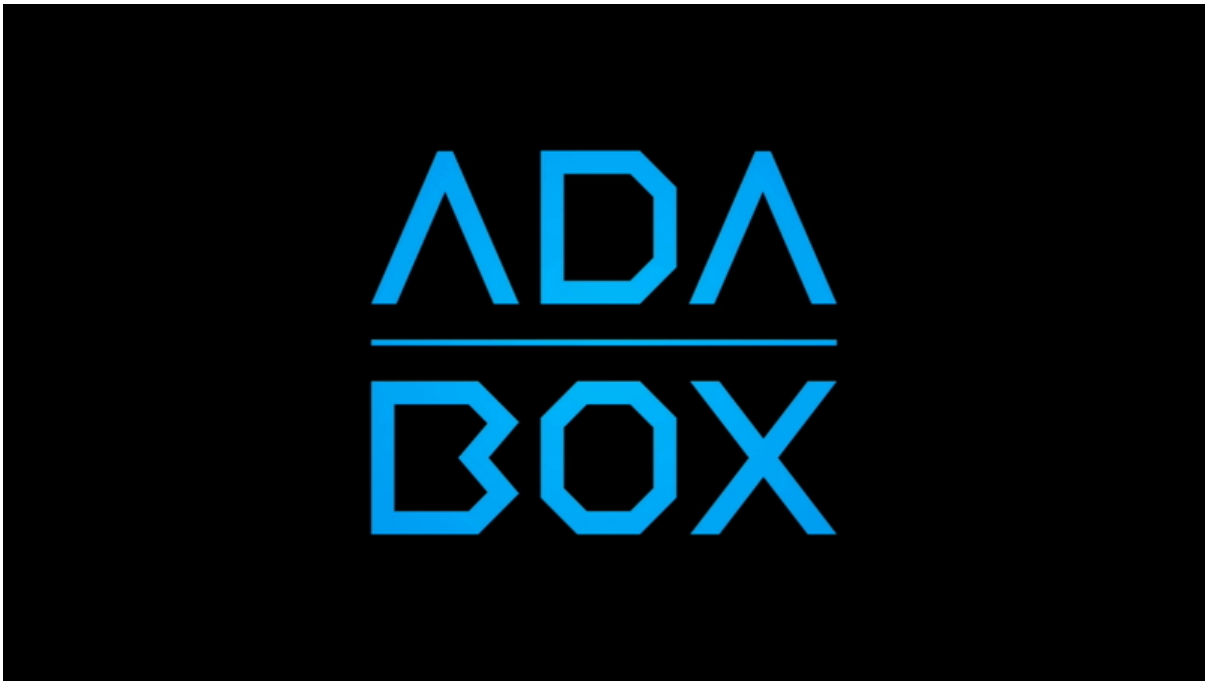
Adabox 001

Created by lady ada



https://learn.adafruit.com/adabox001

Last updated on 2024-03-08 02:29:02 PM EST

Table of Contents

Introduction 3

- Hi there!
- Who is this for?
- Who isn't this for?
- Who are you?
- Want to buy past AdaBoxes?

Unboxing Adabox 001 6

- Kit Contents
- Feather, USB Cable & Battery
- Prototyping tools
- LEDs, Buttons and Components
- Sensors
- Buzzer & Displays

Feather 32u4 Adalogger 8

- Technical Specifications

Lithium Polymer Battery 10

- Safety Notes!

Breadboard 12

Jumper Wires 14

LEDs 16

Push Buttons 18

Resistors and Potentiometers 20

Light Sensor 22

Flex Sensor 23

Temperature Sensor 24

Piezo Buzzer 25

16x2 LCD 26

NeoPixel FeatherWing 27

Redeem your coupon code 28

Introduction

Hi there!

If you're looking to subscribe to AdaBox, click here! (https://adafru.it/tNC)

If you're here, it's because you were given the gift of electronics with an AdaBox! You are a beginner who is getting started with your AdaBox or you just want to relive what it's like being a beginner at electronics again. But most of all, you want to learn how to build and make stuff with electronics! (If, rather than learn electronics, you'd like to look at pictures of cats instead, please check https://www.adafruit.com/galleries/cats-of-engineering (https://adafru.it/oAd))

And, you're in luck: there's never been a better time.

Gone are the days where you need thousands of dollars of equipment and lots physics/math background. Nowadays, if you want to learn to work with electronics, you can jump right in for $100 or less, and any sort of computer. And we're talking about learning a lot of electronics - from the basics of analog to the complexities of firmware. With a good pack of parts, you can build a base of knowledge that will take you from your first blinking LED to someone who can start prototyping and inventing custom products.

Who is this for?

Anyone with a computer they can install software on, an Arduino or compatible and the ability to type and click a mouse. That's pretty much the minimum. Remember, this guide is specifically for people who have purchased or received an AdaBox subscription!

You don't need to know a lot of physics or math, and just like an Art Degree isn't required for making art and being creative, **you don't need to have a computer science degree**. It helps if you're comfortable using computers but that's a skill most people pick up through life.

If you know how to program already - great! If not, don't worry, we'll teach you enough to be dangerous.

Who **isn't** this for?

While you can follow along without an AdaBox, it will not make as much sense unless you have all of the components and more which either came as a gift or purchased yourself - remember, the goal is helping beginners!

If you're an expert, please visit our hundreds other tutorials and jump right in at learn.adafruit.com (https://adafru.it/rdw)

Who are you?

Great question. This is me:

I'm Ladyada, and I love to teach people how to build stuff and how they can be creative with technology.

So, are you ready?

Let's do this thing!

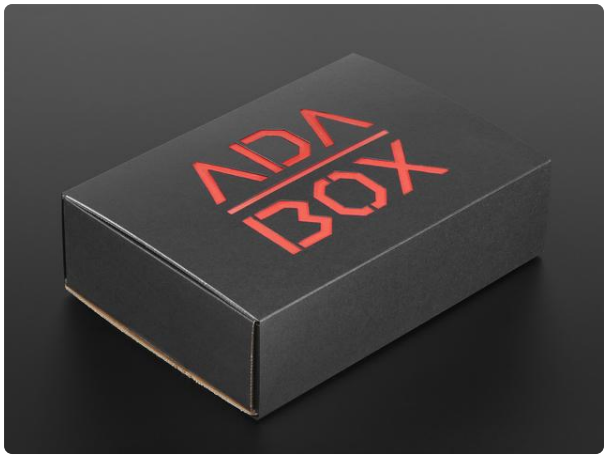
Want to buy past AdaBoxes?

AdaBox001 - Welcome to the Feather Ecosystem
Please note! This is NOT the subscription version of AdaBox! This is ONLY AdaBox001 that shipped out to AdaBox subscribers in September of 2016. This...
https://www.adafruit.com/product/3193

AdaBox002 – Making Things Move

AdaBox002 - Making Things Move with our Feather Bluetooth LE Mini Robot Rover is the perfect gift for folks who are just getting started in the...

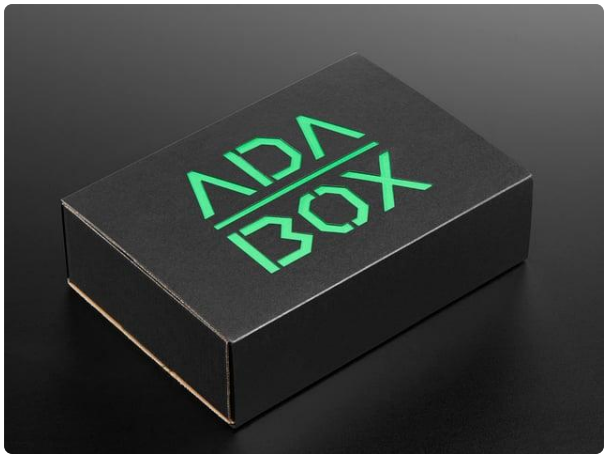
https://www.adafruit.com/product/3235



AdaBox003 – The World of IoT – Curated by Digi-Key

AdaBox003 – The World of IoT (Curated by Digi-Key) is the perfect gift for folks who are just getting started in the world of DIY electronics. It's an...

https://www.adafruit.com/product/3268



AdaBox004 – Making Things Dance

AdaBox004 – Making Things Dance is the perfect gift for folks who are just getting started in the world of DIY electronics. It's an excellent...

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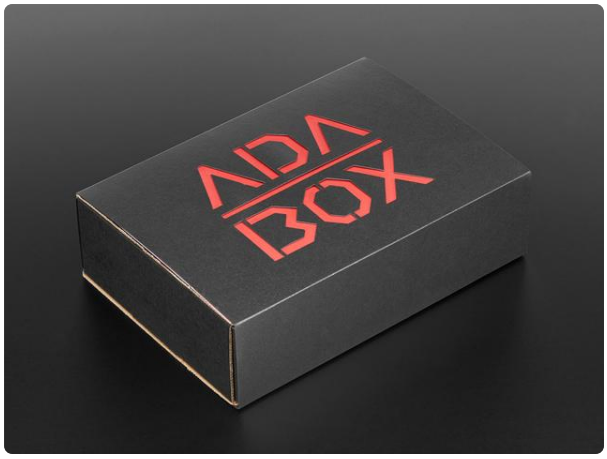

AdaBox005 – Break for Pi

AdaBox005 – Break for Pi is the perfect gift for folks who are just getting started in the world of DIY electronics. It's an excellent...

https://www.adafruit.com/product/3644

Unboxing Adabox 001

ADABOX 001 is designed to introduce a new person to the joys of making with electronics. We decided to come up with a fun pack of parts that:

- Could introduce a beginner to making
- Does not require any additional tools or paid software
- Teach electronics and programming skills
- Does not assume any prior experience
- Comes with enough fun parts that could be combined and adapted for months or years!

Kit Contents

After a lot of thinking, here's what we came up with:

Feather, USB Cable & Battery

- 1 x Adafruit Feather 32u4 Adalogger (http://adafru.it/2795) (fully assembled with stacking headers) - This Arduino-compatible microcontroller board is a tried and true platform. There's hundreds (if not thousands!) of Arduino tutorials that you can follow once you have completed the ADABOX project tutorials. It plugs into a breadboard for storage and prototyping.
- 1 x Micro USB Cable (http://adafru.it/592) - use this to install new code onto your Feather (from any computer) - and to recharge the Feather's battery for portable projects!
- 1 x Lithium Polymer Battery (http://adafru.it/1578) - this rechargeable battery can be used to make your Feather project portable. Plug it into the Feather to have it automatically charge over USB. When removed from USB power, the Feather will automatically flip over to battery power.

