Making the Electronics Board

This document describes how to assemble the electronics board. When complete, you should have a board that can be inserted into the laser unit, attached to the battery unit, and powered on to have 4 flashing lasers.

Parts

This step will need all of the electronics except for the wire, switch, and battery.

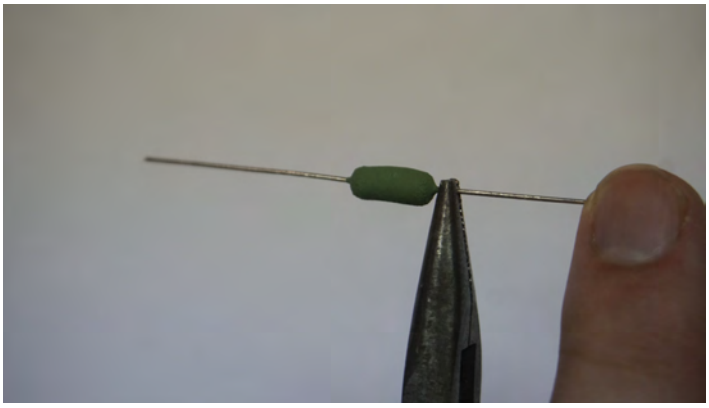
Steps

The following assumes that you have version 2 of our electronics board. You may have version 3, which will have a slightly different layout. However, the basic concepts remain the same.

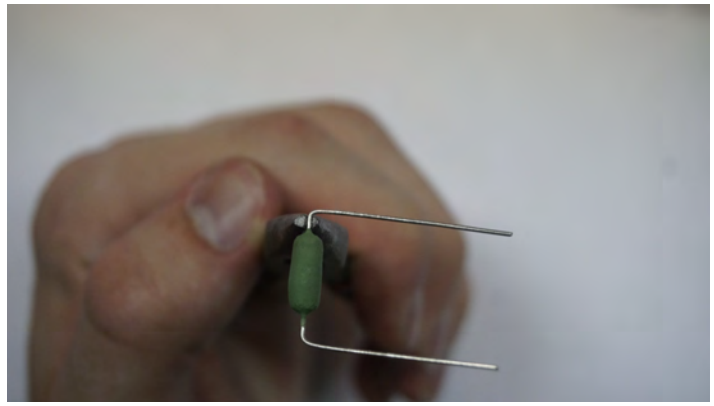
Begin with the PCB. Yours should look something like this:

The first parts to add are the resistors. Grab a 33Ω resistor using pliers as shown:

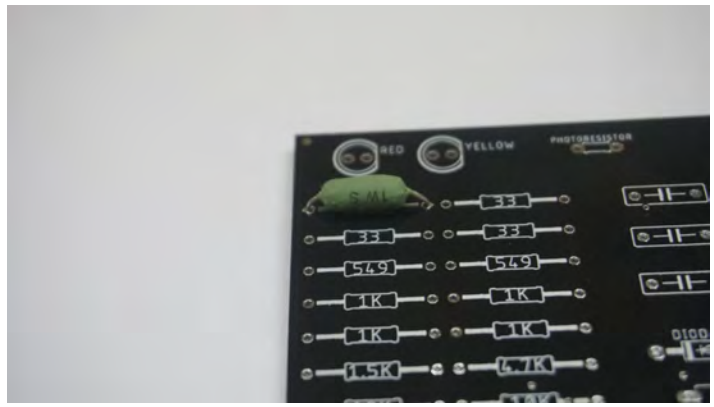
With a finger, gently press the wire lead down to a 90 degree angle:



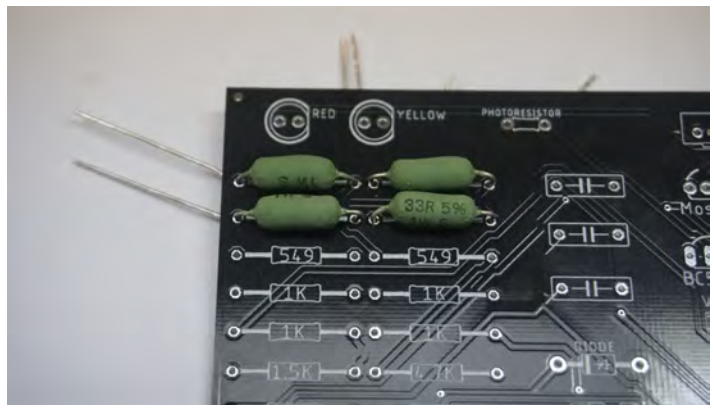
Repeat this for the other side so it looks like this:



