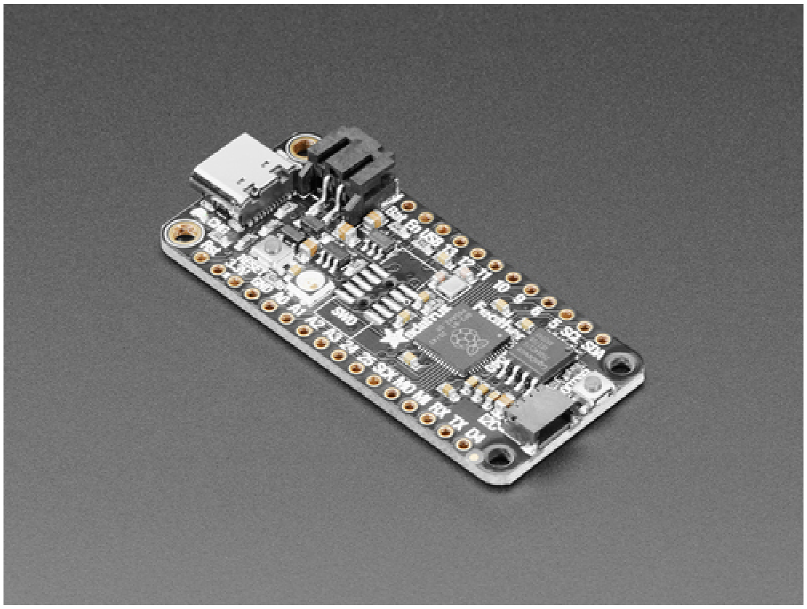
Introducing Adafruit Feather RP2040

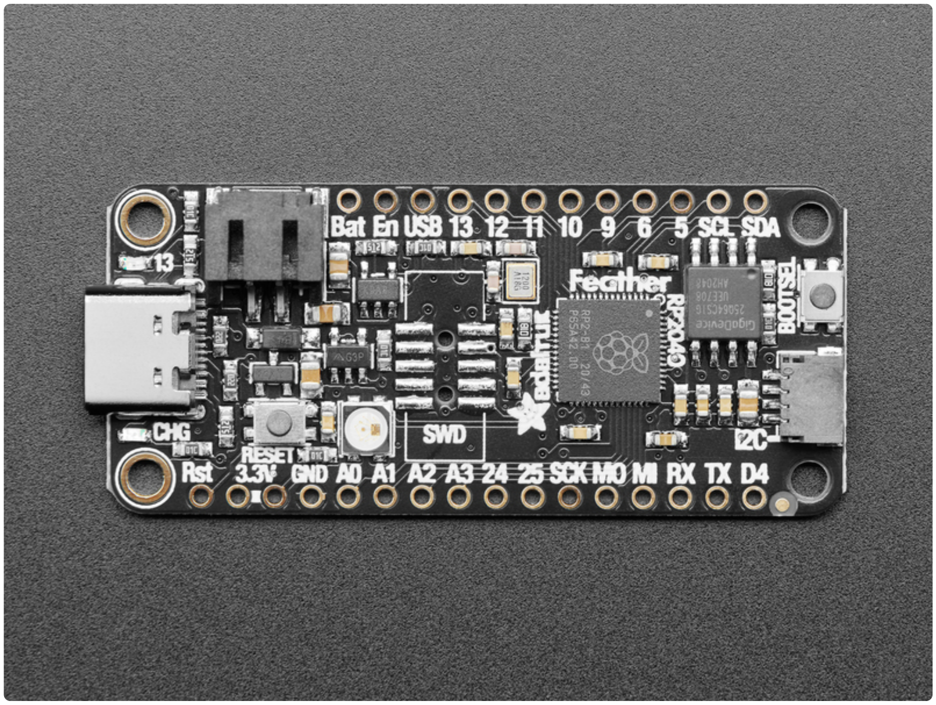
Created by Kattni Rembor



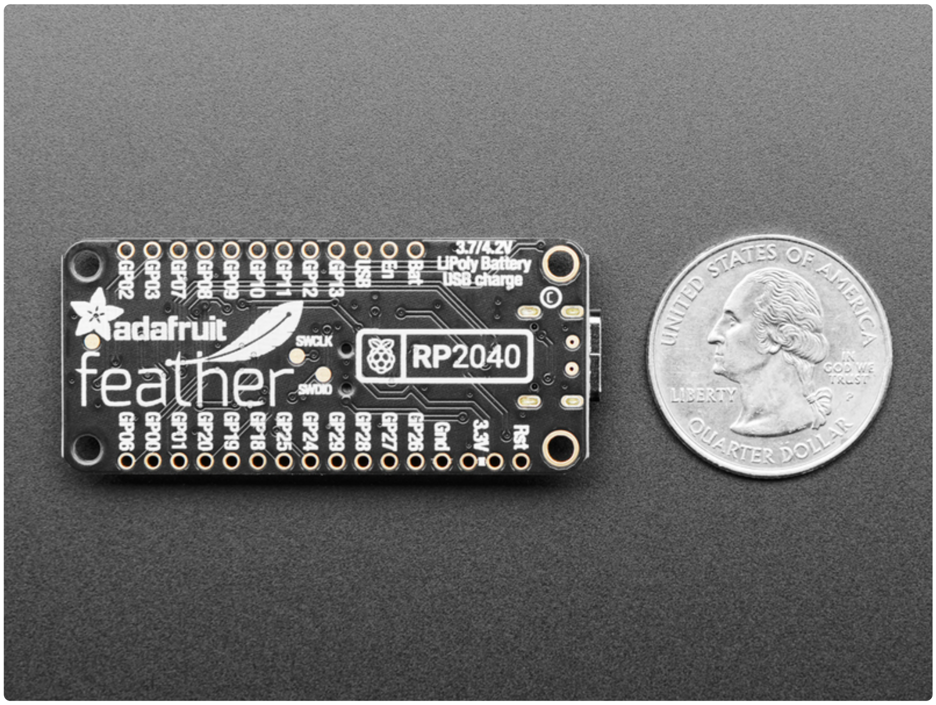
Last updated on 2021-10-16 03:46:00 PM EDT

Guide Contents

Overview

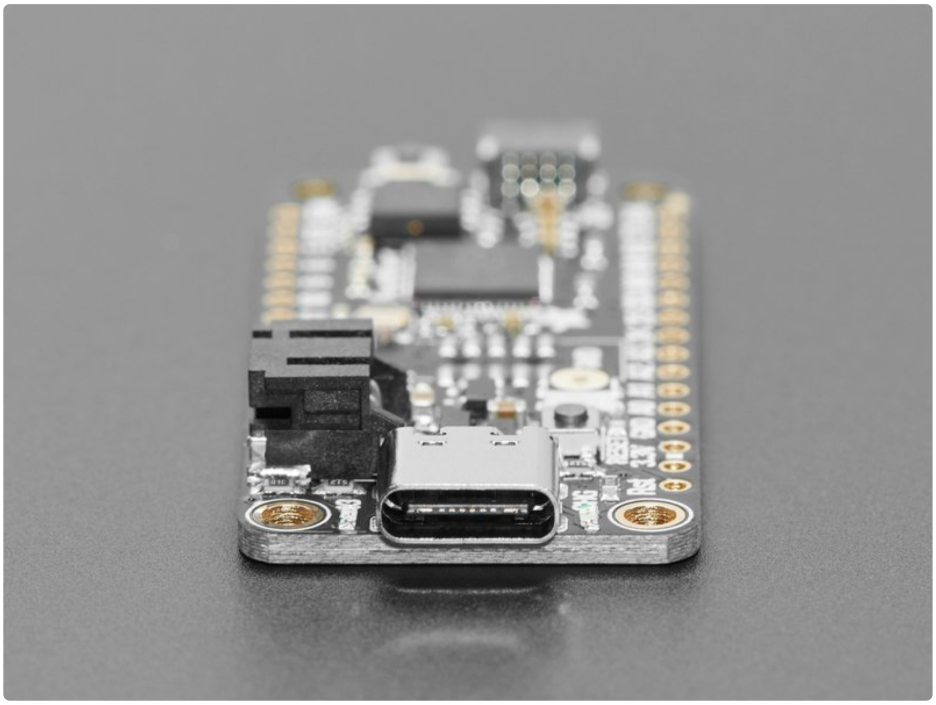

Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather RP2040
BOOTSEL
CHG
RESET
SWD
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

A new chip means a new Feather, and the Raspberry Pi RP2040 is no exception. When we saw this chip we thought "this chip is going to be awesome when we give it the Feather Treatment" and so we did! This Feather features the **RP2040**, and all niceties you know and love about Feather


GP02 GP03 GP07 GP08 GP09 GP10 GP11 GP12 GP13 USB En Bat
3.7/4.2V LiPoly Battery USB charge
adafruit feather
SWCLK
SWDIO
RP2040
GP06 GP00 GP01 GP20 GP19 GP18 GP25 GP24 GP29 GP28 GP27 GP26 Gnd 3.3V Rst
UNITED STATES OF AMERICA
LIBERTY
IN GOD WE TRUST
QUARTER DOLLAR

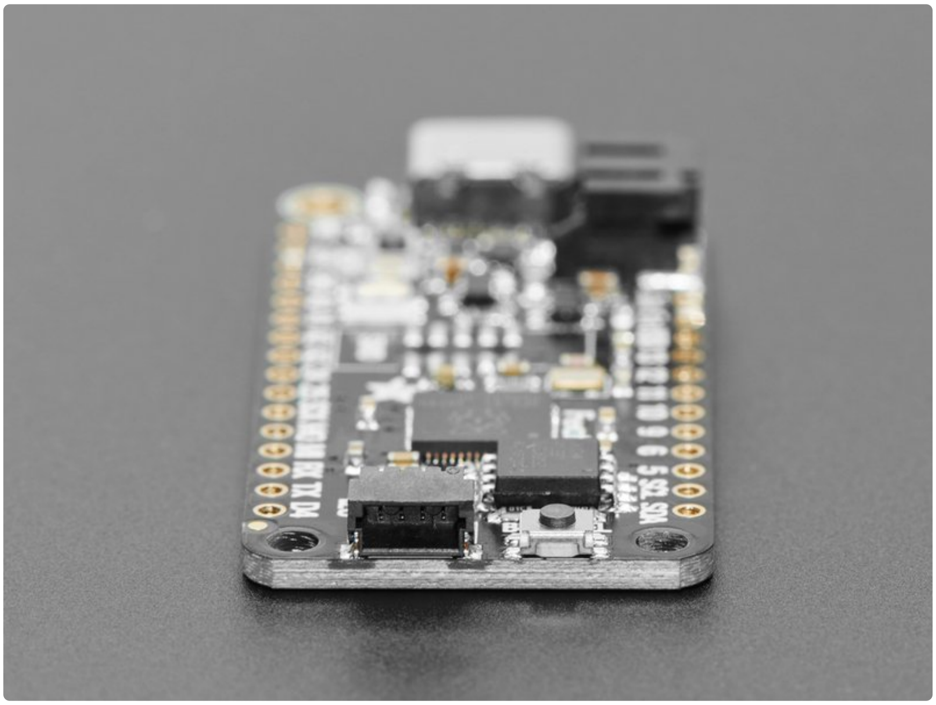
- Measures 2.0" x 0.9" x 0.28" (50.8mm x 22.8mm x 7mm) without headers soldered in

- Light as a (large?) feather - 5 grams
- RP2040 32-bit Cortex M0+ dual core running at ~125 MHz @ 3.3V logic and power
- 264 KB RAM
- **8 MB SPI FLASH** chip for storing files and CircuitPython/MicroPython code storage. No EEPROM
- **Tons of GPIO! 21 x GPIO pins with following capabilities:**
    - **Four** 12 bit ADCs (one more than Pico)
    - Two I2C, Two SPI and two UART peripherals, we label one for the 'main' interface in standard Feather locations
    - 16 x PWM outputs - for servos, LEDs, etc
    - The 8 digital 'non-ADC/non-peripheral' GPIO are consecutive for maximum PIO compatibility
- **Built in 200mA lipoly charger** with charging status indicator LED
- **Pin #13 red LED** for general purpose blinking
- **RGB NeoPixel** with power pin on GPIO so you can depower it for low power usages.
- On-board **STEMMA QT connector** that lets you quickly connect any Qwiic, STEMMA QT or Grove I2C devices with no soldering!
- **Both Reset button and Bootloader select button for quick restarts (no unplugging-replugging to relaunch code)**
- 3.3V Power/enable pin
- Optional SWD debug port can be soldered in for debug access (https://adafru.it/w5e)
- 4 mounting holes
- 12 MHz crystal for perfect timing.
- 3.3V regulator with 500mA peak current output
- **USB Type C connector** lets you access built-in ROM USB bootloader and serial port debugging



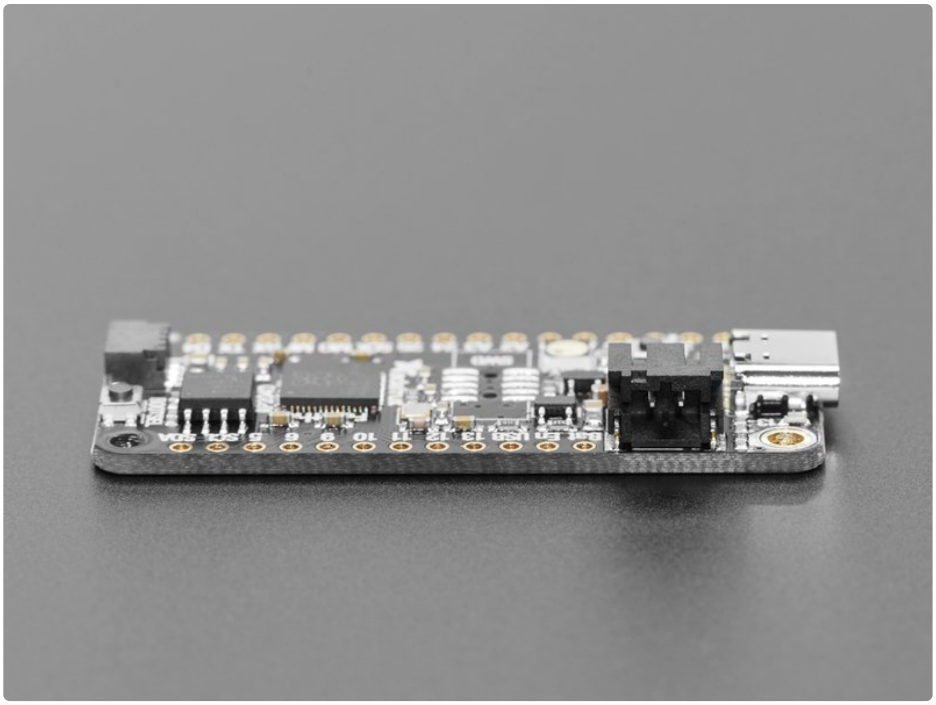
Inside the RP2040 is a 'permanent ROM' USB UF2 bootloader . What that means is when you want to program new firmware, you can hold down the BOOTSEL button while plugging it into USB (or pulling down the RUN/Reset pin to ground) and it will appear as a USB disk drive you can drag the firmware onto. Folks who have been using Adafruit products will find this very familiar - we use the technique on all our native-USB boards. Just note you don't double-click reset, instead hold down BOOTSEL during boot to enter the bootloader!

The RP2040 is a powerful chip, which has the clock speed of our M4 (SAMD51), and two cores that are equivalent to our M0 (SAMD21). Since it is an M0 chip, it does not have a floating point unit, or DSP hardware support - so if you're doing something with heavy floating-point math, it will be done in software and thus not as fast as an M4. For many other computational tasks, you'll get close-to-M4 speeds!



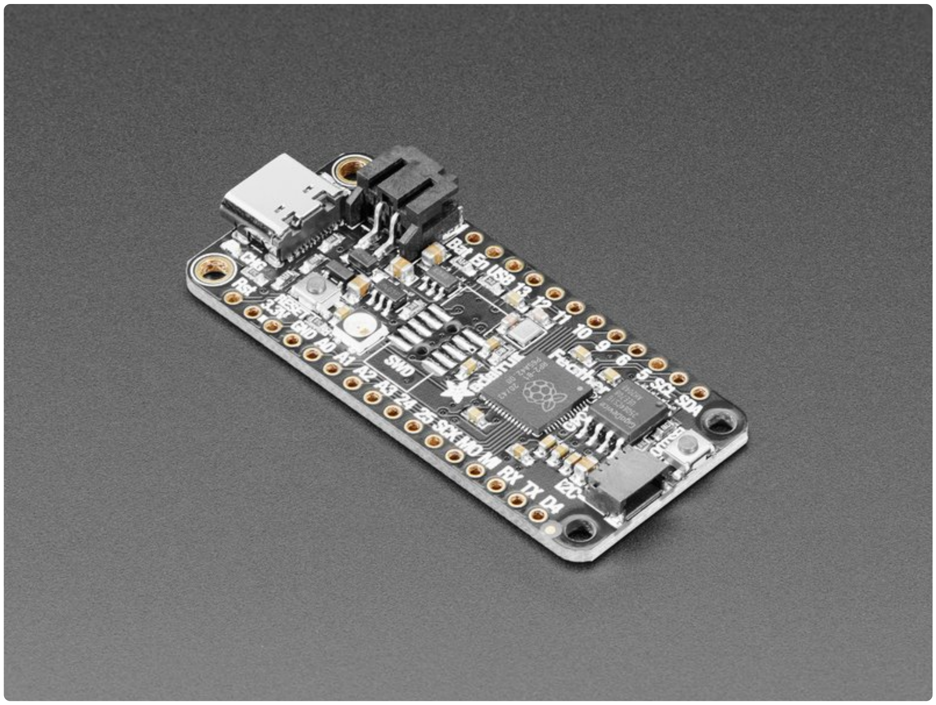
For peripherals, there are two I2C controllers, two SPI controllers, and two UARTs that are multiplexed across the GPIO - check the pinout for what pins can be set to which. There are 16 PWM channels, each pin has a channel it can be set to (ditto on the pinout).

You'll note there's no I2S peripheral, or SDIO, or camera, what's up with that? Well instead of having specific hardware support for serial-data-like peripherals like these, the RP2040 comes with the PIO state machine system which is a unique and powerful way to create *custom hardware logic and data processing blocks* that run on their own without taking up a CPU. For example, NeoPixels - often we bitbang the timing-specific protocol for these LEDs. For the RP2040, we instead use PIO object that reads in the data buffer and clocks out the right bitstream with perfect accuracy. Same with I2S audio in or out, LED matrix displays, 8-bit or SPI based TFTs, even VGA (https://adafru.it/Qa2)! In MicroPython and CircuitPython you can create PIO control commands to script the peripheral and load it in at runtime. There are 2 PIO peripherals with 4 state machines each.



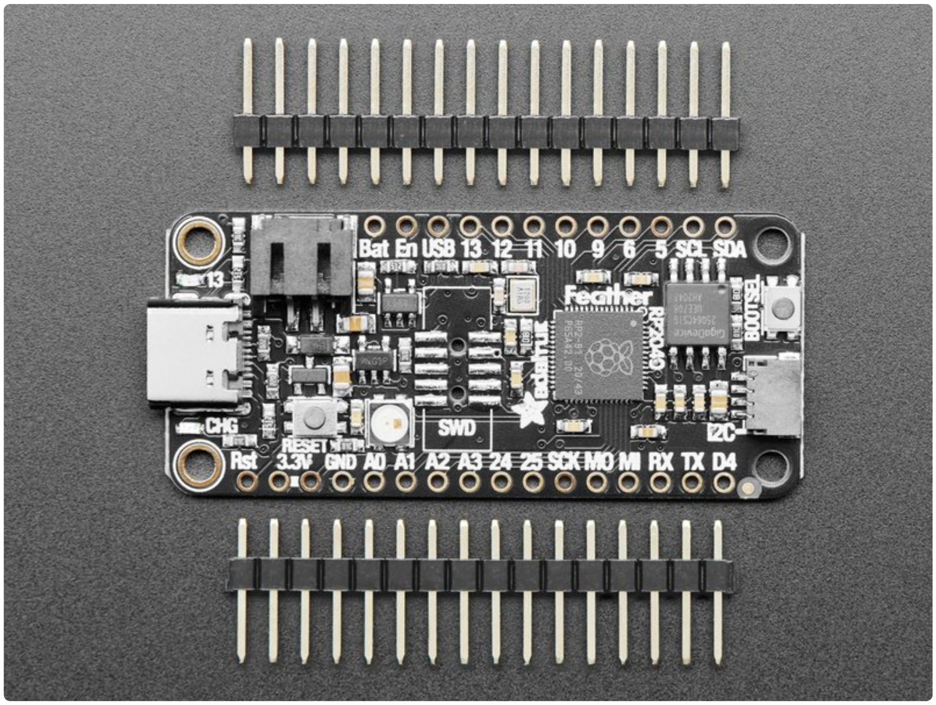
At the time of launch, there is no Arduino core support for this board. There is great C/C++ support **(https://adafru.it/Qa3), an official** MicroPython port **(https://adafru.it/Qa4), and a** CircuitPython port **(https://adafru.it/Em8)!** We of course recommend CircuitPython because we think it's the easiest way to get started (https://adafru.it/cpy-welcome) and it has support with most of our drivers, displays, sensors, and more, supported out of the box so you can follow along with our CircuitPython projects and tutorials.

While the RP2040 has lots of onboard RAM (264KB), it does not have built-in FLASH memory. Instead, that is provided by the external QSPI flash chip. **On this board there is 8 MB** , which is shared between the program it's running and any file storage used by MicroPython or CircuitPython. When using C/C++ you get the whole flash memory, if using Python you will have about 7 MB remaining for code, files, images, fonts, etc.



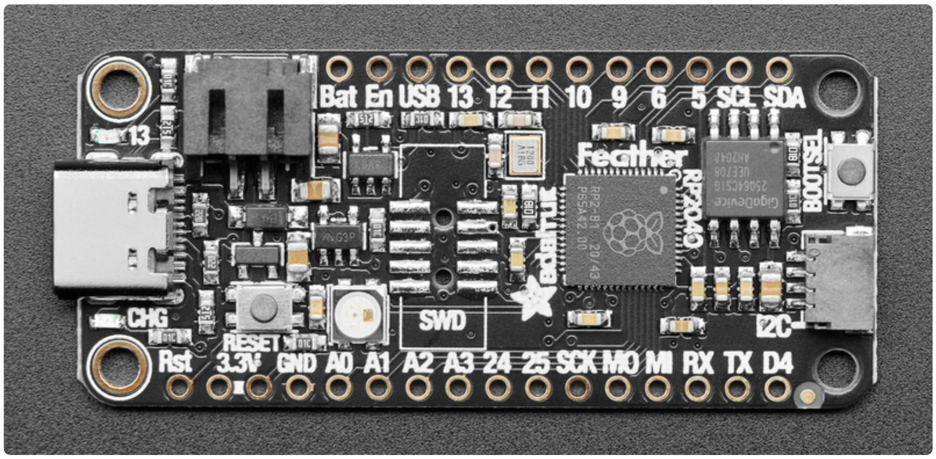
RP2040 Chip features:

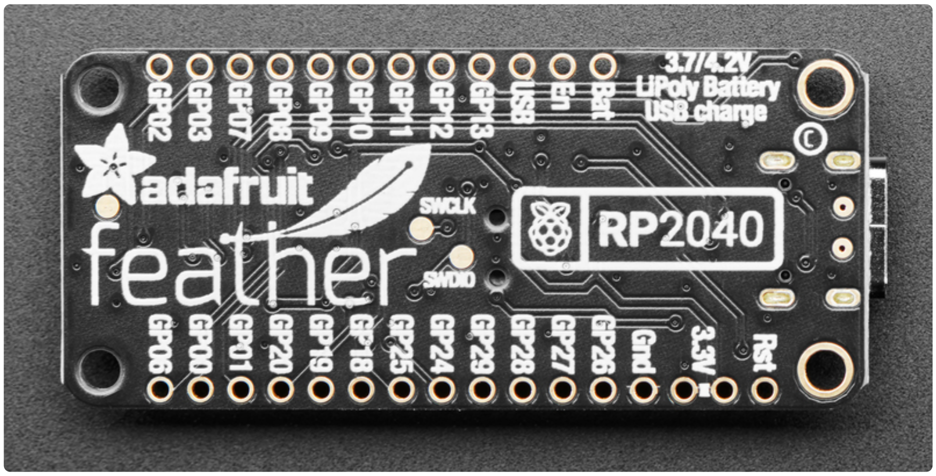
- Dual ARM Cortex-M0+ @ 133MHz
- 264kB on-chip SRAM in six independent banks
- Support for up to 16MB of off-chip Flash memory via dedicated QSPI bus
- DMA controller
- Fully-connected AHB crossbar
- Interpolator and integer divider peripherals
- On-chip programmable LDO to generate core voltage
- 2 on-chip PLLs to generate USB and core clocks
- 30 GPIO pins, 4 of which can be used as analog inputs
- Peripherals
    - 2 UARTs
    - 2 SPI controllers
    - 2 I2C controllers
    - 16 PWM channels
    - USB 1.1 controller and PHY, with host and device support
    - 8 PIO state machines


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOT
CHG
RESET
SWD
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

Comes fully assembled and tested, with the UF2 USB bootloader. We also toss in some header, so you can solder it in and plug it into a solderless breadboard.

