FLUKE®

Test lab in your toolbox

Application Note

Fluke's 180 Series Digital Multimeters (DMM) are a result of decades of test equipment development by a company well known for producing products that are rugged, versatile and safe. People around the world turn to Fluke when they need to get the job done. When you buy a Fluke 180 Series DMM, you get more than just a digital multimeter. You get generations of experience designing and producing high-accuracy test equipment. You get the experience that comes with producing millions of meters. You get a rugged, dependable meter that can take more abuse than one might expect.

Fluke continues to find ways of producing DMMs that are feature rich without compromising its reputation for safe reliable products. These are just some of the reasons the Fluke 180 Series will stay on the job longer.

- Overload protection to 1000 volts on all inputs, even while in the resistance measuring mode.
- Fused current inputs to protect against overcurrents and accidental application to voltage sources.
- Ruggedized case and safety approvals to the IEC 1010-1 CAT IV 1000 V standards.

This article will emphasize specific features by describing solutions to some application problems. Although they describe a particular application, these testing techniques should be useful in a variety of situations and environments.

AC and DC voltage measurements

The 180 Series has the ability to combine its ac and dc measurement capabilities in several different ways. You can make the standard ac and dc measurements separately or you can measure both the ac and dc components of a signal simultaneously.

After selecting a dc function (dc volts, dc mV, dc amps, dc mA or dc mA) you can activate the "ac and dc" function by pressing the blue function button. And with each additional press of the button, you change how these two components of the measured signal are displayed. With the first press, the ac component is displayed in the primary (large digits) display with the dc component in the secondary display (ac/dc). The second press swaps the readings between the primary and secondary displays (dc/ac). A third press of the button combines the two readings into one, giving you the true-rms value of the two components combined (true-rms ac+dc).

One example of using the ac and dc feature can be found in the checking of a silicon controlled rectifier (SCR). An SCR controls the amount of ac voltage applied to a load by adjusting how much of the positive and negative cycle is allowed to reach the load.

Figure 1 shows the signal waveform applied to the load when the SCR is adjusted to approximately 50 percent. As you can see, under normal operation the amount of positive cycle and negative cycle are pretty well balanced. Theoretically, a dc measurement across the load would result in a zero volts reading, whereas the ac voltage measurement would be determined by the setting of the input to the SCR.

If the SCR should become defective in a way that causes it to fire at a different point on the negative half-cycle than the positive half-cycle, we would expect an imbalance between the negative and positive voltage applied to the load. This imbalance can be detected with a dc measurement on the load.

With a 180 Series DMM measuring load voltage in the ac and dc mode, a dc voltage would be indicated that would increase as the SCR is adjusted to apply more voltage to the load. Although readings on a properly operating SCR have a small amount of dc voltage that varies as the control is adjusted, readings of three volts or more may indicate a misfiring SCR.

Another 180 Series feature can be brought into play on this same problem. The pulse width measurement function will identify the difference in length of the positive and negative portion of the waveform applied to the load.

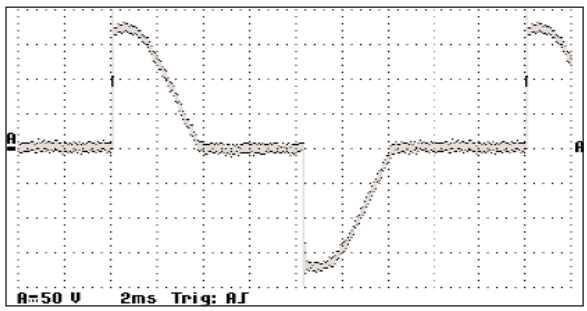

Figure 1. SCR output at approximately 50 percent

Switch the DMM to ac volts and activate the pulse width measurement by pressing the Hz % ms button twice. You will notice, the primary display indicates the length of time in milliseconds while the secondary display indicates the frequency of the measured signal. You want to measure the length of time the voltage is applied to the load. This will require making two measurements. With the SCR less than full on, press the ⎍ button and then the ⎎ button to switch the trigger point between a positive going edge and negative going edge. In effect, you are switching the displayed measurement between the time the signal is above the trigger point and the time it is below the trigger point. Select the one that gives the smallest reading. As shown in Figure 2, this is the time the positive part of the waveform is on.

