UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Water Blaster

Electrical & Computer Engineering

Team 19

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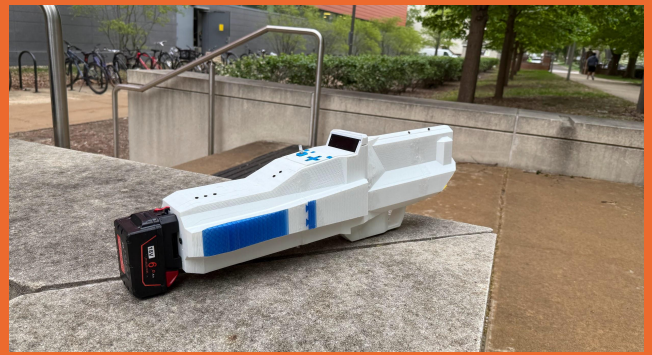

Overview

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Our New Solution
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Firmware
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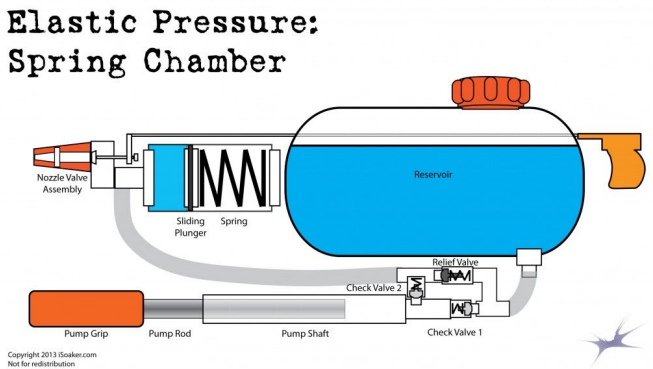


How does a water blaster work?

- Water is put under pressure
- Mechanism to release water
- Nozzle

Two options:

Store at pressure
Or
Pump from reservoir

Existing Electric Water Blasters

- Very Limited Range
- Low Capacity
- No Customization
- Not Easily Maintainable
- Not Interactive

Images Courtesy of Bambulab

Requirements

AI generated image

High level requirements

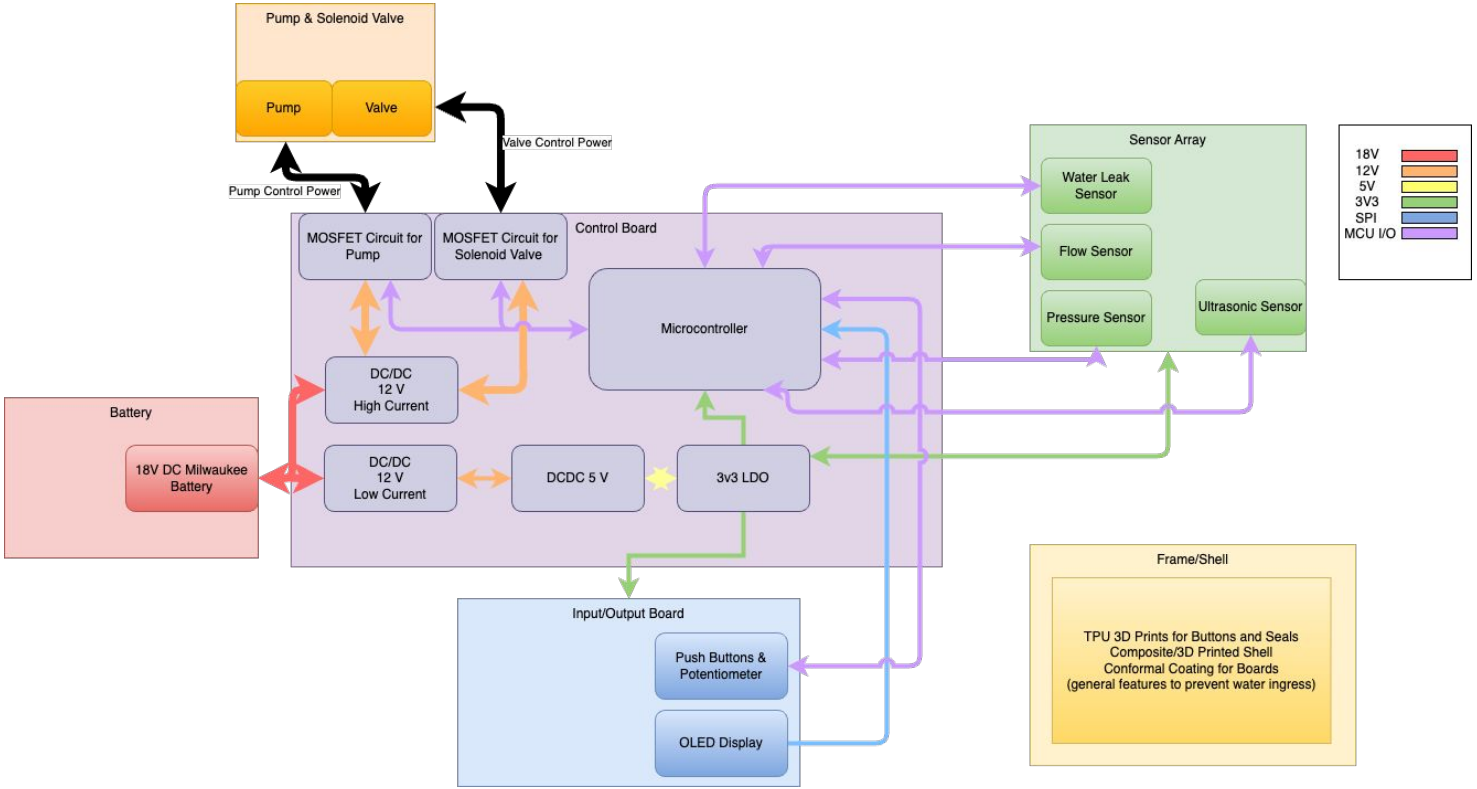
1. The blaster should consistently shoot water bursts covering a distance of over 20 ft.
2. The blaster must be lightweight with a total weight not to exceed over 10 lbs.
3. The display must accurately reflect the state of the state machine and update in under 1 second to ensure accurate data is displayed.