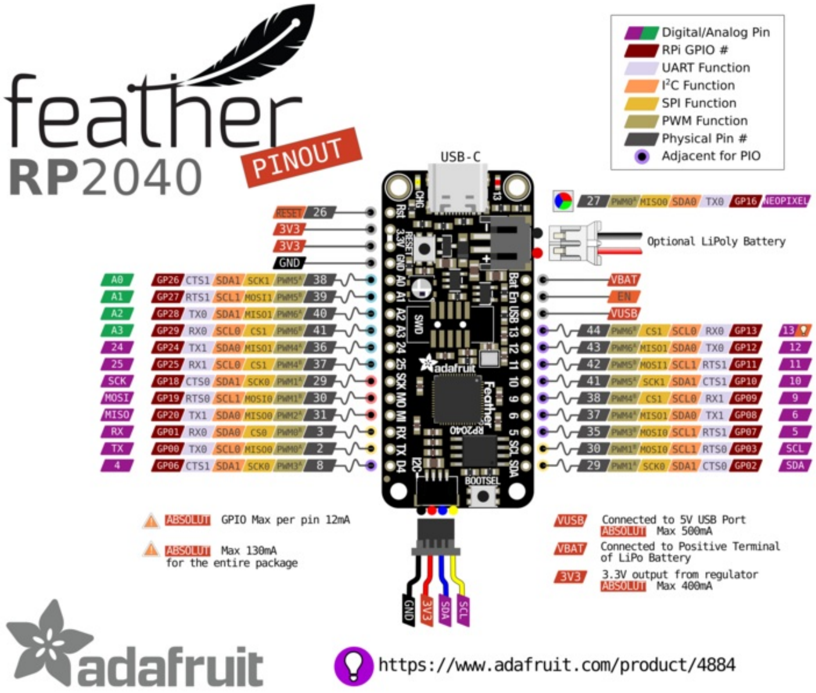
Pinouts



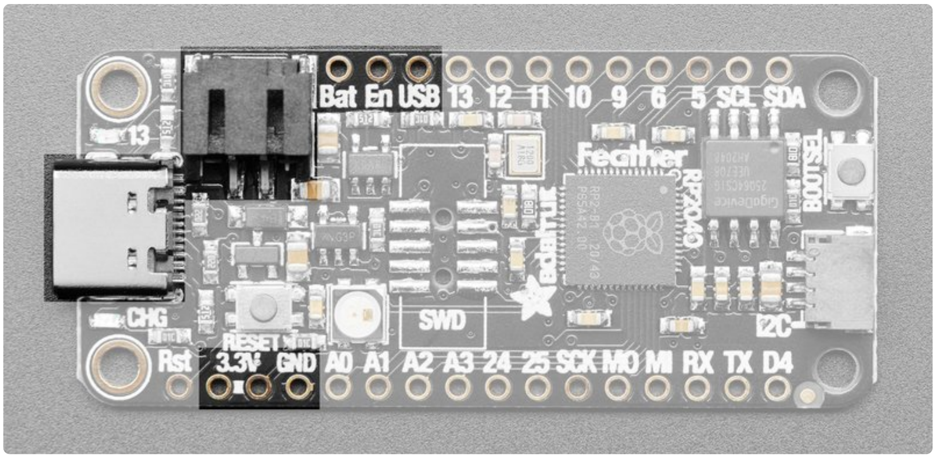


The Feather RP2040 has many pins, ports and features. This page takes you on a tour of the board!

Pinout diagram courtesy of Bill Binko at ATMakers.

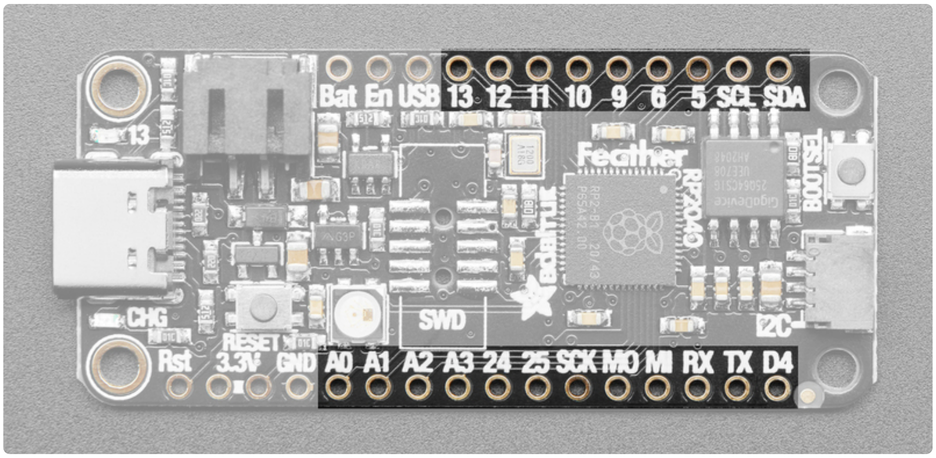

feather
RP2040
PINOUT
USB-C
Digital/Analog Pin
RPi GPIO #
UART Function
I²C Function
SPI Function
PWM Function
Physical Pin #
Adjacent for PIO
RESET 26
3V3
3V3
GND
A0 GP26 CTS1 SDA1 SCK1 PWM5A 38
A1 GP27 RTS1 SCL1 MOSI1 PWM5B 39
A2 GP28 TX0 SDA1 MISO1 PWM6A 40
A3 GP29 RX0 SCL0 CS1 PWM6B 41
24 GP24 TX1 SDA0 MISO1 PWM4A 36
25 GP25 RX1 SCL0 CS1 PWM4B 37
SCK GP18 CTS0 SDA1 SCK0 PWM1A 29
MOSI GP19 RTS0 SCL1 MOSI0 PWM1B 30
MISO GP20 TX1 SDA0 MISO0 PWM2A 31
RX GP01 RX0 SDA0 CS0 PWM0B 3
TX GP00 TX0 SCL0 MISO0 PWM0A 2
4 GP06 CTS1 SDA1 SCK0 PWM3A 8
27 PWM0A MISO0 SDA0 TX0 GP16 NEOPIXEL
Optional LiPoly Battery
VBAT
EN
VUSB
44 PWM6B CS1 SCL0 RX0 GP13 13
43 PWM6A MISO1 SDA0 TX0 GP12 12
42 PWM5B MOSI1 SCL1 RTS1 GP11 11
41 PWM5A SCK1 SDA1 CTS1 GP10 10
38 PWM4B CS1 SCL0 RX1 GP09 9
37 PWM4A MISO1 SDA0 TX1 GP08 6
35 PWM3B MOSI0 SCL1 RTS1 GP07 5
30 PWM1B MOSI0 SCL1 RTS0 GP03 SCL
29 PWM1A SCK0 SDA1 CTS0 GP02 SDA
ABSOLUT GPIO Max per pin 12mA
ABSOLUT Max 130mA for the entire package
VUSB Connected to 5V USB Port ABSOLUT Max 500mA
VBAT Connected to Positive Terminal of LiPo Battery
3V3 3.3V output from regulator ABSOLUT Max 400mA
GND
3V3
SDA
SCL
adafruit
https://www.adafruit.com/product/4884

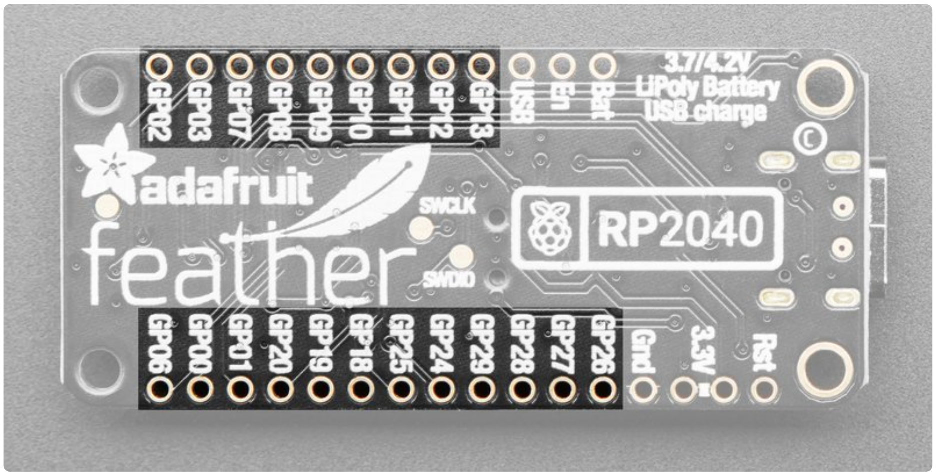
Power Pins and Connections



- **USB C connector** - This is used for power and data. Connect to your computer via a USB C cable to update firmware and edit code.
- **LiPoly Battery connector** - This 2-pin JST PH connector allows you to plug in lipoly batteries to power the Feather. The Feather is also capable of charging batteries plugged into this port via USB.
- **GND** - This is the common ground for all power and logic.
- **BAT** - This is the positive voltage to/from the 2-pin JST jack for the optional Lipoly battery.
- **USB** - This is the positive voltage to/from the USB C jack, if USB is connected.
- **EN** - This is the 3.3V regulator's enable pin. It's pulled up, so connect to ground to disable the 3.3V regulator.
- **3.3V** - These pins are the output from the 3.3V regulator, they can supply 500mA peak.

Logic Pins





I2C and SPI on RP2040

The RP2040 is capable of handling I2C, SPI and UART on many pins. However, there are really only two peripherals each of I2C, SPI and UART: I2C0 and I2C1, SPI0 and SPI1, and UART0 and UART1. So while many pins are capable of I2C, SPI and UART, you can only do two at a time, and only on separate peripherals, 0 and 1. I2C, SPI and UART peripherals are included and numbered below.

PWM on RP2040

The RP2040 supports PWM on all pins. However, it is not capable of PWM on all pins at the same time. There are 8 PWM "slices", each with two outputs, A and B. Each pin on the Feather is assigned a PWM slice and output. For example, A0 is PWM5 A, which means it is first output of the fifth slice. You can have up to 16 PWM objects on the Feather RP2040. The important thing to know is that **you cannot use the same slice and output more than once at the same time**. So, if you have a PWM object on pin A0, you cannot also put a PWM object on D10, because they are both PWM5 A. The PWM slices and outputs are indicated below.

Analog Pins

The RP2040 has four ADCs. These pins are the only pins capable of handling analog, and they can also do digital.

- **A0/GP26** - This pin is ADC0. It is also SPI1 SCK, I2C1 SDA and PWM5 A.
- **A1/GP27** - This pin is ADC1. It is also SPI1 MOSI, I2C1 SCL and PWM5 B.
- **A2/GP28** - This pin is ADC2. It is also SPI1 MISO, I2C1 SDA and PWM6 A.
- **A3/GP29** - This pin is ADC3. It is also SPI1 CS, I2C0 SCL and PWM6 B.

Digital Pins

These are the digital I/O pins. They all have multiple capabilities.

- **D24/GP24** - Digital I/O pin 24. It is also UART1 TX, I2C0 SDA, and PWM4 A.
- **D25/GP25** - Digital I/O pin 25. It is also UART1 RX, I2C0 SCL, and PWM4 B.
- **SCK/GP18** - The main SPI0 SCK. It is also I2C1 SDA and PWM1 A.
- **MO/GP19** - The main SPI0 MOSI. It is also I2C1 SCL and PWM1 B.
- **MI/GP20** - The main SPI0 MISO. It is also UART1 TX, I2C0 SDA and PWM2 A.
- **RX/GP01** - The main UART0 RX pin. It is also I2C0 SDA, SPI0 CS and PWM0 B.
- **TX/GP00** - The main UART0 TX pin. It is also I2C0 SCL, SPI0 MISO and PWM0 A.
- **D4/GP06** - Digital I/O pin 4. It is also SPI0 SCK, I2C1 SDA and PWM3 A.
- **D13/GP13** - Digital I/O pin 13. It is also SPI1 CS, UART0 RX, I2C0 SCL and PWM6 B.
- **D12/GP12** - Digital I/O pin 12. It is also SPI1 MISO, UART0 TX, I2C0 SDA and PWM6 A.
- **D11/GP11** - Digital I/O pin 11. It is also SPI1 MOSI, I2C1 SCL and PWM5 B.
- **D10/GP10** - Digital I/O pin 10. It is also SPI1 SCK, I2C1 SDA and PWM5 A.
- **D9/GP09** - Digital I/O pin 9. It is also SPI1 CS, UART1 RX, I2C0 SCL and PWM4 B.
- **D6/GP08** - Digital I/O pin 6. It is also SPI1 MISO, UART1 TX, I2C0 SDA and PWM4 A.
- **D5/GP07** - Digital I/O pin 5. It is also SPI0 MOSI, I2C1 SCL and PWM3 B.
- **SCL/GP03** - The main I2C1 clock pin. It is also SPI0 MOSI, I2C1 SCL and PWM1 B.
- **SDA/GP02** - The main I2C1 data pin. It is also SPI0 SCK, I2C1 SDA and PWM1 A.

CircuitPython Pins vs GPxx Pins

There are pin labels on both sides of the Feather RP2040. Which should you use? In CircuitPython, use the pin labels on the top of the board (such as A0, D4, SCL, RX, etc.). If you're looking to work with this board and the RP2040 SDK, use the pin labels on the bottom of the board (GP00 and GP01, etc.).

CircuitPython I2C, SPI and UART

Note that in CircuitPython, there is a board object each for I2C, SPI and UART that use the pins labeled on the Feather. You can use these objects to initialise these peripherals in your code.

- `board.I2C()` uses SCL/SDA

- `board.SPI()` uses SCK/MO/MI
- `board.UART()` uses RX/TX

GPIO Pins by Pin Functionality

Primary pins based on Feather RP2040 silk are bold.

I2C Pins

- I2C0 SCL: A3, D25, RX, D13, D9
- I2C0 SDA: A2, D24, MISO, TX, D12, D6
- I2C1 SCL: **SCL**, A1, MOSI, D11, D5
- I2C1 SDA: **SDA**, A0, SCK, D4, D10

SPI Pins

- SPI0 SCK: **SCK**, D4, SDA
- SPI0 MOSI: **MOSI**, D5, SCL
- SPI0 MISO: **MISO**, TX
- SPI0 CS: RX
- SPI1 SCK: A0, D10
- SPI1 MOSI: A1, D11
- SPI1 MISO: A2, D24, D12, D6
- SPI1 CS: A3, D25, D13, D9

UART Pins

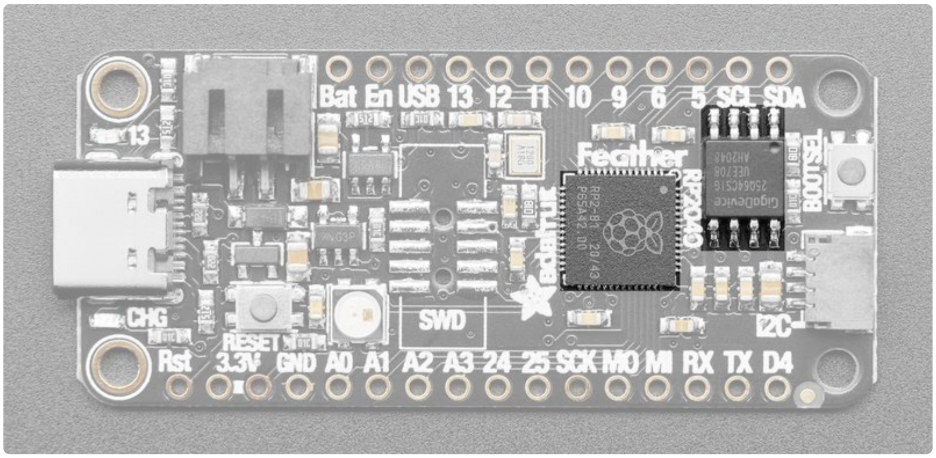
- UART0 TX: **TX**, A2, D12
- UART0 RX: **RX**, A3, D13
- UART1 TX: D24, MISO, D6
- UART1 RX: D25, D9

PWM Pins

- PWM0 A: TX
- PWM0 B: RX
- PWM1 A: SCK, SDA
- PWM1 B: MOSI, SCL
- PWM2 A: MISO
- PWM2 B: (none)
- PWM3 A: D4
- PWM3 B: D5
- PWM4 A: D24, D6

- PWM4 B: D25, D9
- PWM5 A: A0, D10
- PWM5 B: A1, D11
- PWM6 A: A2, D12
- PWM6 B: A3, D13

Microcontroller and Flash

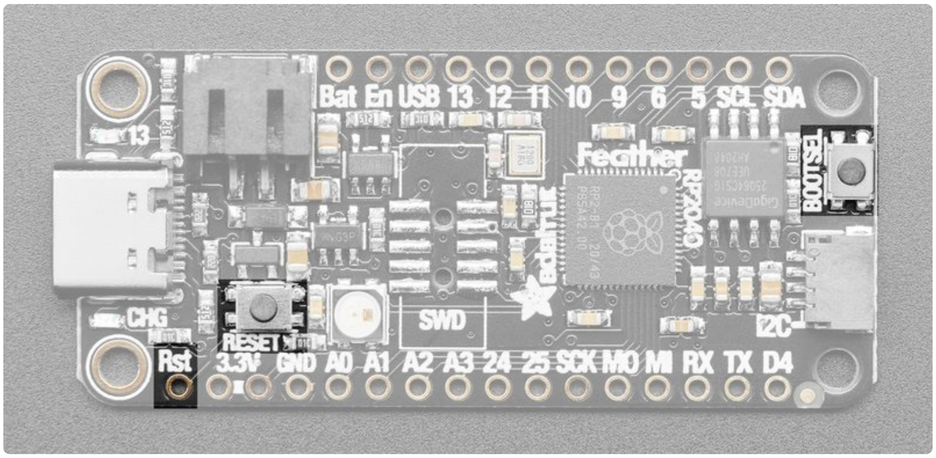


The square towards the middle is the **RP2040 microcontroller**, the "brains" of the Feather RP2040 board.

The square near the BOOTSEL button is the **QSPI Flash**. It is connected to 6 pins that are not brought out on the GPIO pads. This way you don't have to worry about the SPI flash colliding with other devices on the main SPI connection.

QSPI is neat because it allows you to have 4 data in/out lines instead of just SPI's single line in and single line out. This means that QSPI is *at least* 4 times faster. But in reality is at least 10x faster because you can clock the QSPI peripheral much faster than a plain SPI peripheral

Buttons and RST Pin


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
CHG
SWD
I2C
RESET
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

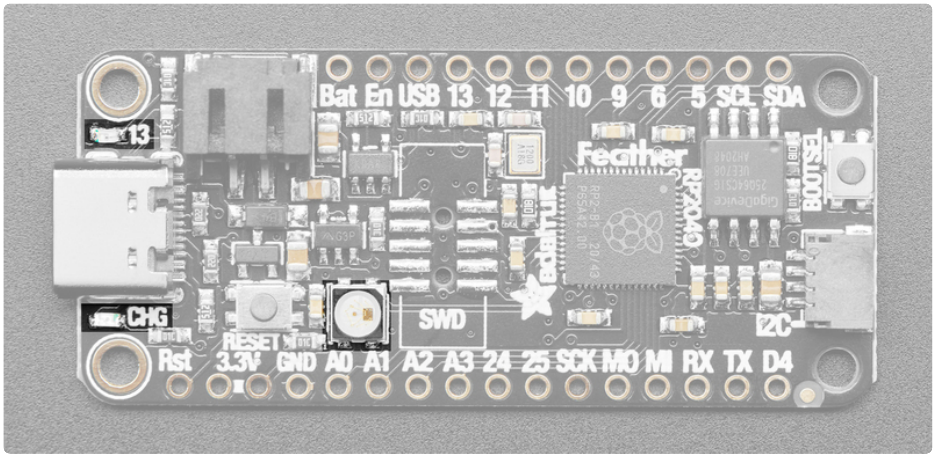
The Feather RP2040 has two buttons.

The **BOOTSEL** button is used to enter the bootloader. To enter the bootloader, press and hold BOOTSEL and then power up the board (either by plugging it into USB or pressing RESET). The bootloader is used to install/update CircuitPython.

The **RESET button** restarts the board and helps enter the bootloader. You can click it to reset the board without unplugging the USB cable or battery.

The **RST pin** is can be used to reset the board. Tie to ground manually to reset the board.

LEDs

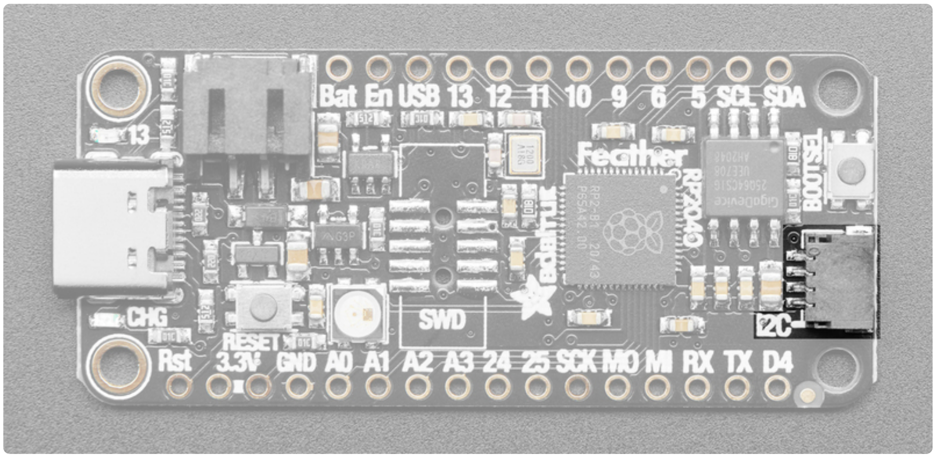

Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
CHG
SWD
I2C
RESET
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

Above the pin labels for A0 and A1 is the status **NeoPixel LED**. In CircuitPython, the NeoPixel is `board.NEOPIXEL` and the library for it is here (https://adafru.it/wby) and in the bundle (https://adafru.it/ENC) The NeoPixel is powered by the 3.3V power supply but that hasn't shown to make a big difference in brightness or color. In CircuitPython, the LED is used to indicate the runtime status.

Below the USB C connector is the **CHG LED**. This indicates the charge status of a connected lipoly battery, if one is present and USB is connected. It is amber while charging, and green when fully charged. Note, it's normal for this LED to flicker when no battery is in place, that's the charge circuitry trying to detect whether a battery is there or not.

Above the USB C connector is the **D13 LED**. This little red LED is controllable in CircuitPython code using `board.LED`. Also, this LED will pulse when the board is in bootloader mode.

STEMMA QT


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
SWD
CHG
RESET
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

The Feather RP2040 comes with a built in **STEMMA QT connector**! This means you can connect up [all sorts of I2C sensors and breakouts](https://adafru.it/GfR) (https://adafru.it/GfR), no soldering required! This connector uses the SCL and SDA pins for I2C meaning it is peripheral I2C1.

STEMMA QT / Qwiic JST SH 4-pin Cable - 100mm Long

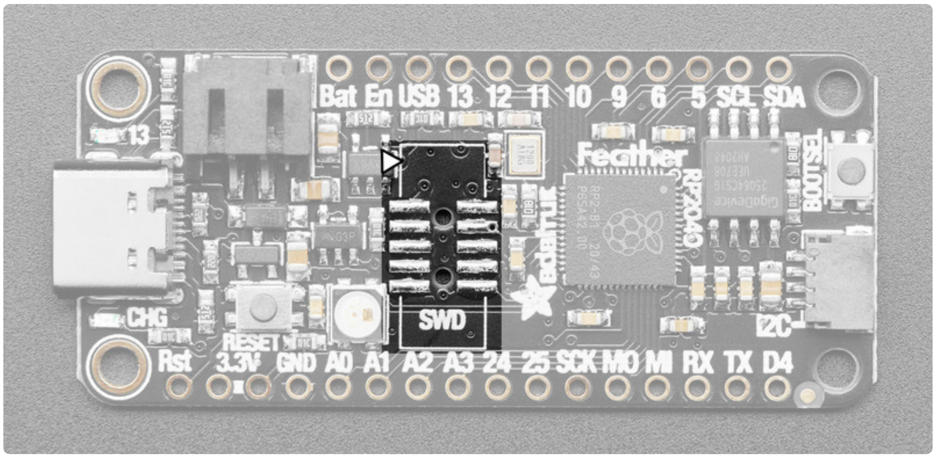
This 4-wire cable is a little over 100mm / 4" long and fitted with JST-SH female 4-pin connectors on both ends. Compared with the chunkier JST-PH these are 1mm pitch instead of...

$0.95

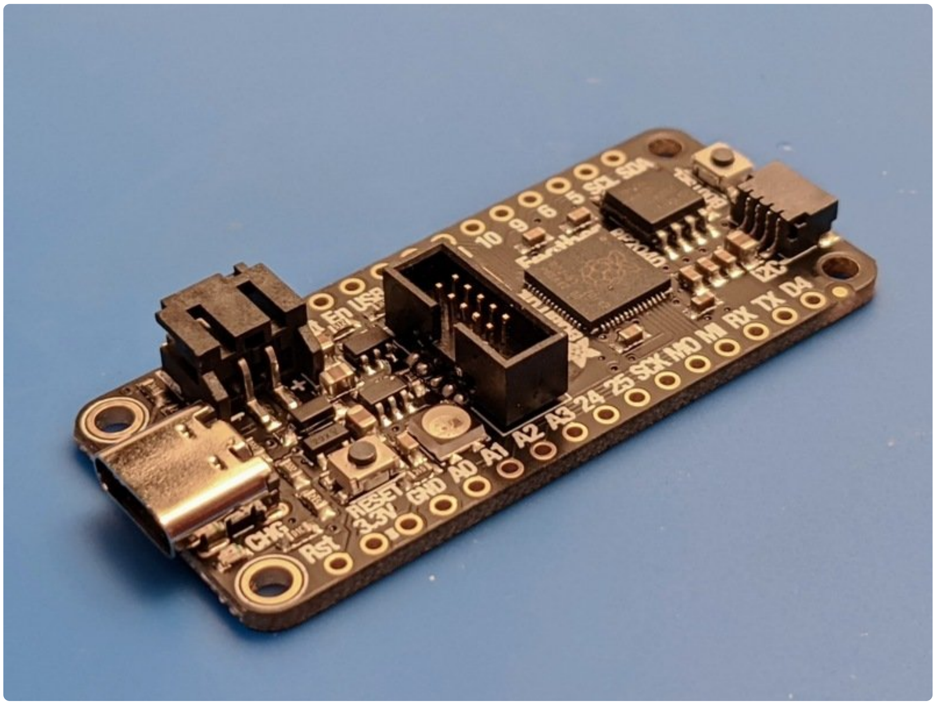
In Stock

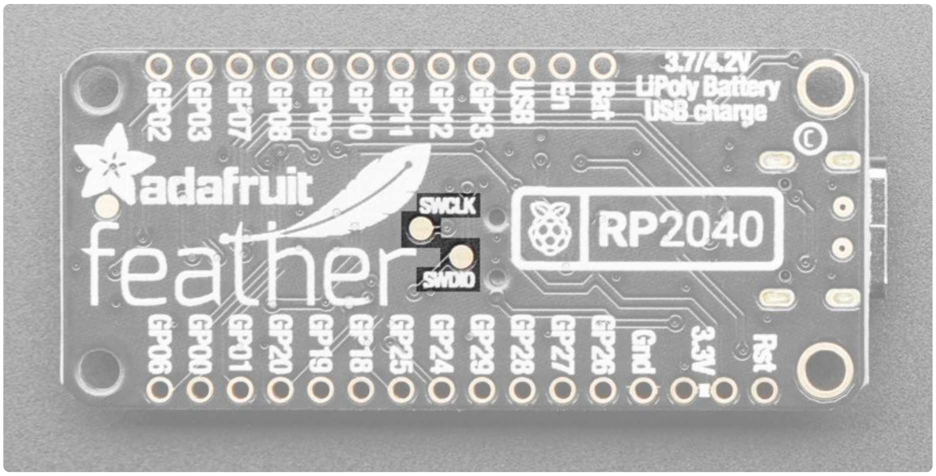
Add to Cart

Debug Interfaces


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
SWD
CHG
RESET
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

For advanced debugging or to reprogram your Feather RP2040, there is a footprint to solder a 2*5 pin 0.05" standard SWD header on the board. The image above shows the "pin 1" location by marking it with a triangle. This orientation places the connector key facing towards the end of the board where the USB connector is. This allows you to use something like a Segger J-Link (https://adafru.it/yDp) and a 1.27mm SWD cable (https://adafru.it/wbA) to connect from your PC to the Feather.





