Final Project Plan

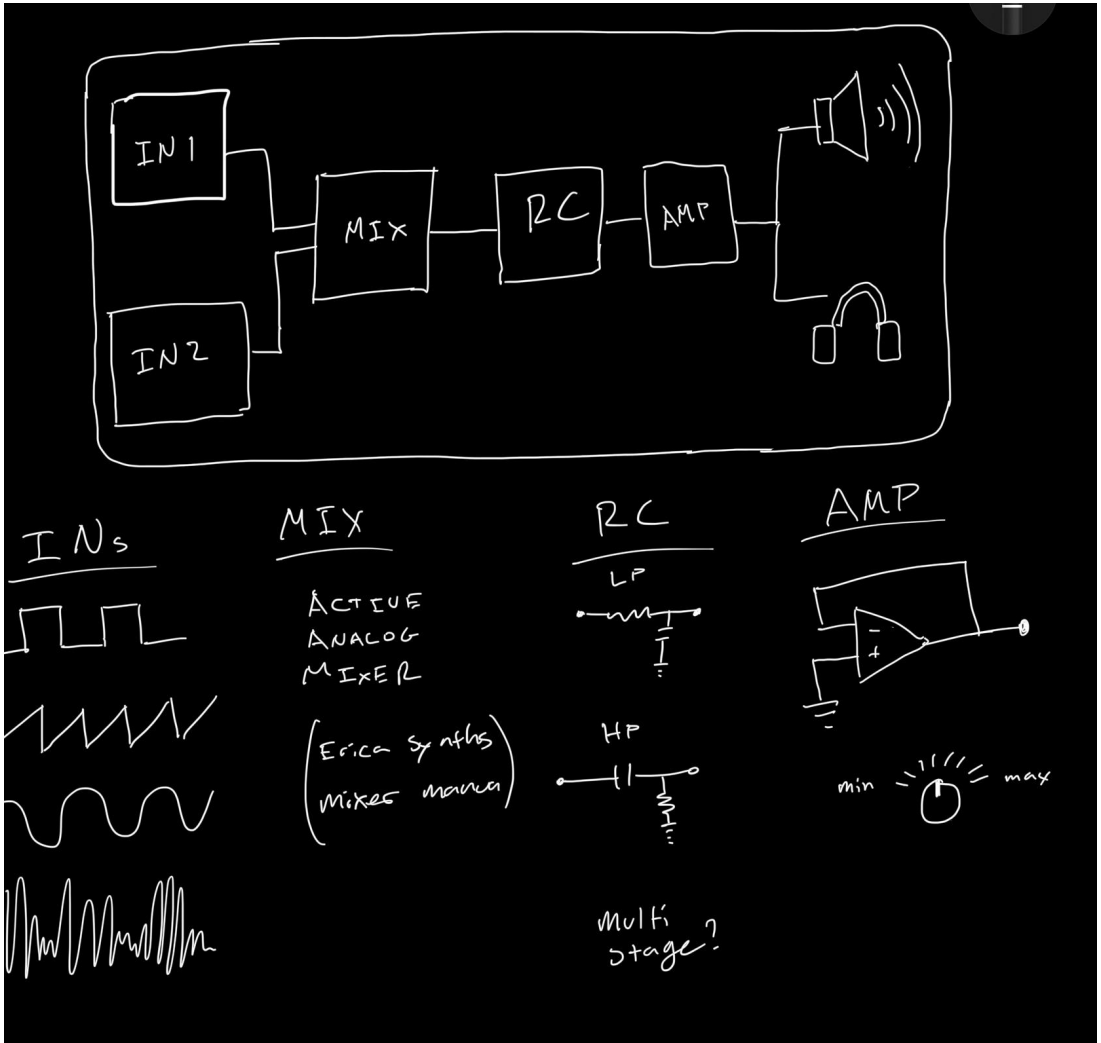
12/4/2025 Update

The Big Idea

- Create a teaching tool to help engineering students learn how to use an oscilloscope.
- Base the platform on a modular synthesizer, composed of a motherboard and many swappable daughter boards for the various components (wave synthesis, mixing, filtering and amplification)
- Create a UI that guides the user through the entire process of generating sounds and probing the signal along its path from synthesis to broadcast.