Prototyping tools

- 1 x Full size Breadboard (http://adafru.it/239) - this is your artistic canvas! It holds your Feather board securely and also lets you plug in other parts and connect them with the jumper wires for infinitely reconfigurable works-of-electronic-art
- 20 x Short Jumper Wires (http://adafru.it/1956) & 20 x Long Jumper Wires (http://adafru.it/1957)- use these to connect parts on your breadboard. You can

peel off the individual wires as you need the. You'll get 2 of each in 10 colors and 2 lengths

LEDs, Buttons and Components

- 1 x 10mm Red (http://adafru.it/845) & 1 x 10mm Green (http://adafru.it/844) & 1 x 10mm Blue (http://adafru.it/847) LEDs - use these to create lights that you can blink, pulse or mix for lovely lightshows
- 1 x RGB LED (http://adafru.it/302) - this is a compact version that contains red + green + blue in one 'package' for a compact colorful light
- 3 x 12mm Push Buttons (http://adafru.it/1119) - plug these into the breadboard and wire them to your Feather to create finger-friendly inputs.
- 5 x 10KΩ resistors (http://adafru.it/2784) (Brown Black Orange Gold stripes) - resistors help you control the flow of electricity. The 10KΩ is the workhorse of resistors, used for almost anything! We'll have this resistor for use as a sensor assistant (as a pullup or pull-down)
- 5 x 560Ω resistors (http://adafru.it/2781) (Green Blue Brown Gold stripes) - These smaller resistors have only about 1/20th of the resistance of the 10K's but they're great for lighting up LEDs!
- 1 x 1uF capacitor & 0.1uF capacitor - These components are used to store and smooth out small bursts of current.

Sensors

- 2 x 10K Mini Breadboard-Friendly Potentiometers (http://adafru.it/356) - These are adjustable resistors. Use them as twistable sensors or as a way to vary a voltage or resistance.
- 1 x CdS Photocell Light Sensor (http://adafru.it/161) - This is a very unique kind of resistor. As you shine a light on it, the resistance value goes down. You can use this to sense light and dark.
- 1 x Flex Sensor (http://adafru.it/1070) - This is also a kind of resistor. As you may be able to guess, when you bend the flexible part, the resistance changes. so you can use it to detect touch and motion.
- 1 x Temperature Sensor (http://adafru.it/165) - This sensor is a little different - it isn't a resistor type. It's a little more complex than that, but it will generate an analog reading that can be converted to the temperature.

Buzzer & Displays

- 1 x Piezo Buzzer (http://adafru.it/160) - Your feather can make cute little beeps and boops with this buzzer. Good for making sounds, songs and notifications.
- 1 x 16x2 LCD (blue and white) (http://adafru.it/1447) - Display text messages on this backlit display. You get 16 characters and two rows for showing information
- 1 x Assembled Neopixel FeatherWing (http://adafru.it/2945) - plug it on top of your Feather for 32 full color LEDs in a 4x8 grid. Great for lighting effects with tons of colors

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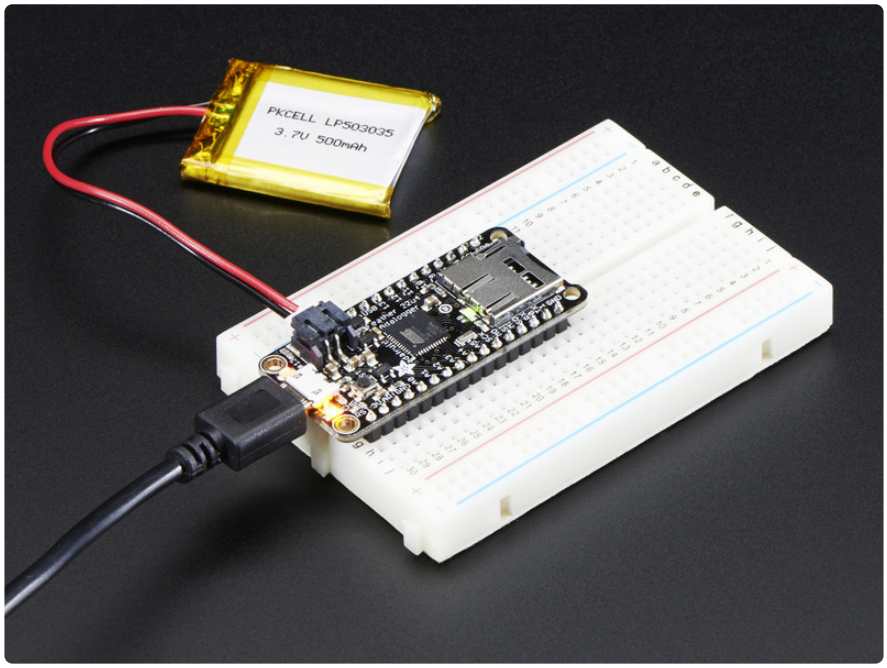
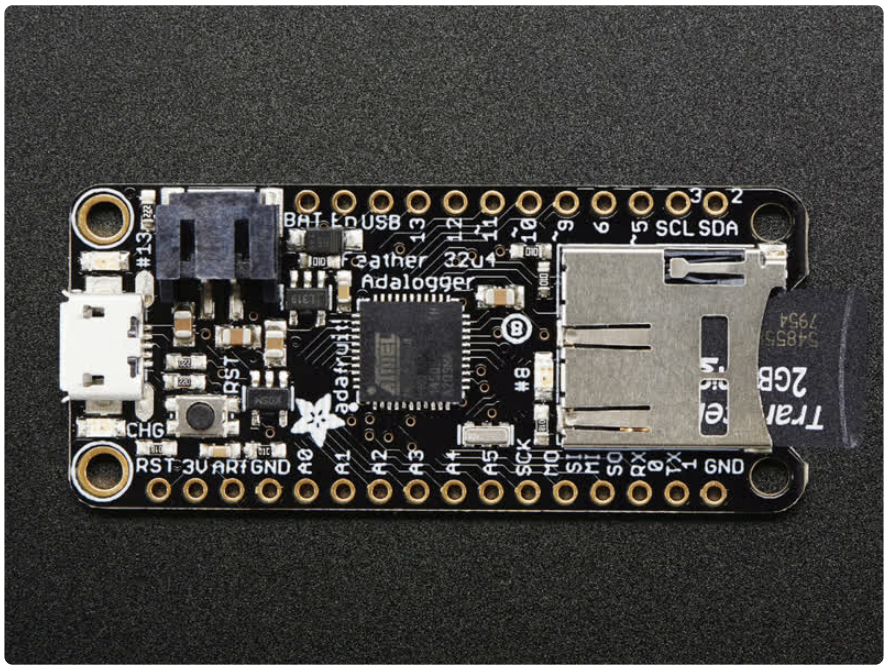
Feather 32u4 Adalogger



If you want to learn electronics these days, it's not enough to build a lamp or crystal radio. All the most interesting projects require "physical computing" skills. That's the ability to write code on a microcontroller using your computer (computing) and then connecting up LEDs, sensors, and displays (the physical stuff) to build a unique creation.

To make AdaBox more fun than just an everyday Arduino-based kit, we decided to include our new microcontroller board the Feather 32u4. Feather is the new development board from Adafruit, and like its namesake it is thin, light, and lets you fly! We designed Feather to be a new standard for portable microcontroller cores. It's Arduino compatible but it's breadboard-friendly, portable, and has a lot of extra goodies built in.

We even upgraded from the basic Feather 32u4 we sell to the **Adafruit Feather 32u4 Adalogger.** This microcontroller board is an 'all-in-one' datalogger (or data-reader) with built in USB and battery charging. Its an Adafruit Feather 32u4 with a microSD holder ready to rock!



Technical Specifications

At the Feather 32u4's heart is at ATmega32u4 clocked at 8 MHz and at 3.3V logic, a chip setup we've had tons of experience with as it's the same as the Flora (http://adafru.it/659). This chip has 32K of flash and 2K of RAM, with built in USB so not only does it have a USB-to-Serial program & debug capability built in with no need for an FTDI-like chip, it can also act like a mouse, keyboard, USB MIDI device, etc.

Here's some handy specs! Like all Feather 32u4's you get:

- Measures 2.0" x 0.9" x 0.28" (51mm x 23mm x 8mm) without headers soldered in
- Light as a (large?) feather - 5.1 grams
- ATmega32u4 @ 8MHz with 3.3V logic/power
- 3.3V regulator with 500mA peak current output
- USB native support, comes with USB bootloader and serial port debugging
- You also get tons of pins - 20 GPIO pins
- Hardware Serial, hardware I2C, hardware SPI support
- 8 x PWM pins
- 10 x analog inputs
- Built in 100mA lipoly charger with charging status indicator LED
- Pin #13 red LED for general purpose blinking

- Pin #8 green LED for more blinking pleasure
- Power/enable pin
- 4 mounting holes
- Reset button
- MicroSD card holder for adding as much storage as you could possibly want, for reading or writing data

