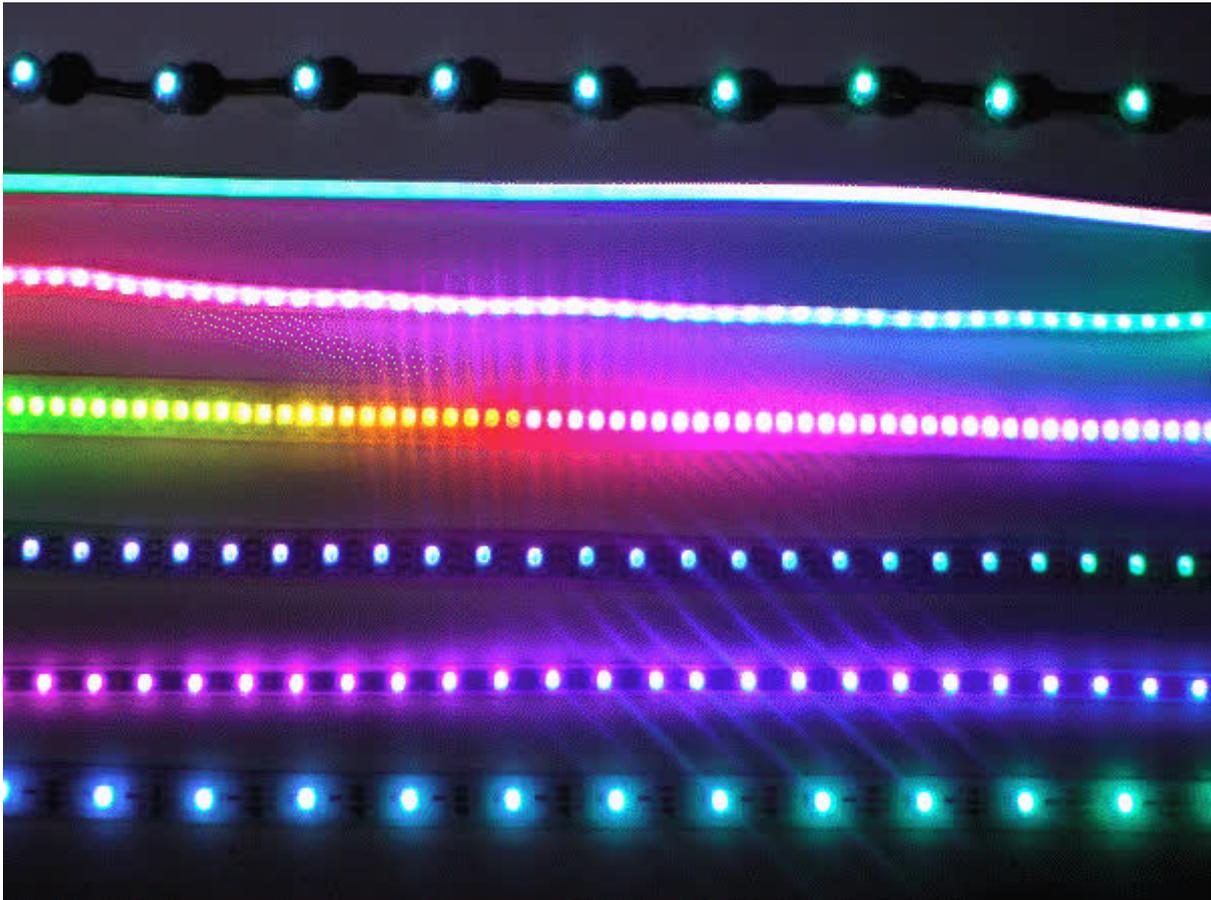




# Make It Glow: How to Solder NeoPixels, A Beginner's Guide

Created by Erin St Blaine



<https://learn.adafruit.com/make-it-glow-how-to-solder-neopixels-a-beginners-guide>

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# Overview

This guide is for beginners who are ready to take the next step in DIY electronics: putting that soldering iron to use to add NeoPixel or other addressable LED lights to your project.

You don't have to be able to solder to use NeoPixels! Here is a beginner tutorial that shows how to use NeoPixels with no soldering: [Make it Glow - Your First NeoPixel Project \(https://adafru.it/KmB\)](https://adafru.it/KmB)

However, there are times when soldering is really the best option. If you want to use [NeoPixel rings \(http://adafru.it/3042\)](http://adafru.it/3042), or [individual pixels \(http://adafru.it/1260\)](http://adafru.it/1260), or create more elaborate or complicated designs with multiple strips, there's really no way to do it without soldering.

The good news: it's not as hard as you think! There are a fair number of tools to acquire, but once you've got your station set up, a whole world of creative possibilities will open up for you.

In this guide, we'll recommend some tools and equipment that every DIY electronics maker should have in their workshop. Then, we'll go over the techniques and skills needed to get a good solder connection, and how to secure your connections so they are sturdy and reliable.

Finally, we'll cover some techniques for repairing broken strips, and troubleshooting help for when your project just won't behave the way you want.

**This guide assumes you're making a fairly small project, with fewer than around 250 NeoPixels and just one NeoPixel strip. Once your projects get more ambitious with more pixels and more strips, dive into the [NeoPixel Überguide \(https://adafru.it/Bej\)](https://adafru.it/Bej) for more advanced techniques.**

Roll up your sleeves, Makers, and let's get started.

## What is a NeoPixel?

NeoPixel is a fancy name for an addressable LED light that can show millions of colors, and also color animations, when you hook them up to a microcontroller and a battery.

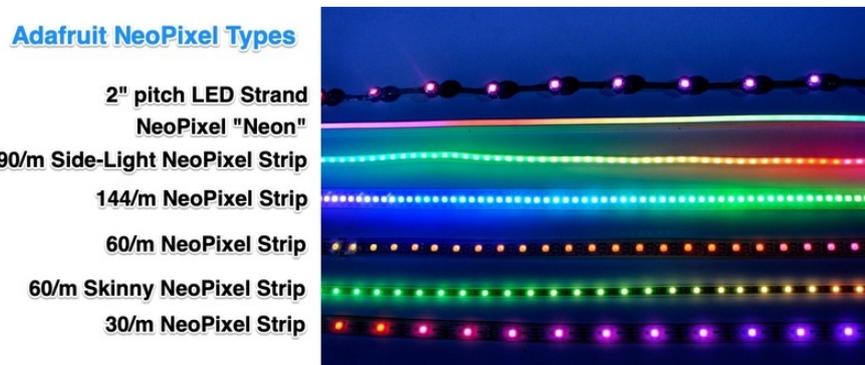
"Addressable" means that every single pixel has its own little brain, so each pixel can show a different color from its neighbors. You may have encountered LED strips that can show all green, or all blue, or even change from one color to the next as a strip -- these are commonly used in everything from fancy architecture to cheap toys you bought on the Internet. NeoPixels are different in that they can show all the colors at once, and can update so fast that they appear to show animations.

## What Kind Should I Get?

There are a lot of options out there. Check out this page of the [NeoPixel Überguide \(https://adafru.it/LaX\)](https://adafru.it/LaX) to learn about the differences between NeoPixel types and their form factors.

This guide will cover soldering NeoPixel strips and rings and pixels and dots, so choose the one that works best with your vision.

If you need bright, pure white lights in your project, use RGBW format. Otherwise, use RGB. And if you need really tight timing, say, for [persistence-of-vision \(POV\) projects \(https://adafru.it/LaY\)](https://adafru.it/LaY), you'll want to use [DotStar LEDs \(https://adafru.it/zbD\)](https://adafru.it/zbD) instead of NeoPixels. Most costume or home-DIY projects work great with NeoPixels, which are a little less expensive and a bit easier to hook up, since they have just 3 connections instead of 4.



## What Else do I Need?

You'll also need a **microcontroller** and a **power source** to make the pixels work.

### Microcontroller

Which to get depends on your project. If you're not sure, get a [Circuit Playground Express \(http://adafru.it/3333\)](http://adafru.it/3333). This is my favorite controller for smaller DIY type

projects like costumes or artwork. It's really easy to program, there are lots of code samples available so you can just copy-paste effects, and it has sensors, which means you can make your artwork interactive.

If you're on a budget, and don't need fancy motion sensors, sound sensors, or other interactivity-enablers, get a [Gemma M0 \(http://adafru.it/3501\)](http://adafru.it/3501).

## Power Sources

If your project will be stationary, plug your microcontroller in to the wall or a USB hub with its onboard USB port.

If your project is mobile, like a costume, get one of these [5v AAA battery packs \(http://adafru.it/727\)](http://adafru.it/727). This is a great option because it's got an on/off switch, which is very handy.

Here's a kit that has a Circuit Playground, a USB cable and a battery pack! Score.



### [Circuit Playground Express - Base Kit](https://www.adafruit.com/product/3517)

It's the Circuit Playground Express Base Kit! It provides the few things you'll need to get started with the new <https://www.adafruit.com/product/3517>

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# Your Soldering Kit

## Soldering Essentials

Here are the essentials. It's a lot of stuff to buy at first, but good tools will last you for years, and you're worth it. Spending a few dollars on yourself to get good equipment will save you so much heartache down the road.

Use the good wire! Cheap wire breaks, especially in wearables. Yes, it's a couple dollars more, but your project will work for 10x as long (I wish someone had convinced me of this when I was first getting started).

30W Soldering Iron. Get a good one! You won't be sorry.

**1 x Soldering Iron**

<https://www.adafruit.com/product/180>

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30W Soldering Iron. Get a good one! You won't be sorry.

**1 x Solder**

<https://www.adafruit.com/product/145>

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Rosin-core solder

**1 x Soldering Iron Stand**

<https://www.adafruit.com/product/150>

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Don't burn your table!

**1 x Solder Wick / Braid**

<https://www.adafruit.com/product/149>

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For fixing mistakes

**1 x Flush Cutters**

<https://www.adafruit.com/product/152>

---

This is my favorite tool in the world! Maybe get two.

**1 x Wire Strippers**

<https://www.adafruit.com/product/147>

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Get the good ones!

**1 x Heat Shrink**

<https://www.adafruit.com/product/1649>

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Multicolored and multi-sized

**1 x Clear Heat Shrink**

<https://www.adafruit.com/product/1020>

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Perfect for sealing up the ends of NeoPixel strips

**1 x Alligator Clips**

<https://www.adafruit.com/product/4100>

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Small alligator clips for testing

**1 x Red Wire**

<https://www.adafruit.com/product/2513>

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Silicone stranded wire (noodle wire) in red

**1 x White Wire**

<https://www.adafruit.com/product/2518>

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Silicone stranded wire (noodle wire) in white

**1 x Black Wire**

<https://www.adafruit.com/product/2517>

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Silicone stranded wire (noodle wire) in black

## Microcontrollers for Testing

Even if you've got a different microcontroller in mind for your final project, having a [Circuit Playground Express \(http://adafru.it/3333\)](http://adafru.it/3333) and/or [Gemma M0 \(http://adafru.it/3501\)](http://adafru.it/3501) on hand for testing your pixels is a great idea. You can hook either board up with alligator clips, so even if your final code isn't ready, you can still test your solder joints.

I always keep a Circuit Playground Express near my workstation with simple test code loaded onto it, so I can test connections as I build.

**1 x [Circuit Playground Express](https://www.adafruit.com/product/3333)** <https://www.adafruit.com/product/3333>  
Circuit Playground Express - Your LED strip's "brain"

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**1 x [Gemma M0](https://www.adafruit.com/product/3501)** <https://www.adafruit.com/product/3501>  
Gemma M0 - Get one for your project and one to keep as a tester!

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**1 x [USB Cable](https://www.adafruit.com/product/4148)** <https://www.adafruit.com/product/4148>  
Trust Your Cable! Get a new one, you'll know it works.

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## Nice-to-Have Items

Items in this section are not 100% essential, but can be super helpful if you're tricking out your workstation. I've also added a few things that I'm grateful to have on-hand since they get used in so very many projects.

**1 x [Multimeter](https://www.adafruit.com/product/2034)** <https://www.adafruit.com/product/2034>  
Oh-so helpful for troubleshooting

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**1 x [Third Hand](https://www.adafruit.com/product/291)** <https://www.adafruit.com/product/291>  
Sometimes you need one. With magnifier for those tiny solder pads.

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**1 x [Soldering Mat](https://www.adafruit.com/product/3536)** <https://www.adafruit.com/product/3536>  
Keep your tabletop nice

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**1 x [Solder Sucker](https://www.adafruit.com/product/148)** <https://www.adafruit.com/product/148>  
Extra help for mistakes

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**1 x [Solid-core Wire](https://www.adafruit.com/product/290)** <https://www.adafruit.com/product/290>  
For making solid connections that don't need to flex

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**1 x [JST Connector with On Off Switch](https://www.adafruit.com/product/3064)** <https://www.adafruit.com/product/3064>  
In case you want to put your battery further from your controller

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**1 x [AAA Batteries](https://www.adafruit.com/product/3520)** <https://www.adafruit.com/product/3520>  
Don't run out!

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More power sources are always a good thing.

1 x [USB Battery Pack](https://www.adafruit.com/product/1959)

<https://www.adafruit.com/product/1959>

More power sources are always a good thing.

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1 x [Pliers](https://www.adafruit.com/product/146)

<https://www.adafruit.com/product/146>

Always come in handy!

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## Round Out your Station

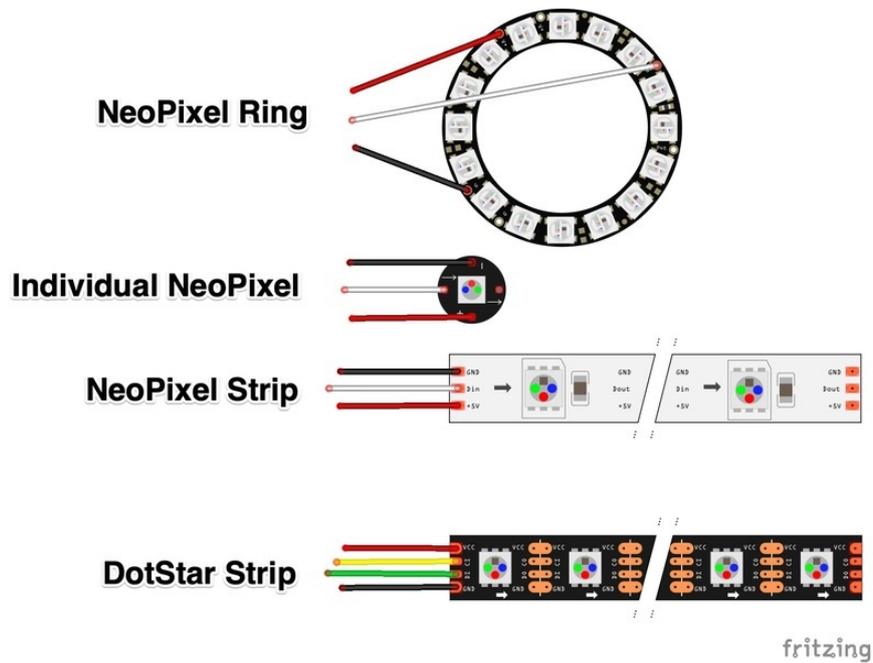
I have a few other tools on my workstation that I use in almost every project. Most of these can be found at your local hardware store or craft store.

