AUTOMATIC GUITAR TUNER

GROUP F

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MOTIVATION

- Tedious for beginners to tune guitar by hand

- Takes significant time to learn and perfect skill

- Automatic tuner allows for easy/quick tuning by beginners and professionals alike

- Allows novices to train their ear

GOALS AND OBJECTIVES

- Primary: Design Automatic Guitar Tuner that accurately tunes to user selected note
  - Handheld, rechargeable, reliable
- Secondary: Create mobile app that interfaces with Automatic Guitar Tuner
 - Stores previous tunings
  - Expands functionality

SPECIFICATIONS

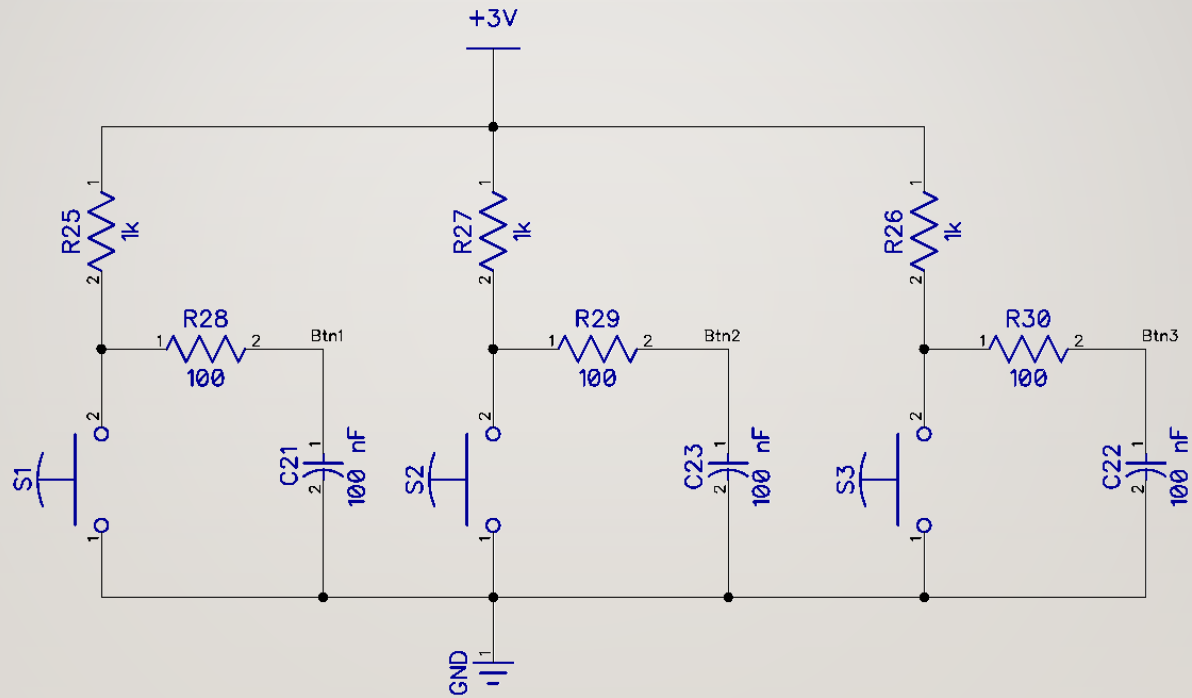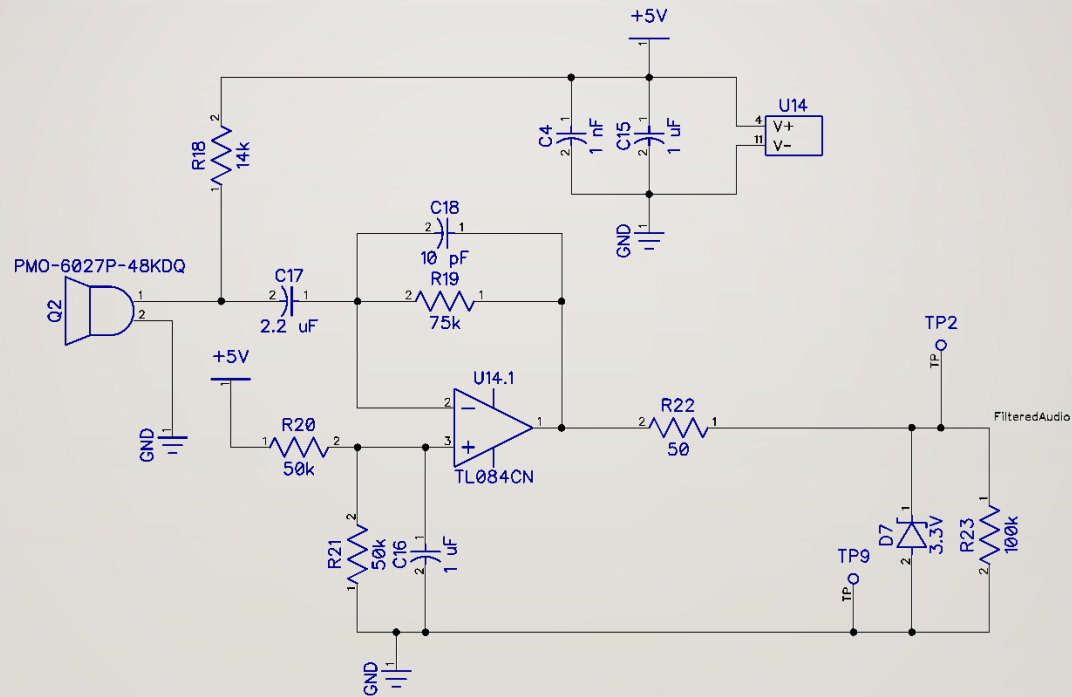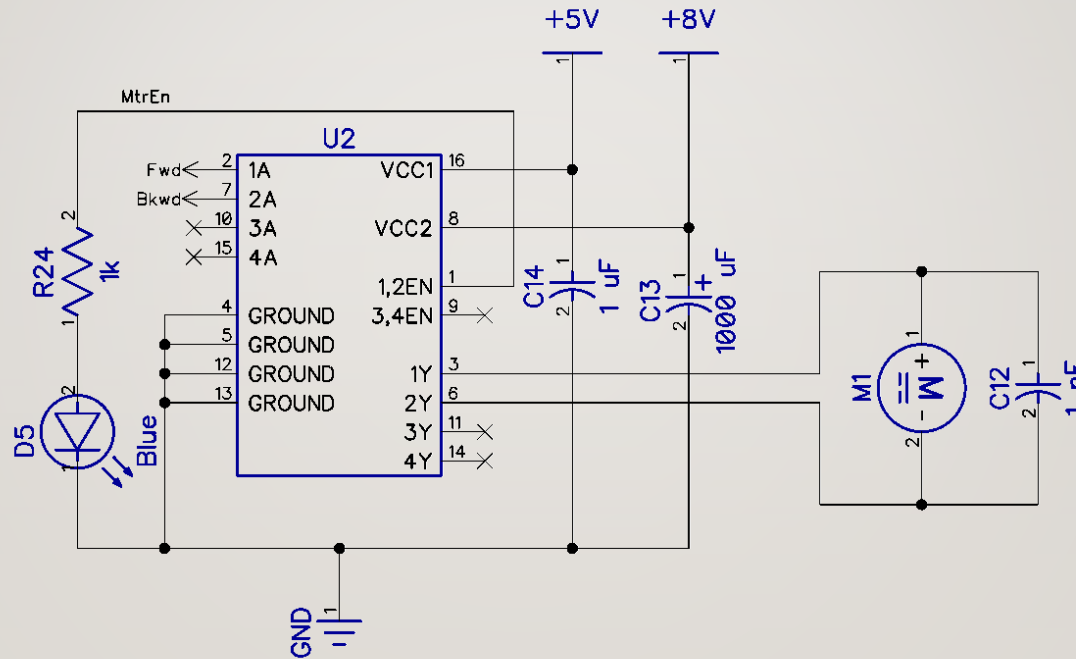| Component	Parameter	Design Specification
Battery	Charge Time	4 hours
Detection Bandwidth	Frequency Range	30 – 4,400 Hertz
Microphone	Accuracy	±2 percent frequency
Mobile Wireless Link	Maximum Range	15 meters
Size	Maximum Weight	0.5 kg
Speed	Maximum Tuning Time	15 seconds

