EE430 Electromagnetism
Project 4: Metal detector
April 21, 2025

- Cameron deLeeuw

Schematic:

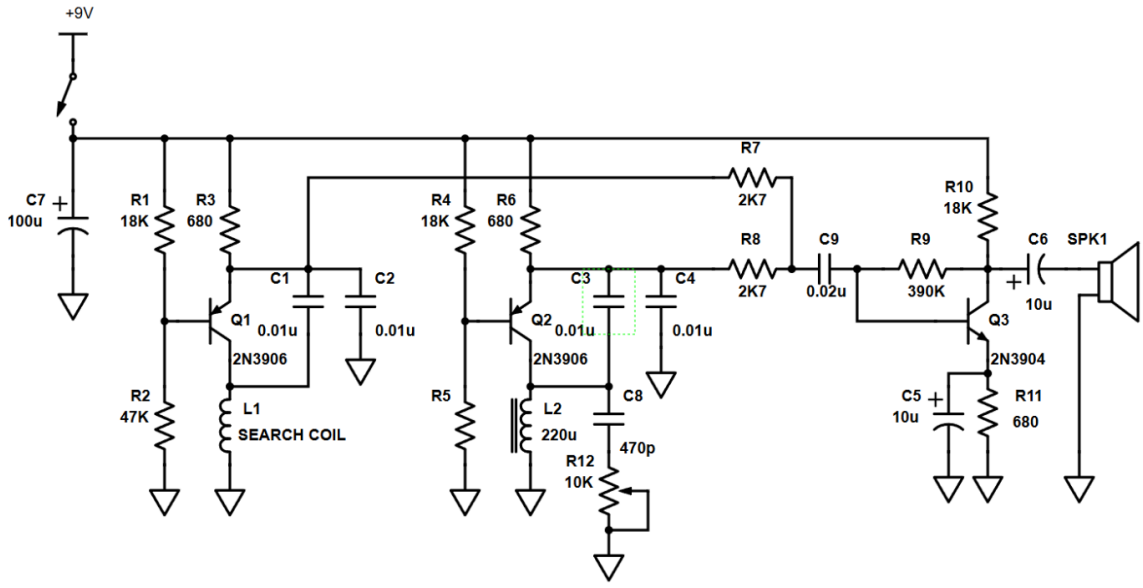


Photo:

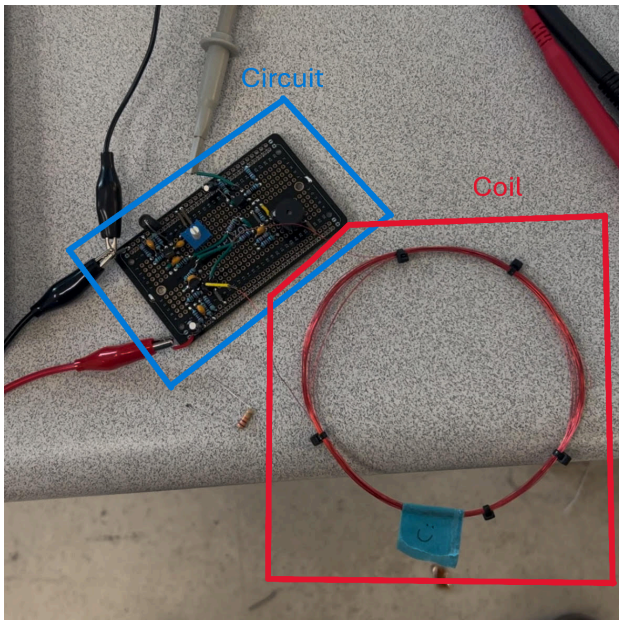


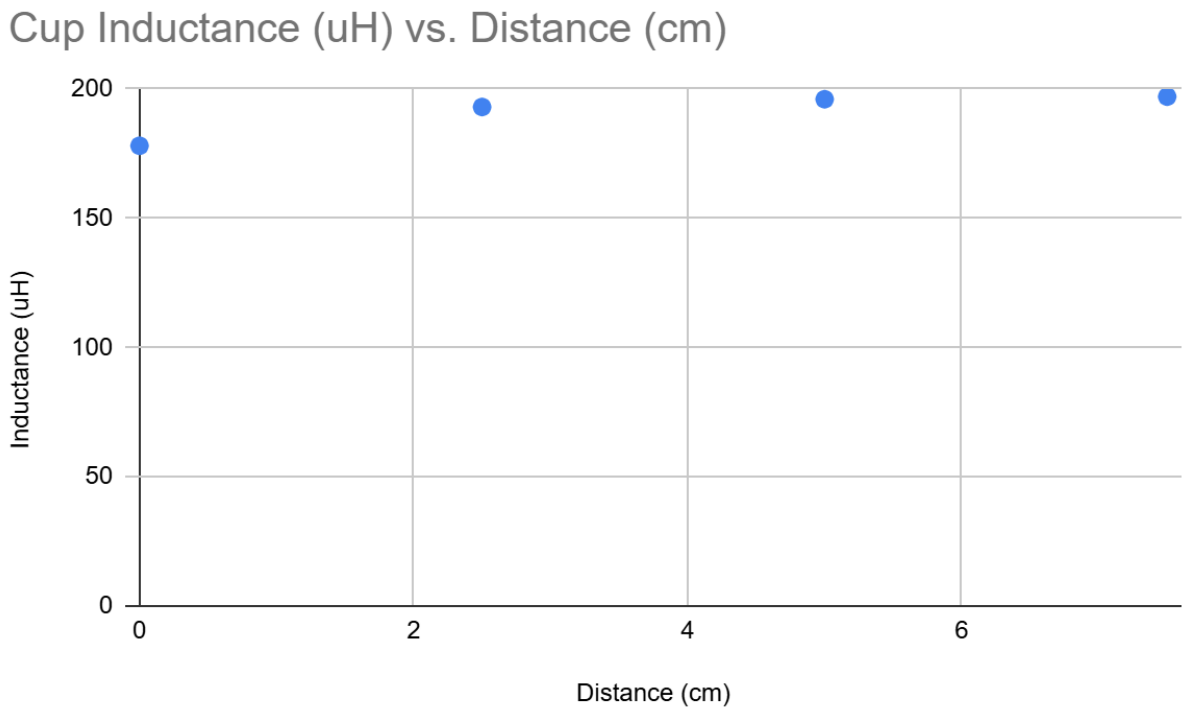
Fig. 1

Theoretical estimate of the search coil inductance based on the beat frequency:

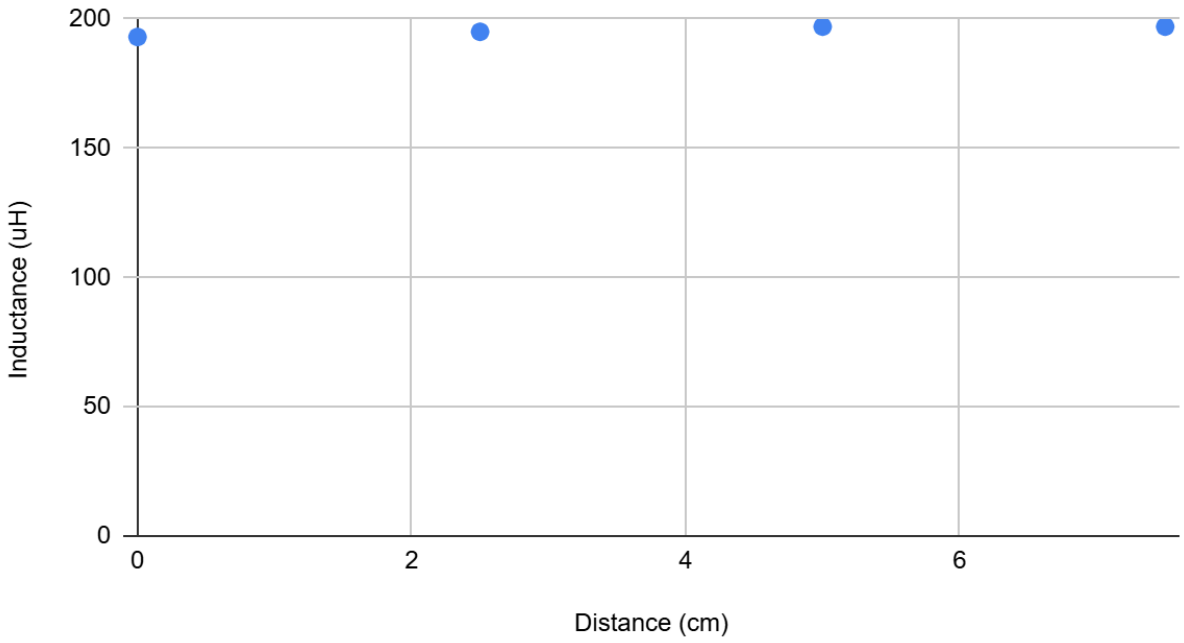
From search coil LC oscillator, f=158050 Hz.

$$L = \frac{1}{(2\pi \cdot 158050)^2 \cdot 5 \times 10^{-9}} \approx 202.5\mu H$$

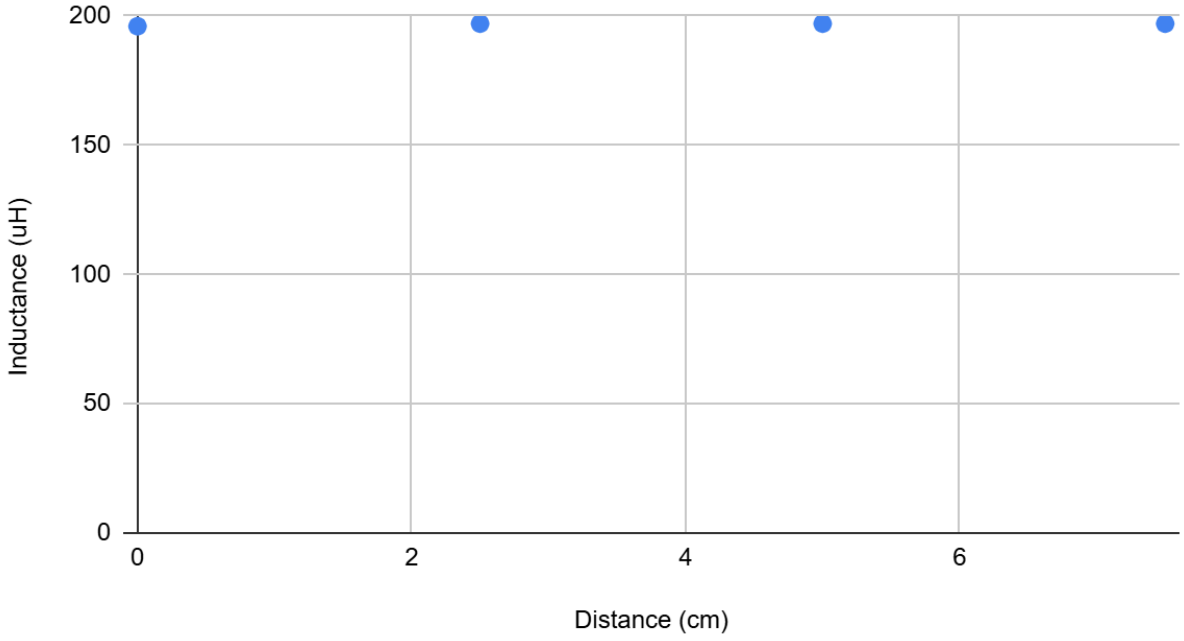
Plots of the search coil inductance versus metallic object distance:



Knife Inductance (uH) vs. Distance (cm)



Wire stripper Inductance (uH) vs. Distance (cm)



Oscilloscope captures of the oscillators frequency measurement:

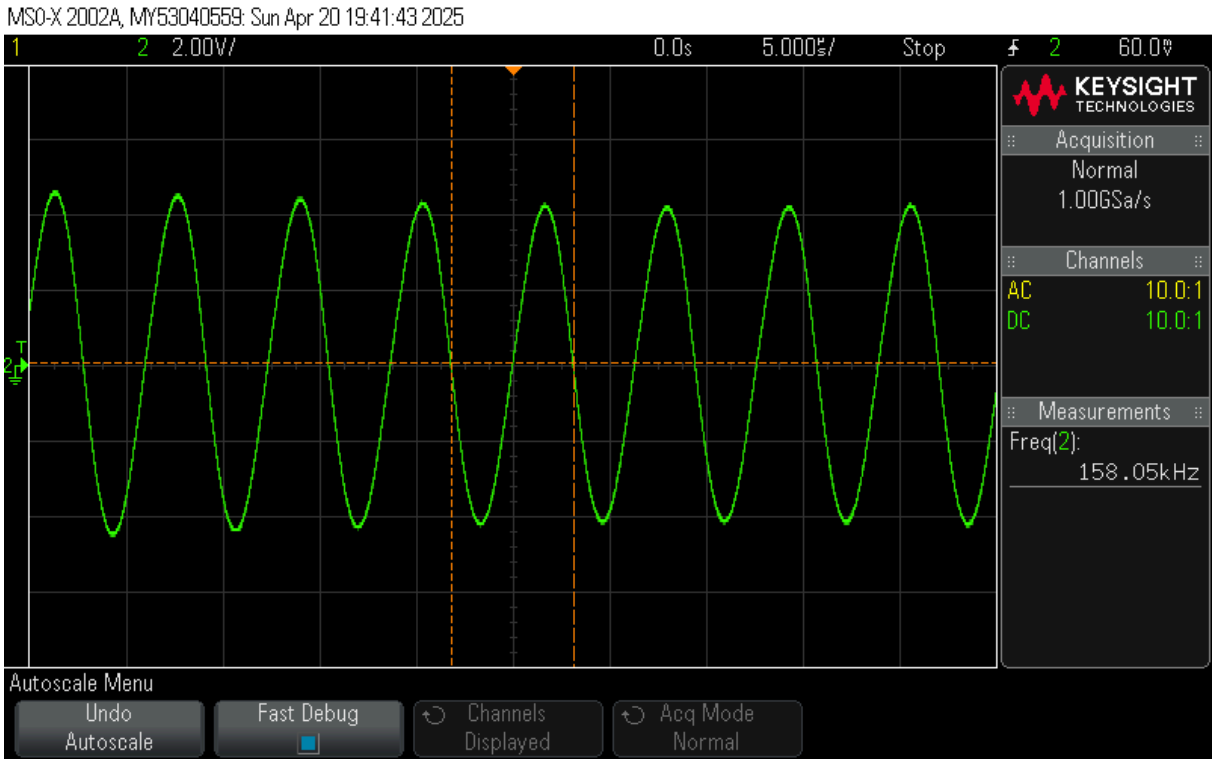


Fig. 2

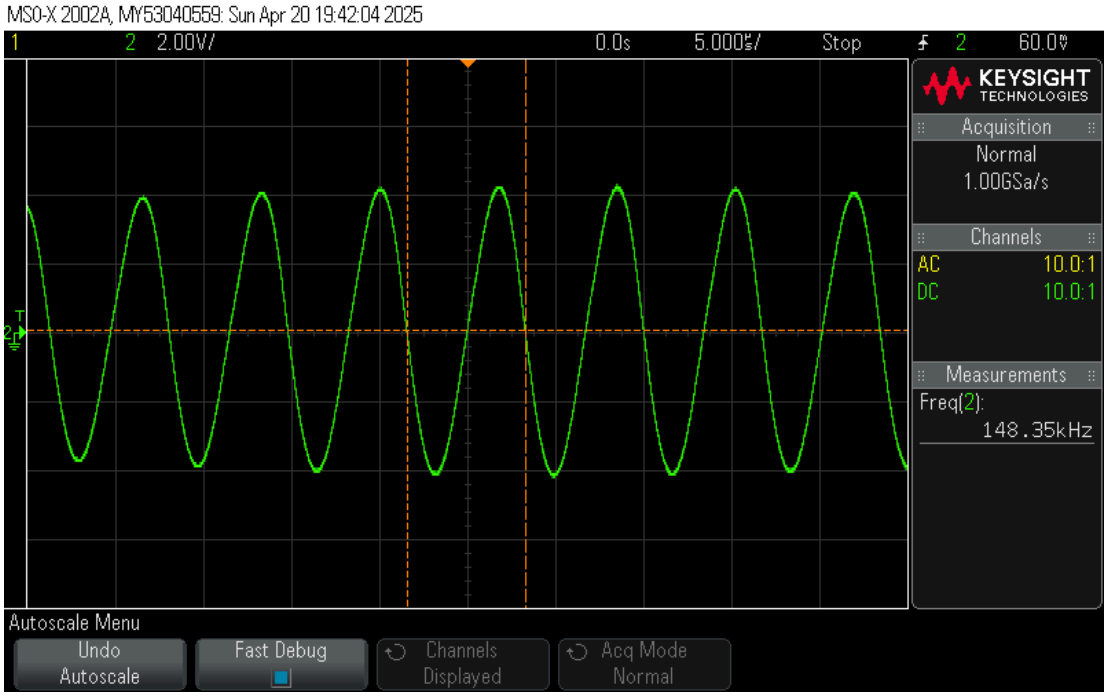


Fig. 3

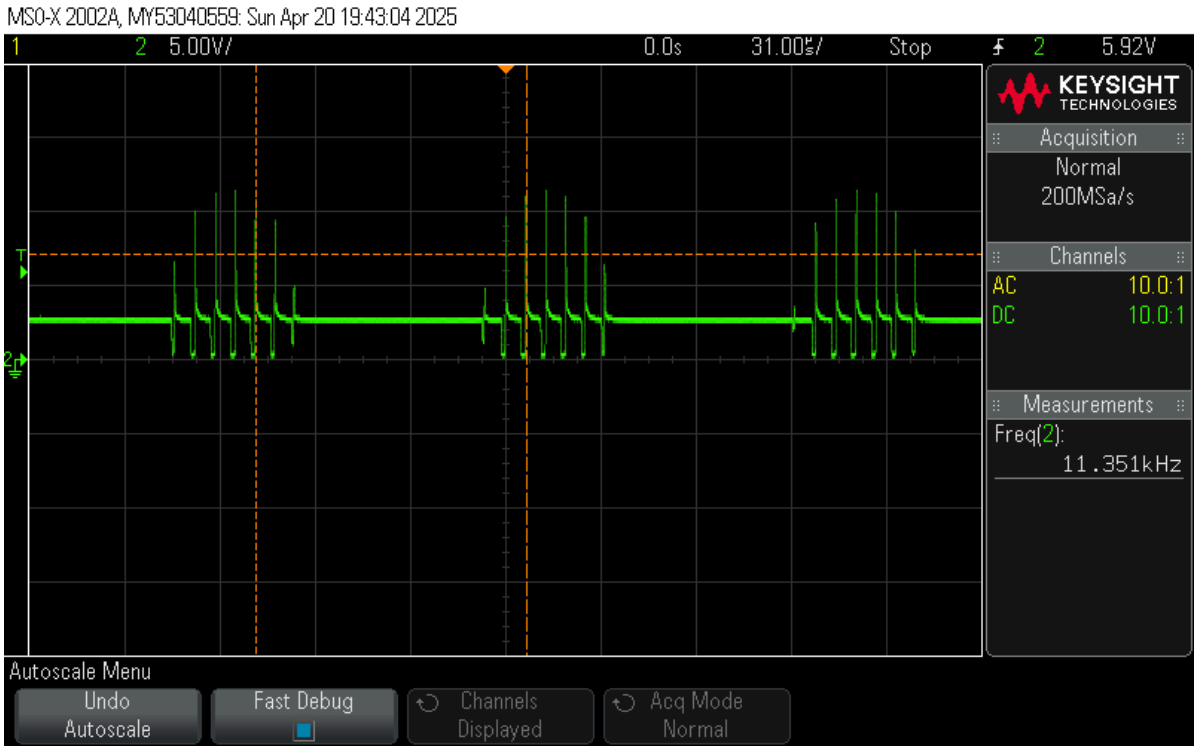

MSO-X 2002A, MY53040559: Sun Apr 20 19:43:04 2025
1
2 5.00V/
0.0s
31.00s/
Stop
2 5.92V
KEYSIGHT TECHNOLOGIES
Acquisition
Normal
200MSa/s
Channels
AC 10.0:1
DC 10.0:1
Measurements
Freq(2):
11.351kHz
Autoscale Menu
Undo Autoscale
Fast Debug
Channels Displayed
Acq Mode Normal

Fig. 4

Oscilloscope captures of the beat frequency measurement for different objects:

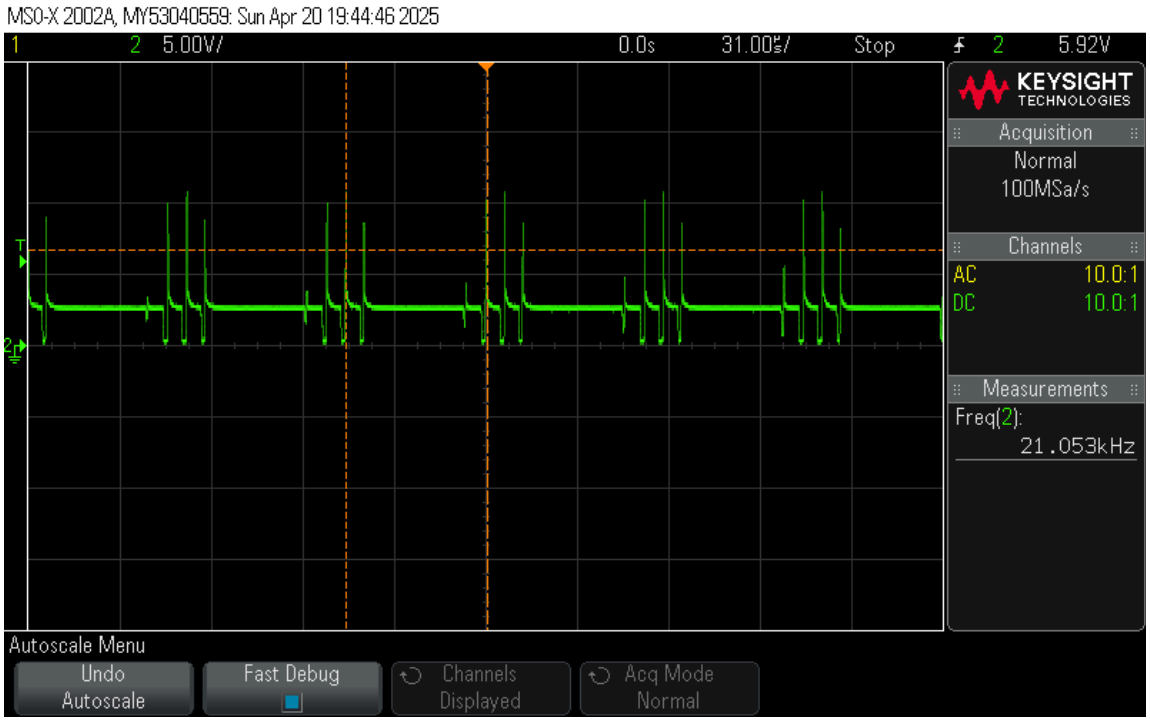


Fig. 5 Cup

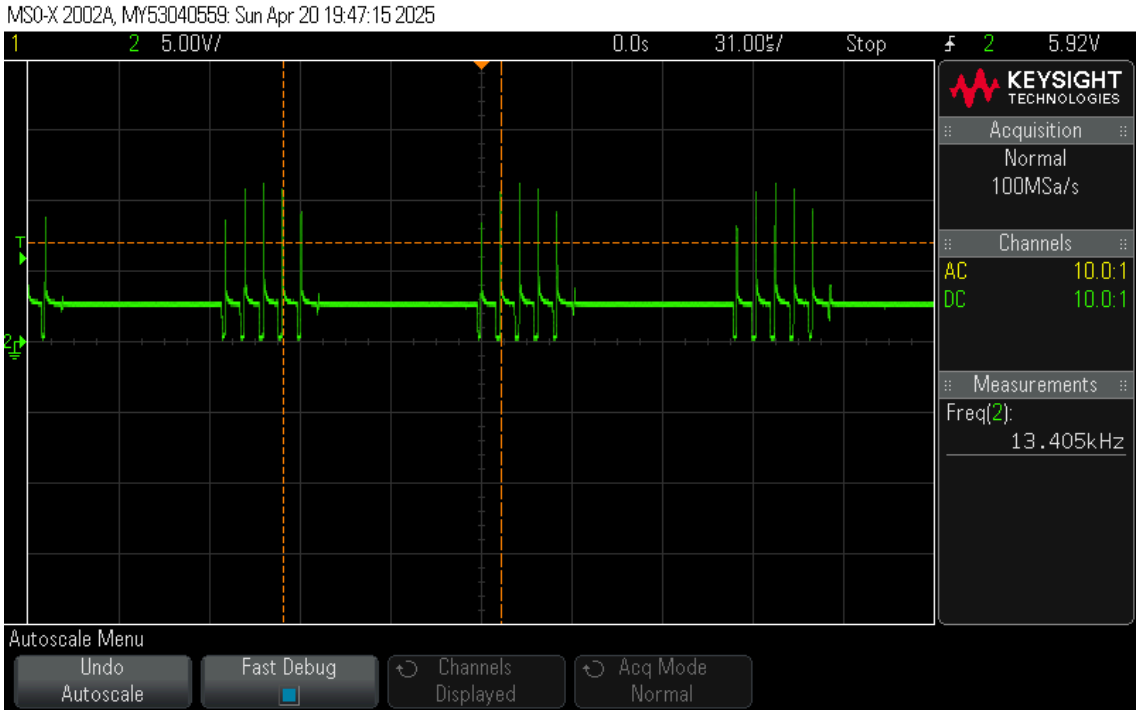


Fig. 6 Knife

Tabulated measurements of beat frequency vs distance for each object:

cup			Knife			Wire Stripper	
Distance (cm)	Beat Fq. (kHz)		Distance (cm)	Beat Fq. (kHz)		Distance (cm)	Beat Fq. (kHz)
0	21		0	13.4		0	11.377
2.5	14.7		2.5	12.3		2.5	11.3
5	12.2		5	11.36		5	11.2
7.5	11.36		7.5	11.36		7.5	11.2