Group 16

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QwikCut

VIDEO & ANALYTICS

Senior Design 2 : Final Presentation

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Motivation

- The motivation for our project is to design and build a new and improved camera and recording system for our sponsor QwikCut to use for their business practice.
- We are trying to design a system that has the ability to be cost effective and efficient enough in its quality to have the possibility of the design being built on a larger scale.

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Goals and Objectives

Goal	Objective
• The new design to be a less cluttered PoE system with a single cord leading to the camera • Fast panning head on a PTZ camera • Streaming using hotspot provided and storage capabilities for film • HD quality for camera	• To create a setup for QwikCut that can be used to film various sports games while streaming and recording of game film where there is no press box.

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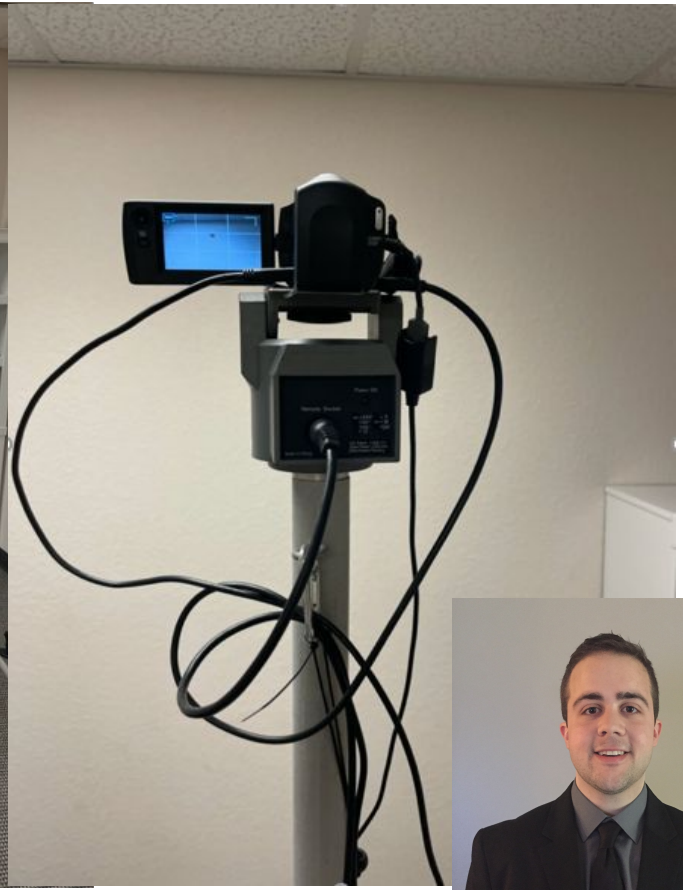
Existing System



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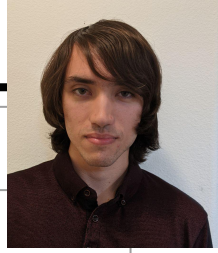
Specifications and Requirements



Device	Constraint	Value
Batteries	Runtime, Storage	• 10-12 hours
Camera	Quality/Definition, PTZ capabilities, Waterproof	• Minimum of 1080p HD • IP66 waterproofing • 0-90° Tilt • 0-180° Minimum Pan • 10x Zoom minimum
PCB	Portability, Functionality	• Ability to fit inside our existing storage box • Must be able to provide IEEE 802.3 af/at capabilities
Software	Ease of use, Features	• Needs to be easy to use • Able to control the camera

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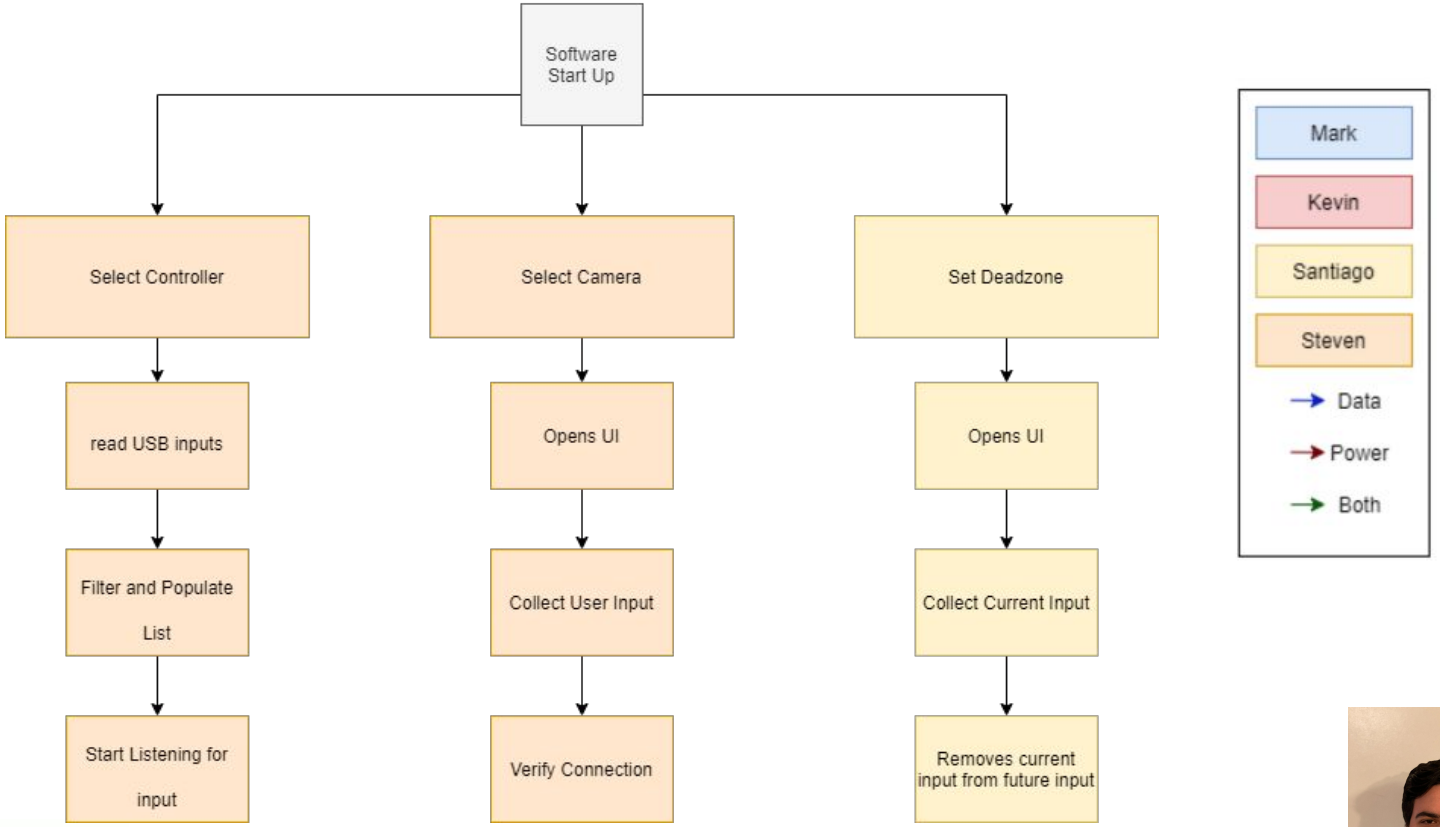
Block Diagram Progression - Software



Software features

- Easy to use and setup
- Be capable of running on most modern computers
- Self contained and portable
- Allow the user to adjust how the inputs are scaled

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Software - Technologies used

Java - used for its ability to run on most platforms.

ONVIF - used to allow for the software to talk to and control the camera. Open industry standard.

Jinput - used to read a gamepad controller. Widely used and documented.

Swing - used to make the UI. Prior experience and ease of use.

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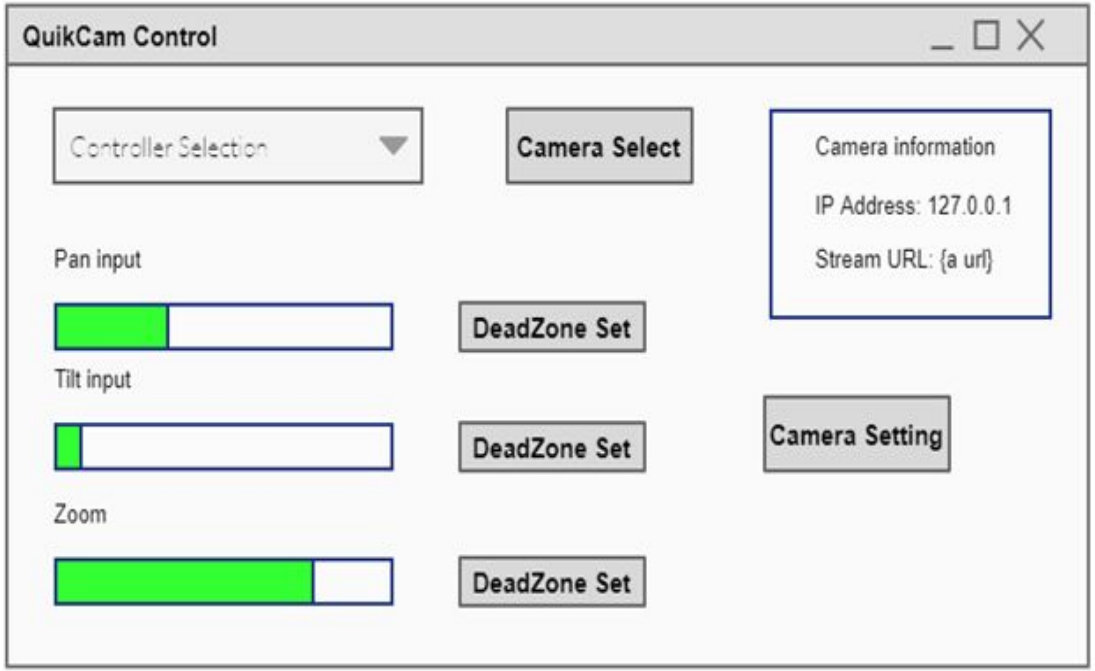
Software UI

The user interface for this software is designed to be minimal.

