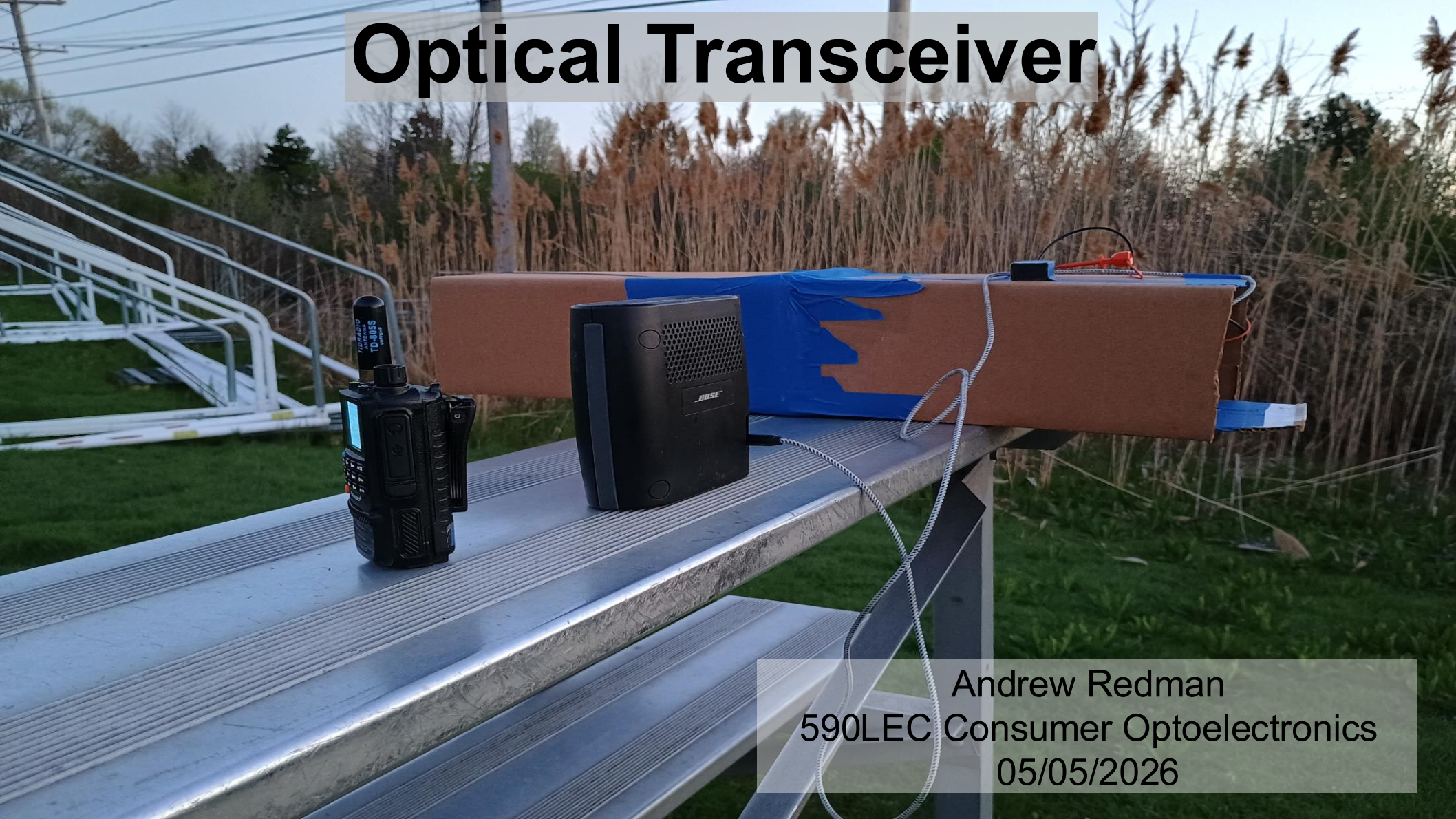
Optical Transceiver



Andrew Redman
590LEC Consumer Optoelectronics
05/05/2026

Outline

- Motivation
- Requirements
- Block Diagram
- BOM, Schematic, Software Design
- Field Testing

US Amateur Radio Bands

US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.

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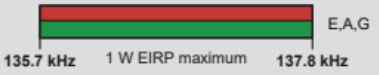

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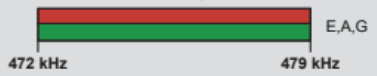
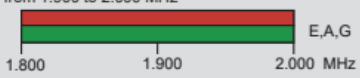
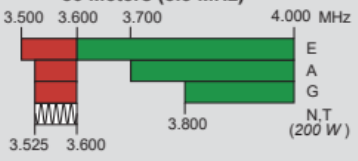


160 Meters (1.8 MHz)

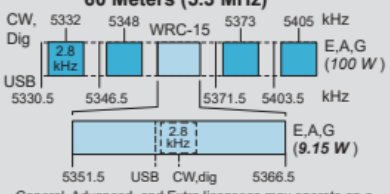
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



80 Meters (3.5 MHz)



60 Meters (5.3 MHz)



General, Advanced, and Extra licensees may operate on a *secondary* basis with an operating bandwith of 2.8 kHz, maximum ERP of 100 W (relative to a half-wave dipole antenna) on individual channels. As February 13, 2026 the WRC-15 band 5351.5 to 5366.5 kHz is available with a max. ERP of ***9.15 W***.

