# Auto FBO

Group 12 CDR

# Team Members

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MG2

# Motivation

- Nearly 20,000 nontowered airports in the United States, compared to approximately 500 that are towered
- Two primary concerns for pilots: real-time weather reports and radio communications checks
- It is critical that pilots are aware of ***wind speed*** and ***direction***, ***barometric pressure***, ***temperature***, and ***dew point*** surrounding the airport

*Orlando-Apopka Airport*

- Pilots need to have a confirmation of correct radio operation before takeoff
- Automatic Terminal Information Service (ATIS) and Automated Surface Observing System (ASOS) in place at larger airports are not cost-efficient for smaller airports

## Slide 3

**MG2** Josh
Michael Graziano, 6/22/2017

# Goals & Objectives

- The objective of this project is to build an easy to use, reliable, and efficient system for pilots to receive critical weather information and perform a communications check when flying into a non-towered airport

1. To increase the safety of pilots and passengers at these smaller airports with no manned Field Base Operator (FBO)

2. Provide a cost-effective alternative to expensive ATIS/ASOS systems

3. Improve upon the previous group's final design and expand the system's capabilities

# Previous Design Flaws

- Cumbersome housing, complicated to deploy
- Only measured wind speed and wind direction
- Playback audio from the communications check/weather reporting was heavily distorted and extremely quiet rendering the final product unusable in the field
- Lack of real-world design considerations
  - Thermal design
  - Circuit protection
  - Reliability

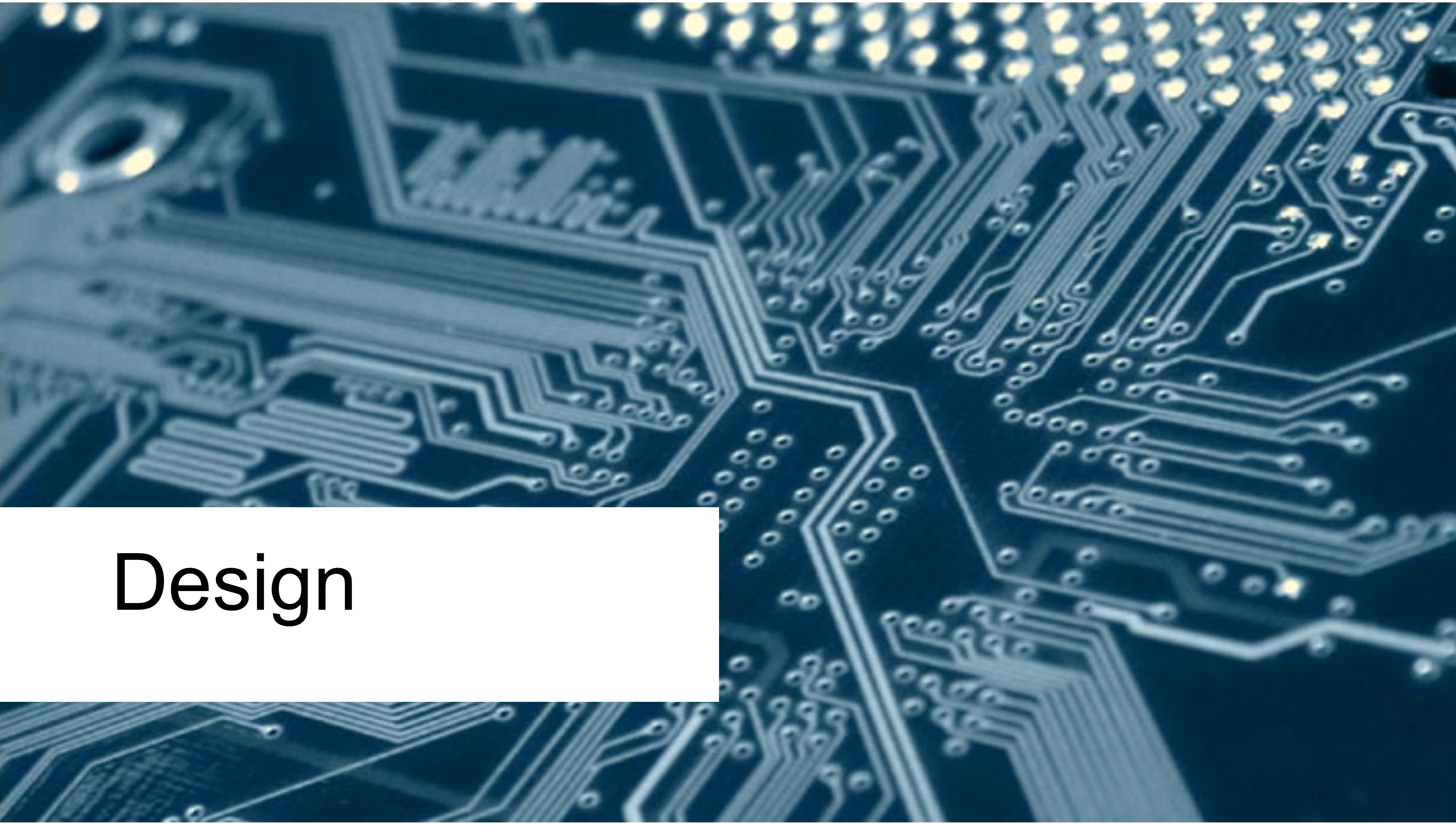
# Requirements

- Expand the capabilities for weather measuring to include temperature, humidity, and pressure sensing
- Completely redesign the audio input and output chain to allow for true “distortion free” playback
- Operate on the airports UNICOM frequency with proper phraseology and not broadcast if the channel is occupied
- Package the final design in a deployable case/enclosure that is easy to setup
- Stay on budget and produce a cost-effective solution
- Address real-world design practices and incorporate them into our final product

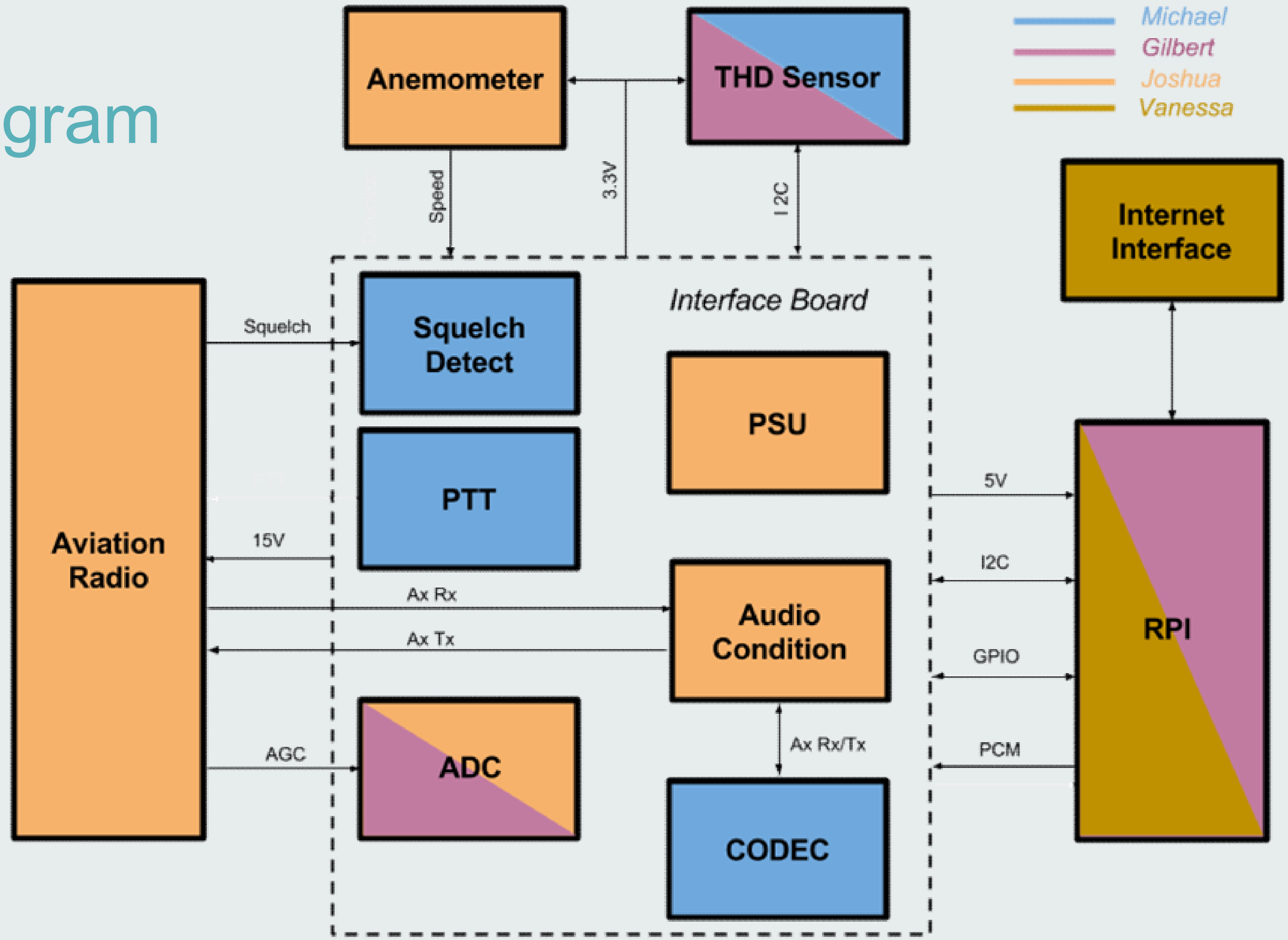
# Engineering Specifications

- Response Time: < 3 s
- Temperature Accuracy: ± 2 °C
- Humidity Accuracy: ± 5%
- Pressure Accuracy: ± 0.12 inHg
- Wind Speed Accuracy: ± 2 kts or ± 5%
- Wind Direction Accuracy: ± 5°
- Maximum Recording Length: 15 seconds
- Power Level Accuracy: ± 5 dBm

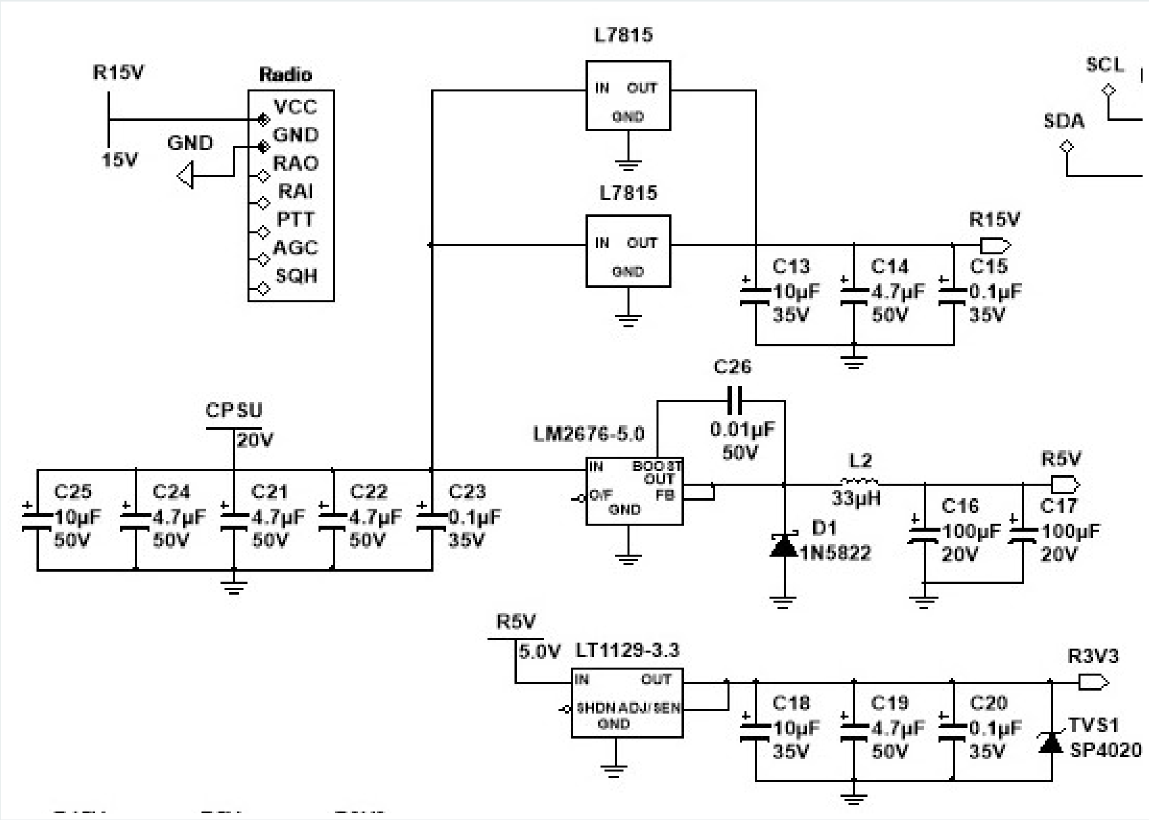
# Design



# Block Diagram



# Power Supply



# Linear Regulator Selection

*3.3 V Linear Regulator Comparison*

| Part No. | Final Decision | Min-Max Regulated Voltage | Max Current Output | Max Input Voltage | Max Voltage Dropout at Max Current Output | Per Unit Price |
|---|---|---|---|---|---|---|
| | | V | A | V | - | |
| **TLV1117I-33** | | 3.168-3.432 | 0.8 | 16 | 1.2 | $0.85 |
| **LT1129I-3.3** | ✓ | 3.250-3.350 | 0.7 | 30 | 0.7 | $5.65 |
| **AMD7150** | | ±2% | 0.8 | 16 | 1 | $4.91 |

*5 V Linear Regulator Comparison*

| Part No. | Final Decision | Max Efficiency | Max Current Output | Max Input Voltage | Min-Max Regulated Voltage | Frequency | Per Unit Price |
|---|---|---|---|---|---|---|---|
| | | % | A | V | V | kHz | |
| **LM2676** | ✓ | 94 | 3 | 45 | 4.9 - 5.1 | 260 | $4.90 |
| **LM2670** | | 94 | 3 | 40 | 4.9 - 5.1 | 260 | $6.00 |
| **LM53625** | | 90 | 2.5 | 36 | 4.92 – 5.125 | 2100 | $3.70 |

# Linear Regulator/Power Supply Selection

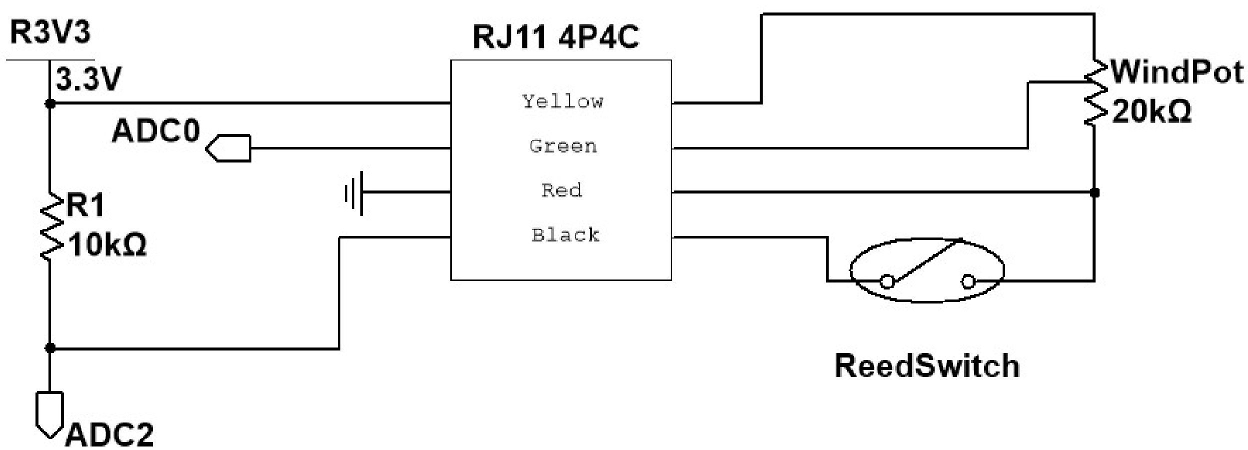
*15 V Linear Regulator Comparison*

| Part No. | Final Decision | Min-Max Regulated Voltage | Max Current Output | Max Input Voltage | Max Voltage Dropout at Max Current Output | Per Unit Price |
|---|---|---|---|---|---|---|
| | | V | A | V | - | |
| **L78S15C** | | 14.25-15.75 | 2 | 35 | 2.5 | $0.84 |
| **L7815C** | ✓ | 14.4-15.6 | 1.5 | 35 | 2 | $0.61 |
| **LM340** | | 14.25-15.75 | 1.5 | 35 | 2 | $1.51 |

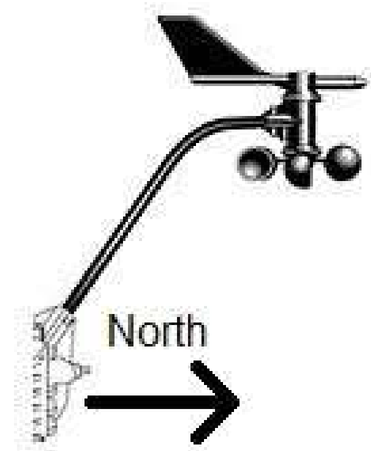
*Central Power Supply Unit Comparison*

| Power Supply Unit | Final Decision | Input Voltage | Output Voltage | Max Output Current | Efficiency | Output Power | Per Unit Price |
|---|---|---|---|---|---|---|---|
| | | VAC | VDC | A | % | W | |
| **GSM160B20-R7B** | | 80-264 | 20 | 8 | 92.5 | 160 | $61.75 |
| **GST120A20-R7B** | ✓ | 85-264 | 20 | 6 | 90 | 120 | $41.68 |

# Anemometer

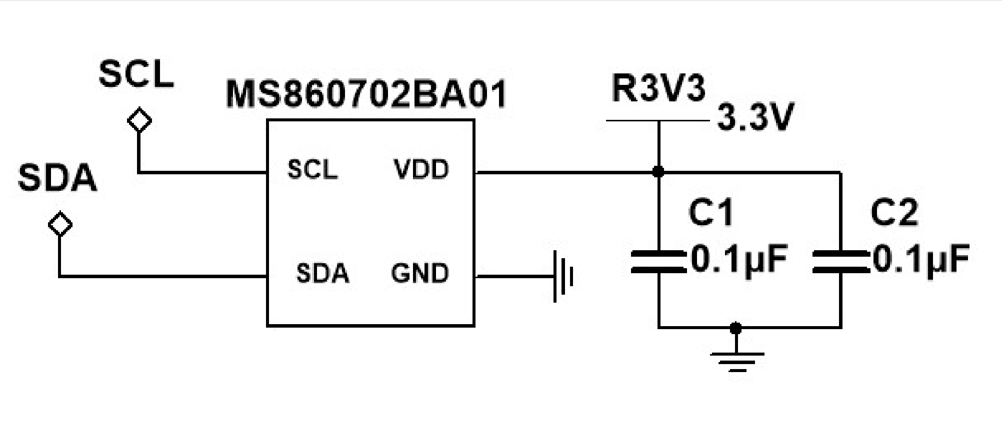


R3V3
3.3V
ADC0
R1
10kΩ
ADC2
RJ11 4P4C
Yellow
Green
Red
Black
WindPot
20kΩ
ReedSwitch

North

# Environmental Sensor



# Environmental Sensor Selection

*Temperature Sensor Comparison*

| Part No. | Range | Accuracy | Resolution | Long Term Stability | Max Response Period | Max Current Use | Per Unit Price |
|---|---|---|---|---|---|---|---|
| | °C | °C | °C | °C/year | s | mA | |
| **DHT22** | -40-80 | ±0.5 | 0.1 | N/A | 2 | 2.5 | $9.95 |
| **HDC1080** | -40-125 | ±0.2 | 0.1 | N/A | 0.0064 | 7.2 | $4.65 |
| **MS8607-02BA01*** | -40-85 | ±1 | 0.01 | ±0.3 | 0.015 | 1.25 | $8.48 |

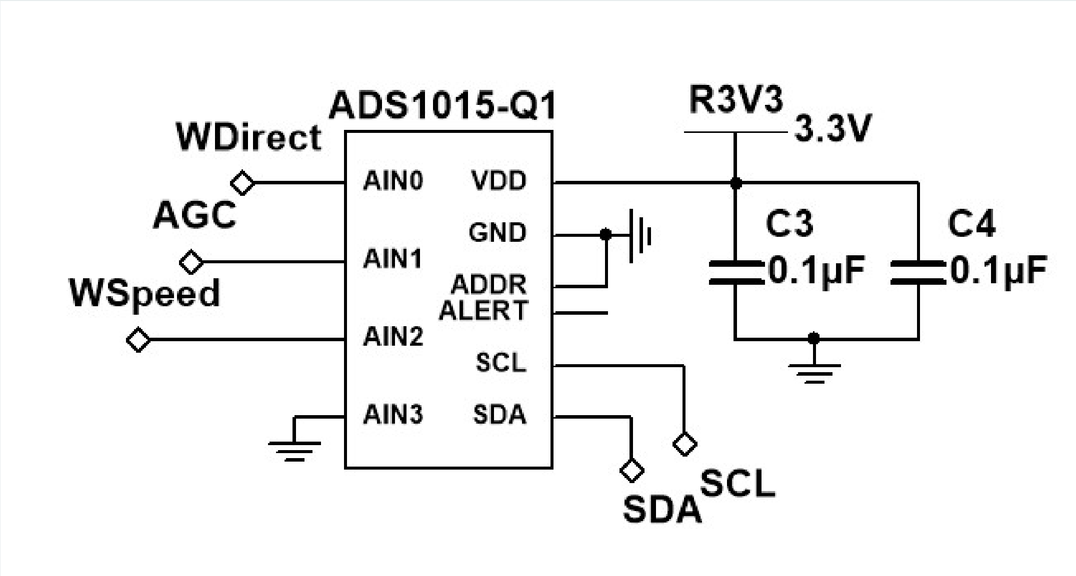
*Humidity Sensor Comparison*

| Part No. | Range | Accuracy | Resolution | Stability | Max Response Period | Max Current Use | Per Unit Price |
|---|---|---|---|---|---|---|---|
| | % | % | % | RH% /year | s | mA | |
| **DHT22** | 0-100% | 2-5% | 0.1% | ±0.5% | 2 | 2.5 | $9.95 |
| **HDC1080** | 0-100% | ±2% | 0.1% | ±0.25 | 0.0065 | 7.2 | $4.65 |
| **MS8607-02BA01*** | 0-100% | ±3% | 0.04% | ±0.5% | 0.015 | 1.25 | $8.48 |

*Pressure Sensor Comparison*

| Part No. | Range | Accuracy | Resolution | Long Term Stability | Max Response Period | Max Current Use | Per Unit Price |
|---|---|---|---|---|---|---|---|
| | inHg | inHg | inHg | inHg/year | s | mA | |
| **KP236N6165** | 17.718-48.7245 | ±0.2953 | 0.2953 | N/A | 0.010 | 10 | $6.80 |
| **MPL3155A2** | 14.765-32.483 | ±0.4 | 0.00044 | ±0.295 | 0.512 | 2 | $9.95 |
| **MS8607-02BA01*** | 0.2953-59.06 | ±0.059 | 0.0005 | ±0.0295 | 0.015 | 1.25 | $8.48 |

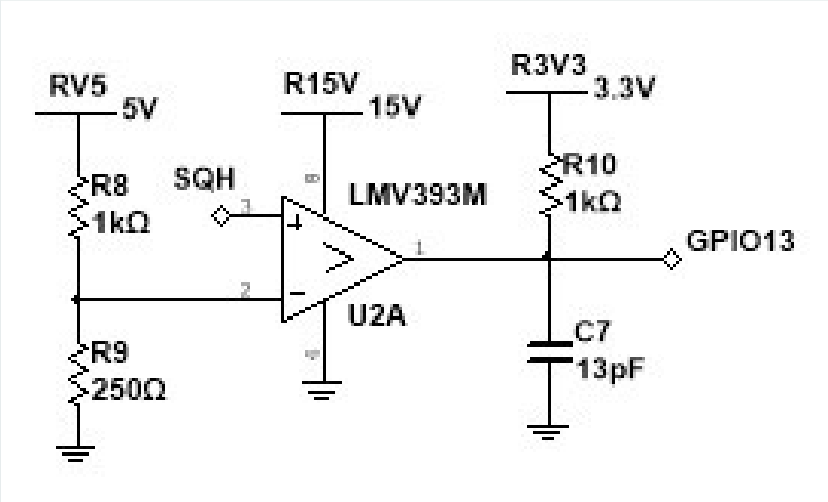
# ADC



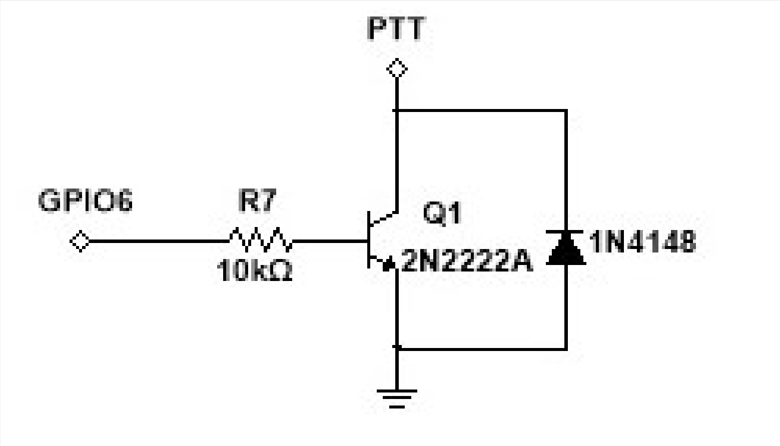

*ADC Comparison*

| Part No. | Resolution | Sample Rate (max) | # of Inputs | Interface | Input Range | Per Unit Price |
|---|---|---|---|---|---|---|
| **MCP3004** | 10 | 200 SPS | 4 | SPI | 0.25-7V | $2.32 |
| **ADS1015*** | 12 | 3300 SPS | 4 | I2C | 0-5.5V | $2.74 |
| **ADS1115** | 16 | 860 SPS | 4 | I2C | 0-5.5V | $6.47 |

