Microcontroller Based Guitar Pedal
ECE 499 – Group 6

Chris Cruz, Zachary Legg, Steven Costa

University of Victoria

Abstract

The prototyped guitar effects pedal is a microcontroller based digital effects box that alters the sound of an electric guitar with the use of signal conditioning circuitry in conjunction with digital signal processing techniques using software.

Project Goals

The project was divided into three subsystems:

1) Signal Conditioning

- Condition the audio signal before and after processing.
- Minimize audible noise during operation.
- Solder to a copper stripboard PCB.

2) Digital Signal Processing

- Use the ATmega2560 microcontroller and C programming language.
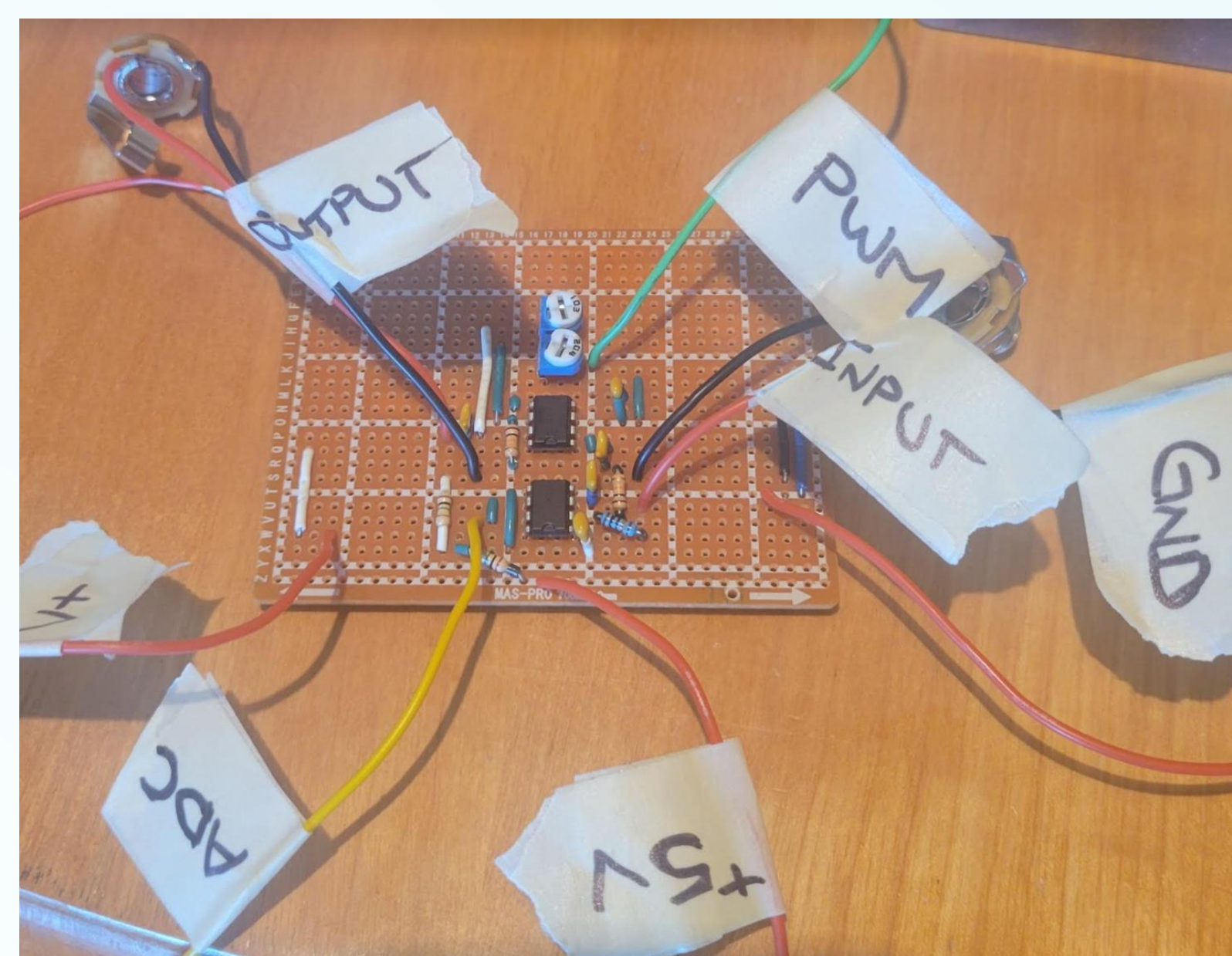- Implement distortion, delay, and fuzz audio effects.

