

# Edgerton Assembly Manual

## Description

This is a complete assembly manual for Edgerton, the High-Speed LED Flash. Some soldering and 3D printing skills are required. Please note that the photographs below may show components that differ somewhat from the most recent models available. The assembly photos were taken during development of the flash and the design has been slightly changed since.

For a complete overview, please visit <https://td0g.ca>.

## Warnings – PLEASE READ

The greatest advantage of an LED flash over an air-gap flash is safety, **but there are still dangerous voltages in this LED flash!** The capacitor charger, if set correctly, will supply 120V to several capacitors. Be careful, try to keep the case closed, and do not touch any circuitry when the capacitor charger is on!

This strobe pushes the capabilities of the LED's. I have worked hard to find the safest limitations of the LED's, but **complete failure of the LED's is still possible**. That means the expensive components can be accidentally destroyed and require replacing. I've taken many precautions in the design to prevent this, but please consider building a strobe at your own financial risk.

The LED's are not as powerful as a Xenon flashtube, and they do not turn on as long as a typical camera strobe. **Expect to crank up the ISO by several (4 or more) stops** in order to capture usable images.

## Tools Required

- 3D printer with 200mm x 200mm bed
- Soldering Iron & Solder
- Small Side Cutters
- Hot Glue Gun
- Allen Wrenches
- Dupont Crimper Kit (Optional but Recommended)

## 3D Printing the First Parts

**Note:** before proceeding, please choose a suitable 3D printing filament. I prefer PETG as it is tough, fairly easy to print, and is not affected by heat. ABS is also a good filament, but requires more care to print. PLA+ is a form of PLA that is more resistant to heat, but retains PLA's amazing printing properties.

1. Download the latest set of .STL files from [https://github.com/td0g/high\\_speed\\_flash/tree/master/MK1\\_Edgerton](https://github.com/td0g/high_speed_flash/tree/master/MK1_Edgerton).
2. 3D print the **Template.STL** (using a cheap filament – this part will not be used in the final assembly) and 8x copies of the **LED Clamp.STL**
3. Begin 3D printing the **Front.STL** and **Back.STL**. This will take many hours and you can proceed to the next steps while these parts are printing.

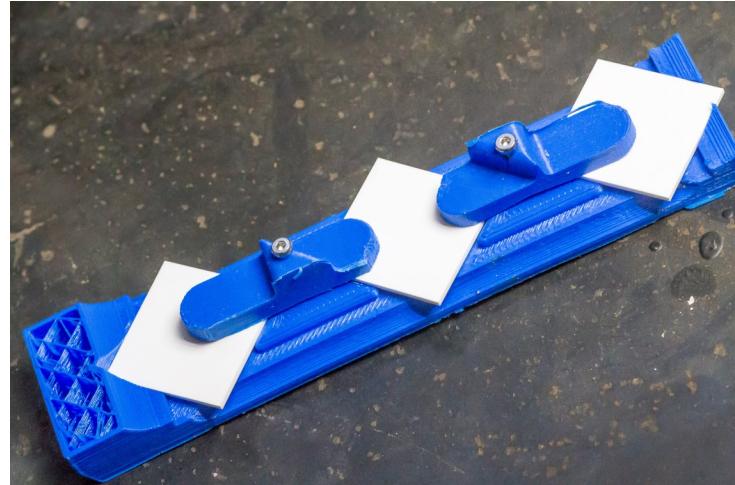
## LED Bank Assembly

4. Take 3x **LED's** and lay them out on the **Template**. Make sure the orientation is the same (anodes / + on one side, cathodes / - on the other).



