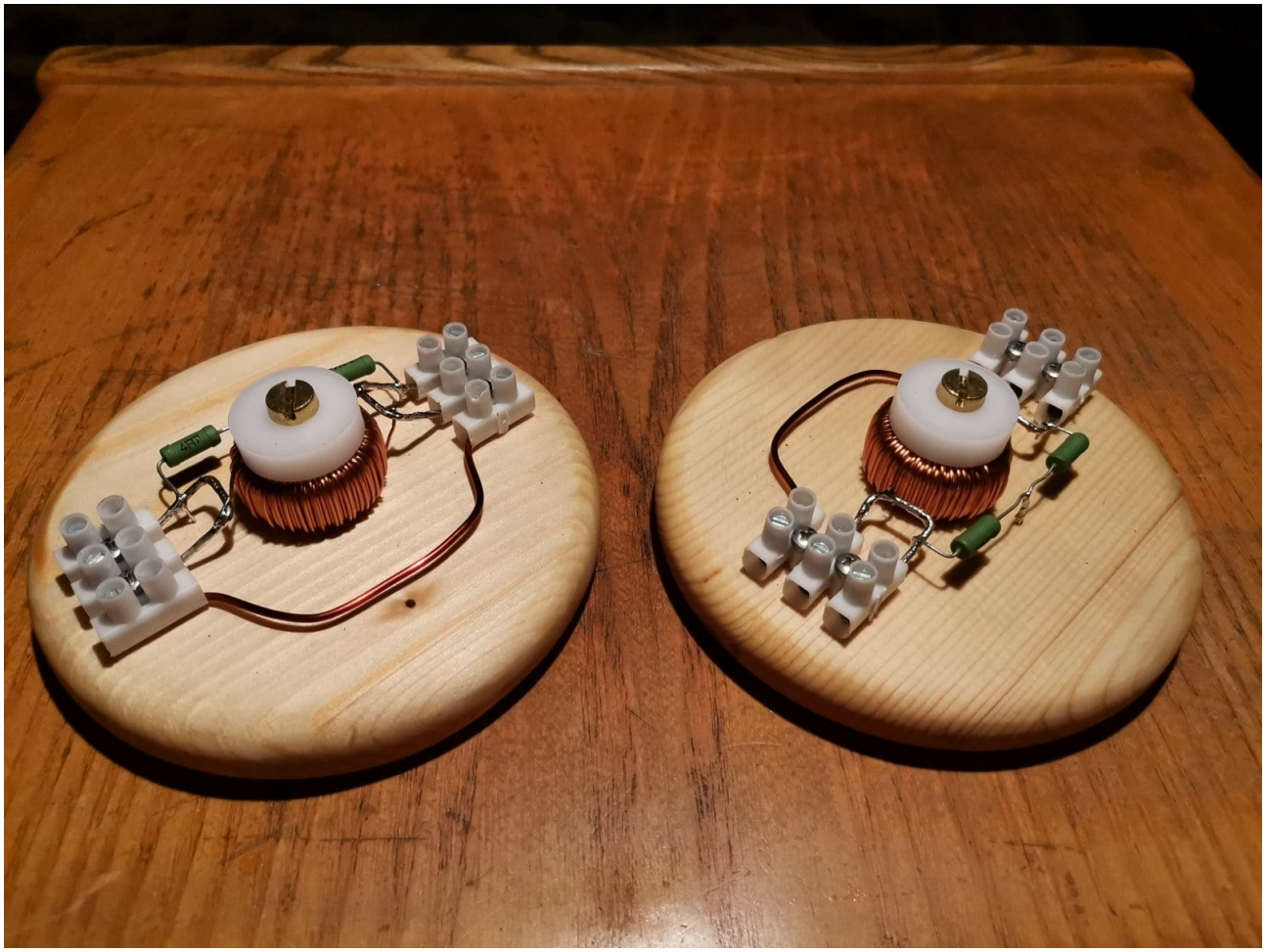

INTERACTION OF COILS IN CROSS-OVER NETWORKS

STEFANO RANCATI
DIY EXTREME LOUDSPEAKER BUILDING GROUP
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The main purpose of this research is the study of the interaction of coils in cross-over networks. Considering the limited space inside the speakers, the correct placement of components plays a fundamental role in order to obtain better performance.

The following measuring instruments were used for this test:

- UNI-T 71B multimeter
- LC200A L/C meter
-Unaohm G4018 oscilloscope

The coils used are air-core type, they measure 0,484mH and 0,488mH.

The test is divided into:

- Interaction coil-base.
- Interaction of the coil with different cores
-Positioning of the coils.
-Crosstalk between coils.

