SMART SIGNALING

Incorporating Light Sensors and Bluetooth LEDs for Turn and Brake Signals on Motorcycle Helmets

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INTRODUCTION

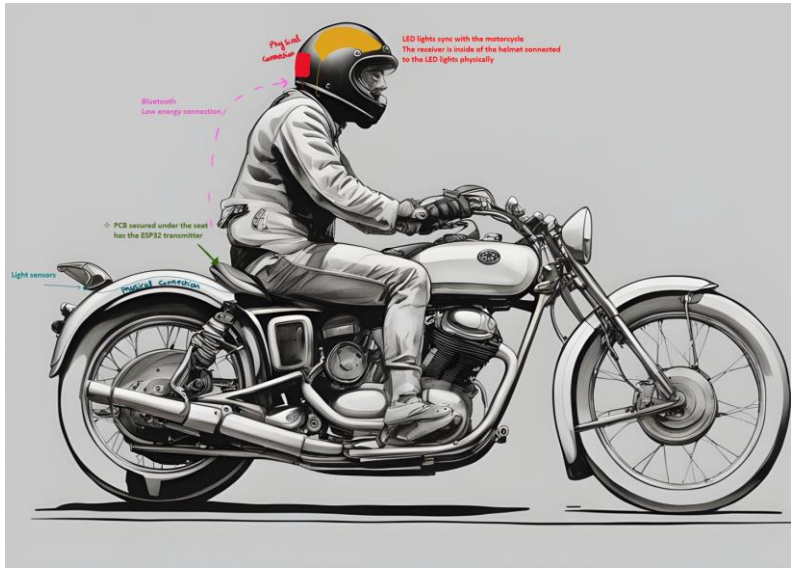
THE BIGGEST CHALLENGE FACING MOTORCYCLISTS ON THE ROAD IS THEIR VISIBILITY TO OTHER VEHICLES

MOTORCYCLE RIDERS ACCOUNT FOR 14% OF ALL TRAFFIC FACILITIES, BUT ONLY 3% OF ALL REGISTERED VEHICLES ARE MOTORCYCLES

“THE NUMBER OF MOTORCYCLIST FATALITIES IN 2021 INCREASED BY 8 PERCENT FROM 2020, FROM 5,506 TO 5,932.”

OUR GOAL: MAKE OUR TRANSPORTATION WORLD A SAFER ENVIRONMENT FOR ALL

TO ADDRESS VISIBILITY TO OTHER VEHICLES AND REDUCE FATALITY, REMOVE AMBIGUITY ABOUT THE MOTORCYCLIST’S PATH AND MAKE TURN SIGNALS AND BRAKING MORE VISIBLE.



OBJECTIVE

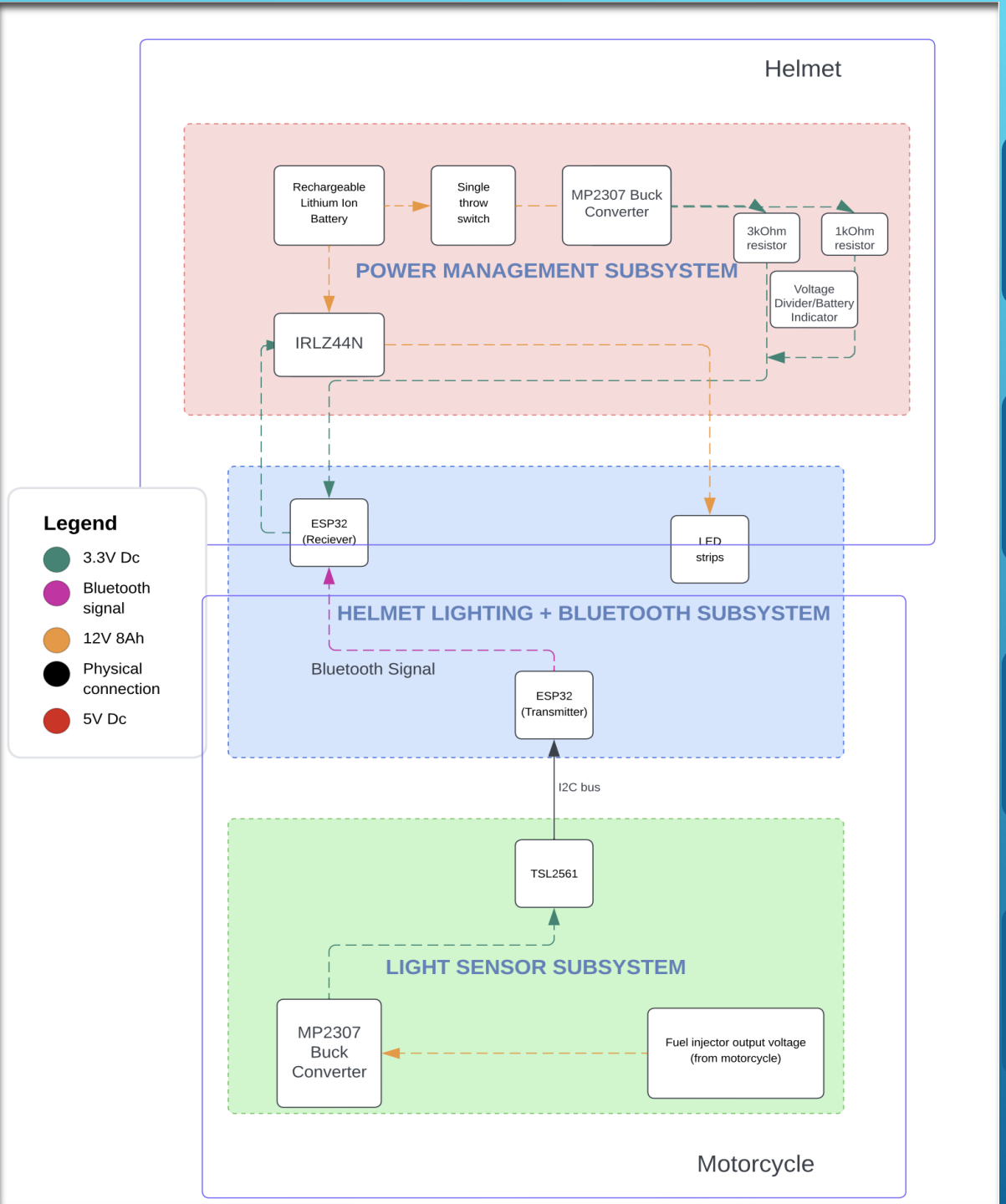
Increase the visibility of motorcyclists by integrating turn and brake signals onto helmets

