Huddy Buddy

Group 6

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Motivation

- Driving with GPS usually involves taking eyes off the road
- Off-the-shelf solutions are focused very close to the windshield and require that the user's phone is placed on top of the dashboard
- Must not be a fixed, permanent add-on
- Combination of knowledge across disciplines

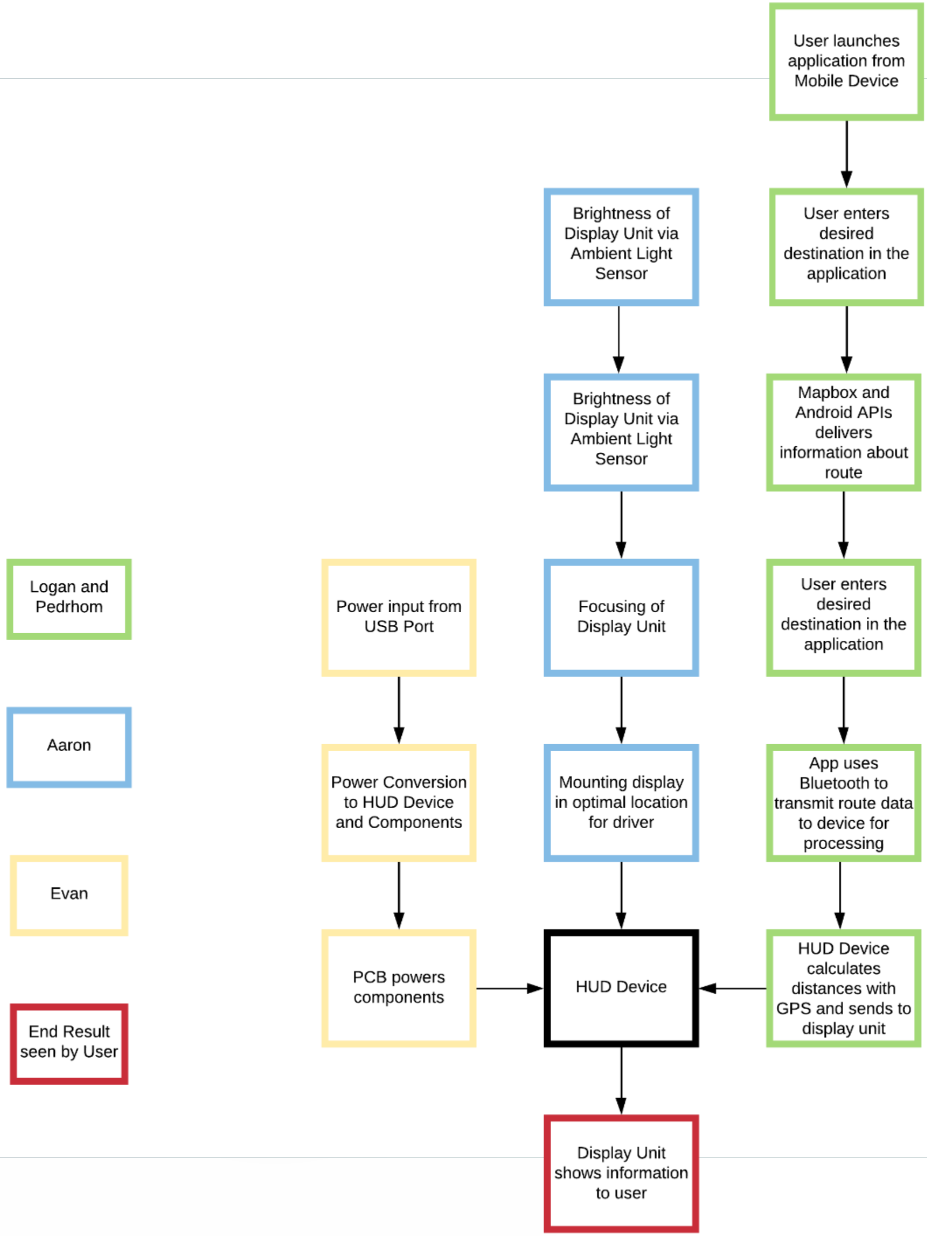
Objectives

- Design a system that displays up-to-date GPS directions from an established mapping service
- Ensure compatibility with modern vehicle OBDII ports and GPS-enabled Android-based smart phones
- Increase safety of operating a vehicle with GPS guidance and crash detection system
- Design must be cost-effective
- The Huddy Buddy must leave a positive impression on the user

Specifications

Component	Parameter	Design Specification
Case	Size	5" x 3" x 2"
Device	Weight	1 lb.
Device	Temperature	-20 C to +60 C
Device	Sunlight Operability	Stored and Operated in Direct Sunlight
Power Delivery	Power Consumption	
Power Connector	Power Source	OBDII
Application	OS Compatibility	Android
Application	Navigation Source	Mapbox API
Wireless Connector	Connectivity Standard	Bluetooth LE
Combiner	Display Surface	Transparent Screen
Display	Resolution	128 x 64 Pixels
Mounting System	Position	Adjustable Positioning
Dimming System	Brightness Control	Capable of Automatically Adjustible Brightness

Block Diagram



Display and Application Basics

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Subsystems of Huddy Buddy

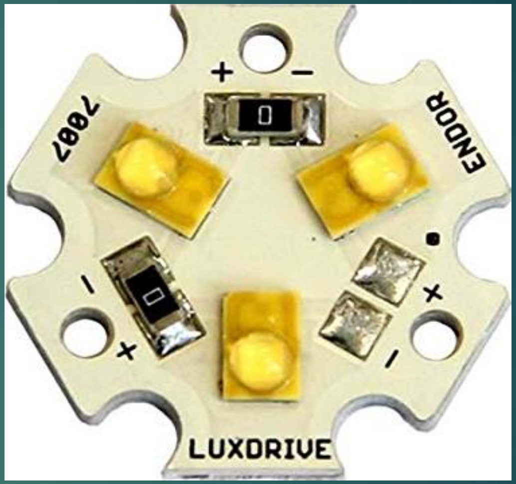
- Display Unit
  - LCD, Backlight, Lens, Light Sensor
- ATmega 2560 Microcontroller
- SIMCom SIM808 2G GSM GPS Module
- Analog Devices ADXL335 Accelerometer
- Power Delivery
  - USB / OBDII Power Sources, Backup Battery
- Android Application
- NRF52840 Bluetooth Module

LCD Display

- **ENH-DG128064-66 Transparent LCD**
  - 128x64 resolution
  - Paired with a high-intensity LED for illumination
  - Low cost

LED Backlight

- The image from the HUD must be visible even in direct sunlight
- Testing showed that a 300-lumen backlight is sufficiently bright, but greater brightness results in a more easily seen image
- The Luxdrive Endor Star 07007-LXA7-40 LED produces up to 500 lumens
- Will be paired with reflectors and diffusors for wide, even beams

