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LOW-COST HANDHELD R-L-C METER

For some time, I've been on the lookout for an RLC meter to help me measure unknown components. Most will measure the basic R, L and C, but either with limited ranges or inadequate accuracy. In addition, most conventional RLC meters are not really optimized to measure todays surface-mount (SM) components. It's tough enough working with surface-mount (SM) parts...let alone trying to identify them once a few parts on your workbench get mixed up together! Other needs are to be able to confirm part values when troubleshooting a PC board assembly or when cobbling together temporary EMI filters. I've also collected assorted components with mysterious or custom markings and would love to be able to identify these for future projects.

Enter Smart Tweezers; an unusually small instrument, but with an unusual twist. The probes are designed to probe SM components. I had heard about Advance Devices, a Canadian company, for at least a couple years, but until now, never seemed to have the real need to invest. This changed once I started dealing more and more with these tiny SM critters.

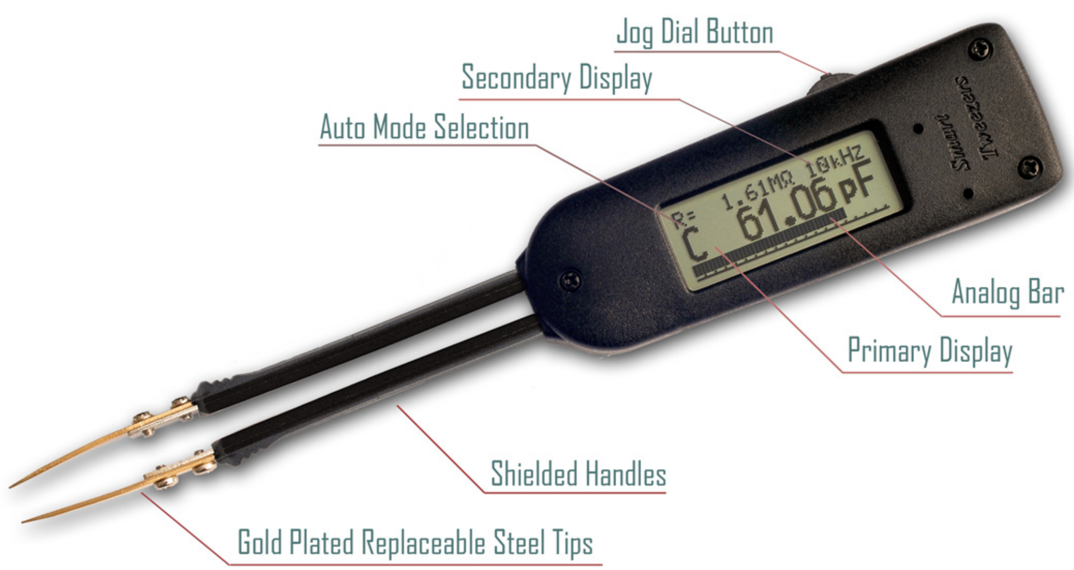

Figure 1 - An overall view of the Smart Tweezers with major features labeled. (Photo courtesy Advance Devices.)

Once I started investigating RLC meters more earnestly, I discovered a critical factor that easily threw me over the edge and I ordered one immediately. This instrument goes way beyond the norm for RLC meters. It actually measures both the real and imaginary impedances. Let me repeat that - it measures both the real and imaginary impedances! What this allows the microprocessor-based instrument to do is measure and read out not only the resistance, but series inductance - - not only capacitance, but equivalent series resistance (ESR) or D - - not only inductance, but DC resistance or Q - - and more! The measurement ranges are also phenomenal!

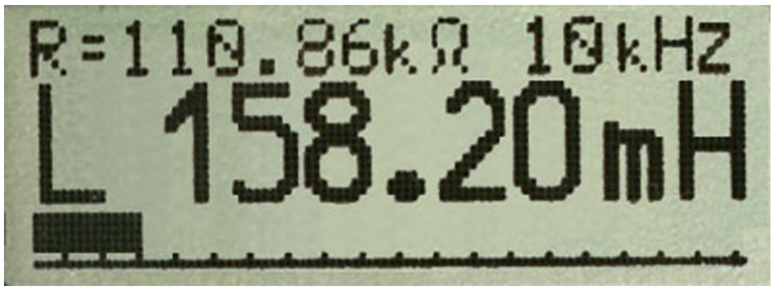

Figure 2 - Closeup of the LCD screen showing the main measurement (larger) and secondary measurement (smaller). There is a bar-graph scale at the bottom, useful for measuring peaks or dips. The built-in generator frequency is also displayed. (Photo courtesy Advance Devices.)