Illegal to ride motorcycles without helmets in 18 U.S. states

Brake light is visible to all facing the back of the helmet & turn signals are visible from the front, back, and side

The helmet communicates wirelessly with signals in real time, and light sensors, microcontrollers with Bluetooth modules and LED lights help us achieve this

DESIGN



3 main subsystems:
1.Power Management
2. Helmet Lighting & Bluetooth
3. Light Sensor

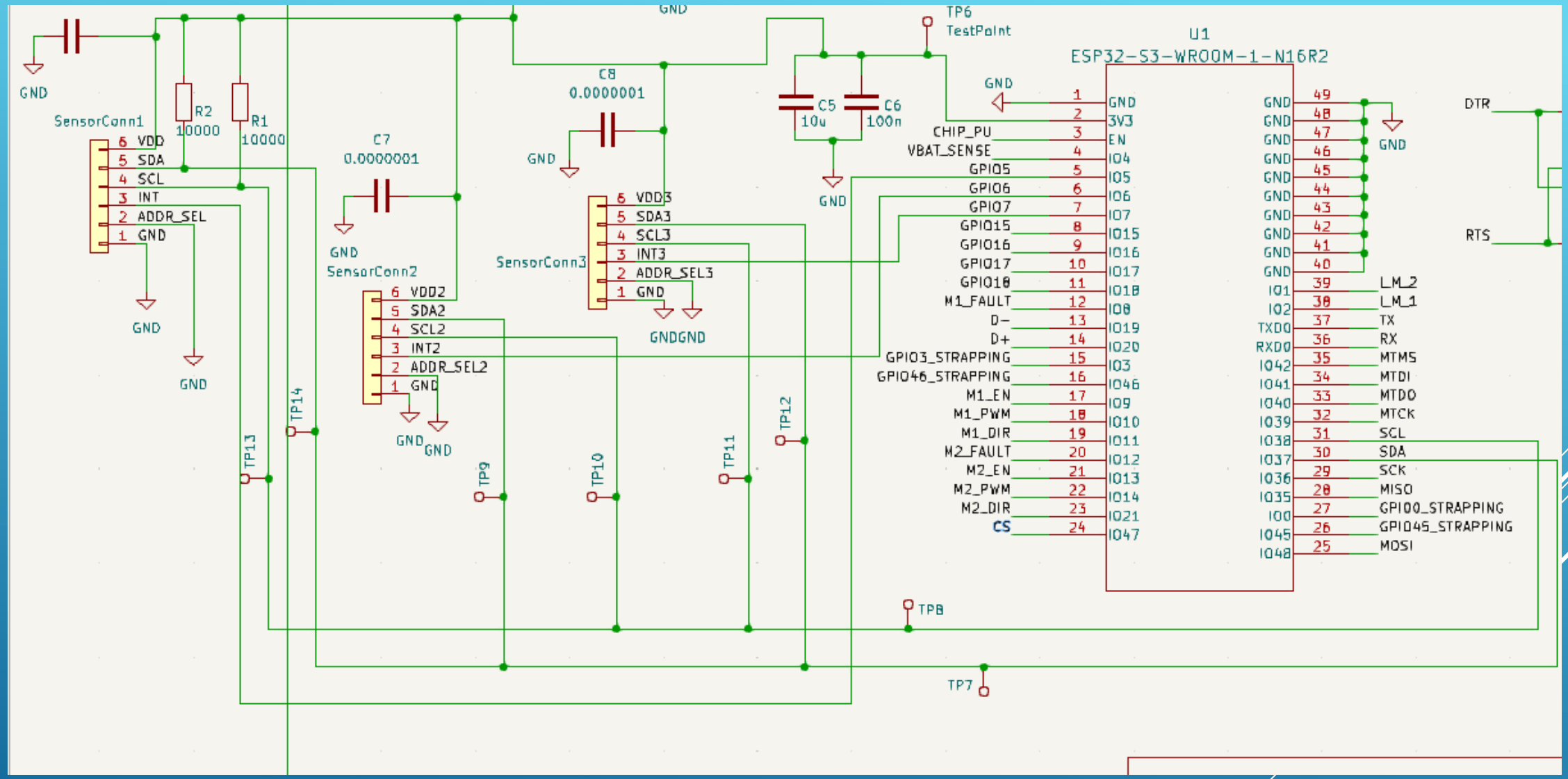
Power Management provides and regulates power to the LEDs and microcontrollers

