Dual Glove Air Guitar

Group 7
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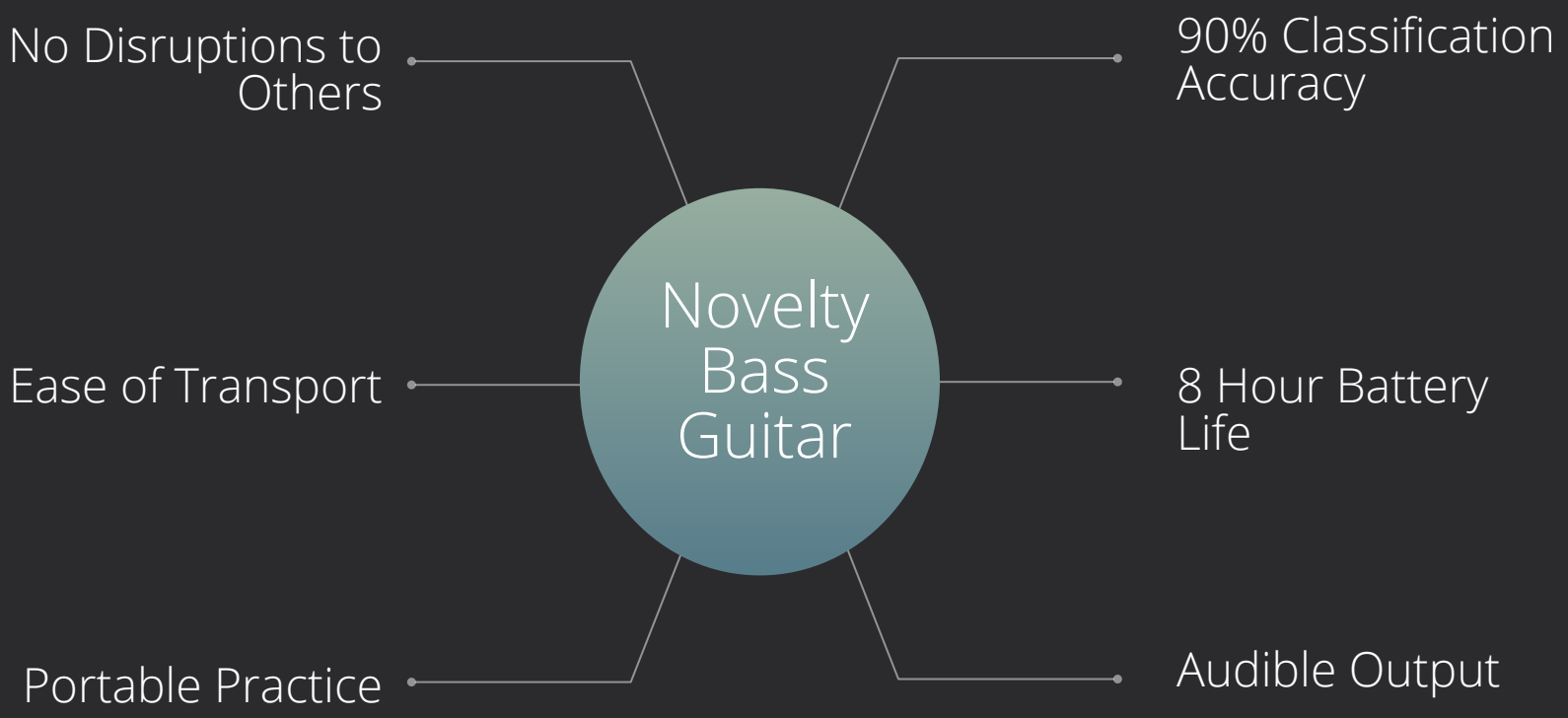
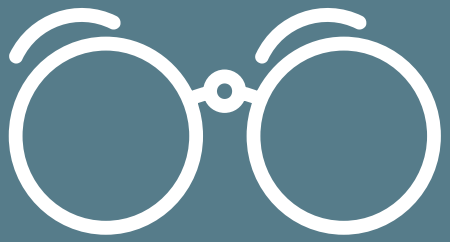
Introduction

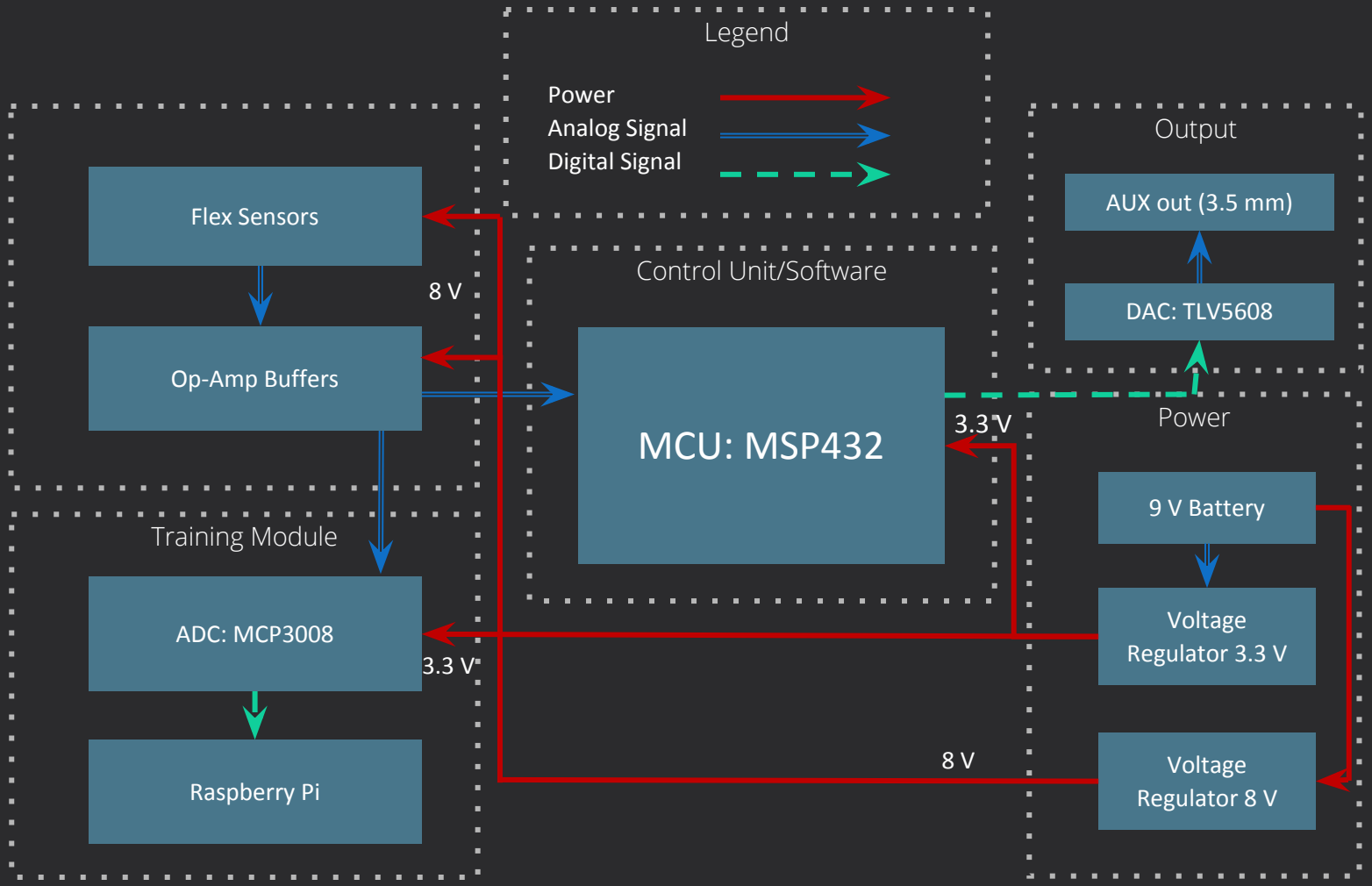
Objective


No Disruptions to Others
Ease of Transport
Portable Practice
Novelty Bass Guitar
90% Classification Accuracy
8 Hour Battery Life
Audible Output

