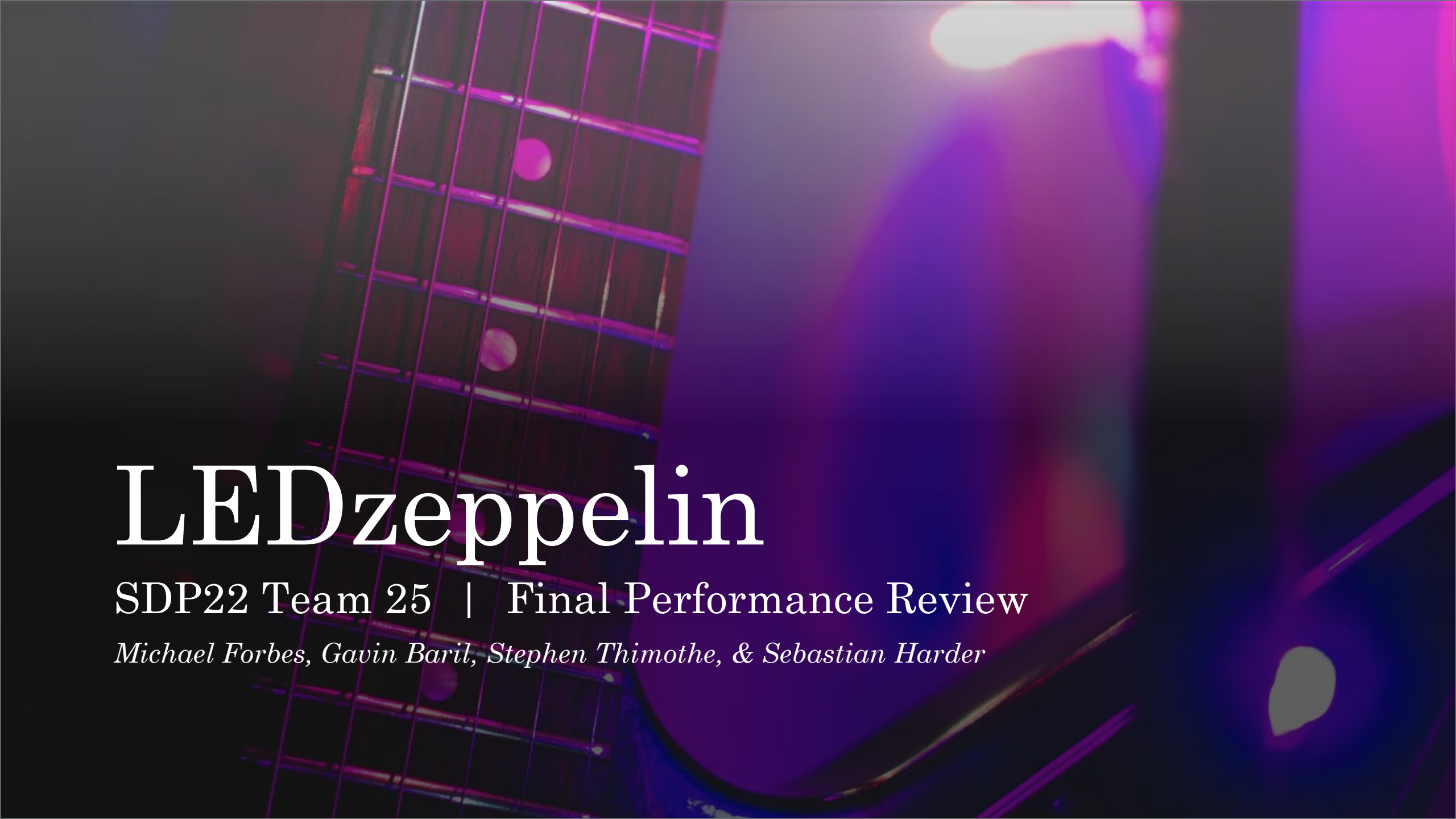


LEDzeppelin

SDP22 Team 25 | Final Performance Review

Michael Forbes, Gavin Baril, Stephen Thimothe, & Sebastian Harder

Team 25 – Senior Design Project 2022

Stephen Thimothe

Computer Engineering

Sebastian Harder

Computer Engineering

Gavin Baril

Electrical Engineering

Michael Forbes

Electrical Engineering

Advisor:
Professor Daniel Holcomb

Team Responsibilities

Stephen Thimothe

Embedded Software Lead

Component Programming

Sebastian Harder

Software Dev Lead

GUI Programming & Design

Gavin Baril

Hardware Lead

Component Design

Michael Forbes

