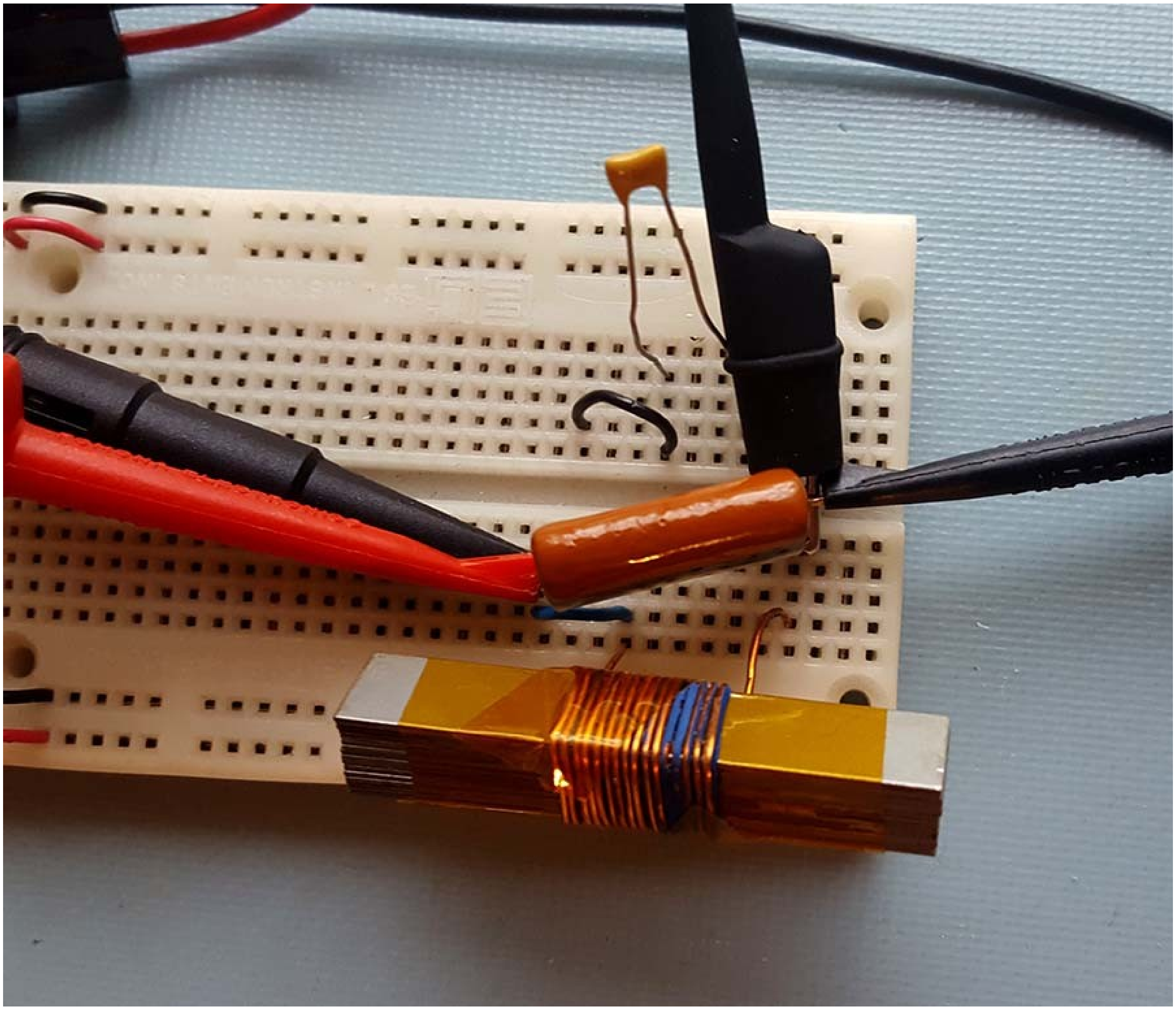
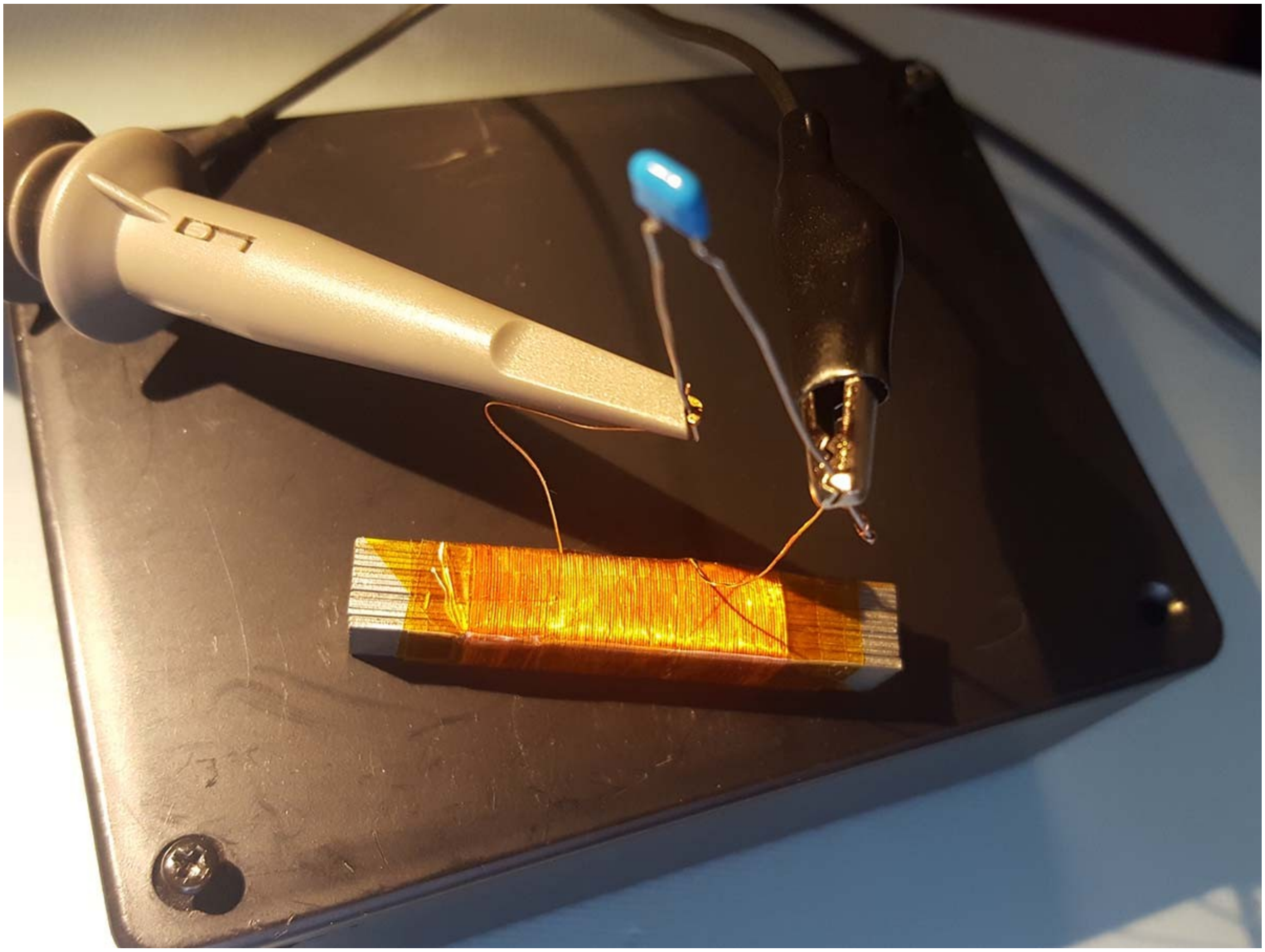
Testing home-built coils for short range transmitting and receiving 38 kHz carrier using magnetic induction.