3) Enclosure Fabrication

- House microcontroller and electronic components.
- Protect from environmental elements and interference from surrounding devices.

Design & Methodology

Signal Conditioning Circuit
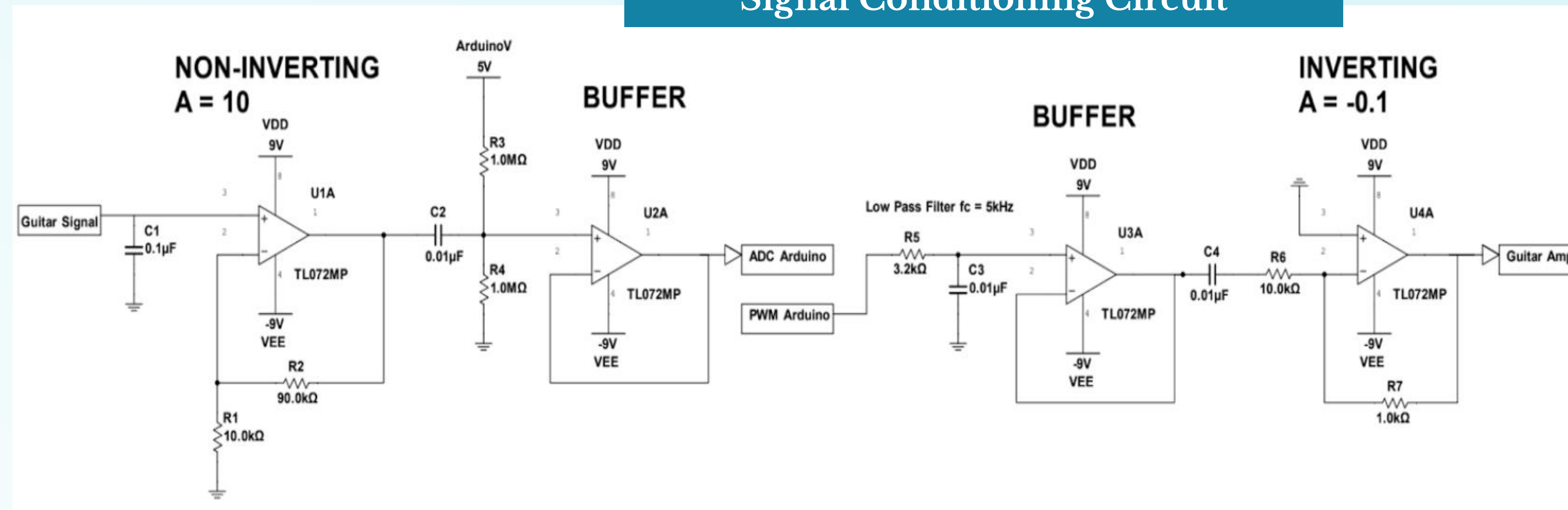
