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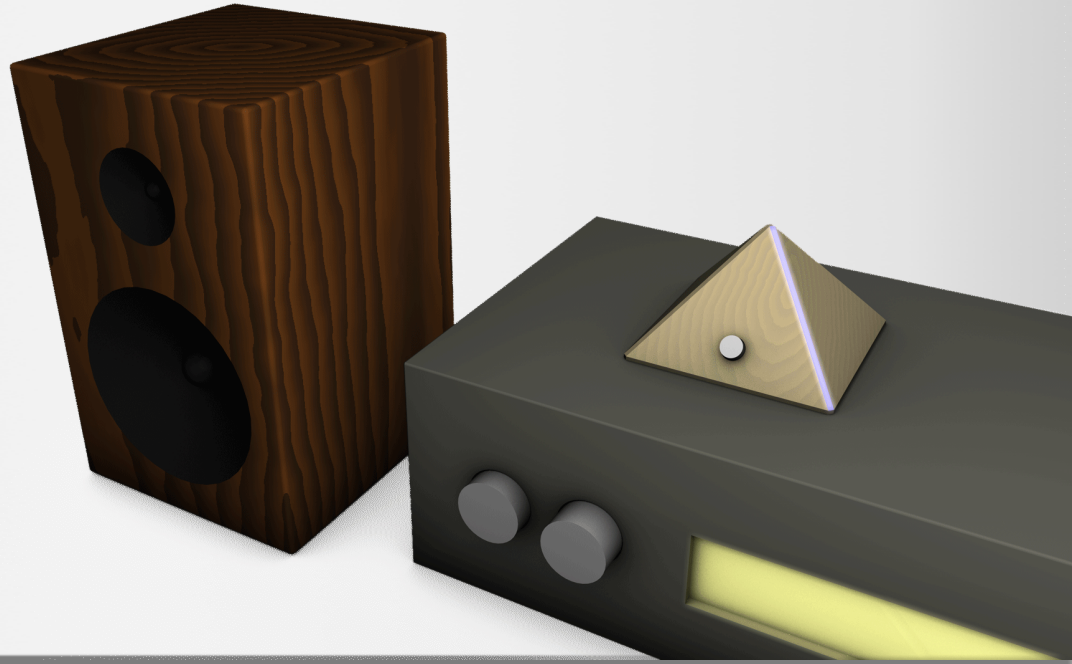
THINKING OF THE WORLD

Arimus Audio

SoundHub

A complete wireless home audio solution.



"Technology is at its best, at its most empowering, when it simply disappears."

- Sir Jonathan Paul "Jony" Ive

Presentation Outline

- Team Members
- Overview of the SoundHub
- Current Market
- Submodules
  - Firmware
  - Hardware
  - Android
- Schedule & Project Costs
- Final Thoughts

We are Arimus Audio

CEO: Sherman Siu
(Hardware Support)

CVO: Scott Malfesi
(Firmware Lead)

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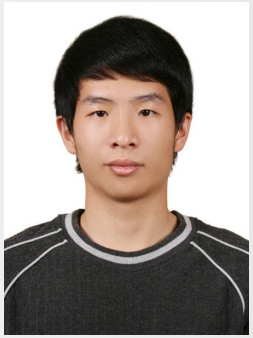
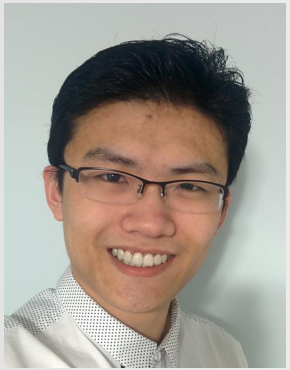
CIO: George Chang
(Software Lead)





CTO : Dongkai Miao
(Hardware Lead)

CFO: David Yin
(Android Lead)

Overview

- What is the SoundHub?
- What are in the market?
- Why are we motivated?

"Listening to the music you love most with the speakers you are most familiar with."

-Team Arimus Audio

What is the SoundHub?

- Attachment for wired speakers to achieve WiFi audio streaming
- Performance DAC system to retain high quality music while streaming wirelessly
- Multiple device streaming
- RoomFlow proximity detection (not in proof-of-concept)

Currently on the Market

- Mostly built into the speakers
- Cheap Bluetooth dongles or expensive WiFi systems

Sonos Connect [1]

Cambridge Audio [2]

Belkin [3]

Motivations

- WiFi vs. Bluetooth
- Affordable full house wireless solution
- Reuse of existing sound systems instead of buying a new system for wireless feature

[4]

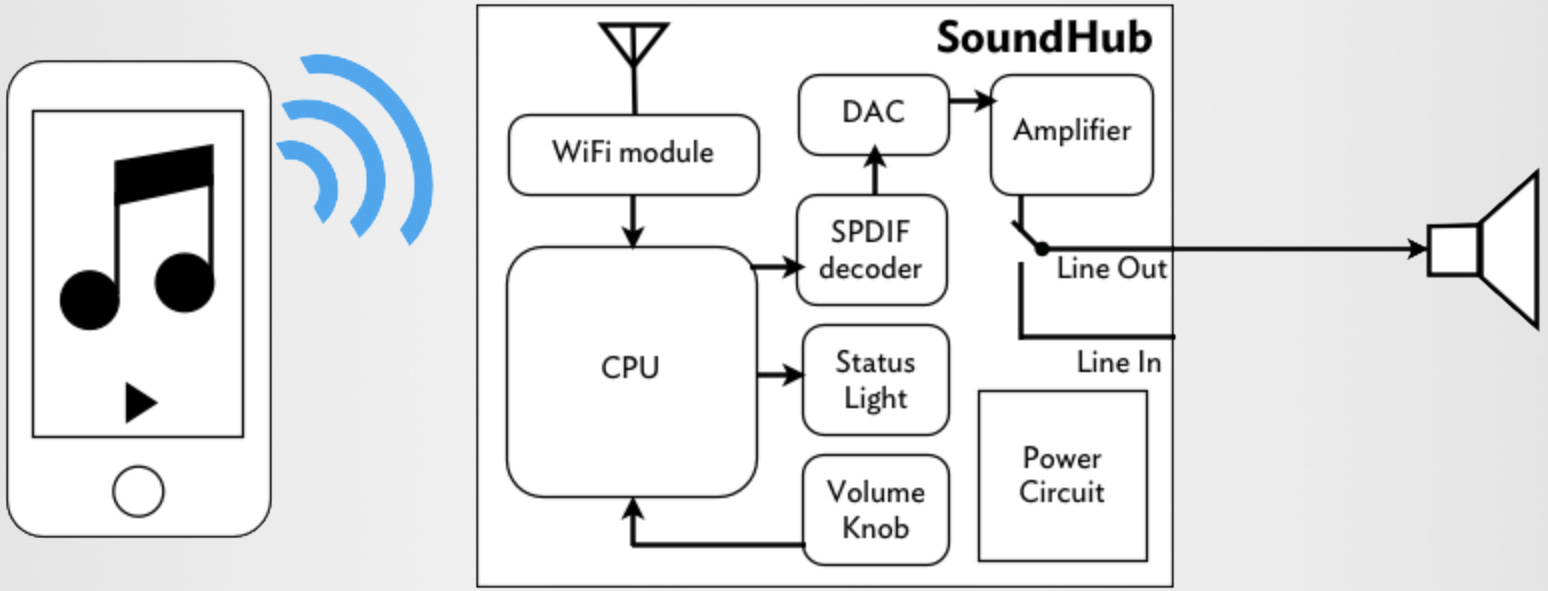
Functions and features

- Multiple point synchronized audio streaming
- High quality audio
- Volume control
- Music source toggling
- Status LEDs

Project Modules

Firmware	Hardware	Android
Code running in the SoundHub	Hardware Audio Codec	Developing an Android app to interact with the SoundHub

SoundHub System Overview



Firmware Specification

- Wireless IEEE 802.11 b/g/n support
- Compressionless audio
- Multi-room streaming
- Linux based architecture
- Music Synchronization
- Automatic Session Discovery and Joining

[5]

Unparalleled Audio

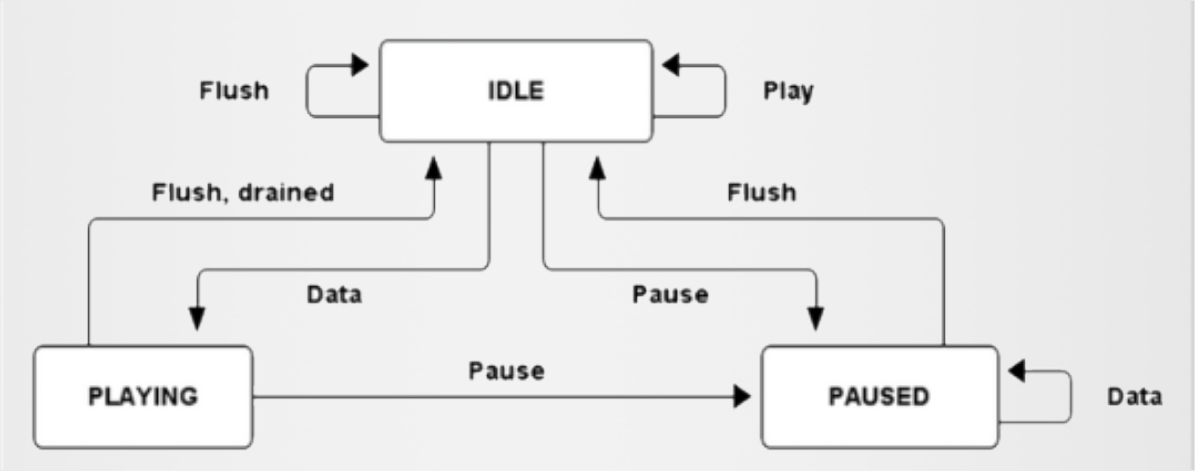
- CD Quality Music Streaming Support
- WAV format
- 16 bit
- 44.1kHz and 48 kHz
- Uncompressed
- Support for more

Multi-room Streaming

- Single Source to Multi-Client Support
- Confirmed 10 separate instances
- Stress tested to ensure system integrity
- Surround Sound effect

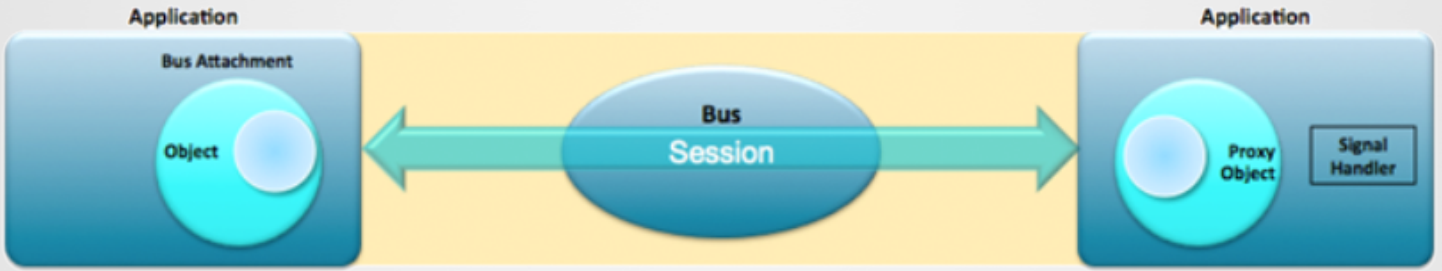
Music Synchronization

- Built in FIFO buffer
- Compensates network latency
- Resynchronization



Automatic Session Discovery & Joining

- Automatic network startup
- Bus creation
- Advertising & Discovery
- Works seamlessly through TCP/IP

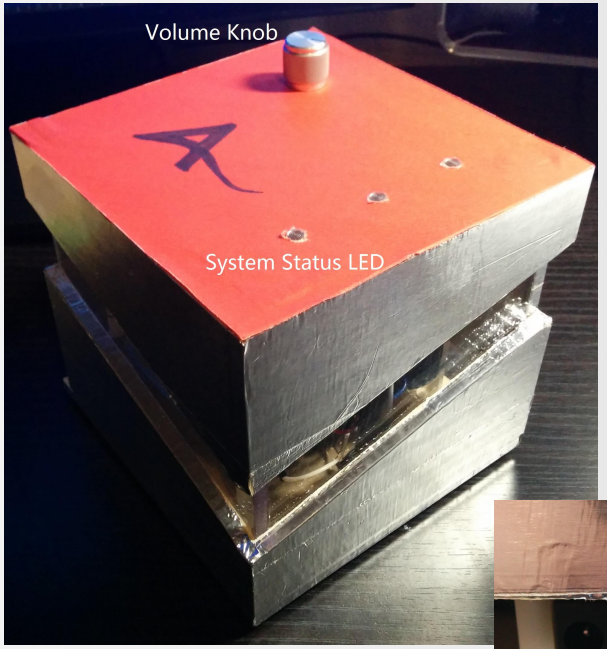


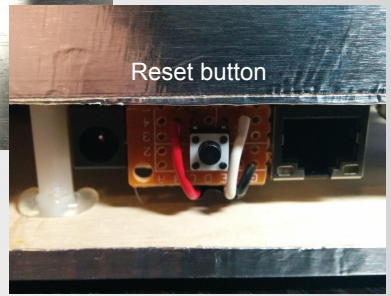
Embedded Linux Operating System

- Open source Linux community
- Multiple processes, threads and locks
- Security library OpenSSL support
- TCP/IP stack
- Fully automated
- Heartbleed issue not affected

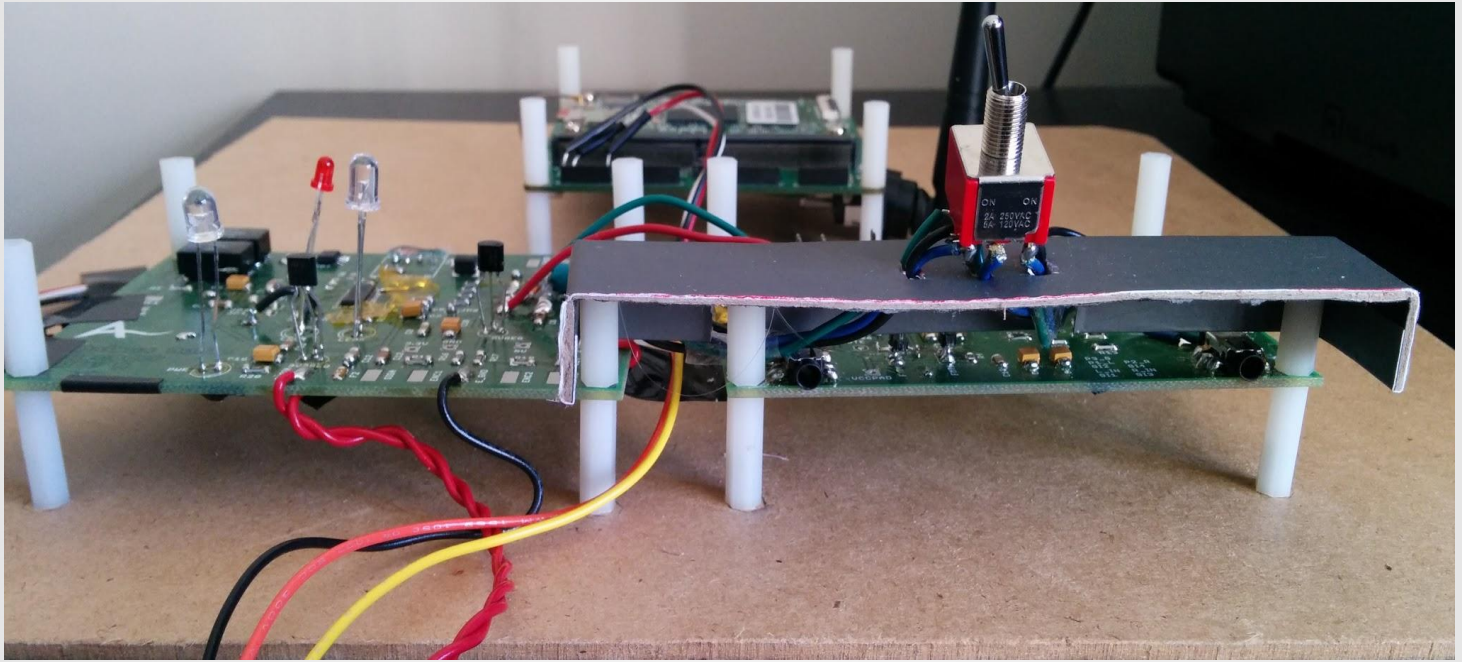
Interfacing with Hardware

- Peripherals:
  - Reset button
  - Volume knob
  - Status LEDs
- Custom hardware driver
- Software Debouncing





Mixed Digital and Analog Hardware



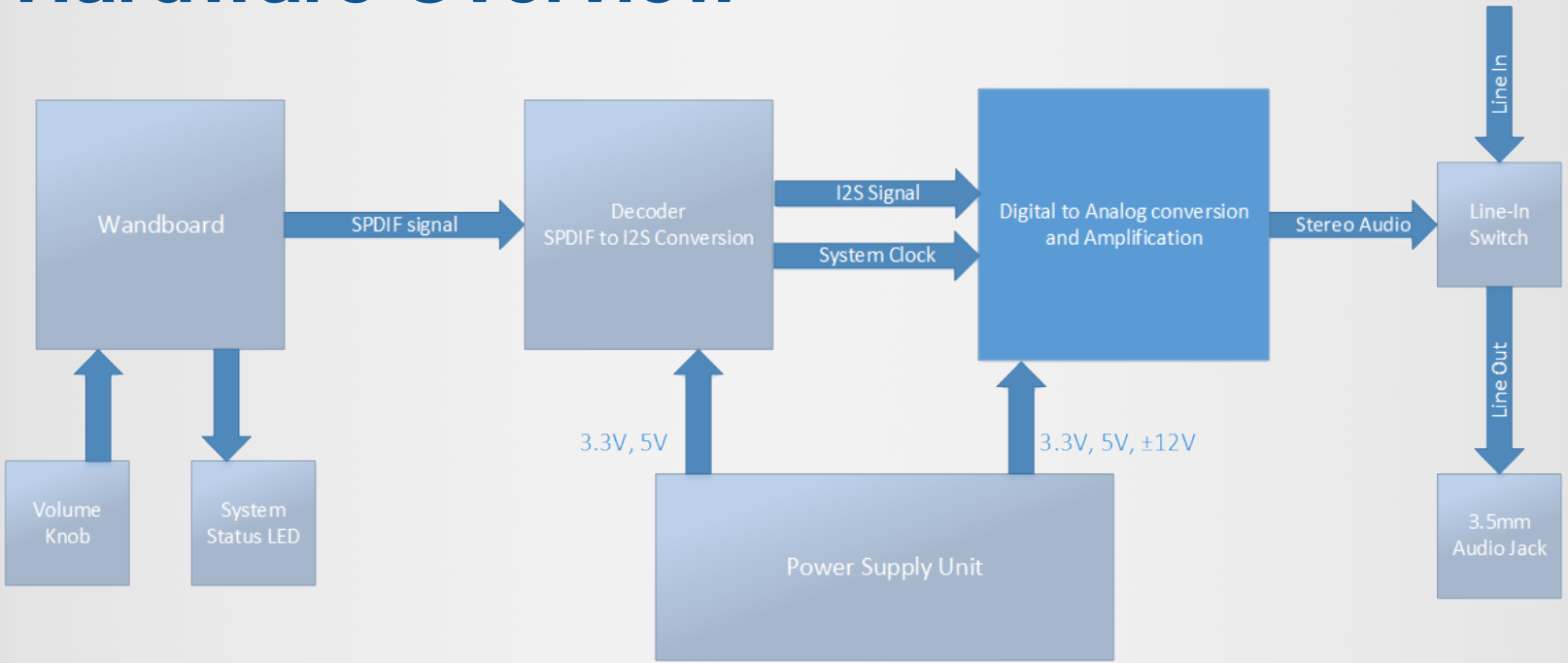
What is it?

- It is an hardware audio codec
  - It converts digital audio signal to analog stereo audio data to 3.5mm audio jack

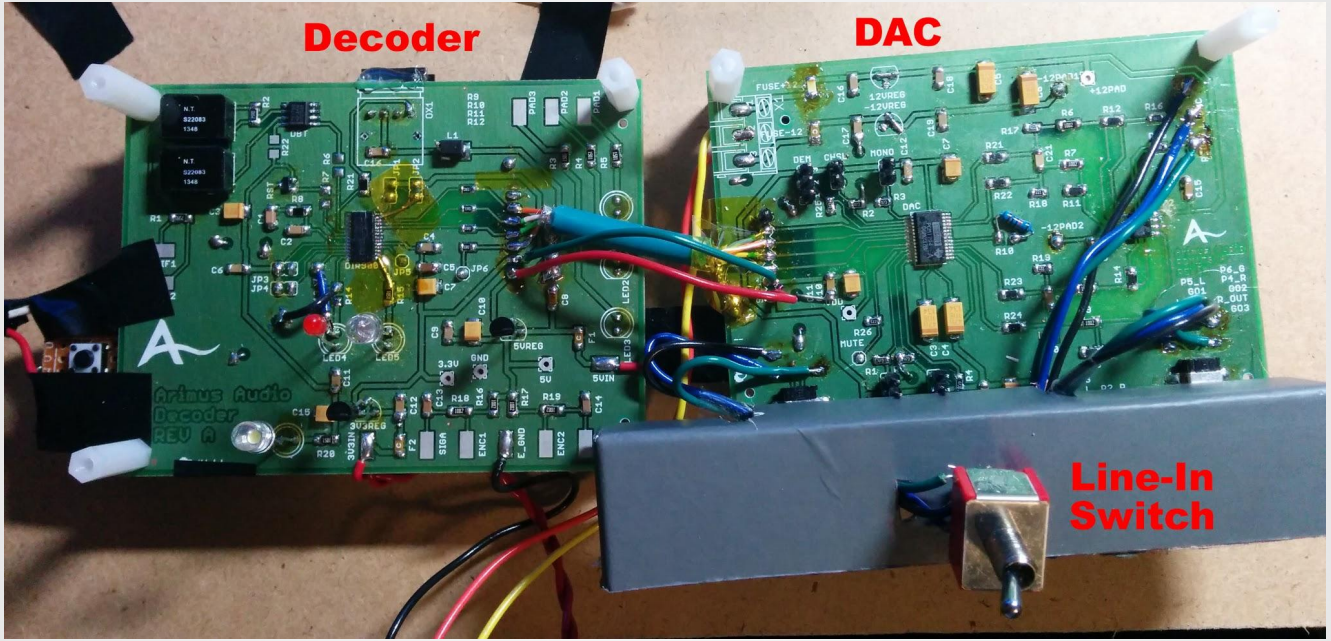
Future-proofing the System

	PCM1794A	SGTL5000
Bit Depth	24bits/192kHz	24bits/96kHz
Output Format	Stereo/Mono	Stereo/Mono
Signal to Noise Ratio (higher is better)	127dB	95dB
Total Harmonic Distortion (lower is better)	-101dB	-80dB

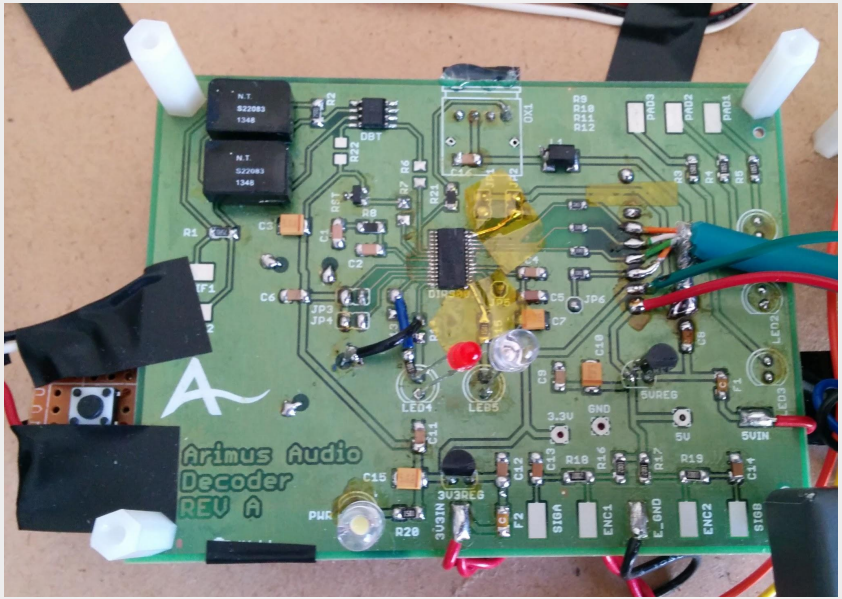
Hardware Overview



Hardware Overview

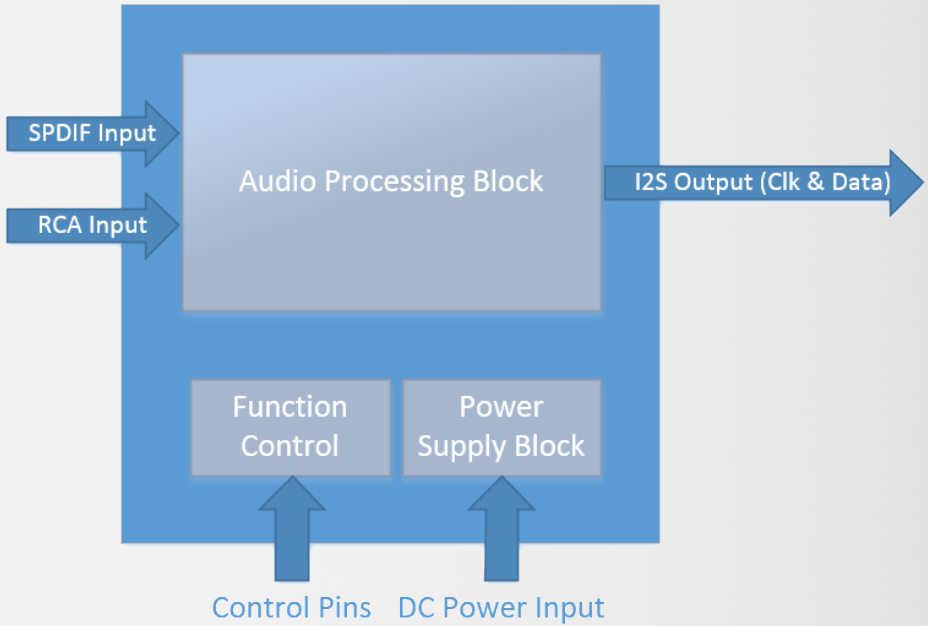


Audio Codec: Decoder



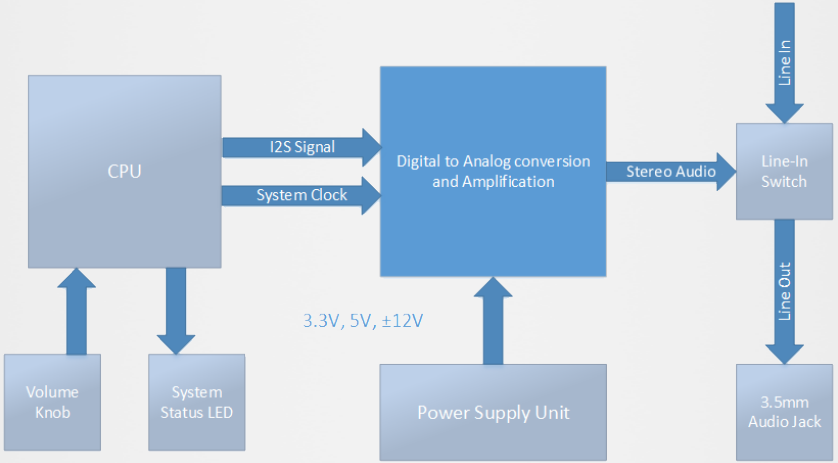
Audio Codec: Decoder

- SPDIF stands for Sony/Phillip Digital interface format. It is a common interface for digital audio output.
- IS2 stands for Inter-IC sound. It is the required input for DAC

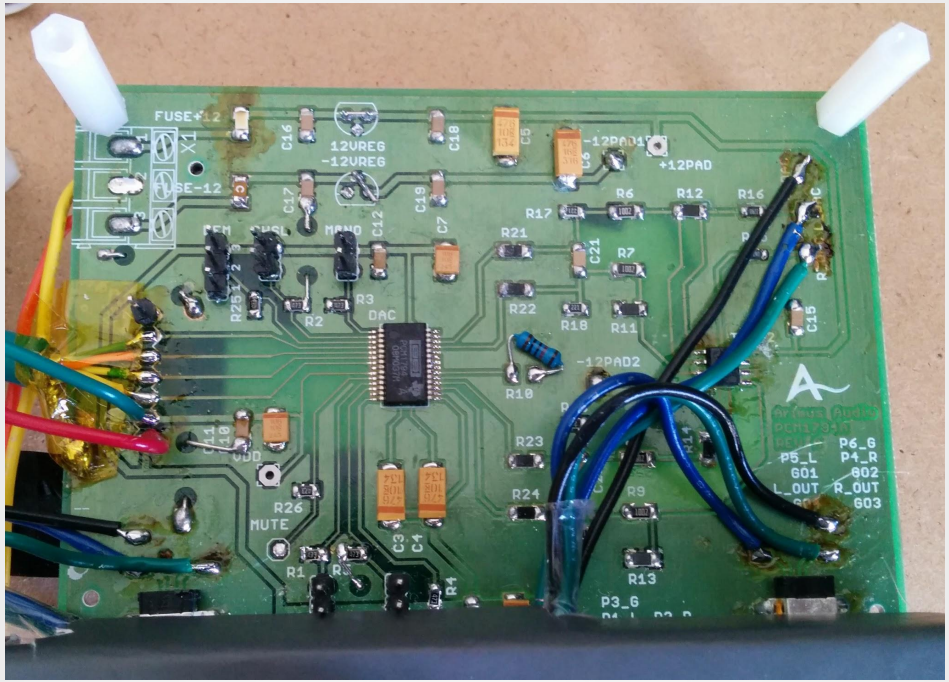


Proof of Concept vs Prototype

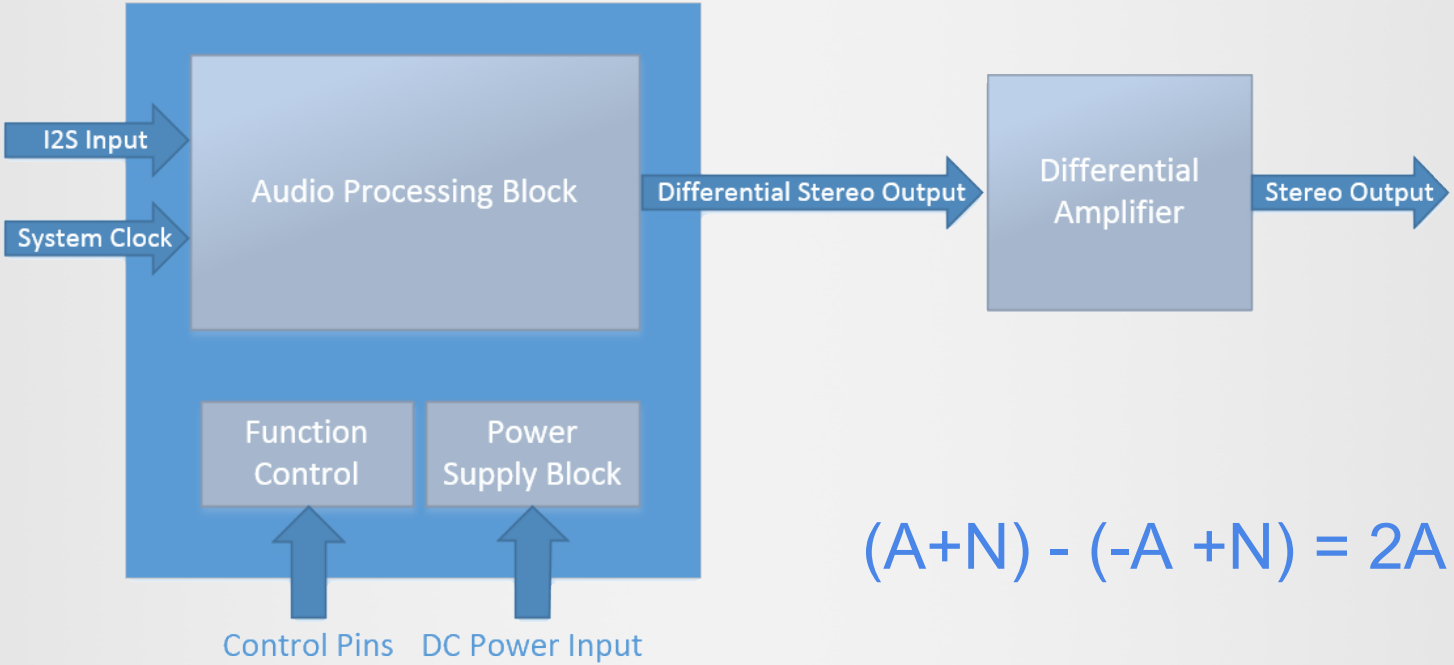
- Wandboard has SPDIF out, but not I2S
- Future prototype will utilize I2S signal directly



Audio Codec: DAC



Audio Codec: DAC

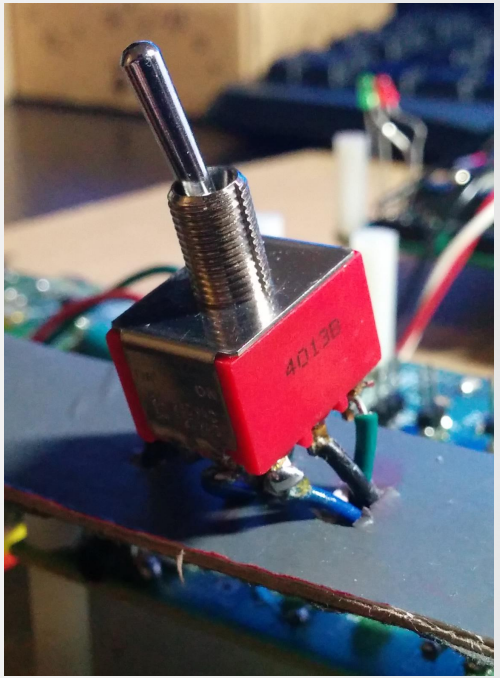


$$(A+N) - (-A +N) = 2A$$

Power Supply

Line-in Switch

Toggles music source between your existing audio system and SoundHub

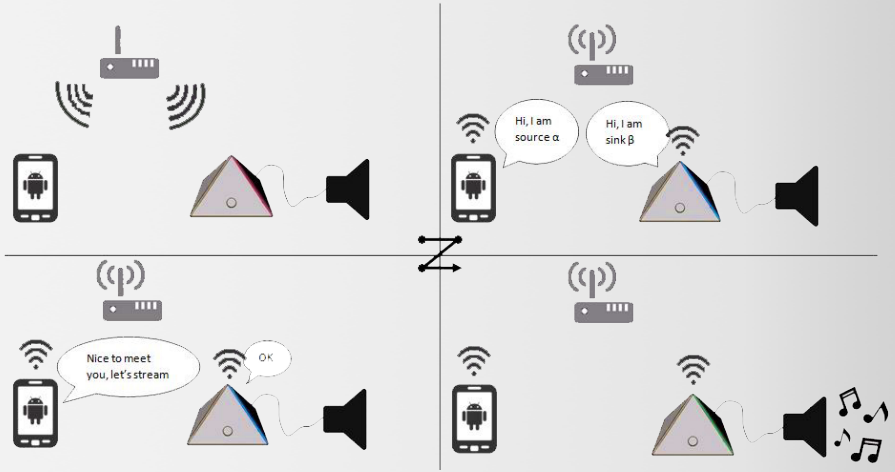


Homebrew PCB

- Attempts at making our own PCB
  - Copper Cleaning
  - Toner Transfer
  - Removing Wax Paper
  - Etching with Ferric Chloride

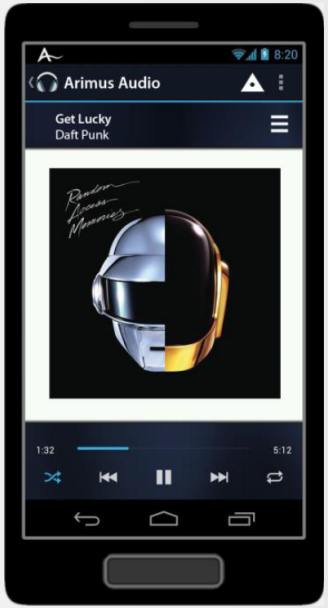
Android Component

- Enable the users to interact with SoundHub with their mobile devices
- Adopt and modify open source Android project named “Musydra” to be able to interact with SoundHub firmware



Android Component - GUI design

- Adopted project already includes basic playback functionalities
- Embed SoundHub detection/connection to interact with SoundHub firmware

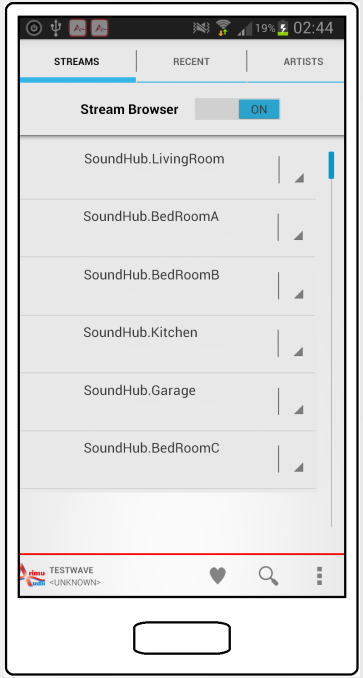


Artist rendering of Main Playback Screen [6]

Android Component - Wireless Streaming

- Able to stream wirelessly between mobile devices

- However unable to interact with SoundHub firmware
  - possibly due to compatibility issues between Android and Linux platforms
  - also not prioritized since Android compatibility is aimed for P2 - prototype revision



Project Costs

Project Budget: $1127 ($500 funding from ESSEF)
Current Total: ~$1110

Part purchasing: Digi-Key, Mouser
Soldering Supplies from Lee's Electronics
PCB from OMNI Circuit Boards (in Richmond)

Item	Estimated Cost	Actual Cost	Difference
Evaluation Boards	$300	$228.86	+$71.14
Test Speakers	$40	$23.28	+$16.72
Active Components (IC's, Transformers, etc.)	$171	$331.17	-$160.17
Passive Components (Resistors, Capacitors, etc.)	$150	$173.85	-$23.85
Soldering Tools and PCB Etching Materials	No Estimate	$106.27	-$106.27
Enclosure	$50	free	+$50.00
Shipping (15%)	$114	$31.36	+$82.64
Contingency (20%)	$152	-	+$152.00
PCB Manufacturing	$150	$199.93	-$49.93
Totals	**$1127**	**$1094.72**	**+$32.28**

Project Schedule

Estimated (Red) and Actual (Green)

	Task Name	Duration	Start	Finish
1	Estimated Research Streaming Protocols	11 days	Mon 1/6/14	Mon 1/20/14
2	Actual Research Streaming Protocols	16 days	Mon 1/6/14	Sun 1/26/14
3	Estimated Setup Linux Image	8 days	Mon 1/6/14	Wed 1/15/14
4	Actual Setup Linux Image	3 days	Mon 1/6/14	Wed 1/8/14
5	Estimated Streaming	38 days	Thu 1/16/14	Mon 3/10/14
6	Actual Streaming	47 days	Mon 1/27/14	Tue 4/1/14
7	Estimated Periferals	11 days	Tue 3/11/14	Tue 3/25/14
8	Actual Perifierals	7 days	Wed 4/2/14	Thu 4/10/14
9	Estimated Firmware Testing	15 days	Tue 3/25/14	Mon 4/14/14
10	Actual Firmware Testing	4 days	Wed 4/9/14	Mon 4/14/14
11				
12	Estimated Hardware Design	26 days	Mon 1/20/14	Sun 2/23/14
13	Actual Hardware Design	29 days	Sun 1/26/14	Wed 3/5/14
14	Estimated Fabricaton and Soldering	6 days	Mon 2/24/14	Sun 3/2/14
15	Actual Fabrication and Soldering	9 days	Sat 3/8/14	Wed 3/19/14
16	Estimated Hardware Testing	31 days	Mon 3/3/14	Mon 4/14/14
17	Actual Hardware Testing	18 days	Thu 3/20/14	Mon 4/14/14
18				
19	Estimated Software Development	31 days	Fri 2/14/14	Fri 3/28/14
20	Actual Software Development	28 days	Wed 2/26/14	Fri 4/4/14
21	Estimated Software Testing	21 days	Mon 3/17/14	Mon 4/14/14
22	Actual Software Testing	11 days	Mon 3/31/14	Mon 4/14/14

Changes in Scope and Design

- Decided to build a hardware audio codec rather than a complete streaming system
- Dropped WPS and RoomFlow features due to limitations of the development board's WiFi chip

Project Summary

- Successful in achieving the core functionality in our proof-of-concept model
- Integration with Android (and other platforms) will require more resources
- Hardware must undergo revisions to be developed into a prototype consumer product

Gained Knowledge

- PCB design and fabrication process
- General audio electronics
- Android development
- AllJoyn framework
- Build systems
- Compiling linux kernels
- Hardware integration and troubleshooting

Special Thanks

Sherman's parents (Michael and Grace)

Dr. Rawicz, Professor Whitmore

TAs - Jamal, Prerna, Lukas, Alireza, Mona

Friends - Clark Hsieh, Jeffrey Hau,
Chris Kwong, Jason Li

References

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[2] Cambridge Audio. (2013, Oct. 16) *Minx Xi Digital Music System* [Online]. Available: http://www.cambridgeaudio.com/products/minx-xi-digital-music-system

[3] Belkin International, Inc. (2014, Jan, 10) *Bluetooth® Music Receiver* [Online]. Available: http://www.belkin.com/us/p/P-F8Z492/

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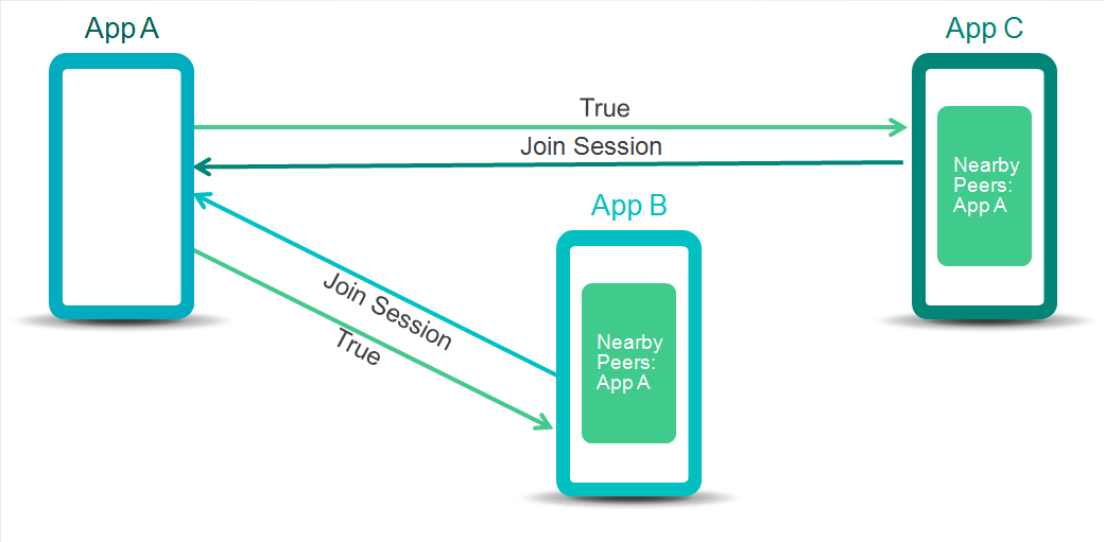
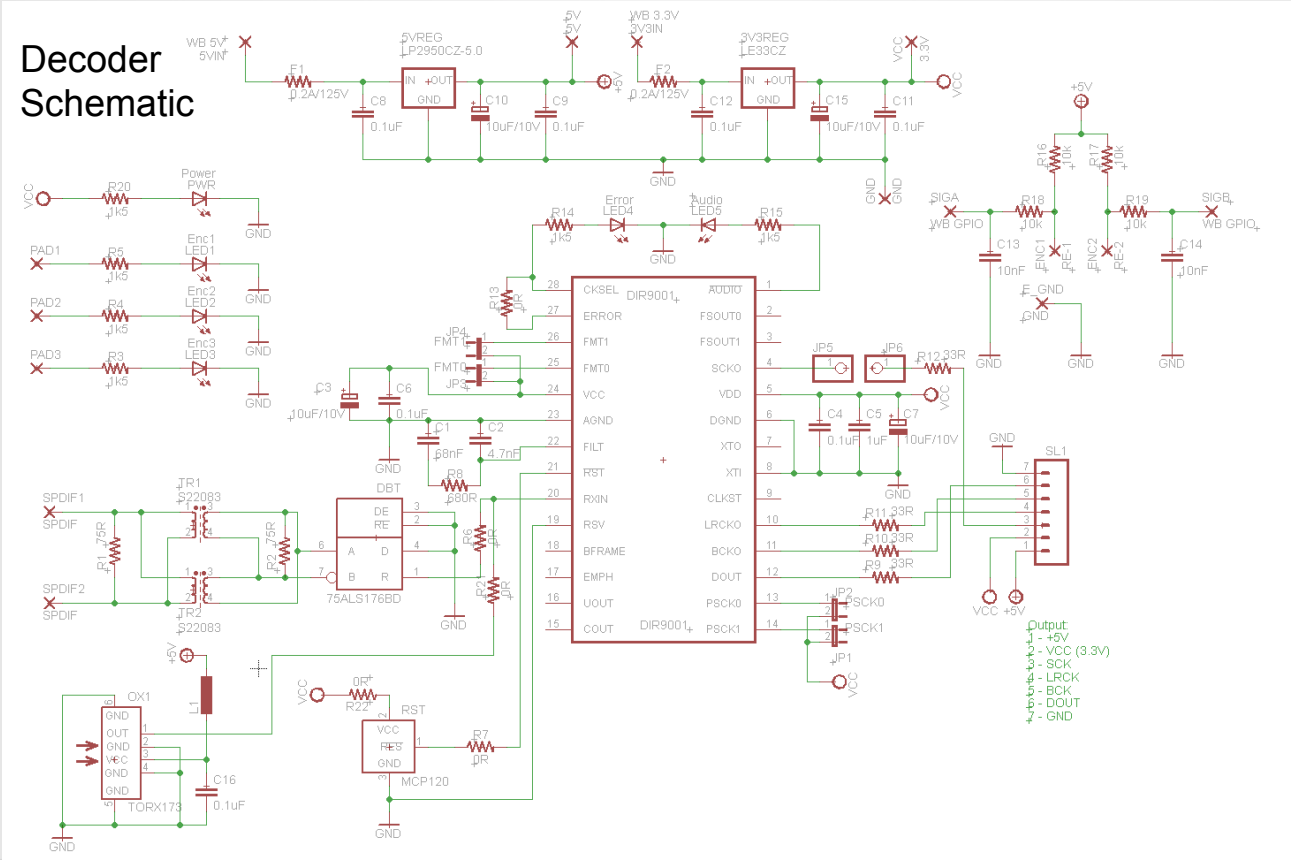
Questions?

Demo

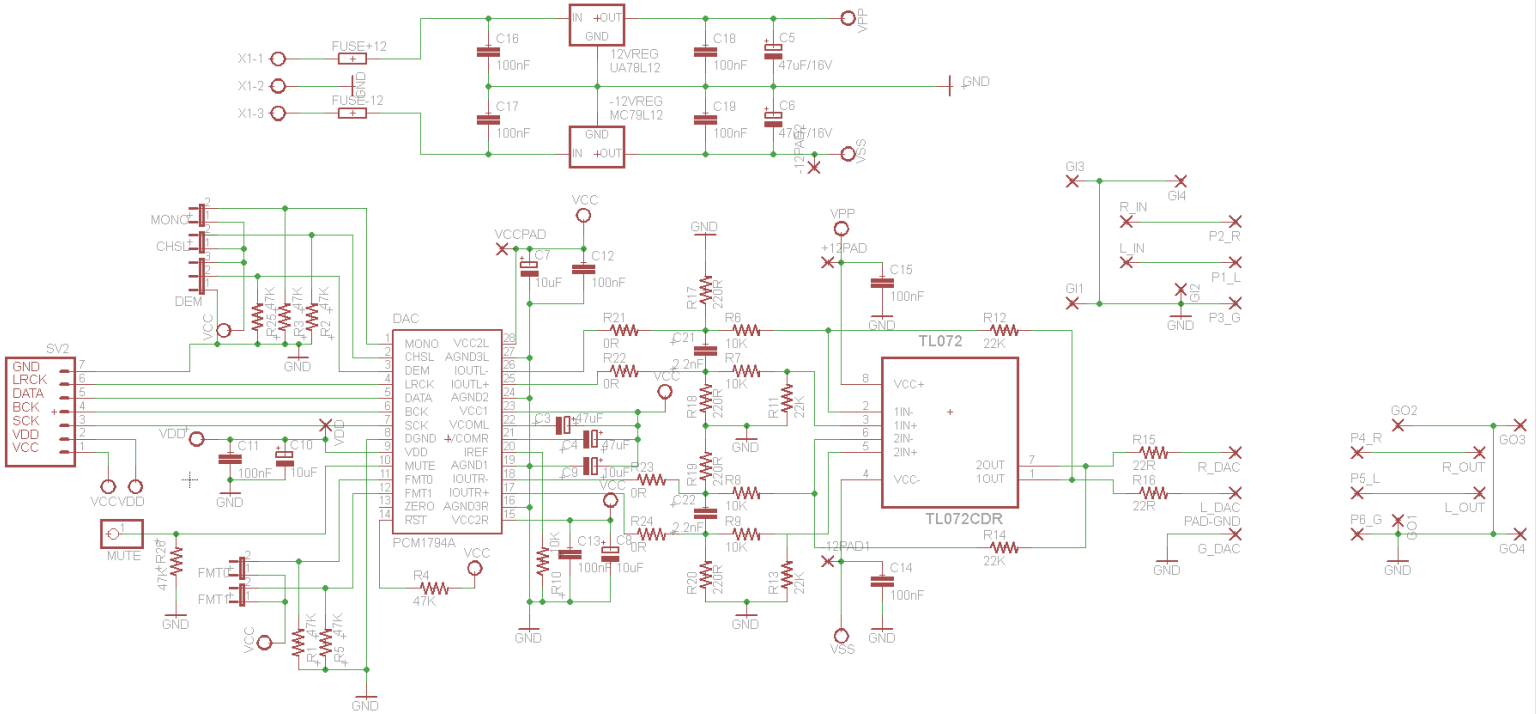
APPENDIX SLIDES



Decoder Schematic



DAC Schematic



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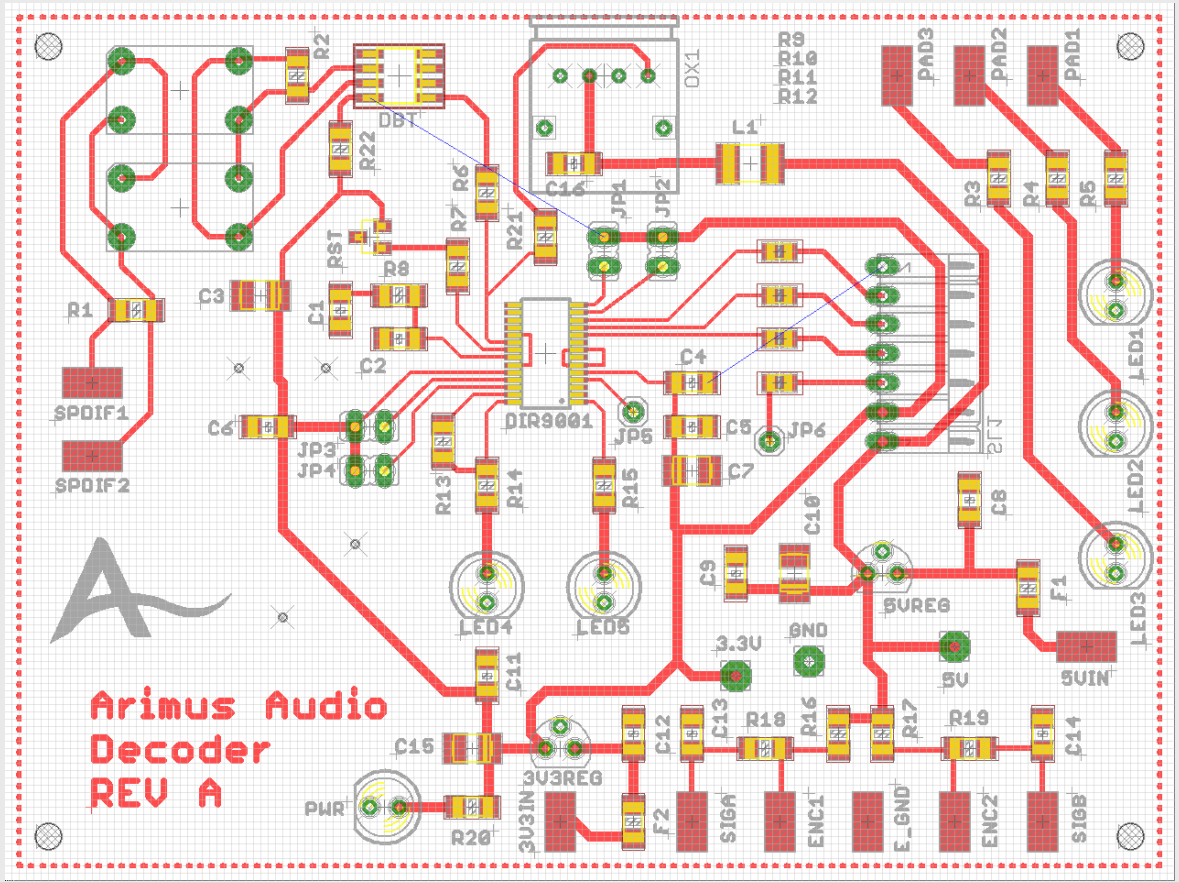
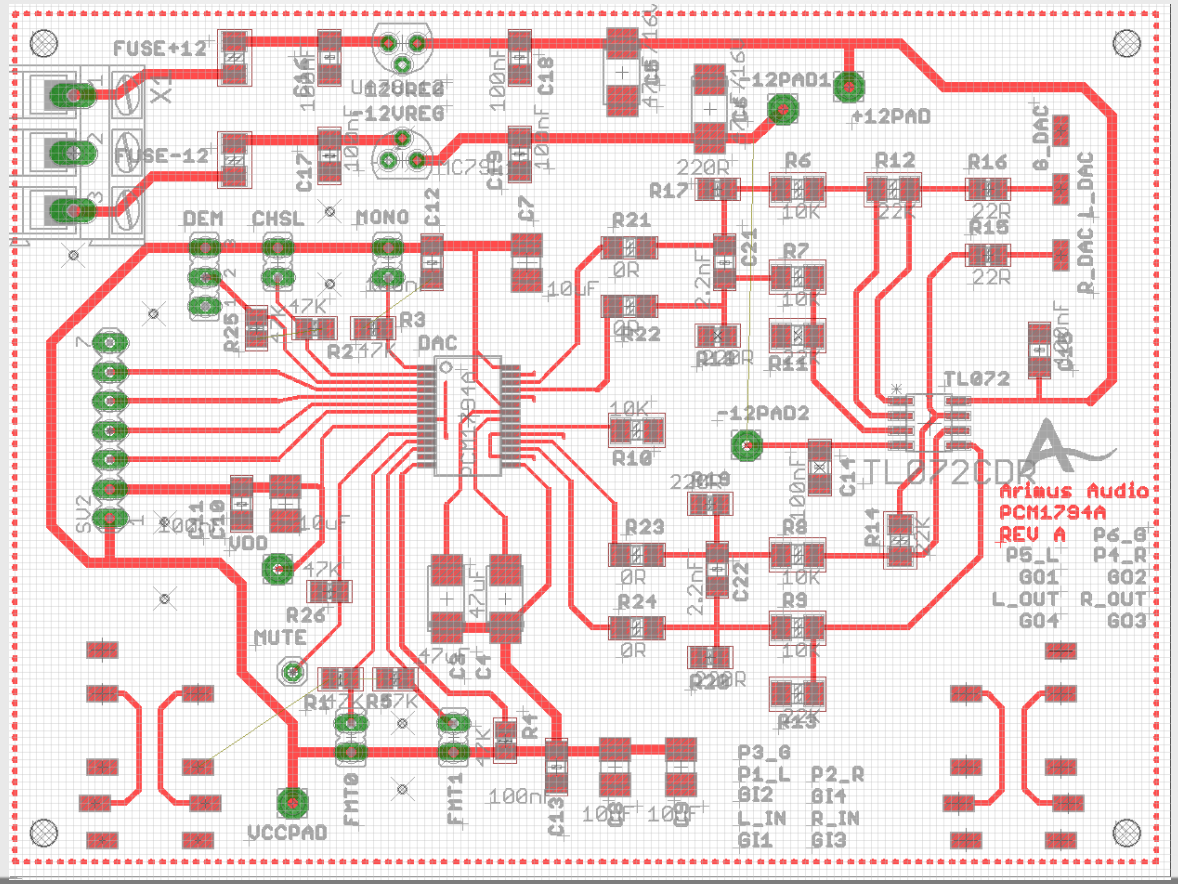
Decoder Layout



DAC Layout


FUSE+12
FUSE-12
+12VREG
-12VREG
DEM
CHSL
MONO
DAC
VDD
MUTE
VCCPAD
+12PAD1
+12PAD
-12PAD2
TL072
TL072CDR
Arimus Audio
PCM1794A
REV A
P5_L
P6_G
G01
G02
L_OUT
R_OUT
G04
G03
P3_G
P1_L
P2_R
GI2
GI4
L_IN
R_IN
GI1
GI3
L_DAC
R_DAC