- Hot glue gun -- find one with a low AND high temperature setting
  - Lots and lots of glue sticks to fit your glue gun
  - 99% Isopropyl alcohol -- great for cleanup, de-sticking hot glue or for electronics repair
  - Cotton swabs for applying 99% alcohol
  - Heat Gun -- Very useful for melting heat shrink or re-melting hot glue
  - A good steady work light. Mine has a magnifying glass built-in.
- 

## Techniques

This section goes into nitty gritty details about soldering NeoPixel strips, rings, and wire connections.

We'll show you how to splice and solder wires to connect up your microcontroller, and how to solder directly to the pads on the strip. We'll also cover connecting two strips end-to-end to lengthen them.



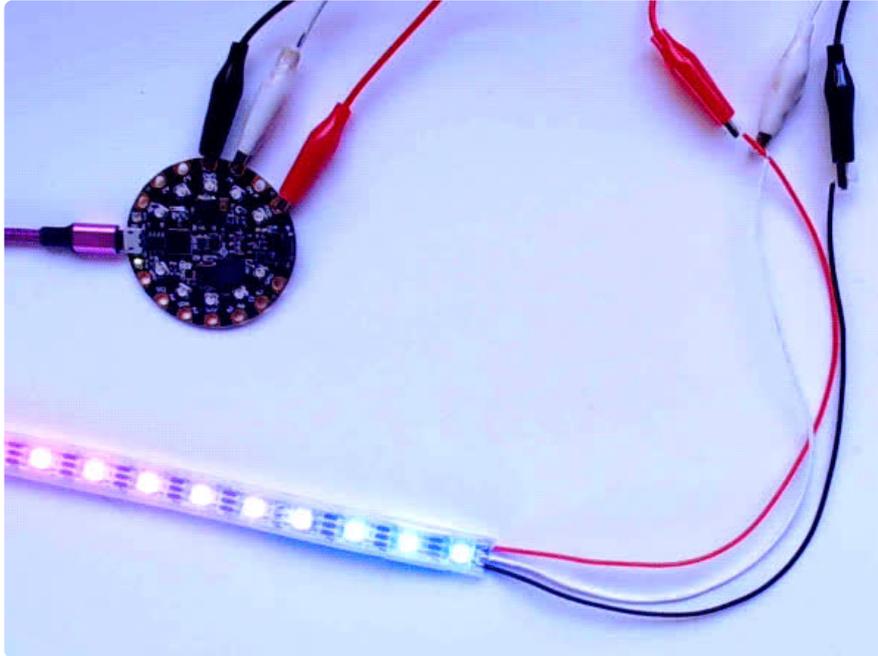
**5V (red wire)** and **G (black wire)** are the power pads. You can connect wires to any pixel in the strip on these two pads and the whole project will get power. Power flows both ways along the strip. This is handy to know! If you damage the pad you're soldering to (we've all done it, no worries mate) then you can just solder the **5V** or **G** wires to a different pixel.

**IN** and **OUT (white wires)** are a bit less promiscuous. These are the data pins, and data must flow from the microcontroller to the **IN** pad. No exceptions -- the strip will simply not work otherwise. If you want to add another strip or ring onto your project, solder from **OUT** on the first strip to **IN** on the second.

If your strip has a fourth solder pad, it's likely that you've got a DotStar strip and this is the **CLK** pin. Treat it like a data pin -- solder from the **IN** end.

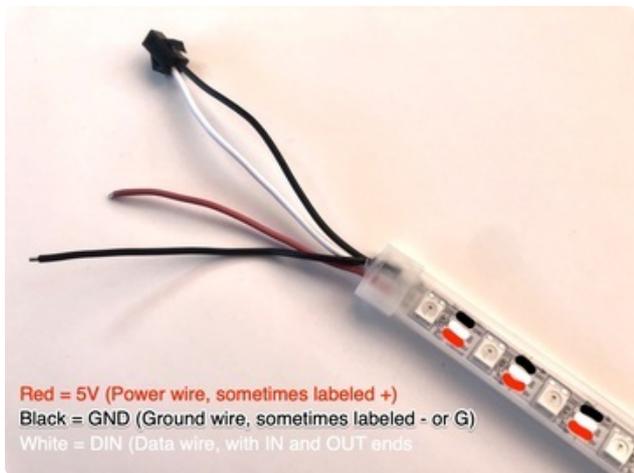
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# Soldering Strips



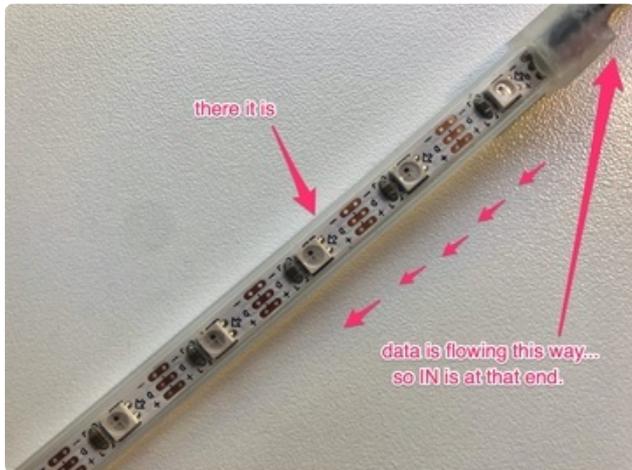
NeoPixel strips have three copper solder pads between each pixel. You can cut the strip through any of the copper pads to get the length you want.

## Step 1: Identify Your Solder Pads



1. **5V** (or sometimes **+**) -- a **RED** wire comes pre-soldered to this pad.
2. **G** (or sometimes **GND**) -- a **BLACK** wire comes pre-soldered to this pad.
3. **IN / OUT** (or sometimes with arrows) -- a **WHITE** wire comes pre-soldered to this pad, and often a female JST connector for **IN** and a male JST connector for **OUT**.

## Step 2: Find the IN End

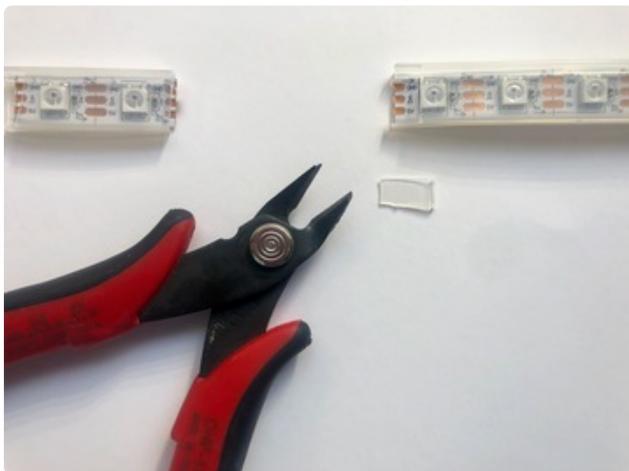


Now that you've identified the three different pads, find the end of the strip marked **IN**. If there are little arrows, they'll be pointing away from the **IN** end and toward the **OUT** end.

We'll solder all three wires to the **IN** end.

If your strip is brand new, it probably has wires and a connector already soldered to one or both ends. Take a look at the [Connecting Wires](#) page (link in the sidebar) if you want to use these.

## Step 3: Expose the Pads



Use your flush cutters to carefully cut through the center of the copper pads, "upstream" of your first pixel. Then, trim out a window in the silicone casing so it's out of your way.

## Step 4: Heat Shrink

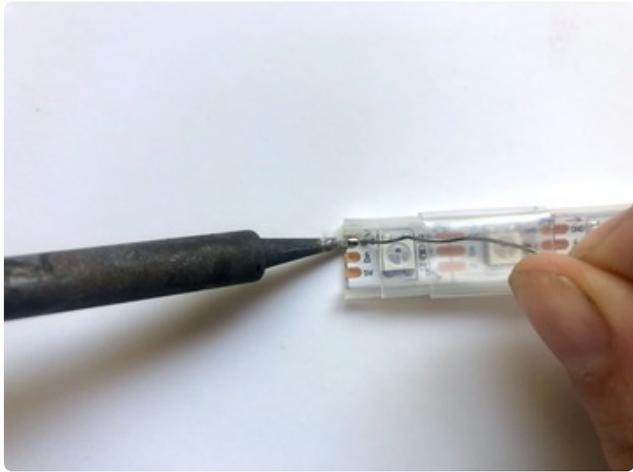


Cut about 3/4 inch of clear heat shrink tubing. Slide it onto your strip and pull it down past exposed soldering pads a bit so it's out of your way. Don't shrink it down yet, just get it in place. When we're done soldering, we'll use this to seal up our connections so they're bulletproof.

## Step 5: Tin the Pads

Turn on your soldering iron and wait until it's fully heated. If it has a temperature gauge, set it to 750 degrees. Otherwise, just wait about 3-5 minutes so you can strike while the iron is hot.

While you're waiting, get the little sponge in your soldering iron stand wet so you can clean off the tip of your iron. Go ahead and clean it off now, once your iron is hot. It's easier to solder with a clean iron.



Unspool a bit of solder. Touch one of the copper pads with your soldering iron to heat it up. Touch the solder to the copper pad at the same time. Once the copper is hot enough, it will melt the solder which will then flow onto the pad and cover it in liquid metal.

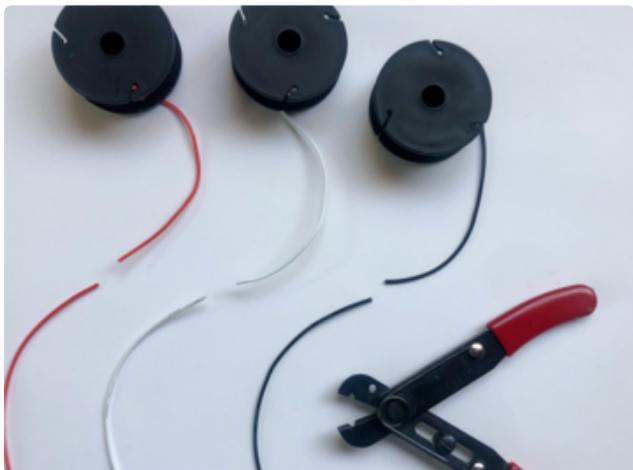
Once this happens, lift your soldering iron away and clean off the tip with the sponge on your stand.

Repeat with the other pads. They should look shiny and have a nice dome-shape when you're done.

If you'd like more help with soldering, [see this guide for all the details \(https://adafruit.it/drl\)](https://adafruit.it/drl).

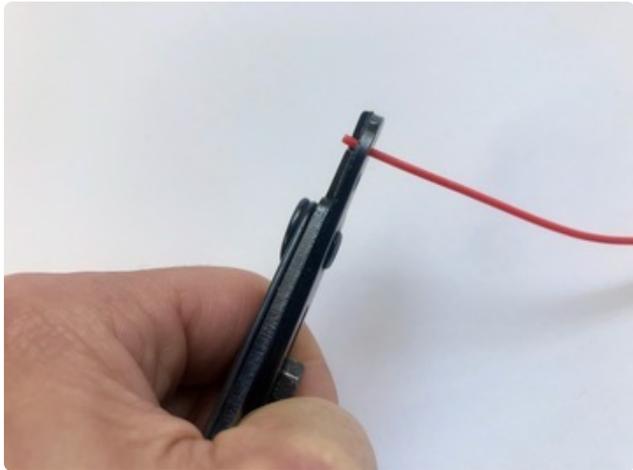


## Step 6: Prepare your Wires



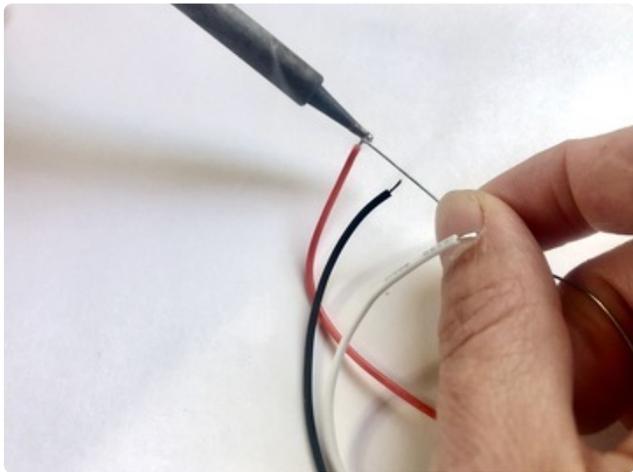
Unspool and cut three wires of about equal length in red, black, and white. These will connect to your microcontroller, so think about how far you want to place your controller from the pixel strip and before cutting them to length.

Your data signal will start to degrade if the wires are more than about 3 feet long, so keep them shorter than that.



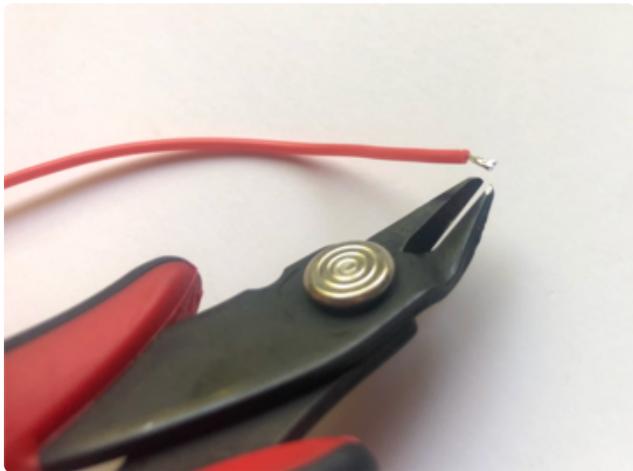
Use your wire strippers to strip a tiny bit off the end of each wire -- no more than 1/16" / 2mm. This will attach to the copper pad so it's helpful to strip just enough wire to sit on the copper without hanging over.

