July 2019

Sound Signal Coalescence

Jeffrey Yangfeng Xiao

Ryan Tarango Lee

Tyler Drew Morris

Sound Signal Coalescence

A Major Qualifying Project submitted to the faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the Degree of Bachelor of Science

Tyler Morris
Electrical and Computer Engineering
Jeffrey Xiao
Computer Science
Ryan Lee
Electrical and Computer Engineering

Submitted to:
Prof. Stephen Bitar
Prof. Dmitry Korkin

E2019

Abstract

When recording professional audio, scores of devices are connected to meet artists' needs, but currently it is difficult to manage these connections without multiple personnel for the hardware and software. This project utilized a combination of embedded systems, microelectronics and signal processing elements to create a product that allows a single user to adjust instrument levels of multiple connected audio devices. A prototype circuit was created as a proof of concept that can control the volume of an output speaker locally as well as remotely via Wi-Fi. Additionally, a simple GUI was developed for remote system control from a desktop computer.

Executive Summary

With the goal of producing an audio product that amplifies a signal and whose output can be changed by external control, a product was developed that would accomplish this task without proprietary software. In the current marketplace, to implement the same features in the developed prototype that was produced in this project, proprietary software is required. Additionally, each audio device in the current market has its own software GUI. The cost of software in a current live audio situation could have a very high cost, sometimes totaling thousands of dollars.

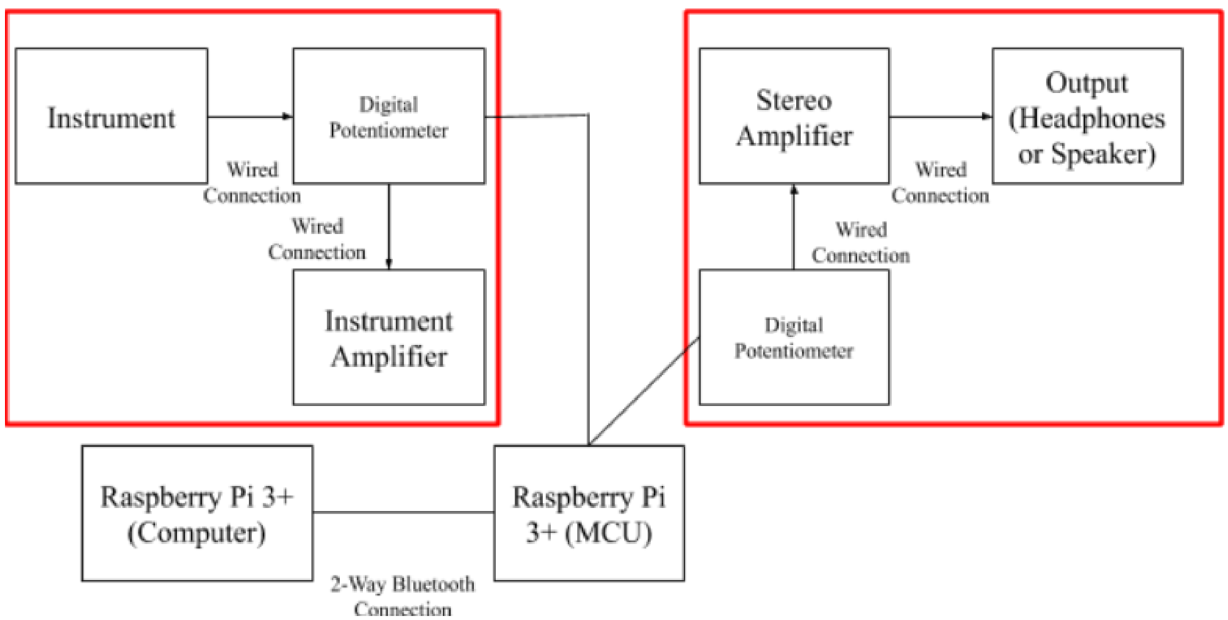

Figure i: *Block Diagram of Prototype, Where the Red Squares Represent Physical Enclosures that are Connected Together via Wires*

The product is divided into three blocks: the power supply unit, the stereo amplifier, and the microcontroller (MCU). The power supply consists of a safety fuse and a dual AC-DC power supply unit that outputs ±18V for the stereo amplifier, connected via a 4-pin cable. The stereo amplifier receives an input signal and amplifies it with a specified gain of Av=5 for an output. For safety, 5-Watt resistors are inserted for ensuring the circuit is protected in the case of overcurrent conditions. The third block can control the second block via the MCU and two digital potentiometers (**Figure i.**). This can be done through a developed Graphical User Interface or physically with a rotary encoder. Using either method will allow the user to increase or decrease the volume of the output signal either linearly or logarithmically.

The MCU uses a prototyped function created in Python to increase and decrease the resistance on a digital potentiometer. This can be conducted using either the GUI or an external encoder that sends a signal to the MCU as well. The digital potentiometer has 128 steps of adjustment.

A functioning prototype was successfully created and implemented within the given time span of this MQP. Each block received its own custom packaging for easy portability and preferred aesthetics for the user (**Figure ii**).

Figure ii*: Final Case for the Audio Amplifier*

The product was tested utilizing various professional audio devices and was quantitatively measured via an oscilloscope and function generator to confirm the system functioned as designed. Using a 1V kHz and 40Hz sine wave signal, a Bode plot (**Figure iii.**) was generated to confirm whether the frequency of the signal would influence the output while in audio range (20Hz-20kHz) and was found to not be affected.

