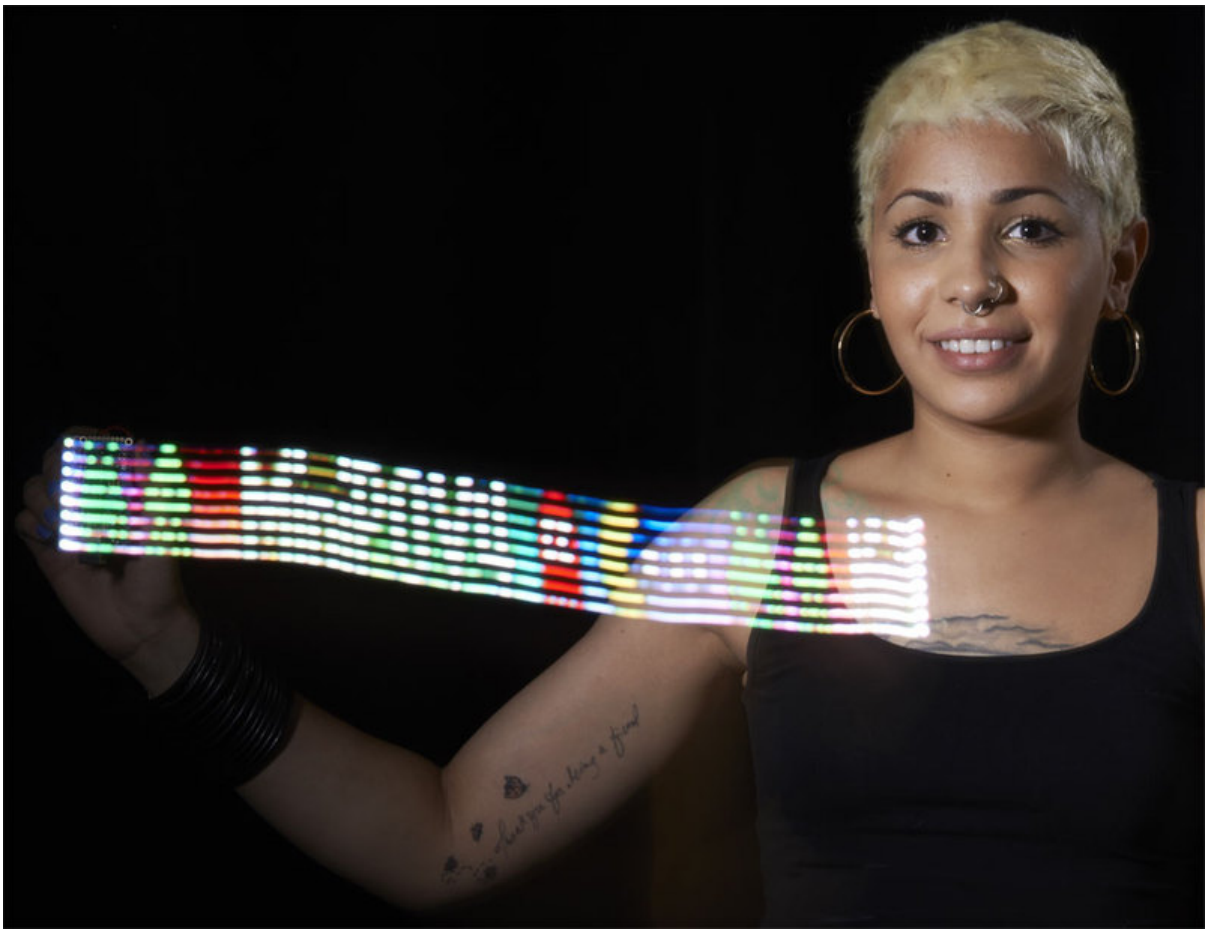
MiniPOV4 - DIY Full-Color Persistence of Vision & Light-Painting Kit

Created by lady ada



https://learn.adafruit.com/minipov4-diy-full-color-persistence-of-vision-light-painting-kit

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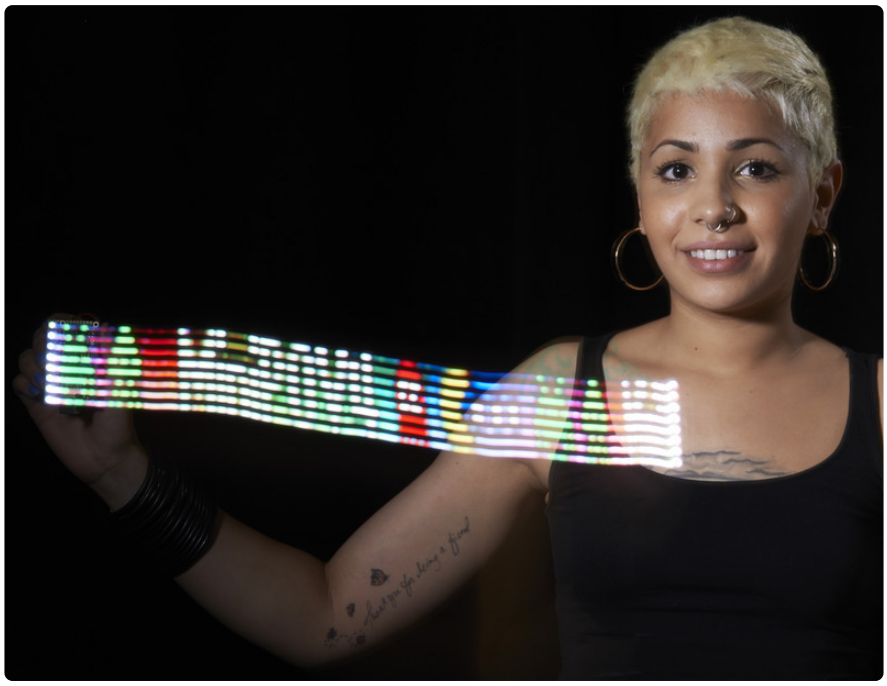
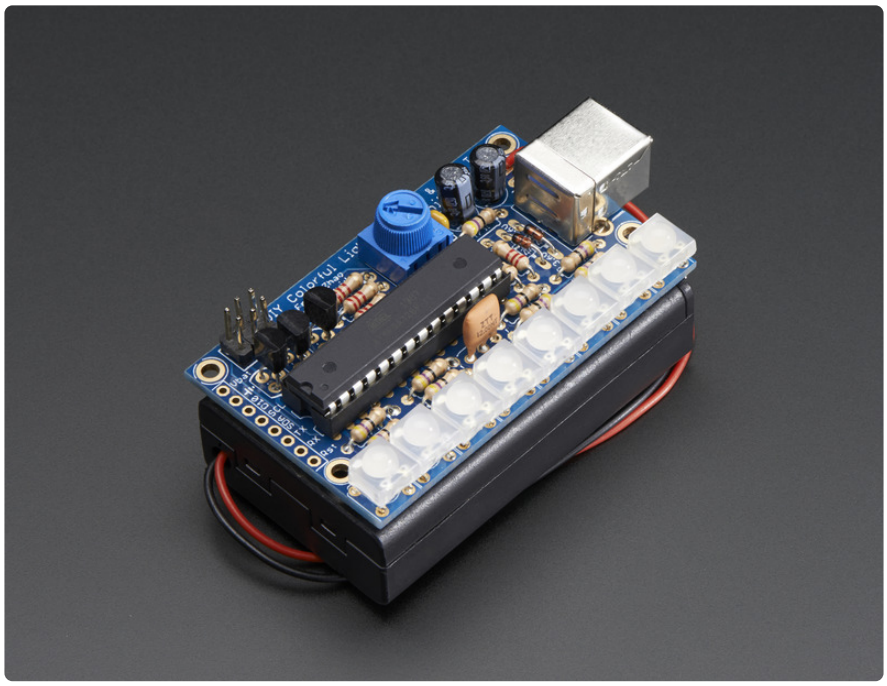
Overview



Angel demos the MiniPOV4!

The latest and greatest MiniPOV kit to hit the streets - MiniPOV4! We have added full color RGB LEDs to the kit as well USB programmability to make this the easiest, most fun Persistence-of-Vision & Light Painting kit ever.

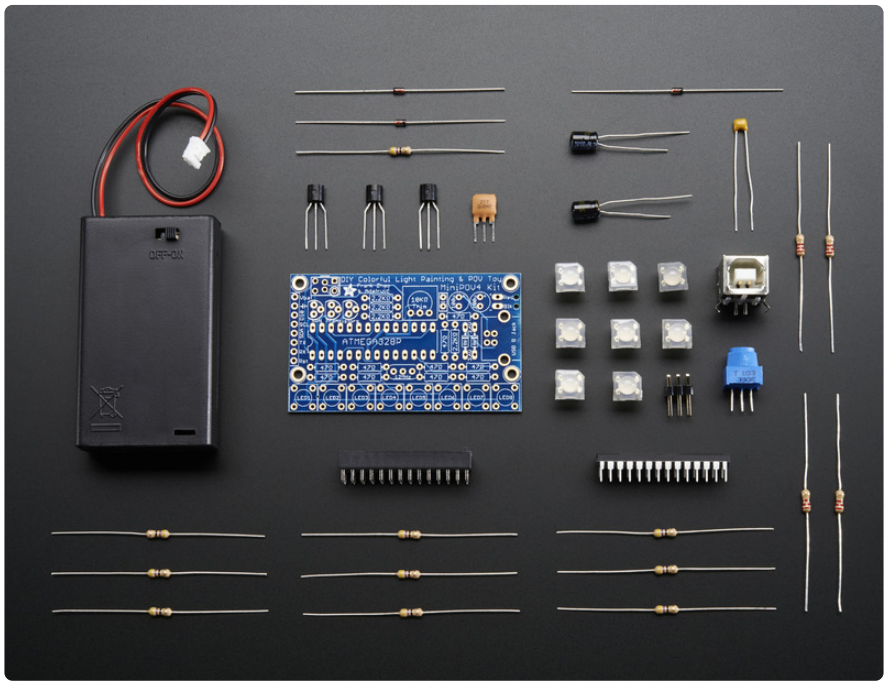


Learn to solder by building this easy kit. About 20 components are soldered onto the custom PCB using a soldering iron, solder and some basic hand tools. Learn as you go, starting with the easier parts and working your way up to the more challenging

ones. Takes about an hour or two to complete following our detailed tutorial

Once finished, you'll have a little battery-powered light painting kit! Insert three AAA batteries (not included, pick some up here or use any you have lying around the house) and wave around to create light trails. The way our eyes work, as the LEDs move we see the image as if it were floating in the air. You can also use a camera with a medium-long exposure to create a light painting as shown above.

Design your own 8-pixel tall images in any drawing program and import them into our software to upload your own custom designs. Simply plug into your computer's USB port and run our Processing sketch - it works on any Mac or Windows computer! (Linux support still being tested)



Each order comes as a kit of parts. Some soldering and tools are required to put together but its a nice learning kit and with patience and a couple of hours can be assembled by any beginner.

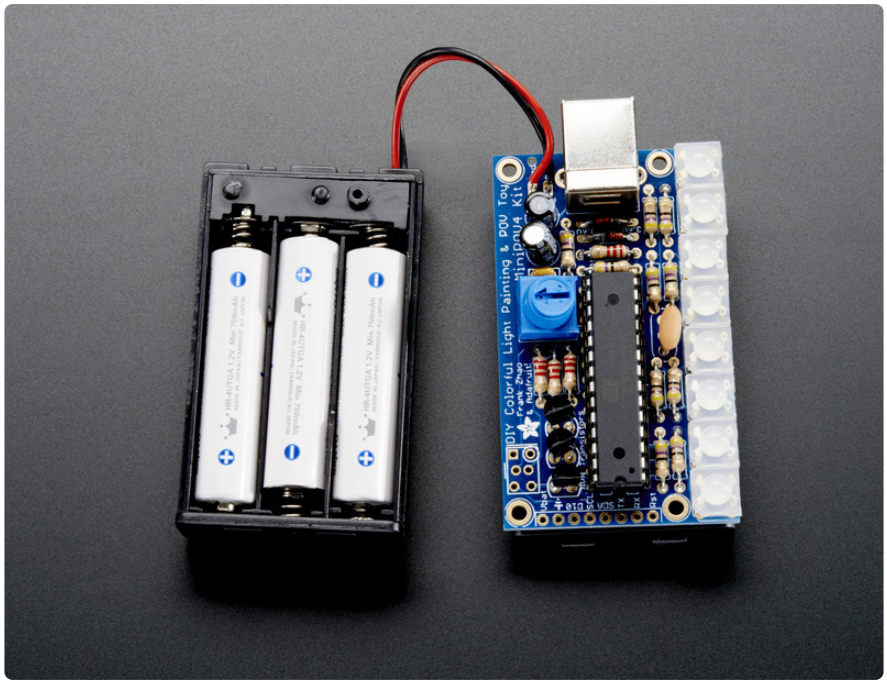
Make it!

Building this kit is a great way to learn soldering and electronics assembly. Its best to build this kit when you have a few hours to devote to the kit, so that you aren't rushed. Making a mistake in soldering can take a bit of time to fix so by following each step fully you will have a great experience without frustration!

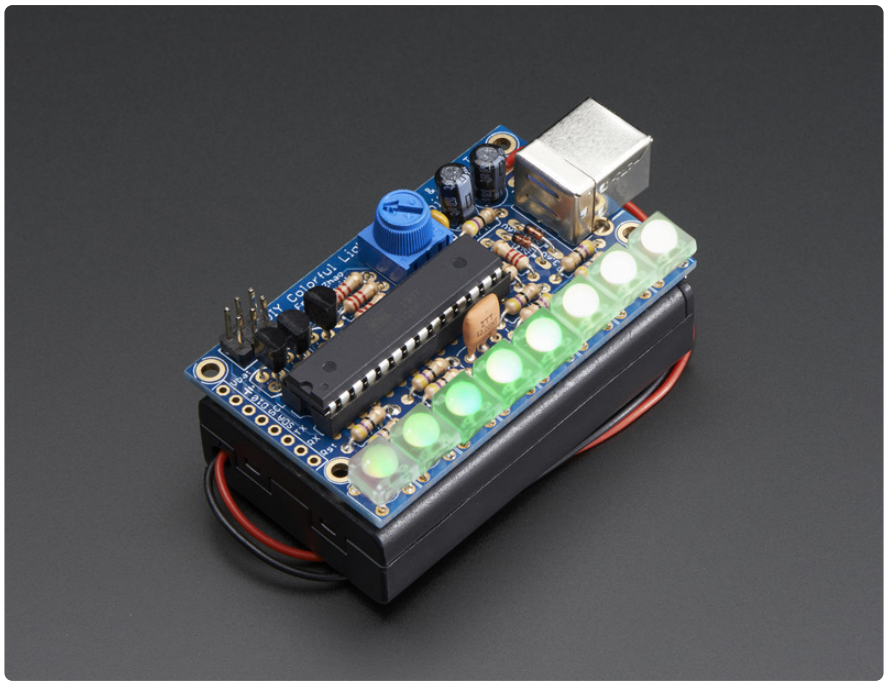
Testing

Before you go further, make sure you have three AAA batteries, they'll need to be good batteries but can be alkaline or rechargables.

Insert the batteries into the battery holder

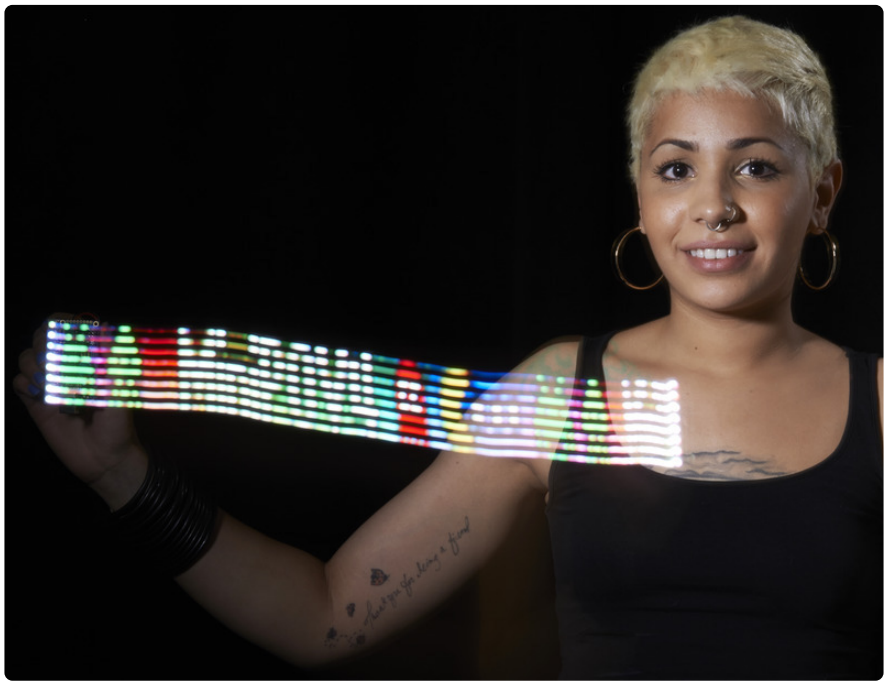


And flip the ON/OFF switch to **ON**



Wait three seconds for the MiniPOV to 'boot' and you'll see the red, green and blue LEDs light up in order

Then the LEDs will flicker white. This is how it looks when not moving. Turn off the lights and wave the MiniPOV around to see the light display!



Angel demos the MiniPOV4!

OK next up we'll check to make sure we can connect to it on the computer before finishing up.

Upload Images

Install Windows Drivers

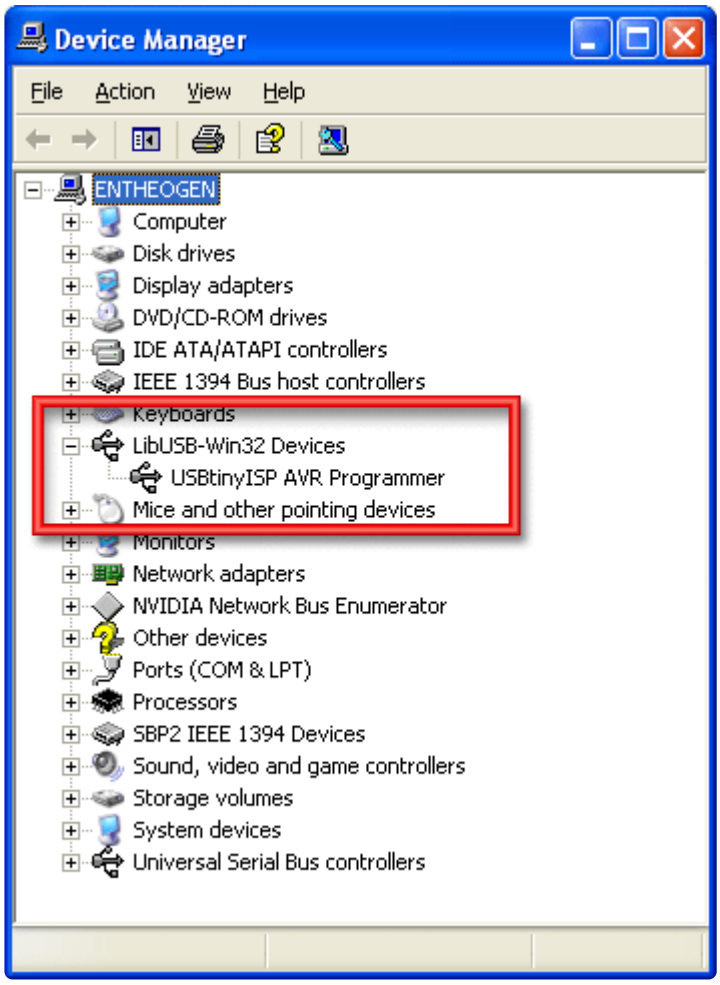
If you are using Windows, you'll need to install the USB driver for the MiniPOV4.