Our Solution

Our New Electric Water Blaster

Quick Video Demonstration

Block Diagram



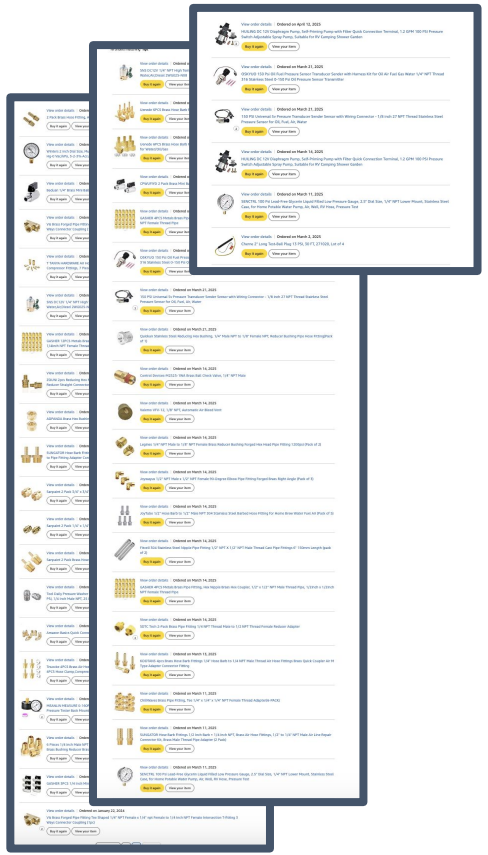
Block Diagram

Mechanical Design

Mechanical Parts

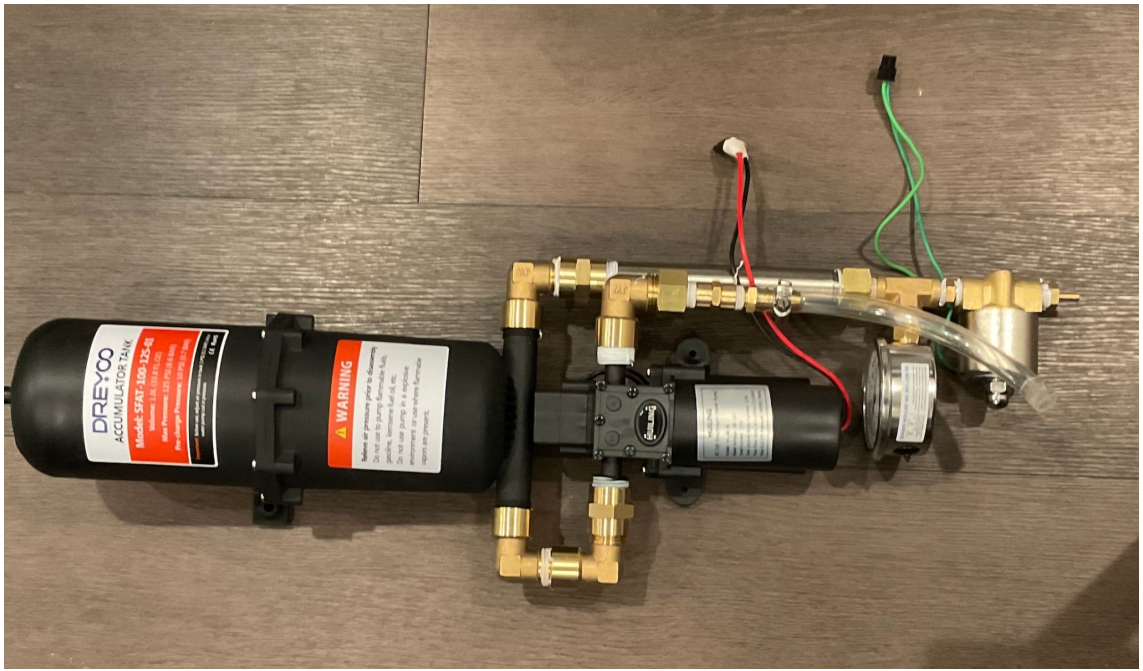
Tested many configurations

- Pump + Expandable Bladder + Solenoid Valve + Nozzle
- Pump + Non Pressurized Reservoir + Nozzle
