Group 20: Funetic Board

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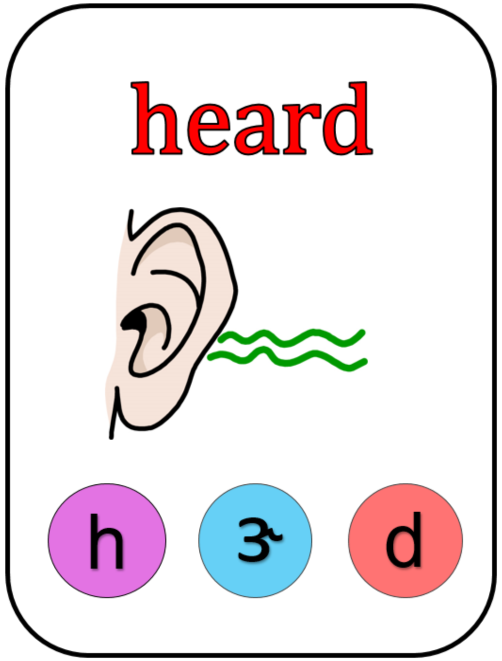
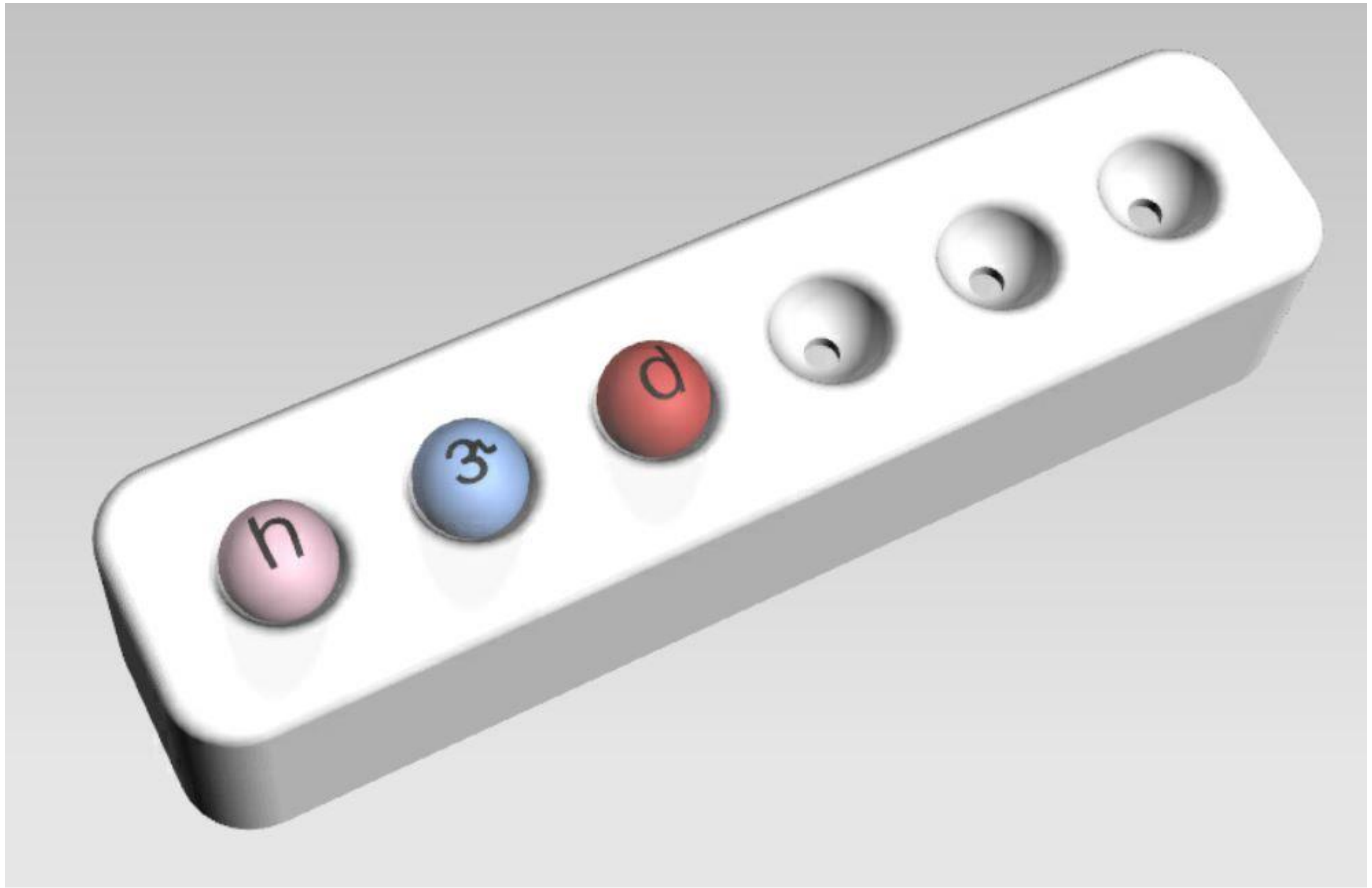
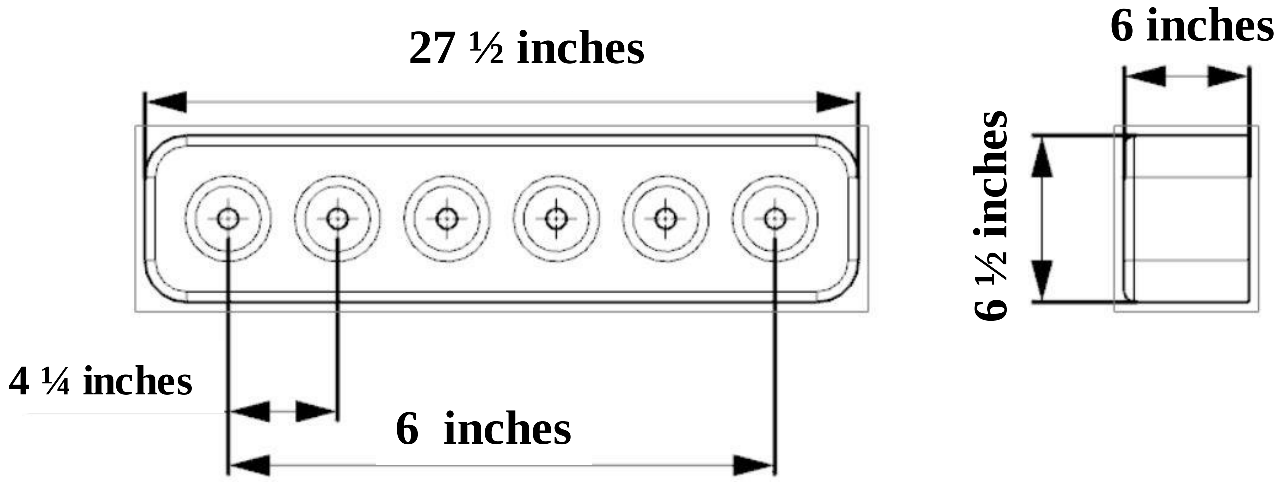
Project Description