Signal Processing Lead

Team Coordinator

Problem Statement

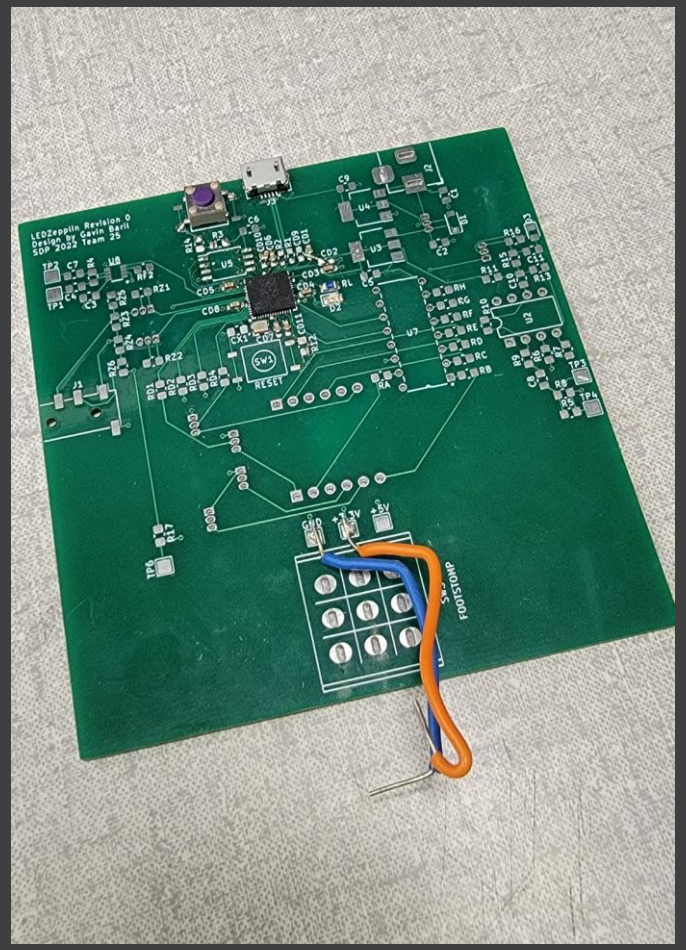
Independent guitarists are often looking for ways to make their sets more interactive and unique. However, as artists at small gigs, their options are limited by finances, space, and portability as well as limited in flexibility and customizability.

LEDzeppelin will be piece of equipment that solo artists or small bands can use to create a customizable lighting experience for live performances. The product will be portable, scalable, and unintrusive as to not interfere with the artists' playing style.

