Input Stage Notes

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1 High Level Design

- Filters before the mixer have a relatively large BW. Most filtering is done at the IF, so the Q value requirement is lower.
- https://electronics.stackexchange.com/questions/153830/should-i-use-a-passive-or-an-active-filter
- Plan to use a simple LC circuit with a variable capacitor for tuning.
- But how do we tune the mixer and input filter together using a single knob?
- It seems like we can use a dual gang capacitors or control the voltage of multiple varactors using a microcontroller.
- However, according to perplexity, most car radios just have a fixed input filter which allows frequencies of 88 MHz to 108 MHz to pass, while the specific band frequency is controlled by the mixer.
- Therefore, we can just use a LC bandpass filter with a low cutoff of 88 MHz and high cutoff of 108 MHz. Since most of the filtering is done at the IF we don't really need to worry about the Q value of this filter.

2 Detailed Filter Design

- I found this online tool to design filters for me. I could have designed it myself since this is a simple filter, but it exports the SPICE model and everything so it makes it easier.
- https://markimicrowave.com/technical-resources/tools/lc-filter-design-tool/
- In FM modulation, the transmitted signal is a function of the baseband signal and the carrier,

$$x(t) = cos(w_c t + \phi(t))$$

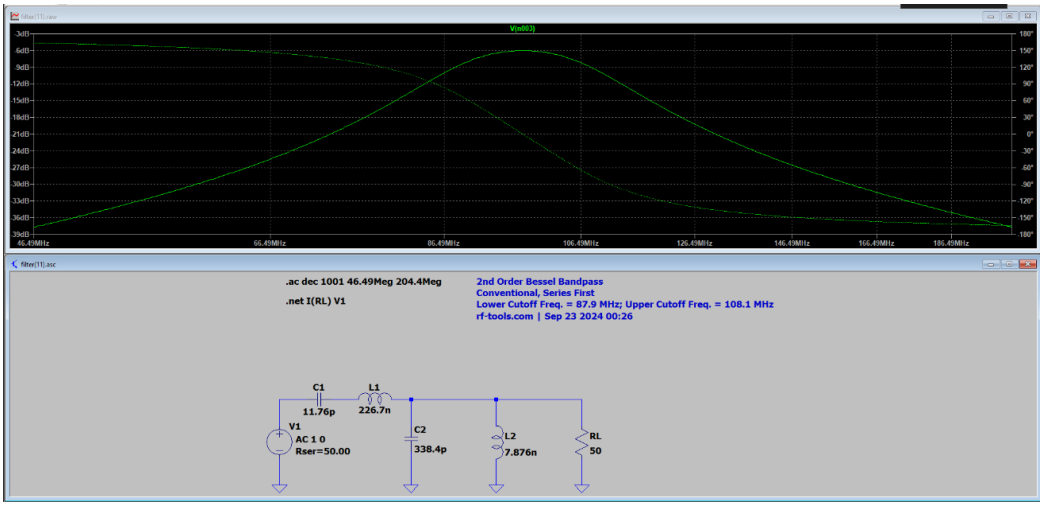
- The frequency of this signal is given by the deriviative of the phase, or

$$f = w_c + \frac{d\phi(t)}{dt}$$

- The fourier transform of $\frac{d\phi(t)}{dt}$ is $2\pi j\omega\frac{d\phi(\omega)}{d\omega}$, which is proportional to group delay. Therefore, I need to choose a filter with a near constant group delay.
- A bessel filter tends to have the smallest group delay out of most popular passive filter types, so let's choose that.

3 Results

Here is the simulation of a second order bandpass filter:



Here is the same simulation with real component values from digikey: