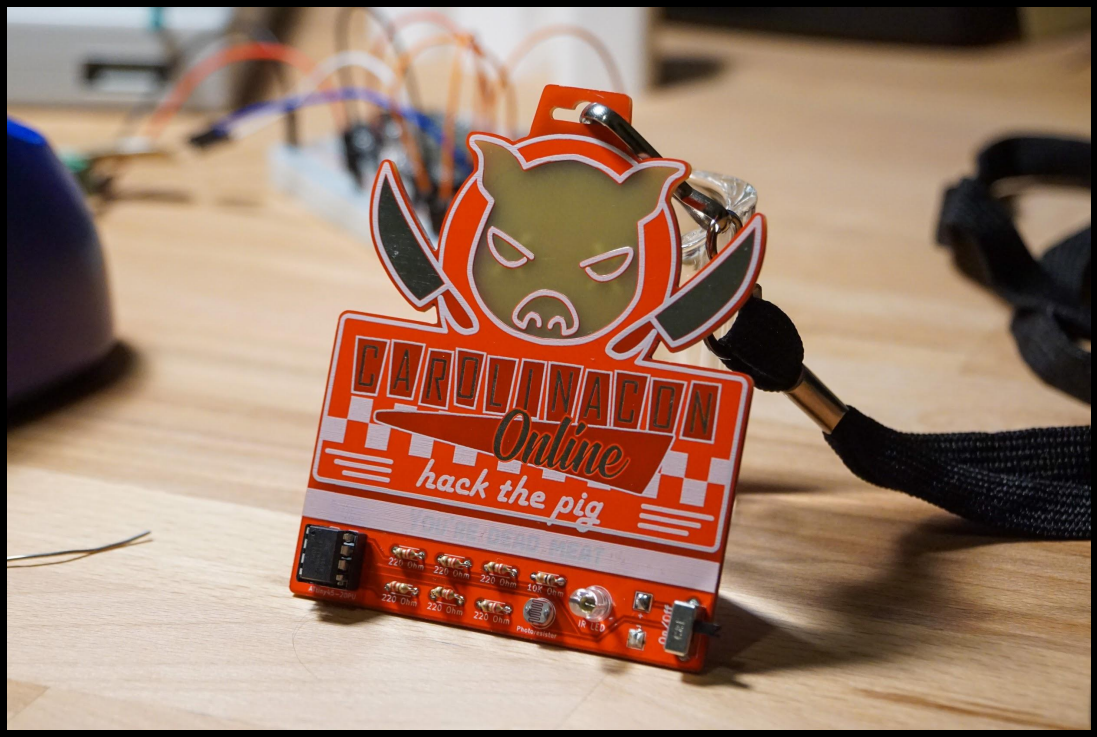
CarolinaCon Online Badge Building Guide

Hack the Pig

By Matt & Wonkey

Microcontroller code:
https://github.com/49thSecurityDivision/CarolinaconOnlineBadge



If you are building a badge this year, it means you went out of your way to buy our merch bundle -- Thank you for that! We have been thrilled to see the enthusiasm for the badge, and are proud people like our design enough to want to build their own.

With CarolinaCon being online, we unfortunately can't provide the full fun and guidance of a badge building room. That being said, please drop into the #Badge room and Voice Chat on Discord with any questions or comments you might have. This guide assumes you have some experience soldering. If you do not, I highly recommend this tutorial before you begin:
https://www.youtube.com/watch?v=VxMV6wGS3NY

While most of the components of this badge are easy to solder, 5 of the LEDs are surface mount LEDs that must be soldered upside down. This can give even skilled badge makers a hard time. I recommend being patient, and going into this project with the expected difficulty in mind.

Tools you will need:

- **Soldering Iron**
- **Solder**
- **Solder wick / Solder sucker (nice to have for mistakes)**
- **Tweezers**
- **Wire Strippers**
- **Cutting Shears (snips) to cut the component leads**
- **A beer or mixed drink to keep things interesting**

Parts included in each kit:

