

500-ppm LCR Meter: Feedback

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The interest Elektor readers have shown in the 500-ppm LCR Meter published in March, April, and May 2013 [1], with a follow-up in November of that same year, was a pleasant surprise, taken as encouragement by the whole team—it's an unmistakable sign when such an advanced project generates so much enthusiasm. This publication won the confidence of hundreds of you who have successfully built the instrument. Let's just remind everyone that the LCR Meter is still available in the form of an assembled, tested module [3].

We'll never be able to praise highly enough the benefits of the direct interaction in the Elektor forum [2] between the author of this project and his readers, whether they have built the circuit themselves or are still thinking about doing so. These fruitful, multilingual exchanges have been the occasion for the author to complete the information given in the article and to correct it where necessary, and even to improve his software.

We can't recommend too highly reading these exchanges, especially in the *Test & Measurement* sub forum, all topics containing "LCR Meter" or similar in the title. The aim of this article is to bring together the key information from there.

Port selection

The port chosen in the Port/Select port... menu is saved in the preferences file (AU2011 X.Y.Z.ini). With the original version of the AU2011 software (version 2.1.2), once the port had been selected and was open, the Port/Select port... menu is disabled.

If you choose the wrong port (which can happen if several devices are connected to the same computer), the program opens the port OK but then won't be able to communicate with a device that is not the LCR meter—for a very good reason. But you are then not able to select another port. The only way to do so was to destroy this preferences file. A radical solution—but not ideal!

As from version 3.0.0, the addition of a Port/Close the port... menu lets you close the wrong port so as to select another.

No connection to port COMx

The rather unfriendly “No connection to port COMx” message can appear even though the connection is good and the port number is correct, if a second instance of the AU2011 program is run without closing the first one! It is impossible to connect to a port that is already busy.

Operation with USB supply

A few people have had a problem with the LCR meter in ‘stand-alone’ mode, powered using a USB supply. The majority of these supplies have the D+ and D– lines either biased at a voltage of around 2–3 V, or else simply connected together. For the LCR Meter’s FT232R IC (U19) to be able to enable the regulator U15, its SLEEP output must be at logic 1. This is not the case if these two lines are floating. In this (rare) case, they need to be connected together (to the power rail)—or change the type of power supply!

Stand-alone and PC mode

To use the LCR Meter in stand-alone mode but powered via a USB cable connected to a PC, don’t forget to press and hold one of the display module keys before powering up using SW1. Otherwise the LCR meter starts up in PC mode; it will briefly display the message “Bootloader v2.1” and then nothing!

ESR (Equivalent Series Resistance)

The LCR meter measures the in-phase and quadrature components of the DUT, i.e. the series resistance R_s and the series reactance X_s . The

other parameters (Z , ϕ , R_p , X_p , Q , D , etc.) are then all deduced by calculation.

In the case of a high-value capacitor (from a few tens to thousands of μF), the series resistance R_s does indeed correspond to its ESR—just so long as the measurement is carried out at a frequency very much lower than its resonant frequency (because the series inductance of such a capacitor is not negligible). For these very high values, the measurement needs to be made at 1 kHz or even 100/120 Hz.

Inconsistency of the measurement in the extreme ranges

A very few readers have told us about a strange, non-reproducible phenomenon when measuring high value resistances (50 M Ω and above) with a value practically doubled @ 10 kHz, or low value capacitors (like 100 pF) with severe instability of this value @ 100 Hz.

This is caused by a slight instability in the U16 (LT1611) regulation loop, and depends solely on the particular specimen of LT1611 used.

The normal signal at output 1 of U16 (frequency around 1.8 MHz) appears in **Figure 1a**. **Figure 1b** shows the same signal with the instability present.

When this occurs, the oscilloscope will show a high level of noise at U6 output (TP6), which interferes with the measurement.

One solution is simply to replace the LT1611, in the hopes of coming across a less lively specimen! The real solution is to insert an RC network (39 k Ω / 1 μF) into the link between U16 pins 5 (V_{in}) and 4 (SHDN) (**Figure 2a**) so that U16 performs a soft start.

