

Keysight Technologies

Simultaneous Measurements with a Digital Multimeter

Application Brief

Test Challenges:

- Making more confident measurements
- Making dual measurements in less time

Overview

Traditionally, digital multimeters (DMMs) have been single-measurement instruments. In some cases; however, system designers want the ability to track more than one parameter on their signal. Doing so often provides complementary data that can make measurements significantly easier to understand. With the right architecture and design, DMMs can now make secondary measurements. See how the Truevolt Series DMMs helps designers make secondary measurements without ever having to change the instrument's configuration. The advanced functionality on the 34465A and 34470A (e.g., expanded math functions) also means that designers can now analyze their data faster.

Making more confident measurements

A test engineer wants to monitor the temperature inside of an environmental chamber and needs a high level of confidence that the measurements are accurate. A 34465A DMM is selected due to its ability to log data and provide simple trend charts. A 5-K Ω NTC thermistor is used to spot check for accuracy.

The engineer notices that the thermistor has a temperature error of a few degrees. To understand the error, the secondary display on the Truevolt DMM is turned on and temperature and resistor readings are read at the same time. According to the datasheet for the thermistor, it should read 25 °C at 5 K Ω . The engineer's probe is put inside of a calibrated chamber set to 27 °C, but the probe reads 25 °C with a 5-K Ω resistance reading, a two degree error. After a bit of characterization, the engineer decides that he can simply add an offset value to adjust for the offset of his thermistor.

Making dual measurements in less time

A system designed to apply a linear force to a small structure has the ability to provide an oscillating force with an AC signal and a constant force with a DC signal. The system designer wants to keep track of both signals concurrently in order to characterize how much force is being applied. Using a Truevolt DMM with its ability to make secondary measurements, he is able to read both the DC and AC components of his control signal at the same time.

Two measurements one screen

Secondary measurements are defined as auxiliary measurements that augment information provided by a main primary measurement function. Depending on the function, you can measure complementary data that traditionally would have taken two different operations and function changes to acquire. The table illustrates all secondary measurement capabilities of the Truevolt DMMs.

Primary measurement function	34460A secondary measurement function	34465A/70A secondary measurement function
DCV	ACV	ACV, peak, pre-math
ACV	Frequency	DCV, frequency, pre-math
2-wire, 4-wire resistance		Pre-math
DCI	ACI	ACI, peak, pre-math
ACI	Frequency	DCI, frequency, pre-math
Frequency	Period	Period, ACV, pre-math
Period	Frequency	Frequency, ACV, pre-math
Temperature	Sensor	Sensor, pre-math
Ratio	Input/Ref	Input/ref, pre-math
Capacitance		Pre-math
Continuity		None
Diode		None

Table 1. Secondary measurement capabilities supported by the Truevolt DMMs.

An example of a common secondary measurement would be the ability to measure the frequency of an AC signal, as shown in Figure 1.

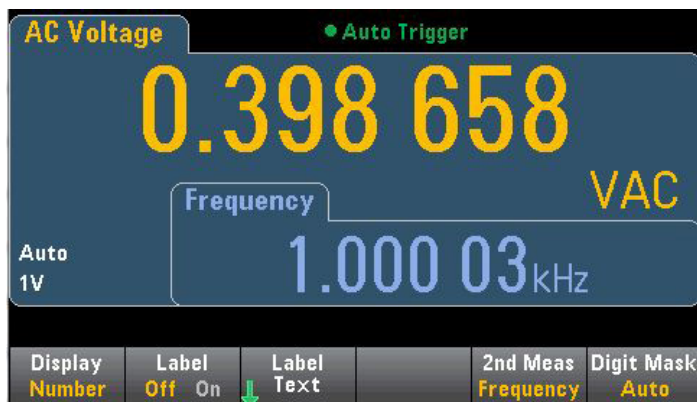


Figure 1. AC voltage with frequency.

With the advanced secondary features of the 34465A and 34470A DMMs, the secondary measurements provide more information than is possible with other DMMs. As an example, Figure 2 shows the primary measurement of DC voltage (DCV) with a secondary measurement of AC voltage (ACV). This is an especially important measurement if your signal has both an AC and DC component.

