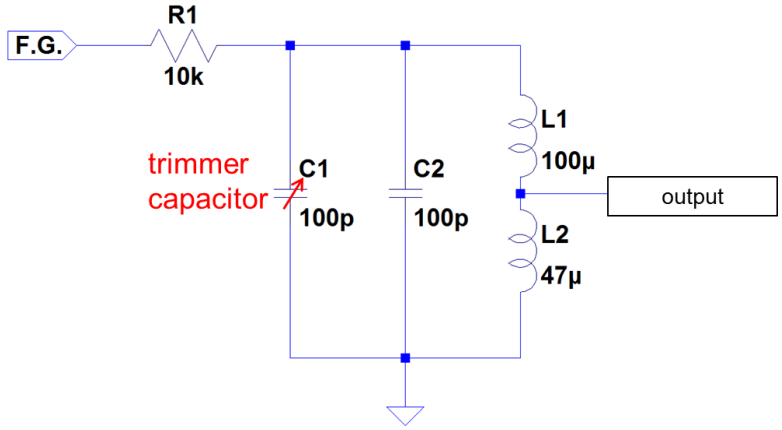
REPORT

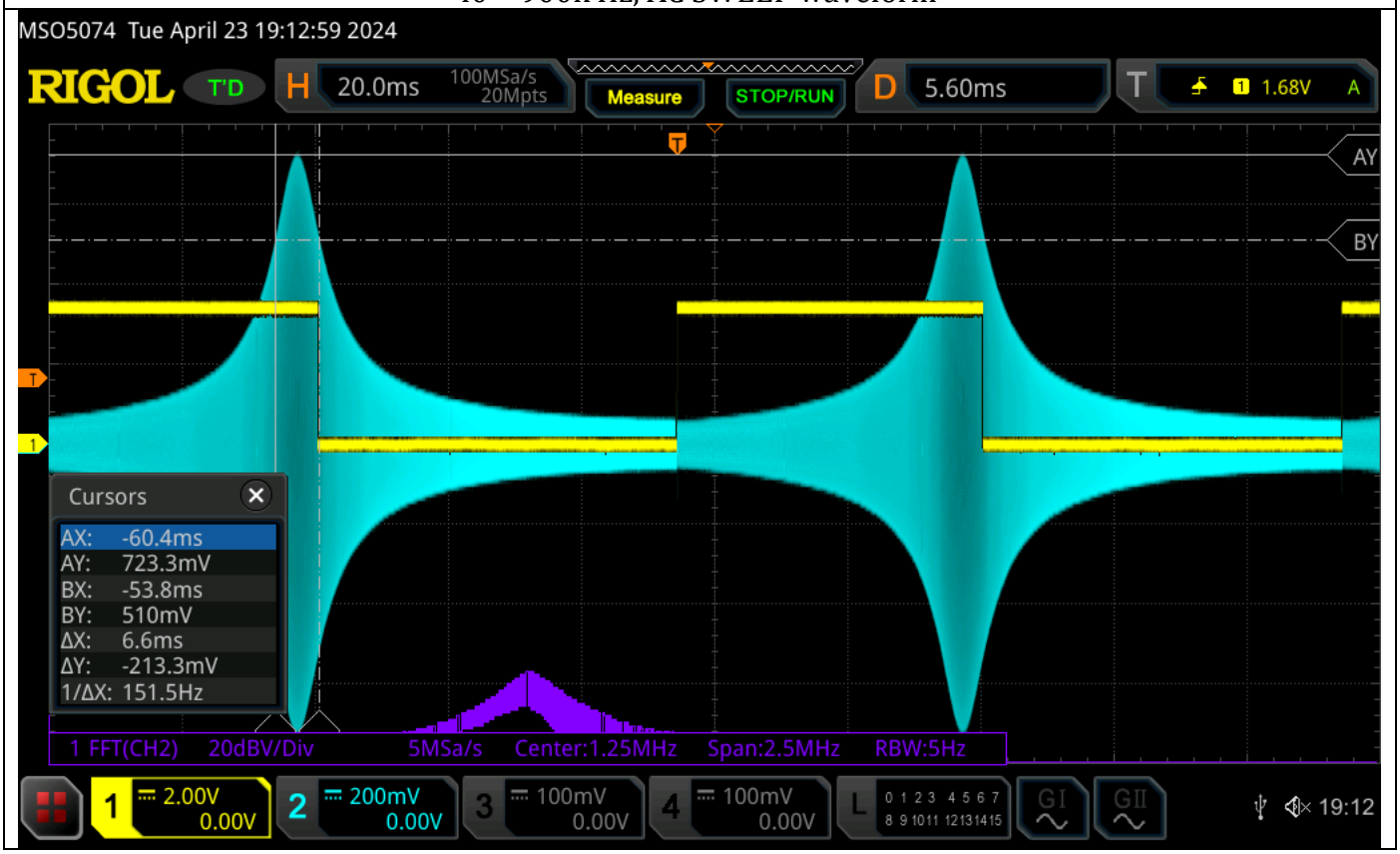
Experiment 1: Parallel RLC Tuner Circuit Basic Properties