- Hands on phonetic learning device
- Alternative and Augmentative Communication (AAC) encompasses the different communication methods used to supplement or replace speech
- International Phonetic Alphabet (IPA) contains 40 different symbols representing each phonetic sound in the English language.
- Limited to American English language


heard
h
ɜː
d


h
ɜː
d



Housing

- Wood material
- Plastic 70 mm spheres changed to 2 1/8 inch wide cards

/r/ Phoneme

Keyword	IPA Transcription
Ran	r æ n
Heard	h ɝ d
Her	h ɝ
Manner	m æ n ɚ
Deer - dear	d ɪ r
Ram	r æ m
Rook	r ʊ k
Sir	sɝ
Were	w ɝ
Rack	r æ k
Work	w ɝ k
Hinder	h ɪ n d ɚ
Winner	w ɪ n ɚ

/s/ and /l/ Phonemes

Keyword	IPA Transcription
Hand	h æ n d
Man	m æ n
Woman	w ʊ m ə n, w ɪ m ə n
would – wood	w ʊ d
Week	w i k
Wind	w ɪ n d
Hook	h ʊ k
Hood	H ʊ d

Other Assorted Sounds

Keyword	IPA Transcription
Kiss	k ɪ s
Look	l ʊ k
see - sea	s i
Sand	s æ n d
Sack	s æ k
Miss	m ɪ s

Motivation

- Young learners
- “Non verbal” communication
- Articulation disorders
- English as a second language ESL
- Fun and interactive learning experience for everyone

Specifications and Requirements

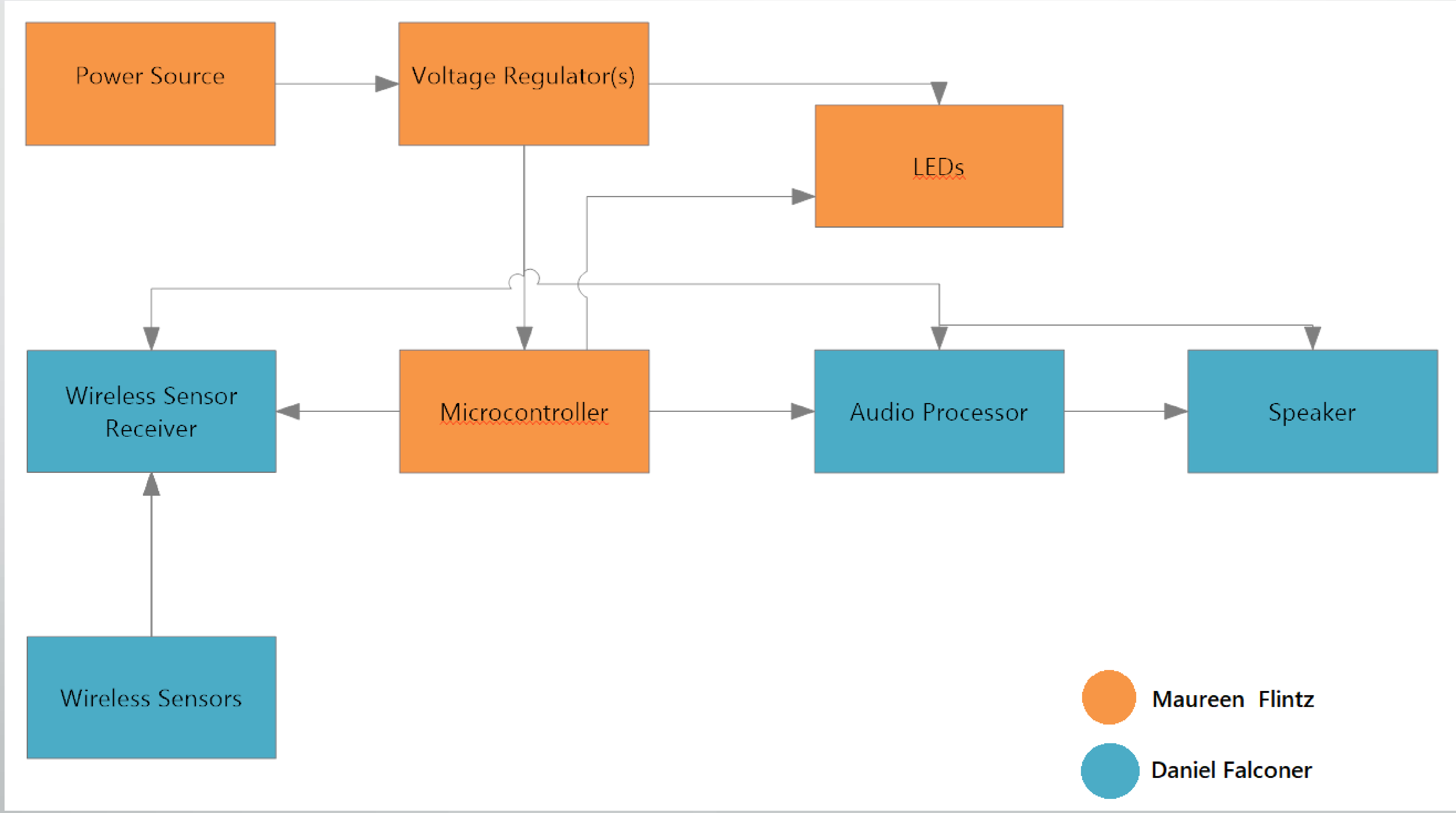
- Audio at 50-60 dB
- 6-8 ohm impedance
- Signal-to-Noise Ratio (SNR): 70 – 100 db

Goals

- Have external charging port to charge battery
- Correct pronunciation of individual phenomes and words
- Use colored LEDs synchronized with sound outputs
- Housing durability

Hardware

Hardware Block Diagram



Microcontroller Choices

MSP430G2

- Clock Speed – 16MHz
- RAM – 512 byes
- Storage – 16 KB
- Digital I/O pins – 16
- $0

ATmega2560 (Arduino Mega)

- Clock Speed – 16MHz
- RAM – 8 KB
- Storage – 256 KB
- Digital I/O pins – 54
- $38.50 (~$12)

ATmega328 (Arduino Uno)

