Agilent 34401A Multimeter

Uncompromising Performance for Benchtop and System Testing

Product Overview

- **Measure up to 1000 volts with 6½ digits resolution**
- **0.0015% basic dcV accuracy (24 hour)**
- **0.06% basic acV accuracy (1 year)**
- **3Hz to 300kHz ac bandwidth**
- **1000 readings/sec. direct to GPIB**

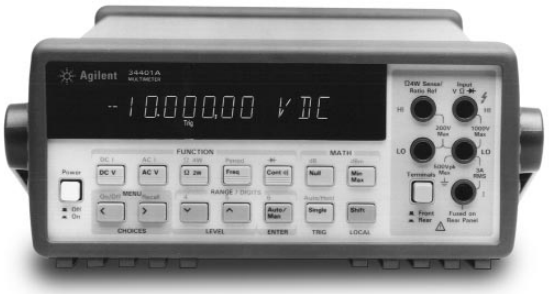
Superior performance

The Agilent Technologies 34401A multimeter gives you the performance you need for fast, accurate bench and system testing. The 34401A provides a combination of resolution, accuracy and speed that rivals DMMs costing many times more. 6½-digits of resolution, 0.0015% basic 24-hr dcV accuracy and 1,000 readings/sec direct to GPIB assure you of results that are accurate, fast, and repeatable.

Use it on your benchtop

The 34401A was designed with your bench needs in mind. Functions commonly associated with bench operation, like continuity and diode test, are built in. A Null feature allows you to remove lead resistance and other fixed offsets in your measurements. Other capabilities like min/max/avg readouts and direct dB and dBm measurements make checkout with the 34401A faster and easier.

The 34401A gives you the ability to store up to 512 readings in internal memory. For trouble-shooting, a reading hold feature lets you concentrate on placing your test leads without having to constantly glance at the display.



Use it for systems testing

For systems use, the 34401A gives you faster bus throughput than any other DMM in its class. The 34401A can send up to 1,000 readings/sec directly across GPIB in user-friendly ASCII format.

You also get both GPIB and RS-232 interfaces as standard features. Voltmeter Complete and External Trigger signals are provided so you can synchronize to other instruments in your test system. In addition, a TTL output indicates Pass/Fail results when limit testing is used.

To ensure both forward and backward compatibility, the 34401A includes three command languages (SCPI, Agilent 3478A and Fluke 8840A /42A), so you don't have to rewrite your existing test software. An optional rack mount kit is available.

Easy to use

Commonly accessed attributes, such as functions, ranges, and resolution are selected with a single button press.

Advanced features are available using menu functions that let you optimize the 34401A for your applications.

To further increase your productivity, the 34401A can be used in conjunction with HP 34812A BenchLink Meter software. The Windows-based program lets you configure and initiate measurements from your computer, and transfer results from your test instrument to your PC. It even enables direct temperature measurements with the 34401A and an RTD or thermistor probe. HP BenchLink Meter also lets you create graphs, charts and histo-grams to help you evaluate results.

3-year warranty

With your 34401A, you get full documentation, a high-quality test lead set, calibration certificate with test data, and a 3-year warranty, all for one low price.

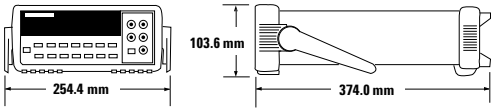
Agilent Technologies

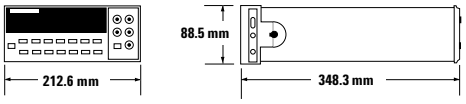
Innovating the HP Way

Accuracy Specifications ± (% of reading + % of range) [1]