Drivers are only required for Windows, if you are using a Mac or Linux, drivers are not required!

For details on installing the drivers for Windows XP, 7, 8 etc... please read this page! (https://adafru.it/cDY)

Turn off the MiniPOV4 and plug in the USB port to a USB cable and your computer. Now turn on the MiniPOV4. You should get this popup (or similar)

Once recognized, windows will ask you for a driver location. Point it at the uncompressed zip file. When done, you will be able to see the **USBtiny** device in the Device manager (you can get to the device manager from the Control Panel)



Mac users do not need any driver installation!

Download Software

Once you know the MiniPOV is blinking right, we can upload brand new images! Start by downloading the MiniPOV4 programming software. Uncompress the zip file and save it to your desktop!

Download the MiniPOV4 software

https://adafru.it/djx

Processing v3 is not suported, use v2.0.3!

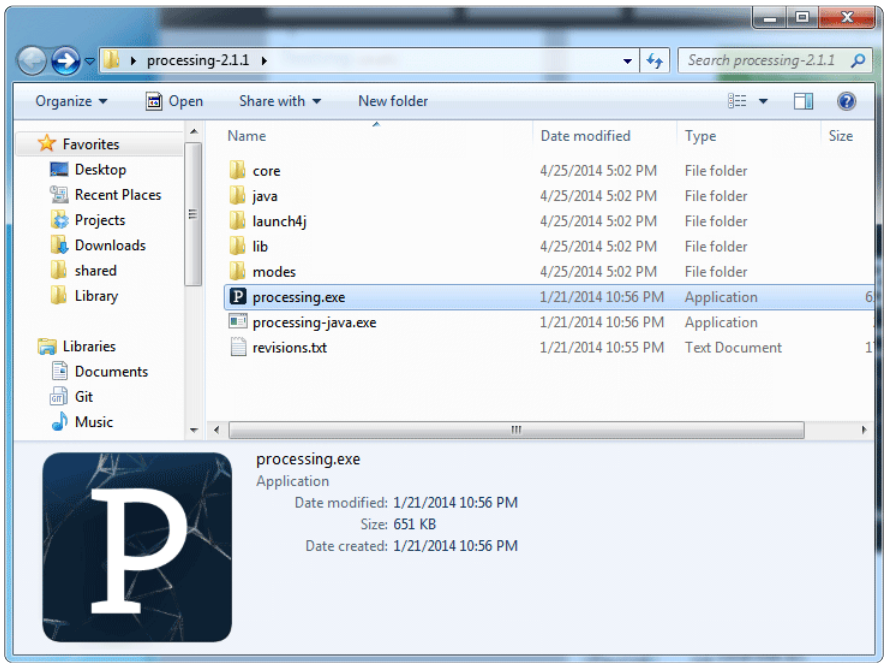
You'll also need a copy of **Processing** - a graphics framework we'll be using to do all the image conversion. You can grab Processing for free here - please download version **2.0.3** (https://adafru.it/cQW)

In addition, please download the controlP5 library for processing (https://adafru.it/djs) you can download it directly by clicking below

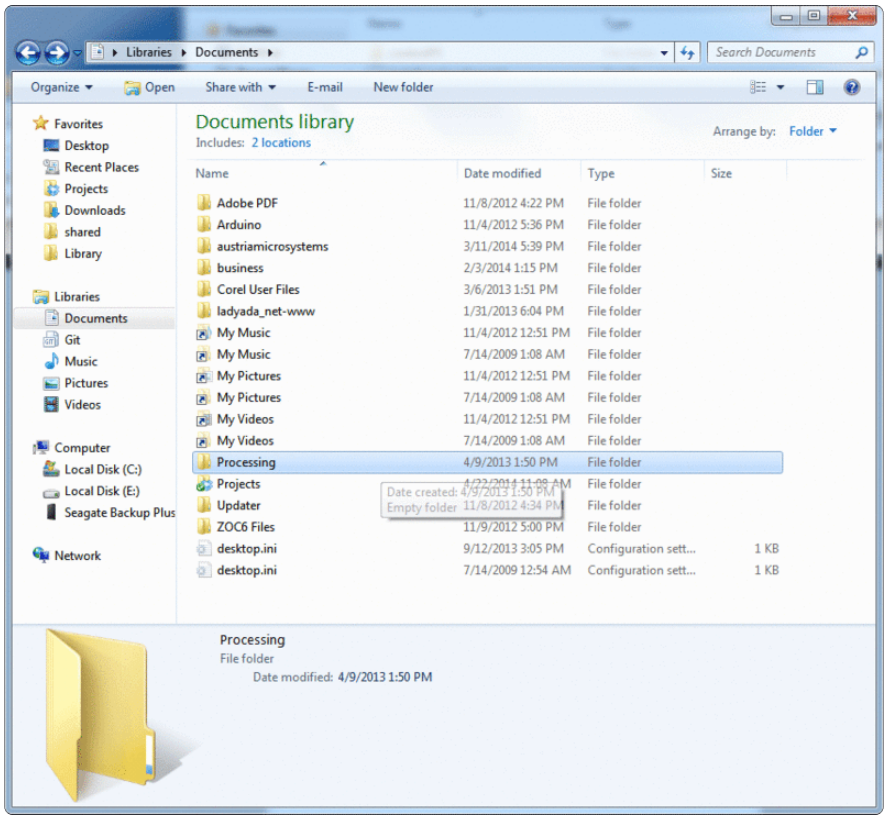
Download ControlP5 Library

https://adafru.it/djt

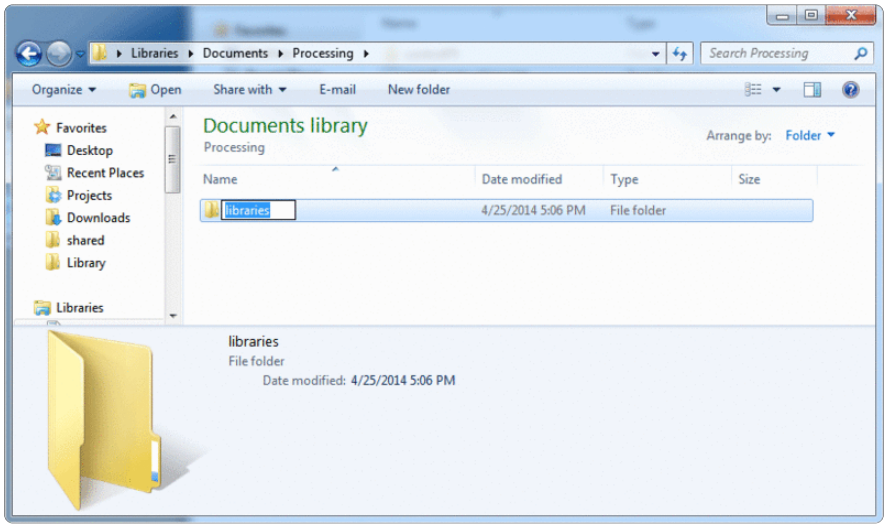
Run Processing once and then quit. This will create the processing sketchbook folder.



Now you will have to install the ControlP5 library. Start by unzipping/uncompressing the ControlP5.zip folder you downloaded. Inside will be two folders, one called **controlP5** and one file with install instructions. Follow the install instructions, for windows & mac users, go to your **Documents Folder** and find the new **Processing** subfolder in there

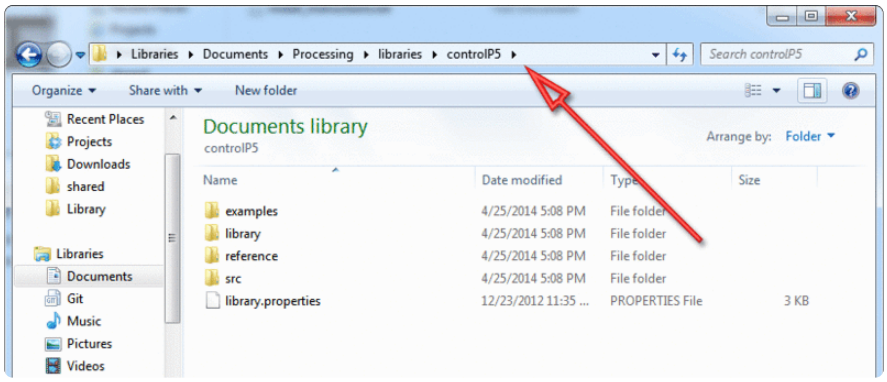


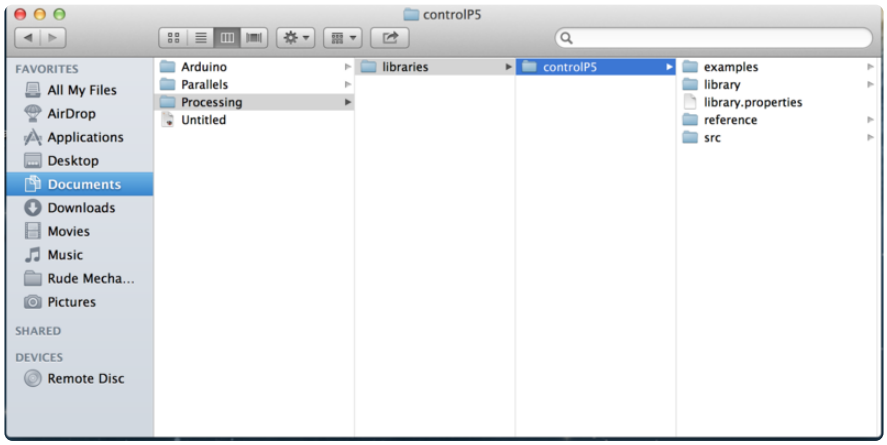
Create a new folder in there called **libraries**



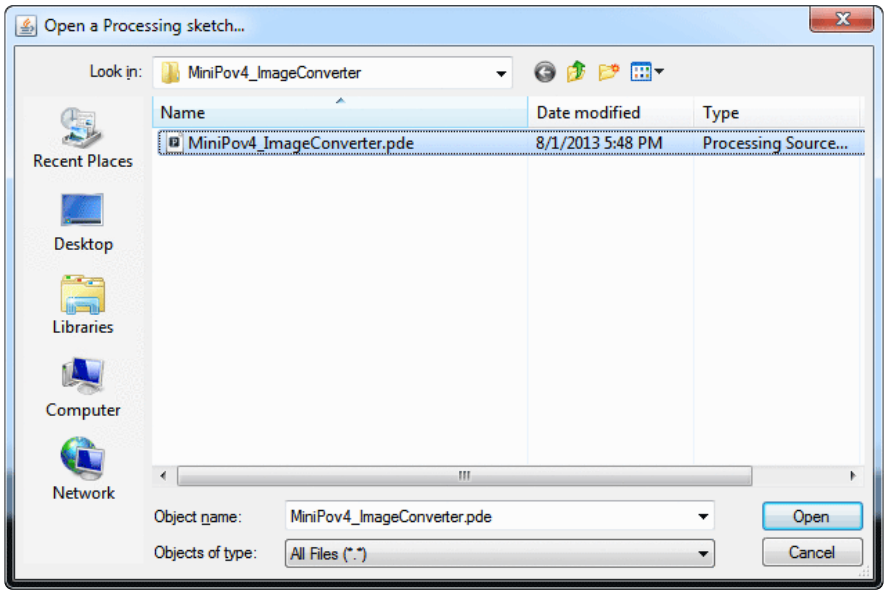
Inside **that** folder, place the **ControlP5** folder

So filewise, you will have **My Documents/Processing/libraries/ControlP5/library.properties** (and the other library files!)

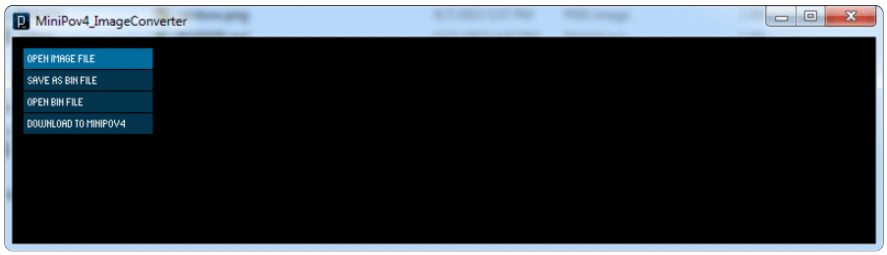




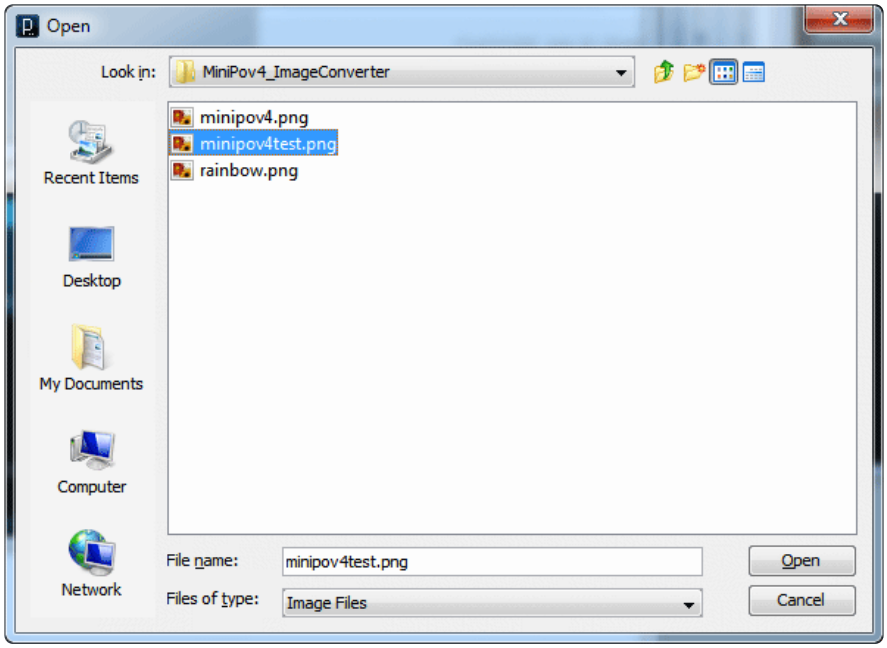
Whew. Now make sure you quit any copies of Processing and start it up again from scratch. Open up the uncompressed **MiniPOV4 Image Converter** pde file



Select the **Sketch->Run** menu item to start it up!

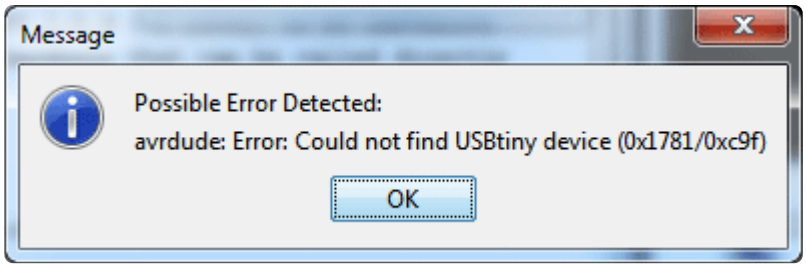


Click **Open Image File** to load a new 8-pixel tall **PNG** file - lets use the **minipov4test.png**



Click **Download To Minipov4** to send the image over. You will see the LEDs light up red/green/blues as the download completes

If there's a problem



If you get an error message, check: is the MiniPOV kit turned on and plugged into USB? remember you need to turn it on with batteries in when its plugged into USB!

Make your own images!

Use your favorite image software to create your own images. For best results, make sure its 8-pixels tall, and 8-bit color. Save as a PNG file if possible. Remember that black pixels are "LEDs off" and white pixels are "LEDs on"

More Usage Tips

Adjusting the POV speed

Remember soldering in that blue potentiometer? You can twist that to adjust the 'speed' of the POV effect. Depending on how you are doing your light painting you can adjust it up and down.

Re-programming the chip (advanced)

The chip in the MiniPOV4 is programmed with a USB bootloader that looks like a USBtinyISP. That means: if you are an advanced user you can use the bootloader with **avrdude** or **Arduino IDE** and selecting USBtiny as the upload protocol!

The EEPROM section of the chip is what holds the 'image', the firmware is in "Arduino-ese" and can be adjusted and reprogrammed by selecting **USBtinyISP** as the programmer and holding down shift when clicking upload

More Pins!

There are a few unused pins, we broke them out on the edge of the PCB in case you

want to connect sensors, switches or other devices. The unused pins are the serial UART rx/tx pins and the i2c/analog pins **A4** and **A5** (in arduino-pin notation)

Downloads

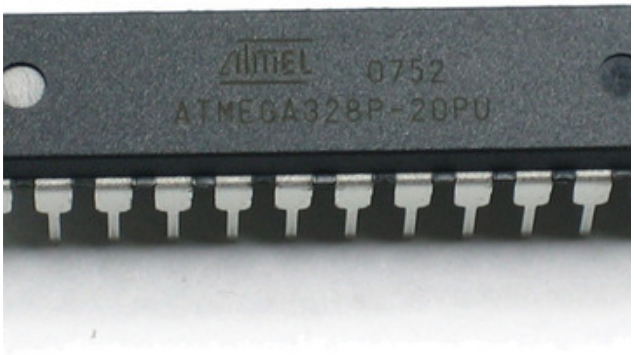
Software

- Download the image converter/uploader tool (requires Processing 2.0+) (https://adafru.it/djq)
- Download Processing here (https://adafru.it/cQW)
- Windows driver (signed drivers, works with Windows 8) (https://adafru.it/djr)

Firmware, PCB files

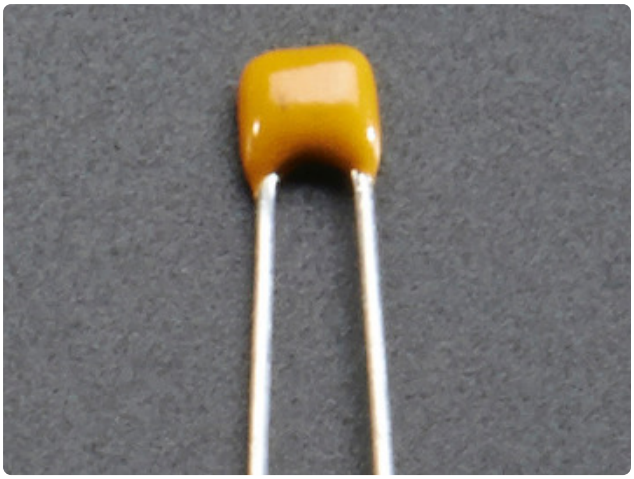
Check out the GitHub repository for more advanced source files including PCB files, bootloader code, etc. (https://adafru.it/dju)