# Carrier Detect/PTT Circuit

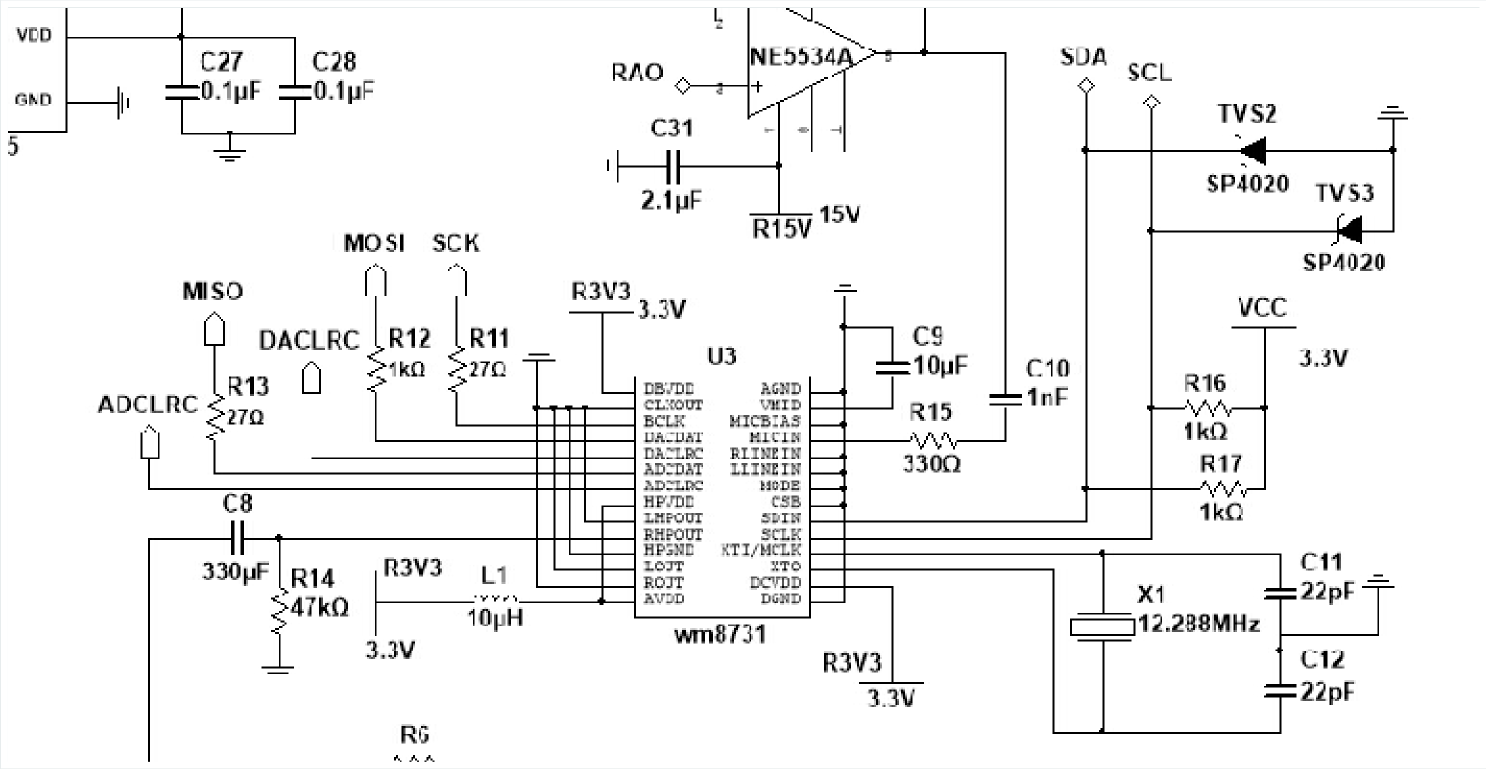



*Carrier Detect Circuit*



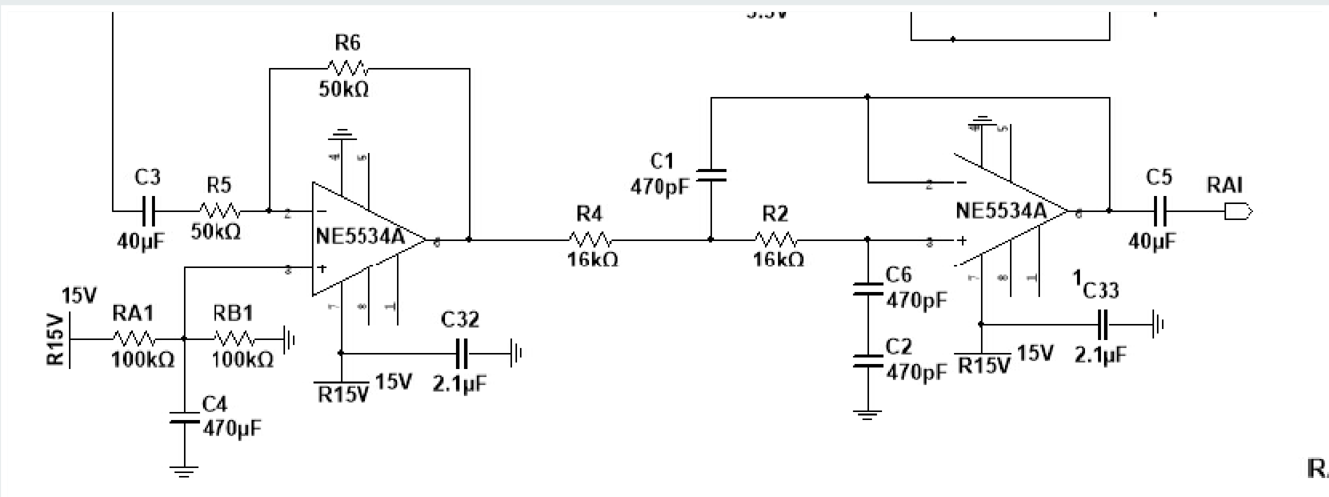

*Push-to-Talk Circuit*

# CODEC



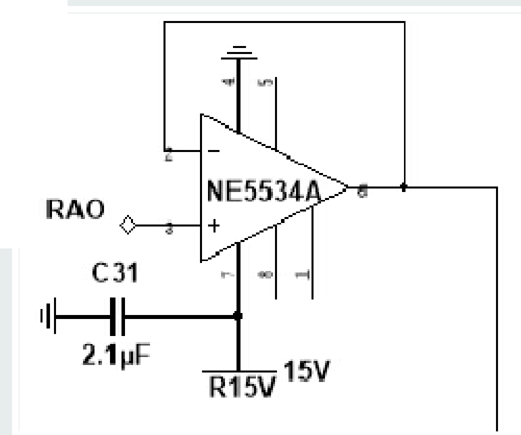
VDD
GND
C27
0.1μF
C28
0.1μF
RAO
NE5534A
C31
2.1μF
R15V
15V
SDA
SCL
TVS2
SP4020
TVS3
SP4020
MOSI
SCK
MISO
DACLRC
R12
1kΩ
R11
27Ω
R3V3
3.3V
U3
C9
10μF
C10
1nF
VCC
3.3V
R13
27Ω
ADCLRC
R15
330Ω
R16
1kΩ
R17
1kΩ
DBVDD
CLKOUT
BCLK
DACDAT
DACLRC
ADCDAT
ADCLRC
HPVDD
LHPOUT
RHPOUT
HPGND
LOUT
ROUT
AVDD
AGND
VMID
MICBIAS
MICIN
RLINEIN
LLINEIN
MODE
CSB
SDIN
SCLK
XTI/MCLK
XTO
DCVDD
DGND
C8
330μF
R14
47kΩ
R3V3
3.3V
L1
10μH
wm8731
X1
12.288MHz
C11
22pF
C12
22pF
R3V3
3.3V
R6