Interaction coil-base

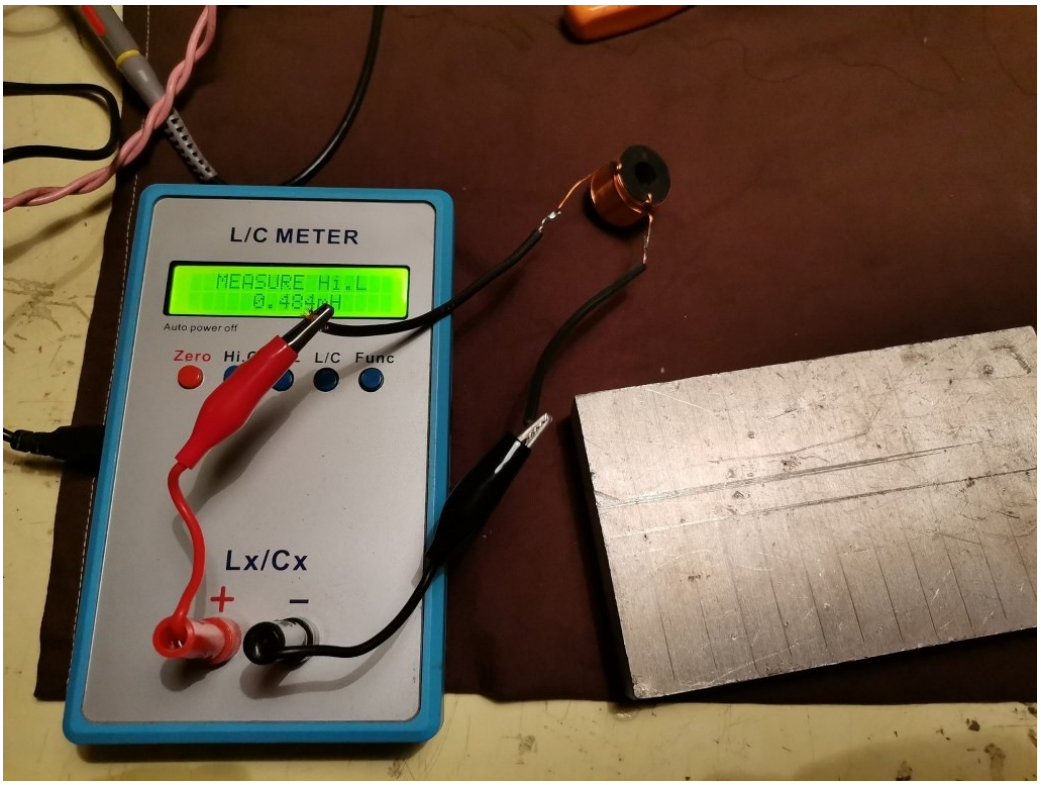

Figura 1: The coil placed on a formica table measures 0,484mH

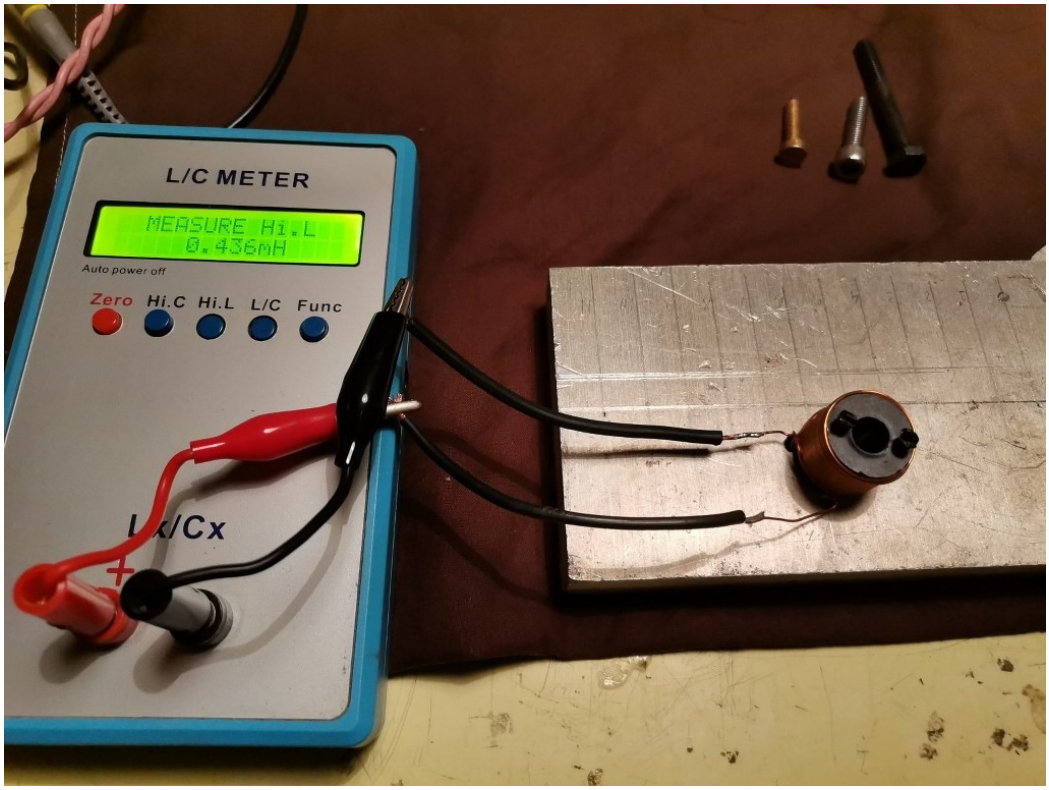

Figura 2: The coil placed on aluminum thick plate measures 0,436mH

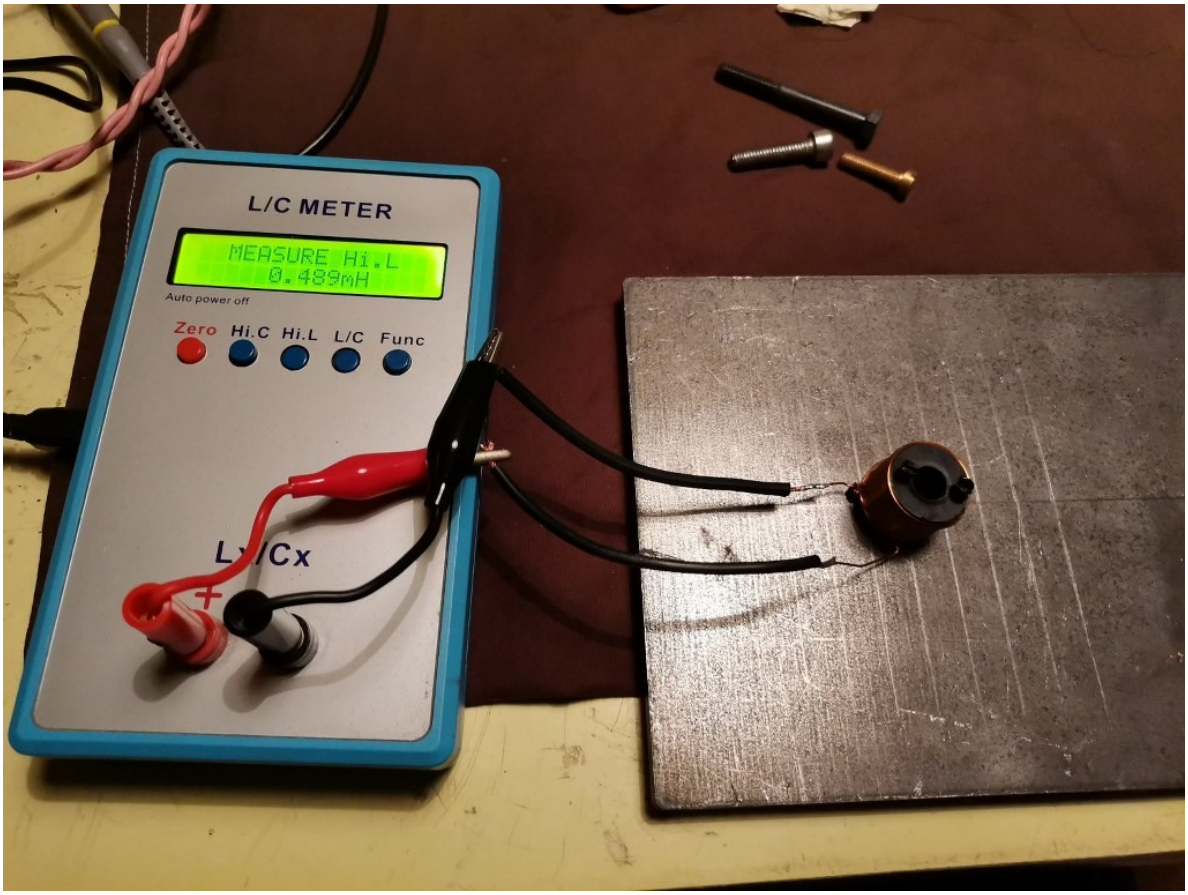

Figura 3: The coil placed on thick Steel plate measures 0,489mH

Considering the support surface, the behaviour of the steel (12mm), the formica and the wood (20mm) is close. It's possible to notice small differences between values. The aluminum plate (15mm) presents a reduction in the inductance measured, 0,436mH compared to 0,484mH, 48uH difference.

Interaction of the coil with different cores

Figura 4: The three screws used for test, M6 size, brass, normal steel and stainless.

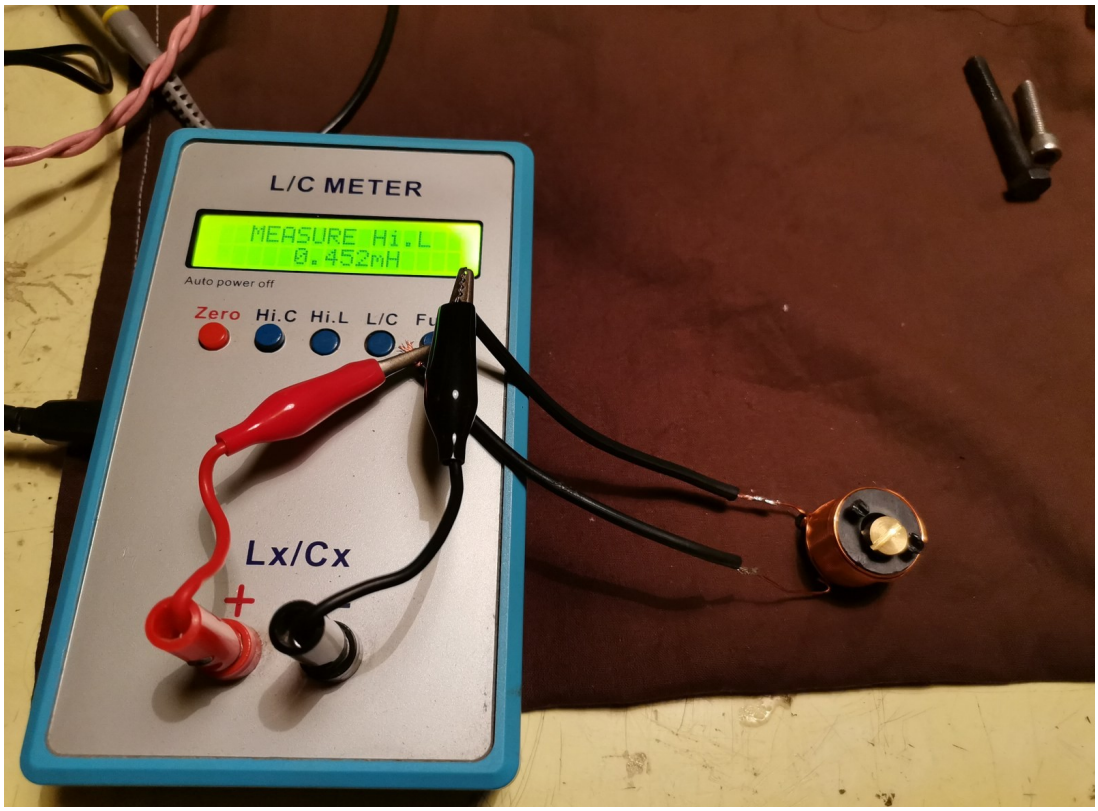

Figura 5: Brass core inserted, the inductance value is 0,452mH

Figura 6: Stainless steel inserted, the inductance value is 0,475mH.