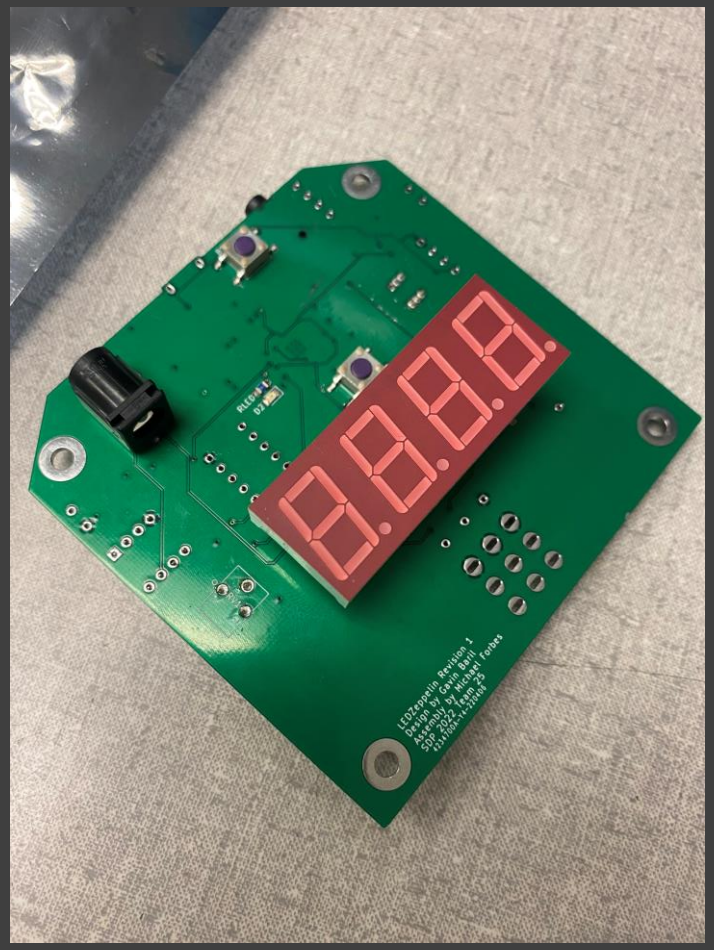
Proposed FPR Deliverables

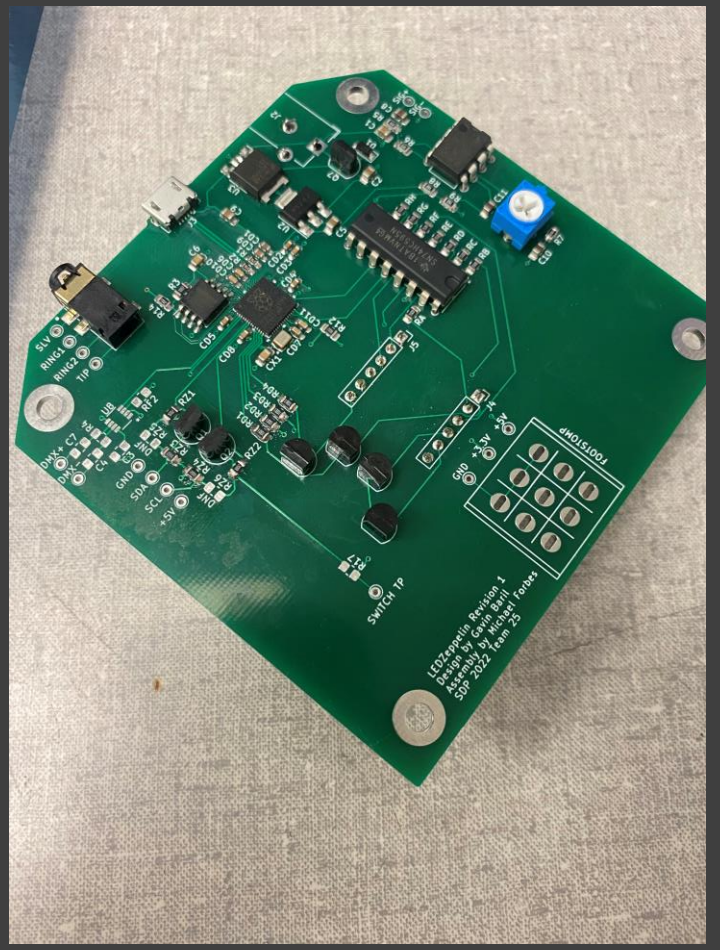
- The system is fully integrated on a printed circuit board.
- Demonstration of frequency and amplitude dependent performance and tuning configurations.
- The GUI fully manipulates all implemented configuration parameters.
- System specifications all successfully tested using test plans and criteria is met.