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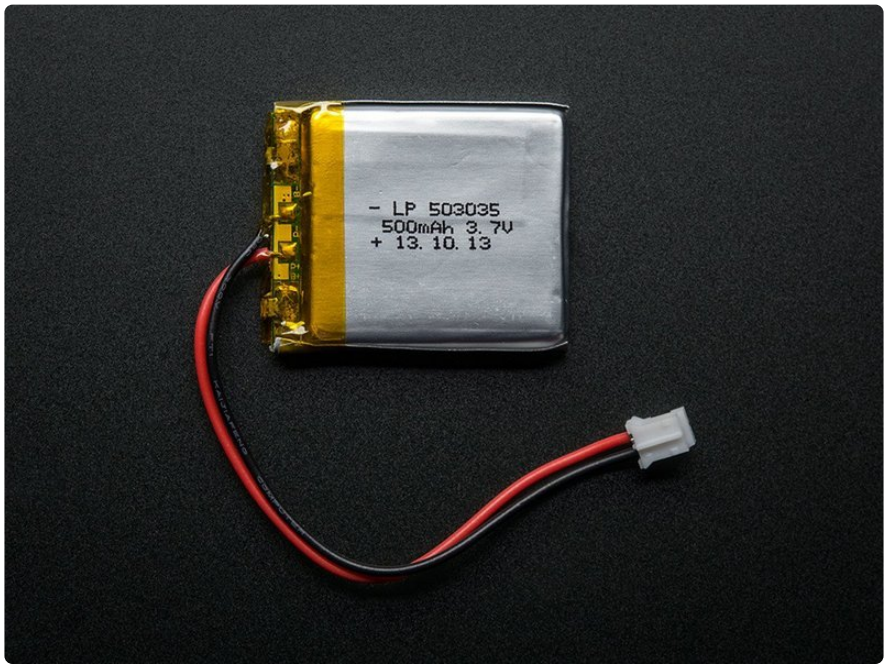
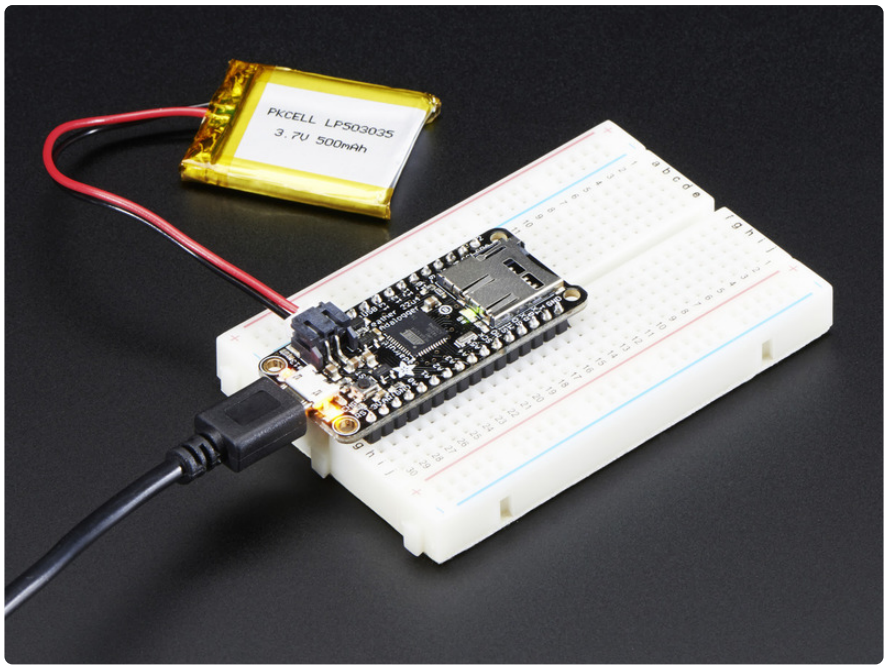
Lithium Polymer Battery



Lithium ion polymer (also known as 'lipo' or 'lipoly') batteries are thin, light and powerful. The output ranges from 4.2V when completely charged to 3.7V. This battery has a capacity of 500mAh for a total of about 1.9 Wh.

The batteries come pre-attached with a genuine 2-pin JST-PH connector as shown and include the necessary protection circuitry. So you can plug it right into your Feather, using the little port on the side. It will only plug in one way.



If the battery is plugged into the Feather and the USB cable is connected to a computer or power supply it will automatically recharge the battery. The yellow LED will light up to let you know. When the yellow light turns off, the battery is done charging

The battery will run most projects for 5-10 hours (depending on what is attached) and recharges in about 5 hours.

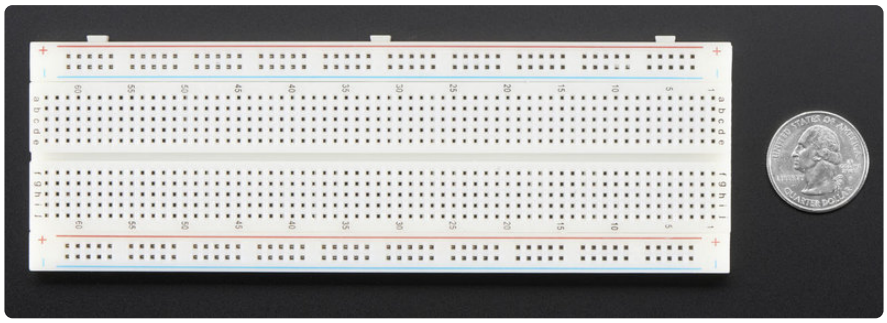
Safety Notes!

The included protection circuitry keeps the battery voltage from going too high (over-charging) or low (over-use) which means that the battery will cut-out when completely dead at 3.0V. It will also protect against output shorts. However, even with this protection **it is very important that you only use a LiIon/LiPoly constant-voltage/ constant-current charger (like the one built into the Feather) to recharge it!**

Additional safety notes: Do not use a NiMH/NiCad/lead-acid charger! Also, do not abuse these batteries, do not short, bend, crush or puncture. **Never charge or use unattended. Always inspect batteries and surrounding circuitry constantly for any damage, loose wiring, or possibility of short circuits.** As with all Lithium ion polymer batteries and with any power source - they should be used by experts who are comfortable working with power supplies.

The Li Poly battery is not required for any projects - if you prefer not to use the battery simply dispose it at your local battery recycling/disposal center.

Breadboard

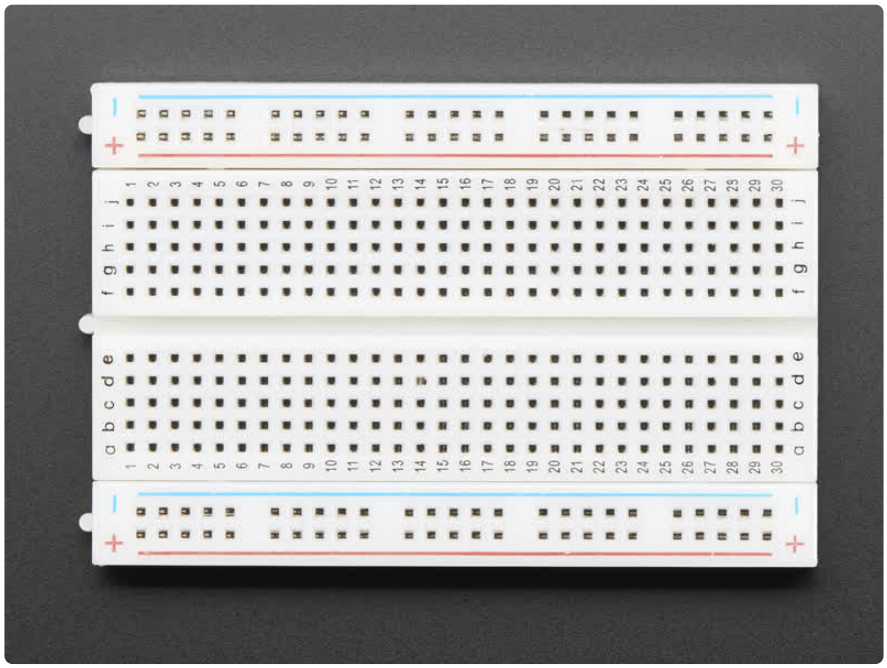


These "Solder-less" Breadboards are incredibly handy for building circuits. They are durable and reusable and have tons of work space. They not only hold your parts steady, a breadboard also has internal wiring to make connections super fast.

We've made a lovely video starring Collin, taking you on a journey to understand breadboards and their usage! You can watch it before, after or during reading the rest of the guide.

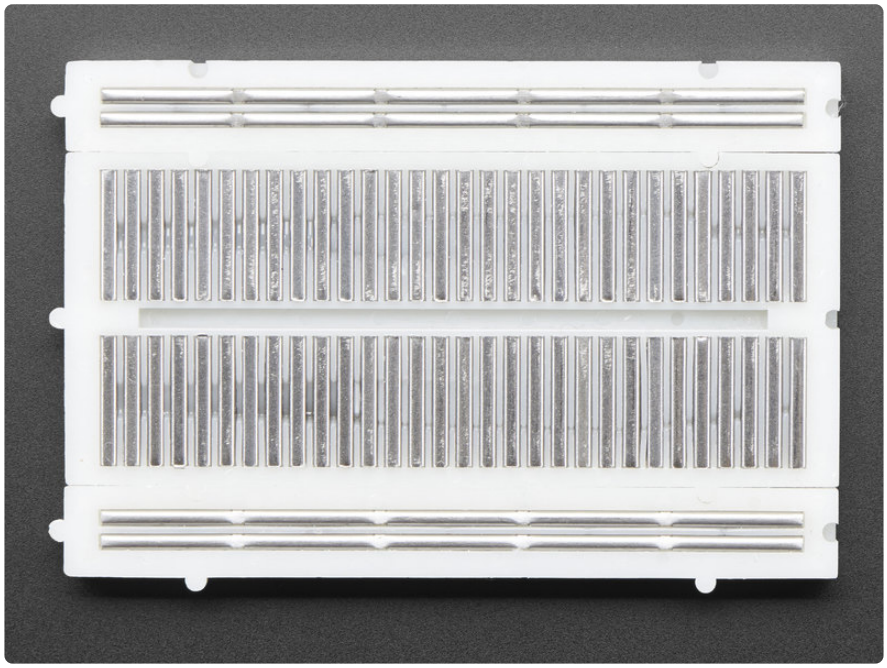
Breadboards make look like just a slab of plastic, but there are secrets hidden deep inside!