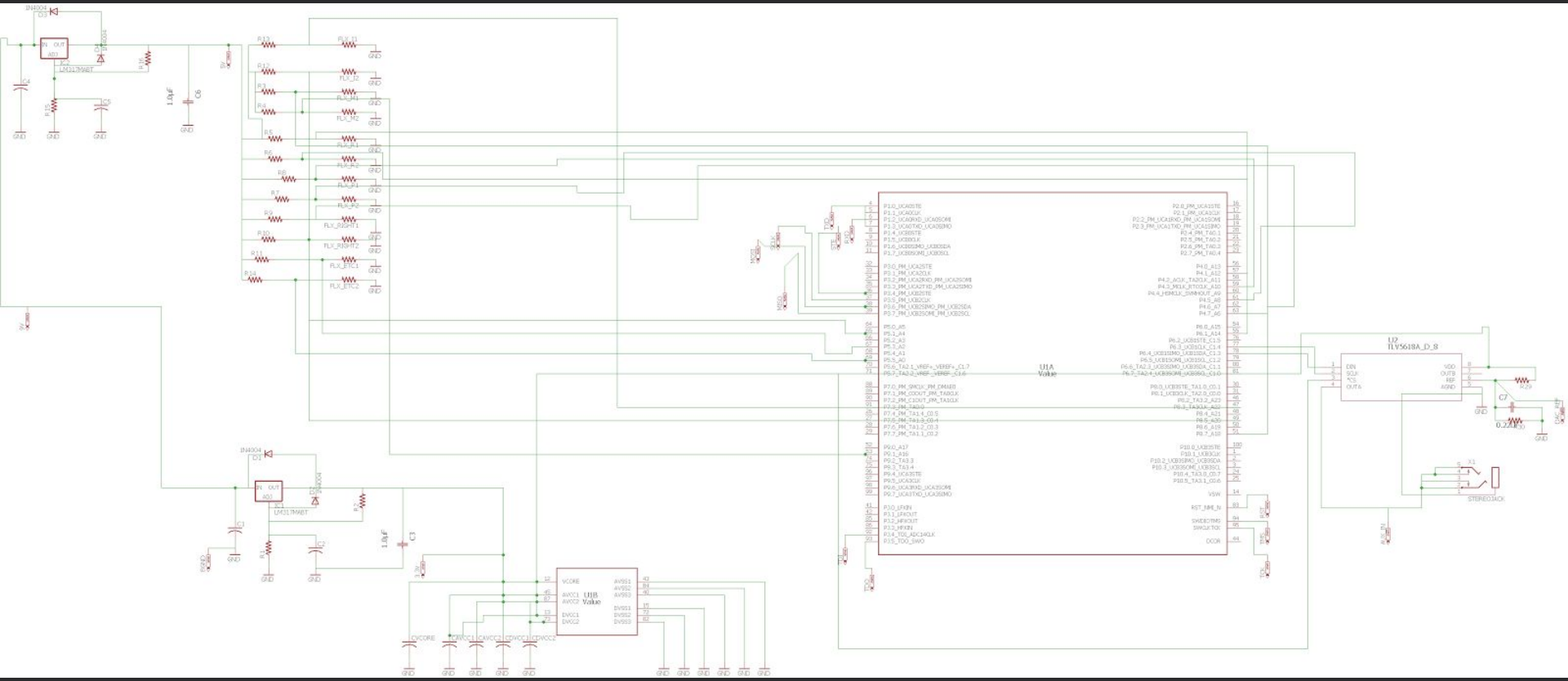


Design

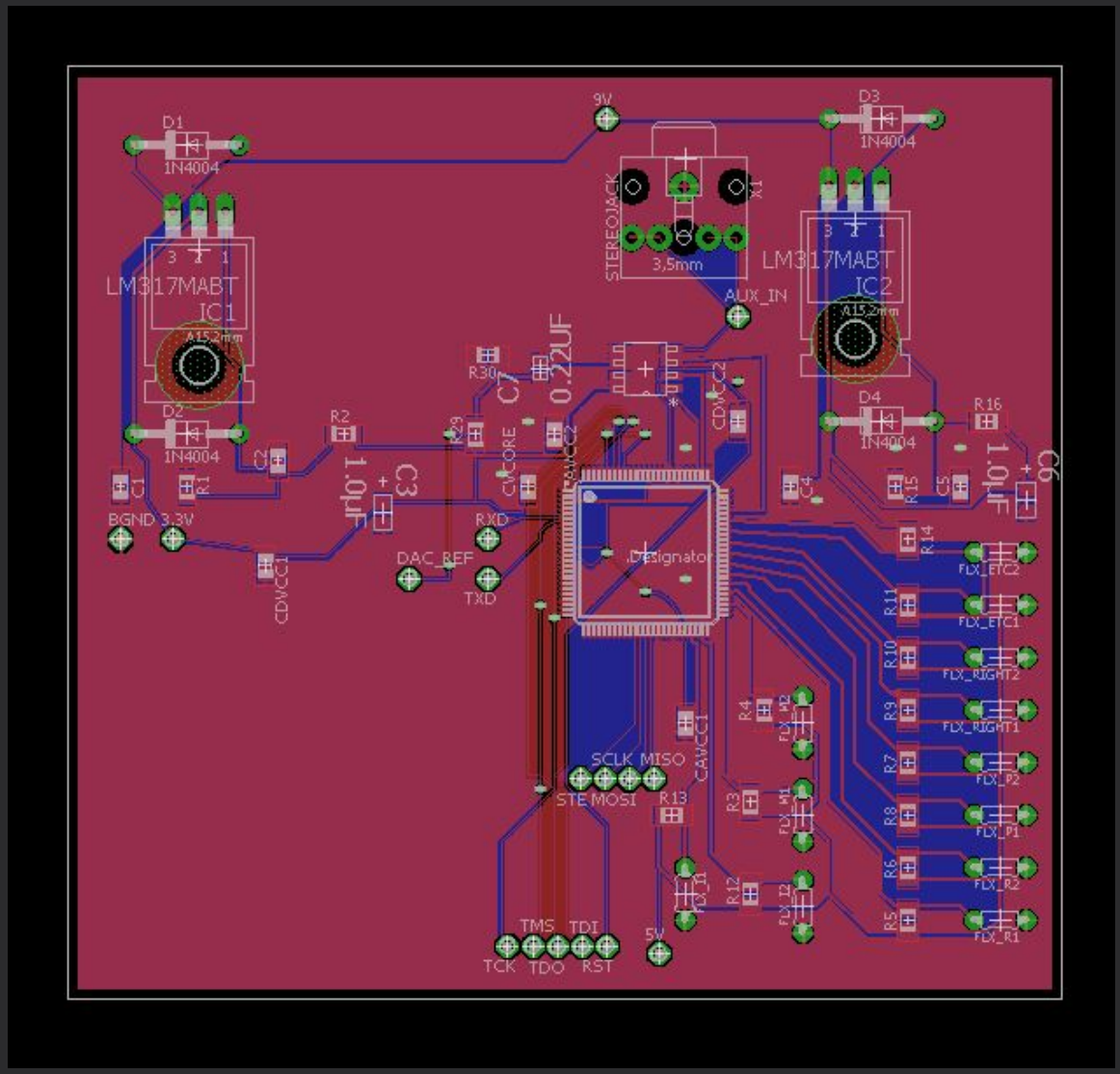
Block Diagram

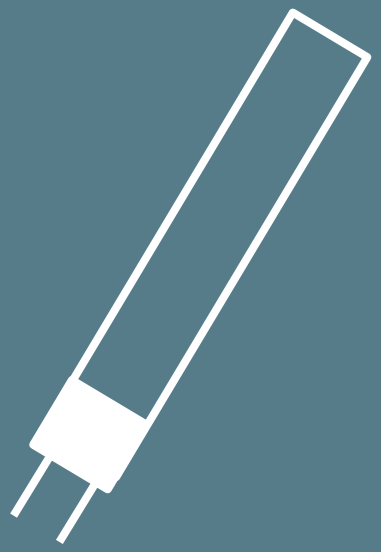


PCB Schematic



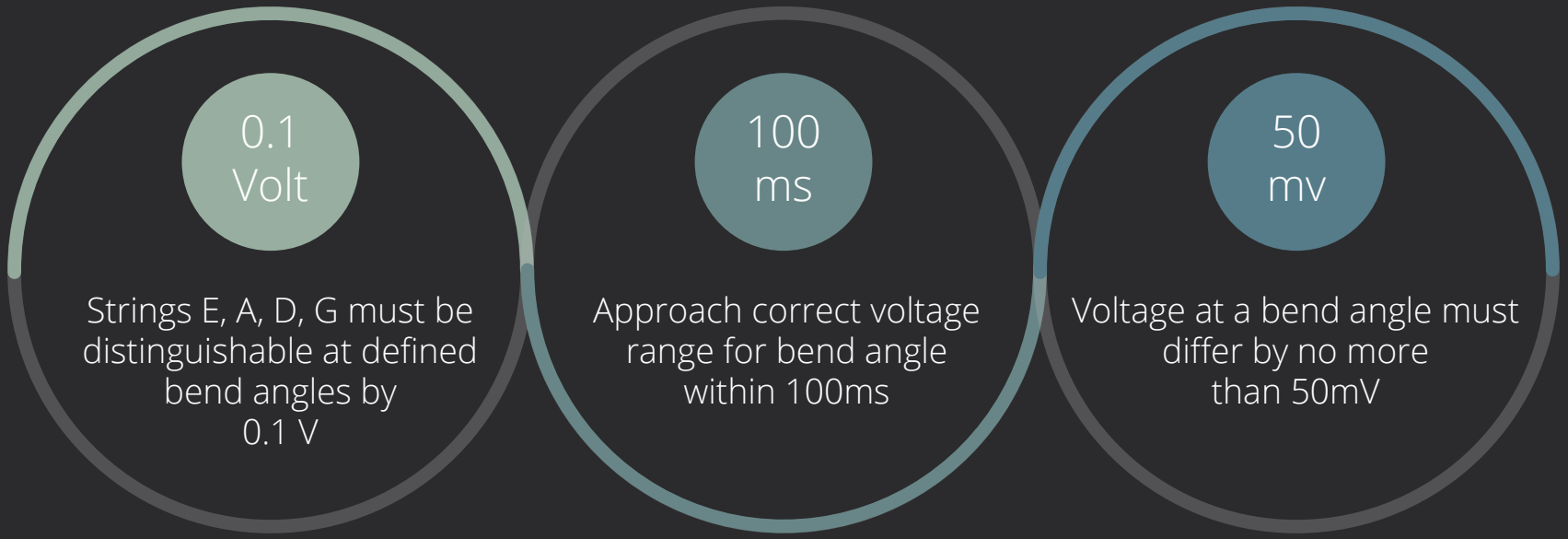
PCB Layout


9V
D1
1N4004
D3
1N4004
STEREOJACK
X1
3,5mm
LM317MABT
IC1
LM317MABT
IC2
AUX_IN
D2
1N4004
D4
1N4004
R30
C7
0.22UF
R2
C3
1.0uF
C6
1.0uF
BGND
3.3V
RXD
TXD
DAC_REF
Designator
FLX_ETC2
FLX_ETC1
FLX_RIGHT2
FLX_RIGHT1
FLX_P2
FLX_P1
FLX_R2
FLX_R1
SCLK
MISO
MOSI
STE
TMS
TDI
TCK
TDO
RST
5V



Flex Sensors

Requirements



Voltage Divider Circuit

Design Requirement