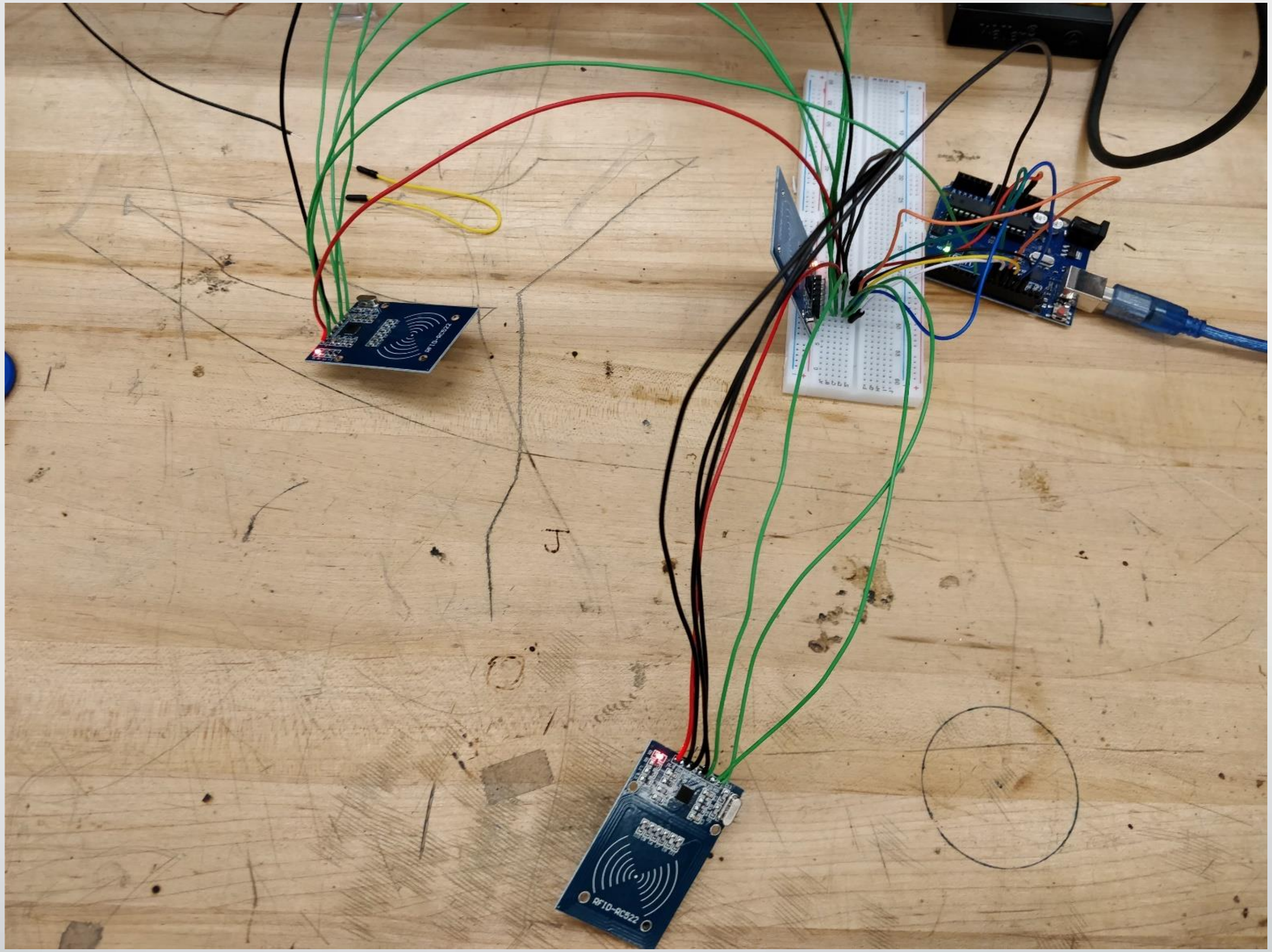
- Clock Speed – 16MHz
- Ram – 2 KB
- Storage – 32 KB
- Digital I/O pins – 14
- $22.00 (~$2)

Wireless Communications

	RFID	NFC	Bluetooth
Range	20 ft	10 cm	10 m
Frequencies	120kHz – 150kHZ, 13.56MHz, 433MHz, 902 – 928MHz, 2450MHz – 5800MHz	13.56MHz	2.4GHz
Frequency Standards	Unregulated low frequency, ISM bands including ISO/IEC and FeliCa	ISO/IEC 14443, ISO/IEC 18092, FeliCa	ISM band
Passive Tag Implementations	Yes	Yes	No

MFRC522

Voltage	3.3V
Current	6.5mA
Interface Support	SPI, I2C, UART
Frequency	13.56MHz
Range	5 - 10 cm
Standards Support	ISO/IEC 14443 A/MIFARE, NTAG
Average Cost	$5/unit (low volume)