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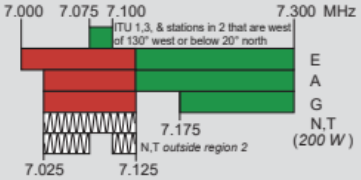

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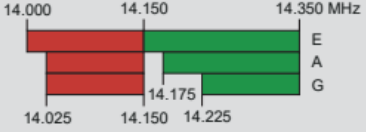
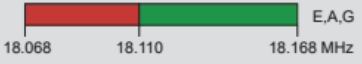
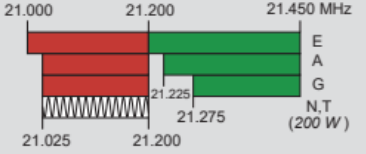


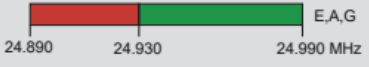
17 Meters (18 MHz)



15 Meters (21 MHz)



12 Meters (24 MHz)



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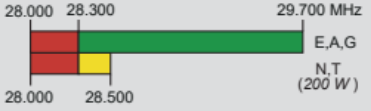
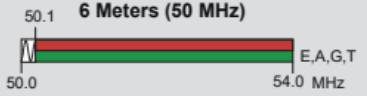
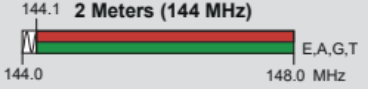


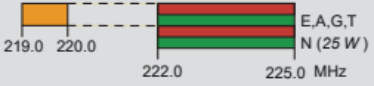
6 Meters (50 MHz)



2 Meters (144 MHz)



1.25 Meters (222 MHz)



*Geographical and power restrictions may apply to all bands above 420 MHz. For information about your area, See *FCC **97.303** Frequency sharing requirements.*

70 cm (420 MHz)*

33 cm (902 MHz)*

23 cm (1240 MHz)*

All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz ‡	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
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5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

KEY

Note:
CW operation is permitted throughout all amateur bands.

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Test transmissions are authorized above 51 MHz, except for 219-220 MHz

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See *www.arrl.org/band-plan* for detailed band plans.

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Getting Started in Amateur Radio:
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email: newham@arrl.org

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 rev. 1/16/2026

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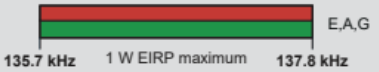

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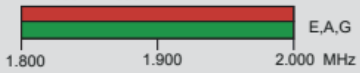

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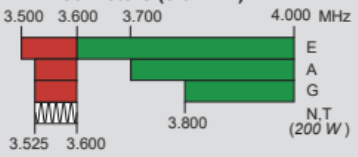

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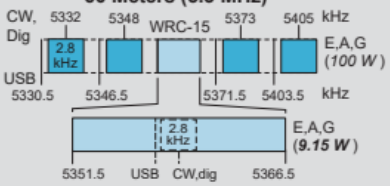

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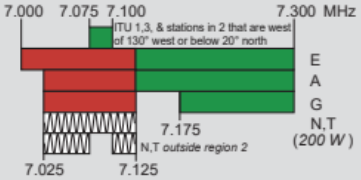

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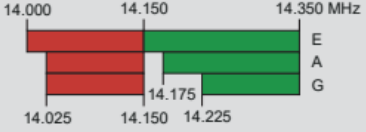

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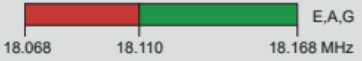

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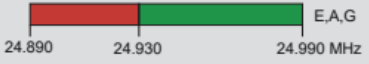

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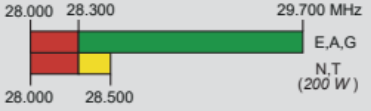

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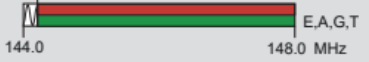

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Wavelength: 624nm
Frequency: 480THz

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System Requirements

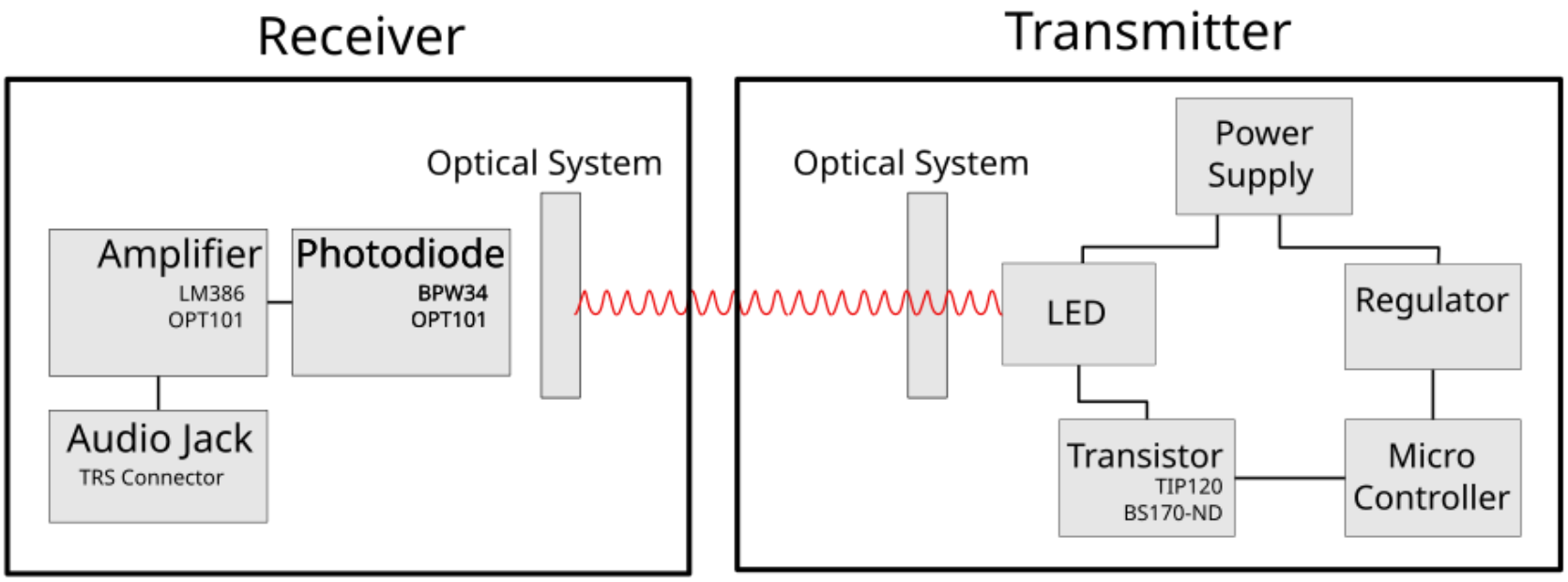
- Enable two-way communication (TX/RX)
- Cost Effective/Simple Circuit Design
- Portable: Battery Powered
- CW with potential for AM in the future