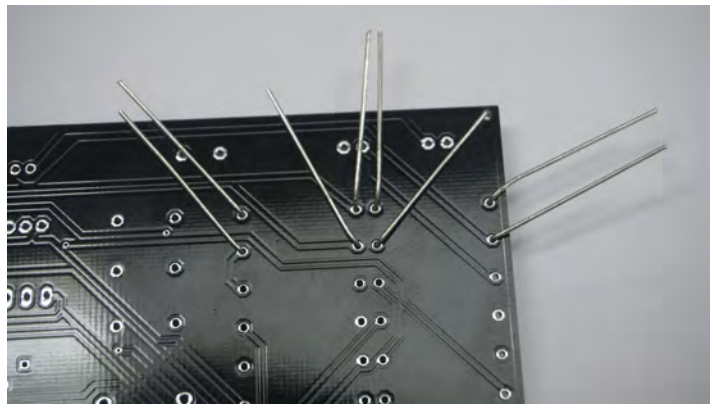
This resistor can now be added onto the board. It is a 33Ω resistor, so locate one of the boxes labeled '33'. Feed one of the leads into one of the adjacent holes, and the other lead into the other adjacent hole. The direction of all of these resistors doesn't matter. When done, you should end up with this:



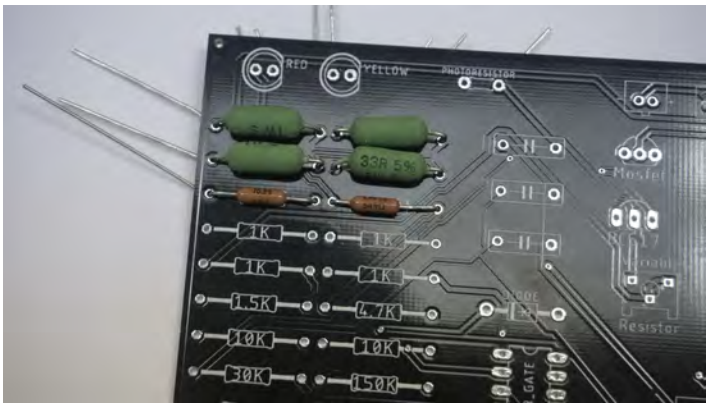
Repeat this for the three other 33Ω resistors. Notice that they have been pulled as close to the board as possible so that they don't accidently touch each other:



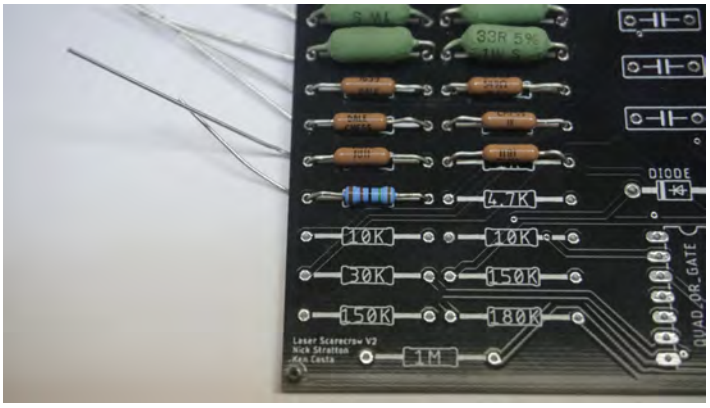
On the bottom, the leads have been folded away to hold the resistors in place. This is only temporary: there is no electrical connection here so it won't work, but it makes working on the board easier.