# Audio Filters




*Transmit Audio Circuit*

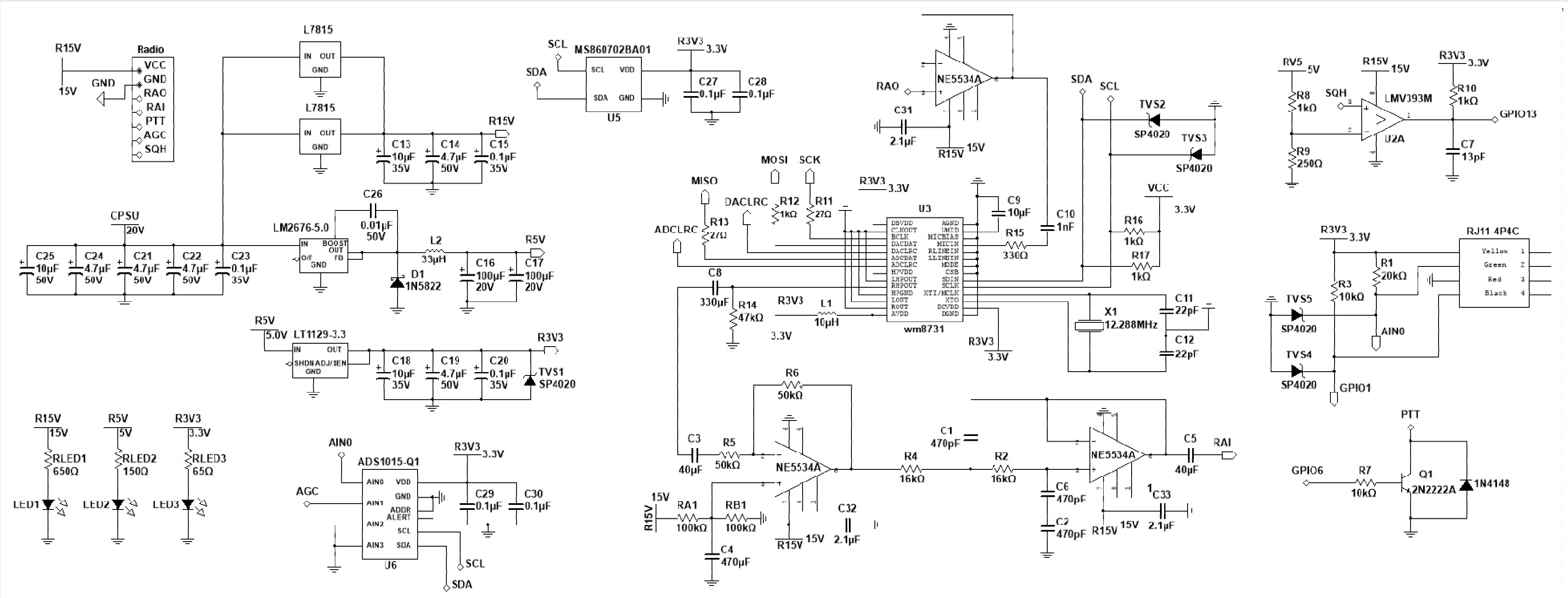
*Receive Audio Circuit*



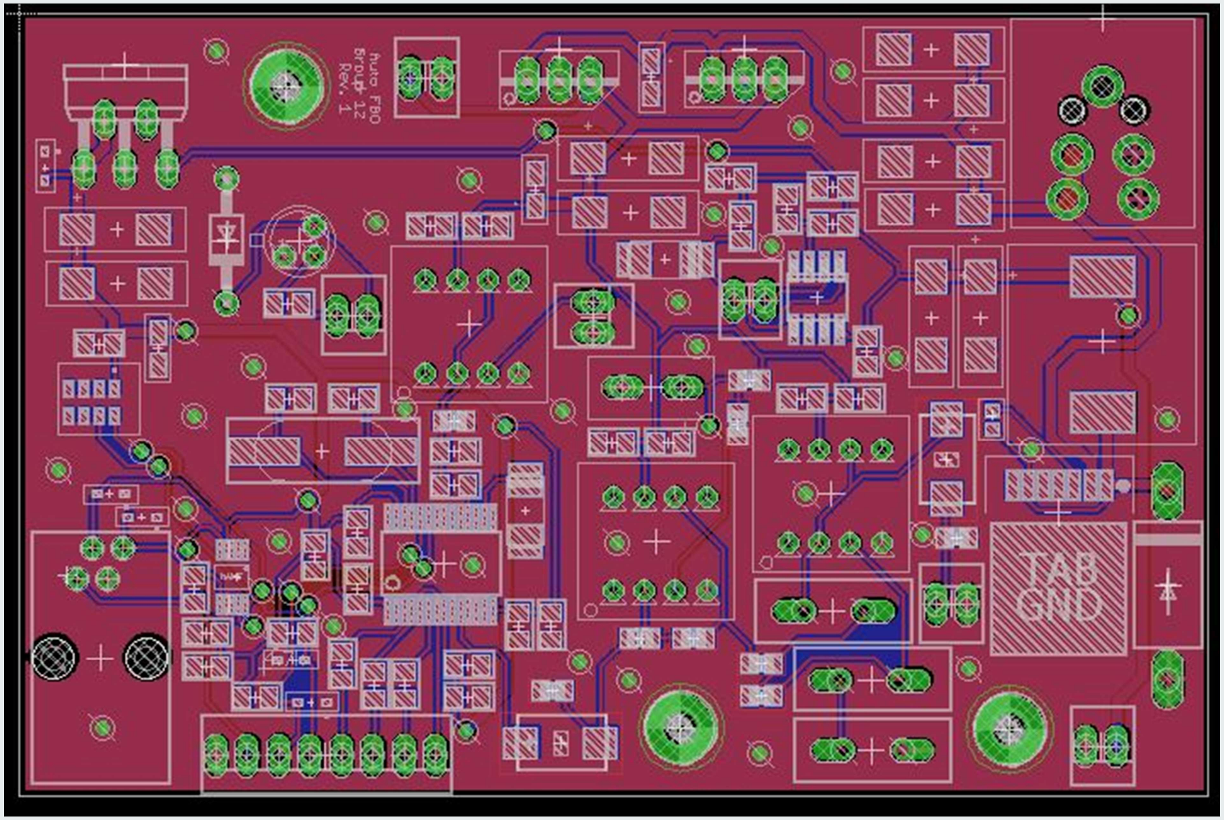
# Op-Amp Selection

| Part Number | Final Decision | Noise | Slew Rate | GBP | THD+N | Supply Voltage | CMRR | Price Per Unit |
|---|---|---|---|---|---|---|---|---|
| | | nV/√Hz (1kHz) | V/µs | MHz | % | V | dB | |
| **OPA2376** | | 7.5 | 2 | 5.5 | 0.00027 | 2.2-5.5 | 90 | 1.20 |
| **NE5534A** | ✓ | 3.5 | 13 | 10 | 0.002 | 6-40 | 100 | 0.90 |
| **OPA209** | | 2.2 | 6.4 | 18 | 0.000025 | 4.5-36 | 130 | 1.50 |
| **LM833** | | 4.5 | 7 | 16 | 0.002 | 10-36 | 100 | 0.40 |