- Pump +Tank + Bleeder Valve + Solenoid Valve + Nozzle
- Pump + Accumulator Tank + Solenoid Valve + Nozzle
- …

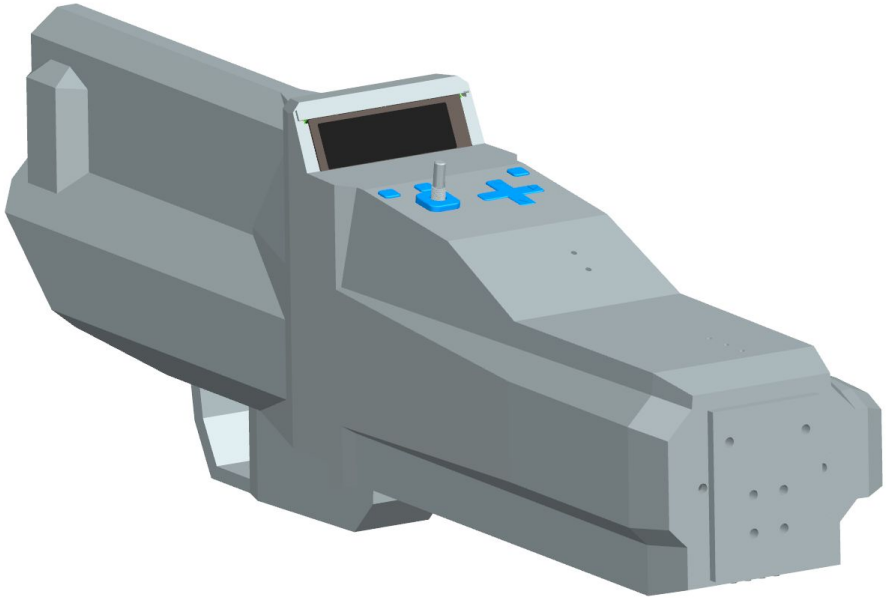


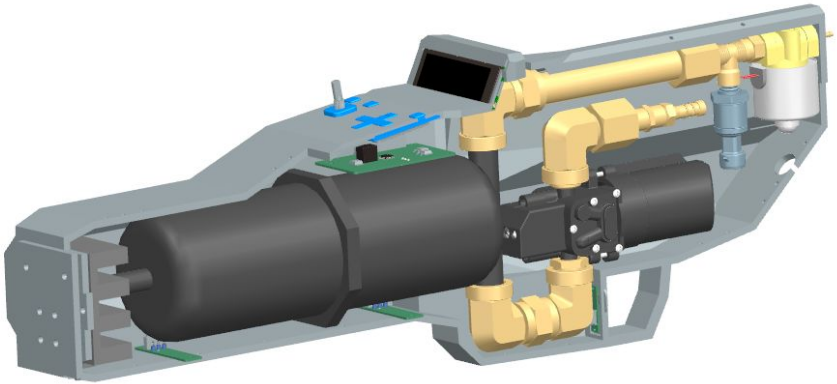
Features

- 12V Solenoid Valve
- 12V DC Pump
  - 110 PSI Max
- Accumulator Tank
  - Charged to 5PSI
- 1/8in Nozzlet