Light Sensor Subsystem sends signals to the helmet when the motorcycle's turn signals & brake lights illuminate

Helmet Lighting and Bluetooth Subsystem communicates with the motorcycle to illuminate the LEDs on the helmet, acting as a transmitter/receiver

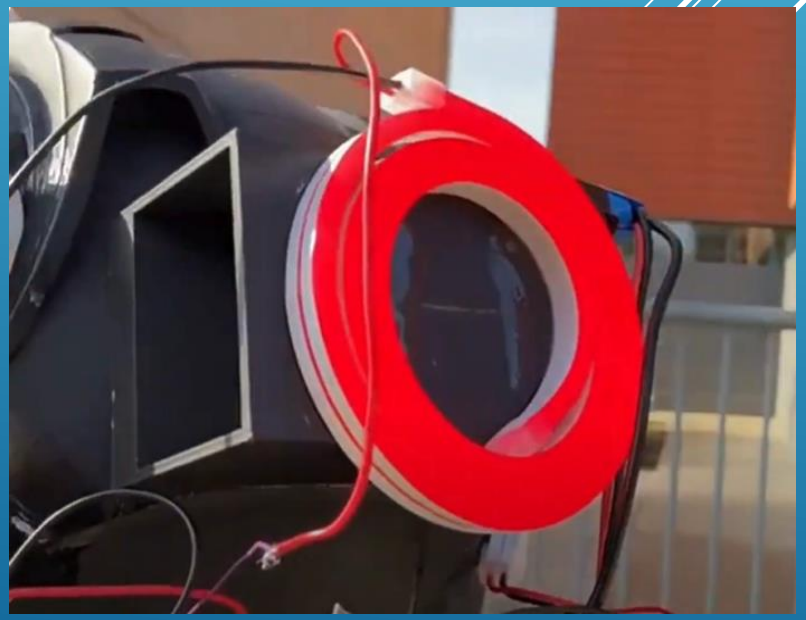
HIGH LEVEL REQUIREMENTS

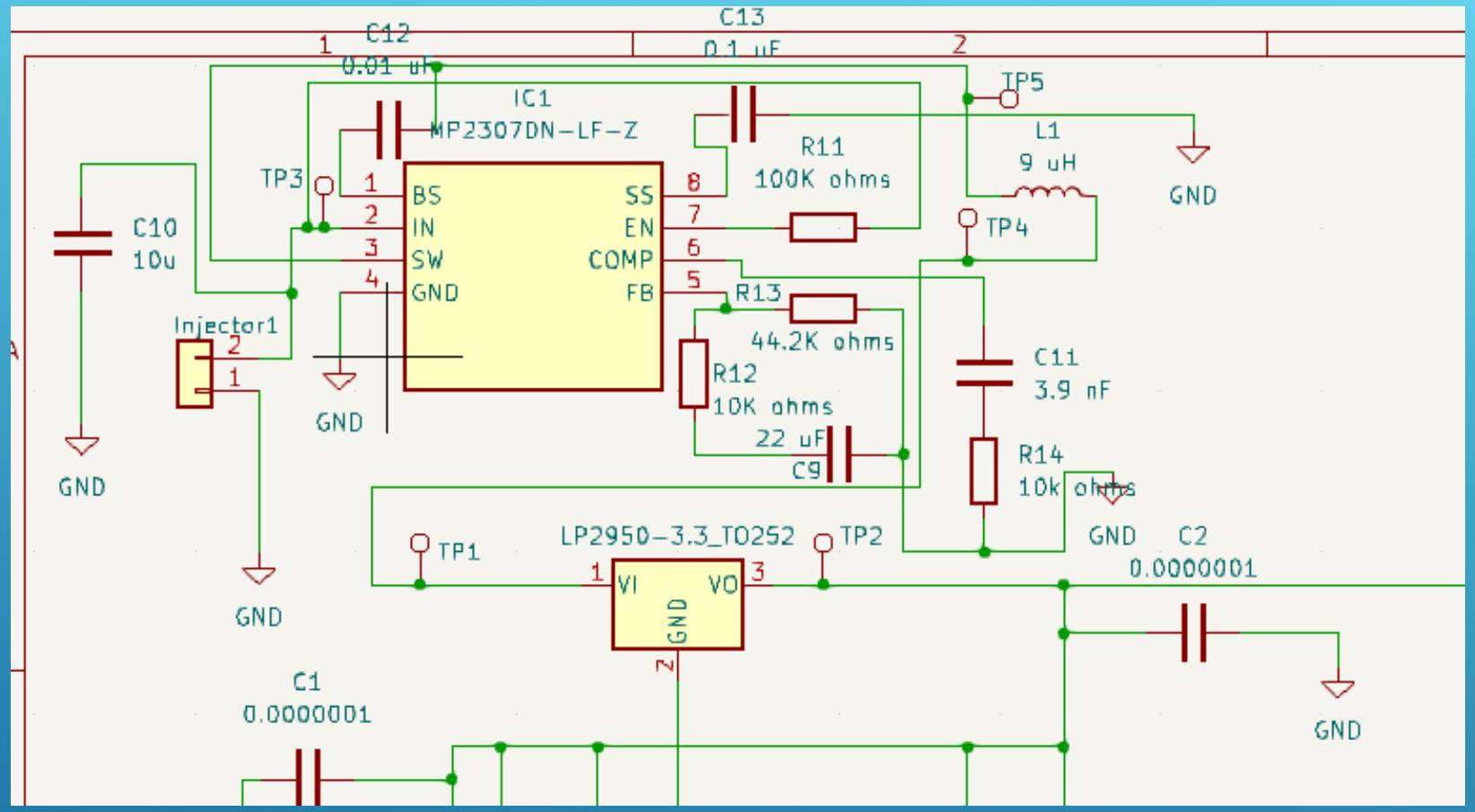
- When the motorcycle’s turn signal illuminates, the helmet's turn signal LED should illuminate
- When the motorcycle applies its brakes and its brake lights illuminate, the helmet’s brake light should illuminate
- Latency for the helmet LED lighting up should not be above 0.5 seconds to communicate in real time
- Indicate when the battery is below 20%.