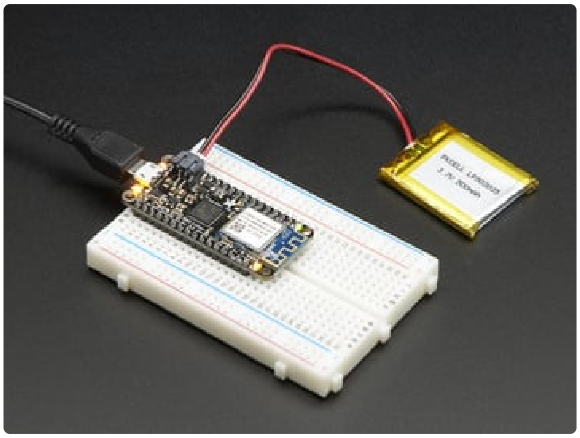
On the back of the board are pads for the **SWCLK** and **SWDIO** pins. They provide access to the internal Serial Wire Debug multi-drop bus, which provides debug access to both processors, and can be used to download code.

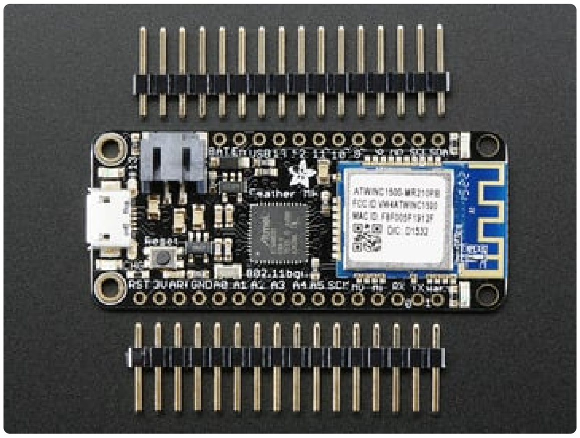
Assembly

We ship Feathers fully tested but without headers attached - this gives you the most flexibility on choosing how to use and configure your Feather

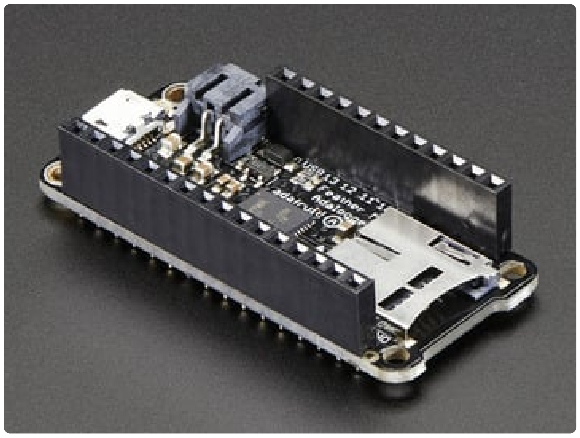
Header Options!

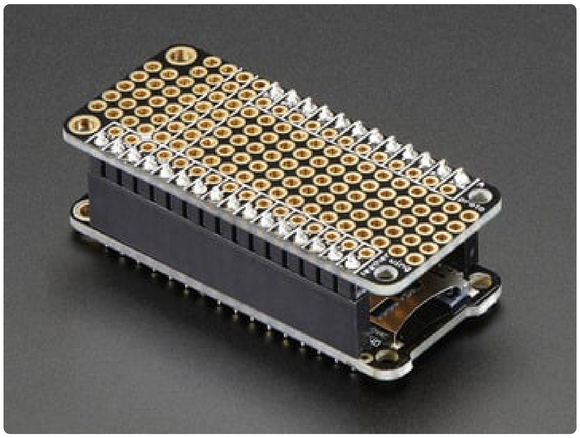
Before you go gung-ho on soldering, there's a few options to consider!



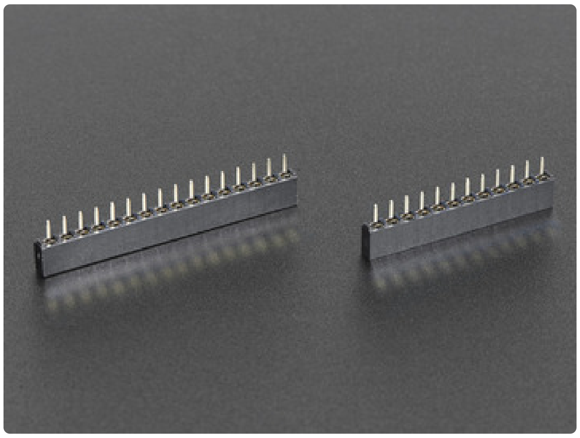


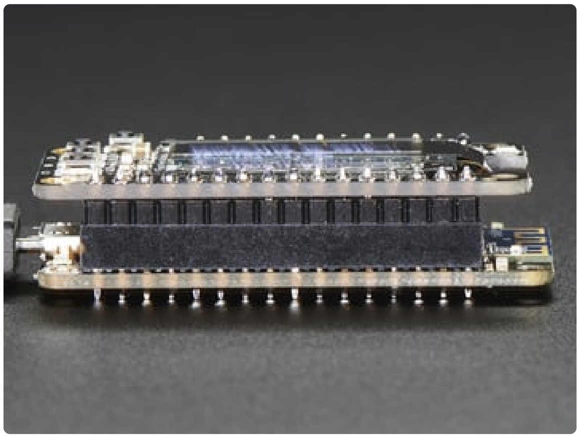
The first option is soldering in plain male headers, this lets you plug in the Feather into a solderless breadboard



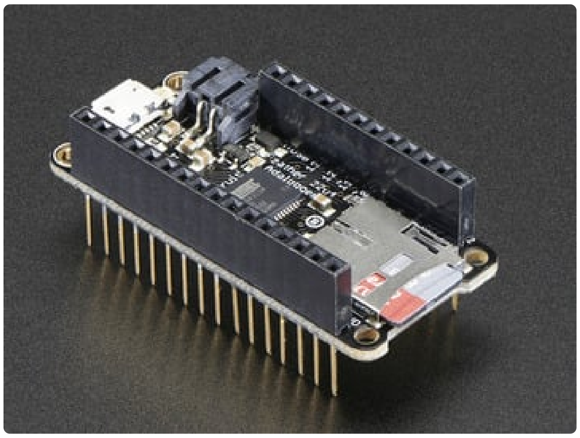


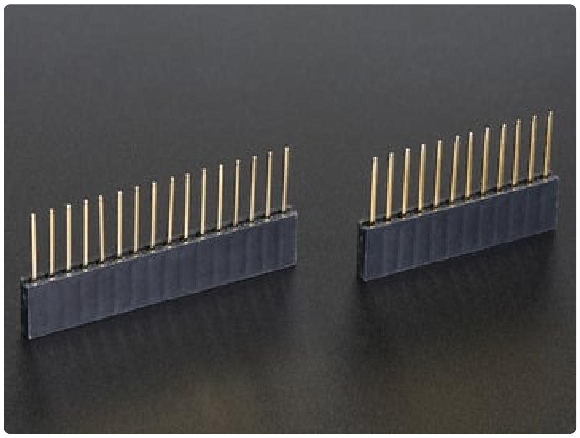
Another option is to go with socket female headers. This won't let you plug the Feather into a breadboard but it will let you attach featherwings very easily





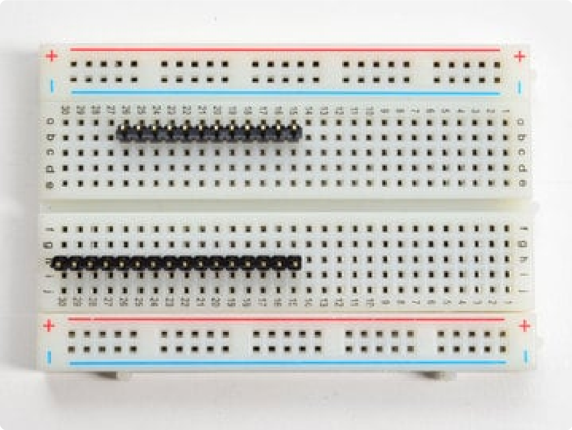
We also have 'slim' versions of the female headers, that are a little shorter and give a more compact shape





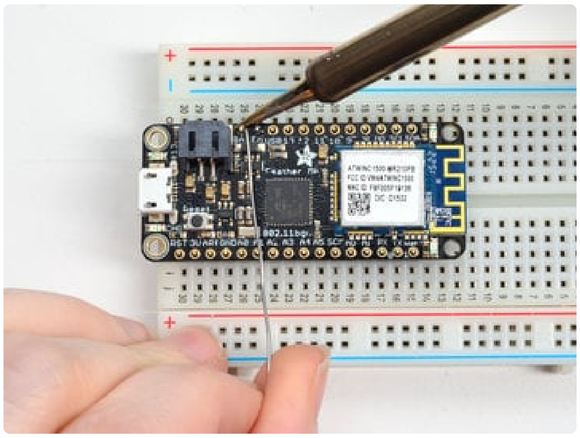
Finally, there's the "Stacking Header" option. This one is sort of the best-of-both-worlds. You get the ability to plug into a solderless breadboard *and* plug a featherwing on top. But its a little bulky

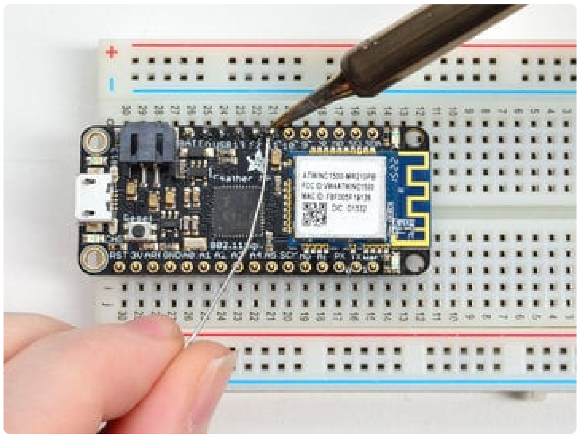
Soldering in Plain Headers

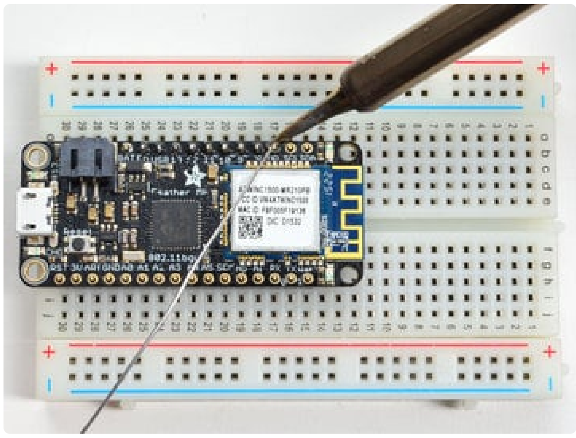


Prepare the header strip:

Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - **long pins down**







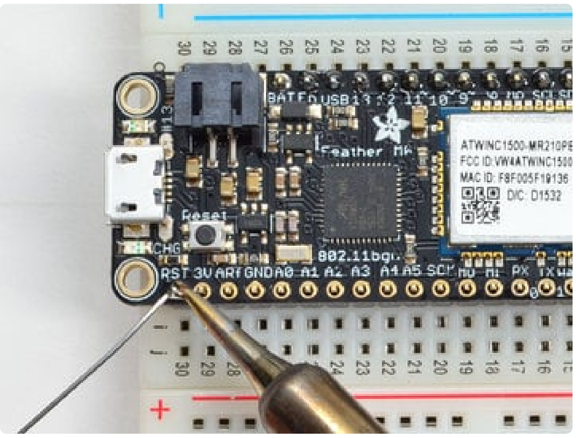
Add the breakout board:

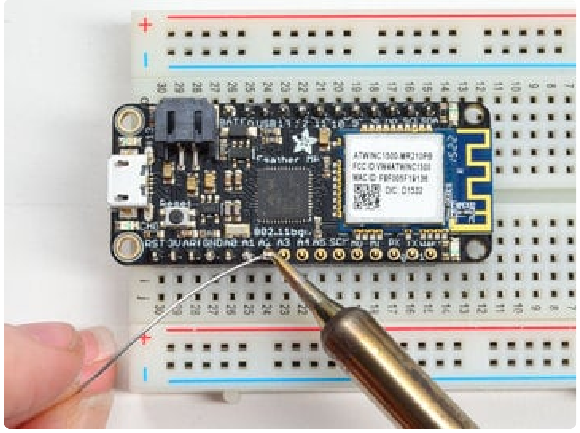
Place the breakout board over the pins so that the short pins poke through the breakout pads

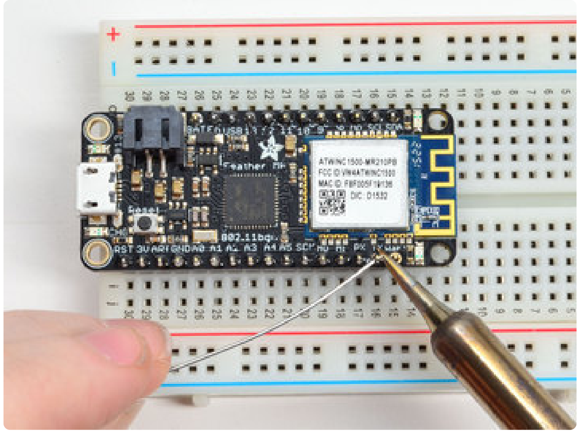
And Solder!

Be sure to solder all pins for reliable electrical contact.

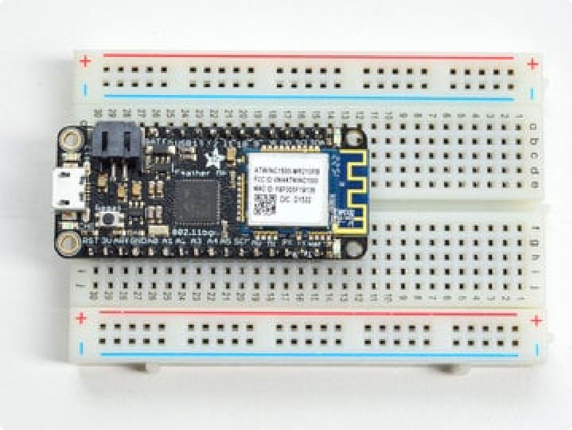
(For tips on soldering, be sure to check out our Guide to Excellent Soldering (https://adafru.it/aTk)).





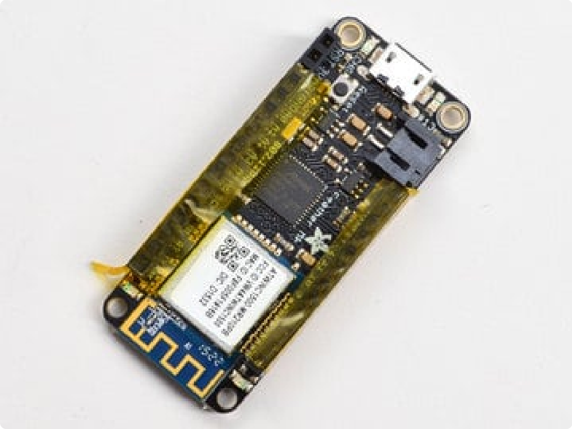


Solder the other strip as well.



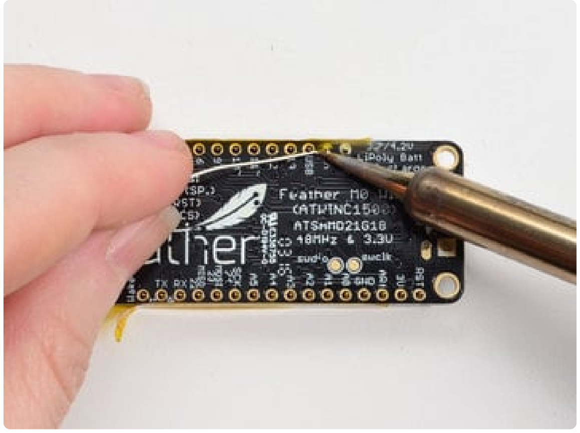
You're done! Check your solder joints visually and continue onto the next steps

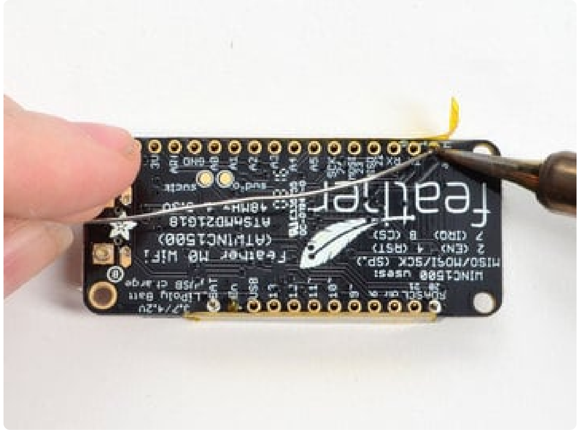
Soldering on Female Header



Tape In Place

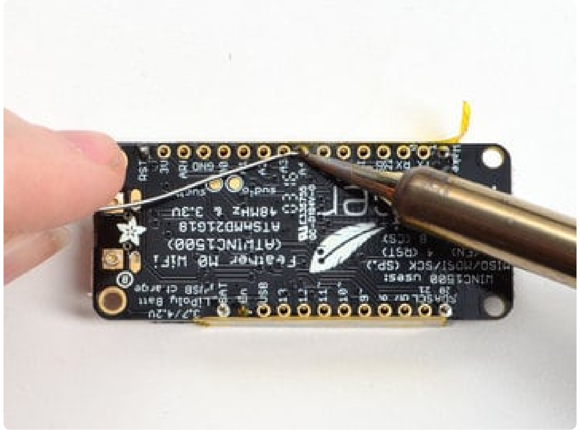
For sockets you'll want to tape them in place so when you flip over the board they don't fall out

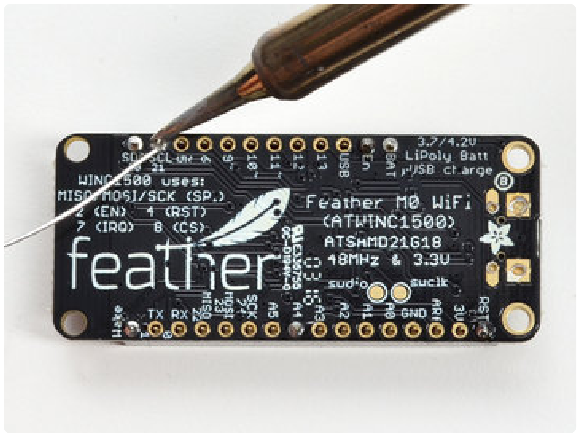




Flip & Tack Solder

After flipping over, solder one or two points on each strip, to 'tack' the header in place





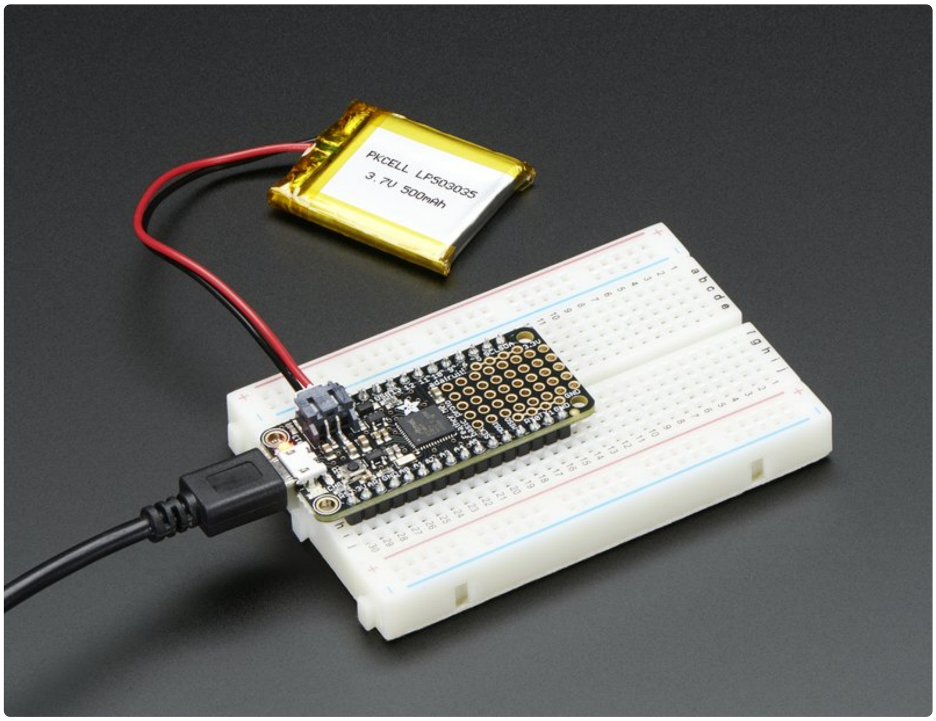
And Solder!

Be sure to solder all pins for reliable electrical contact.

(For tips on soldering, be sure to check out our Guide to Excellent Soldering (https://adafru.it/aTk)).

You're done! Check your solder joints visually and continue onto the next steps

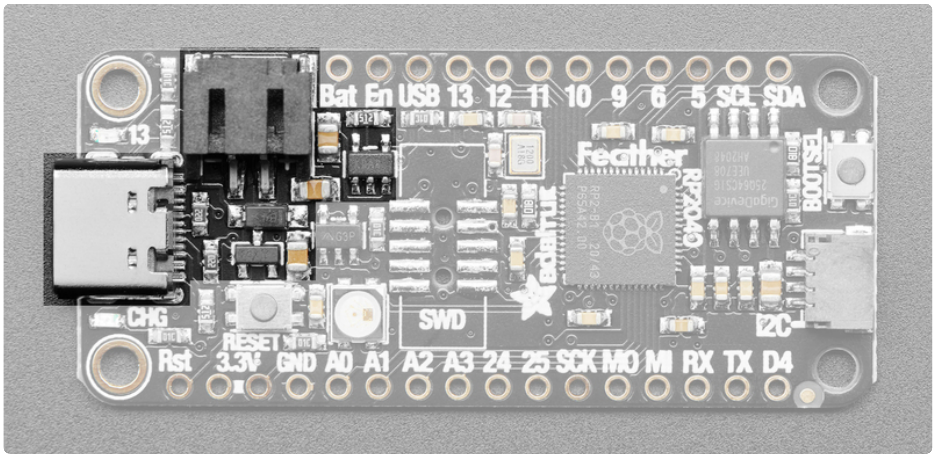
Power Management



Battery + USB Power

We wanted to make the Feather easy to power both when connected to a computer as well as via battery. There's **two ways to power** a Feather. You can connect with a USB cable C (just plug into the jack) and the Feather will regulate the 5V USB down to 3.3V. You can also connect a 4.2/3.7V Lithium Polymer (Lipo/Lipoly) or Lithium Ion (LiIon) battery to the JST jack. This will let the Feather run on a rechargable battery. **When the USB power is powered, it will automatically switch over to USB for power, as well as start charging the battery (if attached) at 200mA.** This happens 'hotswap' style so you can always keep the Lipoly connected as a 'backup' power that will only get used when USB power is lost.

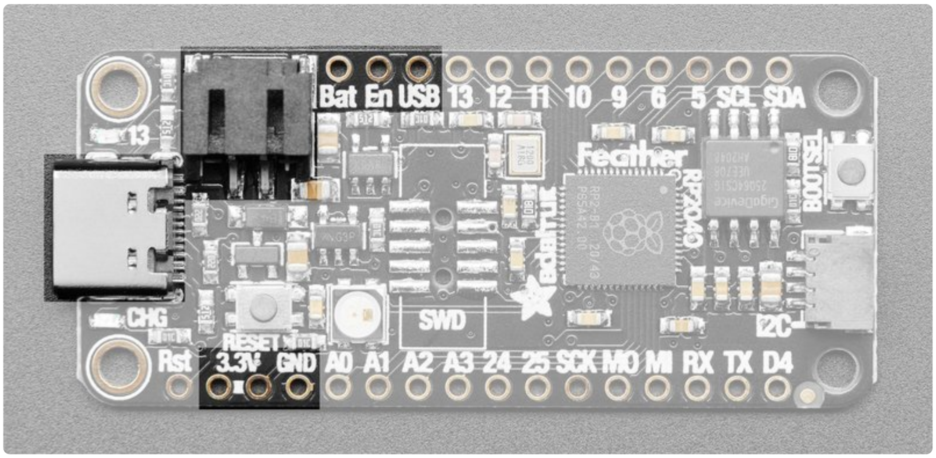
> The JST connector polarity is matched to Adafruit LiPoly batteries. Using wrong polarity batteries can destroy your Feather



The above shows the USB C jack (left), Lipoly JST jack (top left), as well as the changeover diode (just to the right of the JST jack) and the Lipoly charging circuitry (to the right of the JST jack). There's also a **CHG** LED below the USB C connector, which will light up while the battery is charging. This LED might also flicker if the battery is not connected.

Power supplies

You have a lot of power supply options here! We bring out the **BAT** pin, which is tied to the lipoly JST connector, as well as **USB** which is the +5V from USB if connected. We also have the **3V** pin which has the output from the 3.3V regulator. We use a 500mA peak regulator. While you can get 500mA from it, you can't do it continuously from 5V as it will overheat the regulator. It's fine for, say, powering an ESP8266 WiFi chip or XBee radio though, since the current draw is 'spikey' & sporadic.

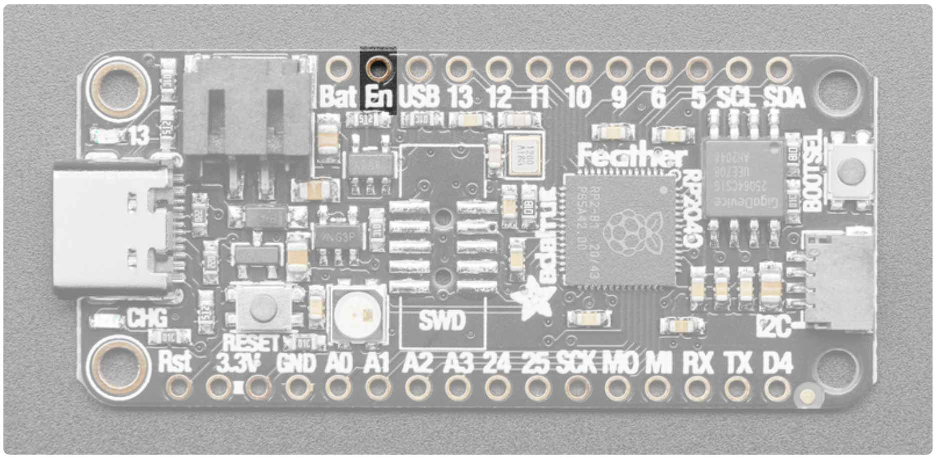


Measuring Battery

Note that unlike other Feathers, we do not have an ADC connected to a battery monitor. Reason being there's only 4 ADCs and we didn't want to use one precious ADC for a battery monitor. You can create a resistor divider from BAT to GND with two 10K resistors and connect the middle to one of the ADC pins on a breadboard.