In DCV mode, there are two additional secondary measurements that can be made to provide insight into your signal: Peak and Pre-Math. The Peak measurement, as shown in Figure 3, keeps track of the minimum and maximum DCV readings read by the DMM. This is similar to the information that is available from the statistics display.

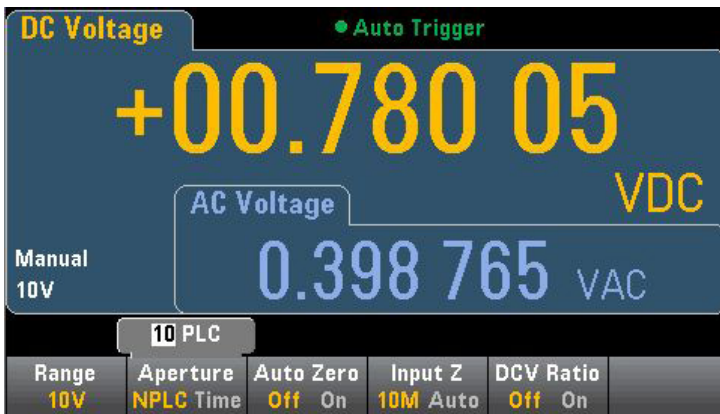


Figure 2. DC voltage (primary) and AC voltage (secondary) measurements.

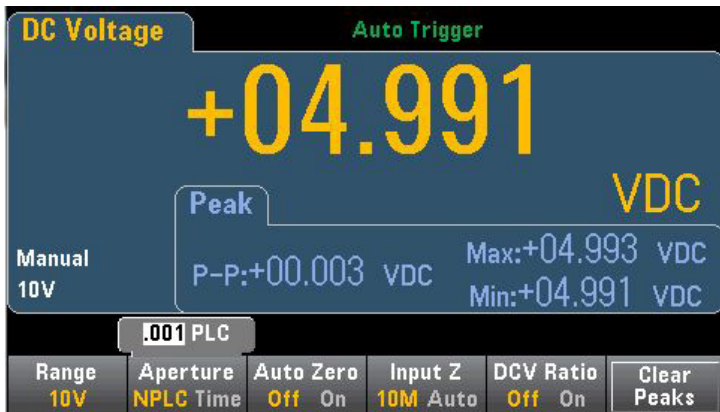


Figure 3. Peak measurement of DCV.

Pre-Math is also a very valuable measurement because it allows you to see modified readings and raw readings in one screen (Figure 4). You can even modify your primary display by applying useful math functions to your data (e.g., a null value or scaling) or filtering your data (Figure 5). See Adding Math Enables Faster Analysis section for more information on applying math function.

Once you have applied the desired math function, the secondary display will display the raw reading without the math. This is useful for determining if the applied math is correct, and if the readings are within the expected range.



Figure 4. A DCV signal with dB scaling with the Pre-Math measurement.

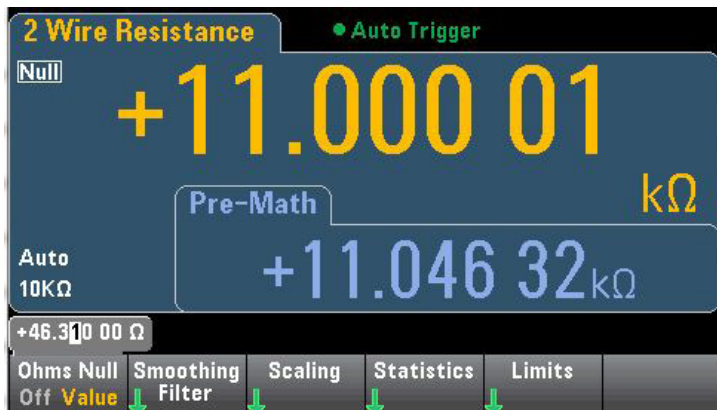


Figure 5. A with the null value applied with the raw measurement on the secondary display.