Designed to see 0.1 V between each key value of R_Flex (4 key values total)

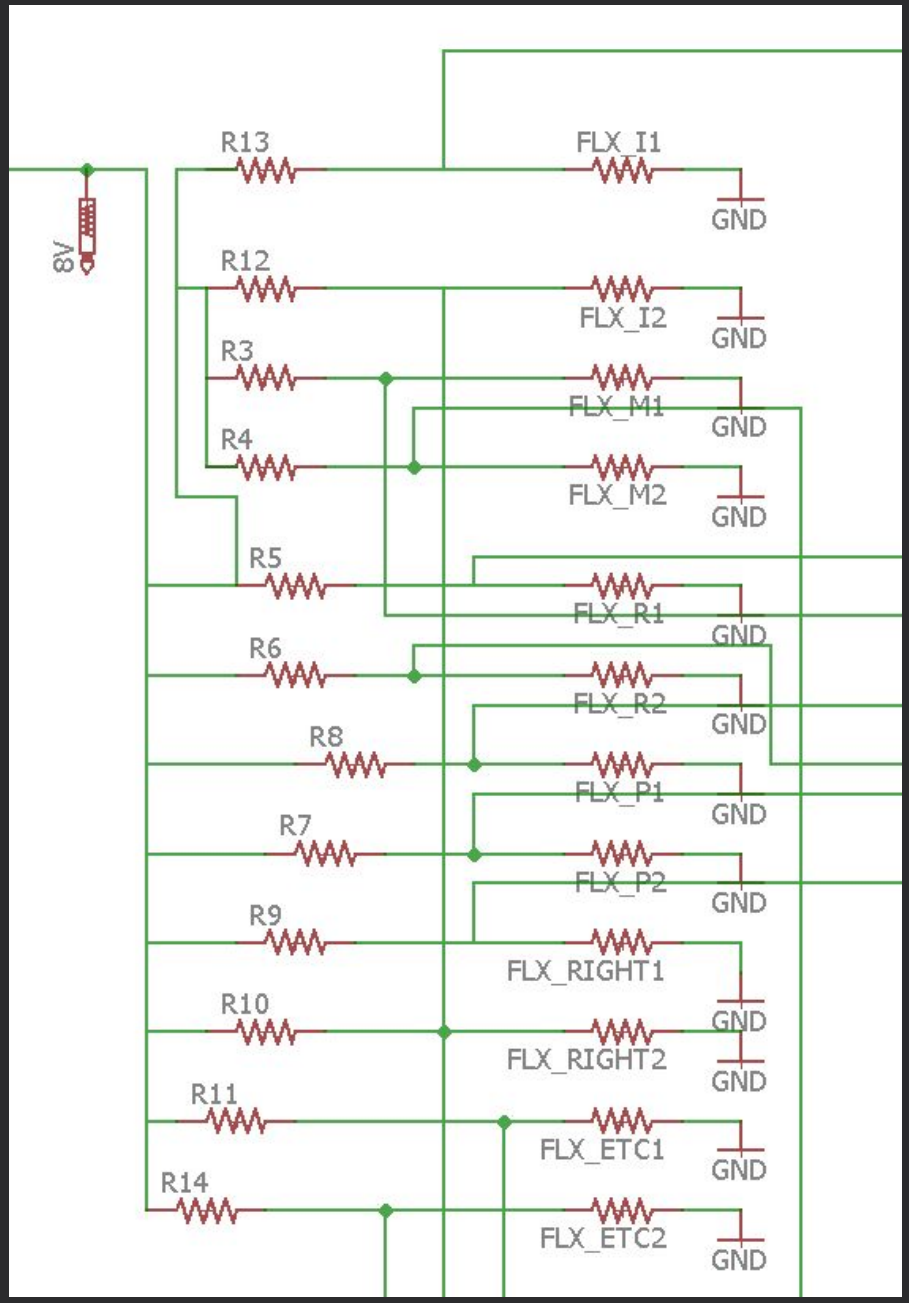
Methodology

Reference resistor is chosen to maximize the change in V_Flex

For best use of ADC range

Observation

Output is high-impedance



Choosing Reference Resistor

$$\frac{V_{cc} - V_{flex}}{R_{ref}} = \frac{V_{flex}}{R_{low}}$$

$$\frac{V_{CC} - (V_{flex} + x)}{R_{ref}} = \frac{V_{flex} + x}{R_{high}}, (x = \Delta V_{flex})$$

$$V_{CC} = 8\,V, R_{low} = 250\,k\Omega, R_{high} = 310\,k\Omega$$

$$V_{flex} = \frac{2000}{R_{ref} + 250}, x = \frac{480R_{ref}}{(R_{ref} + 250)(R_{ref} + 310)}$$