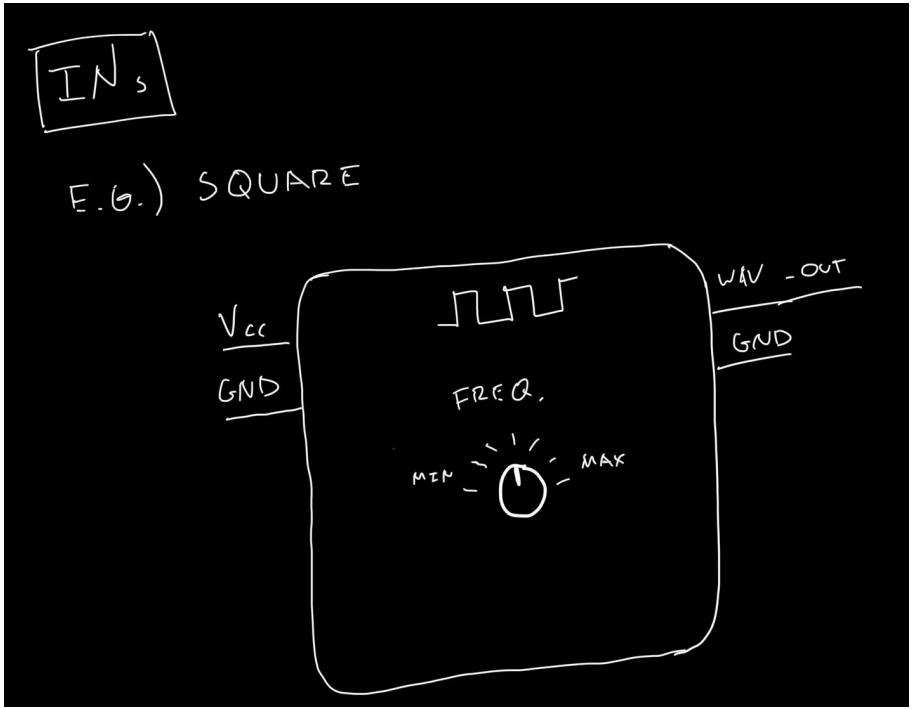
Motherboard

- Each block on the motherboard represents a swappable daughter board
- MVP: use .1” male/female header pins
- End product: use magnetic pogo connectors like these guys for maximum satisfaction (link)



