appliances, test equipment, and other devices that plug into a branch outlet or socket. The 34410A/11A may be used to make measurements with the HI and LO inputs connected to mains in such devices, or to the branch outlet itself (up to 300 VAC). However, the 34410A/11A may not be used with its HI and LO inputs connected to mains in permanently installed electrical devices such as the main circuit-breaker panel, sub-panel disconnect boxes, or permanently wired motors. Such devices and circuits are subject to overvoltages that may exceed the protection limits of the 34410A/11A.

**Note:** Voltages above 300 VAC may be measured only in circuits that are isolated from mains. However, transient overvoltages are also present on circuits that are isolated from mains. The Agilent 34410A/11A is designed to safely withstand occasional transient overvoltages up to 2500 Vpk. Do not use this equipment to measure circuits where transient overvoltages could exceed this level.

## Additional Notices

### Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This product complies with the WEEE Directive (2002/96/EC) marking requirement. The affixed product label (see below) indicates that you must not discard this electrical/electronic product in domestic household waste.

**Product Category:** With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see [www.agilent.com/environment/product](http://www.agilent.com/environment/product) for more information.



### Agilent 34138A Test Lead Set

The Agilent 34410A/11A is provided with an Agilent 34138A Test Lead Set, described below.

#### Test Lead Ratings

Test Leads - 1000V, 15A

Fine Tip Probe Attachments - 300V, 3A

Mini Grabber Attachment - 300V, 3A

SMT Grabber Attachments - 300V, 3A

#### Operation

The Fine Tip, Mini Grabber, and SMT Grabber attachments plug onto the probe end of the Test Leads.

#### Maintenance

If any portion of the Test Lead Set is worn or damaged, do not use. Replace with a new Agilent 34138A Test Lead Set.

### WARNING

**If the Test Lead Set is used in a manner not specified by Agilent Technologies, the protection provided by the Test Lead Set may be impaired. Also, do not use a damaged or worn Test Lead Set. Instrument damage or personal injury may result.**



**Agilent Technologies**

**DECLARATION OF CONFORMITY**  
According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014



**Manufacturer's Name:** Agilent Technologies, Incorporated  
**Manufacturer's Address:** 815 – 14<sup>th</sup> St. SW  
Loveland, CO 80537  
USA

**Declares under sole responsibility that the product as originally delivered**

**Product Name:** 6 ½ Digit Multimeter  
**Model Number:** 34410A, 34411A  
**Product Options:** This declaration covers all options of the above product(s)

**complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:**

Low Voltage Directive (73/23/EEC, amended by 93/68/EEC)  
EMC Directive (89/336/EEC, amended by 93/68/EEC)

**and conforms with the following product standards:**

EMC	Standard	Limit
	IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998	
	CISPR 11:1990 / EN 55011:1991	Group 1 Class A
	IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995	4 kV CD, 4 kV AD
	IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80-1000 MHz
	IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:1995 / EN 61000-4-5:1995	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1996 / EN 61000-4-6:1996	3 V, 0.15-80 MHz 1 cycle, 100%
	IEC 61000-4-11:1994 / EN 61000-4-11:1994	Interrupts: 10 ms, 20 ms
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	

The product was tested in a typical configuration with Agilent Technologies test systems.

**Safety** IEC 61010-1:2001 / EN 61010-1:2001  
Canada: CSA C22.2 No. 61010-1:2004  
USA: UL 61010-1: 2004

**Supplementary Information:**

**This DoC applies to above-listed products placed on the EU market after:**

20 October 2005  
Date

**Ray Corson**  
Product Regulations Program Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor, or Agilent Technologies Deutschland GmbH, Herrenberger Straße 130, D 71034 Böblingen, Germany.

## Agilent 34410A/11A at a Glance

The Agilent Technologies 34410A and 34411A multimeters provide 6½-digit, high-performance dc and ac measurements.

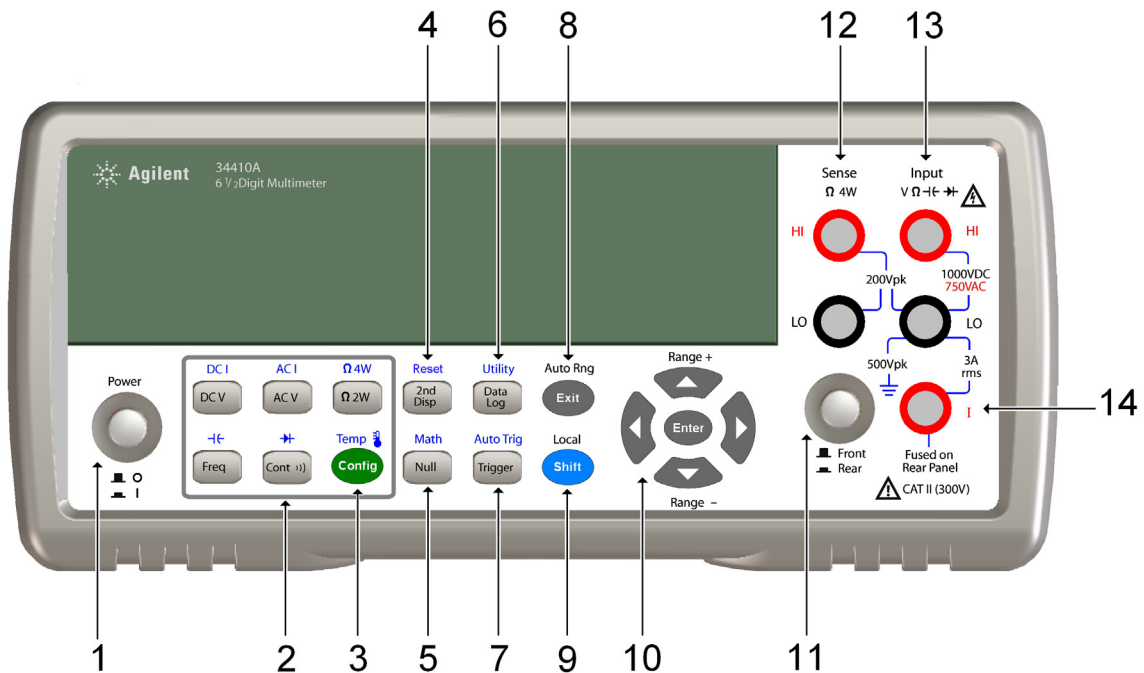
- **Voltage and Current Measurements.** DC and AC<sub>(true-rms)</sub>.
- **Resistance Measurements.** 2-wire and 4-wire.
- **Continuity and Diode Testing.** With audible beep.
- **Frequency and Period Measurements.**
- **Capacitance Measurements.**
- **Temperature Measurements.** Thermistor and RTD.
- **Auto and Manual Ranging.**
- **Convenient Front Panel.** Easy-to-use, menu-driven user interface with dual-display feature.
- **Math Features.** Null, dB, dBm, limits, and statistical functions.
- **Data Logging.** Into *non-volatile* instrument memory.
- **Instrument State Storage.** User-defined named states.
- **GPIB (IEEE-488), USB, and LAN.** All three remote interfaces are standard. *LXI Class C Compliant.*
- **Web Interface.** Direct web browser access to instrument.
- **SCPI Compatibility.** For easy instrument programming.
- **Voltmeter Complete and External Trigger Signals.** Synchronize with other instruments in your test system.
- **Portable, Ruggedized Case.**

*Note: This manual covers the operation of the Agilent 34410A and 34411A 6½ Digit Multimeters. The features described in this manual, except where otherwise noted, apply to both the 34410A and 34411A.*

### Key Differences:

Model 34410A	Model 34411A
• Up to 10,000 readings per second.	• Up to 50,000 readings per second.
• Reading memory (buffer) up to 50,000 readings.	• Reading memory (buffer) up to 1 million readings.
	• Pretriggering, internal level triggering, and digitizer specifications.

## The Front Panel at a Glance



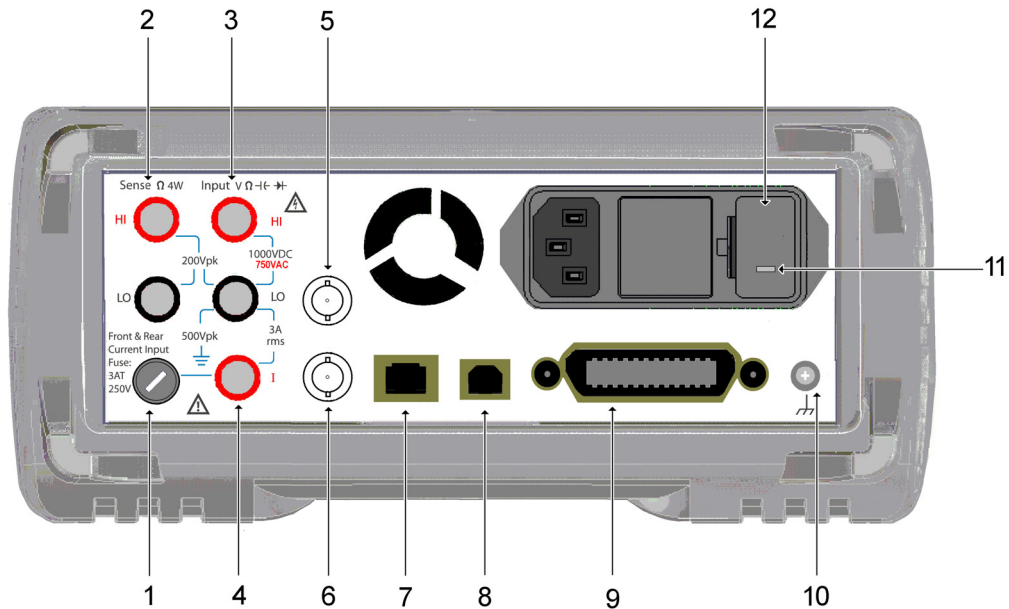
- |                              |   |
|------------------------------|---|
| 1 On/Off Switch              | 8 Exit Key (Auto Range)                                     |
| 2 Measurement Function Keys  | 9 Shift Key (Local)   |
| 3 Configuration Key          | 10 Menu Navigation Keypad (Range)                           |
| 4 Second Display Key (Reset) | 11 Front/Rear Switch  |
| 5 Null Key (Math Functions)  | 12 HI and LO Sense Terminals (4-wire measurements)          |
| 6 Data Logger Key (Utility)  | 13 HI and LO Input Terminals (all functions except current) |
| 7 Trigger Key (Auto Trig)    | 14 Current Input Terminal (ac and dc current)               |

### WARNING

**Front/Rear Switch:** Do not change the position of the Front/Rear switch on the front panel while signals are present on either the front or rear set of terminals. This switch is not intended as an active multiplexer. Switching while high voltages or currents are present may cause instrument damage and lead to the risk of electric shock.



## The Rear Panel at a Glance

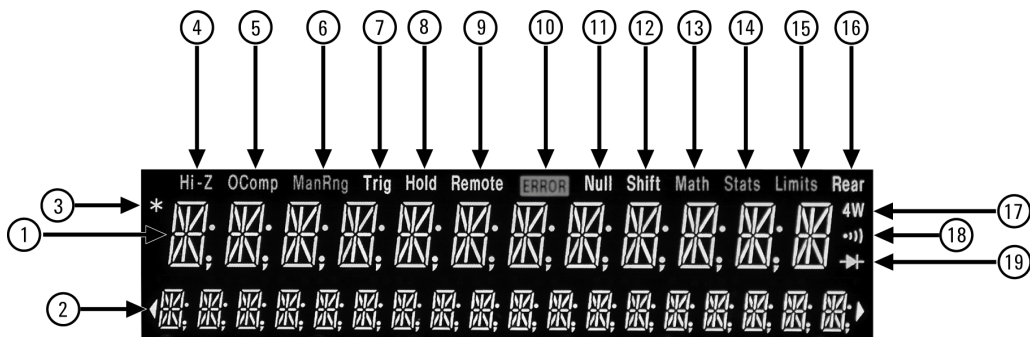


- 1 Current Input Fuse (front and rear)
- 2 HI and LO Sense Terminals (4-wire resistance and temperature)
- 3 HI and LO Input Terminals (voltage, resistance, and other functions)
- 4 Current Input Terminal (ac current and dc current only)
- 5 External Trigger Input (BNC)
- 6 Voltmeter Complete Output (BNC)
- 7 LAN Interface Connector
- 8 USB Interface Connector
- 9 GPIB Interface Connector
- 10 Chassis Ground
- 11 Power-Line Voltage Setting
- 12 Power-Line Fuse-Holder Assembly

### WARNING

**For protection from electrical shock, the power cord ground must not be defeated. For continued protection from fire, replace fuses only with fuses of the specified type and rating.**

## The Display at a Glance



1	Primary display line
2	Secondary display line
3	* annunciator (on during a measurement)
4	<b>Hi-Z</b> (high input impedance) annunciator
5	<b>OComp</b> (offset compensation) annunciator
6	<b>ManRng</b> (manual ranging) annunciator
7	<b>Trig</b> (wait-for-trigger state) annunciator
8	<b>Hold</b> (reading hold) annunciator
9	<b>Remote</b> (remote interface operation) annunciator
10	<b>Error</b> (detected error) annunciator
11	<b>Null</b> (null function enabled) annunciator
12	<b>Shift</b> (shift key just pressed) annunciator
13	<b>Math</b> (dB or dBm function enabled) annunciator
14	<b>Stats</b> (statistics functions enabled) annunciator
15	<b>Limits</b> (limit test function enabled) annunciator
16	<b>Rear</b> annunciator
17	<b>4W</b> (four-wire ohms or temperature) annunciator
18	<b>)))</b> (continuity test function enabled) annunciator
19	<b>▶</b> (diode check function enabled) annunciator

See Chapter 2, “Features and Functions” for further information.

The following key refers to the primary front-panel display.

-H.DDD,DDD EFFF

**Front-panel display format.**

- Negative sign or blank (positive)
- H “ 1/2 ” digit (0 or 1)
- D Numeric digits
- E Exponent ( m, k, M )
- F Measurement units ( VDC, OHM, HZ, dB )

## In This Guide...

### **1 Quick Start**

In this chapter you prepare the multimeter for use and become familiar with the most common front-panel operations.

### **2 Features and Functions**

In this chapter you will find a detailed description of the multimeter's capabilities and operation. This chapter presents both front-panel and remote interface operation of the instrument.

Note. Refer to the *Agilent 34410A/11A Programmer's Reference* help system for a detailed description of the SCPI commands.

### **3 Remote Interface**

This chapter describes how to connect the multimeter using a remote interface.

### **4 Measurement Tutorial**

This chapter discusses measurement techniques and considerations to help you reduce sources of error and obtain the best accuracy from your instrument.

### **5 Specifications**

This chapter lists the 34410A/11A multimeter specifications and describes how to interpret these specifications.



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# 1

## Quick Start

This chapter gives you a quick overview of the 34410A/11A multimeter's front panel and basic features. The examples will help you become familiar with your meter, its measuring functions, and basic operation.

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## Basic Multimeter Operations

This section introduces the basics of the 34410A/11A multimeter, and how to use it.

### Preparing the Multimeter for Use

To verify that your 34410A or 34411A multimeter is ready for use:

#### 1 Check the list of supplied items.

Verify that you have received the following items with your multimeter. If anything is missing, contact your nearest Agilent Sales Office.

- Test Lead Set.
- Power Cord.
- USB 2.0 Cable
- *Agilent 34410A/11A Product Reference* CD-ROM.
- *Agilent Automation Ready* (IO Libraries) CD-ROM.
- *Certificate of Calibration*.

The product documentation, including the *Agilent 34410A/11A Programmer's Reference Help* and the product manuals, are included on the *Product Reference* CD-ROM. Printed (hardcopy) manuals are optional, and included only if you ordered them.

#### 2 Connect the power cord and turn on the multimeter.

The front-panel display will light up while the multimeter performs its power-on self-test. The multimeter powers up in the dc voltage function with autoranging enabled (unless a previous user has configured power-up using a non-default stored state (see "*Multimeter State Storage*" on page 48)).

## Using the Front Panel

This section introduces the 34410A/11A multimeter front panel.

### Front-Panel Keys

The front panel provides keys to select various functions and operations. Pressing a measurement function key (e.g. **DC V**) selects that function. Press **Config** to enter the configuration menu for the selected measurement function.

Most keys have a shifted function printed in blue above the key. To perform a shifted function, press **Shift**, and then press the key that has the desired label above it.



To view and select menu items, use the menu navigation keypad (for example the **Left Arrow** or **Right Arrow** keys). The current (or default) selection is displayed in **FULL BRIGHTNESS**. All other choices are displayed in **HALF BRIGHTNESS**. The selections on each menu level scroll, but do not wrap. Arrow annunciators on the second display line indicate additional selections to the left or right. To accept a selection, press **Enter**.

To set numeric parameters, use **Left Arrow** or **Right Arrow** to select a digit, and **Up Arrow** or **Down Arrow** to increase or decrease that digit.








## Front-Panel Display Shortcuts

Direct front-panel shortcuts are provided for three commonly used display functions: ranging, digit masking, and integration time.







**Ranging** The multimeter's manual range can be set directly from the navigation keypad.

To manually change the current multimeter range, press  or . The **ManRng** annunciator will light, and the selected range (e.g. 100mV RANGE) will be briefly displayed on the second line.

**Digit Masking** The navigation keypad provides a shortcut to mask (change the number of digits displayed) the reading on the main display, easing readability.

To enable digit masking during any measurement function, press   or  . DIGIT MASK will be displayed, along with a list of choices (3.5, 4.5, 5.5, 6.5 and AUTO) on the second display line. Press  or  to scroll through and select one of these settings, and then press .

**Integration Time (Bandwidth, Gate Time)** Four measurement functions allow you to select the multimeter's integration time: dc voltage, dc current, resistance, and temperature. The ac voltage and current measurements allow you to select the ac signal filter (bandwidth). The frequency/period function allows you to select gate time. The navigation keypad provides a shortcut for quickly changing these settings.

- If the multimeter is configured to take the measurement using an integration time in *NPLCs*, pressing  or  during front panel measurement operations will increase or decrease the integration time setting.
- If either the ac voltage or ac current measurement function is selected, pressing  or  during front panel measurement operations will increase or decrease the bandwidth setting.
- If the frequency/period measurement function is selected, pressing  or  during front panel measurement operations will increase or decrease the gate time setting.

## Making Basic Measurements

This section introduces the many types of measurements that you can make with your 34410A/11A multimeter, and how to make connections for each measurement. *Most basic measurements can be taken using the factory default settings.* A more complete description of all multimeter functions, measurement parameter configuration and remote interface operation is provided in Chapter 2.

For each measurement, connect the test leads as shown. The test lead connections are the same for the front or rear set of terminals.

*Before making test lead connections,* use the **Front/Rear** button on the front panel to select either the front or rear set of terminals. The **Rear** annunciator lights if the rear terminals are selected.

### WARNING

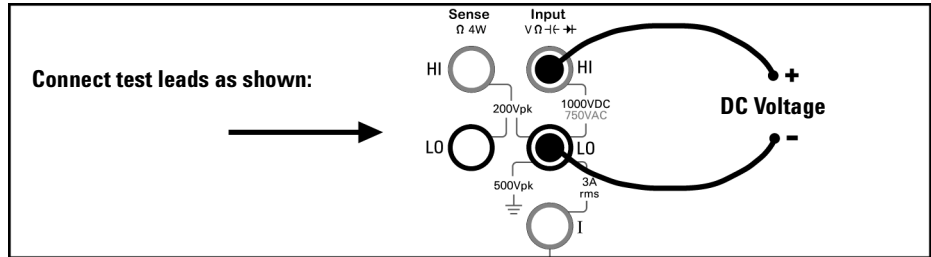
**Do not press the Front/Rear button while signals are present on either the front or rear set of terminals. Switching while high voltages or currents are present can cause instrument damage, and may increase the risk of electric shock.**

---

### To Measure DC Voltage

Press **DCV** to select the dc voltage function.

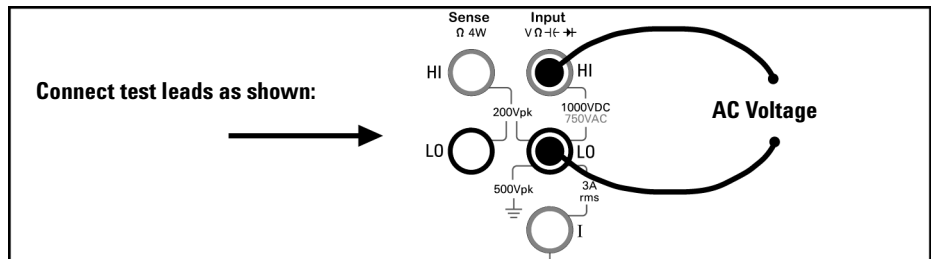
- Ranges: 100 mV, 1 V, 10 V, 100 V, 1000 V
- Configurable parameters: INTEGRATION, RANGE, INPUT Z (input impedance), AUTO ZERO, NULL, and NULL VALUE



### To Measure AC Voltage

Press **ACV** to select the ac voltage function.

- Ranges: 100 mV, 1 V, 10 V, 100 V, 750 V
- AC Technique: true-RMS, ac-coupled
- Configurable parameters: AC FILTER, RANGE, NULL and NULL VALUE

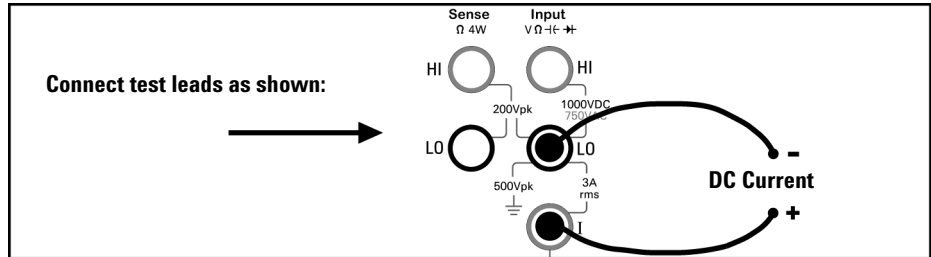




### To Measure DC Current

Press **Shift** **DC V** (**DC I**) to select the dc current function.

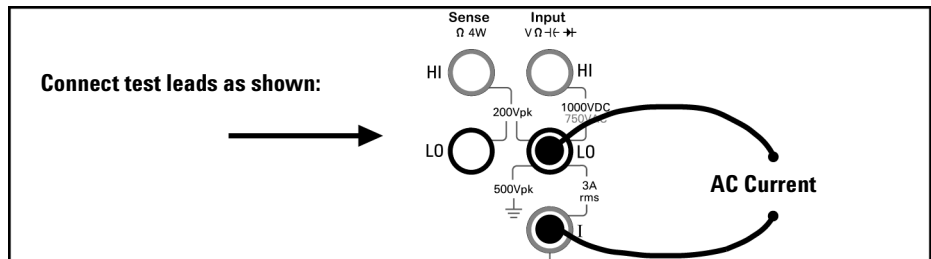
- Ranges: 100  $\mu$ A, 1 mA, 10 mA, 100 mA, 1A, 3A
- Configurable parameters: INTEGRATION, RANGE, AUTO ZERO, NULL, and NULL VALUE



### To Measure AC Current

Press **Shift** **AC V** (**AC I**) to select the ac current function.

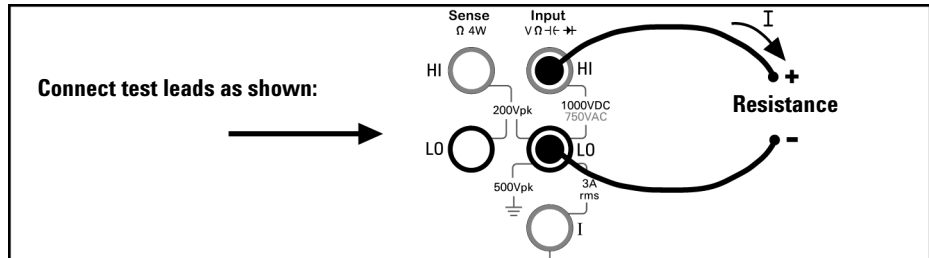
- Ranges: 100  $\mu$ A, 1 mA, 10 mA, 100 mA, 1A, 3A
- AC Technique: true-RMS, ac-coupled
- Configurable parameters: AC FILTER, RANGE, NULL and NULL VALUE



### To Make a 2-Wire Resistance Measurement

Press  $\Omega 2W$  to select the 2-wire resistance function.

- Ranges: 100 $\Omega$ , 1 k $\Omega$ , 10 k $\Omega$ , 100 k $\Omega$ , 1 M $\Omega$ , 10 M $\Omega$ , 100 M $\Omega$ , 1 G $\Omega$
- Configurable parameters: INTEGRATION, RANGE, OFFSET COMP, AUTO ZERO, NULL, and NULL VALUE



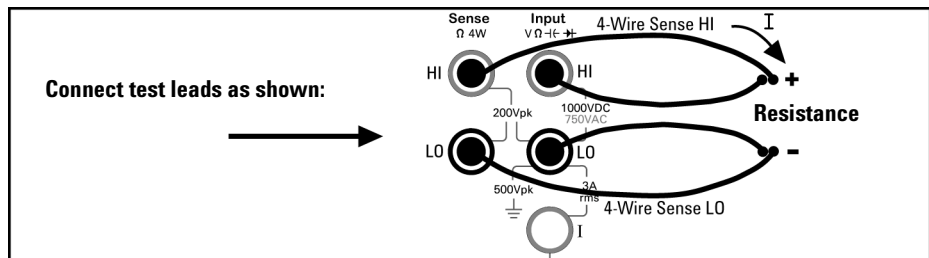
To null-out the test lead resistance:

- 1 Connect one end of the test leads at the meter, and short the probe ends together.
- 2 Press null.
- 3 Connect the probe ends to the test circuit, and measure the corrected resistance value.

