RONArmor

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Team # 31

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1. Introduction

1.1. Objective

Since the end of year 2019, the world has been struck by vicious cycles of a global pandemic and non-stop quarantine where we are responsible not only for our own well-being, but also for the health and safety of those around us. Throughout this entire process, we have received three essential safety precautions: mask up, stay 6 feet apart, and wash or sanitize hands as often as possible. So we thought, why not design a safe, reusable, and affordable facial shield that reinforces the social distancing process and possesses communication-friendly features? While initially everyone struggled to keep up with the supply of masks and settled for whatever they could get their hands on, now we can design new masks that offer proper safety, freedom of expression, comfort and utility.

RONArmor will be a form-fitting, protective facial shield constructed with recyclable plastic that reassures the safety of users by enforcing social distancing guidelines through sensors and ensuring improved and entertaining communication through audio amplification and modulation. Our challenge is to produce a product that will aid people in moving beyond a conventional mask to express themselves better and in a safer manner.

1.2. Background

COVID19 has left the world scrambling for economic stability, social justice, vaccines, and face masks. Daily, frontline workers must gear up with the proper protective equipment and it has led to a shortage of N95 masks throughout the United States [1]. As face masks have become normalized and a required necessity, enormous amounts of plastic waste have been generated throughout the world [2]. Furthermore, a common recurring issue associated with the enforcement of face coverings is difficulty with communication, specifically with the transmission and reception of speech. Companies like Razer and their Project Hazel have proposed to solve this issue with a mask that possesses voice amplifying technology in addition to a UV Sterilizer charging case for repetitive use [3]. However, it still remains a concept as the product is yet to be officially introduced in the marketplace [4]. Moreover, its ample amount of high-tech and smart features will most likely require longer production time as well as higher cost. Both of these factors pose obstacles for countries and their people who are struggling to fulfill their essential duties on a daily basis. Our goal is to create an effective product that can combat these issues so that everyone can easily, affordably, and comfortably attempt to regain some normalcy in their everyday lives while ensuring the safety of themselves and their communities.

1.3. High-Level Requirements List

Mainly three requirements:

1) Audio is properly amplified and can be modulated between three pitches (low, medium, high) or remain unmodulated.

2) Accurately assesses and notifies the user whether people are standing six feet away.

3) Prevents components near the face from shorting, overheating, and other dangerous risks by maintaining a low amperage of less than 2 mA.

2. Design

2.1. Block Diagram

Figure 1 below is the block diagram for RONArmor displaying each individual subsystems, their interconnections, and data flow. The big, gray box in the center that encases the control unit, voice functions, and power supply subsystems symbolizes the protective, wearable battery case as seen in the physical design in Figure 2. Similarly, the blue triangle on the bottom right represents a charging station, or a simple wall outlet.

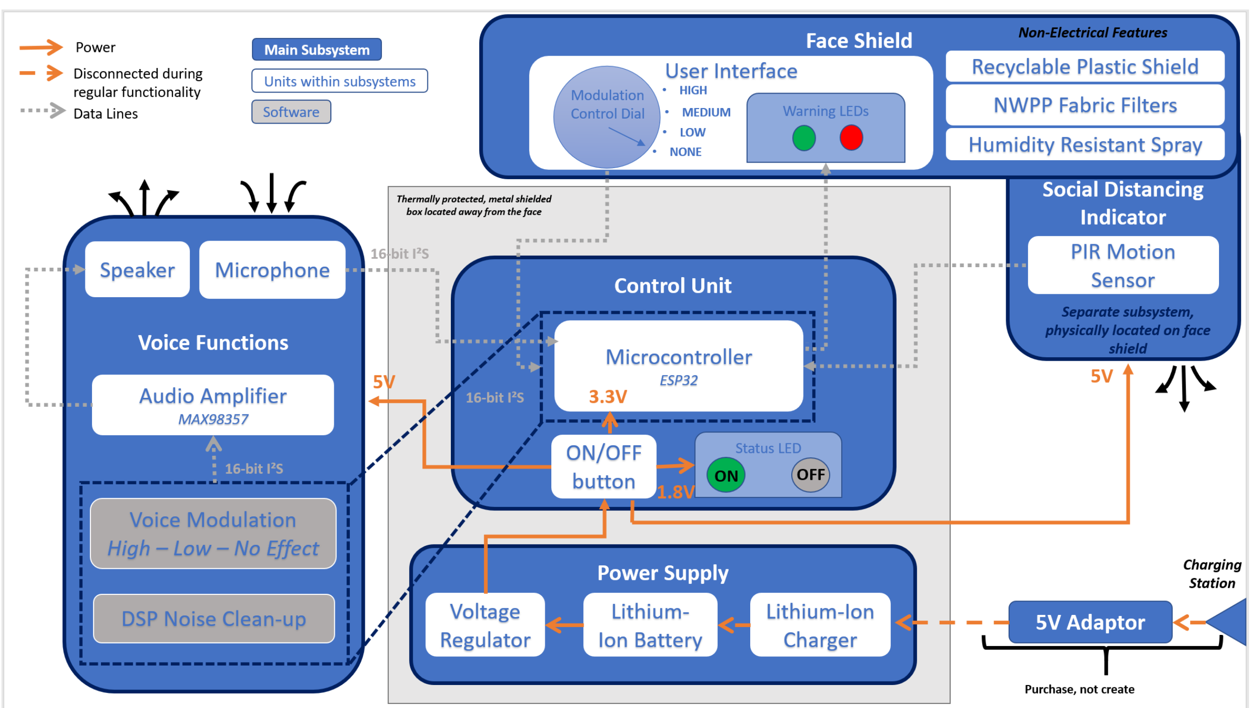


Figure 1: RONArmor Block Diagram

2.2. Physical Design

The physical design of RONArmor consists of a facial shield constructed of recyclable plastic with the intention of being environmentally friendly and transparent. The silicon lining of the facial shield allows for comfortability and flexibility and is secured to the user's head with an adjustable head strap. Fixed to either side of the mouth are breathable filters and a microphone and speaker are mounted at a distance to the right of the mouth. Warning LEDs, with foam coverings to diffuse their brightness and intensity, are positioned at either side of the user's face and within his or her peripheral vision. Located on either side of the head strap is a pair of PIR sensors. Additionally, an ON/OFF button and a frequency dial are placed on the right. Finally, an adjustable lanyard is worn backwards around the neck and has a thermally insulated, clip-on battery case that attaches to the user's clothing and keeps volatile elements away from the face. This is to provide additional support and relieve the stress that is exerted on the enclosed wires between the shield and battery case. The wire enclosure will be constructed of flexible and durable material. Refer to Figure 2 for visuals of the previously mentioned features. It is also important to note that in keeping our user's comfortability in mind, we plan to elongate our PCB design as much as possible and minimize its area so that it can eventually be modified into a physical design similar to that of neckband headphones as seen in Figure 3.