ENable pin

If you'd like to turn off the 3.3V regulator, you can do that with the **EN**(able) pin. Simply tie this pin to **Ground** and it will disable the 3V regulator. The **BAT** and **USB** pins will still be powered



Alternative Power Options

The two primary ways for powering a feather are a 3.7/4.2V LiPo battery plugged into the JST port *or* a USB power cable.

If you need other ways to power the Feather, here's what we recommend:

- For permanent installations, a 5V 1A USB wall adapter (https://adafru.it/duP) will let you plug in a USB cable for reliable power
- For mobile use, where you don't want a LiPoly, use a USB battery pack! (https://adafru.it/e2q)
- If you have a higher voltage power supply, use a 5V buck converter (https://adafru.it/DHs) and wire it to a USB cable's 5V and GND input (https://adafru.it/DHu)

Here's what you cannot do:

- **Do not use alkaline or NiMH batteries** and connect to the battery port - this will destroy the LiPoly charger and there's no way to disable the charger
- **Do not use 7.4V RC batteries on the battery port** - this will destroy the board

The Feather *is not designed for external power supplies* - this is a design decision to make the board compact and low cost. It is not recommended, but technically possible:

- **Connect an external 3.3V power supply to the 3V and GND pins.** Not recommended, this may cause unexpected behavior and the **EN** pin will no longer. Also this doesn't provide power on **BAT** or **USB** and some Feathers/Wings use those pins for high current usages. You may end up damaging your Feather.

- **Connect an external 5V power supply to the USB and GND pins.** Not recommended, this may cause unexpected behavior when plugging in the USB port because you will be back-powering the USB port, which *could* confuse or damage your computer.

Install CircuitPython

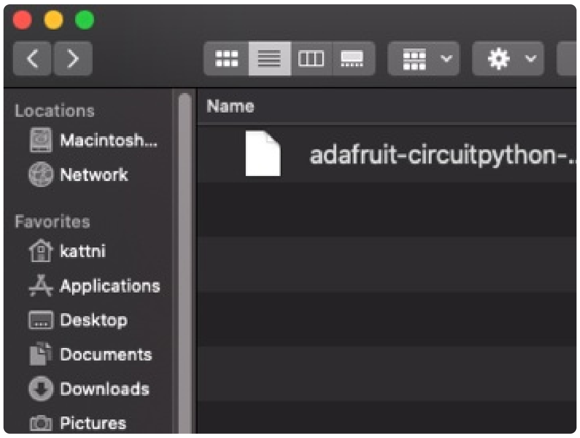
CircuitPython (https://adafru.it/tB7) is a derivative of MicroPython (https://adafru.it/BeZ) designed to simplify experimentation and education on low-cost microcontrollers. It makes it easier than ever to get prototyping by requiring no upfront desktop software downloads. Simply copy and edit files on the **CIRCUITPY** drive to iterate.

CircuitPython Quickstart

Follow this step-by-step to quickly get CircuitPython running on your board.

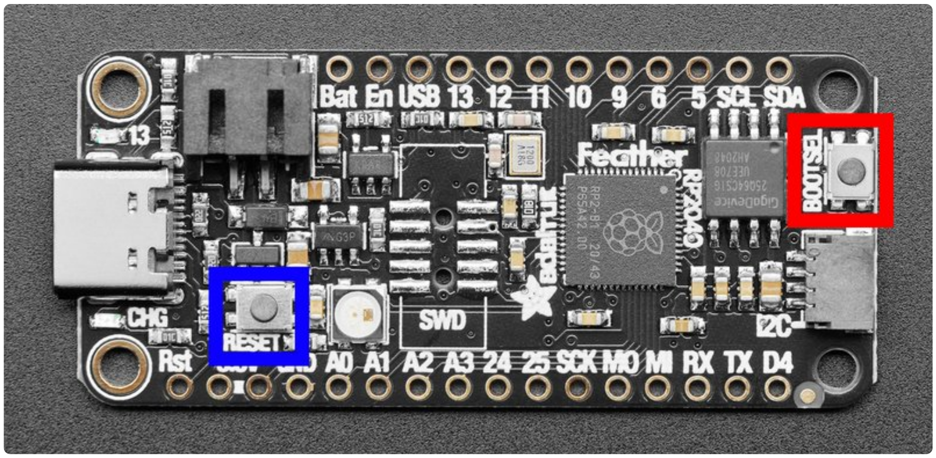
https://adafru.it/R1D

https://adafru.it/R1D



Click the link above to download the latest CircuitPython UF2 file.

Save it wherever is convenient for you.



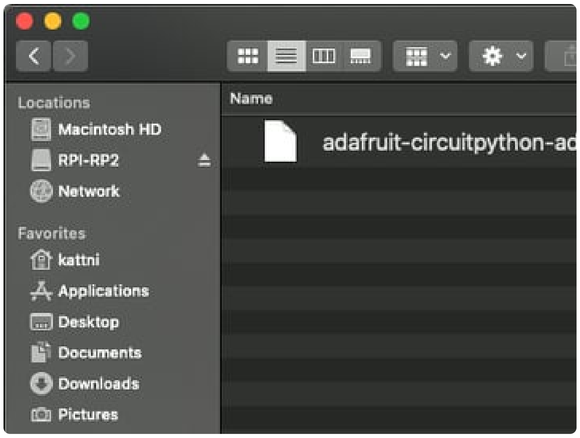
Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
CHG
RESET
SWD
I2C
Rst
A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

To enter the bootloader, hold down the **BOOT/BOOTSEL button** (highlighted in red above), and while continuing to hold it (don't let go!), press and release the **reset button** (highlighted in blue above). **Continue to hold the BOOT/BOOTSEL button until the RPI-RP2 drive appears!**

If the drive does not appear, release all the buttons, and then repeat the process above.

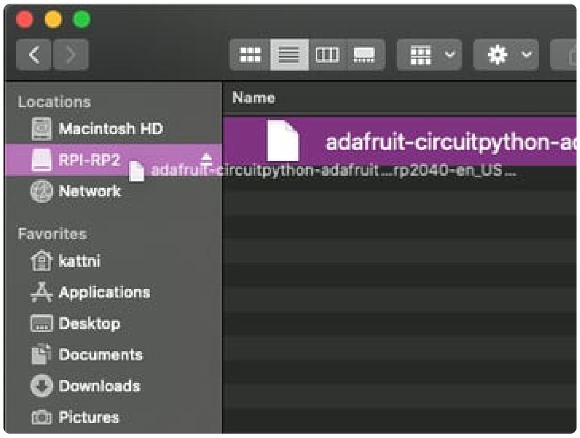
You can also start with your board unplugged from USB, press and hold the BOOTSEL button (highlighted in red above), continue to hold it while plugging it into USB, and wait for the drive to appear before releasing the button.

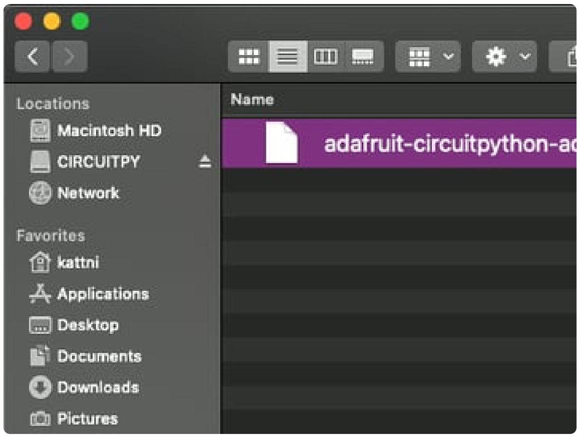
A lot of people end up using charge-only USB cables and it is very frustrating! **Make sure you have a USB cable you know is good for data sync.**



You will see a new disk drive appear called **RPI-RP2**.

Drag the **adafruit_circuitpython_etc.uf2** file to **RPI-RP2.**





The **RPI-RP2** drive will disappear and a new disk drive called **CIRCUITPY** will appear.

That's it, you're done! :)

Safe Mode

You want to edit your **code.py** or modify the files on your **CIRCUITPY** drive, but find that you can't.

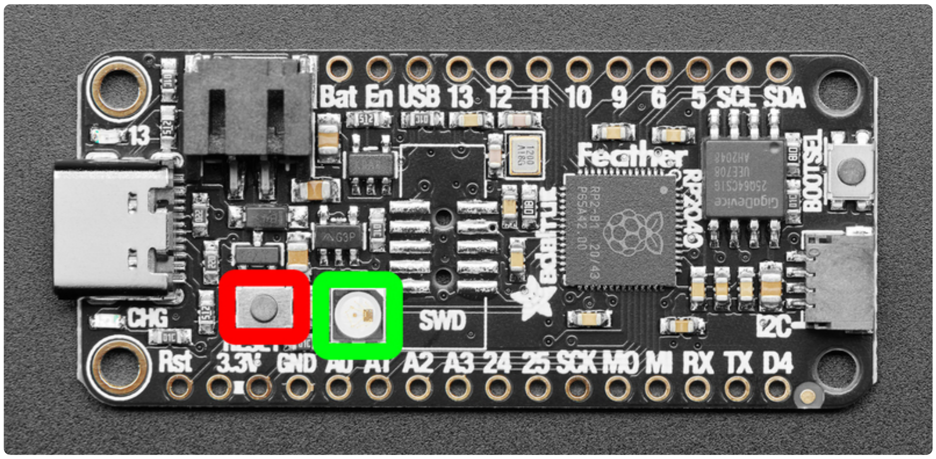
Perhaps your board has gotten into a state where **CIRCUITPY** is read-only. You may have turned off the **CIRCUITPY** drive altogether. Whatever the reason, safe mode can help.

Safe mode in CircuitPython does not run any user code on startup, and disables auto-reload. This means a few things. First, safe mode *bypasses any code in* **boot.py** (where you can set **CIRCUITPY** read-only or turn it off completely). Second, *it does not run the code in* **code.py**. And finally, *it does not automatically soft-reload when data is written to the* **CIRCUITPY** *drive*.

Therefore, whatever you may have done to put your board in a non-interactive state, safe mode gives you the opportunity to correct it without losing all of the data on the **CIRCUITPY** drive.

Entering Safe Mode in CircuitPython 6.x

This section explains entering safe mode on CircuitPython 6.x.


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOTSEL
SWD
I2C
CHG
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

To enter safe mode when using CircuitPython 6.x, plug in your board or hit reset (highlighted in red above). Immediately after the board starts up or resets, it waits 700ms. On some boards, the onboard status LED (highlighted in green above) will turn solid yellow during this time. If you press reset during that 700ms, the board will start up in safe mode. It can be difficult to react to the yellow LED, so you may want to think of it simply as a slow double click of the reset button. (Remember, a fast double click of reset enters the bootloader.)

Entering Safe Mode in CircuitPython 7.x

This section explains entering safe mode on CircuitPython 7.x.

To enter safe mode when using CircuitPython 7.x, plug in your board or hit reset (highlighted in red above). Immediately after the board starts up or resets, it waits 1000ms. On some boards, the onboard status LED (highlighted in green above) will blink yellow during that time. If you press reset during that 1000ms, the board will start up in safe mode. It can be difficult to react to the yellow LED, so you may want to think of it simply as a slow double click of the reset button. (Remember, a fast double click of reset enters the bootloader.)

In Safe Mode

Once you've entered safe mode successfully in CircuitPython 6.x, the LED will pulse yellow.

If you successfully enter safe mode on CircuitPython 7.x, the LED will intermittently blink yellow three times.

If you connect to the serial console, you'll find the following message.

```
Auto-reload is off.
Running in safe mode! Not running saved code.

CircuitPython is in safe mode because you pressed the reset button during boot. Press again to
exit safe mode.

Press any key to enter the REPL. Use CTRL-D to reload.
```

You can now edit the contents of the **CIRCUITPY** drive. Remember, *your code will not run until you press the reset button, or unplug and plug in your board, to get out of safe mode.*

Flash Resetting UF2

If your board ever gets into a really *weird* state and doesn't even show up as a disk drive when installing CircuitPython, try loading this 'nuke' UF2 which will do a 'deep clean' on your Flash Memory. **You will lose all the files on the board**, but at least you'll be able to revive it! After loading this UF2, follow the steps above to re-install CircuitPython.

https://adafru.it/RLE

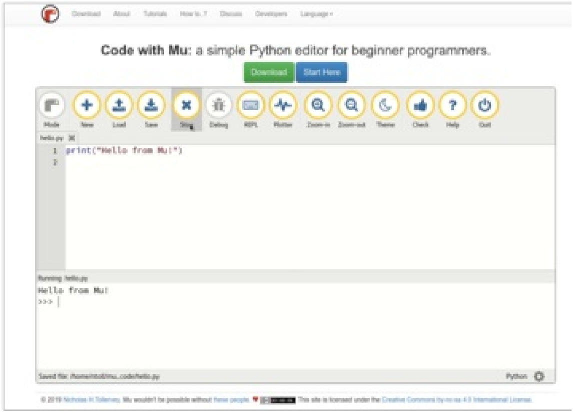
https://adafru.it/RLE

Installing the Mu Editor

Mu is a simple code editor that works with the Adafruit CircuitPython boards. It's written in Python and works on Windows, MacOS, Linux and Raspberry Pi. The serial console is built right in so you get immediate feedback from your board's serial output!

Mu is our recommended editor - please use it (unless you are an experienced coder with a favorite editor already!)

Download and Install Mu



Code with Mu: a simple Python editor for beginner programmers.

```
print("Hello from Mu!")
```

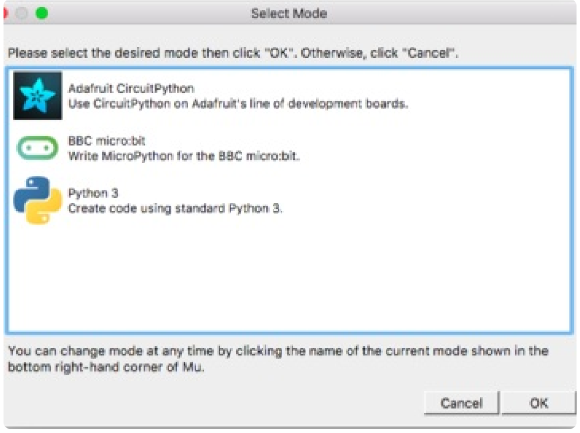
Running: hello.py

```
Hello from Mu!
>>>
```

Saved file: /home/ntoll/mu_code/hello.py

Download Mu from https://codewith.mu (https://adafru.it/Be6). Click the **Download** or **Start Here** links there for downloads and installation instructions. The website has a wealth of other information, including extensive tutorials and and how-to's.

Using Mu



Please select the desired mode then click "OK". Otherwise, click "Cancel".

Adafruit CircuitPython
Use CircuitPython on Adafruit's line of development boards.

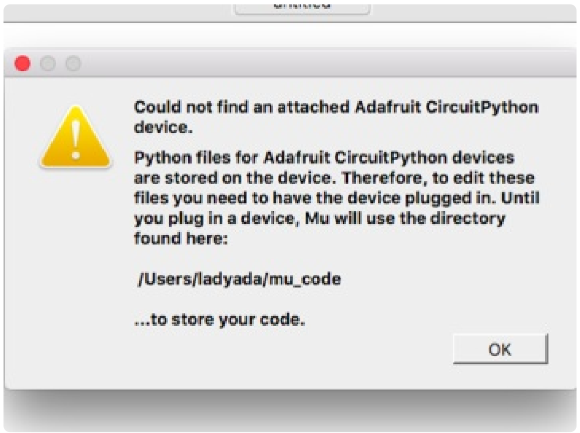
BBC micro:bit
Write MicroPython for the BBC micro:bit.

Python 3
Create code using standard Python 3.

You can change mode at any time by clicking the name of the current mode shown in the bottom right-hand corner of Mu.

The first time you start Mu, you will be prompted to select your 'mode' - you can always change your mind later. For now please select **CircuitPython**!

The current mode is displayed in the lower right corner of the window, next to the "gear" icon. If the mode says "Microbit" or something else, click the **Mode** button in the upper left, and then choose "CircuitPython" in the dialog box that appears.



Could not find an attached Adafruit CircuitPython device.

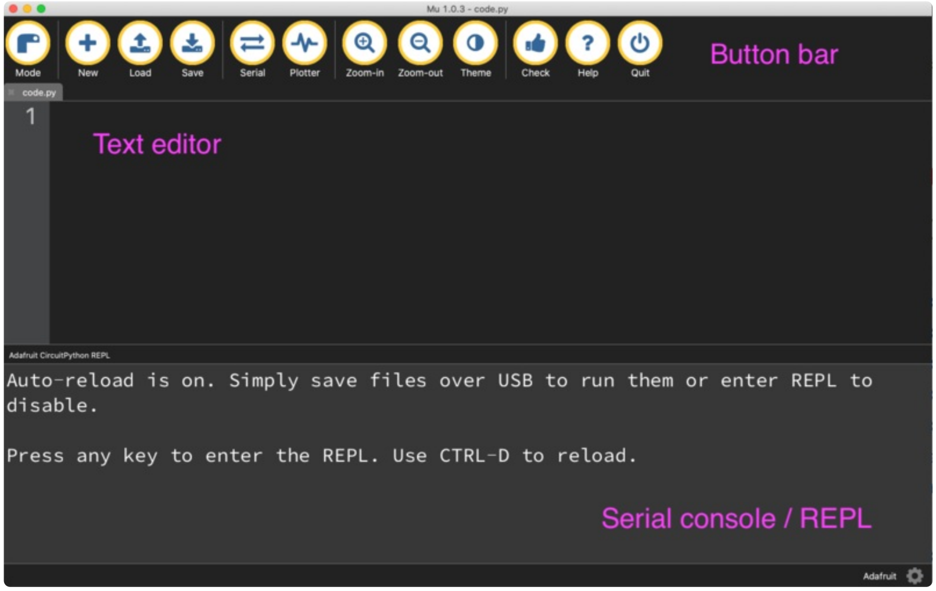
Python files for Adafruit CircuitPython devices are stored on the device. Therefore, to edit these files you need to have the device plugged in. Until you plug in a device, Mu will use the directory found here:

/Users/ladyada/mu_code

...to store your code.

Mu attempts to auto-detect your board, so please plug in your CircuitPython device and make sure it shows up as a **CIRCUITPY** drive before starting Mu

You can now explore Mu! The three main sections of the window are labeled below; the button bar, the text editor, and the serial console / REPL.



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to
disable.

Press any key to enter the REPL. Use CTRL-D to reload.
```

Now you're ready to code! Let's keep going...

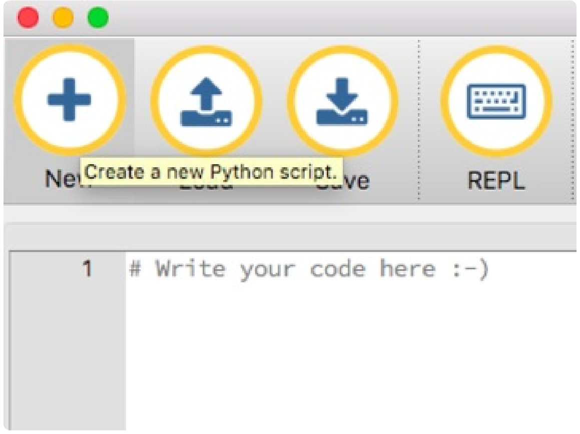
Creating and Editing Code

One of the best things about CircuitPython is how simple it is to get code up and running. In this section, we're going to cover how to create and edit your first CircuitPython program.

To create and edit code, all you'll need is an editor. There are many options. **We strongly recommend using Mu! It's designed for CircuitPython, and it's really simple and easy to use, with a built in serial console!**

If you don't or can't use Mu, there are basic text editors built into every operating system such as Notepad on Windows, TextEdit on Mac, and gedit on Linux. However, many of these editors don't write back changes immediately to files that you edit. That can cause problems when using CircuitPython. See the Editing Code (https://adafru.it/id3) section below. If you want to skip that section for now, make sure you do "Eject" or "Safe Remove" on Windows or "sync" on Linux after writing a file if you aren't using Mu. (This is not a problem on MacOS.)

Creating Code



```
1   # Write your code here :-)
```

Open your editor, and create a new file. If you are using Mu, click the **New** button in the top left

Copy and paste the following code into your editor:

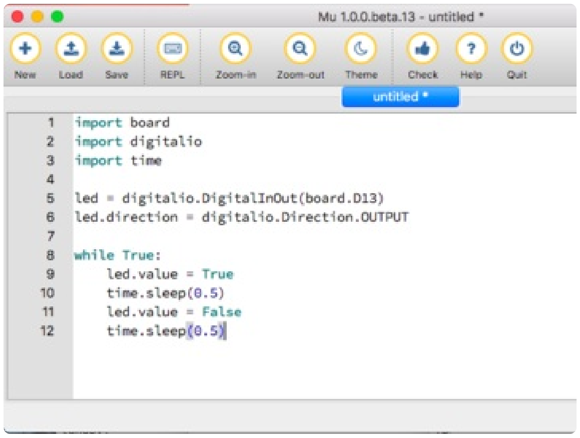
```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

The QT Py and the Trinkeys do not have a built-in little red LED! There is an addressable RGB NeoPixel LED. The above example will NOT work on the QT Py or the Trinkeys!

If you're using QT Py or a Trinkey, please download the [NeoPixel blink example](https://adafru.it/UDU) (https://adafru.it/UDU).

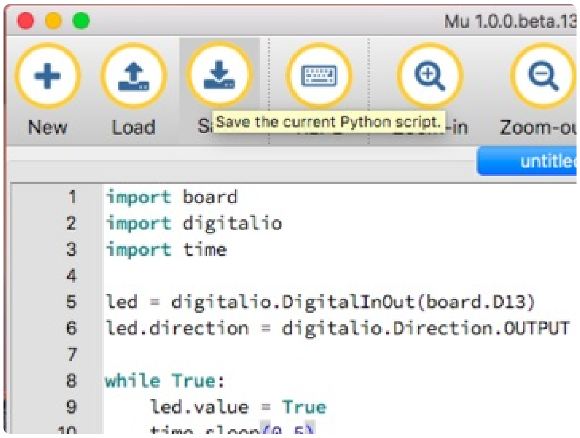
The NeoPixel blink example uses the onboard NeoPixel, but the time code is the same. You can use the linked NeoPixel Blink example to follow along with this guide page.

It will look like this - note that under the `while True:` line, the next four lines have spaces to indent them, but they're indented exactly the same amount. All other lines have no spaces before the text.

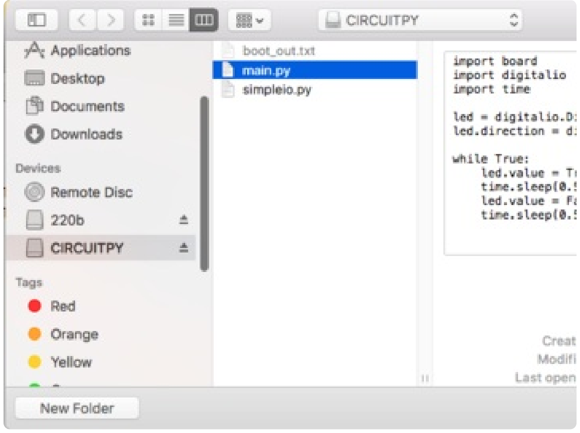


```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.D13)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

Save this file as **code.py** on your CIRCUITPY drive.