### Step 7: Tin your Wires



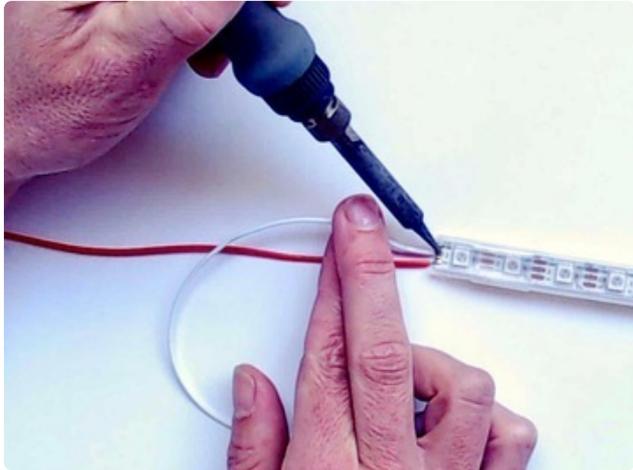
Bend your wires up so they're away from your work surface a bit, or use a [third hand](http://adafru.it/291) to hold them steady. Give the ends a twist to be sure all the little wire strands are stuck together.

Heat the exposed wire with your soldering iron, and touch your solder to the wire at the same time. The solder will melt and flow along the wire just a little bit so it gets coated. Do this for all three wires.



If you end up with a ball of solder on the tip of the wire, snip it off with your flush cutters.

## Step 8: Solder Wires to Pads

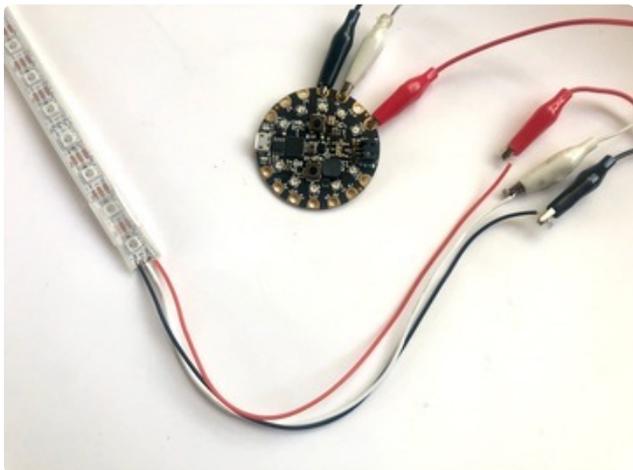


Place your tinned wire right on top of its corresponding tinned pad: red goes to **5V**, white to **DIN**, and black to **G**.

Hold the wire on top of the pad. Touch the soldering iron to both the wire and the pad at the same time, to melt the tinning on both. If all goes well, the solder will melt and flow together, and you'll end up with a beautiful shiny joint.

Repeat with the other two wires, being sure to keep each copper pad self-contained and not touching the other pads.

## Step 9: Test Your Strip



Before we seal up our connections, it's always important to test the strip to be sure it's working. Chasing down a bad solder joint in the middle of a complicated project can be a nightmare -- much better to catch any mistakes early.

Strip about 1/4" of shielding off the free end of your three wires. Get out your alligator clips and hook them up to the color-corresponding wires, then attach the other end of the clips to your microcontroller. If you're using a Circuit Playground Express, hook red to **VOUT**, white to **A1**, and black to **G**.

If you haven't done so yet, upload some test code to your microcontroller. Here's some test code you can use with the Circuit Playground Express or a Gemma M0 that will run a rainbow along your strip if you attach it to pin **A1**.

[Test Code for Circuit Playground](#)

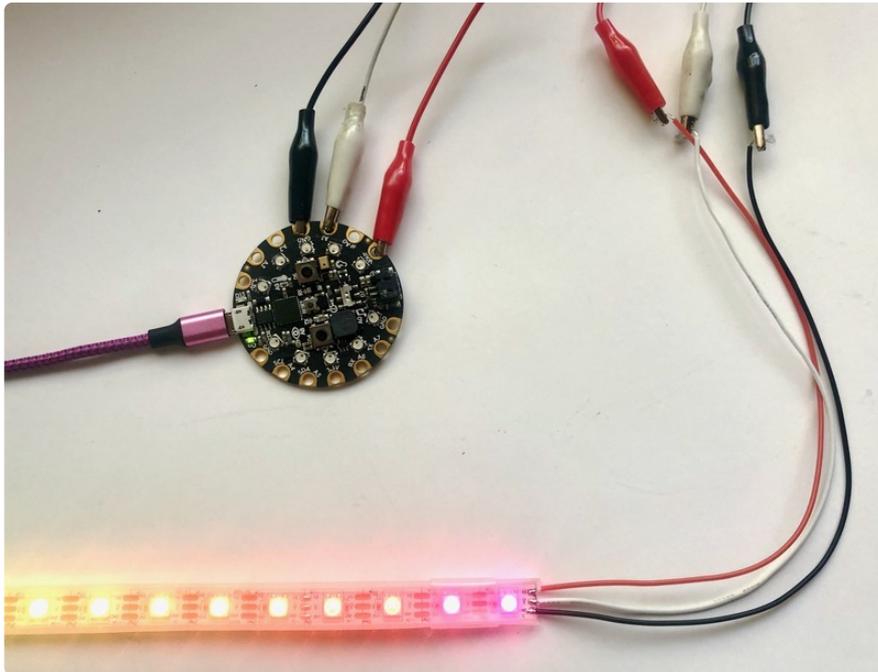
<https://adafru.it/KQB>

## Test Code for Gemma M0

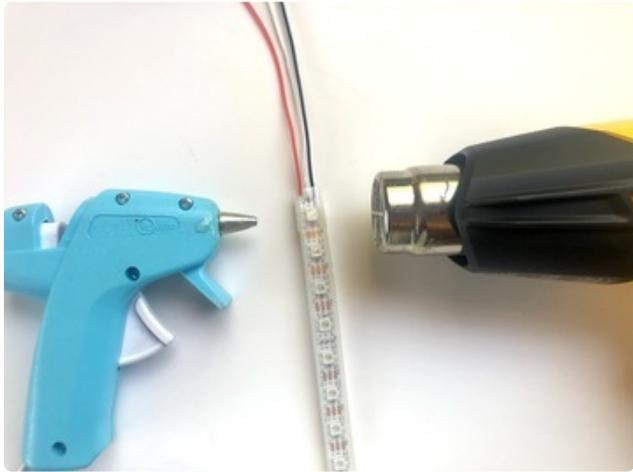
<https://adafru.it/KQC>

1. Download the appropriate UF2 file
2. Plug your microcontroller into your computer with a good USB cable. The lights on the face will turn green. If they don't, click or double-click the tiny "reset" button in the center of the board until they do.
3. A drive will appear on your computer called **CPLAYBOOT** (for Circuit Playground) or **GEMMABOOT** (for Gemma M0). Drag the file you downloaded onto this drive. You're done!

If you're having trouble, [head over to the Circuit Playground guide \(https://adafru.it/ECU\)](https://adafru.it/ECU) to get things working.

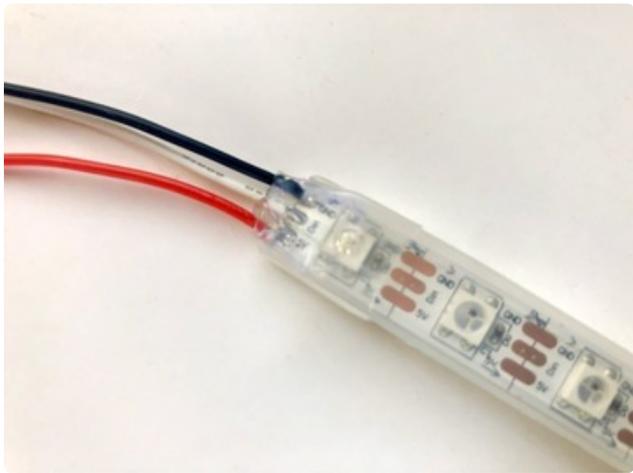


## Step 10: Seal it Up



Hooray, your strip is working! Let's make sure it doesn't break.

Slide that clear heat shrink down until it closes the little "window" you cut in the silicone casing. Squirt a little bit of hot glue inside the heat shrink, then use a heat gun to shrink the heat shrink while the hot glue is still wet.

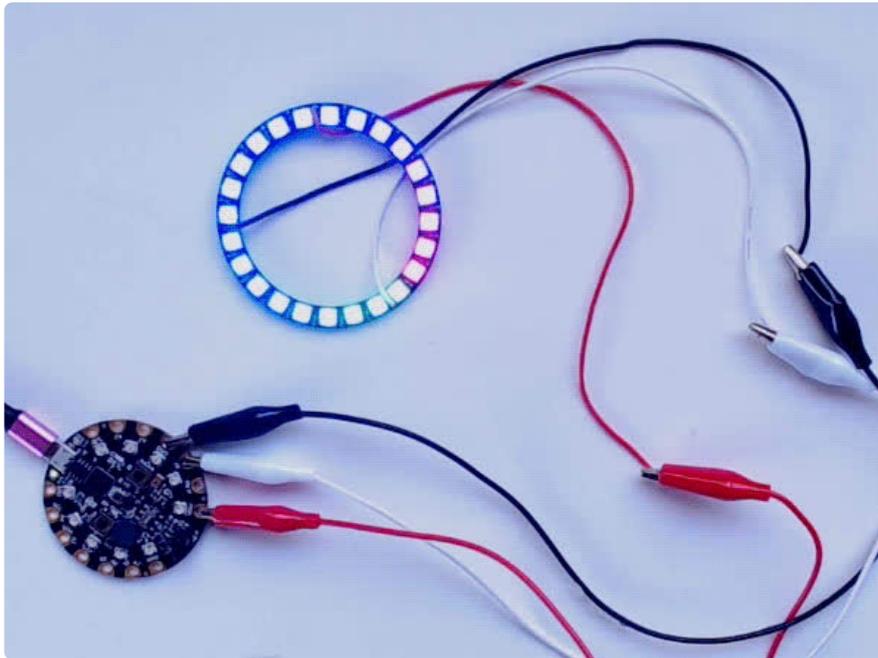


Once the whole assembly cools, your shiny new solder joints will be fully encased in plastic, waterproof, and virtually unbreakable.

If you ever need to open the strip up again, for any reason, it's easy to do. Slide your flush-cutters up under the heat shrink and cut it open as far as you can. Then, pour a little 99% isopropyl alcohol onto the hot glue and connections. After a couple seconds, the hot glue will release and you'll be able to pull it free without damaging your solder joints.

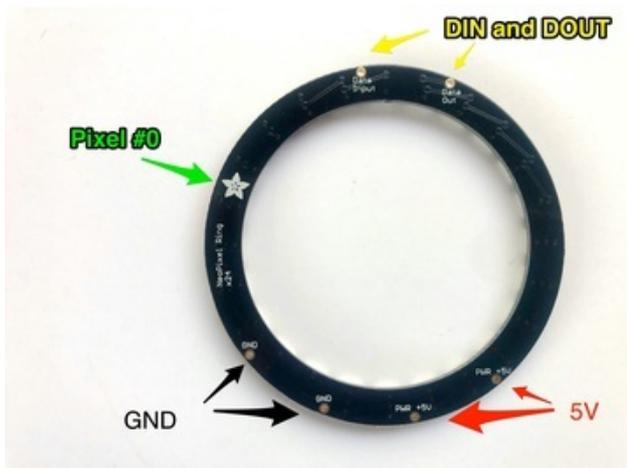
It's like an "undo" button for glue! Hot glue is the best.

# Soldering Rings



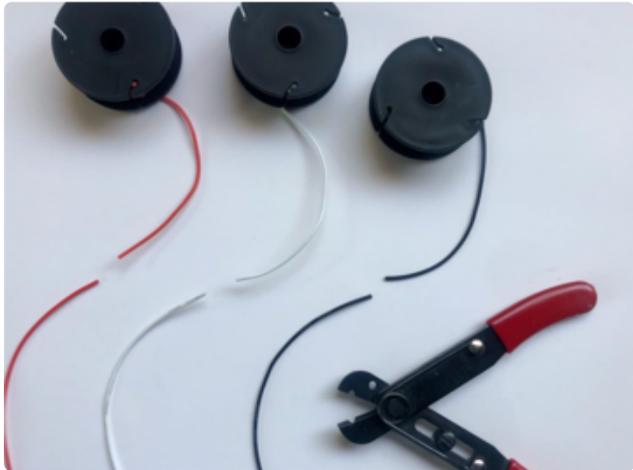
NeoPixel rings and pixels have solder holes spaced out along the circumference of the ring. First we'll solder one ring, then we'll talk about how to chain them together.

## Step 1: Identify Your Solder Pads



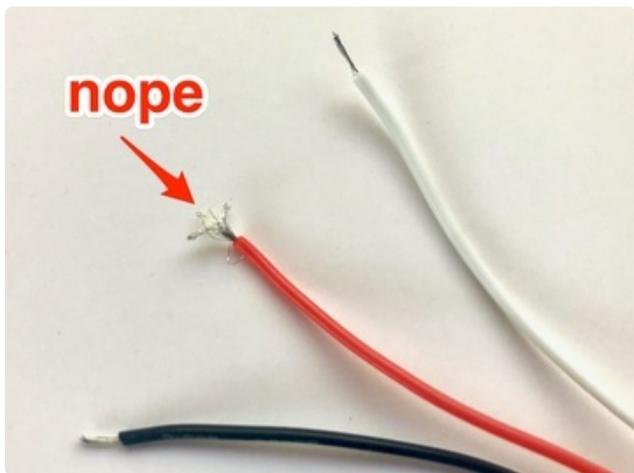
1. **5V** (or sometimes +) -- larger rings have two connections, smaller rings have one
2. **G** (or sometimes **GND**) -- larger rings have two connections, smaller rings have one
3. **Data IN & Data OUT**

## Step 2: Prepare your Wires



Unspool and cut three wires of about equal length in red, black, and white. These will connect to your microcontroller, so think about how far you want to place your controller from the pixel strip and before cutting them to length.