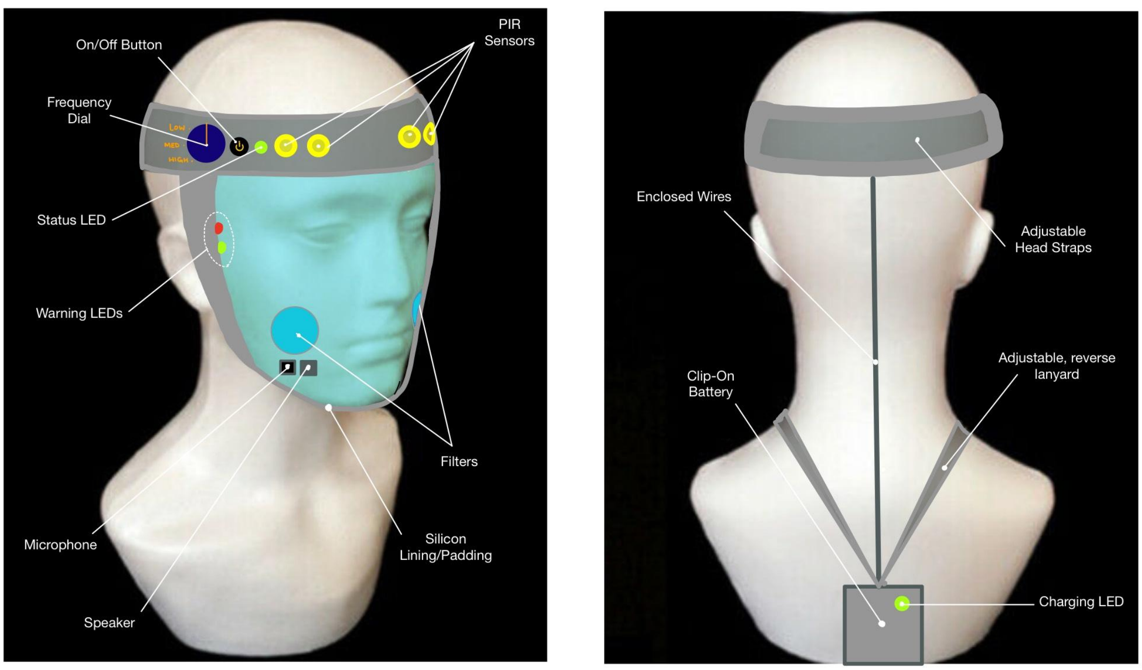


Figure 2: Physical Design

Figure 3: Neckband headphones [5]

2.3. Functional Overview and Block Diagram Requirements:

2.3.1. Power Management and Storage

Since portability is an essential part of our project, we will use lithium-polymer batteries as our voltage source to power our entire project. We also want to incorporate a 5V lithium-polymer battery charging circuit for recharging the batteries so that users could simply plug in their device instead of constantly replacing its batteries. Lastly, we will have a voltage regulator to ensure that each unit in our design is supplied with appropriate voltage levels. Introducing rechargeable batteries so close to the user's face will require a great focus on safety precautions. One of the precautions taken is utilizing a power monitoring IC that switches off charge current when the device reaches 75℃ as shown in Figure 4. Section 5: Ethics and Safety goes into greater depth on the entirety of the safeguards that RONArmor will implement.

Table 1: RV table for Power Management and Storage Unit

Requirements	Verification
1.) Lithium-polymer batteries continuously supply a current between 80 mA and 100 mA at 5 V to the entire system.	1a.) Charge the lithium-polymer batteries by plugging the charging adapter to an AC outlet until the charging LED is green. 1b.) Fully disconnect the adapter from the battery holder. 1c.) Connect a red probe to the mAVΩ port and a black probe to the COM port of a multimeter and set the dial to 20 V DC. 1d.) Carefully insert the two probes to their respective colored ports of the series-connected battery packs and verify that the output voltage is 5V. 1e.) Turn the dial of the multimeter and set it to 200mA and likewise confirm the current being outputted is within the range of 80 mA-100 mA.
2.) Voltage Regulator supplies 5 V to the voice functions and social distance indicator modules as well as 3.3 V to the microcontroller in the control unit.	2a.) Connect leads from both the voltage and ground terminal of the power supply to a breadboard and connect them to the voltage regulator according to the connections specified in Figure 7. 2b.) Repeat step 1c from above using banana to alligator cables instead of probes. 2c.) Insert two additional leads in the breadboard and connect one to the 3.3 V output and the other to the 5 V output of the voltage regulator. 2d.) Attach the alligator clips that are coming from the multimeter to the leads from 2c and confirm the output voltages to be 3.3 V and 5 V.

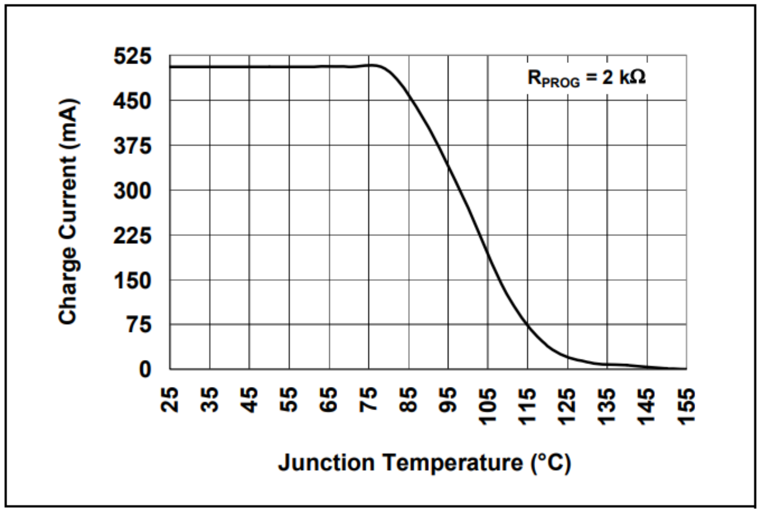


Figure 4: Thermal Regulation of Lithium Polymer Recharging Circuit [6]

2.3.2. Control Unit

An ESP32 microcontroller is responsible for processing the data from our sensors, determining the status of our user interface LEDs, and handling a majority of the signal processing performed from our microphone input to our speaker output.