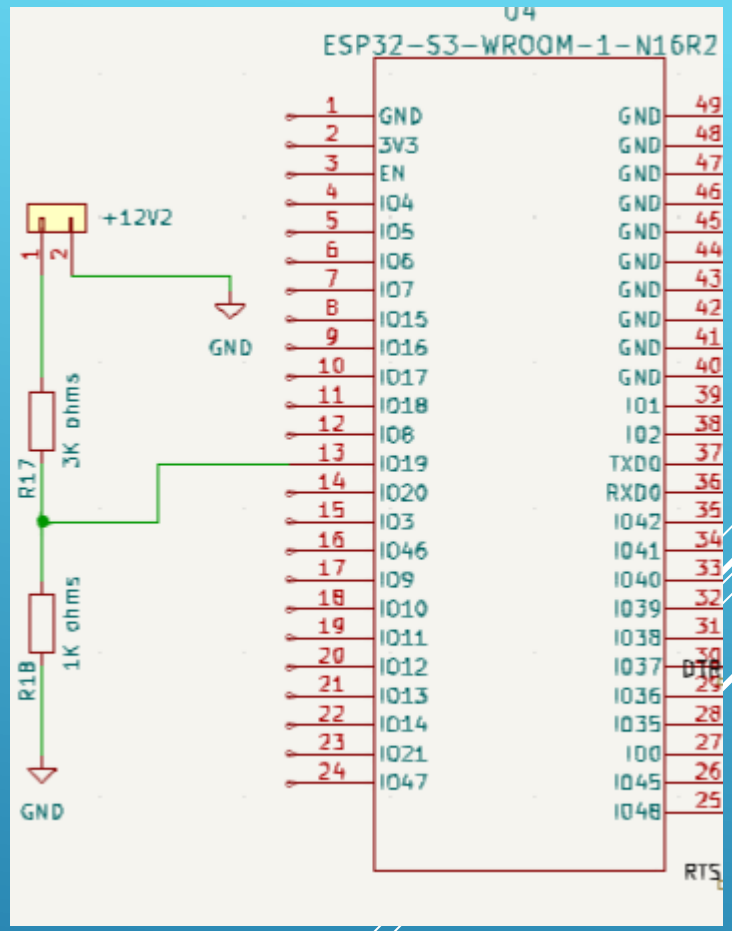
LIGHT SENSOR SUBSYSTEM

Light Sensor Subsystem Requirements	Verifications
The sensor should be able to differentiate between ambient light conditions and the motorcycle's lights	When the gain is set then test in different lighting conditions.
The light sensor should be detected by the ESP32.	We will use the serial monitor to see what light reading is output by the sensors. If the light reading is 0 we know that the sensor is not reading.