```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.D13)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.5)
```



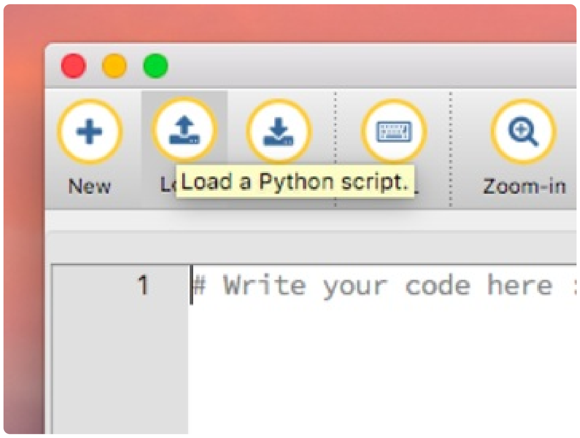
```
import board
import digitalio
import time

led = digitalio.D
led.direction = d

while True:
    led.value = T
    time.sleep(0.
    led.value = F
    time.sleep(0.
```

On each board (except the ItsyBitsy nRF52840) you'll find a tiny red LED. On the ItsyBitsy nRF52840, you'll find a tiny blue LED.

The little LED should now be blinking. Once per second.

Congratulations, you've just run your first CircuitPython program!

Editing Code



```
1 # Write your code here :
```

To edit code, open the **code.py** file on your CIRCUITPY drive into your editor.

Make the desired changes to your code. Save the file. That's it!

Your code changes are run as soon as the file is done saving.

There's just one warning we have to give you before we continue...

Don't Click Reset or Unplug!

The CircuitPython code on your board detects when the files are changed or written and will automatically re-start your code. This makes coding very fast because you save, and it re-runs.

However, you must wait until the file is done being saved before unplugging or resetting your board! Or Windows using some editors this can sometimes take up to 90 seconds, on Linux it can take 30 seconds to complete because the text editor does not save the file completely. Mac OS does not seem to have this delay, which is nice!

This is really important to be aware of. If you unplug or reset the board before your computer finishes writing the file to your board, you can corrupt the drive. If this happens, you may lose the code you've written, so it's important to backup your code to your computer regularly.

There are a few ways to avoid this:

1. Use an editor that writes out the file completely when you save it.

Recommended editors:

- **mu** (https://adafru.it/Be6) is an editor that safely writes all changes (it's also our recommended editor!)
- **emacs** (https://adafru.it/xNA) is also an editor that will fully write files on save (https://adafru.it/Be7)
- Sublime Text **(https://adafru.it/xNB)** safely writes all changes
- Visual Studio Code **(https://adafru.it/Be9)** appears to safely write all changes
- **gedit** on Linux appears to safely write all changes
- IDLE (https://adafru.it/IWB), in Python 3.8.1 or later, was fixed (https://adafru.it/IWD) to write all changes immediately
- thonny (https://adafru.it/Qb6) fully writes files on save

Recommended *only* with particular settings or with add-ons:

- **vim** (https://adafru.it/ek9) / **vi** safely writes all changes. But set up **vim** to not write swapfiles (https://adafru.it/ELO) (.swp files: temporary records of your edits) to CIRCUITPY. Run vim with `vim -n`, set the `no swapfile` option, or set the `directory` option to write swapfiles elsewhere. Otherwise the swapfile writes trigger restarts of your program.
- The PyCharm IDE **(https://adafru.it/xNC)** is safe if "Safe Write" is turned on in Settings->System Settings->Synchronization (true by default).
- If you are using **Atom** (https://adafru.it/fMG), install the fsync-on-save package (https://adafru.it/E9m) so that it will always write out all changes to files on `CIRCUITPY`.
- **SlickEdit** (https://adafru.it/DdP) works only if you add a macro to flush the disk (https://adafru.it/ven).

We *don't* recommend these editors:

- **notepad** (the default Windows editor) and **Notepad++** can be slow to write, so we recommend the editors above! If you are using notepad, be sure to eject the drive (see below)
- **IDLE** in Python 3.8.0 or earlier does not force out changes immediately
- **nano** (on Linux) does not force out changes
- **geany** (on Linux) does not force out changes
- **Anything else** - we haven't tested other editors so please use a recommended one!

If you are dragging a file from your host computer onto the CIRCUITPY drive, you still need to do step 2. Eject or Sync (below) to make sure the file is completely written.

2. Eject or Sync the Drive After Writing

If you are using one of our not-recommended-editors, not all is lost! You can still make it work.

On Windows, you can **Eject** or **Safe Remove** the CIRCUITPY drive. It won't actually eject, but it will force the operating system to save your file to disk. On Linux, use the **sync** command in a terminal to force the write to disk.

You also need to do this if you use Windows Explorer or a Linux graphical file manager to drag a file onto CIRCUITPY

Oh No I Did Something Wrong and Now The CIRCUITPY Drive Doesn't Show Up!!!

Don't worry! Corrupting the drive isn't the end of the world (or your board!). If this happens, follow the steps found on the Troubleshooting (https://adafru.it/Den) page of every board guide to get your board up and running again.

Back to Editing Code...

Now! Let's try editing the program you added to your board. Open your **code.py** file into your editor. We'll make a simple change. Change the first `0.5` to `0.1`. The code should look like this:

```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.1)
    led.value = False
    time.sleep(0.5)
```

Leave the rest of the code as-is. Save your file. See what happens to the LED on your board? Something changed! Do you know why? Let's find out!

Exploring Your First CircuitPython Program

First, we'll take a look at the code we're editing.

Here is the original code again:

```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

Imports & Libraries

Each CircuitPython program you run needs to have a lot of information to work. The reason CircuitPython is so simple to use is that most of that information is stored in other files and works in the background. The files built into CircuitPython are called **modules**, and the files you load separately are called **libraries**. Modules are built into CircuitPython. Libraries are stored on your CIRCUITPY drive in a folder called **lib**.

```
import board
import digitalio
import time
```

The `import` statements tells the board that you're going to use a particular library in your code. In this example, we imported three modules: `board`, `digitalio`, and `time`. All three of these modules are built into CircuitPython, so no separate library files are needed. That's one of the things that makes this an excellent first example. You don't need any thing extra to make it work! `board` gives you access to the *hardware on your board*, `digitalio` lets you *access that hardware as inputs/outputs* and `time` let's you pass time by 'sleeping'

Setting Up The LED

The next two lines setup the code to use the LED.

```
led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT
```

Your board knows the red LED as `LED`. So, we initialise that pin, and we set it to output. We set `led` to equal the rest of that information so we don't have to type it all out again later in our code.

Loop-de-loops

The third section starts with a `while` statement. `while True:` essentially means, "forever do the following:". `while True:` creates a loop. Code will loop "while" the condition is "true" (vs. false), and as `True` is never False, the code will loop forever. All code that is indented under `while True:` is "inside" the loop.

Inside our loop, we have four items:

```
while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

First, we have `led.value = True`. This line tells the LED to turn on. On the next line, we have `time.sleep(0.5)`. This line is telling CircuitPython to pause running code for 0.5 seconds. Since this is between turning the led on and off, the led will be on for 0.5 seconds.

The next two lines are similar. `led.value = False` tells the LED to turn off, and `time.sleep(0.5)` tells CircuitPython to pause for another 0.5 seconds. This occurs between turning the led off and back on so the LED will be off for 0.5 seconds too.

Then the loop will begin again, and continue to do so as long as the code is running!

So, when you changed the first `0.5` to `0.1`, you decreased the amount of time that the code leaves the LED on. So it blinks on really quickly before turning off!

Great job! You've edited code in a CircuitPython program!

What Happens When My Code Finishes Running?

When your code finishes running, CircuitPython resets your microcontroller board to prepare it for the next run of code. That means any set up you did earlier no longer applies, and the pin states are reset.

For example, try reducing the above example to `led.value = True`. The LED will flash almost too quickly to see, and turn off. This is because the code finishes running and resets the pin state, and the LED is no longer receiving a signal.

To that end, most CircuitPython programs involve some kind of loop, infinite or otherwise

What if I don't have the loop?

If you don't have the loop, the code will run to the end and exit. This can lead to some unexpected behavior in simple programs like this since the "exit" also resets the state of the hardware. This is a different behavior than running commands via REPL. So if you are writing a simple program that doesn't seem to work, you may need to add a loop to the end so the program doesn't exit.

The simplest loop would be:

```
while True:

    pass
```

And remember - you can press to exit the loop.

See also the Behavior section in the docs (https://adafru.it/Bvz).

More Changes

We don't have to stop there! Let's keep going. Change the second `0.5` to `0.1` so it looks like this:

```
while True:
    led.value = True
    time.sleep(0.1)
    led.value = False
    time.sleep(0.1)
```

Now it blinks really fast! You decreased the both time that the code leaves the LED on and off!

Now try increasing both of the `0.1` to `1`. Your LED will blink much more slowly because you've increased the amount of time that the LED is turned on and off.

Well done! You're doing great! You're ready to start into new examples and edit them to see what happens! These were simple changes, but major changes are done using the same process. Make your desired change, save it, and get the results. That's really all there is to it!

Naming Your Program File

CircuitPython looks for a code file on the board to run. There are four options: **code.txt**, **code.py**, **main.txt** and **main.py**. CircuitPython looks for those files, in that order, and then runs the first one it finds. While we suggest using **code.py** as your code file, it is important to know that the other options exist. If your program doesn't seem to be updating as you work, make sure you haven't created another code file that's being read instead of the one you're working on.

Connecting to the Serial Console

One of the staples of CircuitPython (and programming in general!) is something called a "print statement". This is a line you include in your code that causes your code to output text. A print statement in CircuitPython looks like this:

```
print("Hello, world!")
```

This line would result in:

```
Hello, world!
```

However, these print statements need somewhere to display. That's where the serial console comes in!

The serial console receives output from your CircuitPython board sent over USB and displays it so you can see it. This is necessary when you've included a print statement in your code and you'd like to see what you printed. It is also helpful for troubleshooting errors, because your board will send errors and the serial console will print those too.

The serial console requires a terminal program. A terminal is a program that gives you a text-based interface to perform various tasks.

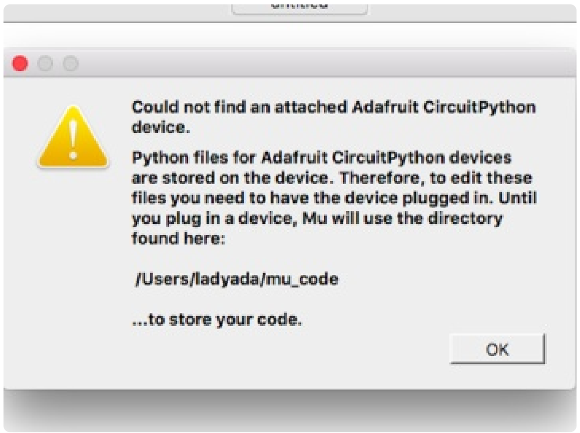
> If you're on Linux, and are seeing multi-second delays connecting to the serial console, or are seeing "AT" and other gibberish when you connect, then the modemmanager service might be interfering. Just remove it; it doesn't have much use unless you're still using dial-up modems. To remove, type this command at a shell:

```
sudo apt purge modemmanager
```

Are you using Mu?

If so, good news! The serial console **is built into Mu** and will **autodetect your board** making using the REPL *really really easy*.

Please note that Mu does yet not work with nRF52 or ESP8266-based CircuitPython boards, skip down to the next section for details on using a terminal program.



Could not find an attached Adafruit CircuitPython device.

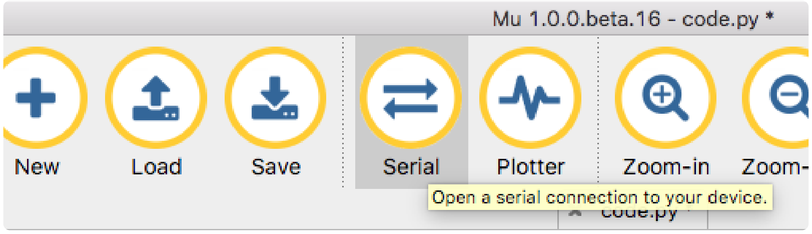
Python files for Adafruit CircuitPython devices are stored on the device. Therefore, to edit these files you need to have the device plugged in. Until you plug in a device, Mu will use the directory found here:

/Users/ladyada/mu_code

...to store your code.

First, make sure your CircuitPython board is plugged in. If you are using Windows 7, make sure you installed the drivers (https://adafru.it/Amd).

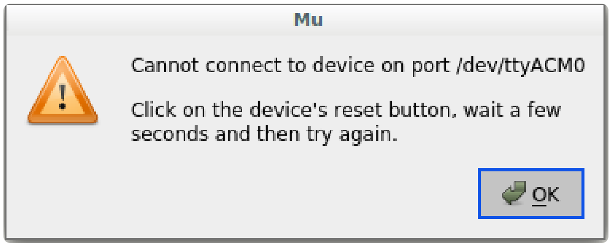
Once in Mu, look for the **Serial** button in the menu and click it.



Mu 1.0.0.beta.16 - code.py *
New
Load
Save
Serial
Plotter
Zoom-in
Zoom-
Open a serial connection to your device.
code.py

Setting Permissions on Linux

On Linux, if you see an error box something like the one below when you press the **Serial** button, you need to add yourself to a user group to have permission to connect to the serial console.



Cannot connect to device on port /dev/ttyACM0

Click on the device's reset button, wait a few seconds and then try again.

On Ubuntu and Debian, add yourself to the **dialout** group by doing:

```
sudo adduser $USER dialout
```

After running the command above, reboot your machine to gain access to the group. On other Linux distributions, the group you need may be different. See Advanced Serial Console on Mac and

Linux (https://adafru.it/AAI) for details on how to add yourself to the right group.

Using Something Else?

If you're not using Mu to edit, are using or if for some reason you are not a fan of its built in serial console, you can run the serial console as a separate program.

Windows requires you to download a terminal program, check out this page for more details (https://adafru.it/AAH)

Mac and Linux both have one built in, though other options are available for download, check this page for more details (https://adafru.it/AAI)

Interacting with the Serial Console

Once you've successfully connected to the serial console, it's time to start using it.

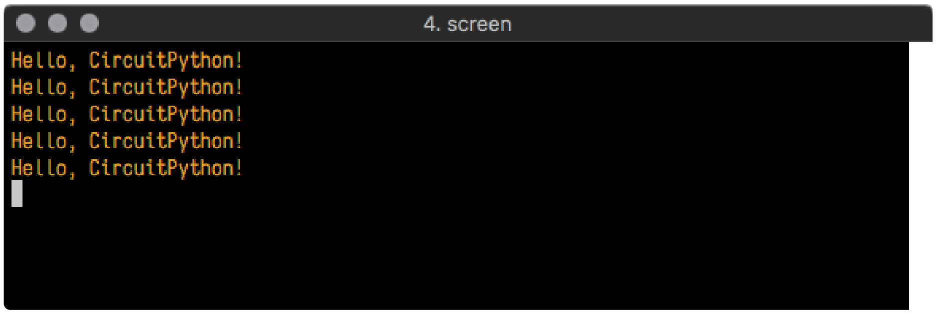
The code you wrote earlier has no output to the serial console. So, we're going to edit it to create some output.

Open your code.py file into your editor, and include a `print` statement. You can print anything you like! Just include your phrase between the quotation marks inside the parentheses. For example:

```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    print("Hello, CircuitPython!")
    led.value = True
    time.sleep(1)
    led.value = False
    time.sleep(1)
```

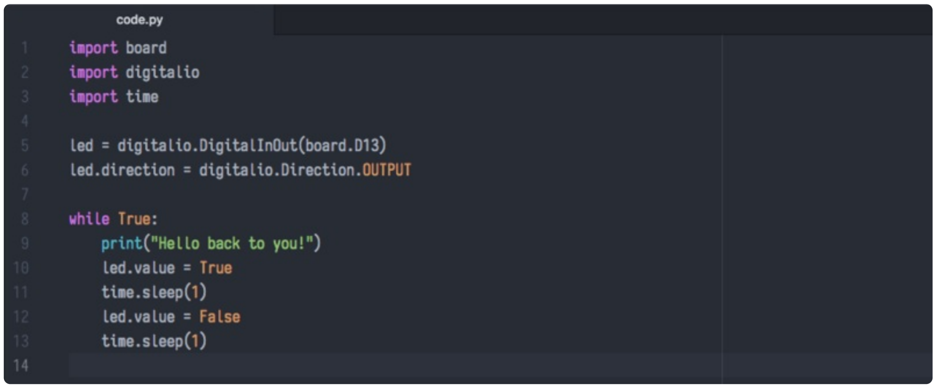
Save your file.

Now, let's go take a look at the window with our connection to the serial console.



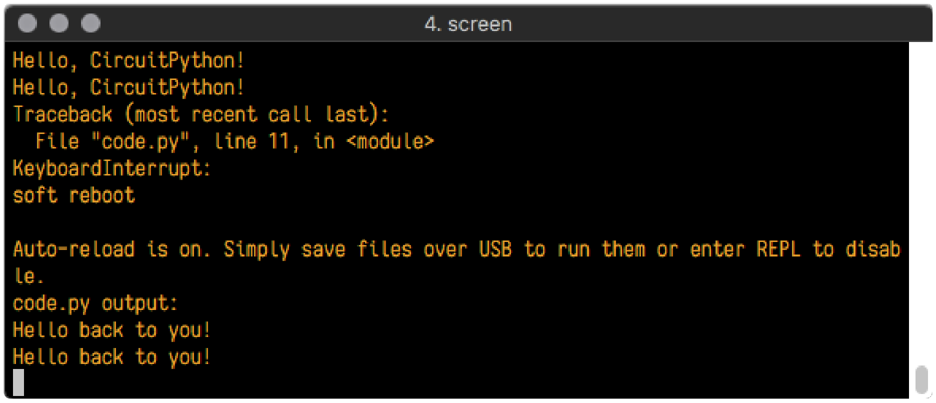
```
Hello, CircuitPython!
Hello, CircuitPython!
Hello, CircuitPython!
Hello, CircuitPython!
Hello, CircuitPython!
```

Excellent! Our print statement is showing up in our console! Try changing the printed text to something else.



```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.D13)
led.direction = digitalio.Direction.OUTPUT

while True:
    print("Hello back to you!")
    led.value = True
    time.sleep(1)
    led.value = False
    time.sleep(1)
```

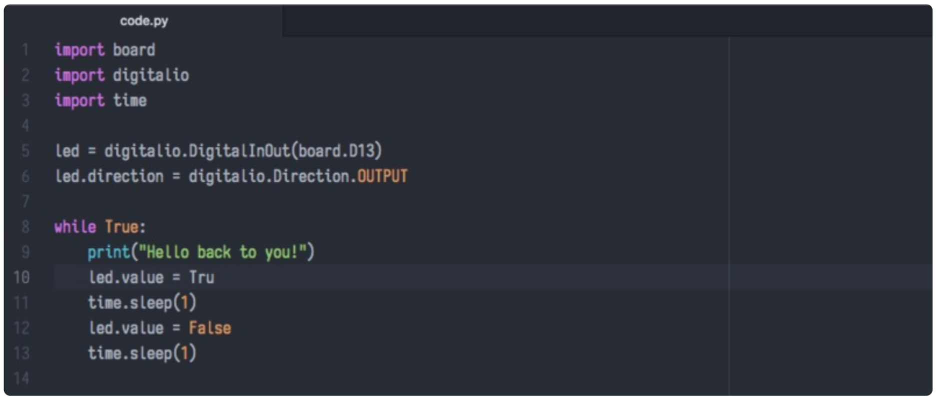
Keep your serial console window where you can see it. Save your file. You'll see what the serial console displays when the board reboots. Then you'll see your new change!



```
Hello, CircuitPython!
Hello, CircuitPython!
Traceback (most recent call last):
  File "code.py", line 11, in <module>
KeyboardInterrupt:
soft reboot

Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.
code.py output:
Hello back to you!
Hello back to you!
```

The `Traceback (most recent call last):` is telling you the last thing your board was doing before you saved your file. This is normal behavior and will happen every time the board resets. This is really handy for troubleshooting. Let's introduce an error so we can see how it is used.

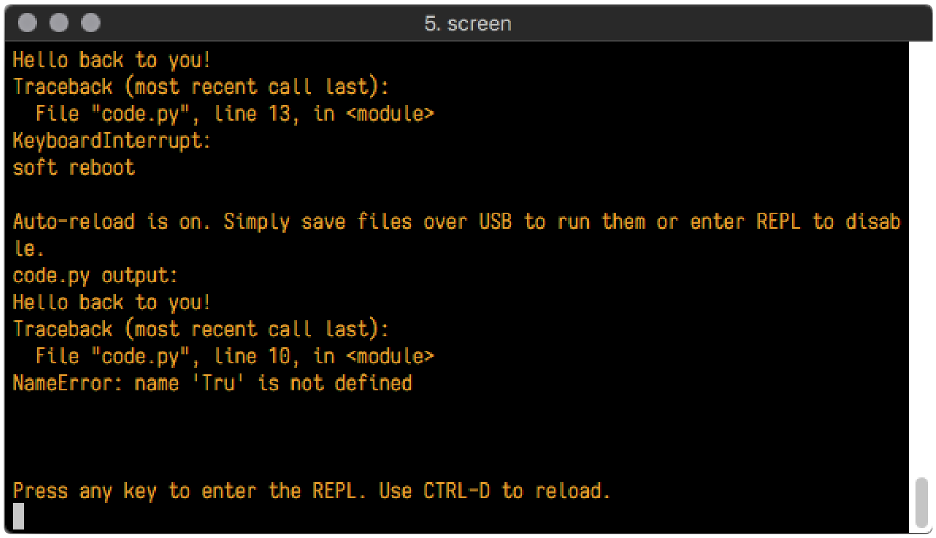
Delete the `e` at the end of `True` from the line `led.value = True` so that it says `led.value = Tru`



```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.D13)
led.direction = digitalio.Direction.OUTPUT

while True:
    print("Hello back to you!")
    led.value = Tru
    time.sleep(1)
    led.value = False
    time.sleep(1)
```

Save your file. You will notice that your red LED will stop blinking, and you may have a colored status LED blinking at you. This is because the code is no longer correct and can no longer run properly. We need to fix it!

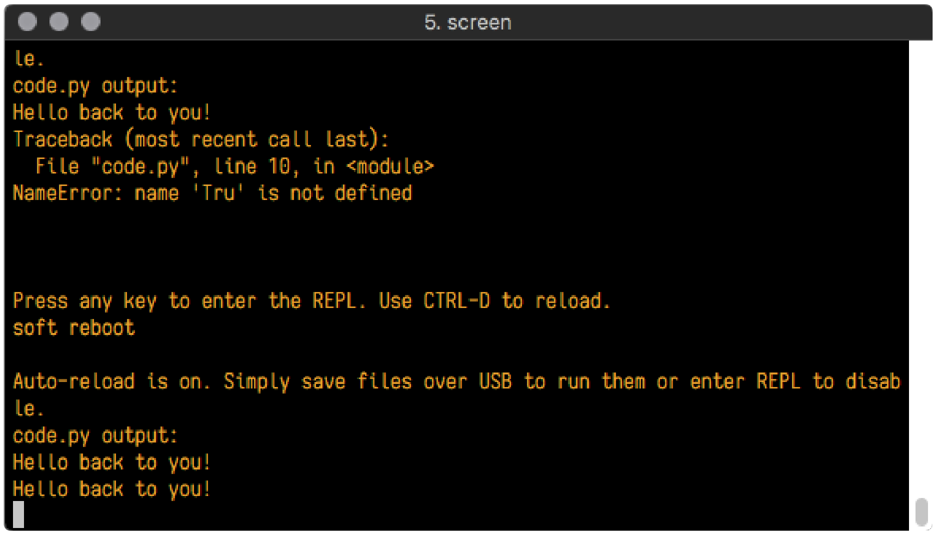
Usually when you run into errors, it's not because you introduced them on purpose. You may have 200 lines of code, and have no idea where your error could be hiding. This is where the serial console can help. Let's take a look!



```
Hello back to you!
Traceback (most recent call last):
  File "code.py", line 13, in <module>
KeyboardInterrupt:
soft reboot

Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.
code.py output:
Hello back to you!
Traceback (most recent call last):
  File "code.py", line 10, in <module>
NameError: name 'Tru' is not defined



Press any key to enter the REPL. Use CTRL-D to reload.
```

The `Traceback (most recent call last):` is telling you that the last thing it was able to run was line 10 in your code. The next line is your error: `NameError: name 'Tru' is not defined`. This error might not mean a lot to you, but combined with knowing the issue is on line 10, it gives you a great place to start!

Go back to your code, and take a look at line 10. Obviously, you know what the problem is already. But if you didn't, you'd want to look at line 10 and see if you could figure it out. If you're still unsure, try googling the error to get some help. In this case, you know what to look for. You spelled True wrong. Fix the typo and save your file.



```
le.
code.py output:
Hello back to you!
Traceback (most recent call last):
  File "code.py", line 10, in <module>
NameError: name 'Tru' is not defined



Press any key to enter the REPL. Use CTRL-D to reload.
soft reboot

Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.
code.py output:
Hello back to you!
Hello back to you!
```

Nice job fixing the error! Your serial console is streaming and your red LED Is blinking again.

The serial console will display any output generated by your code. Some sensors, such as a humidity sensor or a thermistor, receive data and you can use print statements to display that information. You can also use print statements for troubleshooting. If your code isn't working, and you want to know where it's failing, you can put print statements in various places to see where it stops printing.

The serial console has many uses, and is an amazing tool overall for learning and programming!

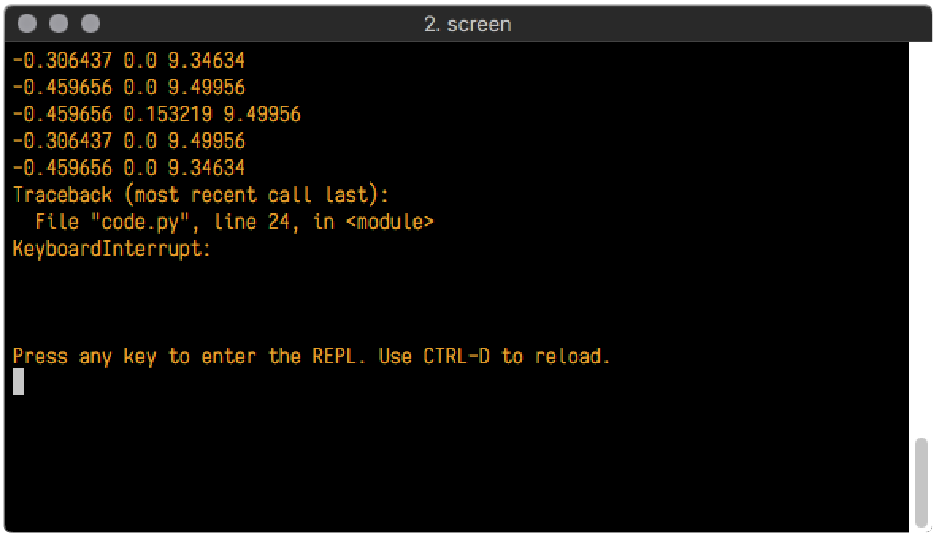
The REPL

The other feature of the serial connection is the **R**ead-**E**valuate-**P**rint-**L**oop, or REPL. The REPL allows you to enter individual lines of code and have them run immediately. It's really handy if you're running into trouble with a particular program and can't figure out why. It's interactive so it's great for testing new ideas.

To use the REPL, you first need to be connected to the serial console. Once that connection has been established, you'll want to press **Ctrl** + **C**.

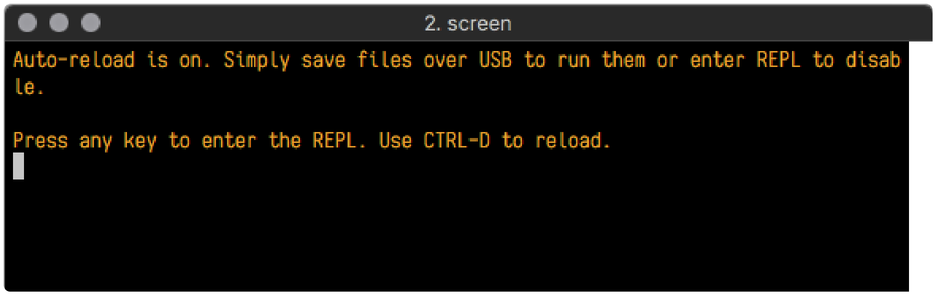
If there is code running, it will stop and you'll see `Press any key to enter the REPL. Use CTRL-D to reload.` Follow those instructions, and press any key on your keyboard.

The `Traceback (most recent call last):` is telling you the last thing your board was doing before you pressed Ctrl + C and interrupted it. The `KeyboardInterrupt` is you pressing Ctrl + C. This information can be handy when troubleshooting, but for now, don't worry about it. Just note that it is expected behavior.



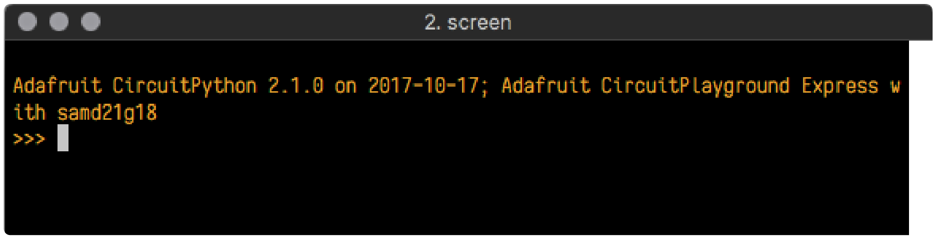
```
-0.306437 0.0 9.34634
-0.459656 0.0 9.49956
-0.459656 0.153219 9.49956
-0.306437 0.0 9.49956
-0.459656 0.0 9.34634
Traceback (most recent call last):
  File "code.py", line 24, in <module>
KeyboardInterrupt:



Press any key to enter the REPL. Use CTRL-D to reload.
```

If there is no code running, you will enter the REPL immediately after pressing Ctrl + C. There is no information about what your board was doing before you interrupted it because there is no code running.



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.

Press any key to enter the REPL. Use CTRL-D to reload.
```

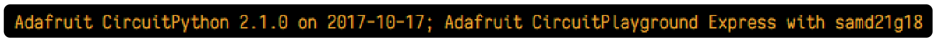
Either way, once you press a key you'll see a `>>>` prompt welcoming you to the REPL!



```
Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit CircuitPlayground Express w
ith samd21g18
>>> 
```

If you have trouble getting to the `>>>` prompt, try pressing Ctrl + C a few more times.