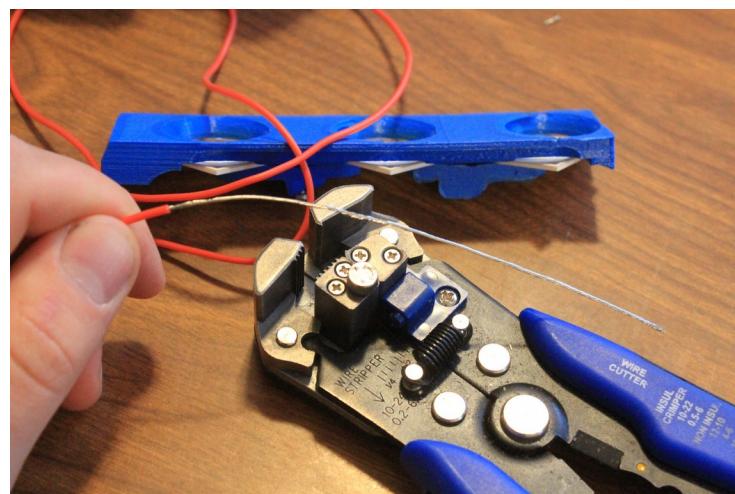
Figure 1: Anodes on top, cathodes on bottom

5. Flip the **LED's** face-down and clamp them down using the **LED Clamps** and **M2 Screws**.



*Figure 2: Do not mix up LED orientation when flipping LED's*

6. Take a 9cm long section of **22AWG** wire and strip the insulation. Twist the conductors (wire strands) so that there are no loose strands.



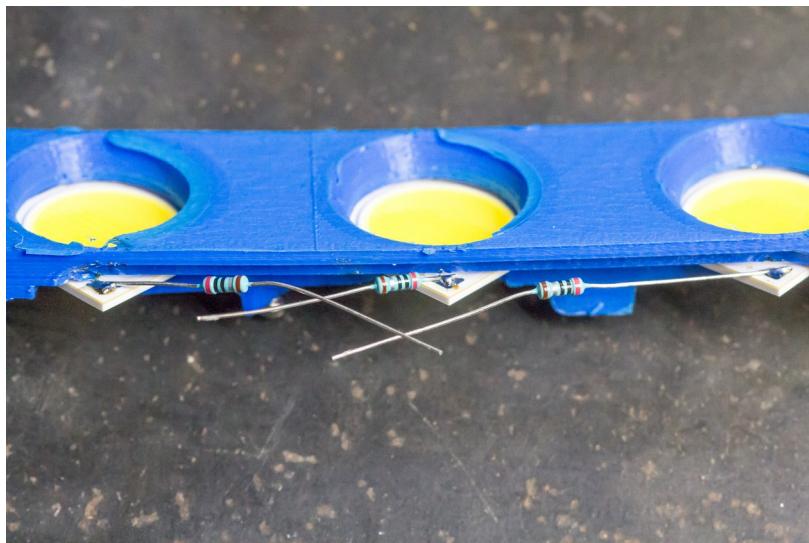
*Figure 3: Removing insulation from 22AWG wire*

7. Solder the bared wires onto the **LED** cathodes (negative). Don't make the wire too tight or too loose.



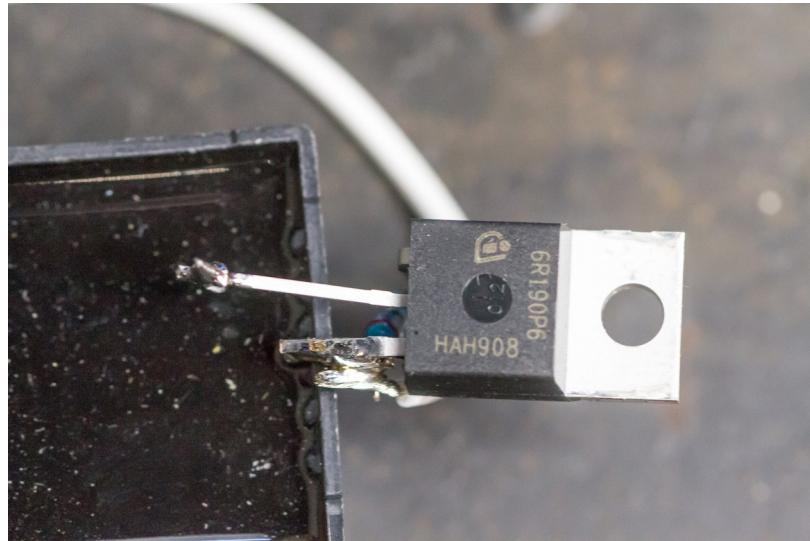
*Figure 4: 22AWG wire soldered to LED cathodes (negative)*