- Conditions the input guitar signal before processing by amplifying the amplitude.
- Reduces audible noise with filters, bypass, and decoupling capacitors.
- Conditions the processed signal by de-amplifying the amplitude before being played through a speaker.
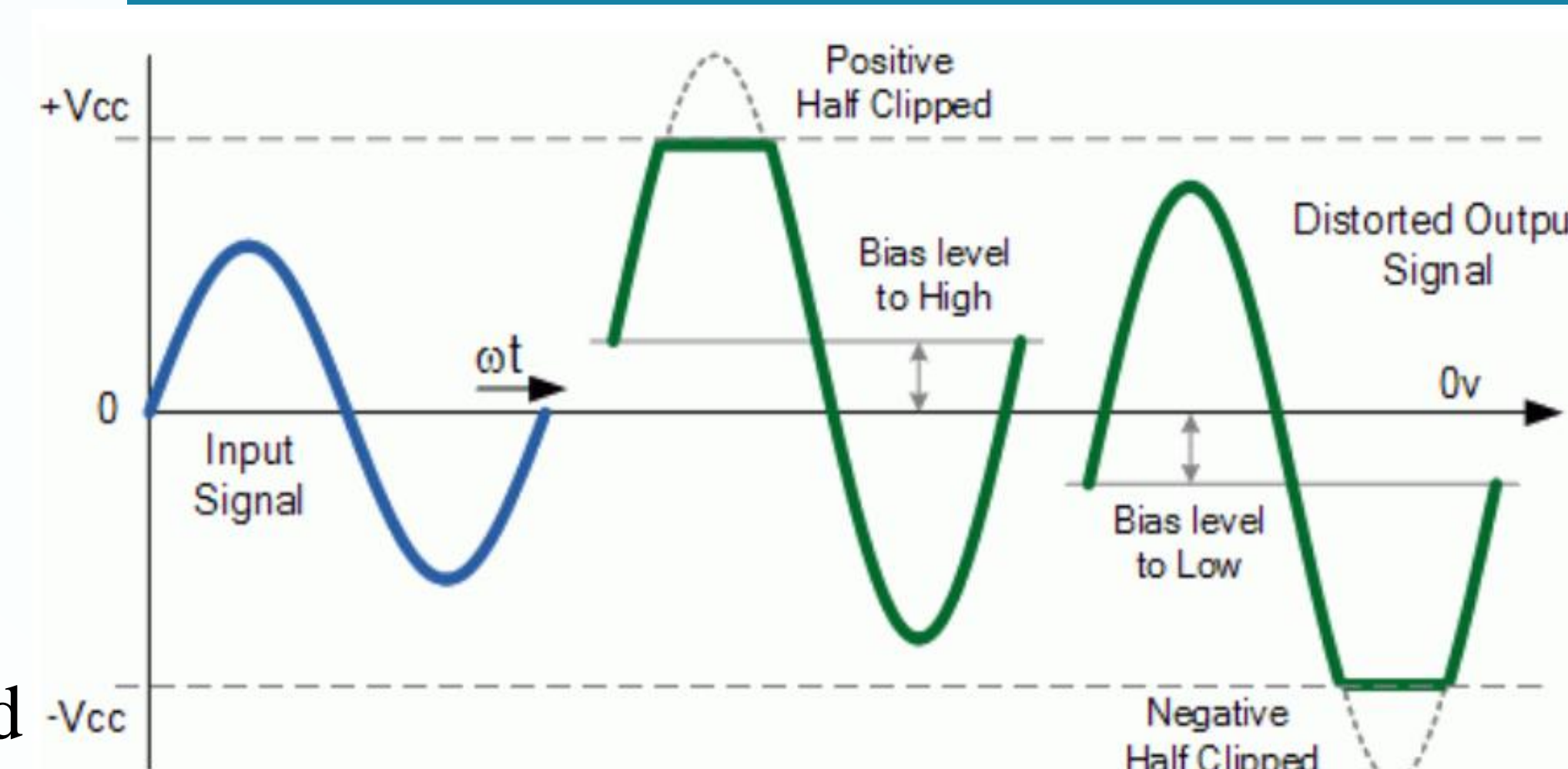
Circuit Board