The first thing you get from the REPL is information about your board.



```
Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit CircuitPlayground Express with samd21g18
```

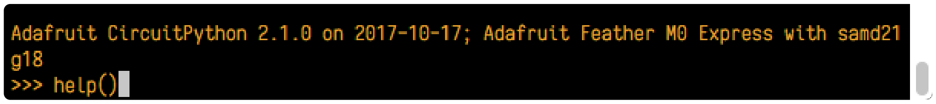
This line tells you the version of CircuitPython you're using and when it was released. Next, it gives you the type of board you're using and the type of microcontroller the board uses. Each part of this may be different for your board depending on the versions you're working with.

This is followed by the CircuitPython prompt.

```
>>>
```

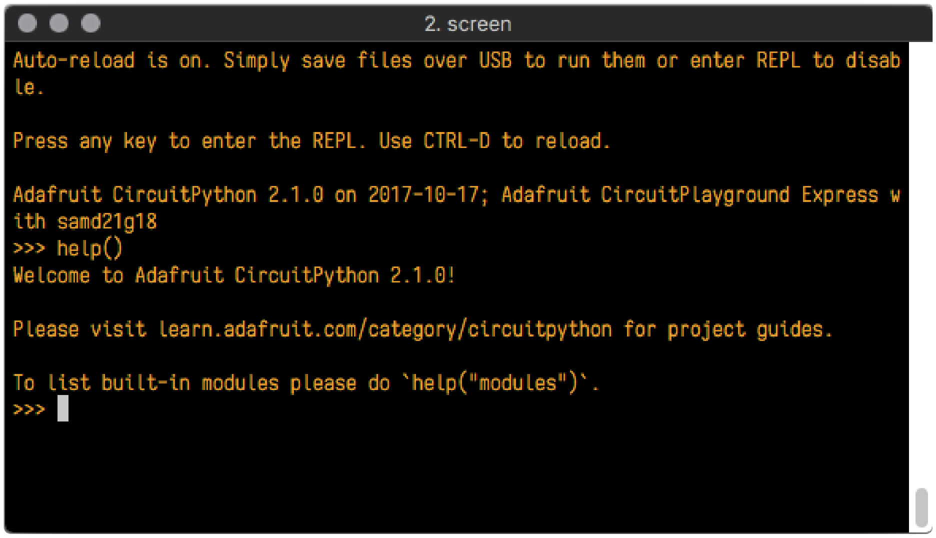
From this prompt you can run all sorts of commands and code. The first thing we'll do is run `help()`. This will tell us where to start exploring the REPL. To run code in the REPL, type it in next to the REPL prompt.

Type `help()` next to the prompt in the REPL.



```
Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit Feather M0 Express with samd21
g18
>>> help()
```

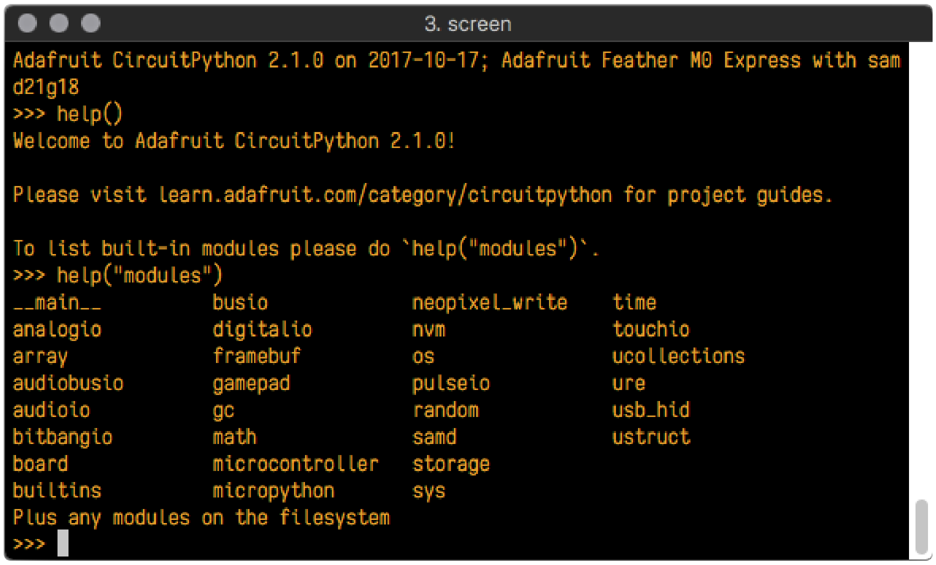
Then press enter. You should then see a message.



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.

Press any key to enter the REPL. Use CTRL-D to reload.

Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit CircuitPlayground Express w
ith samd21g18
>>> help()
Welcome to Adafruit CircuitPython 2.1.0!

Please visit learn.adafruit.com/category/circuitpython for project guides.

To list built-in modules please do `help("modules")`.
>>> 
```

First part of the message is another reference to the version of CircuitPython you're using. Second, a URL for the CircuitPython related project guides. Then… wait. What's this? `To list built-in modules, please do `help("modules")`.` Remember the libraries you learned about while going through creating code? That's exactly what this is talking about! This is a perfect place to start. Let's take a look!

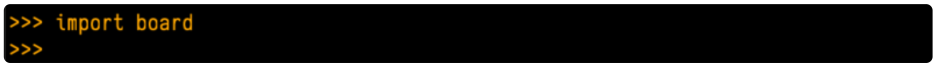
Type `help("modules")` into the REPL next to the prompt, and press enter.



```
Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit Feather M0 Express with sam
d21g18
>>> help()
Welcome to Adafruit CircuitPython 2.1.0!

Please visit learn.adafruit.com/category/circuitpython for project guides.

To list built-in modules please do `help("modules")`.
>>> help("modules")
__main__          busio             neopixel_write    time
analogio          digitalio         nvm               touchio
array             framebuf          os                ucollections
audiobusio        gamepad           pulseio           ure
audioio           gc                random            usb_hid
bitbangio         math              samd              ustruct
board             microcontroller   storage
builtins          micropython       sys
Plus any modules on the filesystem
>>> 
```

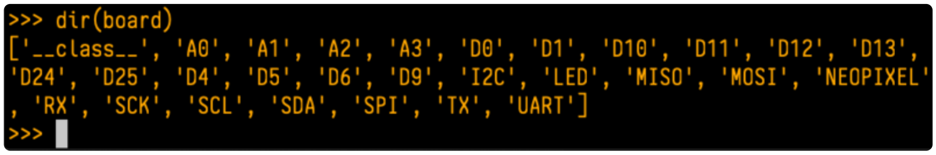
This is a list of all the core libraries built into CircuitPython. We discussed how board contains all of the pins on the board that you can use in your code. From the REPL, you are able to see that list!

Type `import board` into the REPL and press enter. It'll go to a new prompt. It might look like nothing happened, but that's not the case! If you recall, the `import` statement simply tells the code to expect to do something with that module. In this case, it's telling the REPL that you plan to do something with that module.



```
>>> import board
>>>
```

Next, type `dir(board)` into the REPL and press enter.



```
>>> dir(board)
['__class__', 'A0', 'A1', 'A2', 'A3', 'D0', 'D1', 'D10', 'D11', 'D12', 'D13',
'D24', 'D25', 'D4', 'D5', 'D6', 'D9', 'I2C', 'LED', 'MISO', 'MOSI', 'NEOPIXEL'
, 'RX', 'SCK', 'SCL', 'SDA', 'SPI', 'TX', 'UART']
>>> 
```

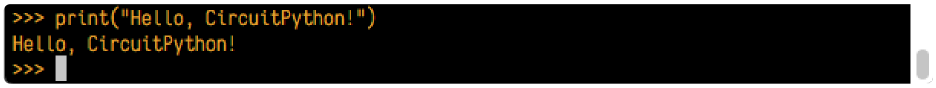
This is a list of all of the pins on your board that are available for you to use in your code. Each board's list will differ slightly depending on the number of pins available. Do you see `LED`? That's the pin you used to blink the red LED!

The REPL can also be used to run code. Be aware that **any code you enter into the REPL isn't saved** anywhere. If you're testing something new that you'd like to keep, make sure you have it saved somewhere on your computer as well!

Every programmer in every programming language starts with a piece of code that says, "Hello, World." We're going to say hello to something else. Type into the REPL:

```
print("Hello, CircuitPython!")
```

Then press enter.



```
>>> print("Hello, CircuitPython!")
Hello, CircuitPython!
>>> 
```

That's all there is to running code in the REPL! Nice job!

You can write single lines of code that run stand-alone. You can also write entire programs into the REPL to test them. As we said though, remember that nothing typed into the REPL is saved.

There's a lot the REPL can do for you. It's great for testing new ideas if you want to see if a few new lines of code will work. It's fantastic for troubleshooting code by entering it one line at a time and finding out where it fails. It lets you see what libraries are available and explore those libraries.

Try typing more into the REPL to see what happens!

Returning to the serial console

When you're ready to leave the REPL and return to the serial console, simply press **Ctrl + D**. This will reload your board and reenter the serial console. You will restart the program you had running before entering the REPL. In the console window, you'll see any output from the program you had running. And if your program was affecting anything visual on the board, you'll see that start up again as well.

You can return to the REPL at any time!

CircuitPython Pins and Modules

CircuitPython is designed to run on microcontrollers and allows you to interface with all kinds of sensors, inputs and other hardware peripherals. There are tons of guides showing how to wire up a circuit, and use CircuitPython to, for example, read data from a sensor, or detect a button press. Most CircuitPython code includes hardware setup which requires various modules, such as `board` or `digitalio`. You import these modules and then use them in your code. How does CircuitPython know to look for hardware in the specific place you connected it, and where do these modules come from?

This page explains both. You'll learn how CircuitPython finds the pins on your microcontroller board, including how to find the available pins for your board and what each pin is named. You'll also learn about the modules built into CircuitPython, including how to find all the modules available for your board.

CircuitPython Pins

When using hardware peripherals with a CircuitPython compatible microcontroller, you'll almost certainly be utilising pins. This section will cover how to access your board's pins using CircuitPython, how to discover what pins and board-specific objects are available in CircuitPython for your board, how to use the board-specific objects, and how to determine all available pin names for a given pin on your board.

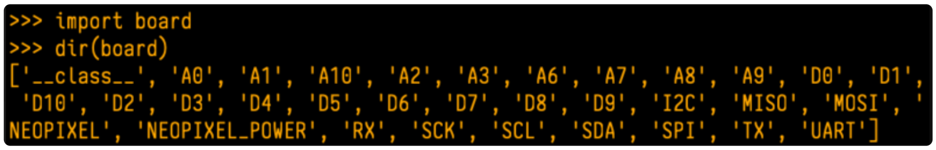
`import board`

When you're using any kind of hardware peripherals wired up to your microcontroller board, the import list in your code will include `import board`. The `board` module is built into CircuitPython, and is used to provide access to a series of board-specific objects, including pins. Take a look at your microcontroller board. You'll notice that next to the pins are pin labels. You can always access a pin by its pin label. However, there are almost always multiple names for a given pin.

To see all the available board-specific objects and pins for your board, enter the REPL (`>>>`) and run the following commands:

```
import board
dir(board)
```

Here is the output for the QT Py.



```
>>> import board
>>> dir(board)
['__class__', 'A0', 'A1', 'A10', 'A2', 'A3', 'A6', 'A7', 'A8', 'A9', 'D0', 'D1',
 'D10', 'D2', 'D3', 'D4', 'D5', 'D6', 'D7', 'D8', 'D9', 'I2C', 'MISO', 'MOSI', '
NEOPIXEL', 'NEOPIXEL_POWER', 'RX', 'SCK', 'SCL', 'SDA', 'SPI', 'TX', 'UART']
```

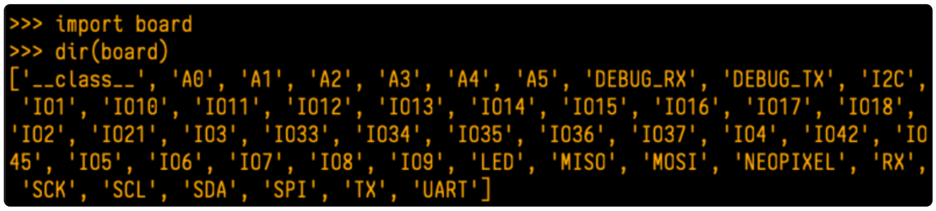
The following pins have labels on the physical QT Py board: A0, A1, A2, A3, SDA, SCL, TX, RX, SCK, MISO, and MOSI. You see that there are many more entries available in `board` than the labels on the QT Py.

You can use the pin names on the physical board, regardless of whether they seem to be specific to a certain protocol.

For example, you do not *have* to use the SDA pin for I2C - you can use it for a button or LED.

On the flip side, there may be multiple names for one pin. For example, on the QT Py, pin **A0** is labeled on the physical board silkscreen, but it is available in CircuitPython as both `A0` and `D0`. For more information on finding all the names for a given pin, see the [What Are All the Available Pin Names?](https://adafru.it/QkA) (https://adafru.it/QkA) section below.

The results of `dir(board)` for CircuitPython compatible boards will look similar to the results for the QT Py in terms of the pin names, e.g. A0, D0, etc. However, some boards, for example, the Metro ESP32-S2, have different styled pin names. Here is the output for the Metro ESP32-S2.



```
>>> import board
>>> dir(board)
['__class__', 'A0', 'A1', 'A2', 'A3', 'A4', 'A5', 'DEBUG_RX', 'DEBUG_TX', 'I2C',
 'IO1', 'IO10', 'IO11', 'IO12', 'IO13', 'IO14', 'IO15', 'IO16', 'IO17', 'IO18',
'IO2', 'IO21', 'IO3', 'IO33', 'IO34', 'IO35', 'IO36', 'IO37', 'IO4', 'IO42', 'IO
45', 'IO5', 'IO6', 'IO7', 'IO8', 'IO9', 'LED', 'MISO', 'MOSI', 'NEOPIXEL', 'RX',
 'SCK', 'SCL', 'SDA', 'SPI', 'TX', 'UART']
```

Note that most of the pins are named in an IO# style, such as **IO1** and **IO2**. Those pins on the physical board are labeled only with a number, so an easy way to know how to access them in CircuitPython, is to run those commands in the REPL and find the pin naming scheme.

> If your code is failing to run because it can't find a pin name you provided, verify that you have the proper pin name by running these commands in the REPL.

I2C, SPI, and UART

You'll also see there are often (but not always!) three special board-specific objects included: `I2C`, `SPI`, and `UART` - each one is for the default pin-set used for each of the three common protocol busses they are named for. These are called *singletons*.

What's a singleton? When you create an object in CircuitPython, you are *instantiating* ('creating') it. Instantiating an object means you are creating an instance of the object with the unique values that are provided, or "passed", to it.

For example, When you instantiate an I2C object using the `busio` module, it expects two pins: clock and data, typically SCL and SDA. It often looks like this:

```
i2c = busio.I2C(board.SCL, board.SDA)
```

Then, you pass the I2C object to a driver for the hardware you're using. For example, if you were using the TSL2591 light sensor and its CircuitPython library, the next line of code would be:

```
tsl2591 = adafruit_tsl2591.TSL2591(i2c)
```

However, CircuitPython makes this simpler by including the `I2C` singleton in the `board` module. Instead of the two lines of code above, you simply provide the singleton as the I2C object. So if you were using the TSL2591 and its CircuitPython library, the two above lines of code would be replaced with:

```
tsl2591 = adafruit_tsl2591.TSL2591(board.I2C())
```

This eliminates the need for the `busio` module, and simplifies the code. Behind the scenes, the `board.I2C()` object is instantiated when you call it, but not before, and on subsequent calls, it returns the same object. Basically, it does not create an object until you need it, and provides the same object every time you need it. You can call `board.I2C()` as many times as you like, and it will always return the same object.

> The UART/SPI/I2C singletons will use the 'default' bus pins for each board - often labeled as RX/TX (UART), MOSI/MISO/SCK (SPI), or SDA/SCL (I2C). Check your board documentation/pinout for the default busses.

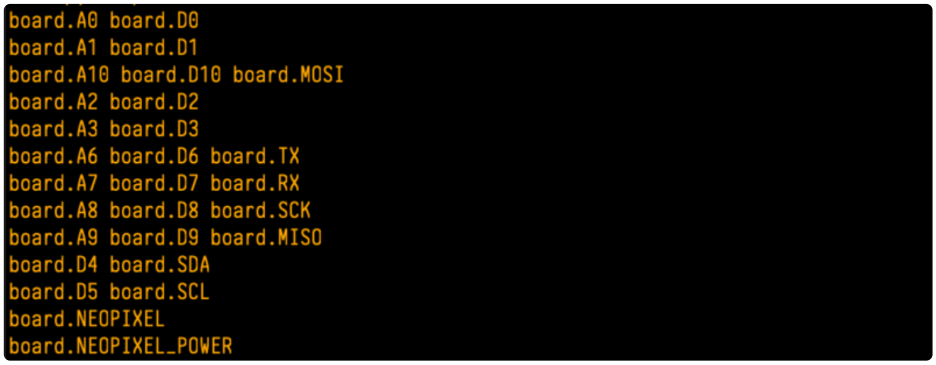
What Are All the Available Names?

Many pins on CircuitPython compatible microcontroller boards have multiple names, however, typically, there's only one name labeled on the physical board. So how do you find out what the other available pin names are? Simple, with the following script! Each line printed out to the serial console contains the set of names for a particular pin.

On a microcontroller board running CircuitPython, connect to the serial console. Then, save the following as **code.py** on your **CIRCUITPY** drive.

```
"""CircuitPython Essentials Pin Map Script"""
import microcontroller
import board

board_pins = []
for pin in dir(microcontroller.pin):
    if isinstance(getattr(microcontroller.pin, pin), microcontroller.Pin):
        pins = []
        for alias in dir(board):
            if getattr(board, alias) is getattr(microcontroller.pin, pin):
                pins.append("board.{}".format(alias))
        if len(pins) > 0:
            board_pins.append(" ".join(pins))
for pins in sorted(board_pins):
    print(pins)
```

Here is the result when this script is run on QT Py:



```
board.A0 board.D0
board.A1 board.D1
board.A10 board.D10 board.MOSI
board.A2 board.D2
board.A3 board.D3
board.A6 board.D6 board.TX
board.A7 board.D7 board.RX
board.A8 board.D8 board.SCK
board.A9 board.D9 board.MISO
board.D4 board.SDA
board.D5 board.SCL
board.NEOPIXEL
board.NEOPIXEL_POWER
```

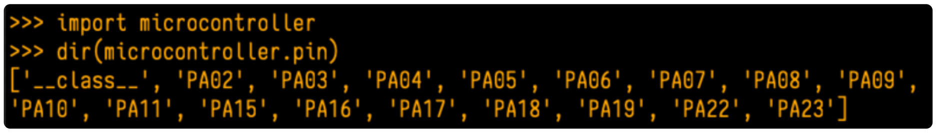
Each line represents a single pin. Find the line containing the pin name that's labeled on the physical board, and you'll find the other names available for that pin. For example, the first pin on the board is labeled **A0**. The first line in the output is `board.A0 board.D0`. This means that you can access pin **A0** with both `board.A0` and `board.D0`.

You'll notice there are two "pins" that aren't labeled on the board but appear in the list: `board.NEOPIXEL` and `board.NEOPIXEL_POWER`. Many boards have several of these special pins that give you access to built-in board hardware, such as an LED or an on-board sensor. The Qt Py only has one on-board extra piece of hardware, a NeoPixel LED, so there's only the one available in the list. But you can also control whether or not power is applied to the NeoPixel, so there's a separate pin for that.

That's all there is to figuring out the available names for a pin on a compatible microcontroller board in CircuitPython!

Microcontroller Pin Names

The pin names available to you in the CircuitPython `board` module are not the same as the names of the pins on the microcontroller itself. The board pin names are aliases to the microcontroller pin names. If you look at the datasheet for your microcontroller, you'll likely find a pinout with a series of pin names, such as "PA18" or "GPIO5". If you want to get to the actual microcontroller pin name in CircuitPython, you'll need the `microcontroller.pin` module. As with `board`, you can run `dir(microcontroller.pin)` in the REPL to receive a list of the microcontroller pin names.



```
>>> import microcontroller
>>> dir(microcontroller.pin)
['__class__', 'PA02', 'PA03', 'PA04', 'PA05', 'PA06', 'PA07', 'PA08', 'PA09',
'PA10', 'PA11', 'PA15', 'PA16', 'PA17', 'PA18', 'PA19', 'PA22', 'PA23']
```

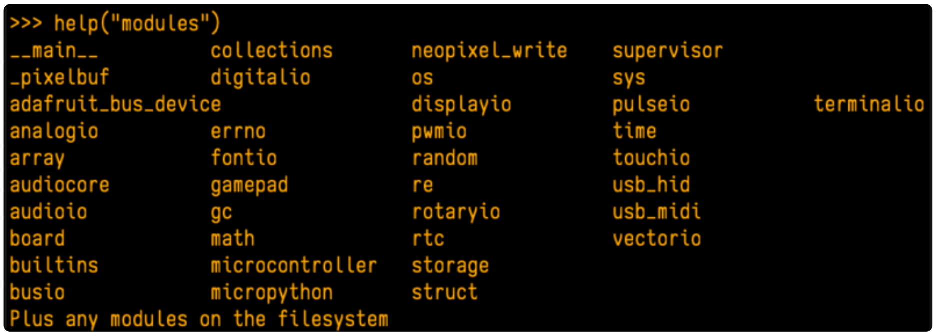
CircuitPython Built-In Modules

There is a set of modules used in most CircuitPython programs. One or more of these modules is always used in projects involving hardware. Often hardware requires installing a separate library from the Adafruit CircuitPython Bundle. But, if you try to find `board` or `digitalio` in the same bundle, you'll come up lacking. So, where do these modules come from? They're built into CircuitPython! You can find an comprehensive list of built-in CircuitPython modules and the technical details of their functionality from CircuitPython here (https://adafru.it/QkB) and the Python-like modules included here (https://adafru.it/QkC). However, **not every module is available for every board** due to size constraints or hardware limitations. How do you find out what modules are available for your board?

There are two options for this. You can check the support matrix (https://adafru.it/N2a), and search for your board by name. Or, you can use the REPL.

Plug in your board, connect to the serial console and enter the REPL. Type the following command.