Function	Range[3]	Frequency, etc.	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient 0°C – 18°C 28°C – 55°C
dc Voltage	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	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		**0.0015 + 0.0004**	**0.0020 + 0.0005**	**0.0035 + 0.0005**	**0.0005 + 0.0001**
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	1000.000 V		0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010	0.0005 + 0.0001
True rms ac Voltage[4]	100.0000 mV	3 Hz - 5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz - 10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz - 20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
		20 kHz - 50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.04	0.011 + 0.005
		50 kHz - 100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz - 300 kHz[6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
	1.000000 V	3 Hz - 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
	to	5 Hz - 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
	750.000 V	**10 Hz - 20 kHz**	**0.04 + 0.02**	**0.05 + 0.03**	**0.06 + 0.03**	**0.005 + 0.003**
		20 kHz - 50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.04	0.011 + 0.005
		50 kHz - 100 kHz[5]	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz - 300 kHz[6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
Resistance[7]	100.0000 Ω	1 mA Current Source	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 µA	**0.0020 + 0.0005**	**0.008 + 0.001**	**0.010 + 0.001**	**0.0006 + 0.0001**
	100.0000 kΩ	10 µA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5.0 µA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA || 10MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
dc Current	10.00000 mA	<0.1 V Burden Voltage	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.002 + 0.0020
	100.0000 mA	<0.6 V	**0.010 + 0.004**	**0.030 + 0.005**	**0.050 + 0.005**	**0.002 + 0.0005**
	1.000000 A	<1 V	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.005 + 0.0010
	3.00000 A	<2 V	0.100 + 0.020	0.120 + 0.020	0.120 + 0.020	0.005 + 0.0020
True rms ac Current[4]	**1.000000 A**	3 Hz - 5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz - 10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
		10 Hz - 5 kHz	**0.10 + 0.04**	**0.10 + 0.04**	**0.10 + 0.04**	**0.015 + 0.006**
	3.00000 A	3 Hz - 5 Hz	1.10 + 0.06	1.10 + 0.06	1.10 + 0.06	0.100 + 0.006
		5 Hz - 10 Hz	0.35 + 0.06	0.35 + 0.06	0.35 + 0.06	0.035 + 0.006
		10 Hz - 5 kHz	0.15 + 0.06	0.15 + 0.06	0.15 + 0.06	0.015 + 0.006
Frequency or Period[8]	100 mV	3 Hz - 5 Hz	0.10	0.10	0.10	0.005
	to	5 Hz - 10 Hz	0.05	0.05	0.05	0.005
	750 V	10 Hz - 40 Hz	0.03	0.03	0.03	0.001
		40 Hz - 300 kHz	**0.006**	**0.01**	**0.01**	**0.001**
Continuity	1000.0Ω	1mA Test Current	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
Diode Test	1.0000V	1mA Test Current	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002

[1] Specifications are for 1hr warm-up and 6½ digits, Slow ac filter.
[2] Relative to calibration standards.
[3] 20% over range on all ranges except 1000Vdc and 750Vac ranges.
[4] For sinewave input > 5% of range. For inputs from 1% to 5% of range and < 50kHz, add 0.1% of range additional error.
[5] 750V range limited to 100 kHz or 8 x107 Volt-Hz.
[6] Typically 30% of reading error at 1MHz.
[7] Specifications are for 4- wire ohms function or 2-wire ohms using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire ohms function.
[8] Input >100 mV. For 10 mV inputs multiply % of reading error x10.





Measurement Characteristics

dc Voltage			
Measurement Method	Continuously Integrating Multi-slope III A-D Converter		
A-D Linearity	0.0002% of reading + 0.0001 % of range		
Input Resistance			
0.1V, 1V,10 V ranges	Selectable 10 MΩ or >10,000 MΩ		
100 V, 1000 V ranges	10 MΩ ± 1%		
Input Bias Current	< 30pA at 25° C		
Input Protection	1000 V all ranges		
dcV:dcV Ratio Accuracy	V_{input} Accuracy + $V_{reference}$ Accuracy		

True rms ac Voltage			
Measurement Method	ac coupled True rms – measures the ac component of the input with up to 400 Vdc of bias on any range.		
Crest Factor	Maximum of 5:1 at Full Scale		
Additional Crest Factor Errors (non-sinewave)			
	Crest Factor	1–2	0.05 % of reading
	Crest Factor	2–3	0.15 % of reading
	Crest Factor	3–4	0.30 % of reading
	Crest Factor	4–5	0.40 % of reading
Input Impedance	1 MΩ ± 2% in parallel with 100 pF		
Input Protection	750Vrms all ranges		