I dismantled an old 120VAC/12VAC transformer I found in a junk box to get the wire to make my own coils. It turned out that the laminated soft iron core had some flat rectangular pieces which were ideal for making square cross section cores for my coils. I have no idea how appropriate this core material is for this application, but my coils do seem to work nicely. I made identical cores for both xmit and recv coils. Here’s the xmit coil (connected across the 1 microF cap, with signal generator and scope leads attached).

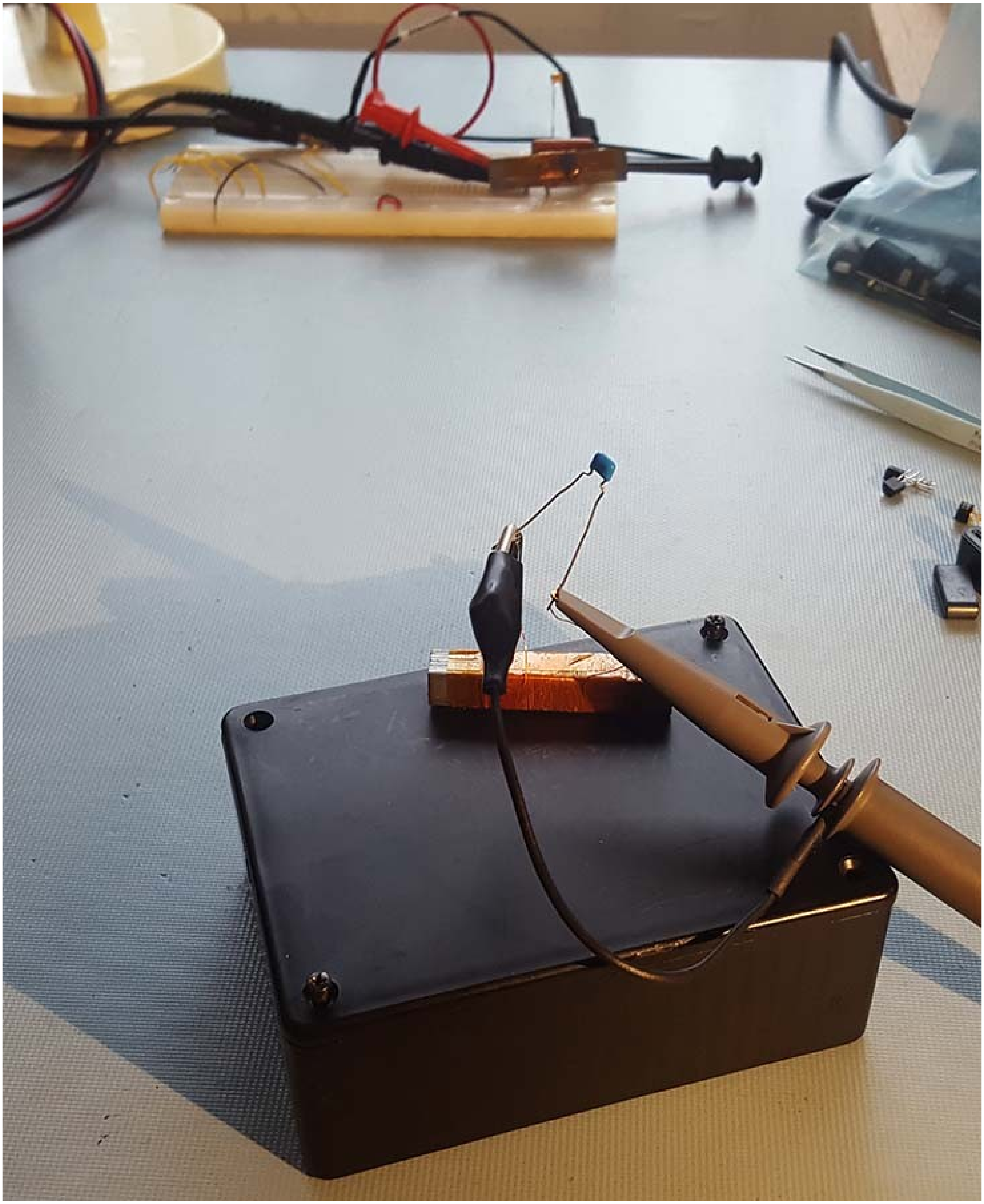


2. I saw much better performance with a low impedence xmit coil (fewer turns, larger diameter wire) but relatively higher impedence recv coil (many more turns, much smaller wire). DC resistance of my two coils is 0.145 ohm and 2.13 ohm, resp. Here's the receive coil. The recv cap is 0.047 microF.