No video preview or processing is performed via the software.



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Software - Completion Percentage

- Overall Software completion

Software Component	Completion Percentage	Testing Needed?
UI	80% (Basic functions are done may need expanding)	Yes - Check for functionality
Camera Interface	70% (Can talk and move a camera needs fine tuning)	Yes - Test multiple cameras
Controller Interface	70% (Basic movement is done need to add and test more advanced features)	Yes - Test more controllers - Test dead zones and nonlinearity
Integration	25% (Need to add and test all components)	Yes - Verify all individual components work together

Laptop

Acer Aspire 5

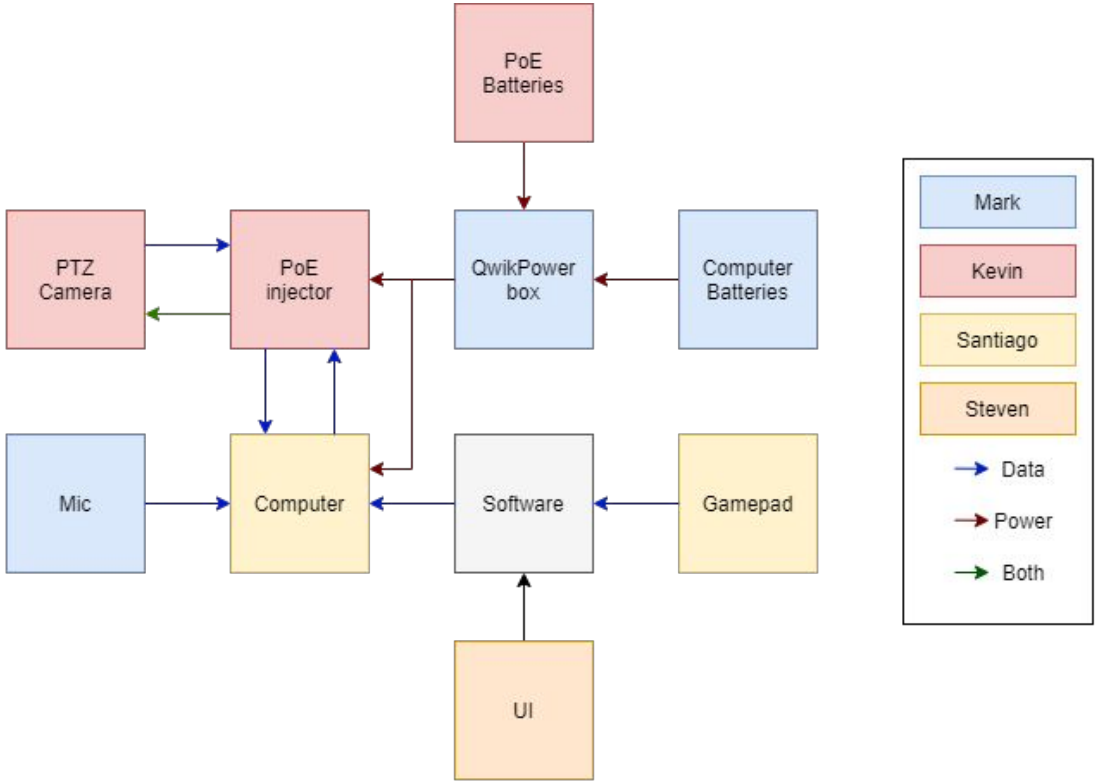
$523

8GB RAM

128GB SSD

Ryzen 3200u 3.5GhZ

Block Diagram Progression - Hardware



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PoE Implementation

- Purpose: Used to provide power to camera and receive data via ethernet cables.
- Helps simplify the system and requires less cabling

- Defined by IEEE 802.3af and 802.3at standards
- PoE can check if the connected device requires power and if this check passes, the PoE device whether it be an injector, switch, or hub, sends the power to the connected device

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Hardware - Data flow

- The most crucial hardware pieces in the design consist of the following parts:
  - PTZ (Pan-Tilt-Zoom) Camera
  - A Printed Circuit Board POE Injector
  - Portable Batteries to power the PCB and Laptop
  - Laptop to record and stream the information provided from the camera system

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Hardware - Camera Options/Designs

- After considering multiple design choices and the possibility of designing our own PTZ camera we decided that the most logical choice and design for our system would be to repurpose an already existing camera on the market and retrofit the camera into our QwikCam design.
- Many different units and designs were considered and presented to our sponsor covering many different specifications and details. Each product was discussed with the pros and cons for each unit and our input on what camera option we think should be incorporated in the overall design
- Price range categories ranged from $500+, $500-300, and below $300

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Hardware - Final Camera Selection and Specifications

- After the careful deliberation and considerations for the multiple camera designs we have chosen the **Alptop 4K Outdoor POE PTZ Camera**
  - This camera company and design is readily available on amazon and other online retailers.
  - At a price point of $330 dollars it fits into the mid range of our price categories and a very good quality camera for the price.
  - With its built in POE capabilities it is capable of being powered and transferring data via a singular Cat 5e or above cable simplifying the connections and overall process for our sponsor.
  - Meets all of the required specifications in regards to Quality, PTZ movement, and Waterproofing.

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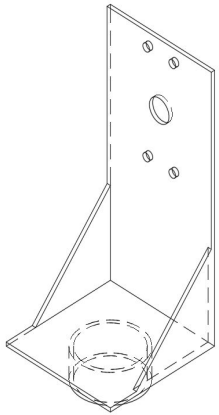
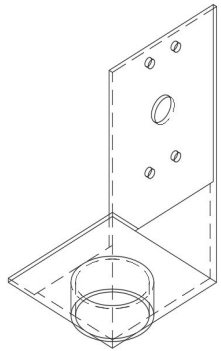
Hardware - Camera Mount

- The camera mount is a critical part of the QwikCam system, as it allows for the adoption of an existing tripod to a new camera system.
- Custom design that should be easy to attach, store, and transport.
- The final design followed a very similar base design.





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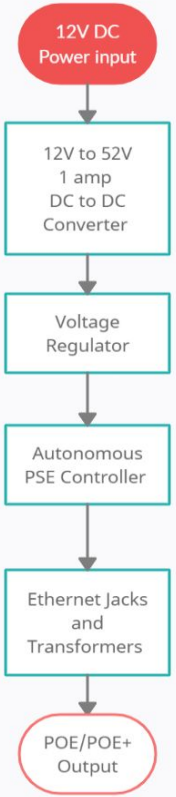
Hardware - PCB Injector

- A portable POE PCB injector will accomplish the goal of powering our PTZ camera remotely while keeping the design in a compact form and power efficient for an extended period of time.
- After doing some research on POE design requirements and capabilities we were able to find some Texas Instruments products and designs that could be used and sourced into our project in order to make sure we can successfully power any POE device that we may use.
- Our PCB Injector can be broken down into a few main sections when building as seen in the flowchart.



