

34401A Digital Multimeter, 6.5 Digit

Frequently-Asked Questions (FAQs)

How do I calculate total measurement error on the Agilent 34401A?

The accuracy specifications for the Agilent 34401A are expressed in the form: "% of reading + % of range" which match the dominate sources of error gain and offset.

The **reading** error term is from inaccuracies in amplifier gains, divider ratios or internal reference voltages. The **range** error term is from inaccuracies in amplifier offsets, leakage current effects and thermocouple effects. Total measurement error is the sum of the readings and range errors.

Example: Assume that you want to measure a 5 Vdc signal using the Agilent 34401A that you purchased nine months ago. The one-year accuracy specification for the 10 Vdc range (assumes 6.5 digits of resolution) is: 0.0035% of reading + 0.0005% of range. Which is $(0.000035) \times (5V) + (0.000005) \times (10V)$ or 225 μV .

Therefore, assuming that you are measuring the output from a perfect 5.000000 Vdc source, your reading will fall between 4.999775 and 5.000225 V.



How does excessive heat and cold affect the accuracy of my measurements?

This can be determined by using the temperature coefficients published in the User's Guide. Consult the accuracy specifications in either the User's Guide or on the Agilent 34401A Data Sheet. Notice the "Temperature Coefficient/degree C" column. Multiply the appropriate temperature coefficient by one for each degree Celsius that your environment differs from the given temperature ranges. Add the resulting number pair to the standard 24 Hour, 90 Day, or 1 Year accuracy specifications.

EXAMPLE:

You are measuring a 500 mV dc voltage at 10 degrees Celsius. You are interested in the one-year accuracy of this measurement.

1. Determine the range. (1.000000 V)
2. Read the % of reading + % of range number pair (0.0040 + 0.0007)
3. Read the corresponding temperature coefficient (0.0005 + 0.0001)
4. Multiply the temperature coefficient by the number of degrees Celsius that your environment is below 18 degrees or above 28 degrees. Note that the instrument is not specified below 0 degrees C or above 55 degrees C. $(18-10)(0.0005 + 0.0001) = (0.0040 + 0.0008)$
5. Add the result from step 4 to the result from step 2. $(0.0080 + 0.0015)$
6. Convert the result from step 5 from percentages to decimals $(0.000080 + 0.000015)$
7. Multiply the result from step 6 by the nominal reading of your measurement (500 mV) and by the range of your measurement (1.000000 V). $(0.000080)(0.5) + (0.000015)(1.000000) = 0.000055$
8. Assuming you measure a perfect 500 mV dc, your reading will be 500.000 mV +/- 0.055 mV.

Does the Agilent 34401A have a Guard terminal?

No. The Agilent 34401A does not have a Guard terminal. The Agilent 34401A was designed with excellent isolation and thus the effects of common mode voltage is minimized below the 6.5 digit accuracy. Therefore there is no need for a Guard terminal.

What is an "Integrating A-to-D" and what are its benefits?

Much of the Agilent 34401A's excellent measurement performance can be attributed to its integrating analog-to-digital converter (ADC). Environmental electrical noise from sources such as lights, wiring, computers, and other instruments imposes itself onto the signals that you may be trying to measure. In addition, you can set the integration time to optimize for speed or accuracy. Note that below 1 PLC (Power Line Cycle), there is no 50/60 Hz noise rejection.

What is the sample rate of the Agilent 34401A?

When configured for the fastest reading rate, the 34401A can sample at 1000 readings/second. To configure it to this mode, you must:

- Measure either DC Volts, DC Current, 2-wire or 4-wire Resistance
- Turn off the display
- Set to 4.5 digit fast
- Turn off autozero
- Turn off autorange
- Turn off all math
- Set the delay to 0
- Set the trigger source to immediate
- VOLTage:DC
- CURRent:DC
- RESistance
- FRESistance

Is there any dead time between measurements with the Agilent 34401A? If so, how much?

Yes, there is a delay between measurements.

- There is the time necessary to make the measurement.
- After each measurement, there is an additional measurement made for internal autozero.
- The front-panel display can require between 10's of milliseconds and 100's of milliseconds to update after each reading.
- There is also a delay while the multimeter transfers data over the remote interface to your PC, even when using buffering.

Therefore, the total time between the start of one measurement and the next can be more than twice the time required for the measurement itself.