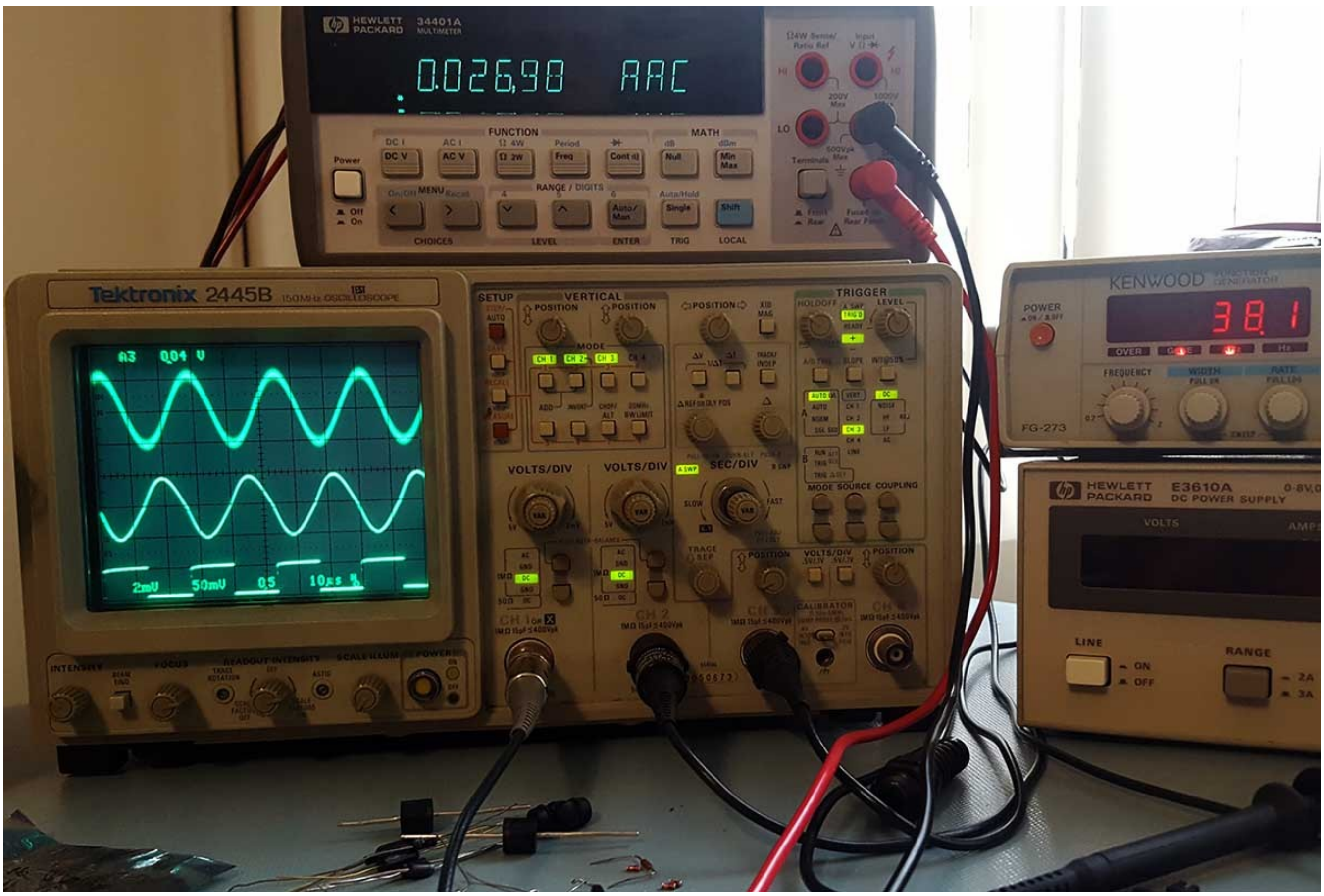
3. Transfer efficiency was much better when the xmit tank was driven by sine wave input: cleaner recv'd signal, stronger recv'd signal for lower xmit pwr. Also, matching tank resonant freq to signal frequency was less critical.

There's nothing fancy about the setup. It's purely passive: just two tank circuits with the xmit side driven by a signal generator, and the recv side connected to the scope. No batteries, no amplification, no additional filtering or other circuits.



