Directional Driver Hazard Advisory System

ECE 445 Mock Design Review Document

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Team: 24

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1 Block Diagram

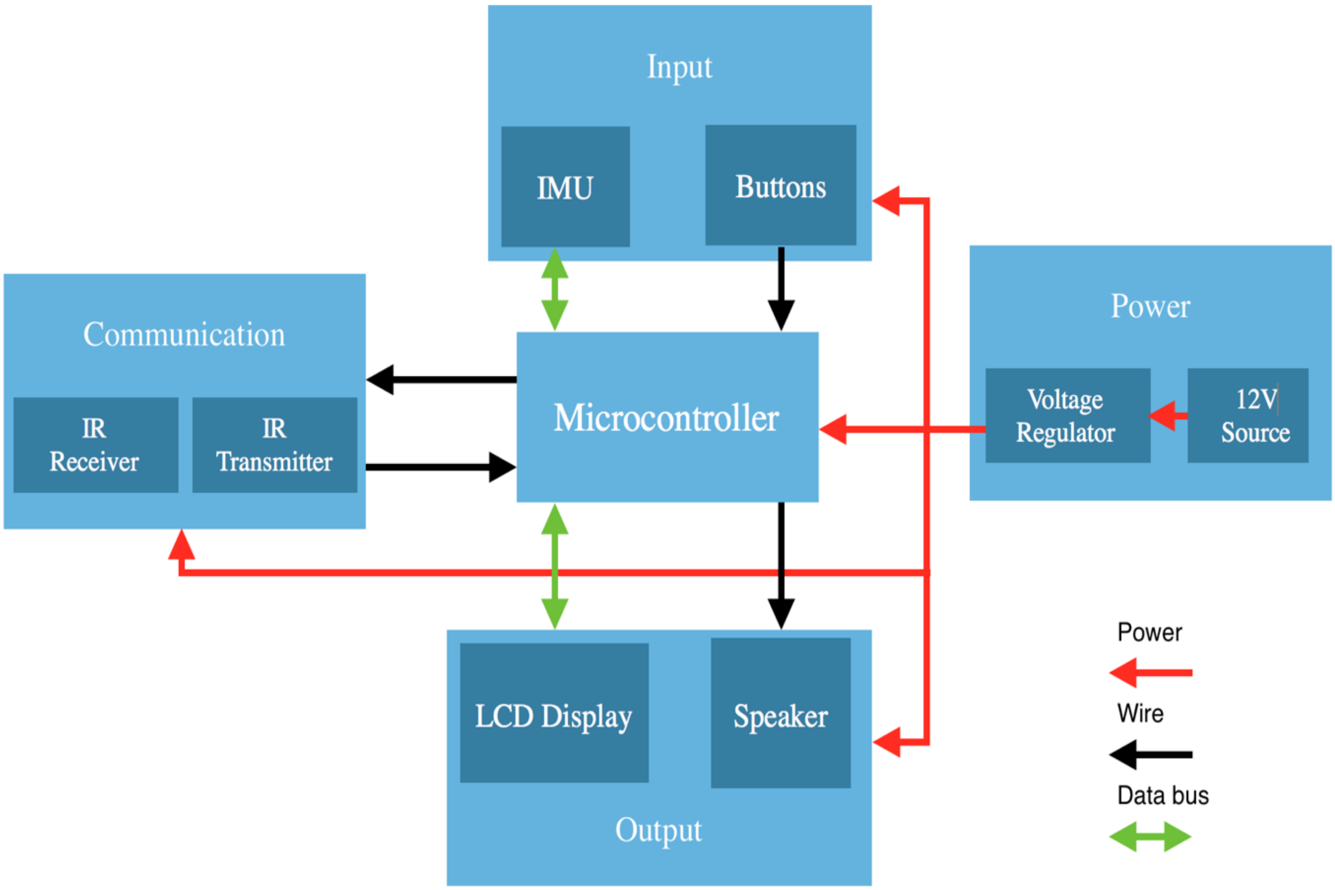

Figure 1: Block Diagram

2 One Circuit Schematic

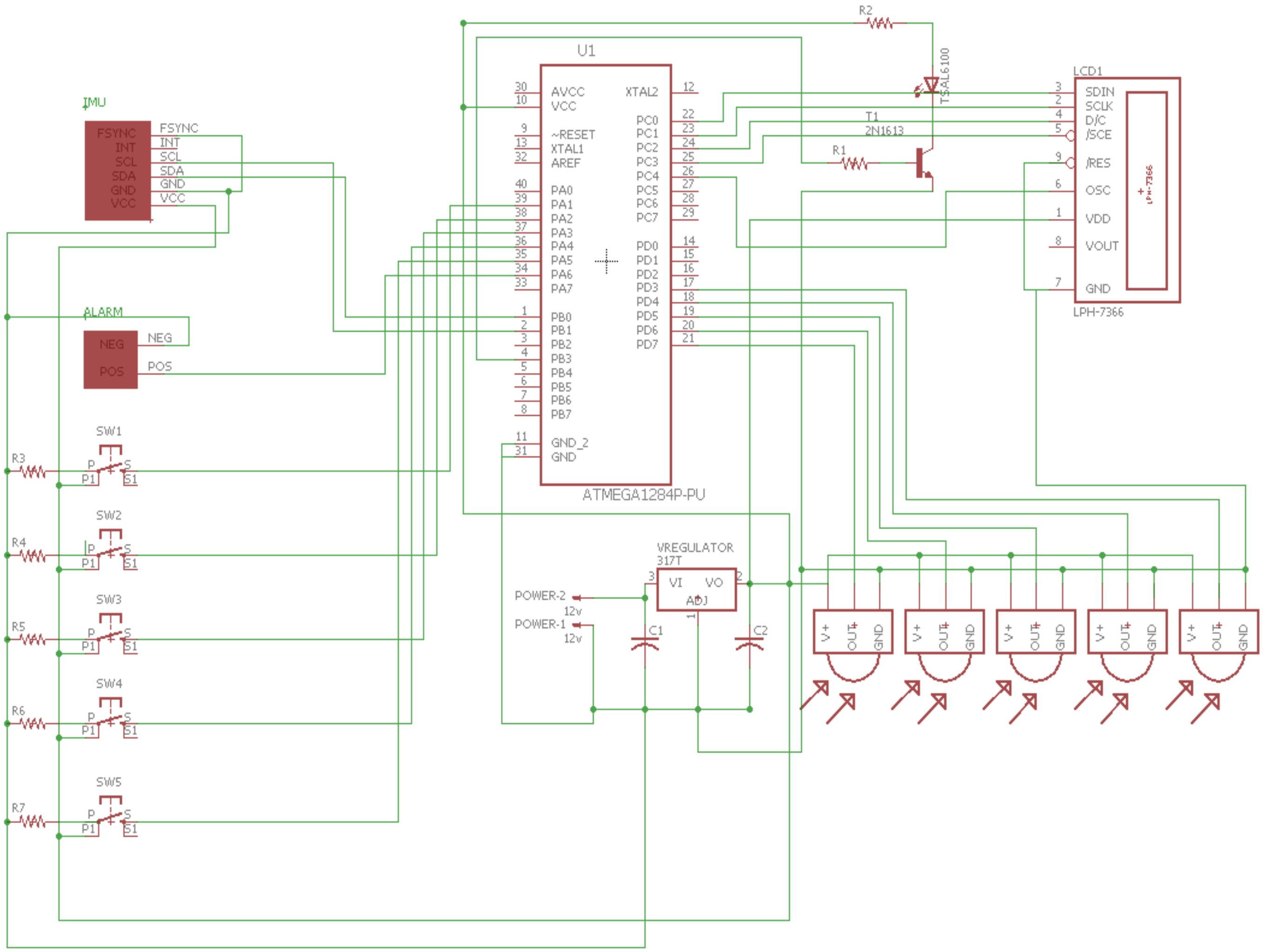

Figure 2: Full Circuit Schematic

3 One Calculation