Resistance	
Measurement Method	Selectable 4-wire or 2-wire Ohms. Current source referenced to LO input.
Maximum Lead Resistance (4-wire)	10% of range per lead for 100Ω and 1kΩ ranges. 1kΩ per lead on all other ranges.
Input Protection	1000 V all ranges

dc Current	
Shunt Resistance	5Ω for 10 mA,100 mA; 0.1 Ω for 1 A, 3 A
Input Protection	Externally accessible 3 A 250 V Fuse Internal 7 A 250 V Fuse

True rms ac Current	
Measurement Method	Direct coupled to the fuse and shunt. ac coupled True rms measurement (measures the ac component only).
Shunt Resistance	0.1 Ω for 1 A and 3 A ranges
Input Protection	Externally accessible 3 A 250 V Fuse Internal 7 A 250 V Fuse

Frequency and Period	
Measurement Method	Reciprocal counting technique
Voltage Ranges	Same as ac Voltage Function
Gate Time	1 s, 100 ms, or 10 ms.

Continuity / Diode	
Response Time	300 samples/s with audible tone
Continuity Threshold	Selectable from 1 Ω to 1000 Ω

Measurement Noise Rejection 60 (50) Hz [1]	
dc CMRR	140 dB
ac CMRR	70 dB

Integration Time	**Normal Mode Rejection** [2]
100 plc / 1.67 s (2 s)	60 dB [3]
10 plc / 167 ms (200 ms)	60 dB [3]
1 plc / 16.7 ms (20 ms)	60 dB
<1 plc / 3 ms or 800 µs	0 dB

Operating Characteristics [4]

Function	**Digits**	**Readings/s**	
dcV, dcI, and	6½	0.6 (0.5)	
Resistance	6½	6 (5)	
	5½	60 (50)	
	5½	300	
	4½	1000	
acV, acI	6½	0.15	Slow (3Hz)
	6½	1	Medium (20Hz)
	6½	10	Fast (200Hz)
	6½	50[5]	
Frequency or	6½	1	
Period	5½	9.8	
	4½	80	

System Speeds [6]	
Configuration Rates	26/s to 50/s
Autorange Rate (dc Volts)	> 30/s
ASCII readings to RS-232	55/s
ASCII readings to GPIB	1000/s
Maximum Internal Trig. Rate	1000/s
Max. Ext. Trig. Rate to Memory	1000/s

Triggering and Memory	
Reading HOLD Sensitivity	10%, 1%, 0.1%,or 0.01% of range
Samples/ trigger	1 to 50,000
Trigger Delay	0 to 3600 s: 10 µs step size
External Trigger Delay	< 1 ms
External Trigger Jitter	< 500 µs
Memory	512 readings

Math Functions

NULL, Min/Max/Average, dBm, dB, Limit Test (with TTL output)

Standard Programming Languages

SCPI (IEEE-488.2), Agilent 3478A, Fluke 8840A/42A

Accessories Included

Test Lead Kit with probe, alligator, and grabber attachments.
Operating Manual, Service Manual, test report, and power cord.

General Specifications	
Power Supply	100 V/120 V/220 V/240 V ±10%
Power Line Frequency	45 Hz to 66 Hz and 360 Hz to 440 Hz Automatically sensed at power-on
Power Consumption	25 VA peak (10W average)
Operating Environment	Full accuracy for 0° C to 55° C Full accuracy to 80% R.H. at 40° C
Storage Environment	– 40° C to 70° C
Weight	3.6 kg (8.0 lbs)
Safety	Designed to CSA, UL-1244, IEC-348
RFI and ESD	MIL-461C, FTZ 1046, FCC
Vibration and Shock	MIL-T-28800E, Type III, Class 5 (Sine Only)
Warranty	3 years

[1] For 1kΩ unbalance in LO lead.
[2] For power line frequency ± 0.1%.
[3] For power line frequency ± 1% use 40dB or ± 3% use 30dB.
[4] Reading speeds for 60Hz and (50Hz) operation.
[5] Maximum useful limit with default settling delays defeated.
[6] Speeds are for 4½ digits, Delay 0, Auto-zero and Display OFF.

