Matching the Requirement: Digital Multimeter Selection Guide

Introduction

Your test and measurement application may require general-purpose measurements, precision DC or AC measurements, waveform capture of mechanical-electrical signals, or fast throughput and programming speed. The latest generation of 6½ digit multimeters provide extraordinary measurement capabilities to help solve measurement problems. These DMMs offer significantly enhanced functionality for both bench and system users. Whether your application is in electronic components, aerospace, communications, automotive, industrial, or one of the many other industries that require DC and AC measurements, you need to know what to consider when buying a multimeter.

KEYSIGHT

Snapshot: Direct Sampling “Sees” Actual Voltage Content

An application engineer needs to test luorescent lamp ballast voltages to ensure the correct voltages are applied. Many DMMs use an analog RMS converter for ACV measurements. Unfortunately, they do not do a good job of measuring short-duration, high voltage spikes (1-kV or higher) present on the input. These spikes have little impact on RMS content, so the resulting measurement hardly deviates from the expected voltage. If the DMM does not have effective input protection, the input circuitry can fail after continued abuse. The Keysight Technologies, Inc. Truevolt DMMs use direct sampling to make AC RMS measurements. Signiicant over-sampling of the input signal can detect narrow, high-voltage spikes, and the DMM then responds to those spikes with an overload error condition. This informs the test engineer that a problem exists either in the wiring connections to the DMM or in the ballast. Thus, he is better informed by a DMM that can “see” the actual signal content. Direct-sampled AC provides that visibility into signal content, so both RMS and peak measurements can be made simultaneously.

Factors to Consider

When buying a digital multimeter, you should consider several factors. Some DMMs are excellent bench-top instruments while others serve better as system instruments. Some DMMs are designed for both worlds and provide a straightforward path from the R&D design bench into design validation and manufacturing. A few obvious consider ations include:

- Measurement functions (DCV, DCI, ACV, ACI, frequency/period, 2-wire, 4-wire, or offset-compensated resistance measurements, etc.)
- Reading rate and reading memory– Component testing (diodes, capacitors, etc.)
- Temperature measurements (thermistor and RTDs)

Other factors may not be as obvious. For example, to determine whether a DMM can achieve a desired reading rate, look beyond the maximum readings/second specification. Faster reading rates require compromising the resolution and the level of normal mode noise that can be rejected.

Highly-Accelerated Life Testing (HALT) may need to run until a product fails. Making measurements every 10 seconds over a period of five days, requires a DMM to store 43,200 readings. But if your application requires sampling an audio signal at 50,000 Sa/sec, the DMM must store 50,000 readings for each second of measurements.

Precision DCV Measurements Combined with Peak Measurements

If your goal is minimizing test time, find a DMM that combines precision DCV and peak measurements. This feature can significantly reduce test time compared to making individual DCV and ACV measurements or digitizing and processing the signal. Power supplies, for example, often have AC ripple voltages riding on top of the desired DC output. Ripple frequencies are often power-line related but can be associated with higher-frequency by-products of switching power supplies. Figure 1 shows a DC signal with an AC component.

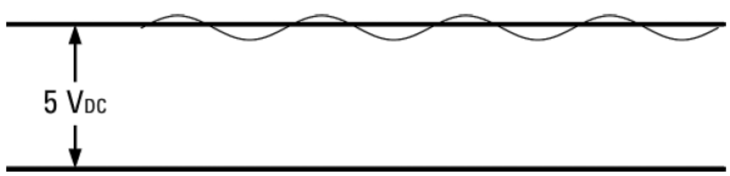

Figure 1. A 5 VDC signal with an AC signal.

One approach to this problem is to make both a DCV and ACV RMS measurement. However, making two measurements takes more time (changing function and range) and a typical ACV RMS measurement lacks valuable peak information.

A DMM that makes peak measurements for precision DCV provides a better solution. Peak measurements:

- Are a precision DCV measurement using 1 or more periods of power-line cycle integration time to reject power line frequencies and random noise.
- Provide both the DCV and peak measurement data.

Precision Measurements with Level Triggering

Do you need to measure the average DC value of a pulse, but only for its duration? This is a relatively simple measurement for a DMM with analog level triggering. Figure 2 illustrates the battery current drain in a hand-held device. This pulse has no associated 5-V logic signal event that can be used as a synchronous external trigger.

Program the DMM to trigger at some point on the rising edge of the pulse. A trigger delay ensures the measurement starts on the "flat" portion of the pulse. The measurement aperture is set to a value that maximizes the precision without exceeding the pulse width duration. In the example, a 100 µs delay from the level trigger places the beginning of the measurement past the rising edge. Using a 1-ms aperture, the DMM makes a 6½ digit measurement.