Here's an "X-Ray" of a breadboard:

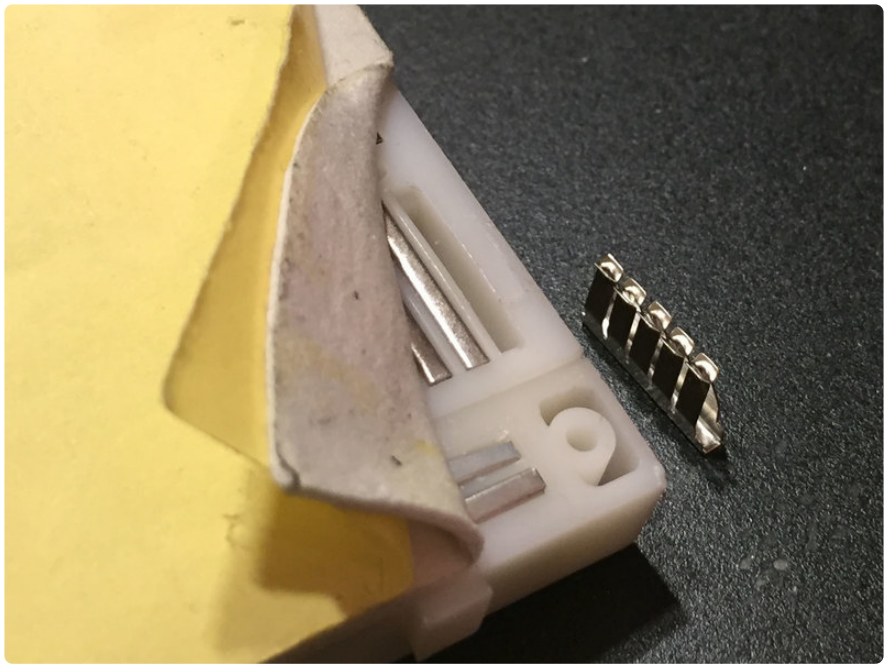


If you look on the back of your breadboard, there's a yellow waxy paper covering some sticky foam. If you were to peel back that foam you'd see dozens of these metal rows.

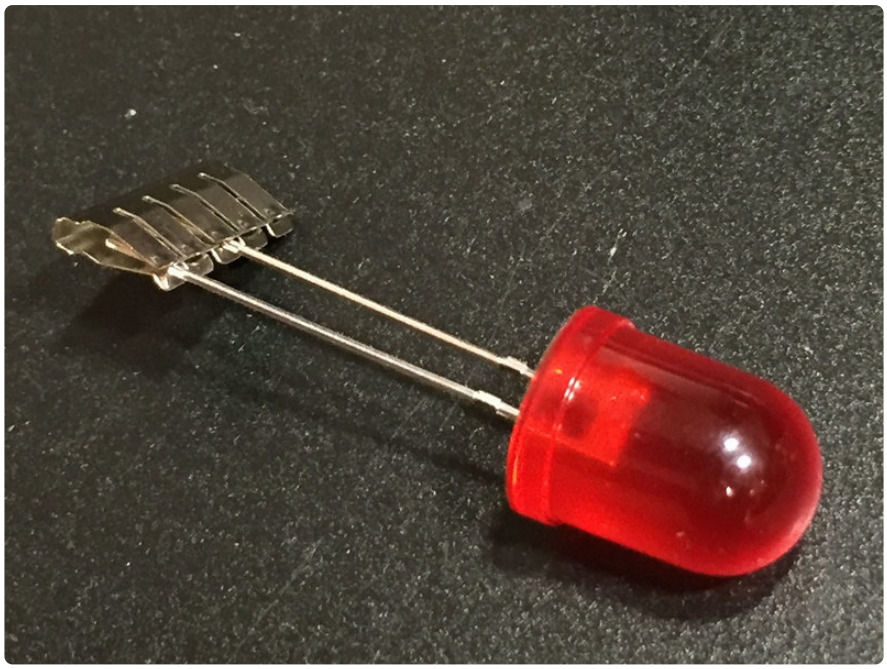
(Don't actually do this, you should keep the yellow paper on your breadboard, we'll sacrifice this one for some photos!)



If you pulled the metal parts out with pliers (again, don't do this yourself!) You'd see each one is a metal clip with little teeth. The rows have 5 teeth - one for each hole on the top of the breadboard. (The power rails have 50 teeth)



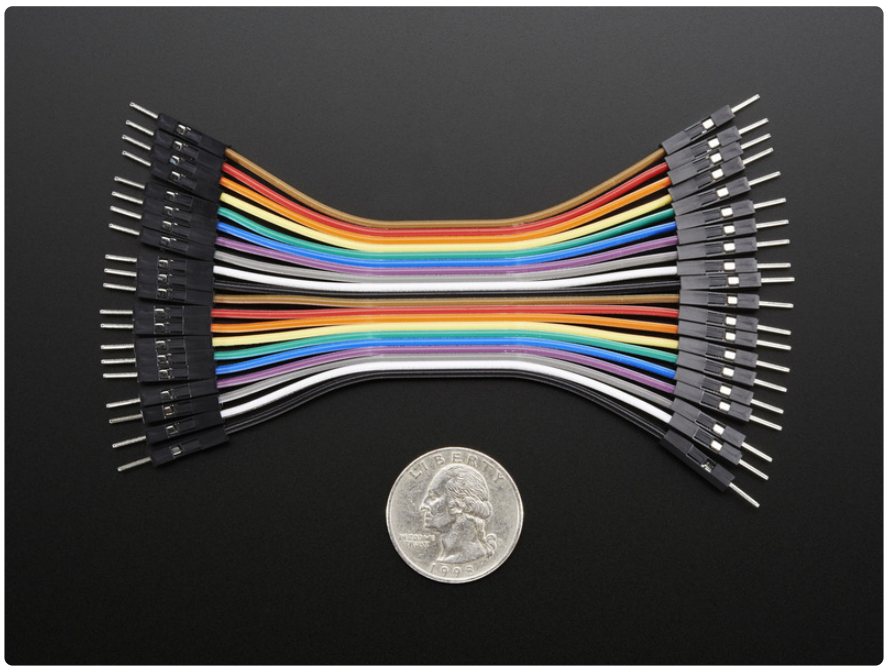
These little teeth are great at gripping onto electronic parts. When a part is pushed into the breadboard, the clip pushes open and grabs onto the metal leg. Any other parts that are plugged into the other 4 teeth are thus electrically connected together



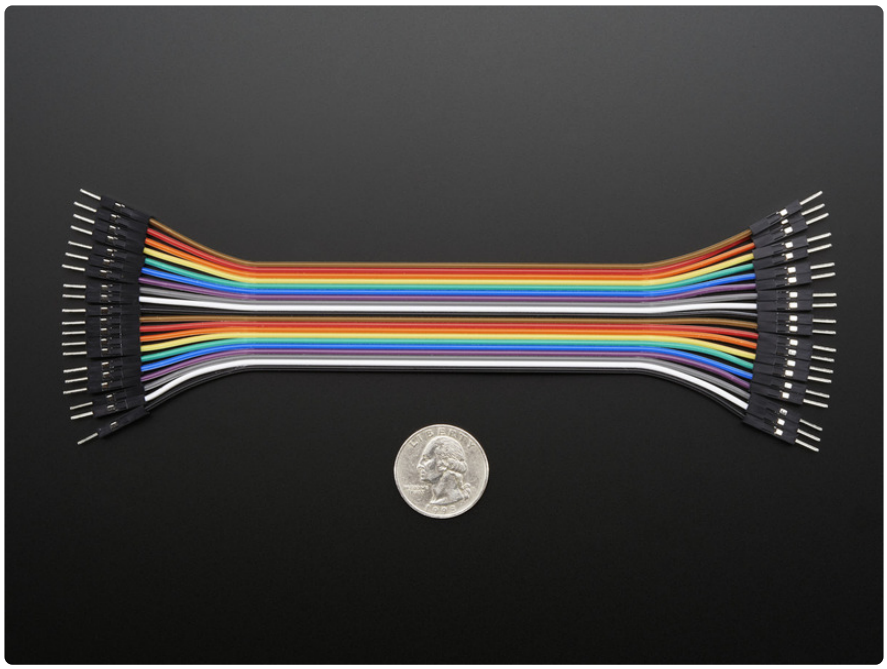
Each clip can handle at least a hundred plugs and unplugs before the springiness of the clip slowly weakens and eventually stops gripping so well. You'll know when the breadboard needs replacing because you wont feel the clip gripping onto the part when you press it in.

However, this takes years to happen. Even if you did have to replace it, breadboards are quite affordable. Most makers have a half dozen different sizes for projects, sometimes dedicating each one to a 'long term' project and keeping one for playing around.

Jumper Wires

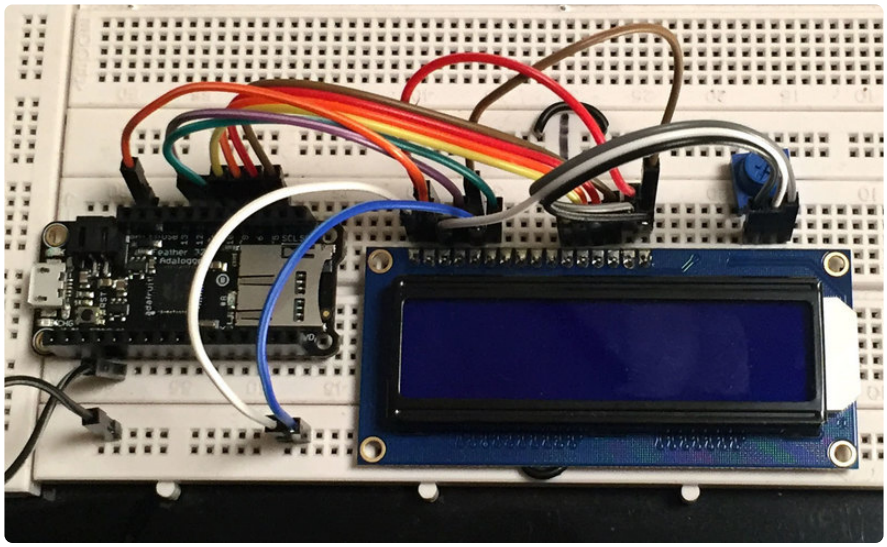


To take full advantage of your breadboard, you'll need to have plenty of wires that can jump between the holes and make electrical connections. These bundles of premium wires come in two lengths, about 3" (75mm) and about 6" (150mm). The lengths aren't exact but between the two you'll have plenty of short and long options.