PCB Iterations

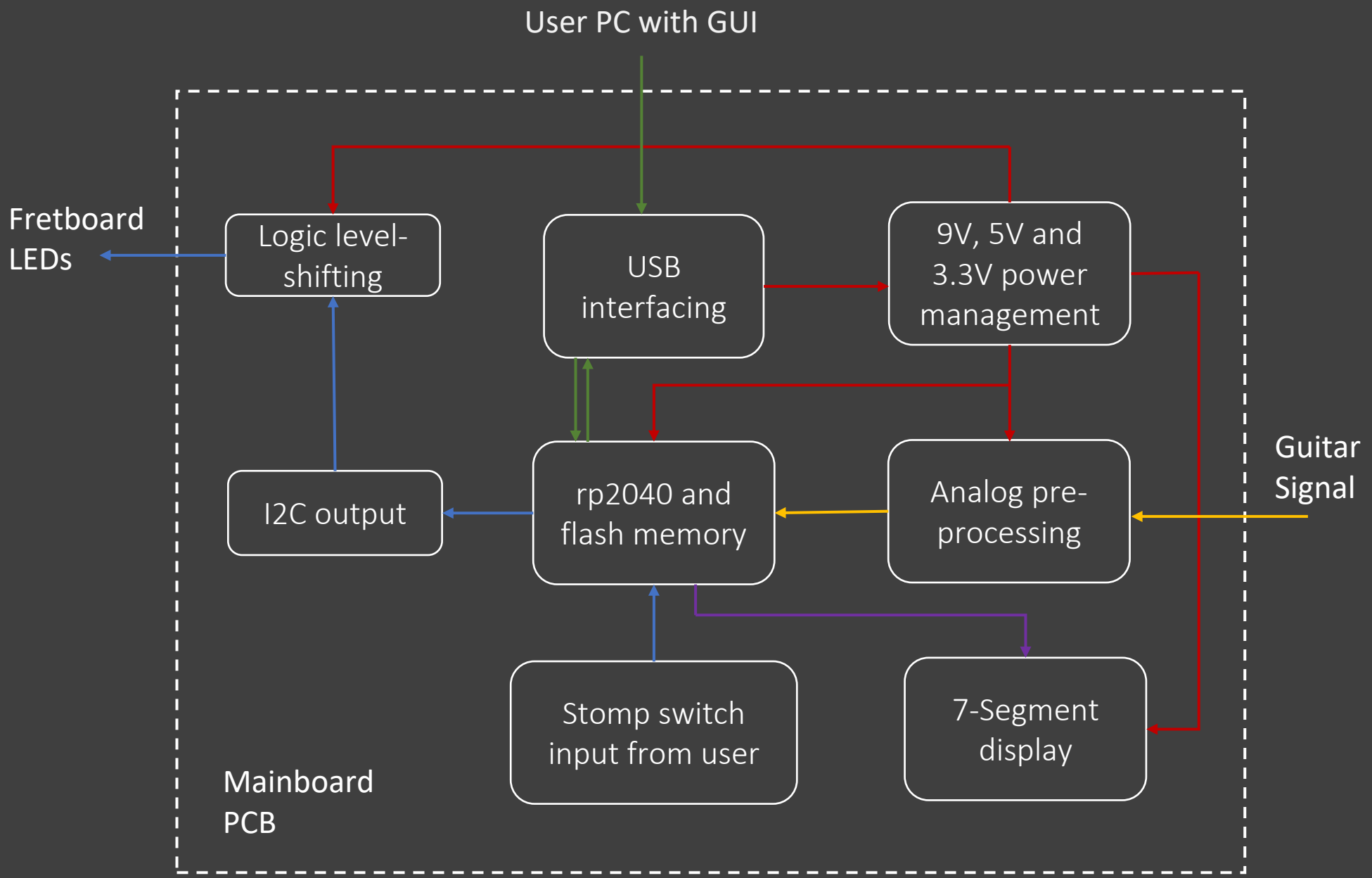


First Iteration





Current Iteration


User PC with GUI
Fretboard LEDs
Logic level-shifting
USB interfacing
9V, 5V and 3.3V power management
I2C output
rp2040 and flash memory
Analog pre-processing
Guitar Signal
Stomp switch input from user
7-Segment display
Mainboard PCB

Demo

FPR Deliverables

- ✓ The system is fully integrated on a printed circuit board.
- ✓ Demonstration of frequency and amplitude dependent performance and tuning configurations.
- ✓ The GUI fully manipulates all implemented configuration parameters.
- ✗ System specifications all successfully tested using test plans and criteria is met.