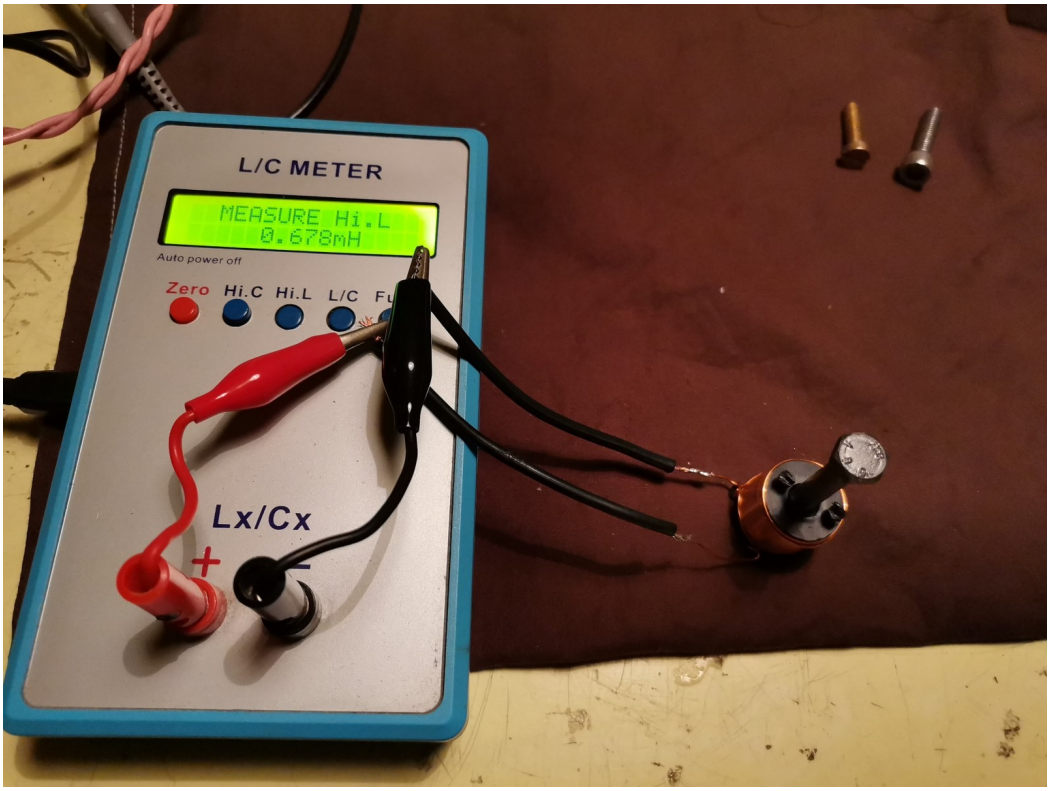

Figura 7: Steel inserted, the inductance value is 0,678mH

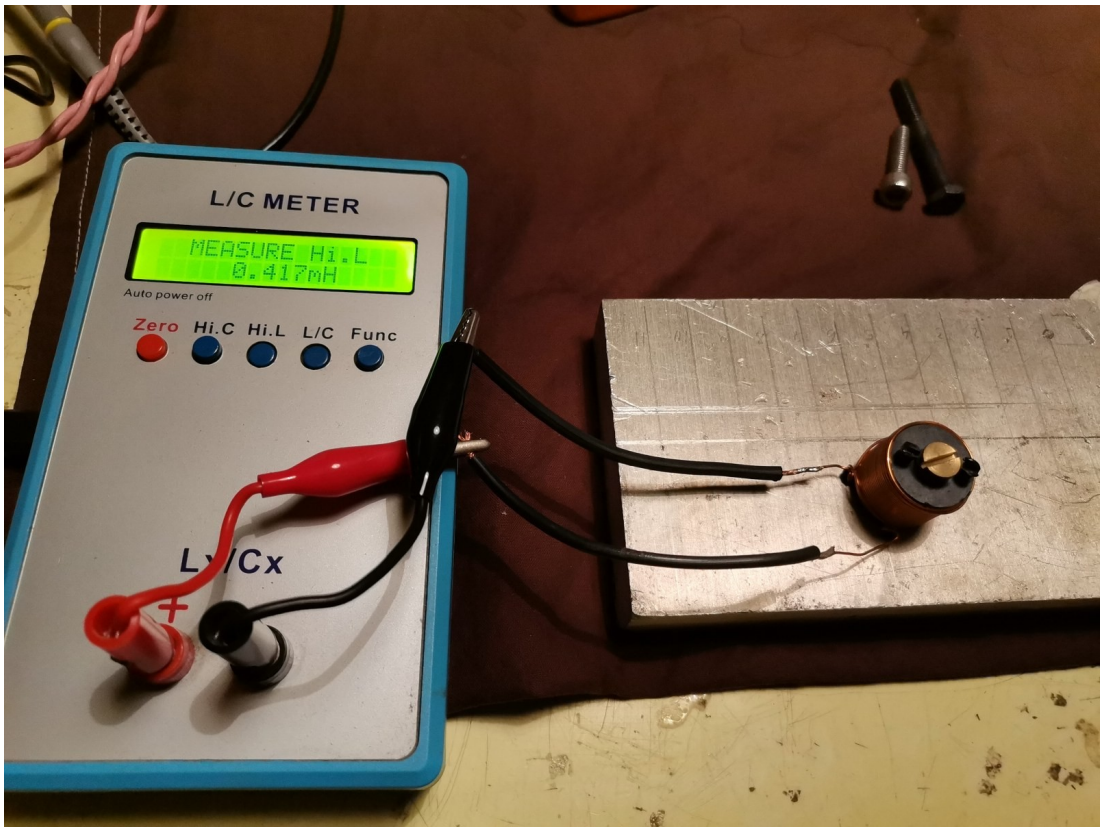

Figura 8: Brass core on aluminum plate, value 0,417mH

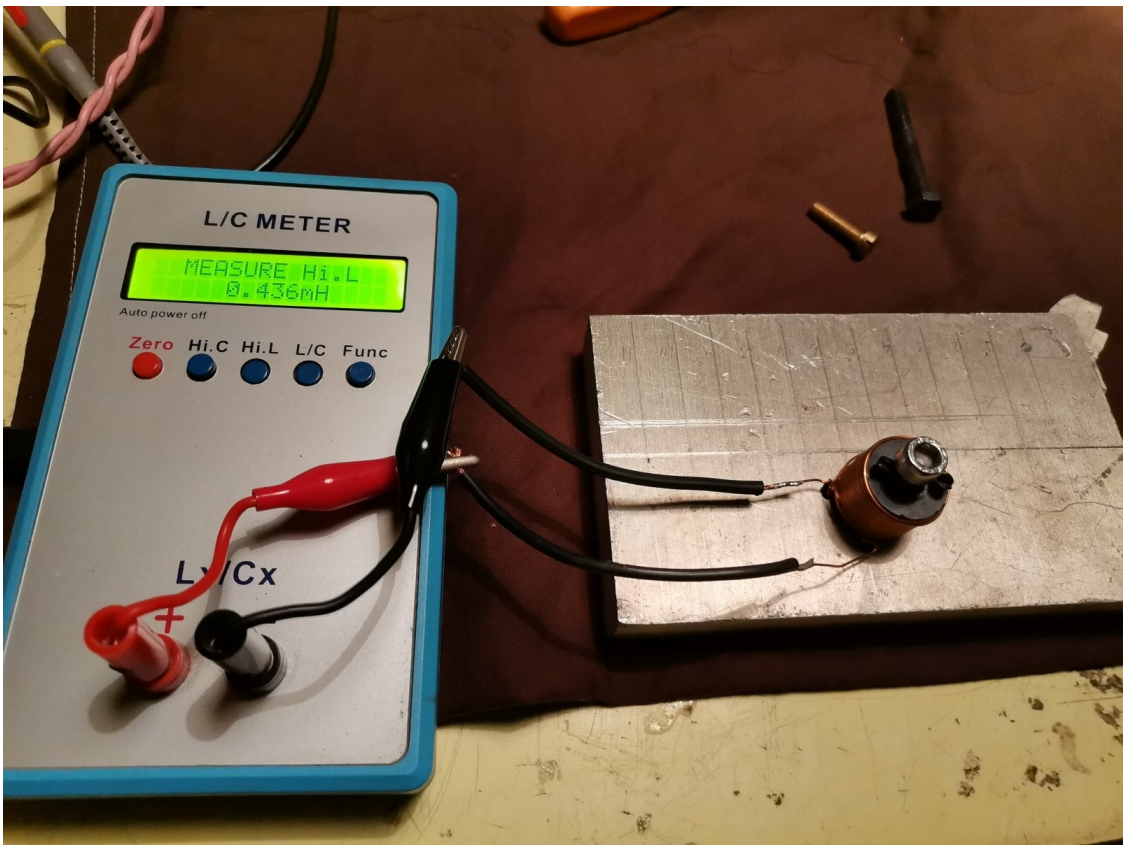

Figura 9: Stainless core on aluminum plate, value 0,436mH.

Figura 10: Steel core on aluminum plate, value 0,608mH.

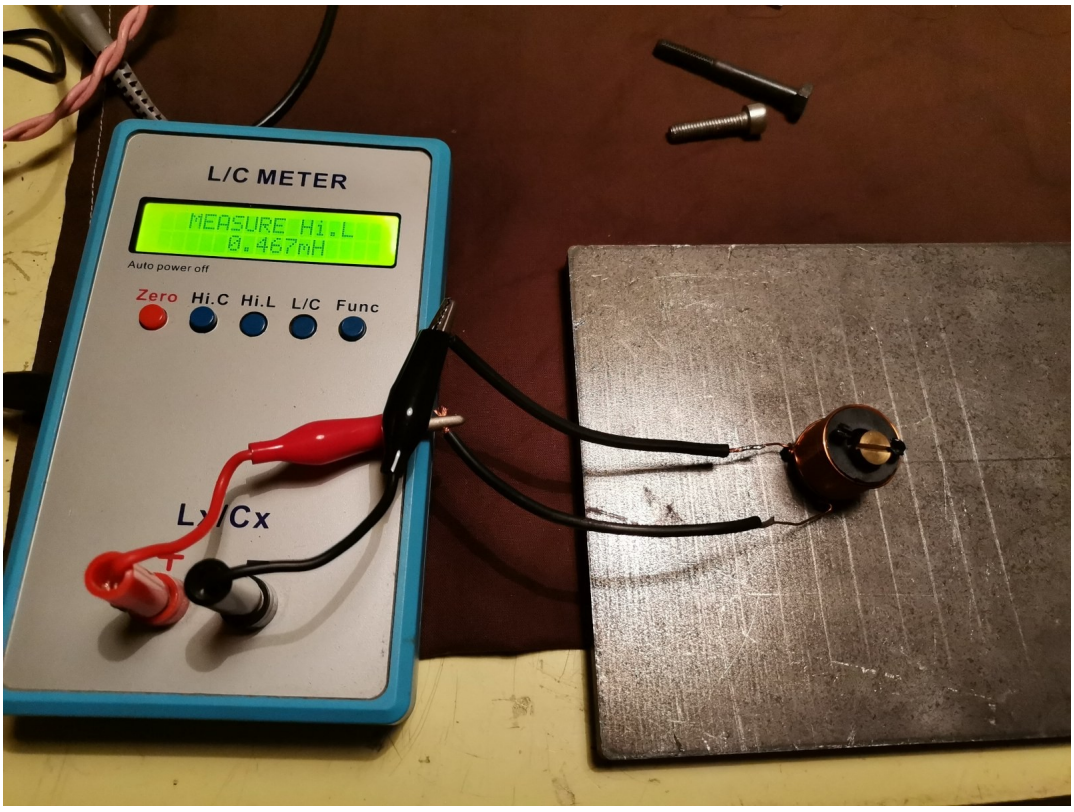

Figura 11: Brass core on steel plate, value 0,467mH.

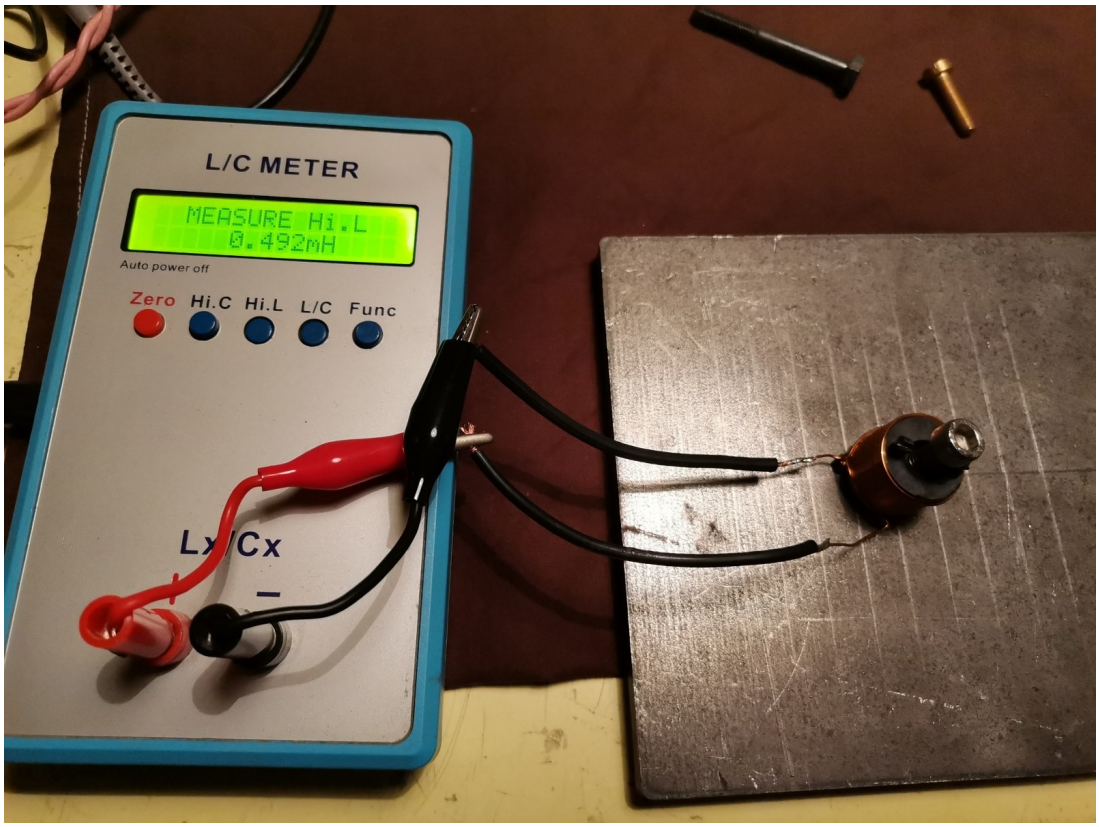

Figura 12: Stainless core on steel plate, value 0,492mH.

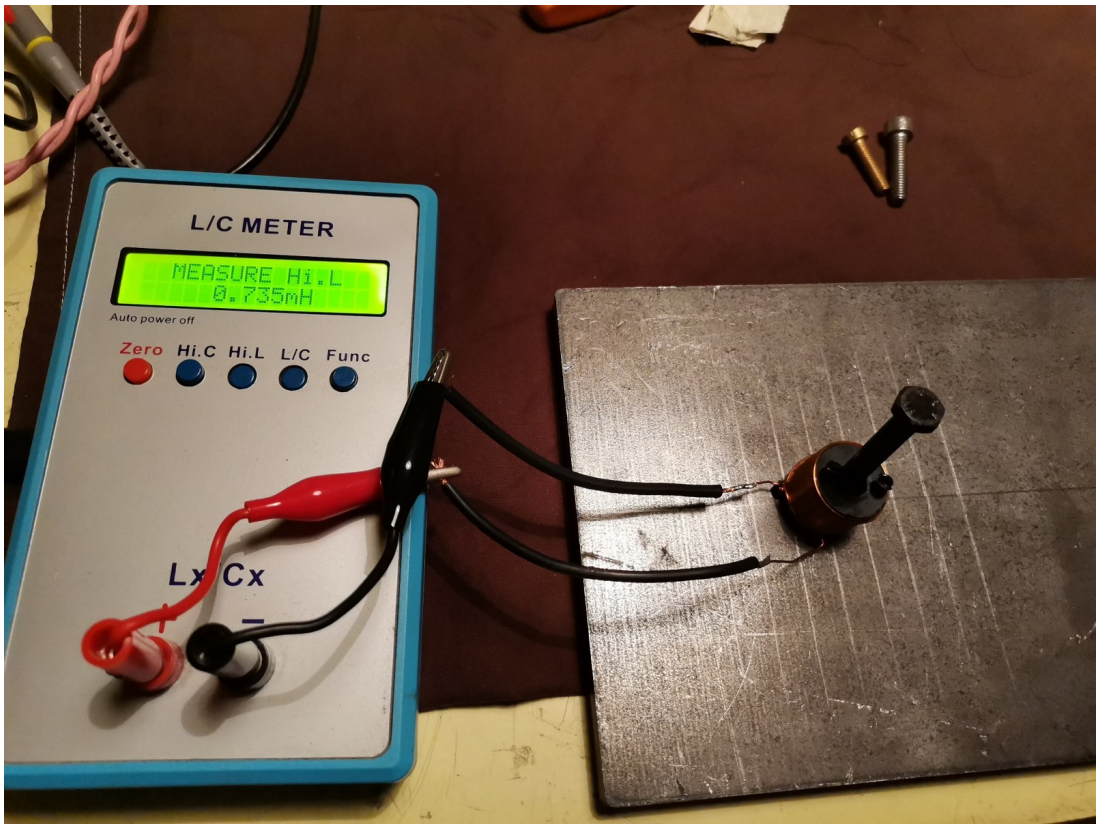

Figura 13: Steel core on steel plate, value 0,735mH.