# Master Schematic

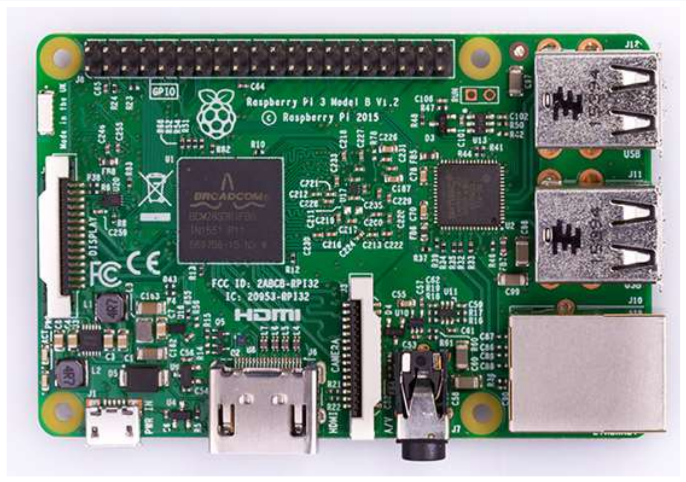


# PCB Design



# MCU Selection

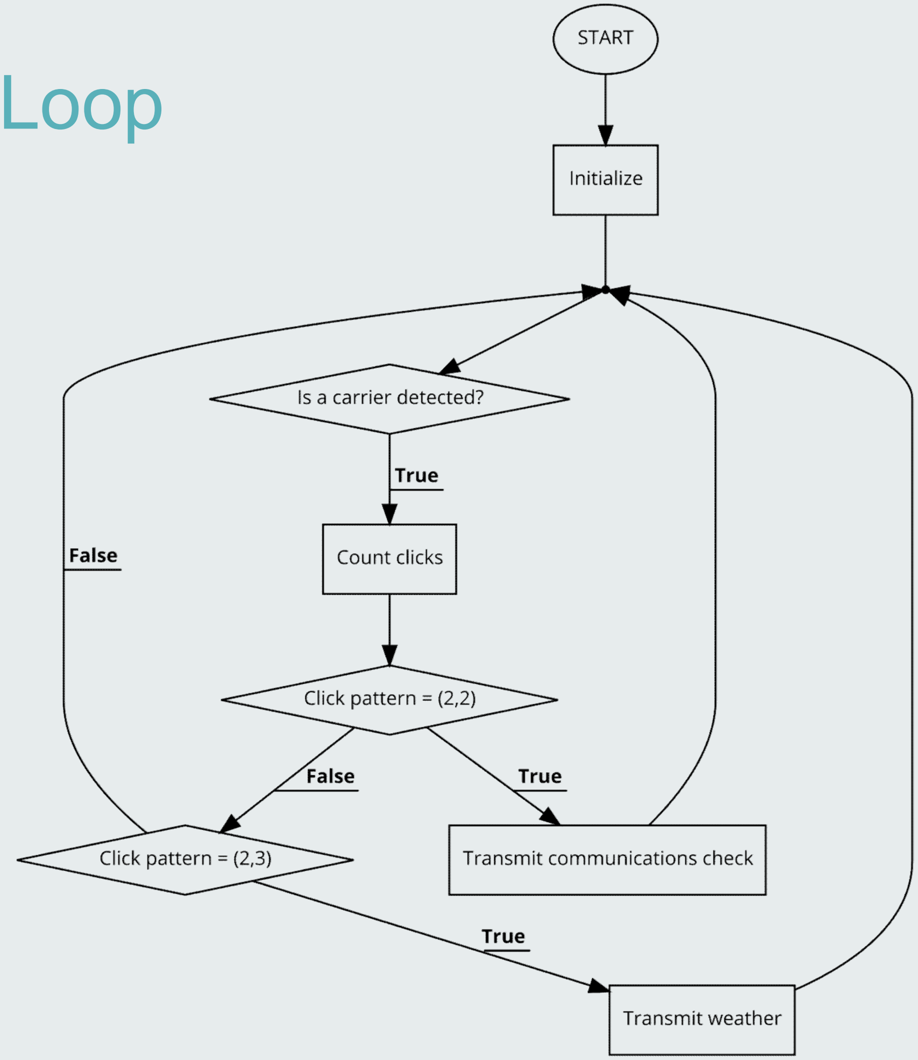
| MCU | Final Decision | Price Range | Dimensions | CPU | Clock Speed | RAM | Flash | GPIO Pins | I2C | SPI |
|---|---|---|---|---|---|---|---|---|---|---|
| **Raspberry Pi 3** | ✓ | $35 | 85 x 56 mm | ARM Cortex A53 | 900MHz | 1GB | Micro-SD Card | 26 | 2 | 1 |
| **Arduino Uno** | | $22 | 74.8 x 53.3 mm | ATmega 328P | 16MHz | 2KB | 32KB | 14 | 2 | 1 |



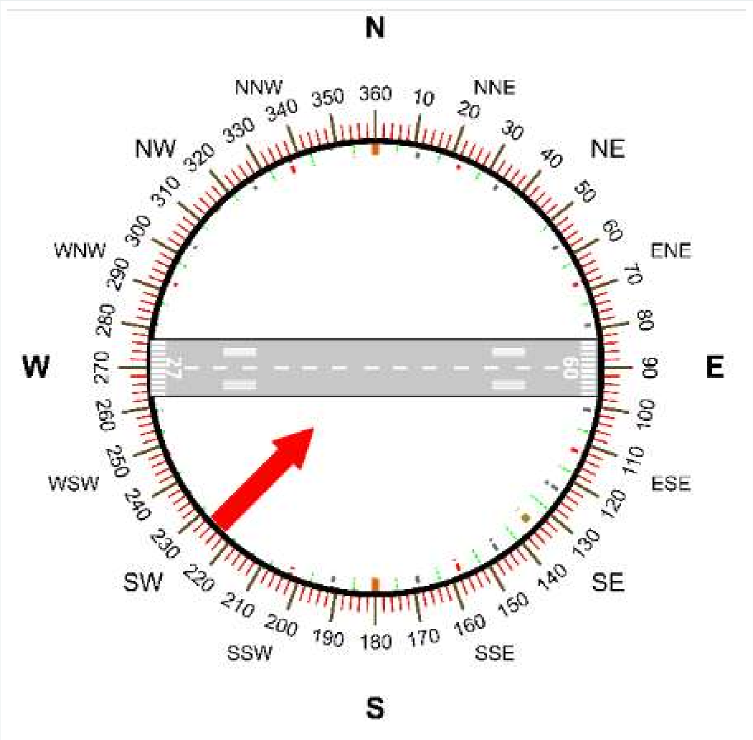
# Programming Language Selection: Python