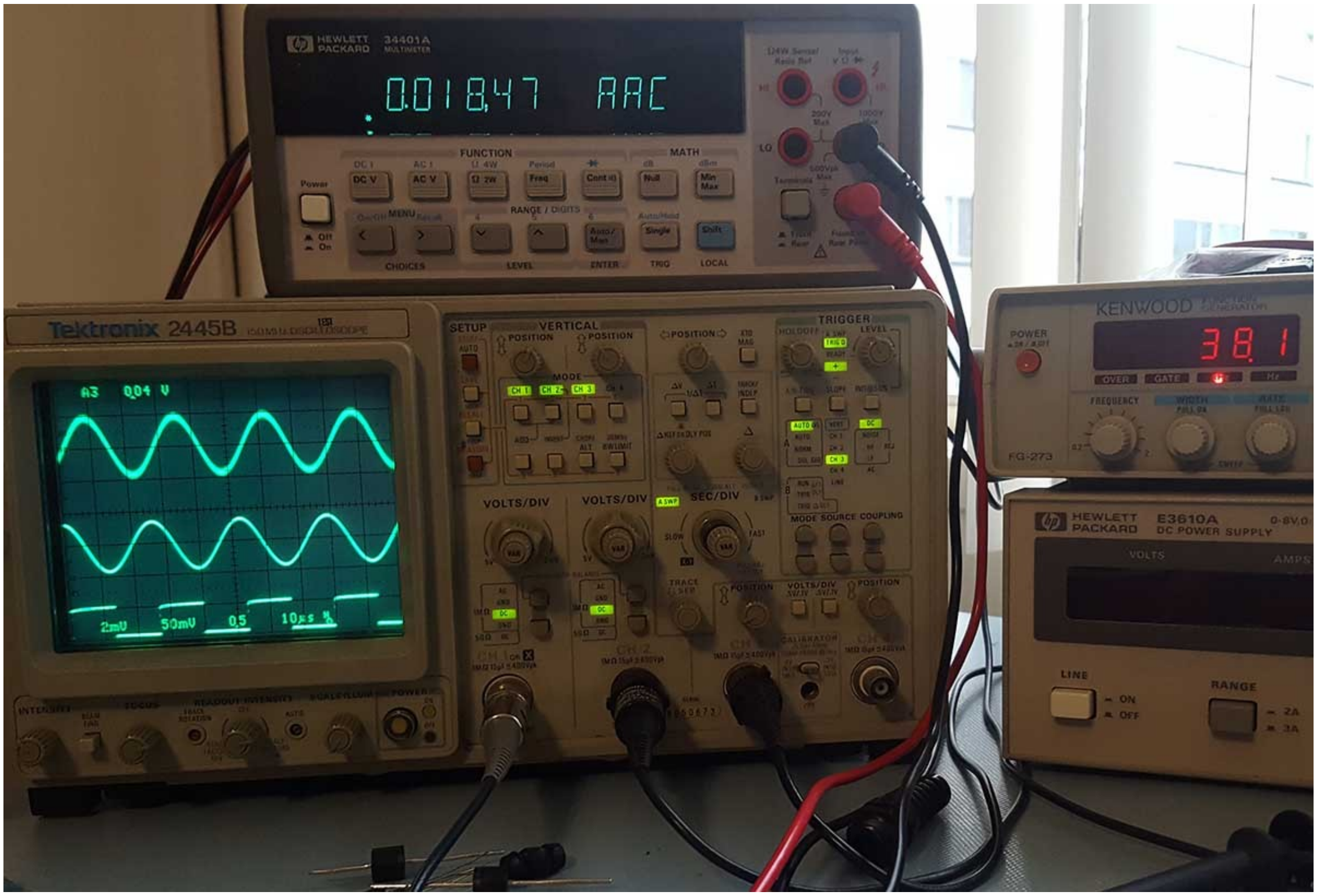
I was surprised by how strong and clean the received signal was given my wiring "technique", which I thought would pick up a lot more stray noise. Of course the distance between coils during measurements was very short - 35 cm - but it seems to me that a transmitter with a well-tuned output tank circuit, and a simple receiver with a couple of tuned amplifier (op-amp) input stages, a diode detector and low-pass filter to extract the 4 kHz modulation signal, should be able to get the job done, with pretty much non-critical components.

Here are some photos of the signals. On the right is the signal generator showing the xmit frequency (kHz). Above the scope is the multimeter showing the RMS current draw of the xmit side. The scope shows 3 traces. The bottom trace is the sync output from the signal generator (5V/div). It goes positive when the output signal is positive. The middle trace is the signal across the xmit tank circuit 0.5V/div). This is the output of the signal generator, but shows the result of the filtering effect of the load. So even when the generator (no load) output is a square wave, the tank circuit is "trying" to turn it into a sine wave, and that's what the scope sees. The top trace is from the probe connected across the recv coil (2mV/div).