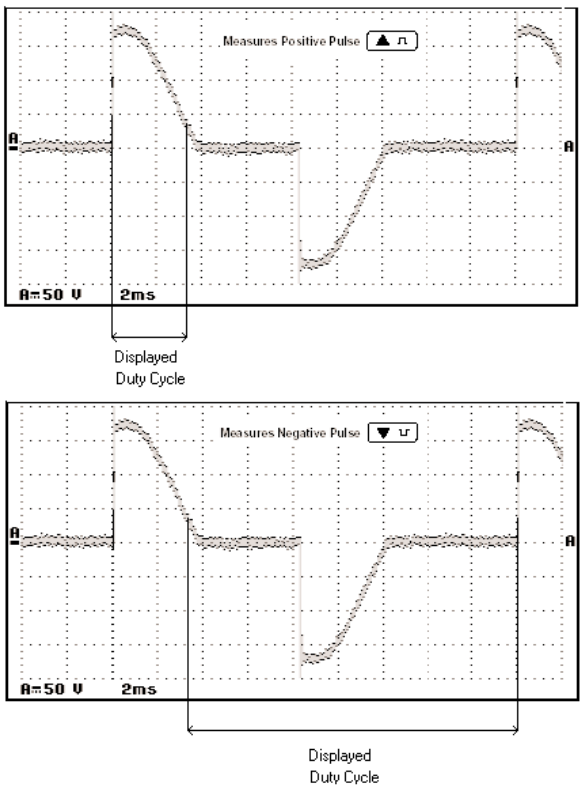

Figure 2. Trigger set for positive pulse

Unlike a timer/counter, the trigger point of the Fluke 180 Series DMM can not be set to a negative value to capture the negative going pulse. However, we can fool the DMM by simply swapping the test leads on the load. Now the DMM is reading the opposite pulse's duration. While you shouldn't expect the readings to be exactly the same, there should be no significant difference between the two.

This is just one example of the pulse width measurement feature. Timing measurements can made on signals up to 100 kHz with the Fluke 180 Series DMMs. Frequency measurements can be made up to 1 MHz. A valuable feature when time period measurements are necessary.

dB measurements

People who work with audio find that measurements made on a logarithmic scale such as decibels (dB) can be extremely informative. The 180 Series is not only capable of displaying ac signal amplitude in volts, but in decibels (dB) as well. In addition, the dB reading displayed can be adjusted for measurements over a wide range of system impedances. This makes it possible to measure power in a circuit. Zero dBm is normally defined as 1 milliwatt into a 600 ohm load. But what is 0 dBm into a 50 ohm load? No need to calculate this value, just switch the reference impedance in the 180 Series to 0050, and you now have dB readings referencing 50 ohms.

One example of using the dB measurement feature is plotting the frequency response of an audio equalizer. If a variable frequency signal of constant amplitude is applied to the input of an equalizer while monitoring the amplitude of its output, you can plot the equalizer's frequency response. Not only is this measurement done in dB, but it is a RELATIVE measurement of its output to its input. The 180 Series can handle this with one easy setup.

Connect a constant output frequency generator to an equalizer's input. Using an oscilloscope, set the signal generator's amplitude at a level that produces no clipping at the output of the equalizer across the equalizer's frequency range. This will be the 0 dB reference level.

Set up the Fluke 180 Series DMM by first connecting the test leads between the DMMs voltage and COM jacks and the INPUT of the equalizer. Next, select ac volts and then press the blue function button. The primary display switches from indicating volts to dB. We also need to monitor the frequency with a frequency counter. The beauty of the 180 Series is that it has a built-in frequency counter that can be displayed simultaneously with the dB reading. Press the Hz % ms button to activate the frequency counter. If you would rather have the dB reading in the primary display instead of the secondary display, press the blue button once more. Now activate the relative mode by pressing the REL Δ button. The display should now indicate 0 dB.

Next, with the signal still applied to the equalizer's input, move the DMM leads to the equalizer's output. Slowly sweep the generator's frequency through the desired frequency range observing the output signal. Stop and record the dB and frequency reading at selected frequency points. See Figure 3 for an example plot.

