AROUND THE MAKER WORKSHOP, BROUGHT TO YOU BY DREMEL

By John Edgar Park

» Make a custom LED tree ornament for some high-tech holiday fun.

Want to build your own custom circuit board, in a fun shape? Don't want to deal with any etching chemicals? You can use your Dremel Rotary Tool to cut a copper clad board into a unique shape and rout festive pathways for your electrons. This technique (sometimes called "dead bug construction" or "ground plane construction") is a fun way to explore circuit board design and surface-mounting of through-hole electronic components. Plus, the result is a really fun high-tech ornament that displays its technology on the outside.

MATERIALS AND TOOLS

- **Dremel Rotary Tool** with metal cutoff wheel, engraving cutter, and cutting guide
- **3"×5" copper clad board**
- **2xAA battery pack (1)** and batteries
- **SPDT switch (1)**
- **10mm diffuse red LED (1)**
- **5mm red LEDs (5)**
- **5mm green LEDs (5)**
- **56Ω resistors (6)**
- **10Ω resistors (5)**
- **Soldering iron and solder**
- **Flux paste**
- **Multimeter**
- **Isopropyl alcohol**
- **320-grit sandpaper**
- **Double-stick foam tape**
- **Small needlenose pliers**
- **Wire stripper**
- **Diagonal cutters**
- **Pencil**
- **Ruler**
- **Safety goggles**
- **Dust mask**

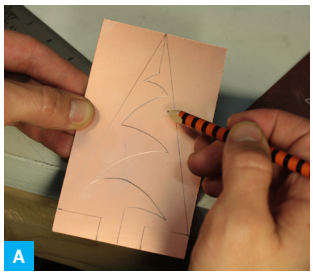
Directions

Step 1: Use the ruler and pencil to draw your tree cutout and routing lines. The design I made has a 1" wide ×½" high trunk, with the triangle of the tree following that guide. We're essentially making two pads on the copper clad board, one side for positive power and one for negative. The rout pattern down the middle divides the copper surface in half, starting at the trunk, zig-zagging along like a garland, and ending at the tip of the tree (Figure A).

WARNING: It's always important to use safety goggles or safety glasses when operating any power tools. This project involves cutting metal, so all caution and common sense should be used.

Step 2 : Clamp the board to your workbench so we can rout the lines. Chuck the engraving bit into your Dremel Rotary Tool, then add the cutting guide (this is much easier than doing it freehand). Set the height and bit depth so that there is only a tiny protrusion of the bit, about 0.25 mm will do nicely. Don your goggles, turn the tool on, and set the speed to about 20,000 RPM.

Looking through the guide viewing cutout, carefully remove the copper cladding from the entire rout line (Figure B). This separates the board circuit into two halves, which will be our positive and negative pads (Figure C). Use a shop vacuum to remove the dust.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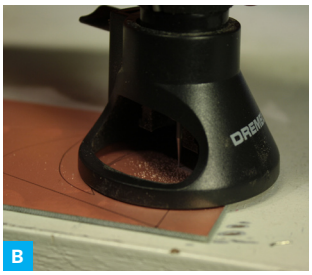
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C

Step 3: Test the pad continuity with a multimeter to make sure there is no connection (short) between the two sides (Figure D).

If there is a short, use a knife to remove any bits of copper that are bridging the pads.

WARNING: When using the cutting wheel, work in a well ventilated place and wear a dust filter to avoid breathing in particles.

Step 4: Re-clamp the board so you can cut the excess board away to reveal the tree shape. Use the metal cutting wheel on the Dremel rotary tool at a speed of about 25,000 RPM (Figure E).

When you're done there may be some scratches in the copper (Figure F); do not panic. Take the sandpaper and sand the surface up and down to remove scratches and add a nice, light-catching vertically brushed surface texture. You can also smooth out the board's edges at this point. Wipe the board down with a soft cloth and some isopropyl alcohol.