Regulatory and Safety

U.S. Department of Transportation **Federal Aviation Administration**

- IEC/EN 62471 Standards for eye/skin safety
  - Guidance on photobiological safety for 200nm - 3000nm
  - Less restrictive as we are working with visible light
  - Could not review standard directly or find safety sheet for red product
  - Similar products from LumilLED were consistently rated in RG1, RG2
- FAA Advisory Circular 70-1B
  - FAA advisory document for outdoor laser activities
  - Sets limit of 50nW/cm^2 for laser activities in most restrictive environment

Block Diagram



BOM

System	Function	Mfg	Mfg Part Number	Vendor
Receiver	Detector	Texas Instruments	OPT101P	Digikey
Receiver	Focusing Optic	-	-	eBay
Transmitter	Arduino Breakout Board	Arduino	ATMEGA 328p	Amazon
Transmitter	Voltage Regulator	STMicroelectronics	L7805CV	Digikey
Transmitter	Emitter	Luxeon	C Color LED	LedSupply
Transmitter	Emitter Housing	LED Dynamics	DHL-3UP-EH	LedSupply
Transmitter	Secondary Optic	Carclo Optics	10510	LedSupply
Transmitter	Collimating Optic	-	-	eBay
Transmitter	Switching Fet	STMicroelectronics	TIP120	Digikey
Transmitter	TRRS Audio Jack Breakout Board	Onyehn	-	Amazon
Receiver	TRRS Audio Jack Breakout Board	Onyehn	-	Amazon
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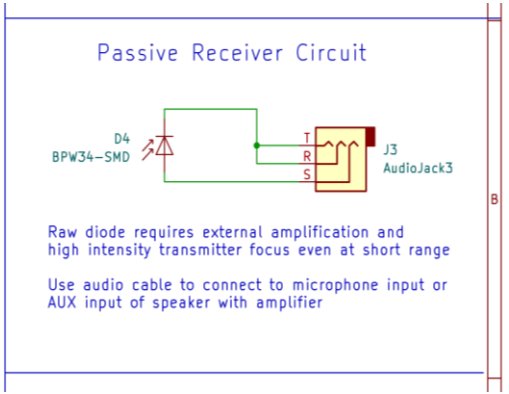
Receiver Schematic



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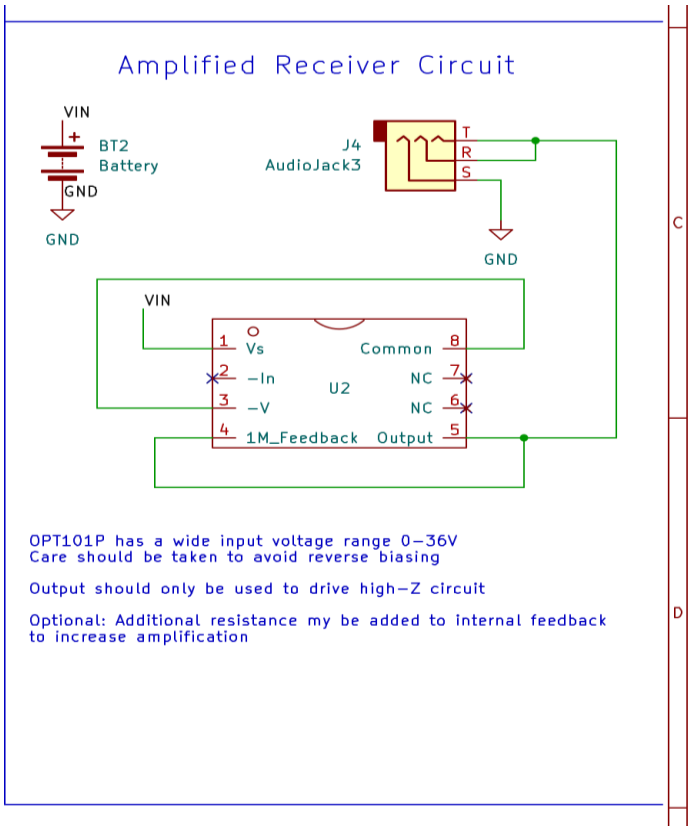
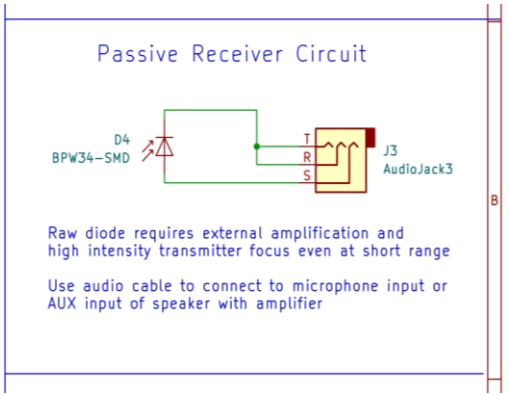
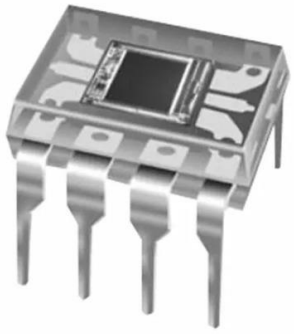