With the temperature measurement capabilities included on Truevolt DMMs, you might also want to see what the sensor readings are in volts or ohms, depending on your sensor (Figure 6). All four Truevolt DMM models provide this capability on the secondary display.

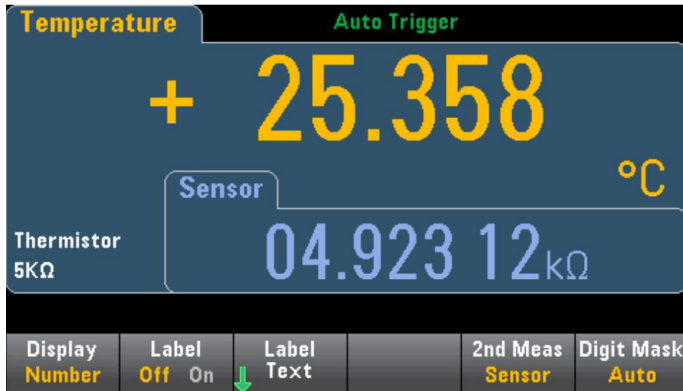


Figure 6. Sensor readings displayed on the secondary display for a given temperature measurement.

Another useful feature of the dual display is the ability to provide raw measurements when you are using the DCV ratio function. With the addition of the second display, you can read the ratio, the input voltage, and the reference voltage in one glance (Figure 7). The DCV ratio is a function measured by comparing the voltage on the Input terminals divided by the reference voltage. The reference voltage is the difference of two separate measurements. These measurements are the DC voltages from the HI Sense terminal to the LO Input terminal and from the LO Sense terminal to the LO Input terminal. Figure 8 shows a simple DCV ratio diagram.



Figure 7. With the Truevolt DMM dual display, you can view 2 voltage measurements when using the DCV ratio function.

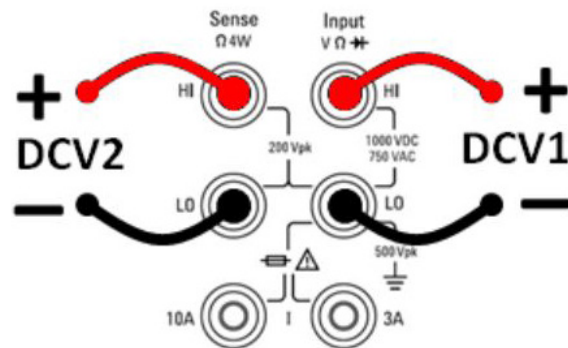


Figure 8. Basic DCV ratio diagram.

Additional information

Adding math enables faster analysis

A key advantage of the 34465A/34470A Truevolt Series DMMs is that they feature additional Math functions as compared to their predecessors, the 34460A and 34461A. These earlier Truevolt DMMs allow you to Null readings to zero out your measurement offsets, set Limits for your readings, and show statistics. The newer 34465A/34470A DMMs provide the same capabilities, but they also include a Smoothing filter and Scaling (Figure 9).

The Smoothing filter is useful if you want to average out statistical outliers. Applying the smoothing filter means the DMM uses a moving average (boxcar) filter to reduce random noise. You may change the filter response by choosing Fast/Medium/Slow (Figure 10). The slower the filter gets, the more readings are used in the filter.

Additional Scaling features are available on the new DMMs as well. You can now change the readings on your front panel by scaling the readings with either a dB, dBm, %, or Mx-B scaling (Figure 11). For dB scaling, the result is the difference between the input signal and the stored dB-relative value reference. The dBm Scaling is a result based on the calculation of power delivered to a reference resistance (Ref R), relative to 1 milliWatt. The % scaling shows a percent change from a reference value, while the Mx-B allows for linear scaling with an offset operation.



Figure 9. Math functions available in the 34465A/34470A DMMs.



Figure 10. Smoothing filter options.



Figure 11. Options for scaling.

Summary

Advanced dual-screen measurements not only allow you to get more information concurrently, they also allow you to check your raw data compared to your adjusted measurements. Using the Truevolt Series DMMs to make dual measurements, you not only save time and but also gain more information than is possible with other similar instruments.

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