System Specifications, Testing Plan (Part 1)

- ✓ An advanced knowledge of programming is not necessary to operate LEDzeppelin.
  - ✗ A DMX controller allows for easy adjustments mid-performance.
  - ✓ The system is compatible with any standard electric guitar.
  - ✓ Impermanent, and easy to install.
    - *FretZealot installation video*
- ✓ The LEDs respond to a variety of signal parameters, including:
  - amplitude
  - frequency
- ✗ The system has no more than 20ms latency.
  - For this project, latency is defined as the time between the creation of the signal (when the guitar is strummed), and the visual response of the LEDs.

- Focus groups will be used in two ways:
  - To test audience reactions to both individual configurations and an entire performance.
  - To test guitarists' experience using the system for the first time.
- Signal control testing:
  - Amplitude detection accuracy will be tested by strumming the guitar at various volumes.
  - Frequency detection accuracy can be tested with an oscilloscope for chords.
  - Open string tuning should be at a known fundamental frequency.
- The refresh rate of the fret board will be tested with an accurate camera and a known shutter speed.

System Specifications, Testing Plan (continued)

- ✓ LEDs are assigned to each string on each fret, at least down to the body of the guitar.
  - Tested by inspection. | *Satisfied*
- ✓ The system is portable.
  - No more than one person is required to set it up.
  - The entire system (not including the guitar) is no more than 5 lbs.
  - Portability testing:
    - Total system weight will be measured.
    - Setup/breakdown time will be recorded.
- ✓ There are LED configurations that users can control and assign.
  - One of the preset functions will be a built-in tuner.
  - Other configuration settings for performing will include color pickers, mode selection, and more.
    - Example: Preset #3 sets the LEDs to change colors depending on the frequency of audio.
  - Tested by inspection.
    - Verify tuner is accurately narrowing suggestions visually toward a consistent note or frequency.
    - Test configurations by inspection, among other methods. More details on next slide.