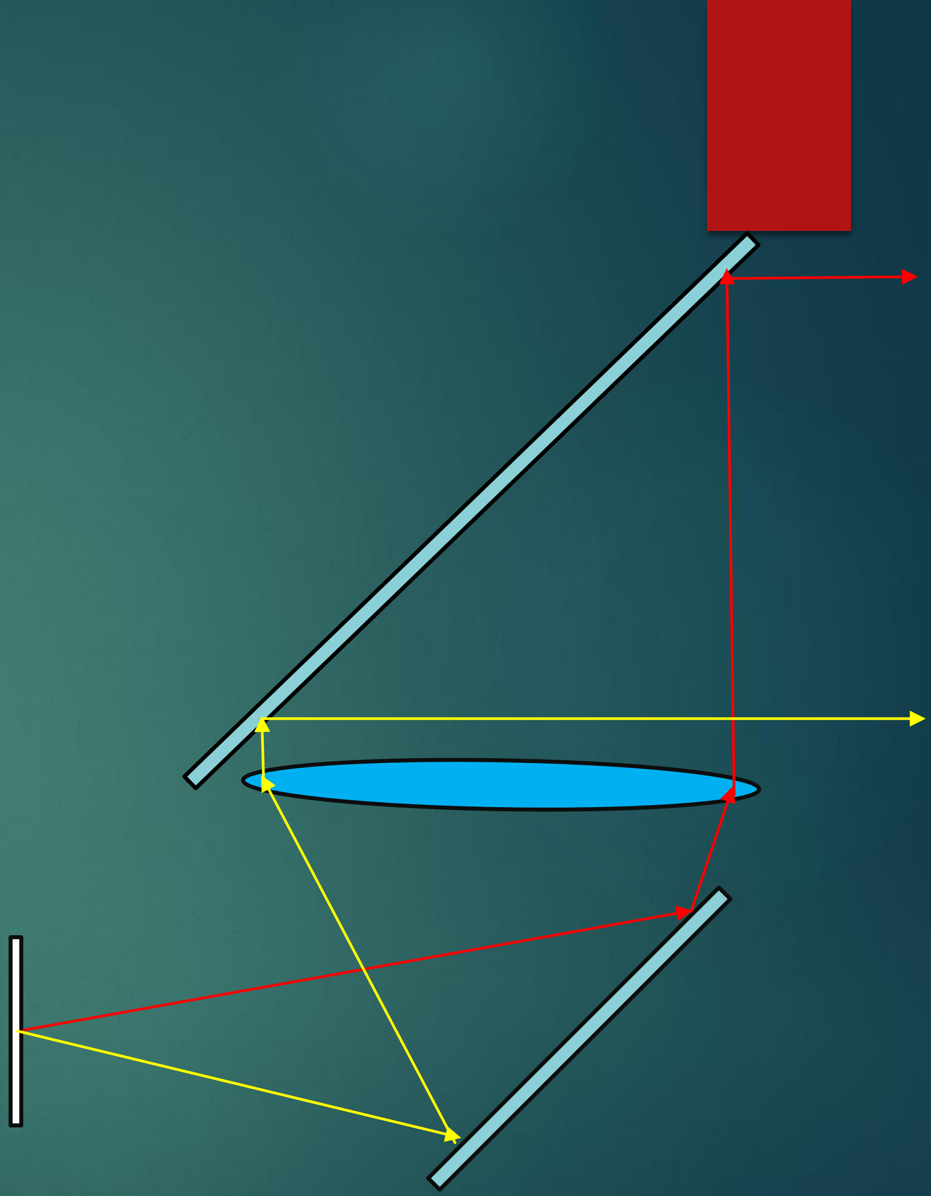


Light Sensor

- To help with lighting, a photodiode will be used to determine the brightness outside. A photodiode is accurate at telling whether it is day or night.
- The way this works is the photodiode will be used in a voltage divider and the photodiode will increase or decrease resistivity depending on the brightness outside.
- This is read in as an analog data into the ATMEGA2560 and this can be translated into how bright the LED backlight needs to be.

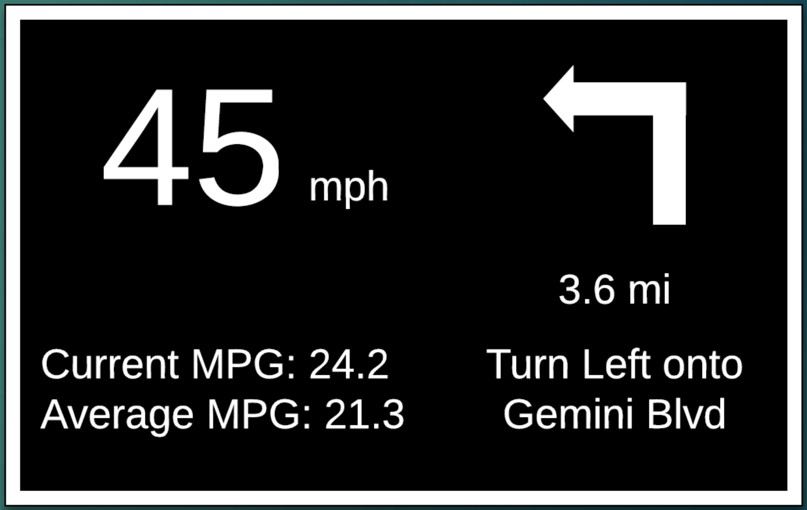
Lens System

- Heads up displays work best when focused at infinity, or "collimated"
- The best way to collimate the image is to place it at the focal point of a lens system
- When the driver looks at distant objects, the image will always be in focus



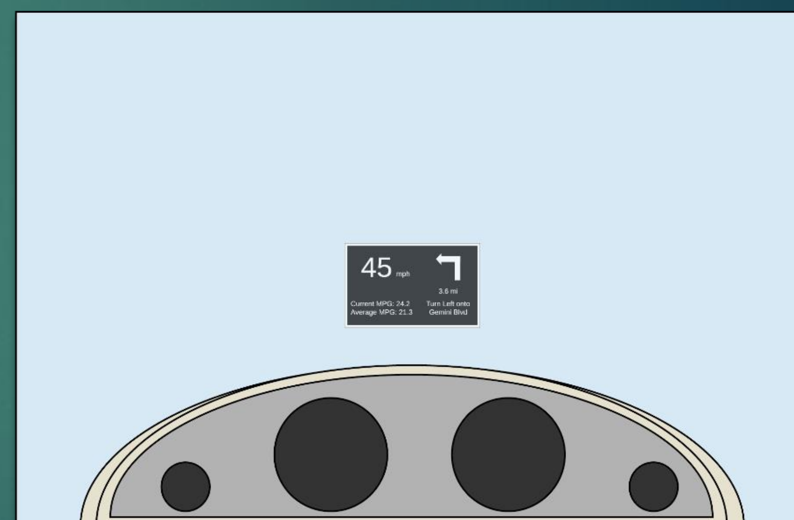
Adding information to display unit

- Speed and Fuel Economy data pulled from OBDII port in vehicle
- Navigation data from API calls to Mapbox via Android App
- Microcontroller sends data to be displayed over serial connection