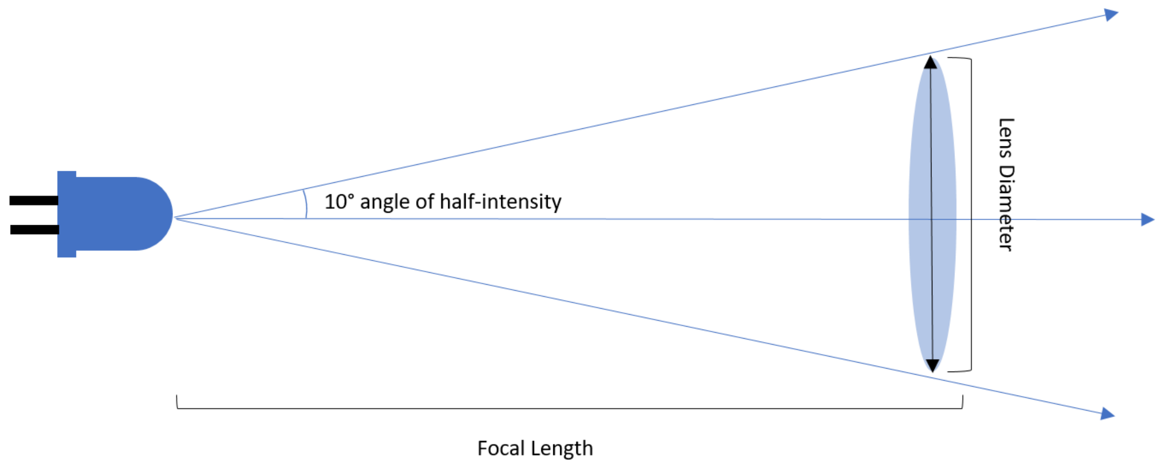

Figure 3: IR Transmitter with Lens

In order to optimize the amount of light gathered by our lens, we have to compute the best distance from the lens to place our IR LED. Our LED has an angle of half-intensity of 10°. The optimal distance of the LED is then the focal length f = diameter/(2* tan(10°)). Below are some pre-computed values in Figure 4.

Lens Diameter (mm)	Tube Length (mm)
20	56.70
25	70.89
30	85.07
35	99.25
40	113.43
45	127.60
50	141.78

Figure 4: Lens vs Tube Table

4 One Plot (Simulation or Experiment)

Below are two figures showing what our signal will look like before and after demodulation. Figure 5 is a modulated signal, and the signal in Figure 6 has been demodulated. We will be using pulse width encoding, modeled after the Sony SIRC protocol [9].