BLOCK DIAGRAM
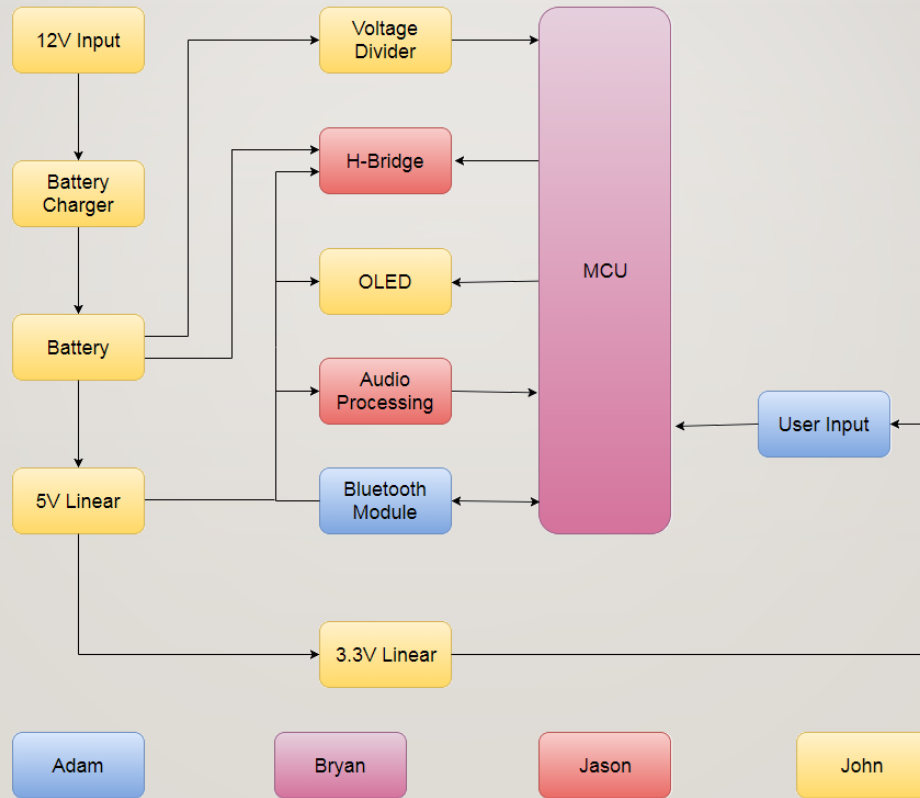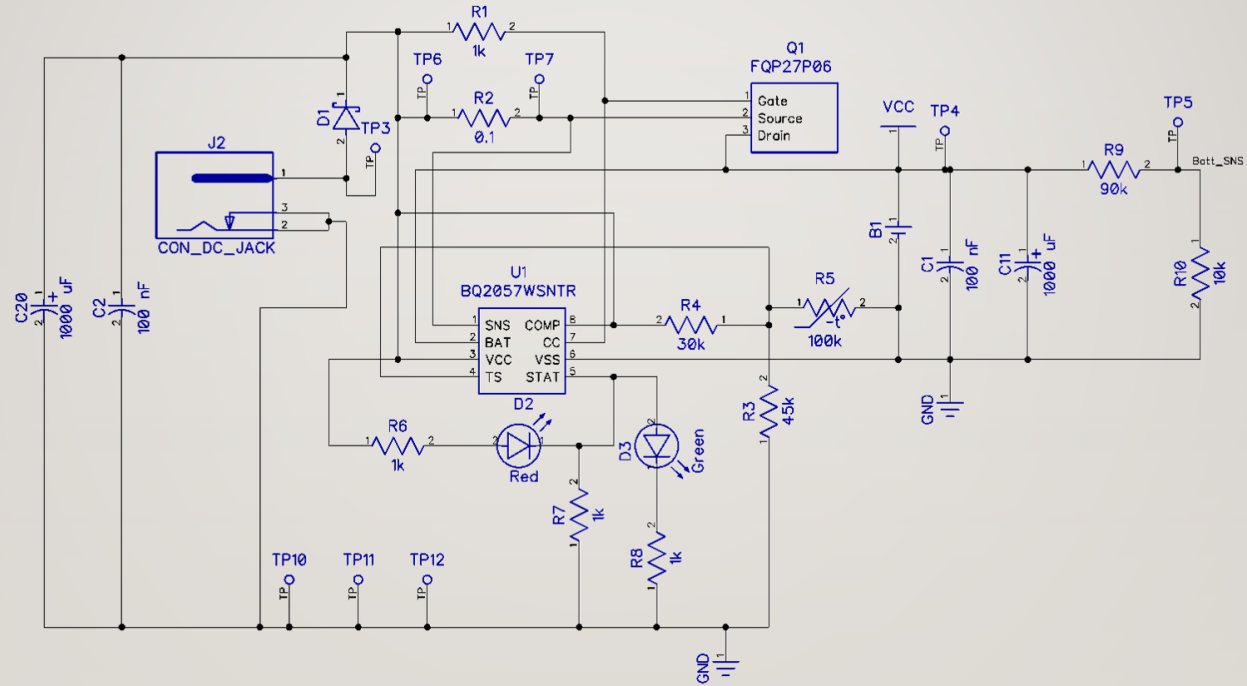
BLUETOOTH AND MCU