8. Solder the **2-ohm Resistors** onto the **LED** anodes (positive) as shown in figure 5.



*Figure 5: 2-ohm series resistors*

9. Take a **Film Capacitor** and solder the **MOSFET** source pin as shown (Polarity of the film capacitor doesn't matter – you can use either side). Don't connect the **MOSFET**'s middle pin yet.



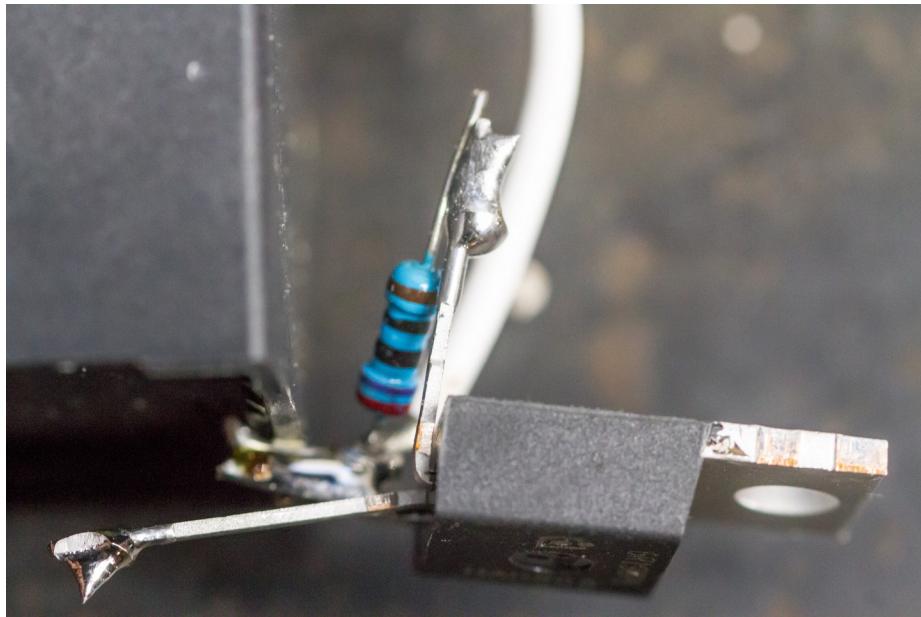
*Figure 6: MOSFET Drain on bottom, Source in middle, and Gate on top*

10. Solder **22AWG Wire** onto the **MOSFET** source / **Capacitor** cathode.



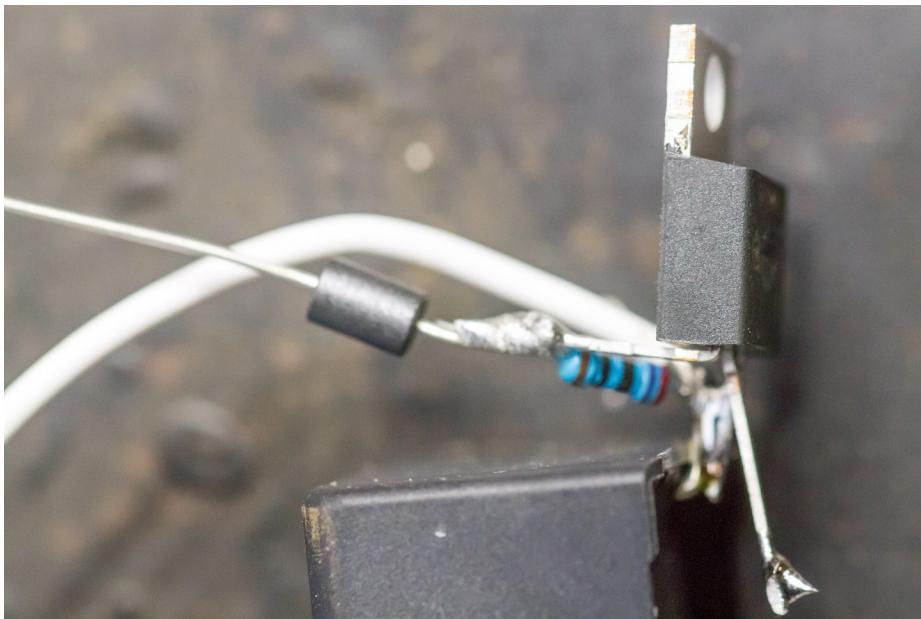
*Figure 7: Ground wire soldered to MOSFET Source / Capacitor cathode*