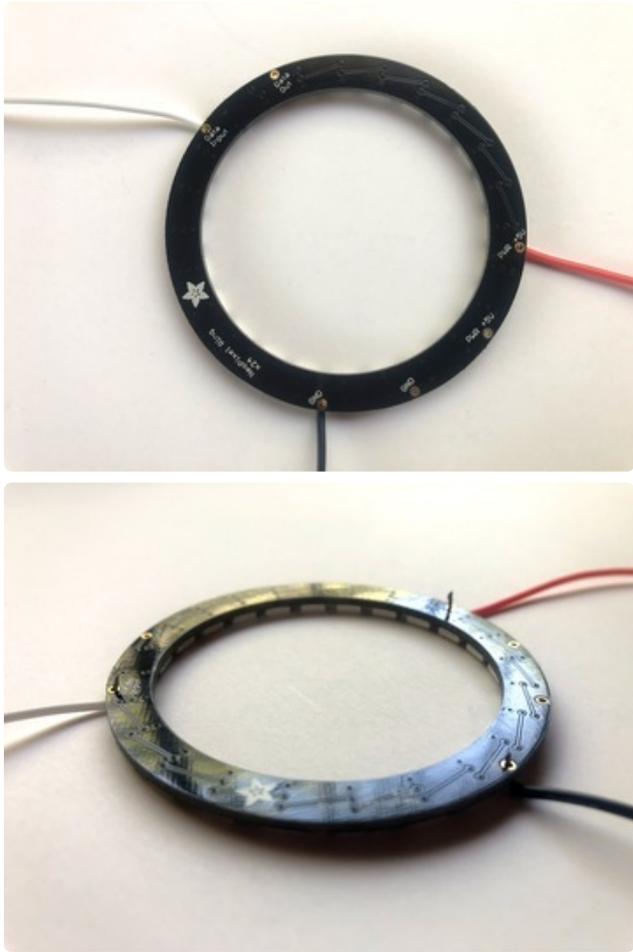
Your data signal will start to degrade if the wires are more than about 3 feet long, so keep them shorter than that.



Use your wire strippers to strip about 1/8" of shielding off the end of the wires -- enough to make it all the way through the hole and out the other side.

Give the exposed wires a twist with your fingers to make sure no tiny little strands are poking out. Make it as neat and tidy as you can. Messy wires are not your friend.

### Step 3: Insert Wires

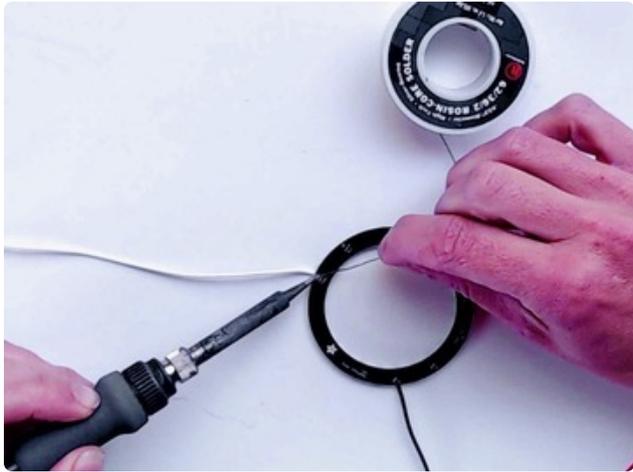


Bend the tips of the stripped wires 90 degrees. Place your NeoPixel ring face down so you can see the markings clearly. Slip the wires through the ring from the front to the back: red to **5V**, white to **Data IN** and black to **GND**. Make sure all the little strands make it through the holes.

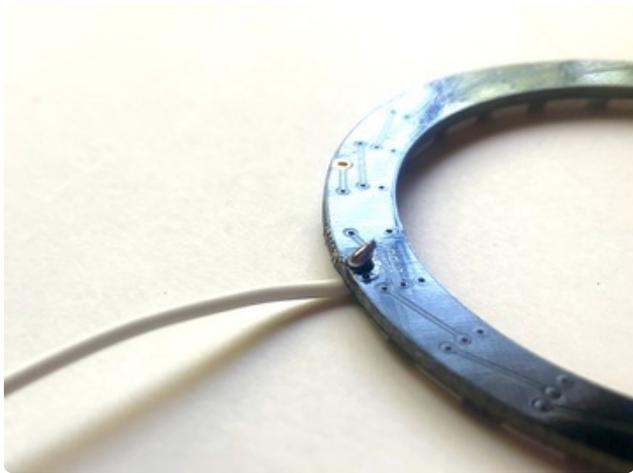
### Step 4: Solder

Turn on your soldering iron and wait until it's fully heated. If it has a temperature gauge, set it to 750 degrees. Otherwise, just wait about 3-5 minutes so you can strike while the iron is hot.

While you're waiting, get the little sponge in your soldering iron stand wet so you can clean off the tip of your iron. Go ahead and clean it off now, once your iron is hot. It's easier to solder with a clean iron.



Unspool a bit of solder. Touch the tip of the soldering iron to the copper pad and also to the wire at the same time. Wait a couple seconds for everything to heat up. Then, touch the solder to the wire and copper pad. The solder will start to melt and flow along the wire and pad, creating a shiny little "hershey's kiss" shaped blob.



Once this happens, lift your soldering iron away and clean off the tip with the sponge on your stand.

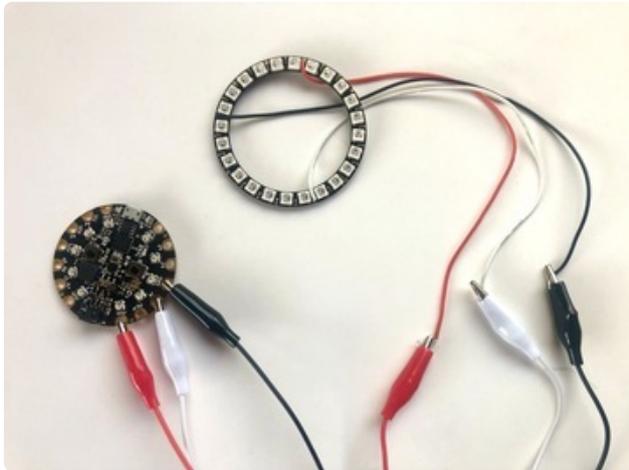
Repeat with the remaining wires.

If your solder blob is really tall, it's fine to trim it down a little bit with your flush cutters.

You may look at this and think it looks backwards -- won't the wires be showing on the front of the project if we hook it up front-to-back?

It's true that the wires are slightly more visible this way, but since the spacing is so tight it's likely that you could damage the pixels if you try to squeeze the soldering iron between them on the front of the ring. Once the lights are on the wires won't be noticeable! So do it front-to-back if you can.

## Step 5: Test Your Ring



Grab your alligator clips and your testing microcontroller. Clip the red wire to **VOUT**, the white wire to **A1** and the black wire to **G**. Make sure the alligator clips are not touching each other and that your connections are firm.

If you haven't done so yet, upload some test code to your microcontroller. Here's some test code you can use with the Circuit Playground Express or a Gemma M0 that will run a rainbow along your ring if you attach it to pin **A1**.

[Test Code for Circuit Playground](https://adafru.it/KQB)

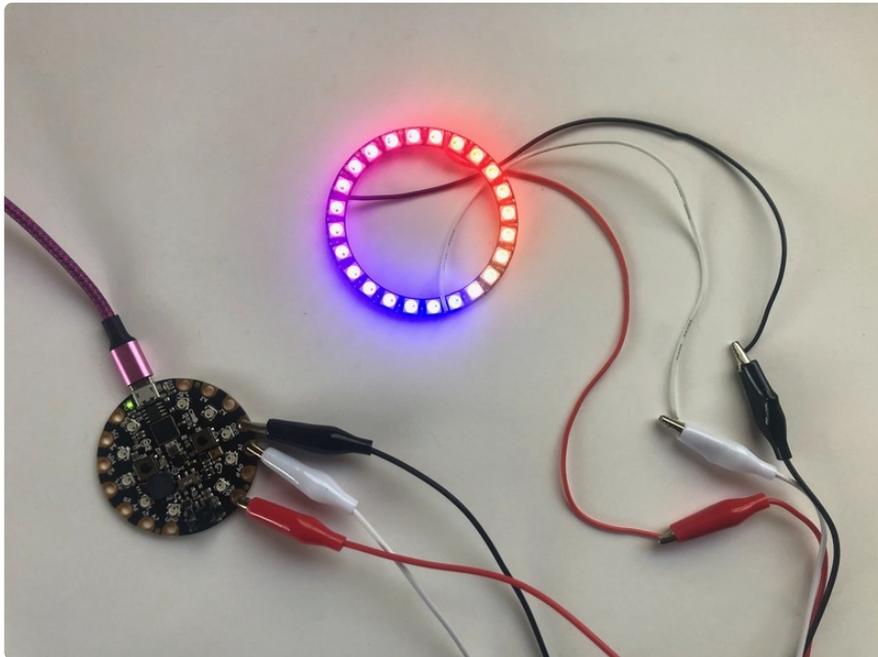
<https://adafru.it/KQB>

[Test Code for Gemma M0](https://adafru.it/KQC)

<https://adafru.it/KQC>

1. Download the appropriate UF2 file
2. Plug your microcontroller into your computer with a good USB cable. The lights on the face will turn green. If they don't, click or double-click the tiny "reset" button in the center of the board until they do.
3. A drive will appear on your computer called **CPLAYBOOT** (for Circuit Playground) or **GEMMABOOT** (for Gemma M0). Drag the file you downloaded onto this drive. You're done!

If you're having trouble, [head over to the Circuit Playground guide \(https://adafru.it/ECU\)](https://adafru.it/ECU) to get things working.



## Adding More Rings

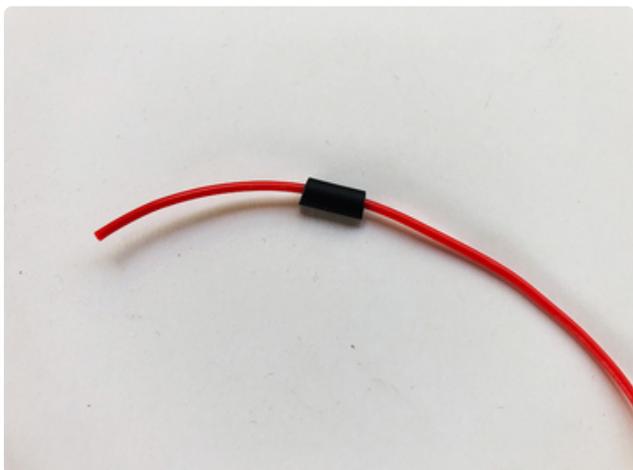
Chaining multiple rings together is fairly easy with the larger rings that have two **5V** and two **GND** pins. Just solder another red and black wire into each of those holes and attach them to the corresponding holes in the next ring. Solder a white wire into the Data **OUT** hole. Data **OUT** from the first ring will attach to Data **IN** on the next ring in the series, and so on.

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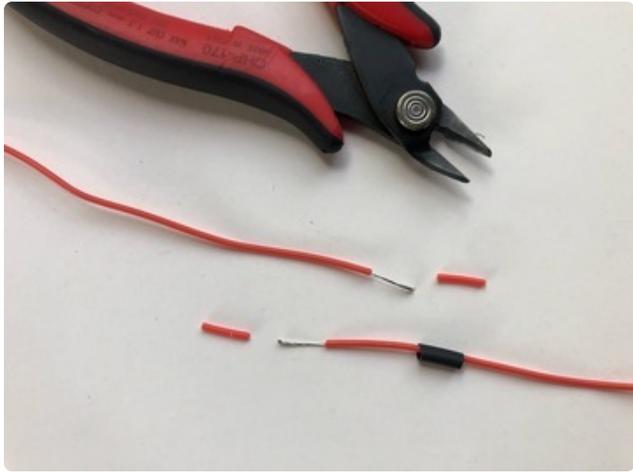
## Splicing Wires

Sometimes you need to lengthen wires, and sometimes you need to split one wire into two or more. This is called splicing, and it's a great skill to add to your arsenal.

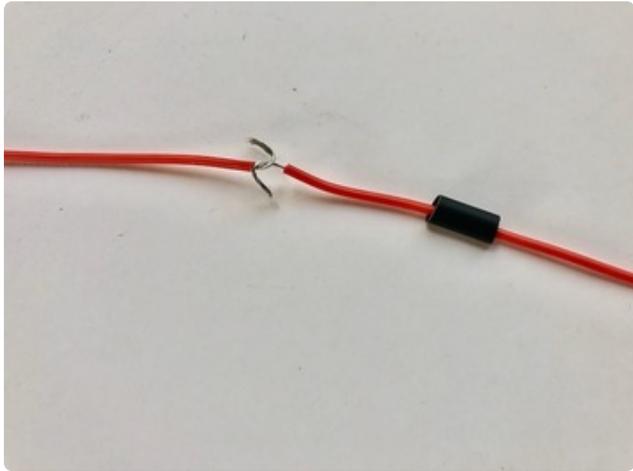
### 2-Way Splice



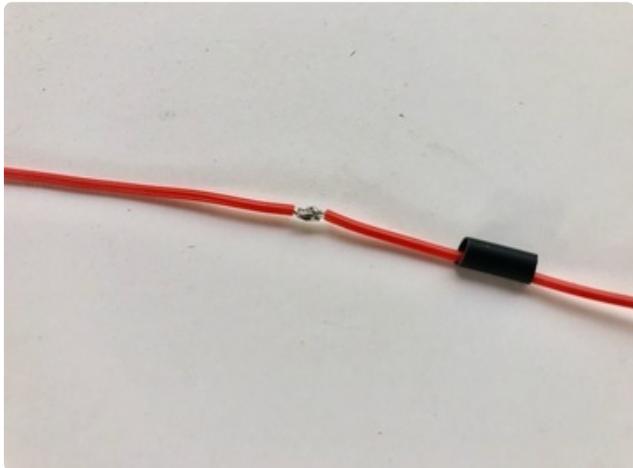
Cut a small piece of 1/8" heat shrink. Make it just long enough to cover your joint - maybe 1/4"-1/2" long. Slide it onto one of your wires, and move it down out of your way a bit.



Strip about 1/4" of shielding from the end of each wire. Give the wires a twist so the strands are all neat and tidy.