Ordering Information

Agilent 34401A Multimeter

Accessories included

Test Lead Kit with probe, alligator, and grabber attachments, operating manual, service manual, calibration certificate, test report, and power cord.

Options

Opt. 908 Rack Mount Kit* (P/N 5062-3972)
Opt. 910 Extra manual set (English)
Opt. 0B0 DMM without manuals
Opt. W50 Additional 2-year warranty (5-year total)
Opt. 1BP MIL-STD-45662A calibration with data

Manual options (please specify one)

ABA US English
ABD German
ABE Spanish
ABF French
ABJ Japanese
ABZ Italian
ABO Taiwan Chinese
AB1 Korean
AB2 Chinese
AKT Russian

Agilent Accessories

11059A Kelvin Probe set
11060A Surface Mount Device (SMD) test probes
11062A Kelvin clip set
34131 Hard Transit Case
34161A Accessory pouch
34330A 30 A current shunt
34812A BenchLink Meter software
E2308A 5K thermistor probe

*For racking two side-by-side, order both items below
Lock link kit (P/N 5061-9694)
Flange kit (P/N 5063-9212)

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

"Our Promise" means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

"Your Advantage" means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

Get assistance with all your test and measurement needs at:

www.agilent.com/find/assist

Or check your local phone book for the Agilent office near you.

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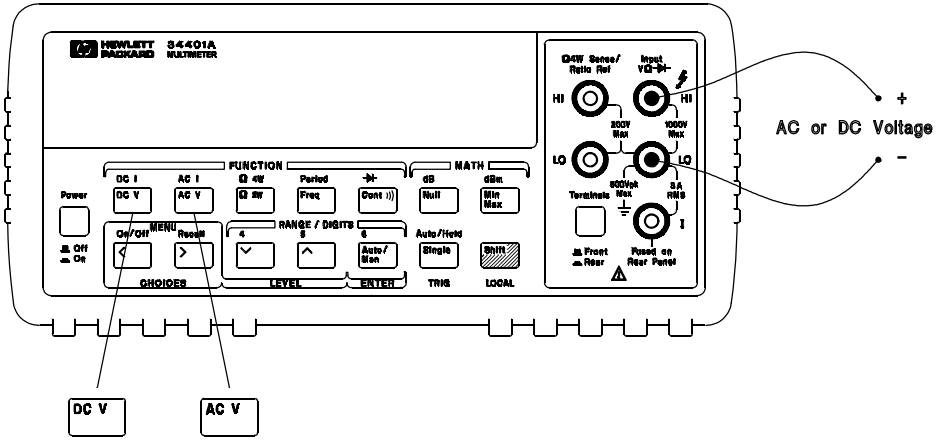
Innovating the HP Way

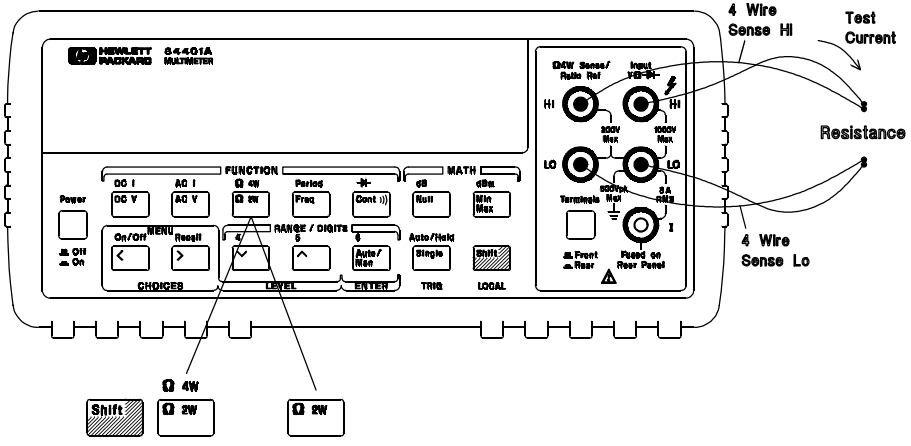
To Measure Voltage

Ranges: 100 mV, 1 V, 10 V, 100 V, 1000 V (750 Vac)
Maximum resolution: 100 nV (*on 100 mV range*)
AC technique: true RMS, ac-coupled



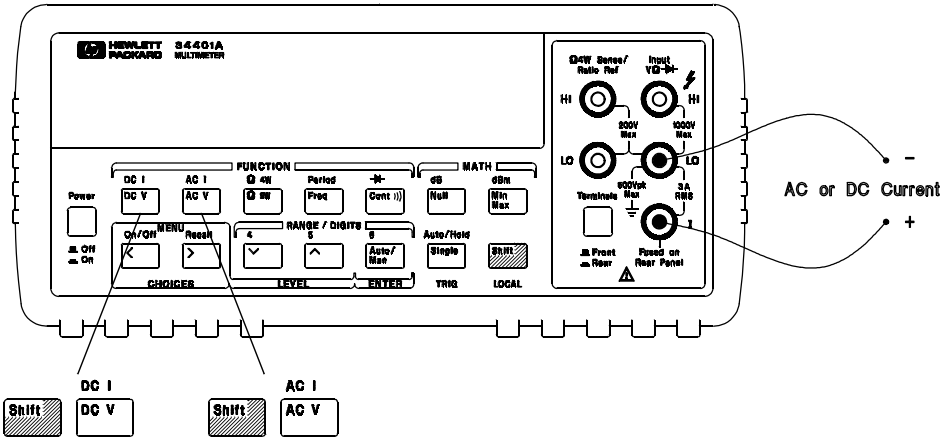
To Measure Resistance

Ranges: 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, 100 MΩ
Maximum resolution: 100 μΩ (*on 100 ohm range*)



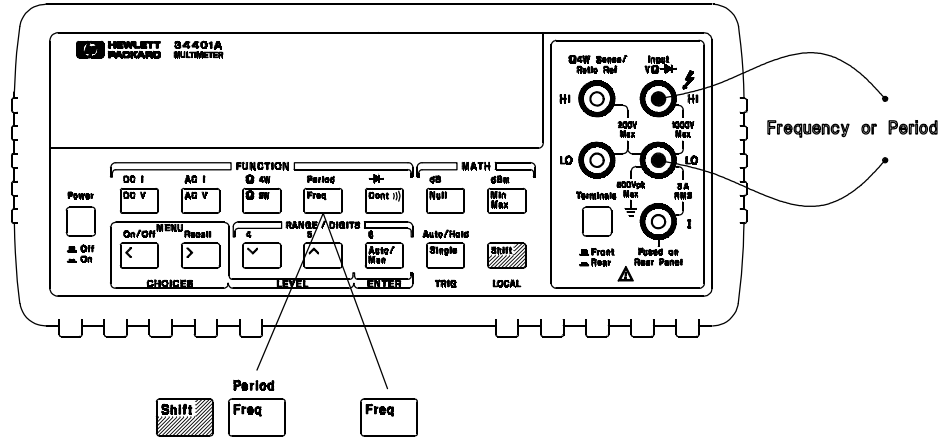
To Measure Current

Ranges: 10 mA (dc only), 100 mA (dc only), 1 A , 3 A
Maximum resolution: 10 nA (*on 10 mA range*)
AC technique: true RMS, ac-coupled



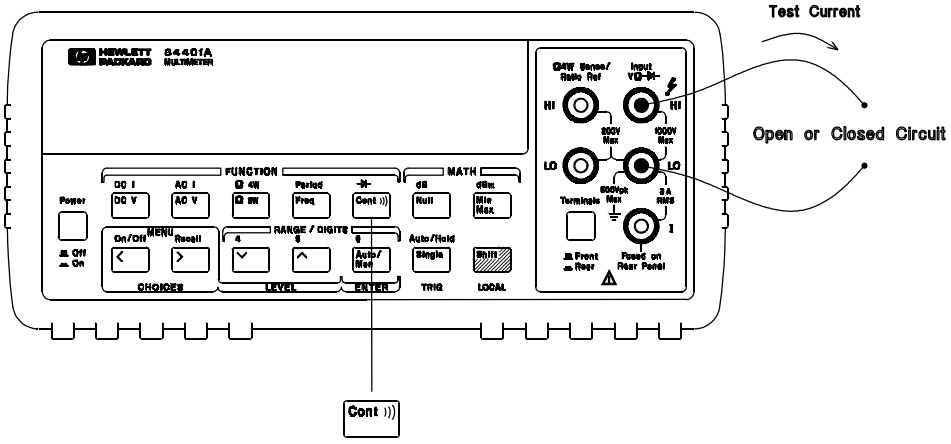
To Measure Frequency (or Period)