11. Solder a **200-ohm Resistor** from the MOSFET Gate to the Source.



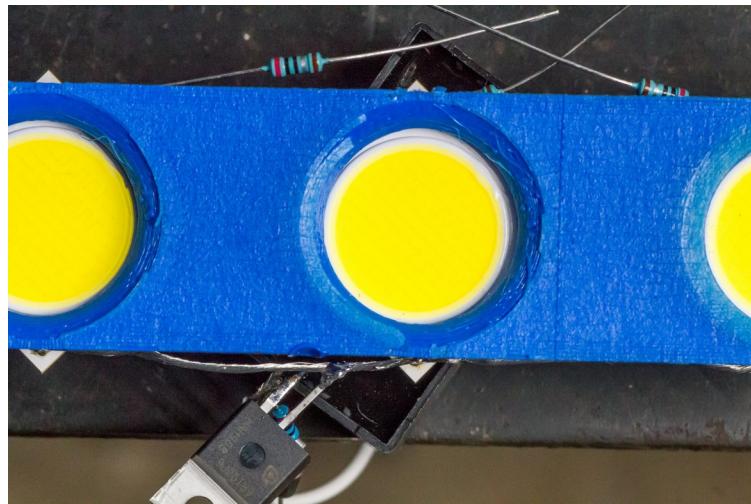
*Figure 8: 1/4W resistor from MOSFET Gate to Source*

12. Solder the **Ferrite Bead** onto the **MOSFET** gate



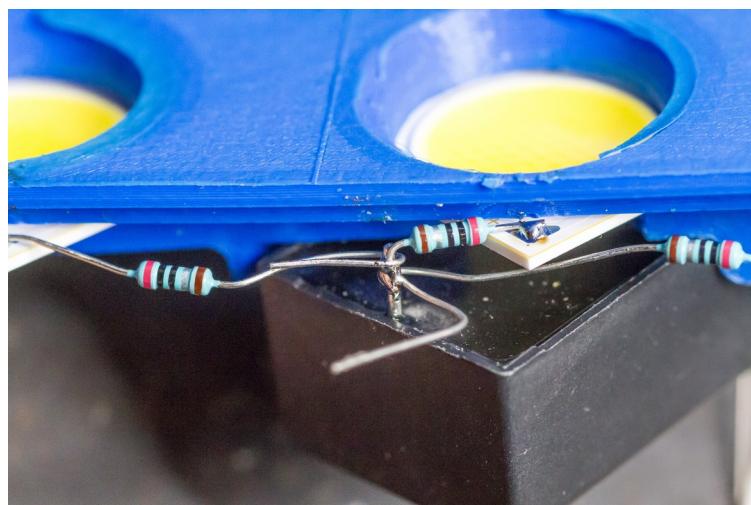
*Figure 9: Short distance from ferrite bead to MOSFET*

13. Lay the **Capacitor** upside down and place the **LED Template** on top. Solder the **MOSFET** drain (middle pin) to the **LED** cathode rail.



*Figure 10: MOSFET Drain (middle) to LED cathode rail*

14. Solder the **Capacitor's** anode to the LED series **2-ohm Resistors**. Clip the excess leads from the **2-ohm Resistors**. Note how the rightmost resistor lead is routed on the opposite side from the LED Anode pad so that they don't touch.