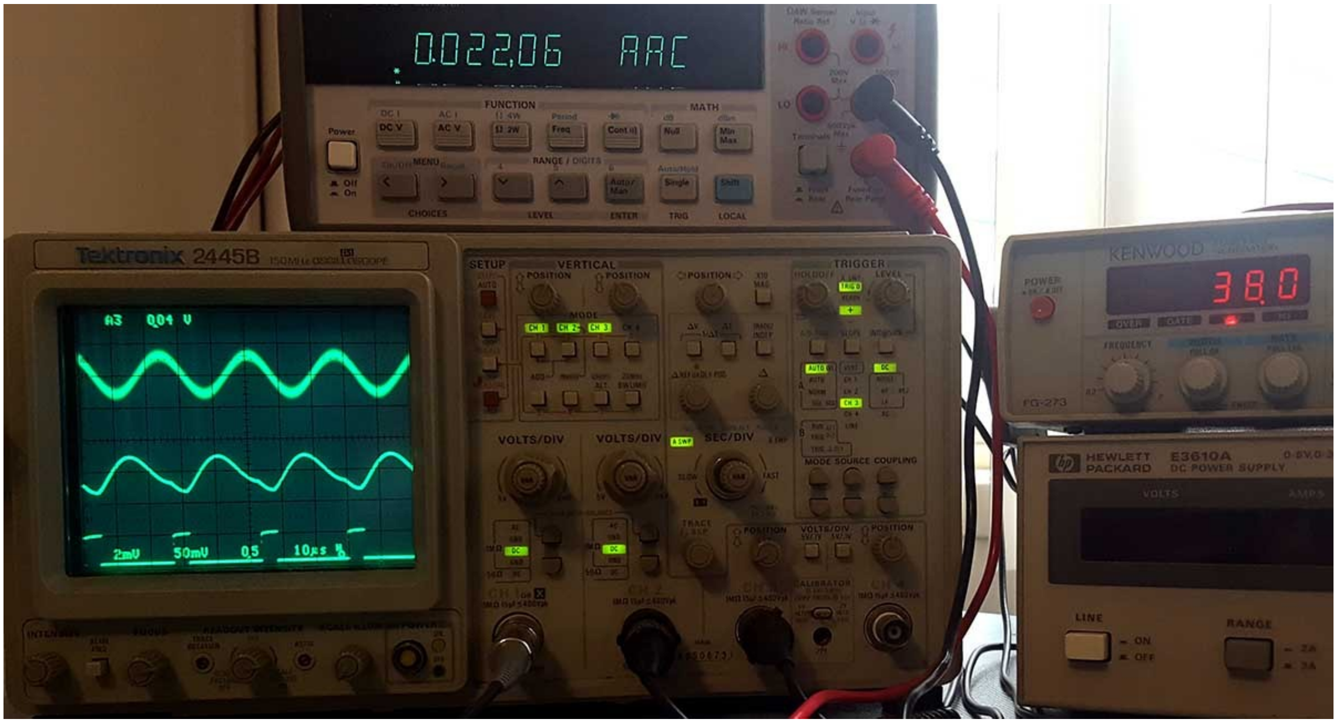


I set the no-load output voltage of the signal generator to 3.5V P-P, to simulate an average voltage in a transmitter using a single LiIon battery. As you can see the xmit tank has loaded that voltage down to 1V P-P; it is drawing 26.98 mA, and has filtered the applied square wave into a pretty respectable sine wave. The top trace shows that the induced voltage in the recv coil is about 4 mV P-P with just a little evenly distributed high-frequency noise.