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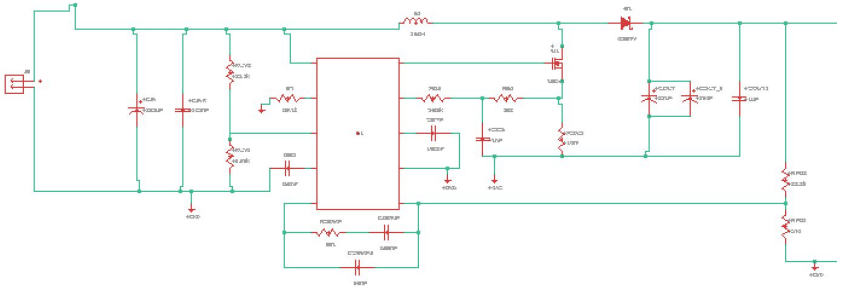
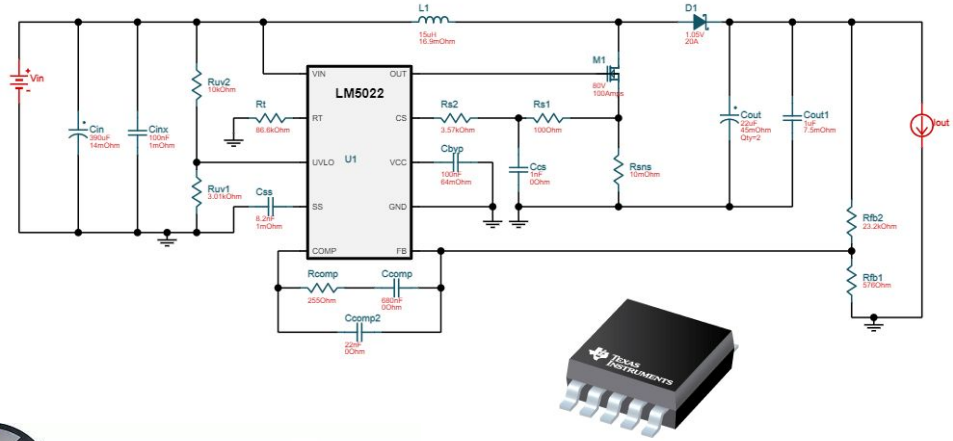
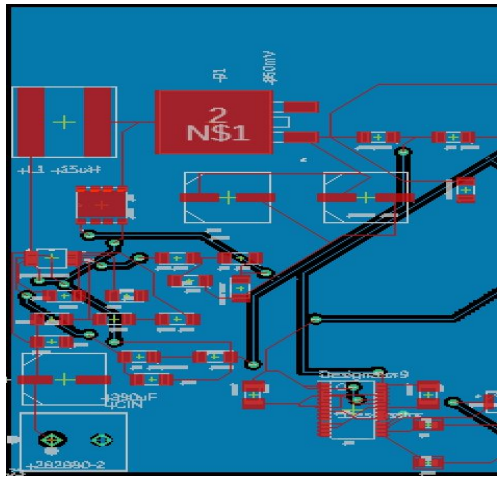
Hardware - PCB Design: DC to DC Converter

- **12V to 52V, 1 Amp DC to DC Converter**
  - The Converter includes the following components:
    - Input/Power jack
    - LM5022 6-60V Boost Controller







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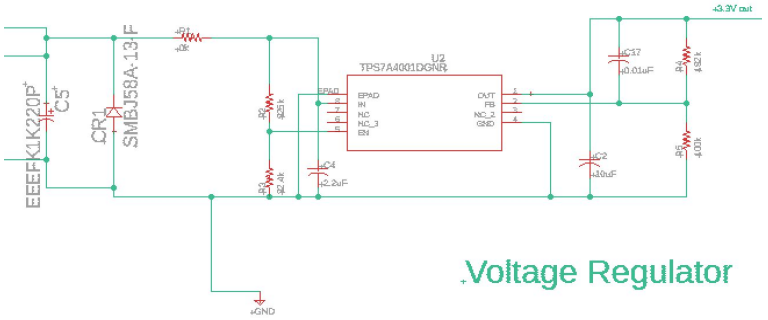
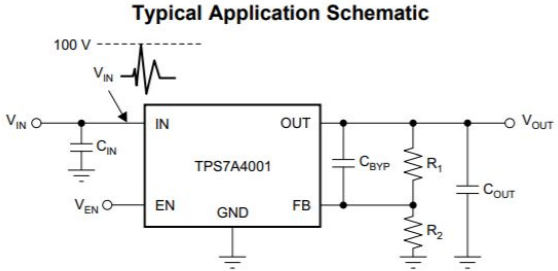
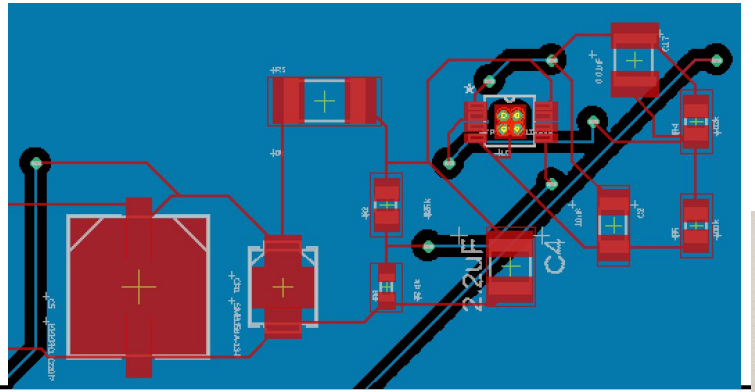
Hardware - PCB Injector - Voltage Regulator



- This section of the PCB Consists of:
  - TPS7A4001 Voltage Regulator
- The TPS7A4001 is used to power the autonomous PSE controller in the next section of the board. Converts the 52V DC back down to a digital 3.3V.





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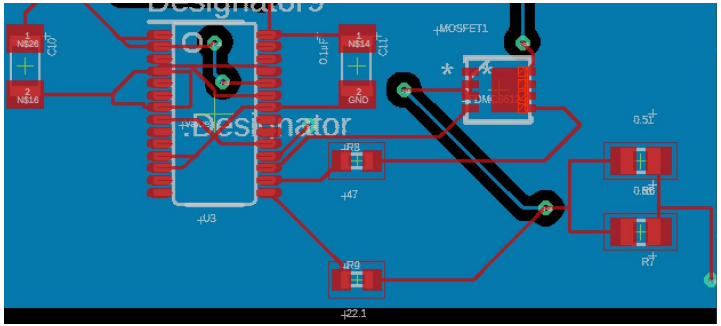
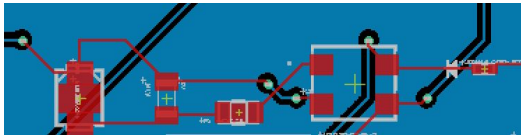
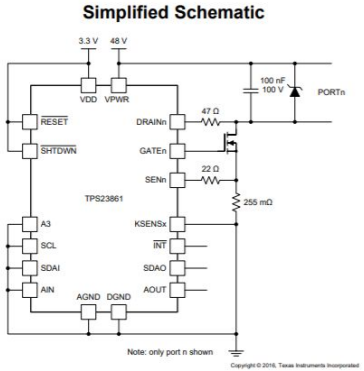
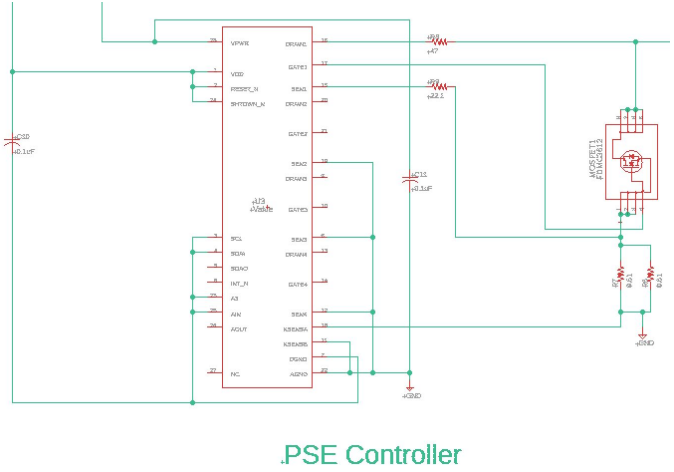
Hardware - PCB Injector - Autonomous PSE Controller

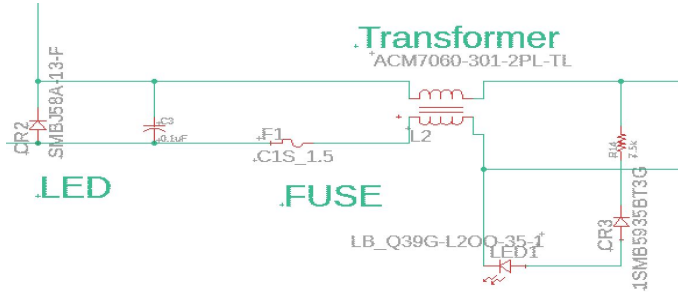
- This section of the PCB consists of :
  - Texas Instruments TPS23861 Autonomous PSE Controller
  - Fuse
  - Power Check LED Indicator
  - Transformer