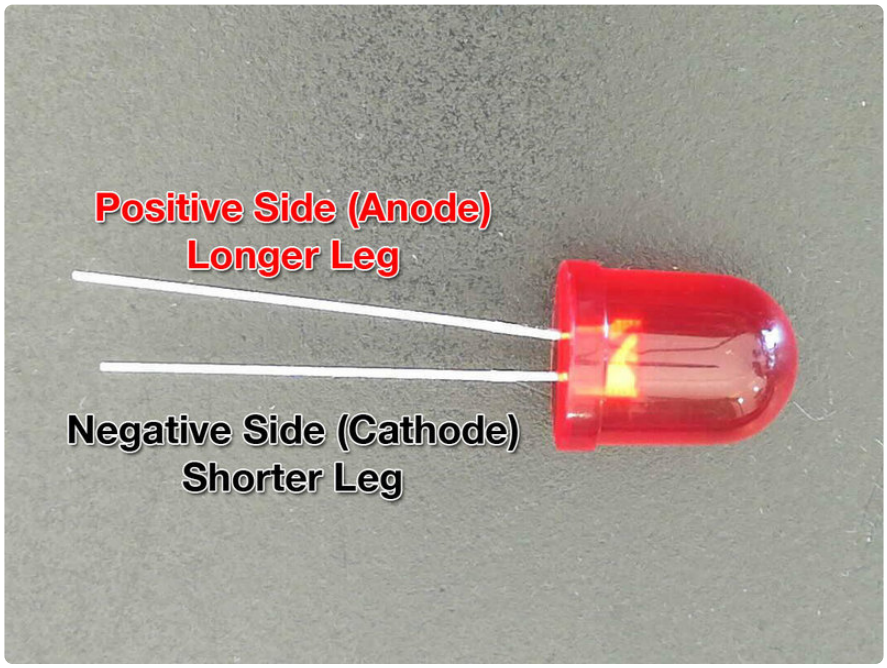
Each version comes in a 'strip' of 20 (2 pieces of each of ten rainbow colors). They have 0.1" male header contacts on either end and fit cleanly next to each other on standard-pitch 0.1" (2.54mm) breadboards. The best part is they come in a 20-pin ribbon cable. You can always pull the ribbon wires off to make individual jumpers, or keep them together to make neatly organized wire harnesses.

Here's an example of a fairly complex wiring setup possible with the jumpers. Note that some wires are indiviual and some, like the brown/red/orange/yellow set are still together to make the wiring a little neater.

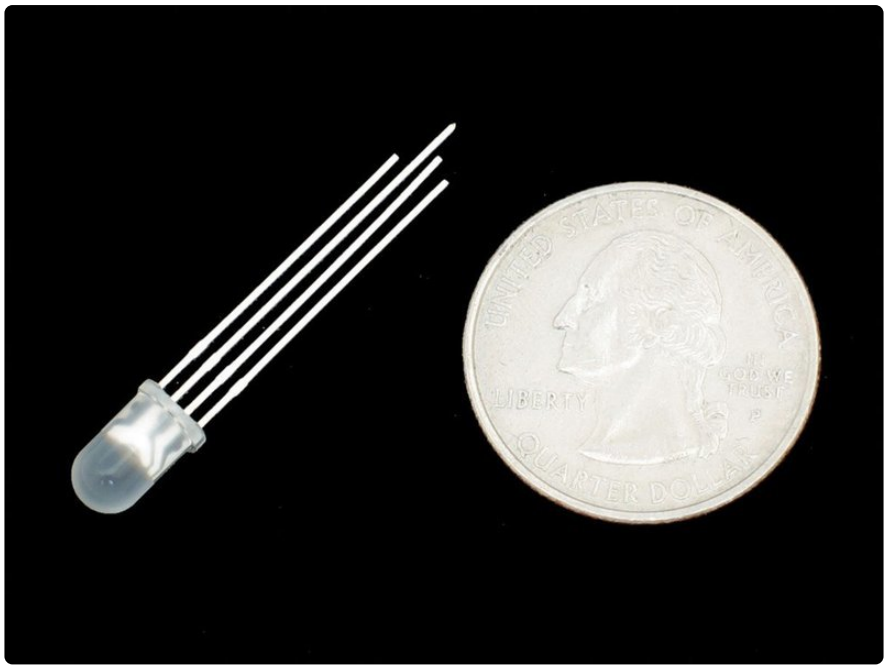


LEDs

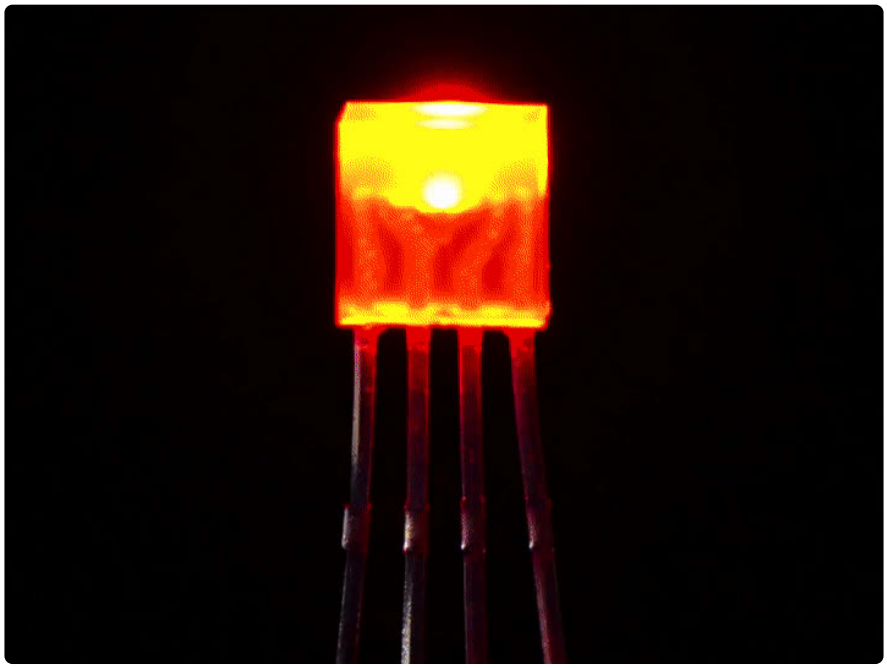
Bright lights, big fun! Your kit comes with a variety of LEDs. For individual LED fun, you'll get one each of Red, Green and Blue in 10mm diameter size. These look like jellybeans but they're not for eating! You can use your Feather to light up each one in the respective color. They look great and you can see them from far away.



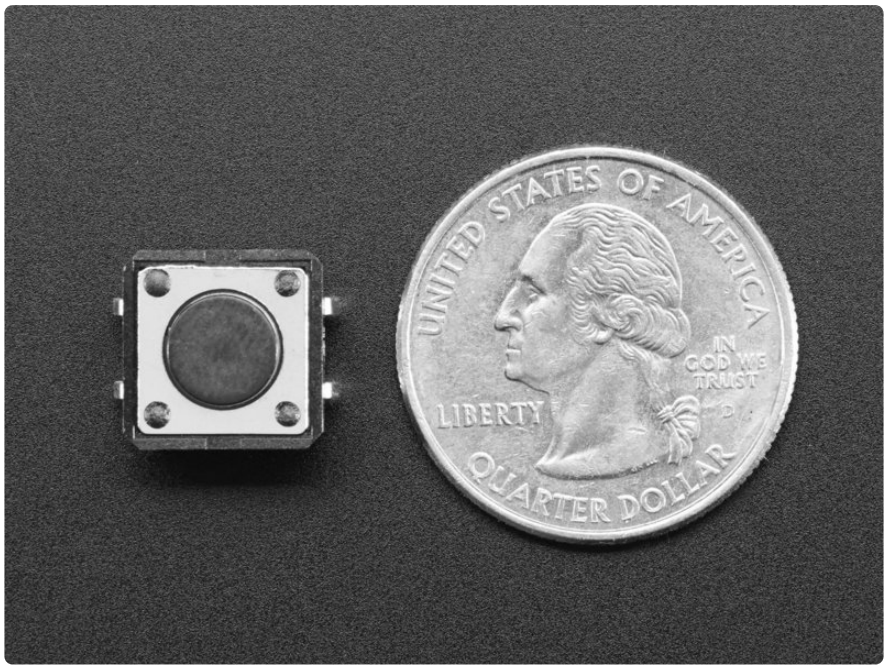
You'll also get a single **RGB** LED - this special LED is like a smoothie made from the three individual LEDs above! You get one plastic package but with a very very tiny Red Green and Blue LED inside.



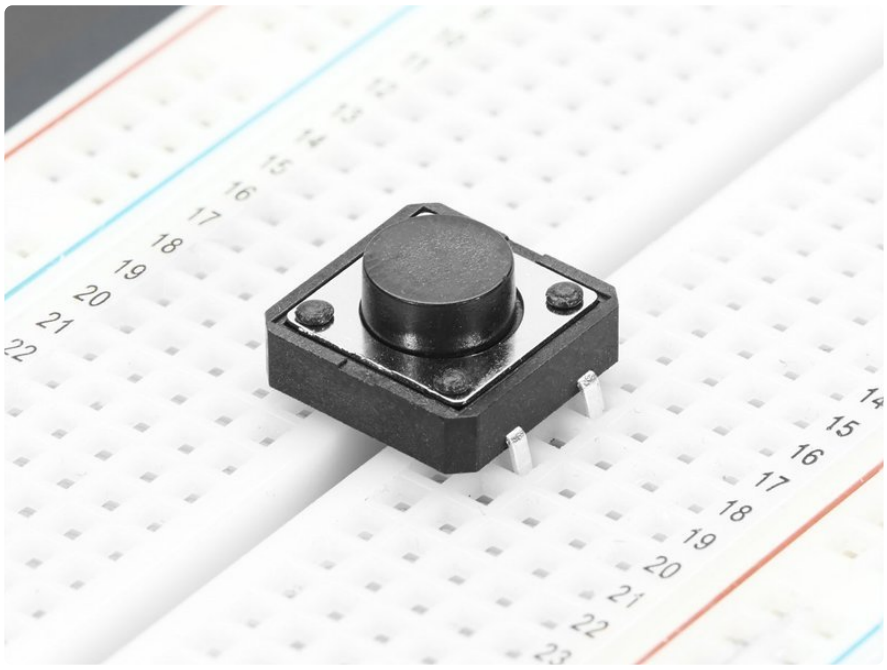
Since the LED is all in one, you can vary the brightness of each color to create swirls of infinite color mixtures. It's like mixing paints but you're using light