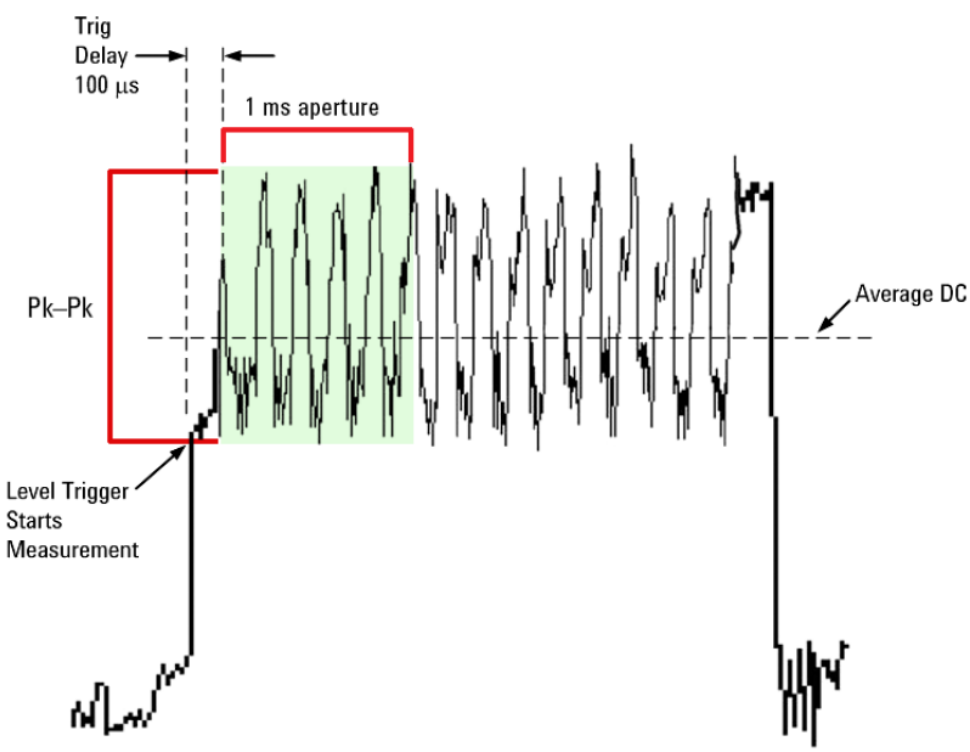

Figure 2. Peak detect occurs at 20 ms intervals over the duration of the measurement aperture

Measurement Tip#1

There are five key factors that control measurement speed for DC measurements:

- Turn Autozero off. It saves time because only one measurement is made per reading.
- Turn Autorange off and manually select the appropriate range. Autorange makes pre-measurements of the applied signal to determine the best range.
- Set the reading aperture. The highest sample rate for the 34465A DMM is 50 k readings/s – 20 µs aperture.
- Disable automatic trigger delay. When disabled, it is disabled for all functions.
- Turn math functions off, turn the display off and disable peak measurements. Peak measurements are for making precision DC measurements; the aperture of the measurement is usually 1 or more PLCs.

Level Triggering with Scope-like Waveform Capture

In aerospace and automotive applications, where the frequency content of signals is low (often less than 8 kHz), a DMM that provides waveform capture allows you to “see” what is happening.

For example, current drain measurements in handheld devices are commonplace in the electronics industry where long battery life is a key factor in customer satisfaction. Once a test system indicates that too much current is being drawn from the battery, several other test points are tested to see which sections of the device are active and for how long. This test requires waveform capture to check the timing of current usage.

Figure 3 shows the current drain from a camera that has just been actuated to take a picture. Represented in the waveform are the mechanical movements of the auto focus, processing the picture, driving the display and status LEDs, and storing the result in flash memory.

You need a DMM that:

- Uses level triggering specified as a DCV measurement
- Takes readings at 50 k samples/s. With 1 million readings, 20 seconds of data can be stored at this rate.
- Provides pre- and post-triggering allowing you to create a scope-like capture of the waveform around an event.
- Continuously makes measurements until the level trigger is met. The DMM retains the pre-trigger count of measurements and then begins the count of post-trigger measurements.