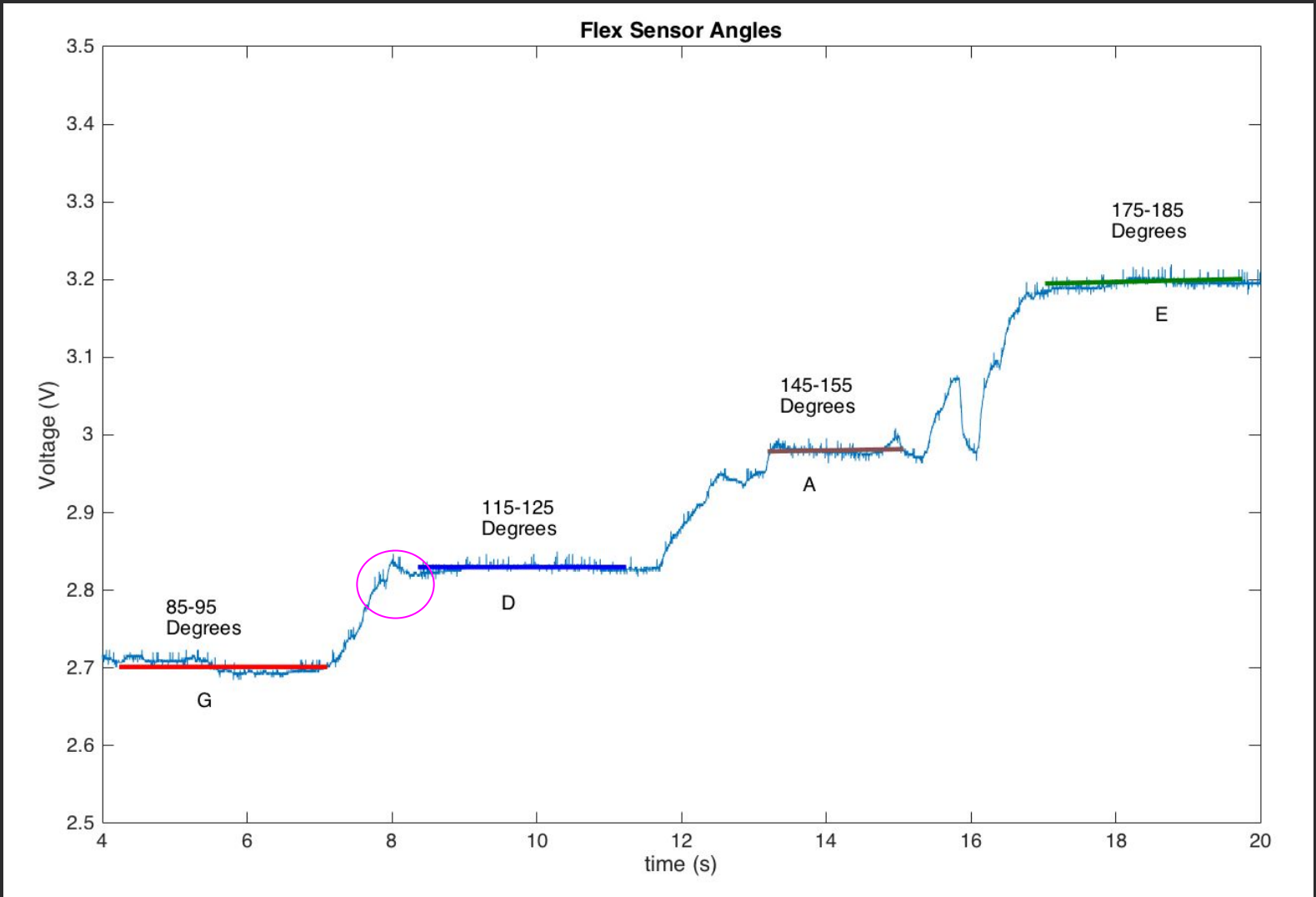
$\boldsymbol{Condition}$:

$V_{flex} + x < 3.25V$

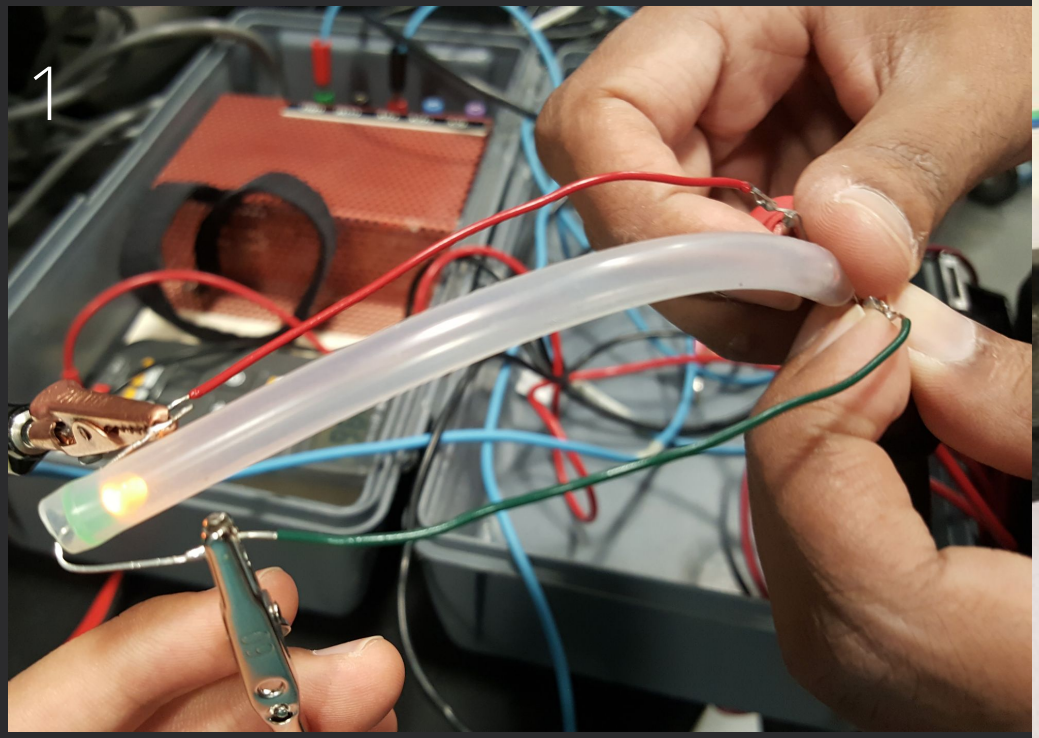
$\boldsymbol{Goal}$: $\boldsymbol{Maximize\ x}$

