

(1) Use Case

We intend to make a unique instrument effects pedal, combining some of the functionality of a sequencer with a basic delay pedal.

- Signals
 - Manipulating audio
- Circuits
 - Input and output
 - Parameter dials
- Software
 - Algorithms to modify digital signals



(2) Use Case Requirements

Controls

- Our pedal must be easily controlled on stage.
- Users will prefer conventions that are similar to existing devices.
- Users will expect to turn the effect on or off **instantaneously**.
 - Bypass control should be large and simple enough to be activated by foot.
- The pedal's parameters must be able to be modified in **seconds**.
 - Dials will control delay time
 - Switches will control the sequencer setup
- The pedal's state must be visible.
 - An LED screen will display the tempo in beats per minute.

(2) Use Case Requirements

Size and Shape

- Our pedal must not take up much room on stage.
 - Length and width must be small; less than **8 in** for each dimension.
- Our pedal must be stable, so it will not fall over.
 - A flat base is required.
 - Height must be short (less than **4 in**) and smaller than length and width.
- Our pedal will be rectangular to fit on a board without wasted space.

(2) Use Case Requirements

Latency

- Our pedal must have an unnoticeable wait between the input signal and its corresponding output.
 - Latency of about 10ms is noticeable by performers.
- Users will expect to use our pedal in series with other pedals
 - Our pedal may be one part of a long signal chain.
- Latency of **5ms** or less is necessary so that our pedal can be used in conjunction with other effects.

(3) Technical Challenges

1. To perform accurate digital signal processing, need effective analog-to-digital and digital-to analog converters
 - a. Test multiple commercial ADC/DAC
 - b. Track speed, accuracy, and noise on our audio inputs in simulation software
2. Sufficient memory storage given sampling rate and desired effects
 - a. Hardware must support calculation-based storage needs
 - b. Current proposed microcontroller - *Daisy Seed* - chosen given its extensive libraries and memory/audio buffer size
 - i. Contains **64 MB** of SDRAM
 - ii. Up to **10 minute** long audio buffers
 - iii. **8MB** external flash

(3) Technical Challenges

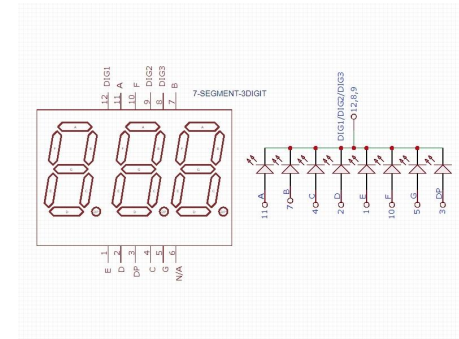
3. Pedal Sizing
 - a. Housing for our circuitry must match industry standards
 - b. Circuitry and other hardware choices must align
4. User Interface
 - a. Must be easy and clear to interact with pedal settings
 - b. Incorporating dials and small LCD display to display pedal setting selections

(4) Solution Approach

- Currently plan to use microcontroller to apply the delay effect
 - Useful if we want to add additional features in software
- Other basic functionalities and controls done through hardware
- Need to make custom housing for pedal components, as pre-existing ones do not have the required parts for the sequencer functionality
 - Will likely design in CAD and 3D print

(4) Solution Approach: Specifics

- Component Requirements:
 - Buttons with visual indicators to control sequence
 - Screen and buttons, perhaps combined, to control and display tempo of delay
 - ADC and DAC, must be higher quality to maintain sound quality, and fast to reduce latency



(5) Testing, Verification, Metrics - Quantitative

- Develop input data set from live musicians or handpick online samples in the form of .wav files
- Test our implementation using microcontroller software simulations
- Incorporate hardware and utilize oscilloscope to verify desirable output waveforms
 - Measure frequency, amplitude, latency, etc.
- Produce differential waveform between input and output waveforms to determine effectiveness of our design
- Probe for power, performance, and area of circuit design
 - Use findings in testing to improve design or explore other avenues

(5) Testing, Verification, Metrics - Qualitative

- The artistic nature of our product demands qualitative testing
 - Run several trials with live audio
 - Measure input and output audio and store in some data format
 - Conduct similar analysis to software simulation to improve the audio quality and the closeness between our desired effect and actual effect
 - Receive feedback from professionals on the resulting sound
 - Ask same set of questions to professionals

(6) Tasks and Division of Labor

Josie

- Signal Design/Processing
- Components Research
- Software Design
- Microcontroller Programming

Nick

- Pedal Housing
- Software Research
- User Interface Design
- Additional Hardware Wiring + Design Choices

Chaitanya

- Hardware Research for circuit-related decisions
- Hardware Design in the form of PCB design to tapeout.
- Microcontroller Programming
- Additional Hardware Wiring + Design Choices