*Figure 11: Careful routing of resistor leads*

15. Solder a **22AWG Wire** to the **Capacitor's** anode.



*Figure 12: High-Voltage Supply Line on capacitor Anode*

16. Repeat steps 4 – 15 three more times to build a total of four banks.

## Control Board

17. There are multiple options available:

- Assemble your own control board on a 5 x 7 cm perfboard using the Circuit Diagram and Perfboard Layout available at [https://github.com/td0g/high\\_speed\\_flash/tree/master/MK1\\_Edgerton](https://github.com/td0g/high_speed_flash/tree/master/MK1_Edgerton).
- Etch your own control board using the Eagle files available at [https://github.com/td0g/high\\_speed\\_flash/tree/master/MK1\\_Edgerton](https://github.com/td0g/high_speed_flash/tree/master/MK1_Edgerton).
- Purchase a ready-to-use control board from <https://www.tindie.com/products/td0g/high-speed-flash-controller/>. If you chose this method, you may skip step 18.

18. If you chose to assemble or etch your own control board, flash the ATMega328P with the latest firmware available at [https://github.com/td0g/high\\_speed\\_flash](https://github.com/td0g/high_speed_flash). There are multiple ways to do this, but I personally recommend burning a Lilypad Arduino bootloader, installing the microcontroller on the control board, then using an FTDI adapter and the Arduino IDE to upload the firmware. Nick Gammon has a good guide for this process, please visit <http://www.gammon.com.au/breadboard>.

19. Mount the **Control Board** onto the body of the flash.

## Complete Assembly

20. Begin printing the **Encoder Knob.STL**.
21. *OPTIONAL* - Slice the **LED Cover.STL**. This component has a built-in magnet. You will need to determine the layer at which the magnet hole is covered and modify the gcode to pause at that point. You might be able to use M226, but I believe most firmware doesn't support this gcode. I simply split the gcode into two files, with the first ending when it's finished the top layer of the magnet hole (and adding G0 X0 Y190 F3000 to move the print head out of the way) and the next file continuing after that. This way, I can leave the printer running, install the magnets when the printer finishes the first file, then continue by running the second file. Once the gcode is ready, go ahead and print the LED cover.
22. Install the **LED Banks** into the front as shown. Alternate the anode/cathode direction so that there is never an anode and cathode adjacent to each other.

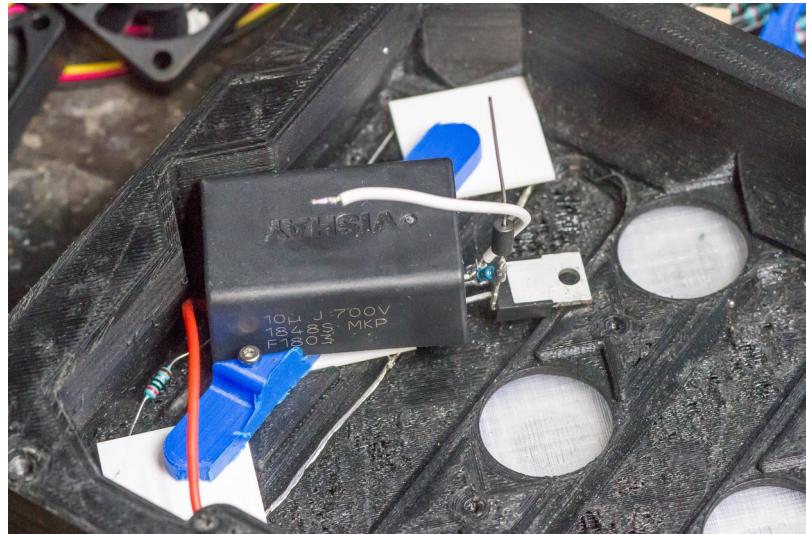


Figure 13: LED bank installed in case front

23. Install the **Arca-Swiss QR** plate onto the **Back** using **M5 Screws** and **Nuts**. You may need to drill holes into the QR plate for this purpose.