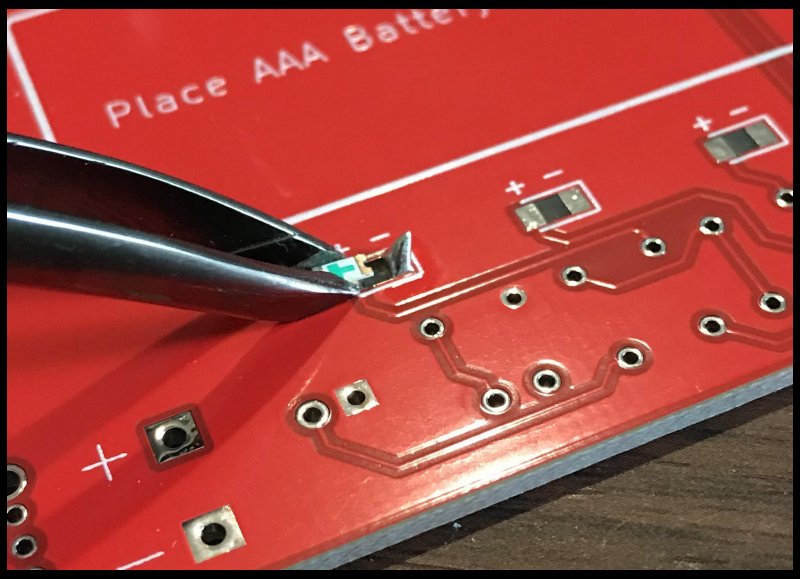
- **1 BBQ themed PCB**
- **1 black lanyard**
- **1 ATTINY45 Microcontroller (This comes preprogrammed with the open source code, but you can reprogram if you want to)**
- **1 8 pin IC socket**
- **6 220 Ohm resistors**
- **1 10k Ohm resistor**
- **1 photoresistor**
- **1 IR LED**
- **1 switch**
- **1 AAA battery pack (with foam tape already applied to the back)**
- **At minimum 5 surface mount LEDs (the badge uses 5, but we include extra in case some are damaged while being soldered)**

1. We are going to start with the 5 surface mount LEDs (the hardest part of the badge). Soldering any surface mount component can be tricky, but these are harder because they are soldered upside down, which lets the LEDs shine through the PCB to the front of the badge.

I have found the easiest way to solder these LEDs is to put a glob of solder on one of the pads then, while keeping the solder hot, use tweezers to push the LED in place.

1a. Let's start by putting a glob of solder on the pad.

1b. Now, you can use tweezers to push the LED in place. While not pictured, you will need to hold the soldering iron next to the pad to keep the solder melted while you push the LED in place.



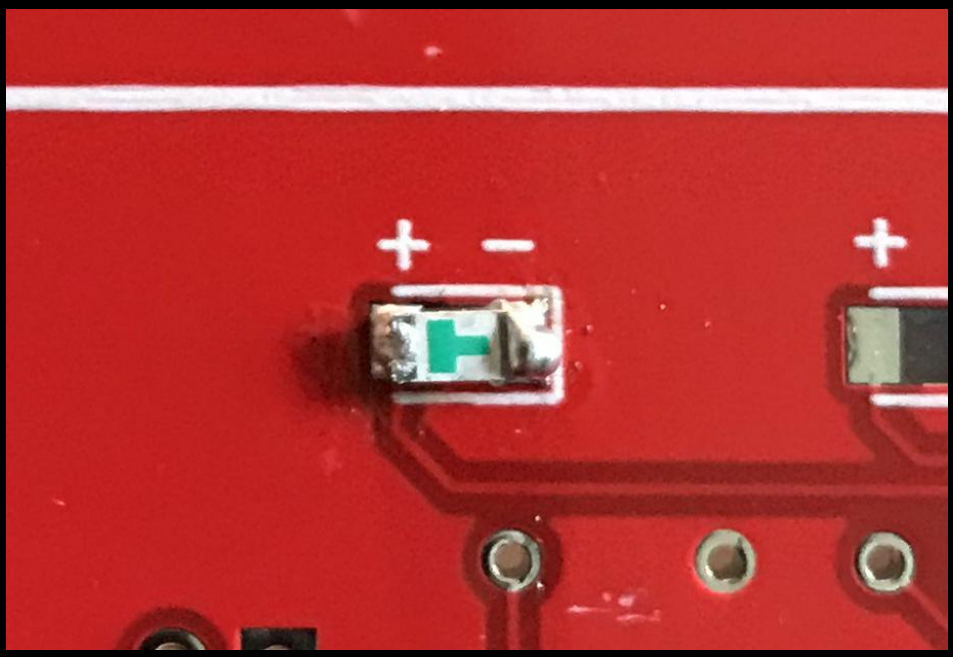
Note: the orientation of the LED. The little green arrow "points" towards the negative pad.