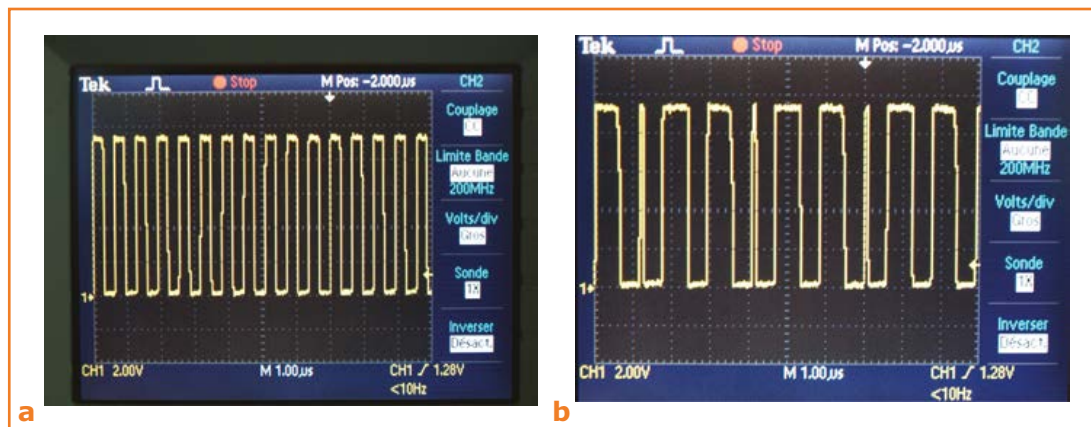


Figure 1. The spread in certain parameters of the LT1611 (gain of built-in error amplifier, temperature, etc.) can cause instability (1b) that interferes with the measurements.

It's easy to modify the board (**Figure 2b**) as follows:

- cut the track between U16 pins 4 and 5, as well as the track between pin 4 and V_{in} ;
- reconnect pin 5 to V_{in} , at C67;

- solder a 39-k Ω resistor (0603 or 0805) between pin 4 and V_{in} ;
- solder a 1- μ F capacitor (0805) to pin 4 and connect its other terminal to the ground side of C67.

Measuring RF inductors

A few readers have been disappointed by the results when measuring inductors with values below 200 nH (SMD RF inductors).

At the frequency of 10 kHz, an ideal 100 nH inductor has a reactance of 6.28 m Ω .

A real inductor also has a series resistance of several tens of milli-ohms. So the quality factor Q of this inductor is very much lower than 1 and the series resistance becomes the main parameter, the reactance being only the secondary parameter with a much greater inaccuracy!

What's more, using measuring cables, even short ones, does not allow you to perform an effective SHORT/TRIM; you only have to move one cable ever so slightly to see the measured value change by several (tens of) nanohenries.

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Figure 2a.
The most reliable solution is to delay the starting of LT1611 using an RC network (soft start).

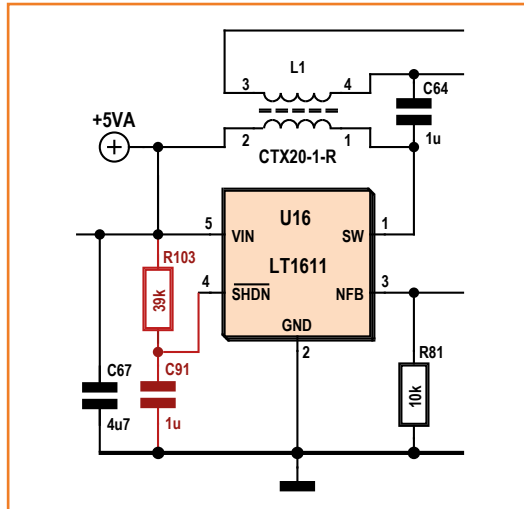
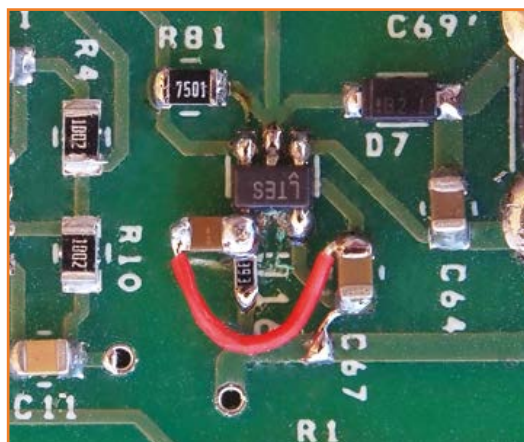


Figure 2b.
The modification to the board to add the RC network in Figure 2a is only needed if you observe the noise seen in Figure 1b.



Web Links

- [1] 500 ppm LCR Meter Part 1, Elektor March 2013: www.elektor-magazine.com/110758
Part 2: Elektor April 2013, www.elektor-magazine.com/130022
Part 3: Elektor, Elektor May 2013, www.elektor-magazine.com/130093
Important Update: Elektor November 2013, www.elektor-magazine.com/130307
- [2] Elektor Forum: <http://forum.elektor.com/viewforum.php?f=1543743>
- [3] Assembled LCR Meter module: www.elektor.com/500-ppm-lcr-meter-main-board
LCR Meter modules in stand-alone version (with display):
www.elektor.com/500-ppm-lcr-meter-kit-with-main-board-and-lcd-board