### To Make a 4-wire Resistance Measurement

Press  $\text{Shift} \Omega 2W$  ( $\Omega 4W$ ) to select the 4-wire resistance function.

- Ranges: 100 $\Omega$ , 1 k $\Omega$ , 10 k $\Omega$ , 100 k $\Omega$ , 1 M $\Omega$ , 10 M $\Omega$ , 100 M $\Omega$ , 1 G $\Omega$
- Configurable parameters: INTEGRATION, RANGE, OFFSET COMP, NULL, and NULL VALUE

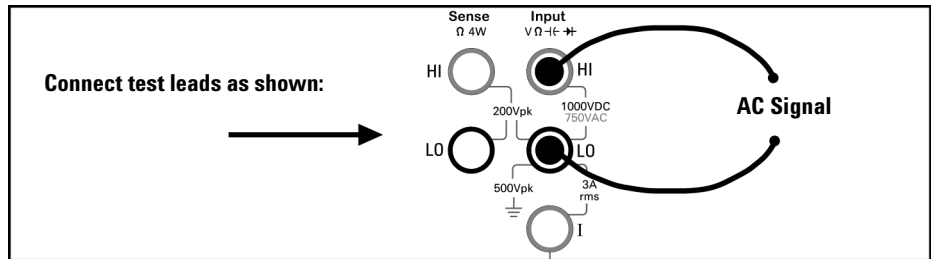


All 4-wire resistance measurements are made with auto-zero on.

## To Measure Frequency

Press **Freq** to select the frequency function.

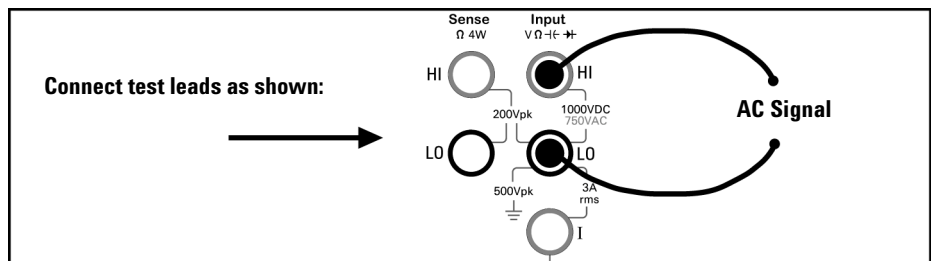
- Measurement band: 3Hz to 300 kHz
- Input signal range: 100 mVAC to 750 VAC
- Technique: reciprocal counting
- Configurable parameters: GATE TIME, RANGE, AC FILTER, NULL and NULL VALUE



## To Measure Period

Press **Freq** to select the frequency function. Then press **Config** and select PERIOD from the menu.

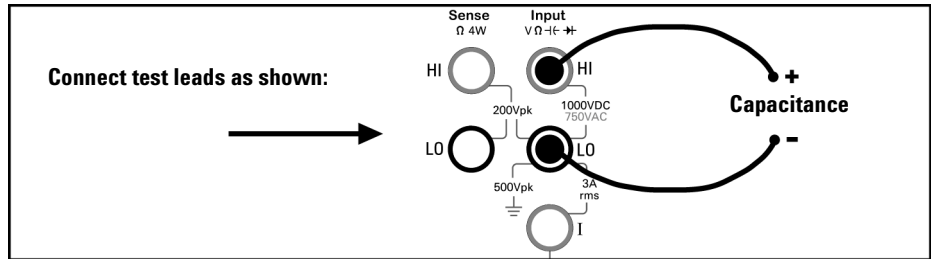
- Measurement band: 0.33 sec to 3.3  $\mu$ sec
- Input signal range: 100 mVAC to 750 VAC
- Technique: reciprocal counting
- Configurable parameters: GATE TIME, RANGE, AC FILTER, NULL and NULL VALUE



### To Measure Capacitance

Press **Shift** **Freq** ( $\text{+}$ ) to select the capacitance function.

- Ranges: 1 nF, 10 nF, 100 nF, 1  $\mu\text{F}$ , 10  $\mu\text{F}$
- Configurable parameters: RANGE, NULL, and NULL VALUE



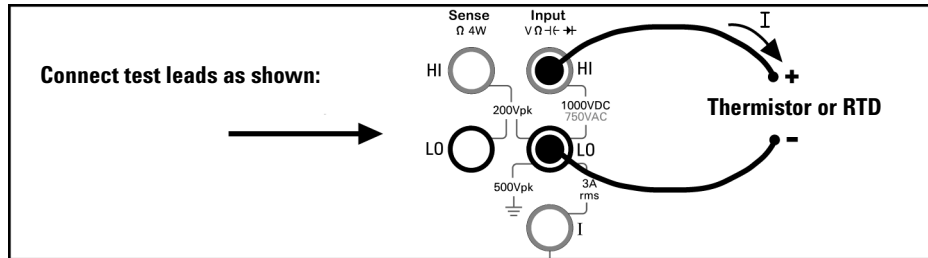
*To null-out the test lead capacitance:*

- 1 Disconnect the + lead's probe end from the test circuit, and leave open.
- 2 Press null.
- 3 Reconnect the + lead's probe end to the test circuit, and measure the corrected capacitance value.

## To Make a 2-Wire Temperature Measurement

Press **Shift** **Config** **(Temp)** to select the temperature function. Then press **Config** and select RTD-2W or THERMISTOR-2W from the menu.

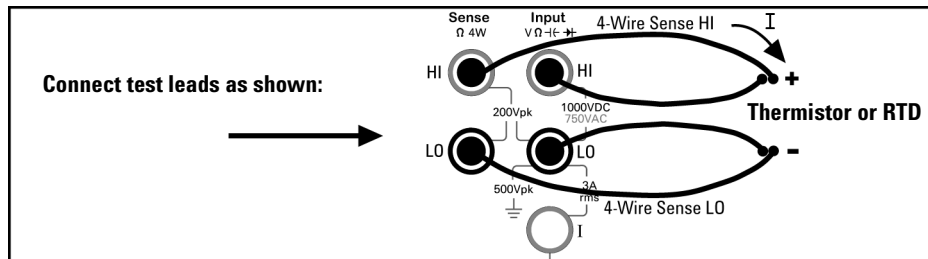
- Probe types: 2.2 k $\Omega$ , 5 k $\Omega$ , 10 k $\Omega$  thermistors; 0.00385%/ $^{\circ}\text{C}$  RTD
- Configurable parameters: PROBE TYPE, THERMISTOR or RTD value, AUTO ZERO, OFFSET COMP (*RTD probes only*), INTEGRATION, UNITS, NULL, and NULL VALUE



## To Make a 4-Wire Temperature Measurement

Press **Shift** **Config** **(Temp)** to select the temperature function. Then press **Config** and select RTD-4W or THERMISTOR-4W from the menu.

- Probe types: 2.2 k $\Omega$ , 5 k $\Omega$ , 10 k $\Omega$  thermistors; 0.00385%/ $^{\circ}\text{C}$  RTD
- Configurable parameters: PROBE TYPE, THERMISTOR or RTD value, OFFSET COMP (*RTD probes only*), INTEGRATION, UNITS, NULL, and NULL VALUE

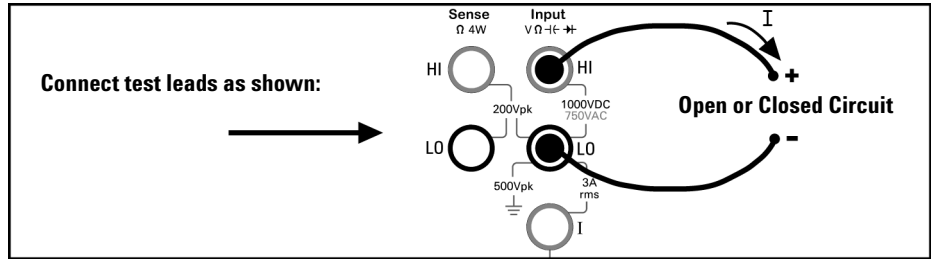


*All 4-wire temperature measurements are made with auto-zero on.*

### To Test Continuity

Press **(Cont )]** to select the continuity function.

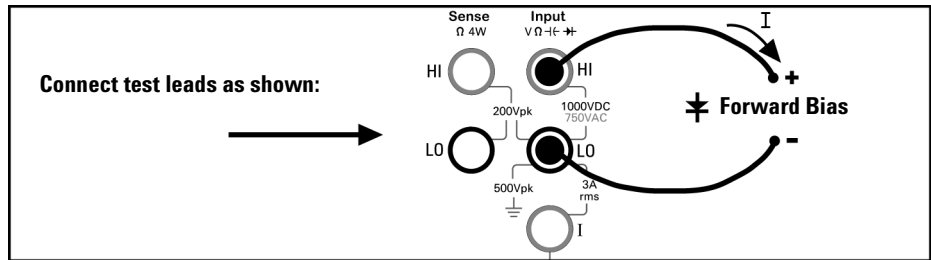
- Test current source: 1 mA
- Beeper Threshold: beeps below  $10\Omega$



### To Check Diodes

Press **(Shift) (Cont )]** ( $\rightarrow$ ) to select the diode test function.

- Test current source: 1 mA
- Beeper Threshold:  $0.3V \leq \text{voltage}_{\text{measured}} \leq 0.8V$  (*not adjustable*)



The diode check function is used to indicate correct diode operation; closed-circuit on forward bias and open-circuit on reverse-bias.

## Other Basics of Operation

This section covers basic troubleshooting and general use.

### If the Multimeter Does Not Turn On

Use the following steps to help solve problems you might encounter when turning on the multimeter. If you need more help, see the *Service Guide* for instructions on returning the multimeter to Agilent for service.

#### 1 Verify that there is ac power to the multimeter.

First, verify that the multimeter's Power switch is in the "On" position. Also, make sure that the power cord is firmly plugged into the power module on the rear panel. You should also make sure that the power source you plugged the multimeter into is energized.

#### 2 Verify the power-line voltage setting.

The line voltage is set to the proper value for your country when the multimeter is shipped from the factory. Change the voltage setting if it is not correct. The settings are: 100, 120, 220, or 240 Vac (for 230 Vac operation, use the 220 Vac setting).

*See "To Replace the Power-Line Fuse" on page 32 if you need to change the line-voltage setting.*

#### 3 Verify that the power-line fuse is good.

The multimeter is shipped from the factory with a power-line fuse installed. The supplied fuse is a **250 mA, 250V, slow-blow, 5x20mm fuse, Agilent part number 2110-0817**. If you determine that the fuse is faulty, replace it with one of the same size and rating.

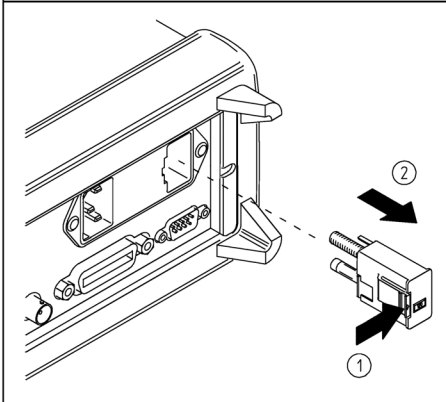
*See "To Replace the Power-Line Fuse" on page 32 if you need to replace the power-line fuse.*

The *current input path* is also fused. The supplied fuse is a **3 AT, 250V, slow-blow, 5x20mm fuse, Agilent part number 2110-0780**, and is housed in a standard screw-in fuse holder on the left side of the rear panel. If you determine that the fuse is faulty, replace it with one of the same size and rating.

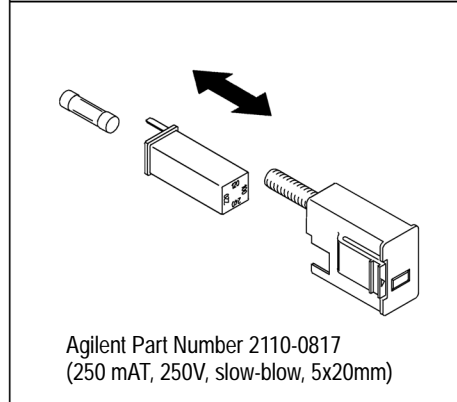
## To Replace the Power-Line Fuse

Remove power cord first. Then follow these steps:

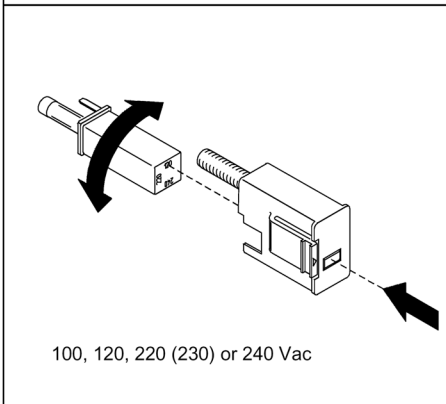
- 1** Depress tab (1) and pull fuse holder (2) from rear panel.



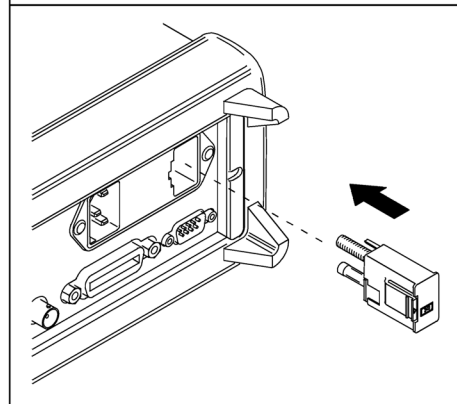
- 2** Remove line-voltage selector from fuse holder assembly.



- 3** Rotate line-voltage selector and reinstall so correct voltage appears in fuse holder window.



- 4** Replace fuse holder assembly in rear panel.



Verify that the correct line voltage is selected and the power-line fuse is good.

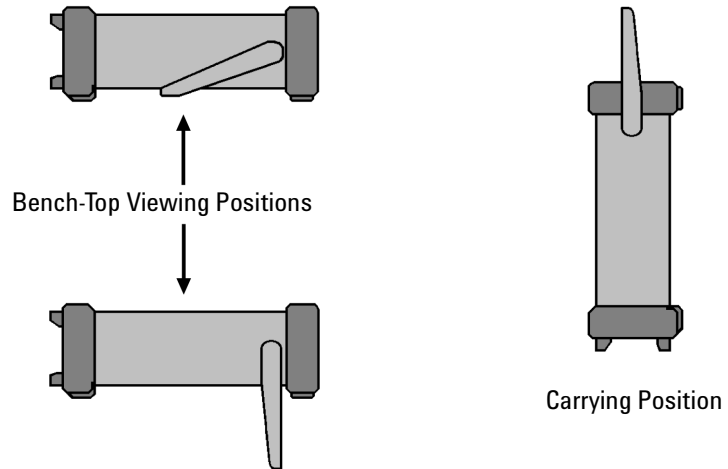
### NOTE

For multimeter operations with a 230 VAC supply, set the line-voltage selector to 220V.



## To Adjust the Carrying Handle

To adjust the position, grasp the handle by the sides and *pull outward*. Then, rotate the handle to the desired position.



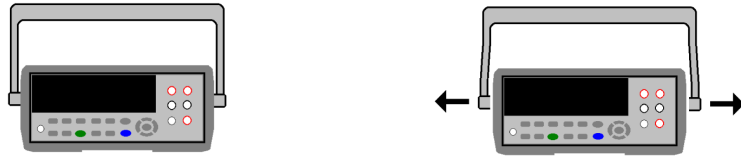
## To Rack Mount the Multimeter

You can mount the multimeter in a standard 19-inch rack cabinet using the available rack-mount kits. Instructions and mounting hardware are included with each rack-mount kit. Any Agilent System II instrument of the same length can be rack mounted side-by-side with the 34410A/34411A.

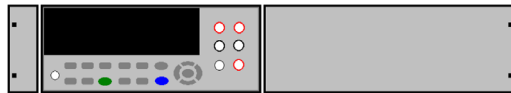
You must remove the carrying handle, and the front and rear rubber bumpers, *before* rack mounting the multimeter.



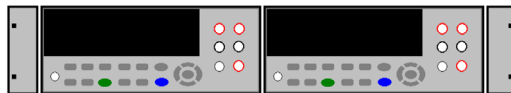
To remove each bumper, stretch a corner and slide it off.



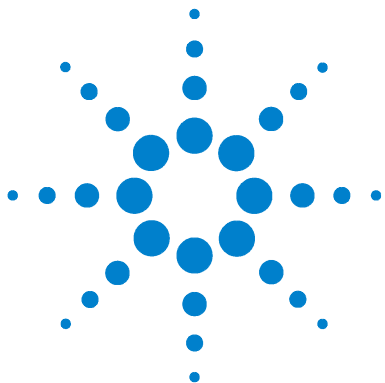
To remove the handle, rotate it to the vertical position and pull the ends outward.



To rack mount a single instrument, order adaptor kit 5063-9240



To rack mount two instruments side by side, order link-lock kit 5061-9694 and flange kit 5063-9212



## 2 Features and Functions

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## SCPI Commands

The Agilent 34410A/11A complies with the syntax rules and conventions of SCPI (*Standard Commands for Programmable Instruments*).

### NOTE

For a *complete* discussion of 34410A/11A SCPI syntax, refer to the *Agilent 34410A/11A Programmer's Reference Help*. This is a standard Windows help system, provided on the *Agilent 34410A/11A Product Reference CD-ROM* that came with your instrument.

### SCPI Language Conventions

Throughout this guide, the following conventions are used for SCPI command syntax for remote interface programming:

- Braces ( { } ) enclose the parameter choices for a given command string. The braces are not sent with the command string.
- A vertical bar ( | ) separates multiple parameter choices for a given command string.
- Triangle brackets ( < > ) indicate that you must specify a value for the enclosed parameter. The brackets are not sent with the command string.
- Some parameters are enclosed in square brackets ( [ ] ). This indicates that the parameter is optional and can be omitted. The brackets are not sent with the command string. If you do not specify a value for an optional parameter, the instrument chooses a default value.

### SCPI Language Version

You can determine the SCPI version with which the multimeter is in compliance by sending a command from the remote interface.

- You can query the SCPI version from the remote interface only.
- **Remote Interface Operation:** The following command queries the multimeter's SCPI language version:  
`SYSTem:VERSion?`
- The SCPI version is returned in the form "YYYY.V", where "YYYY" represents the year of the version, and "V" represents a version number for that year (for example, 1994.0).

# Front Panel Features

## Front Panel Display

The 34410A and 34411A multimeters feature a dual-line, alphanumeric display, *plus* a set of text annunciators to indicate non-default operational states.

















### Displayed Messages

During menu-driven operations (for example, measurement configuration), the primary display line indicates the configuration feature or menu, and the second display line indicates the submenu, configuration choices or parameters. The second display line also displays temporary messages, when exiting menus or to convey meter state changes.

During measurement operations, the primary display line shows the measurement reading and selected measurement function, and the second display line can be enabled to display secondary measurements.

### Self-Guiding Menus

The 34410A and 34411A multimeters provide context-sensitive menus for you to configure measurement functions. The following general guidelines apply to most menu operations.

- Instructions in this guide which use the words “navigation keypad” refer to the , ,  and  keys surrounding the  key.
- Several keys (or shifted key sequences) open a menu. These include:
  - : to configure the currently selected measurement function.
  - : to select a secondary measurement to display on the second display line.
  - : to set up and use the Data Logger function.
  -   ( **Math** ): to turn on and select the Math functions.
  -   ( **Auto Trig** ): to return the multimeter to Auto Trigger mode, enable reading hold or select various triggering options.
  -   ( **Utility** ): to configure utility options or the remote interface.
  -   ( **Reset** ): to reset the multimeter to its reset state (equivalent to the \*RST command in SCPI).

The shifted functions are shown in parentheses, after the key sequence.

- When you press **Shift**, the **Shift** annunciator is lit, indicating that the shifted functions are active.
- If the multimeter is in the remote interface mode (**Remote** annunciator is lit), pressing **Shift** (**Local**) returns the multimeter to Local (front panel) operation.
- Once you have entered a menu, to *view* menu choices (selections) after pressing the key or shifted key sequence, use the **Left Arrow** or **Right Arrow** keys.

The selections on each menu level scroll, but do not wrap. Arrow annunciators on the second display line indicate additional selections to the left or right. These do not light if you are at the end of the selection list, or if all selections are currently visible.

The current (or default) selection is displayed in **FULL BRIGHTNESS**. All other choices are displayed in HALF BRIGHTNESS.

- To *select* a choice, press **Enter**. This action takes you to the next menu level. If you are already at the last selection level in the menu, pressing **Enter** exits the menu.
- To *review* a current menu configuration, pressing **Enter** repeatedly without pressing the navigation keys will take you in order through all current selections in sequence and exit the menu.
- To step through the remaining menu choices after making desired selections, you may hold down **Enter** or the key that you used to enter the menu structure (for example, **Config**).
- To *exit* a menu *before* completing its sequence, press **Exit**. If you have made changes, you are prompted whether to save or discard them.

### Annunciators

There are a number of annunciators in a line at the top of the display. Each annunciator lights to indicate a particular non-default meter state:





- \* (“sample annunciator”)– Turns on during a measurement.
- **Hi-Z** - For DC voltage measurements in the 100 mV, 1V or 10V ranges, an input impedance of >10 G $\Omega$  is configured.
- **OComp** - For resistance measurements in the 100 $\Omega$ , 1 k $\Omega$  and 10 k $\Omega$  ranges, offset compensation is enabled.
- **ManRng** - For the selected measurement function, auto ranging is disabled (a fixed meter range is selected).
- **Trig** - Triggering is enabled. The meter is in the “wait-for-trigger” state.
- **Hold** - The reading hold function is enabled.
- **Remote** - The multimeter is operating in the remote interface mode.
- **Error** - A hardware error or remote interface error has been detected.
- **Null** - For the selected measurement function, the null feature is enabled.
- **Shift** - The Shift key has been pressed.
- **Math** - Either the dB or dBm math feature is enabled.
- **Stats** - The statistics math feature is enabled.
- **Limits** - For an applicable measurement function, the limits math feature is enabled.
- **Rear** - The **Front/Rear** switch is set to **Rear** and the rear set of input terminals is connected internally to make measurements.
- **4W** - A 4-wire resistance or temperature measurement function is selected.
- **))** - The continuity test function is selected.
- **▶|** - The diode test function is selected.



## Second Display Options

Several measurement functions have an auxiliary measurement that can be displayed simultaneously on the second display line,:

Primary Function	Dual Measurement Option
DC V, DC I, AC V, AC I	Peak-to-Peak value
FREQ	AC Voltage *
TEMP	Raw Resistance **
* ac voltage of the input waveform	
** actual raw resistance measured across temperature probe and leads	

- **Front Panel Operation:** To enter the second display menu for the selected measurement function, press . Then press  or  to select the desired second display option, and press . Once the second display is enabled, you can also scroll through the available display options, including STATS or LIMITS if these Math functions are enabled.