Considering the need of fixing the coils to a plate, glue, pcb mounts, or cable ties are a neutral way to install without changing the inductance value.

Stainless screw through the core is still a good way since the change is restrained.

Brass reduces slightly the inductance, the trick is used also in RF coils in order to tune circuits.

Steel, being a ferromagnetic material, increases significantly the inductance, in fact, a like a true core. The use of these metals in particular should be evaluated according to needs.

Positioning of the coils

The position of the coils in the filter is particularly important. The distance, the position of axis and the verse are the crucial points of this test.

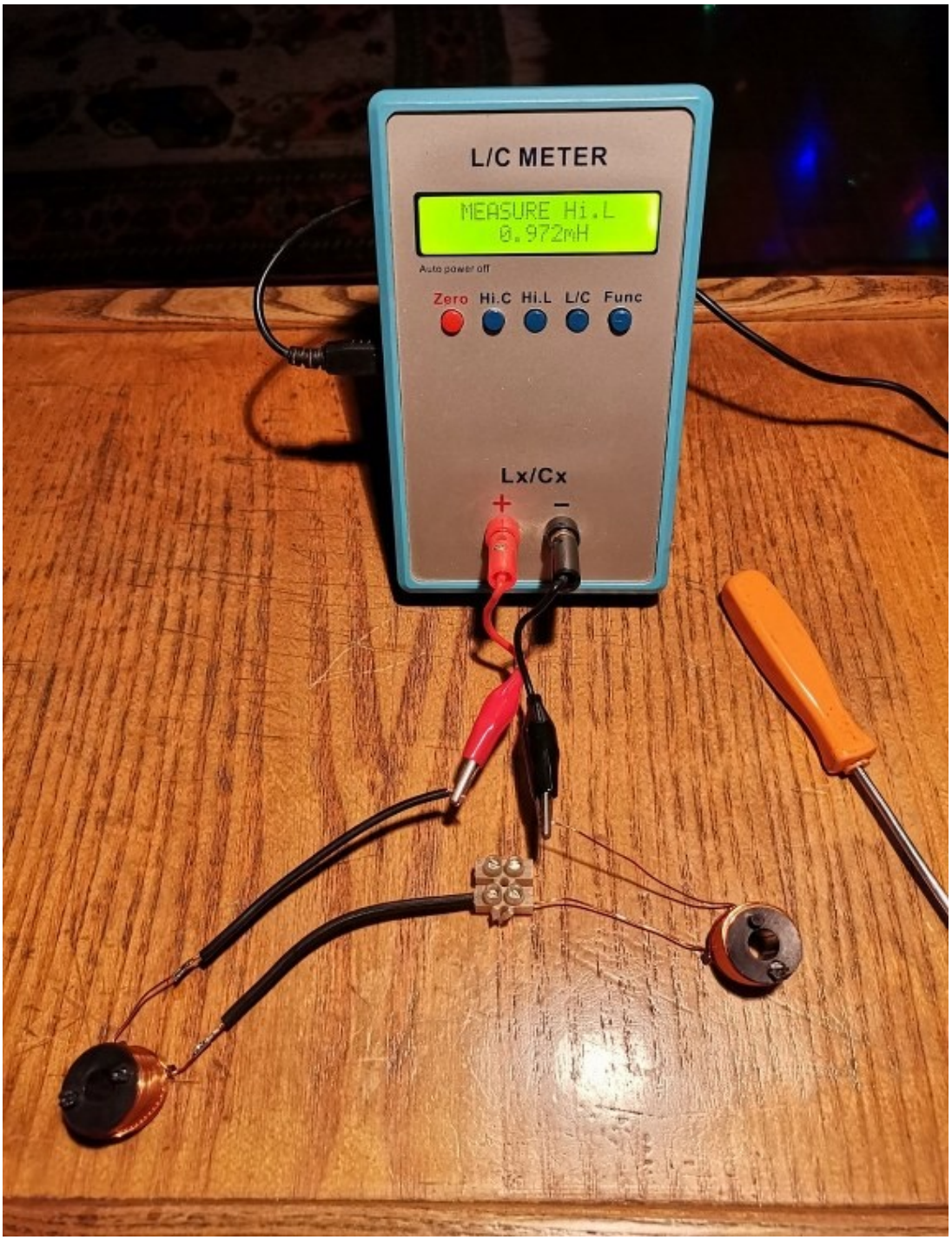

Figura 14: Coils 200mm apart, same verse. 0,972mH

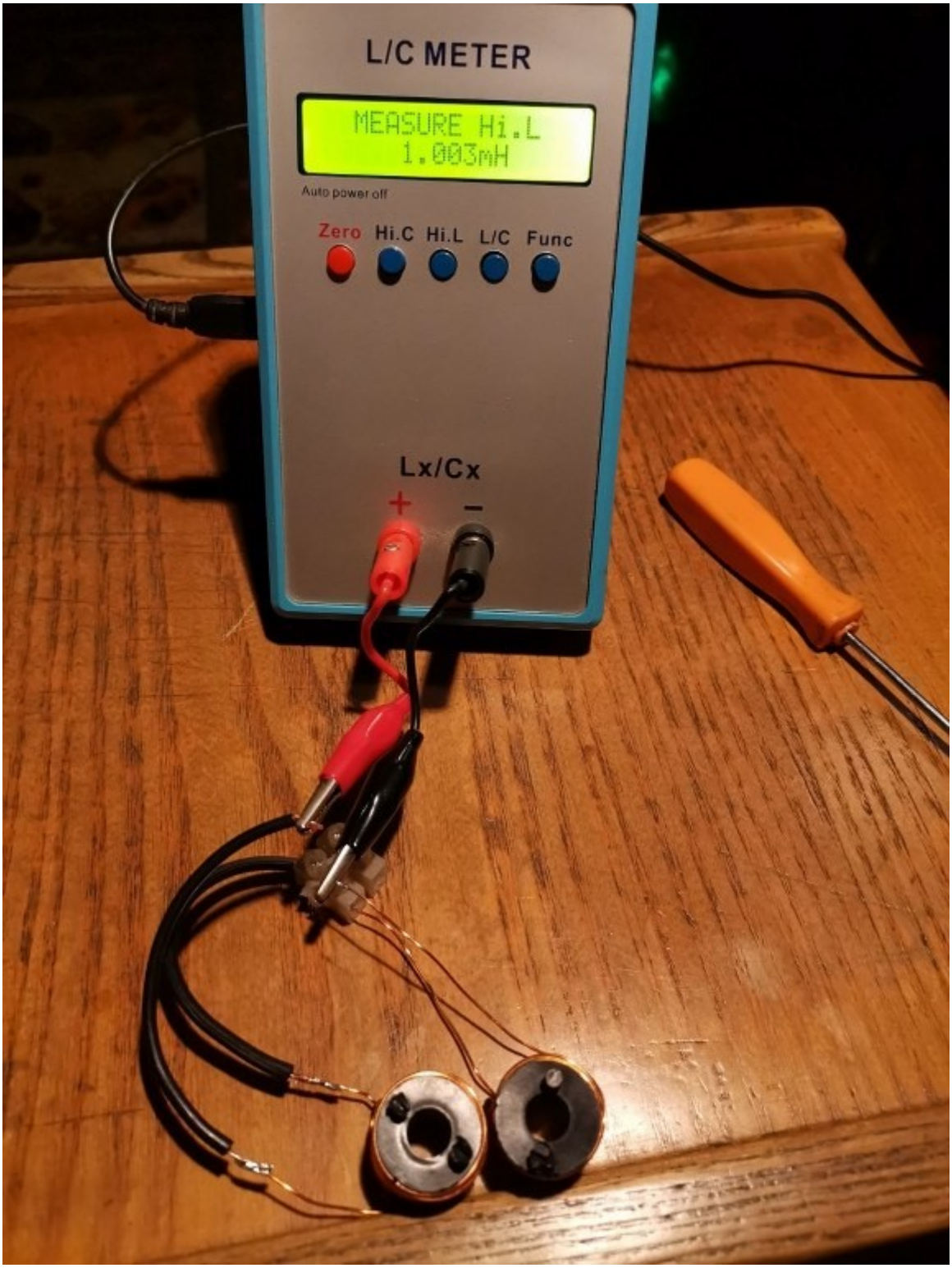

Figura 15: Coils close togheter, same verse, 1,003mH.

