

# Product Design Specification

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Practicum Project Name: Etch-a-Tune

## Executive Summary

Our project is a handheld embedded system that transforms hand-drawn spectrograms into sound. Users interact with a touchscreen interface to sketch time-frequency representations of audio, much like painting the intensity and pitch of sound over time. Once a spectrogram is drawn, the device performs an inverse short-time Fourier transform (ISTFT) to reconstruct the corresponding waveform and plays it through an onboard speaker or audio output.

## Market Analysis

Our intended customers are educators, music makers, and artists. By creating a drawn representation of sound and music, customers can synthesize their musical ideas in a unique and beautiful way.

Our competitors are mainly online websites like chrome music lab and other spectrogram creating and processing websites. In the physical space we are competing with guitar effects pedals, and synthesizer instruments. Our product is unique because we are creating a physical product that can teach about spectrograms and frequency.

We think we would be able to sell our product for around \$150. We estimate each board to cost about \$75 in parts, with further unknown costs in manufacturing.

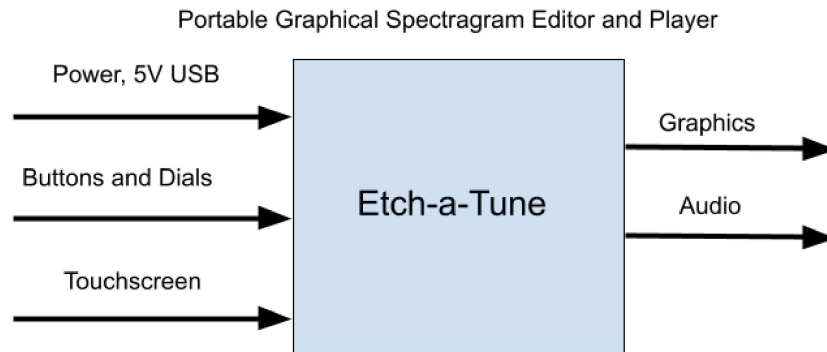
## Requirements

- Must be rechargeable
- Must take touch screen input
- Must have buttons
- Must use a touch screen to convert a drawing into an audio output
- Must be handheld
- Must be portable
- Must last one hour
- Must produce audio signals
- Must be able to switch between recording and playing modes

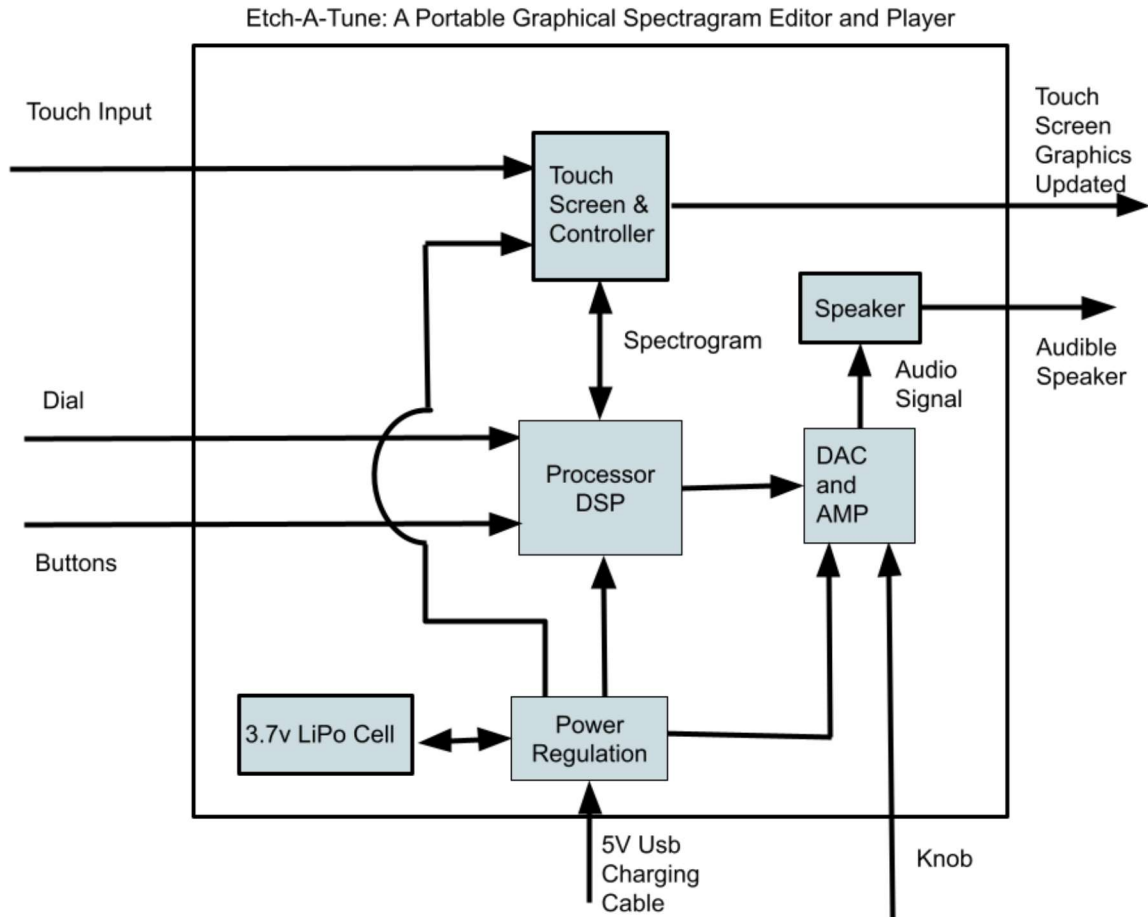
- Should allow a spectrogram to be the drawn and processed
- Should be smaller than  $220\text{cm}^3$
- Should weigh less than 230g
- Should have volume control knob
- Should have a frequency scaling knob