Measurement band: 3 Hz to 300 kHz (0.33 sec to 3.3 µsec)
Input signal range: 100 mVac to 750 Vac
Technique: reciprocal counting



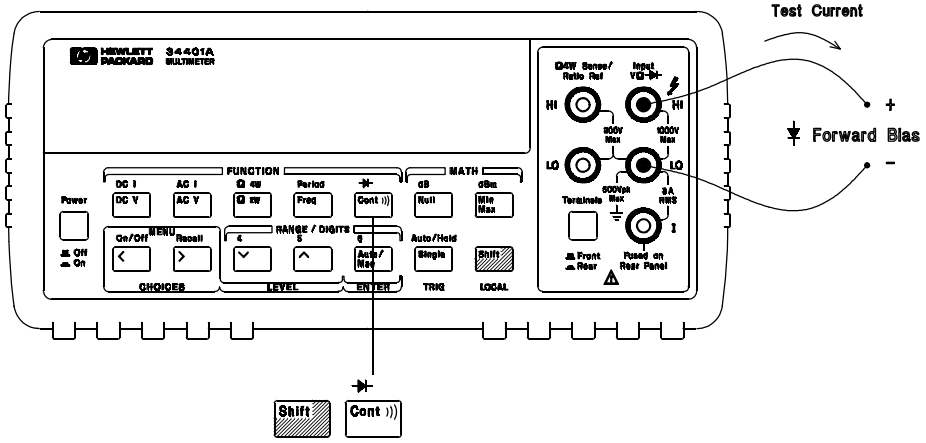
To Test Continuity

Test current source: 1 mA
Maximum resolution: 0.1 Ω (*range is fixed at 1 kohm)*
Beeper threshold: 1 Ω to 1000 Ω (*beeps below adjustable threshold*)



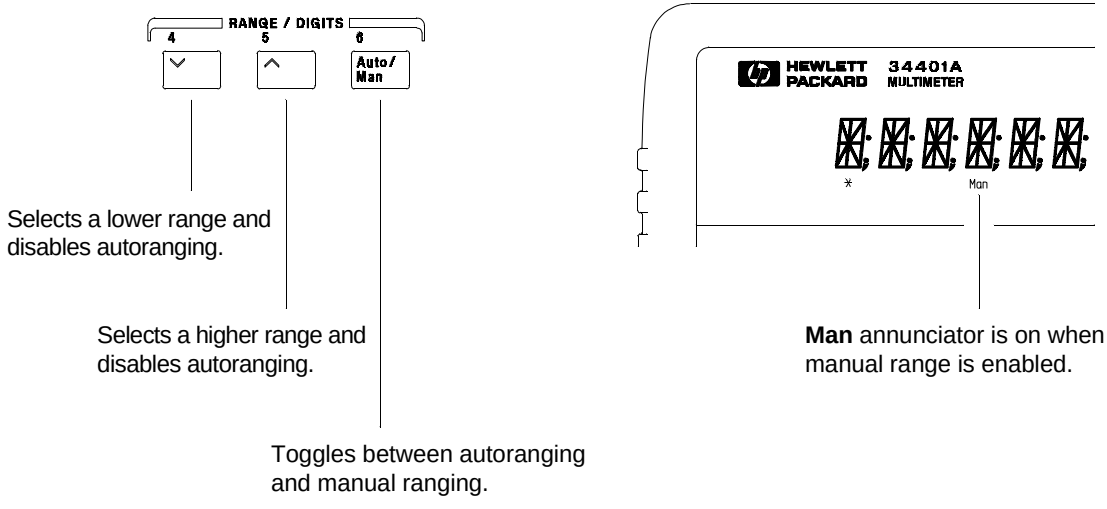
To Check Diodes

Test current source: 1 mA
Maximum resolution: 100 µV (*range is fixed at 1 Vdc*)
Beeper threshold: 0.3 volts $\leq V_{measured} \leq$ 0.8 volts (*not adjustable*)



To Select a Range

You can let the multimeter automatically select the range using *autoranging* or you can select a fixed range using *manual ranging*.