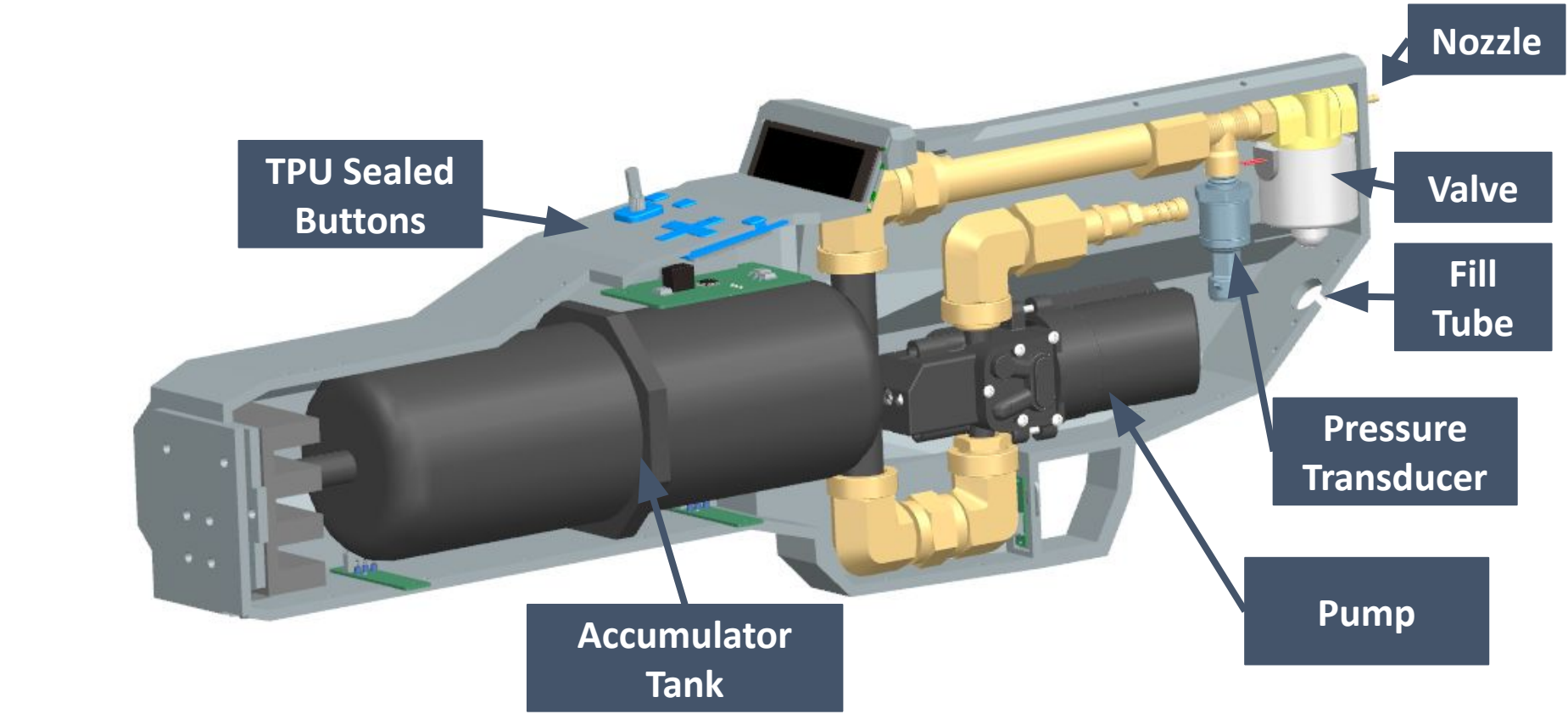


Mechanical Parts

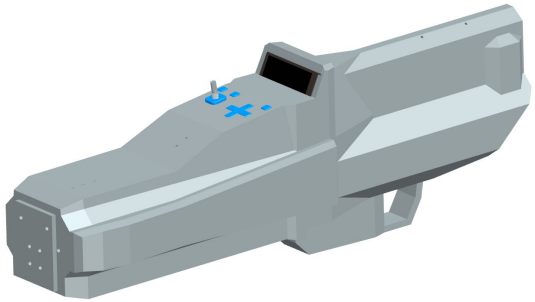




Labeled Mechanical Components

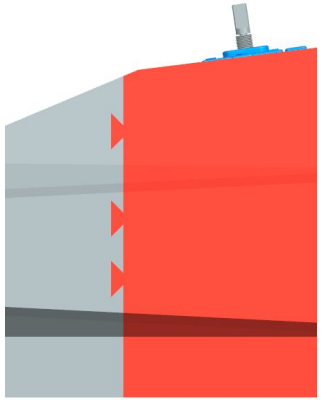


Understanding The Mechanical Design



Mechanical Design

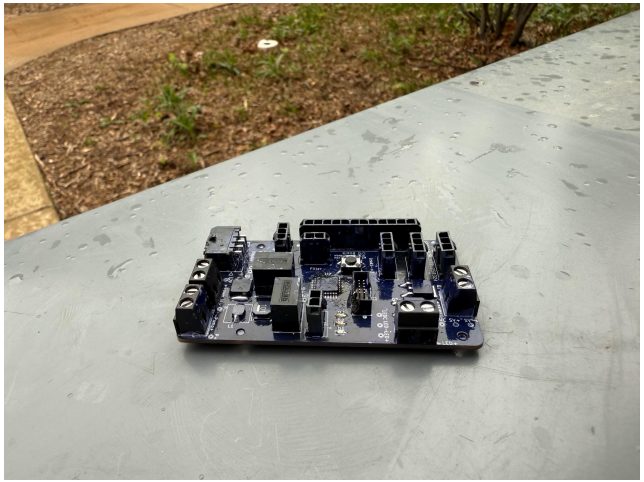
Sleek angular design
Integrated screen
Larger back to accommodate 1.5L tank
Bump out for solenoid valve at front