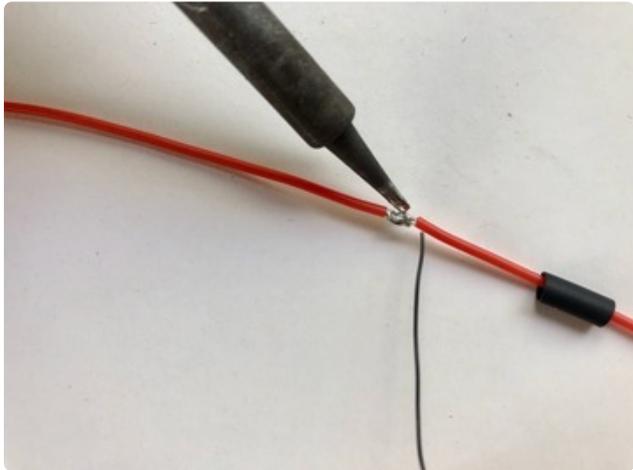


Bend the tips of the wire so they make little hooks. Hook the two hooks together.



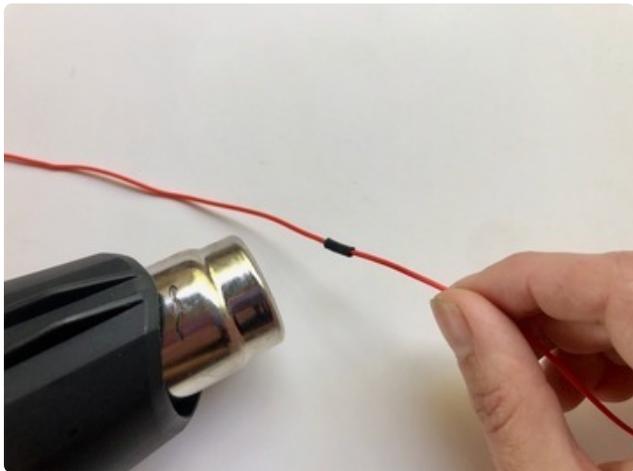
Twist the ends of the hooks around and around the wires to make a little wire ball in the middle. I like to twist one side clockwise and the other side counterclockwise.

Make this connection so mighty and tough that it doesn't come apart when you tug on the two wires. Twist it up tighter than a car salesman's handshake. Make it so twisty and tangled that the wires barely even need to be soldered. They might not even notice if you forget to solder them altogether. They have become One Wire.



Heat up your soldering iron to 750 degrees (or for 3-5 minutes, if you don't have a temperature gauge). Make sure the tip is nice and clean.

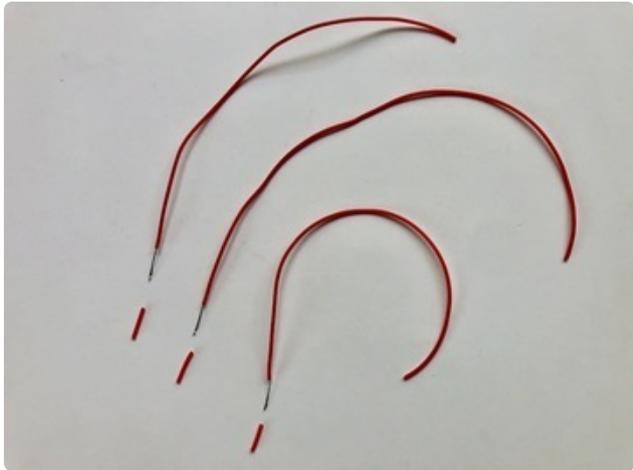
Press your soldering iron right onto the wire connection and wait a few seconds for it to get nice and hot. Unspool a bit of solder and touch it right to the knotty wire connection. The solder will melt and flow in and around your connection until it fills in all the spaces and creates a little shiny ball of solid metal. Lift your the solder away, then remove the iron.



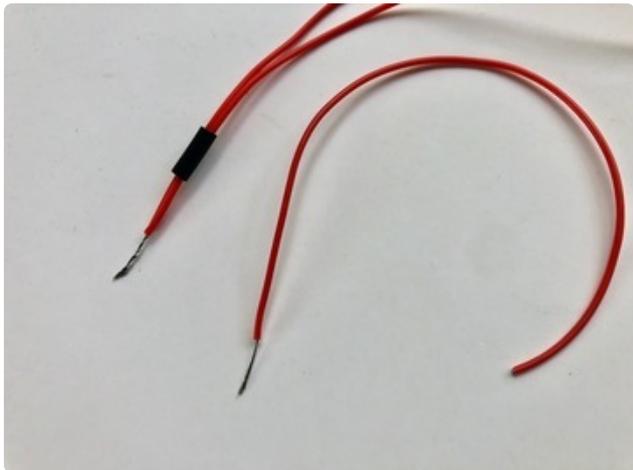
Finish by sliding your heat shrink over the solder joint and shrink it down with a heat gun or the side of your soldering iron.

### 3-Way Splice

Used when you need more wires than you have pads or solder holes available, or if you're connecting multiple strips to the same pin.



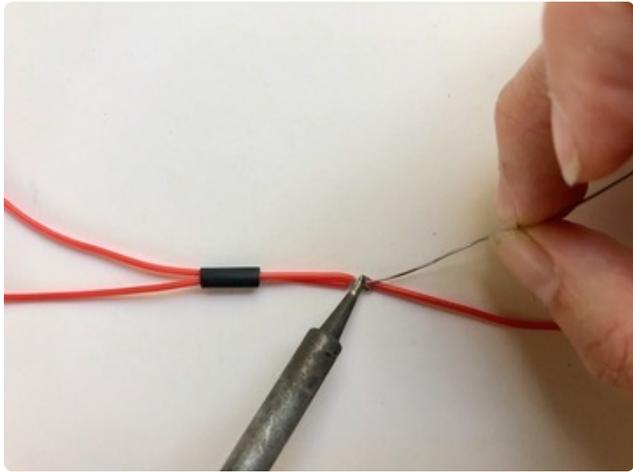
Strip slightly more than 1/4" of shielding from the end of all three wires. Twist two of the wires together with the tips pointing in the same direction.



Slide a piece of heat shrink over the double wire.



Hook the third wire onto this twisted pair so they're strongly connected, and twist the wires around each other, just like you would with a 2-wire connection. You'll end up with a Y-shaped junction.



Heat your soldering iron to temperature (750 degrees, or for 3-5 minutes) and make sure the tip is nice and clean. Press your soldering iron tip to your connection and wait a few seconds until it gets hot. Then, feed in your solder so it melts flows and fills in all the space in your little wire ball.



Slide the heat shrink over the connection and use a heat gun or lighter, or the side of your soldering iron, to shrink down the plastic so the joint is fully covered.

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## Connecting Two Strips

Sometimes you need a longer strip of LEDs than you have and you need to connect more than one strip end-to-end. Or, perhaps one of your pixels has broken or gone bad. If one pixel breaks, all the pixels "downstream" will stop working, so it's great to know how to trim out a pixel and replace it.

### How Can I Tell if a Pixel is Bad?

If your strip only lights up to a certain point but then the rest of the strip is dark, the first thing to check is your code. The most common reason for only having half a strip light up is because your code is only looking for 30 pixels when you actually have 50. So check the code first before you start cutting up your strip!

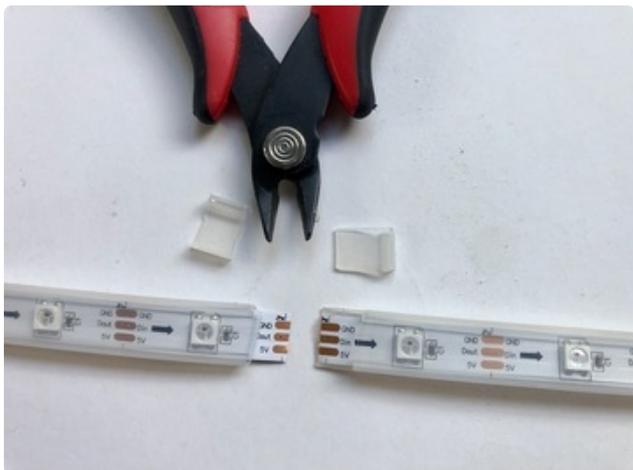
If your code is fine and you still have a strip that either goes completely dark or starts showing inaccurate colors or flickering after a certain point, you likely have a bad pixel or damaged strip. This happens in costumes a lot, especially at bend-points.

These LED strips are really flexible in one direction but very delicate if you try to bend them sideways. Luckily it's not all that hard to repair.

### Step 1: Prepare Your Strip



If you've got a bad pixel, use your flush cutters to carefully trim it out of the strip. You don't need to cut through the center of the copper pads - you can leave almost the entire pad on either side of the pixel in place. This will make it much easier to reattach the pixels.

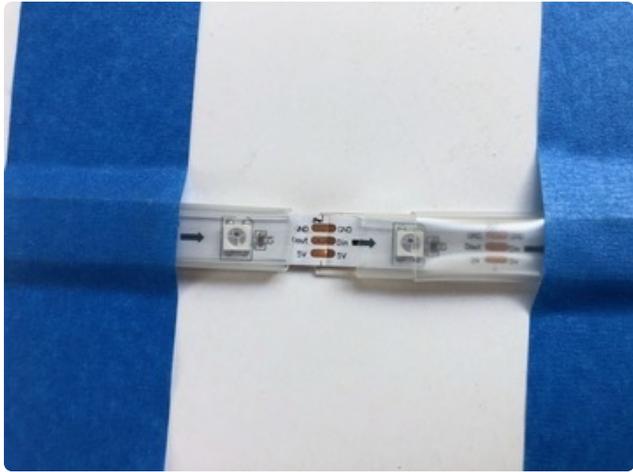


Be sure your copper pads are clean and solder-free. If you're attaching additional strip, double check and make sure you've got the "in" end -- the arrows should be pointing away from the microcontroller end. Trim the silicone casing back so you have plenty of room to work. Take a deep breath.

### Step 2: Heat Shrink



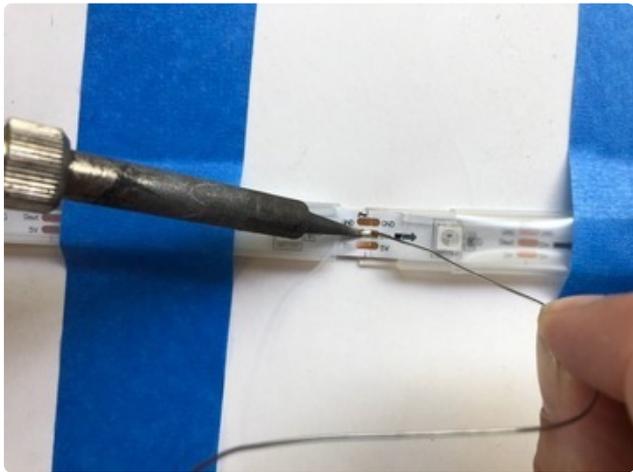
Slide on a piece of clear 3/4" heat shrink tubing that's about an inch long. We'll use this to seal up and reinforce our joint when we're done testing it.



Line up the strips so the copper pads are overlapping each other and are perfectly straight. I like to tape them down to my work surface so they don't move around.

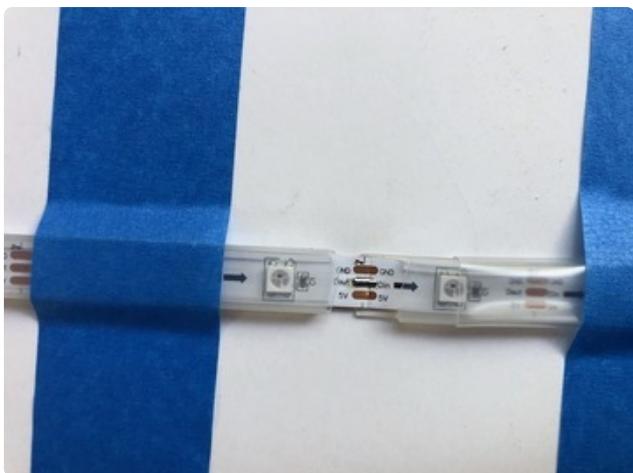
If needed, trim the strips carefully with your flush cutters until the alignment is really perfect and all three pads are connecting with their mates.

### Step 3: Solder



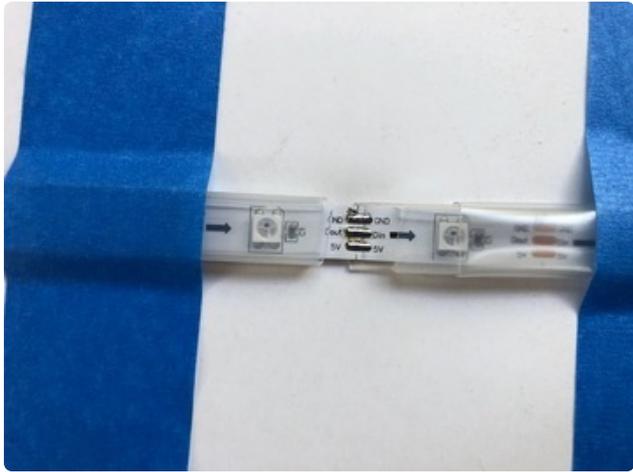
Heat up your soldering iron to 750 degrees (or for 3-5 minutes, if yours doesn't have a temperature gauge). Make sure the tip is nice and clean and hot.

Touch the soldering iron to the **middle** copper pad on the upper strip and wait a few seconds until it gets nice and hot. Touch your solder to this pad as well and let it flow, as though you were tinning the pad for a wire connection. Be a little more generous with the solder. You're looking for a nice little solder dome here.

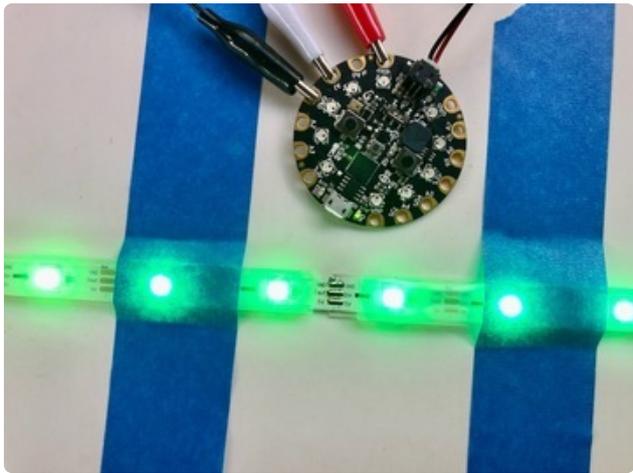


Remove the solder and soldering iron and let the solder dome cool. Take another deep breath. Then, touch your soldering iron to the exposed copper pad on the lower strip. Get it nice and hot.