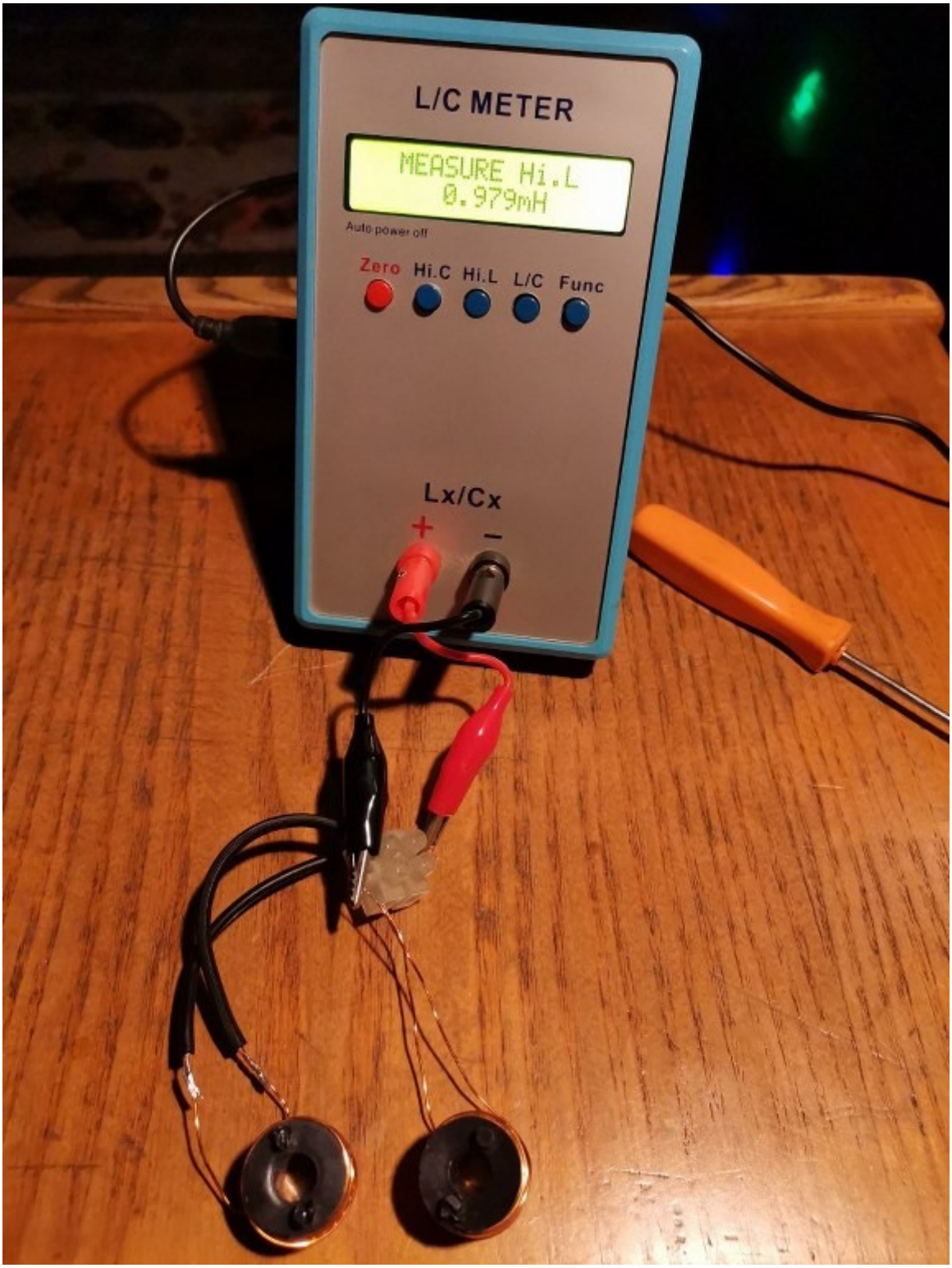

Figura 16: Coils 20mm spaced, same verse, 0,979mH

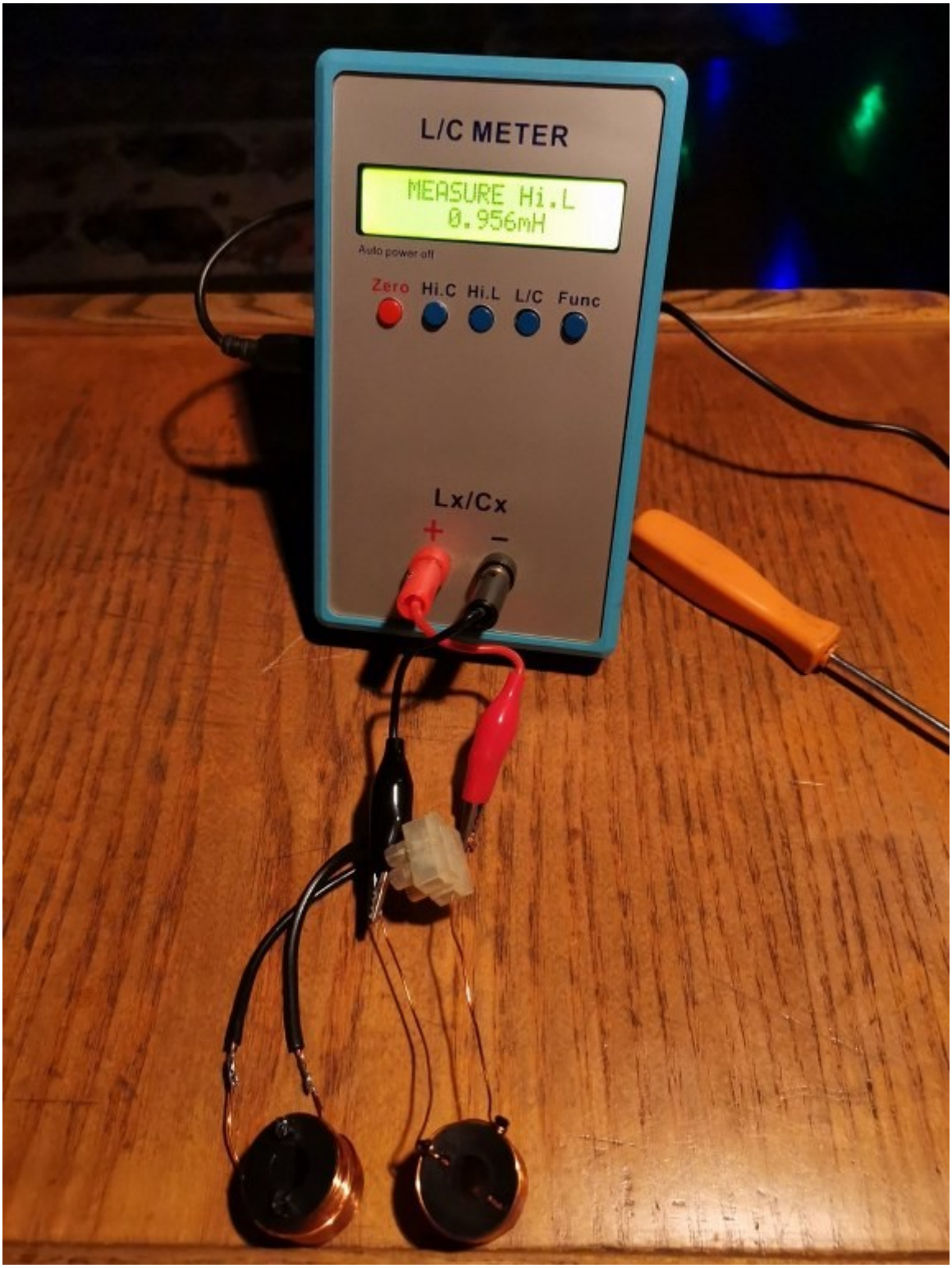

Figura 17: Coils 20mm spaced, one reversed, 0,956mH

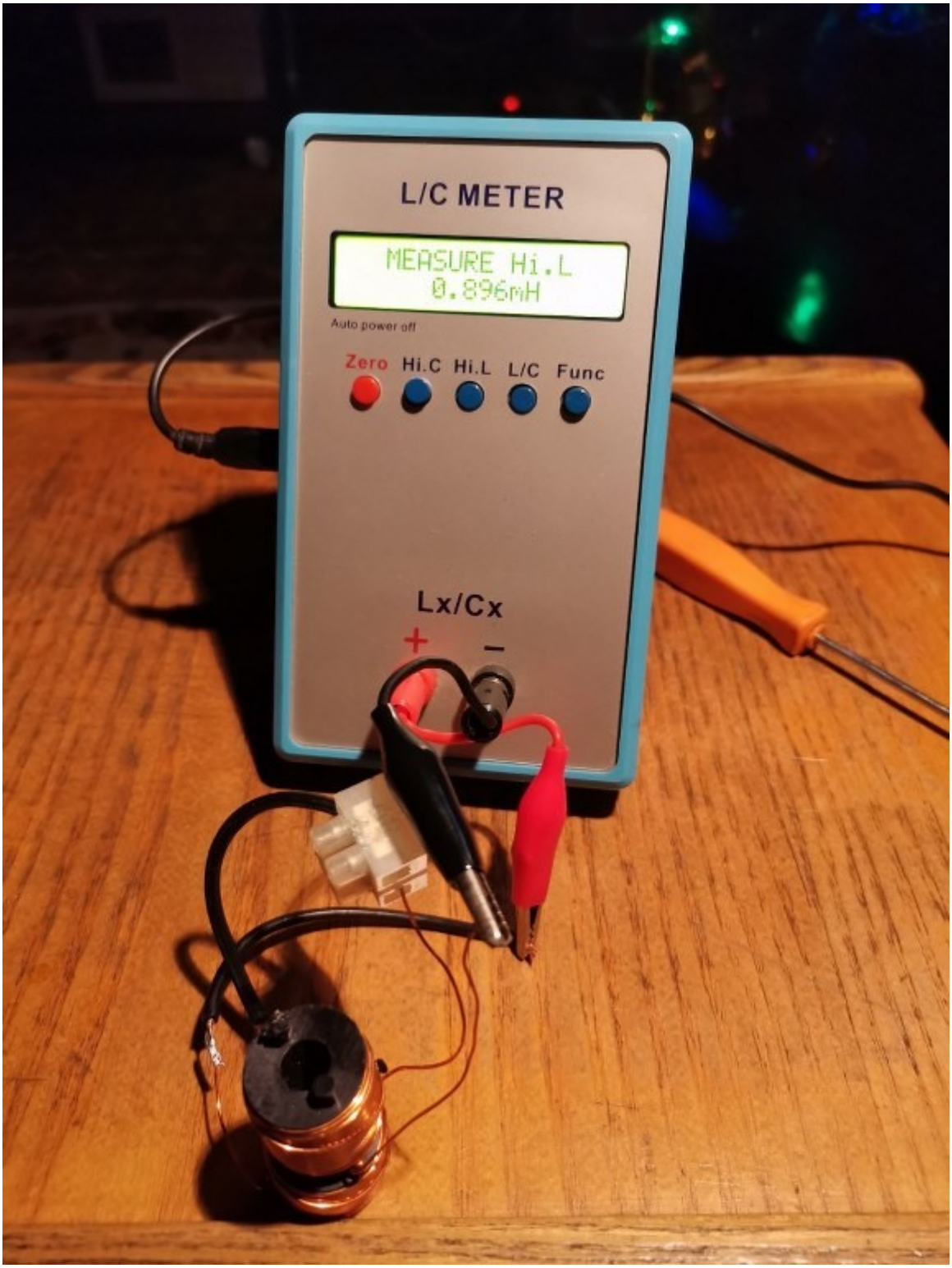

Figura 18: Coils stacked, same verse, 0,896 mH

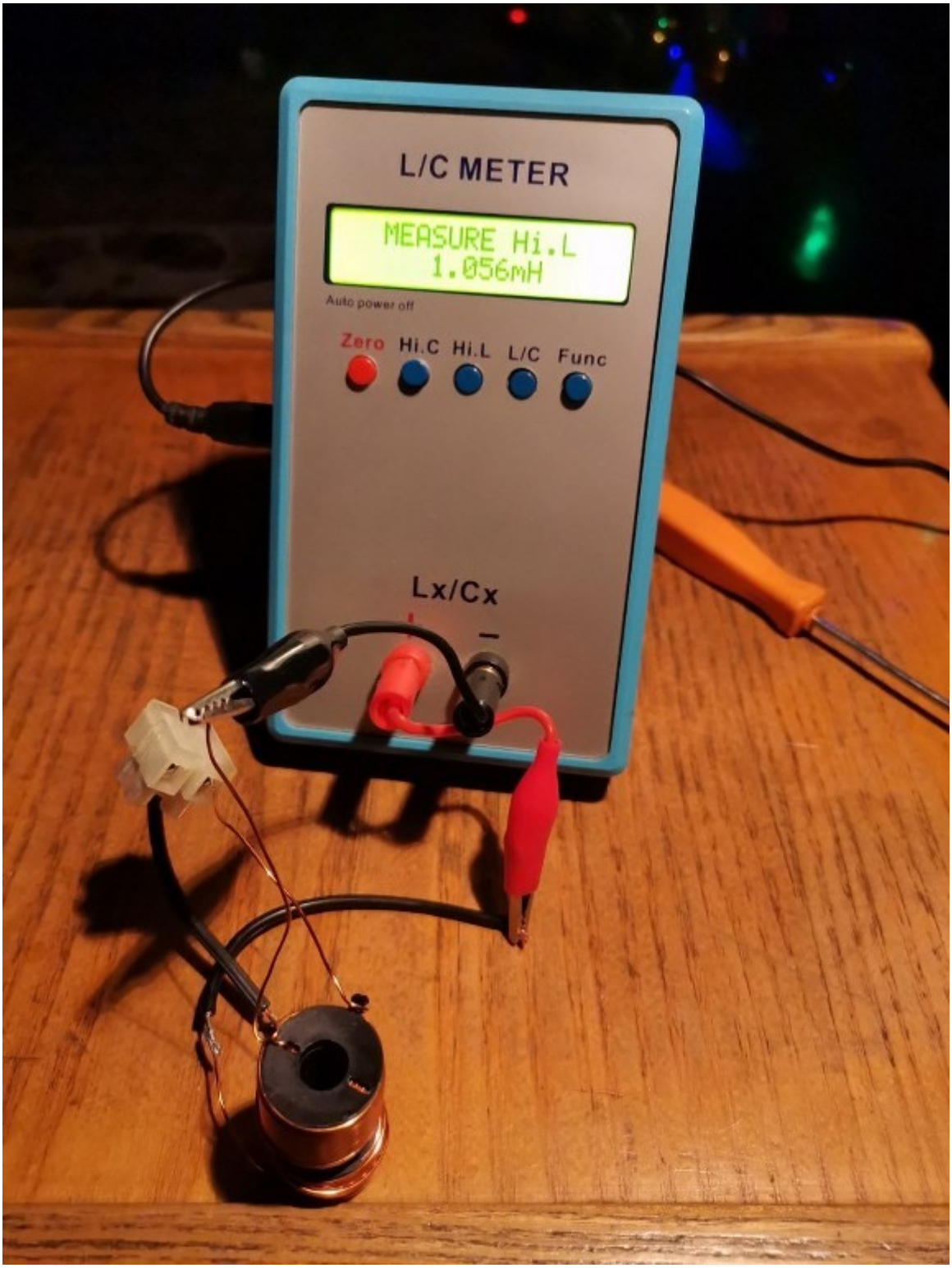

Figura 19: Coils stacked, one reversed, 1,056mH

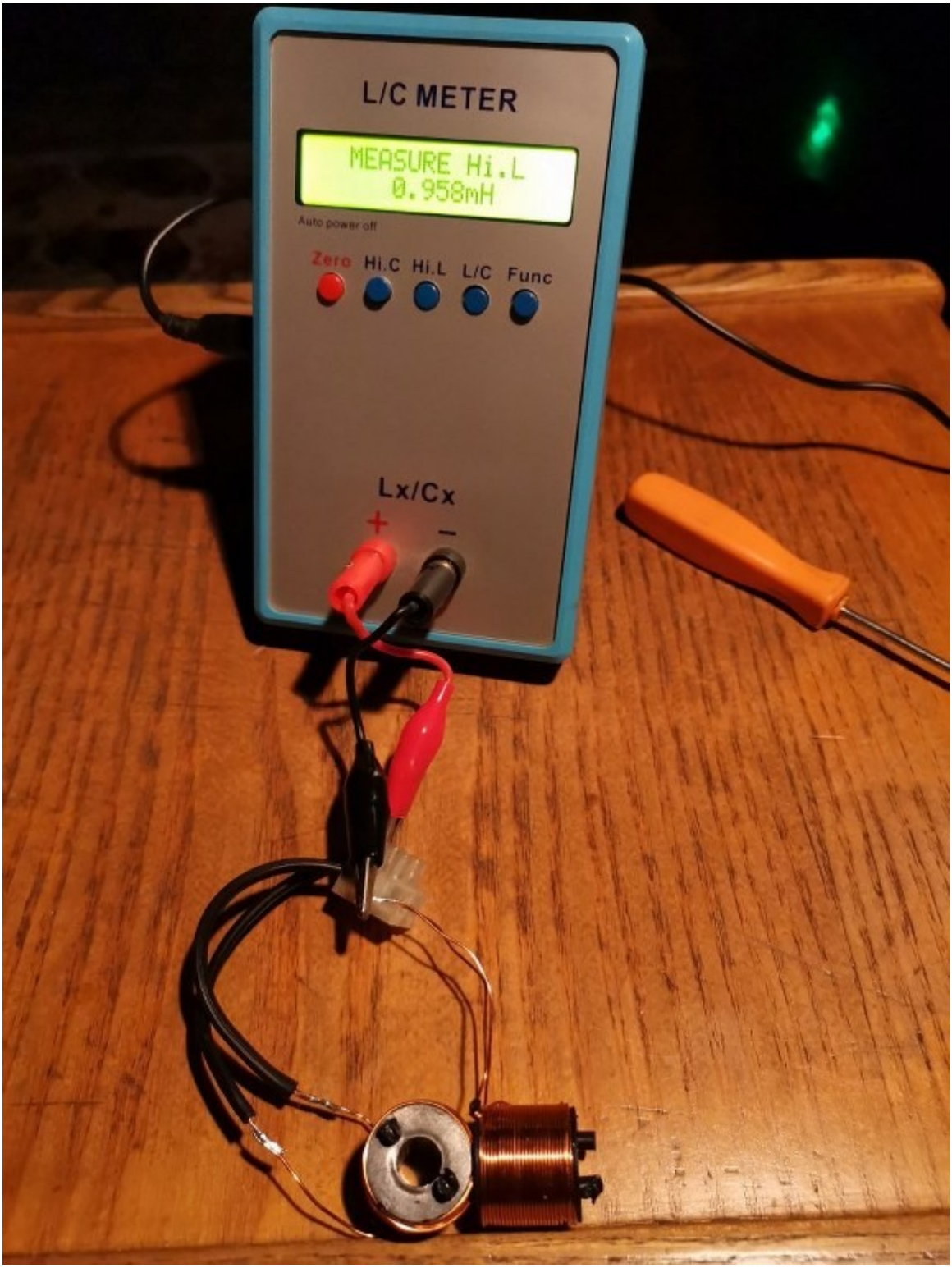

Figura 20: Coils closed together, perpendicular axis, 0,950mH.

Figura 21: Coils close together, one reversed, perpendicular axis, 0,970mH.