OPT101 Monolithic Photodiode and Single-Supply Transimpedance Amplifier



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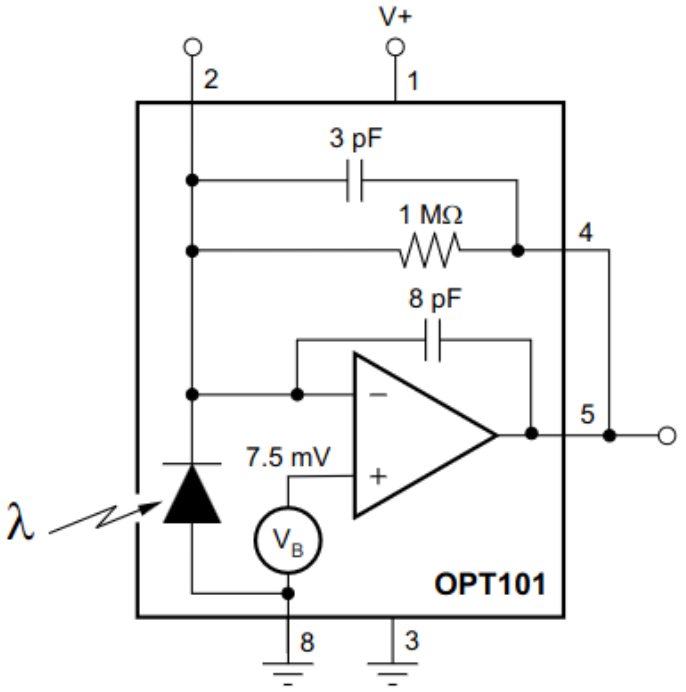
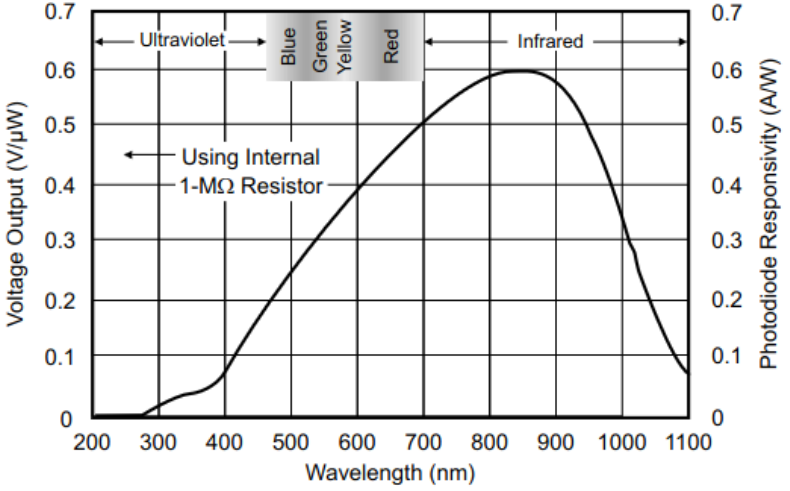
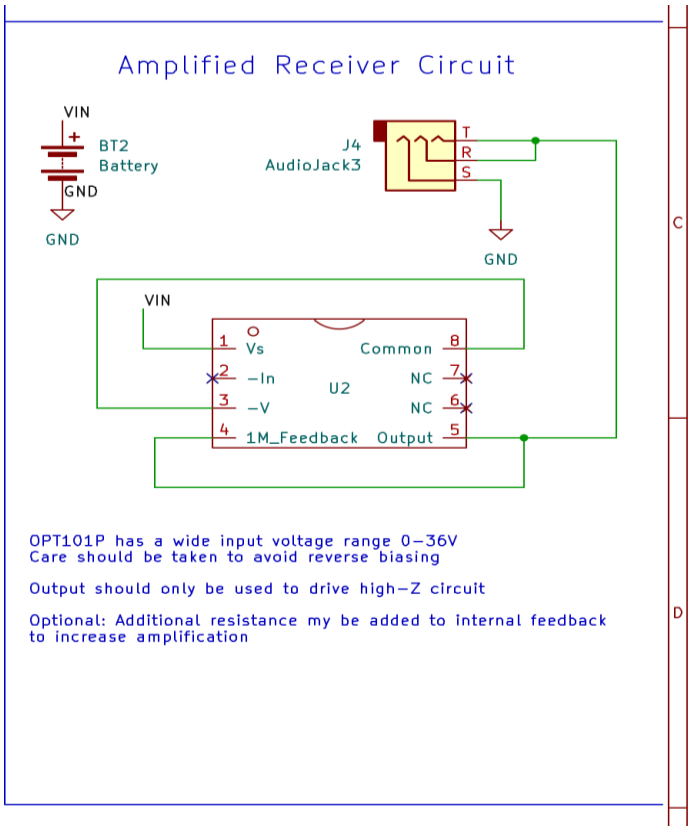
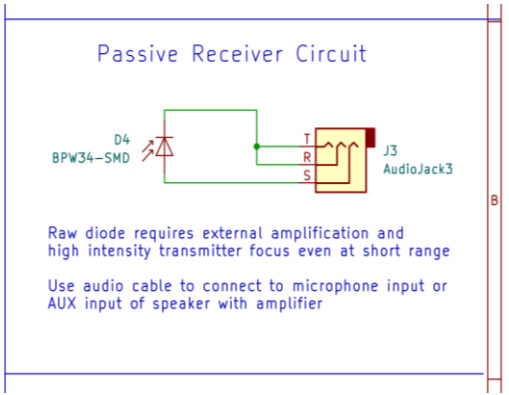