2.

f0 = 900k Hz			
f_{L3dB} (Hz)	f_{H3dB} (Hz)	BW = f_{H3dB} - f_{L3dB} (Hz)	Q = f_0 / BW
865k	945k	80k	11.25

f0 = 900k Hz, AC SWEEP waveform



f0 = 1M Hz			
f_{L3dB} (Hz)	f_{H3dB} (Hz)	BW = f_{H3dB} - f_{L3dB} (Hz)	Q = f_0 / BW
950k	1.05M	100k	10

f0 = 1M Hz, AC SWEEP waveform

f0 = 1.1M Hz			
f_{L3dB} (Hz)	f_{H3dB} (Hz)	BW = f_{H3dB} - f_{L3dB} (Hz)	Q = f_0 / BW
1.04M	1.16M	120k	**9.17**

f0 = 1.1M Hz, AC SWEEP waveform

In this parallel RLC bandpass filter, the resonant frequency f_0 is given by

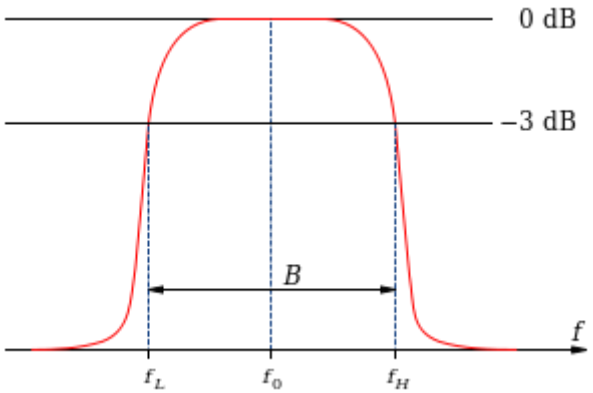
$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Resonant (Oscillation) Frequency:

The resonant frequency is the frequency at which the circuit will respond most strongly

Bandwidth:

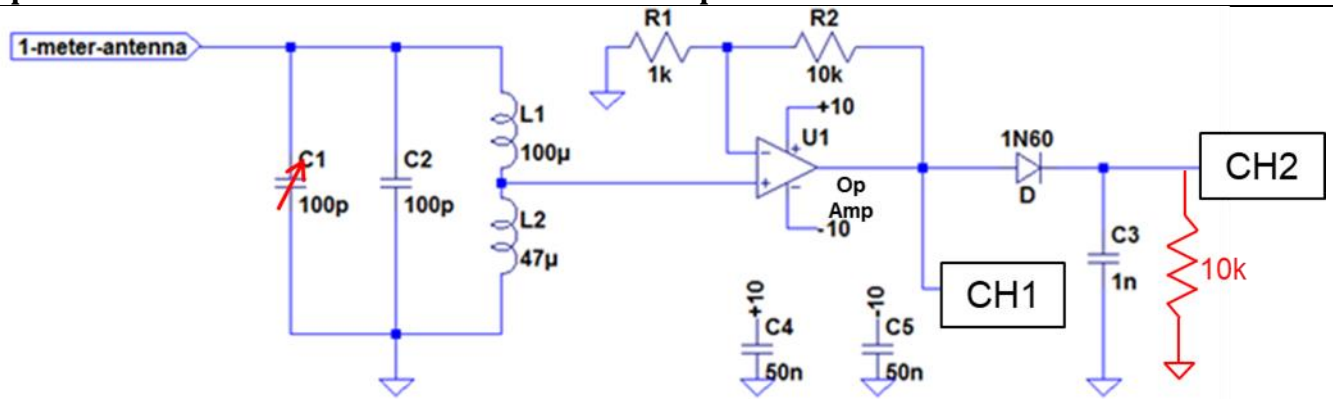
the bandwidth is a measure of the range of frequencies over which the circuit responds or allows signals to pass efficiently. It is the width of the frequency band around the resonant frequency. Given by $f_{H3dB} - f_{L3dB}$ as indicated in the following figure.