Designing for Manufacturability

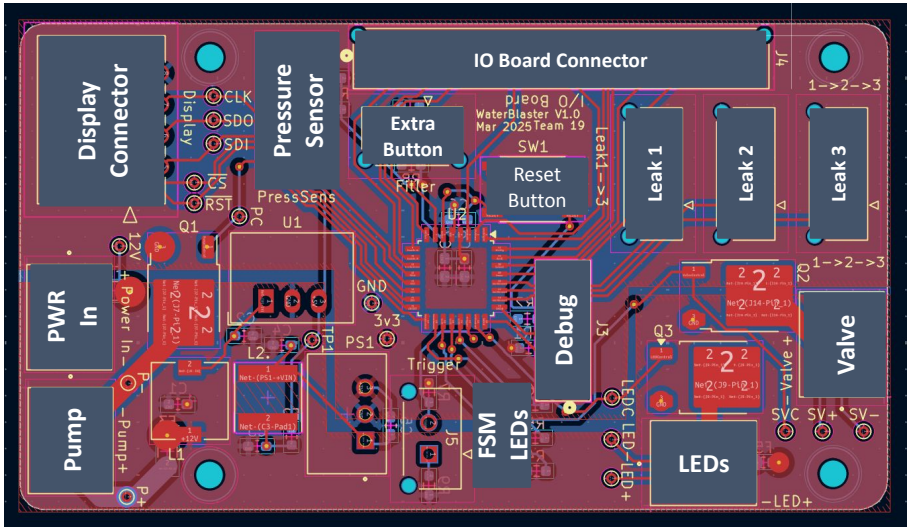
Mounting holes on everything
Multi part print combined with
0 tolerance interlocking joints
Holes for square nut mounting
Asymmetrical parting line

Electrical Design



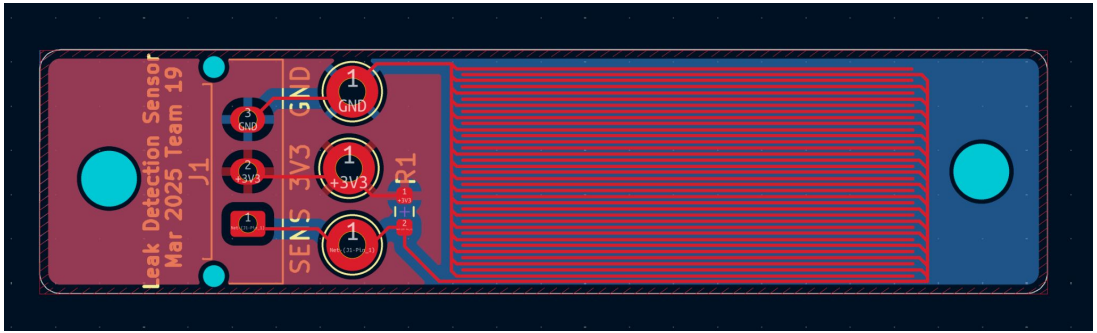
Main Board

- MOSFET Circuit for high power applications
- ADC for Pressure Transducer
- GPIO for leak sensors
- SPI for OLED