OK, so what do you get for your $315? The basic unit comes with a set of hearing three aid batteries and standard tips with a protective plastic shield to protect them from damage. The plastic storage box is an extra $11, which I recommend purchasing to protect the instrument. The gold-plated tips are replaceable, with the standard tips at $40. Premium tips (Swiss-made) are also available for $50 or $60. A ten-pack of spare batteries is $6.40.

Basic Specifications

Parameter	**Measurement Range**	**Basic Accuracy** (at optimum test freq & measurement range)
Resistance	5 ohms - 999 kohms 0.1 ohm - 9.9 Mohms	<1.0 % <5.0 %
Capacitance	10 pF - 100 uF 0.5 pF - 4999 uF	<3.0 % <5.0 %
Inductance	10 uH - 99 mH 0.5 uH - 999 mH	<3.0 % <5.0 %
Q	0.1 - 100	not specified
D	0.01 - 10	not specified
DC Voltage	0 - 8 volts	<1.0 %

- ★ AC Test Frequencies: 100 Hz, 120 Hz, 1 kHz, 10 kHz (at 0.25 %)
- ★ Test Signal Level: 940 mVp-p (+/- 20 mV) Sine wave.
- ★ Source Impedance: 400 ohms (+/- 5 %)

- ★ Auto Mode: Reads out the dominant parameter.
- ★ Equivalent Circuit: Parallel (for C/R), series (for L/R).

- ★ Manual Mode: Dominant or Secondary parameter.
- ★ Equivalent Circuit: Parallel or series.

- ★ Measurement Update Rate: Up to 4 measurements per second.

- ★ Battery Life: 70 hours (alkaline), 200 hours (air-zinc).

- ★ Calibration: NIST-traceable.

Using the Smart Tweezers

The RLC meter is contoured to comfortably fit your hand and the tweezer probes accurately grab even the smallest SM component. The measurement mode is controlled with a three-way jog-dial button - left, right and pushed down. My first fear was alleviated quickly, since to operate the unit would have required me to use it right-handed. Happily, the display may be turned 180 degrees in the Setup Menu, so that it reads right-side up when holding it my my left hand. Well, that's a good start!

AUTO Mode - According to the user manual, the Smart Tweezers determines which component model is the most accurate representation of the device under test and selects the appropriate parameter pair. The determination is as follows:

For $|Q| < 0.15$, the R-Mode is selected.

For $|Q| > +0.15$, the L+R or L+Q mode is selected (depends on user settings).

For $|Q| < -0.15$, the C+R or C+D mode is selected.

Leaving the unit in AUTO Mode automatically identifies and measures most unlabeled SM or leaded components. Only if the component is outside the normal measurement ranges or if you wish to measure the secondary parameters, are you required to place it in manual mode and select the primary and secondary measurements. You may also need to optimize the source frequency to accurately measure components that have very small or very large values. For example, I was able to accurately measure a 1 pF SM capacitor, but I had to increase the source frequency to 10 kHz. By the way, you're probably wondering about the parasitic capacitance of the probes themselves. This can actually be measured at about 1.6 pF when held about the same distance apart as the SM device. This parasitic capacitance should be subtracted from the total measurement to obtain the 1 pF actual value in this example. More information on Manual Modes is in the next section.

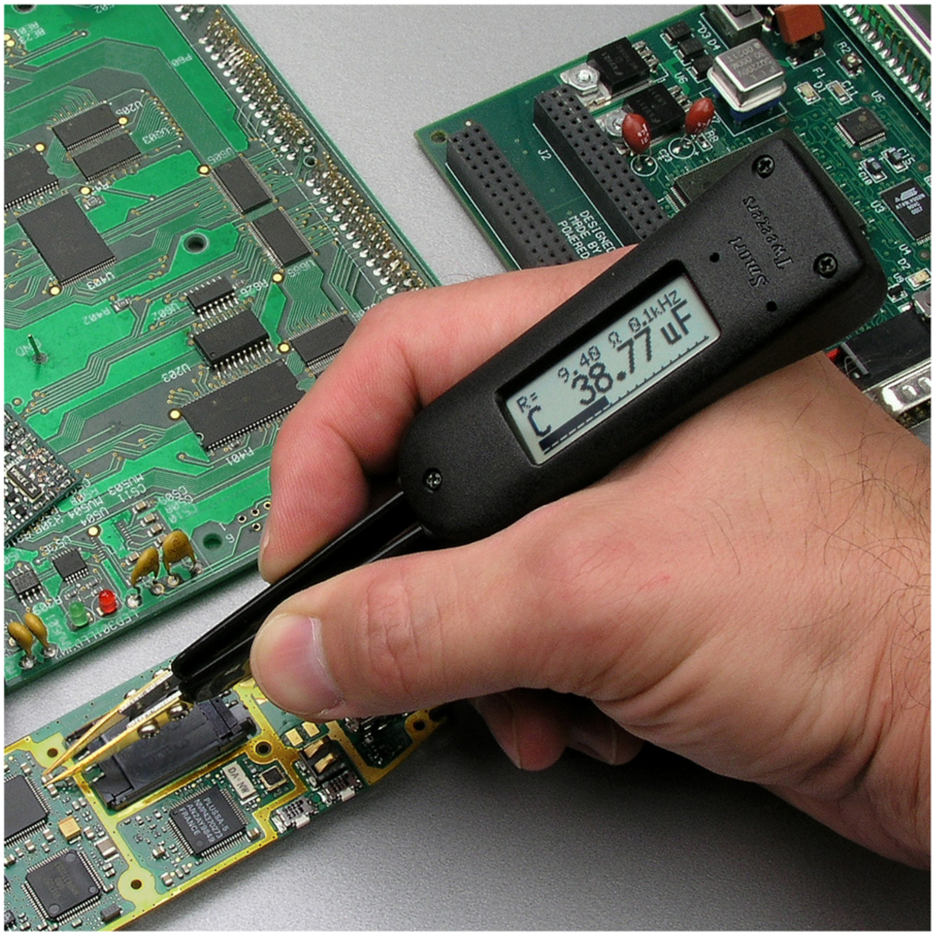

Figure 3 - Smart Tweezers in use. When measuring components mounted to PC boards, you need to realize the measurement includes all components connected to the two measurement nodes. In some cases, the component must be measured "out of circuit". (Photo courtesy Advance Devices.)

As a switch-mode power supply designer in the distant past, I'm aware that a high ESR for an electrolytic or tantalum capacitor leads to high temperature rises and associated losses in power supply efficiency. With the Smart Tweezers, it is possible to measure both the capacitance and ESR of the device in order to verify the ESR is below required specs. Some leaded capacitors I measured had rather high ESRs (10 ohms, or more) and were tossed into the "round file".

Manual Modes

There are several manual modes that are recommended if the components might lie at the fringes of the measurement ranges or if measurement speed is important. You'll also need manual modes when you need to measure the imaginary part (ESR, D, Q, etc.). According to the user manual:

R Mode - Resistance is shown on the primary display and the quality factor (Q) on the secondary display. The resistance is either the equivalent series or parallel resistance of the device under test. Units are mOhms, Ohms, kOhms or MOhms.

L+R Mode - Inductance is shown on the primary display and series resistance on the secondary display. The units of inductance are uH, mH, or H. Resistance is the real part of the impedance. Resistance units are mOhms or Ohms.

L+Q Mode - Inductance is shown on the primary display and the quality factor (Q) on the secondary display. Inductance units are uH, mH or H. Q is the ratio of the imaginary part of the impedance to the real part of the impedance. Q is dimensionless and the same for both series and parallel representations. A good inductance has a large Q (large L and small R).

C+R Mode - Capacitance is shown on the primary display and the parallel resistance is shown on the secondary display. The units of capacitance are pF, nF or uF. Resistance units are Ohms and kOhms.

C+D Mode - Capacitance is shown on the primary display and dissipation factor is shown on the secondary display. The capacitance is either the equivalent series or parallel capacitance of the device under test. The units of capacitance are pF, nF or uF. D is the ratio of the real part of the impedance to the imaginary part of the impedance, or 1/Q. D is dimensionless and the same for series or parallel representations.

Minor Quibbles

While the Smart Tweezers have a lot of advantages, there were a few things I'd like to see improved. One thing I noted right away is that the three-way jog-dial button has a rather sharp nubbin that digs into your finger. After repeated pressings inward, it becomes uncomfortable. I suspect a little filing with sandpaper or carefully grinding/rounding with a Dremel® Tool, might fix this. Lastly, the storage box, while nicely padded, uses a latch design that is not the most secure, so I use a rubber band to ensure it won't open up in transit.

Conclusion

The Smart Tweezers have a lot going for them. They are fast and accurate at measuring SM components. The AUTO mode is really handy when measuring and sorting out a pile of mixed parts. The most important factor for me is their ability to measure the parasitic values, so that I can plug these into computer models or to verify things like series resistance or Q (for L), series inductance (for R or C), ESR or dissipation factor (for C), etc. Finally, the instrument is small and light weight. It easily fits inside my Pelican roller case, along with all my other EMC troubleshooting gear.

The Smart Tweezers are available from Advance Devices for $315 and may be ordered through their Web site at: www.advancedevices.com. Recommended.