Quality(Q) Factor:

The quality factor (Q) in an RLC tuner circuit is a dimensionless parameter that represents the ratio of $\frac{energy\ stored\ in\ the\ capacitor\ \&\ inductor}{energy\ dissipated}$. It is given by $\frac{Resonant\ f}{Bandwidth}$

Experiment 2: Parallel RLC Tuner Circuit with amplifier

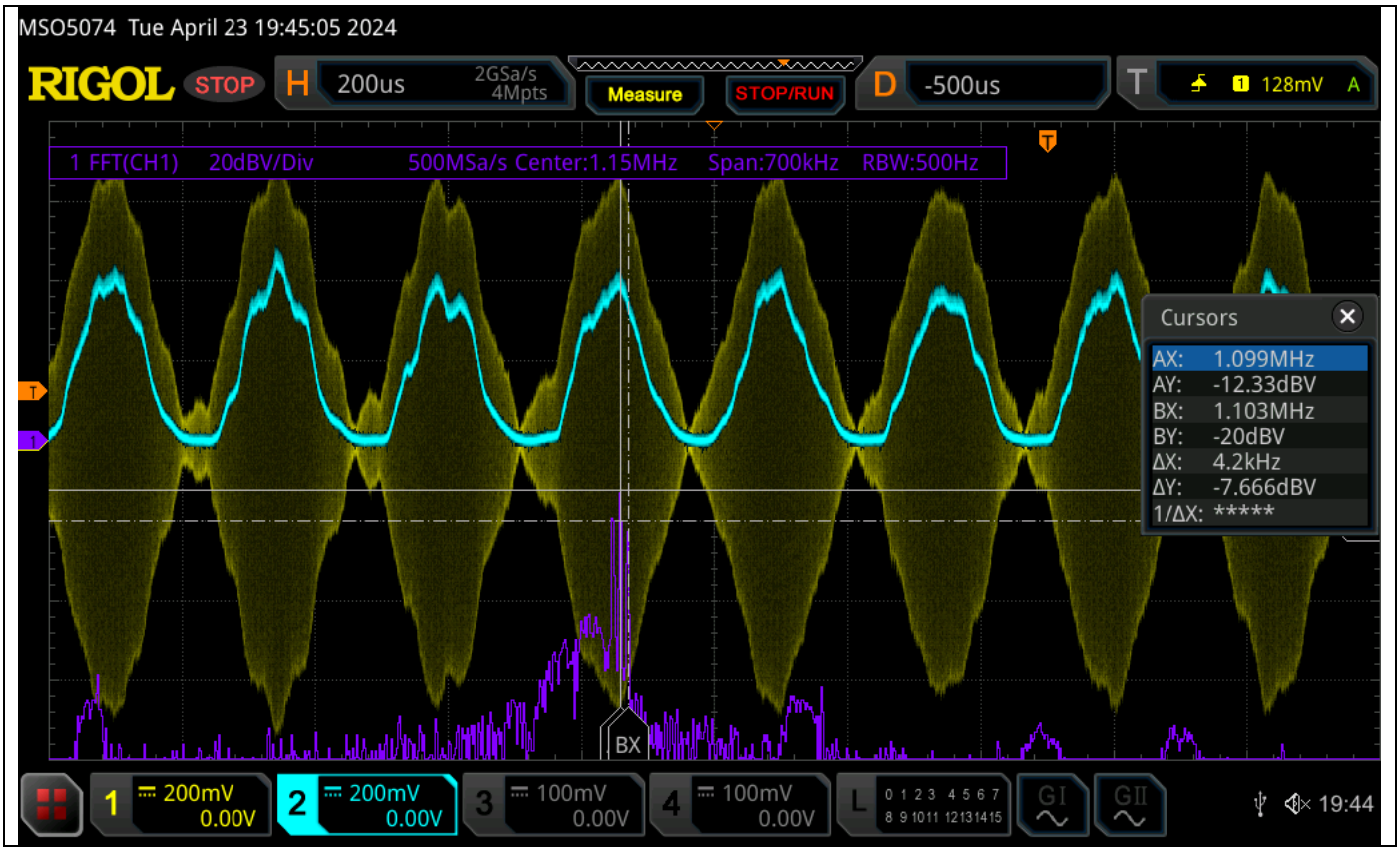


NOTICE: Please add decouple capacitor between +10V, -10V, Ground

1. & 2.

Time-domain Waveform of CH1 & CH2 Note: Align 2 channel's ground to the center.