Multiple 522 Testing

DAC and Op Amp

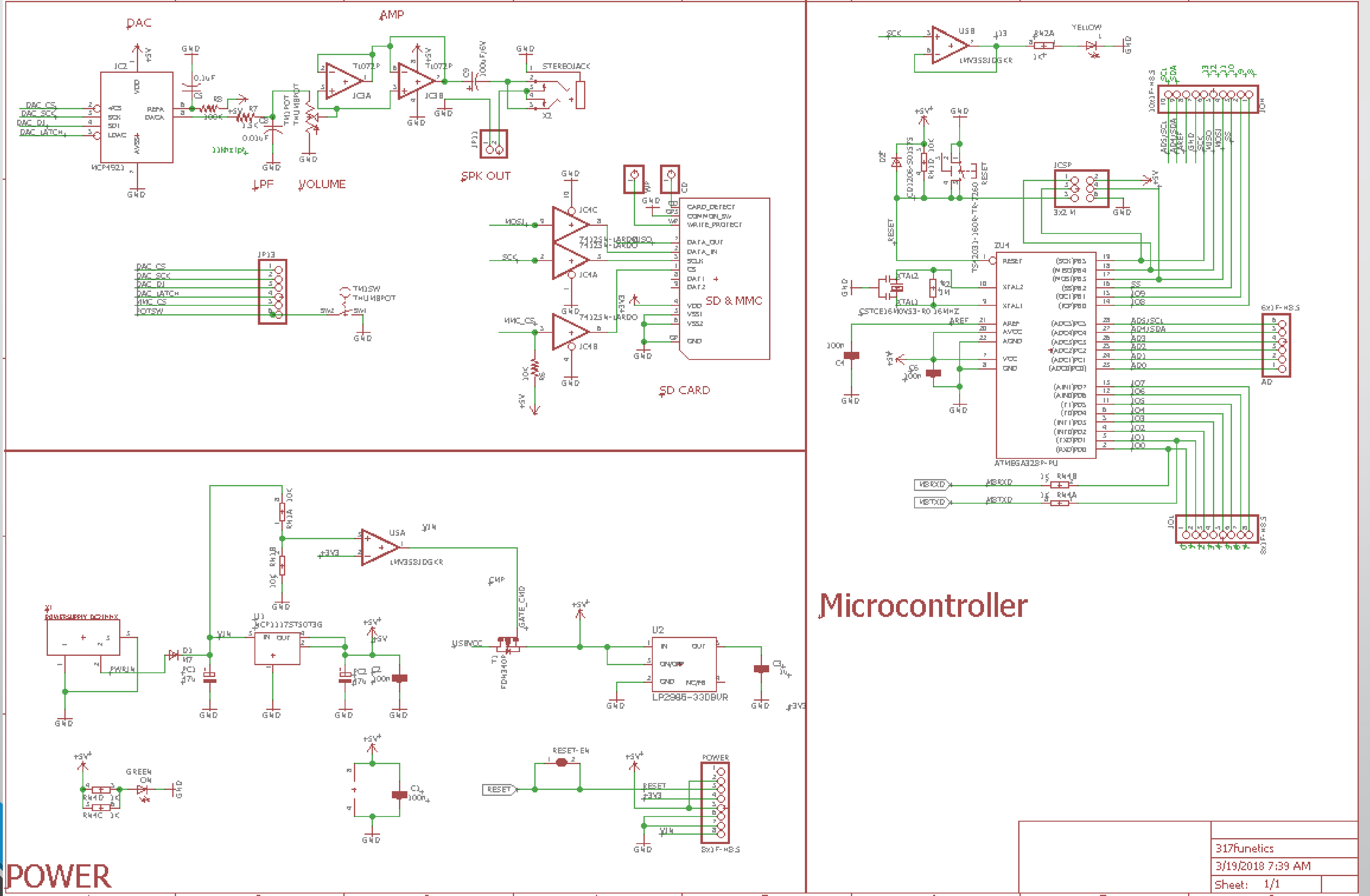
DAC – MPC4921

- 12 bits
- SPI
- Uses less pins than an R2R ladder

Op Amp – TL072

- Low harmonic distortion
- Low noise

PCB Schematic and Board Layout


DAC
AMP
LPF
VOLUME
SPK OUT
STEREOJACK
SD & MMC
SD CARD
POWER
Microcontroller
ATMEGA328P-PU
LP2985-33DBVR
317funetics
3/19/2018 7:39 AM
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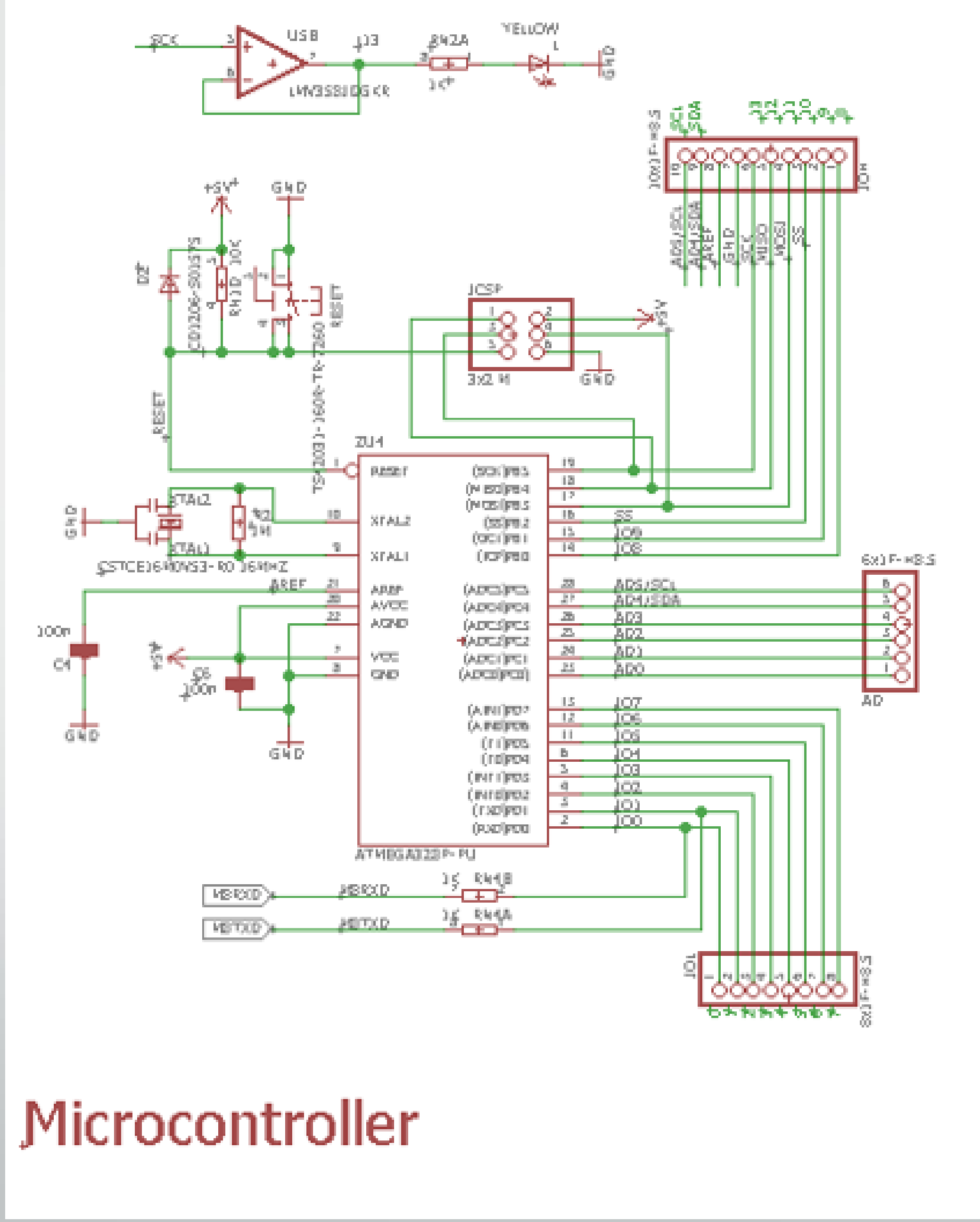
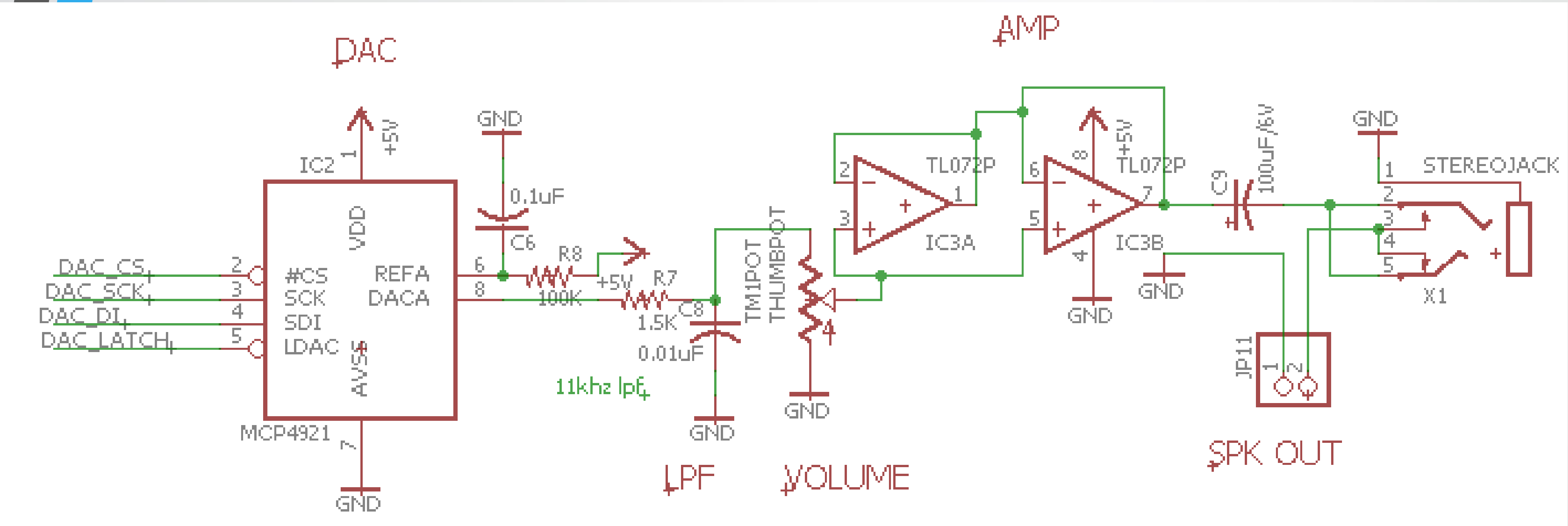
Microcontroller