Consider the following suggestions to minimize this delay time:

- When autozero is enabled (default), the multimeter internally disconnects the input signal following each measurement, and takes a zero reading. It then subtracts the zero reading from the preceding reading. To maximize your reading speed, turn autozero off.
- You can also turn off the front-panel display to increase your reading speed.
- Communications over the GPIB (IEEE-488) interface are much faster than over the RS-232 (serial) interface.

What is the trigger response time for the Agilent 34401A?

There is no specification for this parameter, but it is typically less than 1 ms when using an external trigger and approximately 1.5 ms when using the bus (software) trigger -- this is the time from receipt of the line feed character terminating a single command string.

Can I have multiple math functions (Null, Min-Max, dB, dBm, Limit) on at the same time?

No, the 34401A *only* allows **one** math function to be used at a time. If a math function is turned on and another is selected the 34401A will change to the latest math function.

How do I view min-max values with the Agilent 34401A?

You can store the minimum and maximum readings during a series of measurements. The following discussion shows how to read the minimum, maximum, average, and reading count.

You can use min-max with any function *except* continuity or diode test. The min-max operation is *local* to the selected function; when you change functions, min-max is disabled.

After enabling min-max, by pressing the min-max key, you can read the stored **minimum**, **maximum**, **average**, and **count** values by pressing the "SHIFT" and ">" keys on the 34401A front panel (pressing "SHIFT" and ">" recall the last used menu function).

From "MIN-MAX" in the MATH MENU, press the "V" key to enter the "parameter" menu level, and then read the values by pressing "<" or ">".

The average value (displayed as AVE) is the total of all readings taken since min-max was enabled, not just the average of the stored minimum and maximum. The count (displayed as RDG) is the total number of readings taken since min-max was enabled.

The stored values are *cleared* when you turn min-max off, turn off the power, or perform a remote interface reset.

What is the narrowest pulse that I can capture with a 34401A in min/max mode?

This is directly related to the sample rate for which your meter is configured. For example, if you are measuring dc voltage at 4 1/2 digits resolution with autozero off, the specifications state that the reading rate is 1000 readings per second. In theory, you should not miss any pulses wider than the inverse of the reading rate (i.e. $1/1000 = 1$ ms). Keep in mind, though, that the sample may take place on the rising or falling edge of the pulse and therefore the reading may be much less than the actual amplitude of the pulse.

Does the Agilent 34401A measure "true RMS" ac voltage and ac current?

Yes. The Agilent 34401A uses an analog conversion technique that gives true RMS readings regardless of waveshape as long as the signal is within the bandwidth and crest factor of the 34401A.

Other ac conversion techniques, such as average and peak responding, give correct readings only with pure sinewave inputs.

See chapter 7 of the User's Guide for information on true RMS AC measurements, the errors associated with average responding meters, crest factor errors, and other measurement techniques.

Does the Agilent 34401A use "ac" or "dc" coupling for ac voltage measurements?

The Agilent 34401A uses an **ac-coupled** input when measuring **ACV**, which means that the dc component is blocked and is not included in the measurement.

To do a RMS ac + dc measurement you must do both an AC and a DC measurement of the signal then RMS them together ($\text{SQRT}[\text{SQ}(\text{DCV})+\text{SQ}(\text{ACV})]$).

Is the current path uninterrupted during measurement range changes?

An open circuit does not occur when range changes are made during an autorange function. When the range changes, a 0.1 Ohm resistance is switched in parallel with the current shunt resistor. Then, the current range switch opens, the new range switch closes, and finally the 0.1 Ohm resistance is removed. This way, there will **never** be an open circuit during range changes.

Is there a way to measure low-level ac current using the Agilent 34401A?

Yes.

The lowest specified measurement on the 1A ac current range is 1% of the range, or 10 mA (see footnote 4 in the Data Sheet).

There is a 10mA range on which you can measure down to 100uA.

To enable the 10mA ac current range, send the following command *over the remote interface*:

```
DIAG:POKE 25,0,1
```

Once enabled, you can access the range from the Agilent 34401A front panel or over the remote interface bus. It will typically perform to the 1 A range specifications. This range is tested on the production line.

Why isn't the 10 mA ac current range included as one of the standard ranges for the Agilent 34401A?