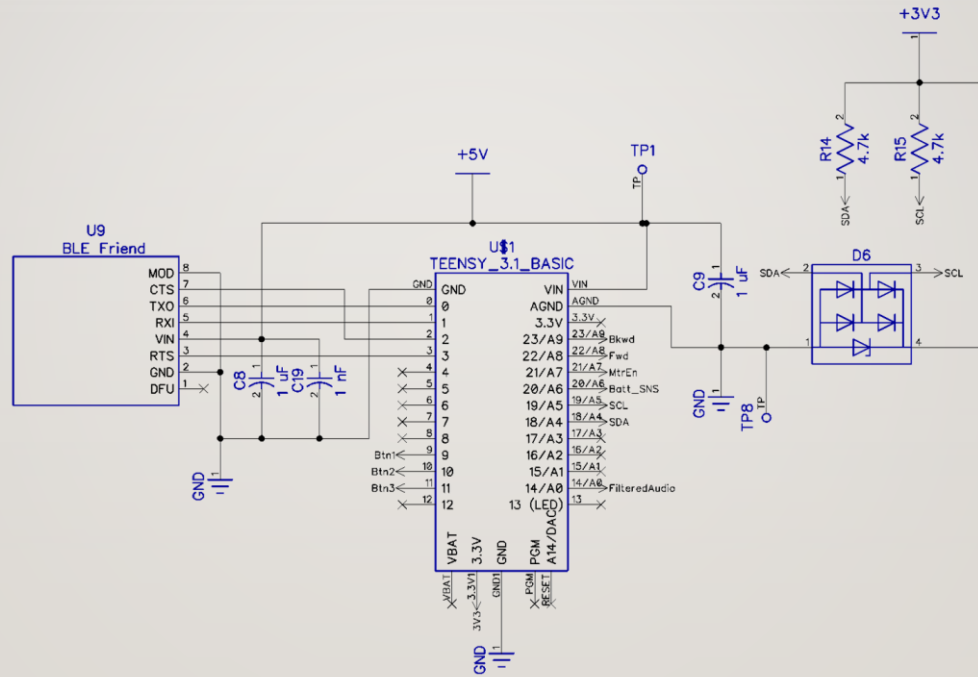
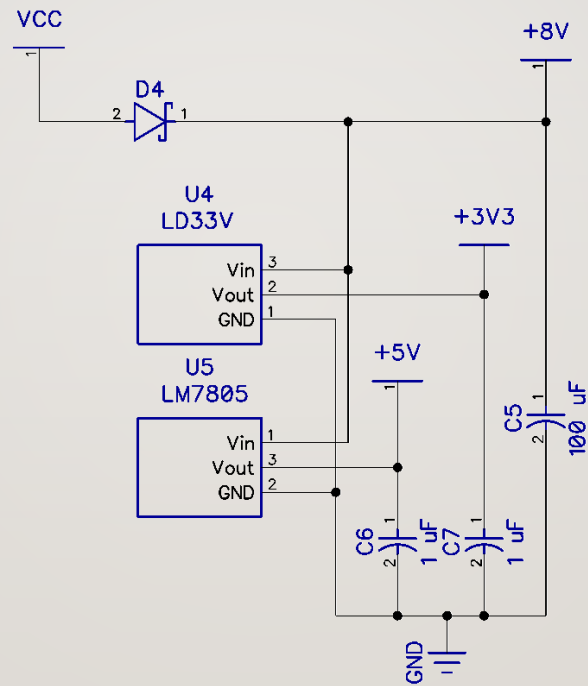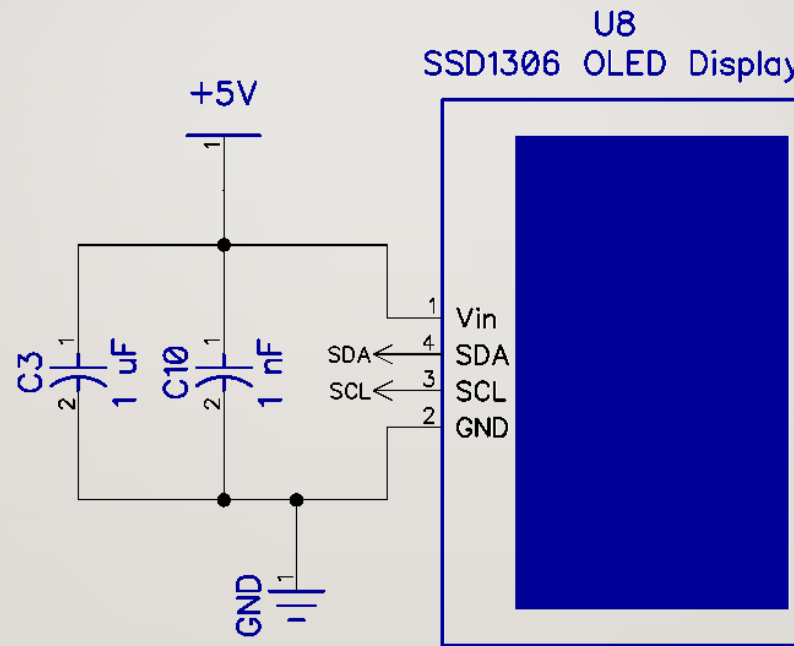# USER INPUT

