

# MEASUREMENT TIPS

Volume 12, Number 3

## Data Logging and Digitizing Using a Digital Multimeter



**Not all data logging or digitizing applications** require multiple channels or the unique features readily available on products designed specifically for those tasks. In cases where you need to make measurements from a single source, the right tool for the job can be a digital multimeter (DMM) that you have readily available and already know how to use. Understanding how to use the features commonly available in DMMs and utilizing some of the advanced features found in more sophisticated meters can help you make the measurements you want and get the results you need in less time and with less hassle.

### DATA LOGGING SHORTCUTS

#### **Snapshot:** Evaluating settling times for a current shunt

A production engineer was tasked with characterizing the performance of a current shunt with temperature variation. As the current shunt changed temperature, the voltage drop varied slightly. This variation contributed to the system error budget, and it needed to be characterized to maintain high quality and confidence in the production test system. The engineer placed the current shunt in an environmental chamber to vary the temperature and used the Agilent 34410A DMM to measure the voltage drop across the shunt. The engineer configured the 34410A using the "Data Log" key on the front panel to begin making measurements, and when the progress bar on the second display showed the test was done, the engineer unplugged the instrument and carried it back to the computer to read the measurements from non-volatile memory into a spreadsheet. The test was completed and the data analyzed in less time than it would have taken to write a program.



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## Memory and Reading Rate

When you use a DMM for simple data logging or digitizing, you need to consider two questions: “Can it achieve my desired reading rate?” and “Can it store all of my measurements?”

The amount of memory required depends on the reading rate and the amount of time over which those readings are made. In some applications, such as highly-accelerated life testing (HALT), you may need to run tests until a product breaks. If you need to take measurements every 10 seconds continuously over a period of five days, you need an instrument that can store 43,200 readings. If your application requires that you sample a mid-audio signal at 50,000 Sa/sec, you will need to store 50,000 readings for each second you wish to measure.

To determine whether the DMM you are considering can achieve the desired reading rate, it is important to look beyond the maximum readings/second specification

### MEASUREMENT TIP #1

If your DMM does not have enough memory to store the readings you require, consider creating a program to transfer the data to a computer. The fast data transfer speed of modern DMMs may allow you to take continuous measurements and transfer the measurements directly to a computer rather than interrupting your test to download a block of data out of memory.

on the data sheet. Faster reading speeds require compromising the amount of resolution and the level of normal mode noise that can be rejected. It is better to start with the resolution or normal mode rejection you require and check that the DMM has a reading speed equal to or greater than your desired reading rate. See **Figure 1** below.

Integration time (NPLC)	Resolution (ppm of range) <sup>1</sup>	Normal mode rejection (dB) <sup>2</sup>	Readings/second <sup>4</sup>
0.001 <sup>5</sup>	30	0	50,000
0.002 <sup>5</sup>	15	0	25,000
0.006	6	0	10,000
0.02	3	0	3,000
0.06	1.5	0	1,000
0.2	0.7	0	300
1	0.3	55	60 (50)
2	0.2	110 <sup>3</sup>	30 (25)
10	0.1	110 <sup>3</sup>	6 (5)
100	0.03	110 <sup>3</sup>	0.6 (0.5)

<sup>1</sup> Resolution is defined as the typical DCV 10V range RMS noise.

Auto-zero on for NPLC ≥ 1. See manual for additional noise characteristics

<sup>2</sup> Normal mode rejection for power line frequency ± 0.1%.

<sup>3</sup> For power-line frequency ± 1% 75 dB and for ± 3% 55 dB.

<sup>4</sup> Maximum rate with auto-zero off for 60 Hz and (50 Hz) operation.

<sup>5</sup> Only available for the 34411A.

**Figure 1: The Agilent 34410A/34411A data sheet specifies the resolution and normal mode rejection in addition to the readings/second.**