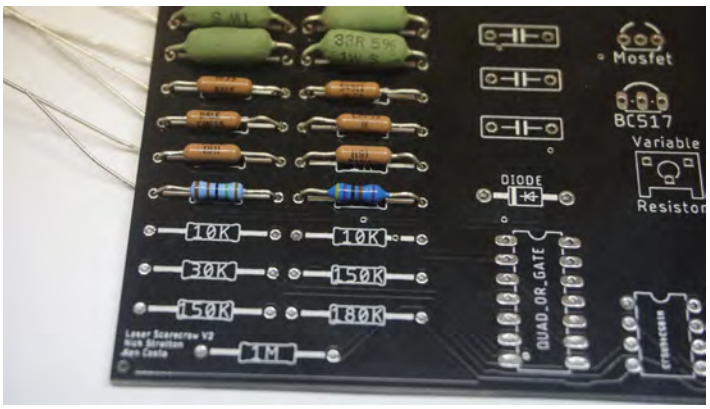
Repeat this process for the two 549Ω resistors. Notice the "549" written on them that shows they are not the 1K resistors.



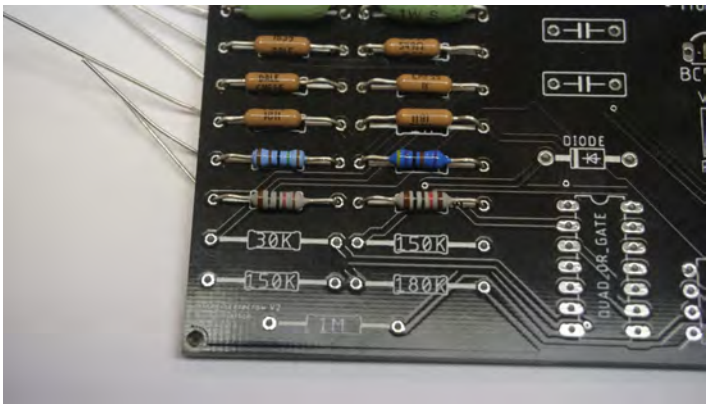
The four 1K resistors are next. They can be identified by the 1K written on the side. The 1.5kΩ resistor has also been added in this photo. To identify these resistors, use the label on the packaging. You can also use the ohm (often labeled Ω) feature on a multimeter, or look up resistor color codes.



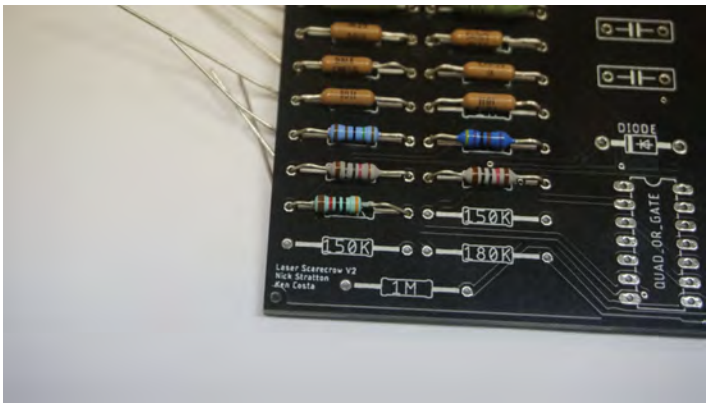
The 4.7kΩ resistor is next:



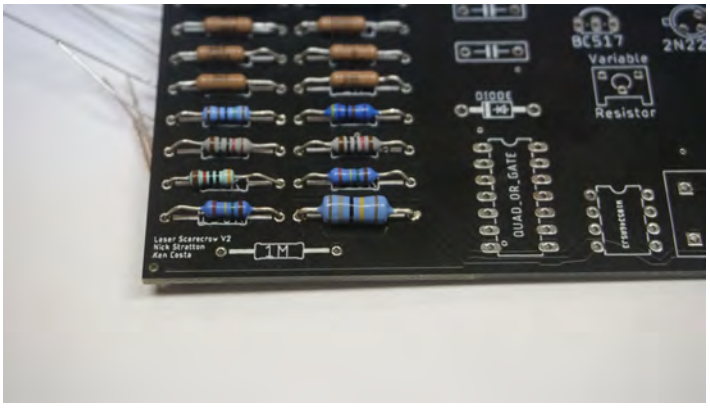
The two 10kΩ resistors come next:



Then a 30kΩ resistor:

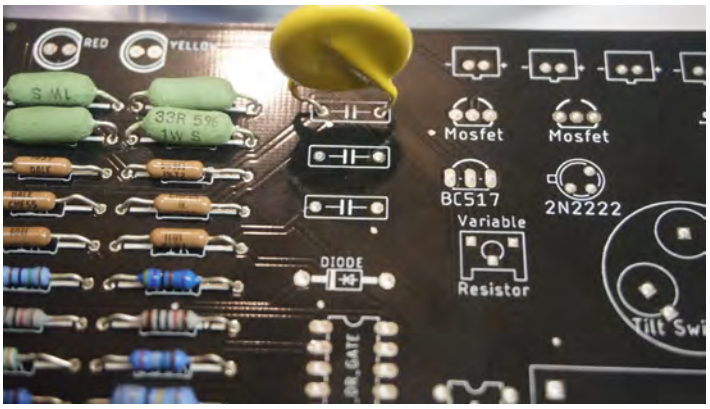


Two 150kΩ resistors and a 180kΩ resistor are next:

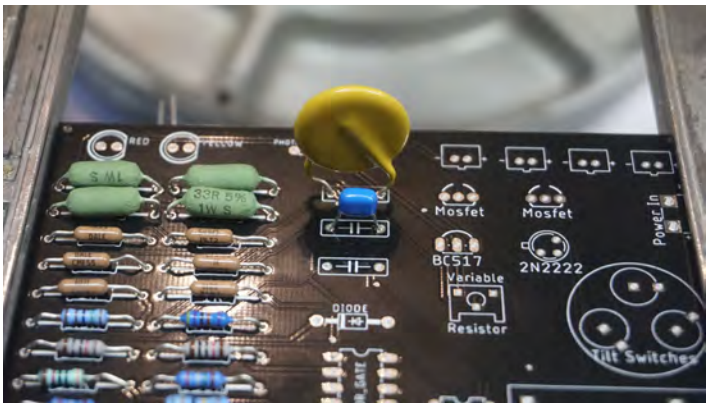


A 1MΩ resistor is the last resistor to add:

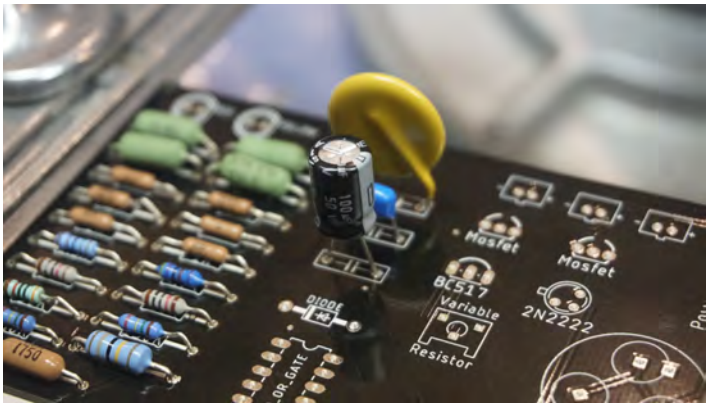
Next up is the capacitors. Start with the 10 nF (nanofarad) capacitor and place it in the top capacitor box. The direction of this part doesn't matter. Push it as low as you can without forcing this part– it won't go down all the way, but that's fine.



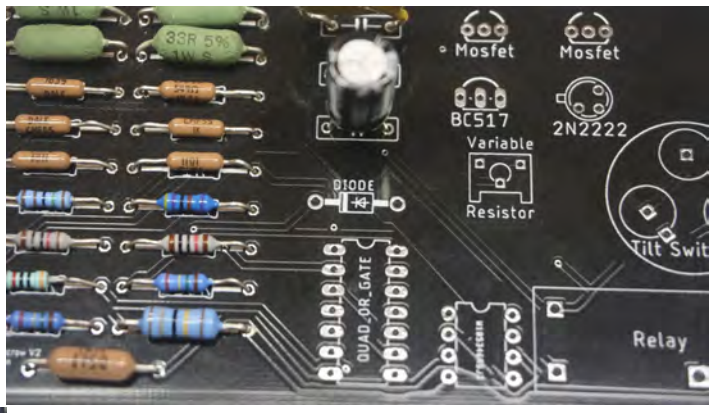
Next is the 10 mF (microfarad) capacitor, inserted in the same way. As before, the direction of this part doesn't matter.



