Some medical applications using a Fluke model 87 multimeter

Many times when you get a new piece of test equipment you don't have time to read the instruction manual completely, so it goes into the file cabinet In the case of the Fluke Model 87 multimeter you will miss some important uses unless you follow up with the manual. Rather then copying the manual here I'm going to try to quickly suggest some practical uses of this meter in a medical equipment environment. You can review the manual for more exact information as time permits.

The meter is a True RMS meter, that is it can calculate the RMS value of even non sinusoidal waveforms. This makes it useful for evaluating events that happen over a long time or quickly, like a pulse from a pacemaker. There are several variations of the 87, but I'm going to concentrate on the features that will work on all versions.

The input jacks are well labelled and the function knob is clearly marked too. The rest of the pushbuttons can be divided into three styles or types of response.

The **Blue** botton on the upper left, the **Peak Min Max** button, the **Rel** button and the **Hold** button operate in a binary mode, i.e. they select when first pushed and toggle or turn off when pushed again.

The **yellow** button on the left side turns on the backlight for 68 seconds -- it turns off automatically. (If pressed before power up it selects a high accuracy mode or 4 and a half digit display mode, but with a slower response.)

The **MIN MAX** and **RANGE** buttons have a multi level function. They select, scroll or increment, and when held for 2 seconds, turn off

Finally the **Hz** button selects frequency, then duty cycle, then exits, a tri-level action.

When first powered on with the function switch **ALL** segments of the display are displayed for a couple of seconds.

Take a couple of minutes here to experiment with these buttons just to be ready for what comes next.

Lets begin with a situation where you suspect a power line fluctuation over time, but you never seem to catch it in progress. You could select **MIN MAX** recording mode along with **AC voltage** and leave the meter connected to the power line. It will record the maximum **AND** minimum line voltage over 24-36 hours (depending on model) as well as the average voltage during that time. You can later use the **MIN MAX** button to scroll through the **Maximum, Minimum and Average values**. You'll see the upper and lower ranges of voltage, but you won't know the exact time each occured. At least you'll have values to determine if a low voltage event happened. (During these measurements a beeper will sound whenever a new value is recorded. This often occurs during the first few seconds of this test and possibly later as well.)

Adding to this line voltage information you can select **Peak MIN MAX** and see the actual peak values, both positive and negative, of the power line. If a perfect sine wave exists (not likely) you'll see peak values of **1.414 times the RMS value**. As an example, 120 Volts RMS should show a peak value of 169.7 volts. The normal reading will be the positive peak -- you can read the negative peak value by pressing or toggling the **MIN MAX** button. You'll see a negative sign appear in front of the digital display. Often the two readings (positive vs. negative peak) won't be equal in value. That's because most power supplies recharge the filter capacitors on the positive half cycle, causing a slightly smaller positive peak voltage value to appear on the meter due to loading effect. (If they're different by more than about 3% or 5 volts, you might be experiencing some harmonic distortion on the power line. Sometimes this shows up as 120 Hz interference with sensitive lab equipment or ECG recording and display devices, as they don't usually filter 120 Hz.)

While measuring line voltage, you can check frequency and duty cycle by **restoring the meter to read AC voltage without the MIN MAX or Peak MIN MAX features**. A simple way to do this is to simply move the function switch to OFF and then back to AC Voltage. You'll cancel the previous set up and return to normal line voltage monitoring.

Once back in AC voltage mode you can push the **Hz** button once for frequency measurement. A second push on the **Hz** button will show duty cycle, a percentage reading of time spent on each half cycle. On a perfect line it should be 50%, i.e. each half cycle should be equal to half the time of a cycle. You can press the **Peak MIN MAX** button to toggle between the positive and negative half cycles of this measurement for comparison. Duty cycle comparison is a useful tool for evaluating pulse waveforms too, without the use of an oscilloscope. More on this later.

(By the way, power line frequency is usually NOT exactly 60 Hz. It varies slightly as the load on the generator changes and the power companies try to maintain exactly 60 Hz for each 24 hour period. You can expect a slightly lower frequency during peak load periods and a bit above that as they "make up" the difference during light load periods.)