```
help("modules")
```



```
>>> help("modules")
__main__          collections       neopixel_write    supervisor
_pixelbuf         digitalio         os                sys
adafruit_bus_device                 displayio         pulseio           terminalio
analogio          errno             pwmio             time
array             fontio            random            touchio
audiocore         gamepad           re                usb_hid
audioio           gc                rotaryio          usb_midi
board             math              rtc               vectorio
builtins          microcontroller   storage
busio             micropython       struct
Plus any modules on the filesystem
```

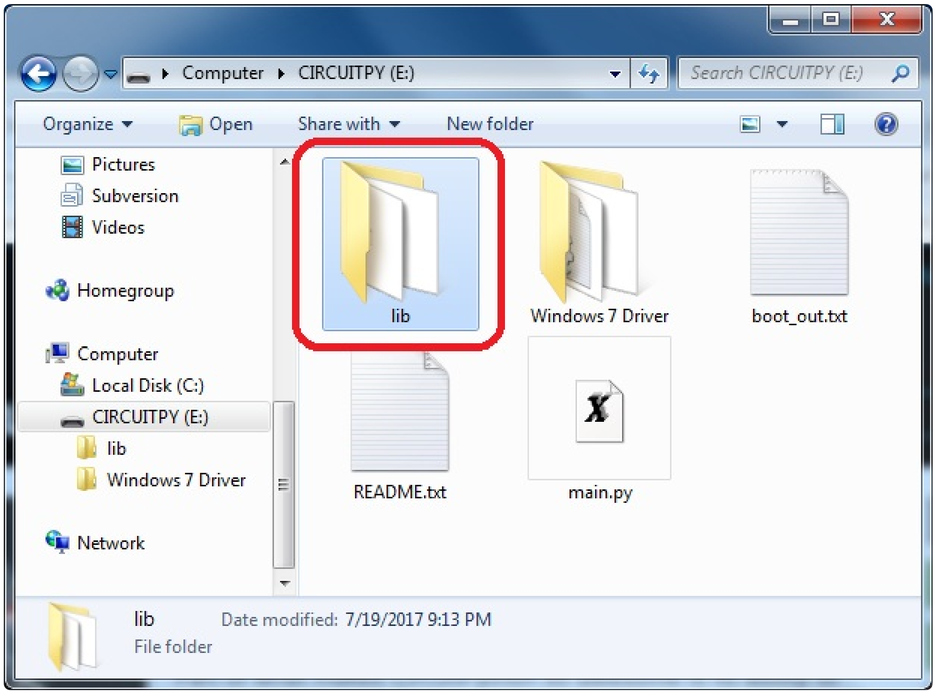
That's it! You now know two ways to find all of the modules built into CircuitPython for your compatible microcontroller board.

CircuitPython Libraries

> As we continue to develop CircuitPython and create new releases, we will stop supporting older releases. Visit https://circuitpython.org/downloads to download the latest version of CircuitPython for your board. You must download the CircuitPython Library Bundle that matches your version of CircuitPython. Please update CircuitPython and then visit https://circuitpython.org/libraries to download the latest Library Bundle.

Each CircuitPython program you run needs to have a lot of information to work. The reason CircuitPython is so simple to use is that most of that information is stored in other files and works in the background. These files are called *libraries*. Some of them are built into CircuitPython. Others are stored on your **CIRCUITPY** drive in a folder called **lib**. Part of what makes CircuitPython so awesome is its ability to store code separately from the firmware itself. Storing code separately from the firmware makes it easier to update both the code you write and the libraries you depend.

Your board may ship with a **lib** folder already, it's in the base directory of the drive. If not, simply create the folder yourself. When you first install CircuitPython, an empty **lib** directory will be created for you.



CircuitPython libraries work in the same way as regular Python modules so the Python docs (https://adafru.it/rar) are a great reference for how it all should work. In Python terms, we can place our library files in the **lib** directory because it's part of the Python path by default.

One downside of this approach of separate libraries is that they are not built in. To use them, one needs to copy them to the **CIRCUITPY** drive before they can be used. Fortunately, we provide a bundle full of our libraries.

Our bundle and releases also feature optimized versions of the libraries with the **.mpy** file extension. These files take less space on the drive and have a smaller memory footprint as they are loaded.

Installing the CircuitPython Library Bundle

We're constantly updating and improving our libraries, so we don't (at this time) ship our CircuitPython boards with the full library bundle. Instead, you can find example code in the guides for your board that depends on external libraries. Some of these libraries may be available from us at Adafruit, some may be written by community members!

Either way, as you start to explore CircuitPython, you'll want to know how to get libraries on board.

You can grab the latest Adafruit CircuitPython Bundle release by clicking the button below.

Note: Match up the bundle version with the version of CircuitPython you are running - 3.x library for running any version of CircuitPython 3, 4.x for running any version of CircuitPython 4, etc. If you mix libraries with major CircuitPython versions, you will most likely get errors due to changes in library interfaces possible during major version changes.

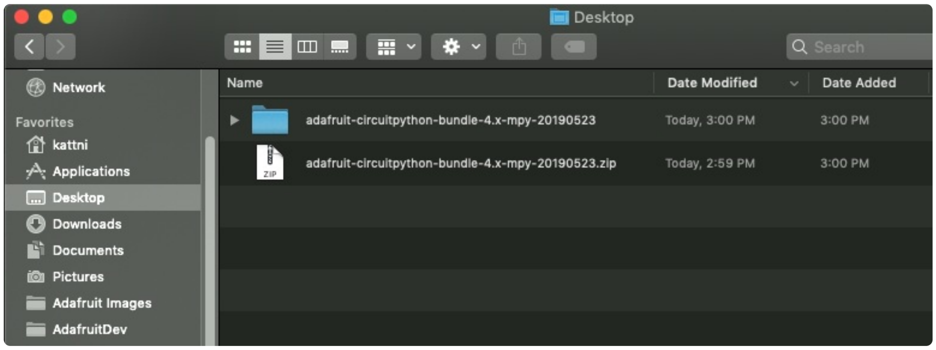
https://adafru.it/ENC

https://adafru.it/ENC

If you need another version, you can also visit the bundle release page (https://adafru.it/Ayy) which will let you select exactly what version you're looking for, as well as information about changes.

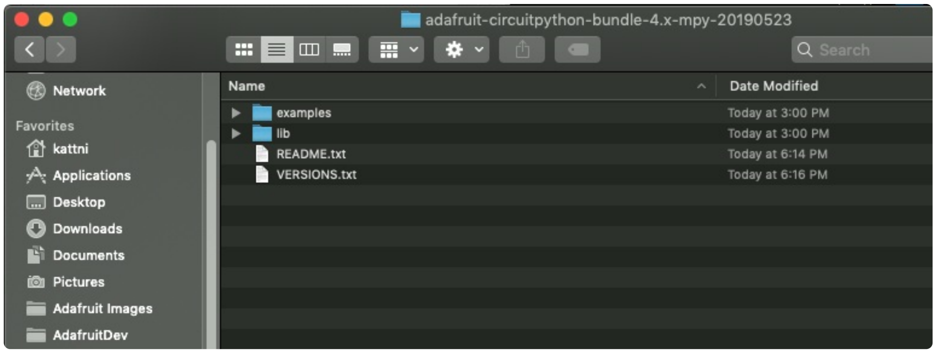
Either way, download the version that matches your CircuitPython firmware version. If you don't know the version, look at the initial prompt in the CircuitPython REPL, which reports the version. For example, if you're running v4.0.1, download the 4.x library bundle. There's also a **py** bundle which contains the uncompressed python files, you probably *don't* want that unless you are doing advanced work on libraries.

After downloading the zip, extract its contents. This is usually done by double clicking on the zip. On Mac OSX, it places the file in the same directory as the zip.



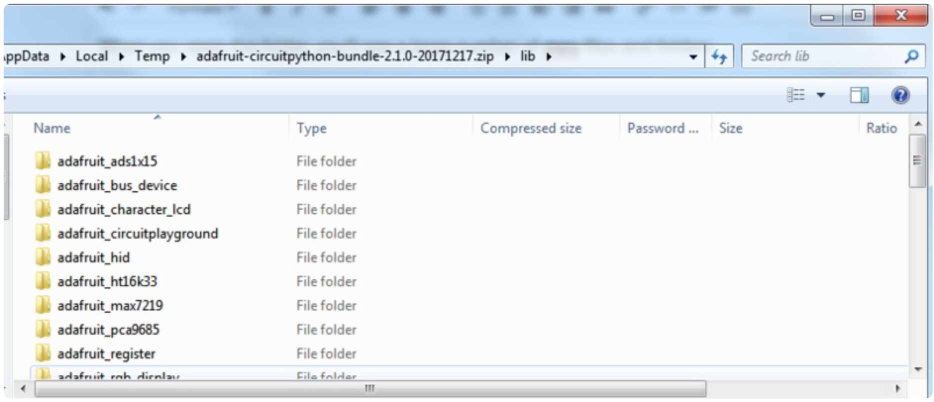
Name	Date Modified	Date Added
adafruit-circuitpython-bundle-4.x-mpy-20190523	Today, 3:00 PM	3:00 PM
adafruit-circuitpython-bundle-4.x-mpy-20190523.zip	Today, 2:59 PM	3:00 PM

Open the bundle folder. Inside you'll find two information files, and two folders. One folder is the lib bundle, and the other folder is the examples bundle.



Name	Date Modified
examples	Today at 3:00 PM
lib	Today at 3:00 PM
README.txt	Today at 6:14 PM
VERSIONS.txt	Today at 6:16 PM

Now open the lib folder. When you open the folder, you'll see a large number of **mpy** files and folders

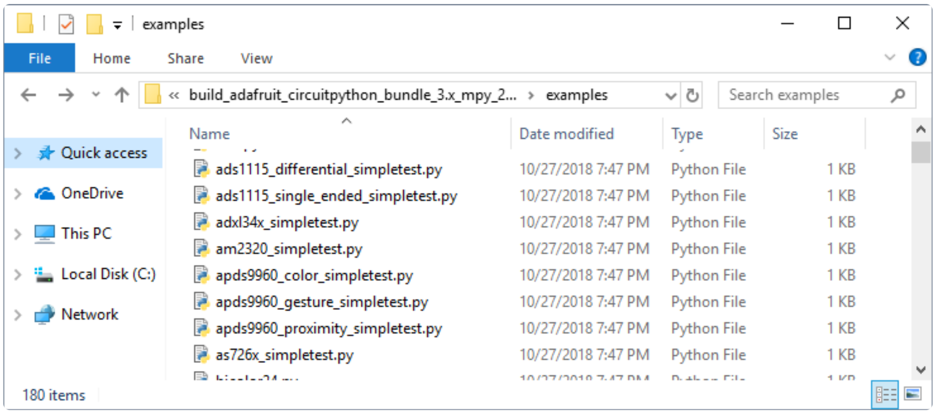

ppData ▸ Local ▸ Temp ▸ adafruit-circuitpython-bundle-2.1.0-20171217.zip ▸ lib ▸
Search lib

Name	Type	Compressed size	Password ...	Size	Ratio
adafruit_ads1x15	File folder				
adafruit_bus_device	File folder				
adafruit_character_lcd	File folder				
adafruit_circuitplayground	File folder				
adafruit_hid	File folder				
adafruit_ht16k33	File folder				
adafruit_max7219	File folder				
adafruit_pca9685	File folder				
adafruit_register	File folder				
adafruit_rgb_display	File folder				

Example Files

All example files from each library are now included in the bundles, as well as an examples-only bundle. These are included for two main reasons:

- Allow for quick testing of devices.
- Provide an example base of code, that is easily built upon for individualized purposes.



Name	Date modified	Type	Size
ads1115_differential_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
ads1115_single_ended_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
adxl34x_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
am2320_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
apds9960_color_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
apds9960_gesture_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
apds9960_proximity_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB
as726x_simpletest.py	10/27/2018 7:47 PM	Python File	1 KB

Copying Libraries to Your Board

First you'll want to create a **lib** folder on your **CIRCUITPY** drive. Open the drive, right click, choose the option to create a new folder, and call it **lib**. Then, open the **lib** folder you extracted from the downloaded zip. Inside you'll find a number of folders and **.mpy** files. Find the library you'd like to use, and copy it to the lib folder on **CIRCUITPY**.

This also applies to example files. They are only supplied as raw **.py** files, so they may need to be converted to **.mpy** using the **mpy-cross** utility if you encounter `MemoryErrors`. This is discussed in the CircuitPython Essentials Guide (https://adafru.it/CTw). Usage is the same as described above in the Express Boards section. Note: If you do not place examples in a separate folder, you would remove the examples from the `import` statement.

> If a library has multiple .mpy files contained in a folder, be sure to copy the entire folder to CIRCUITPY/lib.

Example: `ImportError` Due to Missing Library

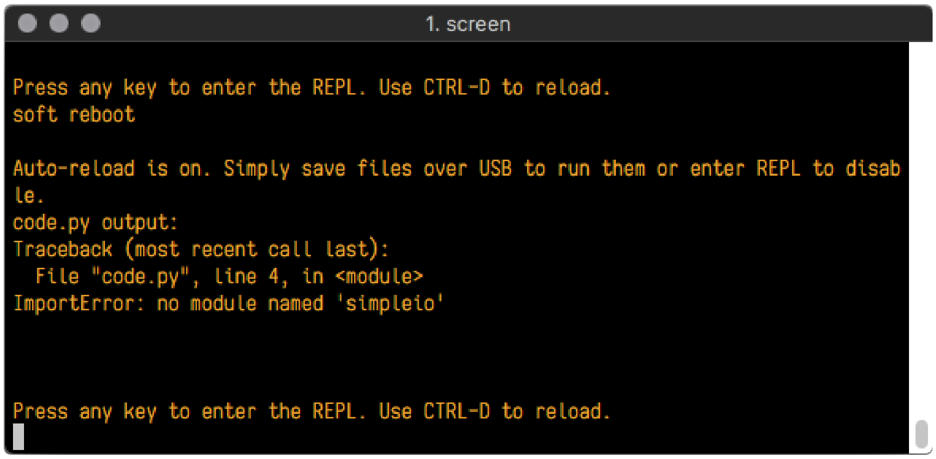
If you choose to load libraries as you need them, you may write up code that tries to use a library you haven't yet loaded. We're going to demonstrate what happens when you try to utilise a library that you don't have loaded on your board, and cover the steps required to resolve the issue.

This demonstration will only return an error if you do not have the required library loaded into the **lib** folder on your **CIRCUITPY** drive.

Let's use a modified version of the blinky example.

```
import board
import time
import simpleio

led = simpleio.DigitalOut(board.D13)

while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

Save this file. Nothing happens to your board. Let's check the serial console to see what's going on.

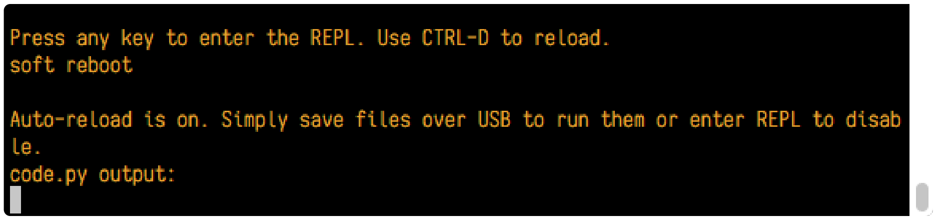


```
Press any key to enter the REPL. Use CTRL-D to reload.
soft reboot

Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.
code.py output:
Traceback (most recent call last):
  File "code.py", line 4, in <module>
ImportError: no module named 'simpleio'



Press any key to enter the REPL. Use CTRL-D to reload.
```

We have an ImportError. It says there is no module named 'simpleio'. That's the one we just included in our code!

Click the link above to download the correct bundle. Extract the lib folder from the downloaded bundle file. Scroll down to find **simpleio.mpy**. This is the library file we're looking for! Follow the steps above to load an individual library file.

The LED starts blinking again! Let's check the serial console.



```
Press any key to enter the REPL. Use CTRL-D to reload.
soft reboot

Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.
code.py output:
```

No errors! Excellent. You've successfully resolved an ImportError!

If you run into this error in the future, follow along with the steps above and choose the library that matches the one you're missing.

Library Install on Non-Express Boards

If you have a Trinket M0 or Gemma M0, you'll want to follow the same steps in the example above to install libraries as you need them. You don't always need to wait for an `ImportError` as you probably know what library you added to your code. Simply open the **lib** folder you downloaded, find the library you need, and drag it to the **lib** folder on your **CIRCUITPY** drive.

You may end up running out of space on your Trinket M0 or Gemma M0 even if you only load libraries as you need them. There are a number of steps you can use to try to resolve this issue. You'll find them in the Troubleshooting page in the Learn guides for your board.

Updating CircuitPython Libraries/Examples

Libraries and examples are updated from time to time, and it's important to update the files you have on your **CIRCUITPY** drive.

To update a single library or example, follow the same steps above. When you drag the library file to your lib folder, it will ask if you want to replace it. Say yes. That's it!

A new library bundle is released every time there's an update to a library. Updates include things like bug fixes and new features. It's important to check in every so often to see if the libraries you're using have been updated.

Frequently Asked Questions

These are some of the common questions regarding CircuitPython and CircuitPython microcontrollers.

> As we continue to develop CircuitPython and create new releases, we will stop supporting older releases. Visit https://circuitpython.org/downloads to download the latest version of CircuitPython for your board. You must download the CircuitPython Library Bundle that matches your version of CircuitPython. Please update CircuitPython and then visit https://circuitpython.org/libraries to download the latest Library Bundle.

I have to continue using an older version of CircuitPython; where can I find compatible libraries?

We are no longer building or supporting library bundles for older versions of CircuitPython. We highly encourage you to update CircuitPython to the latest version (https://adafru.it/Em8) and use the current version of the libraries (https://adafru.it/ENC). However, if for some reason you cannot update, here are points to the last available library bundles for previous versions:

- 2.x (https://adafru.it/FJA)
- 3.x (https://adafru.it/FJB)
- 4.x (https://adafru.it/QDL)
- 5.x (https://adafru.it/QDJ)

Is ESP8266 or ESP32 supported in CircuitPython? Why not?

We dropped ESP8266 support as of 4.x - For more information please read about it here!

https://learn.adafruit.com/welcome-to-circuitpython/circuitpython-for-esp8266 (https://adafru.it/CiG)

We do not support ESP32 because it does not have native USB. We do support ESP32-S2, which does.

How do I connect to the Internet with CircuitPython?

If you'd like to add WiFi support, check out our guide on ESP32/ESP8266 as a co-processor. (https://adafru.it/Dwa)

Is there asyncio support in CircuitPython?

We do not have asyncio support in CircuitPython at this time. However, `async` and `await` are turned on in many builds, and we are looking at how to use event loops and other constructs effectively and easily.

My RGB NeoPixel/DotStar LED is blinking funny colors - what does it mean?

The status LED can tell you what's going on with your CircuitPython board. Read more here for what the colors mean! (https://adafru.it/Den)

What is a MemoryError?

Memory allocation errors happen when you're trying to store too much on the board. The CircuitPython microcontroller boards have a limited amount of memory available. You can have about 250 lines of code on the M0 Express boards. If you try to `import` too many libraries, a combination of large libraries, or run a program with too many lines of code, your code will fail to run and you will receive a `MemoryError` in the serial console (REPL).

What do I do when I encounter a MemoryError?

Try resetting your board. Each time you reset the board, it reallocates the memory. While this is unlikely to resolve your issue, it's a simple step and is worth trying.

Make sure you are using **.mpy** versions of libraries. All of the CircuitPython libraries are available in the bundle in a **.mpy** format which takes up less memory than .py format. Be sure that you're using [the latest library bundle](https://adafru.it/uap) (https://adafru.it/uap) for your version of CircuitPython.

If that does not resolve your issue, try shortening your code. Shorten comments, remove extraneous or unneeded code, or any other clean up you can do to shorten your code. If you're using a lot of functions, you could try moving those into a separate library, creating a `.mpy` of that library, and importing it into your code.

You can turn your entire file into a `.mpy` and `import` that into `code.py`. This means you will be unable to edit your code live on the board, but it can save you space.

Can the order of my `import` statements affect memory?

It can because the memory gets fragmented differently depending on allocation order and the size of objects. Loading `.mpy` files uses less memory so its recommended to do that for files you aren't editing.

How can I create my own `.mpy` files?

You can make your own `.mpy` versions of files with `mpy-cross`.

You can download `mpy-cross` for your operating system from [https://adafruit-circuit-python.s3.amazonaws.com/index.html?prefix=bin/mpy-cross/](https://adafru.it/QDK) (https://adafru.it/QDK). Builds are available for Windows, macOS, x64 Linux, and Raspberry Pi Linux. Choose the latest `mpy-cross` whose version matches the version of CircuitPython you are using.

To make a .mpy file, run `./mpy-cross path/to/yourfile.py` to create a `yourfile.mpy` in the same directory as the original file.

How do I check how much memory I have free?

```
import gc
gc.mem_free()
```

Will give you the number of bytes available for use.

Does CircuitPython support interrupts?

No. CircuitPython does not currently support interrupts. We do not have an estimated time for when they will be included.

Does Feather M0 support WINC1500?

No, WINC1500 will not fit into the M0 flash space.

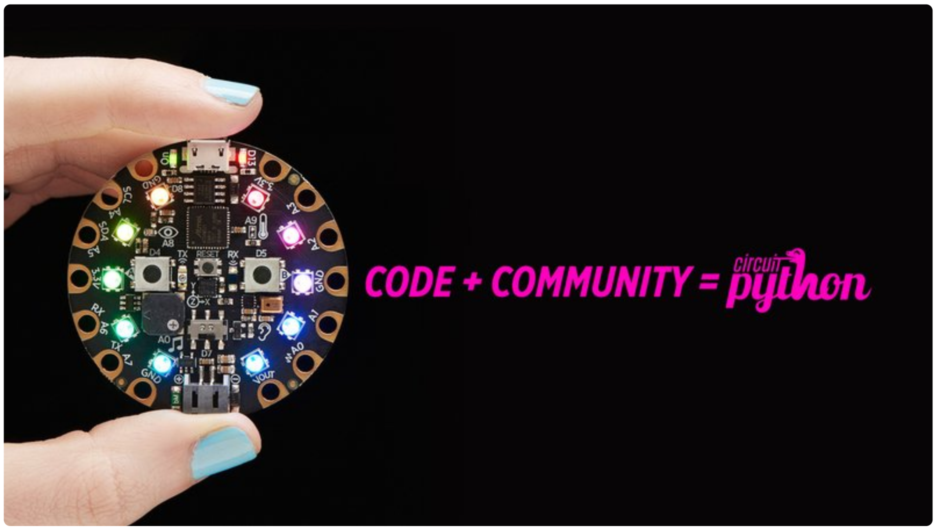
Can AVRs such as ATmega328 or ATmega2560 run CircuitPython?

No.

Commonly Used Acronyms

CP or CPy = CircuitPython (https://adafru.it/cpy-welcome)
CPC = Circuit Playground Classic (https://adafru.it/ncE)
CPX = Circuit Playground Express (https://adafru.it/wpF)

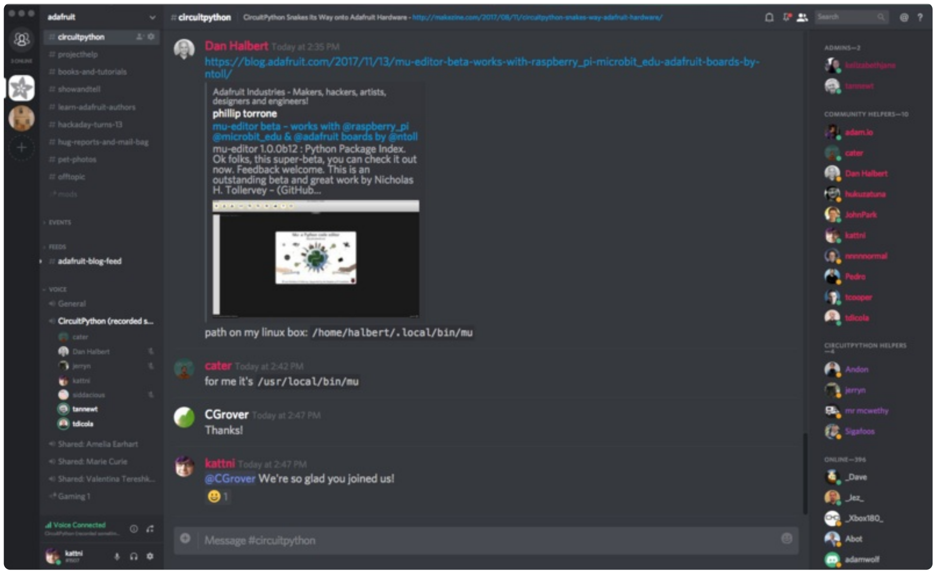
Welcome to the Community!



CircuitPython is a programming language that's super simple to get started with and great for learning. It runs on microcontrollers and works out of the box. You can plug it in and get started with any text editor. The best part? CircuitPython comes with an amazing, supportive community.

Everyone is welcome! CircuitPython is Open Source. This means it's available for anyone to use, edit, copy and improve upon. This also means CircuitPython becomes better because of you being a part of it. It doesn't matter whether this is your first microcontroller board or you're a computer engineer, you have something important to offer the Adafruit CircuitPython community. We're going to highlight some of the many ways you can be a part of it!

Adafruit Discord



circuitpython CircuitPython Snakes Its Way onto Adafruit Hardware - http://makezine.com/2017/08/11/circuitpython-snakes-way-adafruit-hardware/

Dan Halbert Today at 2:35 PM
https://blog.adafruit.com/2017/11/13/mu-editor-beta-works-with-raspberry_pi-microbit_edu-adafruit-boards-by-ntoll/

> Adafruit Industries - Makers, hackers, artists, designers and engineers!
> **phillip torrone**
> mu-editor beta - works with @raspberry_pi @microbit_edu & @adafruit boards by @ntoll
> mu-editor 1.0.0b12 : Python Package Index. Ok folks, this super-beta, you can check it out now. Feedback welcome. This is an outstanding beta and great work by Nicholas H. Tollervey - (GitHub...

path on my linux box: `/home/halbert/.local/bin/mu`

cater Today at 2:42 PM
for me it's `/usr/local/bin/mu`

CGrover Today at 2:47 PM
Thanks!

kattni Today at 2:47 PM
@CGrover We're so glad you joined us!
😃 1

The Adafruit Discord server is the best place to start. Discord is where the community comes together to volunteer and provide live support of all kinds. From general discussion to detailed problem solving, and everything in between, Discord is a digital maker space with makers from around the world.

There are many different channels so you can choose the one best suited to your needs. Each channel is shown on Discord as "#channelname". There's the #help-with-projects channel for assistance with your current project or help coming up with ideas for your next one. There's the #showandtell channel for showing off your newest creation. Don't be afraid to ask a question in any channel! If you're unsure, #general is a great place to start. If another channel is more likely to provide you with a better answer, someone will guide you.

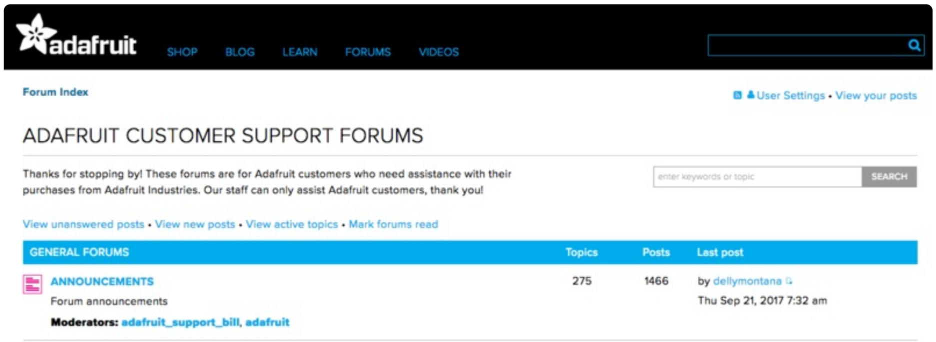
The help with CircuitPython channel is where to go with your CircuitPython questions. #help-with-circuitpython is there for new users and developers alike so feel free to ask a question or post a comment! Everyone of any experience level is welcome to join in on the conversation. We'd love to hear what you have to say! The #circuitpython channel is available for development discussions as well.

The easiest way to contribute to the community is to assist others on Discord. Supporting others doesn't always mean answering questions. Join in celebrating successes! Celebrate your mistakes! Sometimes just hearing that someone else has gone through a similar struggle can be enough to keep a maker moving forward.

The Adafruit Discord is the 24x7x365 hackerspace that you can bring your granddaughter to.

Visit https://adafru.it/discord ()to sign up for Discord. We're looking forward to meeting you!

Adafruit Forums


adafruit
SHOP
BLOG
LEARN
FORUMS
VIDEOS
Forum Index
User Settings • View your posts
enter keywords or topic
SEARCH
View unanswered posts • View new posts • View active topics • Mark forums read

ADAFRUIT CUSTOMER SUPPORT FORUMS

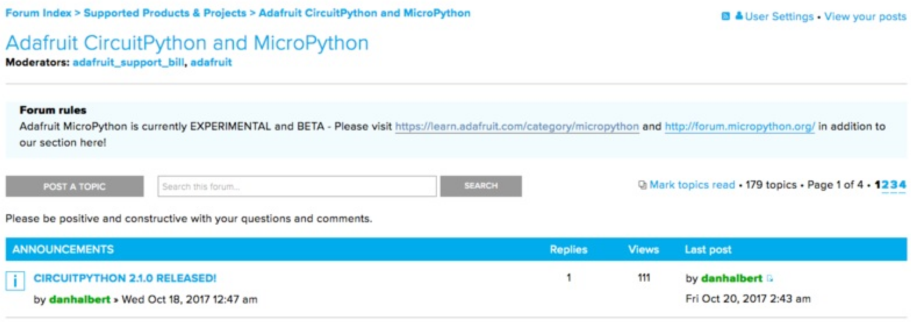
Thanks for stopping by! These forums are for Adafruit customers who need assistance with their purchases from Adafruit Industries. Our staff can only assist Adafruit customers, thank you!

GENERAL FORUMS	Topics	Posts	Last post
ANNOUNCEMENTS Forum announcements **Moderators:** adafruit_support_bill, adafruit	275	1466	by dellymontana Thu Sep 21, 2017 7:32 am

The Adafruit Forums (https://adafru.it/jlf) are the perfect place for support. Adafruit has wonderful paid support folks to answer any questions you may have. Whether your hardware is giving you issues or your code doesn't seem to be working, the forums are always there for you to ask. You need an Adafruit account to post to the forums. You can use the same account you use to order from Adafruit.

While Discord may provide you with quicker responses than the forums, the forums are a more reliable source of information. If you want to be certain you're getting an Adafruit-supported answer, the forums are the best place to be.