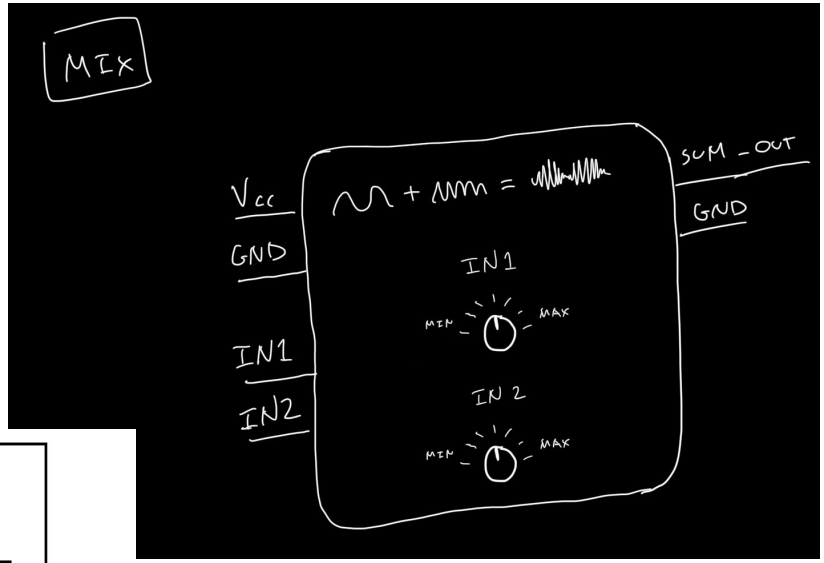
Input Oscillators

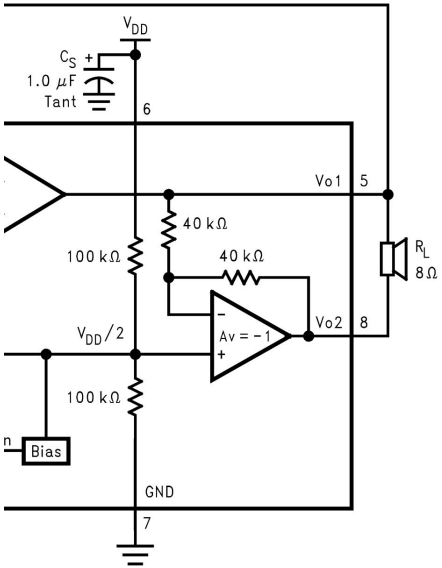
- Types:
  - Sinusoidal, Square, Sawtooth, Digital Audio
- Add potentiometer to daughter boards to enable user to change frequency of the output



Mixer

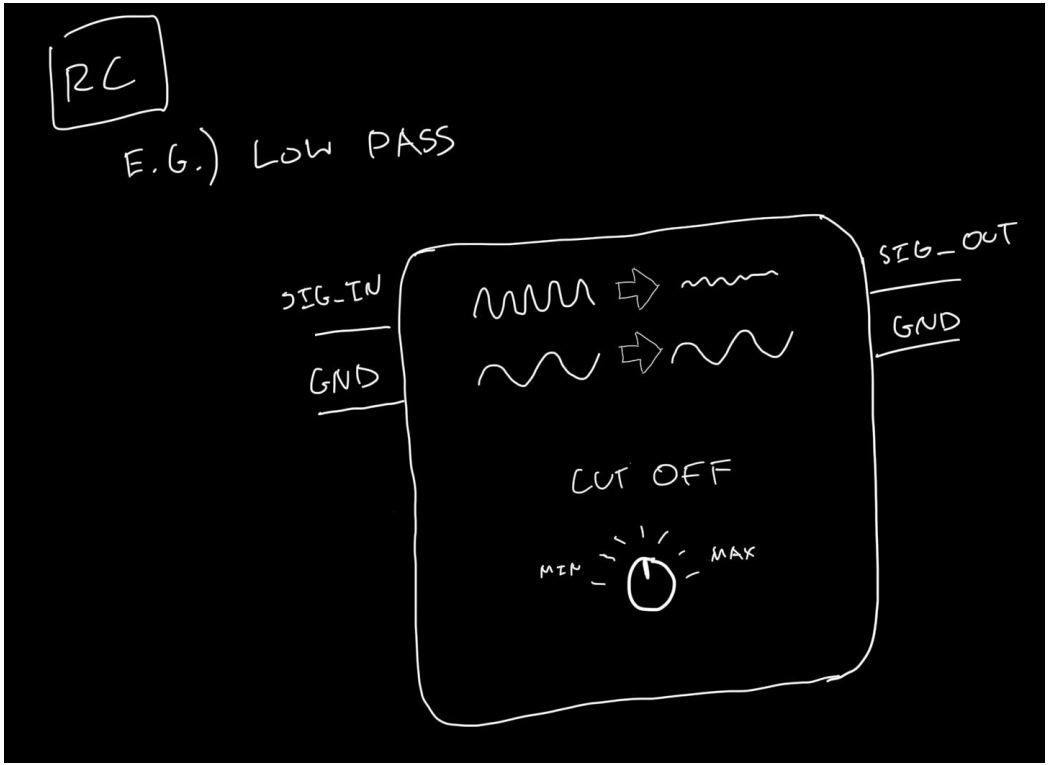
- The mixer will likely be non-swappable and just live on the motherboard.
- It's job is to enable the user to add multiple oscillator outputs together and is based on [this tutorial]
- The tutorial has this as being "dual rail" powered. From my conversation with Dimitar, it sounds like I can instead just offset it's inputs with a voltage divider such that the oscillation occurs around Vcc/2 instead of 0. As is shown in the circuit to the right.