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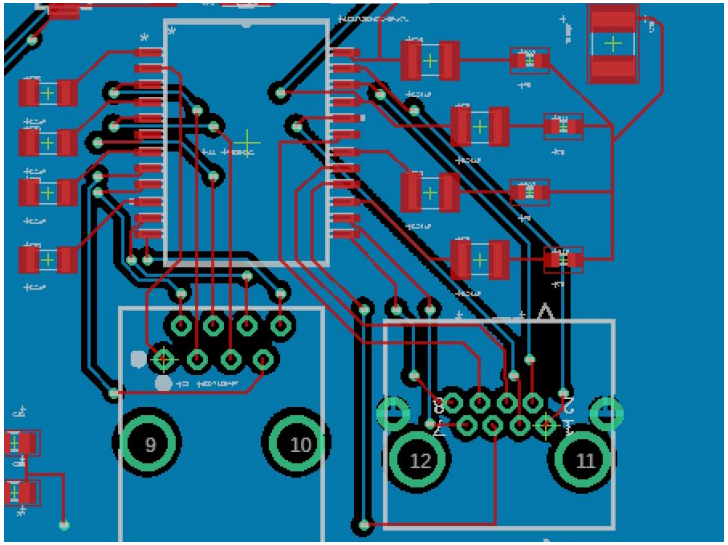
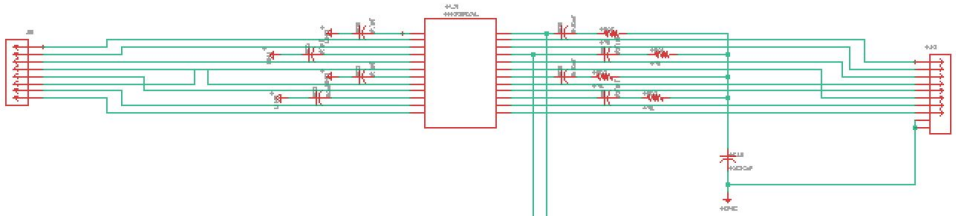
Hardware - PCB Injector - Ethernet Jacks and Transformers

- This section of the PCB consists of:
  - RJ45 Ethernet Jacks
  - Ethernet magnetics
    - Transformers 1000BASE-T compliant





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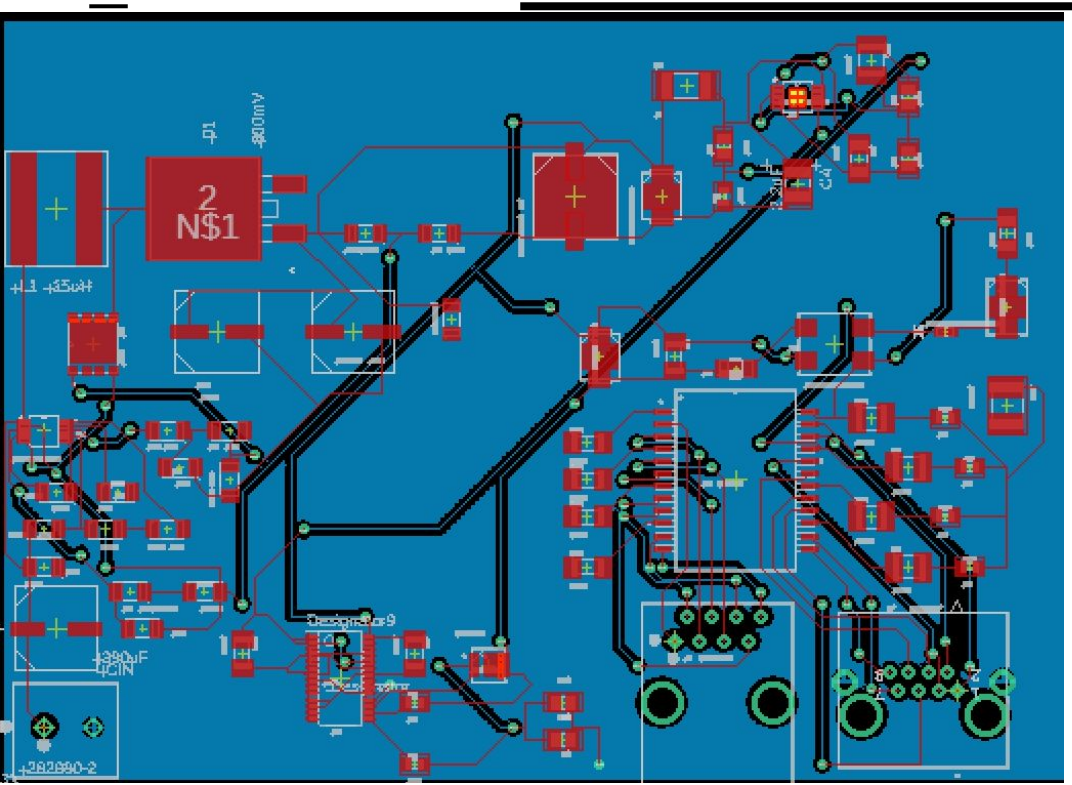
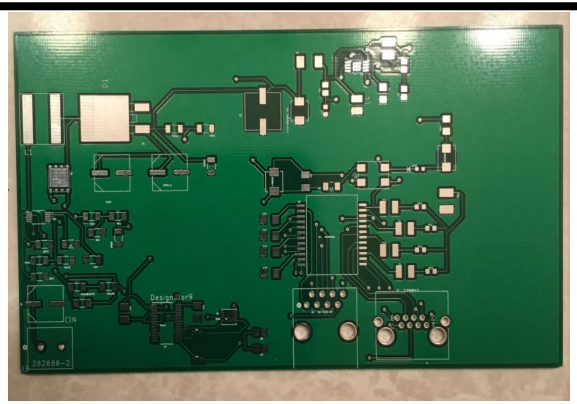
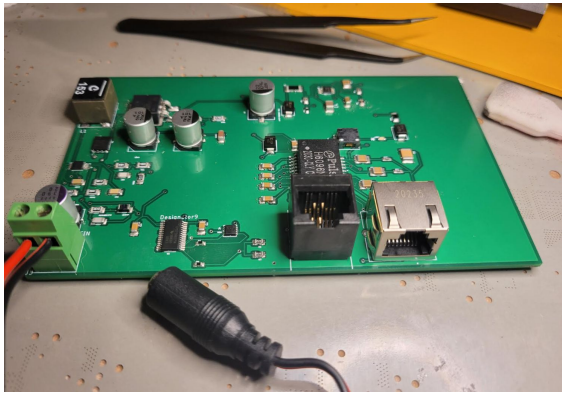
Hardware - PCB Injector - Overall Board







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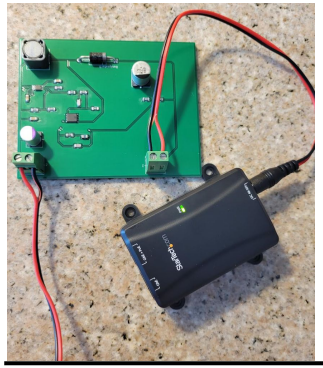
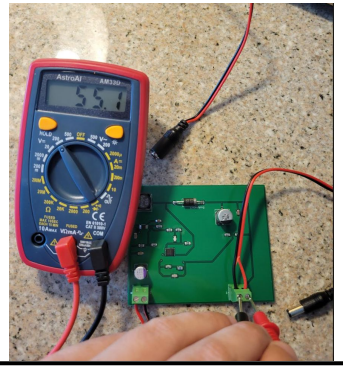
Sponsor Input - Existing POE Injector

- After showing off our design and PCB Injector to our sponsors at Qwikcut they requested that we look into a injector that is pre existing.
- Reasons:
  - Easily Replaceable and Possibility of multiple units needed
- So in order to power a existing POE Injector we still needed to build an autonomous voltage regulator and converter to power our Injector. This regulator would need to output 55V instead of the previous 52V.
- The board below shows an alternative PCB design that was used in our final project implementation to meets our sponsors standards and needs.





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Power System Design

Requirements:

- Portable water resistant storage
- Laptop for live recording and streaming
- Single cord to the camera unlike existing system that has 3, making it more cluttered than desired.

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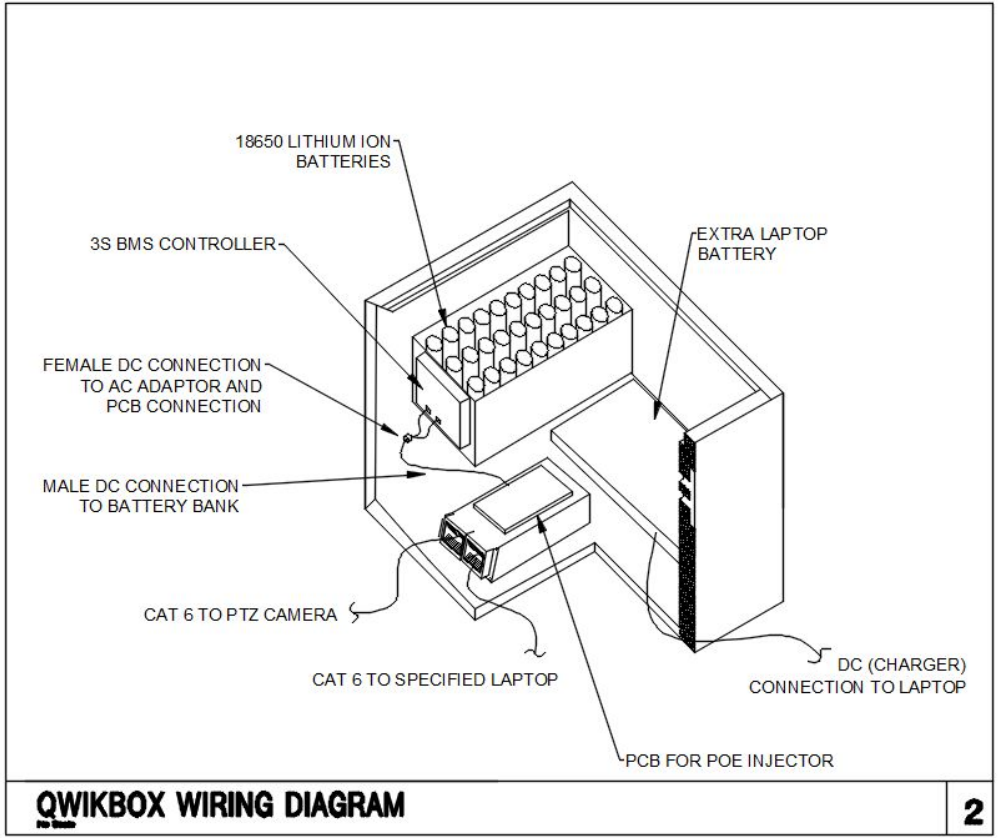
Hardware - Power flow