FFT waveform of CH1

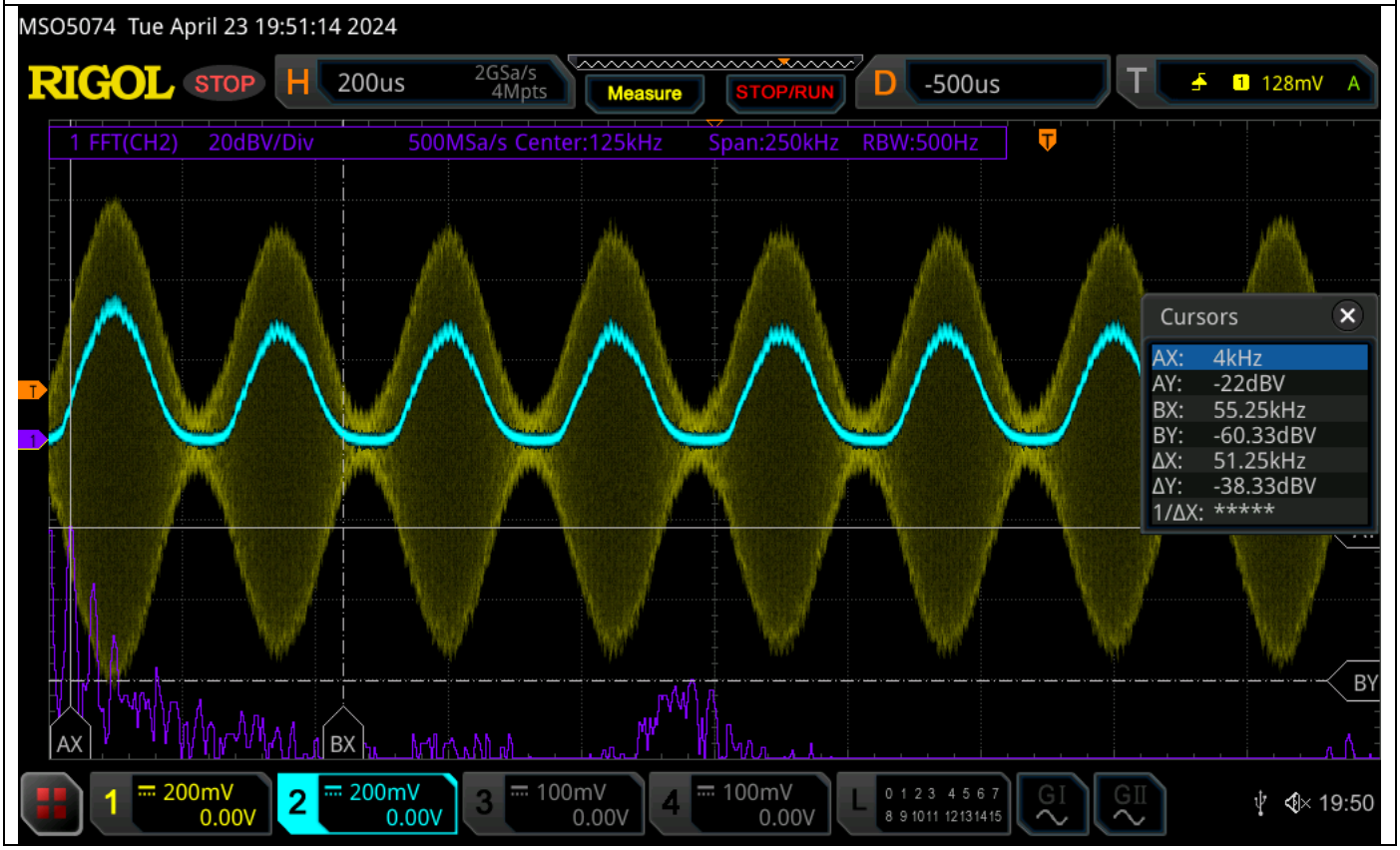


3.

Signal Name	Carrier	Lower sideband	Upper sideband
Frequency (Hz)	**1.099M**	**1.095M**	**1.103M**
Magnitude (dB)	-12	**-19.66**	**-22.66**

4.

FFT waveform of CH2



5.

Signal Name	Mod wave
Frequency (Hz)	**4k**
Magnitude (dB)	**-22**

Let's take a closer look at the amplifier circuit connected to the RLC tuner.
Non-inverting Amplifier:

The amplifier is connected in the non-inverting configuration, providing a gain of 10V/V.

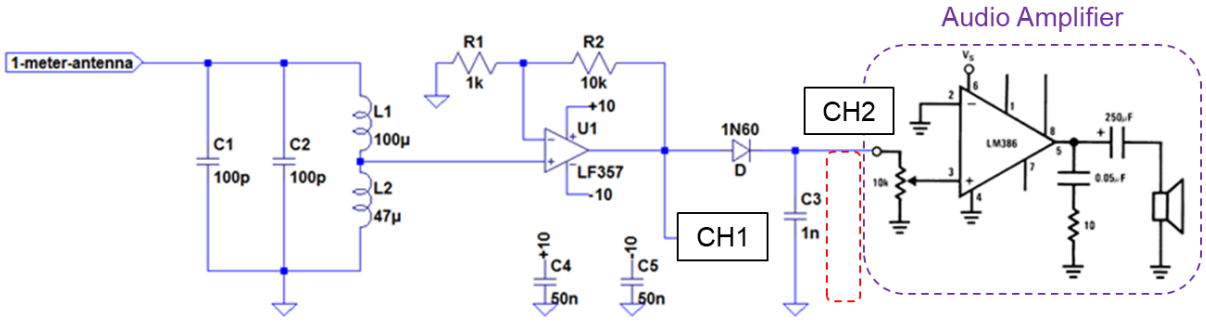
Decoupling Capacitors:

Decoupling capacitors are connected to the power supply of the amplifier to short the AC signal to ground, preventing it from interfering with the DC bias of the amplifier.