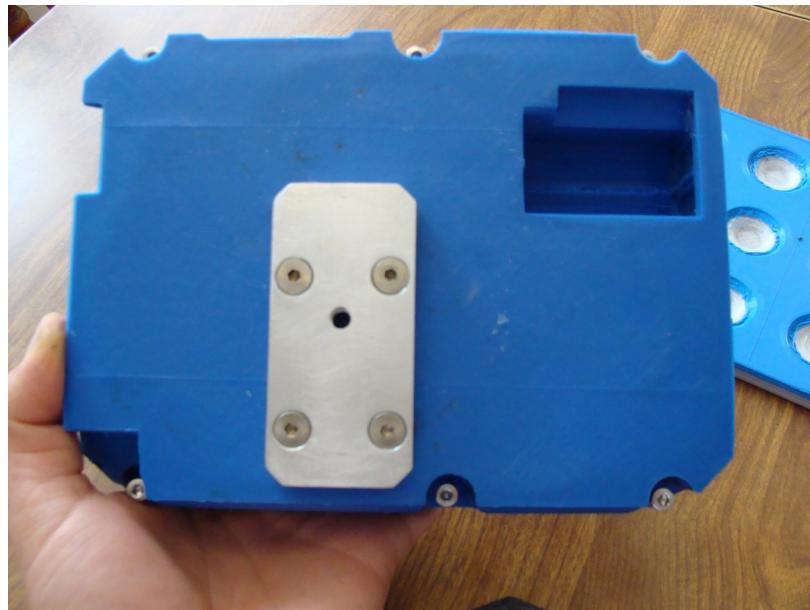


Figure 14: Arca-Swiss QR plate

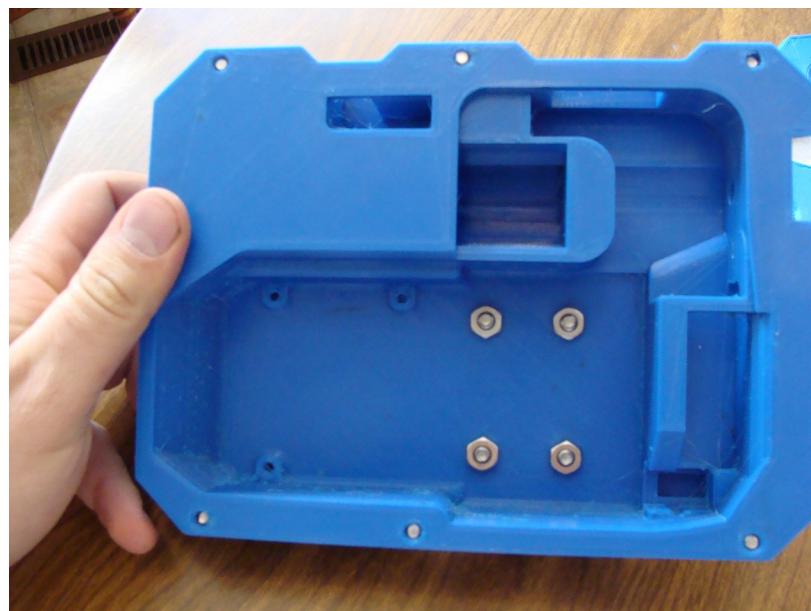
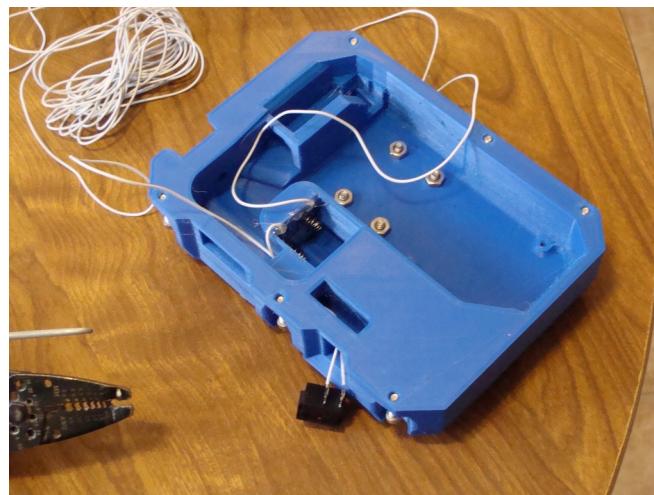