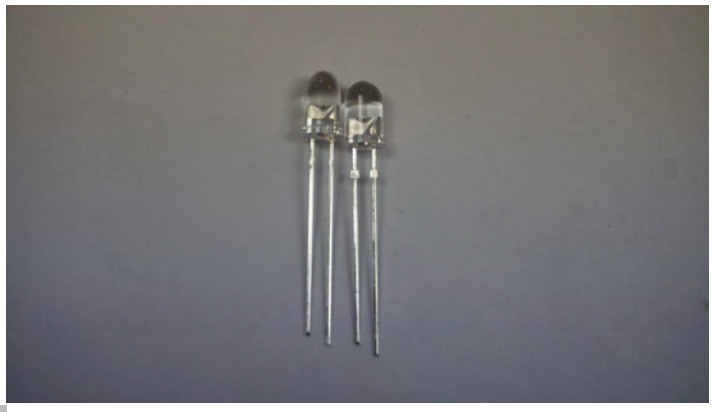
Finally, add the 100 mF capacitor. Unlike the other two capacitors, the direction of this part does matter. Notice that the white stripe is facing to the right side of the board:

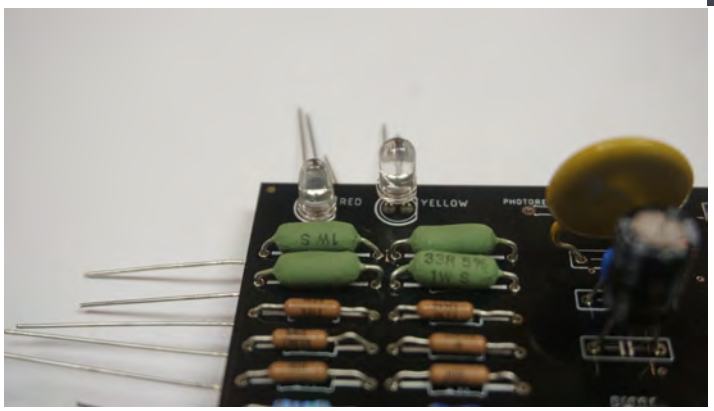


With the capacitors done, it's time to start adding the diodes. The directions of these parts to matter. Start with the diode that looks most like one of the resistors, and note the white stripe on one side. Fold the leads in the same way you folded the resistor leads, and place it on the diode box so that the white stripe on the diode lines up with the white strip on the board:

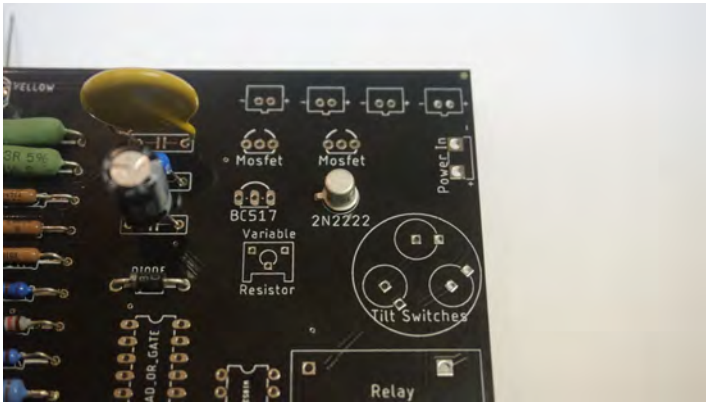


Next, add the LED's. The colors are labeled on the board: the yellow is on the right and the red is on the left. Be careful– as before, the direction of this part is matter. Notice that the LED's will have one lead that is shorter than the other. On the board, the outline for the LED has a flat side. The shorter lead should feed into the hole closer to this flat side.