$x = 0.402V, V_{flex} = 2.8V, R_{ref} = 464.6\,k\Omega$

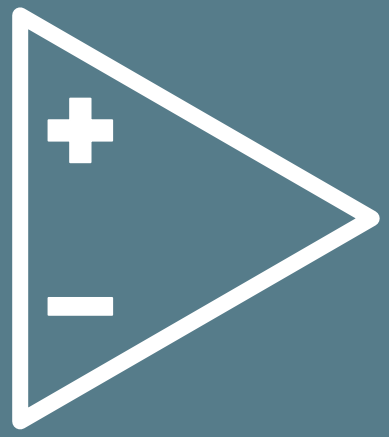
Verification



Flex Sensor Iterations



Flex Sensor Iterations



Op-Amp

Purpose and Requirements

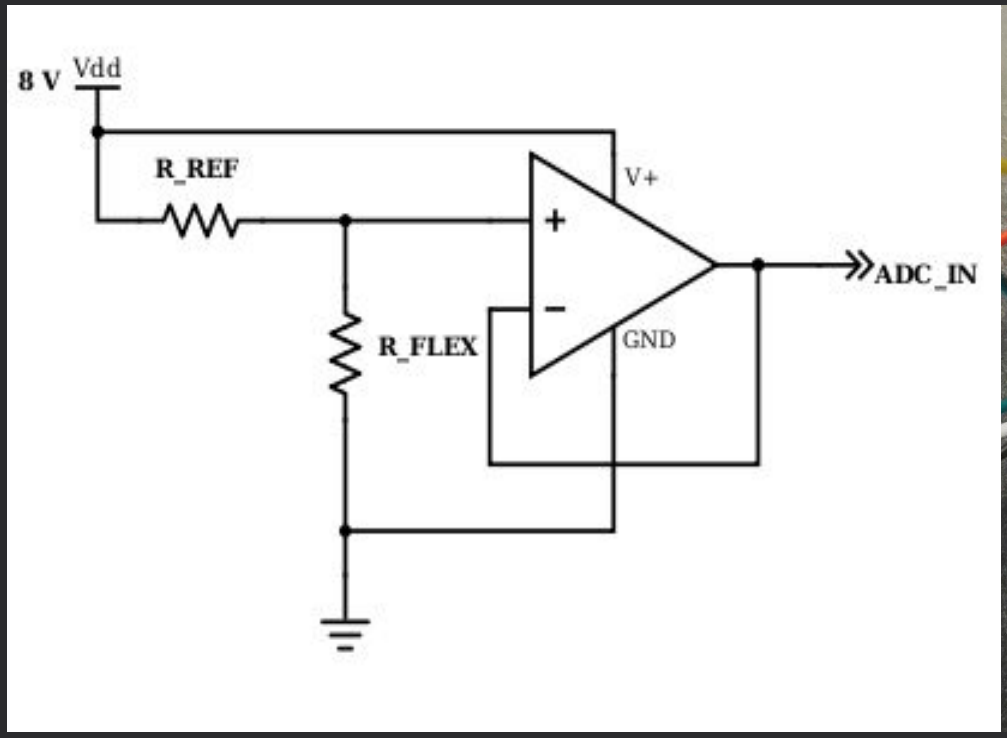
Purpose

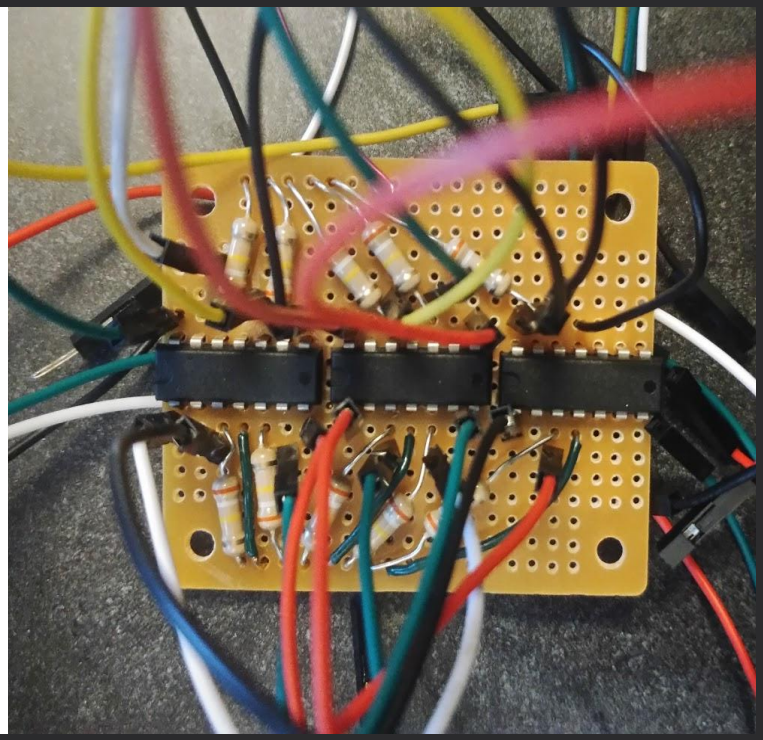
- The ADC sees a **high impedance** source
- Both the MCP3008 and the MSP432 ADCs prefer an input impedance of **less than 1.5 kΩ**
- Op-Amp buffer shorts the negative terminal and the output (unity gain)

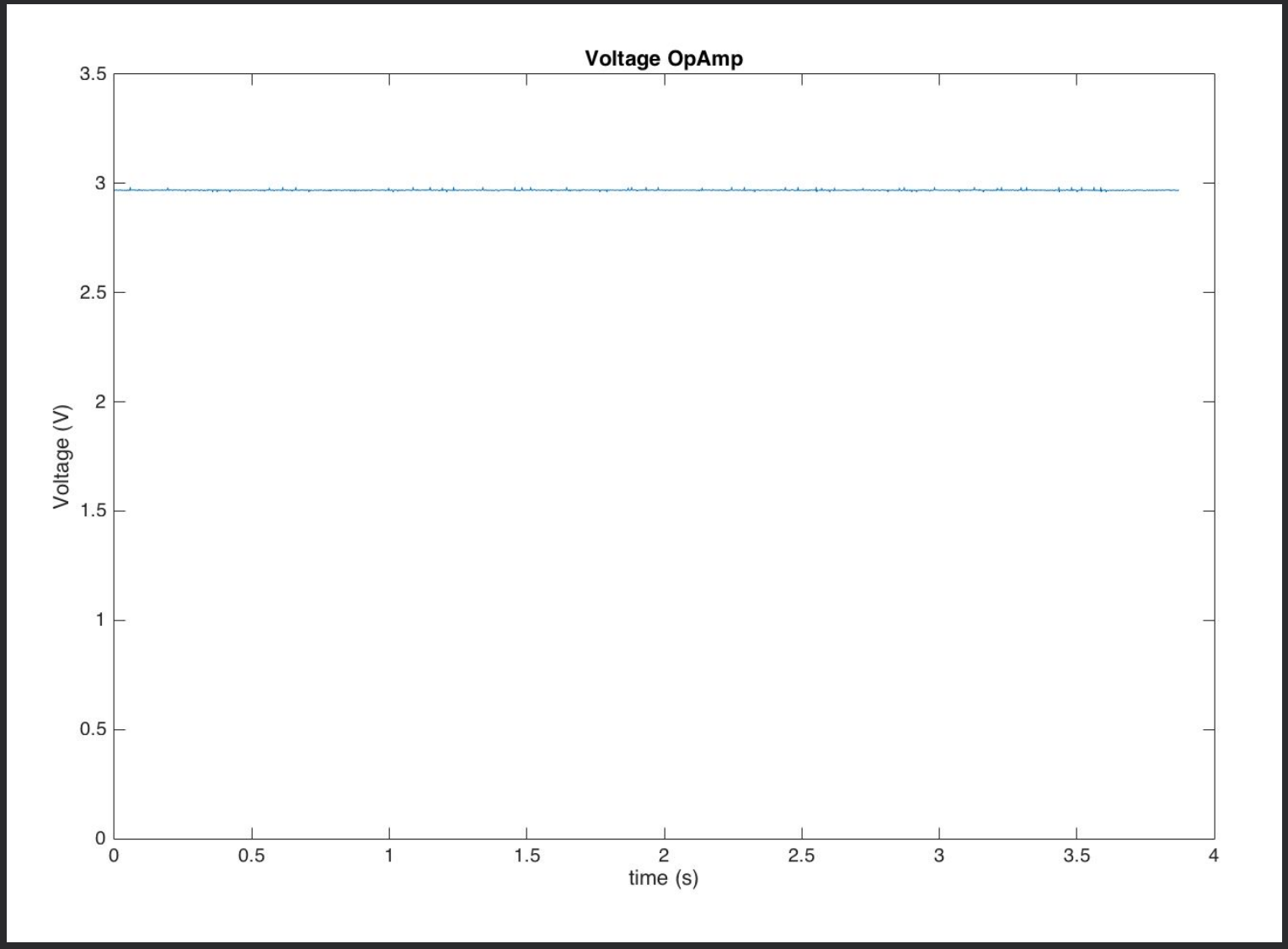
Requirements

- The op-amp buffer circuit will output a value **within 5%** of the intended value, linearly scaled between 1.5 V and 3.2 V.
- The buffer will have an output impedance of **less than 1 kΩ**.

Buffer Circuit



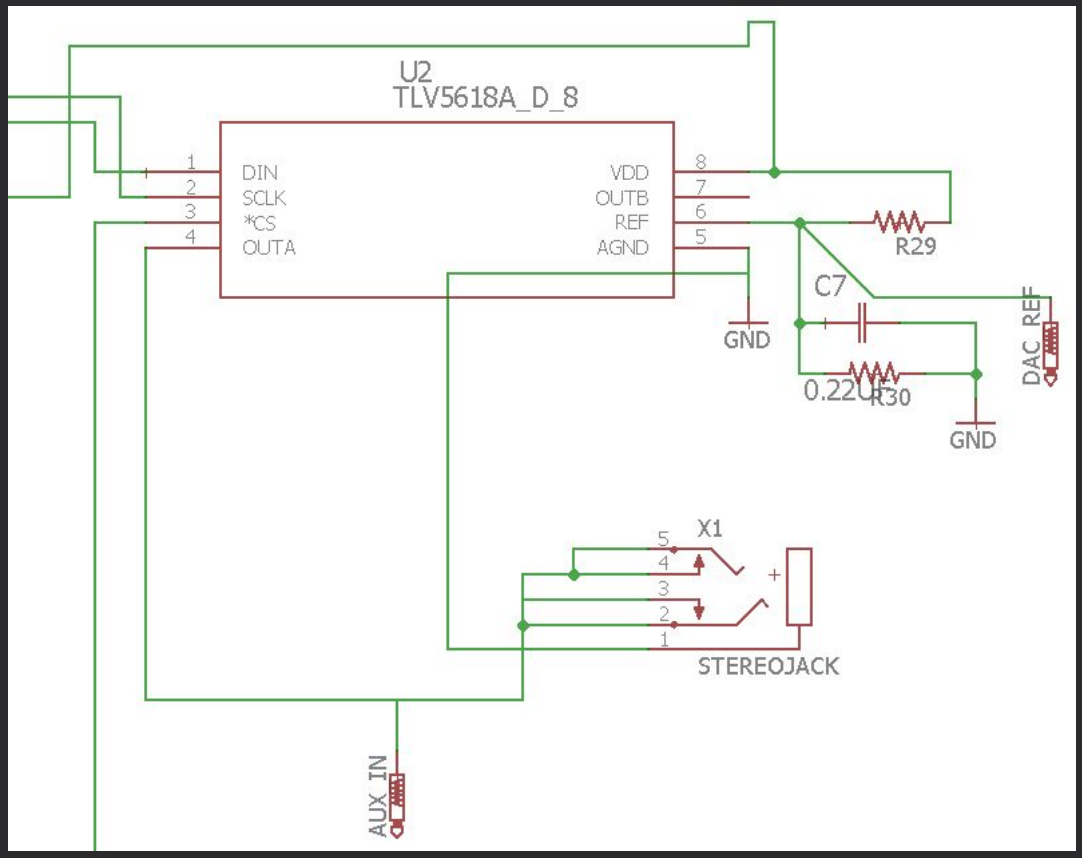



Voltage OpAmp
Voltage (V)
time (s)
0
0.5
1
1.5
2
2.5
3
3.5
4

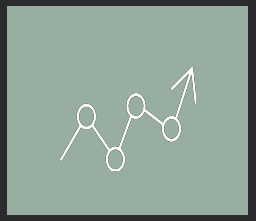
Output

Digital to Analog Converter

- TLV5618
- SPI-controlled
- Outputs a smoothed signal with LPF

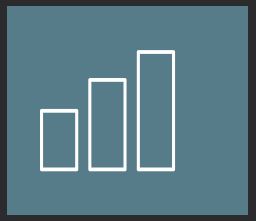


AUX Output



Receives a PWM tone

Consists of a stereo jack that can be plugged into a speaker or headphones



Minimizes power usage without having to power on-board speakers

Power

9V Battery

- Physically convenient on PCB
- Easy to replace
- Commonly found
- Energizer Industrial Battery has 450 mAH capacity at 100 mA current consumption
- Requirement: 8 hours at peak consumption

