



UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

Bone Conduction Discreet Communicator

Electrical & Computer Engineering

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5/2/2023

Topics



- Introduction
- Motivation for project
- Design Overview
- Demonstration
- Successes/Challenges in Development
- Conclusion
- Future Scope



HEADING

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Introduction



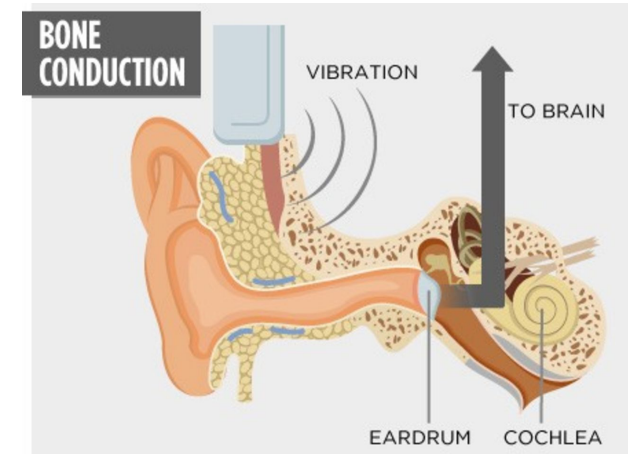
Motivation

Problems in Hearing Aids

- **Conductive Hearing Loss/ Single Sided Deafness**
- **Bone Conduction Uses in Hearing Aids**

Discreet Communication

- **In-mouth wearable reduces outward cues**
- **Uses in espionage, defense, newscasting**



Method of Stimulation in Bone Conduction Speakers

In-Mouth Wearable Bone Conduction Speaker

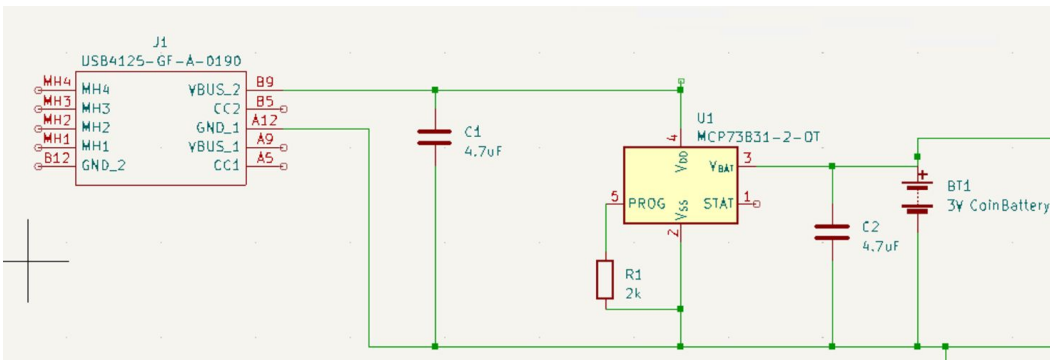
- Battery/ Microcontroller clips into soft palate
- Bone Conduction Transducer clips into outside of back molars
- Wifi used for communication between LAN server and microcontroller



SoundBite Hearing System



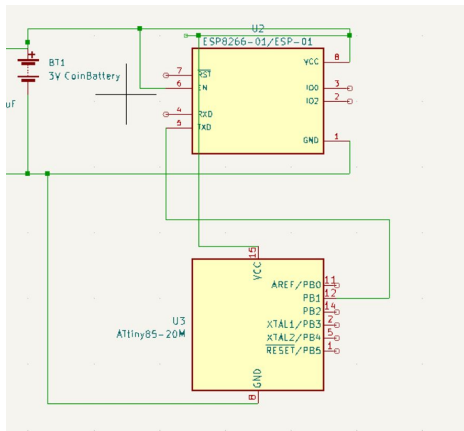
Overview of Design



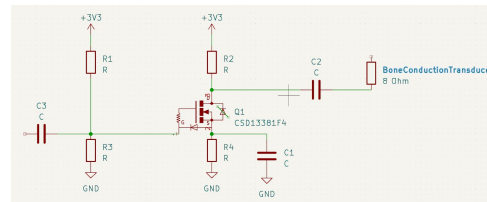
USB – Charging Circuit

Original Design

- USB -> Charging Regulator -> Battery (Same)
- ESP8266 Audio -> ATTiny PWM DAC (Changed)
- Op-Amp based amplifier (Changed)



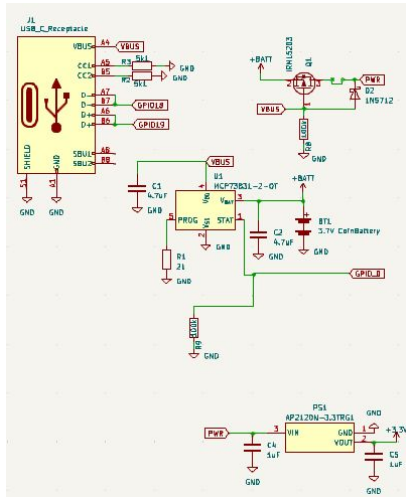
Original Signal Circuit



Original Amplifier Circuit

Changes Made

- Switched entire Signal Subsystem to ESP32 C3 Wroom
- Switched Amplifier to I2S DAC + Amplifier IC



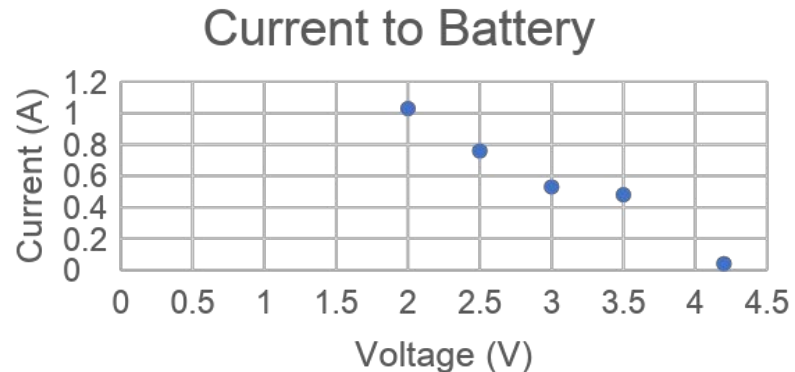
USB -> Battery/ ESP32

Summary of Operation

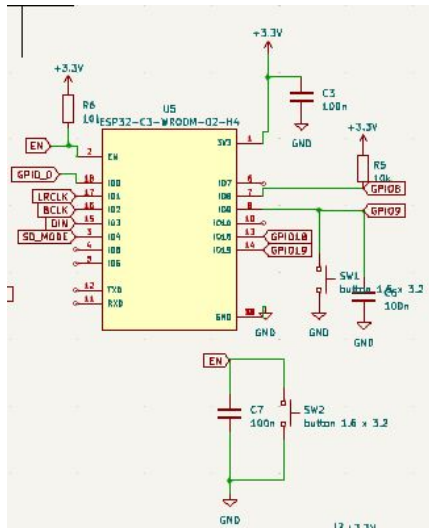
- USB C port sends Voltage bus to the input port of charging regulator
- Sends voltage to the Gate input of a P-channel Mosfet
- Allows for source switching between battery and usb
- Drain of the Mosfet is regulated with an LDO, sent to rest of circuit

Testing

- Different loads across battery terminals are simulated with an E-load, tests the functionality of the charging state machine



Charging Circuit Test



ESP32 Based Subcircuit

Summary of Operation

- ESP32 receives regulated 3V3 line from the power subcircuit
- Connects to Wifi
- Gets an MP3 stream from an https server
- Sends data over the I2S Bus

Testing

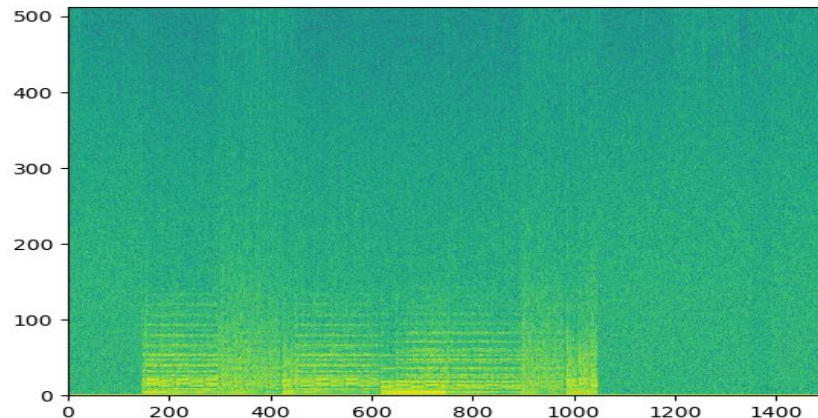
- Data collected with Raspberry Pi ADC, sent to https server



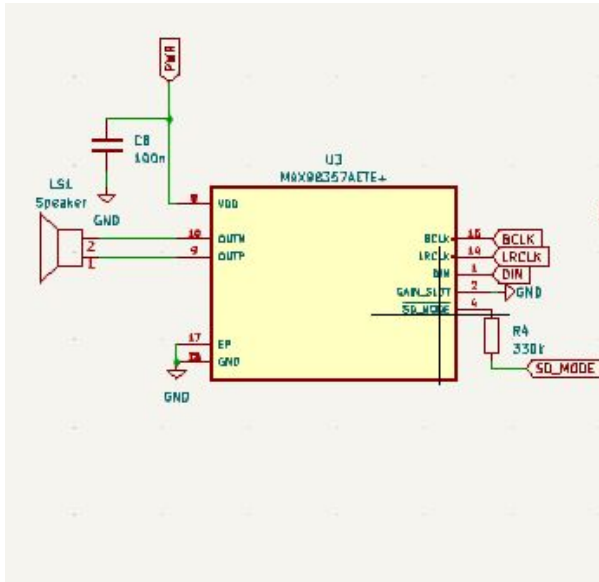
Transmitted Audio



Resampled Audio



STFT of Sampled Transducer Output



I2S DAC +
Amplifier

Summary of Operation

- MAX98375 IC is an I2S DAC + an amplifier with selectable gain
- I2S data is input by the ESP32
- Signal is demodulated and sent to the Transducer at 1W

Testing

- Validity of output on Bone Conduction Transducer



Demo



Vibration of the Bone Conduction Speaker



Challenges

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Successes

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Conclusions

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Future Scope

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