Mounting device in vehicle

- Unit mounted on dashboard behind instrument cluster
- Just inside driver's field of view



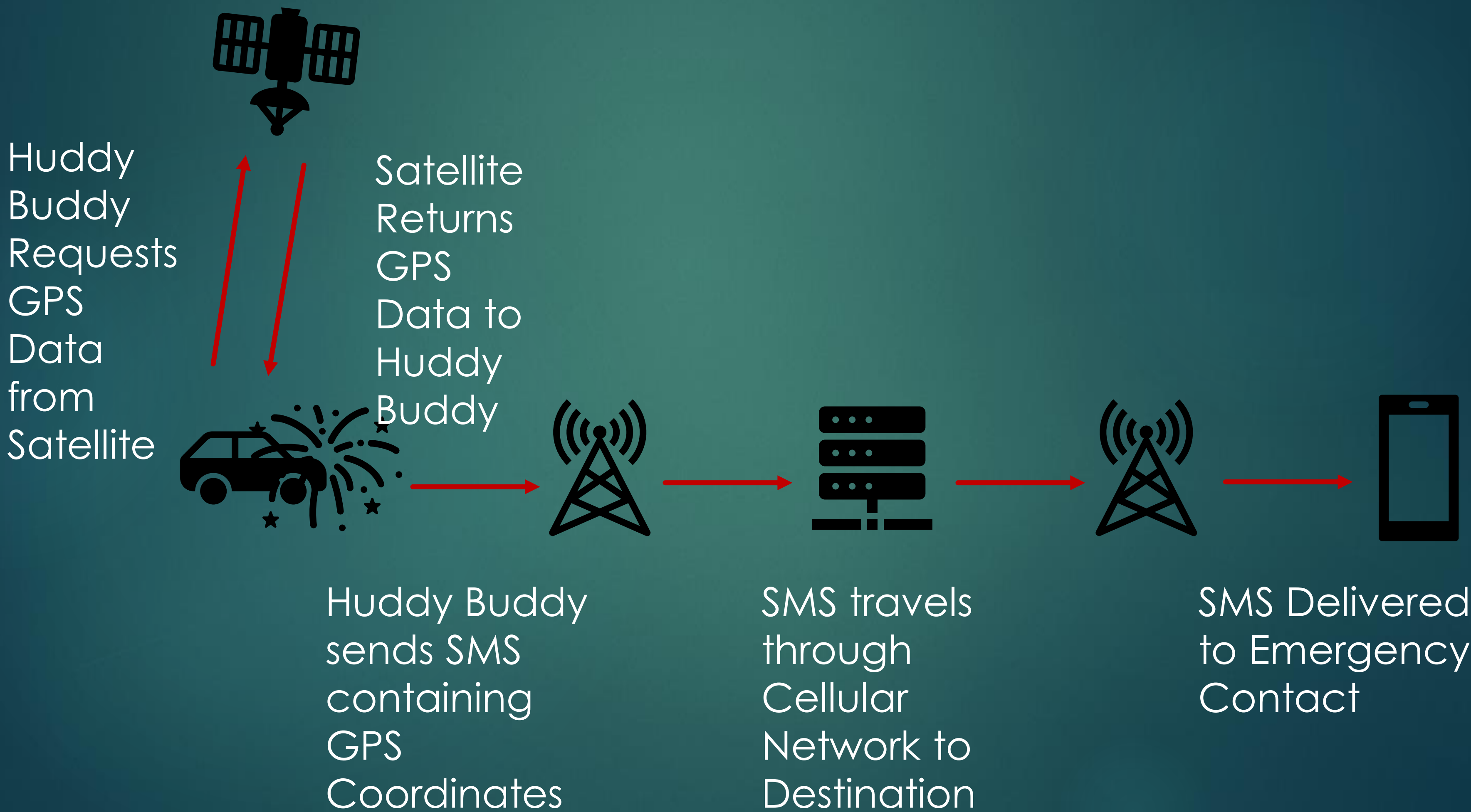
Microcontroller

- **ATmega 2560 8-bit Microcontroller**
  - 54 Digital I/O Pins, of which 15 Pins provide PWM Output
  - 16 Analog Input Pins
  - 5V Operating Voltage
  - 256KB Flash Memory
  - 16 MHz Clock Speed
- Popular for embedded projects such as robotics
- Read in and process data for subsystems of Huddy Buddy

Crash Detection System

- Microcontroller uses accelerometer to detect large change in forces
  - Read in values for gravity relative to x, y, and z axes
  - If a large change in values is detected, microcontroller will initiate emergency response sequence
- Microcontroller issues commands to Cellular 2G Module
  - Retrieve current GPS Coordinates
  - Send text message containing coordinates to emergency contact
- In event of power loss, backup power takes over
  - Power generation switch on impact

Crash Detection System



Cellular and GPS Module

- **SIMCom SIM808 GSM 2G Cellular Module**
  - Quad-Band GSM/GPRS Module with GPS for satellite navigation
  - US Cellular Service via standard SIM Card
  - Ting Mobile
  - AT Command Implementation
  - Receives commands via UART Communication
  - External GSM/GPS Antennas
  - Supply Voltage: 3.4~4.4V

Accelerometer

- **Analog Devices ADXL335 3-Axis Accelerometer**
  - ± 3g sensitivity
  - Operating voltage: 1.8V - 3.6V
  - Analog pinouts for x,y,z axes
  - 10,000 g shock survival

HUD Overview

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Power Delivery

- The power supply will be through the OBD-II port that are in almost all cars today.
  - This will supply a steady 5 volt input and can deliver up to 2.1 amps.
  - Another reason for this choice is because it is possible to pull additional data from the car's sensors and display them.

Power Delivery

- Most of the components will be driven off of the 5 volt input but for a few of the peripheral parts, they require either more or less voltage and to do that either a buck or boost converter.
  - The LM2577-ADJ will be used for the LED backlight which will supply 9 volts and up to 800 mA if needed.
  - The LM317 will supply 3.3 volts for the ADXL335 accelerometer sensor.