Step 5: It's time to prep the LEDs. I used needlenose pliers to coil the LEDs' positive legs into feet (Figure G).

Step 6: Solder the resistors in-line with the negative leg of each LED (Figure H). For the 3V power supply from the batteries, I calculated the resistance needed for the red LEDs at about 56Ω, and for the green at about 10Ω (you can find good LED resistance calculators online).

Once the resistors are soldered, cut the excess length of the LED negative leg, then coil the resistor legs into feet as in Step 5 (Figure I).

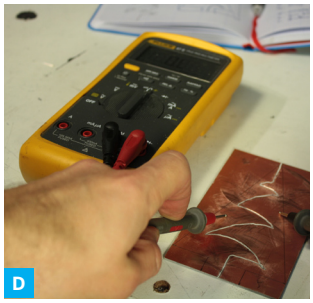
Step 7: Apply a dab of flux to two spots where you will solder your first LED onto the board (Figure J). Make sure all of the resistor legs (which are soldered to the negative side of the LEDs) are then soldered to the same-side tree pad — I chose the "left" side for negative. This also means keeping the positive leg on the "right" pad.

No drilling required! This is surface mount soldering using full-size electronic components. I find it easiest to heat up the board at the dot of flux with the soldering iron, apply some solder, and then quickly add the component leg to the hot solder (Figure K).

I also like to test the circuit after each LED is soldered in place by touching the battery pack's red wire to the positive pad and black wire to the tree's negative pad (Figure L). It should light up! If it doesn't, double check continuity with your multimeter, and remove any solder or LED wire that may be bridging the tree's pads.

Step 8: After each LED is soldered, wipe away the excess flux with the cloth and isopropyl alcohol. Then solder each remaining LED/resistor pair to the tree.

Step 9: Solder the 10mm LED vertically on top of the tree (Figure M).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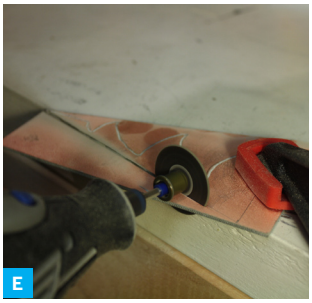
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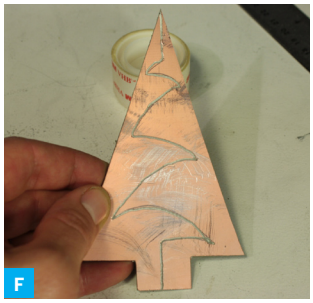
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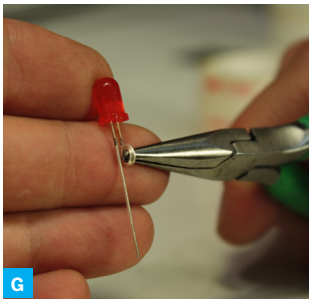
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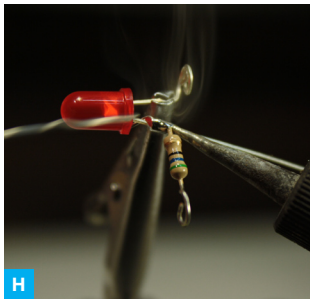
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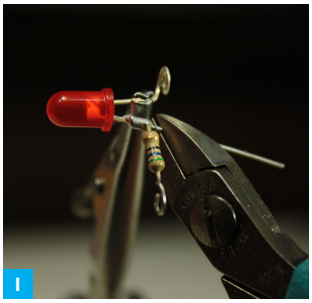
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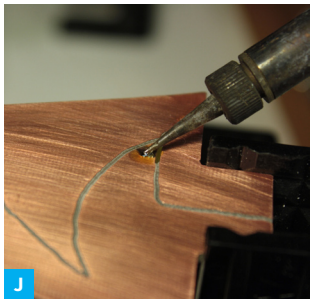
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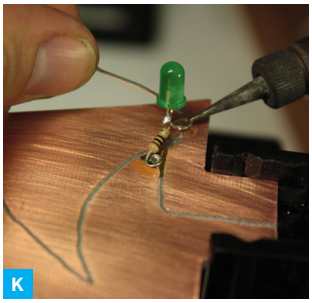
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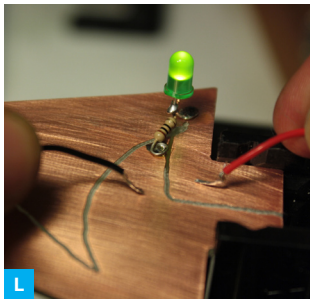
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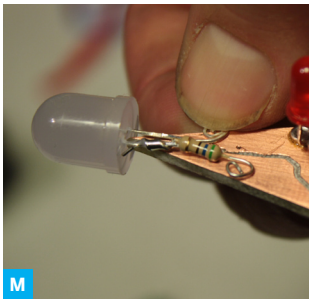
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Step 10: Now we need more permanent power. Solder the black wire of the battery case to the negative pad of the trunk (Figure N). I attached the wire from the side so it wouldn't interfere with the tree base.