SOUND FEEDBACK

MOTOR AND H BRIDGE

BATTERY CIRCUIT

POWER REGULATION

DISPLAY

MICROPHONE SELECTION

Selected Component

- The Mallory Sonalert Productions Microphone fulfills all desired requirements and is cheaper than the competitor

- The Pass Band on this microphone will allow all desired notes to be picked up

- The high Signal to Noise Ratio will ensure a quality signal

| Part Number	CME-1538-100LB	ECM-60P	PMO-6027P-40KDQ
Manufacturer	CUI Inc.	Jameco Valuepro	Mallory Sonalert Products Inc.
Type of Microphone	Condenser	Condenser	Condenser
Pass Band	20 Hz - 20 kHz	20 Hz - 12 kHz	20 Hz - 16 kHz
Sensitivity	-38dB	-54dB	-40dB
Signal to Noise Ratio	58dB	40dB	56dB
Diameter	4mm	9.8mm	6mm
Depth	2.9mm	12.8mm	2.95mm
Termination Type	Termination Wires	Termination Pins	Termination Wires
Unit Price	$3.16	$0.99	$2.08
Bulk Price	$1.896	$0.55	$.8736

ADC SELECTION

Selected Component

- Built in ADC fulfilled all our desired specifications while remaining cheaper than the competitors

- The higher sampling rate will ensure the product will be able to tune to greater accuracy

- By having the ADC built into the MCU, it allows for easier implementation.

| Part Number	ADC128D818CIMTX/NOPB	579-MCP3221A5T-I/OT	MK20DX256VLH7
Manufacturer	Texas Instruments	Microchip Technology	NXP/Freescale
Resolution	12 Bit	12 Bit	16 Bit
Number of Channels	8	1	2
Sampling Rate	8.33 kS/s in Standard Mode 33.3 kS/S in Fast Mode	22.3 kS/sec	818.33 kS/sec
Interface Type	Serial, I2C	Serial, I2C	Built In MCU
Operating Supply Voltage	3 V - 5.5 V	2.7 V - 5.5 V	Built In MCU
Single Purchase Price	$5.27	$1.58	N/A

SOUND FEEDBACK CIRCUIT

- Microphone coupled with active filter to reduce noise and amplify signal

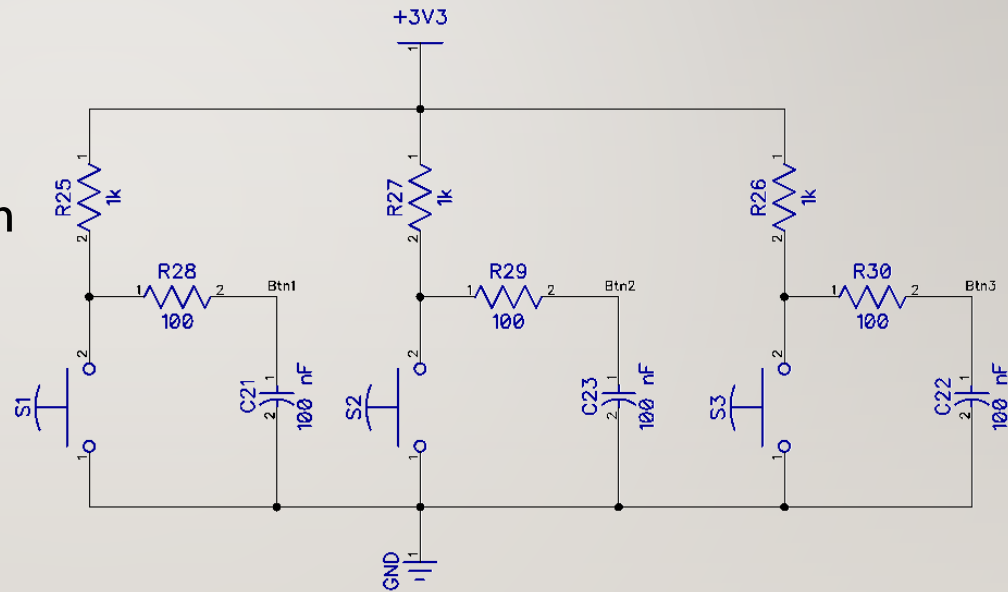- Active filter is connected to the built in ADC on the MCU
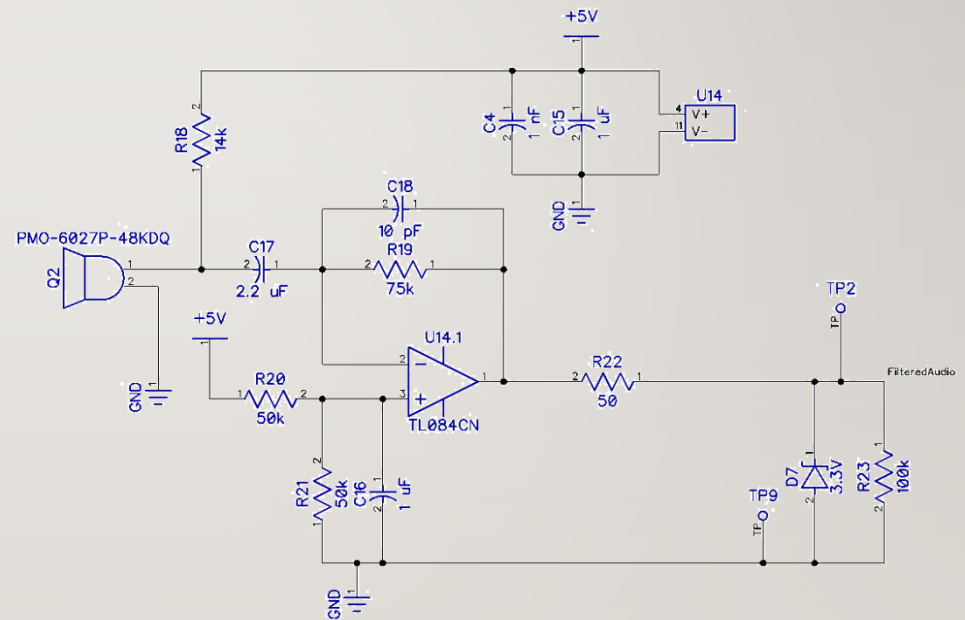
MOTOR AND H BRIDGE