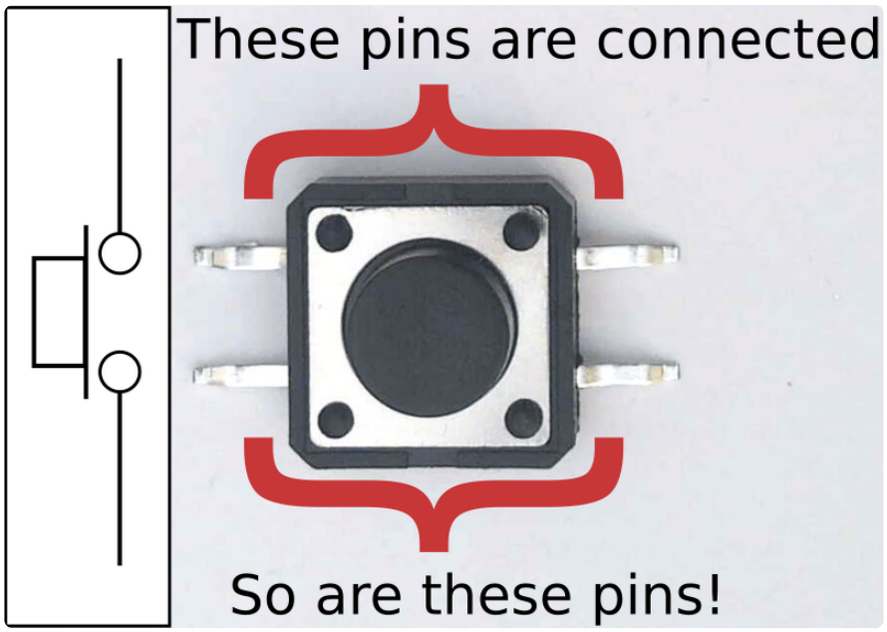
Push Buttons



These large clicky switches are great for making finger-friendly pushbuttons that can connect to your Feather. You'll get three switches so you can use them for projects that need a lot of options

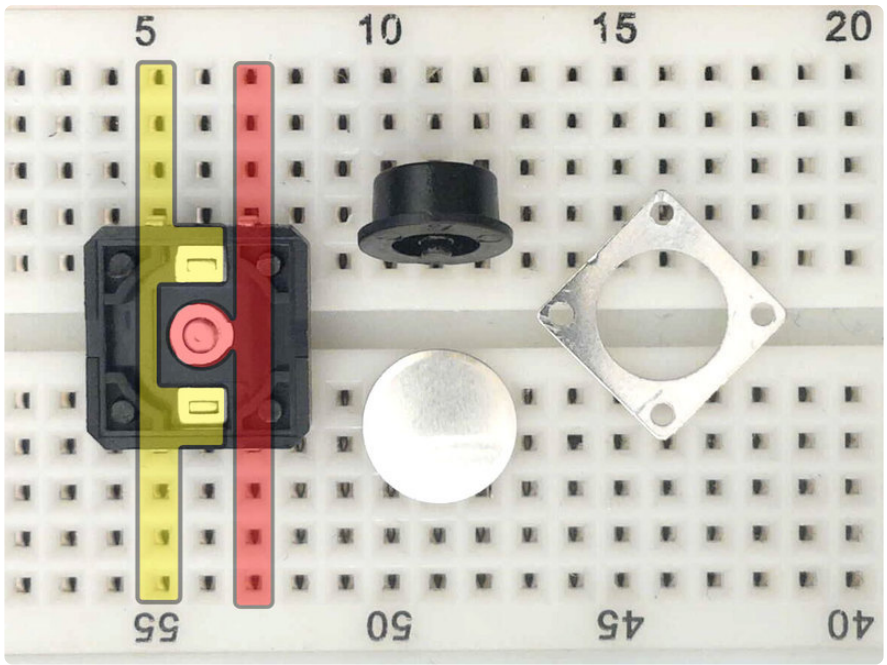


The switches have four legs, but there's only two halves to the switch. The two sets of pins are normally open (disconnected) and when the button is pressed they are momentarily closed.



So don't forget when using in the breadboard that the two rows across from each other will be connected on the inside of the switch!

Inside there is a round contact and two side contacts. a little round dome sits on top and then a plastic 'hat' that makes the switch. When you push on the hat, it clicks the dome down to touch the middle part and connects it to the side bits.

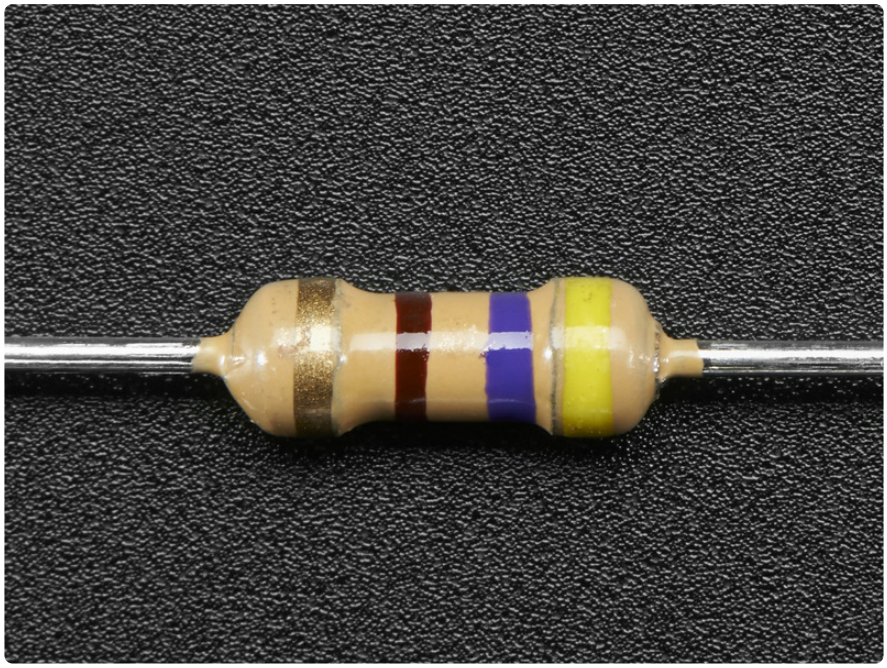


Resistors and Potentiometers

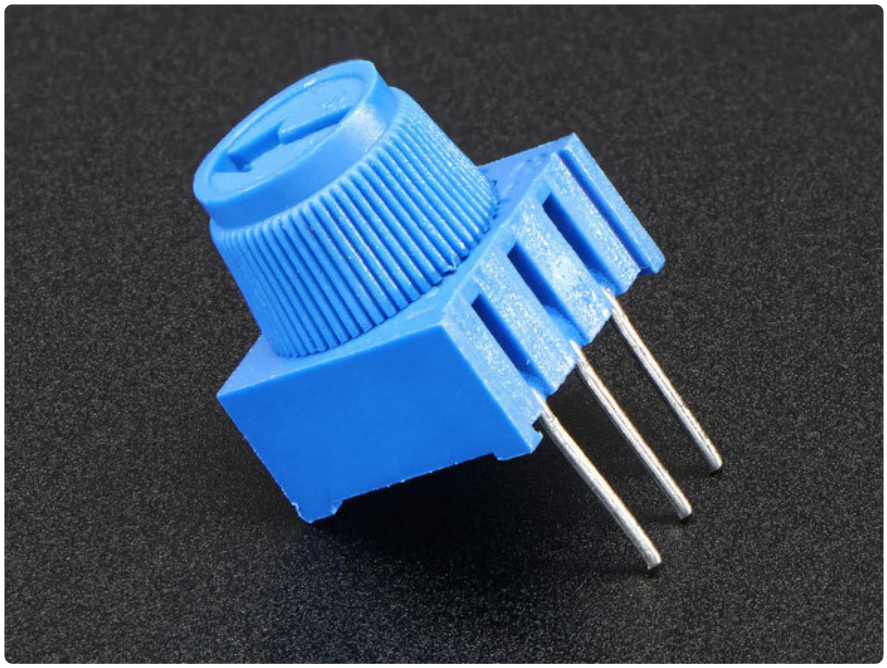
Resistors are the most common electronic component. They resist the flow of current, which lets you control how much current is going through your circuit. They're great for changing the brightness of LEDs, as well as pulling voltages on signals up or down.

You get 5 of two types. The first is 10,000 ohms. This resistor has **Brown Black Orange Gold** stripes. This one is used the most for sensors and switches

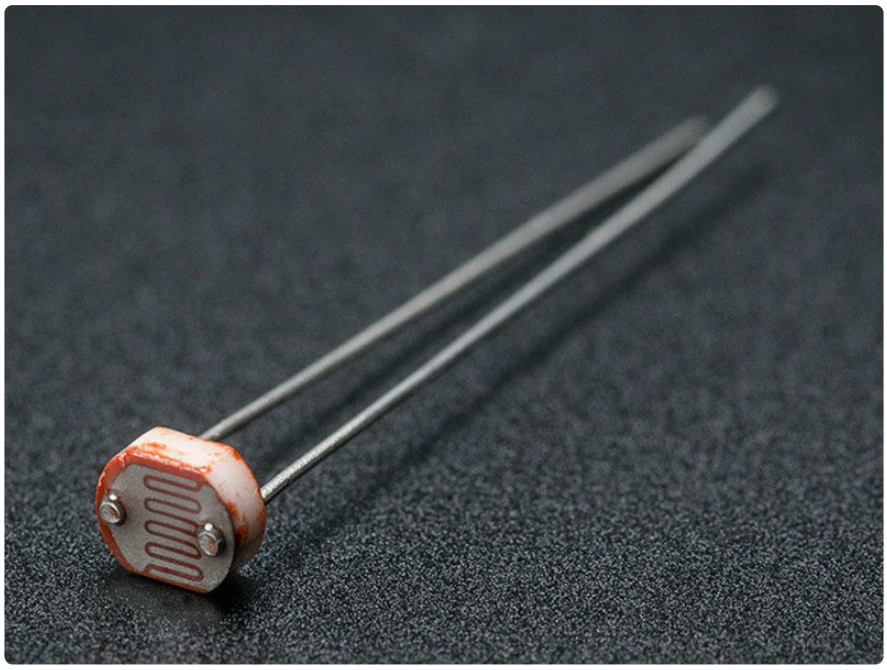
The other is a set of five 560 ohm resistors You can tell it apart because it has **Green Blue Black Gold** stripes. This one is used the most for LEDs