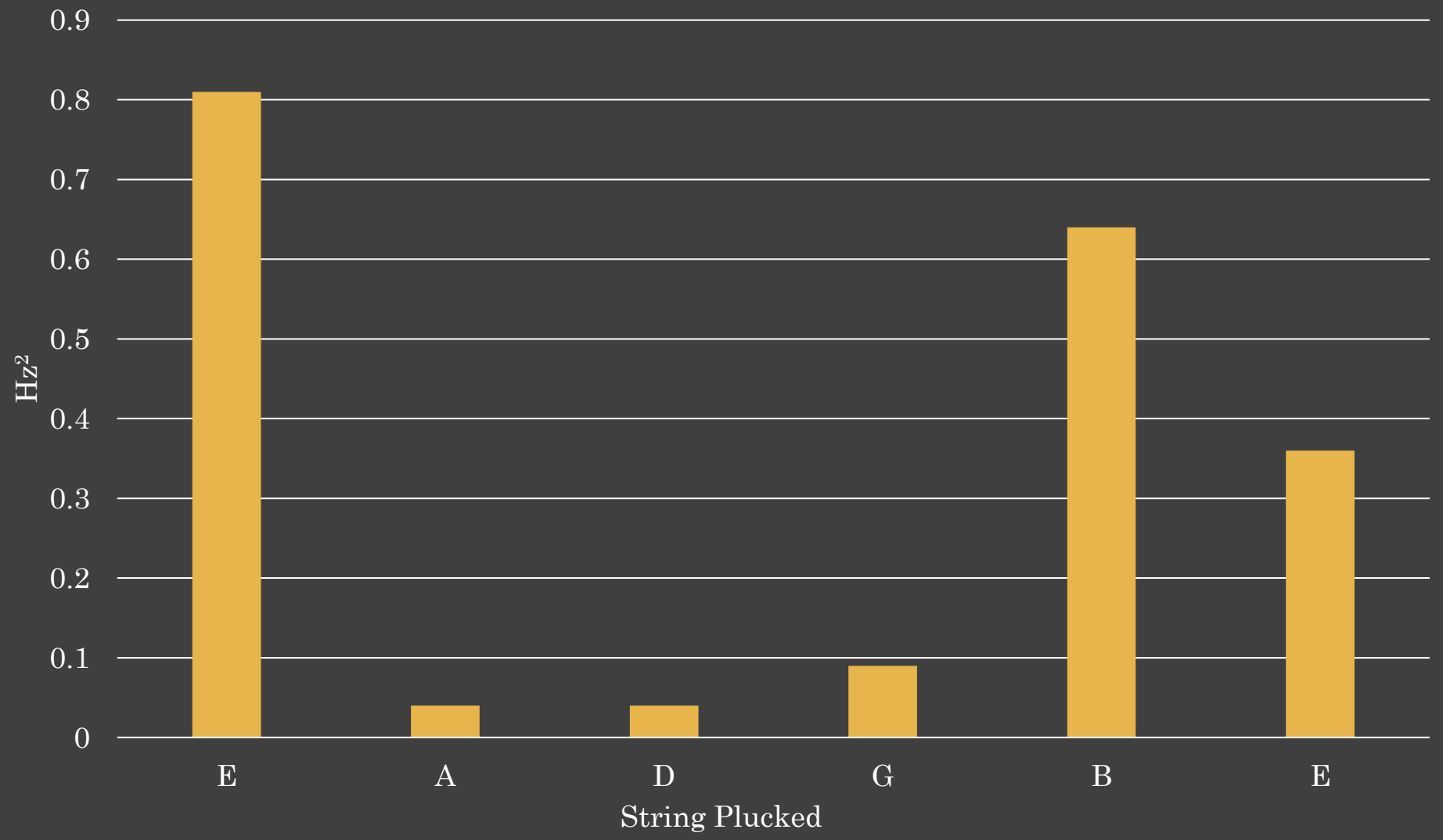
Frequency Detection

- Using KissFFT library.
- For the tuner:
  - Sampling at 1KHz, and buffer size 2000.
  - ½ Hz frequency resolution.
  - Harmonic Product Series identifies string fundamental.

Frequency Accuracy

String	‘CCGT’ Mobile Tuner	LEDzeppelin
E	83.9 Hz	83.0 Hz
A	109.7 Hz	109.5 Hz
D	145.7 Hz	105.5 Hz
G	193.8 Hz	193.5 Hz
B	245.6 Hz	244.7 Hz
E	333.1 Hz	332.5 Hz

Magnitude of the difference (in reported frequency) between ‘CCGT’ mobile tuner and LEDzeppelin