2.3.2.1. Microcontroller

We intend to use digital audio since it allows for easier signal manipulation. The ESP32 microcontroller will permit us to control the two main units: the voice functions and the social distancing indicator. The ESP32 will receive, process, and deliver signals and commands in accordance to the user's inputs via the modulation control dial, the ON/OFF button, and the social distancing indicator's signals. Each of these systems are connected via the IO connections on the microcontroller and will be controlled by the programmed embedded software.

2.3.2.2. Software

Since the social distancing indicator and the voice functions will be driven by the microcontroller, we will need to control their respective behavior by programming it.

a. *Algorithm for social distancing indicator:*

For the social distancing part, we will utilize the DIG OUT signals from the PIR sensors. Each PIR sensor will be set to activate only at a certain range. One PIR sensor will activate when there is activity within 6 ft, and the other will activate when there is activity within 4 ft range. This leads to the following cases:

1.) When only the first DIG OUT is high: The microcontroller should then trigger the green warning LED.

2.) Both the DIG OUT are high: The microcontroller should trigger the red led indicating that a person is too close.

Our initial plan is to test the sensitivity of each of the PIR sensors to attain a combination that helps us in the most accurate detection of a person within the 6 ft and 4 ft range.

b. Algorithm for Voice functions:

For audio processing on the microcontroller, we plan on using either the Espressif DSP Library for ESP32 [7] or MicroPython. We intend to use the provided functions in the DSP Library to digitally modulate the voice input from the digital microphone breakout board as well as denoise the output audio by implementing/utilizing relevant libraries.

Table 2: RV Table for Control Unit

Requirements	Verification
1.) ESP32 microcontroller is powered at 3.3 V as the I/O pins are not 5 V tolerant [8]. I/O pins are needed to control the other components so it is crucial that 3.3 V is maintained.	1a.) Power the microcontroller with a voltage regulated lithium-polymer battery pack. 1b.) Connect the voltage inputs of the microcontroller to a voltmeter and confirm that a voltage reading of 3.3 V is being powered to the system.
2.) Microcontroller receives a high signal from the PIR sensors' DIG. OUT (3.3 V) based on the range set on each sensor. The first PIR needs to set OUT to HIGH when a person is detected within 6 ft. The second sensor needs to set OUT to HIGH when a person is detected within 4 ft.	2a.) Connect the microcontroller to a computer using a USB cable. Place the microcontroller on a breadboard for ease of connection. 2b.) Connect the sensors to the microcontroller by wiring them to the microcontroller's IO pins on the breadboard and power the sensors with a 5V DC input from a function generator. Leave the sensors idle for ~30 - 60 seconds for them to stabilize. 2c.) Place the breadboard at a height of 5.5 ft and have a human walk at a distance 4 ft, 6 ft, and greater than 6ft within the range of the sensor (side view: ± 50 degrees, top view: ± 30 degrees assuming that the line of sight of the sensor is the central axis). 2d.) Use a voltmeter to confirm the 6 ft PIR sensor's output voltage to be 3.3 V for within 6 ft and 0 V for beyond. 2e.) Repeat step 2d for the 4 ft PIR sensor.

3.) The green LED should light up when only the 6 ft PIR sensor has OUT as High. The red LED should light up when both 6 ft and 4 ft PIR sensors OUT are High. At a distance greater than 6 ft neither LED should turn on.	3a.) Repeat steps 2a to 2c. 3b.) Replace the voltmeter from the 6 ft PIR sensor's circuit with a green LED. 3c.) Repeat step 3b for the 4 ft PIR sensor with a red LED. 3d.) Confirm that neither the green or red LED is lit at a distance greater than 6 ft. .

2.3.3. Voice Functions

The other main characteristic of our project will be its voice amplification and/or modulation features. This subsystem will utilize a microphone inside the shield to take in the user's voice signal. This signal will then be sent to the microcontroller via an I^2S protocol where software will perform noise filtering and the appropriate voice modulation. Finally the new audio signal will be sent through a digital audio amplifier to a speaker on the shield, making the voice more audible. The modulation to be performed will be determined by a dial on the shield with four functions for the user to select from: no modulation, low pitch, medium pitch, and high pitch.

For voice functions we will use SPH0645 breakout board (I2S digital microphone) and MAX98357 (I2S audio amplifier) [9]. Each of these operates on 3.3 V inputs and has low amperage of about 20 mA. Since these utilize only digital signals, we will be able to test and monitor the desired nature of audio using the microcontroller. The interaction between the controller and these chips will be done via C code using specific libraries for the ESP32 board. The ESP32 microcontroller has good support for I^2S protocol and by using the separate breakout boards we will ensure that there is no loss in quality since the microcontroller natively supports only 8 bit stream while the breakout boards support 16 bit and 32 bit. Using DSP, we will also be able to provide noise filtering and voice modulation options.

Requirement 1: Microphone receives speech input at a minimum of 30 dB [10].

Requirement 2: *Speaker outputs modified speech between the range of 30 to 100 dB for clear audibility to account for various environmental conditions[10].*

Table 3: RV Table for Voice Functions

Requirements	Verification
1.) Audio outputs with a latency time frame between 8-12 ms [11].	1a.) Set the voice modulation knob to “No modulation.” 1b.) In a silent room, attach an oscilloscope probe to pin 6 (digital audio out) of the MEMs device. 1c.) Using a second probe, connect the oscope to the input pin on the speaker. 1d.) Set the oscope to trigger on the rising edge of both channels. 1e.) Simulate an audio pulse (a clap, finger snap, whistle, etc). 1f.) Measure the timing from the rising edge of channel 1 to the rising edge of channel 2 and verify that it is between 8-12 ms. 1g.) Reat steps 1b-1f with the voice modulation knob set to “Low,” “High,” and “Medium” modulation settings.
2.) Speaker projects clear and denoised audio with a signal to noise ratio (SNR) that is greater than 65 dB.	2a.) Set the voice modulation knob to “No modulation.” 2b.) Simulate continuous background noise with an audio recording at a volume of at least 60 dB. 2c.) Attach an oscope probe to pin 6 on the MEMs device and observe the waveform. 2d.) Increase the persistence of the oscope so that it displays a clear eye diagram. 2e.) Position yourself so that your mouth is approximately 3 cm from the bottom port of the MEMS device. 2f.) At your natural tone and volume, speak into the MEMs device. 2g.) Freeze the oscope screen. 2h.) Measure the signal’s SNR and verify that it is greater than 65 dB 2i.) Reat steps 2b-2h with the voice modulation knob set to “Low,” “High,” and “Medium” modulation settings.