Light Sensor

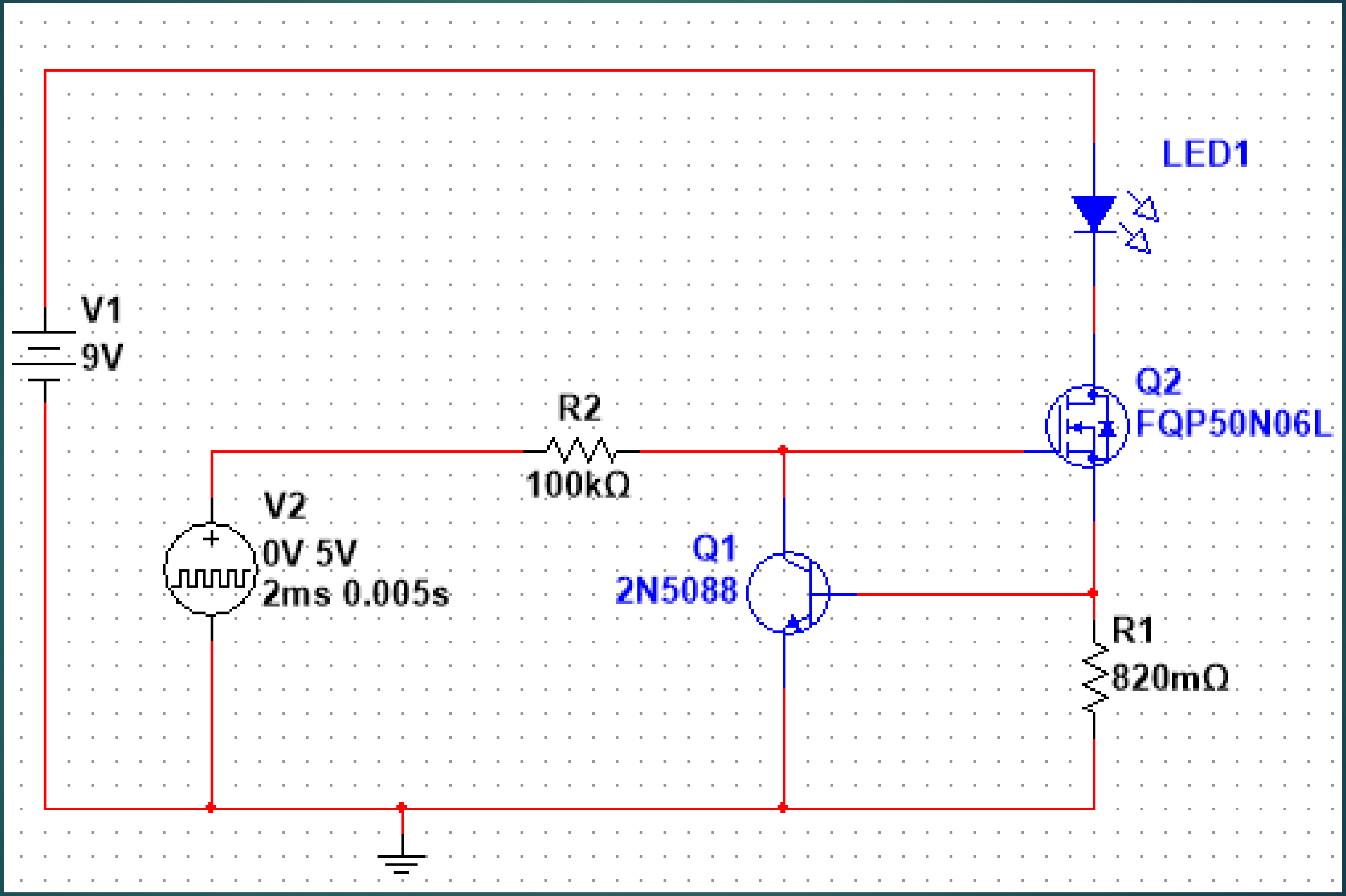
Light is Like	Lux Value	Approxiamte Photoresistor Value	Current (mA)	Voltage (V)
Moonlight	1	70 kΩ	0.0704	0.07
Dark Room	10	10 kΩ	0.455	0.455
Bright Room	100	1.5 kΩ	2	2
Overcast Day	1000	300 Ω	3.85	3.85
Daylight	10000	100 Ω	4.55	4.55

Response of Photodiode used with a 1 kΩ resistor

LED Backlight Dimmer

- The LED backlight is super bright and to not constantly blind the driver a dimmer circuit is to be used in conjunction with the photodiode.
  - The photodiode's analog input will be translated into duty cycles for the PWM on the ATMEGA2560.
  - If it's dark and needs to be brighter a shorter duty cycle will be needed. If it's bright and less light is needed then a larger duty cycle will be needed.