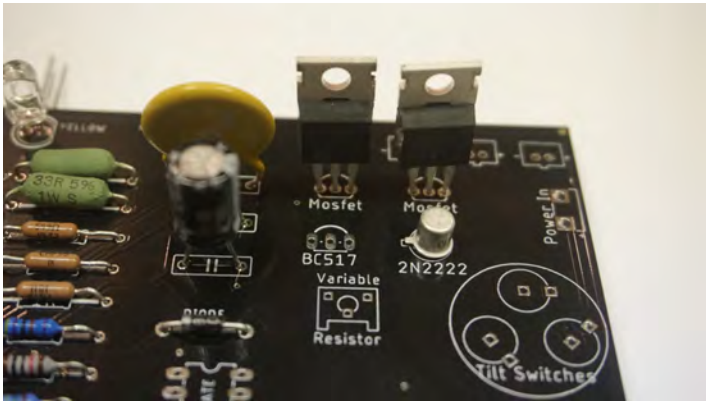




The 2N2222 can now be added. Notice that the tab on the part lines up with the outline on the board:



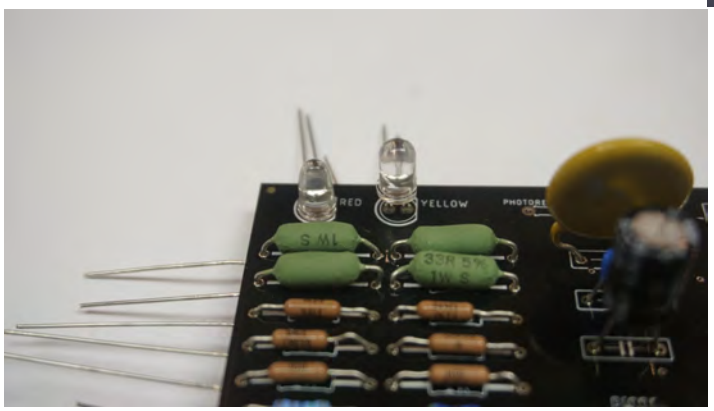
The MOSFETs will be a slightly tighter fit and won't need to be inserted to the base. Don't bother bending these pins on the other side– it's difficult and not necessary since the tight fit should hold them in. The direction of these parts matter, so make sure that yours matches this photo:



If you have version 2 of this board, you will also need to solder a $10k\Omega$ resistor across the outer two pins, making sure not to create a connection with the middle pin. In version 3, this should not be necessary.

The direction the BC517 is mounted also matters. Notice that it has a flat edge, and that the outline on the board also has an outline. The flat edge on theBC517 should line up with the flat edge on the outline.

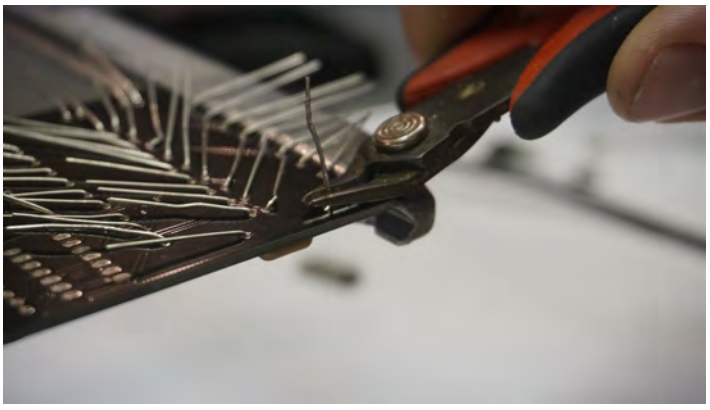
Next, add the LED's. The colors are labeled on the board: the yellow is on the right and the red is on the left. Be careful– as before, the direction of this part is matter. Notice that the LED's will have one lead that is shorter than the other. On the board, the outline for the LED has a flat side. The shorter lead should feed into the hole closer to this flat side.