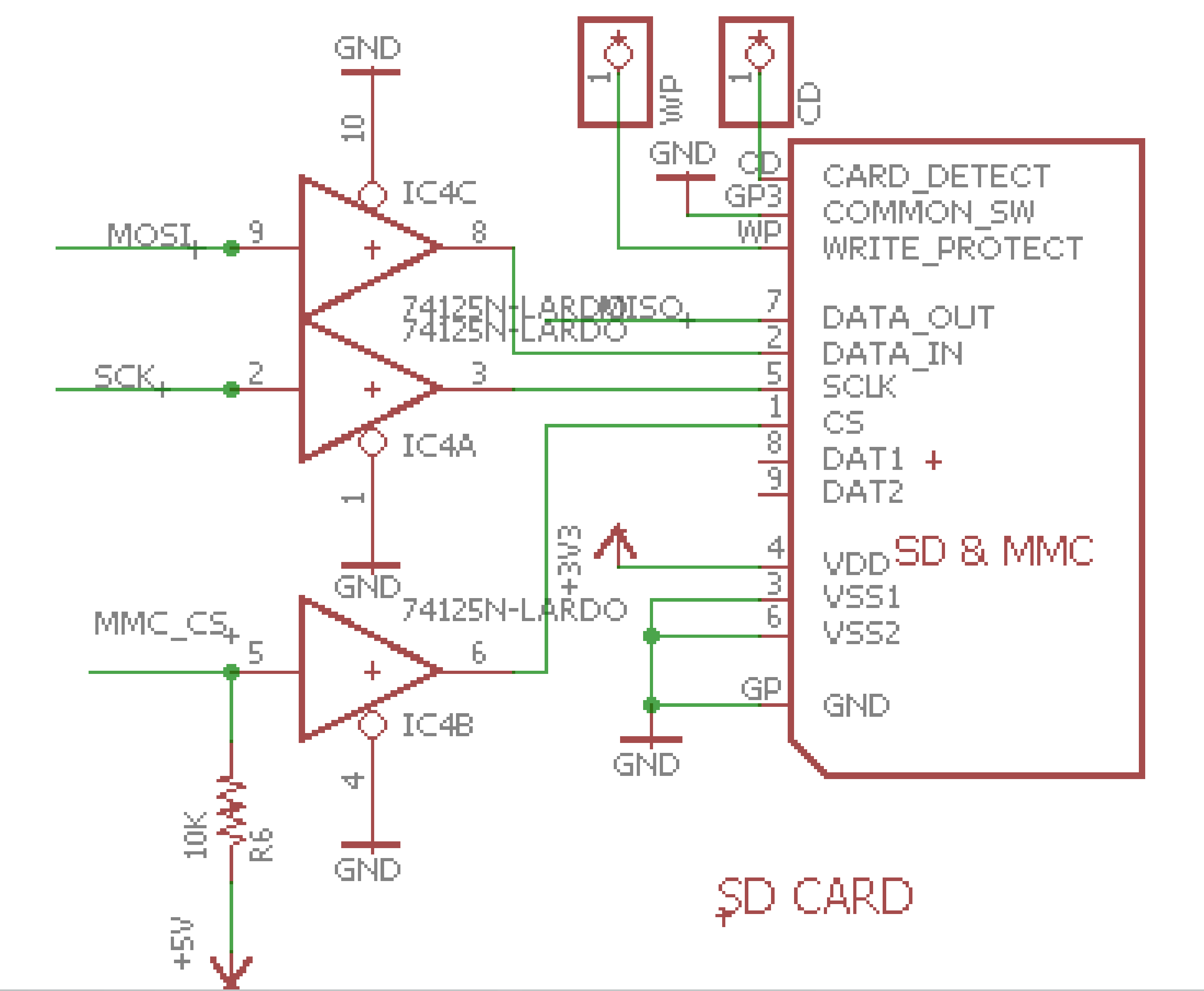


DAC and AMP

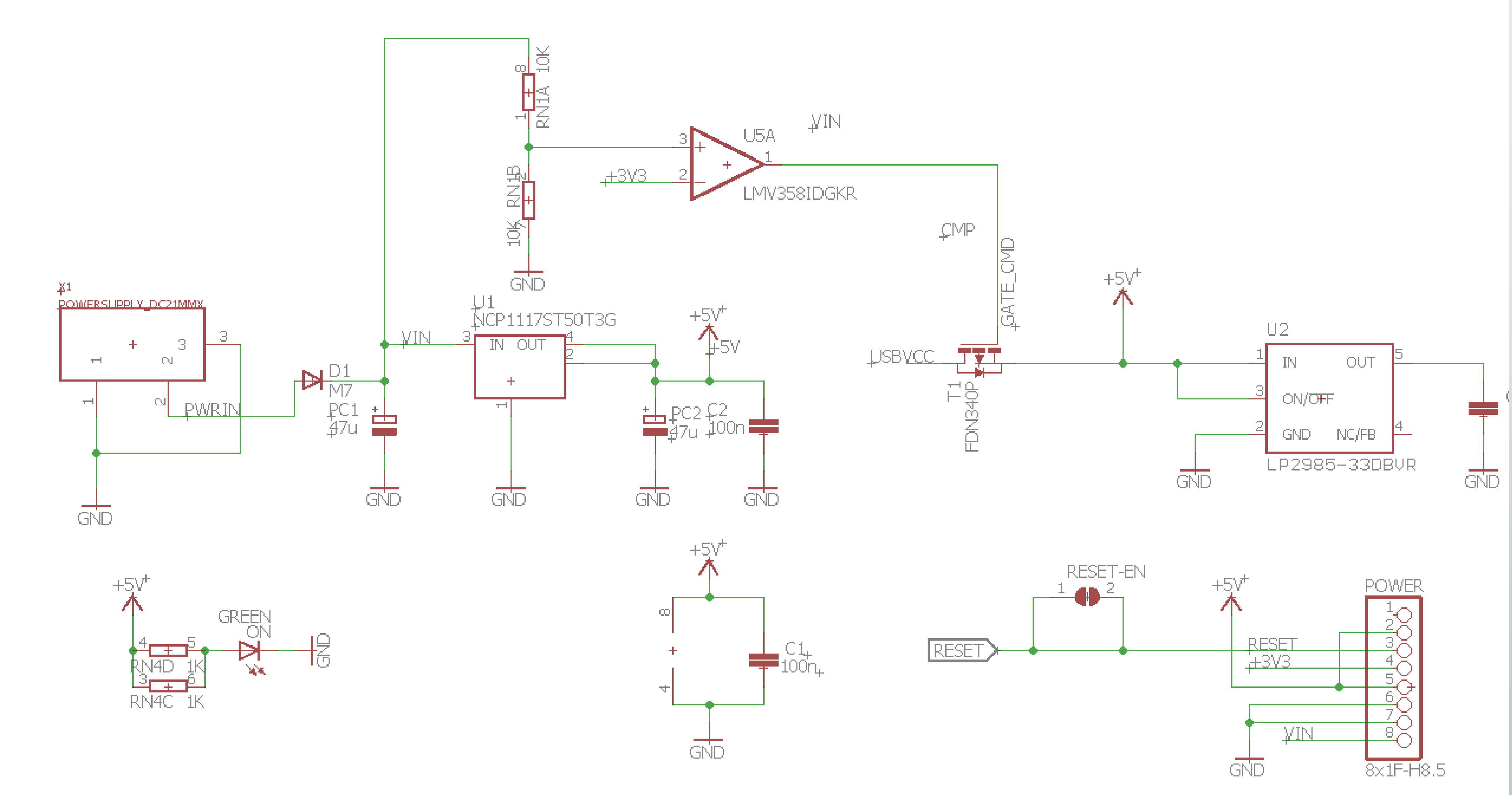


DAC
AMP
+5V
IC2
1
GND
0.1uF
C6
VDD
DAC_CS
DAC_SCK
DAC_DI
DAC_LATCH
2
3
4
5
#CS
SCK
SDI
LDAC
REFA
DACA
6
8
AVSS
MCP4921
7
GND
R8
100K
+5V
R7
1.5K
C8
0.01uF
11khz lpf
GND
LPF
TM1POT
THUMBPOT
GND
VOLUME
TL072P
IC3A
TL072P
IC3B
+5V
GND
GND
C9
100uF/6V
GND