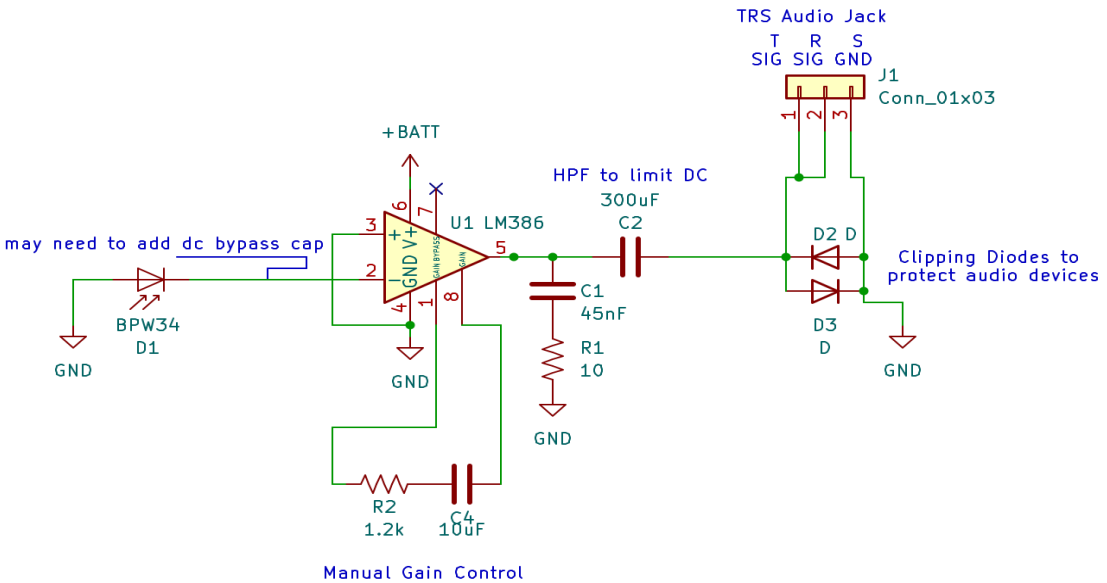
Spectral Responsivity



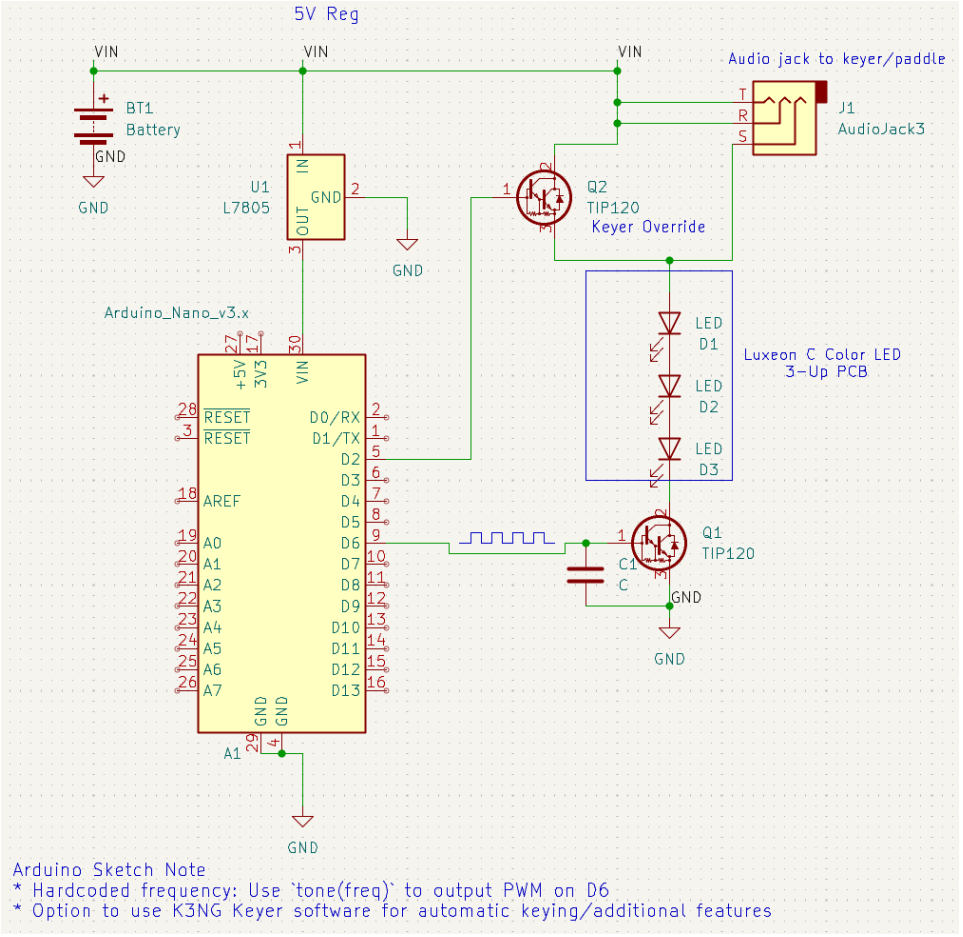
Receiver Schematic



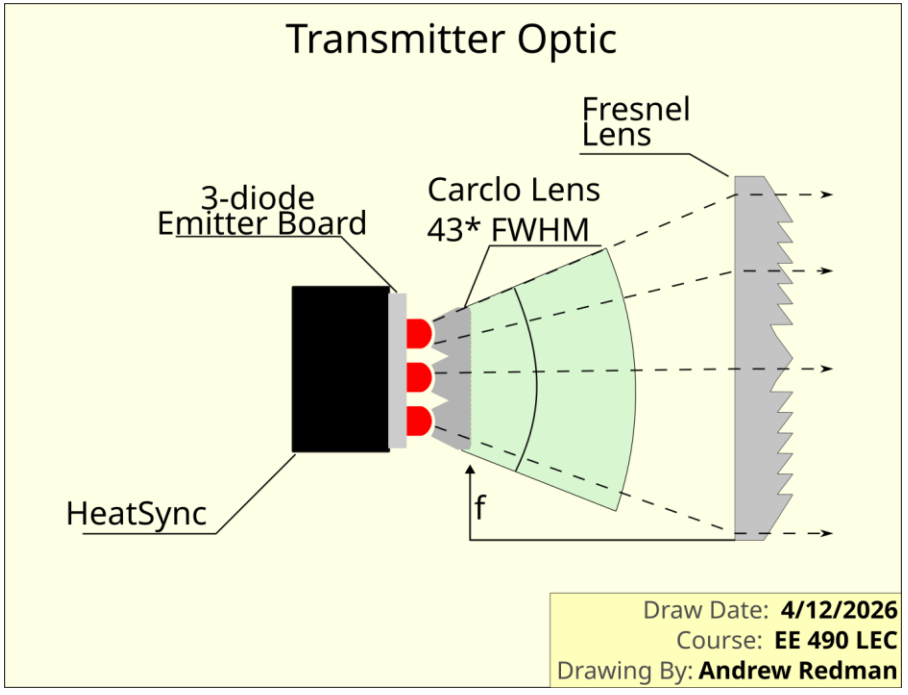


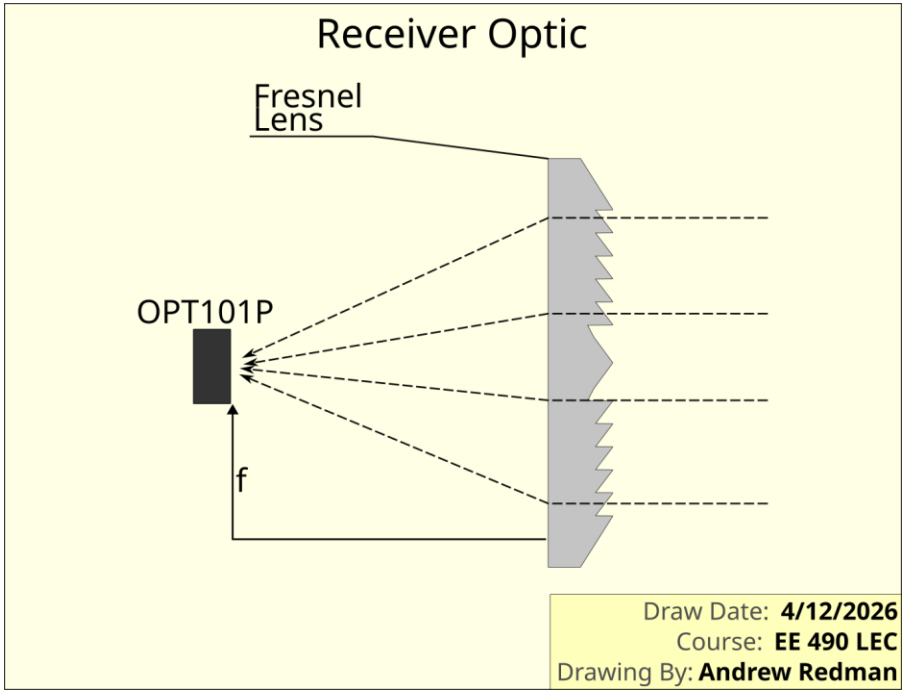


Transmitter Schematic



Optical System Design





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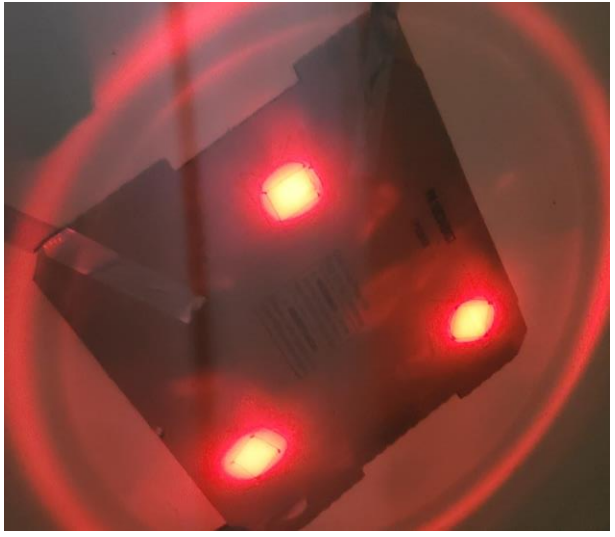

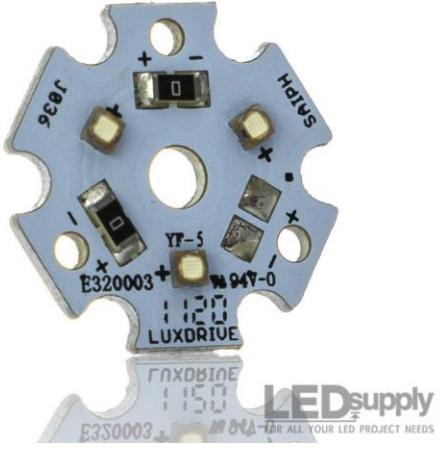