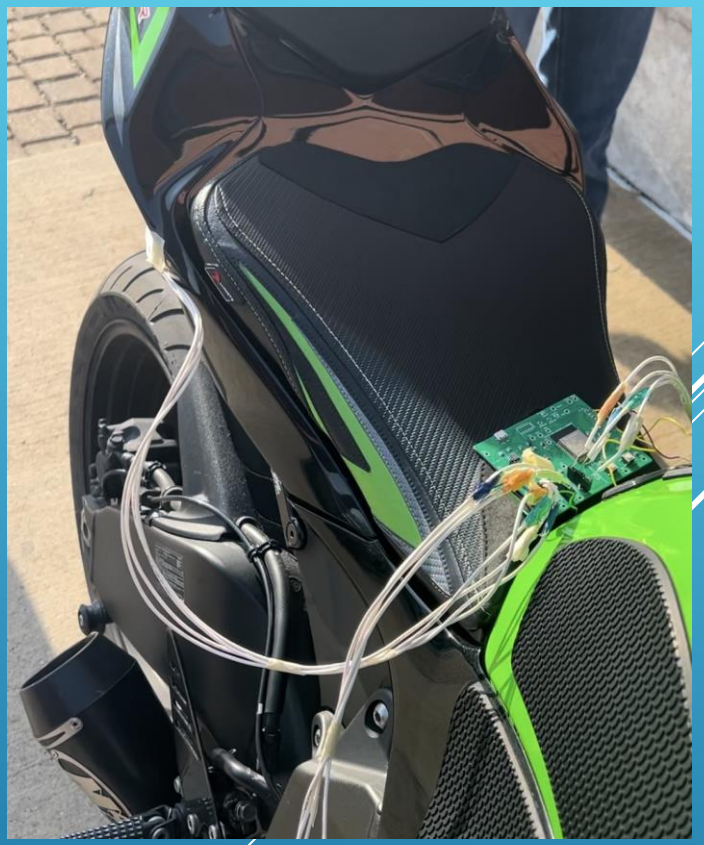
STEP-DOWN CIRCUITRY

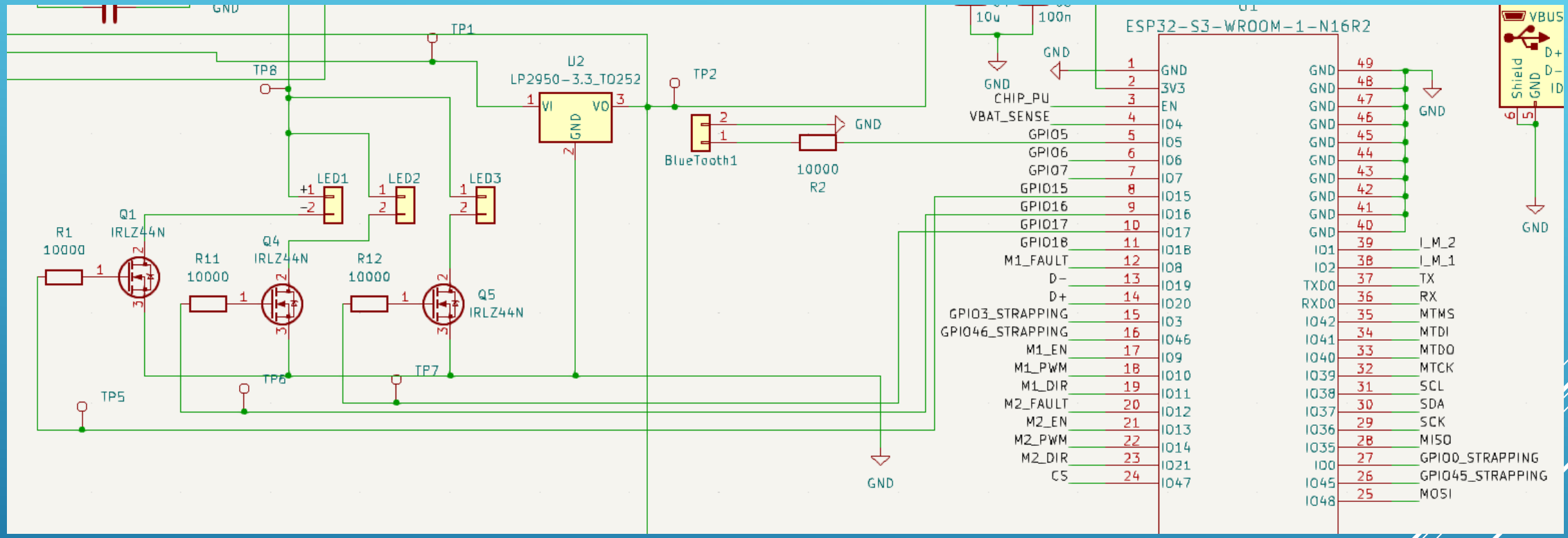


VOLTAGE DIVIDER CIRCUIT

MOTORCYCLE POWER SUBSYSTEM

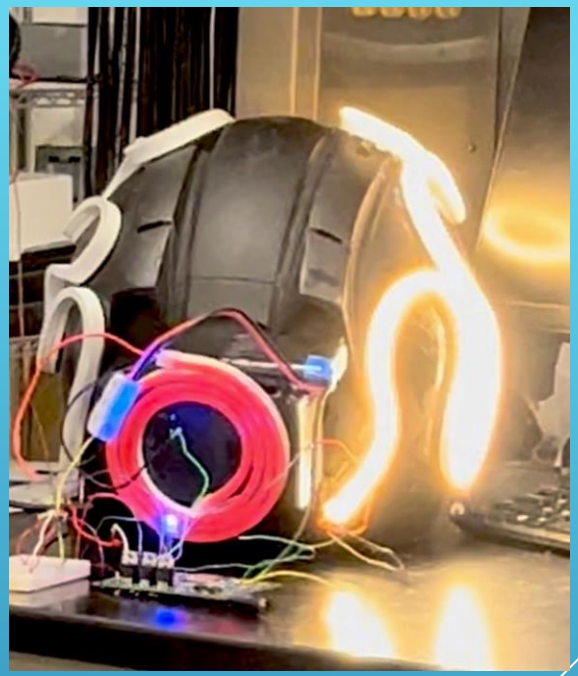
Power Management Subsystem Requirements	Verification
Components directly connected with the motorcycle must receive power from the fuel injector voltage output only when the motorcycle is on	Using a multimeter, measure 12 volts output from the fuel injector when the motorcycle is on and 0 volts when the motorcycle is off.
The system should only use/drain power when the motorcycle is on	Multimeter probing should output at: Buck converter: 5V Voltage regulator: 3.3V
The system should have a voltage divider to alert user when the battery supply has fallen from 12V to 8V.	This was verified by using the ADC on the ESP32 which read the input voltage. At 8V the Bluetooth light started blinking.