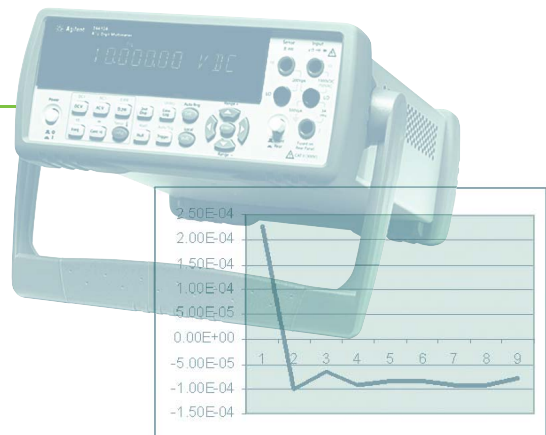
## Triggering

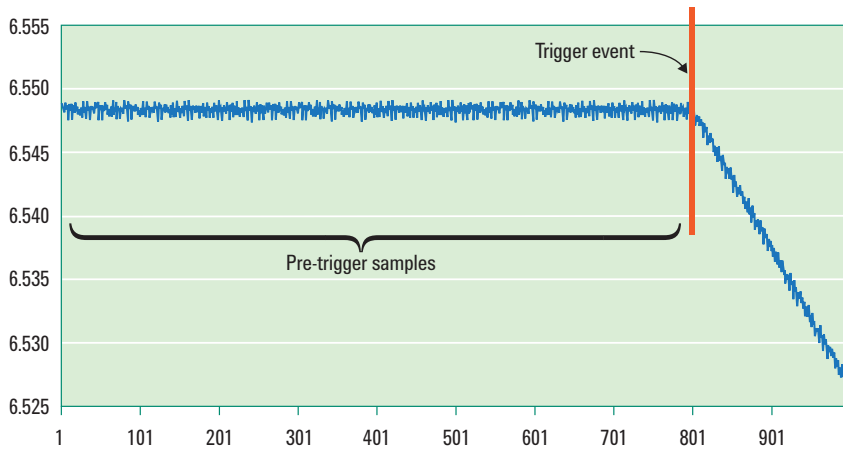
Next, you will want to consider how to start your measurements. You can press a button on the front panel or send a programming command to tell the DMM to begin making measurements. If you want to align your measurements with another event, you can use an external trigger, which is a common way to initiate the DMM. Many DMMs will also allow you to specify a delay between the trigger and the first sample to account for signal settling times.

Some DMMs offer more sophisticated triggering methods. **Level triggering** allows you to specify the slope and the level of the input signal that is used to begin making measurements. With level triggering, you can monitor the signal and begin making measurements when it passes the threshold, eliminating the need for a separate external trigger.

### MEASUREMENT TIP #2

Another advanced trigger feature that is useful for digitizing or data logging is the ability to capture **pre-trigger** and **post-trigger** samples. For example, if you use the Agilent 34411A and L4411A DMMs, you can specify a number of pre-trigger samples that are retained before the trigger is received so that you can investigate the behavior of your device under test leading up to and after the event. See Figure 2, page 3.





**Figure 2:** DMMs that provide pre-trigger samples allow you to collect data leading up to and after an event.

## Sample Intervals

When you use a DMM for data logging or digitizing, you will want to minimize the variation in the timing between samples. One method is to use an external trigger to pace the measurements being made — one measurement per trigger.

Using an external trigger is not always practical, and it can slow down the rate at which you can make measurements. In such cases, eliminating the sources of additional delays can improve the consistency between readings. The time required for autoranging, range changes, auto zero, performing math functions and updating the display can add to the variability between measurements. See measurement tip Volume 5, Number 1, *Improving Digital Multimeter Throughput*, for more information.

Some DMMs include additional features to help provide more precise sampling. Rather than insert a trigger delay between one sample and the next, a sample interval specifies the time to wait after a trigger event has occurred before making the next measurement. See Figure 3 below.

### MEASUREMENT TIP #3

Using a DMM that allows you to specify a sample interval instead of a trigger delay allows precise sampling times, even when you are using features such as autoranging and auto zero. Make sure to account for the worst-case sample time when you set the interval.

## Retrieving Data

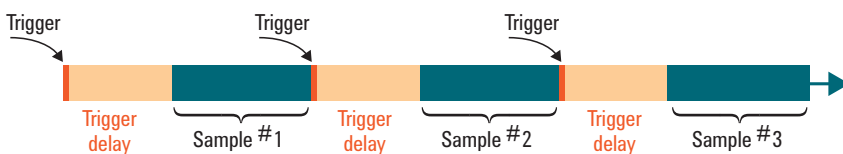
After the measurements are complete, you will need to retrieve your readings for analysis or documentation. Many DMMs available today provide connectivity using GPIB, USB, and/or LAN interfaces. The LAN interface provides opportunities for using new capabilities, such as:

- LAN VXI-11 protocol, which provides emulation of GPIB on LAN
- LAN sockets for fast connections
- Remote access to the DMM using a standard Web browser — no software or drivers are required. Some DMMs, such as Agilent's 34410A, 34411A and L4411A, allow you to cut and paste readings into your applications.

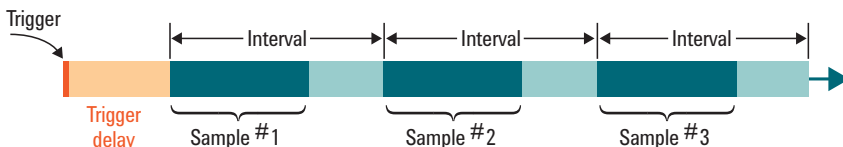
### MEASUREMENT TIP #4

If you are making measurements in one location and analyzing the data at another, consider a DMM that offers the LAN eXtensions for Instrumentation (LXI) and non-volatile storage for readings. Instruments that provide LXI functionality will often allow you to monitor and control the DMM from a remote location, and the non-volatile memory will allow you to bring the DMM back to your PC to retrieve the readings without losing any data.

### Count and delay pacing — Agilent 34401A triggering model



### Precision sample timing — Agilent 34410A/11A



**Figure 3:** Specifying the sample interval specifies the timing of the measurements rather than the delay between samples.

## Summary

Simple data logging or digitizing can often be done using a DMM. By using the equipment you already have and know how to use, you can improve your efficiency. We have reviewed common issues such as memory, reading rate, triggering, and sample intervals, and how a DMM with the right features, such as Agilent's 34410A, 34411A, and L4411A, can simplify the task.



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