- **Remote Interface Operation:** The following command selects the measurement or math function to be displayed on the second display line. The <feed> parameter is a quoted ASCII string designating the function to be displayed, such as VOLTage:PTPeak.

```
DISPlay:WINDow2:TEXT:FEED <feed>
```

The following query returns the currently selected <feed> parameter, as a quoted ASCII string:

```
DISPlay:WINDow2:TEXT:FEED?
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Turning the Display Off

*This feature is available from the remote interface only.*

For security reasons, you may wish to disable the front panel display. When disabled, the entire front panel display (except for the **Error** and **Remote** annunciators) goes dark.

- **Remote Interface Operation:** The following command disables the front panel display:

```
DISPlay OFF
```

The following command queries the front panel display setting:

```
DISPlay?
```





The query returns a "0" (OFF) or "1" (ON).

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.








### Front-Panel Display Shortcuts

Direct front-panel shortcuts are provided for three commonly used display functions: ranging, digit masking and integration time.






**Ranging** The multimeter's manual range can be set directly from the navigation keypad.

- To manually change the current multimeter range, press  or . The **ManRng** annunciator will light, and the selected range (for example, 100mV RANGE) will be briefly displayed on the second line.
- To quickly toggle between the selected manual range and auto ranging, press  (**Auto Rng**). The second line will briefly display the selected range or AUTO RANGE and the **ManRng** annunciator will light or turn off, as appropriate. *Note: This is a dual-function key, not a shifted key. Pressing  when in a menu will exit the menu.*















**Digit Masking** The navigation keypad provides a shortcut to mask (change the number of digits displayed) the reading on the main display, easing readability.

- To enable digit masking during any measurement function, press   or  . DIGIT MASK will be displayed, along with a list of choices (3.5, 4.5, 5.5, 6.5 and AUTO) on the secondary display line. Press  or  to scroll through and select one of these settings, and press .
- Masking digits only affects what is displayed; it does not affect measurement speed or accuracy.

**Integration Time (Bandwidth, Gate Time)** Four measurement functions allow you to select the integration time: dc voltage, dc current, resistance, and temperature. The ac voltage and current measurements allow you to select the ac signal filter (bandwidth). The frequency/period function allows you to select gate time. The navigation keypad provides a shortcut for quickly changing these settings.









- If the multimeter is configured to take the measurement using an integration time in *NPLCs*, pressing  or  during front panel measurement operations will increase or decrease the integration time setting, and briefly display the new setting on the second display line (for example, if the setting was 0.2 NPLC, the display will show 0.06 NPLC when you press ). Repeated use of  or  will scroll through the entire range of integration time settings (0.001\*, 0.002\*, 0.006, 0.02, 0.06, 0.2, 1, 2, 10 and 100 NPLC).

*\*These additional two settings are provided on model 34411A only.*

- If the multimeter is configured to take the measurement using an *aperture* integration time, pressing  or  during front panel measurement operations will display APERTURE on the main display line and the current setting on the second display line (for example, 101.005mSEC). You can then use the navigation keypad to change the aperture setting. Press  to save the setting. If you wish to keep the previous setting, press  and do not save the changes.
- If either the ac voltage or ac current measurement function is selected, pressing  or  during front panel measurement operations will increase or decrease the bandwidth setting, and briefly display the new setting on the second display line (for example, if the setting was 20 HZ : MEDIUM, the display will show 3 HZ : SLOW when you press ). Repeated use of  or  will scroll through the selection of three bandwidth settings (3 HZ : SLOW, 20 HZ : MEDIUM and 200 HZ : FAST).
- If the frequency/period measurement function is selected, pressing  or  during front panel measurement operations will increase or decrease the gate time setting, and briefly display the new setting on the second display line (for example, if the setting was 0.1 GATE TIME, the display will show 0.01 GATE TIME when you press ). Repeated use of  or  will scroll through the selection of gate time settings in seconds (0.001 GATE TIME, 0.01 GATE TIME, 0.1 GATE TIME and 1 GATE TIME).

## Front Panel Alphanumeric Character Entry

When you are in the menus for storing instrument states (see “*Multimeter State Storage*” on page 48), data logging and advanced triggering, you may need to manually enter an alphanumeric character on the second display line.

- **To enter a number or character**, press  or  to select the displayed character (digit or letter) you wish to edit. The selected character will flash to indicate it can be edited. Use the  and  keys to modify a digit (from 0 to 9) or a letter (from A to Z).
- **To quickly enter large numbers**, you may press  to scroll over to the most significant digit allowed and/or add leading zeros, instead of incrementing the less significant digits up from zero. For non-zero floating-point entries, you may also press  to scroll to the magnitude prefix (for example, u, m, k, M), then use the  and  keys to change the numerical entry.

The left and right arrow annunciators on the second display line will indicate if there are editable characters left or right of the one selected.

## Front Panel Measurement Configuration Menus

Each measurement function is configured separately, except for  $\Omega$  **2W** and  $\Omega$  **4W** (which are partially inter-dependent), and for Frequency and Period, (which share a configuration menu). The configuration settings (for example, range, null value, and so forth) for each measurement function are retained when switching between functions.

- **To enter the configuration menu** for any selected measurement function, press **Config**. The menus are context-sensitive; only the options applicable to the selected function will appear. Descriptions of the menu selections are listed in the sections that follow.
- The continuity and diode test features have no parameters to configure.
- When digit masking is enabled (see *“Digit Masking”* on page 42) the DIGIT MASK submenu will appear before other configuration choices.
- *For further information, see “Advanced Configuration Options” on page 48.*

### Configuring DC Voltage and DC Current Measurements

For dc voltage and current measurements, your menu selections are: INTEGRATION, RANGE, AUTO ZERO, NULL and NULL VALUE. For dc voltage measurements, you can also configure INPUT Z.

- **INTEGRATION:** Allows you to set the integration time for the measurement in two ways; in power-line cycles (select NPLC) or in seconds (select APERTURE).
- **RANGE:** Allows you to select a fixed range (select MANUAL), or let the multimeter automatically select the range using the *autoranging* feature (select AUTO).
- **INPUT Z:** Allows you to select an input impedance of 10 M $\Omega$  (select 10 M) or >10 G $\Omega$  (select HI-Z) for the 100 mVdc, 1 Vdc and 10 Vdc ranges only.
- **AUTO ZERO:** Allows you to enable for all readings (select ON), enable for one reading (select ONCE), or disable (select OFF) the auto zero feature, which subtracts a subsequent zero reading from each measurement taken, to prevent offset voltages in the multimeter input circuitry from affecting measurement accuracy.
- **NULL:** Allows you to enable (ON) or disable (OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- **NULL VALUE:** Allows you to view and edit the null value (if enabled).

## Configuring AC Voltage and Current Measurements

For ac voltage and ac current measurements, your menu selections are: AC FILTER, RANGE, NULL and NULL VALUE.

- AC FILTER: Allows you to select one of three choices (SLOW, MEDIUM or FAST). The ac filter allows you to trade off low-frequency bandwidth versus ac settling time.
- RANGE: Allows you to let the multimeter automatically select the range using the *autoranging* feature (select AUTO), or you may select a fixed range (select MANUAL).
- NULL: Allows you to enable (ON) or disable (OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- NULL VALUE: Allows you to view and edit the null value (if enabled).

## Configuring Resistance Measurements

For 2-wire and 4-wire resistance measurements, your menu selections are: INTEGRATION, RANGE, OFFSET COMP, AUTO ZERO, NULL and NULL VALUE.

- INTEGRATION: Allows you to set the integration time for the measurement in two ways; in power-line cycles (NPLC) or in seconds (APERTURE).
- RANGE: Allows you to let the multimeter automatically select the range using the *autoranging* feature (select AUTO), or you may select a fixed range (select MANUAL).
- OFFSET COMP: Allows you to enable (ON) or disable (OFF) the offset compensation feature. With offset compensation enabled, the multimeter makes a normal resistance measurement first, followed by a second measurement to determine any offset voltage in the input circuitry. The resultant displayed measurement corrects for this offset. Enabling offset compensation increases measurement time.
- AUTO ZERO: Allows you to enable for all readings (ON), enable for one reading (ONCE), or disable (OFF) the auto zero feature, which subtracts a subsequent zero reading from each measurement taken, to prevent offset voltages in the multimeter input circuitry from affecting measurement accuracy.
- NULL: Allows you to enable (ON) or disable (OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- NULL VALUE: Allows you to view and edit the null value (if enabled).

### Configuring Frequency and Period Measurements

For frequency and period measurements, your menu selections are: CONFIGURE, GATE TIME, RANGE, AC FILTER, NULL and NULL VALUE.

- CONFIGURE: Allows you to select either FREQUENCY or PERIOD as the primary measurement.
- GATE TIME: Allows you to select one of four choices (0.001, 0.01, 0.1 or 1) for gate time, in seconds.
- RANGE: Allows you to let the multimeter automatically select the range using the *autoranging* feature (select AUTO), or you may select a fixed range (select MANUAL).
- AC FILTER: Allows you to select one of three choices (SLOW, MEDIUM or FAST). The ac filter allows you to trade off low-frequency bandwidth versus ac settling time.
- NULL: Allows you to enable (ON) or disable (OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- NULL VALUE: Allows you to view and edit the null value (if enabled).

### Configuring Temperature Measurements

For temperature measurements, your menu selections are: PROBE TYPE, OFFSET COMP, AUTO ZERO, INTEGRATION, NULL, NULL VALUE, and UNITS.

- PROBE TYPE: Allows you to select from four choices (RTD-4W, RTD-2W, THERMISTOR-2W, or THERMISTOR-4W) of temperature probe type.
- OFFSET COMP (*for RTD probes only*): Allows you to enable (ON) or disable (OFF) the offset compensation feature. With offset compensation enabled, the multimeter makes a normal temperature measurement first, followed by a second measurement to determine any offset voltage in the input circuitry. The resultant displayed measurement corrects for this offset. Enabling offset compensation increases measurement time.
- AUTO ZERO: Allows you to enable (ON) or disable (OFF) the auto zero feature for 2-wire temperature measurements. This feature subtracts a subsequent zero reading from each measurement taken, to prevent offset voltages in the multimeter input circuitry from affecting measurement accuracy.

*Note that 4-wire temperature measurements are automatically made with auto zero always on.*

- **INTEGRATION:** Allows you to set the integration time for the measurement in two ways; in power-line cycles (NPLC) or in seconds (APERTURE).
- **NULL:** Allows you to enable (select ON) or disable (select OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- **NULL VALUE:** Allows you to view and edit the null value.
- **UNITS:** Allows you to select from three choices of temperature degree units, Celsius (select C), Fahrenheit (select F) or Kelvin (select K).

### Configuring Capacitance Measurements

For capacitance measurements, your configuration menu choices are: RANGE, NULL and NULL VALUE.

- **RANGE:** Allows you to let the multimeter automatically select the range using the *autoranging* feature (select AUTO), or you may select a fixed range (select MANUAL).
- **NULL:** Allows you to enable (ON) or disable (OFF) the null measurement feature, which measures the difference between a stored null value and the input signal.
- **NULL VALUE:** Allows you to view and edit the null value (if enabled).

### Front/Rear Input Terminal Switching

Any measurement made using the front panel input terminals may also be made using the input terminals on the rear panel. See *“The Front Panel at a Glance”* on page 8, for the location of the front/rear switch.

#### WARNING

**Do not change the position of the Front/Rear button on the front panel while signals are present on either the front or rear set of terminals. Switching while high voltages or currents are present may cause instrument damage, and increase the risk of electric shock.**

- **Remote Interface Operation:** You may only select the terminals using the front panel switch, but you may remotely query the multimeter to determine which terminals are selected. The query:

```
ROUTE:TERMinals?
```

returns either “FRON” or “REAR”

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for this command.

## Advanced Configuration Options

### Multimeter State Storage

The current multimeter state, including all settings for measurement configuration, math operations, triggering operations, system operations and I/O configuration, can be saved in one of five system memory states, and later recalled. Store State 0 retains the multimeter configuration at power down. Store States 1 through 4 are available for storing other configurations.

- **Front Panel Operation:** To *store* the current multimeter state, press **Shift** **Data Log** (**Utility**). UTILITY MENU is displayed. Press **▶** as needed to select STORE/RECALL, and press **Enter**. Select STORE, and press **Enter**. STORE STATE is displayed. Select 1: STATE\_1, 2: STATE\_2, 3: STATE\_3, or 4: STATE\_4 and press **Enter**. CHANGE NAME is displayed, along with the current state name on the second display line. Use the navigation keypad to enter a name for the selected multimeter state, up to twelve characters, and press **Enter**.

To *recall* any of the five stored multimeter states, enter the STORE/RECALL level of the UTILITY MENU. Press **▶** as needed to select RECALL, and press **Enter**. RECALL STATE will be displayed, along with any stored states, on the second display line. Press **▶** as needed to select a stored state, and press **Enter**. STATE RECALLED will be displayed briefly.

To *name* any manually stored state (1 through 4), enter the STORE/RECALL level of the UTILITY MENU. Press **▶** as needed to select RENAME, and press **Enter**. RENAME STATE will be displayed, along with any stored states, on the second display line. Press **▶** as needed to select a stored state, and press **Enter**. CHANGE NAME will be displayed. Use the navigation keypad to change the name of the selected state, up to 8 alphanumeric characters. CHANGE SAVED will be displayed briefly.

To *delete* any manually stored state (1 through 4), enter the STORE/RECALL level of the UTILITY MENU. Press **▶** as needed to select DELETE, and press **Enter**. DELETE STATE will be displayed, along with any stored states, on the second display line. Press **▶** as needed to select a stored state, and press **Enter**. STATE DELETED will be displayed briefly.



To select any stored state (0 through 4) as the power-on default state, enter the STORE/RECALL level of the UTILITY MENU. Press **▶** as needed to select PWR-ON, and press **Enter**. PWR-ON-AUTO will be displayed. Select ON (OFF is the default), and press **Enter**. PWR-ON STATE will be displayed, along with any stored states, on the second display line. Press **▶** as needed to select a stored state, and press **Enter**. CHANGE SAVED will be briefly displayed on the secondary display line.

- **Remote Interface Operation:** Refer to the MEMORY command subsystem in the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for the commands which store, recall and name multimeter storage states.

## Multimeter Reset

A system reset feature is provided. This function resets all multimeter settings to their factory settings, except if the power-on state has been manually set to a stored state (*see explanation on page 49*). This is faster than cycling power because the power-on self tests are not done.

- Refer to *“Power-On and Reset State” on page 83* for a complete listing of the settings affected by a (front panel or remote interface) reset command.
- **Front Panel Operation:** To reset the multimeter, press **Shift** **2nd Disp** (**Reset**). RESET DMM is displayed, along with the options NO (default) and YES. Select YES to reset the multimeter.
- **Remote Interface Operation:** The following commands reset the multimeter to the instrument reset state:

```
SYSTEM: PRESet
*RST
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## DC Measurements

### Integration Time and Resolution

For dc voltage, dc current, resistance and temperature measurements only, the multimeter allows for two ways to set integration time, both of which affect the measurement resolution. These are in the number of power-line cycles (NPLCs) and aperture (settable in seconds).

**NPLC mode.** Using NPLCs sets the number of power line cycles, during which the multimeter's analog-to-digital (A/D) converter samples the input signal for a measurement. The multimeter automatically detects the AC line frequency, using it and the NPLC selection to set integration time. Selecting a larger NPLC value yields better resolution; a shorter value provides for faster measurements. Choices are [0.001, 0.002 (34411A only), 0.006, 0.02, 0.06, 0.2, 1, 2, 10 or 100 (PLCs)].

To obtain *normal mode* (line-frequency noise) rejection, you *must* select NPLC mode, with an integral number of power line cycles (for example, 1, 10 or 100 NPLC). The following table shows the resulting resolution for each integration time value (in power-line cycles) selected.

Integration Time	Resolution
0.001 PLC*	30 ppm x Range
0.002 PLC*	15 ppm x Range
0.006 PLC	6.0 ppm x Range
0.02 PLC	3.0 ppm x Range
0.06 PLC	1.5 ppm x Range
0.2 PLC	0.7 ppm x Range
1 PLC (default)	0.3 ppm x Range
2 PLC	0.2 ppm x Range
10 PLC	0.1 ppm x Range
100 PLC	0.03 ppm x Range
*These two settings are provided on model 34411A only.	

- **Front Panel Operation:** After selecting an applicable measurement function (DC V, DC I, Ω 2W, Ω 4W or TEMP), press **Config** until INTEGRATION is displayed. press **←** or **→** to select NPLC, then press **Enter** or **Config** to display NPLC on the primary line and a range of choices on the secondary line. Press **←** or **→** to select the desired NPLC value, and press **Enter**. Then step through or exit the configuration menu.

- **Remote Interface Operation:** The following commands set the integration time in NPLC:

```
[SENSE:] VOLTage [:DC] :NPLC {<PLCS>|MIN|MAX|DEF}
[SENSE:] CURRent [:DC] :NPLC {<PLCS>|MIN|MAX|DEF}
[SENSE:] RESistance:NPLC {<PLCS>|MIN|MAX|DEF}
[SENSE:] FRESistance:NPLC {<PLCS>|MIN|MAX|DEF}
[SENSE:] TEMPerature:NPLC {<PLCS>|MIN|MAX|DEF}
```

The following command (similar queries for current, resistance and temperature) queries the integration time setting:

```
[SENSe:] VOLTage [:DC] :NPLC? [{MIN|MAX}]
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

**Aperture mode.** *Aperture* is the period, measured in *seconds*, during which the multimeter's analog-to-digital (A/D) converter samples the input signal for a measurement. A longer aperture yields better resolution; a shorter aperture provides for faster measurements. This mode allows the user to set a specific integration time, not based on power line frequency. Values range from 300  $\mu$ s to 1 second for the 34410A, and from 100  $\mu$ s to 1 second for the 34411A.

- To allow for normal mode (line frequency noise) rejection, select the NPLC option for INTEGRATION, with an integral number of NPLCs. Use the APERTURE method only if you *need* precise control over the multimeter's integration time, in seconds.
- **Front Panel Operation:** After selecting an applicable measurement function (DC V, DC I,  $\Omega$  2W,  $\Omega$  4W or TEMP), press **Config** until INTEGRATION is displayed. Press **Left** or **Right** as needed to select APERTURE, then press **Enter** or **Config** to display APERTURE on the primary line and the current aperture value on the secondary line. Use the navigation keypad to set the desired aperture value, and press **Enter**. Then step through or exit the configuration menu.
- **Remote Interface Operation:** The following commands set the aperture value, in seconds:

```
[SENSe:] VOLTage [:DC] :APERTure {<seconds>|MIN|MAX|DEF}
[SENSe:] CURRent [:DC] :APERTure {<seconds>|MIN|MAX|DEF}
[SENSe:] RESistance:APERTure {<seconds>|MIN|MAX|DEF}
[SENSe:] FRESistance:APERTure {<seconds>|MIN|MAX|DEF}
[SENSe:] TEMPerature:APERTure {<seconds>|MIN|MAX|DEF}
```

The following command (similar queries for current, resistance and temperature) queries the aperture setting:

```
[SENSe:] VOLTage [:DC] :APERture? [{MIN|MAX}]
```

The following command (similar queries for current, resistance and temperature) queries if aperture mode is enabled:

```
[SENSe:] VOLTage [:DC] :APERture:ENABled?
```

This query returns a “0” (disabled) or “1” (enabled)

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

### DC Input Impedance

*This feature applies to dc voltage measurements only.*

The default setting for the multimeter’s input impedance is fixed at 10 M $\Omega$  for all dc voltage ranges, to minimize noise pickup. To reduce the effects of measurement loading errors when making low-voltage measurements, this fixed resistance can be set to HI-Z (>10 G $\Omega$ ) for the 100 mVdc, 1 Vdc and 10 Vdc ranges.

- **Front Panel Operation:** After the **DC V** function is selected, press **Config** repeatedly until INPUT Z is displayed. Press **Left** or **Right** to select 10M or HI-Z, then press **Enter**. Then step through or exit the configuration menu.

Note: when HI-Z is selected, the multimeter will set an input impedance of >10 G $\Omega$  for the three lowest dc voltage ranges. The input impedance remains 10 M $\Omega$  for all measurement ranges above 10 Vdc.

- **Remote Interface Operation:** The following command turns on the auto input impedance function for dc voltage measurements. The auto function (equivalent of setting HI-Z from the front panel) uses 10 M $\Omega$  for the 100V and 1000V ranges, and >10 G $\Omega$  for all other ranges:

```
[SENSe:] VOLTage:DC:IMPedance:AUTO {OFF|0|ON|1}
```

The following command queries the auto impedance function setting:

```
[SENSe:] VOLTage:DC:IMPedance:AUTO?
```

This query returns a “0” (OFF) or “1” (ON).

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

## AC Measurements

### AC Filter

*This feature applies to ac voltage, ac current, frequency and period measurements only.*

The multimeter provides three choices of bandwidth (ac signal filter), enabling you to obtain low-frequency bandwidth or achieve faster ac settling times. Set the bandwidth for the lowest frequency you expect to encounter, noting that a lower bandwidth results in longer settling times. The three filters, and their corresponding settling times, are shown below:

AC Filter Selected	Input Frequency	Settling Time ACV	Settling Time ACI
Slow filter	3 Hz – 300 kHz	2.5 seconds/reading	1.66 seconds/reading
Medium filter (default)	20 Hz – 300 kHz	0.625 seconds/reading	0.25 seconds/reading
Fast filter	200 Hz – 300 kHz	0.025 seconds/reading	0.025 seconds/reading

- **Front Panel Operation:** After selecting either the AC V or AC I function, press **Config** to display AC FILTER. with the current setting on the secondary display line. Press **Left Arrow** or **Right Arrow** to select 3 HZ: SLOW, 20 HZ: MEDIUM, or 200 HZ: FAST, then press **Enter**. Then step through or exit the menu.
- **Remote Interface Operation:** The following commands set the ac filter (3, 20 or 200 Hz) for ac measurements:

```
[SENSe:] VOLTage:AC:BANDwidth {<filter>|MIN|MAX|DEF}
[SENSe:] CURRent:AC:BANDwidth {<filter>|MIN|MAX|DEF}
```

The following commands query the filter setting:

```
[SENSe:] VOLTage:AC:BANDwidth? [{MIN|MAX}]
[SENSe:] CURRent:AC:BANDwidth? [{MIN|MAX}]
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Gate Time

*This feature applies to frequency and period measurements only.*

The multimeter provides four choices of *gate time* (also called aperture) for frequency or period measurements. The gate time selection affects resolution as shown below.

Gate Time	Resolution
1 ms	100 ppm x range
10 ms	10 ppm x range
100 ms	1 ppm x range
1 s	0.1 ppm x range

- **Front Panel Operation:** After selecting the frequency or period function, press **Enter** to display GATE TIME, and select one of the four gate time settings. Then step through or exit the menu.

- **Remote Interface Operation:** The following commands set the gate time (aperture) for frequency or period measurements:

```
[SENSe:] FREQuency:APERTure {<seconds>|MIN|MAX|DEF}
[SENSe:] PERiod:APERTure {<seconds>|MIN|MAX|DEF}
```

The following commands query the gate time setting:

```
[SENSe:] FREQuency:APERTure? [{MIN|MAX}]
[SENSe:] PERiod:APERTure? [{MIN|MAX}]
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Autozero

This feature is selectable for dc voltage, dc current, 2-wire resistance, and 2-wire temperature measurements only. *Autozero is always enabled for 4-wire resistance or 4-wire temperature measurements.*

When autozero is ON (default) the multimeter internally disconnects the input signal immediately following each measurement, and takes a *zero* reading. It then subtracts the zero reading from the preceding measurement. This method prevents small offset voltages present on the multimeter's input circuitry from affecting measurement accuracy.

When autozero is OFF, the multimeter takes one zero reading and subtracts it from all subsequent measurements. A new zero reading is taken each time you change the function, range or resolution (integration time).

When autozero is set to ONCE, the multimeter takes one zero reading, then sets auto zero to OFF. The zero reading taken is used for all subsequent measurements until the next change to the function, range or integration time. If the selected integration time is less than 1 PLC, the zero reading is taken at 1 PLC to ensure normal mode noise rejection in the zero reading; then subsequent readings are taken at the set integration time.

- **Front Panel Operation:** The autozero function is enabled (on) by default at power-on. To turn autozero to OFF or ONCE for a selected function, press **Config** repeatedly until AUTO ZERO is displayed, then make the desired selection, and press **Enter**. Then step through or exit the menu.
- **Remote Interface Operation:** Autozero may be enabled or disabled using this SENSE command:

```
SENSE: <function>:ZERO:AUTO {OFF|ONCE|0|ON|1}
```

Autozero may be also set indirectly using the CONFIGure or MEASURE commands.

The following command queries the autozero feature status for the specified function:

```
SENSE: <function>:ZERO:AUTO?
```

This query command returns “0” (OFF) or “1” (ON).

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Ranging

*This feature is selectable for voltage, current, resistance, capacitance and frequency/period measurements only.*

You can let the multimeter automatically select the range using *autoranging*, or you can select a fixed range using *manual ranging*. Autoranging is convenient because the multimeter automatically selects the appropriate range for sensing and displaying each measurement. However, manual ranging results in better performance, since the multimeter does not have to determine which range to use for each measurement.

- Autorange thresholds – The multimeter will shift range as follows:
  - Down range at <10% of current range
  - Up range at >120% of current range
- Ranging is local to the selected function; the multimeter remembers the selected ranging method (auto or manual) and selected manual range when you switch between measurement functions.
- *For frequency and period measurements*, the selected range is for the *ac voltage* level of the input signal.
- *For temperature measurements*, the multimeter uses auto ranging, depending on the probe type.
- *For continuity tests*, the multimeter range is fixed at 1 k $\Omega$ , and *for diode tests* the range is fixed at 1 Vdc with a 1 mA current source output.
- **Front Panel Operation:** For applicable measurement functions, the ranging method and manual range may be selected by front panel shortcuts (see “*Ranging*” on page 42), or through the configuration menu for the selected function. For the latter method, press **Config** until RANGE is displayed, then select AUTO or MANUAL using the navigation keypad and press **Enter**. If MANUAL has been selected, press **Left Arrow** or **Right Arrow** as needed to select the desired range, and press **Enter**. Then step through or exit the menu.

Manual ranging – If the input signal is greater than can be measured on the selected range, the multimeter provides these overload indications:  $\pm$ OVLD from the front panel or “ $\pm 9.9E+37$ ” from the remote interface.



- **Remote Interface Operation:** *For all measurements except temperature, diode check and continuity:*

Autoranging may be enabled or disabled for the specified <function> using this SENSE command:

```
SENSe:<function>:RANGe:AUTO {OFF|ONCE|0|ON|1};
  where <function> = VOLTage:DC, VOLTage:AC, CURRent:DC,
  CURRent:AC, RESistance, or FRESistance
```

The following command queries the autoranging feature status for the specified <function>:

```
SENSe:<function>:RANGe:AUTO?
```

This query command returns “0” (OFF) or “1” (ON).

The following command manually sets the multimeter range for the specified <function>:

```
SENSe:<function>:RANGe[:UPPER] {<range>|MIN|MAX|DEF}
```

**Note:** for <function> = FREQuency, this command changes the ac input range.

A manual range may also be set using the CONFigure or MEASure commands.

The following command queries the multimeter range setting for the specified <function>:

```
SENSe:<function>:RANGe[:UPPER]? [{MIN|MAX}]
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for all commands on this page.

**A Word About Ranging and Digits.** The 34410A/11A is capable of displaying “6½ digits” for most measurements. The crossover is at a 20 percent overload for the currently selected range. Let’s look at an example for dc voltage with autoranging enabled. As the input voltage increases from just below 1 volt to just above 1.2 volts, you might see the following progression of readings on the front-panel display:

```
0.997,385 VDC
1.000,544 VDC
1.099,004 VDC
1.190,188 VDC
0.120,013 VDC
```

The first four readings are taken on the 1 Vdc range, but the autoranging feature switches to the 10 Vdc range for the final reading, which is a 20 percent overload for the 1 Vdc range. This is a typical 6½ digit behavior.

*For frequency measurements only*, the 34410A/11A is capable of displaying a full seven digits (for example, “999.980,3 HZ”).

## Null Measurements

The multimeter allows separate null settings to be saved for each of the following measurement functions: DC Volts, AC Volts, DC Current, AC Current, Resistance, Frequency/Period, Capacitance and Temperature.