Active Low Leak Sensors

Interlaced traces GND and SENS
SENS pulled up to 3v3 through 1M resistor
Water completes circuit
MCU GPIO goes to logic low

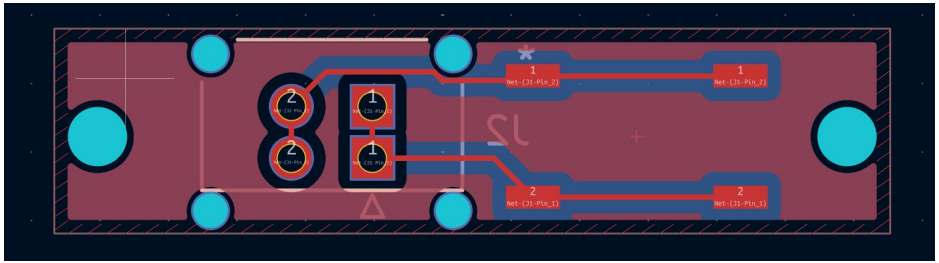


IO Board

Interfaces with Main Board
Step Encoder
D-Pad
Power Button
Fill Button
Settings Menu Button
3D Printed TPU Button Covers

Trigger Board

- Mount easily in enclosure
- Can unplug to service
- Connector works both ways

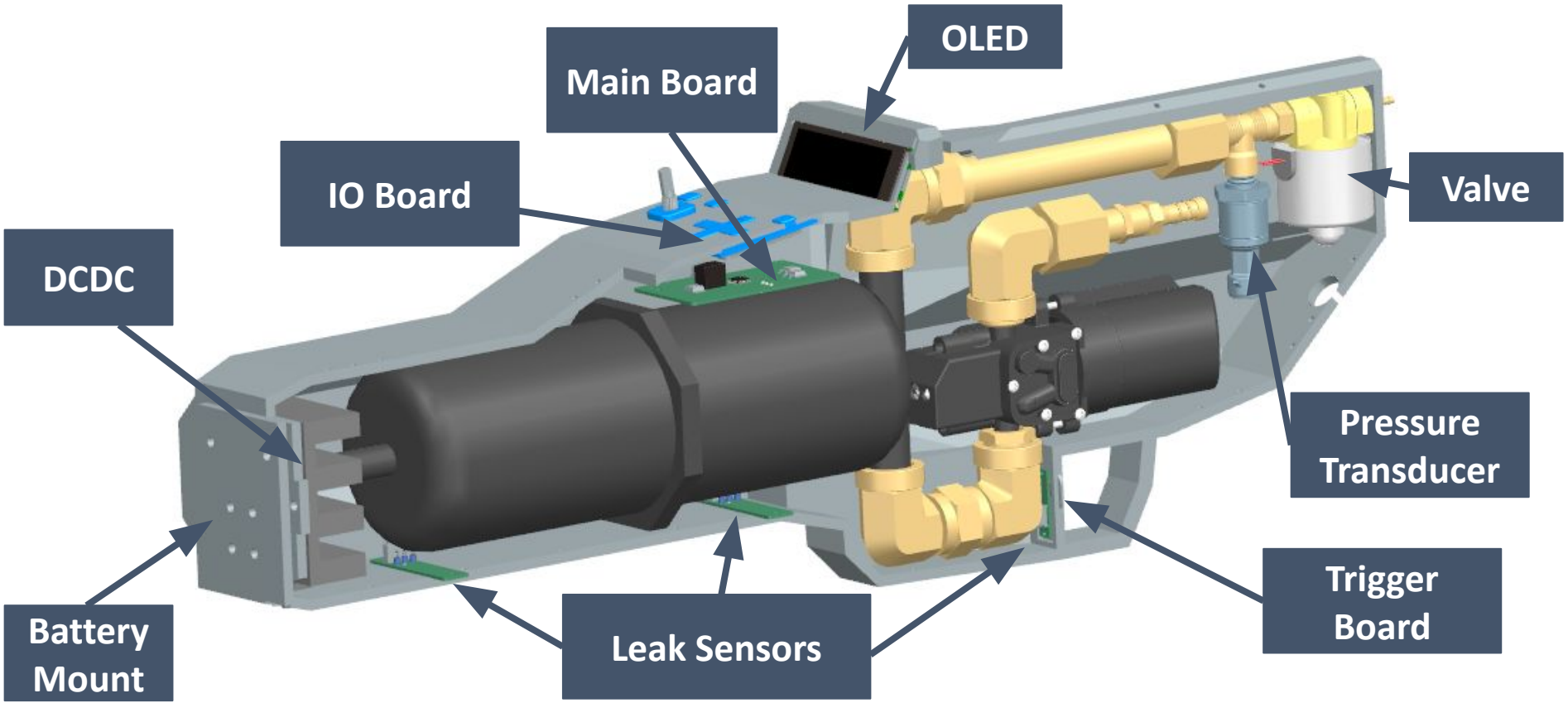


Battery and DCDC

- Milwaukee Tool Battery Mount
- Step Down Converter
- ~18V -> 12V
- Multiple hours of use on a single charge*

Roughly 7,000 50 ms bursts on a single charge

Labeled Electrical Components



Firmware

State Machine

Features

- Settings Menu
- Sensor Monitoring
- Firing Modes