Power inside Qwikbox:

- Injector battery bank lasting 10-12 hours max for long days
- Extra laptop battery to charge laptop for any additional time needed
- DC connection to PCB injector and for charging of battery bank
- DC connection for laptop battery to charge



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Hardware - Component Decisions

- 30 x 18650 batteries
- A 3S 25A BMS Board that manages the lithium ion battery pack.
- Ni Strips for connection of the batteries in series and parallel.
- DC jack.
- Holder for the 18650 batteries.

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Hardware - 18650 Batteries

- 18650 lithium Ion Cells (3400mAh at 3.7V) chosen for the Storage and powering of the Injector.
- Will be used in series and parallel to create a chargeable battery pack with Li-ion BMS board to help with protection.
- Provide best discharge curve and allow a good size to storage ratio.

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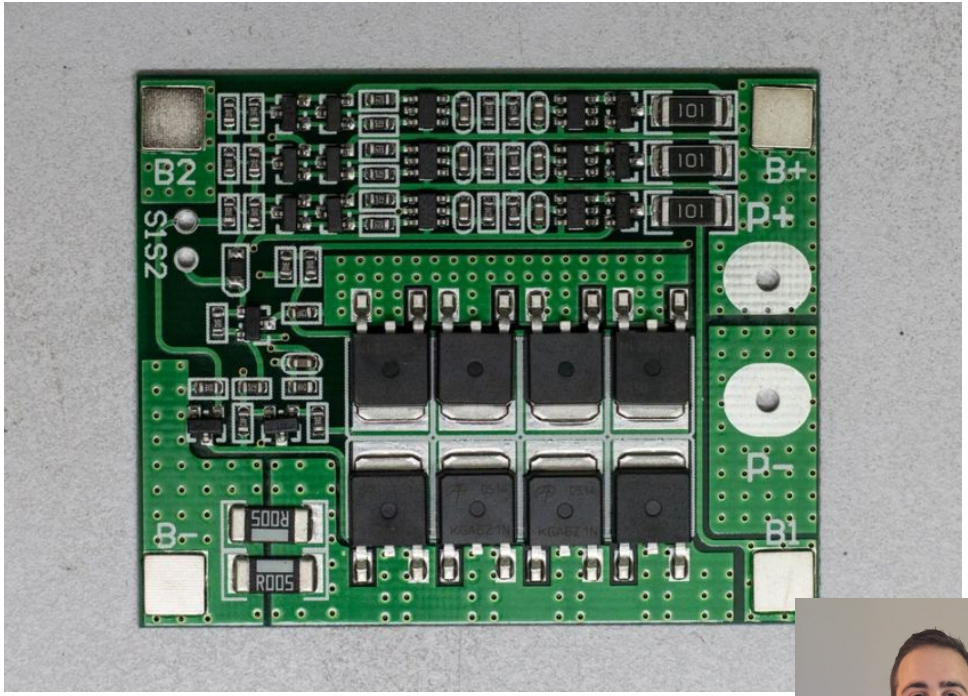
Hardware - Battery Management

- Using a 3S and 25A BMS board (HX-3S-FL25A) at $5 a board
- Monitors all of the parallel groups in the battery pack and disconnect it from the input power source when fully charged
- Balances the cells voltages equally
- Overvoltage range: 4.25~4.35V ± 0.05V
- Over-discharge voltage range: 2.3~3.0V ± 0.05V
- Maximum operating current: 0~25A
- Working temperature: -40℃ ~ +50℃



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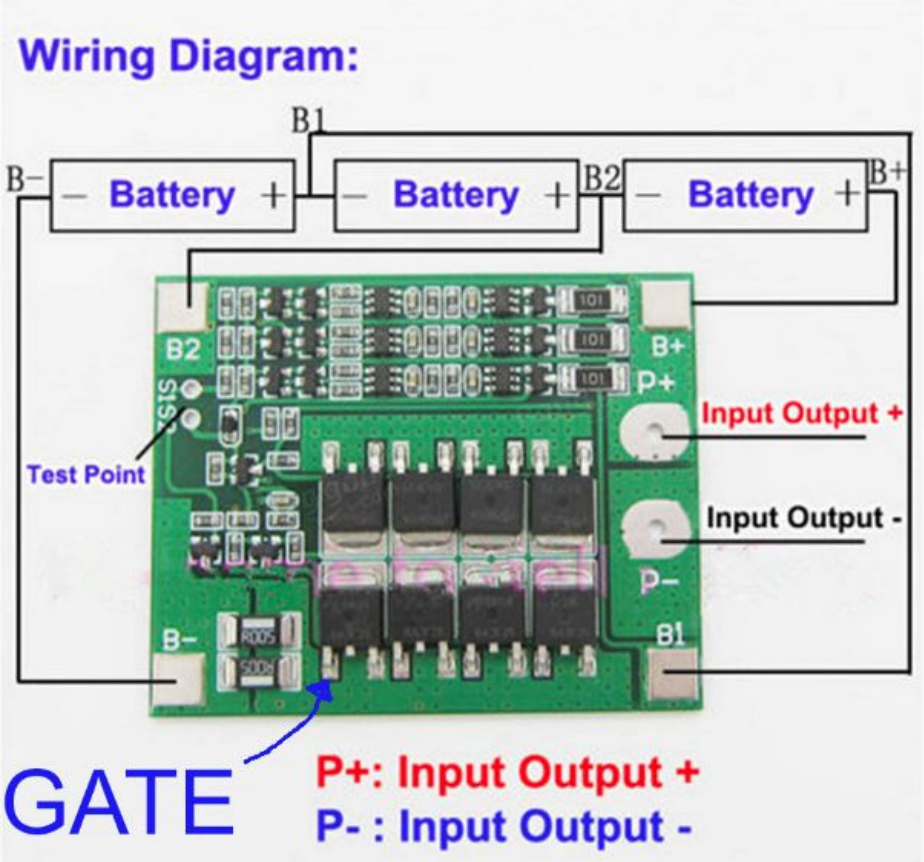
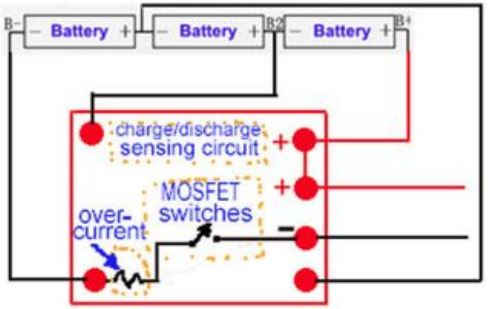
Hardware - BMS Components





B+ connected to P+

B- connected to P- through MOSFET switches

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BMS Calculations

Efficiency	Number of 18650 batteries in parallel	Resulting Amp Hour Battery Bank	Amp Hour battery Bank / draw from POE+	Hours Provided
100%	5 x 3400mAh	17Ah	17000mAh/ 2400mA	7.08 Hours
	6 x 3400mAh	20.4Ah	20400mAh/ 2400mA	8.5 Hours
	7 x 3400mAh	23.8Ah	23800mAh/ 2400mA	9.916 Hours
	8 x 3400mAh	27.2Ah	27200mAh/ 2400mA	11.33 Hours
80%	5 x 3400mAh	17Ah	17000mAh/ 2880mA	5.902 Hours
	6 x 3400mAh	20.4Ah	20400mAh/ 2880mA	7.08 Hours
	7 x 3400mAh	23.8Ah	23800mAh/ 2880mA	8.26 Hours
	8 x 3400mAh	27.2Ah	27200mAh/ 2880mA	9.44 Hours
	9 x 3400mAh	30.6Ah	30600mAh/ 2880mA	10.625 Hours
	10 x 3400mAh	34Ah	34000mAh/ 2880mA	11.81 Hours

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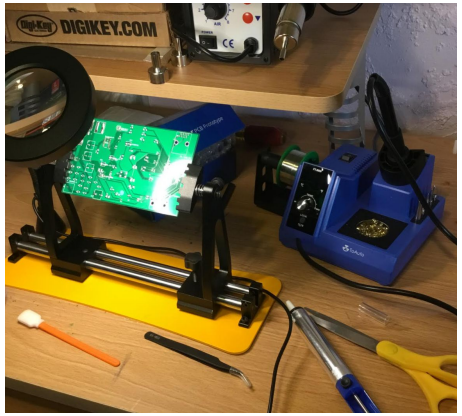
Hardware - Testing and Assembly

- The PCB Board is currently being built as a prototype and will be getting tested against multiple camera systems and POE types in the coming days.
- The Alptop PTZ camera has been acquired and will be tested for its quality and overall movement functions before its final mounting in the system.
- Battery components for the PCB injector are being built and will be connected to multimeters and smart charger to make sure the power output and voltage is sufficient enough for our design.