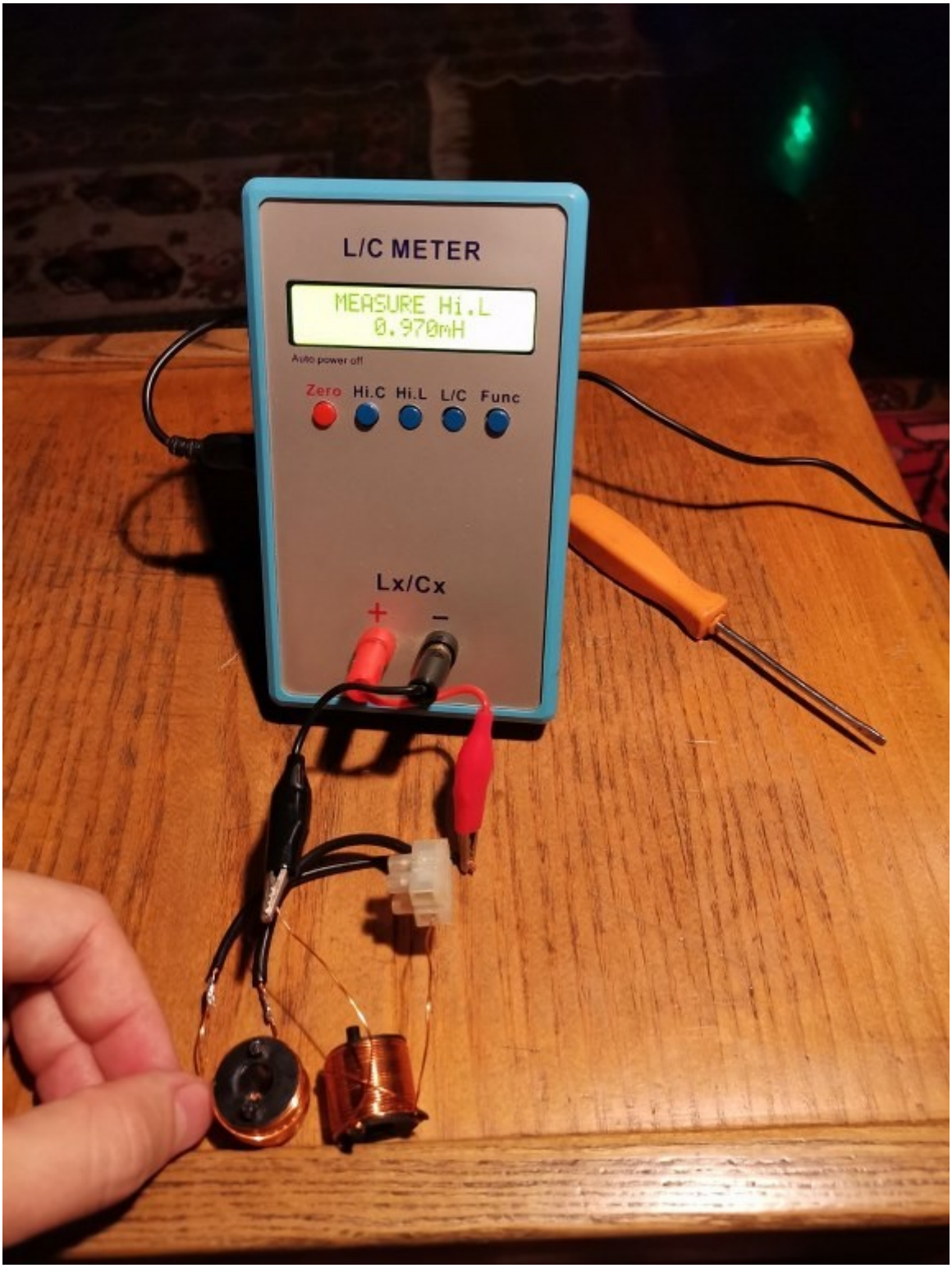

Figura 22: Coils closed together, non-tangent axis, 0,970mH.

The key aspect of placement is the proper spacing. Talking about normal loudspeaker filters, usually the space is limited and compromises must be accepted.

At a certain distance the interaction between the coils is almost zero, an ideal placement condition, unluckily not easy to implement.

In particular the stacked position presents more noticeable changes in inductance value, it should be avoided except for specific purposes.