Take your time. If the LED doesn't look centered, you can move it around with the tweezers while keeping the solder hot with your iron.

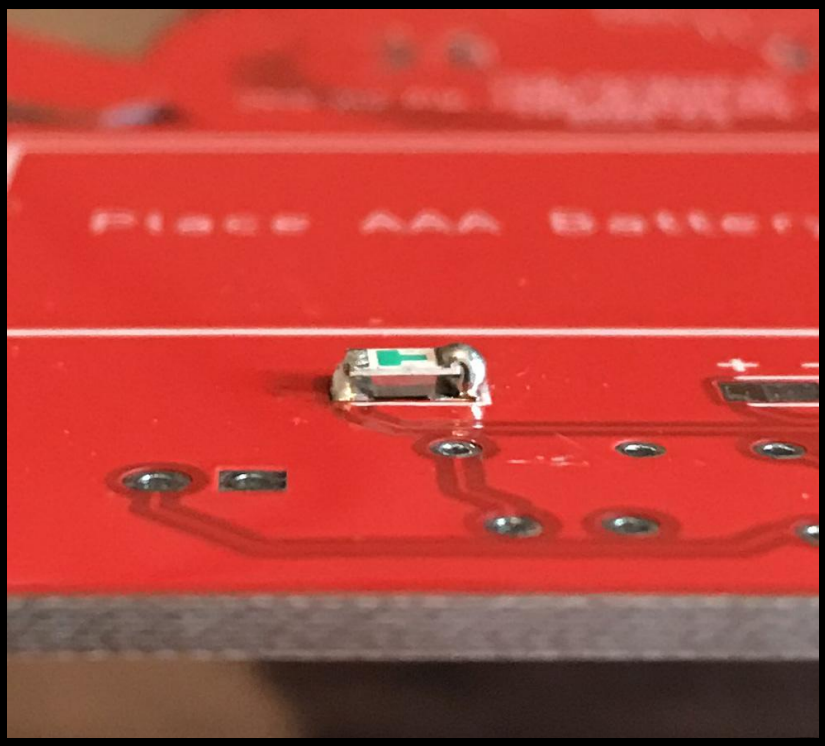
Add more solder if your gob can't reach the metal pad on the LED. Remove solder if you can't get the LED close enough to the pad.

Practice patience and when in doubt, take another sip of your drink.

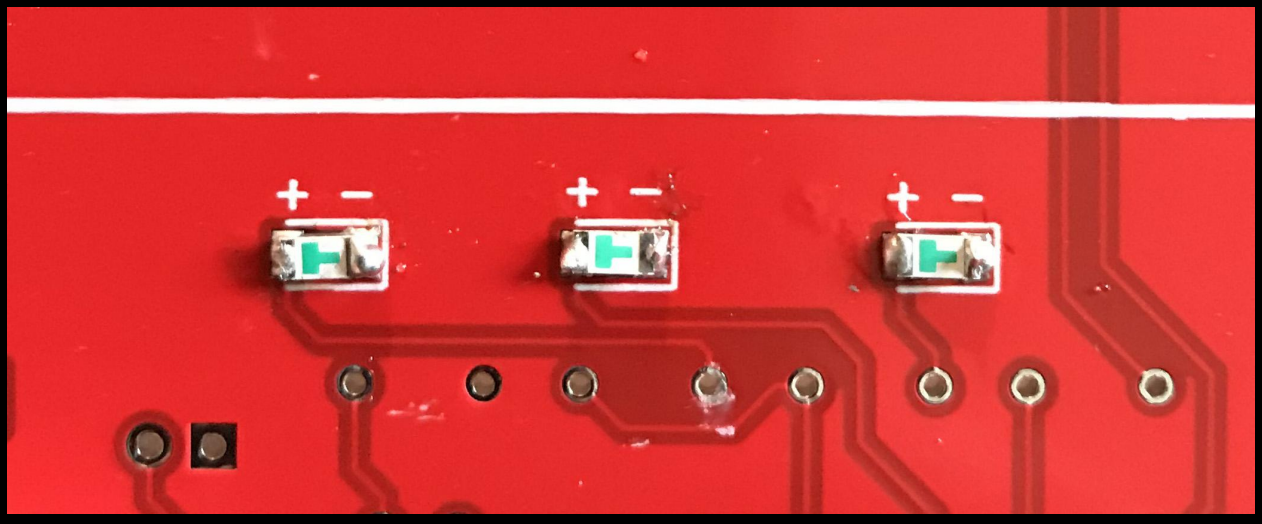
1c. Once the LED is held in place by the one solder connection you can solder the other pad the same as you would any other component, no tweezers needed.