Parts List

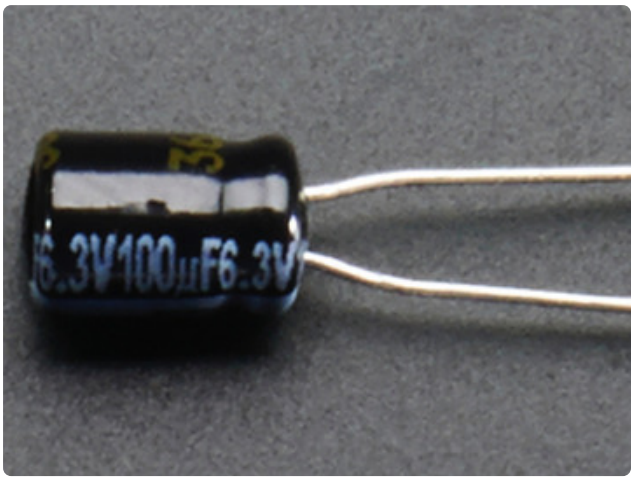


1 x Programmed 8-bit Microcontroller - Atmega328P-PU

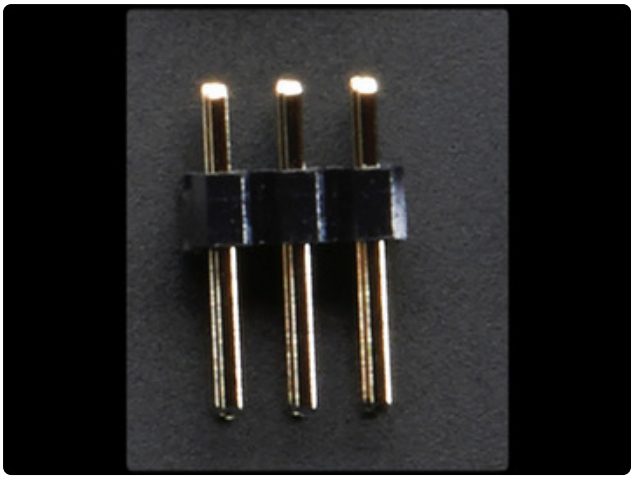
4x 2.2K 5% 1/4W Resistor



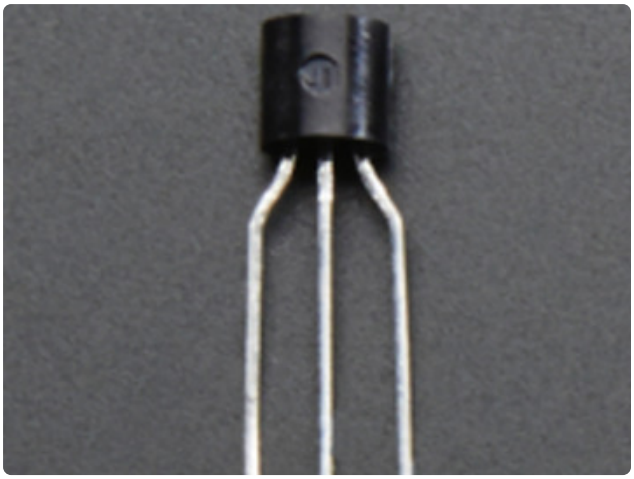
1x 0.1uF Ceramic Capacitor



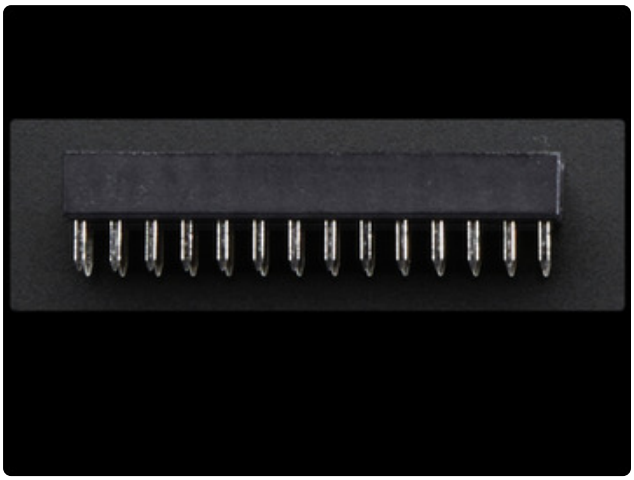
2x 100uF/6V Capacitor



1x 2x3 Male Header - 0.1"



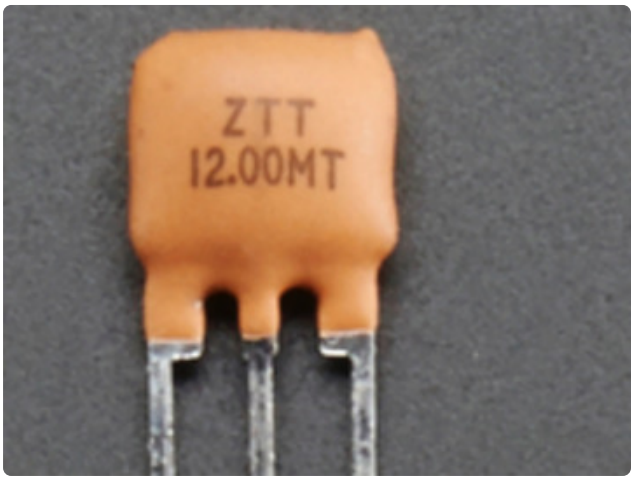
3x PN2222 - General Purpose Transistor



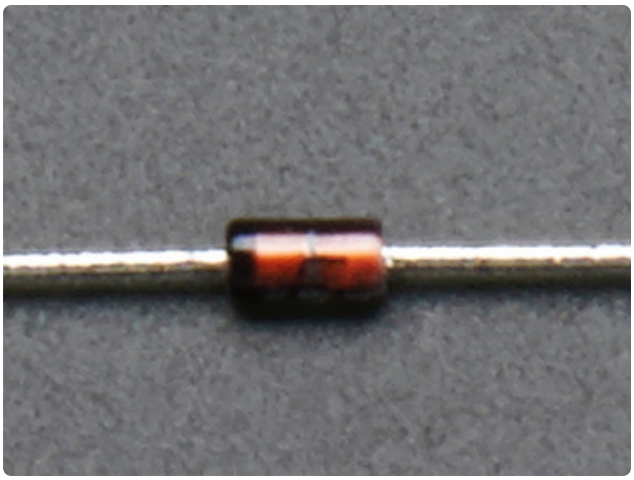
1x 28-pin socket

10x 47ohm 5% 1/4W Resistor

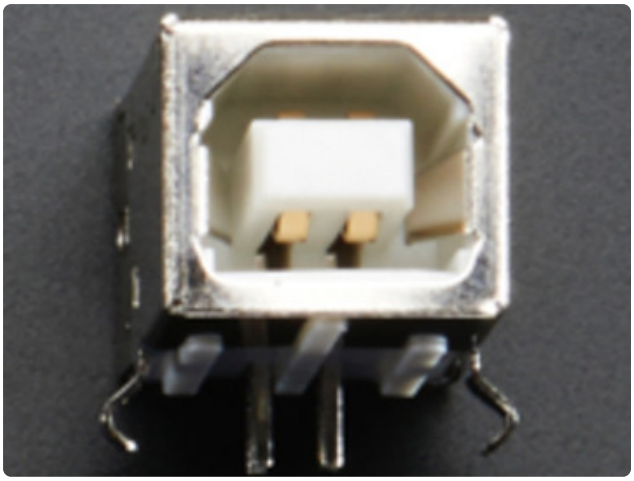
1x Foam Tape - Rectangle



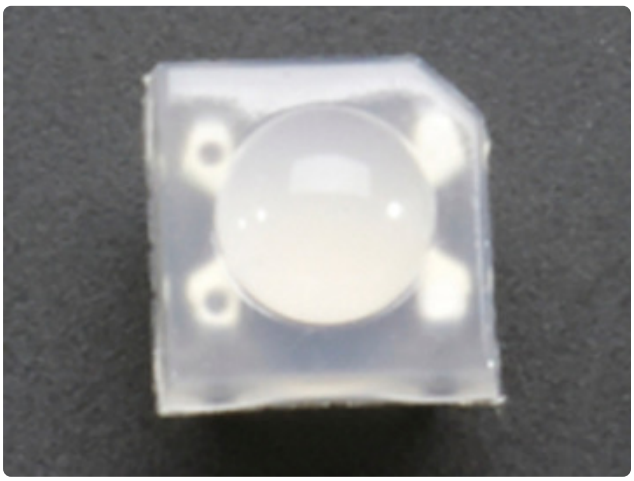
1x 12MHz Ceramic Oscillator



2x 3.6v Zener Diode



1x USB B-type Jack



8x Diffused 'Piranha' RGB LEDs

1x MiniPOV 4 PCB

1x 10k Breadboard Trim Potentiometer (http://adafru.it/356)

1x 3xAAA Battery Holder with On/Off Switch and 2-pin JST (http://adafru.it/727)

Preparations

Learn how to solder with tons of tutorials! (https://adafru.it/aTk)
Don't forget to learn how to use your multimeter too! (https://adafru.it/aZZ)

Tools

There are a few tools that are required for assembly. None of these tools are included. If you don't have them, now would be a good time to borrow or purchase them. They are very very handy whenever assembling/fixing/modifying electronic devices! I provide links to buy them, but of course, you should get them whereever is most convenient/inexpensive. Many of these parts are available in a place like Radio Shack or other (higher quality) DIY electronics stores.

Soldering iron

Any entry level 'all-in-one' soldering iron that you might find at your local hardware store should work. As with most things in life, you get what you pay for.

Upgrading to a higher end soldering iron setup, like the Hakko FX-888 that we stock in our store (http://adafru.it/180), will make soldering fun and easy.

Do not use a "ColdHeat" soldering iron! They are not suitable for delicate electronics work and can damage the kit (see here (https://adafru.it/aOo)).

Click here to buy our entry level adjustable 30W 110V soldering iron (http://adafru.it/180).

Click here to upgrade to a Genuine Hakko FX-888 adjustable temperature soldering iron. (http://adafru.it/303)

Solder

You will want rosin core, 60/40 solder. Good solder is a good thing. Bad solder leads to bridging and cold solder joints which can be tough to find.

Click here to buy a spool of leaded solder (recommended for beginners) (http://adafru.it/145).

Click here to buy a spool of lead-free solder (http://adafru.it/734).

Multimeter

You will need a good quality basic multimeter that can measure voltage and continuity.

Click here to buy a basic multimeter. (http://adafru.it/71)

Click here to buy a top of the line multimeter. (http://adafru.it/308)

Click here to buy a pocket multimeter. (http://adafru.it/850)

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Click here to buy a pocket multimeter. (http://adafru.it/850)

Flush Diagonal Cutters

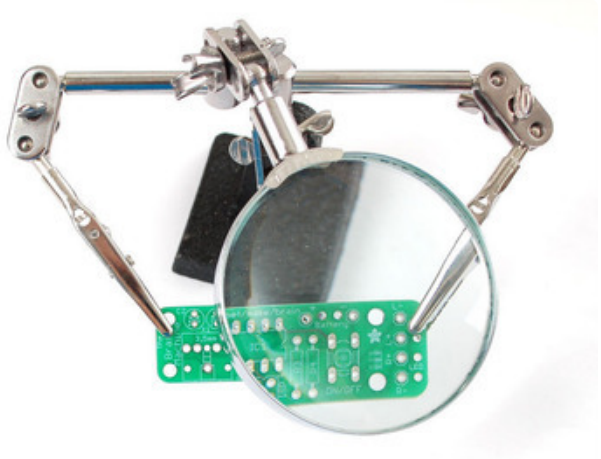
You will need flush diagonal cutters to trim the wires and leads off of components once you have soldered them in place.

Click here to buy our favorite cutters (http://adafru.it/152).

Solder Sucker

Strangely enough, that's the technical term for this desoldering vacuum tool. Useful in cleaning up mistakes, every electrical engineer has one of these on their desk.

Click here to buy a one (http://adafru.it/148).



Helping Third Hand With Magnifier

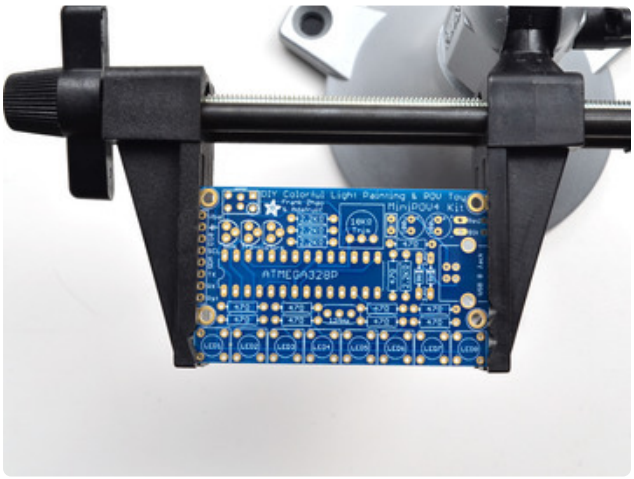
Not absolutely necessary but will make things go much much faster, and it will make soldering much easier.

Pick one up here (http://adafru.it/291).

Solder up

Solder It!

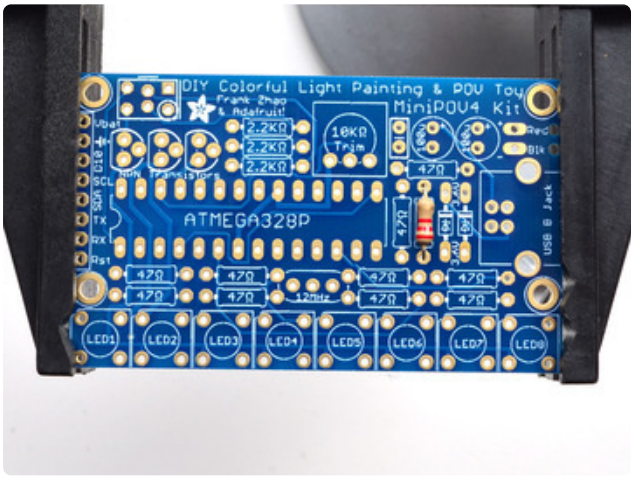
The first step is to solder the kit together. If you've never soldered before, check the Preparation page for tutorials and more.



Place the PCB in a vise, and turn on the soldering iron.

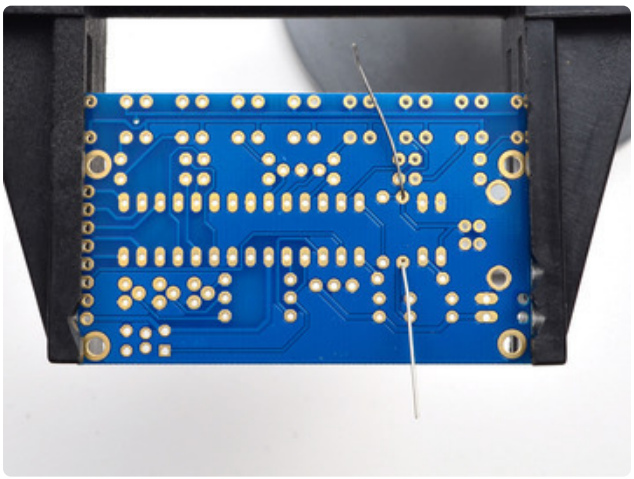
Make sure you have all the tools you'll need to assemble the kit (https://adafru.it/map).

If you don't know how to solder, we suggest checking out the videos in the link above. They're quite good! Keep them in a window so you can watch and review as you work through the kit



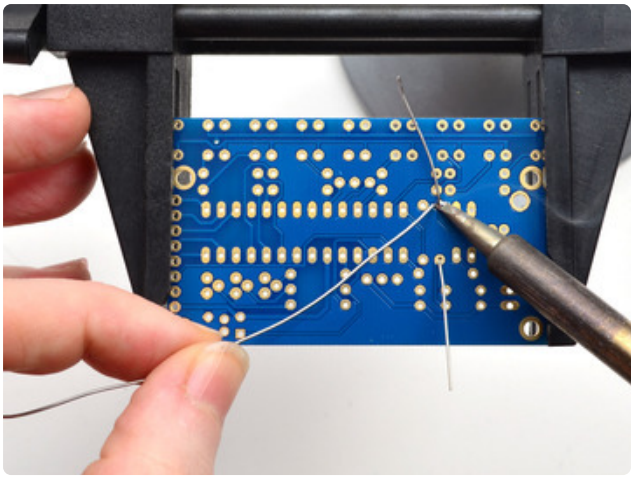
The first part we will place is a resistor - this is a small oval tan thing with two wires (leads) and color stripes. The stripes are **red red red** which indicates a 2.2K resistor. This particular resistor is used in the MiniPOV4 kit to let the computer know we've plugged in the USB port when it comes time to upload a new image. The resistor goes right in the middle, over the silkscreen text that says **2.2K**.

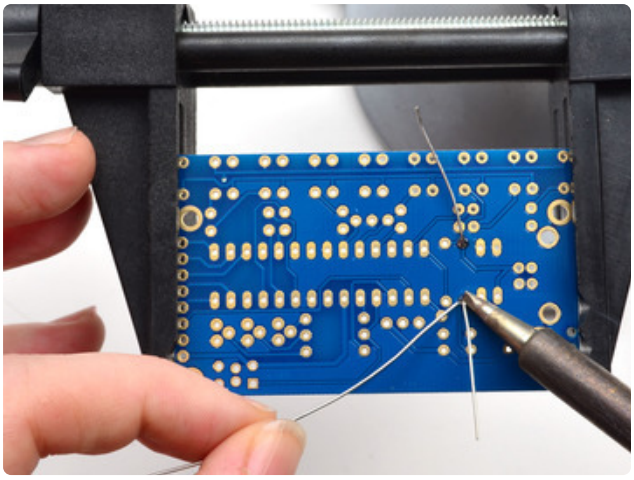
Resistors are **non-polar** which means they don't have a direction: you don't have to worry about putting it in 'backwards' because they work the same either way



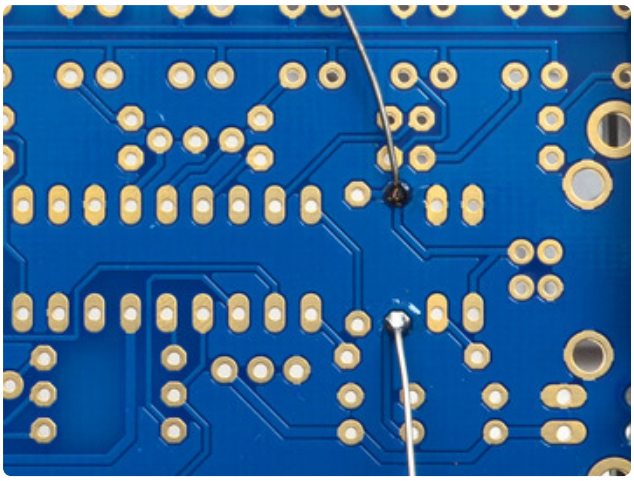
Bend the resistor into a staple and slip it onto the top of the Printed Circuit Board. Bend the little leads out so that you can flip over the PCB and the resistor will stay in place.