STEREOJACK
X1
JP11
SPK OUT

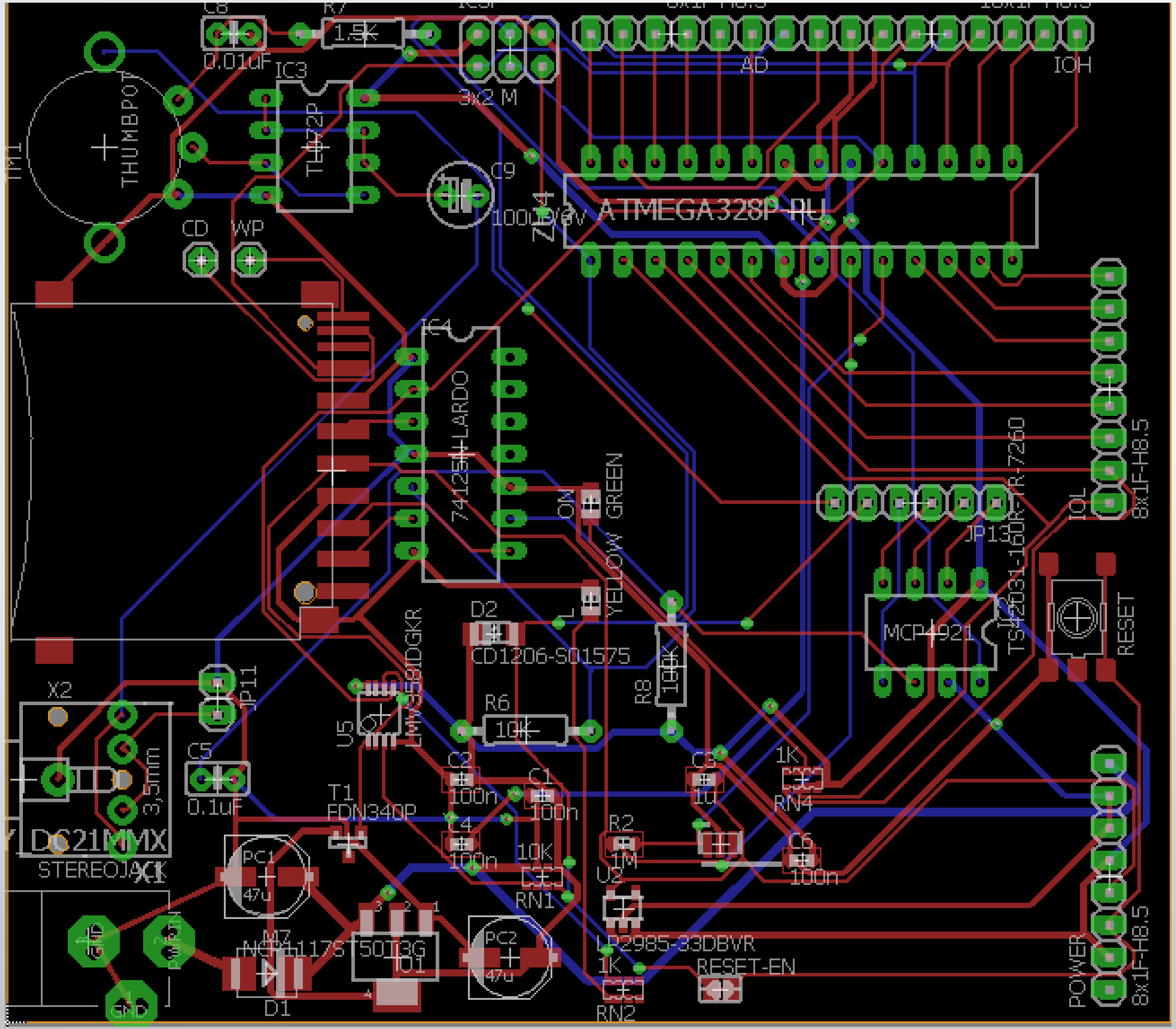
SD Card


GND
10
IC4C
MOSI
9
8
74125N-LARDO
MISO
74125N-LARDO
SCK
2
3
IC4A
1
GND
MMC_CS
5
74125N-LARDO
6
IC4B
4
GND
10K
R6
+5V
1
WP
1
CD
GND
CD
GP3
WP
CARD_DETECT
COMMON_SW
WRITE_PROTECT
7
2
5
1
8
9
DATA_OUT
DATA_IN
SCLK
CS
DAT1
DAT2
+3V3
4
3
6
VDD
VSS1
VSS2
SD & MMC
GP
GND
GND
SD CARD