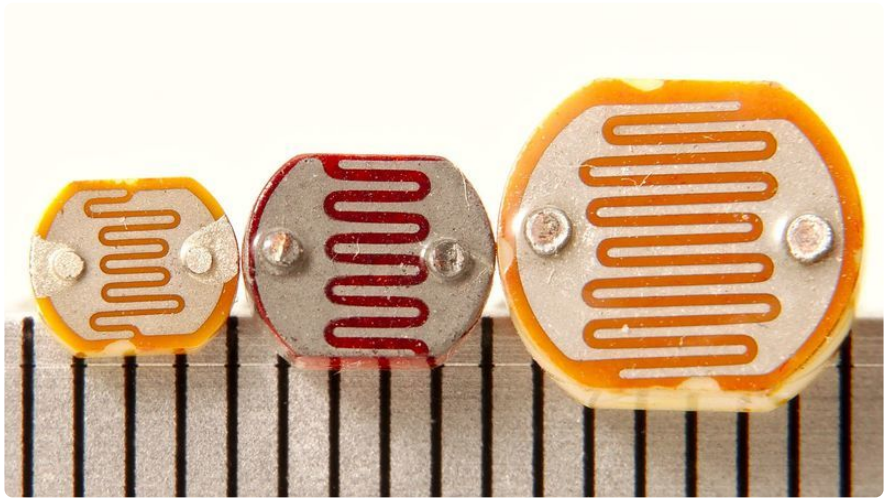
Resistors are very simple, and they have a **fixed** value. Wouldn't it be cool if you had an adjustable resistor? Such things exist! They are called potentiometers. We give you two: the total resistance of each is 10,000 ohms (like the top resistor) but as you twist the knob the resistance between the middle pin and the outer pins ranges from 0 to 10,000 ohms



Light Sensor



Photocells are sensors that allow you to detect light. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they often appear in toys, gadgets and appliances. They are often referred to as CdS cells (they are made of Cadmium-Sulfide), light-dependent resistors (LDR), and photoresistors.



Photocells are basically a resistor that changes its resistive value (in ohms Ω) depending on how much light is shining onto the squiggly face. They are very low cost, easy to get in many sizes and specifications, but are very innacurate. Each photocell sensor will act a little differently than the other, even if they are from the same batch. The variations can be really large, 50% or higher! For this reason, they shouldn't be used to try to determine precise light levels in lux or millicandela. Instead, you can expect to only be able to determine basic light changes.

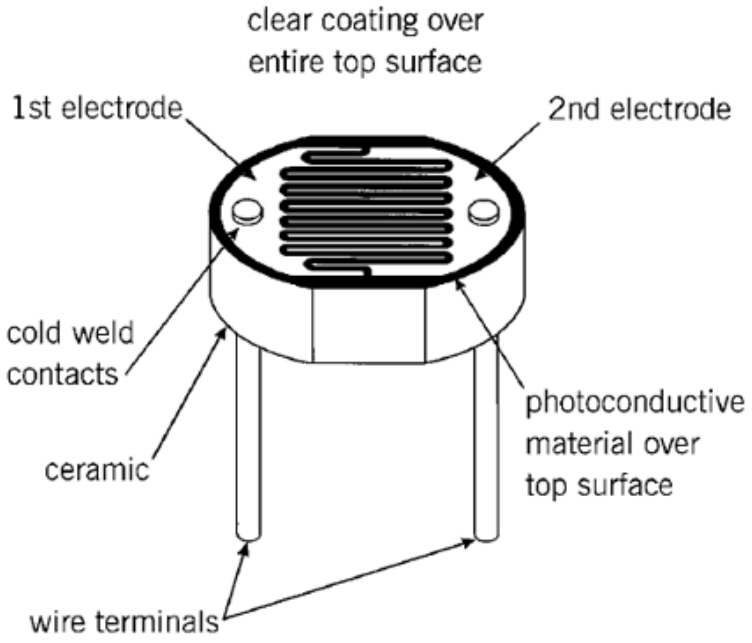
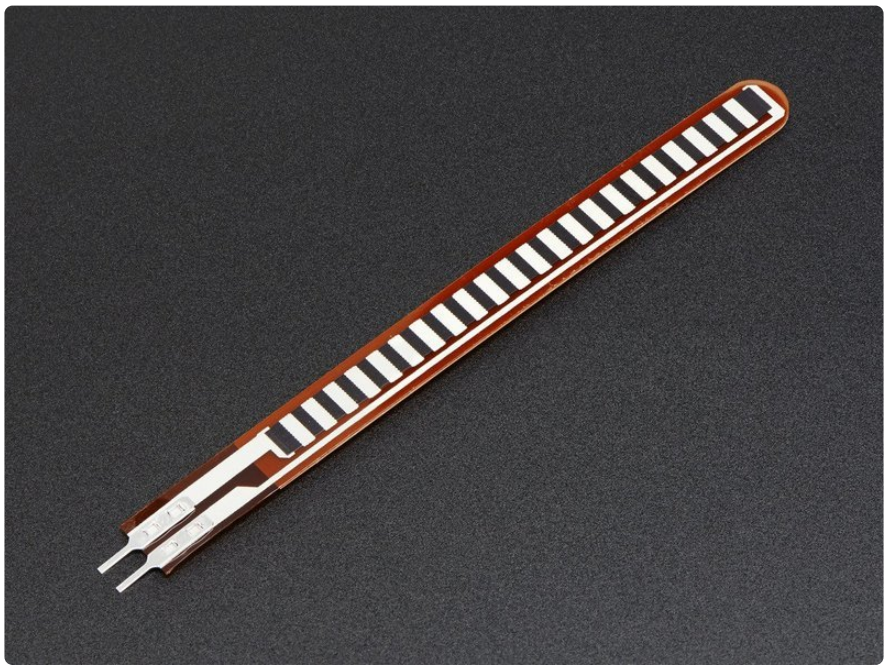


Figure 3
Typical Construction of a Plastic Coated Photocell

For most light-sentsitive applications like "is it light or dark out", "is there something in front of the sensor (that would block light)", "is there something interrupting a laser beam" (break-beam sensors), or "which of multiple sensors has the most light hitting it", photocells can be a good choice!

Flex Sensor



This sensor can detect flexing or bending in one direction. They were popularized by being used in the Nintendo PowerGlove as a gaming interface.

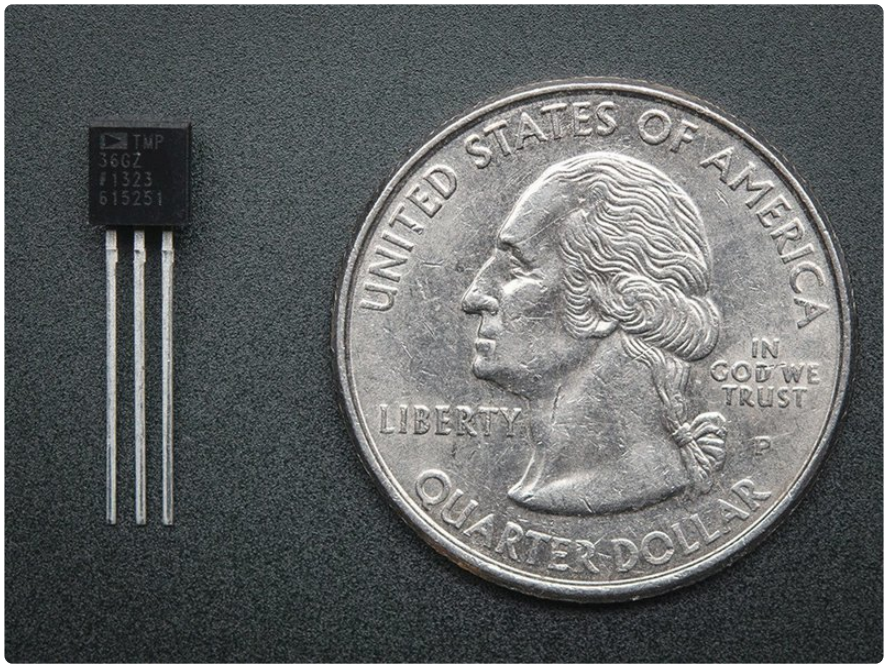
These sensors are easy to use, they are basically resistors that change value based on how much their flexed. If they're unflexed, the resistance is about ~25KΩ. When flexed all the way the resistance rises to ~100KΩ. They're pretty similar to FSRs so following this tutorial will get you started (https://adafru.it/aHC).

The bottom part of the sensor (where the pins are crimped on) is very delicate so make sure to have strain relief - such as clamping or gluing that part so as not to rip out the contacts!

Note that the sensor can only measure bending in one direction. Bending the other way doesn't do anything.

Temperature Sensor

An analog temperature sensor is pretty easy to explain, its a chip that tells you what the ambient temperature is!