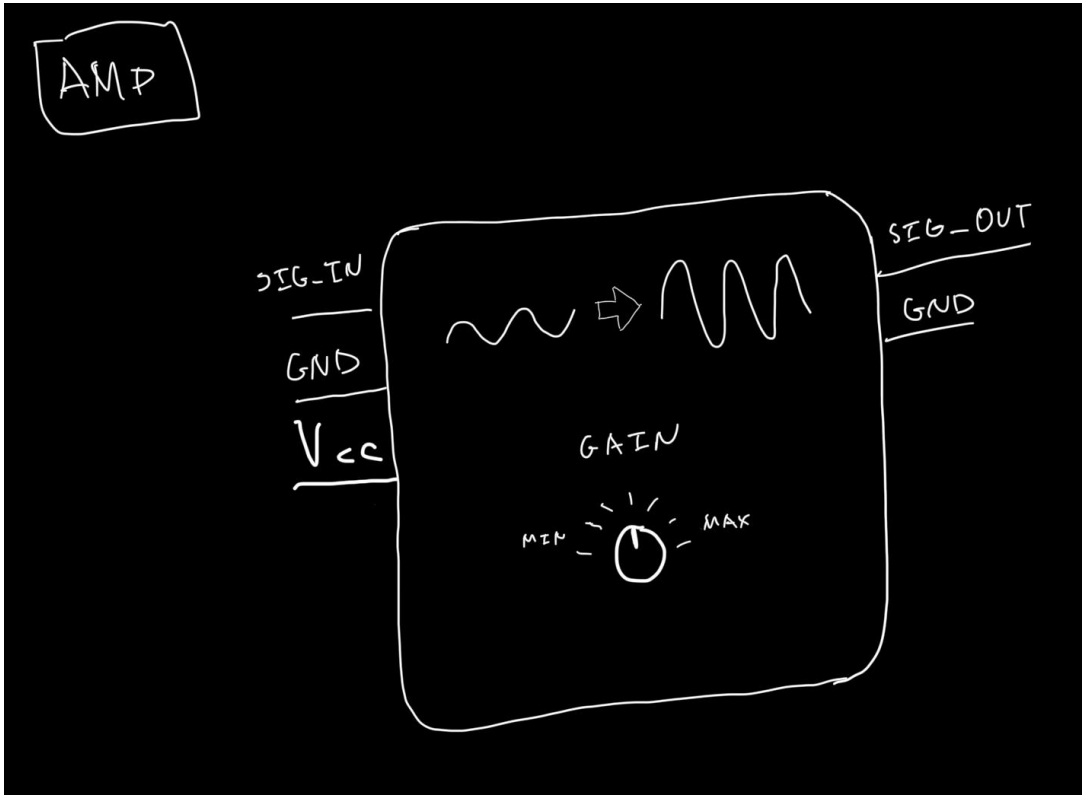
Filters

- Filter Types
  - Low Pass/High Pass
  - Active/Passive
  - Single/Multi Pole
- Include a potentiometer where possible to adjust cutoff frequency
- See HTMAA HW6 for an example circuit, and HW5 for all the theory (including possible alternative filter topologies.



Amplifier

- Used to amplify signal output and drive speaker
- Also include a separate signal path to a headphone jack for quiet listening
- See HTMAA HW9