Power Supply



PCB Board

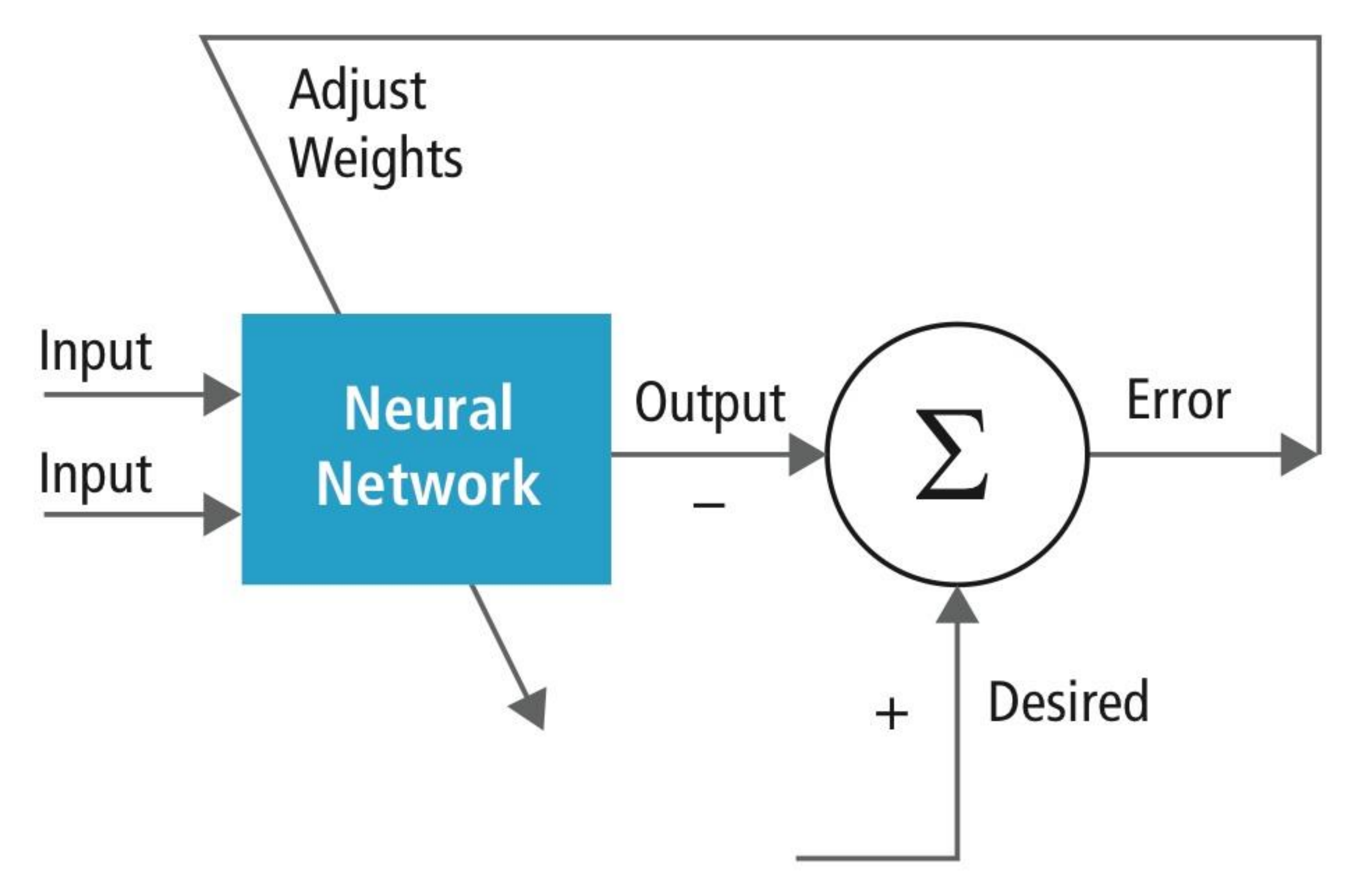


Software

Creating the audio

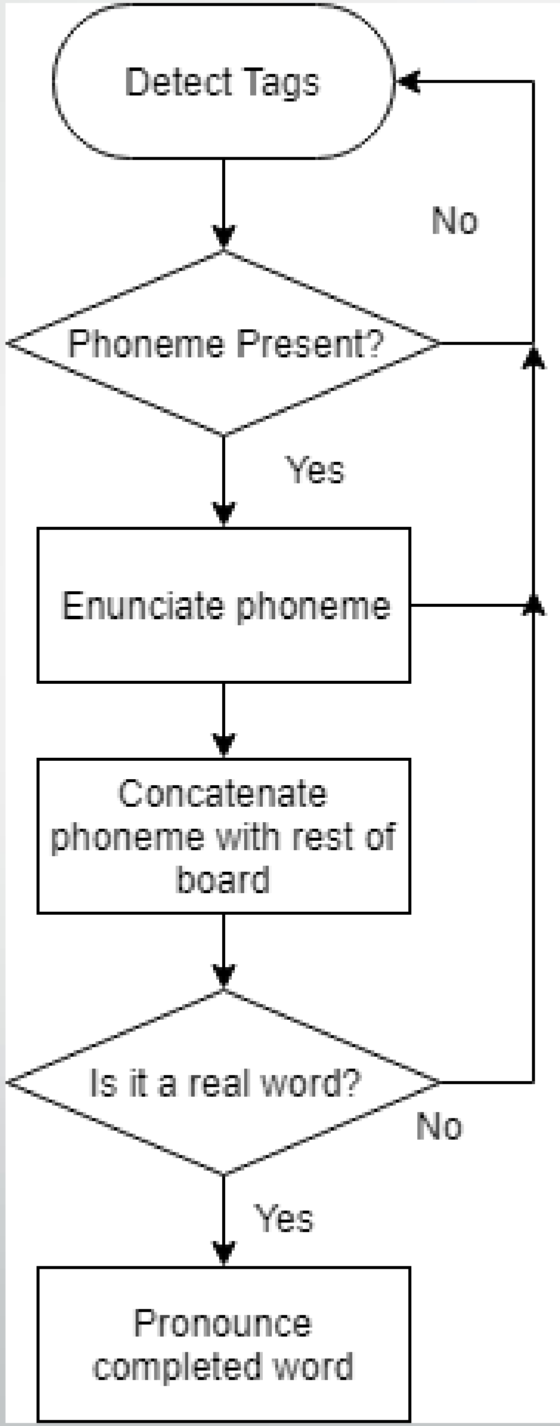
- Originally, we decided to use all computerized voices. But, due to restraints, we opted to have full words produced in computer voices and phonemes in human voice.
- This was ideal and practical for full words. Our computer voice can easily be used to generate any word whereas recording every word would be tremendously time consuming.
- In contrast, phonemes are the most important part to enunciate. Teaching a computer such precise pronunciation properly was not only difficult but also lacking in data and samples. The time invested to just record a human voice for such a small set of sounds where we know it would sound the way it should was the better choice.

Computer Voice



Finalizing the audio

- Once the audio files were created, it was necessary to configure them to match our hardware.
- Having all the components connected to our board caused the audio to have a slow down. To compensate, we lowered the speed of the audio to match that of the board so it could have a normal playback speed again.
- This results in our audio to play with configurations of 8 bit 11kHz