2.3.4. Social Distancing Indicator

One of the main functionalities of our project will be its ability to warn its user if there are people within a 6 ft radius. To do this, we will utilize two Passive Infrared (PIR) Sensors set at a sensitivity of 4 ft and at 6 ft to detect people. We will send this data to our software in the microcontroller to establish whether the person detected is too close per the CDC’s social distancing guidelines using logic. Signals will then be sent to a range of LEDs from red to green that indicate to the user whether social distancing guidelines have been breached and to what extent.

We intend to use the PIR sensor module controlled by the ESP32 microcontroller to ensure the social distancing aspect of our project. The PIR sensor takes in 3.3 V and is controlled via the IO pins on the microcontroller. We will be using PIR motion sensors by Adafruit. It has a overlooking horizontal range of ~100-110 degrees and vertical range of ~60-70 degrees as shown in Figure 5 [12]. Given the range of each sensor we will have a total of four sensors to maximize the detection range.

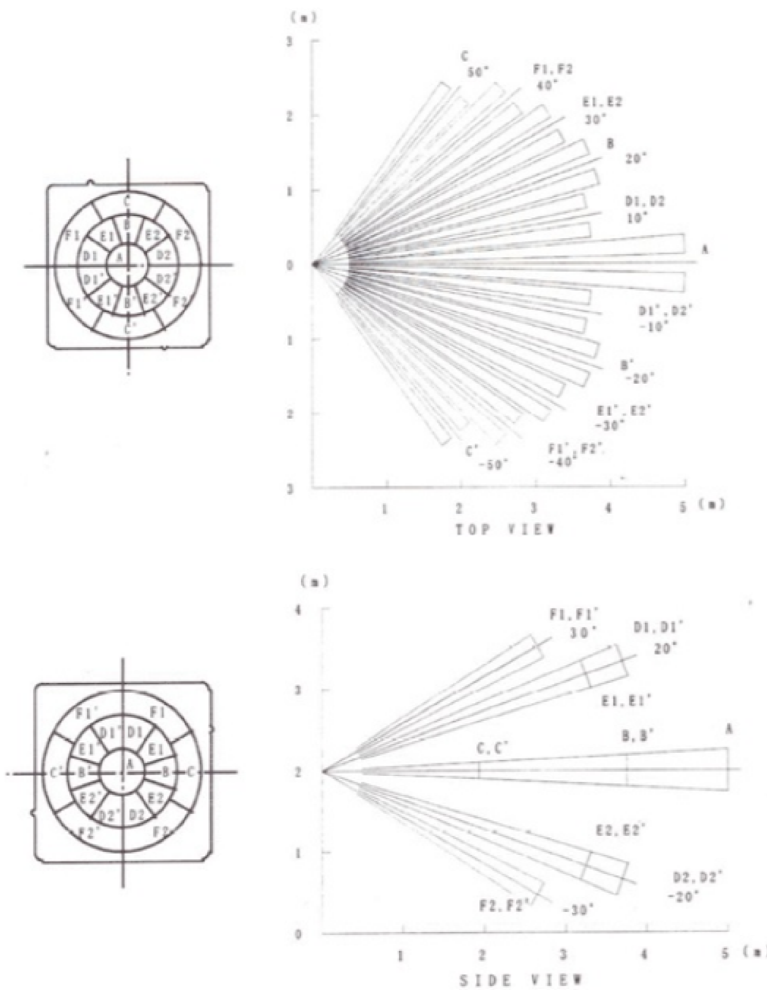


Figure 5: PIR Sensor’s different faceting and sub-lenses and their range of detection areas [12]

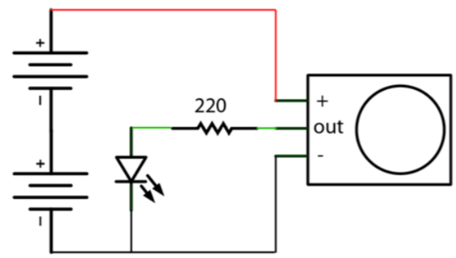


Figure 6: Verification circuit for PIR sensors [13]

Table 4: RV Table for Social Distancing Indicator

Requirements	Verification
1.) Each PIR sensor is powered at 5 V. The sensitivity trimpots on the PIR module need to be adjusted so that one sensor has a range of 6ft, and the other has a range of 4 ft. The DIGI. OUT of the module should be 3.3 V to indicate a HIGH within their respective ranges (4 ft and 6 ft)..	1a.) Set up the circuit from Figure 6 and power by connecting to a 5 V DC supply using a function generator. 1b.) Place the breadboard at a height of 5.5 ft. 1c.) Have a person pace at a distance 6 ft away in a perpendicular manner to the breadboard. 1d.) Connect a lead to the DIGI. OUT of the sensor which is also connected to a voltmeter using an alligator-banana cable. 1e.) Turn the trimpot of the sensor clockwise until the voltmeter reads 3.3 V. Otherwise, turn it counter-clockwise until 3.3 V is reached. 1f.) Repeat steps c through e at a distance of 4 ft away for the second sensor.

2.3.5. Face Shield

As for the physical shield, of our project, we will use clear, recyclable plastic for the shield itself, silicon lining and padding around the face, and spunbond non-woven polypropylene (NWPP) fabric filters around the edges for filtration. Lastly, the inside will be coated with a transparent humidity resistant spray.

Requirement: *Face shield's applied anti-moisture coating spray is safe for inhalation.*

2.3.5.1. Power Button

This button will allow the unit to power up and down as a whole, it determines when voltage can or cannot be supplied and when signals will or will not be transmitted to and from the microcontroller. When the unit is powered on, a green status LED will illuminate to indicate that the facial shield is active.

Requirement: Power button registers on/off action only when a minimum actuation force of 0.8 oz is applied [14].

2.3.5.2. Warning LEDs

Each warning LED will consist of red and green LEDs which correspond to the relative distance the user is in comparison to the people around them. Red represents less than 6 ft apart and green represents a distance of at least 6 ft. According to the signals received by the microcontroller from the social distancing indicator's PIR sensors, the embedded software will delegate which colored LEDs are activated.