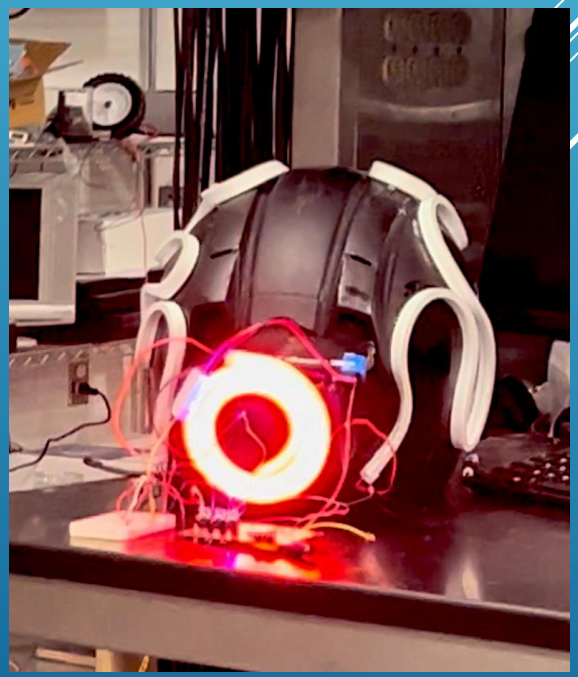


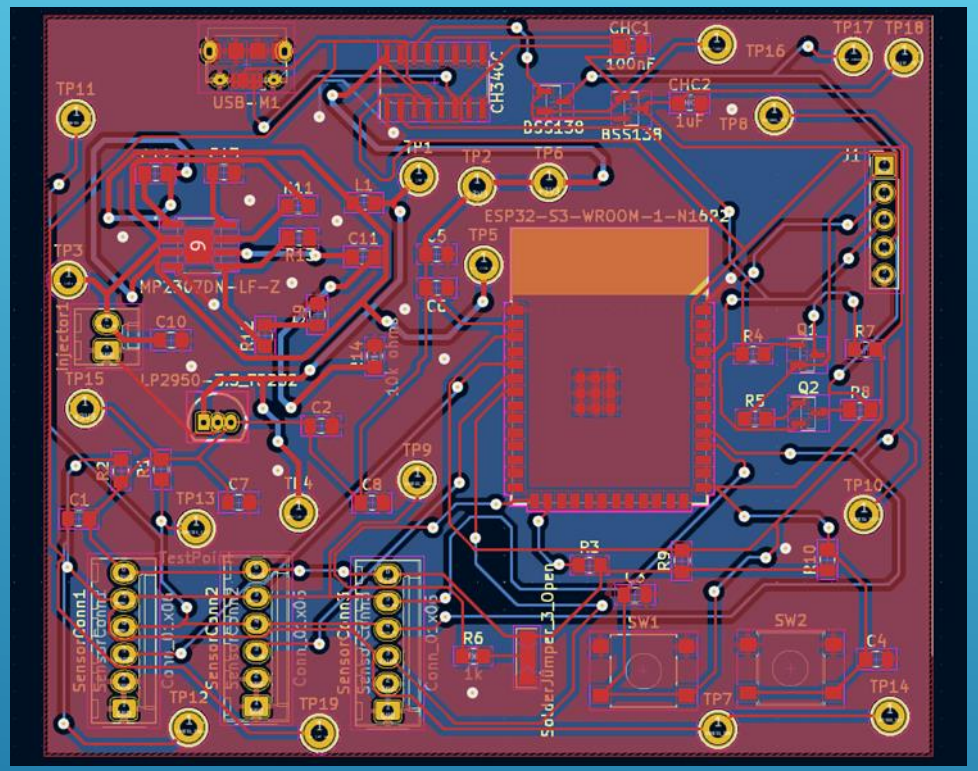


HELMET LIGHTING SUBSYSTEM

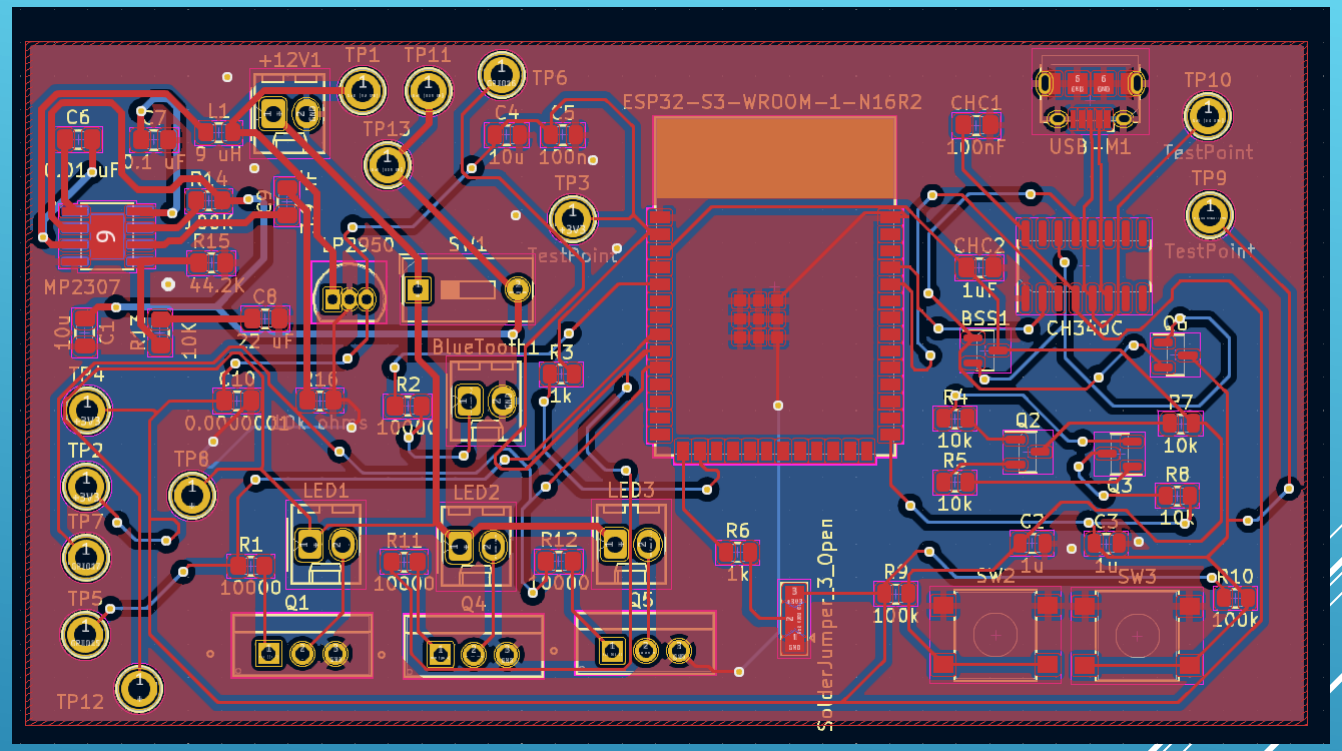
Helmet Lighting Subsystem Requirements	Verification
Turn signal LEDs must be visible from the front & back and the brake light LED must be visible from the back	Visibility test of the helmet at different angles and in different lighting conditions
LEDs must be securely fixed to the helmet	Perform an adhesion test by applying a pulling force by hand to the LEDs in dry and wet conditions
LEDs must not restrict the motorcyclist vision	identifying markers placed within view of the helmet at different angles while wearing it
Latency of motorcycle indicator turning on and helmet LED turning on should not exceed 0.5 seconds.	latency remains below our fixed value using a timer when indicator lights are turned on