$$I_{estim} = 40mA$$
$$Capacity: 450\ mAH$$
$$Time_{estim}(hours) = 11.25$$

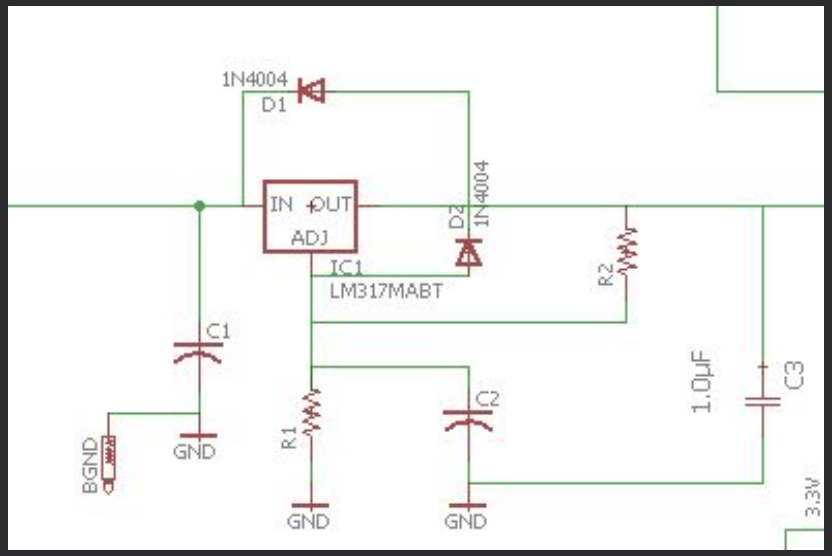
Voltage Regulators

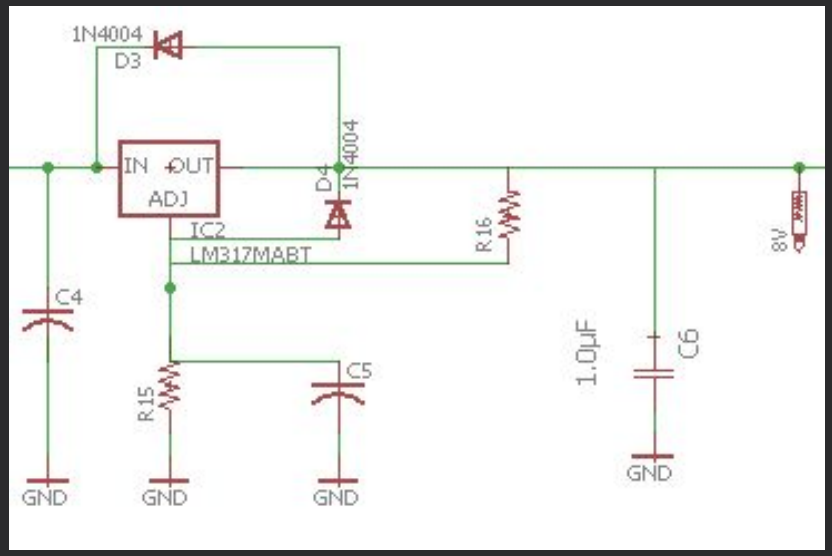
Regulator 1

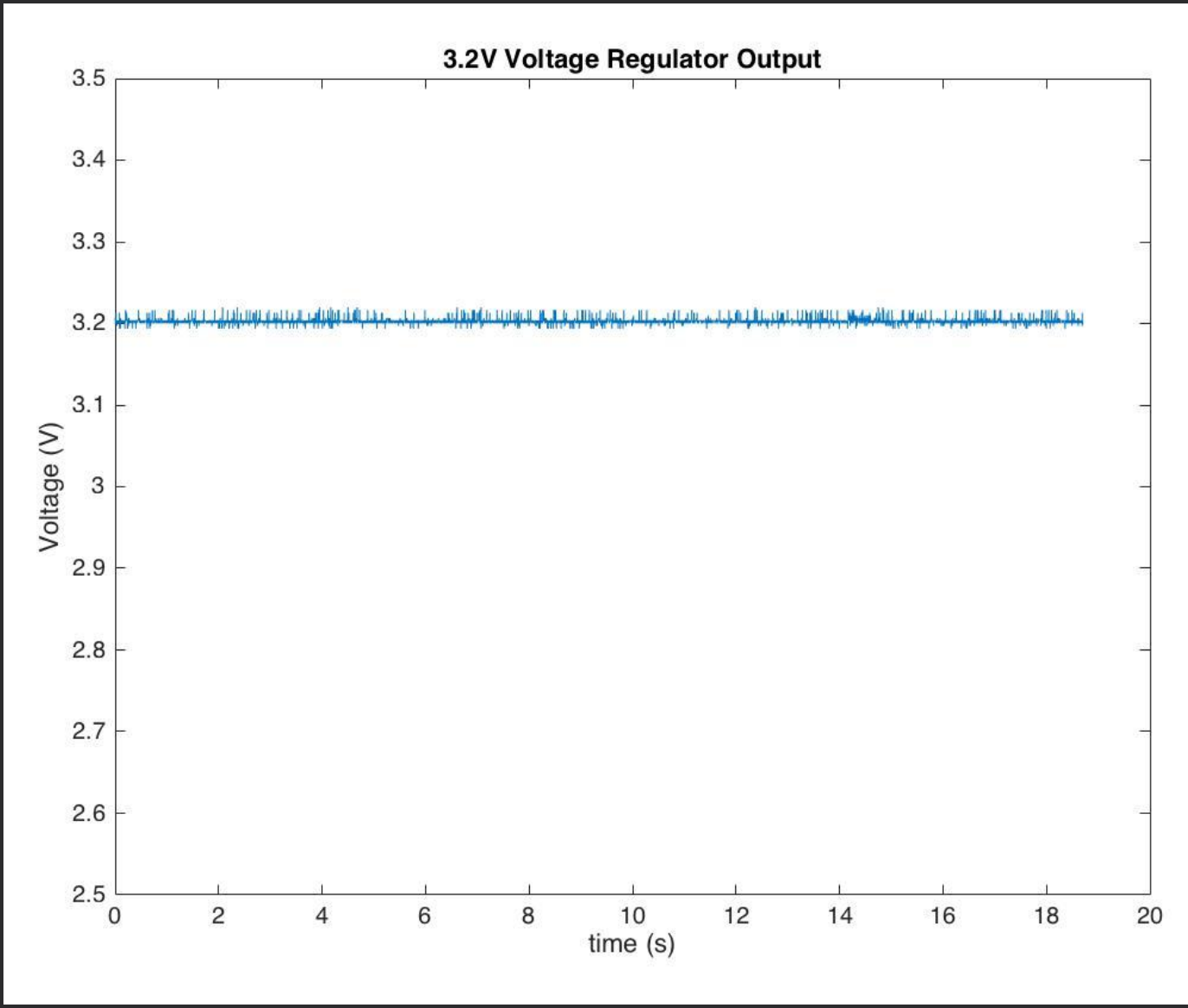
- Ideal: 3.3 V
- Empirical: 3.22 V
- Delivers power to MCU, DAC

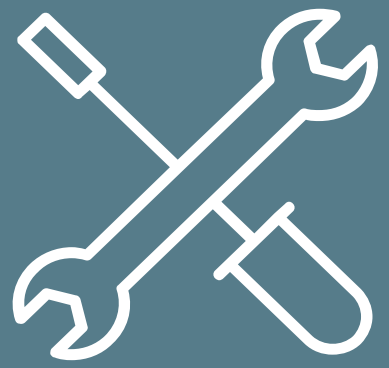
Regulator 2

- Ideal: 8 V
- Empirical: 8.04 V
- Delivers power to Flex Sensor Circuit, Op-Amp Circuit