The resistor sits flat right up against the PCB and the leads hold it in place when bent

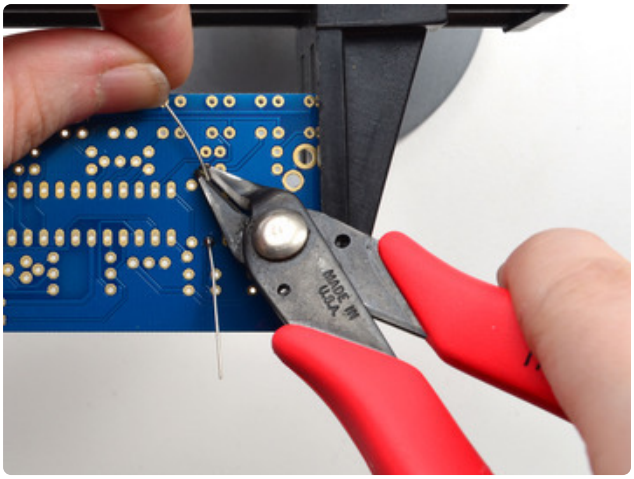


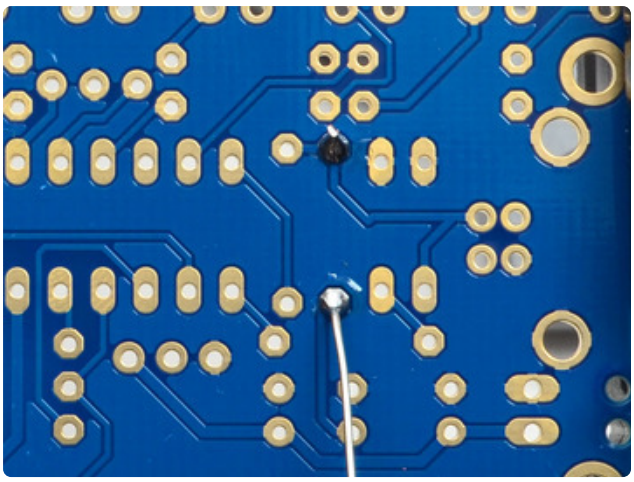


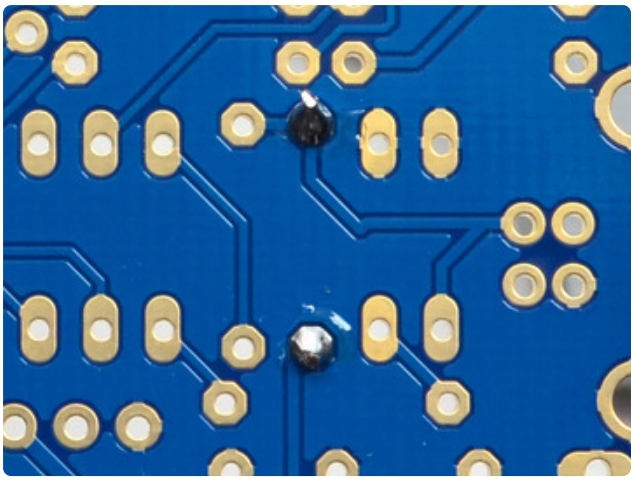
Now you'll solder! Place the flat of the soldering iron tip against the silver ring (pad) and one of the wires of the resistor (lead) at the same time for 2 seconds. This will heat them both up to 600-700 degrees. Then poke the end of the solder so that it flows into the hole and forms a solder joint.



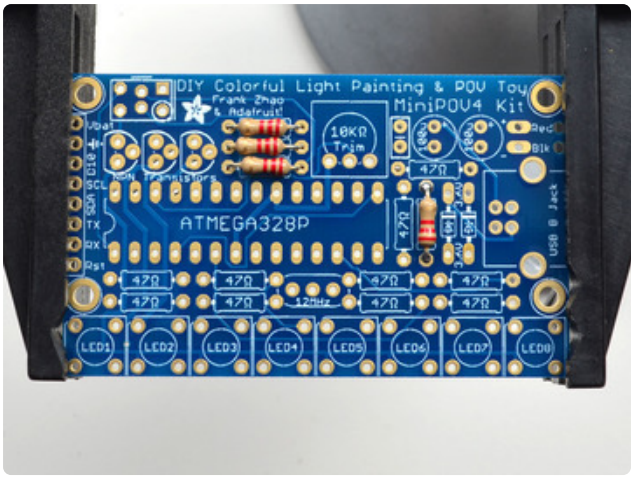
Solder joints should be smooth and shiny and fill the entire pad, wicking up to the lead. You shouldn't be able to wiggle the wire and have it move in the hole.

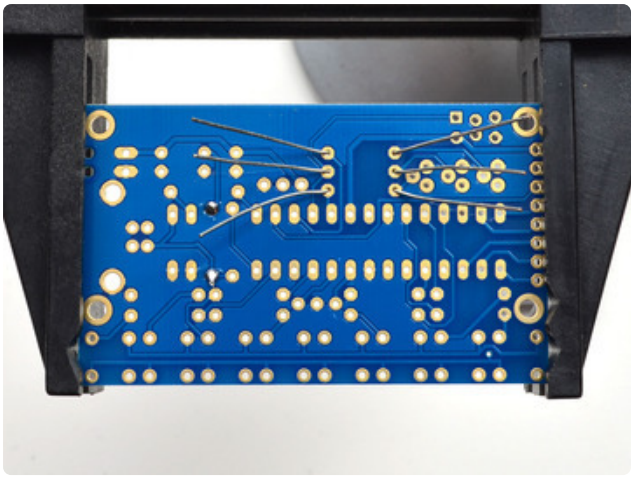






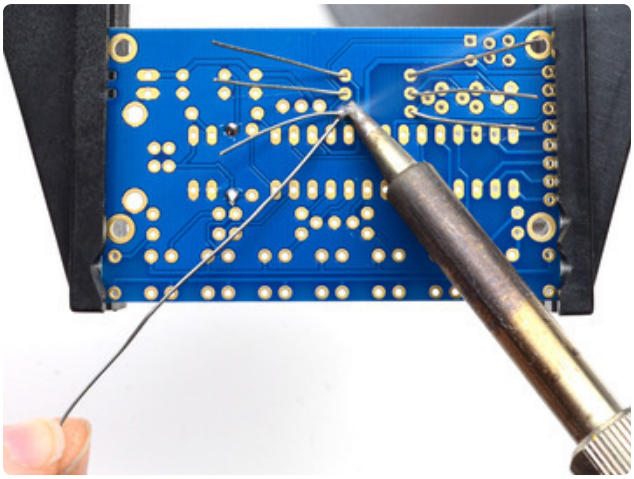
Now we will get rid of all that excess wire. Use your diagonal nippers to clip the wire just above the end of the solder joint. There should be almost no 'wire' sticking out.

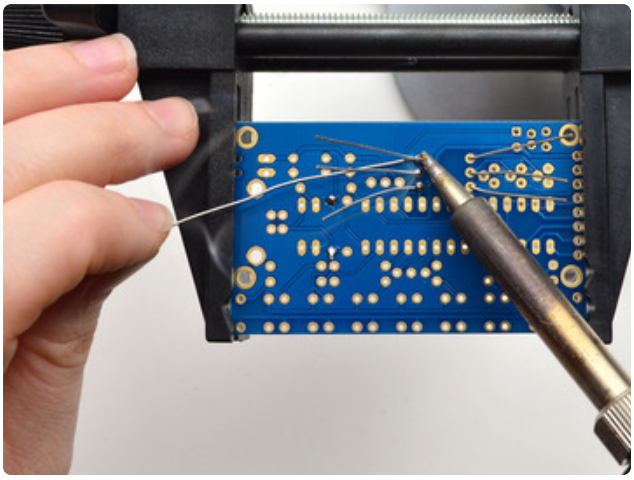


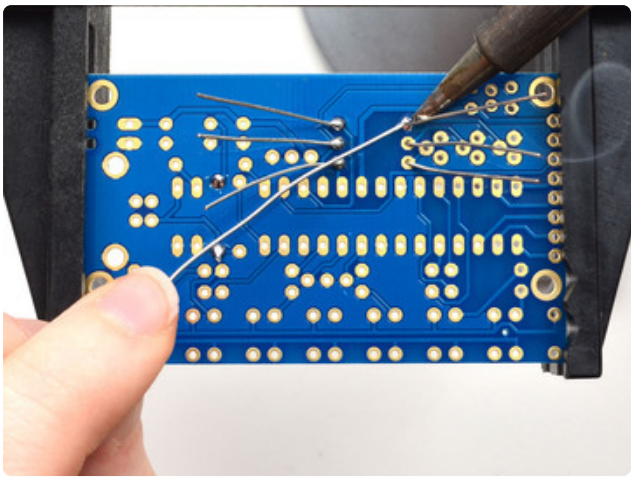


Next up we'll do the other three **2.2K** resistors. These three resistors are the **base current resistors** for the transistors. They are used to balance out the amount of current going into the transistors so that they are not overloaded by the microcontroller.

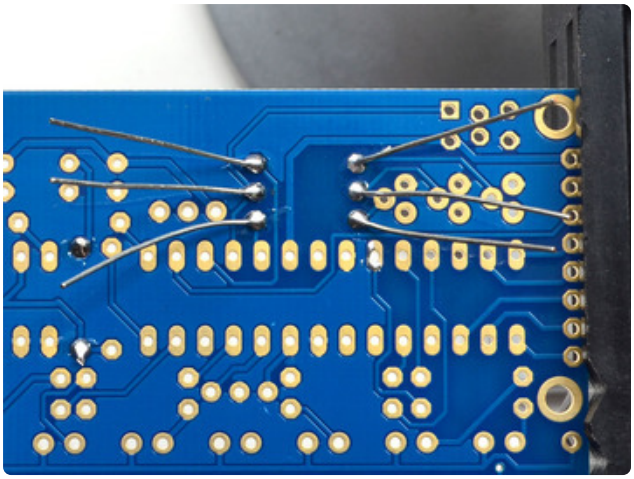
They go three in a row all next to each other. Again, the colors are **red red red** and they are non-polar so they can go in 'either way'



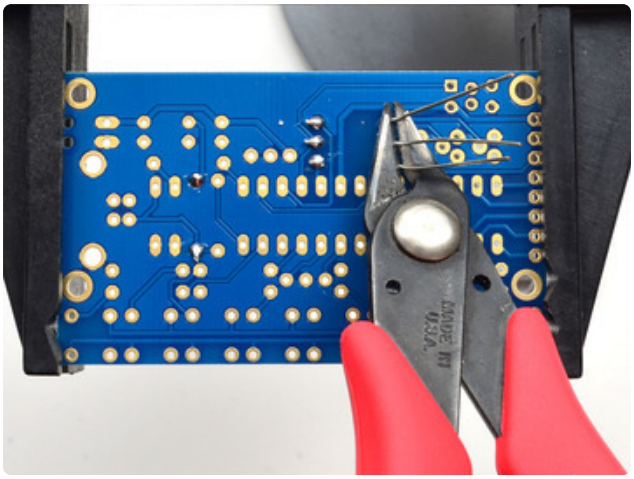




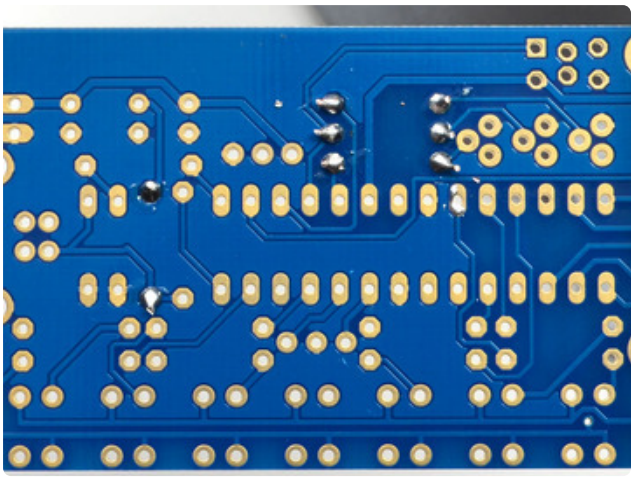
Flip over the kit and solder in these three resistors. You can do one at a time, or all three at once if you feel up to it!

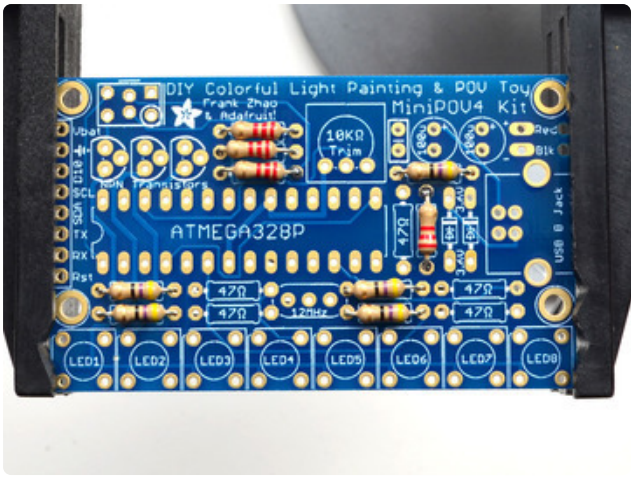


Check your soldering after done to make sure each solder point is nice and neat and shiny!



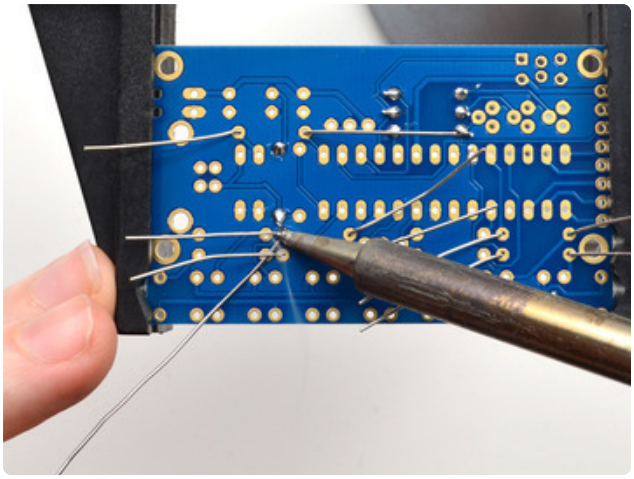
Now you can clip the long legs, all six!

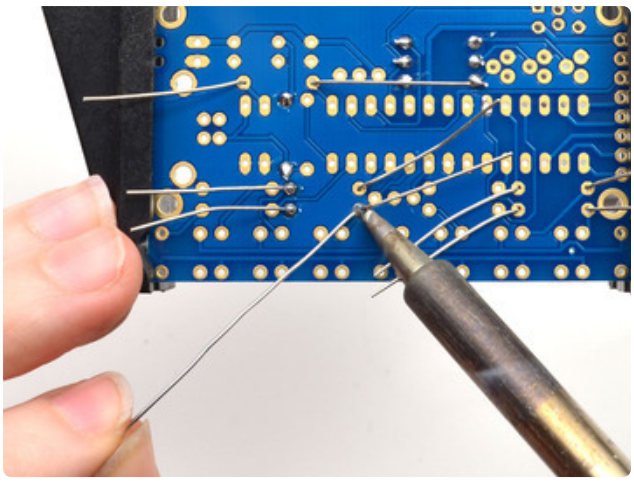




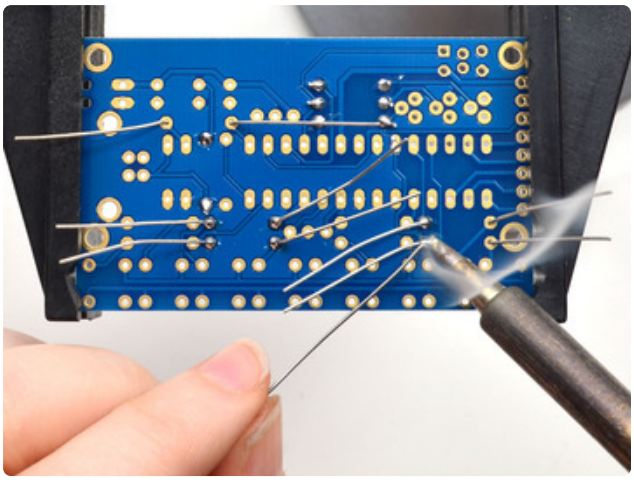
Now that we are done with the **2.2k** resistors we'll move onto the **47 ohm** resistors. These smaller resistors are used to set the brightness of the LEDs. LEDs need current-setting resistors so that they don't burn out from too much current! We also have two we use for the USB data connection, plus 8 for the 8 LEDs makes for 10 total.

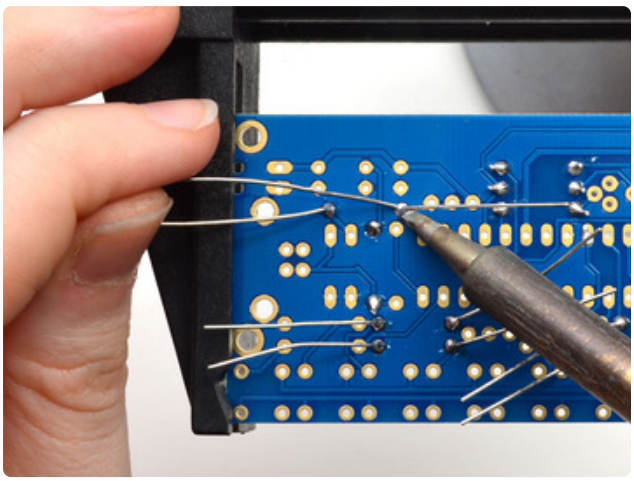
These resistors have the **yellow violet black** color stripes. There's quite a few so we're going to do half at a time. Start by placing these four.

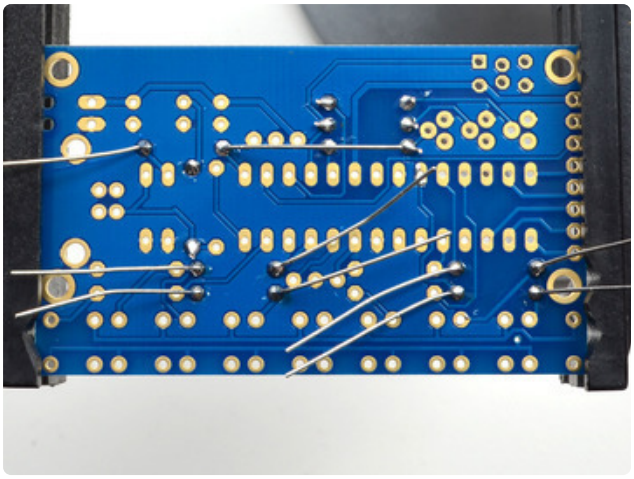


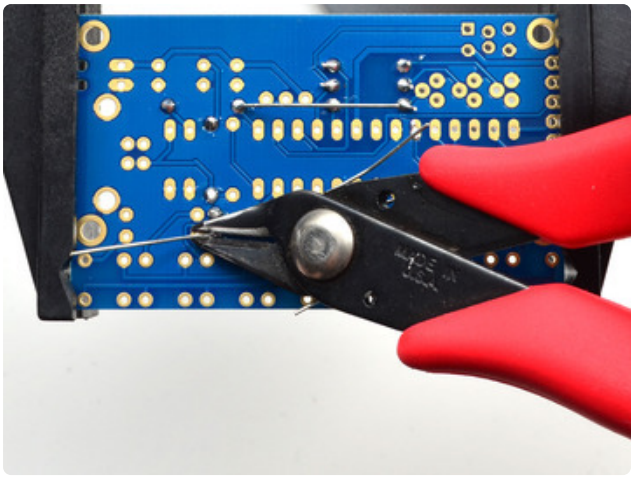


Solder up all 8 solder points. You can clip the leads as you go if they're in the way.