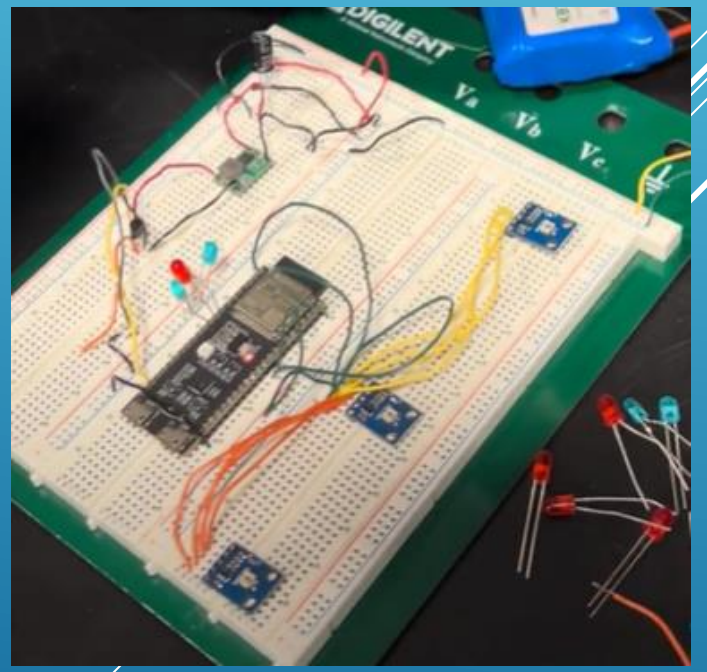
TRANSMITTER (MOTORCYCLE PCB)



RECEIVER (HELMET PCB)

BLUETOOTH SUBSYSTEM

Bluetooth Subsystem Requirements	Verifications
The ESP32 must establish a Bluetooth Low Energy connection between the helmet and the motorcycle.	Used blinking led indicator to signal whether Bluetooth connection was successful or not.
The Bluetooth subsystem must reliably transfer light sensor data between the helmet and motorcycle.	Verified by a polling mechanism which polls at a fixed rate to receive light sensor information in varying brightness conditions.
The Bluetooth system should be able to remain connected during travel	Send data messages between the devices to ensure an active connection. If a timeout occurs (no acknowledgement of the data message), it will attempt to reconnect.