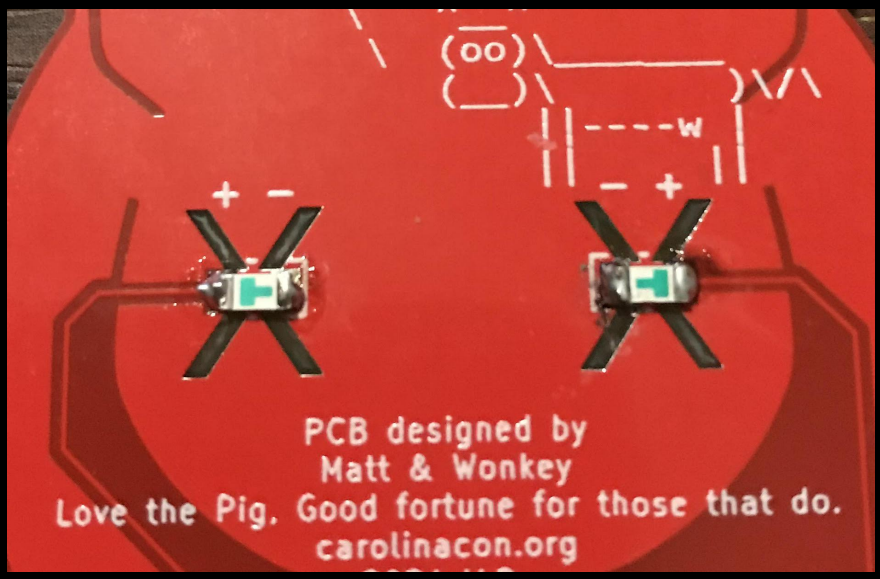
Take a look at a finished LED from the side.



1d. Repeat the process for the 2 remaining LEDs on the bottom of the badge.



2. We repeat the same process for the 2 LEDs on the top of the badge. Note that one of the LEDs is flipped so that the polarity is opposite that of the other LEDs. (This was done to ensure a copper trace is not visible through the pig head from the front of the badge.)



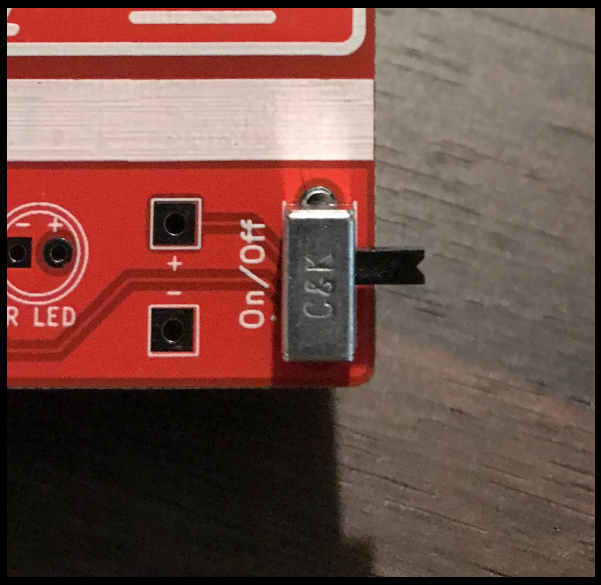
2b. Congrats y'all, the hard part is done! If you have soldering experience, you will find the remaining components are pretty standard, and will just take time to complete.

3. Place the IC socket onto the board. Ensure the semi circle notch is facing the top of the badge.

3a. Flip the board over and solder the pins to the copper pads. You may need to hold the PCB flat to the socket to keep the pins level.

The picture here shows all of the pins soldered in place.

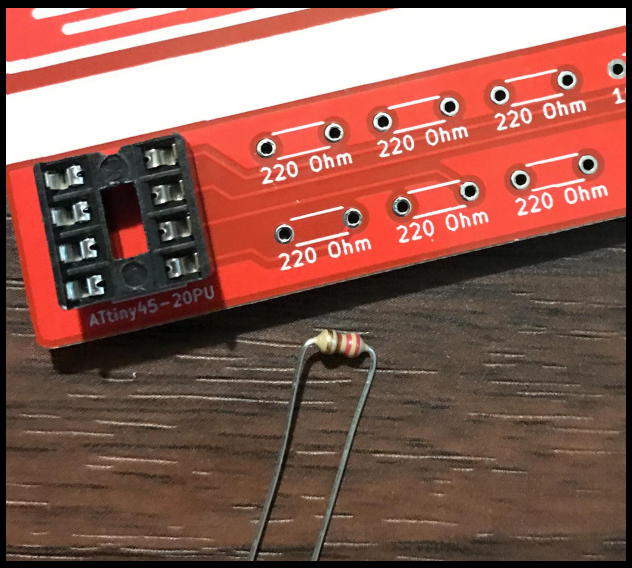
4. Place the switch in place on the PCB, flip the board over, and solder it the same as the IC socket.