- May have an ergonomic package
- May have graphical user interface
- May have CD quality audio

## System Architecture



Level 0	
Module	- Etch-a-Tune
Inputs	- 5V USB charging cable
	- Touch screen touch data
	- Control Dial
	- Mode Buttons
Outputs	- Touch screen graphics
	- Converted audio signal
Functionality	Allows the user to draw an image on the touch screen, and updates the graphics in real time. Once the user changes modes using a button, the audio of what they drew will be played, and can be modified using the control dials



Level 1	
Module	- Touch Screen & Controller
Input	- Regulated 3.3V Power
	- Touch Data
	- New Graphics Data
Outputs	- Updated Graphics
	- Completed Drawing Data
Function	Primary user interface that allows the user to draw a waveform on the touchscreen. The graphics are updated as the user touches it. When the drawing is complete the screen outputs the finished drawing.

Level 1	
Module	- Processor
Inputs	- Regulated 3.3V Power
	- Dail
	- Buttons
	- Spectrogram
Outputs	- New graphics data
	- Converted audio signal
Functionality	The brains of our product. Collects and processes data from all other modules, and does the DSP needed for our audio.

Level 1	
Module	- Power Regulation
Inputs	- 5V 500mA input
	- Battery Charge Data
Output	- 3.7V Power
Functionality	Monitors the charge of our batteries, and regulates a 5V USB input to charge the batteries

Level 1	
Module	- 3.7V LiPo Cell
Input	- Regulated power for charging
Output	- 3.3V Power
Functionality	Battery for powering the device when not plugged in. Able to be recharged for longer use.

Level 1	
Module	- DAC and AMP
Inputs	- Regulated 3.3V Power
	- Processed Audio Signal
	- Volume Control Knob
Output	- Audio Out
Functionality	Converts digital signal from processor into audio signal for speaker

Level 1	
Module	- Speaker
Inputs	- Processed Audio Signal
Outputs	- Volume
Functionality	- Make noise

## Design Specification

### Sensors

- Touch screen
- SPST switch
- Tactile buttons

### Actuator

- Touch screen
- 3mm audio jack
- DAC
- Speaker

### Power

- LiPo battery
- BMS
- USB Passthrough

### Firmware

- FreeRTOS
- LVGL
- STM32CubeIDE
- STM32H7 family MCU

## Mechanical design

- Form factor and weight of a DS Lite