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Hardware - Completion Percentage

- Overall Hardware completion

Hardware Component	Completion Percentage	Testing Needed?
PTZ Camera	90% (Product Acquired)	Yes - To check specifications and make sure camera fits quality requirements
PCB Injector	70% (Components Acquired, Beginning to assemble)	Yes - Test multiple cameras
PCB Batteries	50% (Components Acquired)	Yes - Voltage Levels and connection with injector
PC/Laptop	100% (Product Acquired)	No

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Work Distribution

	Batteries + BMS	Networking PoE + PCB	Hardware Camera	Storage and Portability	Software Camera	Software Gamepad	Software UI
Mark	X			X			
Steven					X		X
Kevin		X	X				
Santiago						X	X

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Budget and Financing

Sponsor: Qwikcut

- Goal is to beat the cost of the current quickbox price which is sitting at $2,060.
- Should be reasonable price for manufacturing of further systems
- All components and equipment that is not already in use in the previous design and that need to be ordered are to be paid for by our sponsor Todd Denoyer from QwikCut.

Part	Part Description	Quantity	Price ($USD)
Housing unit	Waterproof containment apparatus	1	45
PTZ Camera	Camera to be used in the filming	1	330
Tripod	Tripod the system needs to be mounted upon	1	0
Game controller	Controller to control the movement of the PTZ camera	1	0
Cable	CAT 5e cable to be connected to the computer and the camera	10m	25
Batteries - POE	External batteries to power PCB board or PTZ camera	1-4	236.44
Batteries - Computer	Batteries to operate the laptop - Minimum 4 hour life	1-3	0
Computer	Laptop to operate and control the camera from	1	524.99
Poe Injector	Injects power into a ethernet cable	1	60
Camera Mount	Custom mount for PTZ to tripod	1	50
		Total Price:	$1,271.43

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Progress Timeline

Week of	June 7th	June 14th	June 21st	June 28th	July 5th	July 12th	July 19th	July 26th
Acquire initial components & equipment	x	x						
Test components	x	x	x					
Develop, Build and test Prototype			x	x				
Adjust Documentation				x	x	x		
FInalize & Fine tune						x	x	x

June 10th

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Issues

- Testing and prototyping of our overall design is still being done. Some portions and components selected are subject to change based off our sponsors feedback and desired performance.

Software Testing

Unit testing: ONVIF, Inputs, and UI

Integration testing: verification that ONVIF accepts the input values, verification that the GUI displays information from the inputs and ONVIF

System testing: given a simple manual can the tester use the software.

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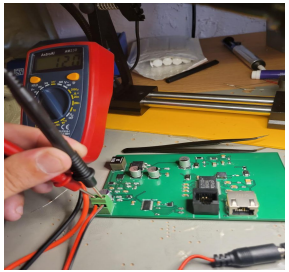
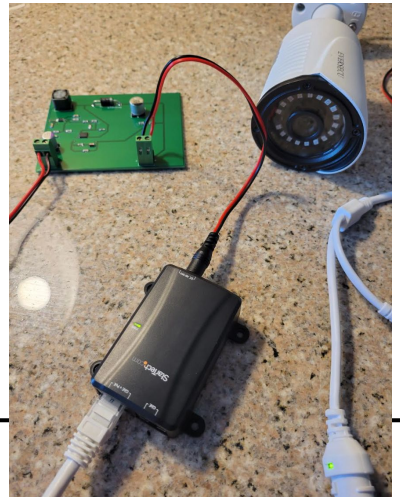
Hardware Testing

- For overall testing and final troubleshooting we connect a standard 12V DC connector to our input and connected our injectors to POE detectors.
- We can see a capable 55V output and a IEEE 802.3 at/af capable injector that can easily power our ptz camera.
- Many different cameras and electronics were tested to make sure that any POE capable device could be powered.





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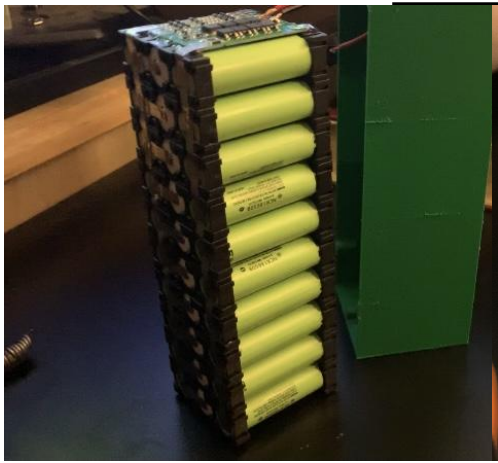
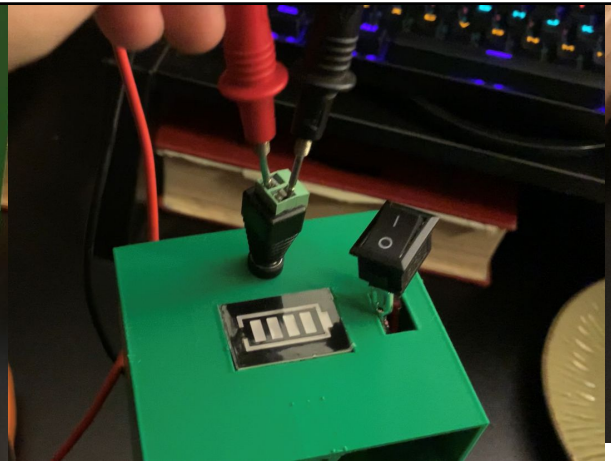
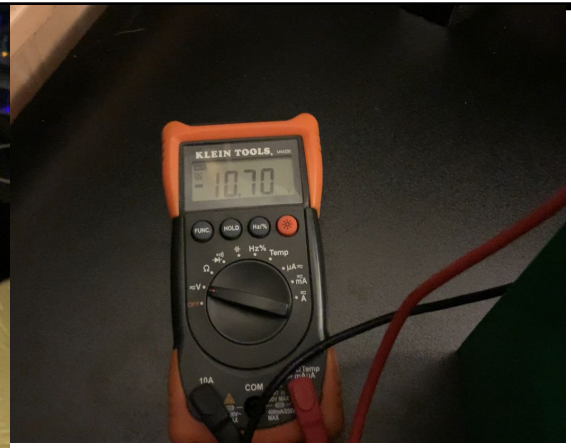
Power Testing







Battery Bank estimated Uncharged voltage:	10.68V
Battery Bank actual Uncharged Voltage:	10.70V
Battery Bank estimated full charge voltage:	12.6V
Battery Bank actual full charge voltage:	12.54V

Questions

Group 16

Mark Escott
Steven Little
Kevin Brown
Santiago Alvarez

Sponsor:
Todd DeNoyer

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Senior Design 2 : Midterm Demo

Steven Little
Computer Engineering

Santiago Alvarez
Computer Engineering

Kevin Brown
Electrical Engineering

Mark Escott
Electrical Engineering

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Goals and Objectives

Goal	Objective
• The new design to be a less cluttered PoE system with a single cord leading to the camera • Fast panning head on a PTZ camera • Streaming using hotspot provided and storage capabilities for film • HD quality for camera	• To create a setup for QwikCut that can be used to film various sports games while streaming and recording of game film where there is no press box.

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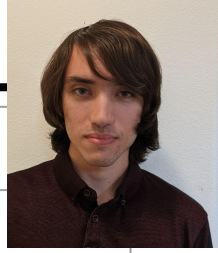
Specifications and Requirements



Device	Constraint	Value
Batteries	Runtime, Storage	• 10-12 hours
Camera	Quality/Definition, PTZ capabilities, Waterproof	• Minimum of 1080p HD • IP66 waterproofing • 0-90° Tilt • 0-180° Minimum Pan • 10x Zoom minimum
PCB / Injector	Portability, Functionality	• Ability to fit inside our existing storage box • Must be able to provide IEEE 802.3 af/at capabilities
Software	Features	• Able to control the camera

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Software

Successes & Challenges

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Camera fails

The Altop camera we tried advertised ONVIF compliance, however it was not fully compliant.

The Reolink camera, which was used for development works with the software but has limitations in video quality.

The sponsor gave us ways to meet the camera requirement with field scale tests.

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Camera successes

The Reolink camera was determine to have too fast motion.

The image quality from both cameras were above what QwikCut expected.

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Mount

The wooden prototype worked well and showed that this simple design is viable.