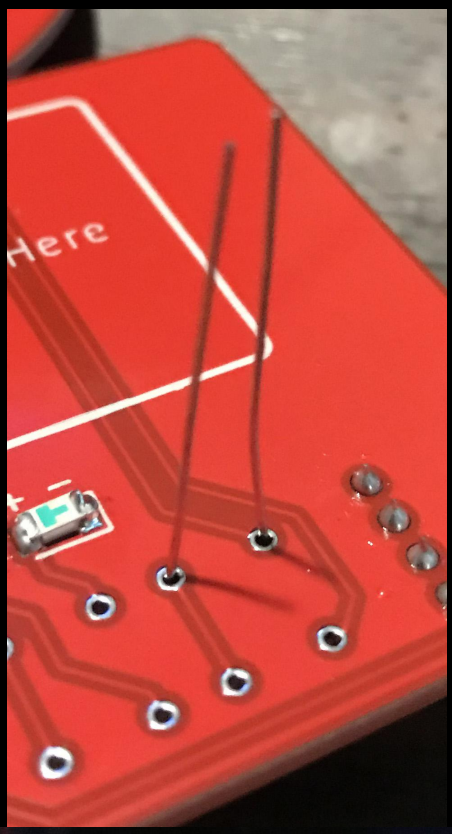
5. Next, we will solder the six 220 Ohm resistors. They don't have polarity, so it does not matter which direction you solder them in.

5a. Bend the leads into a U shape to prep the resistor for the PCB. I recommend trying to place the bends as close to the resistor as you can.

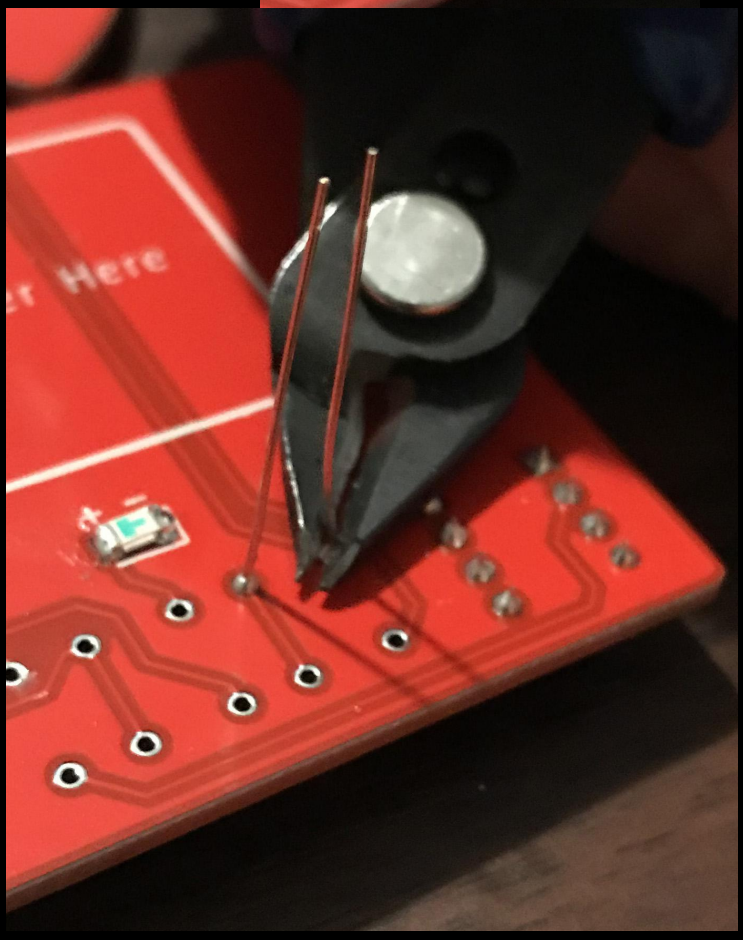
Once the bends are made the resistor can be placed into the PCB.