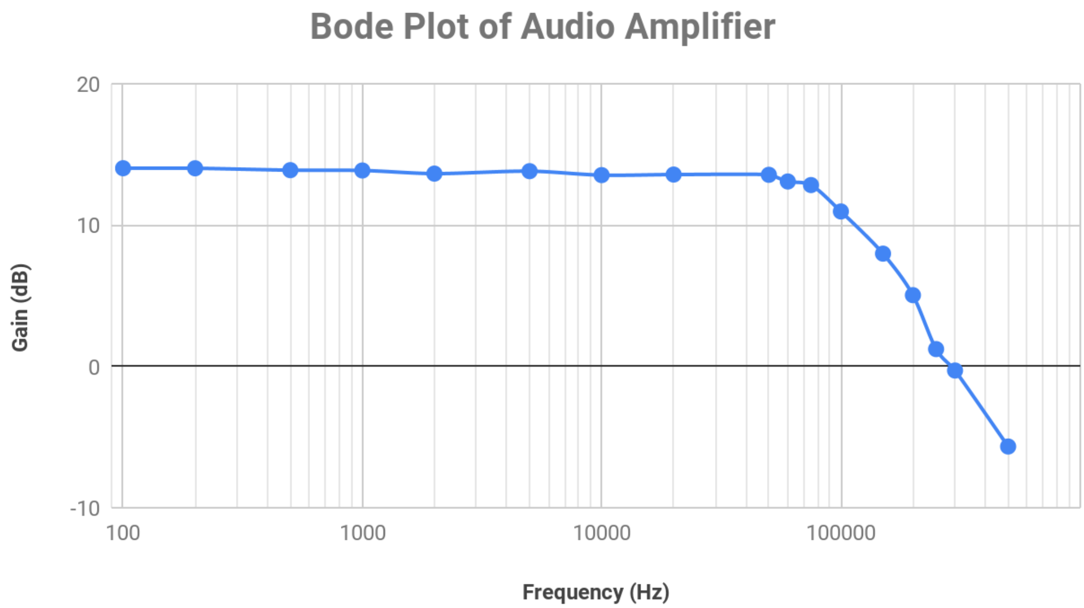

Figure iii: *Bode Plot of Stereo Audio Amplifier where Cutoff Frequency = 100kHz, Showing Audio Spectrum is Unaffected*

The wireless function of the product also worked, albeit we did not have the GUI finished when the testing was done. Instead, direct commands were inputted in the Command Prompt Window of the laptop connected to the MCU to change the values of the digital potentiometers. The output signal was measured based on the value of the potentiometer with the same 1V 1kHz Sine wave, and a linear slope was the result as the value of the potentiometer increased from Step 0 to Step 127 (**Figure iv.**)

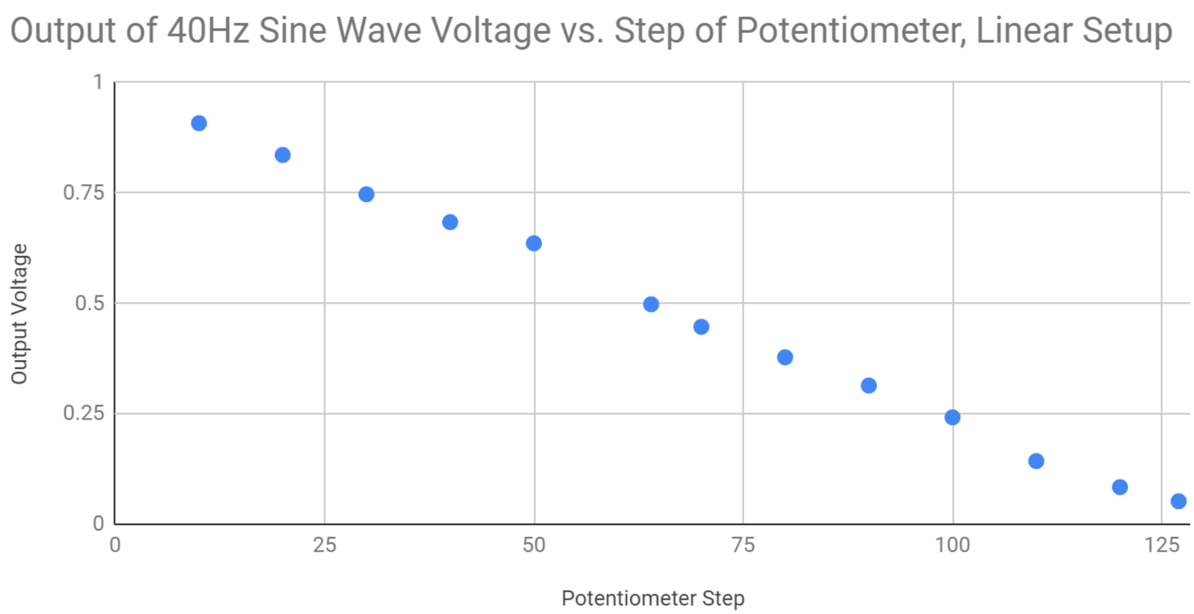

Figure iv: *Output of 40Hz Sine Wave Measured in Comparison to Potentiometers in Linear Setup, Showing the Potentiometer Functions Properly*

In the future, the product will host more functions and be able to control multiple amplifiers at once regardless of the manufacturer or model simply by plugging them into the product. This will be a very intuitive product for audio consumers to use in comparison to the offerings on the current marketplace.

For the full report please contact Professor Stephen Bitar at sjbitar@wpi.edu