For the final design the size of plates and possible reinforcements need to be adjusted.

The final design will be welded steel plates to ensure durability.

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Software

The software performs well for its current state of development. Most of the adjustments are based around how the camera responds to the motion requests.

QwikCut outlined some minor tweaks and features that would be beneficial for their use case.

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Program

- Works for all fully compatible ONVIF cameras.
- Needs tuning for smooth camera movement
- Current features include:
  - Setting Speed Limits
  - Setting Deadzone
  - Changing Movement Curve
- A temporary shift in movement while holding a button will be added due to feedback request.

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Hardware

Successes & Challenges

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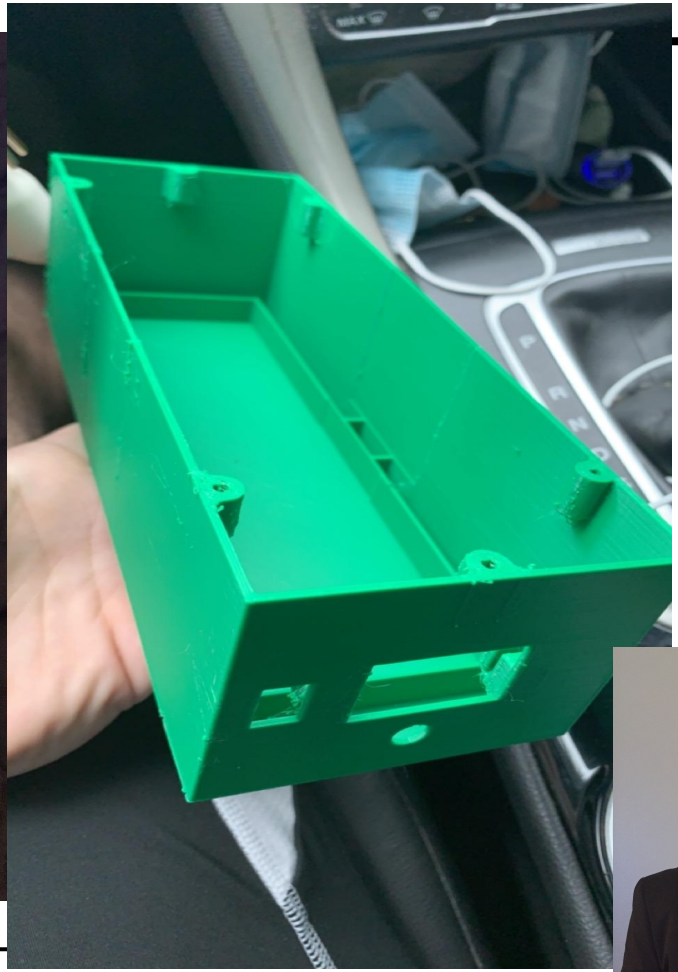
Building the Battery



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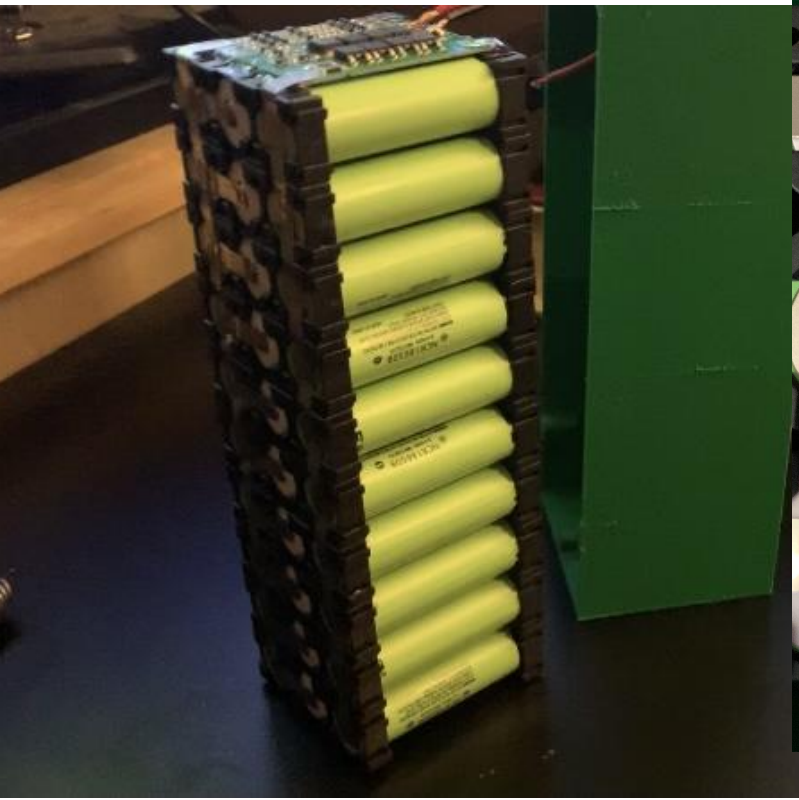
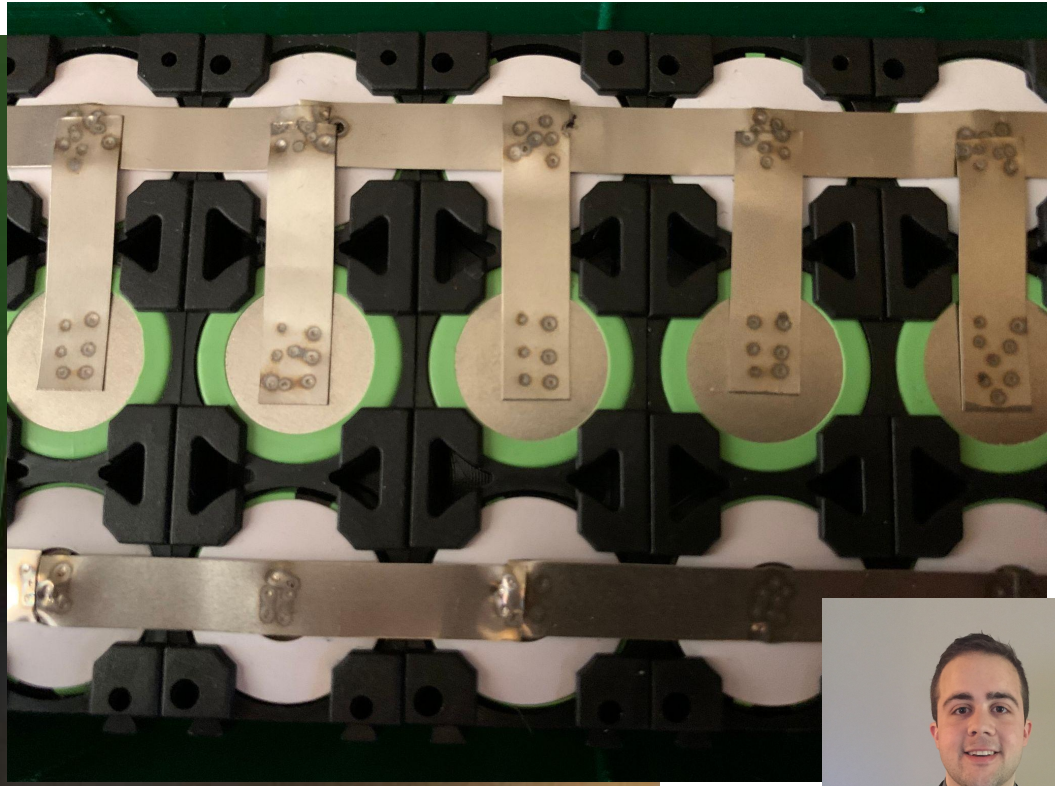
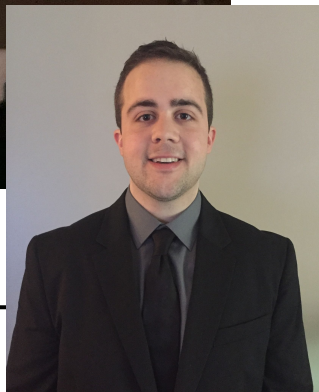
Connections & Wiring