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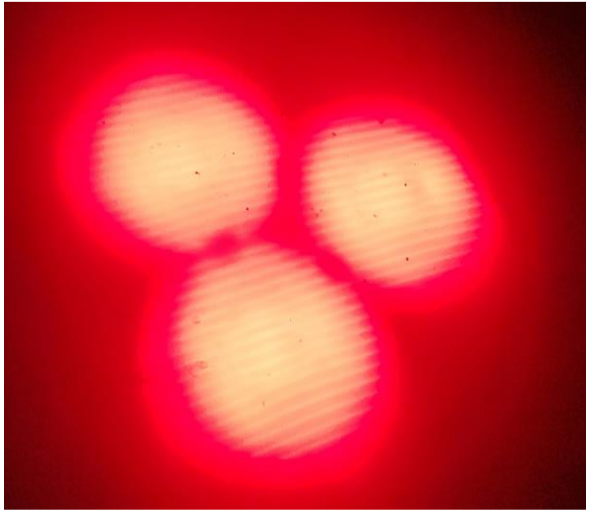

Software Design

Base code just sets up a PWM output and sends a constant tone

```
#define TONE_PIN 6
#define TONE_FREQ 800

void setup(){
pinMode(TONE_PIN,OUTPUT);
tone(TONE_PIN, TONE_FREQ);
}

void loop(){
// No changes needed
}
```

Software Design

Base code just sets up a PWM output and sends a constant tone

Used AI to make a few musical sections which use simple PWM to send individual notes