Requirement: LED light intensity is below 10,000 cd/m^2 [15].

2.3.5.3. Frequency Dial

The dial will consist of four frequency options: none, low, medium, and high. When the dial is turned to a specific frequency setting, a signal will be sent to the microcontroller for signal processing. Once the microcontroller receives the voice signal it will improve the SNR ratio by performing DSP noise clean-up and then applying the appropriate voice modulation before outputting the new audio via a speaker mounted on the facial shield.

Requirement: The frequency dial possesses a maximum response time of 1s, but preferably within 100 µs [16].

Table 5: RV Table for Face Shield

Requirements	Verification
1.) The frequency dial possesses a maximum response time of 1 s, but preferably within 100 µs [16].	1a.) Use an oscilloscope to track the response time and latency of the dial by speaking into the microphone with a roughly constant frequency. 1b.) Simultaneously record the time displayed in the oscilloscope and turn the frequency dial on the mask to "High". 1c.) Note the time at which the frequency displayed on the oscilloscope changes to a steady, higher frequency. 1d.) Ensure that the time difference between that of 1c and 1b is between 100 µs to 1 s.
1.) The entirety of the printed circuit board and the power supply is no larger than the enclosure that can be clipped-on and away from the face.	1a.) Position the PCB as well as the battery inside of the enclosure and confirm that it will close and can be clipped at a safe distance away from the face.

2.4. Schematics & Physical Components

2.4.1. Top Level Schematic

Figure 7 shows the rough schematic setup of our main PCB. At the very center is the ESP 32 microcontroller (Figure 8) which controls the microphone, amplifier, PIR sensors and warning LED's through the various IO pins. The battery, microphone, amplifier and speaker, and the PIR modules utilize external breakout boards and thus, are connected to the main board via connectors. These appear in the diagram below as the X#-# molex connectors.

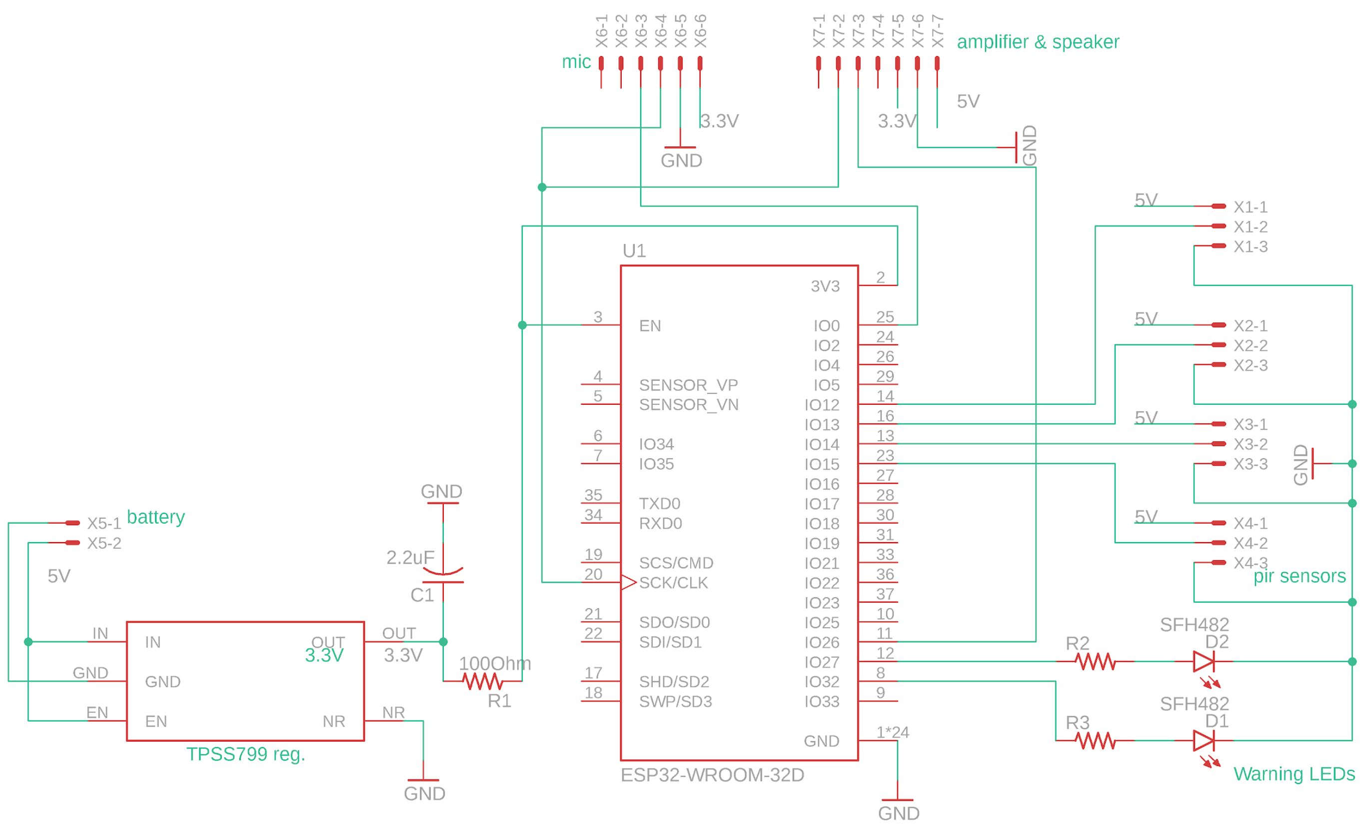


Figure 7: Top Level Schematic

Figure 8: ESP32-WROOM-32D Microcontroller [8]

2.4.2. Rechargeable Battery Breakout Board

Figure 9 shows the schematic of the rechargeable battery breakout that we are planning to use. Figure 10 shows how the breakout board (in blue) will be used to connect and recharge the battery.