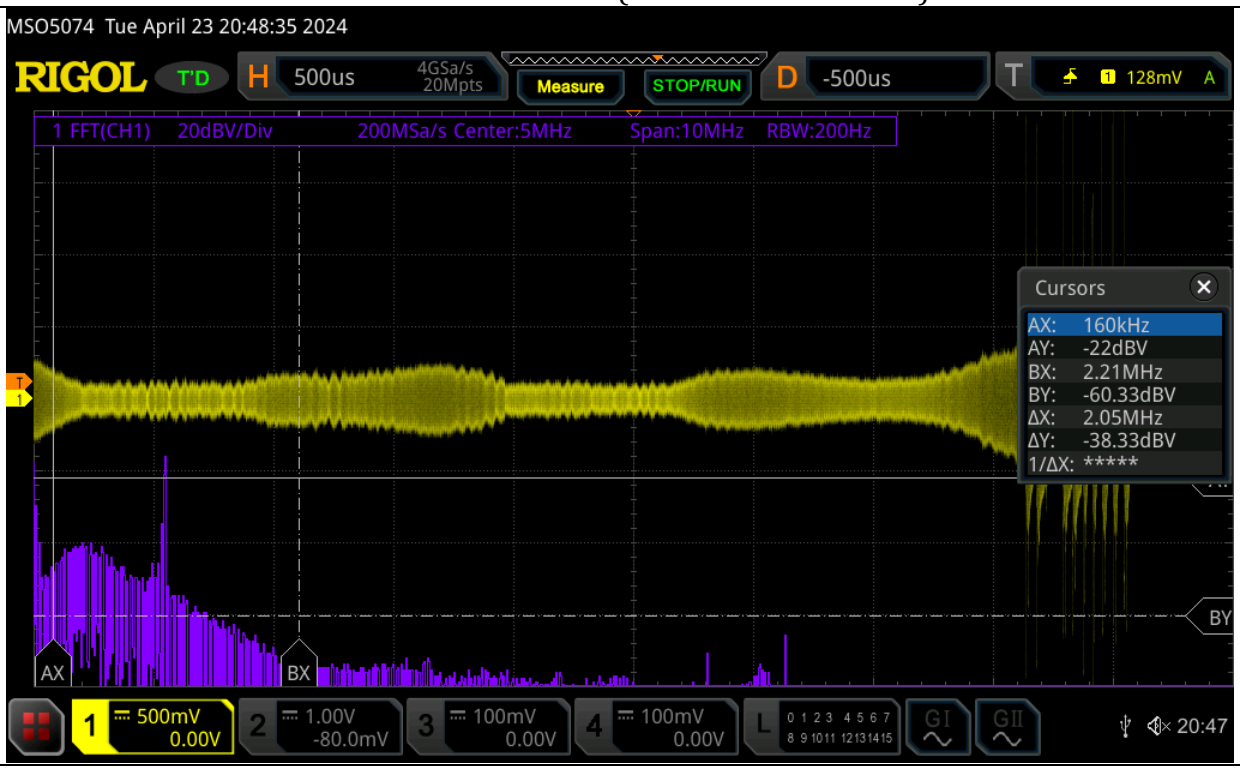
Diode:

The diode is used as a rectifier to rectify the modulated signal. It prevents the high frequency carrier from getting through. An additional capacitor is placed at the output of the diode to filter out RF signal (3kHz ~ 300GHz).