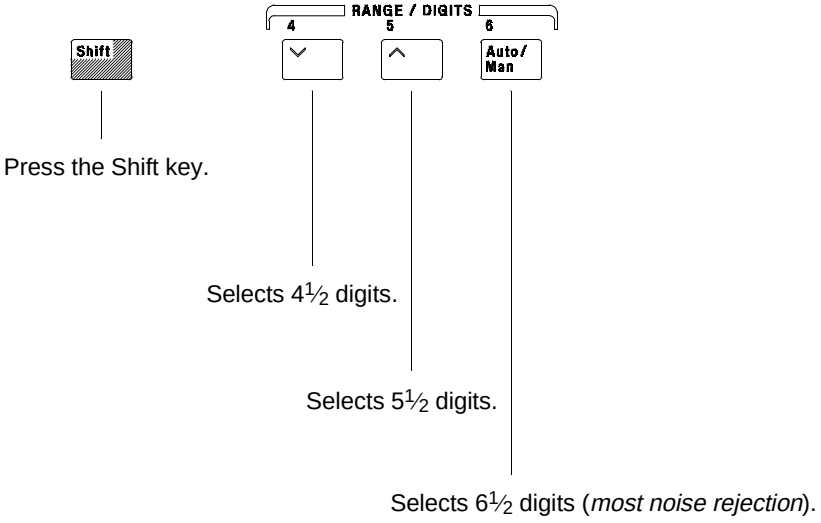


- Autoranging is selected at power-on and after a remote interface reset.
- Autorange thresholds:
  Down range at <10% of range
  Up range at >120% of range
- If the input signal is greater than the present range can measure, the multimeter will give an *overload* indication ("OVLD").
- For frequency and period measurements from the front panel, ranging applies to the signal's input *voltage*, not its frequency.
- The range is fixed for continuity (1 kΩ range) and diode (1 Vdc range).

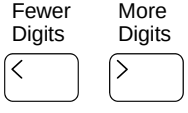
Ranging is local to the selected function. This means that you can select the ranging method (auto or manual) for each function independently. When manually ranging, the selected range is local to the function; the multimeter remembers the range when you switch between functions.

To Set the Resolution

You can set the display resolution to 4½, 5½, or 6½ digits either to optimize measurement speed or noise rejection. In this book, the most significant digit (leftmost on the display) is referred to as the "½" digit, since it can only be a "0" or "1."

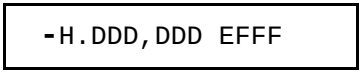


- The resolution is set to 5½ digits at power-on and after a remote interface reset.
- The resolution is fixed at 5½ digits for continuity and diode tests.
- You can also vary the number of digits displayed using the arrow keys (however, the integration time is not changed).



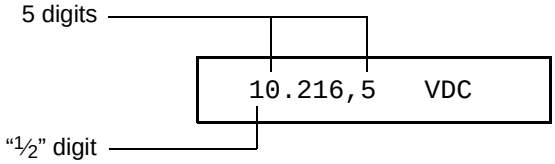
Resolution is local to the selected function. This means that you can select the resolution for each function independently. The multimeter remembers the resolution when you switch between functions.

Front-Panel Display Formats

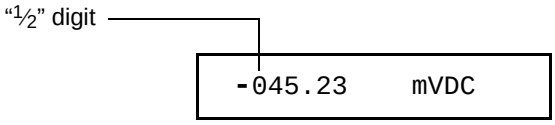


Front-panel display format.