If the coils are close together the best position is the one shown in the last picture (22).

Considering the results, according to the type and value of coils, a minum air distance is recommended in order to avoid interactions between units.

The verse of the coil is also an important aspect to keep in mind.

Crosstalk between coils

When a current flows in a conductor, a magnetic field is created. The coil shape and the numbers of turns increase the strenght of the magnetic field. Considering the placing of multiple coils in a cross-over circuit is important to consider the cross-talk effect between units. The first channel of scope is connected to one coil, powered with 1v rms, 1khz signal. The second channel is connected to the second test coil.

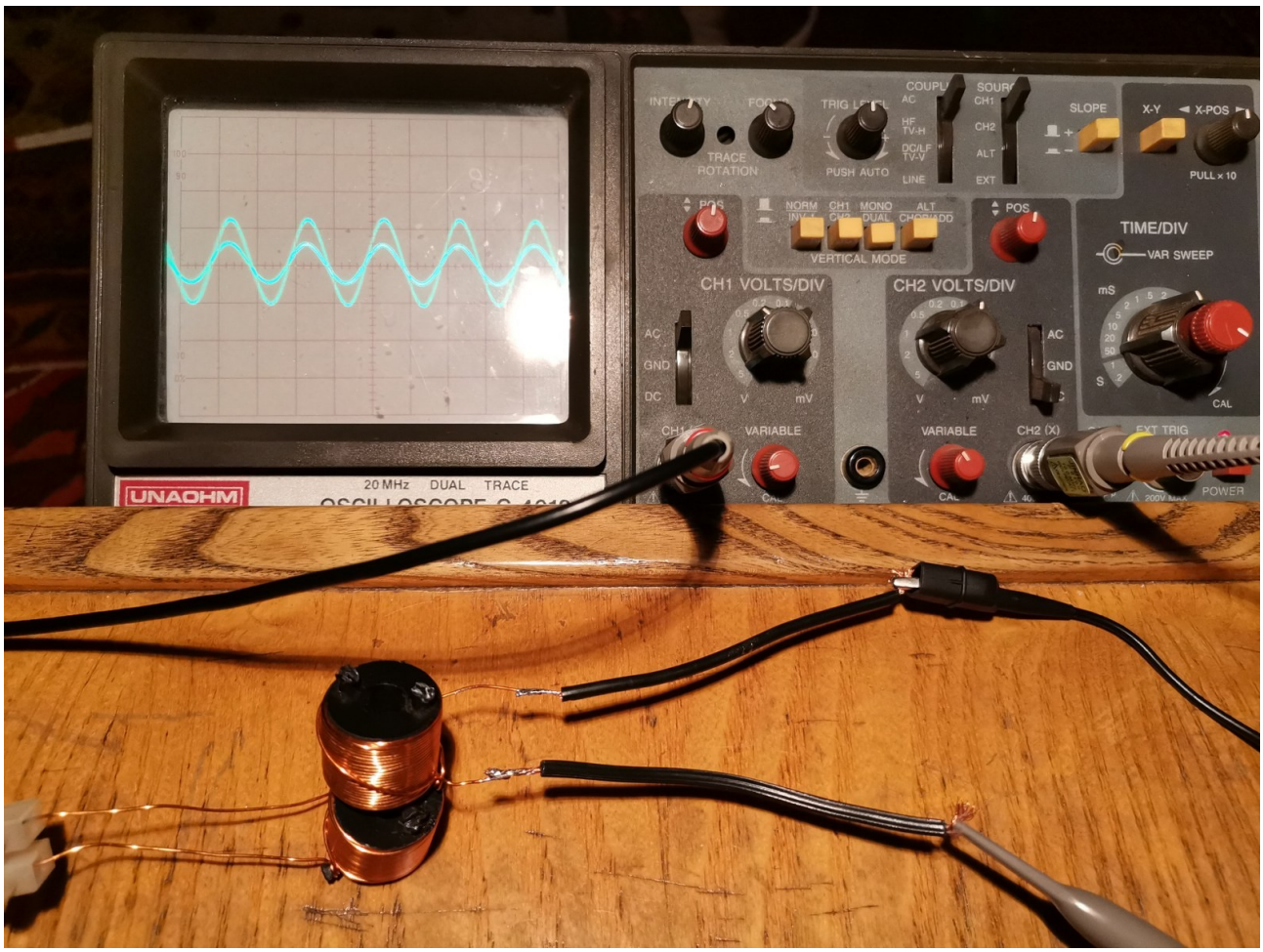

Figura 23: Coils stacked, same verse, 1v IN (volt/div 0,5) - 0,1v OUT (volt/div 0,1)

Figura 24: True-rms multimeter shows 0,103v rms at 1khz.

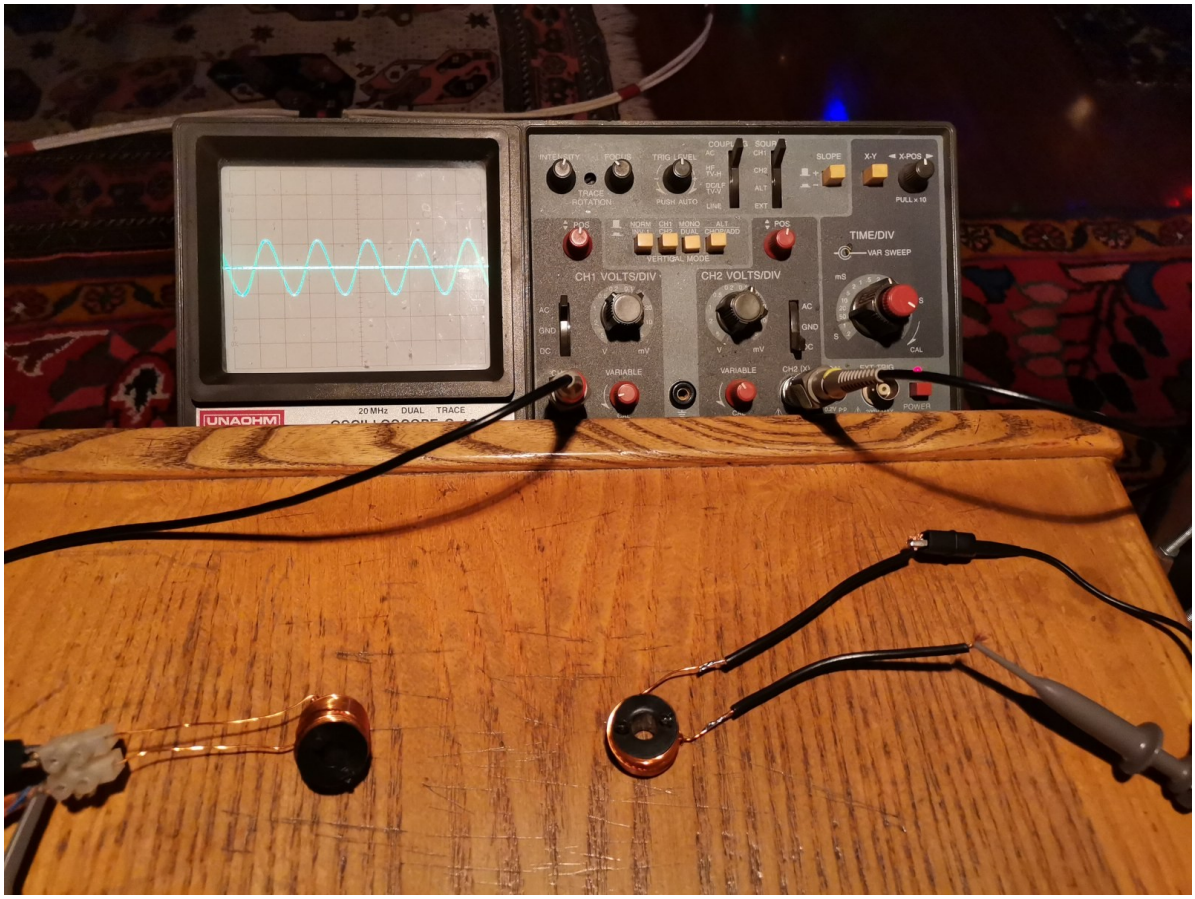

Figura 25: Distance and position decrease cross-talk between coils.

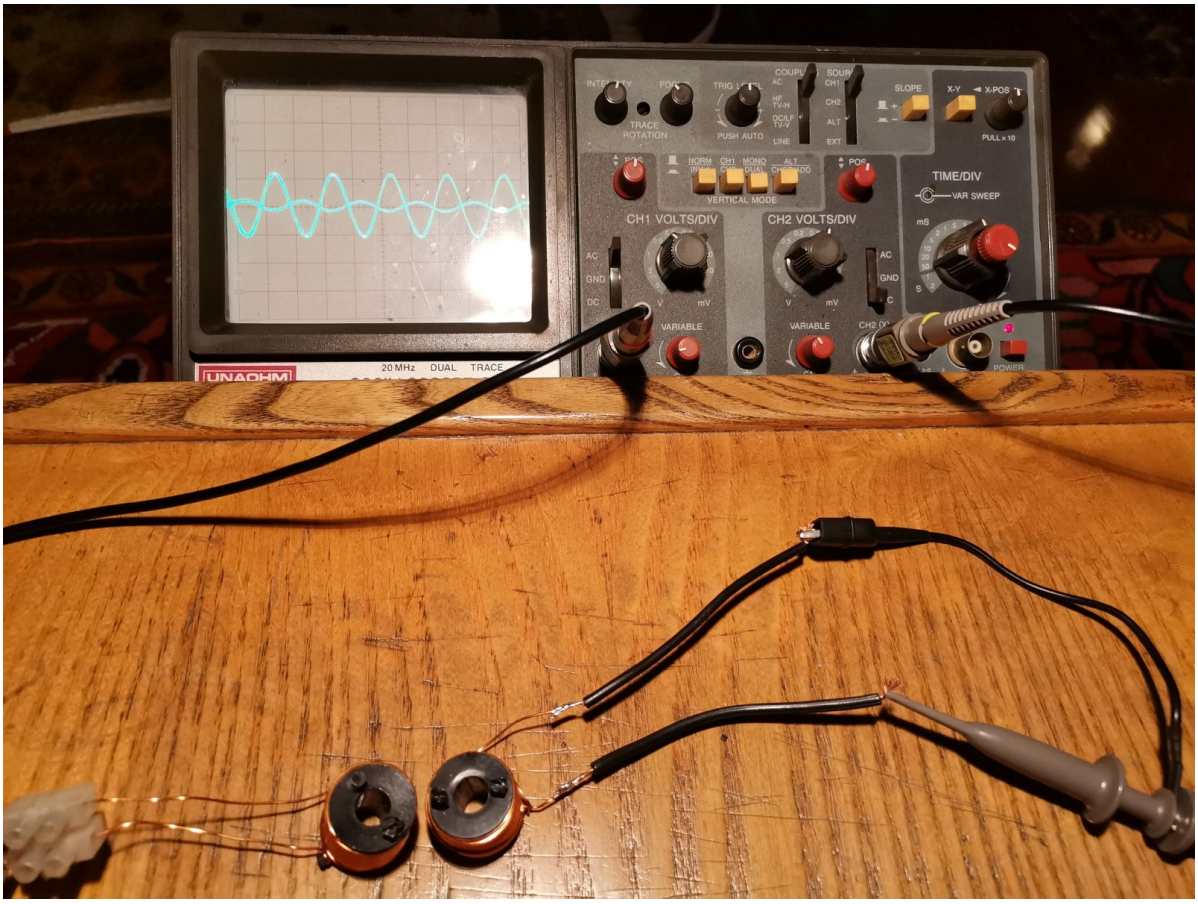

Figura 26: Proximity and position increase cross-talk.

