The Commitment

- Interface with AD9220 ADC
    - Input to RF digital signal processing chain. AM analog signal within the range of AM broadcast radio frequencies modulating a single tone will be provided by a function generator for demodulation.
    - Show by inputting different signals into the ADC and seeing how they change the audio and VGA out
- Demodulate AM audio from function generator and output to speaker
    - Mixer
        - Performs frequency shift on digital waveform output from ADC down to an intermediate frequency of 455 kHz.
        - Display FFT on VGA to show the before and after for frequency shifting
    - AM Bandpass Filter
        - Tuned to 455 kHz, will severely attenuate frequencies outside 455 kHz +/- 5 kHz. Two signals with center frequencies at least 10 kHz apart will be input to the ADC in order to verify filter operation (show that it gets attenuated)
    - AM Demodulation
        - Removes high frequency carrier via peak detection and hold and outputs 48 kHz audio signal. Successful demodulation will be demonstrated by viewing the output analog signal on a scope. This should be a constant amplitude sine wave with zero distortion to prove successful demodulation.
        - Show that incoming signal is AM modulated and how we can get an audio signal out
- Perform FFT on input spectrum and display full spectrum on VGA monitor
    - FFT Module
        - Grabs the magnitude of frequencies for the whole signal
        - Given from piazza. Will relate to the VGA out to show how it is representative of the actual frequency spectrum. Test different signals to show that
    - Zoom module
        - Oversample or undersample to drop the top frequency. Also can change what frequency window we want to look at
        - Show how we can zoom and display specific frequency ranges with the different knobs
- Display audio signal on VGA monitor
    - Trigger
        - Show for a simple audio signal that the output is triggered and doesn't shift around
    - Height Adjustment
        - Show how a knob can adjust the height limit for the incoming signal
    - Time adjustment

        - Show how a knob can change the overall sampling period so that you can see higher and lower frequency signals at will.

The Goal

- Demodulate FM audio
    - Implement additional bandpass filter tuned to 455 kHz and FM demodulation module that operates via frequency detection. Prove successful demodulation with the same process as for AM, with function generator outputting FM signal.
        - Put frequencies outside of bandpass into the filter to show that it gets attenuated
    - Show that incoming signal is FM modulated and how we can get an audio signal out.
- Display waterfall on VGA monitor
    - Memory writer
        - Writes the magnitude over time to memory on FPGA. Pulls that out to show the waterfall magnitude over time
        - Show the magnitude change over time and switch frequencies around to show how it accounts for changes.
    - Pixel Out
        - Show color gradient that is supposed to display the magnitude strength
- Control volume and center frequency with encoders
    - State Machine for input from encoder
        - Use ILA to show the signal increase and decrease as you turn the knob clockwise and counter-clockwise.

Stretch Goal

- Interface with full analog front end (ADC + amplifier + antenna) to detect and display RF spectrum from 0 - 5 MHz
    - No Digital part. Show that we can pick up real AM radio
- Demodulate FSK, BPSK and QPSK
    - Implement additional bandpass filter for specific demodulation scheme
        - Put frequencies outside of bandpass into the filter to show that it gets attenuated
    - Show that incoming signal is modulated and how we can get an audio signal out.
- Apply sound effects to output audio (e.g. echo) played on speaker
    - Filtering Module
        - Show the IIR filter that we are applying for the effect and use a switch to turn the filter on and off to show it working.