When making null (also called *relative*) measurements, each reading is the difference between a stored (selected or measured) null value and the input signal. One possible application is to increase accuracy of two-wire resistance measurements by nulling the test lead resistance. Nulling the leads is particularly important prior to making capacitance measurements. The formula used for calculating null measurements is:

**Result** = reading – null value

- The null value is adjustable, and you can set it to any value between 0 and  $\pm 120\%$  of the highest range, for the present function. *Note that the null value is entered in fundamental units* (for example, Vdc).
- **Front Panel Operation:** For any measurement function, you can directly measure and store the null value by pressing **Null** with the test leads open (nulls the test lead capacitance), shorted (nulls the test lead resistance) or across a desired null value circuit.
- *Alternately*, you can enable null measurements by pressing **Config** repeatedly until NULL is displayed. Select ON with the navigation keypad, then press **Enter** to display NULL VALUE. Enter the desired null value with the navigation keypad, then press **Enter**. Then step through or exit the configuration menu. The **Null** annunciator will turn on, indicating that the null function is enabled.
- **Remote Interface Operation:** The following command enables the null measurement feature for the specified <function>:  
SENSe:<function>:NULL[:STATe] {ON|OFF}

The following command queries the null measurement feature setting:  
SENSe:<function>:NULL[:STATe] ?

This query returns a “0” (OFF) or “1” (ON).

The following command stores a null value for the specified <function>:

```
SENSe:<function>:NULL[:VALue] {<value>|MIN|MAX}
```

The following command queries the null value stored for the specified function:

```
SENSe:<function>:NULL[:VALue]?
```

This query returns the stored null value.

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

## Miscellaneous Configuration Settings

### Radix Character

*This feature is available from the front panel only.*

The multimeter can display the radix character (decimal point) as a period or a comma.

- The factory (default) setting is PERIOD.
- The radix character setting is stored in non-volatile memory.
- **To change the radix character:** Press **Shift** **Data Log** (Utility) to display UTILITY MENU, and press **▶** as needed until MISC SETTINGS is displayed. Press **Enter** as needed to display RADIX CHAR, press **◀** or **▶** as needed to select PERIOD or COMMA, and press **Enter**. Then step through or exit the menu.

### Thousands Separator

The multimeter can display front panel readings with or without a comma (thousands separator) delimiting the first set of 3 digits left of the radix character.

- The factory (default) setting is ON.
- **Front Panel Operation:** Press **Shift** **Data Log** (Utility) to display UTILITY MENU, and press **▶** as needed until MISC SETTINGS is displayed. Press **Enter** as needed to display THOUSAND SEP, press **◀** or **▶** to select OFF or ON, and press **Enter**.

### Beeper

Normally, the multimeter will emit a tone from the front panel whenever certain conditions are met (for example, the multimeter will beep when a stable reading is captured in reading hold mode). The beeper is factory set to ON, but may be disabled or enabled manually.

- Turning off the beeper does *not* disable the key click generated when you press a front-panel key.
- A beep tone is always emitted (even with the beep state turned OFF) in the following cases.
  - A continuity measurement is less than or equal to the continuity threshold.
  - A SYSTEM:BEEPer command is sent.
- A beep tone is emitted *only* if the beep state is ON in the following cases.
  - An error is generated.
  - A set LO or HI limit is exceeded in a limit test.
  - A stable reading is captured in the reading hold mode.
  - A forward-biased diode is measured in the diode test function.
- **Front Panel Operation:** Press **Shift** **Data Log** (**Utility**) to display UTILITY MENU, and press **▶** as needed until MISC SETTINGS is displayed. Press **Enter** to display BEEPER, select OFF or ON, and then step through or exit the menu.

- **Remote Interface Operation:** The following command disables or enables the front panel beeper:

```
SYSTEM:BEEPer:STATE {OFF|0|ON|1}
```

The following command queries the state of the beeper:

```
SYSTEM:BEEPer:STATE?
```

This query returns a “0” (OFF) or “1” (ON).

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Math Functions

In addition to providing separate null measurement per function capability, the multimeter provides four additional math functions: dB measurements (dB), dBm measurements (dBm), statistics for multiple readings (STATS) and limit testing (LIMITS). Only one of these four functions can be enabled at a time (in addition to null measurement), and remains in effect until you turn it off or change it.

- **Front Panel Operation:** To enable or change an enabled math function, press **Shift** **Null** (**Math**) to display MATH. Press **Left Arrow** or **Right Arrow** as needed to select the desired math function (OFF, dB, dBm, STATS or LIMITS), and press **Enter**. Follow the instructions in the following sections of this guide to set parameters for dB measurements, dBm measurements or limit testing, or to display statistics.

- **Remote Interface Operation:** The following command selects the math function to be used:

```
CALCulate:FUNCTION {NULL|DB|DBM|AVERAge|LIMit}
```

The following command queries the currently selected math function:

```
CALCulate:FUNCTION?
```

This query returns the currently selected function

The following command turns the CALCulate subsystem, and thus all math functions, on or off:

```
CALCulate[:STATe] {OFF|ON}
```

The following command queries the current calculation state:

```
CALCulate:STATe?
```

This query returns a “0” (OFF) or a “1” (ON).

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

## dBm Measurements

*The dBm math function applies to ac and dc voltage measurements only.*

Because of the wide range of values used in RF signal measurements, the logarithmic dBm (decibels relative to one milliwatt) scale is often used. The multimeter's dBm operation takes a measured voltage, and calculates the power delivered to a reference resistance (typically 50, 75 or 600Ω). The formula used for conversion from the voltage reading is:

$$dBm = 10 \times \log_{10}(\text{mW}) = 10 \times \log_{10}(\text{reading}^2 / \text{ref. resistance} / 1 \text{ mW})$$

- You can choose from several reference resistance values: 50, 75, 93, 110, 124, 125, 135, 150, 250, 300, 500, 600, 800, 900, 1000, 1200 or 8000 (Ω). The default setting is 600 Ω.
- **Front Panel Operation:** To enable dBm measurements: Press **Shift** **Null** (**Math**) to display MATH. Press **Left Arrow** or **Right Arrow** as needed to select dBm, and press **Enter**. Press **Left Arrow** or **Right Arrow** as needed to select the desired dBm REF R, and press **Enter**. The **Math** annunciator will turn on, and the primary display line will indicate a voltage reading in dBm.
- **Remote Interface Operation:** The following command sequence will select the dBm function, turn that function on, and set the reference resistance.  
 CALCulate:FUNCTION DBM  
 CALCulate:STATE ON  
 CALCulate:DBM:REFERENCE <value>

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## dB Measurements

*The dB math function applies to ac and dc voltage measurements only.*

The dB operation calculates the difference between the input voltage signal and a stored relative value, with both values converted to dBm. The formula used for calculation from the converted reading is:

$$dB = \text{reading in dBm} - \text{relative value in dBm}$$

- The relative value is adjustable, and you can set it to any value between 0 dBm and ±200.0 dBm. The default relative value is 0 dBm.

There are two ways to specify the relative value. First, you can enter a specific number into the register from the front panel menu or from the remote interface. The new value will replace any previously stored value.

The second way to enter the relative value is to take an initial reading in dBm (or take a reading and convert it to dBm), and store that value in the register. Note that the reading in dBm *and* the relative value in dBm are computed using the dBm reference resistance.

- **Front Panel Operation:** To enable dB measurements: Press **Shift** **Null** (**Math**) to display MATH. Press **1** or **2** as needed to select dB, and press **Enter**. You can select MEASURE or VALUE.

*If you want to set a specific dBm relative value, press **2** as needed to select VALUE, and press **Enter**. Use the navigation keypad to set the desired dB REL VALUE, and press **Enter**. The **Math** annunciator will turn on, and the primary display line will indicate a voltage reading in dB.*

*If you want to set the dBm relative value by measurement, select MEASURE, and press **Enter** to set the value to the measured voltage connected to the input terminals. The **Math** annunciator will turn on, the primary display line will briefly flash VDC or VAC to indicate that the relative value has been measured, and then will indicate a voltage reading in dB.*

If the configured settings will result in a long measurement time or have the multimeter waiting for an external trigger, the Math annunciator will flash until the relative value measurement has been taken. Subsequently, 0.000 VDC (or VAC) will be displayed, until the following measurement is completed.

- **Remote Interface Operation:** The following command sequence will select the dBm function, turn that function on, and store a relative value in the meter's dB Relative Register.

```
CALCulate:FUNCTION DB
CALCulate:STATE ON
CALCulate:DB:REFEReNce <value>
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

### Using Statistics

*The statistics math function applies to all measurement functions except continuity and diode tests.*

The statistics you may view for any set of readings are: average (mean) value (AVG), maximum value (MAX), minimum value (MIN), standard deviation (SDEV) and number of samples taken (COUNT). These are shown on the second line of the display when the statistics math function is enabled, and are updated in real time as subsequent readings are taken.

- **Front Panel Operation:** To enable statistics: Press **Shift** **Null** (**Math**) to display MATH. Press **Left Arrow** or **Right Arrow** as needed to select STATS, and press **Enter**. The **Stats** annunciator will turn on, indicating that statistics are enabled. Press **Left Arrow** or **Right Arrow** as needed to scroll through the options of AVG, MAX, MIN, SDEV and COUNT.

- **Remote Interface Operation:** The following command enables the statistics function:

```
CALCulate:FUNCTION AVERAge
```

The following queries return the mean, minimum value, maximum value, standard deviation, peak-to-peak value, and number of readings, respectively, since statistics were enabled or cleared.

```
CALCulate:AVERAge:AVERAge?
```

```
CALCulate:AVERAge:MINimum?
```

```
CALCulate:AVERAge:MAXimum?
```

```
CALCulate:AVERAge:SDEVIation?
```

```
CALCulate:AVERAge:PTPeak?
```

```
CALCulate:AVERAge:COUNT?
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.



## Limit Testing

*The limit test math function applies to all measurement functions except continuity and diode tests.*

The limit test function (LIMITS) enables you to perform pass/fail testing to upper and lower limits which you specify.

You can set the upper and lower limits to any value between 0 and  $\pm 120\%$  of the highest range, for the present function. The upper limit you select should always be a more positive number than the lower limit. The initial factory settings for both are “0”.

- Front Panel Operation:** To enable limit testing: Press **(Shift)** **(Null)** (**Math**) to display MATH. Press **(Left Arrow)** or **(Right Arrow)** as needed to select LIMITS, and press **(Enter)**. LOW LIMIT will be displayed, and the multimeter’s second display line will show the current or default low limit. Use the navigation keypad to set the desired low limit, and press **(Enter)**. HIGH LIMIT will be displayed, and the multimeter’s second display line will show the current or default high limit. Use the navigation keypad to set the desired high limit, and press **(Enter)**. The second display line will briefly show LIMITS ENABLED, then will display a bar graph that indicates the reading on a scale from LO to HI. The **Limits** annunciator will also turn on, indicating that the limits function has been enabled. If the reading is lower than the set low limit, LO will flash. If the reading exceeds the set high limit, HI will flash. In either case, as a limit is crossed, the multimeter will also beep, if the beeper is enabled.
- Remote Interface Operation:** The following command sequence will select the limit test function, turn that function on, and set the lower and upper limits.

```
CALCulate:FUNCTION LIMit
CALCulate:STATe {OFF|ON}
CALCulate:LIMit:LOWer {<value>|MINimum|MAXimum}
CALCulate:LIMit:UPPer {<value>|MINimum|MAXimum}
```

You can assign a lower limit, an upper limit, or both.

The following commands query the selected lower and upper limits.

```
CALCulate:LIMit:LOWer?
CALCulate:LIMit:UPPer?
```

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

## Triggering the Multimeter

The 34410A/11A triggering system allows you to generate triggers either manually or automatically, take multiple readings per trigger, and insert a delay before each reading. The 34411A also allows you to set a *level* for *internal* triggering, and to set up *pre-triggering*.

*From the front panel*, you can trigger the multimeter using a single manual trigger or auto-triggering.

- Single triggering takes one reading each time you press **Trigger**, or upon receiving an external trigger signal on the **Ext Trig** BNC connector.
- Auto triggering takes continuous readings at the fastest rate possible for the set configuration (that is, the selected measurement function, auto-zero setting, resolution setting, and so forth).

*From the remote interface*, triggering the multimeter is a three-step process:

- 1 First, you must configure the multimeter for the measurement by selecting the function, range, resolution, and so forth
- 2 Second, you must specify the source from which the multimeter will accept a trigger. Choices are – a software (bus) trigger from the remote interface, a hardware trigger from the **Ext Trig** connector, or an immediate internal trigger (default trigger source).
- 3 Third, you must ensure that the multimeter is ready to accept a trigger from the specified source (called the *wait-for-trigger* state).

*From the rear panel*, the **Ext Trig** BNC connector accepts *external* (hardware) triggers.

### Selecting a Trigger Source

You must specify the source from which the multimeter will accept a trigger. The power-on default trigger source is auto-triggering, from the front panel.

- **Front Panel Operation:** Press the **Trigger** key once to go to the single-trigger mode (see “*Single Triggering*” on page 67). A single reading is taken, and another reading is taken each time you press the **Trigger** key, or when a hardware trigger is received on the **Ext Trig** connector (see “*External Triggering*” on page 74) on the rear panel. Press **Shift** **Trigger** (**Auto Trig**) to return to the auto-trigger mode, in which readings are taken continuously (see “*Auto Triggering*” on page 67).

- **Remote Interface Operation:** The following command selects the trigger source from the remote interface for the 34410A:

```
TRIGger:SOURce {BUS|IMMediate|EXTernal}
```

Or, for the 34411A:

```
TRIGger:SOURce {BUS|IMMediate|EXTernal|INTernal}
```

Where INTernal triggering applies only to the 34411A.

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for this command.

## Auto Triggering

*The auto trigger mode is available from the front panel only.*

The power-on trigger default mode for the multimeter is front panel operation, in auto trigger mode.

- Auto triggering takes continuous readings at the fastest rate possible for the measurement configuration (for example, measurement function, auto-zero setting, resolution setting, and so forth).
- To enable auto triggering, press **Shift** **Trigger** ( **Auto Trig** ) to display TRIGGER. Select AUTO, then press **Enter**.

## Single Triggering

*The single trigger mode is available from the front panel only.*

- The multimeter takes one reading, or a number of readings specified by a sample count you enter, each time you press **Trigger**, or upon receiving an external trigger signal on the rear-panel **Ext Trig** connector (see *“External Triggering”* on page 74). See also *“Number of Samples per Trigger”* on page 70.
- When in single trigger mode, the **Trig** annunciator is displayed to indicate that the multimeter is waiting for a trigger.

### Reading Hold

*The reading hold feature is available from the front panel only.*

The reading hold feature allows you to capture and hold a stable reading on the front panel display. This is especially useful in situations when you want to take a reading, remove the test probes, and have the reading remain on the display. When a stable reading is detected, the multimeter emits a beep (if the front-panel beeper is enabled) and holds the reading on the display.

- The sensitivity band for reading hold depends on the measurement function that is selected. The multimeter captures and displays a new value only when reading stability is detected.
- If you change to remote operation with reading hold enabled, hold is disabled.
- Reading hold is disabled if you change measurement functions.
- The currently configured range (auto or manual) is used for reading hold. If you manually select a new range, reading hold is disabled.
- *To enable reading hold*, press **(Shift) Trigger (Auto Trig)** to display TRIGGER. Select HOLD, and press **(Enter)**.
  - The **Hold** annunciator will be lit.
  - Each time a stable reading is detected, the reading is displayed and the beeper sounds (if enabled).

### Immediate Triggering

*The immediate triggering mode is available from the remote interface only.*

In the *immediate* trigger mode, the trigger signal is always present. When you place the multimeter in the wait-for-trigger state, the trigger is issued immediately. This is the default trigger source for remote interface operation.

- **Remote Interface Operation:** The following command selects the immediate trigger source:

```
TRIGger:SOURce IMMEDIATE
```

The CONFIGure and MEASure? commands automatically set the trigger source to IMMEDIATE.

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Software (Bus) Triggering

*The bus trigger mode is available from the remote interface only.*

The bus trigger mode corresponds in function to pressing the **Trigger** key from the front panel, except that it is initiated by sending a bus trigger command, after selecting BUS as the trigger source.

- The following command selects the bus trigger source:

```
TRIGger:SOURce BUS
```

Then, any of the following commands will initiate readings:

```
MEASure?
```

```
READ?
```

```
INITiate
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Internal (Level) Triggering (34411A only)

*The internal triggering mode is available from the remote interface, and for the 34411A only.*

In the *internal* trigger mode, the 34411A will trigger on a positive or negative crossing of a specified level for the input signal.

- **Remote Interface Operation:** The following command selects the internal trigger source:

```
TRIGger:SOURce INTernal
```

The following command sets the trigger level on which to trigger:

```
TRIGger:LEVel <level>
```

The following command sets the trigger slope (positive or negative), determining on which level crossing to trigger:

```
TRIGger:SLOPe { POS|NEG }
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Number of Samples per Trigger

By default, when the multimeter is in the wait-for-trigger state, it takes one reading (or sample) each time you trigger the multimeter. You can, however, instruct the multimeter to take up to 50,000 readings (up to 1 million for model 34411A) each time a trigger is initiated, whether from the front panel or remote interface.

- **Front Panel Operation:** To change the number of samples taken per trigger, press **(Shift) Trigger (Auto Trig)** to display TRIGGER. Press **(▶)** as needed to select SETUP, and press **(Enter)** to display N SAMPLES. Use the navigation keypad to select the desired number of samples per trigger, and press **(Enter)**. Then step through or exit the menu.
- **Remote Interface Operation:** The following command selects the number of samples the multimeter will take per trigger:

```
SAMPlE:COUNT { <count> | MIN | MAX }
```

After setting the sample count, you must place the meter in the wait-for-trigger state before readings are triggered (see “[Software \(Bus\) Triggering](#)” on page 69).

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for this command.

## Number of Pre-Trigger Samples (34411A only)

The 34411A (but not the 34410A) provides *pre-triggering*. This feature allows you to specify a pre-trigger sample count of readings to be retained before the trigger is received. The pre-trigger sample count must be less than the sample count. *Pre-triggering is primarily a remote interface function, and is described more completely in the Agilent 34410A/11A Programmer’s Reference Help.* However, you can set the pre-trigger count from the front panel, and you can use pre-triggering with the Data Logger feature (see “[Data Logging](#)” on page 77).

- **Front Panel Operation:** To set the pre-trigger count, press **(Shift) Trigger (Auto Trig)** to display TRIGGER. Press **(▶)** as needed to select SETUP, and press **(Enter)** to display N SAMPLES. Set N SAMPLES to the desired value with the navigation keys, and press **(Enter)** again. Provided you have set N SAMPLES to a value greater than one, PRE-TRIG CNT will appear. Set the desired pre-trigger count, and press **(Enter)**. Then step through or exit the menu.

- **Remote Interface Operation:** The following command selects the number of samples the multimeter will take per trigger:

```
SAMPlE:COUNT:PRETrigger {<PTcount>|MIN|MAX|DEF}
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for this command.

## Trigger Delay

You can manually specify a delay between the trigger signal and the first sample that follows. This may be useful in applications where you want to allow the input signal to settle before taking a reading, or for pacing a burst of readings.

- The trigger delay may be set from 0 to 3600 seconds.
- If a trigger delay is not manually set, the default trigger delay is automatically set, based on function, range, integration time and/or ac filter setting (see also “Automatic Trigger Delay” on page 72).
- If you manually specify a trigger delay, *that delay* is used for *all* measurement functions.
- **Front Panel Operation:** To manually specify the trigger delay, press **Shift** **Trigger** (**Auto Trig**) to display TRIGGER. Press **▶** twice to select SETUP, and press **Enter** as needed to display TRIG DELAY. Press **▶** as needed to select MANUAL, and press **Enter**. Use the navigation keypad to set the desired trigger delay, and press **Enter**. Then step through or exit the menu.

To specify a trigger delay of *zero*, press **Shift** **Trigger** (**Auto Trig**) to display TRIGGER. Select SETUP, and press **Enter** as needed to display TRIG DELAY. Press **◀** or **▶** as needed to select ZERO, and press **Enter**. Then step through or exit the menu.

- **Remote Interface Operation:** The following command specifies the trigger delay, in seconds:

```
TRIGger:DElay {<seconds>|MIN|MAX}
```

If the multimeter is configured to take more than one sample per trigger, the trigger delay you specify is inserted between the trigger and *each* reading (if the sample source is set to AUTO), or only before the first reading (if the sample source is set to TIMer). See the SAMPlE:SOURce command description for more information.

After setting the trigger delay, you must use the INITiate or READ command to place the meter in the wait-for-trigger state before readings are triggered (see “Software (Bus) Triggering” on page 69). The MEASure? command sets the trigger delay to AUTO.

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these command.

### Automatic Trigger Delay

If you do not specify a trigger delay, the multimeter selects the trigger delay time automatically. Automatic trigger delays are set to ensure that completely settled and accurate measurements are taken. The delay is determined by function, range, integration time and ac filter setting. For measurements from the remote interface, the automatic trigger delay values are as listed in the following tables. *From the front panel, the automatic trigger delay is 50 ms for all measurements.*

#### DC Voltage Measurements (all ranges):

Integration Time	Trigger Delay
≥ 1 PLC	160 μs
0.06 PLC or 0.2 PLC	130 μs
≤ 0.02 PLC	100 μs

#### DC Current Measurements (all ranges):

Integration Time	Trigger Delay
≥ 1 PLC	1.5 ms
0.06 PLC or 0.2 PLC	1.0 ms
≤ 0.2 PLC	1.0 ms

#### 2-wire Resistance Measurements:

Range	Trigger Delay (for ≤ 0.02 PLC)	Trigger Delay (for 0.06 or 0.2 PLC)	Trigger Delay (for ≥ 1 PLC)
100 Ω	80 μs	100 μs	130 μs
1 kΩ	110 μs	130 μs	160 μs
10 kΩ	130 μs	160 μs	190 μs
100 kΩ	540 μs	670 μs	800 μs
1 MΩ	5.0 ms	6.0 ms	7.5 ms
10 MΩ – 1GΩ	60 ms	70 ms	84 ms



**4-wire Resistance Measurements**

Range	Trigger Delay (for $\leq 0.02$ PLC)	Trigger Delay (for 0.06 or 0.2 PLC)	Trigger Delay (for $\geq 1$ PLC)
100 $\Omega$ – 100 k $\Omega$	1.0 ms	1.0 ms	1.5 ms
1 M $\Omega$	10 ms	10 ms	15 ms
10 M $\Omega$ – 1 G $\Omega$	100 ms	100 ms	100 ms

**Capacitance**

Trigger Delay
0 s

**AC Voltage Measurements (all ranges):**

AC Filter	Trigger Delay
Slow (3 Hz)	2.5 s
Medium (20 Hz)	625 ms
Fast (200 Hz)	25 ms

**AC Current Measurements (all ranges):**

AC Filter	Trigger Delay
Slow (3 Hz)	1.66 s
Medium (20 Hz)	250 ms
Fast (200 Hz)	25 ms

**Frequency and Period**

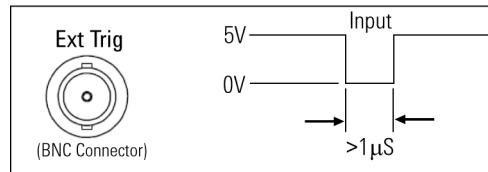
Trigger Delay
1 s

Temperature measurements actually use the 2-wire or 4-wire resistance functions. The above tables for resistance apply to temperature measurements, but all temperature measurements use autoranging. The range in use cannot be predicted, nor can the delay. Use the TRIGger:DElay? command to show the actual trigger delay.

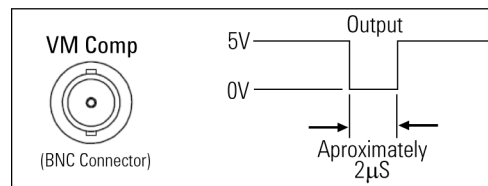
Capacitance measurements have an automatic trigger delay of zero, because discharging the capacitor is part of the measurement time.

## External Triggering

External triggering takes one reading (or the specified number of readings) each time the multimeter receives a pulse on the rear-panel (coaxial) **Ext Trig** terminal. You may select whether the multimeter uses the rising edge (POS) or falling edge (NEG) of the applied external trigger signal to trigger a reading (see “*Trigger Slope*” on page 75). The diagram below shows the **Ext Trig** terminal and NEG timing:



- The multimeter buffers one external trigger. If the multimeter is currently taking a reading while another trigger occurs, that second trigger is accepted. After the reading in progress is completed, the stored trigger is issued.
- The **Trig** annunciator turns on when the multimeter is waiting for an external trigger.
- The rear panel **VM Comp** (voltmeter complete) terminal provides a pulse after completion of each measurement. Voltmeter complete and external trigger implement a standard hardware handshake sequence between measurement and switching devices. The diagram below shows the **VM Comp** terminal and NEG timing:



- **Front Panel Operation:** The external trigger mode corresponds in function to pressing the **Trigger** key from the front panel, except that you apply the trigger signal to the **Ext Trig** terminal.
- **Remote Interface Operation:** The following command selects the trigger source from the external terminal:  
`TRIGger:SOURce EXTernal`

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for this command.

## Trigger Slope

You may select whether the multimeter uses the rising edge (POS) or falling edge (NEG) of the applied external trigger signal to trigger a reading, or (independently) for the resultant voltmeter complete signal. The default for both is NEG.

- **Front Panel Operation:** To select the *trigger slope* for external triggering, press **Shift** **Trigger** (**Auto Trig**) to display TRIGGER. Press **Left** or **Right** as needed to display SETUP, and press **Enter**. Press **Left** or **Right** as needed to select EXT:TRG SLOPE, and press **Enter**. Press **Left** or **Right** as needed to select NEG or POS, and press **Enter**. VM:COMP SLOPE will be displayed.

Then, to select the slope for the *voltmeter complete* signal, press **Left** or **Right** as needed to select NEG or POS, and press **Enter**. Then step through or exit the configuration menu.

- **Remote Interface Operation:** The following command selects the trigger slope for the external terminal:

```
TRIGger:SLOPe {POSitive|NEGative}
```

The following query returns the selected trigger slope for the external terminal:

```
TRIGger:SLOPe?
```

This query returns POS or NEG.

The following command selects the signal slope for the voltmeter complete signal:

```
OUTPut:TRIGger:SLOPe {POSitive|NEGative}
```

The following query returns the selected trigger slope for the external terminal:

```
OUTPut:TRIGger:SLOPe?
```

This query returns POS or NEG.

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for this command.

## Reading Memory

*This feature is available from the remote interface only.*

The multimeter's reading memory is a first-in, first out (FIFO) buffer holding up to 50,000 readings (model 34410A) or 1 million readings (model 34411A). The oldest readings are preserved.

- **Remote Interface Operation:** The following command transfers readings stored in non-volatile memory into the multimeter's output buffer, from where you can read them into your computer:

```
FETCh?
```

The following command will obtain whatever readings are present in NVMEM, and erase them as they are read:










```
R?
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

## Data Logging

The Data Logger feature provides a front-panel user interface that allows you to set up data logging into the instrument's non-volatile memory without programming, and without a connection to a computer. Once you have finished collecting data, you can view it from the front panel, or you can then connect your computer and import the data. The 34410A/11A Web Interface provides a very convenient way of importing the data into your spreadsheet or other application.

The 34410A/11A allows you to set the following data logging parameters: START DELAY, INTERVAL, EVENTS/TIME (COUNT or DURATION).

- START DELAY is the delay time, settable from 0 to 3600 seconds, from initiating a trigger before the data logging function takes its first reading.
- INTERVAL is the time, settable from 0 to 3600 seconds, between subsequent readings.
- EVENTS/TIME is the total duration of the data logging session. You can set a COUNT of total readings, with N SAMPLES settable from 1 to 50,000 readings (for either the 34410A or 34411A). Or, you can set a DURATION in hours, minutes and seconds. The maximum duration that you can set is limited to that which results in 50,000 readings, but in no event more than HH:MM:SS = 99:59:59 (just under 100 hours).
- **Front Panel Operation:** To set up a data logging session, press  to display DATA LOGGER. Select SETUP and press  to display START DELAY. Use the navigation keypad to set the desired start delay, and press  to display INTERVAL. Use the navigation keypad to set the desired reading interval, and press  to display EVENTS/TIME. Select COUNT or DURATION, and press .
  - If COUNT was selected, use the navigation keypad to set the desired total number of readings, and press . If DURATION was selected, use the navigation keypad to set the desired total session time, and press .
  - Upon pressing , the message TO START - PRESS TRIGGER KEY appears. The data logger is now ready to go. Just press  to begin logging. (A trigger pulse on the **Ext Trig** connector will also initiate the session.) After the specified delay, the main display will show the data as it is collected, while the second display line shows a progress bar and the current count.

- The multimeter will continue taking readings until the specified total readings count has been reached, unless the data logger is stopped manually. After the programmed count has been reached, the display will show SAVING READINGS, then LOGGING COMPLETE. The readings are stored in non-volatile memory.

To stop a data logging session in progress, press any key. The display will show DATA LOGGER? and offer the selections CONTINUE or STOP. *The data logger continues to take readings while this is displayed.*

- If you select STOP and press **Enter**, the display will read DATA TO NV?, prompting you to SAVE or DISCARD the readings already logged. Select one of these options and press **Enter** to terminate data logging.
- If you select CONTINUE and press **Enter**, the data logging function will continue as set up, until complete.

To read the data logged from the front panel, press **Data Log** to display DATA LOGGER. Press **▶** to select VIEW-RDGS, and press **Enter**. Press **▶** or **◀** to scroll through the stored readings.

### NOTE

The 34411A (but not the 34410A) provides *pre-triggering*. The data logger function can be used in conjunction with pre-triggering to collect data both before and after the triggering event. See “[Number of Pre-Trigger Samples \(34411A only\)](#)” on page 70 for information about setting a pre-trigger sample count.

- **Remote Interface Operation:** The following command returns all readings stored in non-volatile memory (NVMEM):

```
DATA:DATA? NVMEM
```

The following command deletes all readings stored in NVMEM.

```
DATA:DELEte NVMEM
```

The following command returns the number of data points stored in NVMEM

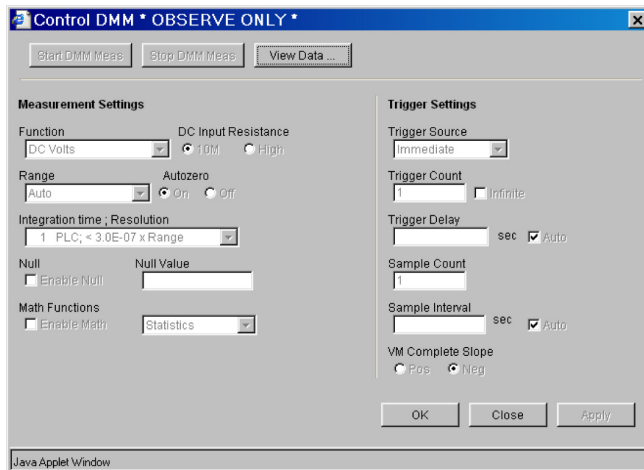
```
DATA:POINts? NVMEM
```

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.

- Web Interface Operation:** To access the data in the multimeter's non-volatile memory, launch the 34410A/11A web server as described in “34410A/34411A Web Browser Interface” on page 93. The Welcome Screen appears:

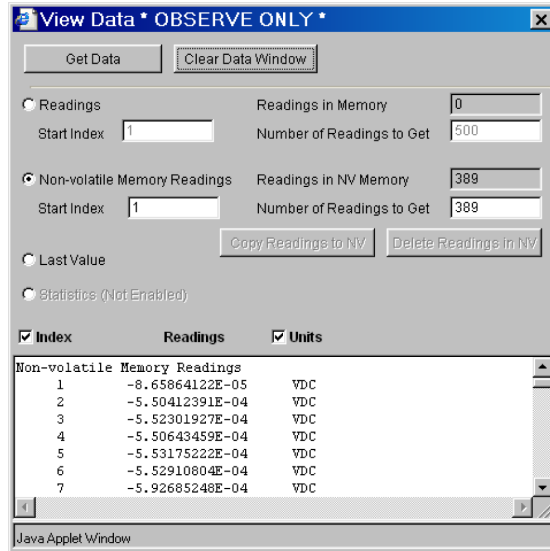


Click on “Browser Web Control” to display the Control DMM dialog box:



## 2 Features and Functions

Now click on “View Data”. In the dialog, select Non-volatile Memory Readings and then click on Get Data to view the logged data:



From this window, you can select (click) and copy the data into another application such as a spreadsheet using the Windows® clipboard.



## System-Related Operations

The utility menu accesses the following system-related operations: self-test, display of error conditions, calibration, and instrument information. These features are described in the subsections that follow.

The utility menu is *also* used to access the following three menus:





- REMOTE I/O menu (see “*Remote Interface Configuration Methods*” on page 86 for a complete description of the remote interface features).
- STORE/RECALL menu (see “*Multimeter State Storage*” on page 48 for a complete description of the state storage feature).
- MISC SETTINGS menu (see “*Miscellaneous Configuration Settings*” on page 59 for a complete description of these features).

### Self-Test

A *power-on self-test* occurs automatically when you turn on the instrument. This limited test assures you that the multimeter is operational. This self-test does not perform the extensive self test described below.

A *complete* self-test performs a series of internal tests, and takes approximately 5 seconds to execute.

If the power-on or complete self-test fails, an error is stored in the error queue. See the *Agilent 34410A/34411A Service Guide* for more information on returning the instrument to Agilent for service.

- Following the complete self-test, the instrument issues a Factory Reset (\*RST) command.
- **Front Panel Operation:** Press   (Utility) to display UTILITY MENU. Press  as needed until SELF TEST is displayed, and press  to initiate the self-test procedure. If the test fails, the **Error** annunciator will light.
- **Remote Interface Operation:** The following command returns “+0” if the self-test is successful or “+1” if it fails.  
\*TST?

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for this command.

### Error Conditions

When the front panel ERROR annunciator turns on, one or more command syntax or hardware errors have been detected. A record of up to 20 errors can be stored in the instrument's *error queue*.

- The instrument beeps once each time a command syntax or hardware error is generated.
- Each remote interface I/O session (for example, GPIB, USB, LAN) has its own interface-specific error queue.
- A special *global* error queue holds all power-on and hardware-related errors (for example, over-temperature).
- Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. Errors are cleared as you read them. Once you have read all of the interface-specific errors, the errors in the global queue are retrieved.
- Errors are cleared as you read them. When you have read all errors from the interface-specific and global error queues, the ERROR annunciator turns off and the errors are cleared.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350, "Error queue overflow".  
No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0, "No error".
- The front panel reports errors from all I/O sessions as well as the global error queue.
- Both the interface-specific and global error queues are cleared by the \*CLS (Clear Status) command and when power is cycled. The errors are also cleared when you read the error queue. The error queue is not cleared by a Factory Reset (\*RST) command or an Instrument Preset (SYSTEM:PRESet) command.

### Calibration

#### NOTE

Only service-qualified personnel should calibrate the multimeter. Improper use of the front-panel CALIBRATION procedure in the UTILITY menu could result in damage to the multimeter.

Refer to the *Agilent 34410A/34411A Service Guide* for calibration procedures.

## Power-On and Reset State

The tables that follow show the factory defaults for various instrument settings. The parameters marked with a bullet (●) are stored in *non-volatile* memory, and are not affected by power-on or a system reset. For those parameters, the *initial factory settings* are shown. All other parameters are stored in volatile memory, and are reset to the indicated values at power-on, after a front-panel Reset command, or after a \*RST or SYSTem:PRESet remote interface command.

Measurement Configuration	Factory Setting
Function	DC Volts
Range	Autorange (for all functions)
Resolution	6.5 digits (0.3 ppm x Range) *
Integration Time	NPLC On, 1 PLC *
Autozero	On *
Aperture	Off, 1 second *
● Input Impedance	● 10 M $\Omega$ (fixed for all dc V ranges)
AC Input Filter (bandwidth)	20 Hz (medium filter)
Nulls (for individual measurement functions)	Off, 0 (for all functions)
Second Display	Off
*for all dc measurements	

Math Operations	Factory Setting
Math State	Off
Math Registers	Cleared (all registers)
dB Relative Value	0
dBm Reference Resistance	600 $\Omega$

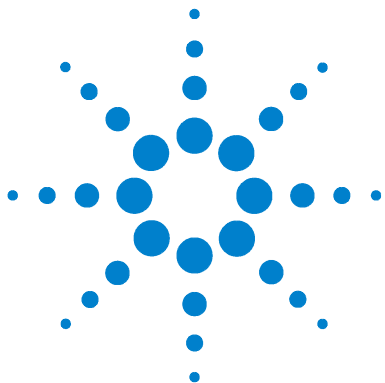
Triggering Operations	Factory Setting
Trigger Count	1
Trigger Source	Immediate
Trigger Delay	Auto Delay
Sample Count	1
Sample Source	Auto
Sample Timer	1 second

System-Related Operations	Factory Setting
● Beeper Mode	● On
● Radix Character	● Period
● Thousands Separator	● On
Display State	On
Reading Memory	Cleared
Error Queue	Cleared at Power-On. Not cleared by a front panel or remote interface Reset command
● Stored States	● No change
● Calibration State	● Secured

Input/Output Configuration	Factory Setting
<b>Enable Interfaces:*</b>	
● LAN	● Enabled
● GPIB	● Enabled
● USB	● Enabled
<b>Lan Settings:</b>	
● DHCP	● On
● Auto IP	● On
● IP Address	● 169.254.4.10
● Subnet Mask	● 255.255.0.0
● Default Gateway	● 0.0.0.0
● DNS Server	● 0.0.0.0
● Host Name	● A-34410A-nnnnn (for 34410A)** ● A-34411A-nnnnn (for 34411A)
● LAN Services	● Enable All
<b>GPIB Settings:*</b>	
● GPIB Address	● 22
* Interface enable changes take effect only after a reboot (cycle the power). ** Where nnnnn is the last 5 digits of the serial number.	

**NOTE**

The power-on/reset state may be different than that in the above tables if you have enabled the power-on state recall mode (PWR-ON AUTO set to On from the **Utility** menu). Also, you can recall one of four stored instrument states other than the power-on state. See “*Multimeter State Storage*” on page 48 for further information.



## 3 Remote Interface Configuration

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## Remote Interface Configuration Methods

This section gives information on configuring the instrument for remote interface communication. Complete information on configuration, and on using SCPI commands to program the instrument over the remote interface, can be found in the following resources:

- The *Agilent Connectivity Guide*, at [www.agilent.com/find/connectivity](http://www.agilent.com/find/connectivity).
- The *Programmer's Reference Help* file included on the *Agilent 34410A/34411A Product Reference CD-ROM*.

The Agilent 34410A/34411A multimeters support GPIB, USB, and LAN interfaces. All three interfaces are enabled at power on. The front panel **Remote** annunciator turns on whenever there is activity on the remote interface.

- **GPIB Interface** You need only set the GPIB address for the instrument (the factory default is 22) and connect it to your PC using a GPIB cable (sold separately).
- **USB Interface** There is nothing to configure on your instrument for a USB connection. Just connect the instrument to your PC using the USB 2.0 cable included with the instrument.
- **LAN Interface** By default, DHCP is enabled on the instrument, which may enable network communication over the LAN interface (10BaseT/100BaseTx). You may need to set several configuration parameters as described in the LAN configuration sections that follow.

### NOTE

To easily configure and verify an interface connection between the 34410A/34411A and your PC, you can use the *Agilent IO Libraries Suite* (E2094M Agilent IO Libraries for Windows) or an equivalent. For more information about Agilent's I/O connectivity software, go to [www.agilent.com/find/iolib](http://www.agilent.com/find/iolib).

- Agilent IO Libraries Suite for Windows® 98/2000/ME/XP. For more information and to install this software, see the Automation-Ready CD, which is shipped with your 34410A/34411A.
- To download the latest (and previous) version(s) of this software for Windows® 98/NT/2000/ME/XP *from the Web*, go to [www.agilent.com/find/iolib](http://www.agilent.com/find/iolib).











### NOTE

For more information on connecting instruments to USB, LAN, and GPIB and how to configure and troubleshoot these interfaces, refer to the *Agilent Connectivity Guide*.

- If you have installed the Agilent IO Libraries Suite, you can access the guide from the Agilent IO Libraries Control icon.

## Configuring a GPIB Interface

Each device on the GPIB (IEEE–488) interface must have a unique address. You can set the multimeter’s address to any integral value between 0 and 30. The address is set to “22” when the instrument is shipped from the factory.

- Your computer’s GPIB interface card has its own address. Be sure to avoid using *the computer’s* address for any instrument on the interface bus.
- The GPIB address is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTEM:PRESet) command.
- **Front Panel Operation:** To enable GPIB and set the GPIB address, Press   (Utility) to display UTILITY MENU. Press  or  as needed to select REMOTE I/O, and press  to display I/O PORT. Press  as needed to select GPIB, and press  to display ENABLE GPIB?. Press  as needed to select YES, and press  to display GPIB ADDRESS. Use the navigation keypad to set the desired GPIB address, and press .

After enabling or disabling GPIB connectivity, power to the multimeter must be cycled off/on for the change to take effect.

- **Remote Interface Operation:** The following command enables the GPIB remote interface:

```
SYSTEM:COMMunicate:ENABLE ON,GPIB
```

The following command queries the state of the GPIB interface:

```
SYSTEM:COMMunicate:ENABLE? GPIB
```

This query returns a “0” (OFF) or a “1” (ON).

The following command sets the multimeter’s GPIB (IEEE–488) address:

```
SYSTEM:COMMunicate:GPIB:ADDRESS {<address>}
```

The following query returns the IP address, in the form “+XX”:

```
SYSTEM:COMMunicate:GPIB:ADDRESS?
```

Refer to the *Agilent 34410A/34411A Programmer’s Reference* for complete description and syntax for these commands.

## Configuring a USB Interface

For the USB interface, no configuration parameters are *required* to set up the multimeter. Connect your multimeter to a USB port on your computer. Note that it may take several seconds for the computer to recognize and establish a connection to the multimeter.

- **Front Panel Operation:** To enable USB: Press **Shift** **Data Log** (**Utility**) to display UTILITY MENU. Press **Left Arrow** or **Right Arrow** as needed to select REMOTE I/O, and press **Enter** to display I/O PORT. Press **Right Arrow** as needed to select USB, and press **Enter** to display ENABLE USB?. Press **Right Arrow** as needed to select YES, and press **Enter** to display the multimeter's USB ID. Press **Enter** or **Exit** to exit the menu.

After enabling or disabling USB connectivity, power to the multimeter must be cycled off/on for the change to take effect.

- **Remote Interface Operation:** The following command enables the USB remote interface:

```
SYSTem:COMMunicate:ENABle ON,USB
```

The following command queries the state of the USB interface:

```
SYSTem:COMMunicate:ENABle? USB
```

This query returns a "0" (OFF) or a "1" (ON).

Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete description and syntax for these commands.



## Configuring a LAN Interface

By default, local access network (LAN) connectivity with DHCP (Dynamic Host Configuration Protocol) is enabled on the multimeter. DHCP (Dynamic Host Configuration Protocol) is a protocol for automatically assigning a dynamic IP address, subnet mask and default gateway to a device on a network, and is typically the *easiest* way to configure your multimeter for remote communication using the LAN interface.

- Changing the DHCP setting will cause an automatic LAN restart.
- When DHCP is *enabled* (factory setting), the multimeter will try to obtain an IP address from a DHCP server. If a DHCP server is found, it will assign a dynamic IP address, Subnet Mask, and Default Gateway to the instrument. The DHCP server may also assign the DNS address, and may change the specified Host Name if a manually specified Host Name is already in use.
- When DHCP is *disabled* or unavailable, the multimeter will use the static IP address, Subnet Mask, and Default Gateway during power-on.
- If a DHCP LAN address is *not* assigned by a DHCP server, then a static IP will be assumed after approximately 1 minute.
- If Auto-IP is enabled, a *dynamic* – rather than static – IP address will be assigned by the server at power-on.

### LAN Configuration Parameters

You may choose to manually set several of the following parameters, as described in the subsections below. Following these descriptions are procedures for setting up a LAN configuration from the front panel and the remote interface.

- IP Address\*
- Subnet Mask\*
- Default Gateway\*
- DNS Server\*
- Host Name
- LAN Services (Visa LAN, Sockets, Telnet, Agilent Web Server)
- Web Password

\**These four parameters use dot-notation addresses. See NOTE below.*

#### NOTE

Dot-notation addresses (“nnn.nnn.nnn.nnn” where “nnn” is a byte value) must be expressed with care:

Most *computers* will interpret byte values with leading zeros as *octal numbers*. For example, “255.255.020.011” is actually equivalent to decimal “255.255.16.9” not “255.255.20.11” because the computer will interpret “.020” as “16” expressed in octal, and “.011” as “9”.

However, *the multimeter* assumes that all dot-notation addresses are expressed as *decimal byte values* and strips all leading zeros from these byte values. Thus, attempting to set an IP address of “255.255.020.011” will become “255.255.20.11” (a purely decimal expression). Be sure to enter the exact expression, “255.255.20.11”, in your computer web software to address the instrument. To avoid confusion, use only decimal expressions of byte values (0 to 255), with no leading zeros.

---

## Assigning the LAN IP Address Using Auto-IP

The Auto-IP standard automatically assigns an IP address to the multimeter when on a network that does not have DHCP servers.

- Changing the Auto-IP setting will cause an automatic LAN reset.
- Auto-IP allocates IP addresses from the link-local address range (169.254.xxx.xxx).
- From the factory, the Auto-IP setting is enabled.
- The IP address is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTEM:PRESet) command.

## Setting the LAN IP Address Manually

An Internet Protocol (IP) Address is required for all IP and TCP/IP communications with the instrument. If DHCP is enabled (factory setting), the specified static IP address is not used. However, if the DHCP server fails to assign a valid IP address, *or* if DHCP and Auto-IP are *both* off, the currently configured static IP address will be used.

- Changing the IP address will cause an automatic LAN reset.
- The default IP Address for the multimeter is “169.254.4.10”.
- If you are planning to use a static IP address on a Corporate LAN, contact your network administrator to obtain a fixed IP address to be used exclusively for your instrument.

## Setting the LAN Subnet Mask

The multimeter uses the Subnet Mask to determine if a client IP address is on the same local subnet. When a client IP address is on a different subnet, all packets must be sent to the Default Gateway. Contact your network administrator to determine if subnetting is being used and for the correct Subnet Mask.

- Changing the Subnet Mask setting will cause an automatic LAN reset.
- The default Subnet Mask for the 34410A multimeter is “255.255.0.0”.
- A value of “0.0.0.0” or “255.255.255.255” indicates that subnetting is not being used.
- The Subnet Mask is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTEM:PRESet) command.

## Setting the LAN Default Gateway

A Default Gateway address allows the multimeter to communicate with systems that are not on the local subnet. Thus, this is the Default Gateway where packets are sent which are destined for a device not on the local subnet, as determined by the Subnet Mask setting. Contact your network administrator to determine if a gateway is being used and for the correct address.

- Changing the Default Gateway setting will cause an automatic LAN reset.
- The default for the multimeter is “0.0.0.0” (no gateway, and subnetting is not being used).
- The Default Gateway is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTEM:PRESet) command.

#### Setting the LAN Host Name

The Host Name is the host portion of the domain name, which is translated into an IP address.

- Changing the Host Name will cause an automatic LAN reset.
- The default Host Name for the multimeter is “A-34410A-*nnnnn*” for the 34410A, and “A-34411A-*nnnnn*” for the 34411A, where *nnnnn* is the last five digits of the instrument’s serial number representation.
- If Dynamic Domain Name System (DNS) is available on your network and your multimeter uses DHCP, the Host Name is registered with the Dynamic DNS service at power-on.
- The Host Name is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTem:PRESet) command.

#### Setting the LAN DNS Server

The Domain Name Service (DNS) is an Internet service that translates Domain names into IP addresses. Contact your network administrator to determine if DNS is being used and for the correct address.

- If you change the DNS address, you must cycle power on the multimeter to activate the new setting.
- The default DNS Address for the multimeter is “0.0.0.0”.
- The DNS Server address is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (\*RST) command, or after an Instrument Preset (SYSTem:PRESet) command.

#### Setting a Web Password

If desired, you can control access to the multimeter’s Web Interface (*see “34410A/34411A Web Browser Interface” on page 93*) using password protection. As shipped from the factory, no password is set. Once the Web server is launched, follow its instructions to establish or change a password.

## 34410A/34411A Web Browser Interface

The multimeter provides a built-in Web Interface. You can use this interface over LAN for remote access and control of the multimeter via a Java enabled Web browser, such as Microsoft® Internet Explorer.

- *To access and use the 34410A/34411A Web Interface:*
  - 1 Establish a LAN interface connection from your computer to the multimeter.
  - 2 Open your computer's Web browser.
  - 3 Launch the *34410A/34411A Web Interface* by entering the IP address of your multimeter, or its fully-qualified host name, in the browser address field. The following welcome screen appears:

**Agilent Technologies** 6-1/2 Digit Multimeter

Welcome to your **Web-Enabled 6-1/2 Digit Multimeter**

Information about this Web-Enabled Instrument

<b>Instrument:</b>	34410A 6-1/2 Digit Multimeter
<b>Serial Number:</b>	2000920082
<b>Description:</b>	Agilent 34410A (2000920082)
<b>Hostname:</b>	host.lvd.agilent.com
<b>IP Address:</b>	156.140.0.0
<b>VISA TCPIP Connect String:</b>	TCPIP0::host::INSTR

[Turn Off Front Panel Identification Indicator](#)

[Advanced information](#)

Use the navigation bar on the left to access your 6-1/2 Digit Multimeter and related information.

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- 4 Follow the instructions in the Web Interface's on-line Help.

## Setting up a LAN connection from the Front Panel

- Press **Shift** **Data Log** ( **Utility** ) to display UTILITY MENU. Press **Left Arrow** or **Right Arrow** as needed to select REMOTE I/O, and press **Enter** to display I/O PORT. Select LAN, and press **Enter** to display ENABLE LAN?. Select YES, and press **Enter** to display LAN SETTINGS. Select VIEW and press **Enter** to step through the existing LAN settings, or select MODIFY and press **Enter** to change them. *If you choose to modify LAN settings, the following submenus will be displayed:*
  - 1** RESET LAN? – Select YES and press **Enter** to restart the LAN connection. Select NO and press **Enter** to continue modifying LAN settings.
  - 2** DHCP – Select YES and press **Enter** to enable DHCP, and jump to **Step 8**. Select NO and press **Enter** to continue modifying LAN settings.
  - 3** AUTO IP – Select YES and press **Enter** to enable Auto IP, and jump to **Step 8**. Select NO and press **Enter** to continue modifying LAN settings.
  - 4** IP ADDRESS. – Use the navigation keypad to enter the desired IP address, in dot notation with no leading zeros, and press **Enter**.
  - 5** SUBNET MASK – Use the navigation keypad to enter the desired Subnet Mask, in dot notation with no leading zeros, and press **Enter**.
  - 6** DEF GATEWAY – Use the navigation keypad to enter the desired Default Gateway address, in dot notation with no leading zeros, and press **Enter**.
  - 7** DNS SERVER – Use the navigation keypad to enter the desired DNS Server address, in dot notation with no leading zeros, and press **Enter**.
  - 8** HOST NAME – Use the navigation keypad to enter the desired Host Name, and press **Enter**. The Host Name must be a string of alphanumeric characters plus dashes (“-”), up to 15 characters, with the first character a letter.
  - 9** LAN SERVICES – Select ENABLE ALL to xxxxxx and press **Enter** to jump to **Step 10**. Select SELECT and press **Enter** to individually enable or disable the following specific services: VISA LAN, SOCKETS, TELNET or WEB SERVER. Changing LAN services will require a computer reboot for the change to take effect.
  - 10** WEB PASSWORD – Select ENABLE, and press **Enter**. Then use the navigation keypad to enter the desired password, up to 12 alphanumeric digits in length.