Then, reach over with your soldering iron to the solder dome. Use the tip of your iron to push the solder blob over so that it spans both strips, making a good solid connection between the strips. You may need to add a little more solder. Take your time, this isn't as easy as it looks.



Repeat the process with the two outer pads.



Before you go any further, connect your project to power and test to see if it all works.

## Step 4: Seal it Up



Once you're sure the joint is rock-solid, slide your clear heat shrink over the window you cut in your silicone sleeves. Slip the nozzle on your hot glue gun in under the heat shrink and squirt a little glue in there, then use a heat gun to shrink your heat shrink in place. This will make a stiff spot in your strip, but will keep your solder joint connected since it's all encased in plastic and won't break again.

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## Soldering to Microcontrollers

We'll cover soldering to large copper pads, like you find on Circuit Playground Express, and soldering to smaller through-hole connections like you'll find on the Feather.

This page will show you the simplest way to connect strips, for smaller low-power projects. **If you have more than around 100 pixels, you'll want to connect the power separately, as drawing too much power through the microcontroller can cause problems.** See this [Powering NeoPixels \(https://adafru.it/DCq\)](https://adafru.it/DCq) page for more info.

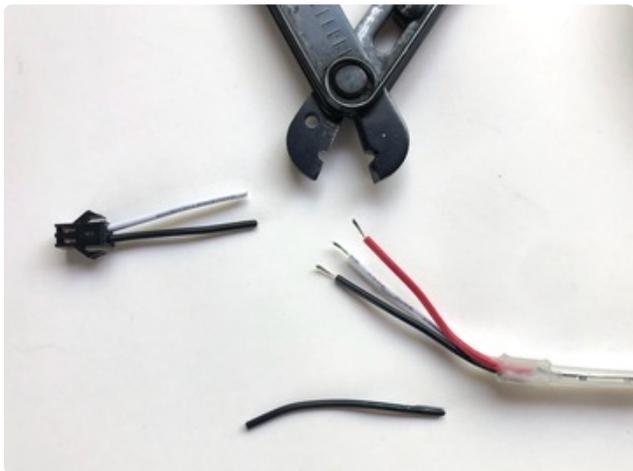
**Do Not Solder to Live Electronics**

Be sure your microcontroller is **NOT PLUGGED IN** while you're soldering to it: not plugged into a battery, not plugged into a wall socket, and definitely not plugged into your computer via the USB port. Only solder to electronics that are completely

powered off. Don't get lazy about this, or you may make some very expensive mistakes.

## Prepare Your Strip

Follow the steps on the previous few pages to get your strip or ring ready to connect to your controller. Or, if you're using a new strip with wires already attached:



Find the **IN** end of the strip. Look for little arrows on the strip pointing away from the **IN** end and toward the **OUT** end. This is important -- if you solder to the wrong end of the strip it won't work.

If there's a connector, go ahead and cut it off. Also trim off any "extra" power wires, so you're left with just one red, one black, and one white/colored wire.

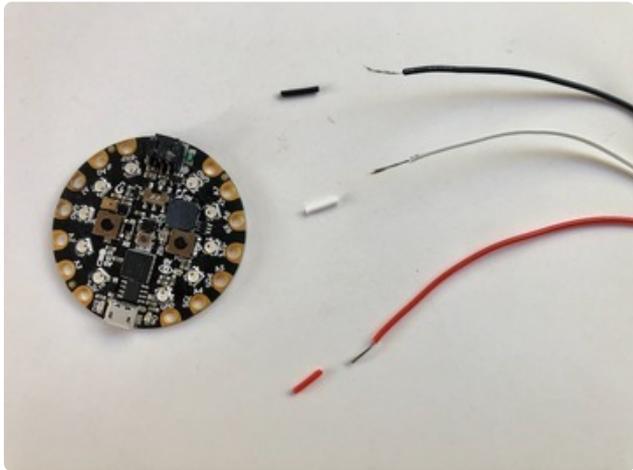
These extra wires are there for larger installations where you need to power the strip separately instead of through the microcontroller.

## Microcontrollers with Large Copper Pads

Some boards have big, friendly copper pads which make soldering easy. This is not a comprehensive list by any means, but here are some of my favorites:

- [Circuit Playground Express](http://adafru.it/3333) (<http://adafru.it/3333>)
- [Gemma M0](http://adafru.it/3501) (<http://adafru.it/3501>)
- [CLUE](http://adafru.it/4500) (<http://adafru.it/4500>)
- [Hallowing](http://adafru.it/3900) (<http://adafru.it/3900>)

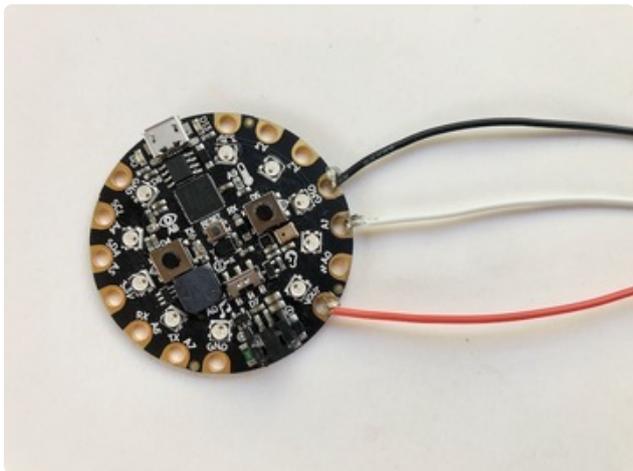
## Step 1: Prepare Wires



Trim your wires so they're more-or-less the same length. If you want to be extra tidy, trim the white wire just a little bit shorter than the other two.

Strip about 1/4" of shielding from each wire.

## Step 2: Connect Wires



Twist the stripped wires so they're neat and tidy. Insert each wire through the correct pad or hole on the microcontroller and wrap it around. Connect it firmly, so it wants to stay put on its own. Keep the strands tidy -- you want to avoid any strands touching other pads.

Red --> **VOUT** (or **BATT**, on some controllers)

Black --> **GND**

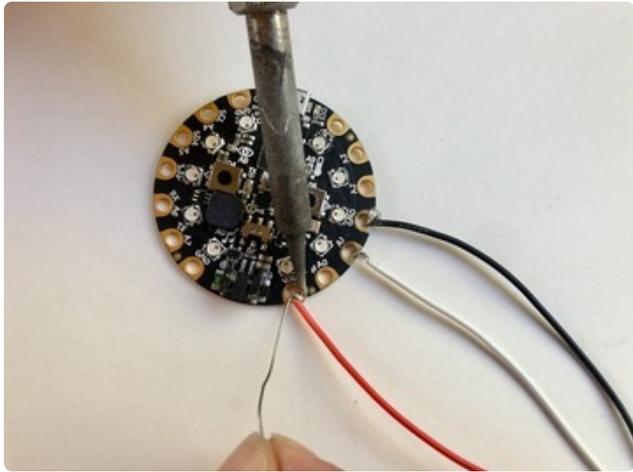
White --> **A1** (or your chosen digital i/o pin from your code)

The labels on the pads may vary based on which microcontroller you're using, but the above is a good rule-of-thumb for most projects.

## Step 3: Solder

**First, be sure your microcontroller is unplugged and not connected to power.**

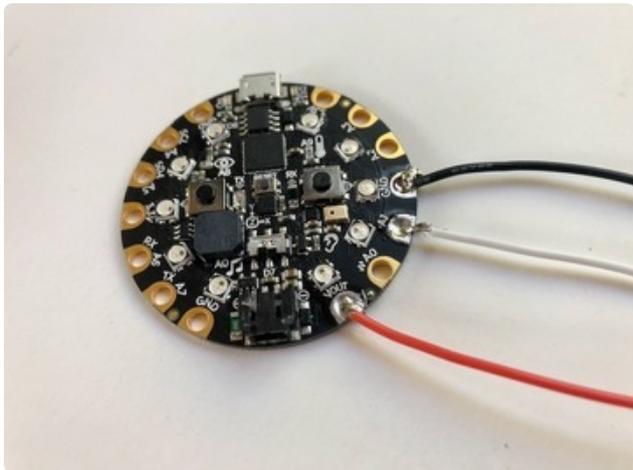
Soldering on live electronics is an open invitation for a visit from the [Blue Smoke Monster](http://adafru.it/565) (<http://adafru.it/565>). He will destroy your board and then laugh while you open the window and try not to cry.



Press your soldering iron to the copper pad right next to where the strands wind through. Leave it there a few seconds so everything gets nice and hot.

Unspool a bit of solder and touch it to the hot copper pad. It will melt and soak into the stranded wire, creating a good strong electrical connection. It should be shiny and smooth. Use enough solder so the wire gets completely coated and won't come free if you tug on it.

I like to add enough so the entire hole gets "closed" with solder.



#### Step 4: Test

If you haven't done so yet, upload some test code to your microcontroller. Here's some test code you can use with the Circuit Playground Express or a Gemma M0 that will run a rainbow along your strip if you attach it to pin **A1**.

[Test Code for Circuit Playground](https://adafru.it/KQB)

<https://adafru.it/KQB>

[Test Code for Gemma M0](https://adafru.it/KQC)

<https://adafru.it/KQC>

1. Download the appropriate UF2 file
2. Plug your microcontroller into your computer with a good USB cable. The lights on the face will turn green. If they don't, click or double-click the tiny "reset" button in the center of the board until they do.
3. A drive will appear on your computer called **CPLAYBOOT** (for Circuit Playground) or **GEMMABOOT** (for Gemma M0). Drag the file you downloaded onto this drive. You're done!

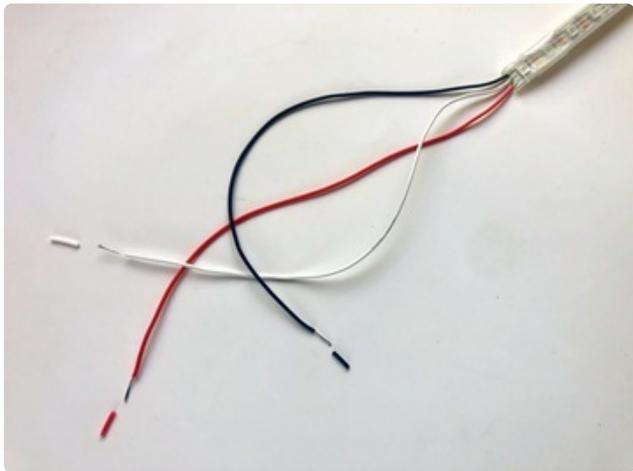
If you're having trouble, [head over to the Circuit Playground guide \(https://adafru.it/ECU\)](https://adafru.it/ECU) to get things working.

## Microcontrollers with Small Through-Hole Pads

There are too many to list, but here are some of my favorites:

- [Feather Boards \(https://adafru.it/BC6\)](https://adafru.it/BC6)
- [Raspberry Pi Zero \(http://adafru.it/3400\)](http://adafru.it/3400)
- [Itsy Bitsy \(http://adafru.it/3677\)](http://adafru.it/3677)
- [Trinket M0 \(http://adafru.it/3500\)](http://adafru.it/3500)

### Step 1: Prepare Wires



Trim all 3 wires to exactly the same length. Strip about 1/4" of shielding from each wire.

### Step 2: Tin Wires

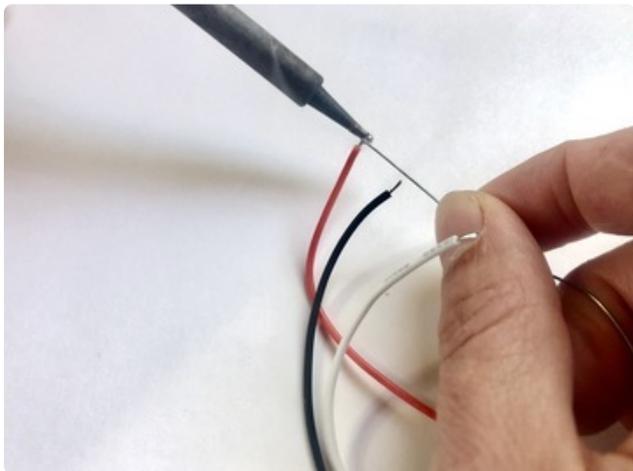
These little stranded wires can break your project if they get "fuzzy" and touch the surrounding holes, which can be maddeningly close by on the smaller boards.

"Tinning" the wires means adding a bit of solder so all the strands are stuck together. In effect, you're trying to make just a little bit of solid wire, so it will go into the hole easily. The idea is to get all the strands to bond together as one, without making the wire so bulky that it won't fit through the hole.

Use the smallest amount of solder you can, and don't be afraid to trim off any extra solder that balls up at the end of the wire.

Turn on your soldering iron and wait until it's fully heated. If it has a temperature gauge, set it to 750 degrees. Otherwise, just wait about 3-5 minutes so you can strike while the iron is hot.

While you're waiting, get the little sponge in your soldering iron stand wet so you can clean off the tip of your iron. Go ahead and clean it off now, once your iron is hot. It's easier to solder with a clean iron.

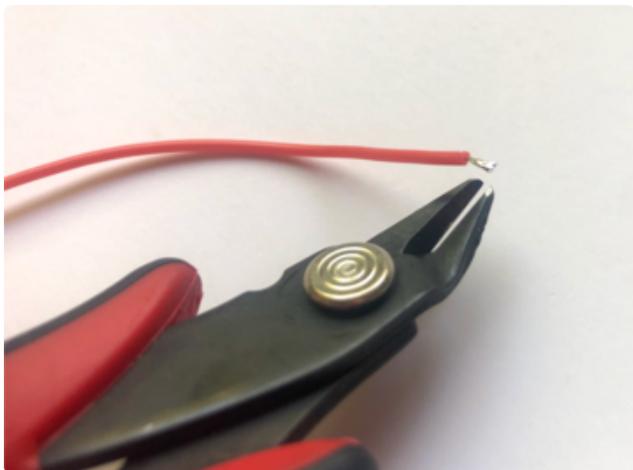


Bend your wires up so they're away from your work surface a bit, or use a [third hand](http://adafru.it/291) to hold them steady. Give the ends a twist to be sure all the little wire strands are stuck together.