- 6V planetary gearbox motor chosen for low speed and high torque

- H-Bridge allows selectable rotation

- LED shows when motor is enabled
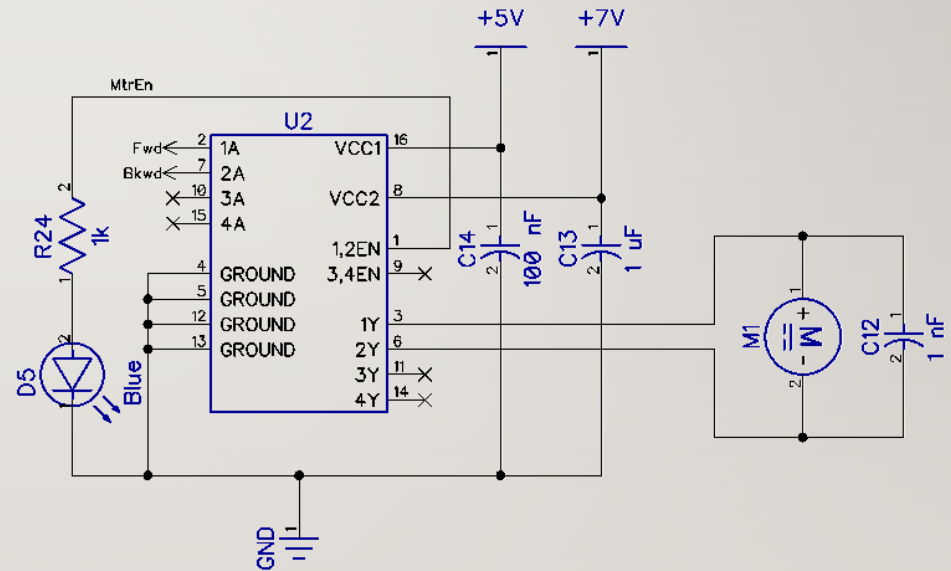
USER INPUT

- Normally open buttons chosen with debounce circuits

- Debounce coupled with Schmitt Trigger proves error free user input

WIRELESS CONNECTION

Connection type	USB 2.0	Wi-Fi Direct	Bluetooth
Range	5 meters	200 meters	92 meters
Transfer rate(max)	280 Mbps	250 Mbps	25 Mbps
Compatible	Both Android & iOS	Android	Both Android & iOS

- Smart phones are capable of Wi-Fi and Bluetooth connection

- Bluetooth is easier to implement, consumes less power

BLUETOOTH MODULE SELECTION

- ADAFRUIT BLUEFRUIT LE UART Friend fulfilled all our desired specifications

- The Bluetooth Low Energy technology on the chip ensures low power consumption

Spec	HC-05	nRF8001 Breakout	BLE UART Friend
Dimension(mm)	12.7 by 27	29 by 28	21 by 32
Power needed for Operation(V)	1.8 to 3.6	1.9 to 3.6	1.8 to 3.6
Power consumption(mA)	30	25	20
Baud rate(bps)	Default: 9,600 Up to: 460,800	9,600	9,600
Weight(g)	9.6	1.8	3.4
UART capable	Yes	Yes	Yes