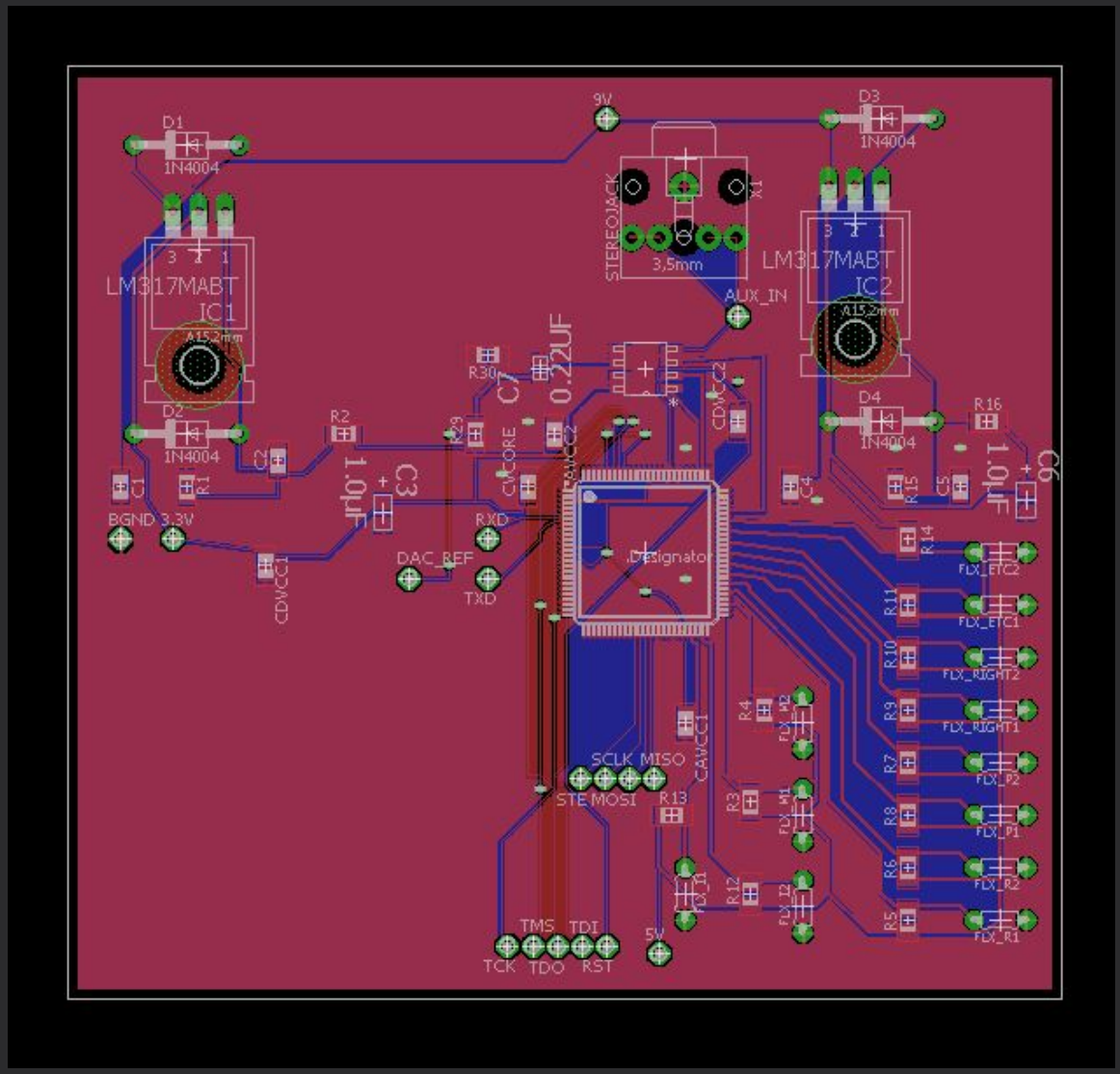



3.2V Voltage Regulator Output
Voltage (V)
time (s)
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
0
2
4
6
8
10
12
14
16
18
20

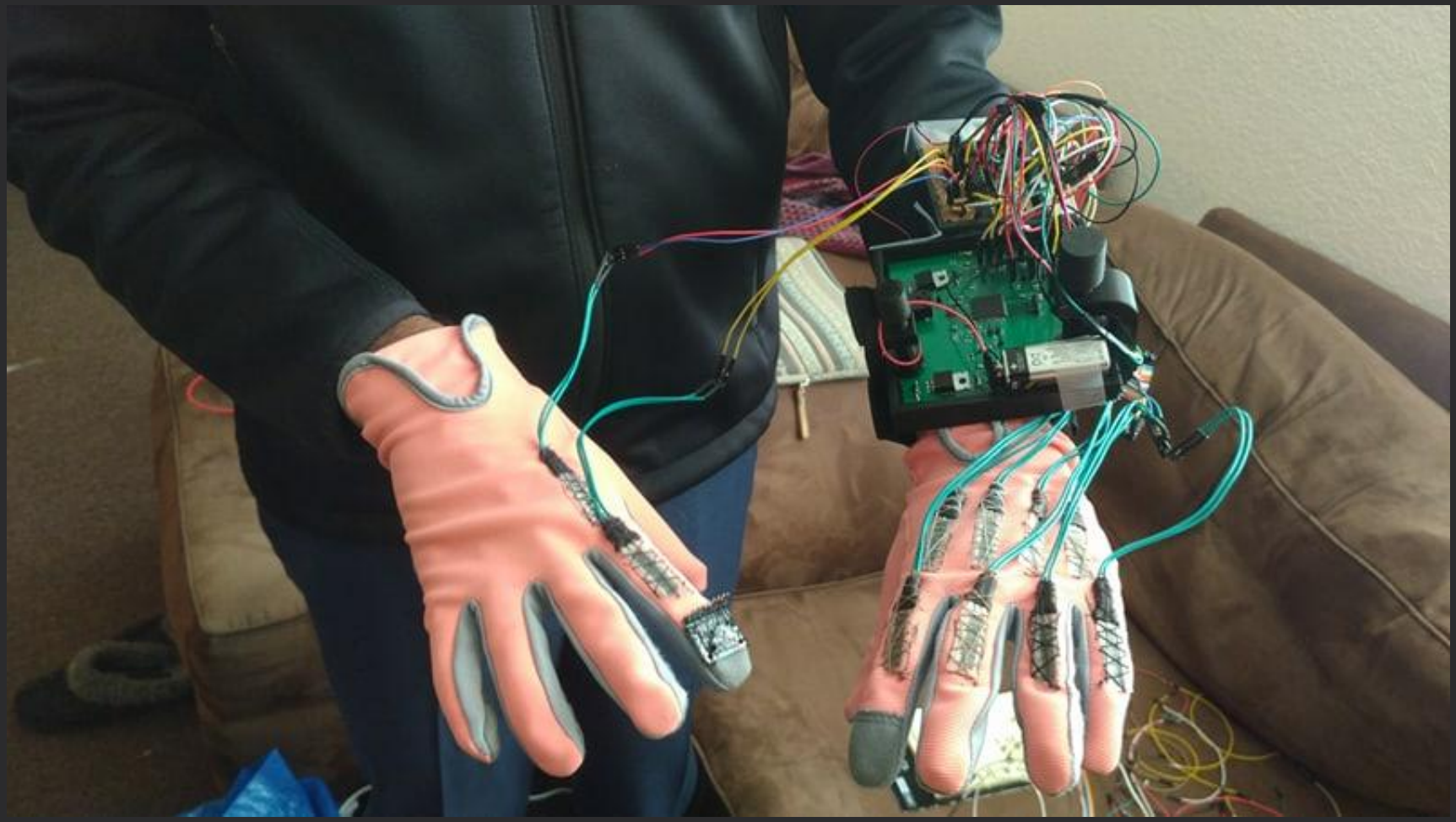


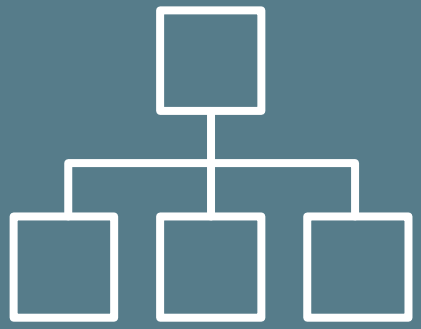
Build

PCB Layout


9V
D1
1N4004
D3
1N4004
STEREOJACK
X1
3,5mm
LM317MABT
IC1
LM317MABT
IC2
AUX_IN
D2
1N4004
D4
1N4004
R30
C7
0.22UF
R2
C3
1.0uF
C6
1.0uF
BGND
3.3V
RXD
TXD
DAC_REF
Designator
FLX_ETC2
FLX_ETC1
FLX_RIGHT2
FLX_RIGHT1
FLX_P2
FLX_P1
FLX_R2
FLX_R1
SCLK
MISO
MOSI
STE
TMS
TDI
TCK
TDO
RST
5V