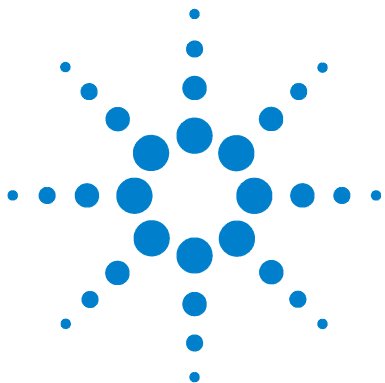
## Setting up a LAN connection from the Remote Interface

- To enable or disable the LAN remote interface:  
`SYSTem:COMMUnicate:ENABle {OFF|0|ON|1}, LAN`
- To enable or disable the use of DHCP for the LAN interface:  
`SYSTem:COMMUnicate:LAN:DHCP {OFF|0|ON|1}`
- To enable or disable the use of Auto-IP for the LAN interface:  
`SYSTem:COMMUnicate:LAN:AUTOip[STATE] {OFF|0|ON|1}`
- To assign the LAN a static IP address:  
`SYSTem:COMMUnicate:LAN:IPADdress <address>`
- To assign a LAN Subnet Mask:  
`SYSTem:COMMUnicate:LAN:SMASk <address>`
- To assign a LAN Default Gateway:  
`SYSTem:COMMUnicate:LAN:GATEWay <address>`
- To assign a LAN Host Name:  
`SYSTem:COMMUnicate:LAN:HOSTname "<name>"`
- To assign the LAN a static DNS address:  
`SYSTem:COMMUnicate:LAN:DNS <address>`
- To assign a LAN Domain Name:  
`SYSTem:COMMUnicate:LAN:DOMain "<name>"`

Query forms of these commands are also available. Refer to the *Agilent 34410A/34411A Programmer's Reference* for complete command description and syntax.

### **3 Remote Interface Configuration**





## 4 Measurement Tutorial

The Agilent 34410A and 34411A multimeters are capable of making highly accurate measurements. In order to achieve the greatest accuracy, you must take the necessary steps to eliminate potential measurement errors. This chapter describes common errors found in measurements and gives suggestions to help you avoid these errors.

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## DC Measurement Considerations

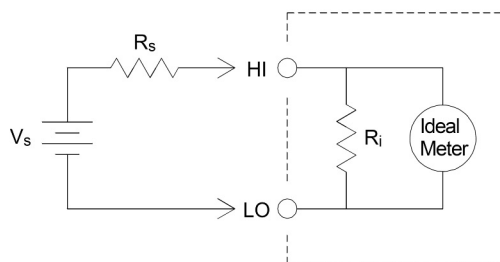
### Thermal EMF Errors

Thermoelectric voltages are the most common source of error in low-level dc voltage measurements. Thermoelectric voltages are generated when you make circuit connections using dissimilar metals at different temperatures. Each metal-to-metal junction forms a thermocouple, which generates a voltage proportional to the junction temperature. You should take the necessary precautions to minimize thermocouple voltages and temperature variations in low-level voltage measurements. The best connections are formed using copper-to-copper crimped connections, as the multimeter's input terminals are a copper alloy. The table below shows common thermoelectric voltages for connections between dissimilar metals.

Copper to –	Approx. mV / °C	Copper to –	Approx. mV / °C
Cadmium-Tin Solder	0.2	Aluminum	5
Copper	<0.3	Tin-Lead Solder	5
Gold	0.5	Kovar or Alloy 42	40
Silver	0.5	Silicon	500
Brass	3	Copper-Oxide	1000
Beryllium Copper	5		

### Loading Errors (dc volts)

Measurement loading errors occur when the resistance of the device-under-test (DUT) is an appreciable percentage of the multimeter's own input resistance. The diagram below shows this error source.



$V_s$  = ideal DUT voltage  
 $R_s$  = DUT source resistance  
 $R_i$  = multimeter input resistance  
 ( 10 M $\Omega$  or >10 G $\Omega$  )

$$\text{Error (\%)} = \frac{100 \times R_s}{R_s + R_i}$$

To reduce the effects of loading errors, and to minimize noise pickup, you can set the multimeter's input resistance to >10 G $\Omega$  (the HI-Z setting) for the 100 mVdc, 1 Vdc, and 10 Vdc ranges. The input resistance is maintained at 10 M $\Omega$  for the 100 Vdc and 1000 Vdc ranges.

## Noise Rejection

### Rejecting Power-Line Noise Voltages

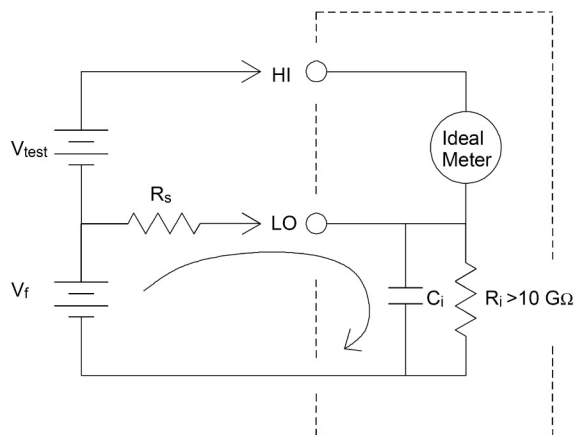
A desirable characteristic of integrating analog-to-digital (A/D) converters is their ability to reject power-line related noise present with dc input signals. This is called normal mode noise rejection, or NMR. The multimeter achieves NMR by measuring the average dc input by "integrating" it over a fixed period. If you set the integration time to a whole number of power line cycles (PLCs), these errors (and their harmonics) will average out to approximately zero.

The multimeter provides four integration selections (1, 2, 10 and 100 PLCs) which achieve NMR. The multimeter measures the power-line frequency (50 Hz or 60 Hz), and then determines the corresponding integration time. For a complete listing of NMR, approximate added RMS noise, reading rate and resolution for each integration setting, *see the Performance vs. Integration Time table on page 124.*

You can also program specific apertures, using the INTEGRATION settings, to reject undesired signal frequency components.

### Common Mode Rejection (CMR)

Ideally, a multimeter is completely isolated from earth-referenced circuits. However, there is finite resistance between the multimeter's input LO terminal and earth ground, as shown below. This can cause errors when measuring low voltages which are floating relative to earth ground.



$V_f$  = float voltage  
 $R_s$  = DUT source resistance imbalance  
 $R_i$  = multimeter isolation resistance (LO-Earth)  
 $C_i$  = multimeter input capacitance:  
 $\approx 200$  pF (LO-Earth)

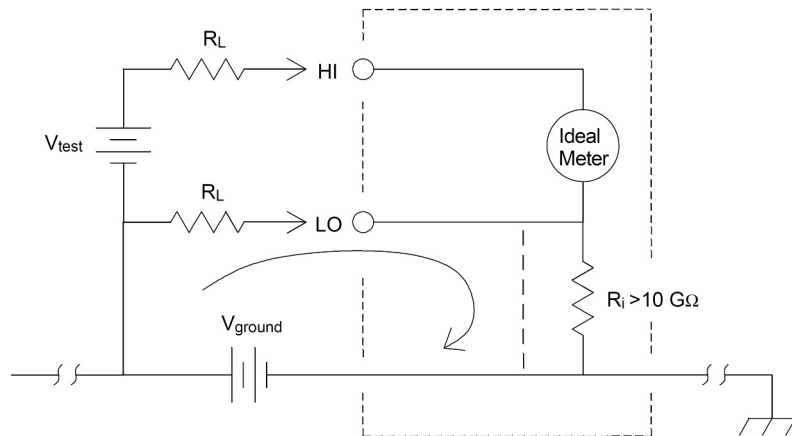
$$\text{Error (v)} = \frac{V_f \times R_s}{R_s + R_i}$$

## Noise Caused by Magnetic Loops

If you are making measurements near magnetic fields, take caution to avoid inducing voltages in the measurement connections. You should be especially careful when working near conductors carrying large currents. Use twisted-pair connections to the multimeter to reduce the noise pickup loop area, or dress the test leads as close together as possible. Loose or vibrating test leads will also induce error voltages. Tie down test leads securely when operating near magnetic fields. Whenever possible, utilize magnetic shielding materials or increased distance from magnetic sources.

## Noise Caused by Ground Loops

When measuring voltages in circuits where the multimeter and the device-under-test are both referenced to a common earth ground, a "ground loop" is formed. As shown below, any voltage difference between the two ground reference points ( $V_{\text{ground}}$ ) causes a current to flow through the measurement leads. This causes noise and offset voltage (usually power-line related), which are added to the measured voltage.



$R_L$  = lead resistance

$R_i$  = multimeter isolation resistance

$V_{\text{ground}}$  = voltage drop on ground bus

The best way to eliminate ground loops is to isolate the multimeter from earth by *not* grounding the input terminals. If the multimeter must be earth-referenced, connect it *and* the device-under-test to the same common ground point. Also connect the multimeter and device-under-test to the same electrical outlet whenever possible.

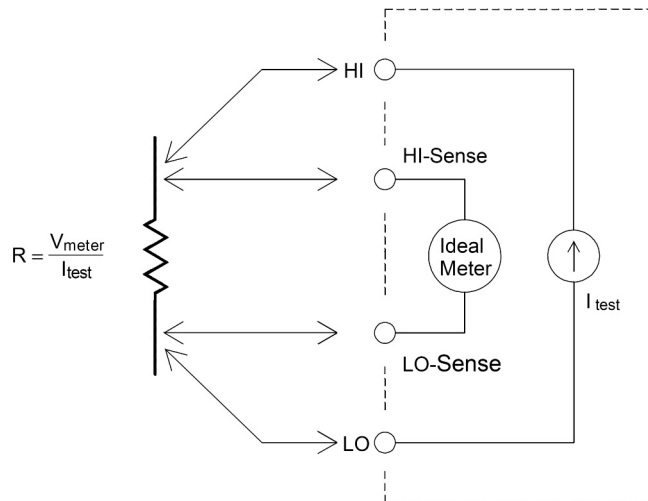
## Resistance Measurement Considerations

The multimeter offers two methods for measuring resistance: 2-wire and 4-wire ohms. For both methods, the test current flows from the input HI terminal and then through the resistor being measured. For 2-wire ohms, the voltage drop across the resistor being measured is sensed internal to the multimeter. Therefore, test lead resistance is also measured. For 4-wire ohms, separate "sense" connections are required. Since no current flows in the sense leads, the resistance in these leads does not give a measurement error.

*The errors mentioned earlier in this chapter for dc voltage measurements also apply to resistance measurements. Additional error sources unique to resistance measurements are discussed on the following pages.*

### 4-Wire Ohms Measurements

The 4-wire ohms method provides the most accurate way to measure small resistances. Test lead resistances and contact resistances are automatically reduced using this method. Four-wire ohms is often used in automated test applications where resistive and/or long cable lengths, numerous connections, or switches exist between the multimeter and the device-under-test. The recommended connections for 4-wire ohms measurements are shown below. See also ["To Make a 4-wire Resistance Measurement"](#) on page 26.



## Removing Test Lead Resistance Errors

To eliminate offset errors associated with the test lead resistance in 2-wire ohms measurements, follow the steps below.

- 1 Short the ends of the test leads together. The multimeter displays the test lead resistance.
- 2 Press **Null**. The multimeter will store the test lead resistance as the 2-wire ohms null value, and enable that value to be subtracted from subsequent measurements.

See also “Null Measurements” on page 58.

## Minimizing Power Dissipation Effects

When measuring resistors designed for temperature measurements (or other resistive devices with large temperature coefficients), be aware that the multimeter will dissipate some power in the device-under-test.

If power dissipation is a problem, you should select the multimeter's next higher measurement range to reduce the errors to acceptable levels. The following table shows several examples.

Range	Test Current	DUT Power at Full Scale
100 $\Omega$	1 mA	100 $\mu$ W
1 k $\Omega$	1 mA	1 mW
10 k $\Omega$	100 $\mu$ A	100 $\mu$ W
100 k $\Omega$	10 $\mu$ A	10 $\mu$ W
1 M $\Omega$	5 $\mu$ A	25 $\mu$ W
10 M $\Omega$	500 nA	2.5 $\mu$ W

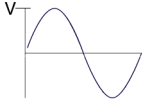
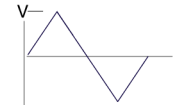
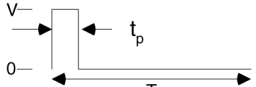
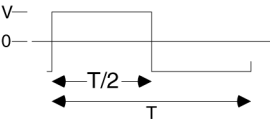
## Errors in High Resistance Measurements

When you are measuring large resistances, significant errors can occur due to insulation resistance and surface cleanliness. You should take the necessary precautions to maintain a "clean" high-resistance system. Test leads and fixtures are susceptible to leakage due to moisture absorption in insulating materials and "dirty" surface films. Nylon and PVC are relatively poor insulators ( $10^9 \Omega$ ) when compared to PTFE (Teflon) insulators ( $10^{13} \Omega$ ). Leakage from nylon or PVC insulators can easily contribute a 0.1% error when measuring a 1 M $\Omega$  resistance in humid conditions.

## True RMS AC Measurements

True RMS responding multimeters, like the Agilent 34410A/11A, measure the "heating" potential of an applied voltage. Power dissipated in a resistor is proportional to the square of an applied voltage, independent of the waveshape of the signal. This multimeter accurately measures true RMS voltage or current, as long as the wave shape contains negligible energy above the meter's effective bandwidth.

Note that the 34410A/11A uses the same techniques to measure true RMS voltage and true RMS current. The effective ac voltage bandwidth is 300 kHz, while the effective ac current bandwidth is 10 kHz.

Waveform Shape	Crest Factor	AC RMS	AC + DC RMS
	$\sqrt{2}$	$\frac{V}{\sqrt{2}}$	$\frac{V}{\sqrt{2}}$
	$\sqrt{3}$	$\frac{V}{\sqrt{3}}$	$\frac{V}{\sqrt{3}}$
	$\sqrt{\frac{T}{t_p}}$	$\frac{V}{CF} \times \sqrt{1 - \frac{1}{CF^2}}$	$\frac{V}{CF}$
	1	V	V

The multimeter's ac voltage and ac current functions measure the *ac-coupled* true RMS value. In this Agilent meter, the "heating value" of *only the ac components* of the input waveform are measured (dc is rejected). As seen in the figure above; for sinewaves, triangle waves, and square waves, the *ac-coupled* and *ac+dc* values are equal, since these waveforms do not contain a dc offset. However, for non-symmetrical waveforms, such as pulse trains, there is a dc voltage content, which is rejected by Agilent's *ac-coupled* true RMS measurements. This can provide a significant benefit.



An ac-coupled true RMS measurement is desirable when you are measuring small ac signals in the presence of large dc offsets. For example, this situation is common when measuring ac ripple present on dc power supplies. There are situations, however, where you might *want* to know the ac+dc true RMS value. You can determine this value by combining results from dc and ac measurements, as shown below:

$$ac + dc = \sqrt{ac^2 + dc^2}$$

For the best ac noise rejection, you should perform the dc measurement using an integration time of at least 10 power-line cycles (PLCs).

### **True RMS Accuracy and High-Frequency Signal Content**

A common misconception is that "since an ac multimeter is true RMS, its sine wave accuracy specifications apply to all waveforms." Actually, the shape of the input signal can dramatically affect measurement accuracy, for any multimeter, especially when that input signal contains high-frequency components which exceed the instrument's bandwidth.

As an example, consider a pulse train, one of the most challenging waveforms for a multimeter. The pulse-width of that waveform largely determines its high-frequency content. The frequency spectrum of an individual pulse is determined by its Fourier Integral. The frequency spectrum of the pulse train is the Fourier Series that samples along the Fourier Integral at multiples of the input pulse repetition frequency (prf).

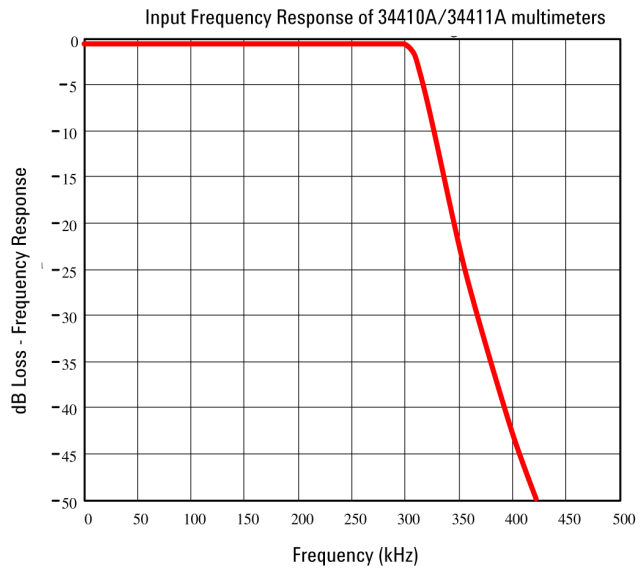
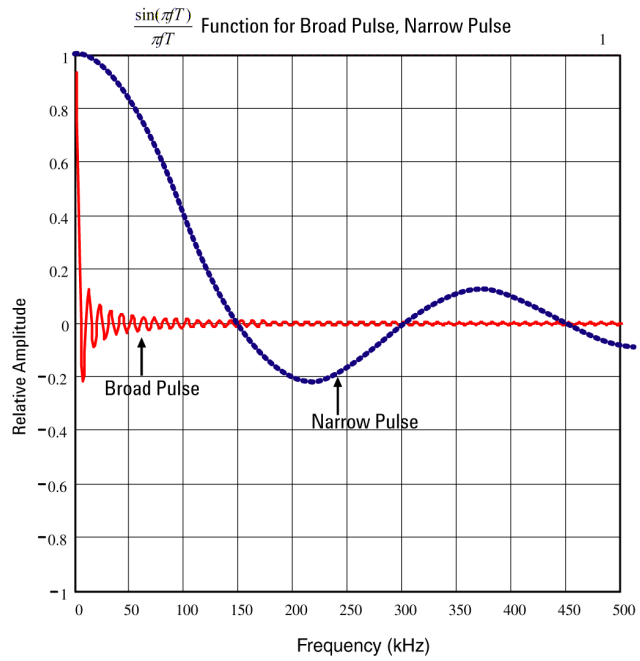
On the following page, the first figure shows the Fourier Integral of two very different pulses: one of broad width ( $200\mu\text{s}$ ); the other narrow ( $6.7\mu\text{s}$ ). The second figure is an approximation of the shape of the input frequency response of the 34410A/11A.

Comparing these two figures along the frequency axis, notice that the  $\frac{\sin(\pi fT)}{\pi fT}$  spectrum of the narrow pulse significantly exceeds the effective bandwidth of the instrument. The net result is a less accurate measurement of the narrow, high-frequency pulse.

In contrast, the frequency spectrum of the broad pulse has fallen off significantly below the multimeter's 300kHz (approximately) band-width, so measurements of this pulse are more accurate.

Reducing the prf increases the density of lines in the Fourier spectrum, and increases the portion of the input signal's spectral energy within the multimeter's bandwidth, *which improves accuracy*.

In summary, error in RMS measurements arise when there is significant input signal energy at frequencies above the multimeter's bandwidth.



### Estimating High-Frequency (Out-of-Band) Error

A common way to describe signal waveshapes is to refer to their “Crest Factor”. Crest factor is the ratio of the peak value to RMS value of a waveform. For a pulse train, for example, the crest factor is approximately equal to the square root of the inverse of the duty cycle.

$$CF = \frac{1}{\sqrt{d}} = \frac{1}{\sqrt{\frac{t_p}{T}}} = \frac{1}{\sqrt{prf \times t_p}}$$

Notice that crest factor is a composite parameter, dependent upon the pulse-width and repetition frequency; crest factor alone is not enough to characterize the frequency content of a signal.

Traditionally, DMMs include a crest factor derating table that applies at all frequencies. The measurement algorithm used in the 34410A/11A multimeters is not inherently sensitive to crest factor, so no such derating is necessary. With this multimeter, as discussed in the previous section, the focal issue is high-frequency signal content which exceeds the multimeter’s bandwidth.

For periodic signals, the combination of crest factor and repetition rate can suggest the amount of high-frequency content and associated measurement error. The first zero crossing of a simple pulse occurs at

$$f_1 = \frac{1}{t_p}$$

This gives an immediate impression of the high-frequency content by identifying where this crossing occurs as a function of crest

factor:  $f_1 = CF^2 \cdot prf$

The following table shows the typical error for various pulse waveforms as a function of input pulse frequency:

Typical error for square wave, triangular wave, and pulse trains of CF=3, 5, or 10					
prf	square wave	triangle wave	CF=3	CF=5	CF=10
200	-0.02%	0.00%	-0.04%	-0.09%	-0.34%
1000	-0.07%	0.00%	-0.18%	-0.44%	-1.71%
2000	-0.14%	0.00%	-0.34%	-0.88%	-3.52%
5000	-0.34%	0.00%	-0.84%	-2.29%	-8.34%
10000	-0.68%	0.00%	-1.75%	-4.94%	-26.00%
20000	-1.28%	0.00%	-3.07%	-8.20%	-45.70%
50000	-3.41%	-0.04%	-6.75%	-32.0%	-65.30%
100000	-5.10%	-0.12%	-21.8%	-50.6%	-75.40%

This table gives an additional error for each waveform, to be added to the value from the accuracy table provided in the Specifications chapter.

The 34410A/11A specifications are valid for  $CF \leq 10$ , *provided there is insignificant signal energy above the 300kHz bandwidth for voltage, or the 10 kHz bandwidth for current*. Multimeter performance is not specified for  $CF > 10$ , or when significant out-of-band signal content is present.

**Example:**

A pulse train with level  $1 V_{\text{rms}}$ , is measured on the 1 V range. It has pulse heights of 3 V (that is, a Crest Factor of 3) and duration 111  $\mu\text{s}$ . The prf can be calculated to be 1000 Hz, as follows:

$$prf = \frac{1}{CF^2 \times t_p}$$

Thus, from the table above, this ac waveform can be measured with 0.18 percent additional error.

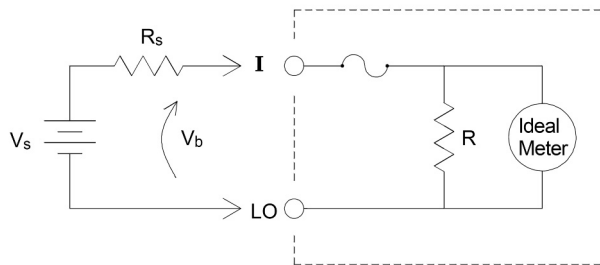
## Other Primary Measurement Functions

### Frequency and Period Measurement Errors

The multimeter uses a reciprocal counting technique to measure frequency and period. This method generates constant measurement resolution for any input frequency. The multimeter's ac voltage measurement section performs input signal conditioning. All frequency counters are susceptible to errors when measuring low-voltage, low-frequency signals. The effects of both internal noise and external noise pickup are critical when measuring "slow" signals. The error is inversely proportional to frequency. Measurement errors also occur if you attempt to measure the frequency (or period) of an input following a dc offset voltage change. You must allow the multimeter's input dc blocking capacitor to fully settle before making frequency measurements.

### DC Current Measurements

When you connect the multimeter in series with a test circuit to measure current, a measurement error is introduced. The error is caused by the multimeter's series burden voltage. A voltage is developed across the wiring resistance and current shunt resistance of the multimeter, as shown below.