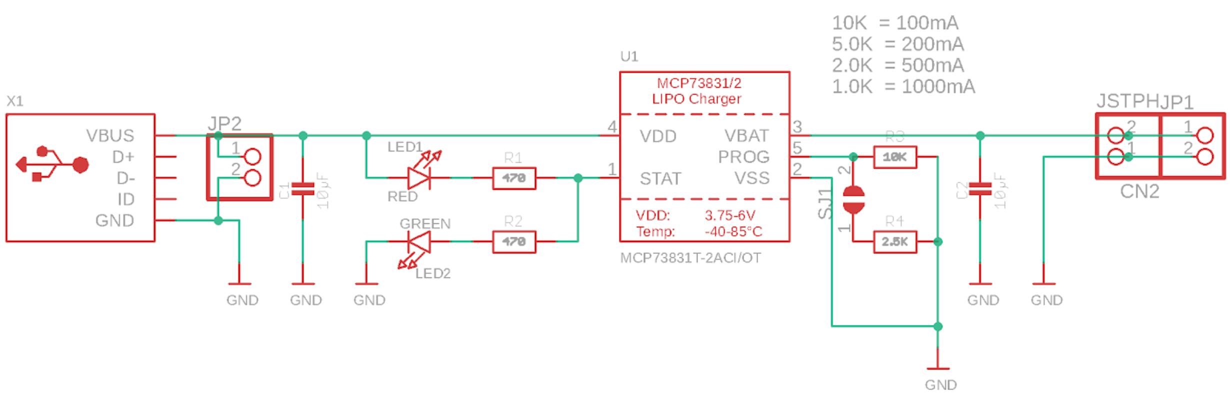


Figure 9: Rechargeable battery breakout board schematic [17]

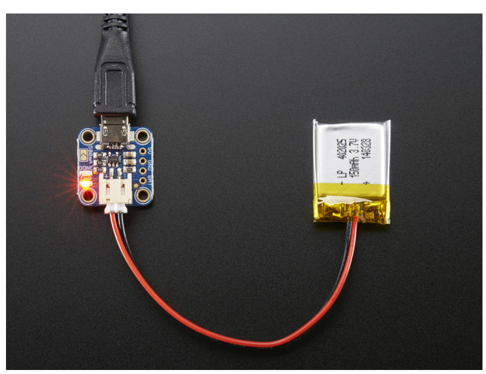


Figure 10: Breakout board with the battery [17]

2.4.3. Microphone Breakout Board

Figure 11 and 12 are the schematic and picture of the microphone breakout board respectively. Refer to the top level schematic to see how we plan to connect it to the main PCB.

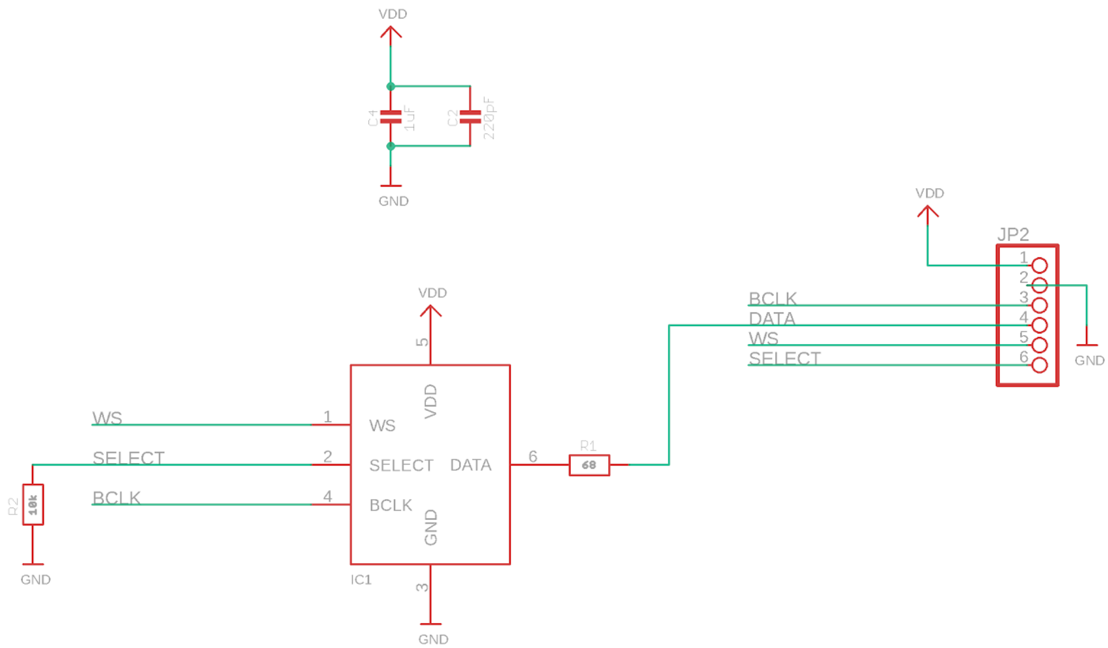


Figure 11: MEMS I2S microphone breakout board schematic [18]

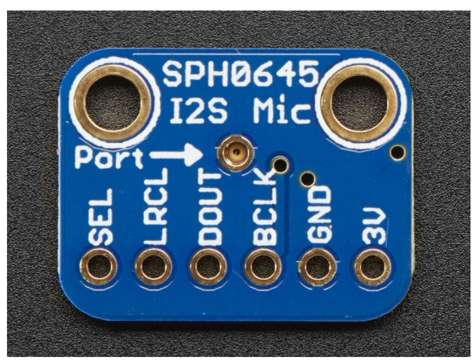


Figure 12: MEMS I2S microphone breakout board[18]

2.4.4. Amplifier Breakout Board

The schematic and picture of the amplifier breakout board are displayed in Figure 13 and 14 respectively.

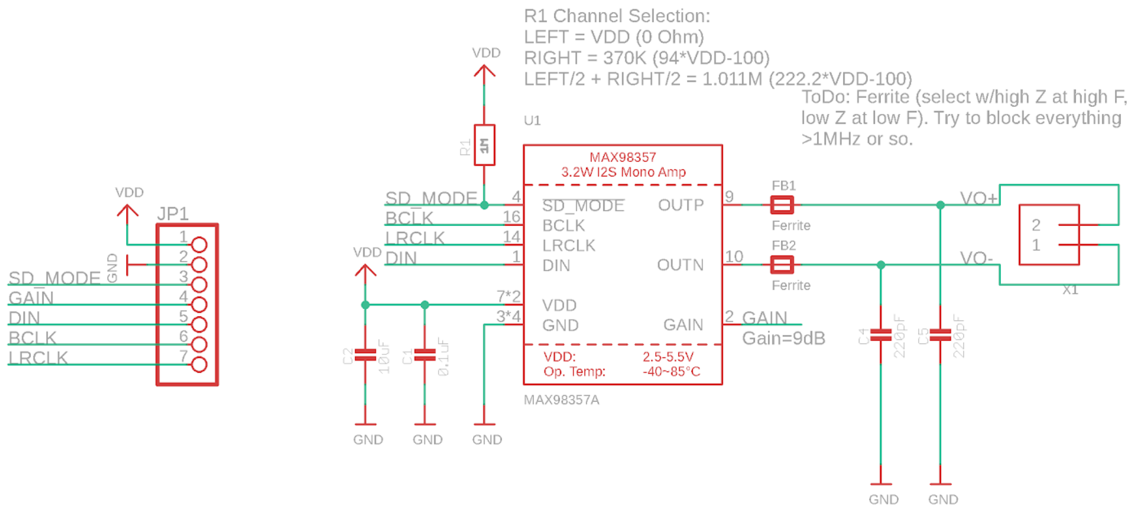


Figure 13: I2S amplifier (MAX98457) schematic [19]