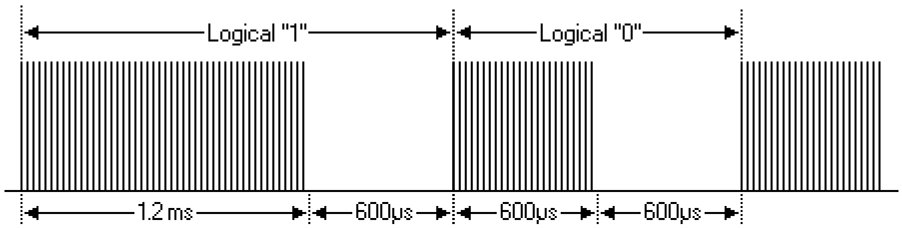

Figure 5: Modulated IR Signal

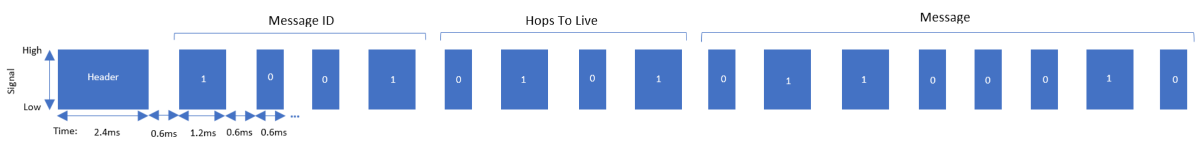

Figure 6: Demodulated IR Signal

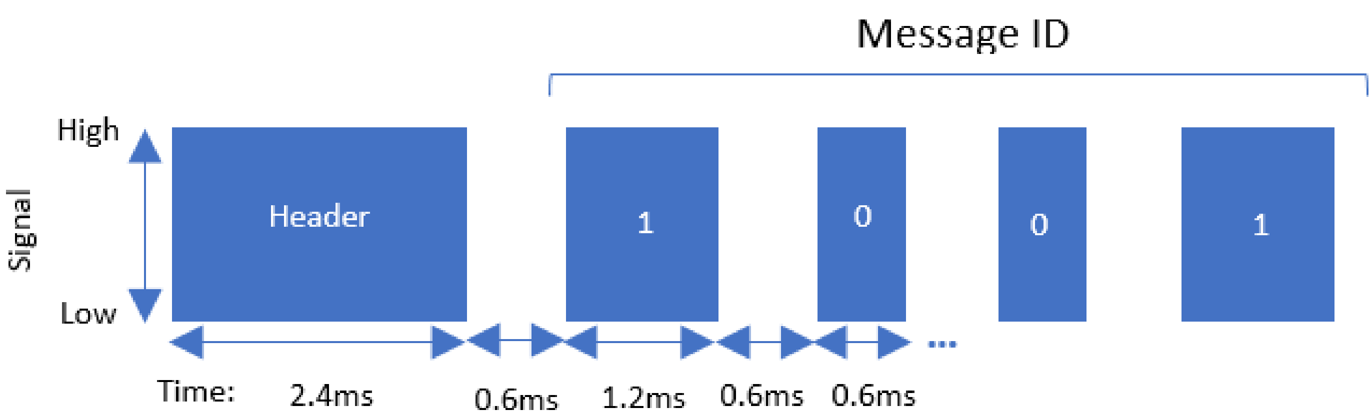

Figure 7: Demodulated IR Signal Zoomed In

5/6 One Block Description / Requirements and Verifications

Communication

For communication between the cars, we have chosen to use IR (Infrared radiation) to limit communication to the car in front or behind the sender. This section is split into 3 main components of the **IR Receiver**, **IR Transmitter**, and the **Message Protocol** used to communicate between them. Each car will have an IR receiver in the front of the car to receive messages, and an IR Transmitter in the rear of the car to send messages.

IR Receiver – Vishay Semiconductor TSOP38338

The IR Receiver will be mounted near the front of the car for an optimal view of the car directly in front of the user's car. It will be connected to the microcontroller through a single input pin to relay message data, and it will be powered with 3.3V from the Voltage Regulator. Current is estimated at ~0.45mA for each IR receiver.

Requirement	Verification
Must be able to correctly receive a message from at least 100ft during daylight and night with good visibility.	A. Place IR Receiver exactly 100ft downrange from IR Transmitter (Once at night and once during the day). B. Send message with random data. C. Ensure message was received correctly.
Must maintain at most a 60% packet lost rate.	A. Place IR Receiver exactly 100ft downrange from IR Transmitter. B. Send 50 messages with random data. C. Ensure at least 40% of the messages were received by comparing sent and received.
Must have a field of view between 25° and 180°.	A. Place IR Receiver exactly 10ft downrange from IR Transmitter. B. Move the IR Transmitter 2.22ft in a perpendicular direction, creating a ~12.5°angle. C. Send a message and ensure that it was received.