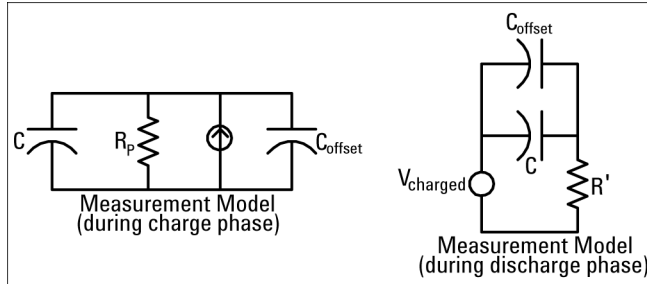


$V_s$  = source voltage  
 $R_s$  = DUT source resistance  
 $V_b$  = multimeter burden voltage  
 $R$  = multimeter current shunt

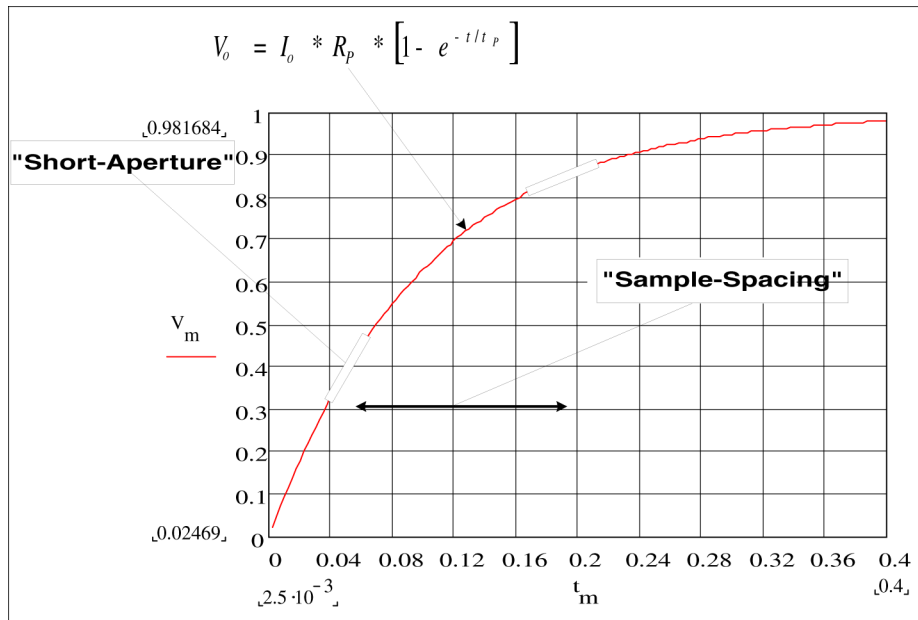
$$\text{Error ( \% )} = \frac{-100\% \times V_b}{V_s}$$

## Capacitance Measurements

The multimeter implements capacitance measurements by applying a known current to the capacitor as shown below:



An Illustration of the response curve while charging is shown below:



Capacitance is calculated by measuring the change in voltage ( $\Delta V$ ) that occurs over a “short aperture” time, ( $\Delta t$ ). This measurement is repeated at two different times during the exponential rise that occurs. An algorithm takes the data from these four points, and by linearizing that exponential rise over these “short apertures”, accurately calculates the capacitance value.

The measurement cycle consists of two parts: a charge phase (shown in the graph) and a discharge phase. The time-constant during the discharge phase is longer, due to a 100k $\Omega$  protective resistor in the measurement path. This time-constant plays an important role in the resultant reading rate (measurement time).

The incremental times, or “sample times”, as well as the width of the “short apertures”, vary by range, in order to minimize noise and increase reading accuracy. The following table lists the current amplitude, peak voltage and average dc voltage developed across the capacitor during the measurement.

Range	Current Source	Reading Rate at full scale	Reading Rate @ 10% of full scale	Applied Voltage	Approx. dc bias @ full scale
1 nF	500nA	5/second	12/second	5V	2V
10 nF	1 $\mu$ A	5/second	24/second	5V	2V
100 nF	10 $\mu$ A	5/second	26/second	4V	2V
1 $\mu$ F	10 $\mu$ A	2/second	18/second	1.5V	1V
10 $\mu$ F	100 $\mu$ A	0.3/second	2.5/second	1.5V	1V

These values all vary by range. Control of the peak voltage across the capacitor is important in some cases, such as when measuring larger electrolytic capacitors.

The values of capacitance and loss resistance measured with the multimeter may differ from the values measured using an LCR meter. This is to be expected, since this is essentially a dc measurement method, while LCR measurement uses applied frequencies anywhere from 100 Hz to 100 kHz. In most cases, neither method measures the capacitor at its exact frequency of application.

The multimeter measures capacitance over a range from 1nF to 10 $\mu$ F. Voltage developed across the capacitor being measured is limited to less than 10V. The multimeter’s measurement accuracy is 0.4% of the reading, + 0.1% of the range in use (except for the 1nF range, for which the accuracy is 0.5% of the reading, + 0.5% of the range).

**Example:** For a 5 nF capacitor, measured using the 10 nF range, the accuracy is  $(0.4\%)(5 \text{ nF}) + (0.1\%)(10 \text{ nF}) = 30 \text{ pF}$  total error possible.

For the best accuracy, take a zero null measurement with open probes, to null out the test lead capacitance, before connecting the probes across the capacitor to be measured.



## Temperature Measurements

The multimeter allows the measurement of temperature by measurement of the temperature sensitive resistance of two different "Probe" types: the resistance temperature detector (RTD) of .0385%/°C; and thermistors of 2.2 K $\Omega$ , 5 K $\Omega$  or 10 K $\Omega$ ). There are a number of measurement parameter and technique choices available to you, and these affect various aspects of the measurement:

- Temperature range and resolution can direct the probe-type choice.
- Choice of four-wire or two-wire technique affects measurement accuracy.
- Use of the auto zero feature affects measurement speed and accuracy.
- Choice of integration (measurement time) setting affects measurement accuracy and power-line noise rejection.
- Use of the offset compensation feature can eliminate residual voltages in the test instrumentation or circuit.

### Probe Type Choice

*RTD's* provide very accurate, highly linear relationships between resistance and temperature, over a range of roughly -200 to 500 °C. There is very little conversion complexity for an RTD since it is so intrinsically linear. The multimeter provides measurement for the IEC751 standard RTD, which has a sensitivity of .0385%/°C.

*Thermistors* consist of semiconductor materials, and provide roughly 10 times the sensitivity of the RTD. Because they are semiconductors, their temperature range is more limited, commonly to -80 °C to 150 °C. Thermistors have highly non-linear temperature-resistance relationships; therefore their conversion algorithms are more complex. The Agilent multimeters use the standard Hart-Steinhart Approximation to provide accurate conversions, with a typical resolution of .08 °C.

### 2-Wire vs. 4-Wire Measurements

As with resistance measurements, four-wire temperature measurement is more accurate, since it *completely* eliminates errors due to lead wire resistance. Alternately, you can use the multimeter's Null function to remove the test lead resistance from the measurement (see "*NULL Reading:*" on page 114).

### **Auto Zero On/Off**

Enabling the auto zero feature (ON) provides greater accuracy; however, the additional measurement (of zero) reduces the reading speed.

### **Integration**

There are two methods of integrating the sampled data taken in the measurement, NPLC's and Aperture.

*NPLC's* sets the number of power line cycles in the gating of the measurement. The range of choices for NPLC includes 0.001 and 0.002 (for model 34411A only), 0.006, 0.06, 0.02, 0.2, 1, 2, 10 and 100.

The fractional NPLC values offer faster measurements, at the expense of some time integration accuracy. When you set the NPLC to 1 or more, you not only achieve improved accuracy associated with time averaging, but also achieve rejection of the power-line interference (normal mode rejection, or NMR); the greater the integral NPLC value, the larger the NMR.

*Aperture* is the period, measured in seconds, during which the multimeter's analog-to-digital (A/D) converter samples the input signal for a measurement. A longer aperture yields better resolution; a shorter aperture provides for faster measurements. This feature allows the user to set a specific measurement period, not based on power line frequency. Values range from 100  $\mu$ s to 1s for the 34410A, and from 20  $\mu$ s to 1s for the 34411A. *No* normal mode rejection is provided in aperture mode.

### **Offset Compensation**

With offset compensation enabled (ON), the multimeter makes a normal temperature measurement first, followed by a second measurement to determine any offset voltage in the input circuitry. The resultant displayed measurement corrects for this offset. Enabling offset compensation increases measurement time.

### **NULL Reading:**

The multimeter allows a separate null setting to be saved for the temperature function. When making null measurements, each reading is the difference between a stored null value and the input signal. One application of NULL is to increase accuracy of two-wire resistance measurements by first nulling the closed-circuit test lead resistance.

## High-Speed Measurements

### Making High-Speed AC Measurements

The multimeter's ac voltage and ac current functions implement three different low-frequency filters. These filters allow you to trade-off minimum measured frequency for faster reading speed. The FAST filter settles in 0.025 seconds, and is useful for frequencies above 200 Hz. The MEDIUM filter settles in 0.63 seconds for voltage and 0.25 seconds for current, and is useful for measurements above 20 Hz. The SLOW filter settles in 2.5 seconds for voltage and 1.67 seconds for current, and is useful for frequencies above 3 Hz.

With a few precautions, you can perform ac measurements at speeds up to 500 readings per second. Use manual ranging to eliminate autoranging delays. By setting the trigger delay to 0, the FAST, MEDIUM, and SLOW filters allow up to 500, 150, and 50 readings per second, albeit with reduced accuracy, since the filter may not fully settle. If the sample-to-sample levels are similar, little settling time is required for each new reading. Under this specialized condition, the MEDIUM filter provides reduced accuracy results at 20 readings per second, and the FAST filter provides reduced accuracy results at 200 readings per second.

AC Filter	Filter Bandwidth	Settling Time (Seconds)		Full Settling (rdgs/Sec)		Partial Settling	Maximum rdgs/Sec
		ACV	ACI	ACV	ACI	ACV/ACI	ACV/ACI
Slow	3 Hz	2.5	1.67	0.4	0.6	2	50
Medium	20 Hz	0.63	0.25	1.6	4	20	150
Fast	200 Hz	0.025	0.025	40	40	200	500

In applications where sample-to-sample levels vary widely, but the dc offset level does not change, the MEDIUM filter settles at 2 to 4 readings per second (depending upon the lowest frequency component in the waveform) as shown in the following table:

Medium Filter Performance	Full Accuracy Reading Rate No DC Level Change			
	20 Hz	50 Hz	100 Hz	200 Hz
Lowest Frequency Component				
AC Current (allowable rate rdgs/Sec)	4	4	4	4
AC Voltage (allowable rate rdgs/Sec)	2	3	4	4

For ac voltage, additional settling time may be required when the dc level varies from sample to sample. The default sample delays allow for a dc level change of 3% of range for all filters. If the dc level change exceeds these levels, additional settling time is required. The multimeter's dc blocking circuitry has a settling time constant of 0.2 seconds. This settling time only affects measurement accuracy when dc offset levels vary from sample to sample. If maximum measurement speed is desired in a scanning system, you may want to add an external dc blocking circuit to those channels with significant dc voltages present. This circuit can be as simple as a resistor and a capacitor.

For ac current, additional settling time is not required when the dc level varies sample to sample.

### **Making High-Speed dc and Resistance Measurements**

The multimeter incorporates an automatic zero measurement procedure (autozero) to eliminate internal thermal EMF and bias current errors. Each measurement actually consists of a measurement of the input terminals followed by a measurement of the internal offset voltage. The internal offset voltage error is subtracted from the input for improved accuracy. This compensates for offset voltage changes due to temperature. For maximum reading speed, turn autozero off. This will more than double your reading speeds for dc voltage, resistance, and dc current functions. Autozero does not apply to other measurement functions.

## Other Sources of Measurement Error

### Settling Time Effects

The multimeter has the ability to insert automatic measurement settling delays. These delays are adequate for resistance measurements with less than 200 pF of combined cable and device capacitance. This is particularly important if you are measuring resistances above 100 kΩ. Settling due to RC time constant effects can be quite long. Some precision resistors and multi-function calibrators use large parallel capacitors (1000 pF to 0.1 μF) with high resistor values to filter out noise currents injected by their internal circuitry. Non-ideal capacitances in cables and other devices may have much longer settling times than expected just by RC time constants due to dielectric absorption (soak) effects. Errors are measured when settling after the initial connection and after a range change.

### Loading Errors (ac volts)

In the ac voltage function, the input of the multimeter appears as a 1 MΩ resistance in parallel with 100 pF of capacitance. The cabling that you use to connect signals to the multimeter also adds capacitance and loading. The table below shows the multimeter's approximate input resistance at various frequencies.

Input Frequency	Input Resistance
100 Hz	1 MΩ
1 kHz	850 kΩ
10 kHz	160 kΩ
100 kHz	16 kΩ

For low frequencies, the loading error is:

$$\text{Error (\%)} = \frac{-100 \times R_s}{R_s + 1 \text{ M}\Omega}$$

At high frequencies, the additional loading error is:

$$\text{Error (\%)} = 100 \times \left[ \frac{1}{\sqrt{1 + (2\pi \times F \times R_s \times C_{in})^2}} - 1 \right]$$

$R_s$  = source resistance

$F$  = input frequency

$C_{in}$  = input capacitance (100 pF) plus cable capacitance

### Measurements Below Full Scale

You can make the most accurate ac measurements when the multimeter is at or near the full scale of the selected range. Autoranging occurs at 10% (down-range) and 120% (up-range) of full scale. This enables you to measure some inputs at full scale on one range and 10% of full scale on the next higher range. In general, the accuracy is better on the lower range; for the highest accuracy, select the lowest manual range possible for the measurement.

### High-Voltage Self-Heating Errors

If you apply more than  $300 V_{\text{rms}}$ , self-heating occurs in the multimeter's internal signal-conditioning components. These errors are included in the multimeter's specifications.

Temperature changes inside the multimeter due to self-heating may cause additional error on other ac voltage ranges. The additional error is less than 0.02% and dissipates in a few minutes.

### AC Current Measurement Errors (Burden Voltage)

Burden voltage errors, which apply to dc current, also apply to ac current measurements. However, the burden voltage for ac current is larger due to the multimeter's series inductance and your measurement connections. The burden voltage increases as the input frequency increases. Some circuits may oscillate when performing current measurements due to the multimeter's series inductance and your measurement connections.

### Low-Level Measurement Errors

When measuring ac voltages less than 100 mV, be aware that these measurements are especially susceptible to errors introduced by extraneous noise sources. An exposed test lead acts as an antenna and a properly functioning multimeter will measure the signals received. The entire measurement path, including the power line, act as a loop antenna. Circulating currents in the loop create error voltages across any impedances in series with the multimeter's input. For this reason, you should apply low-level ac voltages to the multimeter through shielded cables. You should connect the shield to the input LO terminal.

Make sure the multimeter and the ac source are connected to the same electrical outlet whenever possible. You should also minimize the area of any ground loops that cannot be avoided. A high-impedance source is more susceptible to noise pickup than a low-impedance source. You can reduce the high-frequency impedance of a source by placing a capacitor in parallel with the multimeter's input terminals. You may have to experiment to determine the correct capacitor value for your application.

Most extraneous noise is not correlated with the input signal. You can determine the error as shown below.

$$\text{Voltage Measured} = \sqrt{V_{\text{in}}^2 + \text{Noise}^2}$$

Correlated noise, while rare, is especially detrimental. Correlated noise always adds directly to the input signal. Measuring a low-level signal with the same frequency as the local power line is a common situation that is prone to this error.

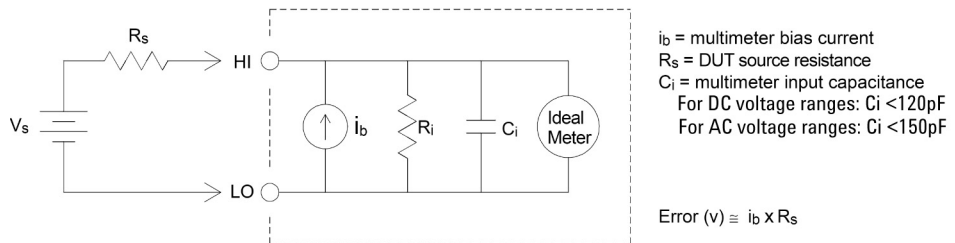
### Common Mode Errors

Errors are generated when the multimeter's input LO terminal is driven with an ac voltage relative to earth. The most common situation where unnecessary common mode voltages are created is when the output of an ac calibrator is connected to the multimeter "backwards." Ideally, a multimeter reads the same regardless of how the source is connected. Both source and multimeter effects can degrade this ideal situation. Because of the capacitance between the input LO terminal and earth (approximately 200 pF), the source will experience different loading depending on how the input is applied. The magnitude of the error is dependent upon the source's response to this loading.

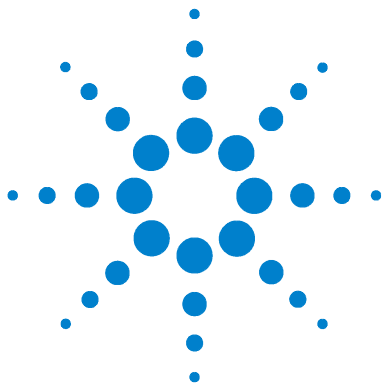
The multimeter's measurement circuitry, while extensively shielded, responds differently in the backward input case due to slight differences in stray capacitance to earth. The multimeter's errors are greatest for high-voltage, high-frequency inputs. Typically, the multimeter exhibits about 0.06% additional error for a 100 V, 100 kHz reverse input. You can use the grounding techniques described for dc common mode problems to minimize ac common mode voltages.

### Leakage Current Errors

The multimeter's input capacitance will "charge up" due to input bias currents when the terminals are open-circuited (if the input resistance is  $>10\text{ G}\Omega$ ). The multimeter's measuring circuitry exhibits approximately 30pA of input bias current for ambient temperatures from 0 °C to 30 °C. Bias current doubles (x2) for every 8 °C change in ambient temperature above 30 °C. This current generates small voltage offsets dependent upon the source resistance of the device-under-test. This effect becomes evident for a source resistance of greater than 100 k $\Omega$ , or when the multimeter's operating temperature is significantly greater than 30 °C.







## 5 Specifications

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These specifications apply when using the 34410A/34411A multimeter in an environment that is *free* of electromagnetic interference and electrostatic charge.

When using the multimeter in an environment where electromagnetic interference or significant electrostatic charge *is* present, measurement accuracy may be reduced. *Particularly note:*

- The voltage measurement probes are not shielded and can act as antennas, causing electromagnetic interference to be added to the signal being measured.
- Electrostatic discharges of 4000 V or greater may cause the multimeter to temporarily stop responding, resulting in a lost or erroneous reading.

Note: Specifications are subject to change without notice. For the latest specifications, go to the product page.

[www.agilent.com/find/34410A](http://www.agilent.com/find/34410A)

or

[www.agilent.com/find/34411A](http://www.agilent.com/find/34411A)

*This ISM device complies with Canadian ICES-001.*

*Cet appareil ISM est conforme à la norme NMB-001 du Canada.*



## DC Characteristics

Accuracy Specifications ( % of reading + % of range )<sup>[1]</sup>

Function	Range <sup>[3]</sup>	Test Current or Burden Voltage	24 Hour <sup>[2]</sup> $T_{CAL} \pm 1\text{ }^{\circ}\text{C}$	90 Day $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	1 Year $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	Temperature Coefficient $0\text{ }^{\circ}\text{C} - (T_{CAL} - 5\text{ }^{\circ}\text{C})$ $(T_{CAL} + 5\text{ }^{\circ}\text{C}) - 55\text{ }^{\circ}\text{C}$
<b>DC</b>	100.0000 mV		0.0030+0.0030	0.0040+0.0035	0.0050+0.0035	0.0005+0.0005
	1.000000 V		0.0020+0.0006	0.0030+0.0007	0.0035+0.0007	0.0005+0.0001
	10.00000 V		0.0015+0.0004	0.0020+0.0005	0.0030+0.0005	0.0005+0.0001
	100.0000 V		0.0020+0.0006	0.0035+0.0006	0.0040+0.0006	0.0005+0.0001
	1000.000 V <sup>[5]</sup>		0.0020+0.0006	0.0035+0.0006	0.0040+0.0006	0.0005+0.0001
<b>Resistance<sup>[4]</sup></b>	100.0000 $\Omega$	1 mA Current Source	0.0030+0.0030	0.008+0.004	0.010+0.004	0.0006+0.0005
	1.000000 K $\Omega$	1 mA	0.0020+0.0005	0.007+0.001	0.010+0.001	0.0006+0.0001
	10.00000 K $\Omega$	100 $\mu$ A	0.0020+0.0005	0.007+0.001	0.010+0.001	0.0006+0.0001
	100.0000 K $\Omega$	10 $\mu$ A	0.0020+0.0005	0.007+0.001	0.010+0.001	0.0006+0.0001
	1.000000 M $\Omega$	5.0 $\mu$ A	0.0020+0.0010	0.010+0.001	0.012+0.001	0.0010+0.0002
	10.00000 M $\Omega$	500 nA	0.0100+0.0010	0.030+0.001	0.040+0.001	0.0030+0.0004
	100.0000 M $\Omega$	500 nA    10 M $\Omega$	0.200+0.001	0.600+0.001	0.800+0.011	0.1000+0.0001
1000.000 M $\Omega$	500 nA    10 M $\Omega$	2.000+0.001	6.000+0.001	8.000+0.001	1.0000+0.0001	
<b>DC Current</b>	100.0000 $\mu$ A	<0.03 V Burden V	0.010+0.020	0.040+0.025	0.050+0.025	0.0020+0.0030
	1.000000 mA	<0.3 V	0.007+0.006	0.030+0.006	0.050+0.006	0.0020+0.0005
	10.00000 mA	<0.03 V	0.007+0.020	0.030+0.020	0.050+0.020	0.0020+0.0020
	100.0000 mA	<0.3 V	0.010+0.004	0.030+0.005	0.050+0.005	0.0020+0.0005
	1.000000 A	<0.80 V	0.050+0.006	0.080+0.010	0.100+0.010	0.0050+0.0010
	3.00000 A	<2.0 V	0.100+0.020	0.120+0.020	0.150+0.020	0.0050+0.0020
<b>Continuity</b>	1000 Ohms	1 mA Test Current	0.002+0.010	0.008+0.020	0.010+0.020	0.0010+0.0020
<b>Diode Test</b>	1.0000 V <sup>[6]</sup>	1 mA Test Current	0.002+0.010	0.008+0.020	0.010+0.020	0.0010+0.0020

[ 1 ] Specifications are for 90 minute warm-up and integration setting of 100 NPLC.

[ 2 ] Relative to calibration standards.

[ 3 ] 20% overrange on all ranges, except 1000 Vdc, 3 A range.

[ 4 ] Specifications are for 4-wire ohms function, or 2-wire ohms using Math Null. Without Math Null, add 0.2  $\Omega$  additional error in 2-wire ohms function.

[ 5 ] For each additional volt over  $\pm$  500 VDC add 0.02 mV of error.

[ 6 ] Accuracy specifications are for the voltage measured at the input terminals only. 1 mA test current is typical. Variation in the current source will create some variation in the voltage drop across a diode junction

## 5 Specifications

### Performance Versus Integration Time – 60Hz (50Hz) Power line frequency

Integration Time Number of Power Line Cycles (NPLC)	Resolution ppm Range <sup>[1]</sup>	NMR db <sup>[2]</sup>	Readings / Second <sup>[3]</sup>	RMS Noise adder % range <sup>[4]</sup>		
				DCV 10, 1000 V	DCV 1, 100 V Resistance 1K, 10K ohm	DCV 0.1 V Resistance 100 ohm DCI 1 amp
0.001 <sup>[6]</sup>	30	0	50,000	0.0060	0.0100	0.1000
0.002 <sup>[6]</sup>	15	0	25,000	0.0030	0.0060	0.0600
0.006	6	0	10,000	0.0012	0.0040	0.0600
0.02	3	0	3000	0.0006	0.0030	0.0300
0.06	1.5	0	1000	0.0003	0.0020	0.0200
0.2	0.7	0	300	0.0002	0.0015	0.0150
1	0.3	55	60(50)	0.0	0.0001	0.0010
2	0.2	110 <sup>[5]</sup>	30(25)	0.0	0.0001	0.0010
10	0.1	110 <sup>[5]</sup>	6(5)	0.0	0.0	0.0005
100	0.03	110 <sup>[5]</sup>	0.6(0.5)	0.0	0.0	0.0

[ 1 ] Resolution is defined as the typical 10 VDC range RMS noise.

[ 2 ] Normal mode rejection for power–line frequency  $\pm 0.1\%$ .

[ 3 ] Maximum rate for DCV, DCI, and 2–Wire resistance functions  
(using zero settling delay, autozero off, etc.).

[ 4 ] Autozero on for  $\Rightarrow 1$  NPLC.

[ 5 ] For power–line frequency  $\pm 1\%$  75 dB and for  $\pm 3\%$  55 dB.

[ 6 ] Only for 34411A.

#### Transfer Accuracy (Typical)

All DC volts, <0.12 A DC Current, < 1.2 M $\Omega$ : (24 hour % of range error) / 2)

All other DC current and resistance: (24 hour % of range error + % of reading)/2

Conditions: - Within 10 minutes and  $\pm 0.5$  °C

- Within  $\pm 10\%$  of initial value.

- Following a 2–hour warm–up.

- Fixed range.

- Using  $\geq 10$ .

- Measurements are made using accepted metrology practices.

**DC Voltage**

Measurement Method:	Continuously integrating multi-slope IV
10 VDC Linearity:	0.0002% of reading + 0.0001% of range
Input Resistance:	
0.1 V, 1 V, 10 V Ranges	Selectable 10 M $\Omega$ or >10 G $\Omega$ (For these ranges, inputs beyond $\pm 17$ V are clamped through 100 k $\Omega$ typical)
100 V, 1000 V Ranges	10 M $\Omega$ $\pm 1\%$
Input Bias Current:	< 50 pA at 25 °C
Input Terminals:	Copper alloy
Input Protection:	1000 V
DC CMRR	140 dB for 1 k $\Omega$ unbalance in LO lead. $\pm 500$ VDC maximum

**Resistance**

Measurement Method:	Selectable 4-wire or 2-wire ohms.
Max. Lead Resistance	10% of range per lead for 100 $\Omega$ , 1 k $\Omega$ ranges.
(4-wire ohms)	1 k $\Omega$ per lead on all other ranges
Input Protection:	1000 V on all ranges
Offset Compensation:	Selectable on the 100 $\Omega$ , 1 k $\Omega$ , and 10 k $\Omega$ ranges

**DC Current**

Shunt Resistor:	0.1 $\Omega$ for 1 A, 3 A. 2 $\Omega$ for 10 mA, 100 mA. 200 $\Omega$ for 100 $\mu$ A, 1 mA.
Input Protection:	Externally accessible 3 A, 250 V fuse

**Continuity / Diode Test**

Response Time:	300 samples / sec with audible tone
Continuity Threshold:	Fixed at 10 $\Omega$

**Autozero OFF Operation (Typical)**

Following instrument warm-up at a stable ambient temperature  $\pm 1$  °C and <5 minutes. Add 0.0002% of range + 2  $\mu$ V for DCV or + 2 m $\Omega$  for resistance.