After the "alignment intro" the constant tone is output for use as CW carrier

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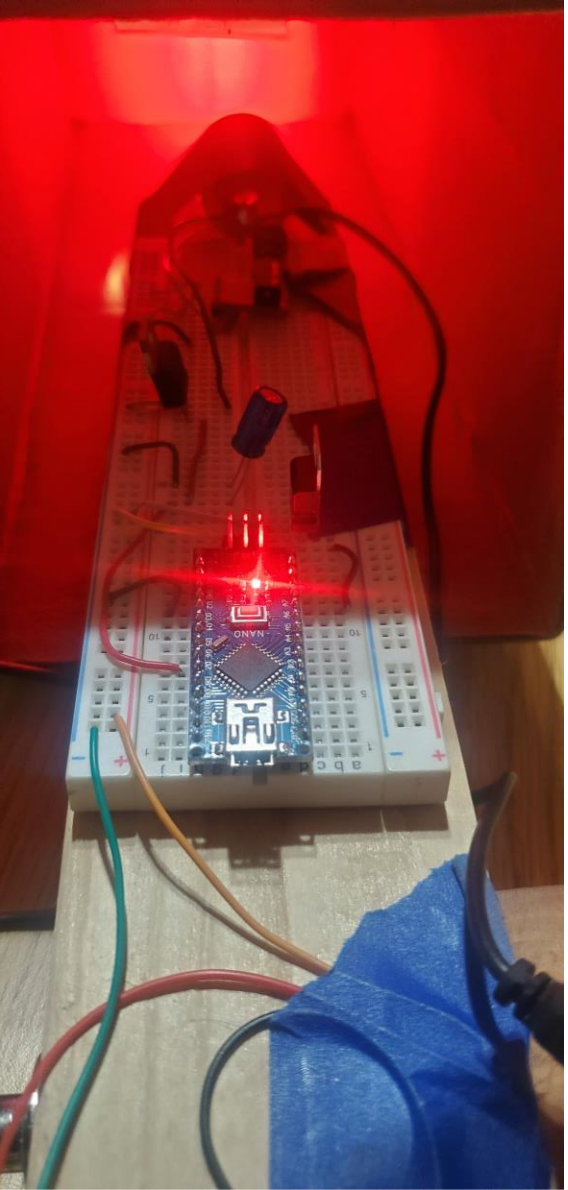
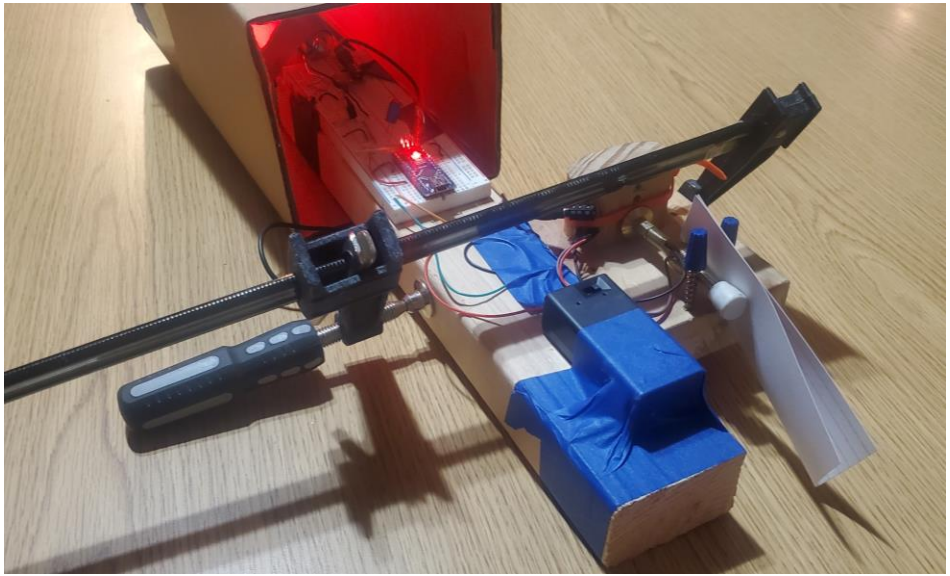
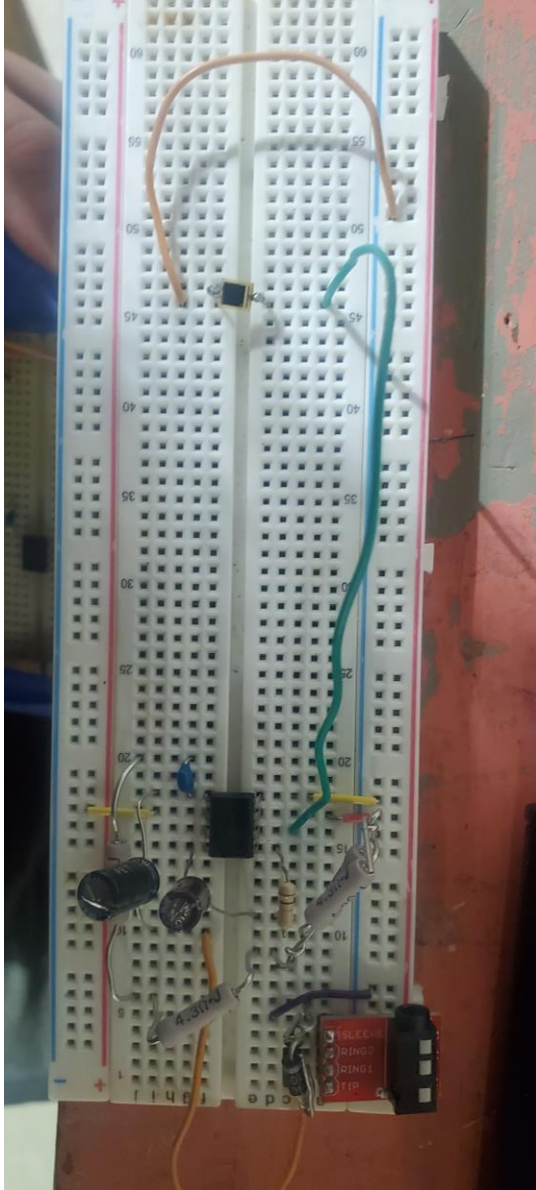
```

Construction

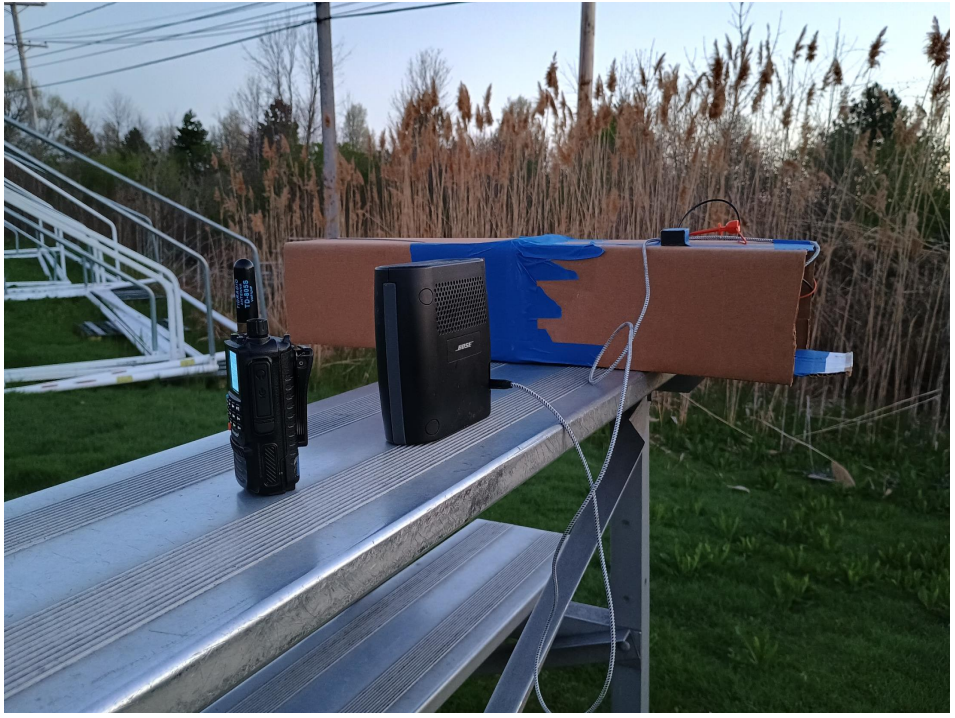






Field Testing

Field Testing



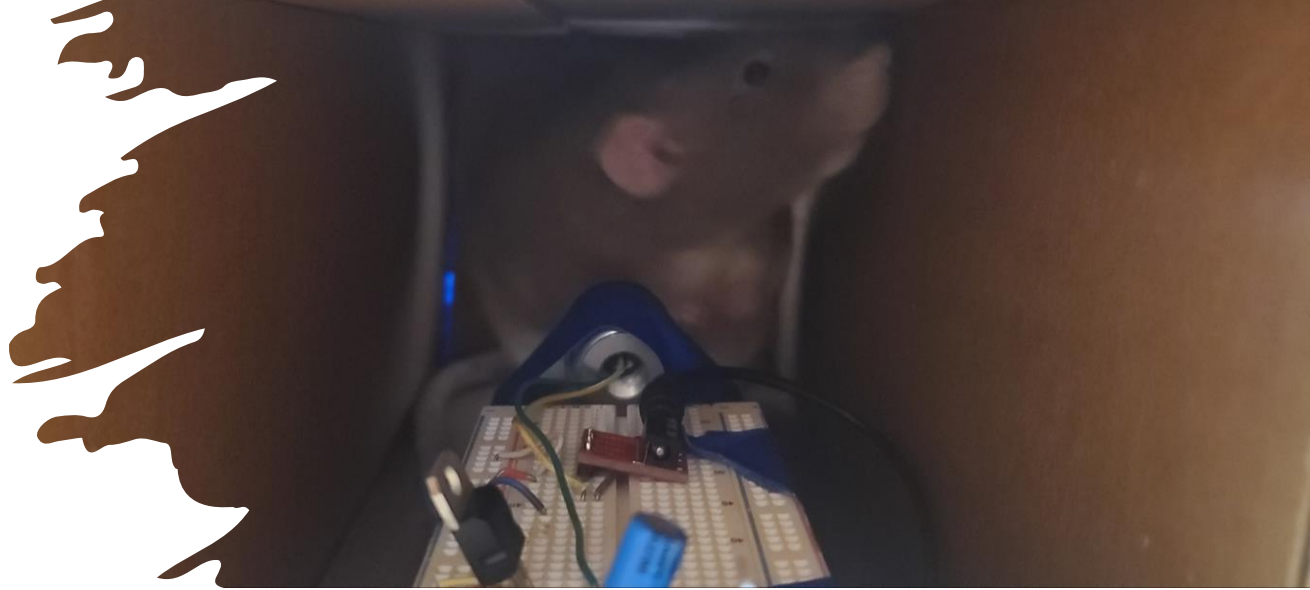
Field Testing Results

- Range 250m
- Dusk just after sundown
- Audio feedback over handheld radio (GMRS)