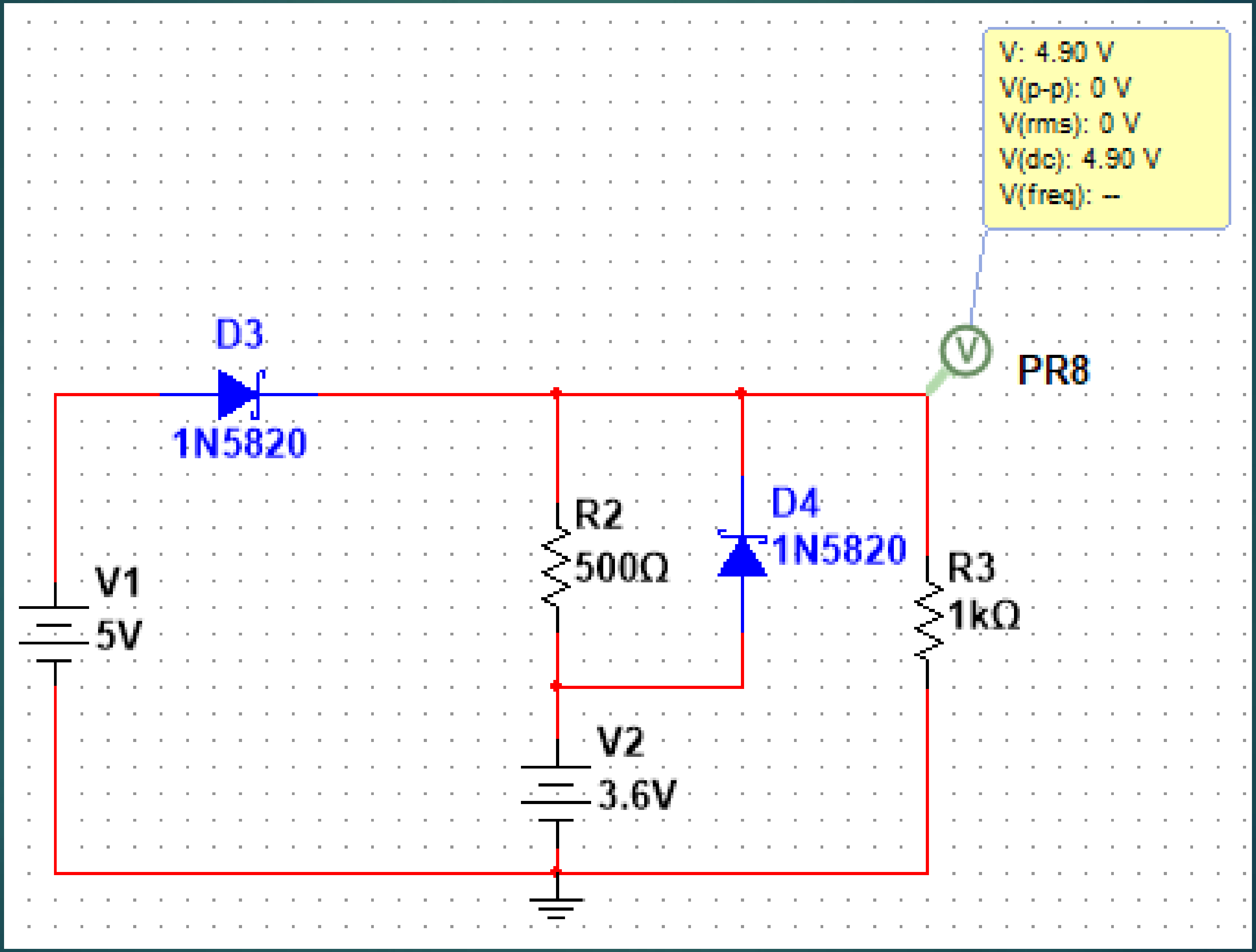
LED Backlight Dimmer



Backup Battery System

- In the event of a crash and no power can be provided to the SMS module, there still needs to be power to allow for the emergency text message or email to be sent out to the respective emergency contacts.
  - The normal DC power supply will be connected to a blocking diode rated at a current higher than the power supply. Then the rechargeable battery is connected to the circuit with a resistor and another diode. The value of the resistor is very important because while the battery isn't being used its going to be charged.