Selected Component

BLE FRIEND TO MCU

- BLE UART Friend allows fairly simple connection to MCU over serial interface

- Uses standard UART RX/TX connection to transmit data back and forth
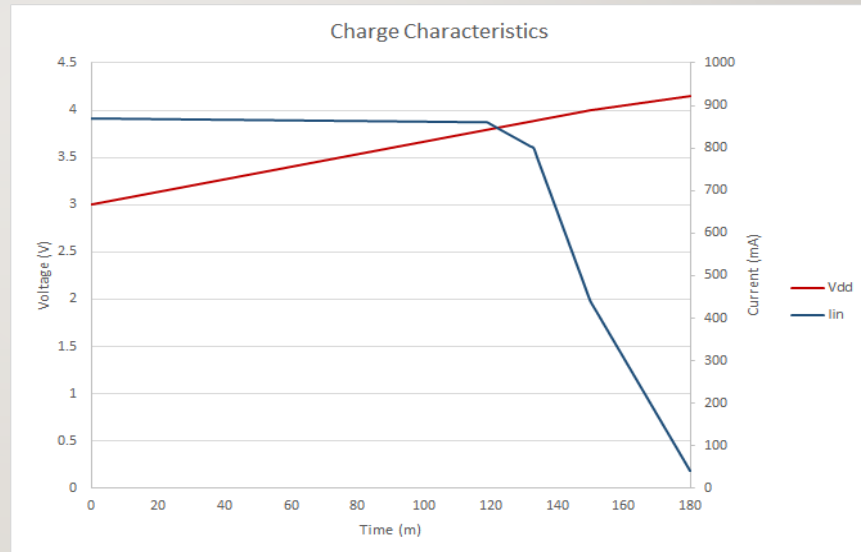
DISPLAY

- OLED display chosen for excellent contrast and good brightness

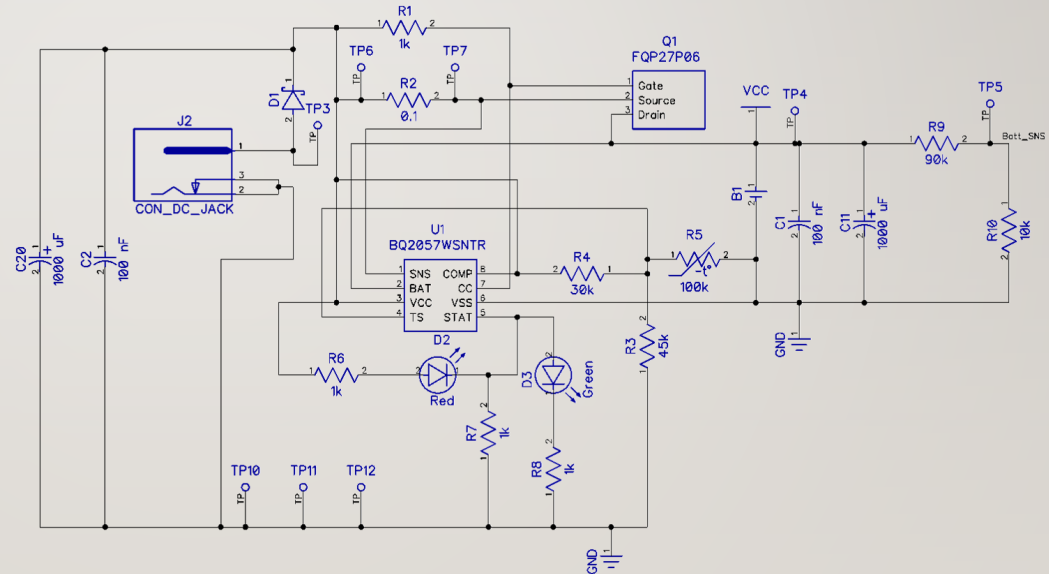- I2C interface to MCU

- 5V Power
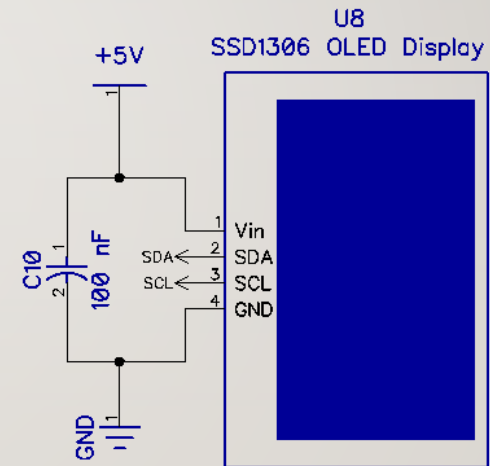
L-ION CHARGING

- Step 1: Constant Current

- Step 2: Constant Voltage

- Step 3: Trickle Charge

BATTERY RECHARGING

- Bq2057W linear Lithium Ion cell charger

- Two Lithium Ion Samsung 18650 3000mAh cells in series

- Power Pole charging port

- Status LEDs

- Thermal cutoff

- Voltage divider to MCU ADC for battery statistics

POWER REQUIREMENTS

Parts (5V)	Current Draw
Teensy 3.2	35 mA
TL084CN	60 mA
579-MCP3221A5T-I/OT	250 uA
OLED	20 mA
Total (5V)	115.25 mA

Parts (7V)	Current Draw
5V	115.25 mA
Motor	500 mA
Total	615.25 mA

POWER REGULATION

- LM7805

  - 7V->5V

- Teensy 3.2 Onboard Reg

  - 5V->3.3V

- LD33V left unpopulated on V2 PCB

PCB DESIGN

- Designed PCB V1 and V2 in Diptrace

- Allowed for easy export from schematic to layout

- V1 PCB made large for ease of testing

- V2 PCB shrunk to fit in handheld form factor
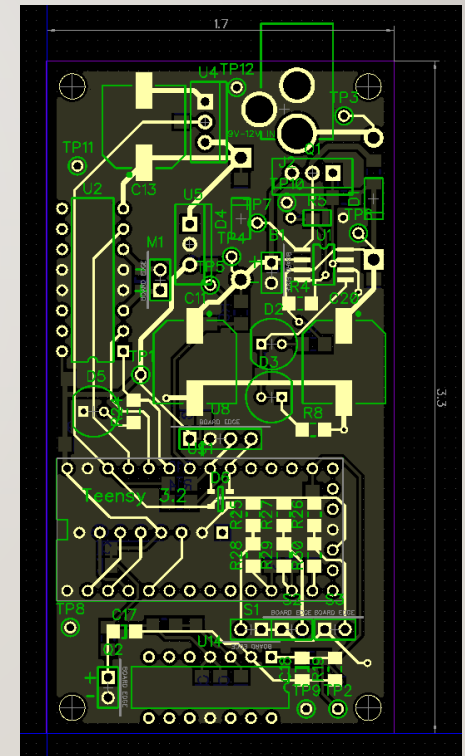
PACKAGING