- Python has libraries for both the Raspberry Pi and the ADC
- For the web interface, we decided to use Django for the framework which utilizes a combination of HTML and Python
- Libraries and Packages:
  - Adafruit_ADS1x15
  - Smbus
  - Svox pico tts
- Other Languages Considered: C and Java
  - Unlike C or Java, Python is the language of choice for the Raspberry Pi and already had many of the libraries we needed
  - Though familiar with C and Java, we have more experience with Python

# Main Logic Loop



# Weather Reporting GUI



# Management

# Budget

| Component | Design Quantity | Backup Quantity | Design Expense | Total Expense |
|---|---|---|---|---|
| Anemometer | 1 | 0 | $0.00 | $0.00 |
| THD Sensor | 1 | 3 | $2.12 | $8.48 |
| ADC | 1 | 3 | $0.81 | $3.23 |
| Raspberry Pi 3 | 1 | 1 | $40.00 | $80.00 |
| Operational Amplifiers | 3 | 6 | $3.27 | $9.82 |
| Comparator | 1 | 3 | $0.77 | $3.08 |
| Diodes | 2 | 6 | $0.62 | $2.46 |
| Transistor | 1 | 3 | $2.23 | $8.92 |
| Voltage Regulators | 4 | 10 | $8.29 | $29.00 |
| Connectors/Headers | 4 | 8 | $6.66 | $20.00 |
| PCB + Labor | 1 | 1 | $150.00 | $300.00 |
| Passive Components | 50 | 150 | $17.50 | $70.00 |
| Power Supply | 1 | 1 | $40.00 | $80.00 |
| Aviation Radio | 1 | 0 | $55.00 | $55.00 |
| TVS | 5 | 15 | $3.86 | $15.45 |
| LEDs | 4 | 12 | $0.20 | $0.80 |
| CODEC | 1 | 3 | $4.38 | $17.52 |
| Case | 2 | 0 | $20.00 | $20.00 |
| **Estimated Total** | | | **$355.71** | **$723.76** |

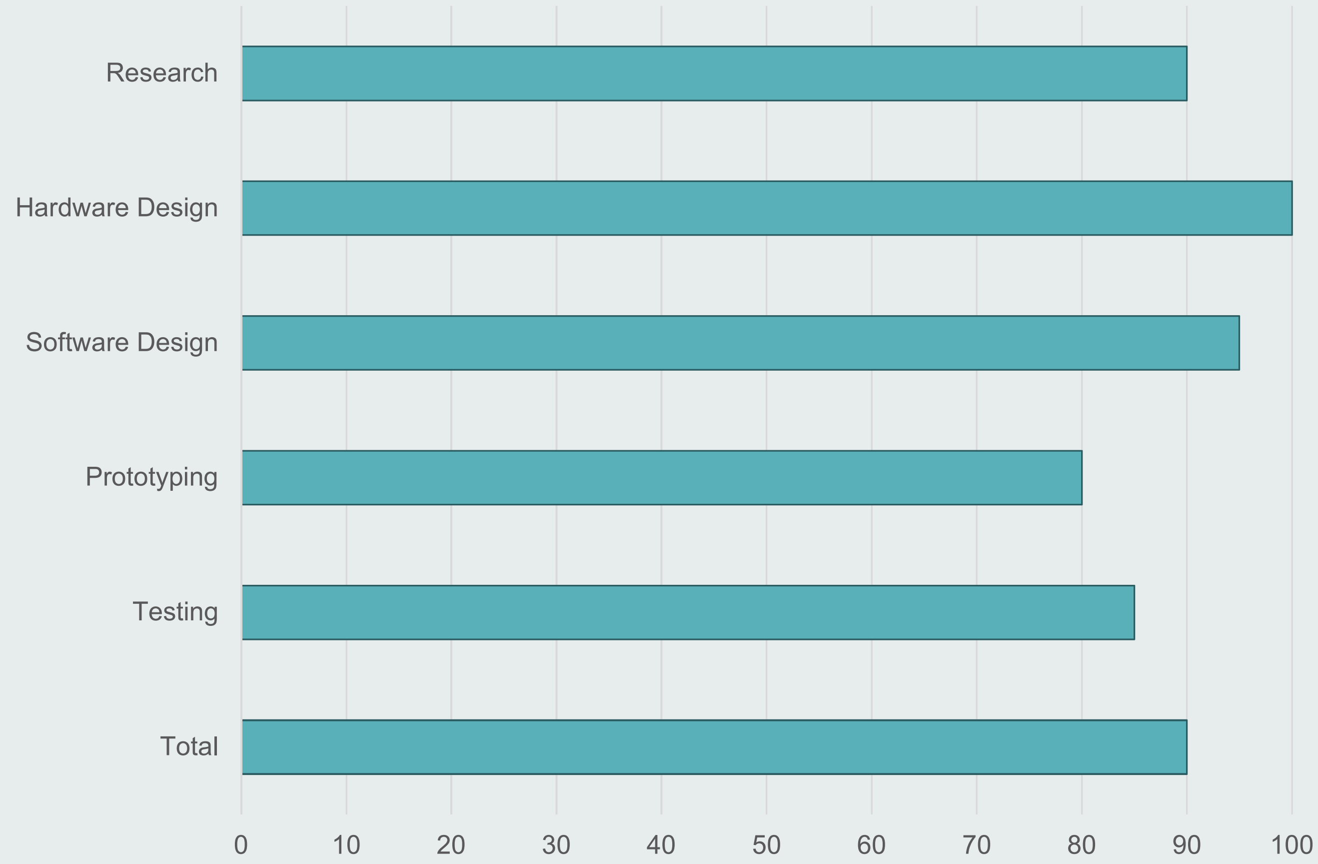
# Major Goals for Completion

- Design & print 3D housing
- Continue to test overall functionality of system
- Resolve issue with CODEC
- Finish software design and programming

# Work Distribution

| | Aviation Radio | Weather Sensors | PCB | PTT/ Squelch | Audio | Power | Digital Interface | Web Interface |
|---|---|---|---|---|---|---|---|---|
| Gilbert | - | P | - | S | P | - | - | S |
| Vanessa | - | S | - | P | S | - | - | P |
| Josh | P | P | S | S | P | P | S | - |
| Michael | S | S | P | P | S | S | P | - |

# Progress



Research
Hardware Design
Software Design
Prototyping
Testing
Total
0
10
20
30
40
50
60
70
80
90
100

# Questions