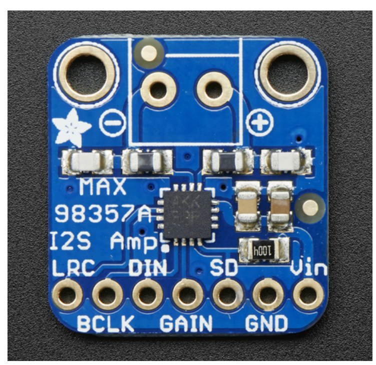


Figure 14: I2S amplifier (MAX98457) [19]

2.4.5. PIR Sensor Module

We are planning to use the above PIR module (Figure 15) from Adafruit industries for our social distancing sensor as it has a built in trimpot adjustment to control sensitivity of the sensor. This will help us control the range of each sensor, thus, exhibiting behaviour as described in its RV table.

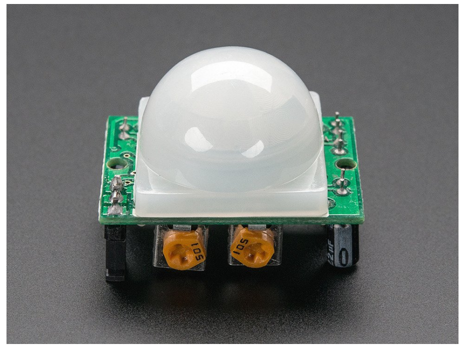


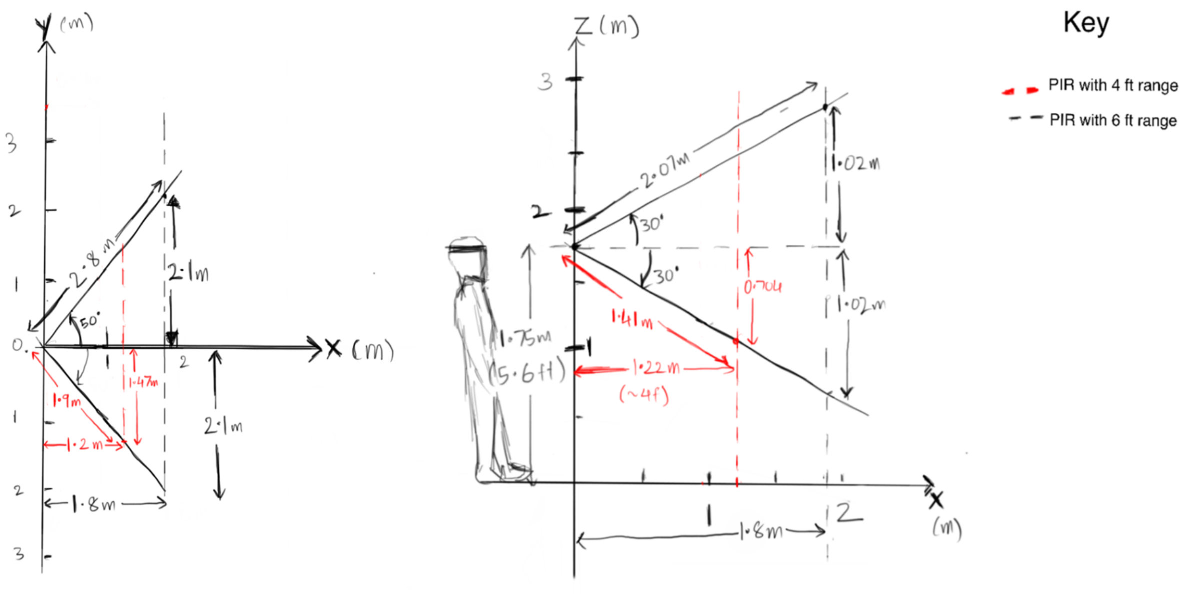
Figure 15: PIR module from Adafruit [12]

2.5. Tolerance Analysis

Our project depends on two major subsystems: social distancing indicator and voice functions. While the voice functions subsystem follows the conventional style of how its components are utilized, the social distancing module does not and is subject to some challenges.

The first challenge will be the reduction of false positives and negatives using the PIR sensor module. A false positive in this case would be triggering the wrong LED based on detection by the PIR sensors. An example of this is if a person walks in the 6ft range, but they are out of the sensor's range, the LEDs will not indicate the presence of the person. To reduce this error, we plan to increase the range of coverage by using four sensors (two on either end of the forehead as shown in Figure 2). Since the sensors are going to be placed near the forehead, we plan to experiment with the angles and distances that cover the most area and yield the least amount of false positives. While the datasheets provide a good estimation of the angles (refer to Figure 4 and 14), there will be additional testing required to account for extraneous factors such as the curvature of the forehead and head tilt. We intend to implement a testing method similar to what is specified in the verification table for the social distancing indicator subsystem (refer to Table 2 and 4) and compile the results into a table (possibly a graph) to determine the combination that fits the best.

The second challenge is to accurately trigger the LEDs based on which of the ranges (4ft or 6ft) a person is detected in. Typically an ultrasonic sensor would suffice, however, it will detect the distance of the closest object in its range regardless of whether or not it is a person. To avoid a wrong reading from using a PIR sensor, we intend to use two PIR sensors placed above each other and set to different ranges. As can be seen in Figure 16, one of the sensors is set to a range of 6 feet and the other to 4 feet. The angles and ranges for such a system have been calculated using the distances provided in the datasheet for the PIR sensor. As with the first challenge, we will need to follow a testing suite similar to the verification table for the social distancing indicator subsystem and compile the results to find the best fit.



Top View Side view

Figure 16: Angles and Ranges for a two PIR sensor social distancing module.