- Casing designed in Solidworks

- 3D Printed in ABS Plastic

- Designed with pistol-grip handle for ease of use

MCU SELECTION

- 32-bit

- 72 MHz

- 64 KB RAM

- 256 KB Flash

- $19.80

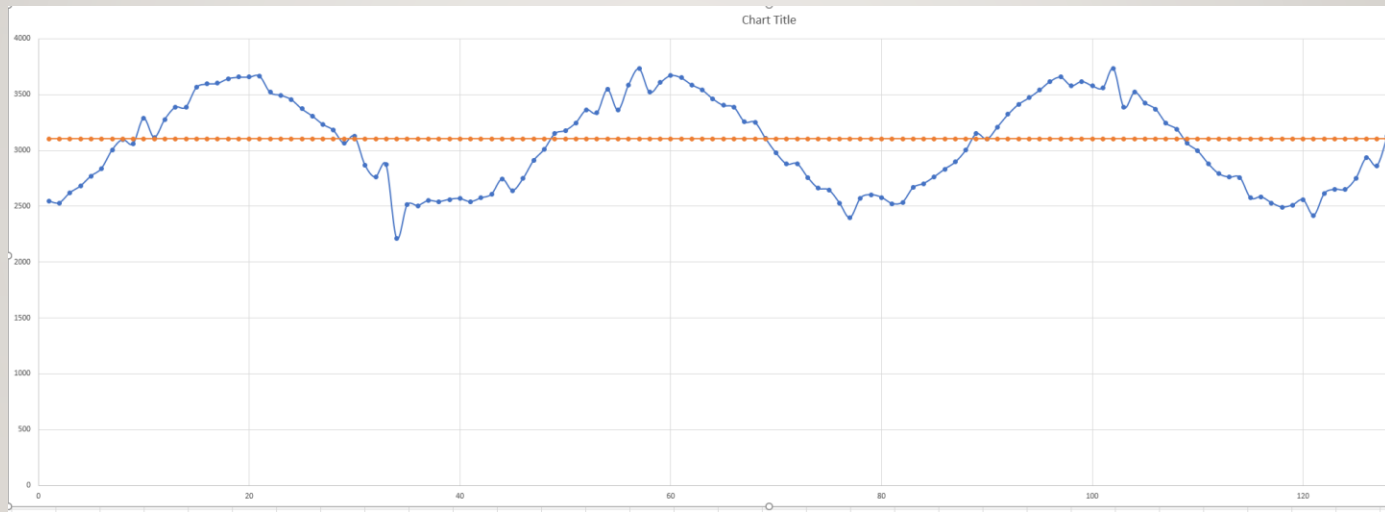| Name	Operating Voltage (V)	Bit Width (bits)	Frequency (MHz)	Flash (KB)	RAM (KB)	Price (USD)
MSP430G2 553	1.8-3.6	16	16	16	0.5	2.50
MSP430F5 529	1.8-3.6	32	25	128	10	8.06
Quark D1000	1.62-3.63	32	33	8	32	9.63
dsPIC33EV 32GM104	4.5-5.5	16	70 MIPs	32	4	3.20
ATUC64L3 U	1.62-3.6	32	50	64	16	5.71
Teensy 3.2	3.6-6.0	32	72	256	64	19.80

Selected Component

ZERO CROSSING
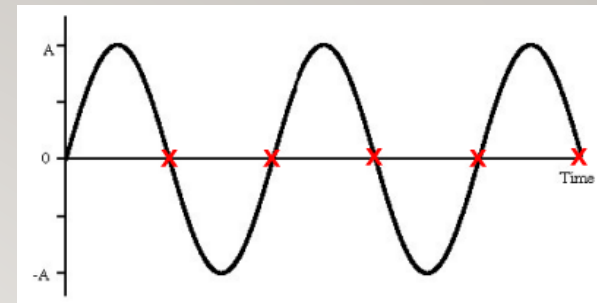
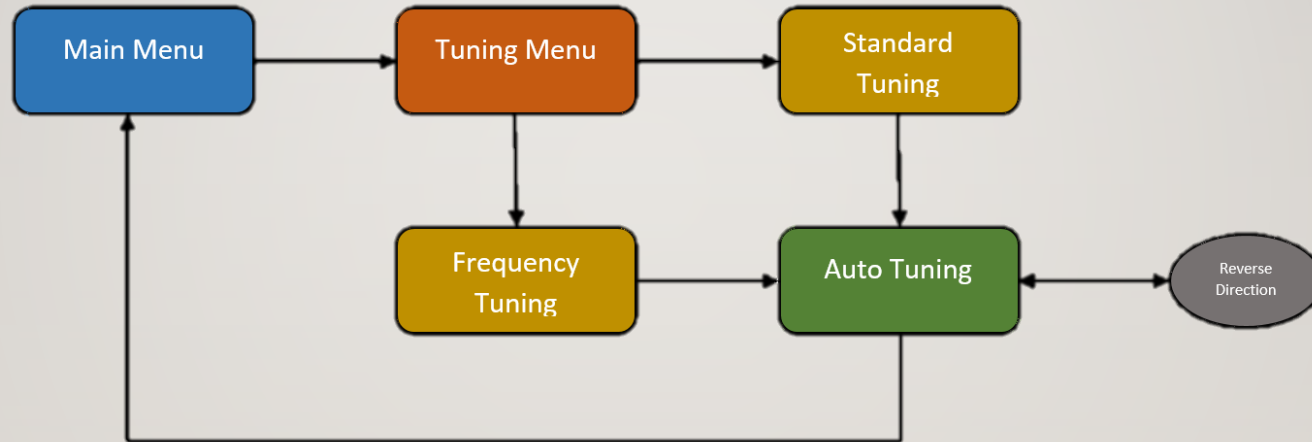Credit: Lewis Loflin, BristolWatch.com