5b. Flip the board over and solder the leads sticking out.



5c. After the resistor is soldered, cut the leads with the cutting shears (snips). Take caution when cutting them as some snips have the extra feature of shooting the cut leads right into your eyes!



5d. Repeat the process for the 5 remaining 220 Ohm resistors.

6. Now solder the single 10K Ohm resistor the same as the 220 Ohm resistors.

7. The process for soldering the photoresistor is similar to the regular resistors, except that the leads don't need to be bent. Again, this component does not have polarity, so it can be placed in either orientation.

8. The IR LED does have polarity, so it must be soldered in the proper orientation. Through hole LEDs have a longer positive lead, which will go into the positive pad on the right side of the board. (You might also notice that the LED has a flat edge on the negative side, which matches with the PCB silkscreen)

9. Drink break -- Amazing job so far!

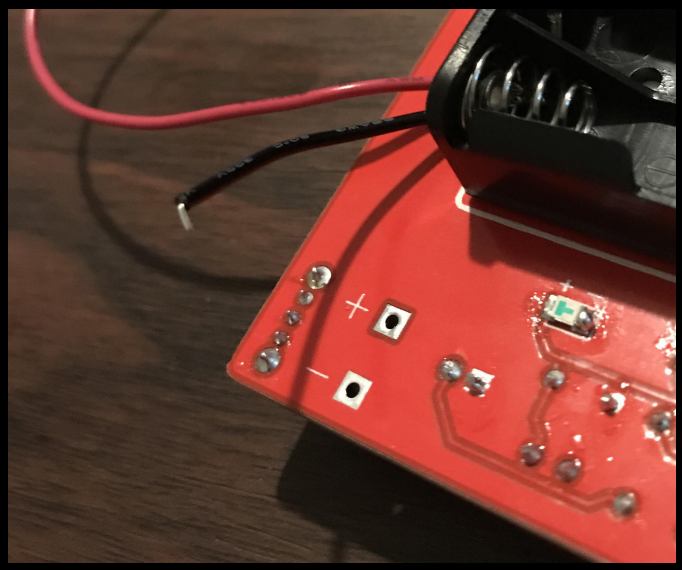
10. Next we will be installing the battery pack onto the back of the PCB. Double sided foam tape has already been placed on the battery pack, so you only need to peel the paper off and stick the battery pack on the PCB.

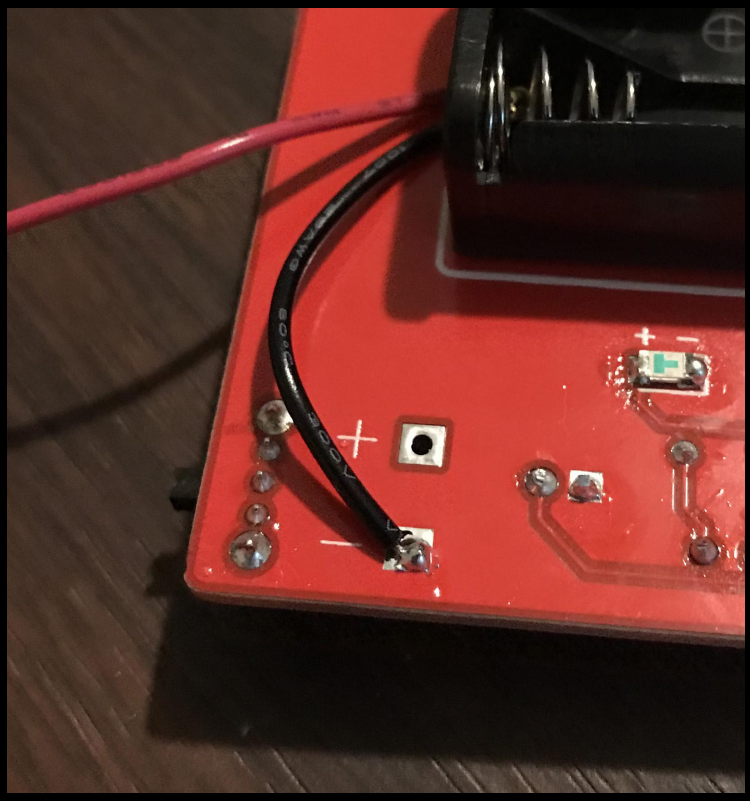
Badge design fun fact: Designing badges exposes us to a ton of weird niche knowledge. We were unhappy with the stickiness of double sided foam tape we used for the CarolinaCon 15 badge. This year we learned how to read the datasheets for 3M adhesives and found out they use kPa to measure tensile strength on their products, which for us just meant we needed a bigger kPa value to buy sticker tape. The more you know. ¯_(ツ)_/¯

10a. Next we are going to strip and solder the battery wires to the badge.