Figure 15: Case interior view, M5 nuts securing Arca-Swiss QR plate

24. Install the **High-Voltage Boost Regulator (capacitor charger)** onto the back using **3x M3 Screws**.
25. Screw the **Encoder** into the hole in the **Back**. You may need to tap the hole first if it is difficult to thread in.
26. Slide the **TM1637 Display** into the hole in the back.
27. Slide the **3.5mm Jack** into the small hole in the back. Solder wires to all three pins then secure the jack with hot glue.
28. Install the **AA Battery Contacts** onto the back using hot glue.
29. Solder a wire from the battery output positive and run it to the power switch hole. Solder the other end onto the **Power Switch**, and run another wire through the hole to the **Power Switch**.



*Figure 16: Wiring to power switch installed, proceed to slide power switch into case*

30. Slide the **Power Switch** into the hole in the **Back**.

### 31. Connect the **High-Voltage Boost Converter** to the **Control Board**.



Figure 17: Connecting High-Voltage Boost Converter to Control Board

32. Connect the **3.5mm Jack**, **Encoder**, and **TM1637 Display** to the **Control Board** (see the following figures). I used Dupont connectors and headers on the **Control Board**, but if you don't have a crimper tool then you can solder the wires directly onto the **Control Board**. The Capacitor and MOSFET connections are all connected in parallel. NOTE: It is recommended to solder the Capacitor Gnd and Gate connections onto the male headers.



*Figure 18: EMCB0 Control Board Hookup Guide*



Figure 19: EMCB0 Control Board  
Hookup Guide



Figure 20: EMCB0 Control Board  
Hookup Guide



Figure 21: EMCB0 Control Board Hookup Guide



Figure 22: EMCB0 Control Board Hookup Guide



Figure 23: EMCB0 Control Board Hookup Guide

## Firmware Setup

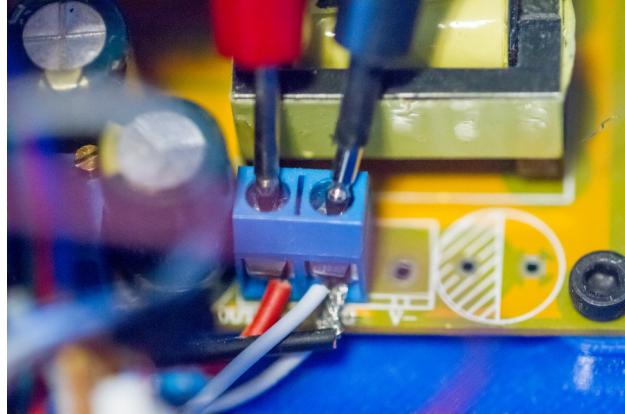
33. The setup routine can be run by holding the button for several seconds while the flash is turned on. The screen will remain blank until the setup routine begins, at which point you may release the button.
34. Measure the input voltage at the batteries as shown in figure 18. Using the encoder wheel, adjust the voltage displayed to match the input voltage. *NOTE: if you purchased a control board from me, the voltage should be correct already.*



Figure 24: Input (battery) voltage measurement

35. Press the button to proceed to the next step.

36. The **High-Voltage Boost Regulator** will turn on. **CAREFULLY** measure the output voltage as shown in figure 25 while adjusting the potentiometer on the converter. Adjust the voltage to the desired LED drive voltage (120 V recommended, anything higher is at your own risk).
37. Using the encoder wheel, adjust the voltage display to match the output voltage. *NOTE: If you purchased a control board from me, the displayed voltage should already be correct.*



*Figure 25: Output voltage from boost converter*

38. Press the button again to save the settings to memory and resume normal operation.

**DONE!**

