Mini-Maglite 2AA conversion to white LED
PART NO. 2208403

Project Overview:
The Maglite 2-AA with an incandescent bulb was a popular flashlight for many years and I have several of them myself. In the past few years, low cost white LEDs and LED driver chips have become available so I decided to convert them to white LED bulbs using a LED driver chip. Using a driver chip offers the benefit of a constant current drive and constant light output independent of the battery voltage. An additional benefit is that LEDs are a much more efficient light source and the battery life will be significantly longer for about the same light output.

The 2-AA Mini-Maglite’s specification are:

- 14 Lumens total light output
- 2305 mcd maximum beam intensity
- 5.25 hour operating time

LED Selection:
To be able to use the focus control of the flashlight, the LED will need a wide angle output and its beam intensity will have to be in the range of 2300 mcd. The Cree white LED, part number C535A-WJN-CU0V0231, has a specified beam intensity of 1700 to 3000 mcd with a 110 degree half power angle and was selected to use in this project. The maximum diameter of the LED is 0.228" (5.8mm) which is a little larger then the diameter of the incandescent bulb. The hole in the base of the reflector will have to be enlarged slightly.

The LED's forward voltage is 3.2 volts with a forward current of 20mA. Two alkaline or NiMH batteries in series do not have a high enough voltage to drive the LED and a step up voltage converter will be needed. The CAT4137TD is designed to drive LEDs with a constant current from a 2 to 5 volt supply and is available in a SOT23-5 package.

PCB Considerations:
The bulb socket and switch assembly in this flashlight is 0.560 inches diameter. This determines the size of the PCB. The PCB will have two pins that connect to the battery power through the switch plate on the same side as the LED driver circuit, while the white LED is mounted on the opposite side of the PCB from the power pins. The PCB is assembled into the flashlight assembly between the pressure switch plate and the reflector.

Time Required: 2 hrs depending on experience
Experience Level: Intermediate

Required tools and parts:
- Mini-Maglite flashlight
- Fine tip soldering iron
- Solder paste or liquid flux and 30GA solder
- Tweezers
- Pliers
- PCB holder
- Voltmeter
- Magnifying glass
- Tapered reamer or a or #12 or 4.8mm drill bit and a drill motor
- Surface mount component soldering skill
Bill of Materials:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Jameco/Mfr SKU</th>
<th>Component Name</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0805ZC105KAT2A</td>
<td>C1, 1uF Capacitor, 0805 package</td>
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<td>GRM219R71E224KA01D</td>
<td>C2, 220nF, capacitor, 0805 package</td>
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<td>BAT54XV2</td>
<td>D1, Schottky Diode, SOD-523F package</td>
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<td>1</td>
<td>CAT4137TD-GT3</td>
<td>IC1, LED Driver, TSOT23-5 package</td>
</tr>
<tr>
<td>1</td>
<td>2098478</td>
<td>J1, 24GA wire 0.2” long,</td>
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<tr>
<td>2</td>
<td>2098478</td>
<td>PIN_1, 24GA wire, 0.55” long; and PIN_2, 24GA wire, 0.55” long</td>
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<tr>
<td>1</td>
<td>2208729</td>
<td>3mm Nylon spacer</td>
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<td>1</td>
<td>LQH32MN220J23L</td>
<td>L1, 22uH, low profile inductor, 1210 package</td>
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<td>1</td>
<td>C535A-WJN-CU0V0231</td>
<td>LED1, White LED, T1.75 package</td>
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<tr>
<td>1</td>
<td>RC0805FR-0712RL</td>
<td>R1, 12 ohm, 0805 resistor, 1%</td>
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Step 1 - Disassemble the flashlight

Rotate the focus control clockwise until it disconnects from the flashlight's barrel. Remove the bulb from the socket.

Remove the lens cap from the focus control by rotating it clockwise.

![Figure 1: Mini Maglite 2AA](image1)

Step 2 - Socket Polarity

This step will require a voltmeter and 2 pieces of 24 gauge wire.