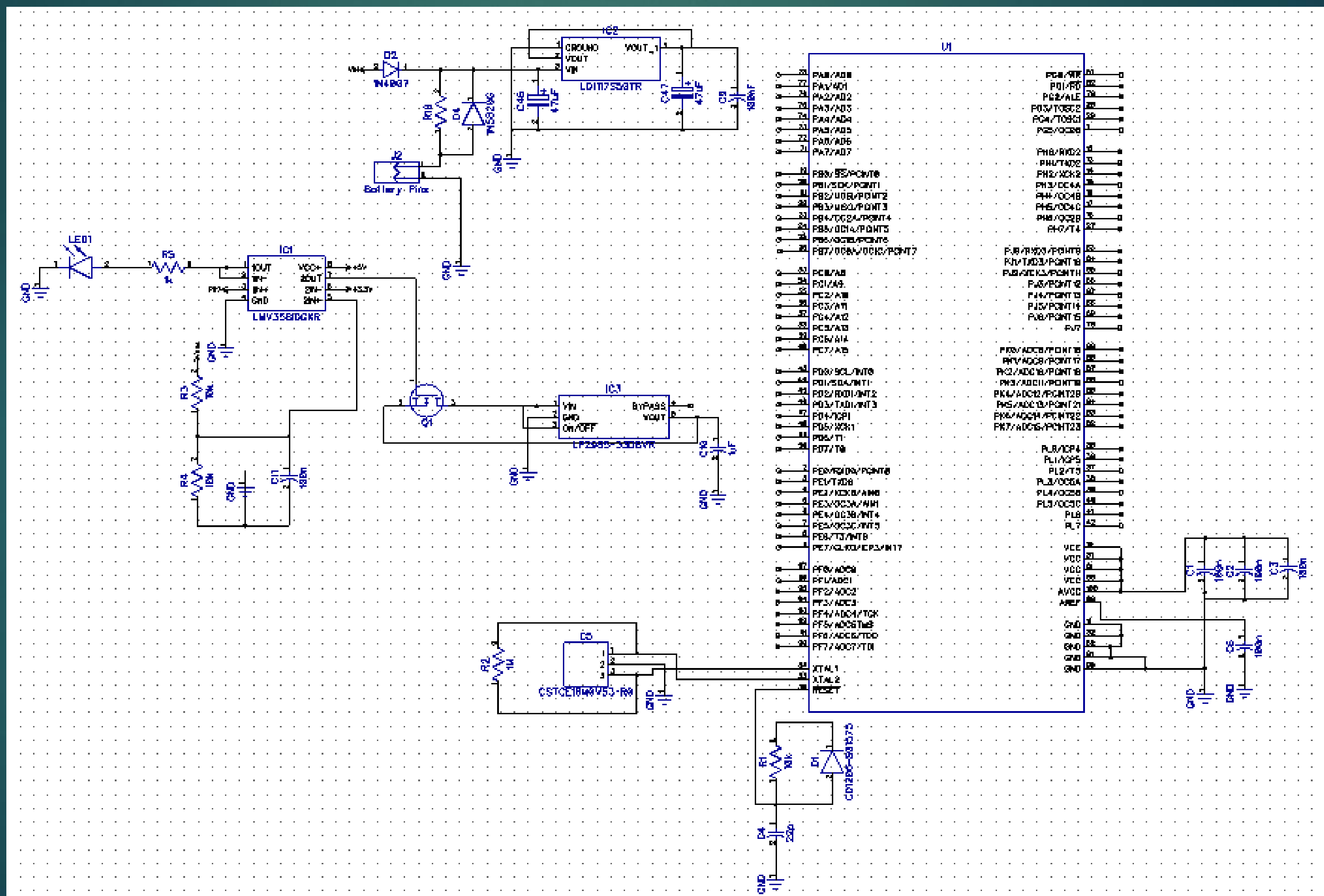
Backup Battery System



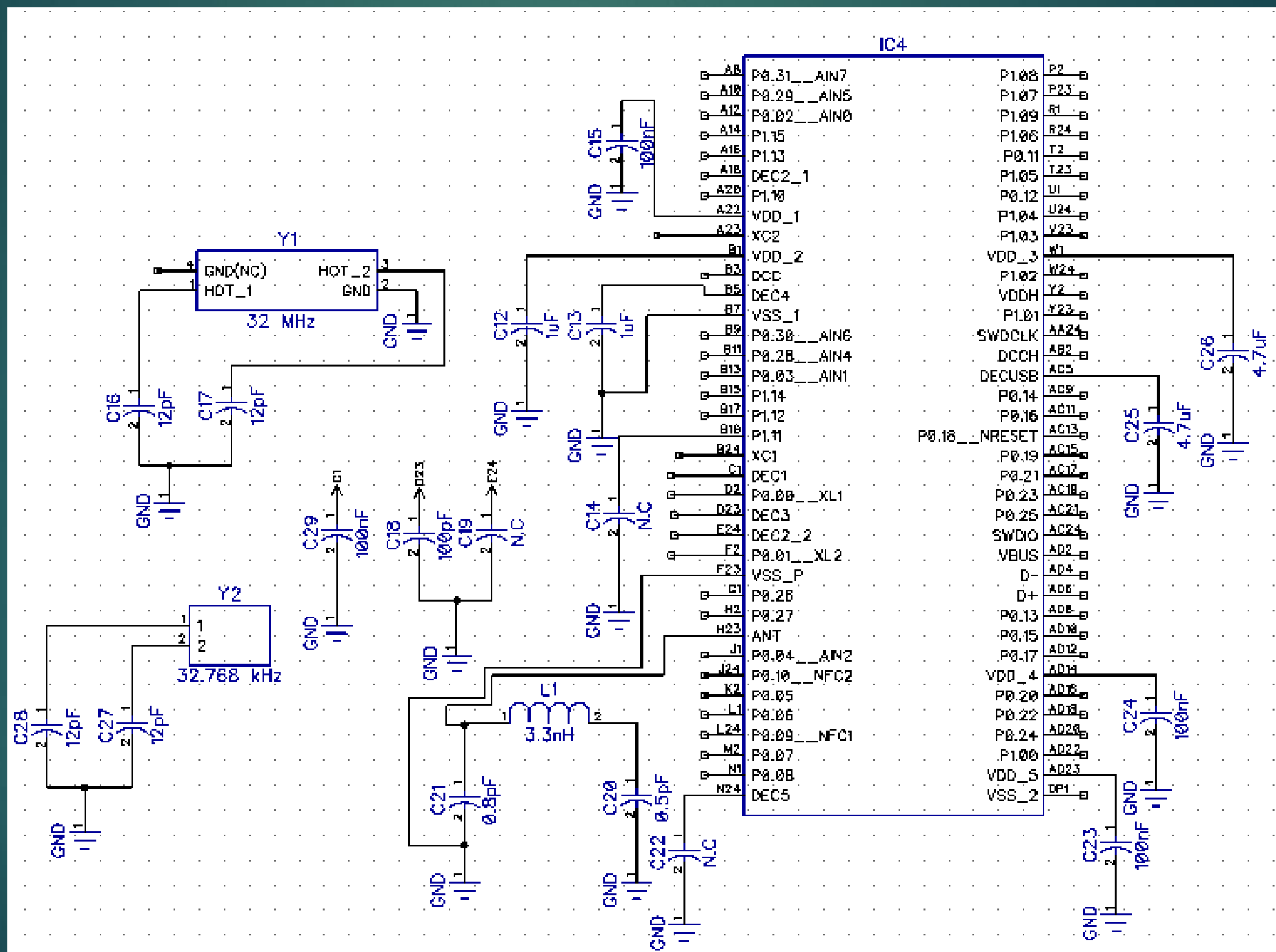
PCB Development

- Being a beginner with designing PCBs there are a lot of designer tools out there and the one I went with is called DipTrace. It is very easy to use and in my opinion is a lot like Mulitsim which most everyone is familiar with.
  - One small drawback is having to make individual part schmatics and footprints, but there are tools to easily make the parts that were not included in its already extensive library.
  - The supplier for most of the RLC components can be obtained through Mouser.com. The actual chips may come from separate vendors. The PCB will be created through JLCPCB.

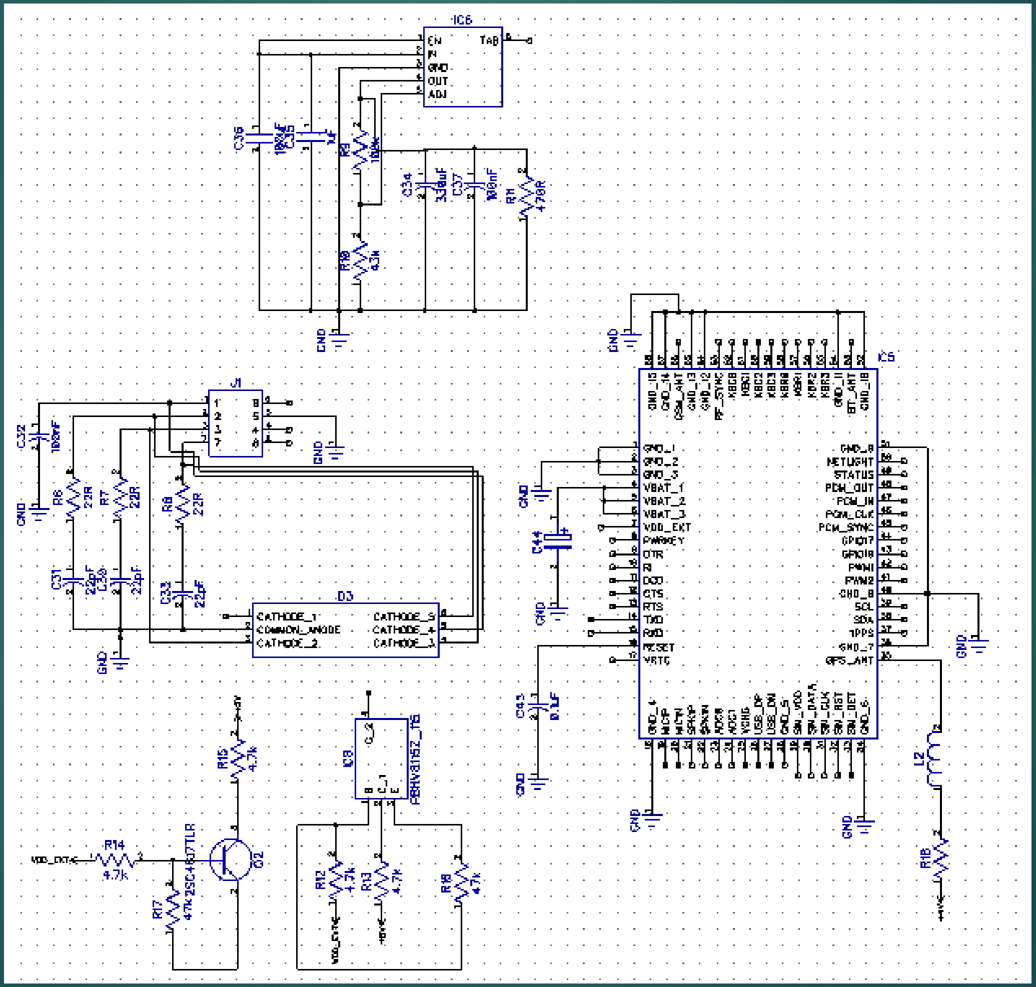
PCB Development (ATmega2560)