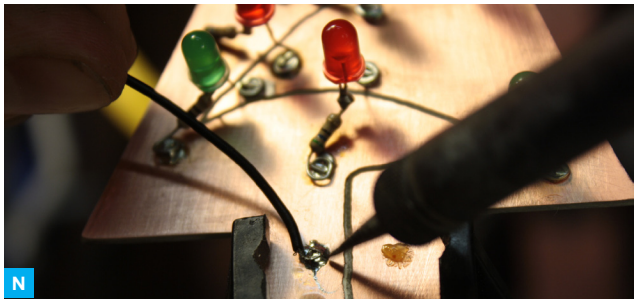
If your battery pack lacks a switch, cut the red battery pack wire, strip it, and solder the SPDT switch in-line with it. Then solder the red wire to the positive pad of the trunk (Figure O).

Step 11: You can now attach the tree circuit board to the battery pack with some double-sided foam tape (FIgure P). Clean the back of the board and the battery pack with the isopropyl alcohol. The battery pack will serve as the base for standing the tree up, so keeping it flush or slightly higher than the tree's bottom edge will allow it to stand upright. Tuck the wires in neatly and tape the switch to the back of the board as well (Figure Q).

Flip it on and enjoy your beautiful little high-tech holiday tree.

About the Author

John Edgar Park is the host of *Make:* television and a CG Supervisor at DisneyToon Studios. Find him online at jpixl.net.



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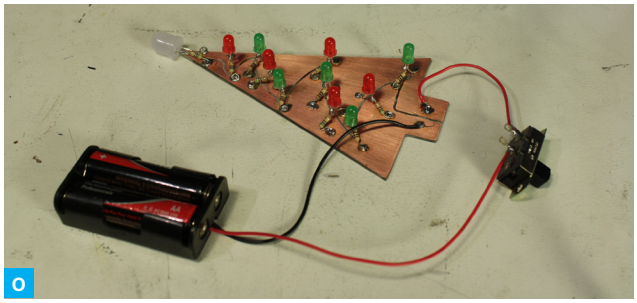

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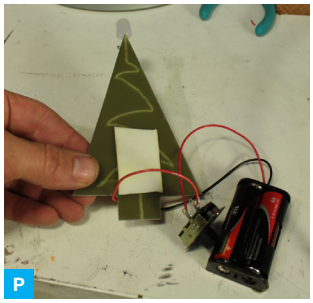

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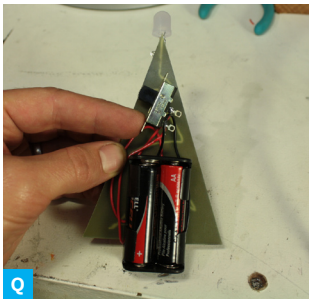

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