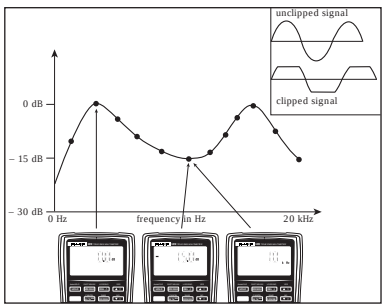

Figure 3. Plot of equalizer output

The same technique is useful for determining the "Q" of a filter. Using the audio signal generator, search for the point of maximum or minimum output, depending on whether you are testing a bandpass or bandstop filter. Use this point as the 0 dB reference using the REL Δ as above.

As shown in Figure 4, sweep the oscillator up frequency until the 3 dB point is reached and note the frequency. Continue sweeping the frequency up until the 3 dB point is reached again and note the frequency. Plug the frequencies into the "Q" formula (Q = cf/hi – lo) and you have the Q of the filter.

Where cf = center frequency
hi = Upper 3 dB point
lo = Lower 3 dB point

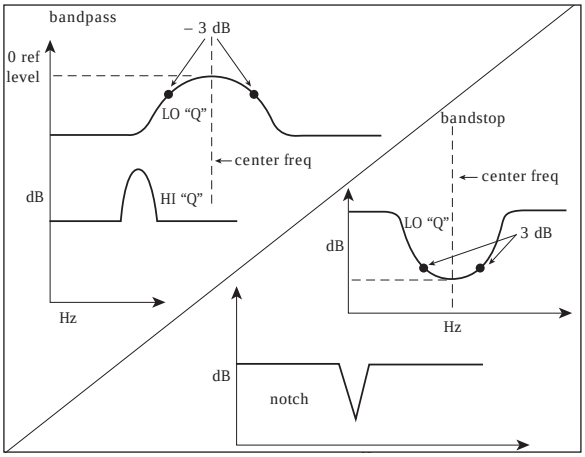

Figure 4. Bandpass and stopband output response plots

Stored readings

The ability to store measured values comes in handy when you need to make a determination based on a series of readings. Instead of recording each reading on a piece of paper and then entering those values in a spreadsheet and then making a calculation, let the Fluke 189 True-rms Multimeter simplify the task.

The Fluke 189 will store up to 100 separate readings for later recall or transfer to a PC. FlukeView® Forms Documenting Software will not only take the stored readings from the 189, but will also export the data to a spreadsheet or database.

One real-life example of using the stored reading feature of the Fluke 189 is determining battery condition. Telephone companies use a series of individual battery cells for power back up. Typically, 24 2-volt cells are connected in series to provide backup power whenever main power fails. These batteries need to be ready to go at an instant's notice, and making a determination of their condition presents a real challenge. The cells can not be removed and tested individually since that would remove the backup system from operation. Testing the battery by measuring the voltage generated by the entire bank of cells does not reveal enough to tell which cell or cells are not up to specifications. However, each cell can be measured while still connected to the system. Then a comparison of all the measurements made on individual cells is required.

You could take the readings and log each reading on a piece of paper along with the corresponding battery number for a manual comparison. An easier method would be to use a Fluke 189 and a PC with FlukeView Forms Documenting Software.

After clearing memory, place the DMM test leads across each cell in sequence, storing each reading as you go. This will place readings in sequential memory locations that are labeled 001 through 100, depending on the number of cells in the bank. After gathering the readings, download them to a PC that has FlukeView Forms installed. Figure 5 shows a FlukeView Forms report of the readings taken on a bank of 24 2-volt cells.

Notice that the form allows each reading to be documented as to its origin, along with the data and time. Additional information about who took the readings and comments can be a part of the record as well.