- Soldered signal conditioning circuit to a stripboard.
- Reduces occupied space in enclosure.
- Shortens path lengths between sensitive components.

Aluminum Enclosure

- Houses microcontroller and electronic components.
- Protects from environmental elements and interferences.
- Powdered coated a champagne finish.
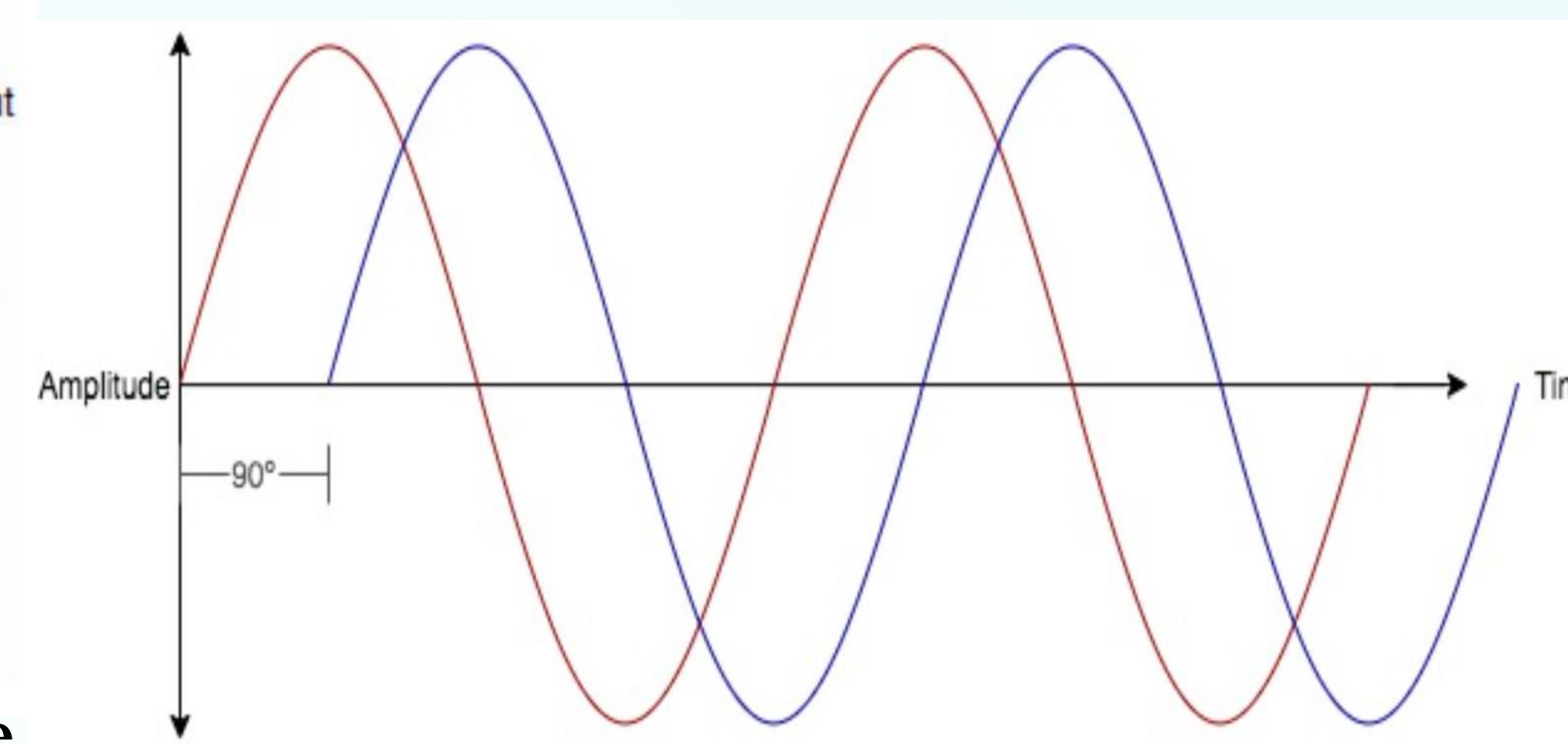
Audio Effects

Distortion [1]