**Settling Considerations**

Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes. Default delays are selected to give first reading right for most measurements.

**Measurement Considerations**

Agilent recommends the use of Teflon or other high-impedance, low-dielectric absorption wire insulation for these measurements.

## AC Characteristics

**Accuracy Specifications** ( % of reading + % of range ) <sup>[1]</sup>

Function	Range <sup>[3]</sup>	Frequency Range	24 Hour <sup>[2]</sup> $T_{CAL} \pm 1\text{ }^{\circ}\text{C}$	90 Day $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	1 Year $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	Temperature Coefficient $0\text{ }^{\circ}\text{C} - (T_{CAL} - 5\text{ }^{\circ}\text{C})$ $(T_{CAL} + 5\text{ }^{\circ}\text{C}) - 55\text{ }^{\circ}\text{C}$
<b>True RMS AC Voltage</b> <sup>[4]</sup>	100.0000 mV to 750.000 V	3 Hz – 5 Hz	0.50 + 0.02	0.50 + 0.03	0.50 + 0.03	0.010 + 0.003
		5 Hz – 10 Hz	0.10 + 0.02	0.10 + 0.03	0.10 + 0.03	0.008 + 0.003
		10 Hz – 20 kHz	0.02 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003
		20 kHz – 50 kHz	0.05 + 0.04	0.09 + 0.05	0.10 + 0.05	0.010 + 0.005
		50 kHz – 100 kHz	0.20 + 0.08	0.30 + 0.08	0.40 + 0.08	0.020 + 0.008
		100 kHz – 300 kHz	1.00 + 0.50	1.20 + 0.50	1.20 + 0.50	0.120 + 0.020
<b>True RMS AC Current</b> <sup>[5]</sup>	100.0000 $\mu\text{A}$ to 3.00000 A	3 Hz – 5 kHz	0.10 + 0.04	0.10 + 0.04	0.10 + 0.04	0.015 + 0.006
		5 kHz – 10 kHz	0.20 + 0.04	0.20 + 0.04	0.20 + 0.04	0.030 + 0.006

[ 1 ] Specifications are for 90 minute warm-up, slow ac filter, sinewave.

[ 2 ] Relative to calibration standards.

[ 3 ] 20% overrange on all ranges, except 750 Vac, 3 A range.

[ 4 ] Specifications are for sinewave input >0.3% of range and > 1mVrms.

Add 30  $\mu\text{V}$  error to AC voltage specification for frequencies < 1kHz.

750 VAC range limited to  $8 \times 10^7$  Volt-Hz.

750 VAC range add 0.7 mV of error for each additional volt over 300 VAC.

[ 5 ] Specifications are for sinewave input >1% of range and > 10uArms.

Frequencies > 5 kHz are typical for 100  $\mu\text{A}$ , 1 mA, 1.0 A and 3.0 A ranges.

For 3.0 A range add 0.05 + 0.02.

### Low Frequency Performance

Three filter settings are available: 3 Hz, 20 Hz, 200Hz.

Frequencies greater than these filter settings are specified with no additional errors.

### AC Current Burden Voltage

ACI Ranges	Voltage
100.0000 $\mu\text{A}$	<0.03 V
1.000000 mA	<0.3 V
10.00000 mA	<0.03 V
100.0000 mA	<0.3 V
1.000000 A	<0.8 V
3.00000 A	<2.0 V

**Voltage Transfer Accuracy ( typical )**

Frequency	Error
10 Hz to 300 kHz	(24 hour % of range + % of reading)/5
Conditions:	<ul style="list-style-type: none"> <li>- Sinewave input only using slow filter.</li> <li>- Within 10 minutes and <math>\pm 0.5</math> °C.</li> <li>- Within <math>\pm 10\%</math> of initial voltage and <math>\pm 1\%</math> of initial frequency.</li> <li>- Following a 2-hour warm-up.</li> <li>- Fixed range between 10% and 100% of full scale (and &lt;120 V).</li> <li>- Measurements are made using accepted metrology practices</li> </ul>

**True RMS AC Voltage**

Measurement Type	AC-coupled True RMS. Measures the AC component of the input.
Measurement Method:	Digital sampling with anti-alias filter.
AC Common Mode Rejection	70 dB For 1 k $\Omega$ unbalanced in LO lead and <60 Hz. $\pm 500$ V peak maximum.
Maximum Input:	400 Vdc, 1100 Vpeak
Input Impedance:	1 M $\Omega$ $\pm$ 2%, in parallel with <150 pF
Input Protection:	750 V rms all ranges

**True RMS AC Current**

Measurement Type:	Directly coupled to the fuse and shunt. AC-coupled True RMS measurement (measure the AC component only).
Measurement Method:	Digital sampling with anti-alias filter.
Maximum Input:	The peak value of the DC + AC current must be <300% of range. The RMS current <3 A including the DC current content.
Shunt Resistor:	0.1 $\Omega$ for 1A, 3A, 2 $\Omega$ for 10 mA 100 mA, 200 $\Omega$ for 100 $\mu$ A, 1 mA
Input Protection:	Externally accessible 3A, 250 V fuse

**Crest Factor and Peak Input**

Crest Factor:	For <10:1 errors included. Limited by peak input and 300 kHz bandwidth.
Peak Input:	300% of Range. Limited by maximum input
Overload Ranging	Will select higher range if peak input overload is detected during auto range. Overload is reported in manual ranging.

**Settling Considerations**

Default delays are selected to give first reading right for most measurements. The input blocking RC time constant must be allowed to fully settle before the most accurate measurements are possible

## Frequency and Period Characteristics

### Accuracy Specifications ( % of reading ) <sup>[1,3]</sup>

Function	Range	Frequency Range	24 Hour <sup>[2]</sup> $T_{CAL} \pm 1\text{ }^{\circ}\text{C}$	90 Day $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	1 Year $T_{CAL} \pm 5\text{ }^{\circ}\text{C}$	Temperature Coefficient $0\text{ }^{\circ}\text{C} - (T_{CAL} - 5\text{ }^{\circ}\text{C})$ $(T_{CAL} + 5\text{ }^{\circ}\text{C}) - 55\text{ }^{\circ}\text{C}$
Frequency Period	100 mV to 750 V	3 Hz – 5 Hz	0.07	0.07	0.07	0.005
		5 Hz – 10 Hz	0.04	0.04	0.04	0.005
	40 Hz – 300 kHz	10 Hz – 40 Hz	0.02	0.02	0.02	0.001
		40 Hz – 300 kHz	0.005	0.006	0.007	0.001

### Additional Errors ( % of reading ) <sup>[3]</sup>

Frequency	Aperture (resolution / range)			
	1 Second (0.1 ppm)	0.1 Second (1 ppm)	0.01 Second (10 ppm)	0.001 Second (100 ppm)
3 Hz – 5 Hz	0	0.11	0.11	0.11
5 Hz – 10 Hz	0	0.14	0.14	0.14
10 Hz – 40 Hz	0	0.16	0.16	0.16
40 Hz – 300 kHz	0	0.045	0.17	0.17

[ 1 ] Specifications are for 90 minute warm-up, using 1 second aperture.

[ 2 ] Relative to calibration standards.

[ 3 ] For AC input voltages 10% to 120% of range except where noted. 750 V range limited to 750 Vrms. 100 mV range specifications are for full scale or greater inputs. For inputs from 10 mV to 100 mV, multiply total % of reading error by 10.

### Transfer Accuracy ( typical ) 0.0003% of reading

Conditions:

- Within 10 minutes and  $\pm 0.5\text{ }^{\circ}\text{C}$ .
- Within  $\pm 10\%$  of initial voltage and  $\pm 1\%$  of initial frequency.
- Following a 2-hour warm-up.
- For inputs  $> 1\text{ kHz}$  and  $> 100\text{ mV}$
- Using 1 second gate time
- Measurements are made using accepted metrology practices.



**Frequency and Period**

Measurement Type:	Reciprocal-counting technique. AC-coupled input using the AC voltage measurement function.
Input Impedance:	1 M $\Omega$ $\pm$ 2%, in parallel with <150 pF
Input Protection:	750 V rms all ranges

**Measurement Considerations**

All frequency counters are susceptible to error when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

**Settling Considerations**

Errors will occur when attempting to measure the frequency or period of an input following a dc offset voltage change. The input blocking RC time constant must be allowed to fully settle ( up to 1 sec. ) before the most accurate measurements are possible.

## Capacitance Characteristics

**Accuracy Specifications** ( % of reading + % of range )<sup>[1]</sup>

Function	Range [2]	Test Current	1 Year 23 °C ± 5 °C	Temperature Coefficient 0 °C – (T <sub>CAL</sub> – 5 °C) (T <sub>CAL</sub> + 5 °C) – 55 °C
Capacitance	1 nF	500 nA	0.50 + 0.50	0.05 + 0.05
	10 nF	1 µA	0.40 + 0.10	0.05 + 0.01
	100 nF	10 µA	0.40 + 0.10	0.01 + 0.01
	1 µF	100 µA	0.40 + 0.10	0.01 + 0.01
	10 µF	1 mA	0.40 + 0.10	0.01 + 0.01

[ 1 ] Specifications are for 90 minute warm-up using Math Null. Additional errors may occur for non-film capacitors.

[ 2 ] Specifications are for 1% to 120% of range on the 1 nF range and 10% to 120% of range on all other ranges.

### Capacitance

Measurement Type: Current input with measurement of resulting ramp.

Connection Type: 2 Wire

## Temperature Characteristics

**Accuracy Specifications** ( % of reading + % of range )<sup>[1]</sup>

Function	Probe Type	R <sub>0</sub>	Best Range	1 Year	Temperature Coefficient
Temperature	RTD	from 49 Ω to 2.1 kΩ	–200 °C to 600 °C	0.06 °C	0.003 °C
	Thermistor	N/A	–80 °C to 150 °C	0.08 °C	0.002 °C

[ 1 ] For total measurement accuracy, add temperature probe error

## Additional 34411A Specifications

Resolution	See table on <a href="#">page 124</a>
Overall Bandwidth, DCV and DCI	15 kHz typical @ 20 $\mu$ s aperture (–3 dB)
Triggering	Pre or Post, Internal or External, Positive or Negative
Timebase Resolution	19.9524 $\mu$ s, 0.01% accuracy
Trigger Jitter	2 $\mu$ s(p-p), 20 $\mu$ s(p-p) when pre-triggered
External Trigger Latency	< 3 $\mu$ s
Internal Trigger Level Accuracy	1% of range

### Spurious-Free Dynamic Range and SNDR

Function	Range	Spurious-Free Dynamic Range	Signal to Noise Distortion Ratio (SNDR)
DCV	100.0000 mV	–55 dB	40 dB
	1.000000 V	–75 dB	60 dB
	10.00000 V <sup>[1]</sup>	–70 dB	65 dB
	100.0000 V	–75 dB	60 dB
	1000.000 V	–60 dB	55 dB
DCI	100.0000 $\mu$ A <sup>[2]</sup>	–50 dB	38 dB
	1.000000 mA	–65 dB	50 dB
	10.00000 mA	–45 dB	38 dB
	100.0000 mA	–65 dB	50 dB
	1.000000 A	–65 dB	55 dB
	3.00000 A	–70 dB	55 dB

[1] 10 V range specifications are valid for signals  $2 \text{ V(p-p)} < x(t) < 16 \text{ V(p-p)}$

[2] 100  $\mu$ A range specifications are valid for signals  $28.8 \text{ } \mu\text{A(p-p)} < x(t) < 200 \text{ } \mu\text{A(p-p)}$

## Measurement and System Speeds

### DMM Measurements Speeds

Function	Resolution (NPLC)	Direct I/O Measurements <sup>[1]</sup> Single Reading – Measure and I/O Time				Measurement Into Memory (Readings/Sec) (VM Complete)
		GPIB Sec	USB 2.0 Sec	LAN (VXI-11) Sec	LAN (Sockets) Sec	
<b>DCV (10 V Range)</b>	0.001 <sup>[2]</sup>	0.0030	0.0036	0.0050	0.0035	50000
	0.006	0.0030	0.0036	0.0050	0.0035	10000
	0.06	0.0035	0.0044	0.0048	0.0043	1000
	1	0.0200	0.0200	0.0200	0.0200	60
<b>ACV (10 V Range)</b>	Slow Filter	0.0100	0.0100	0.0100	0.0100	50
	Medium Filter	0.0100	0.0100	0.0100	0.0100	150
	Fast Filter	0.0100	0.0100	0.0100	0.0100	500
<b>2–Wire <math>\Omega</math> (10 k<math>\Omega</math> Range)</b>	0.001 <sup>[2]</sup>	0.0035	0.0036	0.0049	0.0035	50000
	0.006	0.0035	0.0036	0.0049	0.0035	10000
	0.06	0.0043	0.0045	0.0049	0.0043	1000
	1	0.0195	0.0200	0.0200	0.0200	60
<b>4–wire <math>\Omega</math> (10 k<math>\Omega</math> Range)</b>	0.001 <sup>[2]</sup>	0.0054	0.0040	0.0045	0.0056	1500
	0.006	0.0054	0.0040	0.0045	0.0056	1200
	0.06	0.0074	0.0078	0.0078	0.0074	380
	1	0.0390	0.0390	0.0390	0.0390	30
<b>Frequency 1 KHz, 10 V Range Fast Filter</b>	1 ms Gate	0.0100	0.0100	0.0100	0.0100	500
	10 mS Gate	0.0200	0.0200	0.0200	0.0200	80
	100 mS Gate	0.1150	0.1150	0.1130	0.1130	10
	1 S Gate	1.0200	1.0200	1.0200	1.0200	1
<b>Capacitance (100 nF Range)</b>		0.0820	0.0820	0.0820	0.0820	11

[1] Typical. Display off, ½ scale input signal, immediate trigger, trigger delay 0, autozero off, autorange off, no math, 60 Hz line, null off, sample count 1, trig count 1

[2] 0.001 PLC applies to 34411A only.

**Direct I/O Measurements** <sup>[1]</sup> (any remote interface)

Sustained maximum reading rate to I/O, 32-bit BINARY data ("SAMP:COUN 50000::R?")

Function	Resolution (NPLC)	rdgs/Sec
<b>DCV</b>	0.001	50000 (34411A only)
	0.006	10000
<b>ACV</b>	Fast Filter	500
<b>2-Wire <math>\Omega</math></b>	0.001	50000 (34411A only)
	0.006	10000
<b>4-Wire <math>\Omega</math></b>	0.001	1500 (34411A only)
	0.006	1200
<b>Frequency/Period (1 k rdgs)</b>	1 mS gate, fast filter	450
<b>Capacitance (100 rdgs)</b>		10

[1] ½ scale input signal, immediate trigger, trigger delay 0, autozero off, autorange off, no math, 60 Hz line, null off, sample count 50000, trigger count INF

**Data From Memory****Maximum reading rate out of memory**

(Sample count 50000, trigger count 1, "FETC?" or "R?")

Readings	GPIB rdg/Sec	USB 2.0 rdg/Sec	LAN (VXI-11) rgs/Sec	LAN (Sockets) rdg/Sec
<b>ASCII</b>	4000	8500	7000	8500
<b>4-byte Binary</b>	89,000	265,000	110,000	270,000
<b>8-byte Binary</b>	47,000	154,000	60,000	160,000

**System Speeds**

	Configuration <sup>[2]</sup> (Sec)	Range <sup>[3]</sup> Change (Sec)	Auto Range <sup>[4]</sup> (Sec)	Maximum External Trigger Rate <sup>[1]</sup>	Maximum Internal Trigger Rate <sup>[1]</sup>
<b>DCV</b>	0.022	0.0055	0.0075	5000 / S	10000 / S
<b>ACV</b>	0.037	0.0065	0.019	500 / S	500 / S
<b>2/4-Wire <math>\Omega</math></b>	0.022	0.0055	0.0075	5000 / S	10000 / S
<b>Frequency/Period</b>	0.037	0.0065	0.019	500 / S	500 / S

[1] Readings to memory.

[2] Time for configuration change from 2W ohms to listed function (or from dc volts to 2W ohms) using appropriate FUNCtion command.

[3] Time to change from one range to next higher range, <=10V, <=10Mohm.

[4] Time to automatically change one range and be ready for new measurement, <=10V, <=10Mohm.

## General Specifications

Power Supply:	100V/120V/ 220V / 240V ± 10%
Power Line Frequency:	50–60 Hz ± 10%, 400 Hz ± 10%. Automatically sensed at power–on, 400 Hz defaults to 50Hz.
Power Consumption:	25 VA peak ( 16 W average )
Operating Environment:	Full accuracy for 0 °C to 55 °C Full accuracy to 80% R.H. at 40 °C Non–condensing
Storage Temperature	–40 °C to 70 °C
Operating Altitude	Up to 3000m
Rack Dimensions (WxHxD):	212.8mm x 88.3mm x 272.3mm
Bench Dimensions (WxHxD):	261.2mm x 103.8mm x 303.2mm
Weight:	3.72 kg (8.2 lbs)
Safety:	IEC 61010-1 EN 61010-1 UL 61010-1 CAN/CSA-C22.2 No. 61010-1 Refer to Declaration of Conformity for current revisions. Measurement CAT II 300V, CAT I 1000V Pollution Degree 2
EMC:	IEC 61326 EN 61326 CISPR 11 ICES-001 AS/NZS 2064.1 Refer to Declaration of Conformity for current revisions.
Acoustic Noise	37 dBa
Display:	Dual–line, 17–segment vacuum florescent display
State Storage Memory	Power Off state automatically saved, 4 User Configurable Stored States
Remote Interfaces	GPIO IEEE–488, 10/100Mbit LAN, USB 2.0 Standard
Language	SCPI – 1999, IEEE–488.2
LXI Compliance	LXI Class C, version 1.0
Warm–up Time	90 minutes

**Triggering and Memory**

Reading Hold Sensitivity: 1% of reading

Samples per Trigger: 1 to 50,000 (*34410A*)1 to 1,000,000 (*34411A*)Trigger Delay: 0 to 3600 sec (20  $\mu$ s step size)**External Trigger** Low-power TTL compatible input programmable edge triggeredDelay: < 1  $\mu$ sJitter: < 1  $\mu$ s

Max rate up to 5 kHz

Min Pulsewidth 1  $\mu$ s**Voltmeter Complete** 3 V Logic output

Polarity Programmable edge pulse

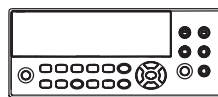
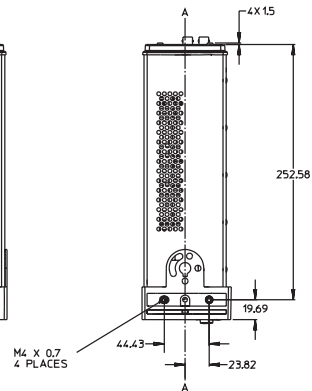
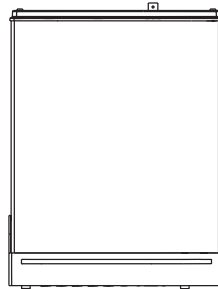
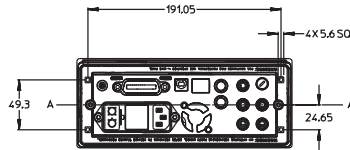
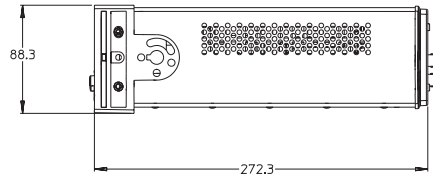
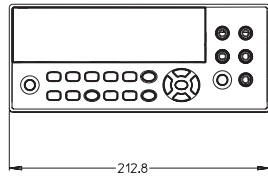
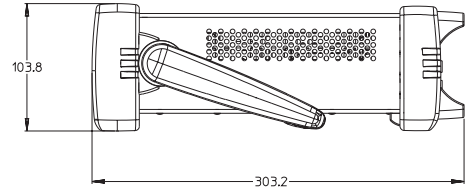
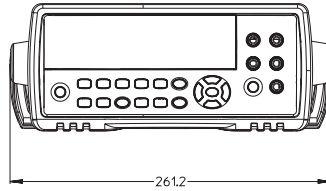
Pulsewidth Approximately 2  $\mu$ s

Non-volatile Memory 50,000 reading

**Sample Timer**Range Up to 3600 sec in 20  $\mu$ s steps

Jitter &lt; 100 ns

Dimensions



All dimensions are shown in millimeters



## To Calculate Total Measurement Error

The multimeter's accuracy specifications are expressed in the form: ( % of reading + % of range ). In addition to the reading error and range error, you may need to add additional errors for certain operating conditions. Check the list below to make sure you include all measurement errors for a given function. Also, make sure you apply the conditions as described in the footnotes on the specification pages.

- If you are operating the multimeter outside the temperature range specified, apply an additional temperature coefficient error.
- For dc voltage, dc current, and resistance measurements, you may need to apply an additional reading speed error or autozero OFF error.
- For ac voltage and ac current measurements, you may need to apply an additional low frequency error or crest factor error.

**Understanding the " % of reading " Error** The reading error compensates for inaccuracies that result from the function and range you select, as well as the input signal level. The reading error varies according to the input level on the selected range. This error is expressed in percent of reading. The following table shows the reading error applied to the multimeter's 24-hour dc voltage specification.

Range	Input Level	Reading Error (% of reading)	Reading Error (Voltage)
10 VDC	10 VDC	0.0015	$\pm 150 \mu\text{V}$
10 VDC	1 VDC	0.0015	$\pm 15 \mu\text{V}$
10 VDC	0.1 VDC	0.0015	$\pm 1.5 \mu\text{V}$

**Understanding the " % of range " Error** The range error compensates for inaccuracies that result from the function and range you select. The range error contributes a constant error, expressed as a percent of range, independent of the input signal level. The following table shows the range error applied to the multimeter's 24-hour dc voltage specification.

Range	Input Level	Range Error (% of range)	Range Error (Voltage)
10 VDC	10 VDC	0.0004	$\pm 40 \mu\text{V}$
10 VDC	1 VDC	0.0004	$\pm 40 \mu\text{V}$
10 VDC	0.1 VDC	0.0004	$\pm 40 \mu\text{V}$

**Total Measurement Error** To compute the total measurement error, add the reading error and range error. You can then convert the total measurement error to a "percent of input" error or a "ppm (parts-per-million) of input" error as shown below.

$$\% \text{ of input error} = \frac{\text{Total Measurement Error}}{\text{Input Signal Level}} \times 100$$

$$\text{ppm of input error} = \frac{\text{Total Measurement Error}}{\text{Input Signal Level}} \times 1,000,000$$

**Error Example** Assume that a 5 VDC signal is input to the multimeter on the 10 V range. Compute the total measurement error using the 90-day accuracy specifications:  $\pm (0.0020\%$  of reading +  $0.0005\%$  of range).

$$\text{Reading Error} = 0.0020\% \times 5 \text{ VDC} = 100 \mu\text{V}$$

$$\text{Reading Error} = 0.0020\% \times 5 \text{ VDC} = 100 \mu\text{V}$$

$$\begin{aligned} \text{Total Error} &= 100 \mu\text{V} + 50 \mu\text{V} &&= \pm 150 \mu\text{V} \\ & &&= \pm 0.003\% \text{ of } 5 \text{ VDC} \\ & &&= \pm 30 \text{ ppm of } 5 \text{ VDC} \end{aligned}$$

## Accuracy Specifications

### Transfer Accuracy

Transfer accuracy refers to the error introduced by the multimeter due to noise and short-term drift. This error becomes apparent when comparing two nearly-equal signals for the purpose of "transferring" the known accuracy of one device to the other.

### 24-Hour Accuracy

The 24-hour accuracy specification indicates the multimeter's relative accuracy over its full measurement range for short time intervals and within a stable environment. Short-term accuracy is usually specified for a 24-hour period and for a  $\pm 1$  °C temperature range.

### 90-Day and 1-Year Accuracy

These long-term accuracy specifications are valid at the calibration temperature ( $T_{cal}$ )  $\pm 5$  °C temperature range. These specifications include the initial calibration errors plus the multimeter's long-term drift errors.

### Temperature Coefficients

Accuracy is usually specified at the calibration temperature ( $T_{cal}$ )  $\pm 5$  °C temperature range. This is a common temperature range for many operating environments. You must add additional temperature coefficient errors to the accuracy specification if you are operating the multimeter outside the  $\pm 5$  °C temperature range (the specification is per °C).

## Configuring for Highest Accuracy Measurements

The measurement configurations shown below assume that the multimeter is in its power-on or reset state. It is also assumed that auto-ranging is enabled to ensure proper full scale range selection.

### DC Voltage, DC Current, and Resistance Measurements:

- Select NPLC and 100 (NPLCs) for INTEGRATION.
- Set INPUT Z to HI-Z (for the 100 mV, 1 V, and 10 V ranges) for the best dc voltage accuracy.
- Use the 4-wire ohms function ( $\Omega$  4W) for the best resistance measurement accuracy.
- For 2-wire ohms, dc voltage and dc current measurements, set AUTOZERO to ON to remove thermal EMF and offset errors.
- Null the test lead resistance for 2-wire ohms measurements, and to remove any interconnection offset for dc voltage measurements.

### AC Voltage and AC Current Measurements:

- Set the AC FILTER to 3 Hz: SLOW.

### Frequency and Period Measurements:

- Set the GATE TIME to 1 sec.

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