Those are all the parts that can be inserted in a way that they won't fall out. This means that it's time to start soldering. On the back of the board, solder by applying heat to the pad, applying solder and allowing it to melt and flow, pulling away with the solder, then removing the heat:

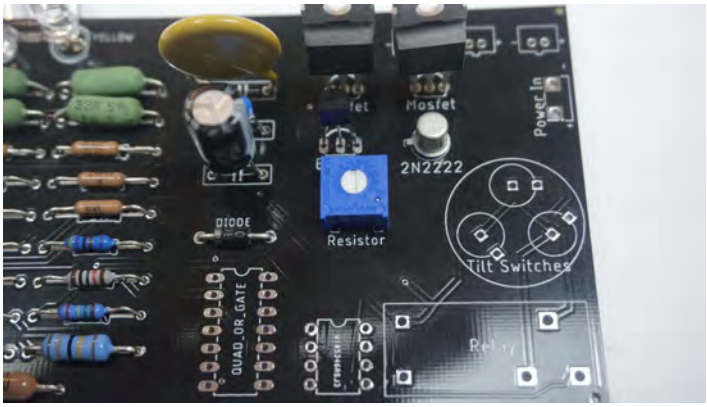
If you aren't familiar with soldering, Adafruit has a great tutorial: https://learn.adafruit.com/adafruit-guide-excellent-soldering. Sparkfun also has a tutorial that may be helpful: https://learn.sparkfun.com/tutorials/how-to-solder-through-hole-soldering.

When the lead has been soldered, cut away the remainder of the lead using wire cutters. Repeat this process until all of the leads have been soldered.

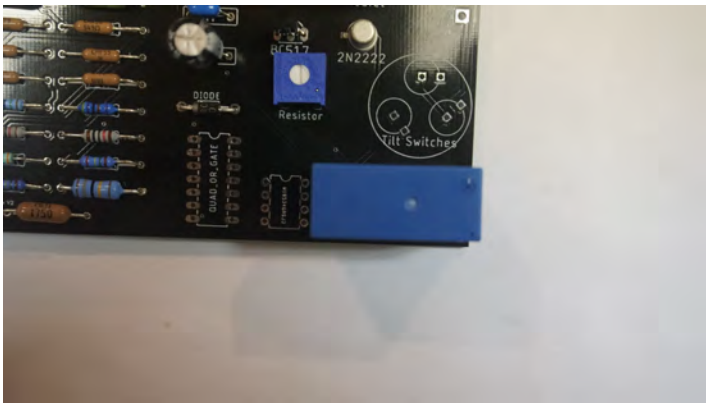


Be careful not to hold the heat onto the parts for too long, since some of these parts can be damaged by the heat of the soldering iron. The resistors are a lot less sensitive to heat than many of the other parts on this board, so it's probably best to start with them if you think you need more experience with soldering.

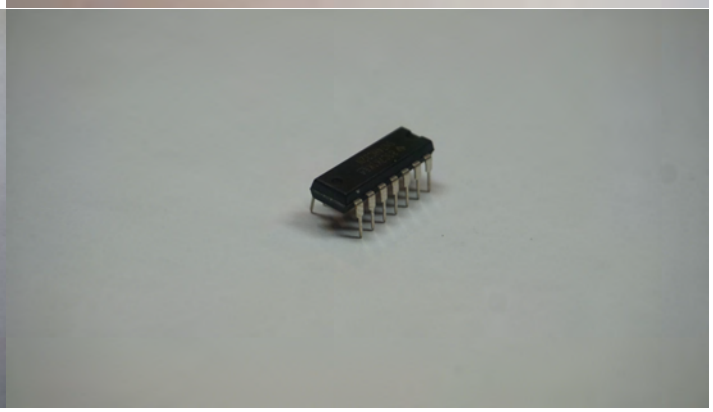
The rest of the parts will need to be added by flipping the board to the front, inserting the part, holding it in place, and flipping it back over to solder the back. Try this with the variable resistor. It should only be able to fit in in one direction.



Try the same thing with the relay:



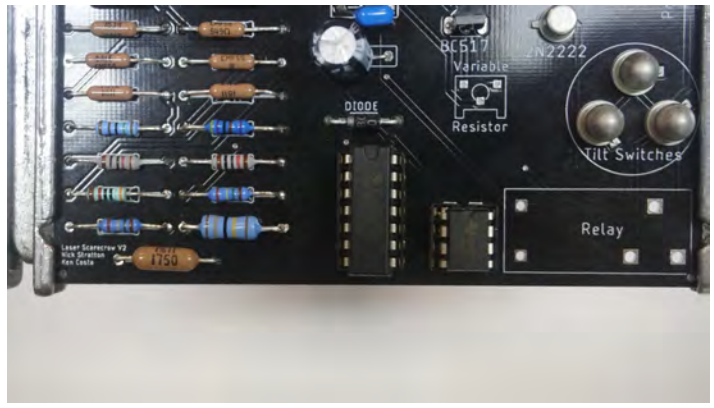
The Quad OR Gate and 555 Timers are direction dependent and delicate. For this reason, we've used sockets. Notice that the socket, outline, and part has a semicircular indent on the top:



These semicircular indents should be made to all line up.