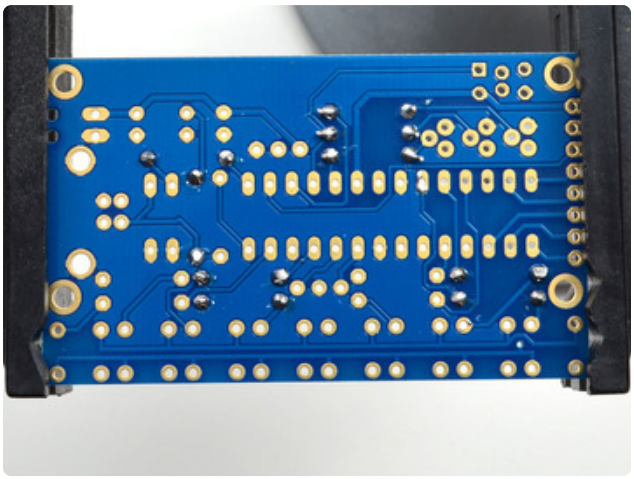


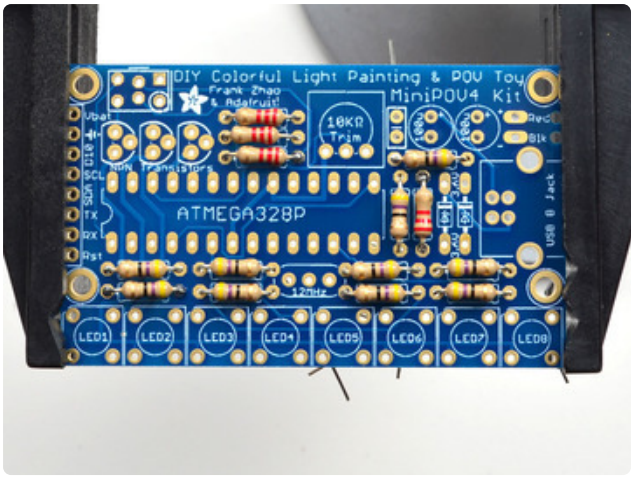




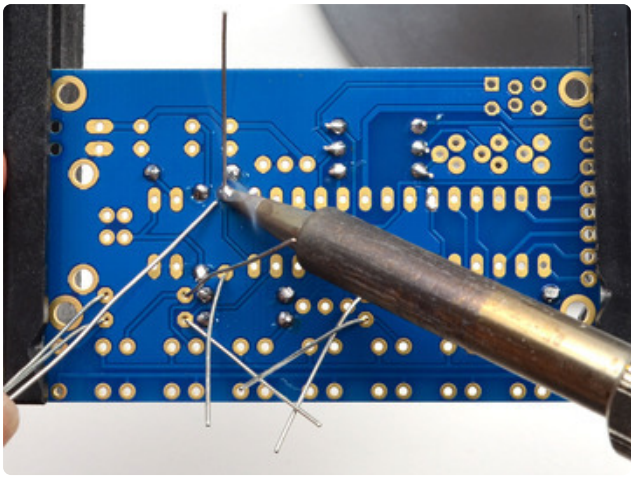


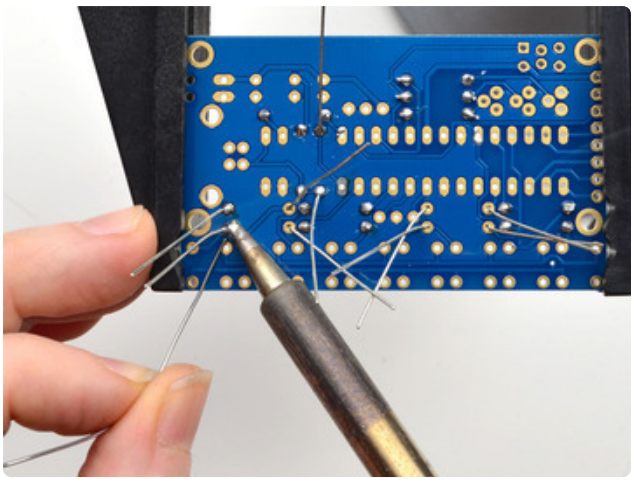
Check your work, then clip the leads off cleanly.

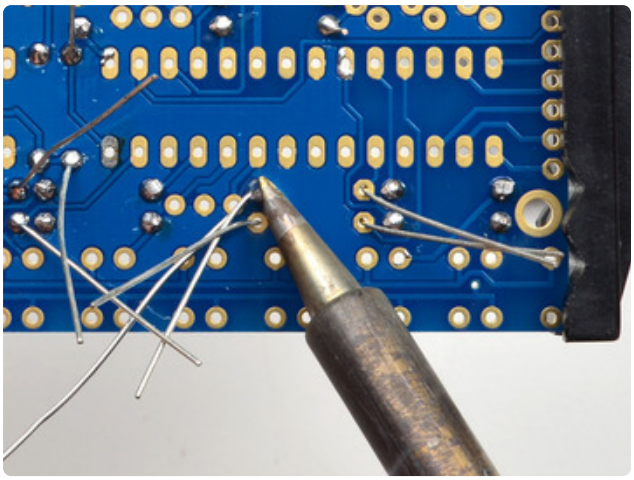


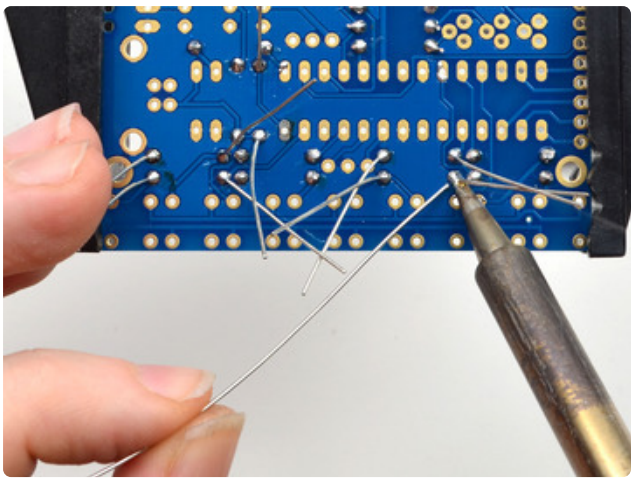


Place the remaining 47 ohm resistors over their silkscreens as shown.

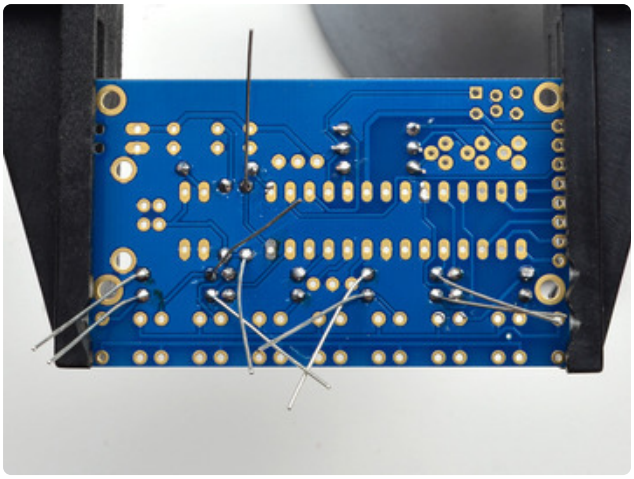


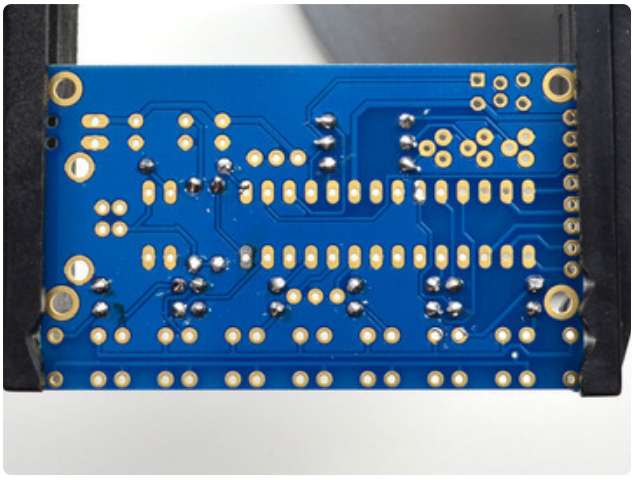




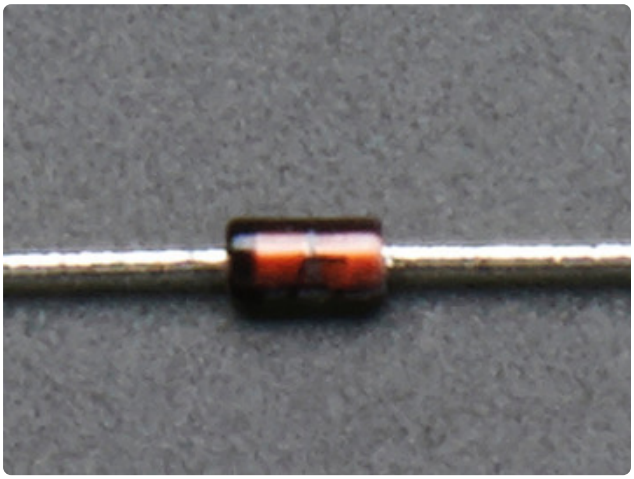


Solder the remaining resistors! Finally we have done all the resistor components



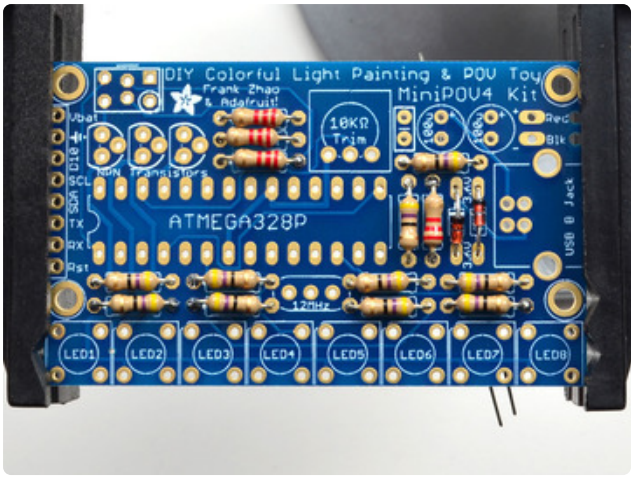


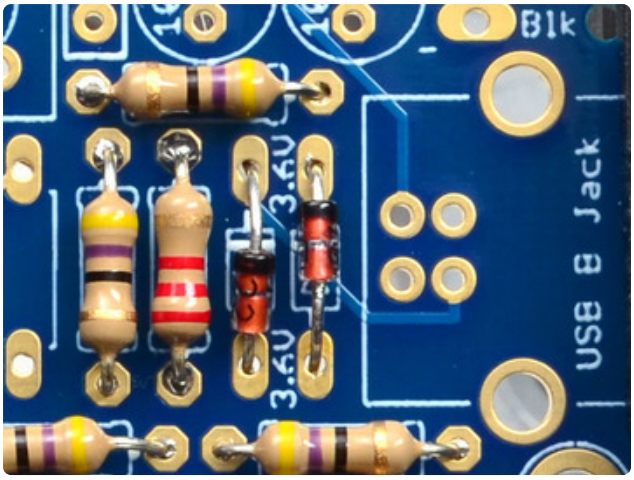
Check your soldering work, and then clip the leads



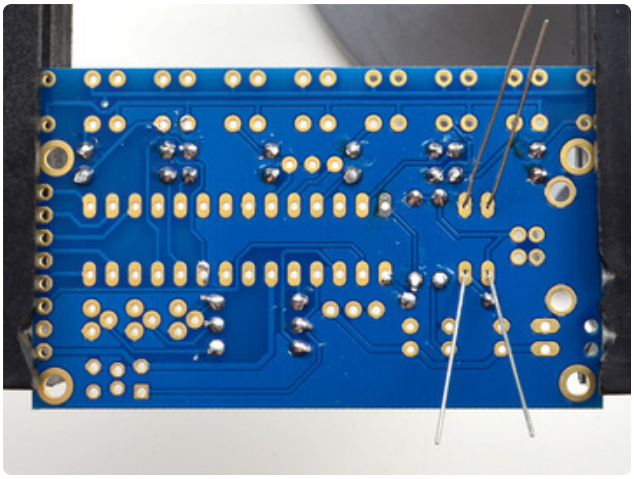
Next up we will do the **Zener Diodes** - these are semiconductor devices that only let current go one way. These particular ones are used for the USB interface to keep the voltages stable on the USB data lines.

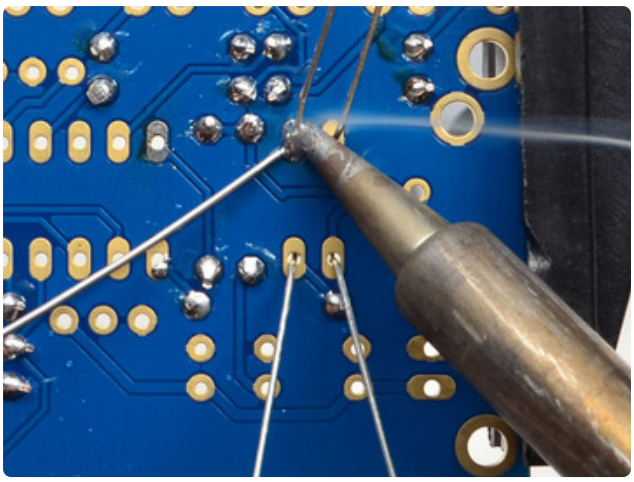
Zener Diodes are directional! So you should pay attention to make sure you place them correctly. The Diodes have a little black mark at one end.



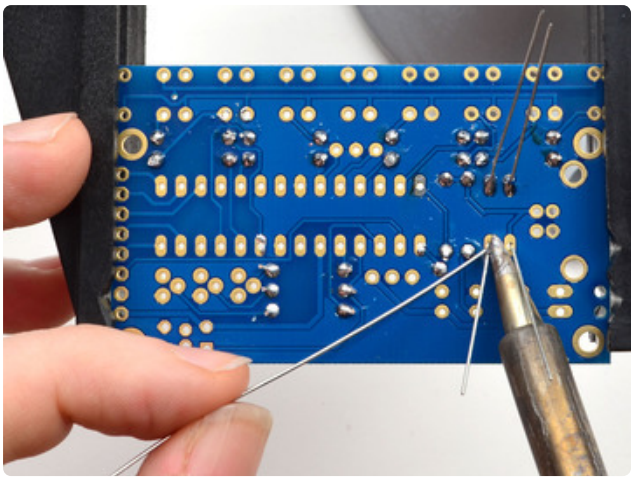


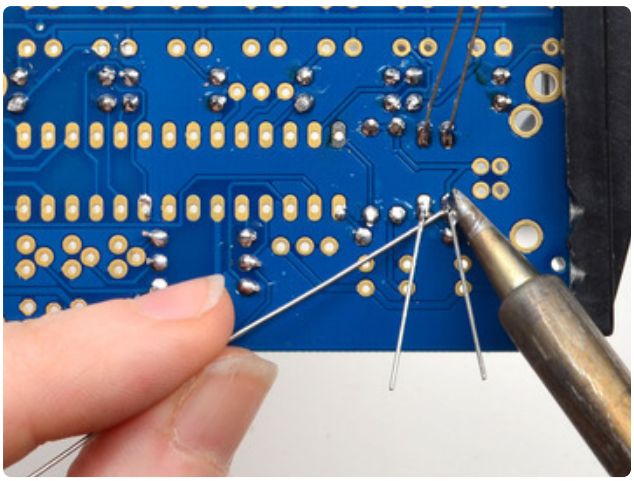
Place the dioes in the two spots next to the USB jack. You'll notice on the silkscreen for the diodes there's a white stripe mark. That white stripe matches the same end of the diode with the black stripe. Check the photos to make sure you have the two diodes in the right way!

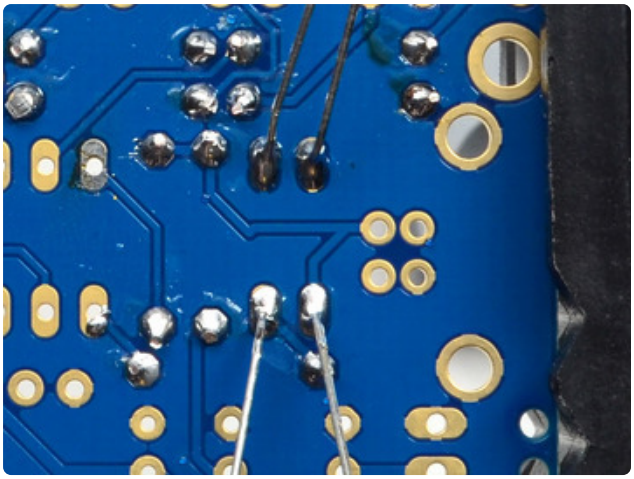




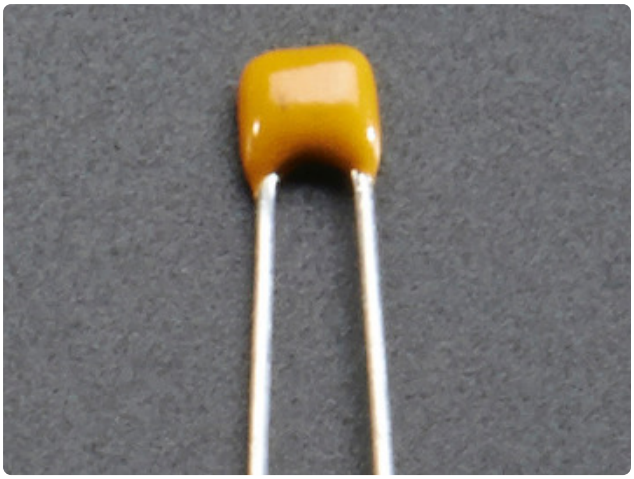
Flip the board over and solder in the two diodes.





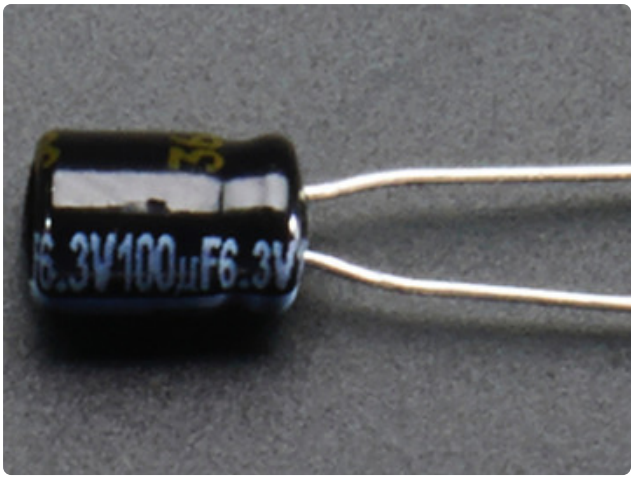


Check your work - then clip the leads.

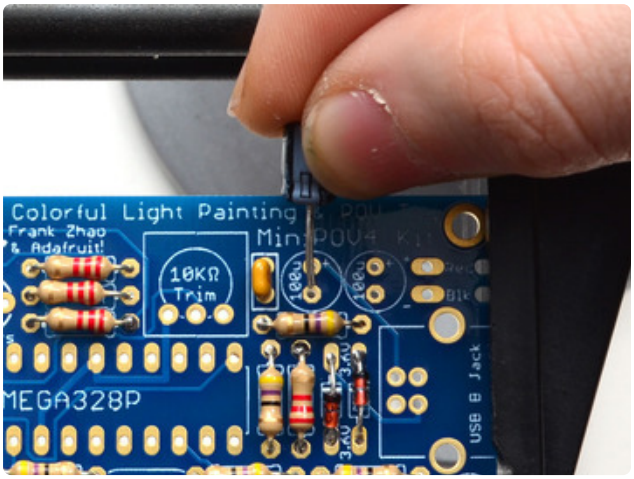


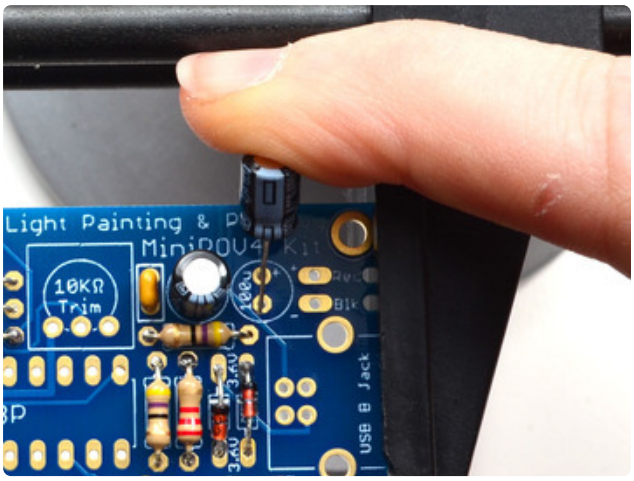
Next is the ceramic capacitor. **Capacitors** helps stabilize the output voltage, and filters out high frequency noise so that the battery voltage nice and smooth.

Place the capacitor so that the 2 legs (leads) slide thru the two metal holes in the PCB (pads). The capacitor will sit flat against the PCB. The capacitor goes right below the text on the top of the board, its the little yellow blobby thing.