It is because adding a 100 mA range would have added significant cost to the instrument for a measurement that is infrequently used, and implementing the 10 mA range without the 100 mA range might have made users feel something was "left out" of the product. **Therefore the decision was made to document only the 1 A and 3 A ranges.**

The increased cost is due to the addition of a precision shunt resistor. The selection of shunt resistors for the rest of the design only required .1 Ω and 5 Ω . With a 100 mA input, the shunt voltage would be either (.1 * .1) 10 mVAC or (.1*5) .5 VAC. The 5 Ω shunt cannot be used because a signal with a crest factor of 5 would generate a burden voltage of 2.5V, and the front-end protection would clamp the voltage to 2 Volts. This leaves the .1 Ω shunt; however, at 10% of full scale (10 mA), this generates only 1 mVAC, which has poor accuracy on the 100 mVAC input.

If you ever want to disable this range the command to do it is:

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DIAG:POKE 25,0,0
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Can I set the test current when making resistance measurements?

No, the test current is set depending on the range of the instrument. The specifications are the following:

Range Test Current

100.0000 ohm	1 mA
1.000000 kohm	1 mA
10.000000 kohm	100 uA
100.0000 kohm	10 uA
1.000000 Mohm	5 uA
10.000000 Mohm	500 nA
100.0000 Mohm	500nA 10Mohm

If you need a fixed source current, we suggest using an external current source. You may then measure the voltage across the device under test and use Ohm's Law to find the resistance.

Is "offset compensation" available for resistance measurements with the Agilent 34401A?

No. The 34401A does not have this capability.

Unexpected dc voltages within the instrument, at the input, or the device being measured will add error to the resistance measurement. Offset compensation makes two measurements on the circuit connected to the meter input terminals. The first measurement is a conventional resistance measurement. The second is the same except the test current source is turned off, this is essentially a normal dc voltage measurement. The second dc voltage measurement is subtracted from the first voltage measurement prior to scaling the result for the resistance reading, thereby giving a more accurate resistance measurement.

What are the advantages of 4-wire resistance measurements with the Agilent 34401A?

Lead resistance is not included in the measurement results when using four wire ohms. Thus the accuracy is higher especially for small resistances. (If your application requires very low resistance measurements, consider the Agilent 34420A Nano Volt / Micro Ohm Meter.)

Why do I see a real value during a 4-wire ohm measurement when the test leads are open?

When making 2 wire ohm measurements the source and sense leads are connected together internally and can be driven into an overload situation. When in the **4 wire ohm** mode the source and sense leads are not connected. Since there is a very high input impedance the meter can charge up to a real value the same way it charges up when making a voltage measurement. Only when the source and sense leads are connected together will the meter go into overload.

Can I measure temperature with the Agilent 34401A?

Most temperature sensors convert temperature to a corresponding resistance (thermistors and RTDs) or low-level dc voltage (thermocouples). While the Agilent 34401A can very accurately measure the raw output from a temperature sensor, it does **not** have the built-in conversion algorithms required to measure temperature directly.

IntuiLink for Multimeters has the functionality to convert resistance readings for a 5k Thermistor or a Type 85 RTD to temperature. Alternatively, once the data has been imported into the computer, either using IntuiLink or another program, the equation for converting the voltage or resistance reading for the particular temperature sensor can be applied.

What is the voltage limit that is considered open for diode testing?

The 34401A diode test function was designed specifically for **silicon** diodes. The cutoff voltage for diode testing is 0.8 VDC. Voltages above 0.8 VDC are considered an open circuit. The 0.8 VDC limit cannot be changed. The audible tone will be activated when the measured voltage is in the range of 0.3 to 0.8 VDC.

What is aperture time?

Aperture time is *analogous* to integration time or Number of Power Line Cycles (NPLCs). It is used for **frequency and period measurements**.

The programming commands are:

FREQuency:APERture {0.01|0.1|1|MINimum|MAXimum}

PERiod:APERture {0.01|0.1|1|MINimum|MAXimum}

Where the aperture is specified as 10ms (4 1/2 digits, minimum), 100 ms (5 1/2 digits, default), or 1 second (6 1/2 digits maximum).

From the **front panel**, select either frequency or period, and the number of digits of resolution.

Can I measure duty cycle or pulse width with the 34401A?

No, the 34401A was not designed to measure either duty cycle or pulse width.

To make these measurements we suggest using a Universal Counter.

Can I store instrument setups for the Agilent 34401A? How do I recall the factory default configuration?

The Agilent 34401A does **not** have the ability to store instrument setups from the front panel. Every time it is turned on, it is reset to the factory default configuration.

Agilent **IntuiLink** for Multimeters provides the ability to store and download instrument setups using GPIB connections to the computer.

You can also write your own programs (using VEE, C++, VisualBasic, etc.) to set the instrument configuration prior to taking any measurements.

WEB site: <http://www.agilent.com>

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