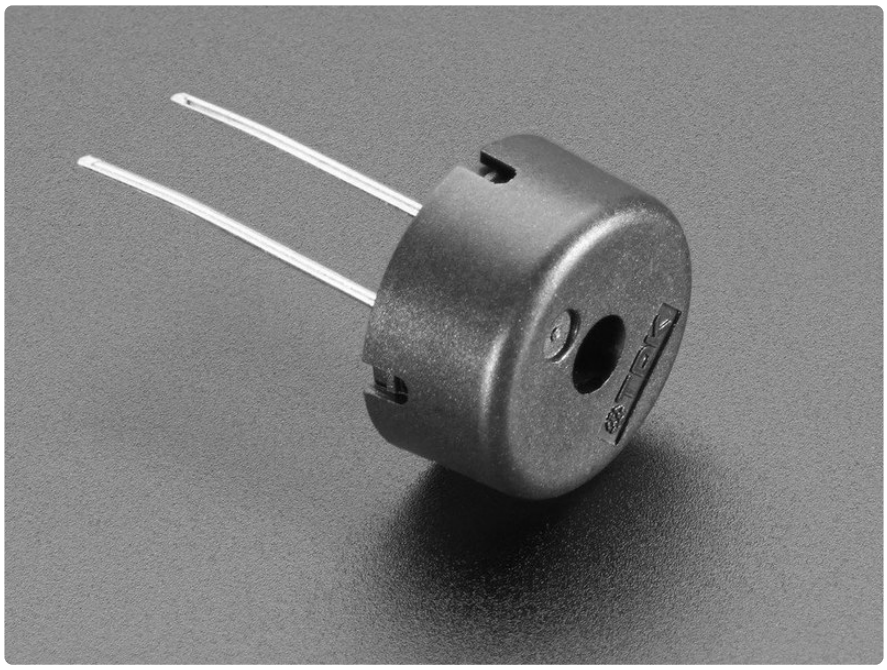
These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetalic strips (https://adafru.it/aKJ) (like in some home thermometers or stoves), nor do they use thermistors (https://adafru.it/aK6)(temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. (Technically, this is actually the voltage drop between the base and emitter - the Vbe -

of a transistor.) By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature. There have been some improvements on the technique but, essentially that is how temperature is measured.

The good news is all that complex calculation is done inside the chip - it just spits out the temperature, ready for you to use!

Because these sensors have no moving parts, they are precise, never wear out, don't need calibration, work under many environmental conditions, and are consistant between sensors and readings. Moreover they are very inexpensive and quite easy to use.

Piezo Buzzer

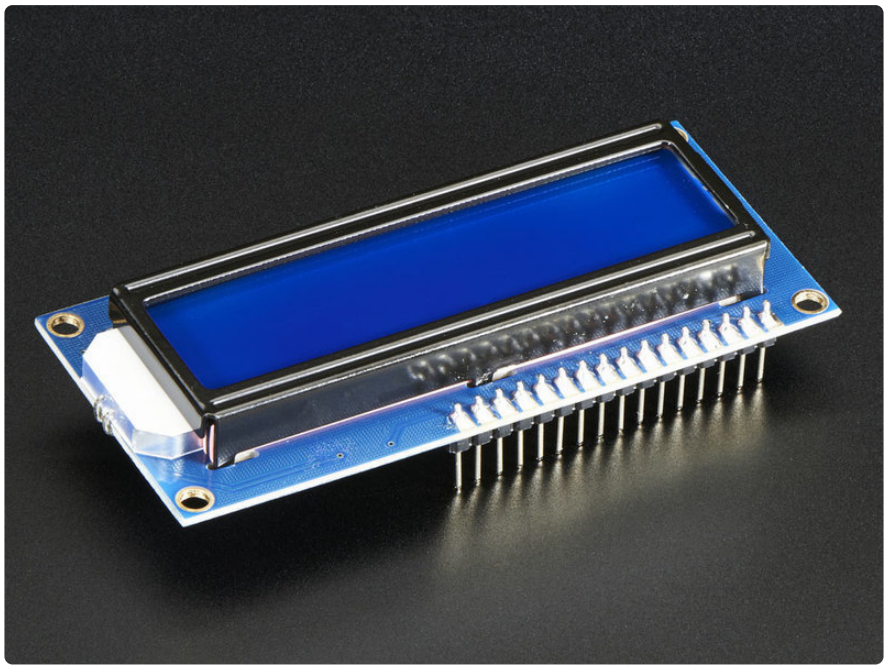


Piezo buzzers are used for making beeps, tones and alerts. Its the same thing that's in your microwave, alarm clock or washing machine to alert you when your food is done, or laundry complete. This one is petite but loud! You can plug it into your breadboard easily. Drive it with square wave to make tones - that's it, pretty easy.

To use, connect one pin to ground (either one) and the other pin to a square wave out from the Feather microcontroller. For the loudest tones, stay around 4 KHz, but works quite well from 2KHz to 10KHz.

For advanced usage/extra loudness, you can connect both pins to a microcontroller and swap which pin is high or low ('differential drive') for double the volume.

16x2 LCD



When just beeps and tones are not enough, adding a **Liquid Crystal Display** to your project will let you print out messages and information onto a small light up display.

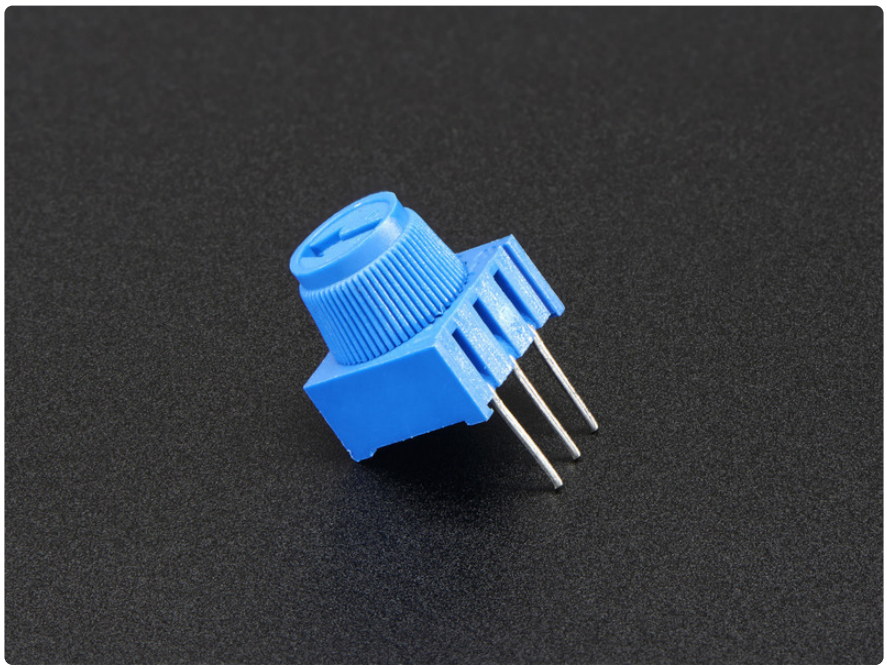
These LCDs are in almost all electronics, and can display basic text as well as very very small icons like the heart and smiley face in this picture:

If you look closely you can see the little rectangles where the characters are displayed. Each rectangle is a grid of pixels. Normally all the pixels are blue, but when

you tell the LCD to change them, they swich to transparent, and the white backlight shines through.

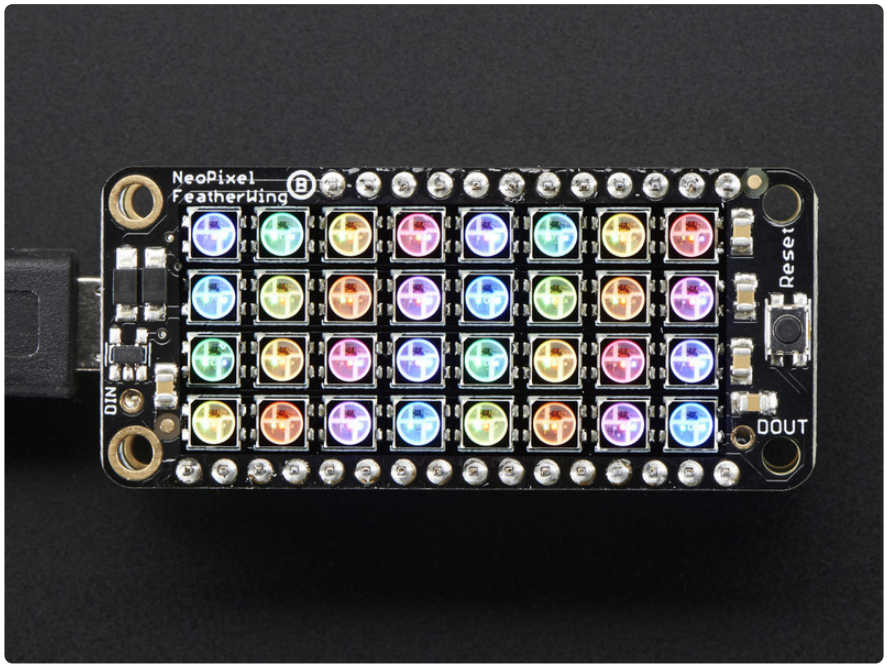
You can mix an LCD with sensors to display instant feedback, and when powered with a battery lets you have a project that can go portable.

The LCD also may come with an extra 10KΩ resistor which is used to change the contrast/visibility.



NeoPixel FeatherWing

Aww yeah we saved the best for last. One of the nice things about the Feather board you have is that it comes with stackable headers. This means you can plug it into the breadboard and then stack another circuit board on top. Since the main board is called a **Feather**, the attachments are called **FeatherWings**. We have about 50 different options for 'Wings - from powerful relays that can let you turn on/off lamps and appliances (http://adafru.it/3191) to a GPS add on so your Feather can figure out where it's location is anywhere on Earth (http://adafru.it/3133).



Specifically, this is the **NeoPixel FeatherWing,** a 4x8 RGB LED add on! Connect this FeatherWing on top or bottom of your Feather board and make your Feather board strut like a peacock at a rave.

You may need to put on your sunglasses before staring into these 32 configurable eye-blistering RGB LEDs. Arranged in a 4x8 matrix, each pixel is individually addressable, so you can have them all be the same color or create patterns and animations by progamming the Feather.

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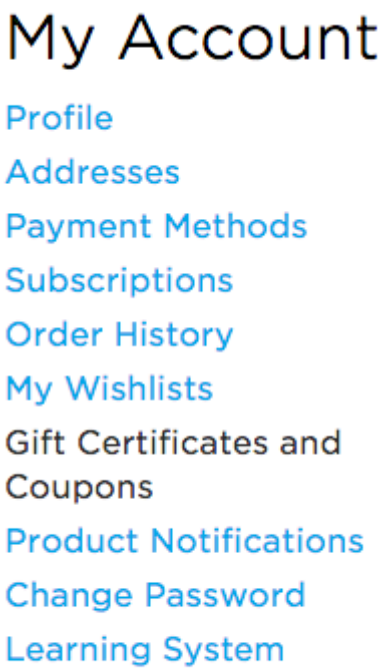

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