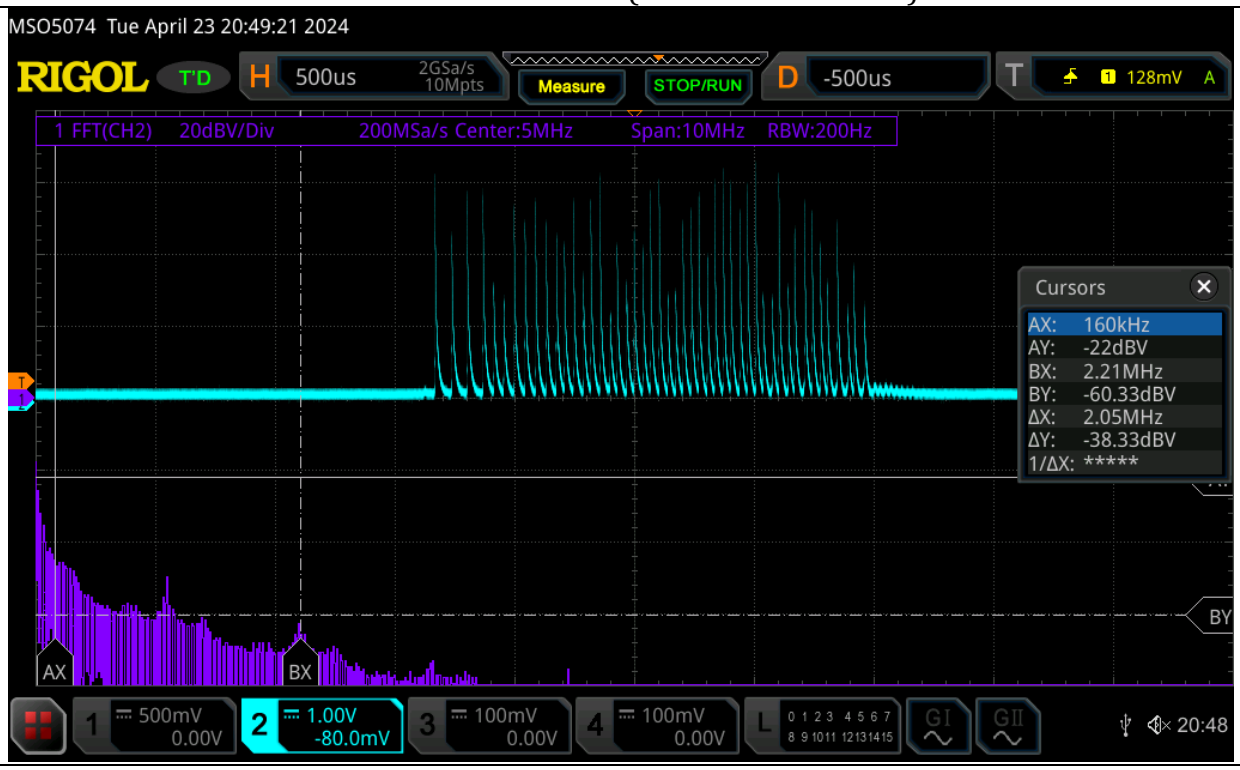
Experiment 3: AM radio receiver



FFT waveform of CH1 (Before demodulation)



FFT waveform of CH2 (After demodulation)



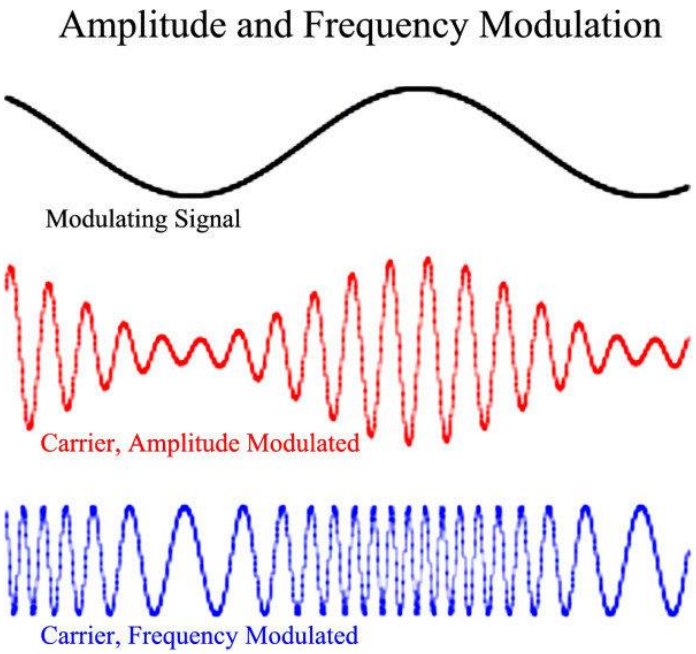
Why is it that most news channels use AM and most music channels use FM on the radio?

The following chart is a comparison of the different characteristics between AM & FM.

Modulation Type	AM	FM
Noise Resistance	Poor	Strong
Audio Fidelity(保真度)	Low	High
Bandwidth	Narrow(10kHz)	Wide(200kHz)
Distance	Long	Short, limited to line of sight
Power Usage	Uses more power	Uses less power
Transmitter/Receiver Complexity	Simpler	More complex
Stereo(立體聲)	Hard to implement	Easily supported
Capture Effect	None, multiple signals can interfere with each other	Yes, Locks on to the stronger signal

You can notice that FM has the advantage of higher fidelity over AM. Additionally, stereo can be easily implemented using FM. These two main advantages make FM a better choice over AM for playing music.

On the other hand, AM's main advantage is long-distance coverage, so utility services like the Police Broadcasting Service(警廣) and Fishery Radio Station(漁業廣播電台) use AM instead.



What is the capture effect?

The capture effect refers to a phenomenon in FM radio reception where a receiver locks onto the stronger of two signals on the same frequency, suppressing the weaker signal. This effect occurs because of the way FM receivers process signals using limiters and discriminators, which effectively filter out the weaker signals.

References:

1. **http://hyperphysics.phy-astr.gsu.edu/hbase/electric/serres.html**
2. **https://www.diffen.com/difference/AM_vs_FM**
3. **https://www.pbs.org/wgbh/aso/tryit/radio/radiorelayer.html**