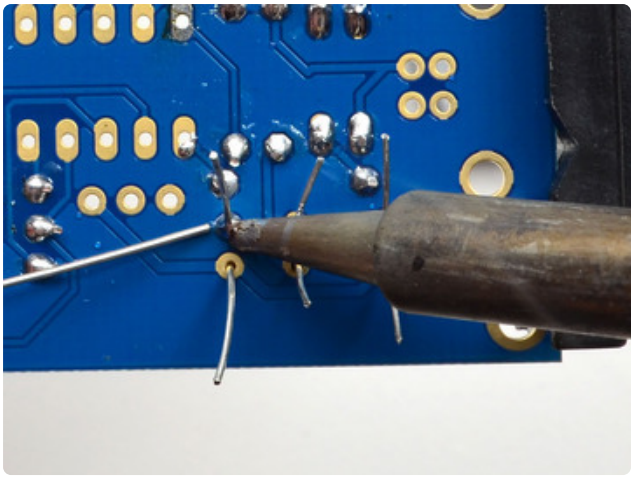
Next are the two electrolytic capacitors. These help smooth both the input and output voltages, to keep them stable during the up-conversion. They are used for low frequency noise, and are often paired with a ceramic capacitor.

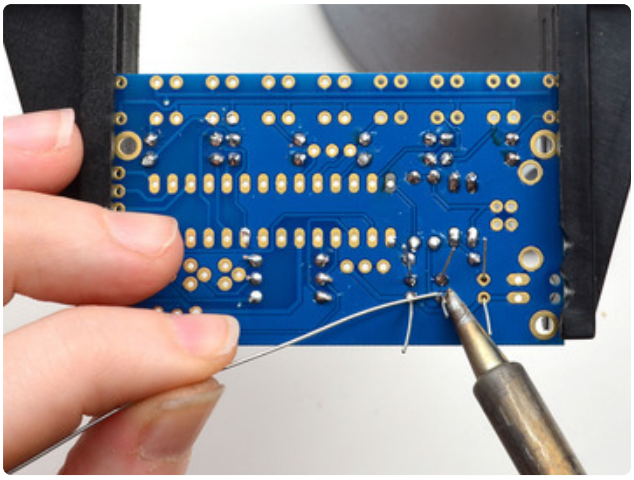




Electrolytic capacitors are polarized and must be placed correctly or the circuit will not work. Each capacitor has a side with a stripe on it, here its a white stripe with a big - symbol on it. This is the negative (-) side. This goes in the hole that isn't marked with a +

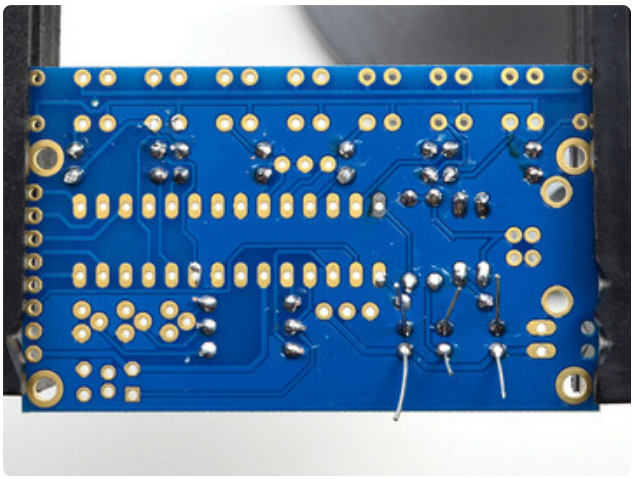
Check the photos to make sure you have the side with the strip in the right way before continuing

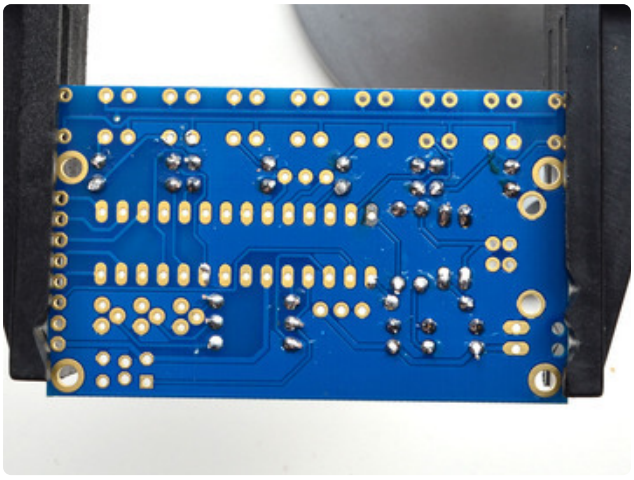


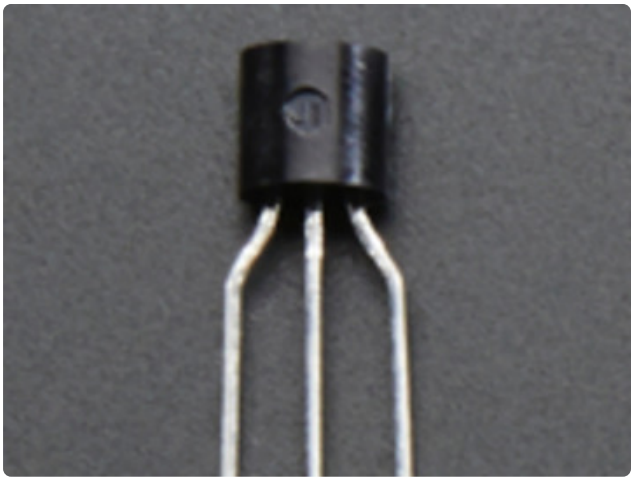


Now you can solder all three capacitors in at once!

Clip the leads when done

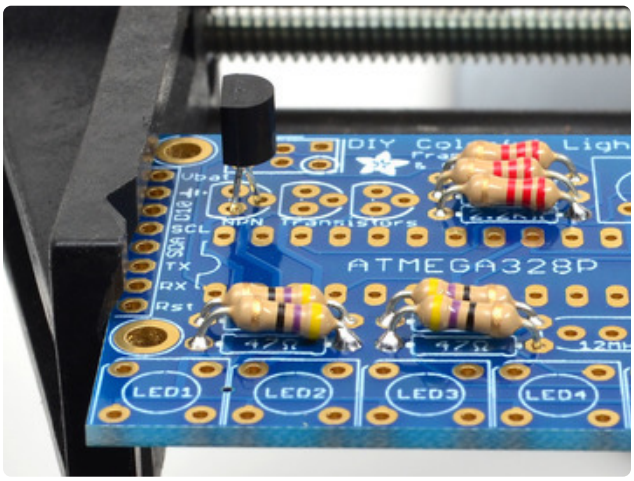


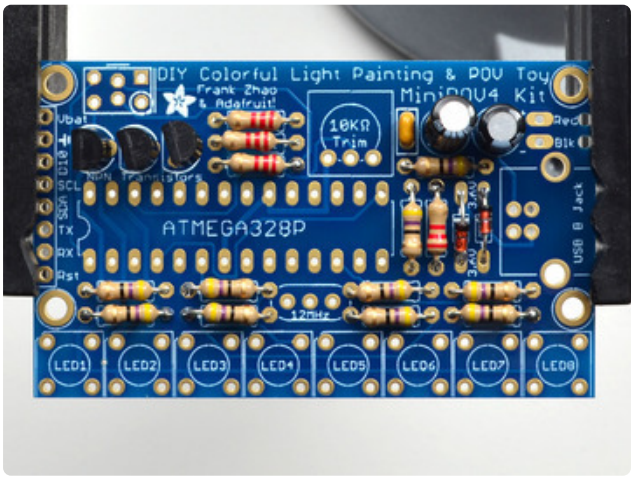




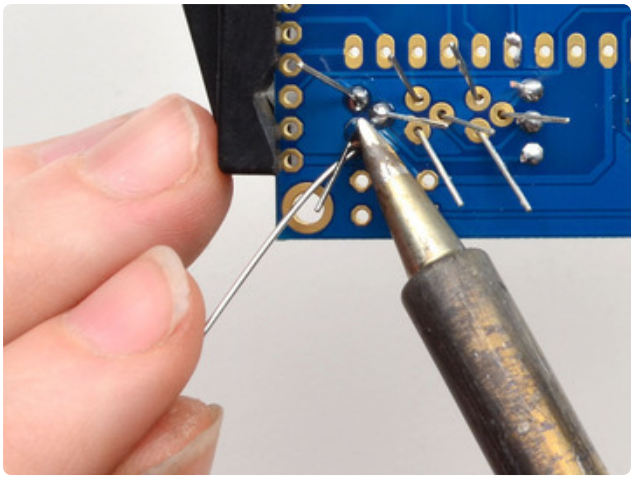
Next up we'll move beyond capacitors and resistors and diodes with only two pins and move up to **transistors**! Transistors are like the power-tools of electronics, they are strong so you can use them to 'heavy lifting'.

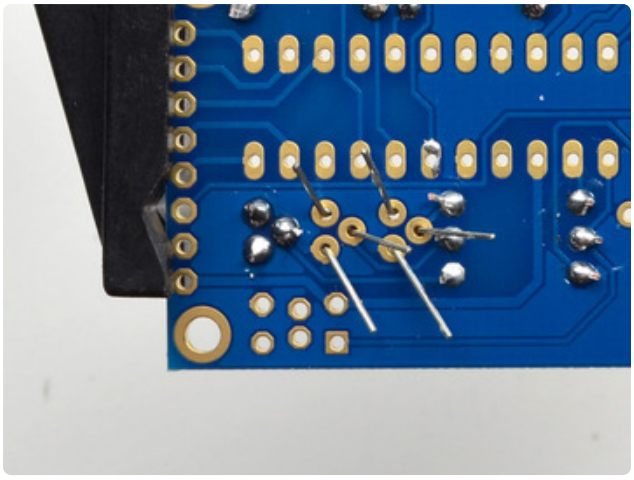
In this case we use three transistors to control the **Red Green** and **Blue** colors of the 8 LEDs all at once. Since they have to drive 8 LEDs at once, you can't do it from a plain microcontroller pin - they're weaklings. These transistors amplify the signal over 100x so they are plenty strong to handle 8 LEDs.



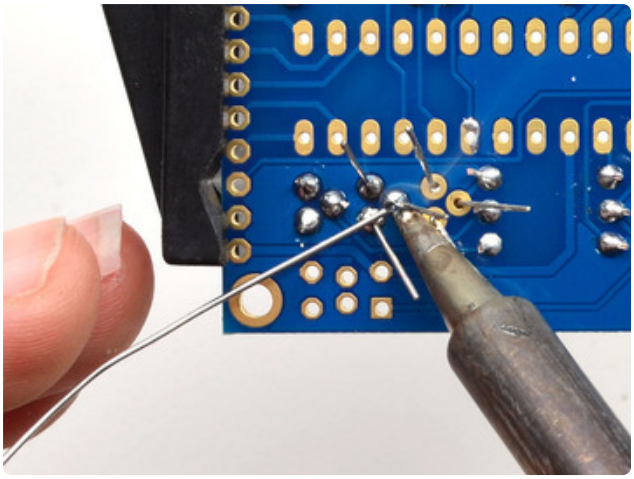


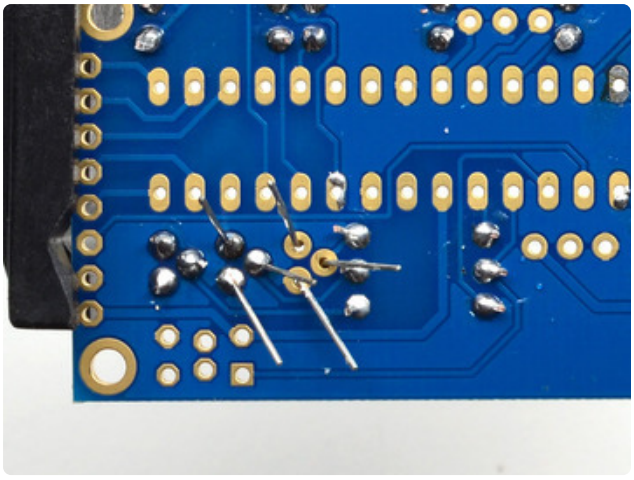
Transistors have a rounded side and a flat side. When placing these parts, make sure the rounded side of the transistor matches the rounded silkscreen image. You will have to bend the legs a bit to fit into the triangular shape so they dont sit nice and flat against the printed circuit board.

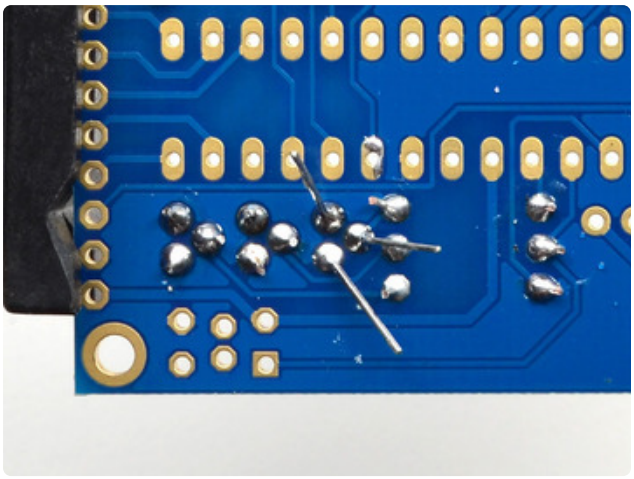


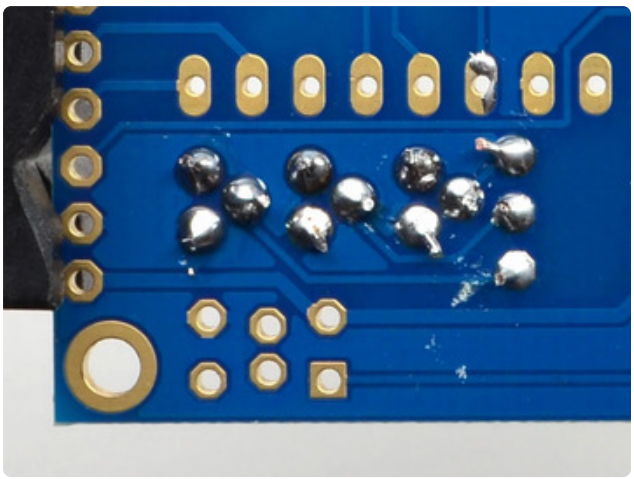


Solder all three legs of a transistor. I like to solder in one, then clip the leads before moving onto the next one, so the leads dont get in the way of my soldering.

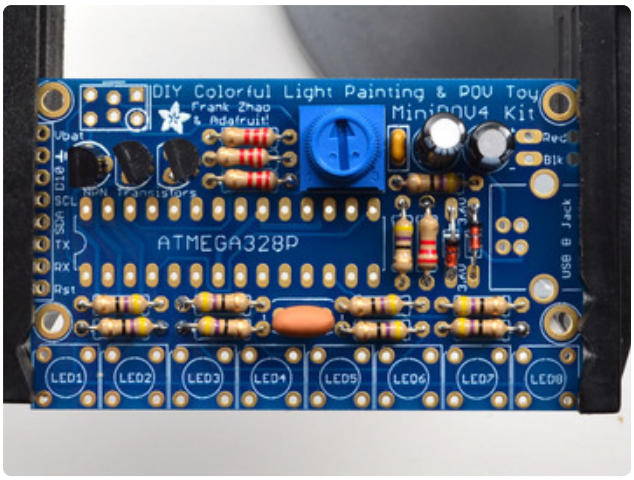








Keep soldering! Finish all three transistors by carefully checking your work before continuing.

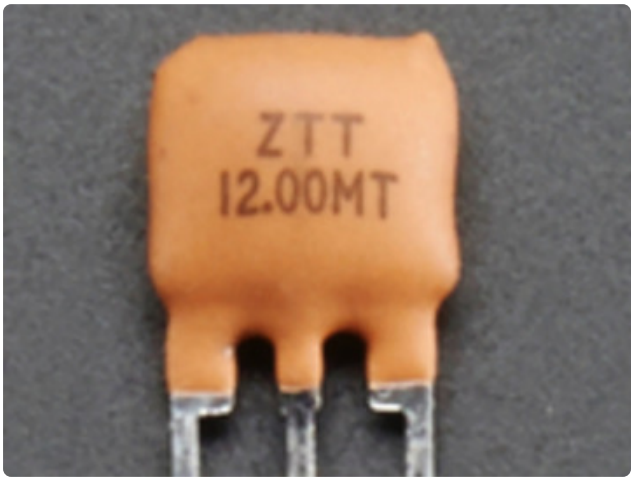


Now we're moving to the point where we can place two components at a time. We'll be placing the **Potentiometer** and the **12MHz Crystal**

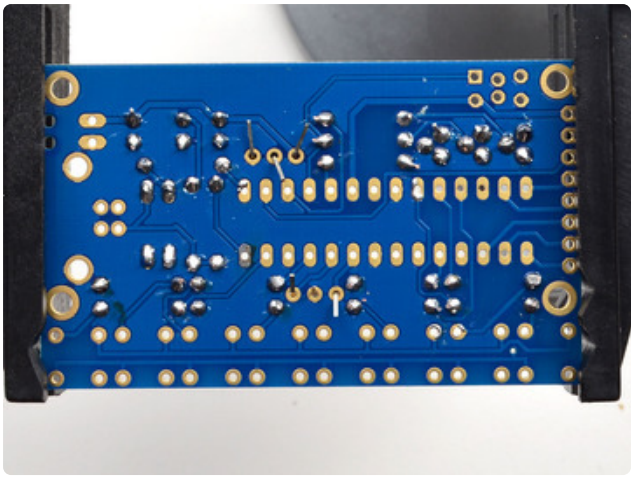
The potentiometer is the blue thing that goes near the top middle of the PCB. It can only fit on one way to match the silkdscreen

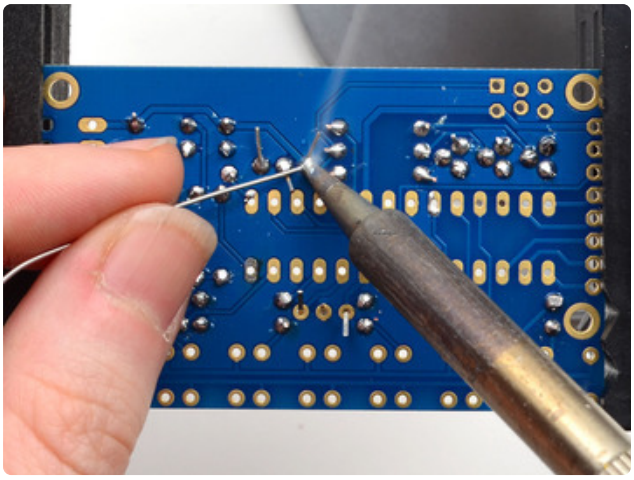
The crystal oscillator goes in between the sets of resistors near the bottom, its orange and has three legs. It is symmetric so you can put it in 'either way'

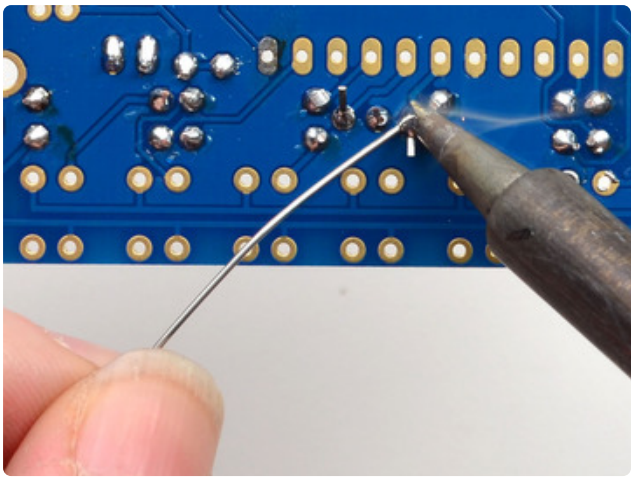
The potentiometer is a blue three-pin knob. It translates rotation into resistance. We use this part in the kit to set the speed of the LED blinking. potentiometers are often used in electronics to set things like voltage range (a volume knob!) or frequency range (a radio tuner!)