Heat the exposed wire with your soldering iron, and touch your solder to the wire at the same time. The solder will melt and flow along the wire just a little bit so it gets coated. I like to "stroke" the wire just a bit with the tip of the soldering iron to spread the solder out and make it nice and even.

Do this for all three wires.

If you end up with a ball of solder on the tip of the wire, snip it off with your flush cutters.



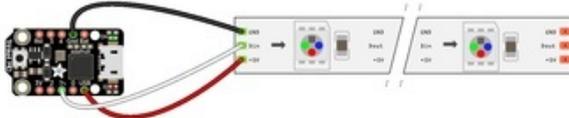
### Step 3: Insert Wires into Holes

Which wire goes to which hole will depend on your project's wiring diagram. Here's the wiring that will work with the test code below.

### Feather M4 (wired for battery power)



### Trinket M0 (wired for USB power)



fritzing

For Feather M4:

Red --> **BAT** (if your project is battery powered) or **USB** (if you're powering via USB)

White --> **A1**

Black --> **GND**

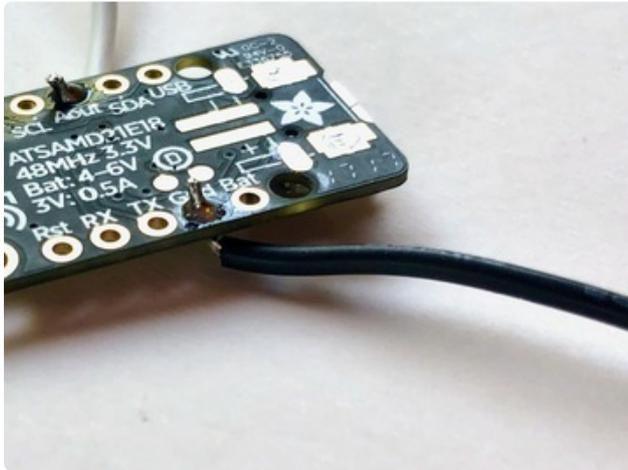
For Trinket M0:

Red --> **USB** (if you're powering via USB) or **BATT** (if you're using battery power)

White --> **D1**

Black --> **GND**

## Step 4: Solder



Make sure your soldering iron is fully heated and the tip is nice and clean.

Press your soldering iron to the copper pad and the wire so it's touching both at the same time. Wait a few seconds until everything gets nice and hot.

Unspool a bit of solder and touch it to the hot copper pad. It will melt and flow up the wire until you have a nice, shiny blob of solder covering the whole pad and looking a bit like a hershey's kiss.

Snip off any extra wire that's sticking out of the top.

This takes a bit of practice, and there are plenty of exciting ways to get it wrong. Head over to [Adafruit's Guide to Excellent Soldering \(https://adafru.it/CfQ\)](https://adafru.it/CfQ) for a whole lot of tips and tricks and troubleshooting. Getting the perfect solder joint is a bit of an art form, and it's something to be very proud of!



Once you get the hang of it, [order yourself a soldering sticker \(http://adafru.it/694\)](http://adafru.it/694). You've earned it!

## Step 5: Test

If you haven't done so yet, upload some test code to your microcontroller. Here's some test code you can use with the Trinket M0 or a Feather M4 that will run a rainbow along your strip.

[Test Code for Trinket M0](https://adafru.it/L3c)

<https://adafru.it/L3c>

[Test Code for Feather M4](https://adafru.it/L3d)

<https://adafru.it/L3d>

1. Download the appropriate UF2 file
2. Plug your microcontroller into your computer with a good USB cable. The lights on the face will turn green. If they don't, click or double-click the tiny "reset" button in the center of the board until they do.
3. A drive will appear on your computer called **TRINKETBOOT** (for Trinket M0) or **FEATHERBOOT** (for Feather M4). Drag the file you downloaded onto this drive. You're done!

If you have a different board, not to worry: all Adafruit's boards have a dedicated guide with test code and pinouts and all kinds of goodies. Just do a search in the Learn System search box to find your board and learn all about how to use it.

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# Troubleshooting

## If Your Strip Doesn't Light Up At All

First, check your **wiring**. Make sure you've got power, ground, and data all connected to the right pins on your microcontroller and that you've soldered to the **IN** pin and not the **OUT** pin.

Next, check your **code**. Does your code specify the same data pin your strip is connected to? Make sure they match -- if you soldered to **A1**, be sure you've called **A1** in your code.

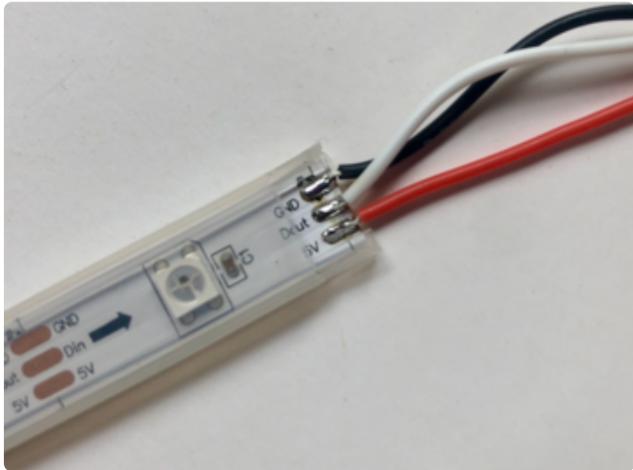
If you're using code you found on the internet or wrote yourself, put it aside and upload some tried-and-true sample code. There are code samples on the guide pages associated with all the microcontrollers Adafruit sells. Using strandtest or example code will eliminate some variables so you can confidently test your physical connections.

Then check your **power**. Are you powering from a battery? Check to be sure it's got a charge, and if there's a switch on your battery case, make sure it's switched on. Try plugging into USB to see if that fixes the problem. If it does, make sure your wiring is correct -- on some microcontrollers, connect your red wire to **BATT** for a battery powered project or **USB** for a USB powered project.

If you're using a Gemma M0, there's a tiny on/off switch on the face of the board. Make sure it's in the on position.

Here are a few more common problems, and their solutions.

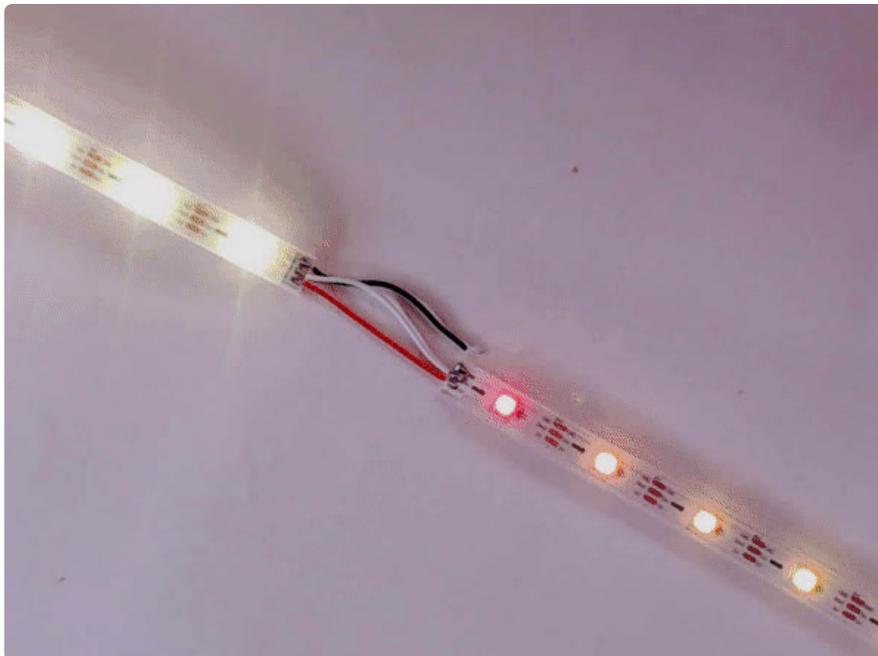
## Data Wire Connected to OUT instead of IN



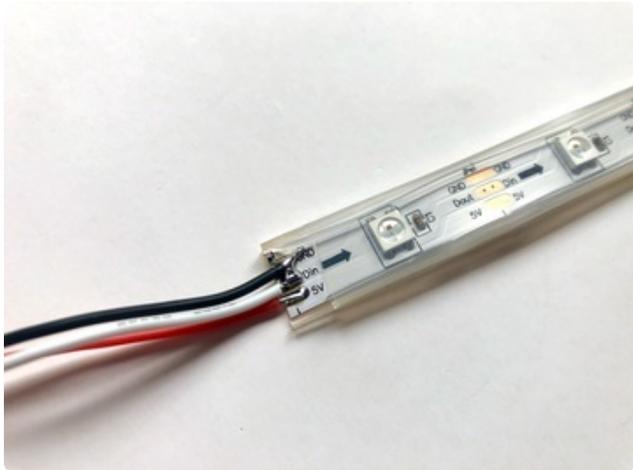
This is one of the most common mistakes, and even seasoned veterans still do this on occasion. If your strip isn't lighting up, double check that you've soldered to the **IN** end.

## Loose / Unconnected Ground Wire

If your ground wire (GND) has a bad connection, the strip will often flicker like in the image below. Check all your ground wires and make sure you've got good ground connection on both ends of the wire. This can sometimes happen further down the line in larger projects with longer runs of lights, so another thing to try is to connect a second ground wire from the far end of the strip back to the microcontroller.



## Bridged Solder Pads

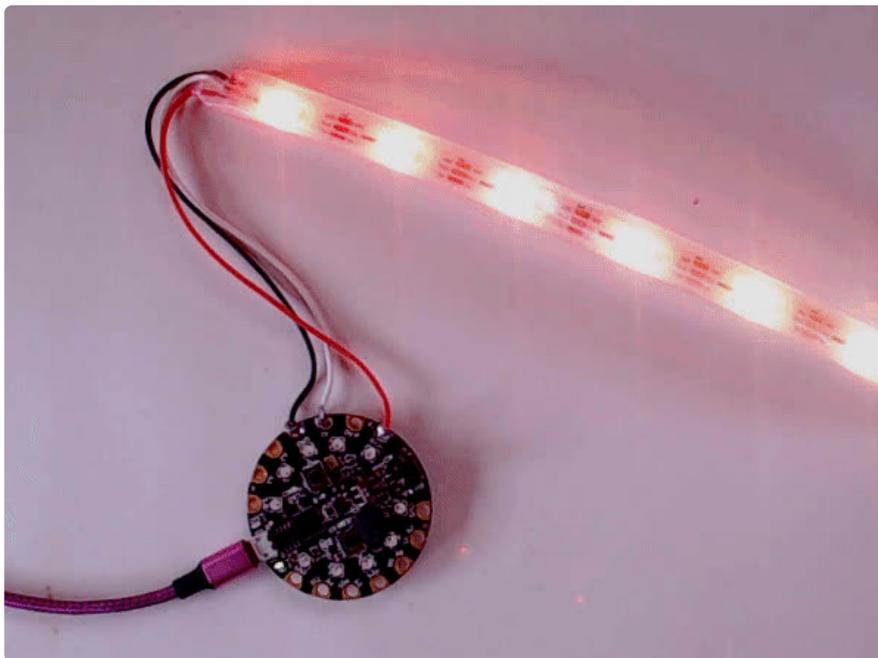


This strip has too much solder on the **GND** pin, and it's muscled its way over onto the **DIN** pin. You can fix it with a little [solder wick](http://adafru.it/149) - just remove some of the extra solder so the two pads are not bridged.

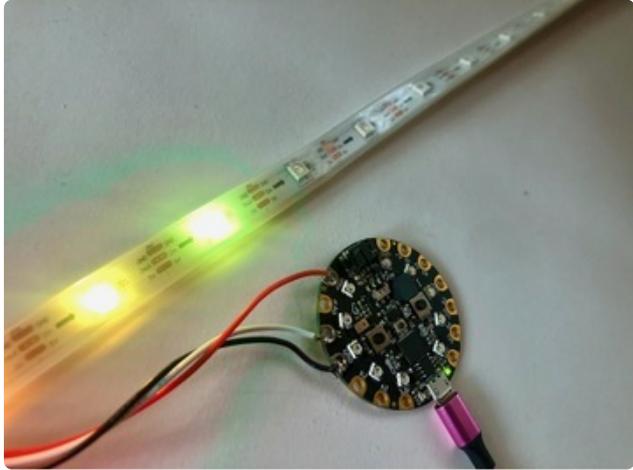
## Short Circuit

If your ground wire and your power wire touch each other at any point, you'll get what's called a short circuit. Your microcontroller will reset and your strip will go dark. If this is happening to you, check to be sure there's nowhere that ground and power can touch.

This happens pretty commonly with alligator clips, if you're moving your project around while it's turned on. It's not great for the microcontroller so try to avoid it -- if your project uses alligator clips, cut the lead wires to uneven lengths so the alligator clip heads aren't all right next to each other.



## Only Half the Strip Is On



If the first half of your strip is working fine, but the second half is off, the first thing to check is your code. You have to specify how many LEDs are in your strip in the code, and if you downloaded sample code without editing it, or ended up with more LEDs than you thought, this could likely be the problem. Check your code before you cut into your strip!

If that's not the problem, you have a bad pixel or a damaged strip. Sometimes the copper pads can get torn if the strip is flexed too much. Take a look at the Tips & Tricks page for a couple ways to fix this.

If none of this helps, drop us a line in the [Adafruit Forum \(https://adafru.it/18fN\)](https://adafru.it/18fN). We've got customer service reps who are very excited about helping you with your project.