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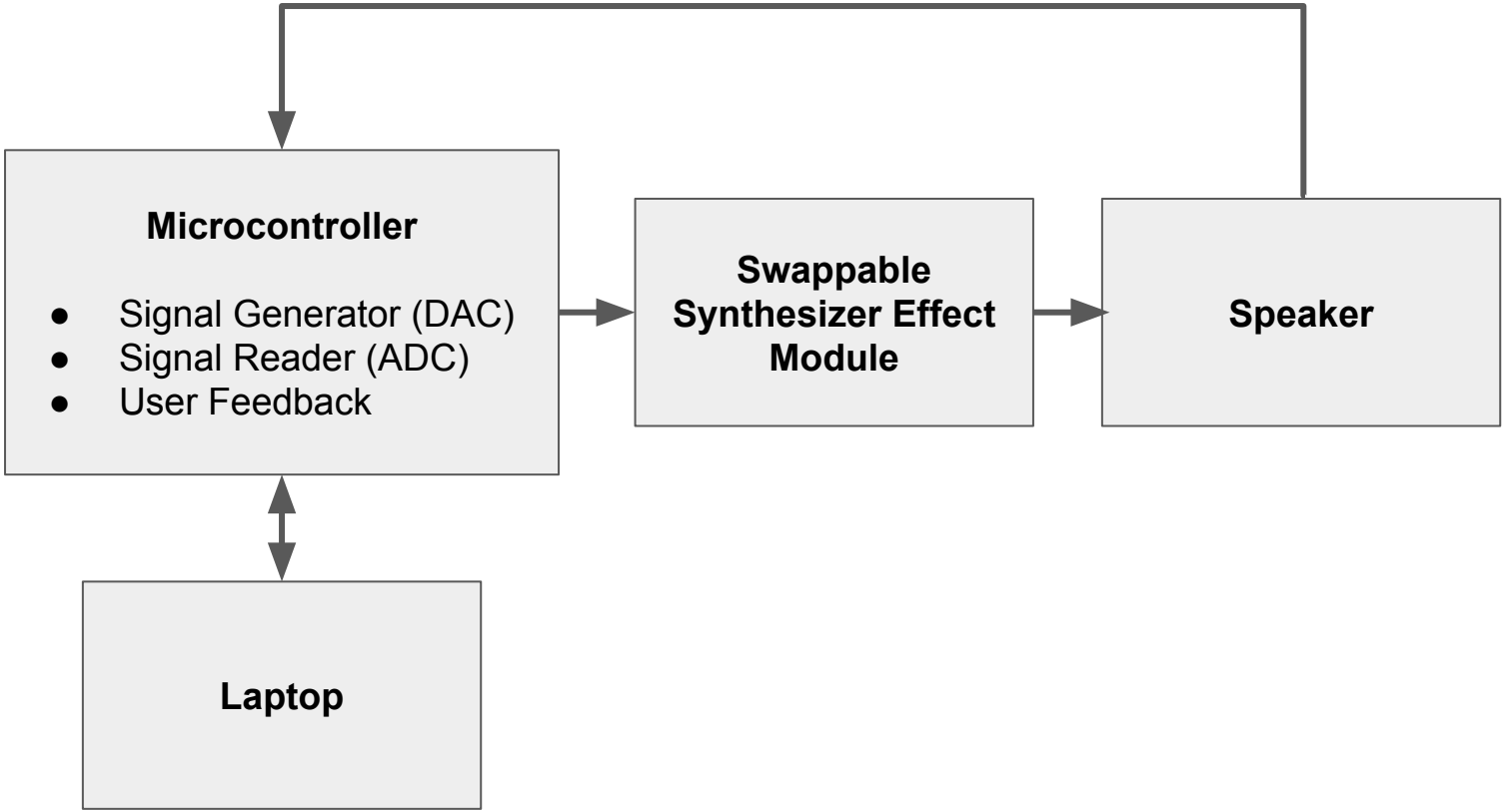
Ben Weiss 11.17.2025


Microcontroller
Signal Generator (DAC)
Signal Reader (ADC)
User Feedback
Swappable Synthesizer Effect Module
Speaker
Laptop

Task To Complete

- Prototype Boards
  - Mc signal generator with quick snappable interface for modules
  - Multiple swappable synth board options
- Prototype Hardware
  - Make some sort of 3D printed case
- Prototype Software
  - Firmware on MCU
  - Some sort of laptop based GUI
- Test
- Iterate
- Final Production Run

Timeline

- By 11/26
  - Complete Prototypes and initial Testing
- 11/31-12/6
  - Iterate
- 12/6-12/12
  - Final Production Run
- 12/12-12/15
  - Final presentation and documentation preparation