- Video

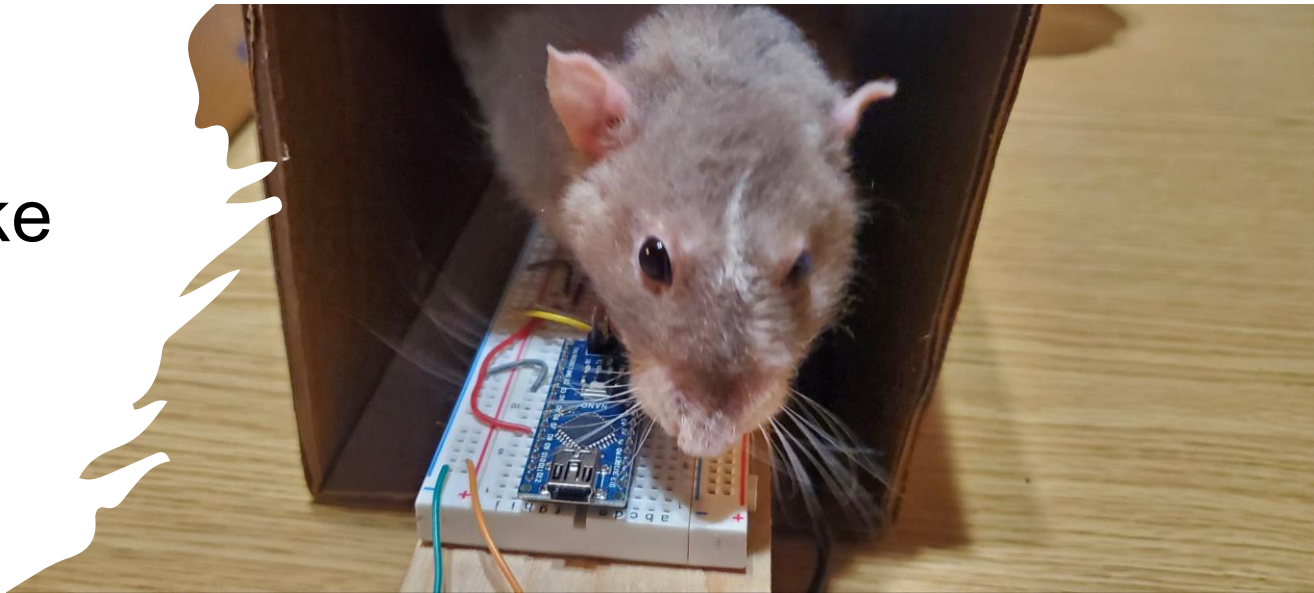
Future Improvements

- Larger Optics
- Can reduce BOM cost by making component swaps
  OPT101 -> BPW34, LM386
  Arduino -> LM386
- Improve durability by redesigning enclosure
- Redesign support system to allow for better control of direction
- Add AM to support voice and digital modes
- Repeat Testing over a larger distance

Demonstration Questions



QA Technician: Pancake



Slide Layout Recommended by Microsoft's AI