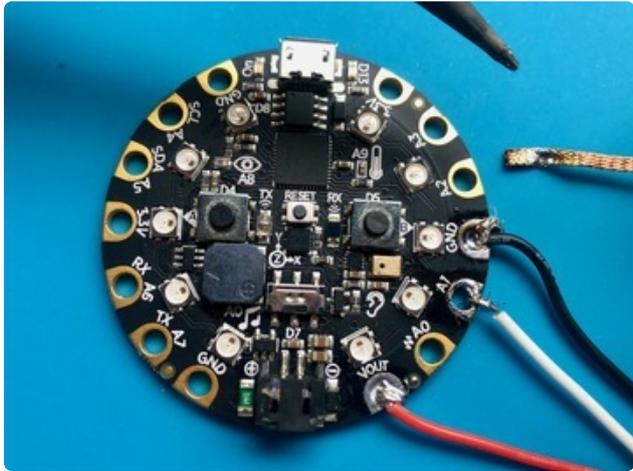
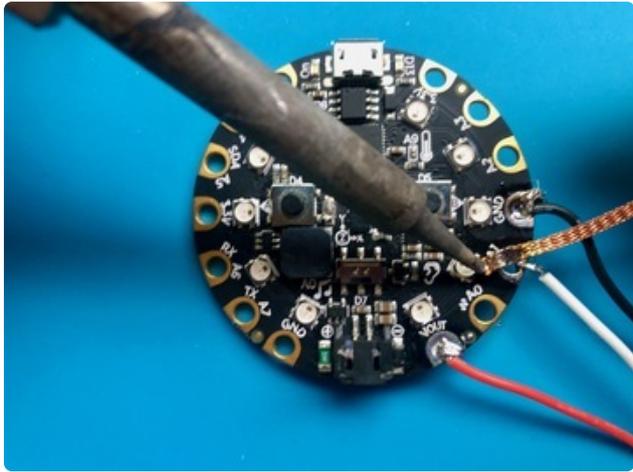
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## Tips & Tricks

### Un-Soldering

If you mess up, don't worry! It's pretty easy to re-melt solder and redo your connections.

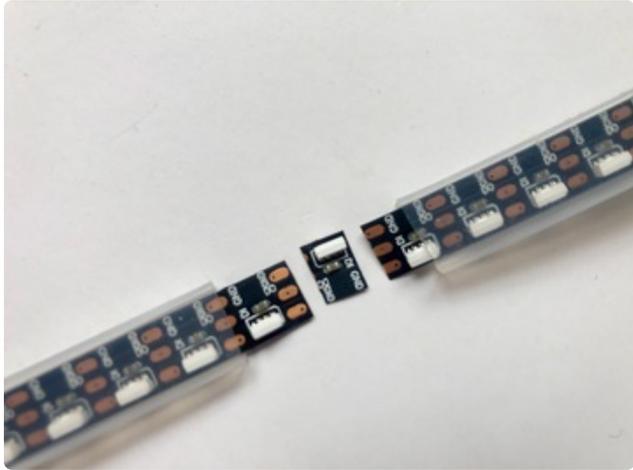
Most of the time, you can just re-melt the solder with your soldering iron and pull the wire off, trim it a bit, and try again.



If you've just got way too much solder on your joints and the pads are melting into each other, reach for your [solder wick](http://adafru.it/149) (<http://adafru.it/149>). This stuff is made of braided copper and solder absolutely loves it. Get it in between your soldering iron and the solder pads, and it will soak up any extra solder that's in your way.

## The Sacrificial Pixel

Sometimes you're soldering to side-light pixels or 144/m pixels where the pads are teeny tiny. How the heck are you supposed to securely solder three whole wires to those tiny little pads when they've been cut in half? Sheesh.

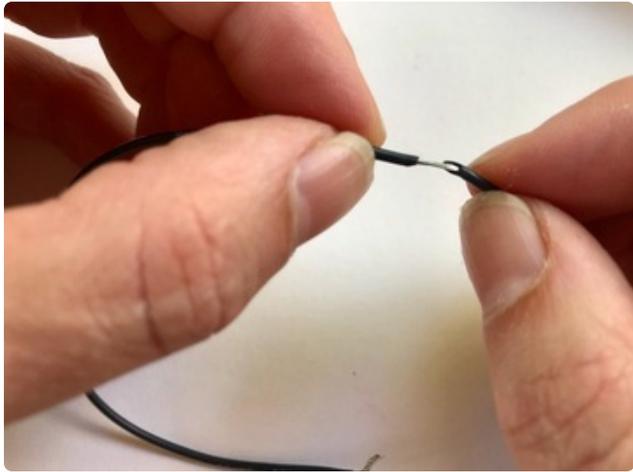


The trick here is to use what's lovingly called the "Sacrificial Pixel" method. Instead of cutting through the middle of the pad when you trim down your strip, you can cut one pixel out entirely and leave full pads on either side. This pixel becomes useless, since the pads are cut off on both sides, but the strips remain functional and much easier to work with.

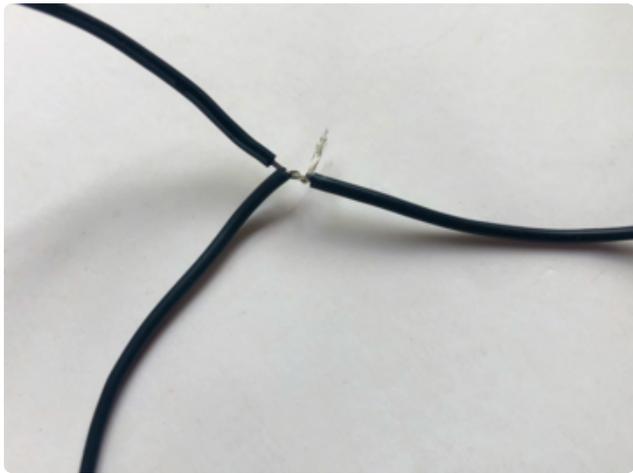
I do this pretty often, even with the strips that have larger pads. I like keeping my sanity intact (more-or-less), and this helps. Just remember to account for the missing pixel in your planning, if your project needs to be an exact length.

## The Insulation Gap

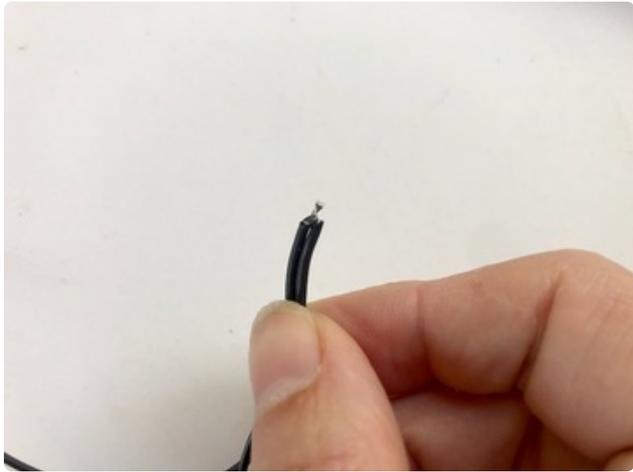
[Silicone stranded wires \(http://adafru.it/1877\)](http://adafru.it/1877) are absolutely my favorite. One reason is because the silicone coating is so very stretchy and flexible that I can grab it with my fingernails and pull, and expose a bit of un-shielded wire **without cutting the wire at all**. This is difficult or impossible to do using cheaper wire with regular plastic insulation.



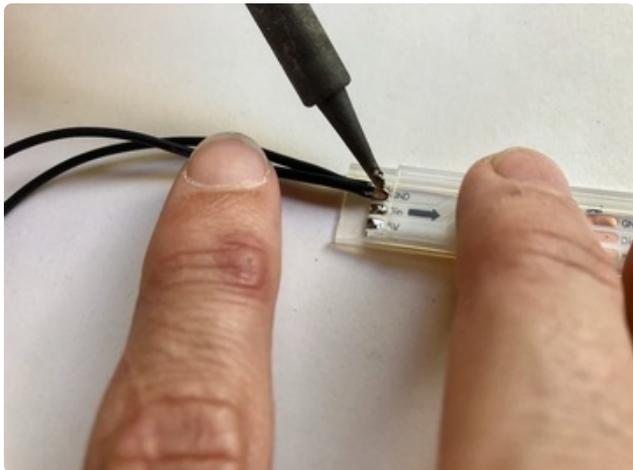
This can be so helpful when there's not much play in your wire lengths but you need to split your wires for some reason -- maybe you need an extra ground connection or you want to splice on another LED strip. It's really useful when making repairs on an installation as well.



You can't get heat shrink on using this method, so be sure to seal up these connections using hot glue afterward.



One more tip: if you split the insulation and then bend the wire 180 degrees, you get a little exposed nubbin of wire that's neat and tidy with no fuzzies. You can solder this onto your NeoPixel strip and get a double-wire connection to your solder pads.



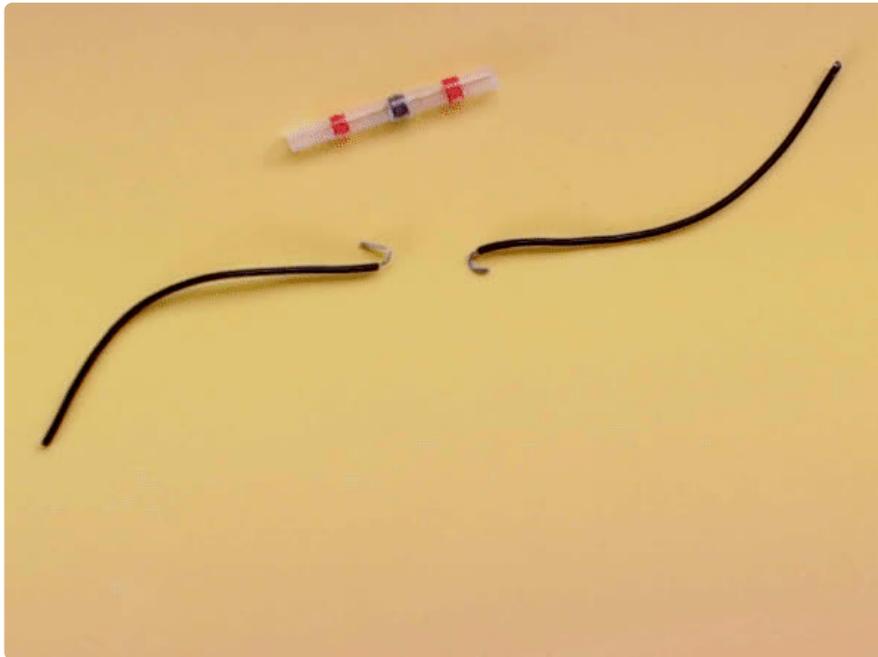
This is great when you have a larger number of LEDs and need to power them directly instead of through the microcontroller, or if you want to create an easy DIY power bus between strips.

## Solder Seal Connectors

Sometimes there are places you can't reach with a soldering iron. If you're making wire connections inside a larger art installation, or doing repairs on a costume while you're at a festival, it's good to have a solution you can use in the field.

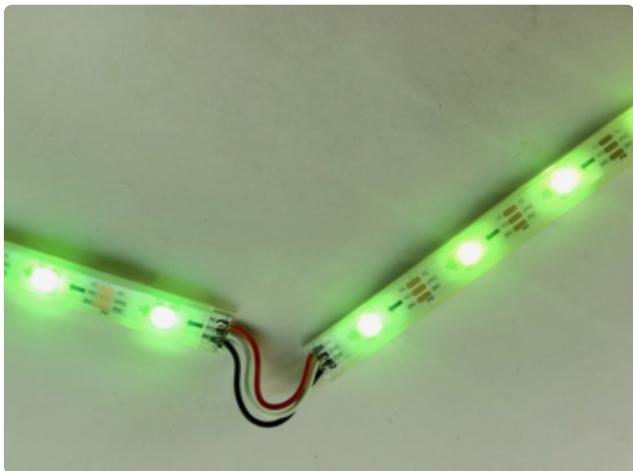
These solder seal connectors are really cool. They're basically heat shrink tubing with superpowers. The two colored bands are filled with hot-melt glue, and the center silver band has low temp solder inside it. All you need to do is slip these on, make your wire connection, slide the solder seal connector over it and hit it with a heat gun or lighter to shrink the plastic and melt the goodies inside.

These things are lifesavers. They aren't in the Adafruit catalog at the moment, but [here's a link to order from Digikey. \(https://adafru.it/L3f\)](https://adafru.it/L3f)



## Flex Joints

Sometimes you have a spot that just keeps on breaking. Waistlines or elbow joints in costumes seem to be particularly vulnerable -- you keep repairing it but it just keeps breaking.



If you're having this issue, one workaround is to connect the two halves of your strip with a couple inches of wire instead of trying to reattach the strip directly. This silicone stranded wire is really flexible and will tuck out of the way easily. You may get a slight dark spot at the flex joint, but it's much better than a costume that just keeps breaking.

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## Links & Resources

### More Soldering Guides

[Adafruit's Guide to Excellent Soldering \(https://adafru.it/drl\)](https://adafru.it/drl) is a great next step if you want to learn to get really good quality soldering joints, and to learn to use headers or other fancy attachment methods.

[Colin's Lab - Soldering \(https://adafru.it/dyT\)](https://adafru.it/dyT) is another wonderful guide, featuring some very well explained and enjoyable soldering tutorial videos.

[S is for Soldering \(https://adafru.it/LaZ\)](https://adafru.it/LaZ) is a great intro video if you're looking to get young makers excited.

## No-Soldering NeoPixel Guide

[Make It Glow - Your First NeoPixel Project \(https://adafru.it/KmB\)](https://adafru.it/KmB) is a great place to start if you're not quite ready to pick up that soldering iron yet, or if you're working with kids. You don't need to solder to use NeoPixels!

## Überguides

The [Adafruit NeoPixel Überguide \(https://adafru.it/dhw\)](https://adafru.it/dhw) is a wonderful resource on NeoPixels and goes in-depth. If you are considering DotStar LEDs instead, see: [Adafruit DotStar LEDs \(https://adafru.it/kDg\)](https://adafru.it/kDg).

## More Project Ideas

We've added links to lots of great beginner projects in the sidebar. Treat yourself and get inspired!

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## Bluefruit Luminary Lanterns

[Bluefruit Luminary Lanterns \(https://adafru.it/HgC\)](https://adafru.it/HgC)

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## Vertical Garden

[Vertical Garden \(https://adafru.it/L3A\)](https://adafru.it/L3A)

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## NeoPixel Badge Lanyard

[NeoPixel Badge Lanyard \(https://adafru.it/IIE\)](https://adafru.it/IIE)

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## Crystal Gem Lantern

[Crystal Gem Lantern \(https://adafru.it/Fv5\)](https://adafru.it/Fv5)

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## Glowing Resin River Table

[Glowing Resin River Table \(https://adafru.it/L3B\)](https://adafru.it/L3B)

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## Rose Quartz Umbrella

[Rose Quartz Umbrella \(https://adafru.it/KcB\)](https://adafru.it/KcB)

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## Glowing Fascinator Hat

[Glowing Fascinator Hat \(https://adafru.it/L3C\)](https://adafru.it/L3C)

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## Dance-Reactive Tutu

[Dance-Reactive Tutu \(https://adafru.it/DCQ\)](https://adafru.it/DCQ)