Figura 27: Coils close together placed with different position, the cross-talk is limited.

In order to avoid cross-talk between coils is recommended to place the units with correct spacing. If not possible, due to design limitation, a good result could be achived with the correct positioning and coil orientation.

Influence of PP cap

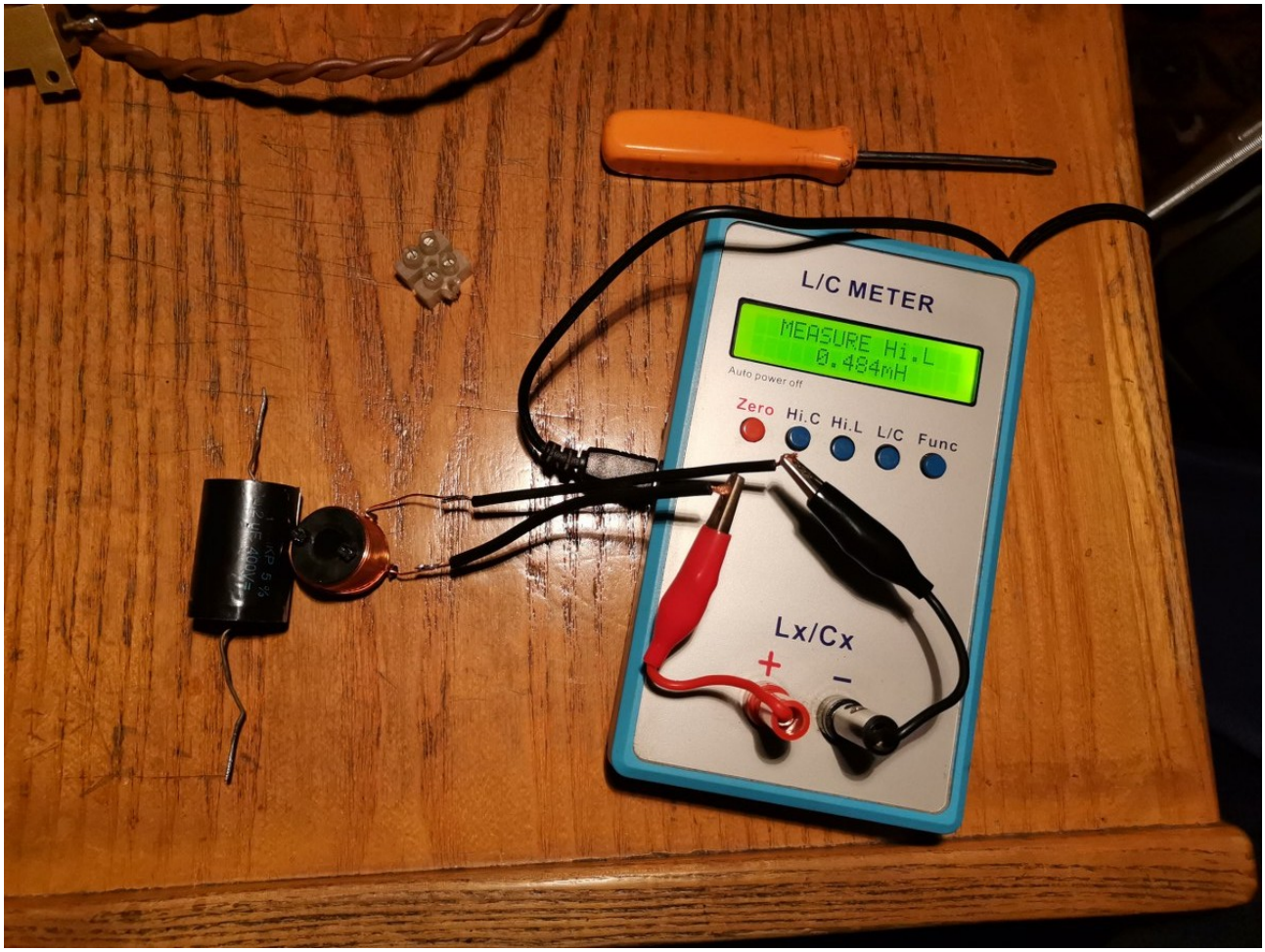

Figura 28: MKP cap, 8,2uF, non metallic shell has no influence on the inductance.

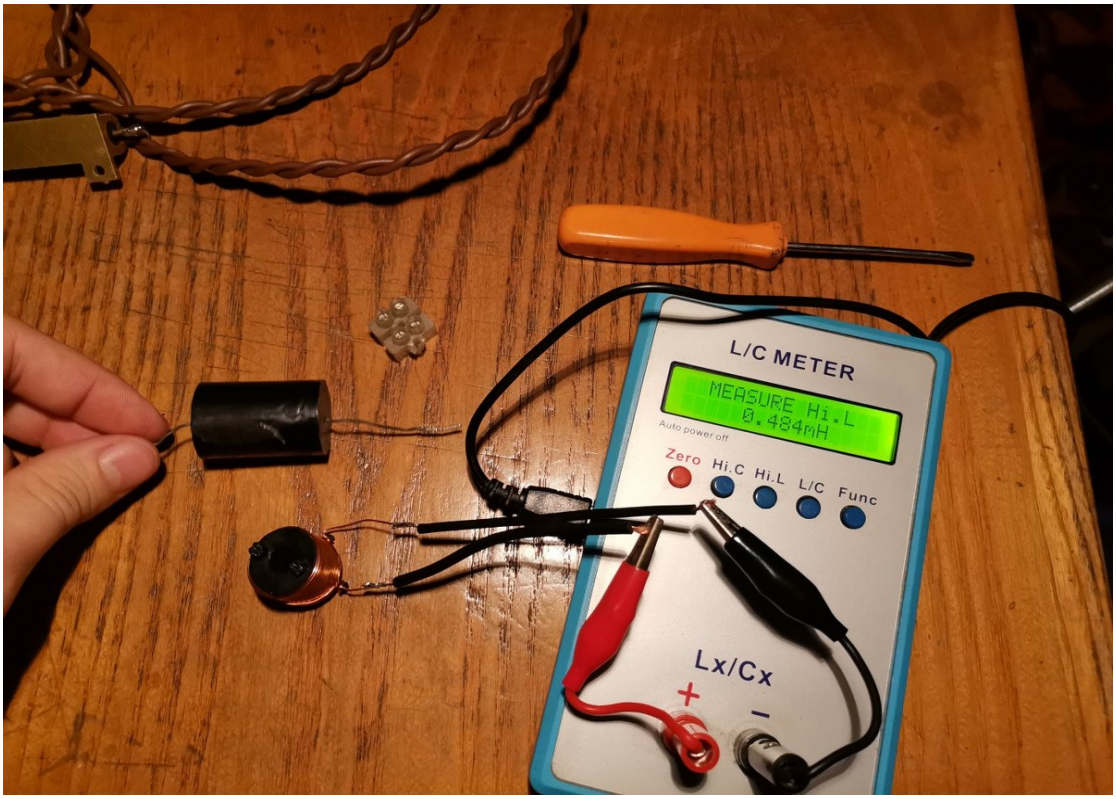

Figura 29: MKP cap, 8,2uF, non metallic shell has no influence on the inductance.

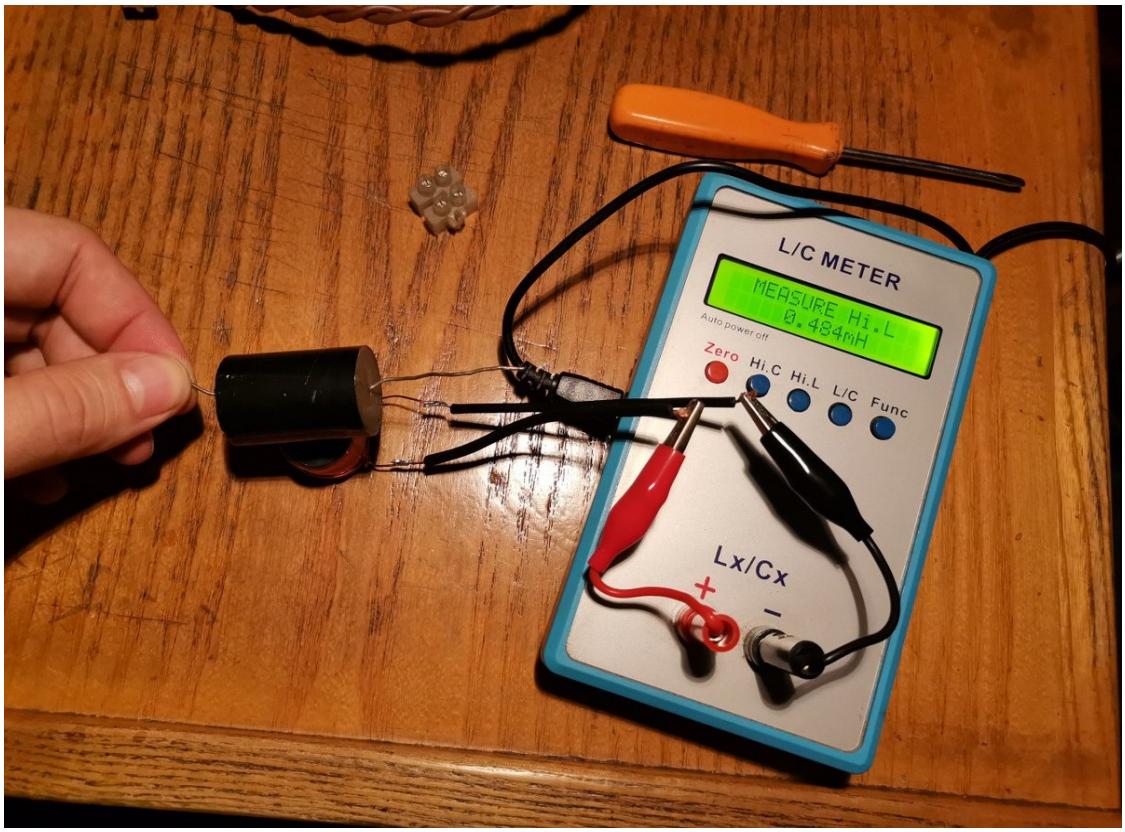

Figura 30: MKP cap, 8,2uF, non metallic shell has no influence on the inductance.

Conclusions

The tests have highlighted in particular:

- The importance of the correct distance, positioning, verse and orientation of the parts in a cross-over circuit.

- The interaction coil-metal plays a fundamental role, proper coupling can help to achieve the desired results.

- The coils during normal operation generate a magnetic field. In order to obtain better performance (low noise), the cross-talk must be kept as low as possible, orienting the coils or spacing them correctly.