3. Costs Analysis

Our fixed development labor cost for each of the three members of our team is estimated to be about \$43.80/hour based on the average starting salary of an ECE graduate from the University of Illinois [20]. Each team member will work on the project for approximately 10 hours a week for the entire duration of the semester - a total of 14 weeks.

$$3\ team\ members \times \frac{\$43.80}{hour} \times \frac{10\ hour}{week} \times 14 weeks \times 2.5 = \$45,990$$

Additional Expenditures are included in Table 6 and Table 7 below:

Table 6: Electrical Expenditures

Part Number	Description	Manufacturer	Quantity	Unit Cost	Bulk Cost
ESP32	Dual-core microprocessor & development board	HiLetgo	1	\$10.99	\$10.99
MAX98357AEWL+T	Audio amplifier (16/24/32-bit I2S)	Maxim Integrated	1	\$2.27	\$2.27

3006	MAX98357A amplifier breakout board	Adafruit Industries LLC	1	$5.95	$5.95
SPH0645LM4H-B	Digital microphone (I2S)	Knowles	1	$2.61	$2.61
3421	SPH0645LM4H microphone breakout board	Adafruit Industries LLC	1	$6.95	$6.95
PIR Motion Sensor module (BIS0001 decoder, RE200B PIR element, NL11NH fresnel lens)	Motion Sensor	Adafruit Industries LLC	4	$9.95	$39.80
1905	MCP73831 board for USB-B LiPolymer Charging	Adafruit Industries LLC	2	$6.95	$13.90
TPS79901DDCR	Linear Voltage Regulator	Texas Instruments	2	$0.98	$1.96
HC-SR04	Ultrasonic Distance Sensor	Sparkfun	1	$3.95	$3.95
HJ-0502000W1-US	5V Adaptor/ Charger	Hanzhiqiang	1	$10.90	$10.90
2011	Lithium-Polymer Battery	Adafruit Industries LLC	2	$14.95	$29.90
AS04008PO-2-LW152 -WR-R	Speaker	PUI Audio, Inc.	1	$4.52	$4.52

Total Electrical Parts Cost: $133.70

Table 7: Mechanical Expenditures

Part Number	Description	Manufacturer	Quantity	Unit Cost	Bulk Cost
ANSI/ISEA Z87.1+	Facial Shield	McMaster-Carr	1	$38	$38
PD3060WH1N	Non-woven	HanilSF	1	$8.95	$8.95

	polypropylene fabric				
1594CBK	Thermally resistant box	Hammond Manufacturing	1	$10.60	$10.60
54-385A	On/Off button	NTE Electronics, Inc	1	$2.13	$2.13
NR01104ANG13-2H	Modulation Knob	NKK Switches	1	$11.68	$11.68

Total Electrical Parts Cost: $71.36

Grand Total

$$\$45,990 + \$133.70 + \$71.36 = \$46,195.06$$

4. Schedule

Week	Aditya	Moriah	Shana
3/8/21	Begin writing software code for ESP32 setup and sensors	Begin testing various sensor formations for signals and combating false positives and finalize sensor layout	Work with mems device, familiarize, and finalize design with machine shop
3/15/21	Draw out circuit schematic for social distancing indicator and control subsystems	Draw out circuit schematic for power, voice functions, and user interface subsystems	Integrate all subsystems onto a PCB design using Eagle and send out PCB order
3/22/21	Begin working on software for the social distancing indicator subsystem	Solder components and begin testing/validating subsystems in a modular manner according to the above R/V tables at the laboratory	Write a script for audio denoising using either MicroPython or the ESP-DSP library

3/29/21	Test and debug written software for the social distancing indicator subsystem alongside with its respective hardware components	Complete testing/validating for all subsystems in the laboratory	Debug and finalize denoising script using the respective voice function subsystem's hardware
4/5/21	Begin working on software for the voice modulation subsystem	Consider and debug all possible edge cases for each subsystem	Write a script for noise modulation for audio using either MicroPython or the ESP-DSP library
4/12/21	Test and debug written software for the voice modulation subsystem alongside with its respective hardware components	Assemble components onto the mask	Debug and finalize denoising script using the respective voice function subsystem's hardware
4/19/21	Test the social distancing indicator subsystem of the mask and debug any errors in preparation for the mock demo	Assess the durability of the entire mask and adjust in preparation for the mock demo	Test the voice functions subsystem of the mask and debug any errors in preparation for the mock demo
4/26/21	Make any necessary adjustments for the demo, prepare for the project presentation, and begin writing the final paper	Make any necessary adjustments for the demo, prepare for the project presentation, and begin writing the final paper	Make any necessary adjustments for the demo, prepare for the project presentation, and begin writing the final paper
5/3/21	Work on Final Paper	Work on Final Paper	Work on Final Paper

5. Safety & Ethics

The main concern we are focused on as we begin to develop RonaAmor is the potential safety hazard that lithium-polymer batteries present. This hazard cannot be completely eliminated due to the necessity of a high energy density, portable power supply for our facial shield. Nevertheless, we are committed to upholding the IEEE standard of prioritizing “the safety, health, and welfare of the public [by striving] to comply with ethical design and sustainable development practices” [21]. In doing so we will center our attention on taking the necessary precautions to ensure the longevity of our facial masks and the safety of the community members who will be wearing them.

Lithium-polymer batteries have been known to cause fires, explosions, and other harmful accidents. Studies have shown that these accidents are largely caused by poor electrical designs such as short circuits, overcharging batteries and exposure to temperatures beyond their thermal rating [22]. To reduce these risk factors, we will integrate an appropriate charge management controller into our power supply subsystem. A good contender for a power management IC (PMIC) is Microchip Technology's MCP73831/2 linear charge management controller. Once this PMIC has reached its Charge Complete mode (meaning the average charge current has diminished below an established percentage of the programmed charge current), the MCP73831/2 will latch off the charge current to prevent overcharging the battery. Furthermore, this PMIC is also designed to suspend charge if the die temperature exceeds 150° C and will not resume charging until the die has cooled to 10° C [6].

Another precaution that RonaAmor takes to prevent the harm of its users is the isolation of the battery pack from the user's face, neck and head. Our design allows for the battery recharging circuit, the battery itself, and much of the supplemental circuitry to be located inside a thermally protective box fashioned to clip onto the users' clothing a safe distance away from the facial shield itself. In this way we are both preventing electrical accidents, as well as preparing for the worst-case scenario. Overall all the engineers on this project are committed to the IEEE standard "to seek, accept, and offer honest criticism of technical work [and] to acknowledge and correct errors" as we launch this new and exciting product that we anticipate will provide some relief in the midst of this global pandemic [21].

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