Measure the black wire, which will lead to the negative pad on the bottom left of the badge. Cut and strip the wire to the desired length. Bend the newly exposed wire at a 90 degree angle and solder it to the negative pad.

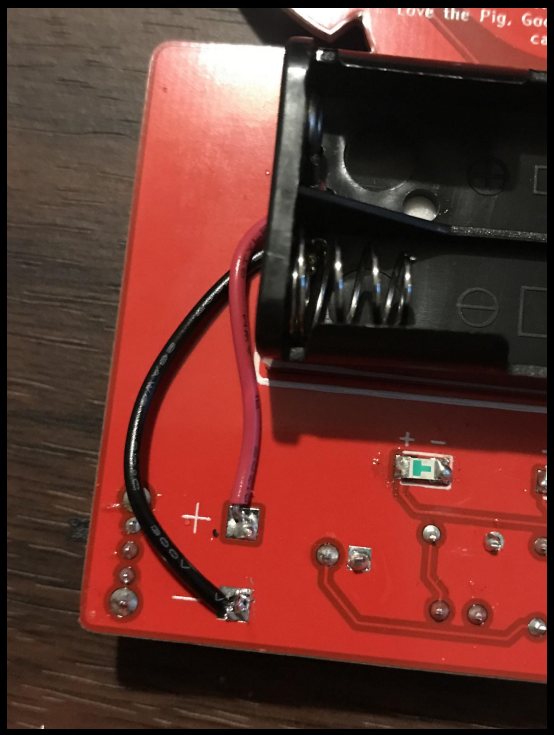
Note: I have found that sometimes it's easiest to place a bit of solder on the wire and then hold it in place with one hand and then hold the soldering iron with your other hand. That way, there is at least a bit of solder already on the wire. When you hold the wire and your iron, you don't have a third hand to hold your solder.





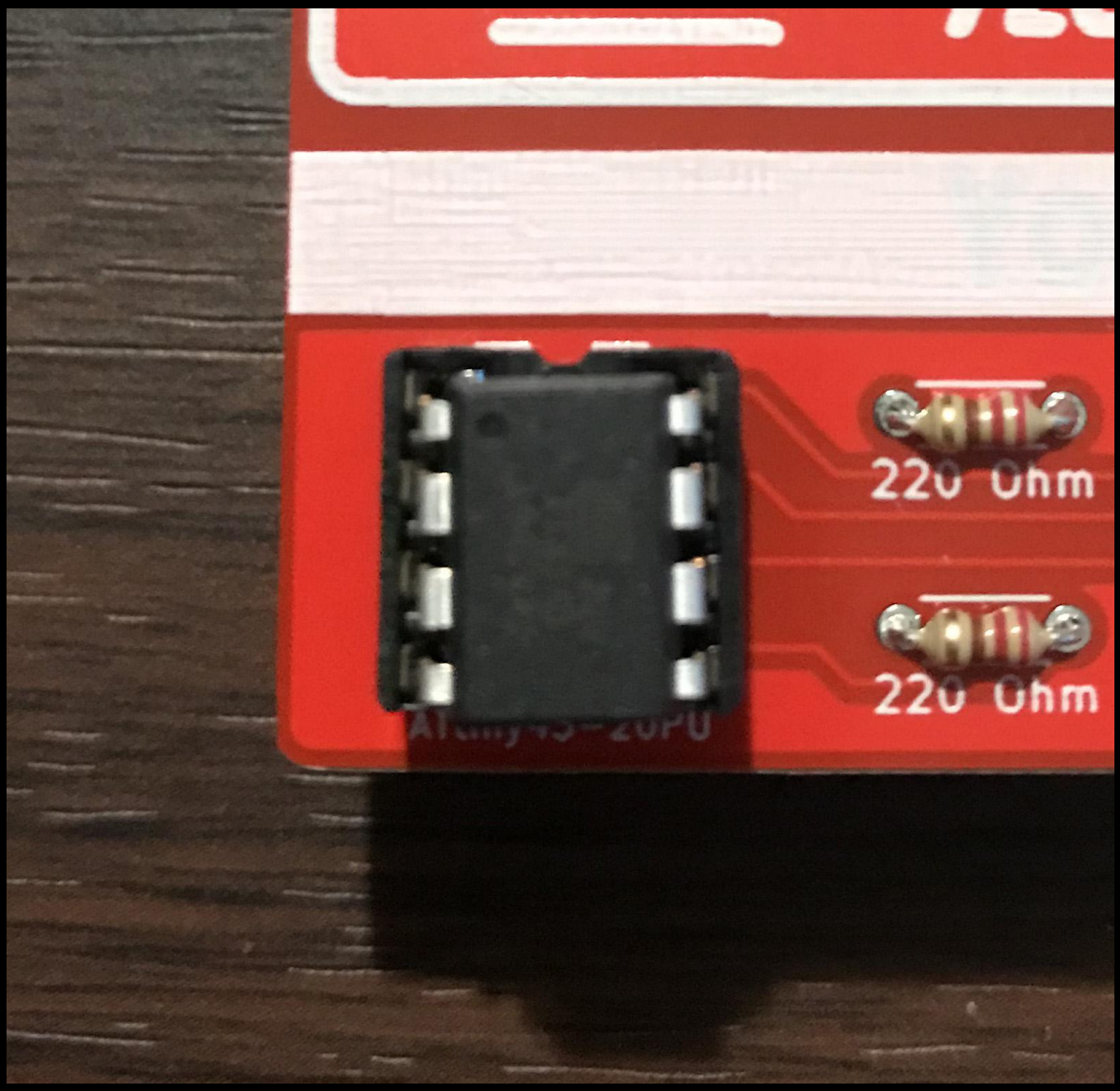
10b. Once the wire is held in place you can place a glob of solder down on the other side of the board.