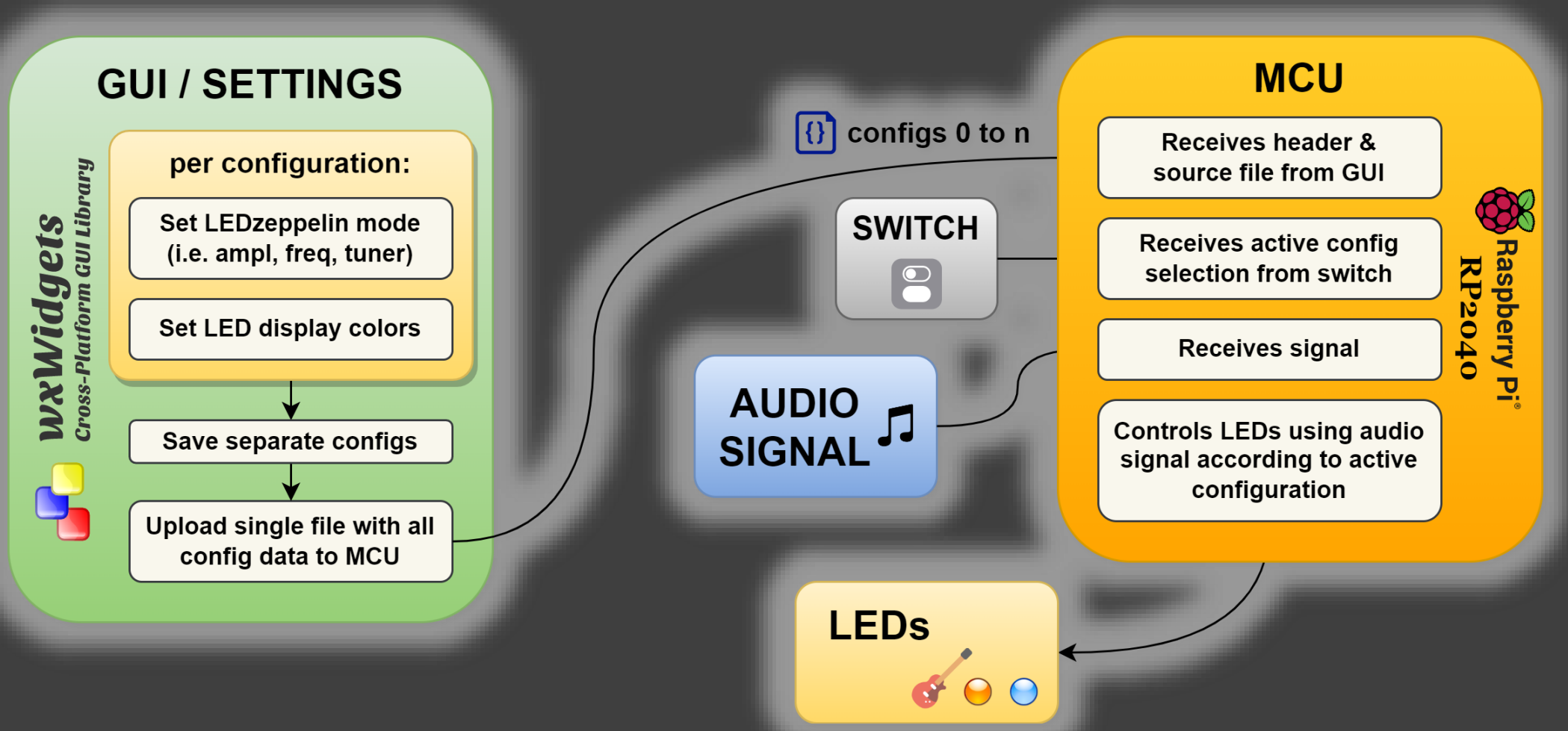
GUI Configuration Specifications, Testing Plan

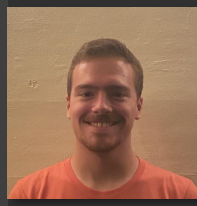
✓ Using the GUI, the user can set the following effects to be implemented:

- ✓ Change LED colors, with the option of setting specific hex color codes.
- ✓ Audio visualizer based on volume of playing / amplitude of signal.
- ✓ Audio visualizer based on note played / frequency of signal.
- ✗ Control any part (all or some) of the LED array with chosen signal elements.
- ✗ Stacking multiple functions in a single configuration.
  - Example: a configuration that scales the neck of the guitar with volume while simultaneously changing LED hue by frequency.

- We will test the color accuracy using a spectrometer.
- Test by inspection, verifying that LED output changes properly for different volumes played.
- Test by inspection, verifying that LED output is consistent for a specific note strummed.
- Test by inspection, checking that GUI settings for turning off sections of the LEDs work.
- Test by inspection, combining the applicable aforementioned tests for the various stacked outputs.

Software Block Diagram





Budget

Item	Quantity	Price
Guitar	1	Already owned
Fret Zealot Strip	1	$100
PCBs and parts	10	$200
Hardware (MCUs, equalizer)	~	$60
9V Power Supply Unit	1	Already owned
Total	~	$360

Questions?