- Shot Duration
- Drain Tank
- Automatic Fill

Autofill Algorithm

- Open Valve
- Start Pump
- Close Valve (15 PSI)
- Boost Sequence (75 PSI)
- Shut-off (~80 PSI)

Successes and Challenges

Successes and Challenges

- Issue: Display flickering
  Solution: buffer

- Issue: Tank not filling
  Solution: drain before filling (State machine)

- Issue: Leak detection sensor not working properly
  Solution: logic flipped in firmware level

- Issue : Inaccurate encoder readings
  Solution : storing previous value

Verifications

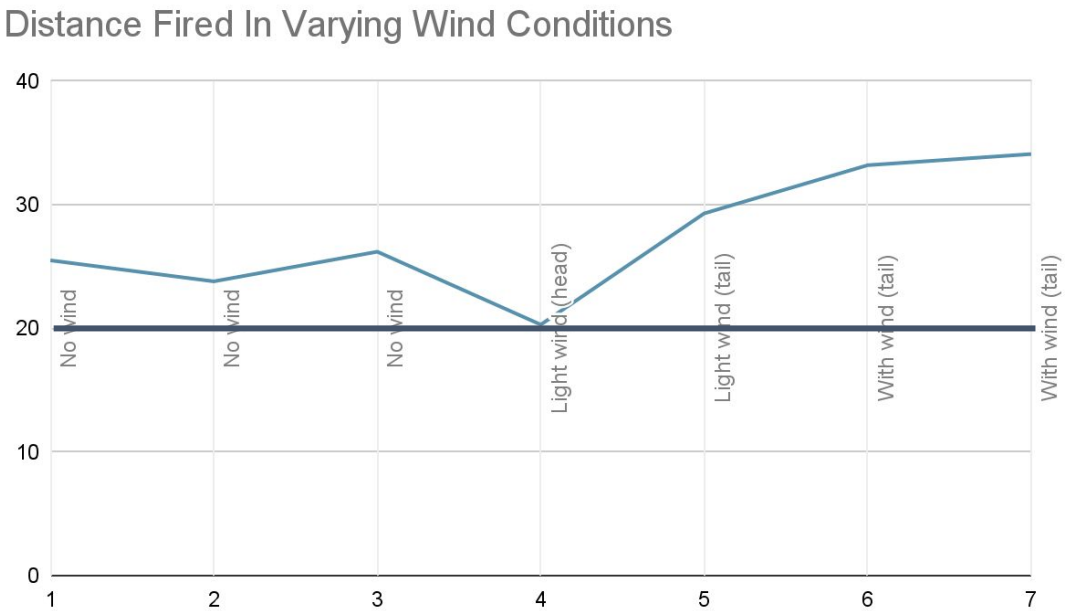
Fill Timing from 0% to 100% capacity

Trial	Fill time (seconds)
1	19.0
2	18.6
3	18.5
4	18.3
5	18.7
6	18.5

AVG: 18.6 seconds

Distance with varying wind conditions (1s Shot Duration)