IR Transmitter – Vishay Semiconductor TSAL6100

The IR Transmitter will be mounted in the rear of the car to be able to propagate messages backwards and is a high-power IR LED. It will be powered with 3.3V and controlled by a MOSFET which is being controlled by the microcontroller (Required current is too high to directly output from the microcontroller). We will use an asymmetric double-convex lens to narrow the LEDs beam for better range. The lens will be roughly 2" in diameter. Without the lens, IR range will be roughly 30-40ft. With the lens we should be able to get at least 100ft, and up to 600ft[8]. The package will consist of a PVC pipe with the lens at one end and the LED at the other. Our carrier frequency will be between 30 to 40 kHz and has transmission rate of a 1 or 0 being 1800 microseconds and 1200 microseconds respectively. We also transmit a header to identify the start of the message which has a transmission rate of 3ms. Current is estimated at ~100mA for the Transmitter. (Note: Requirements and Verification are similar to the Receiver as they work in tandem)

Requirement	Verification
Must be able to correctly receive a message from at least 100ft during daylight and night with good visibility.	D. Place IR Receiver exactly 100ft downrange from IR Transmitter (Once at night and once during the day). E. Send message with random data. F. Ensure message was received correctly.
Must maintain at most a 60% packet lost rate.	D. Place IR Receiver exactly 100ft downrange from IR Transmitter. E. Send 50 messages with random data. F. Ensure at least 40% of the messages were received by comparing sent and received.

Message Protocol

Our messaging protocol will be based around our messages which are going to be 16 bits wide (4 bits for a message_id, 4 bits for a time_to_live, and the remaining bits for the message), and is a simple at-least-once protocol. When a vehicle wants to alert other drivers of an advisory the transmitter will spam a message continuously for 3 seconds which allows us to combat the relatively high packet loss rate while also delivering vehicles who come into range of the transmitter while sending. The receiver will receive the message and will check the message_id against a list of recent message_ids to not spam the user with the same message. The receiver will then deliver the message and check the time_to_live parameter of the received message to see if it should be propagated backwards. If the time_to_live is greater than 0, the message would be propagated with a decremented time_to_live parameter. Currently we believe a default time_to_live of 5 will notify all drivers who would need to immediately be informed of an upcoming advisory.

Requirement	Verification
Must be able to continuously send a single message over the course of 3 seconds.	A. Place IR Receiver exactly 5ft downrange from IR Transmitter. B. Send message with random data. C. Ensure IR Transmitter received an IR signal for the entire 3 seconds.
Must propagate the message if the time_to_live parameter is greater than 0.	A. Place IR Receiver exactly 5ft downrange from IR Transmitter. D. Send 100 messages with random time_to_live parameter between 0 and 5. E. Ensure that all the messages with time_to_live > 0 were attempted to be sent again, and all messages with time_to_live = 0 were only sent once.

7 Safety Statement

The main potential safety hazard with our project is driver distraction. To mitigate this risk, our system will be designed in such a way to not add any user interaction more distracting then what is currently outfitted on a car dashboard. For the manual hazard entry, the buttons are placed so that only a passenger in the front seat can interact with it, preventing the driver from taking his/her eyes off the road or otherwise getting distracted. We will still give the driver some feedback in the form of audio cues in the event of an emergency, but the cues will conform to audio design patterns used in existing driver safety systems (such as blind spot sensors) in the event of an emergency.

Another potential risk factor is IR radiation. Though some IR sources such as IR lasers can cause damage to the eyes, we will be using IR LEDs which, per semiconductor manufacturer Vishay Intertechnology Inc., “nearly all LEDs are far below the Exempt limits” [6] so to mitigate this risk, we need to make sure the IR LEDs we purchase are safe.

Our safety risks and mitigations follow the IEEE code of ethics first point, “to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment” [7]. We believe that the benefits provided through increased driver awareness outweigh the potential risk of driver distraction given our distraction mitigation techniques.

8 Citations

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