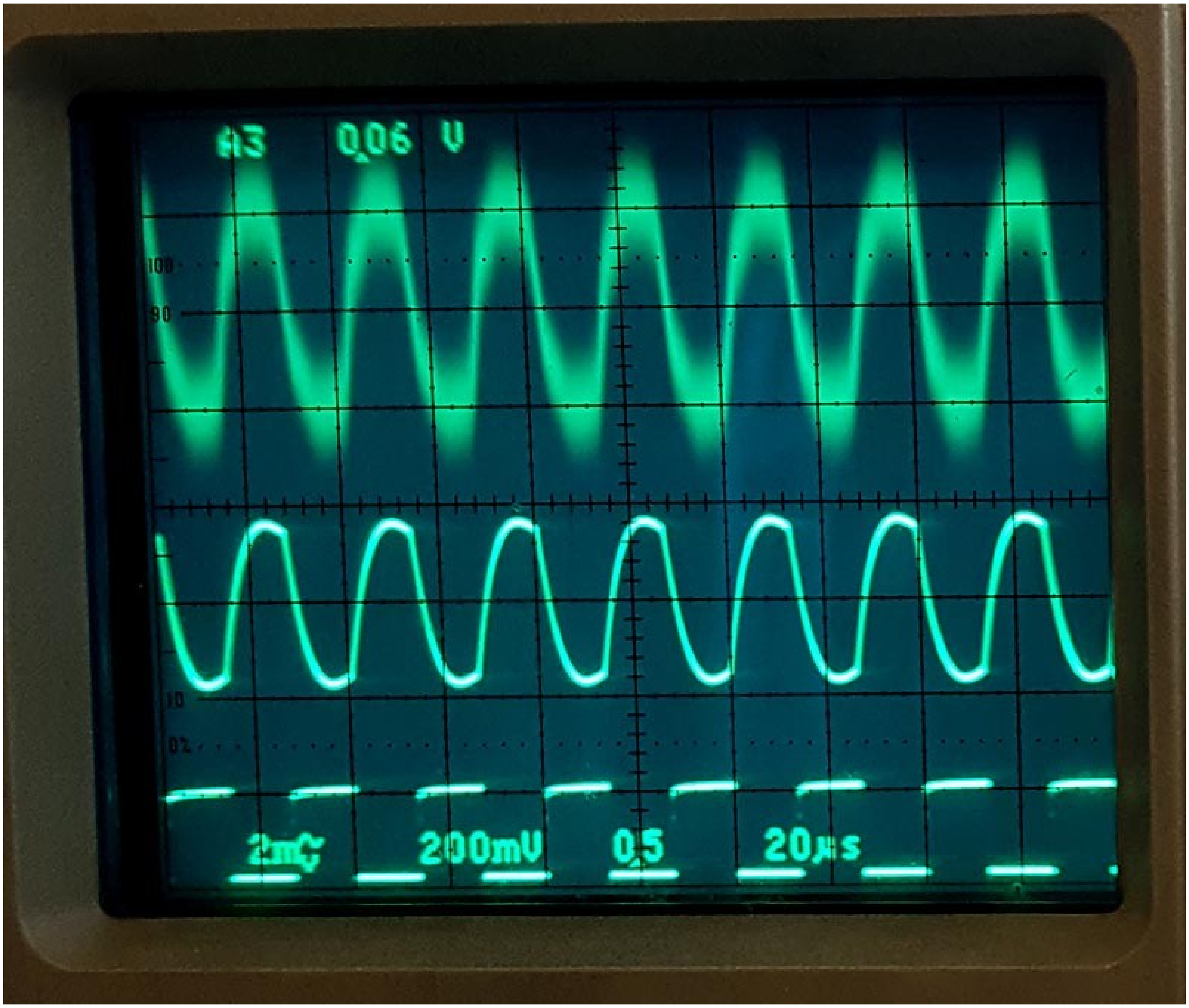
For comparison, here is the same setup with no changes except the xmit tank is driven by a sine wave instead of square wave.



It's hard to see in the photos but the recv'd signal is noticeably cleaner here. Finally, here are the traces when I reduced the square wave duty cycle to about 15% (this could be done to reduce power consumption at the cost of some signal integrity: more spurious transmission and lower S/N).



Although I had thought that it would be a good idea for the xmit coil to be a low impedance load (high current, stronger magnetic field) and for the recv coil to be (relatively) high impedence, I was disappointed by my first tests. Here is an example trace.



The gap between xmit and recv coils was just 3 cm for this test. Also, the signal gen output voltage was increased significantly in order to have about 3.5V P-P under load. Despite this higher xmit power and very short distance, the received signal was very weak and noisy (although still easily recognizable).

While disconnecting this setup, I realized that I had mistakenly used the low impedance coil for the receive side, and the high impedance coil for xmit. So in retrospect this error confirmed that the coil parameters are critical to success, beyond just the choice of inductance.