- Clips the upper and lower amplitudes of the positive and negative half cycles of the guitar signal.
- Achieved in software by specifying boundary points and removing values outside of the boundary points.
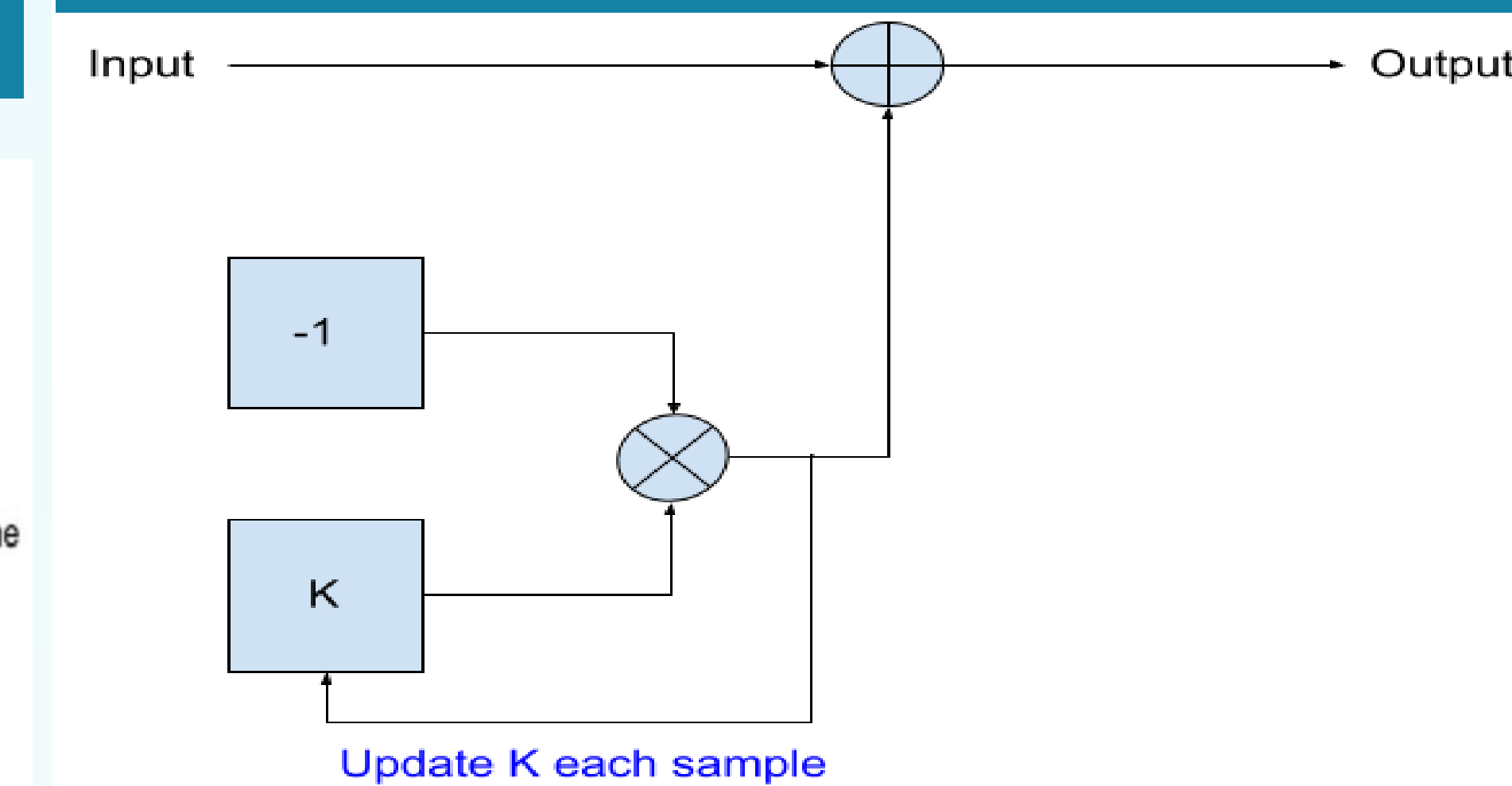- Alters the guitar signal to sound grittier and more aggressive.

Delay [2]

- Records and plays back signals fed into it creating an echo effect.
- Achieved in software by storing signals in a buffer and delaying the playback by a specified time.
- Creates the illusion of a larger space and multiple instruments playing simultaneously.

Fuzz

- Adds noise to the audio signal.
- Achieved in software by adding and subtracting constant values to each sample of the guitar signal
- Produces a fuzzy-static sounding signal.

Results

All project goals listed for each subsystem were achieved and all elements of the prototype work reliably and as designed.

The signal conditioning circuit successfully conditioned the audio signal before and after processing with minimal noise during operation.

The programmed effects distortion, delay, and fuzz all altered the guitar signal and produced unique and distinguishable sounds.

The enclosure successfully housed all components and provided stellar protection from the environment.

Conclusion

The proposed microcontroller based guitar pedal was a success. The completion of this project promoted critical thinking, problem solving, and teamwork skills by applying the culmination of knowledge gained from the UVic ECE programs in a practical environment.

References

[1] "Amplifier distortion in transistor amplifiers," Basic Electronics Tutorials, 13-Jun-2018. [Online]. Available: https://www.electronics-tutorials.ws/amplifier/amp_4.html. [Accessed: 30-Jul-2021].

[2] Arthur, "Complete guide the flanger audio modulation effect," My New Microphone, 29-Jul-2021. [Online]. Available: https://mynewmicrophone.com/complete-guide-to-the-flanger-audio-modulation-effect/. [Accessed: 30-Jul-2021].