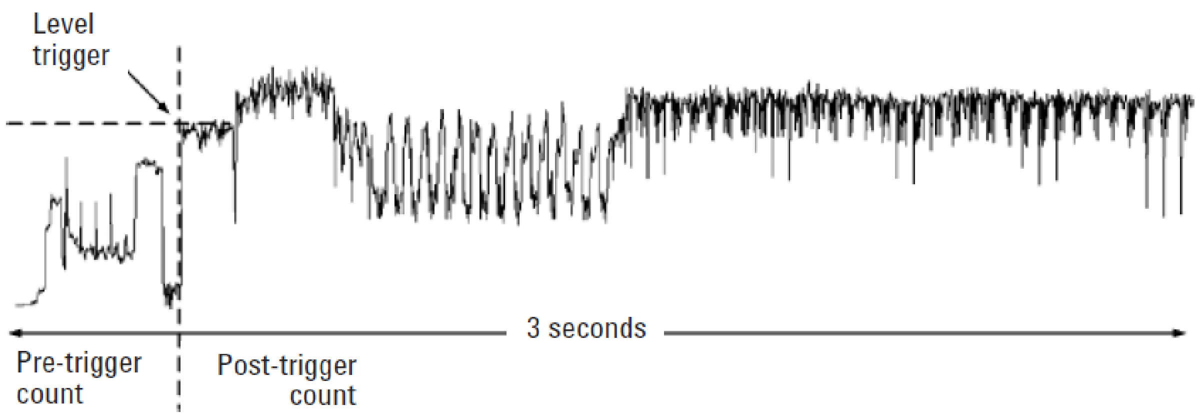

Figure 3. Using level triggering to digitize current draw from a digital camera battery

Measurement Tip#2

Configure the DMM for Fast AC Measurements

For AC measurements, the key factors in measurement speed include:

- AC filter setting is the most significant factor. Set it based on the maximum input frequency.
- Turn Autorange off and manually select the appropriate range.
- Set trigger delay. The automatic trigger delay slows down measurement speed based on the AC filter. If the trigger delay is set to zero, the maximum reading rate is possible.

Precision Measurements with High NMR

Have a noisy test environment?

Does your DMM need to reject spurious signals at the power-line frequency or harmonics of the line frequency?

Most DMMs provide 60 dB of rejection at 10 and 100 NPLC settings and ±0.1% of deviation from line frequency. However, the Truevolt DMMs use a special aperture-shaping algorithm to increase Normal Mode Rejection (NMR) of power-line-related noise in DC measurements.

This algorithm is used on NPLC settings of 2, 10, and 100. At 1 PLC, the NMR is specified as 55 dB, but at 2 PLC, the rejection jumps to 110 dB at ±0.1% of the power line frequency. The aperture algorithm creates a wider notch of operating frequency allowing higher precision measurements at faster rates than most other DMMs.

Measurement Tip#3

Maximize system reading and throughput rates and throughput rates

Measurements and transfer rates are fastest when your DMM uses a 32-bit binary data format and transfers readings in block mode. The host PC can keep up with any sample rate by issuing requests for blocks of readings at periodic times while the DMM makes continuous measurements at up to 50,000 readings/s rate. ASCII reading format is the slowest.

Measurement Tip#4

Advantages of a built-in Web server

The Truevolt DMMs have a built-in Web server providing a very powerful configuration, diagnosis, and programming tool. All you need is a LAN connection, Web browser, and the DMM's IP address. Simply enter the IP address into the Web browser's URL.

Some of the key capabilities provided in the Truevolt DMMs Web server are:

1. Extends ease of use by showing all parameters at once
2. Visual aid in developing external programs
3. Log/capture SCPI commands from any interface
4. Learning tool to understand how to program the DMM
5. Remote/passive monitoring of test system measurements maximum reading rate is possible.

Overview of Truevolt DMMs

Keysight's Truevolt DMMs offer a full range of measurement capabilities and price points with higher levels of accuracy, speed, and resolution. Below is the lineup of Keysight Truevolt DMMs covering 6½- and 7½-digit models.

Technical Overview	DM34460A	DM34461A	34460A
Resolution	6½ digits	6½ digits	6½ digits
Best DCV accuracy	40 ppm	40 ppm	75 ppm
Max reading speed	1,000 readings/s	50,000 readings/s	300 readings/s
Memory	50,000 readings	2 million readings	1,000 readings
Measurements	DCV, ACV (RMS), DCI, ACI, 2- and 4-wire resistance, continuity, diode, frequency, period, temperature, and capacitance		DCV, ACV (RMS), DCI, ACI, 2- and 4-wire resistance, diode, capacitance, temperature, frequency, and period
Display	Color, bar chart	Color, graphical, histogram, bar chart	Color, graphical, histogram, and bar chart

Technical Overview	34461A	34465A	34470A
Resolution	6½ digits	6½ digits	7½ digits
Best DCV accuracy	35 ppm	30 ppm	16 ppm
Max reading speed	1,000 readings/s	50,000 readings/s	50,000 readings/s
Memory	10,000 readings	50,000 readings std / 2 million readings opt	50,000 readings std / 2 million readings opt
Measurements	DCV, ACV (RMS), DCI, ACI, 2- and 4-wire resistance, diode, capacitance, temperature, frequency, and period		
Display	Color, graphical, histogram, and bar chart		

For More Information

Learn more about Keysight's digital multimeter family at www.keysight.com/find/dmm

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