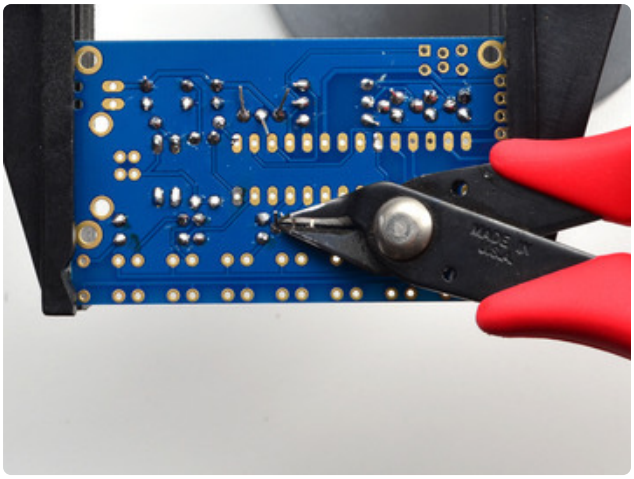
The 12MHz crystal is a time-keeper component. It is used by the main 'brains' of the chip to keep track of time. By having a crystal (sort of like the quartz crystal in a clock or watch) it will be able to flip through all the LEDs at a consistent speed.

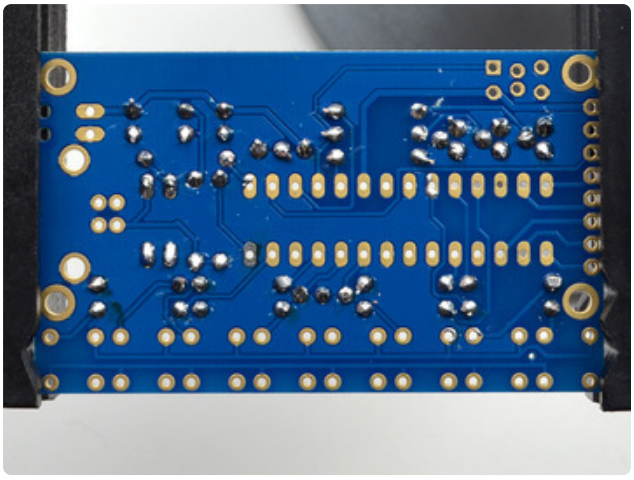


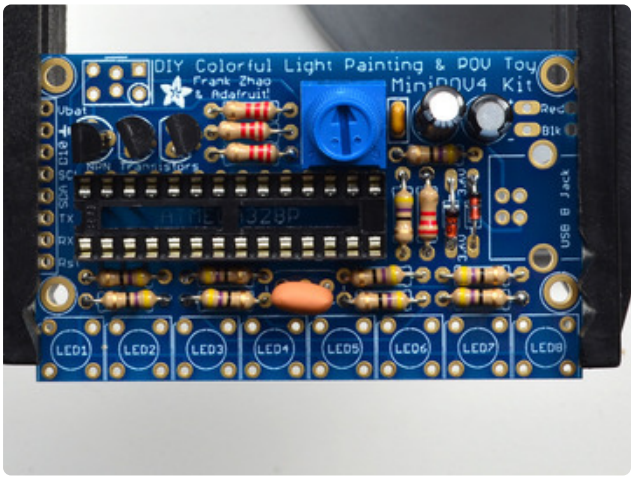




Flip over the board and solder in both 3-pin components. The leads are shorter than other parts so far but you should still clip them so they don't touch other pads by accident.

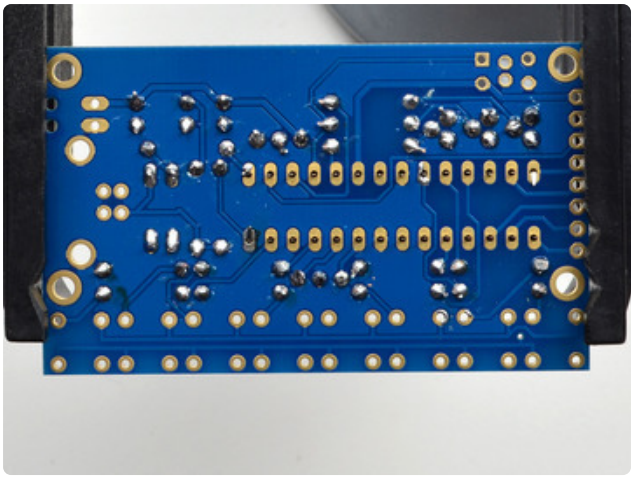




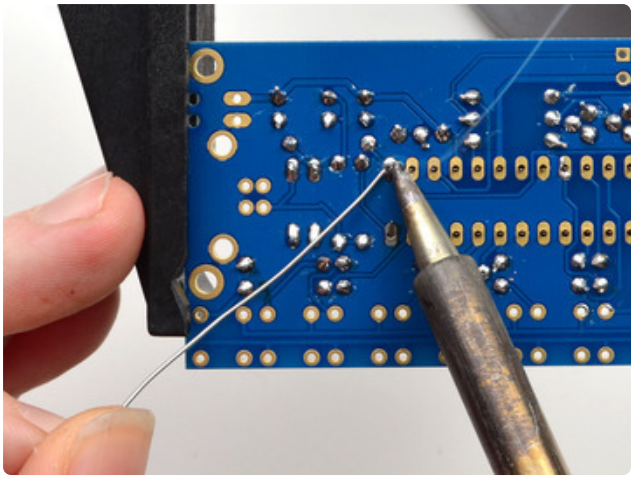


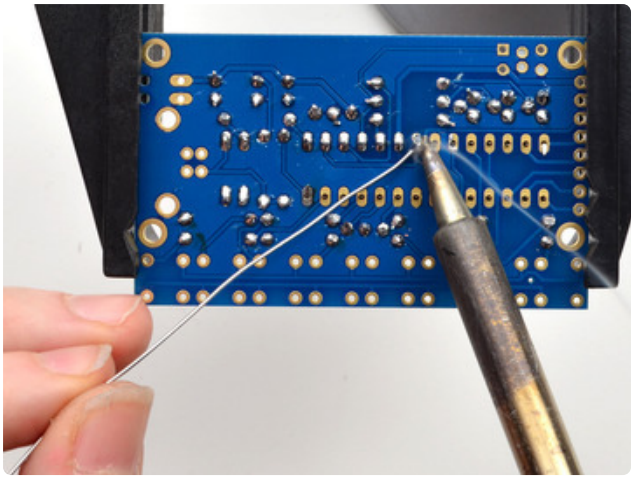
OK now we're onto the big part that goes in the middle. That's where the microcontroller goes. Since the microcontroller has 28 pins, its best to use a socket to keep it in place. Its safer since that way you can always remove the microcontroller later. Also, although its best to put in the socket the right way, its not a big deal - you can always just make sure the chip goes in right!

The silkscreen underneath the socket has a little notch in it. The socket also has a notch! so make sure that the notch in the socket lines up with the silkscreen. In the photo to the left, the notch is on the **left side**

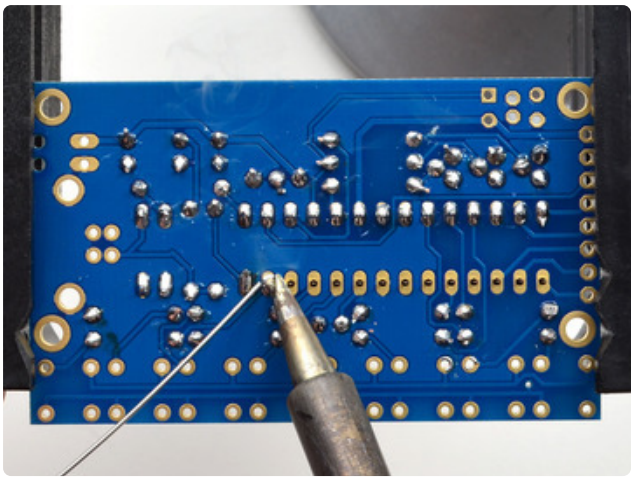


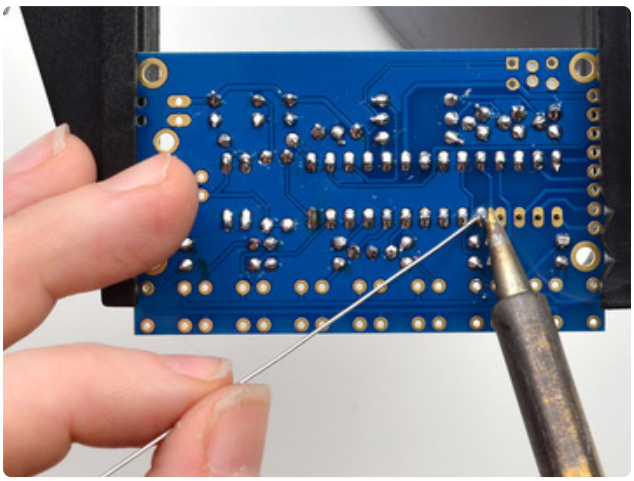
The leads are very short on a socket, if you have fingernails you can try bending over two corner legs to hold it in place. You can also use scotch tape from the top to hold it in place while you solder

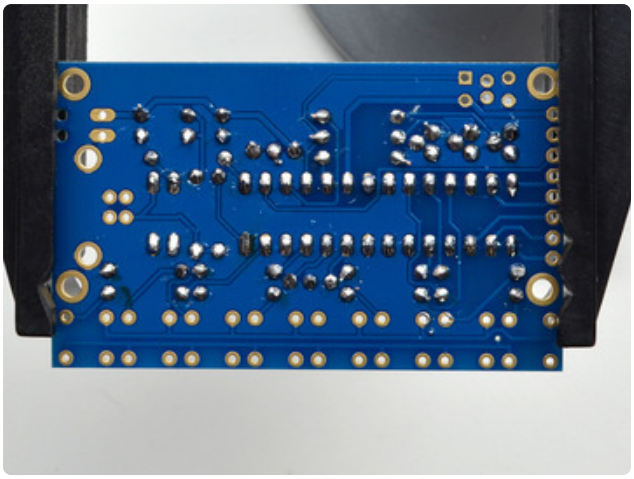




There's 28 pins to solder so go through them one by one, all must be soldered!

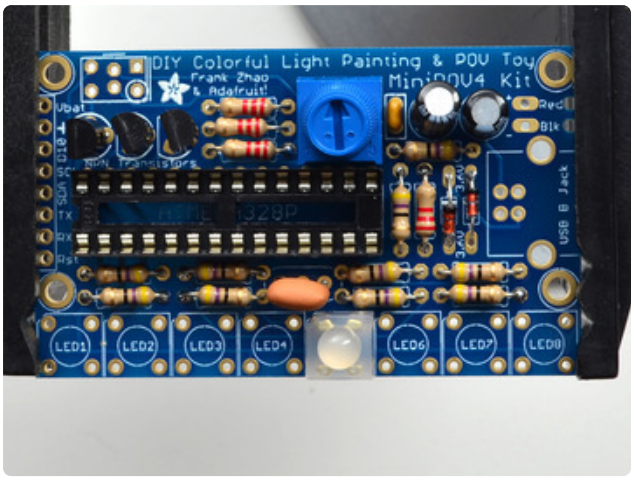




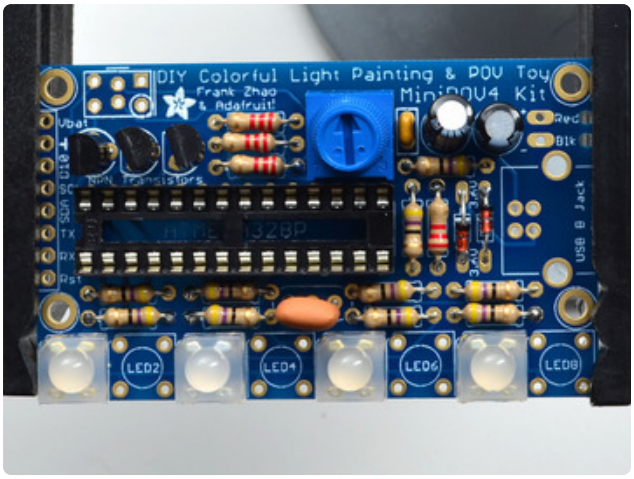


There is no clipping to do when done

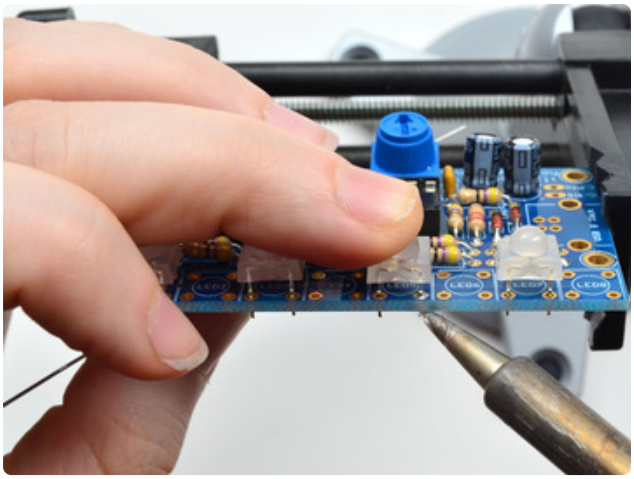
Now we're onto the LEDs. The LEDs have four legs - one common lead and then one for the red, green and blue component LEDs. If you look at the LEDs you'll notice that one corner of each one has a flat notched corner. Make sure you check this for each LED!



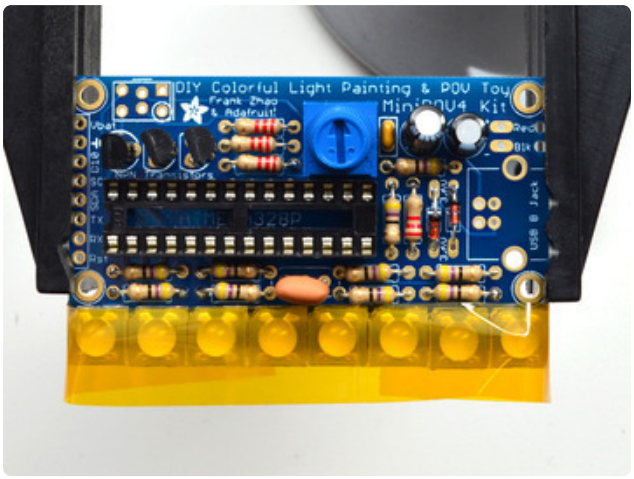
When you place the LED into the PCB, maks sure the flat corner matches the silkscreen. In the photo to the left, the notch is in the **north-west** / **top-left** corner

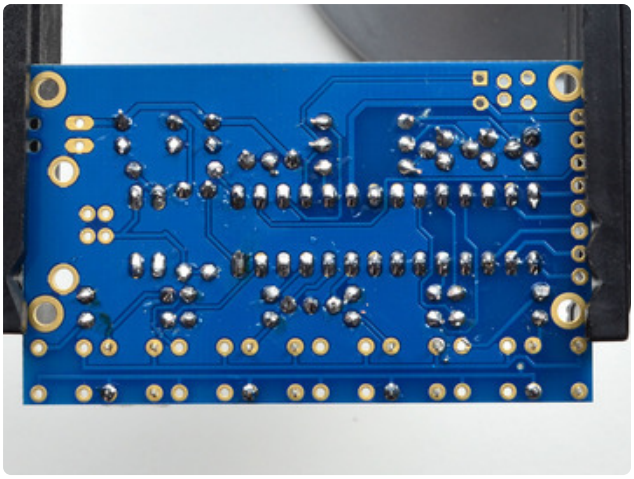


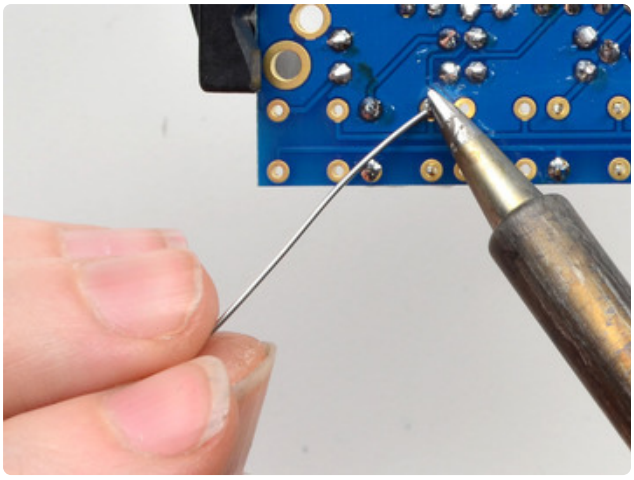
To make soldering easier, I suggest placing only four alternating LEDs to start.

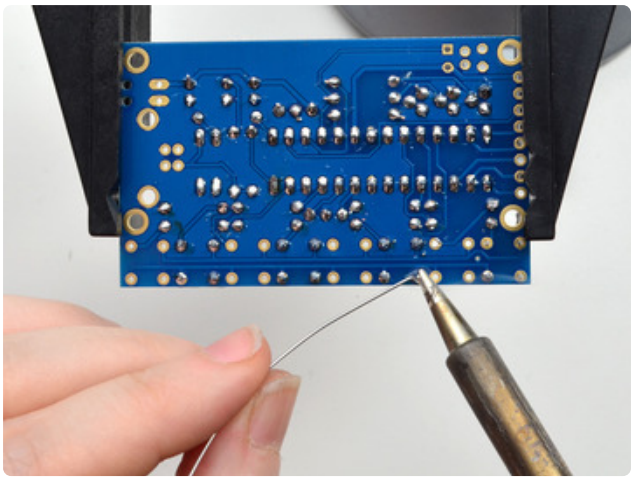


The legs of the LEDs are very short, so you may want to tilt the board and **tack-solder** one pin of each LED with a little solder just to hold it in place. You can also use tape to hold it down!