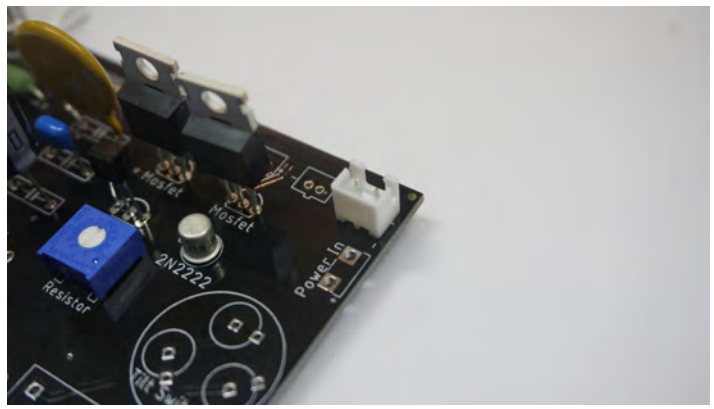
With the part not in the sockets, solder the sockets flush to the board:

The Quad OR gate and the 555 timer can then be inserted into these sockets. Do it carefully– there should be one pin for each port on the socket, and each pin should be inserted into the the port they line up with. Make sure that the pins are lined up properly before pressing the part firmly into the socket, because it's easy to accidently break the pins while inserting them.



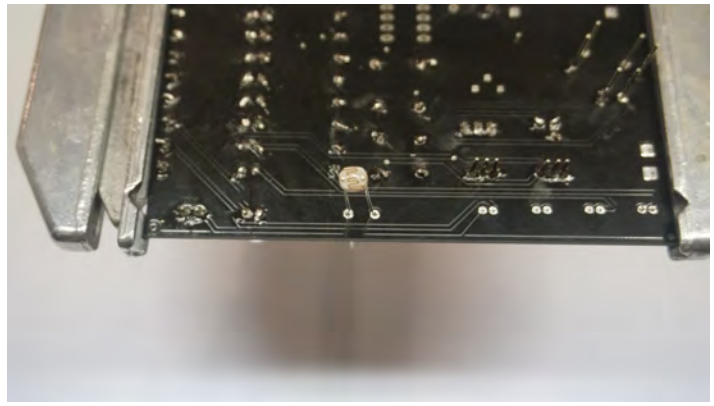
The tilt switches have to be inserted:

The JST connectors that the lasers plug into also need to be mounted. Note the direction that the connector faces:



Repeat this for the three remaining connectors.

Unlike the other parts, the photoresistor should be mounted so it comes out the back of the board:



Checking

Begin with a visual inspection. Check to make sure that each solder joint is connected only to a single lead, and that all leads have been trimmed. Make sure that no parts are touching each other, and that they are all inserted in the right direction.

Plug in the battery but NOT the lasers. Using a small screwdriver, turn the dial in the variable resistor all the way to one extreme and wait 30 seconds. If you do not hear a click within 20 seconds, turn the variable resistor all the way to the other extreme.

Leave the variable resistor at whatever point produces the clicking for now. Making sure the laser is not pointed at anything remotely reflective, and wearing safety glasses approved for this laser wavelength, plug in one of the lasers and wait 30 seconds to see if it produces light. Repeat this step for the three remaining lasers.

If one of the lasers does turn on, the most likely cause is that that laser is broken. If none of the lasers turn on, there is likely issue with the board. Using a multimeter, check each part to find the bad connection and swap out that part. This will likely fix the issue.

Tuning

Tuning is done using the attached variable resistor. By rotating the dial, the sensitivity of the light sensor can be adjusted.