Let's look at resistance measurements with the meter. You can select normal resistance measurements, compensate for lead wire resistance, and even make measurements in very high resistance circuits up to 100,000 Meg ohms. Start with the function switch moved to the **Beeper/Ohms/Capacitance** position. This will select the normal resistance functions. The voltage produced by the meter when used for ranges below 40 Meg ohms, doesn't turn on diodes so they won't affect resistance values when measuring within a circuit containing them. (On the 40 Meg ohms range, the voltage WILL forward bias diodes and transistors so be careful, selecting a lower **RANGE** if necessary.)

DIODE testing is NOT a normal resistance mode, rather a constant current (about 6 mA) is passed through the diode and the voltage drop appears on the display. Expect about 0.6 volts per diode drop (up to 3 volts for 5 diodes in series) the maximum you can measure

For very high resistance measurements push the **RANGE** button until you reach rhe **nanoSiemens** position. You can convert this to Meg Ohms by dividing the number obtained into 1000. (An example would be a reading of 2.0 nSiemens. 1000/2 = 500 Meg Ohms. You probably won't use this one much, but it's available.)

What about measuring low values of resistance where lead wire and contact resistance flaws the actual reading? You can begin by shorting the meter leads together and then pressing the **REL** button. You'll subtract the initial reading -- the meter will read zero. Now any reading is the actual resistance measured. (Very useful for measuring the resistance of a ground wire from chassis to the U blade of a power plug.

(The **REL** feature works in other modes as well, simply select it after getting a reading, it will zero. This means you're now reading values above or below that starting value.)

AC and DC current measurements are a snap with the model 87. Notice that the Ampere positions of the function switch show both AC and DC symbols. This is because the meter is a True RMS measuring device -- it doesn't matter. (If you select the wrong jack for the current range selected on the function switch a beeper will sound, giving you a chance to correct the connections.)

While measuring current you can use the **MIN MAX and Peak MIN MAX** features. An example of this would be the measurement of a cardiac pacemaker pulse. The meter can capture pulses that last 1 millisecond or more, certainly fast enough for a pacemaker pulse. (Later models can capture 250 microsecond pulses.)

You can also measure **Frequency** and **Duty Cycle** when in the current measuring mode by using the **Hz** button.

Since time and frequency have an inverse relationship you can calculate pulse width with a fair degree of accuracy too. Let's assume a frequency of a pacemaker is measured as 1 Hz (or 60 beats/minute). The reciprocal of that would be one second per pulse. If the duty cycle showed a reading of 1% while reading the positive portion, the pulse width would calculate to 1 x 0.01 = 0.010 seconds (or 10 milliseconds if you prefer). The manual gives good examples of these calculations, but they're fairly simple. T = 1/F first, then time multiplied by duty cycle, expressed as a fraction = pulse width. Useful for lots of low frequency measurements, either voltage or current related.

Capacitance measurements are fairly simple for values from 5 nanofarads to 5 microfarads. Check the manual for larger values, they're possible by observing the charge time depending on the range selected. (A table in the manual gives examples -- I've use this feature up to 2500 microfarads so I know it works.)

At this point I'm concluding with the admonition to check specific applications against the manual for your particular meter. My goal is to enable you to use a sophisticated meter in a sophisticated manner -- and to be able to get answers to questions that may help you troubleshoot more effectrively in the medical electronics field!

Ray Nielsen, CBET-Emeritus
< raynielsen@me.com>
612-724-9280

If you found this of use, drop a line with suggestions for other subjects.

P.S. A performance/fuse check is worthwhile whenever you begin to use the meter. Start by verifying proper operation of internal circuitry - select the ohms function and plug in a test lead into the volt/ohms/diode jack. Touch the probe tip to the upper half segment of lthe mA/uA jack (nearest the LCD display) and you should read 1.000K ohms, plus or minus 5 digits. Once this basic check is completed and leaving the function switch in ohms, put the plug end of a test lead into the two amp jacks, one at a time. A beeper sound indicates that each of two fuses are in tact.