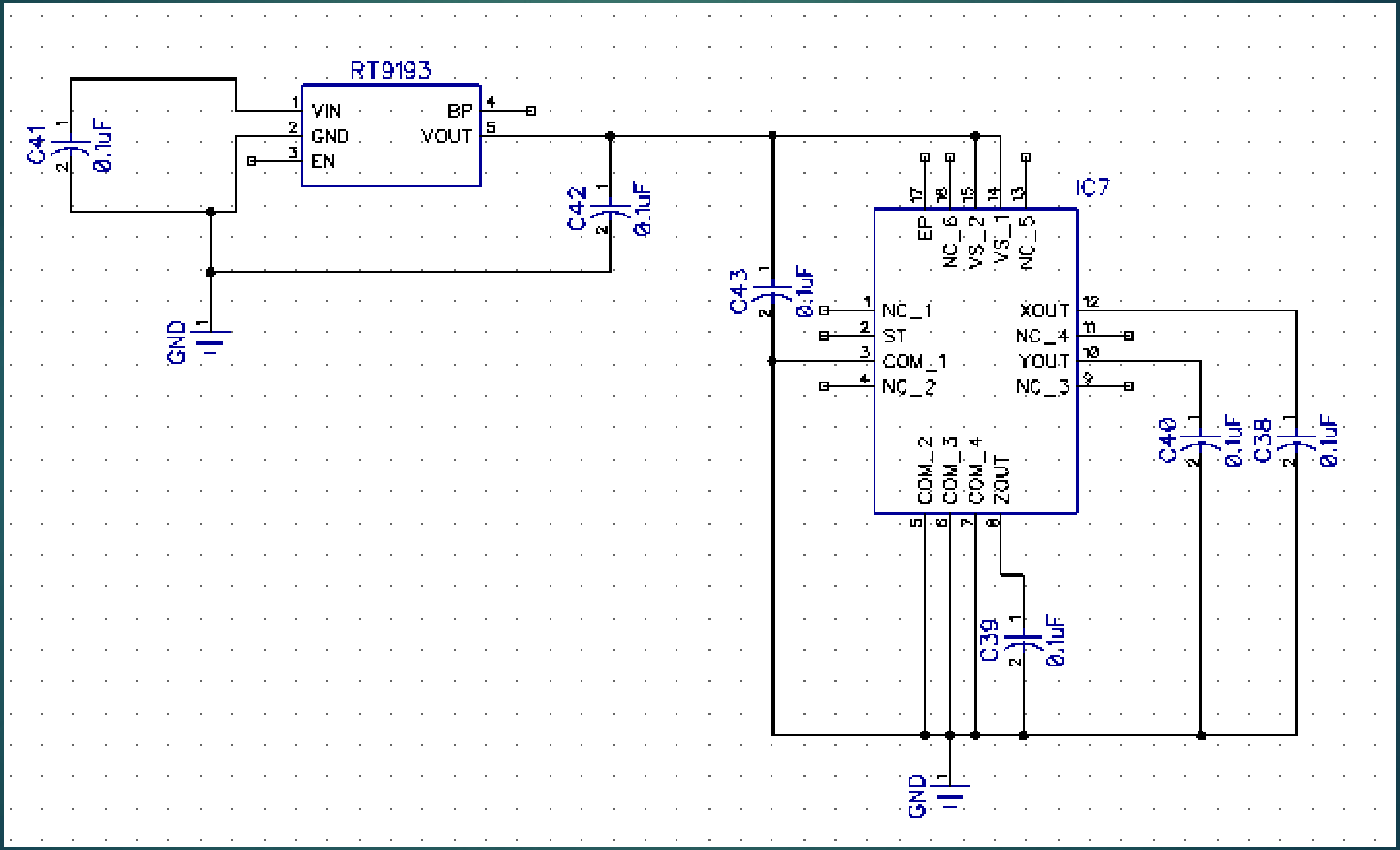
PCB Development (nRF52840)



PCB Development (SIM808)



PCB Development (ADXL335)



HUD Overview

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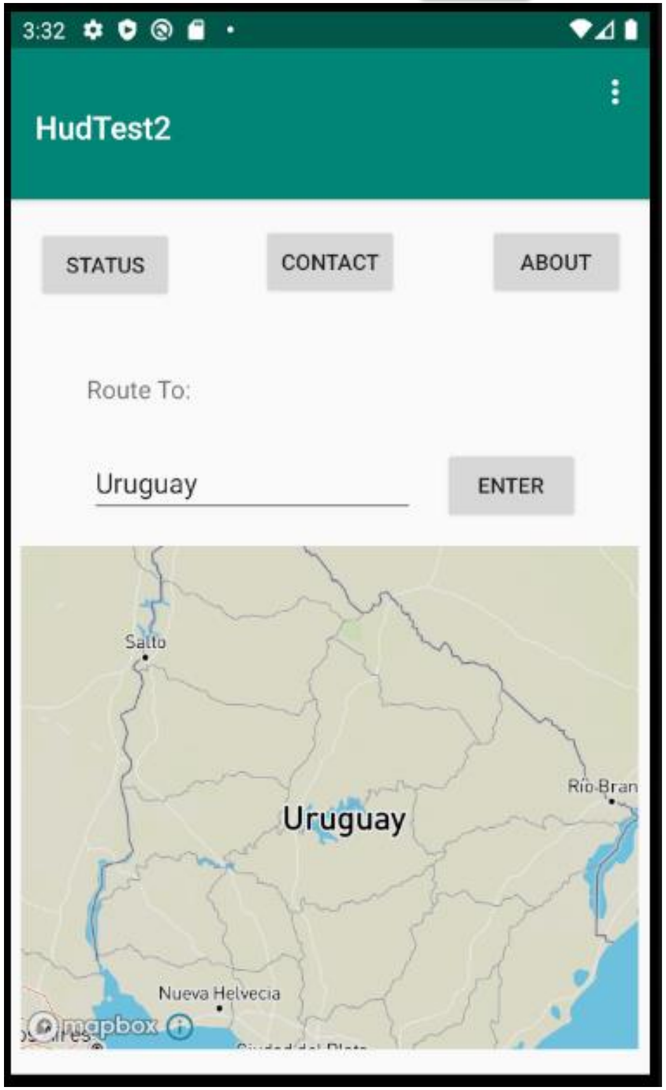
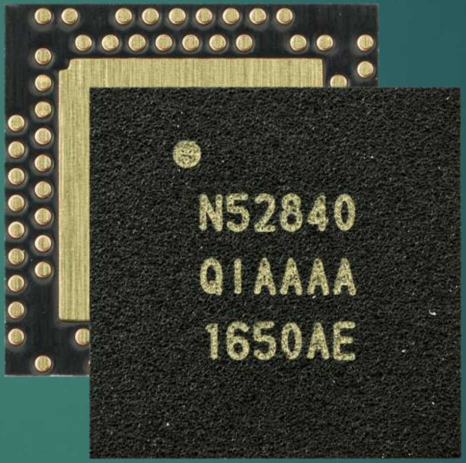
App Development

- Android Studio using Java
- Mapbox for API calls and data
- Choose location to route to based on current location of device
- Allows checking of Bluetooth connection status
- Designate Emergency Contact