Trial	Wind condition	Distance (ft)
1	No wind	25.5
2	No wind	23.8
3	No wind	26.2
4	Light wind (head)	20.3
5	Light wind (tail)	29.3
6	With wind (tail)	33.2
7	With wind (tail)	34.1



Additional Verifications

- No observable glitches on OLED
- Leak sensor reacts quickly <250 ms
- SPI Data sent to display
- Encoder control smoothly updates values
- No cracks from 1 meter drop

Ethics & Safety

Ethics and Safety

Ethical Commitment: Following IEEE & ACM Codes for safety

Safety Measures: Calibrated pressure (110 psi to 80 psi), auto shut-off, secure electrical enclosure

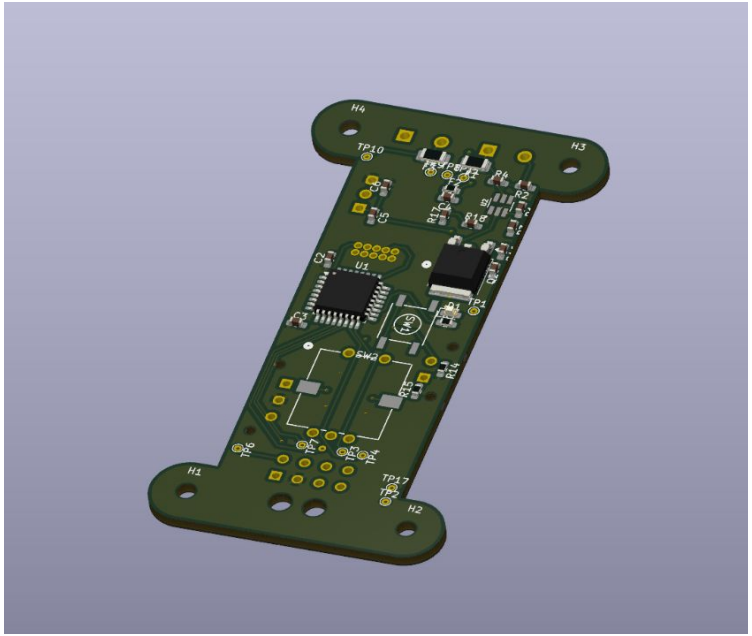
Regulatory Compliance: Adhering to ASTM F962 & OSHA guidelines

Design Focus: Prioritizing user safety & reliability

Future Work & Roadmap

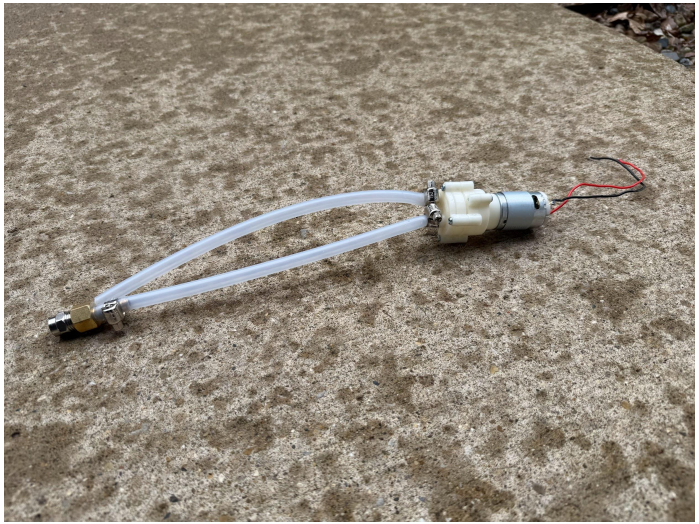
Roadmap & Improved Featureset

- New ergonomic enclosure
  - Composite
  - 2 Part instead of 8 (split mold)
- LED Lighting
  - Circuit designed
- Water Blaster Lite
  - Smaller footprint
  - Combines IO Board & Control Board
  - Transparent OLED
  - Integrated BMS & custom spot welded battery pack
    - Overvoltage & Undervoltage protection
  - Cost Effective Alternative
    - $40



Mechanical Design for Water Blaster Lite

- Pump directly from hand filled reservoir
- BOM
  - Simple nozzle
  - 12V DC Pump
  - 12V Battery
- Roughly $45 Per unit



Summary

- BOM Costs roughly $120
- Shoots 30+ Feet
- Capable of firing 70 bursts per refill*
- Responsive and intuitive UI
- Custom enclosure
- Water Blaster Lite™ Coming Soon…

*on 40ms solenoid valve timing