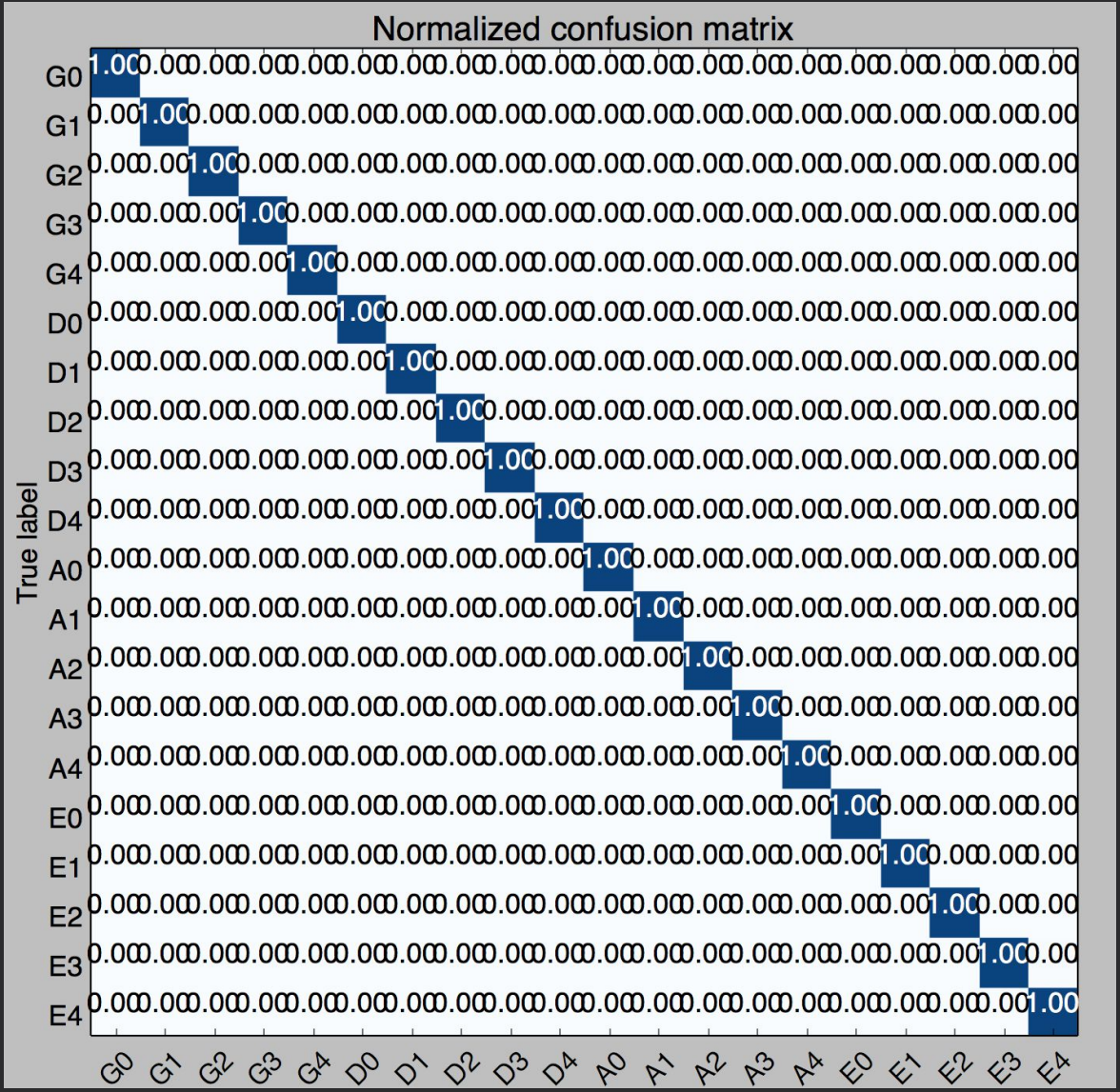
Overall Build



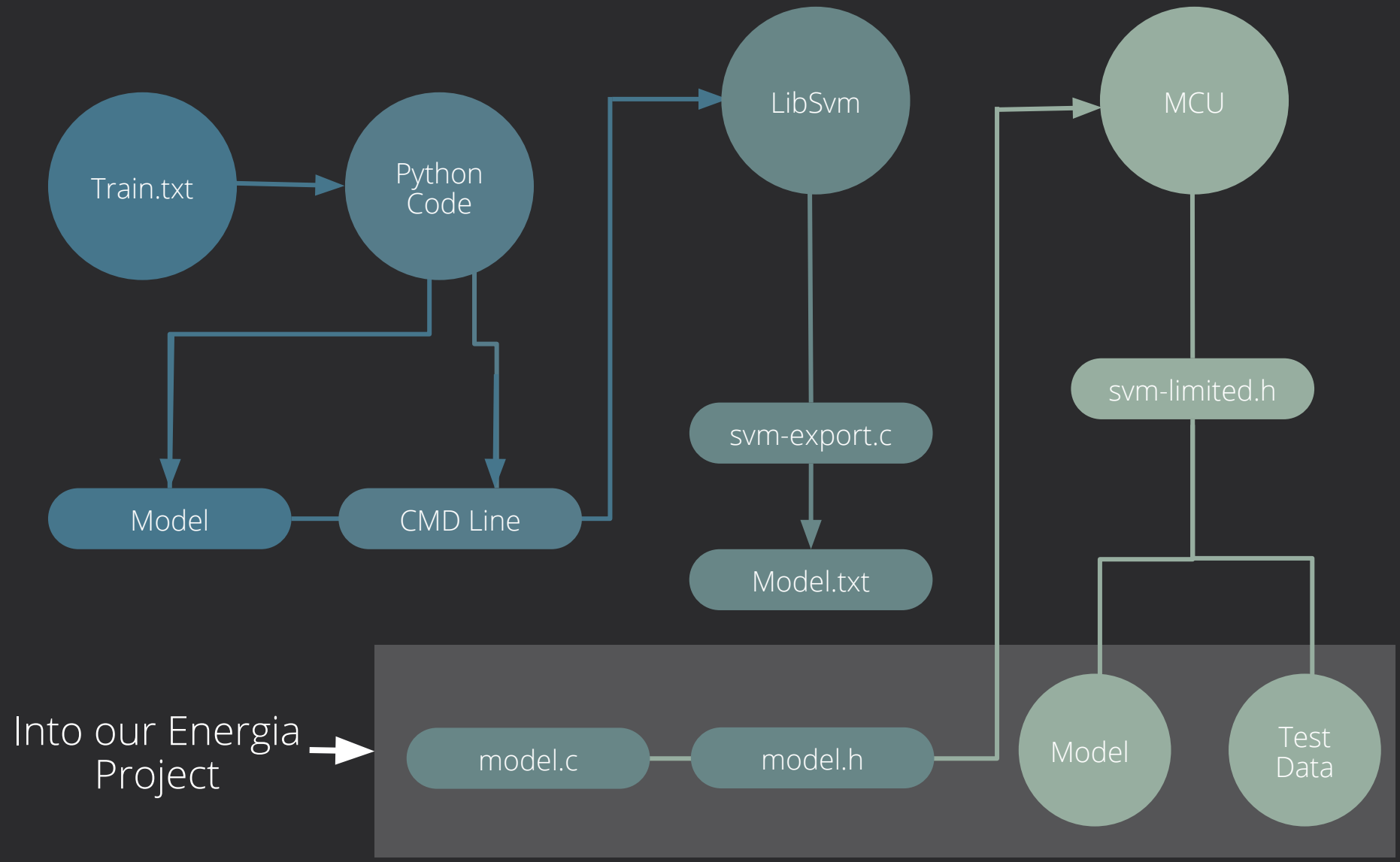


Machine Learning

Confusion Matrix



Software and Data Flow



Demonstration and Final Thoughts

Conclusions

- Classification was heavily biased towards the note G2
- Further ML work required
- Resistors used did not have large enough range
- Inconsistencies between train data and opt-amp data
- Increased physical strain and wear on fragile build

Future Work

- More notes from different hand positions
- Multi-note functionality
- Wireless functionality (WiFi or Bluetooth)

Questions?