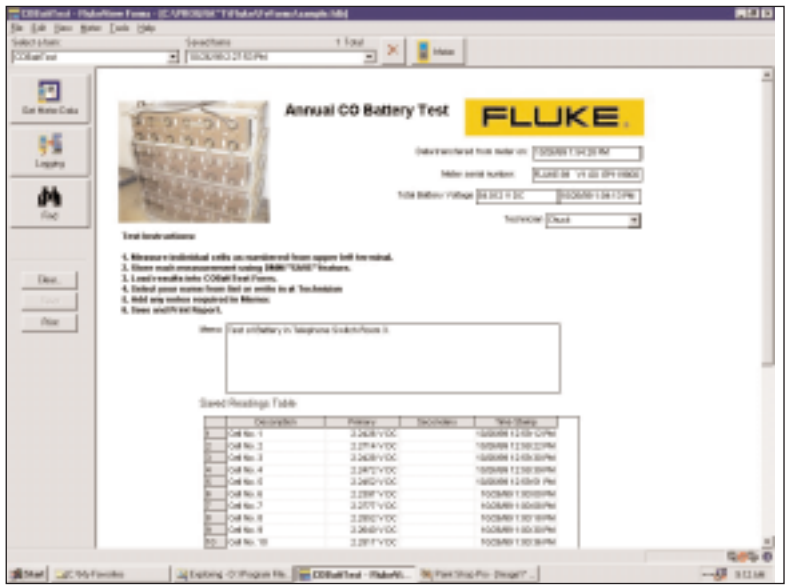

Figure 5. FlukeView Forms Report

Next you can export the data from FlukeView Forms to a spreadsheet where you can employ built-in functions and graphing to further analyze the measurements. As Figure 6 shows, the Average function has been used to find the average of all the measurements. Next, each measurement has been compared to the average value to help identify any cells that measure higher or lower than the average. As can be seen in this example, cell 23 measured 0.0388 above the average and may indicate that it is failing. As a cell ages, its impedance increases and therefore drops more of the charging voltage across its terminals.

Saving readings electronically through the DMM cuts down on errors and saves time in gathering and manipulating the data. In addition, you have a way of easily documenting the measurements taken and archiving them for future reference. More information can be found on using FlukeView Forms Documenting Software by visiting the Fluke Web site. You will also find information about the Fluke 189's logging feature which is beyond the scope it this article.

The examples shown in this article demonstrate just four different measurement features of the Fluke 180 Series. You may never have a need for these specific examples, but they should give you some idea of how the same features can be applied to measurement problems you face in your day-to-day work.

There's a lot more capability packed into the Fluke 180 Series line of products for you to explore. Especially when you consider they are capable of making twelve different measurements, and have seven measurement enhancement features. In addition, there are ten different setup features that allow you to customize the DMM's operation to your needs.

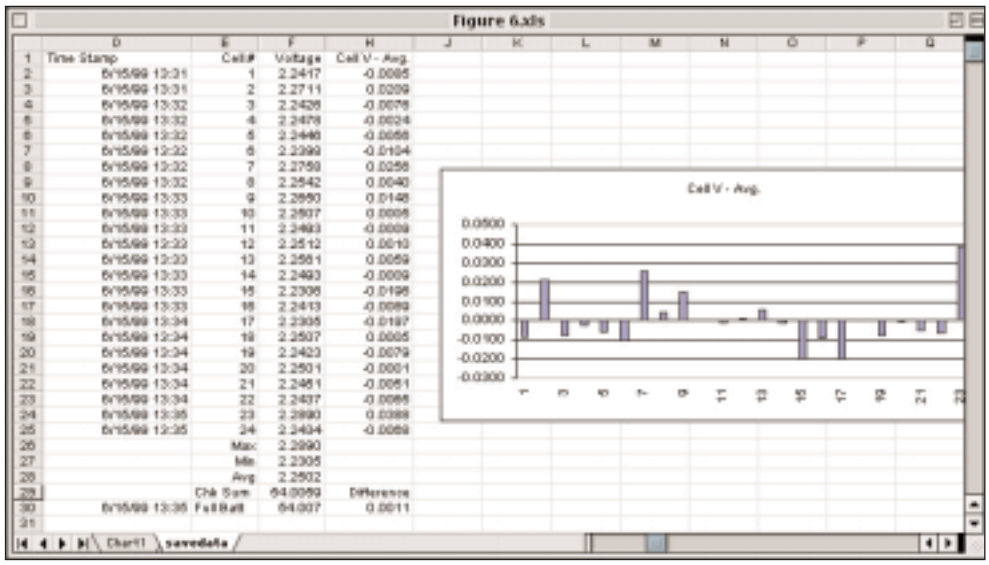

Figure 6 – Spreadsheet analysis of readings.

The Fluke 180 Series Digital Multimeters offer more measurement capabilities and flexibility than most bench/portable models. They are Fluke's finest handheld DMMs, offering unique features with a high degree of accuracy. With 50,000 count resolution at 0.025 percent basic dc accuracy, there isn't another DMM on the market that can beat it.

Fluke also offers more accessories for more digital multimeters than anyone in the world. Contact your local Fluke distributor for more information.

Fluke. *Keeping your world up and running.*

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Printed in U.S.A. 9/2002 2041794 A-ENG-N Rev A