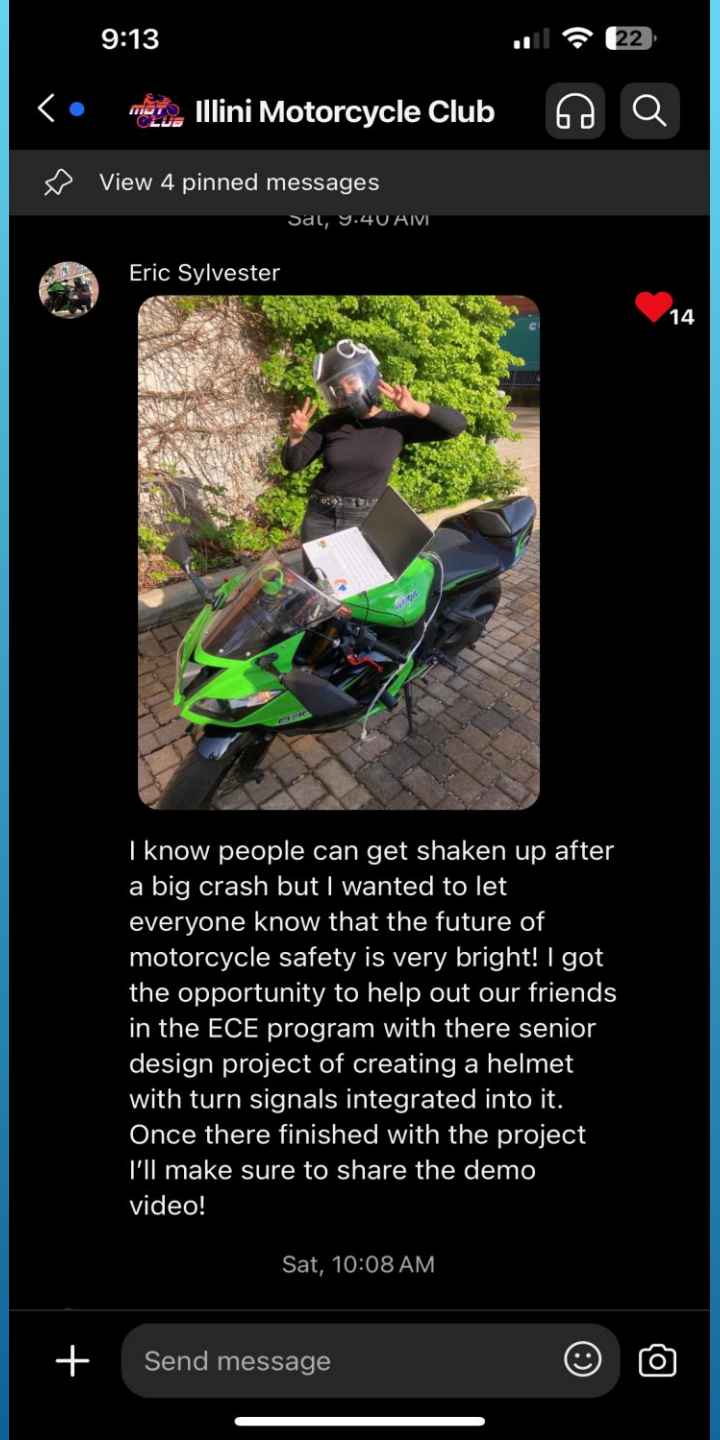
CHALLENGES

1. Our USB to UART bridge inverted the RX to TX connections
2. When calculating Buck converter output voltage values, we did not consider the draw of current from the ESP32 or other connected components, the current changes the output value.
3. We required 3.4 volts due to the extra components so the esp32 undervolted when the voltage regulator was connected.
4. Limited sensors, ultimately decided to simulate it. Currently works with user input.
5. Large voltage draws when accidental short circuits, connect fuses onto the PCB to prevent larger damage.
6. Very low resistance for the voltage sensing which wastes a lot of power. Attach larger resistances in the power circuit.
7. ESP32 antenna was blocked by copper

ECE 445 was an extremely valuable course and allowed us to gain real hands-on experience in product development. As we move forward towards our career as engineers, we are now equipped to bring the many lessons we learned in the course with us on our journeys towards success

CONCLUSION

And lastly….


9:13
Illini Motorcycle Club
View 4 pinned messages
Eric Sylvester
14
I know people can get shaken up after a big crash but I wanted to let everyone know that the future of motorcycle safety is very bright! I got the opportunity to help out our friends in the ECE program with there senior design project of creating a helmet with turn signals integrated into it. Once there finished with the project I'll make sure to share the demo video!
Sat, 10:08 AM
Send message

THANK YOU!

We'd like to give a special thank you to our TA Nithin and Jason for all their guidance throughout the semester