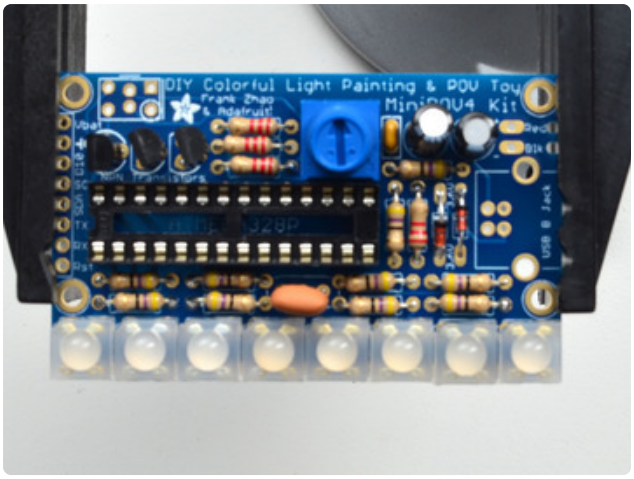


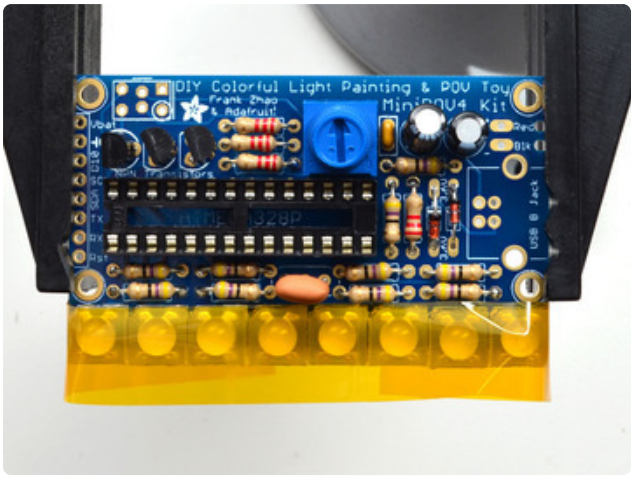




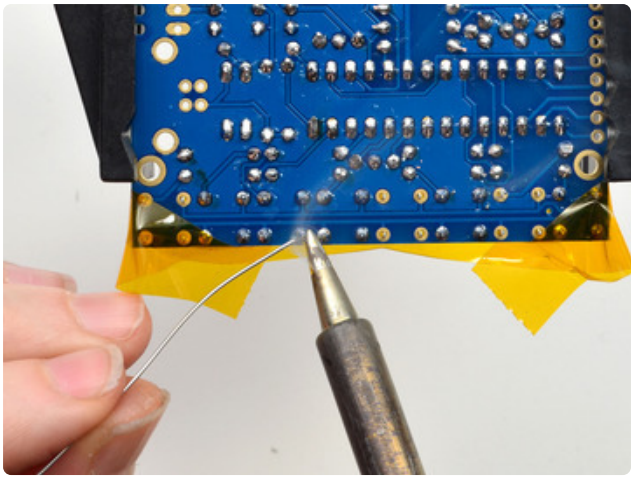


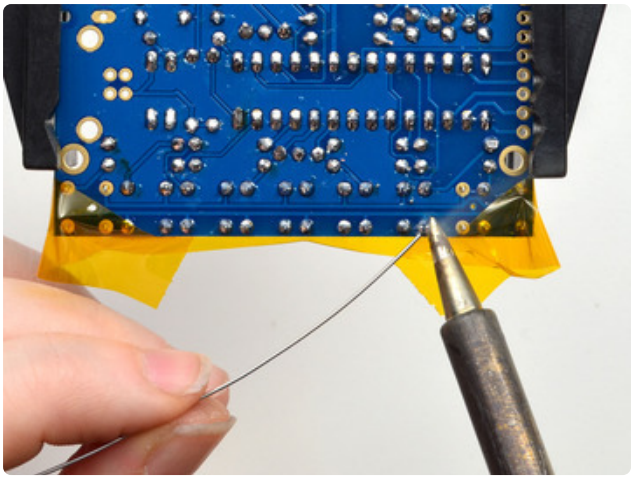
Solder the four LEDs, making sure to do all four pins of each

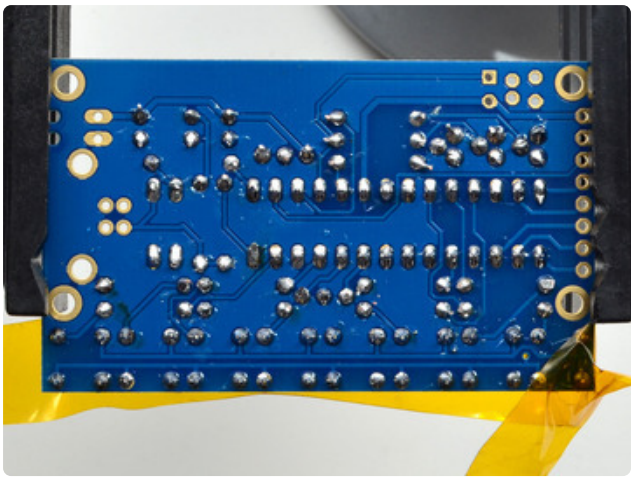




Next up, do the other 4 LEDs - checking that each one has that flat corner in the right spot. I used tape on these four



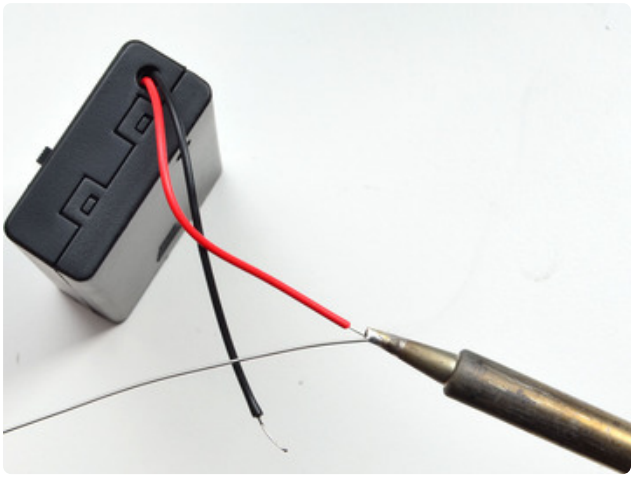




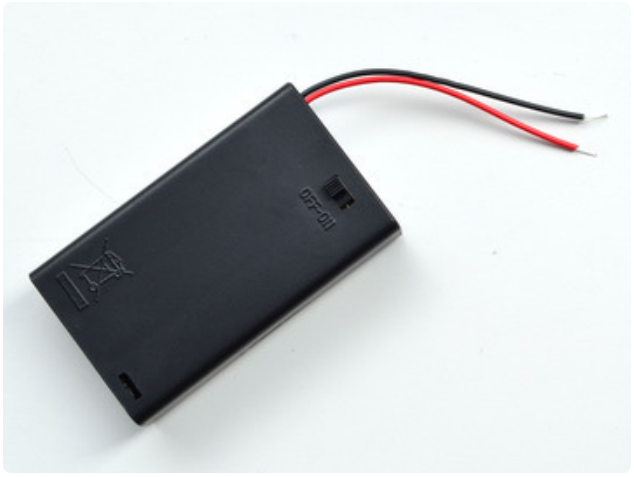
Solder all of them, moving the tape out of the way as needed

We're ready to move to the battery pack. The battery pack comes with a connector but we don't need it, so cut the two wires in half. You can discard the connector half. Make sure no batteries are in the holder!

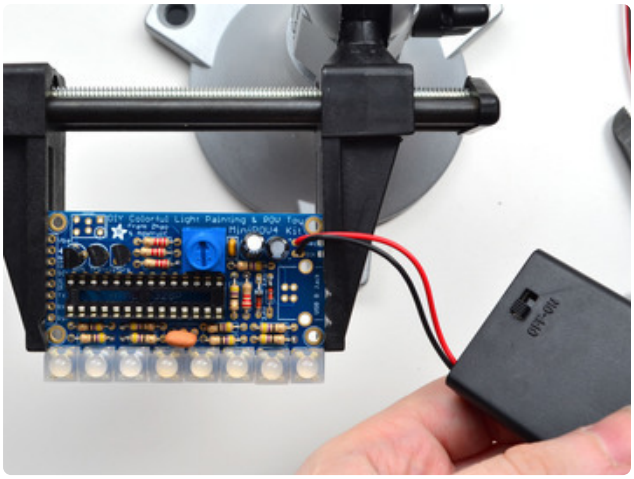
Use a pair of wire strippers to remove about 1/4" of wire insulation from the end of each wire. It's ok if its a little shorter or longer.



Use your soldering iron and a small amount of solder to **tin** the wire by melting a little solder into the bare wires. Tinning wires makes them much easier to solder later so make sure to do this step!

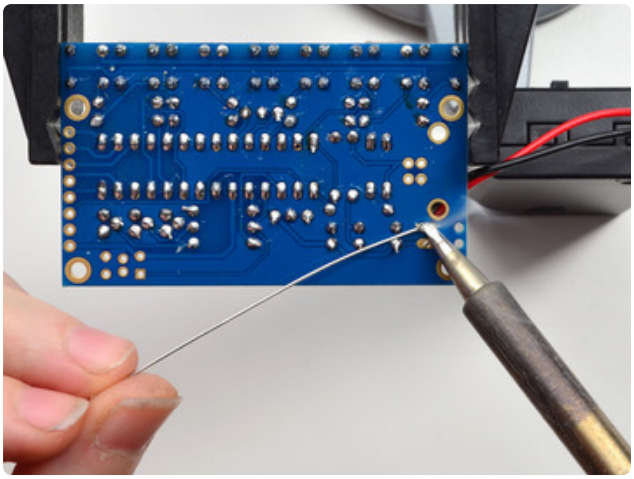


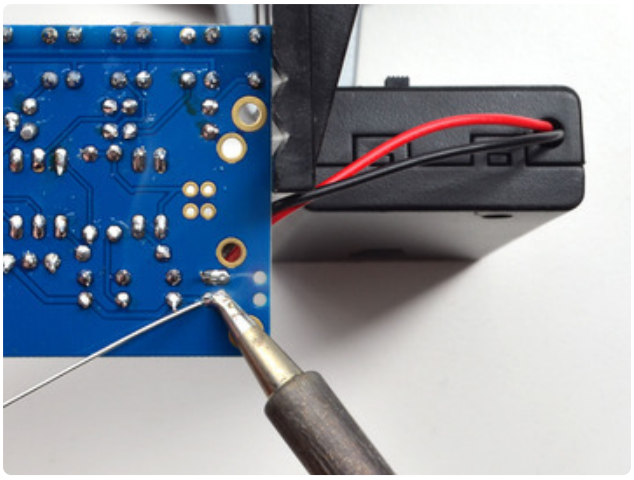
The battery pack is now ready for attaching to the main circuit



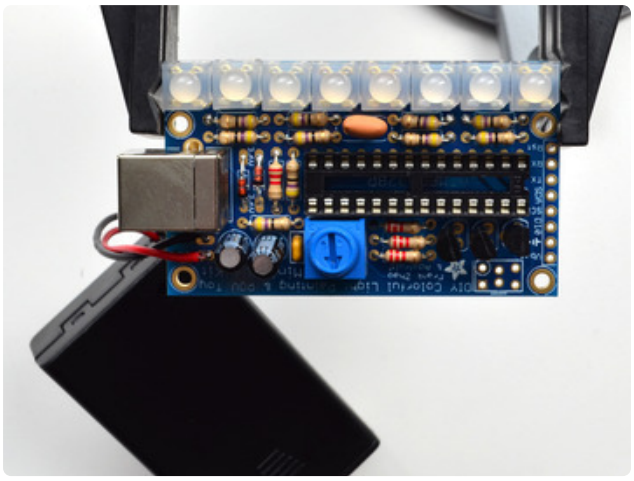
The battery pack has a red wire, thats the positive (+) pin - and a black wire, that's the negative (-) pin.

Put the two wires into the large pads in the top right corner so that the red wire and black wire are in the right holes

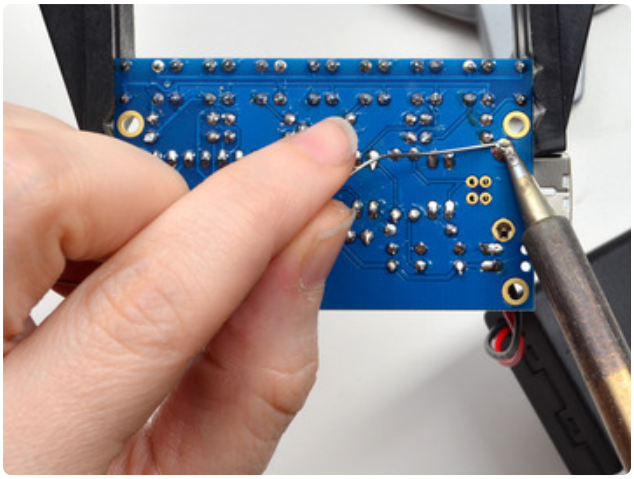




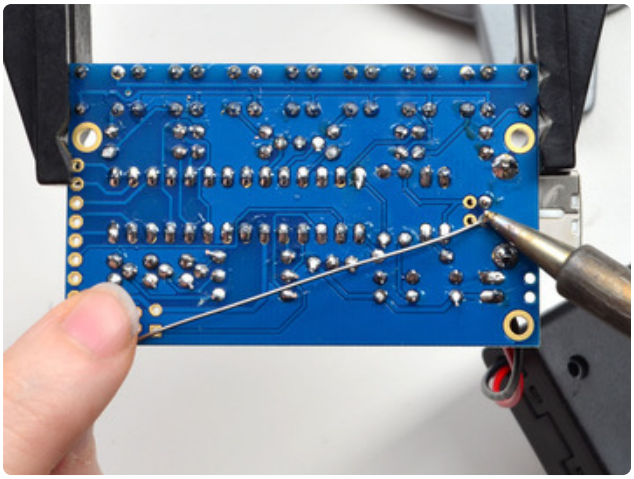
Solder both wires from the bottom. You can use tape to keep them in place if they move around too much.

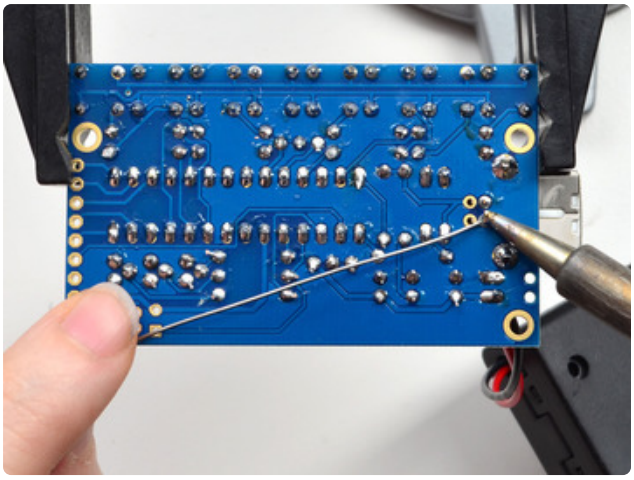


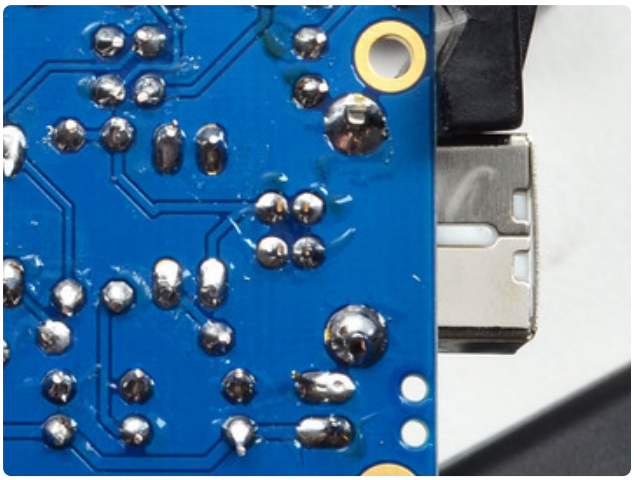
To connect the MiniPOV4 to a computer, you'll need a USB connection. We'll now attach the USB connector, the big silver thing. When placing it, make sure that the 4 little legs don't get bent before going into the holes. They're thin so bend them back so that all four can be soldered.



After making sure that all four little pins made it through, solder the two big "mechanical" pads - these are big holes that hold the connector in place. Use plenty of solder!

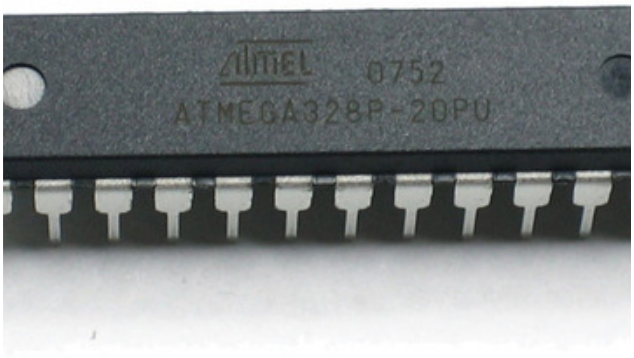




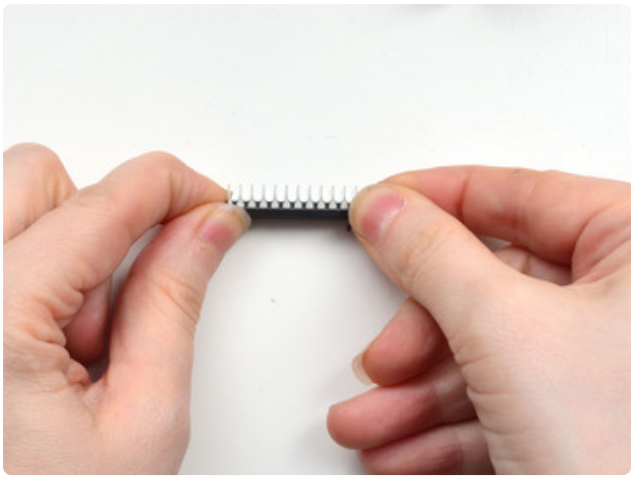


Then do the four little power and data connections.

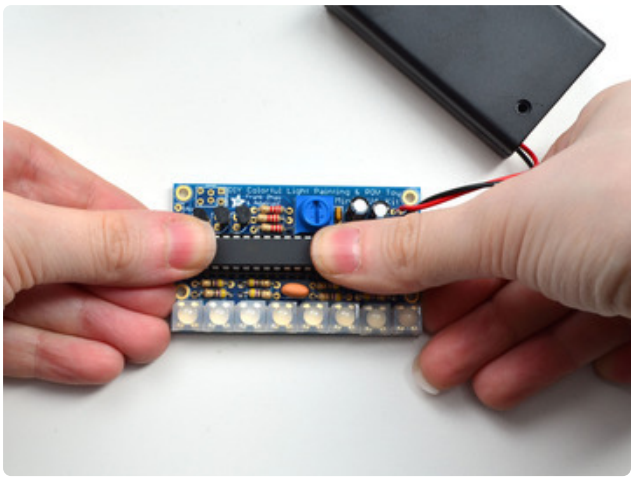
You do not need to clip the leads, they are quite short!



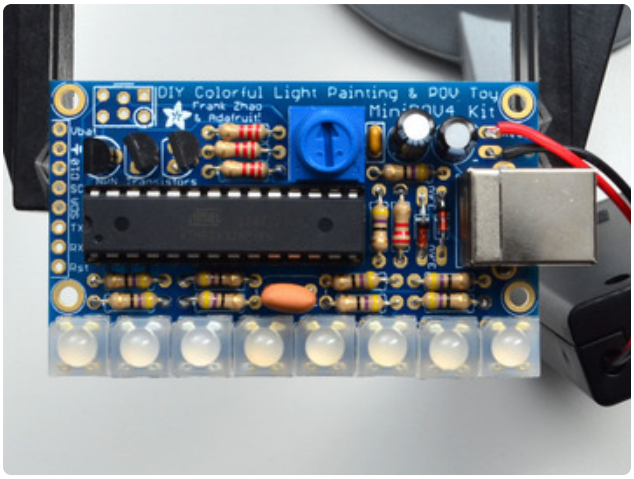
Finally we are going to insert the microcontroller chip. This is the 'brains' of the operation - it stores the image you want to display and times the flashing of the LEDs in the order you want. We're using an Atmel ATMega328 - commonly known as the chip that is the brains of the Arduino Uno board.



Chips come from the factory with the legs in a bit of an A shape when we really need them to be more of an H shape - straight up and down. To make them fit in the socket, grip the chip from both ends and press the legs against a flat table to get rid of the angle. Do this for both sides, a little at a time, until you can see they are nice and parallel



You can now insert the chip. Make sure you insert the chip the right way! The chip has a small notch in one end, that notch needs to match the notch in the silkscreen. Hopefully if you soldered in the socket right, it will also match the notch in the silkscreen but either way, make sure the notch is on the **left side** when you hold it with the LEDs on the bottom as shown here



Check your chip placement one last time before we continue onto testing! Note that you can read the text upright on the chip.

OK now it's time to test!