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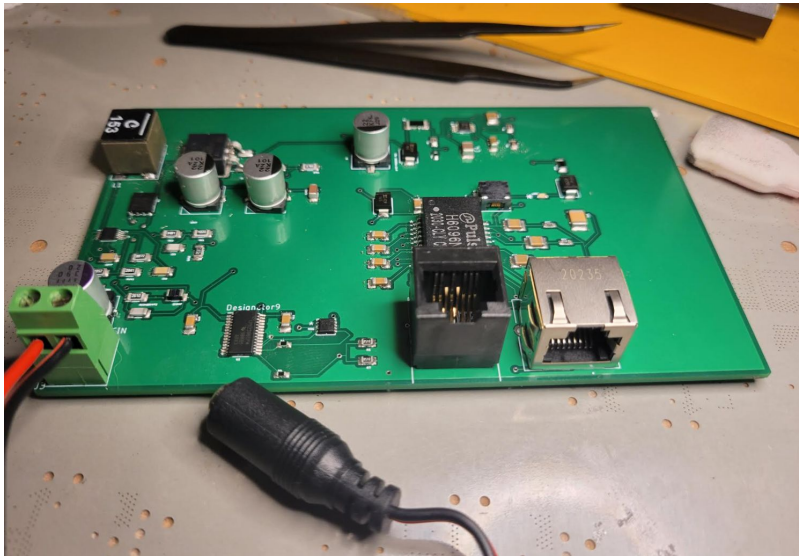
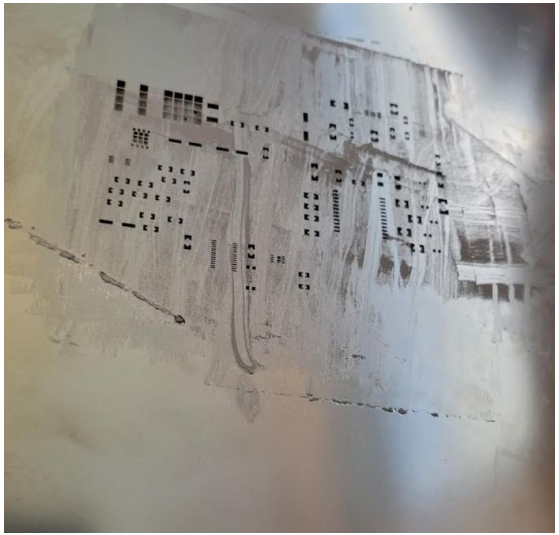
Building the PCB

- Using a stencil for our pcb we were easily able to paste all of our components to our PCB and reflow parts of the board to meet our needs
- Solder bridges did occur during reflow and had to addressed and redone before we began testing and implementing our design.





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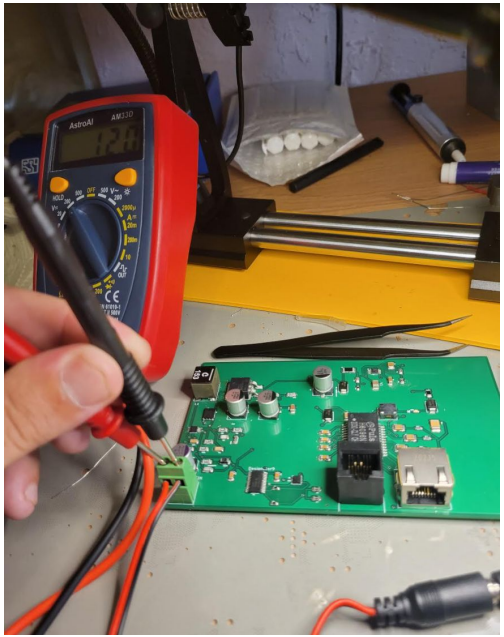
Connections and testing

- After meeting up as a group and with our sponsor Qwikcut at their main office headquarters in sanford we were able to combine our components for testing and troubleshooting if needed.

- Once connected to our handbuilt battery pack we saw a steady 12V voltage coming into the system through our DC input.

- Overall connections between the PCB and battery pack were a success



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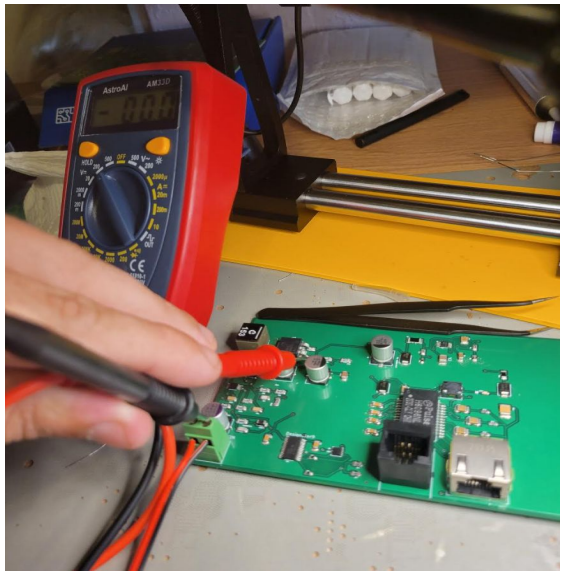
Problems and Obstacles

- However, after connecting the battery pack to our system we seemed to be having problems getting our converter to supply the required voltage to the rest of the system and is causing some problems powering the POE system.
- Connections and nodes in our board were double checked and no direct cause could be seen so a deeper look and testing is needed. This also prompted some sponsor feedback as well.



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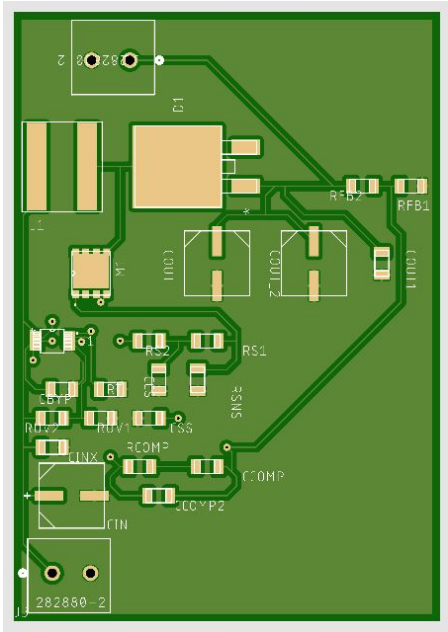
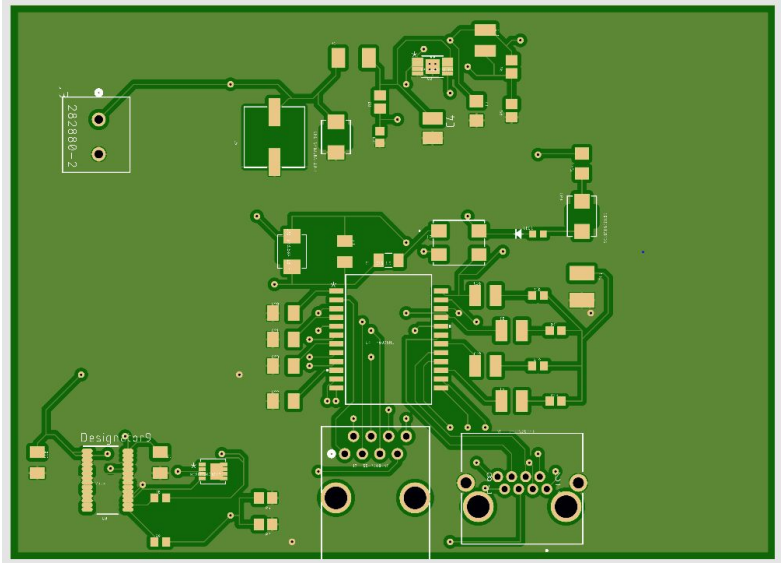
Solutions and Troubleshooting

- A Proposed method for troubleshooting the board is to separate the sections of the boards into smaller boards, thus giving us the ability to test each major function:
  - One for just the DC Converter
  - One for POE functions and capabilities
- This testing should help us determine where the error is and how we may fix it.





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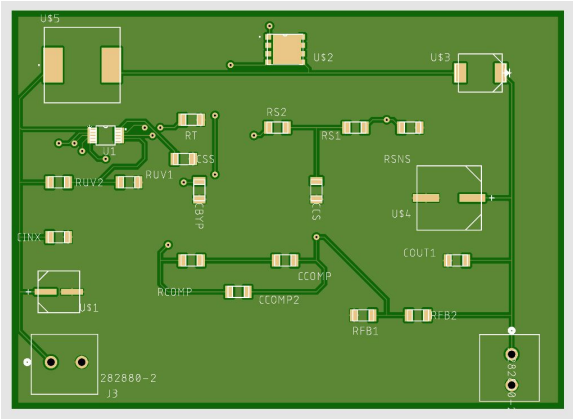
Sponsor Feedback

- Another key to our team meeting was our sponsored feedback on the PCB design. A concern from our sponsor is building our own PCB injector may cause some problems down the road in mainstreaming this design to have multiple units.
- QwikCut would like to make this design as simple as possible for their field technicians and possible customers to use.
- There desire is to have a possible preexisting portable injector that they can purchase and replace as needed.
    - This can be done by designing a Voltage regulator and autonomous controller that can be design in coordination with our portable battery pack and existing injectors on the market today.
- Possible existing injectors are being researched at this moment and a autonomous controller board has been ordered as well to help implement this sponsor goal



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Final Demo

Group 16

Specifications

Device	Constraint	Value
Batteries	Runtime, Storage	• 10-12 hours
Camera	Quality/Definition, PTZ capabilities, Waterproof	• Minimum of 1080p HD • IP66 waterproofing • 0-90° Tilt • 0-180° Minimum Pan • 10x Zoom minimum
PCB / Injector	Portability, Functionality	• Ability to fit inside our existing storage box • Must be able to provide IEEE 802.3 af/at capabilities
Software	Features	• Able to control the camera
Miscellaneous	Features	• New Laptop for recording and streaming • 1 single cable running from camera down tripod