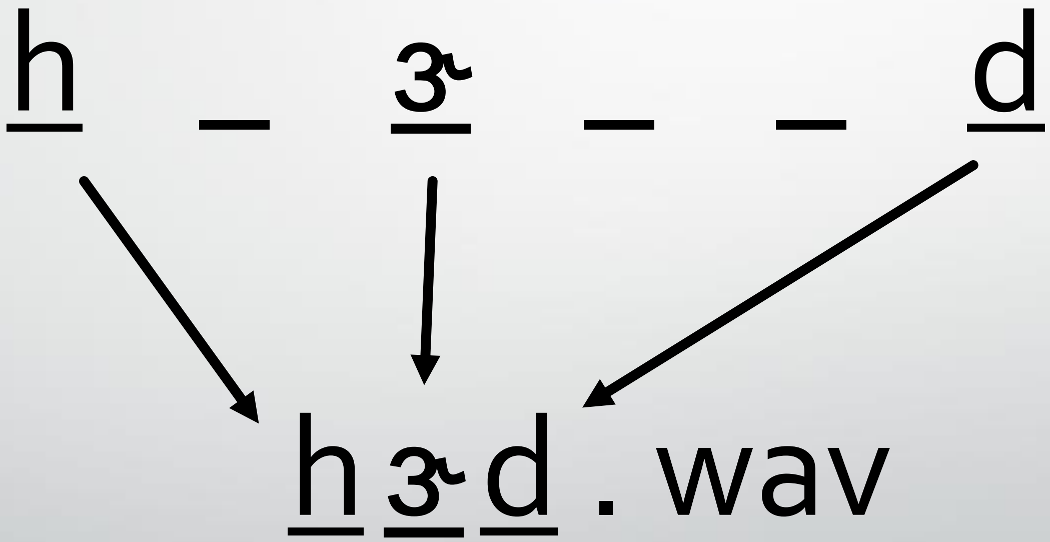
Detect Tags
No
Phoneme Present?
Yes
Enunciate phoneme
Concatenate phoneme with rest of board
Is it a real word?
No
Yes
Pronounce completed word

_ _ _ _ _ _

h _ _ _ _ _

h _ _ _ _ d

h _ ɜː _ _ d



h _ ɜ˞ _ _ d
hɜ˞d.wav

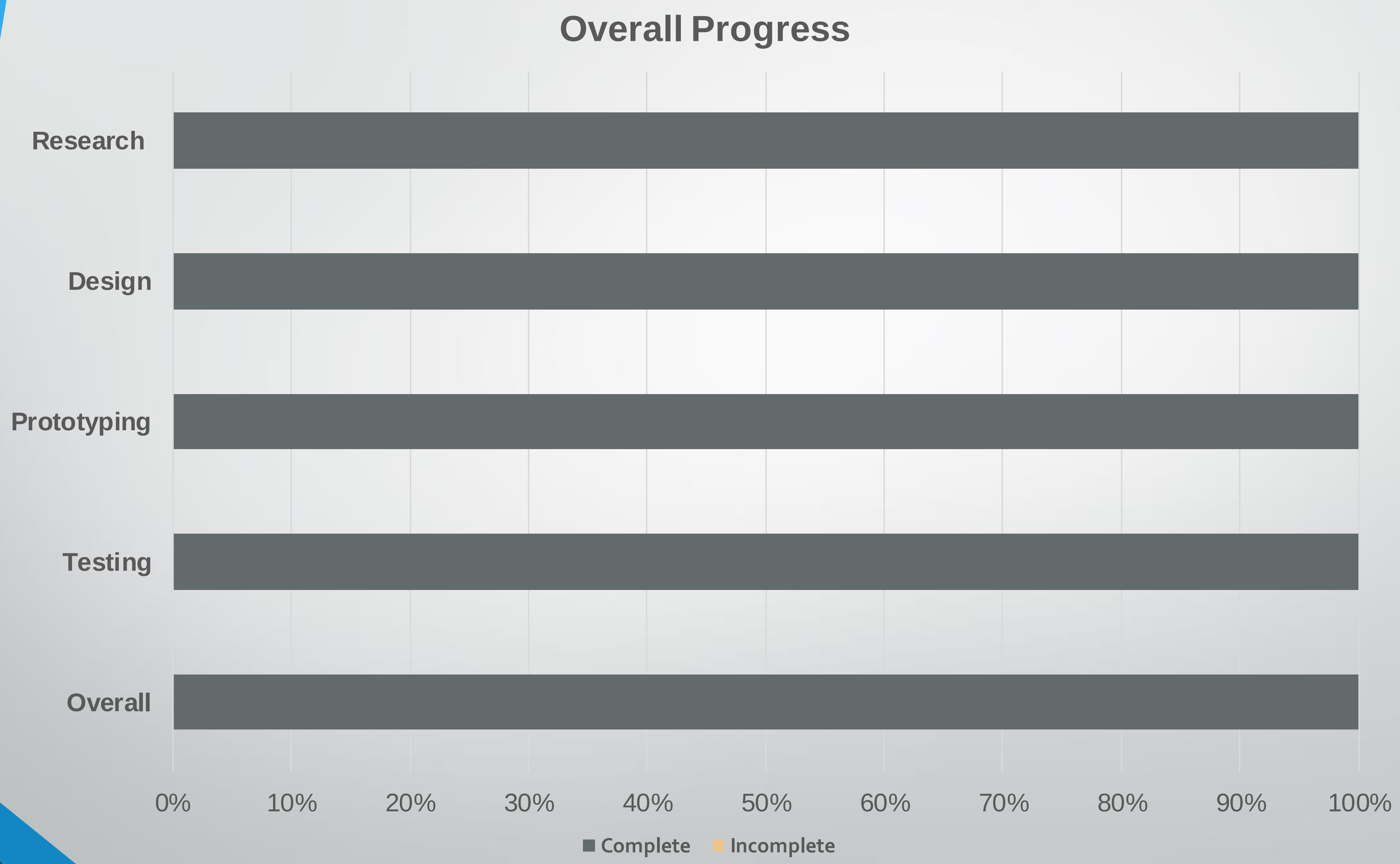
Administrative Content

Work Distribution

Work/Person	Maureen	Daniel	Meychele	EJ
Hardware: PCB	Primary	Secondary		
Hardware: Electronics	Secondary	Primary		
Hardware: Housing	Secondary		Primary	
Software: Programming			Secondary	Primary

Budget

Item	Supplier	Price Per unit	# of units	Total Cost	Item	Supplier	Price Per Unit	# of Units	Total Cost
Testing					**Final**				
Arduino Uno	amazon	$35	1	$35	RC522	amazon	$5.50	6	$33
RFID	amazon	$0	1	$0	RGB LEDs	amazon	$0	6	$0
LEDs	amazon	$0	10	$0	SD card	mouser	$0	1	$0
Wave Shield	adafruit	$25	1	$25	SD card connector	Mouser	$2.18	1	$8.72
SD card	amazon	$0	1	$0	MCP1700	Mouser	$.45	5	$2.25
					MCP4921	Mouser	$2.37	3	$7.11
					TLV2462	mouser	$2.67	3	8.01
					SN74AHC	mouser	$.41	4	$2.05
					tactile switch	mouser	$.25	5	$1.25
					headphone jack	mouser	$1.81	3	$5.43
					10K potentiometer.	mouser	$3.20	3	$9.60
					PCB	OSH park	$50	3	$50
					Housing		$80	1	$80
Overall cost				$60					207.42



Overall Progress
Research
Design
Prototyping
Testing
Overall
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Complete
Incomplete

Beyond Senior Design

- Able to respond to any combination of phonetics and construct each word string and audio file as a new entity regardless if it is a real word or not.
- Implement other languages
- Can be branched into similar designs outside of just human speech

Issues

- SD Card errors, possible corruption
- Combing individual programs for the overall program
- Wiring
- RFID tags

Questions?