10c. Repeat the process with the red wire.



11. The last step is to put the ATTINY45 in the IC socket. Ensure the ATTINY is positioned so that the little dot is placed on the top left corner as seen in the image below. You will need to slightly bend the legs inward. (Although not by much).

We have pre-programmed the ATTINY, but encourage you to hack away at it! We've made the code open source, so feel free to take a look to see how we did things! https://github.com/49thSecurityDivision/CarolinaconOnlineBadge



Congratulations y'all! Your badge is finished! Pop in some AAA batteries and watch the LEDs light up the red X's behind the pig's eyes.

When taken into a dark room the bottom LEDs should light up and reveal a hidden message!

The included IR LED can be used to control consumer electronics that accept IR input, namely, TVs and LED strips.

Troubleshooting:

- **Ensure the switch is in the "On" position.**
- **Take a glance at the solder connections to ensure that they look strong and connecting**
- **Check to make sure the orientation of the LEDs on your badge matches what is on the silkscreen and our images.**
- **LEDs are sturdy, but if nothing else appears to be wrong, LEDs can break if they get too hot while being soldered. Replace any bad LEDs with the extras provided.**
- **Don't forget to ask for help in the #Badges Discord channel**

Some words about designing badges:

This is the 3rd badge designed by Matt & Wonkey for CarolinaCon. We actually finished and ordered the final parts and PCBs for the *in person* CarolinaCon 16 (in what would have been 2020). As you likely know, we had to cancel the Con last minute and have made plans to use those badges at our next in person conference.

So, this badge was designed with an online conference in mind. It may not make much sense to have a badge for a fully online con, but everyone loves hardware badges and #badgelife so much we couldn't resist! We have never seen a BBQ

themed badge before, and are happy we get to spread the joy of North Carolina BBQ with people from all over.

When designing this badge, we wanted to try to do something we haven't seen in many other badges. We like the concept of having LEDs shine through the PCB to light up shapes (the X's behind the eyes) and we wanted to have a hidden message revealed when LEDs lit up (the message hidden under the silkscreen).

Our designing process starts with creating vector art in Inkscape. This year we modeled our badge after the conference logo designed by @MarySafroArt (huge shout out for their awesome work!) We converted the logo into the copper, solder mask, and silkscreen layers that PCBs use. We use an Inkscape plugin called svg2henzen that converts our vector art into a format that KiCad can import. Once the art is in KiCad our process for creating the circuit is not super special, but not trivial. Every step of designing a badge is harder and takes longer than expected, but creating art in a restrictive medium, like PCBs, is a unique challenge that we are always excited about.

Well, so long, and thanks for all the fish. Hack for good, y'all!