Bluetooth

- ❖ Nordic nRF52840
- ❖ 2.4 GHz Transceiver
- ❖ 2 Mbps, 1 Mbps, Long Range
- ❖ Supports Bluetooth Low Energy. Low latency
- ❖ Extensive documentation including schematics and SDK information
- ❖ Firmware written in C



Work Distribution

name	Optics and Display	PCB and Power Delivery	HUD Programming	App Development
Aaron	✓			
Evan		✓		
Logan			✓	
Pedrhom				✓

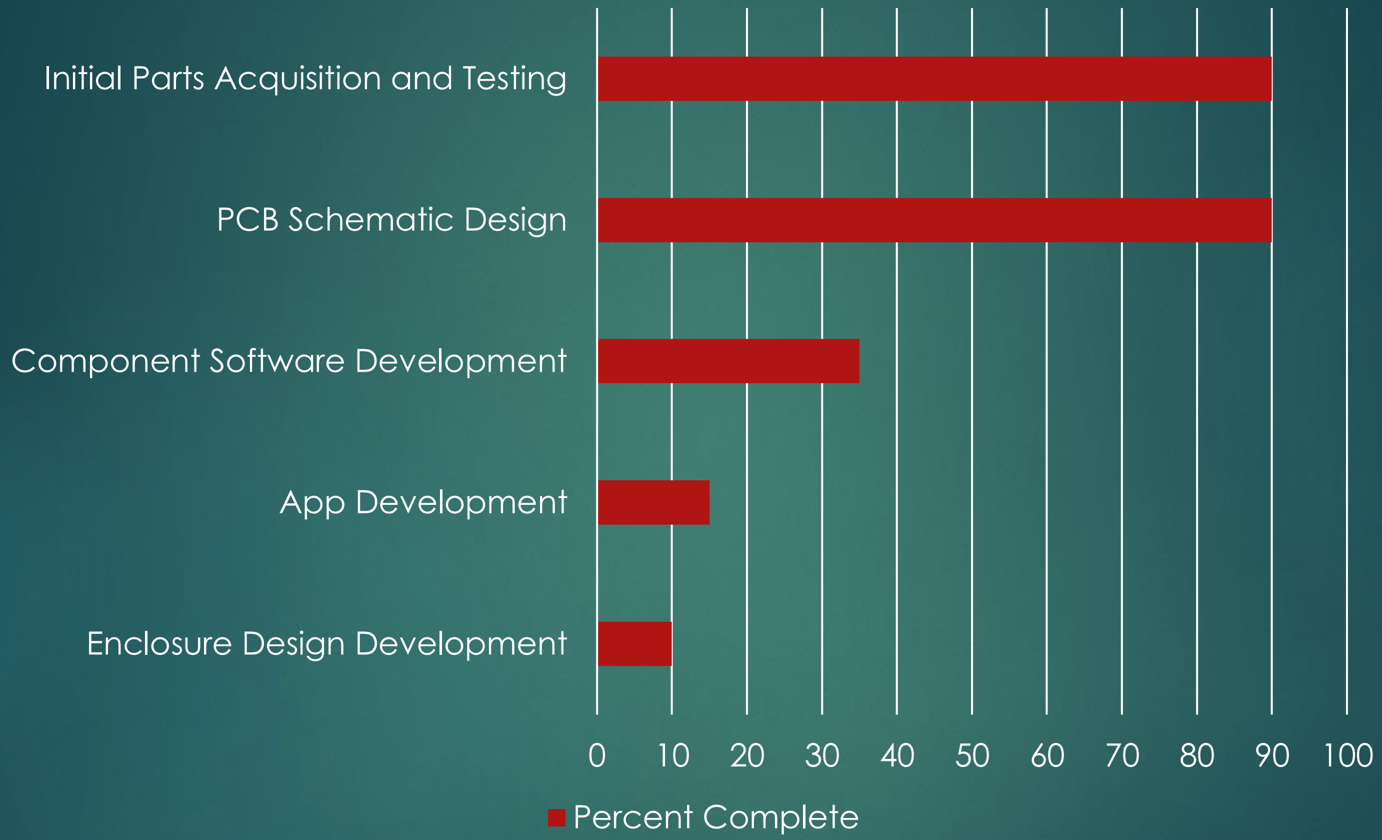
Financing

- Exclusively Student Funded
  - Logging all items purchased
  - Splitting overall cost at end of project
- Use of tools provided by the University of Central Florida
  - TI Innovation Lab
  - Senior Design Lab

Financing

Item	Description	Price ($)
PCB	Implement all hardware needed onto PCB	40
Display Unit	Display information to driver on windshield	100
Power Delivery System	Provides power to system	~45
Microprocessor	Processes data and sends to display	50
LEDs	Show power states and pertinent information	15
Soldering Equipment	Needed to implement electrical components	Provided by UCF
Bluetooth Module	Receive data from phone over Bluetooth connection	20
Bluetooth Testing Development Board	Allows debugging and initial exposure to the nRF52840 through Arduino and Nordic SDK	25
J-Link OB ARM Programmer	Flashes firmware and sends code to blank Bluetooth Module	5
Oscilloscope	Allows testing of RF portions and voltage differences	Provided by UCF
Speaker	Play recorded sounds in specific situations	~10
Mobile Smartphone	Needed to host custom Application	N/A
GPS/Cellular Module	Feed location data to system and send SMS messages	90
Battery	Used as backup power source	20
OBDII Connector	Needed to get data from vehicle's OBDII Port	45

Project Completion Status



To Be Started: Firmware Development, Bare Element Acquisition, PCB Acquisition and Testing

Challenges

- Writing firmware for hardware components
- Selecting display components that will physically fit into our specified size
- Ensuring compatibility with a wide variety of vehicles and smartphones
- Unexpected issues with components
  - Durability of SIM5320 3G GSM Module
  - Configuration of SIM808 Module
  - Software Debugging

Plans for Successful Design

- Order PCB as soon as possible
- Test remaining components to ensure proper operation
- Begin integrating individual components into whole design
- Work within scheduled timeline
  - Unexpected issues
  - Stay within relative scope

Works Cited

- Figure 1. OBD-II picture. Retrieved from https://www.digikey.com/product-detail/en/sparkfun-electronics/CAB-10087/1568-1227-ND/5721422?utm_adgroup=Between%20Series%20Adapter%20Cables&utm_source=google&utm_medium=cpc&utm_campaign=Shopping_Cable%20Assemblies_NEW&utm_term=&utm_content=Between%20Series%20Adapter%20Cables&gclid=Cj0KCQiApaXxBRDNARIsAGFdaB_TN8czxloyzaVaEYN6X-3ChxJNiaZz2ZLFHx6AWiBSORBKhtWuNI8aAu6kEALw_wcB. Accessed 23 Jan. 2020