CROSS CORRELATION
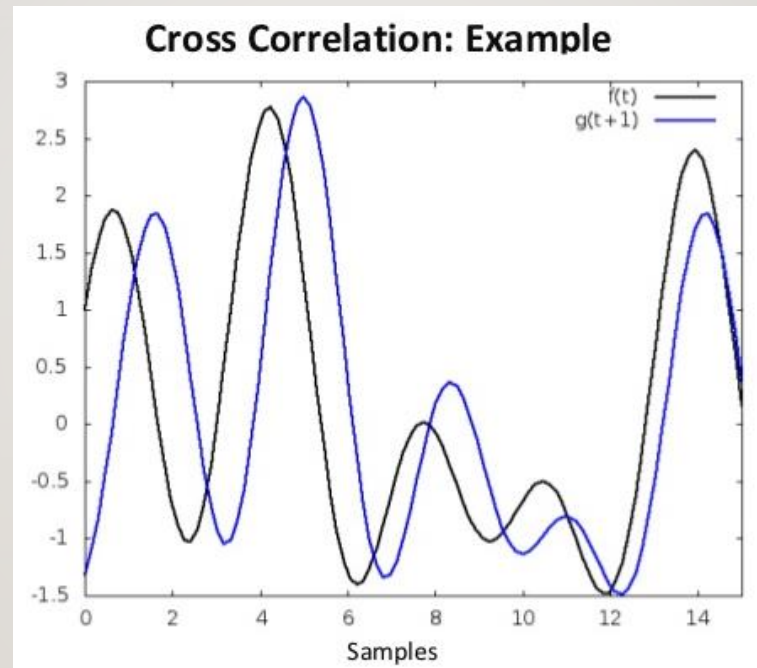
Credit: SCAPE Project, Jesper Sindahl Nielsen,
The State and University Library & MADALGO

AUTOMATIC TUNING PROCESS

MANUAL TUNING PROCESS
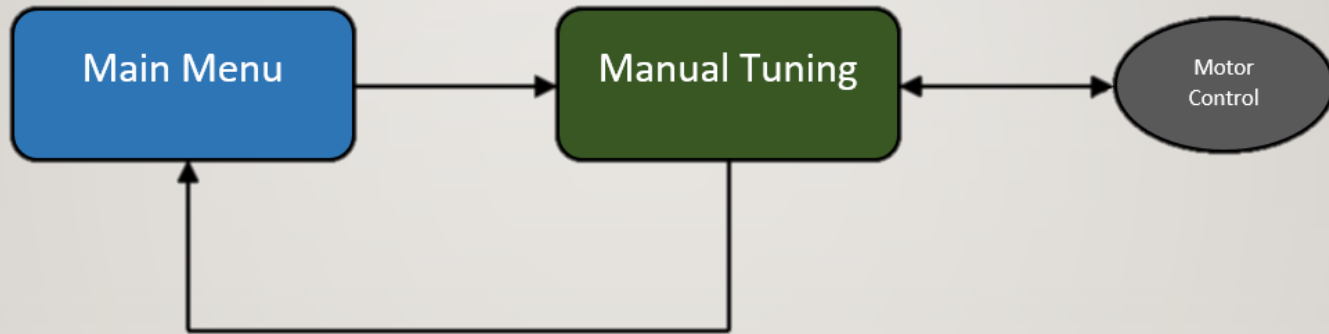
ADMINISTRATIVE CONTENT

WORK DISTRIBUTION

Name	Software	Power	Signal Processing	Wireless Connection
Adam	Secondary			Primary
Bryan	Primary			Secondary
Jason		Secondary	Primary	
John		Primary	Secondary	

BOM COST

Item	Total Towards BOM
Teensy 3.2	24.45
PCB V2	18.8
Gearmotor	12.47
4x 18650 LION Cells	10.725
CAP ALUM 1000UF 20% 16V SMD	3
DIODE SCHOTTKY 45V 7.5A P600	2.92
IC LI-ION LDO CHARGE MGMT 8SOIC	2.07
2s 18650 Battery Pack	1.718
P-FET	1.699
Slide Switch	1.398
1206 4.7k	1.065
OLED Display	1
H-Bridge L293D	0.899
LM7805	0.799
CONN IC DIP SOCKET 16POS GOLD	0.75
CONN IC DIP SOCKET 14POS GOLD	0.72
IC OPAMP JFET 3MHZ 14DIP	0.61
CONN PWR JACK 2X5.5MM SOLDER	0.6
TVS DIODE 5.5VWM SOT143B	0.53
100xLEDs	0.2
DIODE ZENER 3.3V 200MW SOD323F	0.166
Male Header	0.1312
RES 0.2 OHM 5% 1/4W 1206	0.07
Bluetooth Module	17.5
Total:	**104.29**

BUDGET

Component	Cost	Actual
Board Development	$50	$123
Servo	$40	$14
Casing	$10	$5
Microphone	$20	$20
Rechargeable Battery	$20	$22
Battery Charging Circuit	$20	$30
Charger	$5	$10
Unforeseen Costs	$150	$292
OLED Display	$5	$10
Bluetooth Module	$20	$18
Total	**$340**	**$544**

ISSUE(S)

- Microphone sensitivity not being high enough for desired positioning

- Implementation of ADC with different MCU

- Flaw in PCB Design that makes the Bluetooth module unable to communicate with the MCU

QUESTIONS?