The bulb's leads are about 24 gauge wire.

Insert a wire into each of the socket's terminals.

Connect the voltmeter and note which terminal is positive.

Tag the positive terminal for future reference.

![Figure 2: Mini Maglite 2AA Disassembled](image2)

![Figure 3: Bulb Socket](image3)

![Figure 4: Using a Volt Meter to Determine the Socket's Polarity](image4)

![Figure 5: Tag the Positive Terminal of the Socket](image5)
**Step 3 - Trimming the LED Diameter**

The drawing of the LED shows a lip at the base of the LED that adds about 1mm or about 0.040 inch the diameter LED. To minimize the hole size in the reflector, this lip is removed.

Using a flush cut wire cutters, cut the lip off the LED's body.

If needed, a small file can be used to smooth the edge.

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**Step 4 - Reflector Modification**

The hole at the base of the reflector is 0.123 inch diameter and is too small for the LED.

Using a Number 12 drill, or a 4.8 mm drill, drill out the hole. Using a wood backing and slow feed rate will prevent the drill bit from grabbing the plastic reflector and damaging it.

The LED should fit through the hole in the reflector without any interference.
Step 5 - Staging Assembly

Place all the required parts on a tray. The two pieces or 24 gauge wire, 0.55” long, are made as follows:

Start with an uninsulated 24 gauge, tinned copper wire, 3 to 4 inches long. Grip about ½ inch on each end with pliers. Pull the pliers in opposite directions until the wire breaks. This will straighten and work harden the copper wire which will be used for the leads to the flash light's pressure switch. Cut two pieces 0.55 inches long.

Step 6 - Solder Paste

Apply a small dab of solder paste to SMD pad.
**Step 7 - Parts Placement**

Using tweezers, place the components on the PCB with light pressure. This will spread the solder paste as well as supply some adhesion to keep the components in place.

![Image of PCB components](image1)

**Step 8 - Solder component side**

A low wattage, very fine tip soldering iron will be required for this step. The tip of the soldering iron needs to be well tinned.

Holding the component in position with tweezers, touch the tip of the soldering iron to the corner formed by the component's terminal and the SMD pad on the PCB. The solder past will melt and flow around the pad and terminal. Now solder the opposite terminal of the same component.

Repeat this processes until all of the components are soldered.

Insert the 24 gauge wires into their through holes in the PCB. See picture for location.

![Image of PCB with wires](image2)
Step 9 - LED placement

The white LED is soldered to the PCB on the side opposite the other components. The LED's placement is 0.10 inch above the PCB's surface. This places the LED's emitter at the correct position in the reflector to maintain the original range of focus.

Cut a piece of lightweight cardboard, such as a business card, that is about 1/2 inch long and 0.10 inch wide. Place the LED's leads in the PCB's holes. The cathode of the LED, the lead on the side with the flat on the LED's package, aligns with the flat side of the LED outline on the PCB. The cathode is also the short lead lead of the LED.

Use the 0.1 inch wide spacer to position the LED the correct distance from the PCB. See the picture. Solder the LED in place and trim the LED's leads on the component side.

Step 10 - Cleaning

Clean the PCB.

If water soluble flux was used then wash PCB assembly with water, otherwise wash PCB with alcohol to remove flux and solder paste residue. Gently, dry the PCB. This can be done with a heat gun using the low temperature setting.

The picture below shows the completed unit.
Step 11 - Flashlight assembly.

Remove the batteries from the body of the flashlight.

The 24 gauge wire lead that is adjacent to the inductor is the positive lead.

Insert the 24 gauge wire leads from the PCB into the flashlight's pressure switch terminals. Observe the correct polarity.

Install the batteries and end cap. The LED will light at this point. Reassemble the focus control, reflector and lens cover and reattach to the flashlight.

Do not over tighten the focus control when turning off the flashlight. The inductor is pushing on the pressure switch and over tightening can damage the inductor. The nylon spacer centers the force on the pressure switch and protects the components from contact with the switch plate.

You're Done