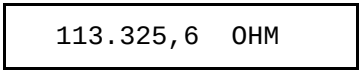
– Negative sign or blank (positive)
H " ½ " digit (0 or 1)
D Numeric digits
E Exponent (m, k, M)
F Measurement units (VDC, OHM, HZ, dB)



This is the 10 Vdc range, 5½ digits are displayed.



This is the 100 mVdc range, 4½ digits are displayed.



This is the 100 ohm range, 6½ digits are displayed.

This is an overload indication on the 100 mVdc range.

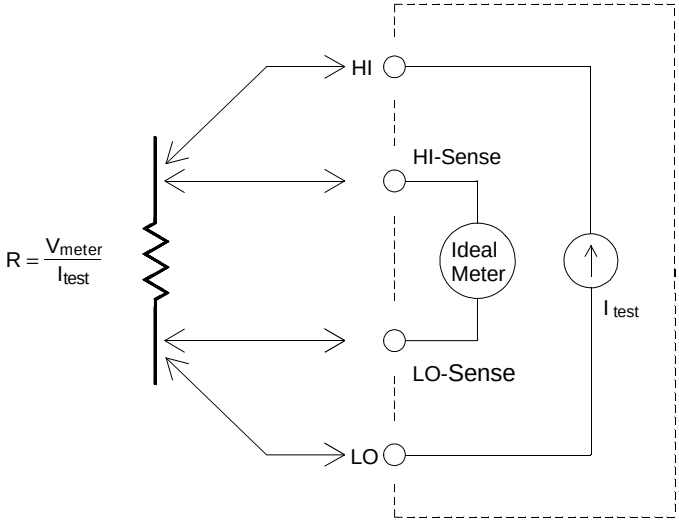
Resistance Measurements

The HP 34401A 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.

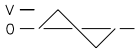
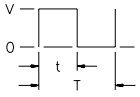
4-Wire Ohms Measurements

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 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 Measure Resistance," on page 17.*



True RMS AC Measurements

True RMS responding multimeters, like the HP 34401A, measure the "heating" potential of an applied voltage. Unlike an "average responding" measurement, a true RMS measurement is used to determine the power dissipated in a resistor. The power is proportional to the square of the measured true RMS voltage, independent of waveshape. An average responding ac multimeter is calibrated to read the same as a true RMS meter for *sinewave inputs only*. For other waveform shapes, an average responding meter will exhibit substantial errors as shown below.

Waveform Shape	Crest Factor (C.F.)	AC RMS	AC+DC RMS	Average Responding Error
	1.414	$\frac{V}{1.414}$	$\frac{V}{1.414}$	Calibrated for 0 error
	1.732	$\frac{V}{1.732}$	$\frac{V}{1.732}$	−3.9%
	$\sqrt{\frac{T}{t}}$	$\frac{V}{C.F.} \times \sqrt{1-\left(\frac{1}{C.F.}\right)^2}$	$\frac{V}{C.F.}$	−46% for C.F. = 4

The multimeter's ac voltage and ac current functions measure the ac-coupled true RMS value. This is in contrast to the ac+dc true RMS value shown above. Only the "heating value" of the ac components of the input waveform are measured (dc is rejected). For sinewaves, triangle waves, and square waves, the ac and ac+dc values are equal since these waveforms do not contain a dc offset. Non-symmetrical waveforms, such as pulse trains, contain dc voltages which are rejected by ac-coupled true RMS measurements.

An ac-coupled true RMS measurement is desirable in situations where 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. You should perform the dc measurement using at least 10 power line cycles of integration (6 digit mode) for best ac rejection.

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

Crest Factor Errors (non-sinusoidal inputs)

A common misconception is that "since an ac multimeter is true RMS, its sinewave accuracy specifications apply to all waveforms." Actually, the shape of the input signal can dramatically affect measurement accuracy. A common way to describe signal waveshapes is *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 as shown in the table on the previous page. In general, the greater the crest factor, the greater the energy contained in higher frequency harmonics. All multimeters exhibit measurement errors that are crest factor dependent. Crest factor errors for the HP 34401A are shown in the specifications in chapter 8. Note that the crest factor errors do not apply for input signals below 100 Hz when using the slow ac filter.