There are forum categories that cover all kinds of topics, including everything Adafruit. The Adafruit CircuitPython and MicroPython (https://adafru.it/xXA) category under "Supported Products & Projects" is the best place to post your CircuitPython questions.



Forum Index > Supported Products & Projects > Adafruit CircuitPython and MicroPython

Adafruit CircuitPython and MicroPython

Moderators: adafruit_support_bill, adafruit

Forum rules

Adafruit MicroPython is currently EXPERIMENTAL and BETA - Please visit https://learn.adafruit.com/category/micropython and http://forum.micropython.org/ in addition to our section here!

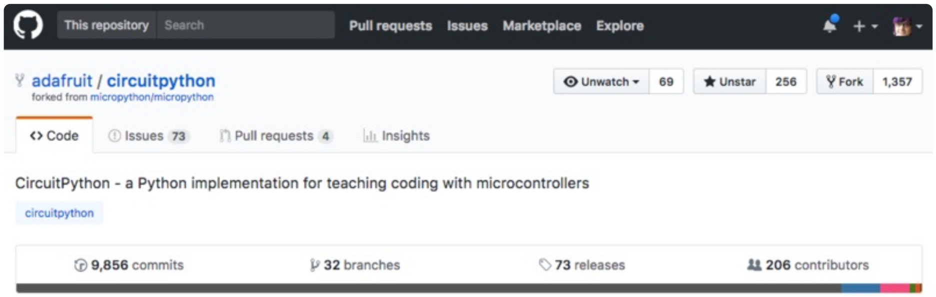
Please be positive and constructive with your questions and comments.

ANNOUNCEMENTS	Replies	Views	Last post
CIRCUITPYTHON 2.1.0 RELEASED! by danhalbert » Wed Oct 18, 2017 12:47 am	1	111	by danhalbert Fri Oct 20, 2017 2:43 am

Be sure to include the steps you took to get to where you are. If it involves wiring, post a picture! If your code is giving you trouble, include your code in your post! These are great ways to make sure that there's enough information to help you with your issue.

You might think you're just getting started, but you definitely know something that someone else doesn't. The great thing about the forums is that you can help others too! Everyone is welcome and encouraged to provide constructive feedback to any of the posted questions. This is an excellent way to contribute to the community and share your knowledge!

Adafruit Github



adafruit / circuitpython

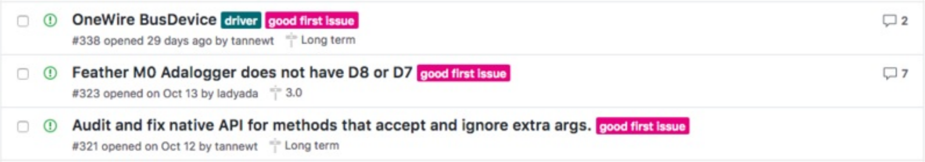
forked from micropython/micropython

CircuitPython - a Python implementation for teaching coding with microcontrollers

9,856 commits | 32 branches | 73 releases | 206 contributors

Whether you're just beginning or are life-long programmer who would like to contribute, there are ways for everyone to be a part of building CircuitPython. GitHub is the best source of ways to contribute to CircuitPython (https://adafru.it/tB7) itself. If you need an account, visit https://github.com/ (https://adafru.it/d6C)and sign up.

If you're new to GitHub or programming in general, there are great opportunities for you. Head over to adafruit/circuitpython (https://adafru.it/tB7) on GitHub, click on "Issues (https://adafru.it/Bee)", and you'll find a list that includes issues labeled "good first issue (https://adafru.it/Bef)". These are things we've identified as something that someone with any level of experience can help with. These issues include options like updating documentation, providing feedback, and fixing simple bugs.



□ ⓘ OneWire BusDevice driver good first issue 2
#338 opened 29 days ago by tannewt Long term

□ ⓘ Feather M0 Adalogger does not have D8 or D7 good first issue 7
#323 opened on Oct 13 by ladyada 3.0

□ ⓘ Audit and fix native API for methods that accept and ignore extra args. good first issue
#321 opened on Oct 12 by tannewt Long term

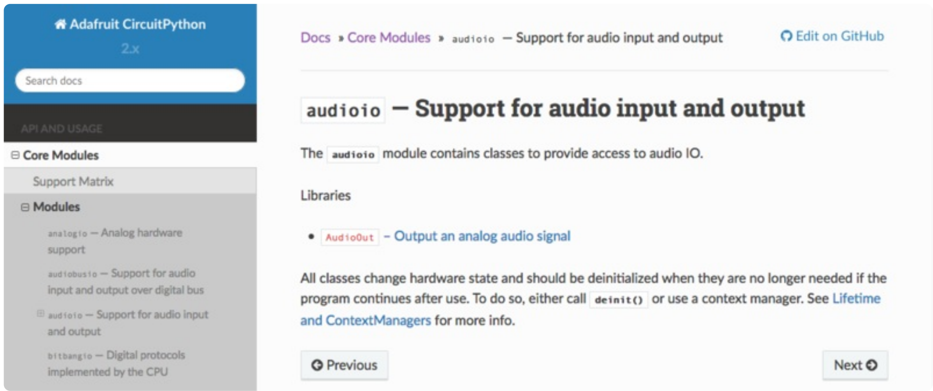
Already experienced and looking for a challenge? Checkout the rest of the issues list and you'll find plenty of ways to contribute. You'll find everything from new driver requests to core module updates. There's plenty of opportunities for everyone at any level!

When working with CircuitPython, you may find problems. If you find a bug, that's great! We love bugs! Posting a detailed issue to GitHub is an invaluable way to contribute to improving CircuitPython. Be sure to include the steps to replicate the issue as well as any other information you think is relevant. The more detail, the better!

Testing new software is easy and incredibly helpful. Simply load the newest version of CircuitPython or a library onto your CircuitPython hardware, and use it. Let us know about any problems you find by posting a new issue to GitHub. Software testing on both current and beta releases is a very important part of contributing CircuitPython. We can't possibly find all the problems ourselves! We need your help to make CircuitPython even better.

On GitHub, you can submit feature requests, provide feedback, report problems and much more. If you have questions, remember that Discord and the Forums are both there for help!

ReadTheDocs



Adafruit CircuitPython
2.x
Search docs
API AND USAGE
⊟ Core Modules
Support Matrix
⊟ Modules
analogio — Analog hardware support
audiobusio — Support for audio input and output over digital bus
⊞ audioio — Support for audio input and output
bitbangio — Digital protocols implemented by the CPU
Docs » Core Modules » audioio — Support for audio input and output
Edit on GitHub
Previous
Next

audioio — Support for audio input and output

The audioio module contains classes to provide access to audio IO.

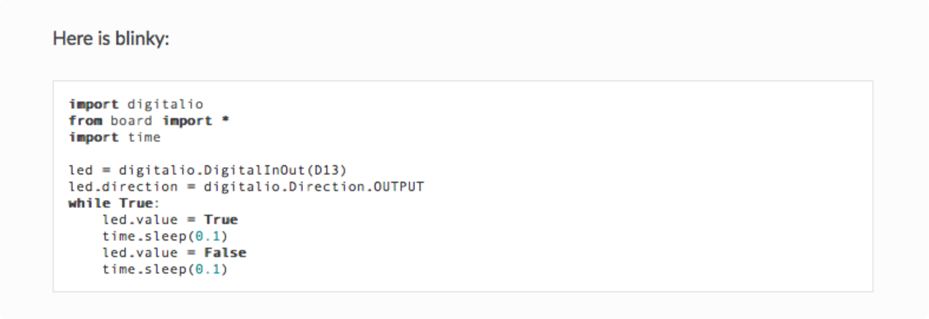
Libraries

- AudioOut – Output an analog audio signal

All classes change hardware state and should be deinitialized when they are no longer needed if the program continues after use. To do so, either call deinit() or use a context manager. See Lifetime and ContextManagers for more info.

ReadTheDocs (https://adafru.it/Beg) is a an excellent resource for a more in depth look at CircuitPython. This is where you'll find things like API documentation and details about core modules. There is also a Design Guide that includes contribution guidelines for CircuitPython.

RTD gives you access to a low level look at CircuitPython. There are details about each of the core modules (https://adafru.it/Beh). Each module lists the available libraries. Each module library page lists the available parameters and an explanation for each. In many cases, you'll find quick code examples to help you understand how the modules and parameters work, however it won't have detailed explanations like the Learn Guides. If you want help understanding what's going on behind the scenes in any CircuitPython code you're writing, ReadTheDocs is there to help!



Here is blinky:

```
import digitalio
from board import *
import time

led = digitalio.DigitalInOut(D13)
led.direction = digitalio.Direction.OUTPUT
while True:
    led.value = True
    time.sleep(0.1)
    led.value = False
    time.sleep(0.1)
```

Advanced Serial Console on Windows

Windows 7 Driver

If you're using Windows 7 (or 8 or 8.1), use the link below to download the driver package. You will not need to install drivers on Mac, Linux or Windows 10.

We *strongly* encourage you to upgrade to Windows 10 if you are still using Windows 7 or Windows 8 or 8.1. Windows 7 has reached end-of-life and no longer receives security updates. A free upgrade to Windows 10 is still available (https://adafru.it/RWc).

https://adafru.it/AB0

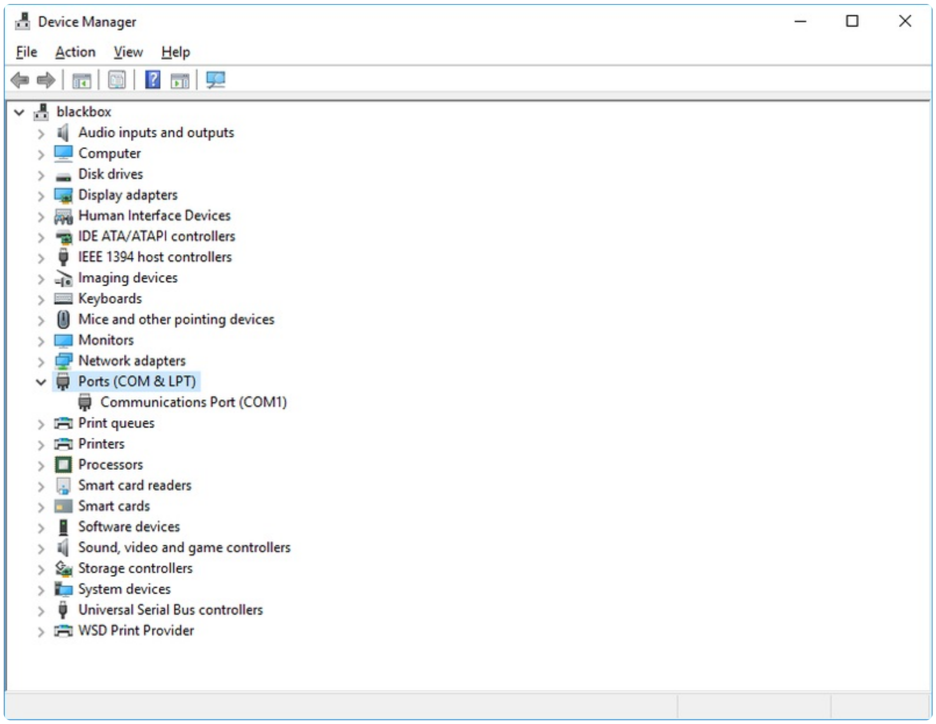
https://adafru.it/AB0

The Windows Drivers installer was last updated in November 2020 (v2.5.0.0) . Windows 7 drivers for CircuitPython boards released since then, including RP2040 boards, are not yet available. The boards work fine on Windows 10. A new release of the drivers is in process.

What's the COM?

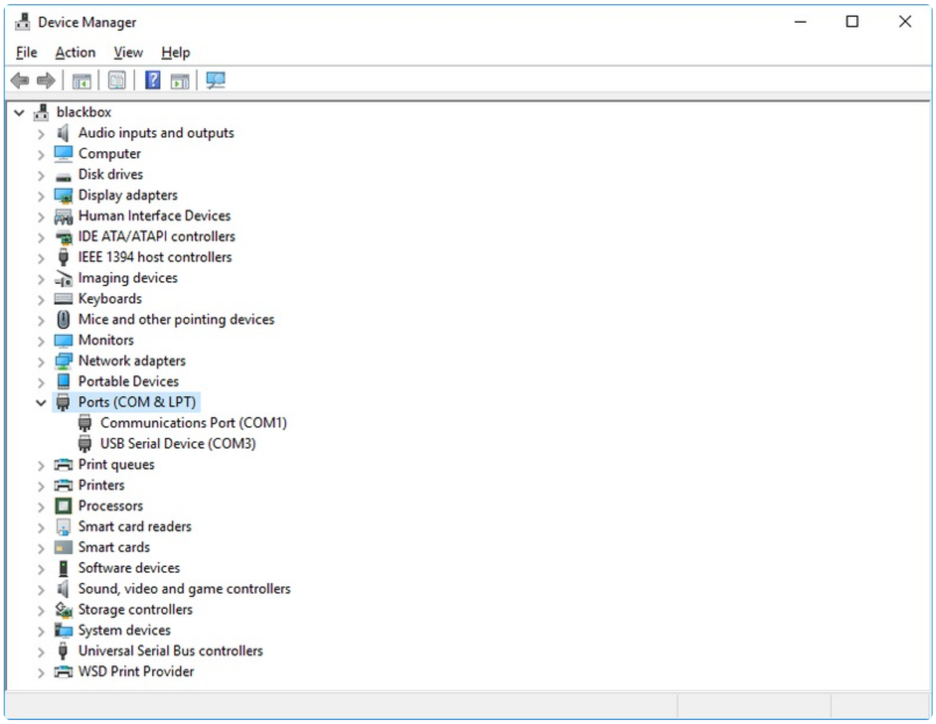
First, you'll want to find out which serial port your board is using. When you plug your board in to USB on your computer, it connects to a serial port. The port is like a door through which your board can communicate with your computer using USB.

We'll use Windows Device Manager to determine which port the board is using. The easiest way to determine which port the board is using is to first check **without** the board plugged in. Open Device Manager. Click on Ports (COM & LPT). You should find something already in that list with (COM#) after it where # is a number.



- blackbox
  - Audio inputs and outputs
  - Computer
  - Disk drives
  - Display adapters
  - Human Interface Devices
  - IDE ATA/ATAPI controllers
  - IEEE 1394 host controllers
  - Imaging devices
  - Keyboards
  - Mice and other pointing devices
  - Monitors
  - Network adapters
  - Ports (COM & LPT)
    - Communications Port (COM1)
  - Print queues
  - Printers
  - Processors
  - Smart card readers
  - Smart cards
  - Software devices
  - Sound, video and game controllers
  - Storage controllers
  - System devices
  - Universal Serial Bus controllers
  - WSD Print Provider

Now plug in your board. The Device Manager list will refresh and a new item will appear under Ports (COM & LPT). You'll find a different (COM#) after this item in the list.



- blackbox
  - Audio inputs and outputs
  - Computer
  - Disk drives
  - Display adapters
  - Human Interface Devices
  - IDE ATA/ATAPI controllers
  - IEEE 1394 host controllers
  - Imaging devices
  - Keyboards
  - Mice and other pointing devices
  - Monitors
  - Network adapters
  - Portable Devices
  - Ports (COM & LPT)
    - Communications Port (COM1)
    - USB Serial Device (COM3)
  - Print queues
  - Printers
  - Processors
  - Smart card readers
  - Smart cards
  - Software devices
  - Sound, video and game controllers
  - Storage controllers
  - System devices
  - Universal Serial Bus controllers
  - WSD Print Provider

Sometimes the item will refer to the name of the board. Other times it may be called something like USB Serial Device, as seen in the image above. Either way, there is a new (COM#) following the name. This is the port your board is using.

Install Putty

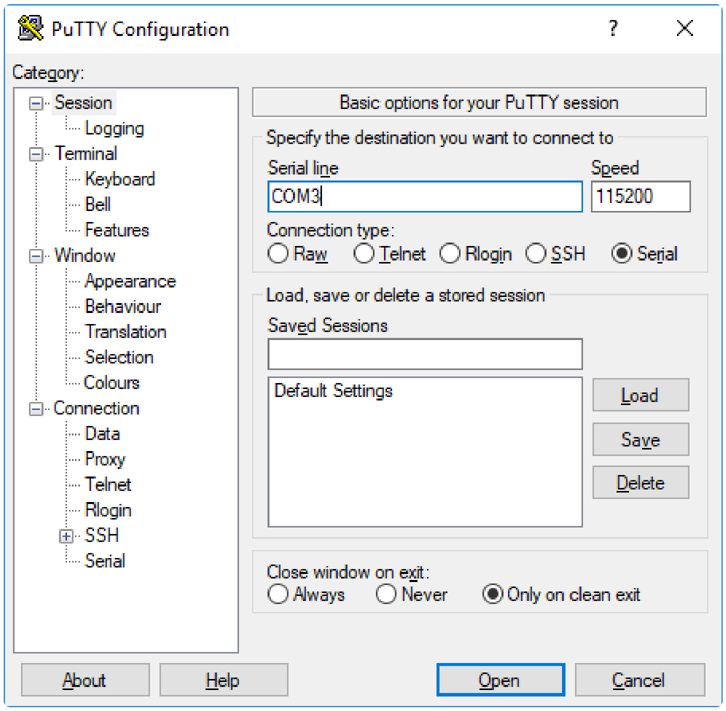
If you're using Windows, you'll need to download a terminal program. We're going to use PuTTY.

The first thing to do is download the latest version of PuTTY (https://adafru.it/Bf1). You'll want to download the Windows installer file. It is most likely that you'll need the 64-bit version. Download the file and install the program on your machine. If you run into issues, you can try downloading the 32-bit version instead. However, the 64-bit version will work on most PCs.

Now you need to open PuTTY.

- Under **Connection type:** choose the button next to **Serial**.
- In the box under **Serial line**, enter the serial port you found that your board is using.
- In the box under **Speed**, enter 115200. This called the baud rate, which is the speed in bits per second that data is sent over the serial connection. For boards with built in USB it doesn't matter so much but for ESP8266 and other board with a separate chip, the speed required by the board is 115200 bits per second. So you might as well just use 115200!

If you want to save those settings for later, use the options under **Load, save or delete a stored session.** Enter a name in the box under **Saved Sessions**, and click the **Save** button on the right.



Serial line: COM3

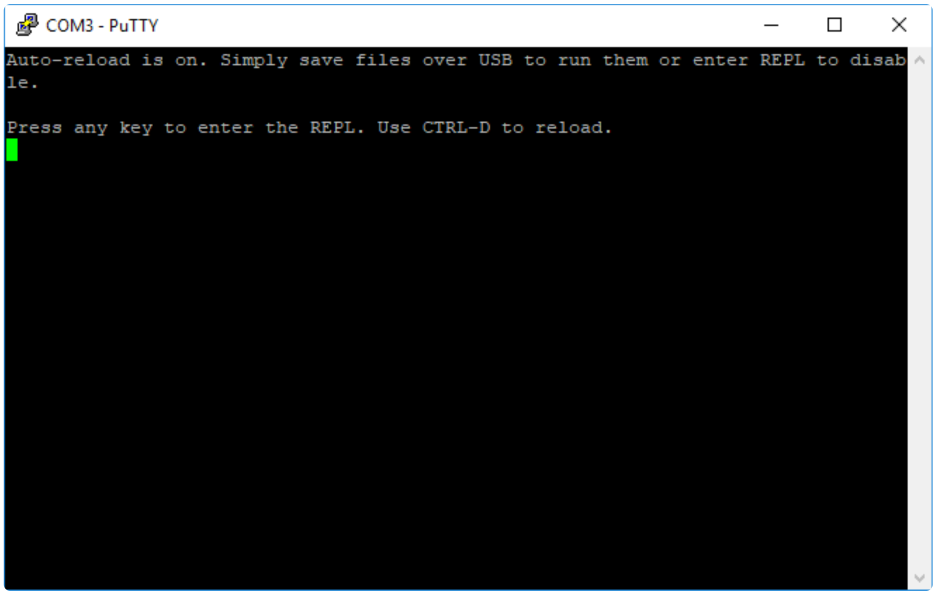
Speed: 115200

Connection type: ○ Raw ○ Telnet ○ Rlogin ○ SSH ● Serial

Saved Sessions: Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

Once your settings are entered, you're ready to connect to the serial console. Click "Open" at the bottom of the window. A new window will open.



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.

Press any key to enter the REPL. Use CTRL-D to reload.
```

If no code is running, the window will either be blank or will look like the window above. Now you're ready to see the results of your code.

Great job! You've connected to the serial console!

Advanced Serial Console on Mac and Linux

Connecting to the serial console on Mac and Linux uses essentially the same process. Neither operating system needs drivers installed. On MacOSX, **Terminal comes** installed. On Linux, there are a variety such as gnome-terminal (called Terminal) or Konsole on KDE.

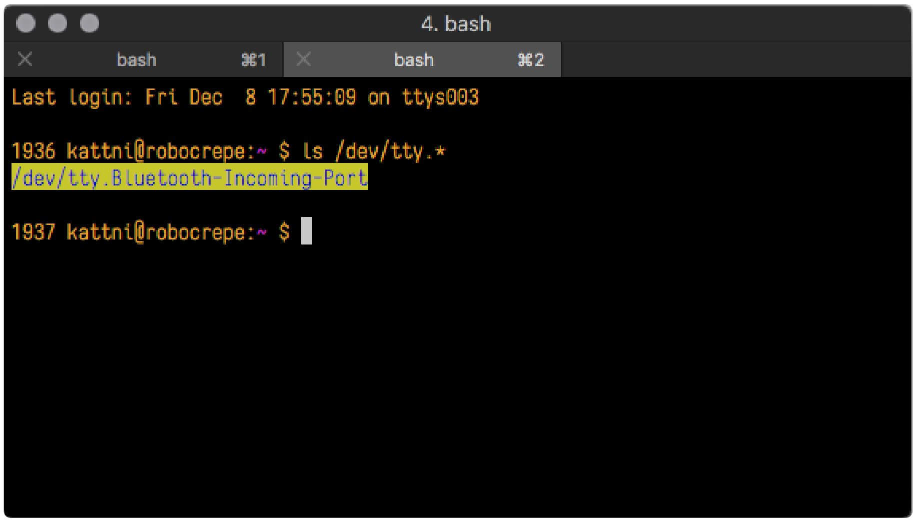
What's the Port?

First you'll want to find out which serial port your board is using. When you plug your board in to USB on your computer, it connects to a serial port. The port is like a door through which your board can communicate with your computer using USB.

We're going to use Terminal to determine what port the board is using. The easiest way to determine which port the board is using is to first check **without** the board plugged in. On Mac, open Terminal and type the following:

`ls /dev/tty.*`

Each serial connection shows up in the `/dev/` directory. It has a name that starts with `tty.`. The command `ls` shows you a list of items in a directory. You can use `*` as a wildcard, to search for files that start with the same letters but end in something different. In this case, we're asking to see all of the listings in `/dev/` that start with `tty.` and end in anything. This will show us the current serial connections.

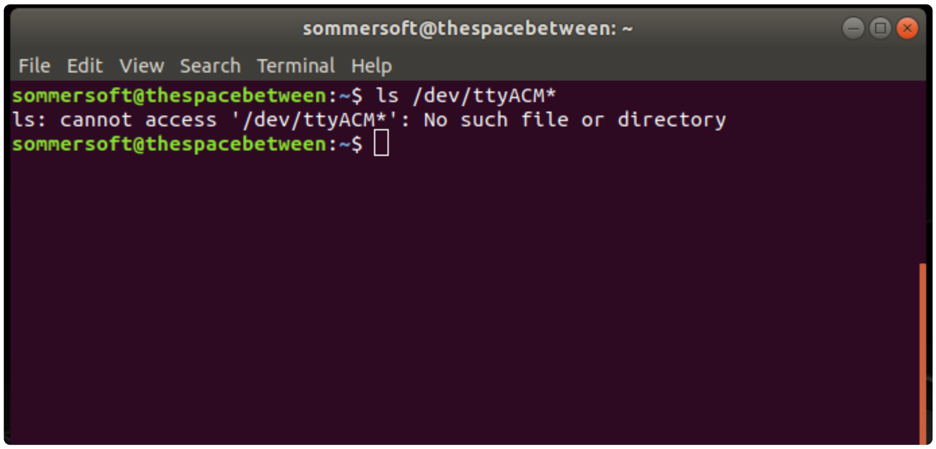


```
Last login: Fri Dec  8 17:55:09 on ttys003

1936 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port

1937 kattni@robocrepe:~ $ 
```

For Linux, the procedure is the same, however, the name is slightly different. If you're using Linux, you'll type:

`ls /dev/ttyACM*`

The concept is the same with Linux. We are asking to see the listings in the `/dev/` folder, starting with `ttyACM` and ending with anything. This will show you the current serial connections. In the example below, the error is indicating that are no current serial connections starting with `ttyACM`.

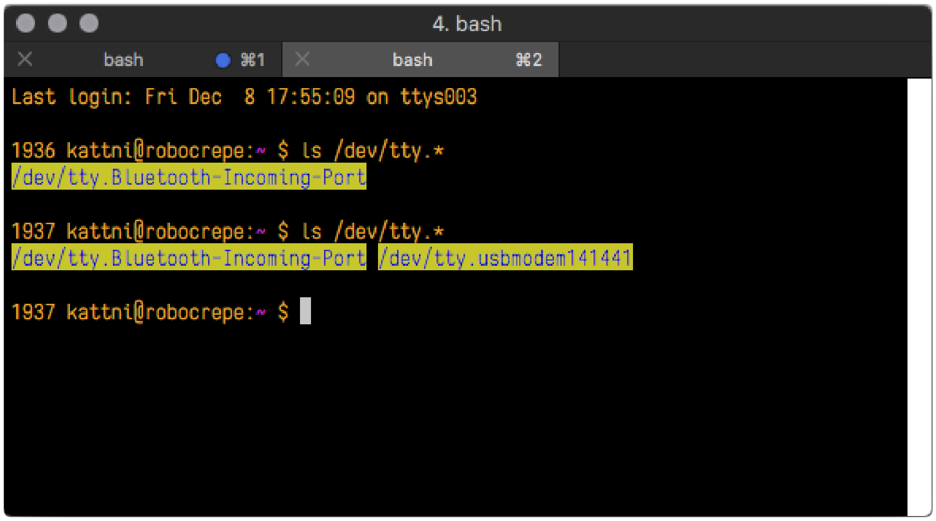

sommersoft@thespacebetween: ~
File Edit View Search Terminal Help

```
sommersoft@thespacebetween:~$ ls /dev/ttyACM*
ls: cannot access '/dev/ttyACM*': No such file or directory
sommersoft@thespacebetween:~$ 
```

Now, plug your board. Using Mac, type:

`ls /dev/tty.*`

This will show you the current serial connections, which will now include your board.



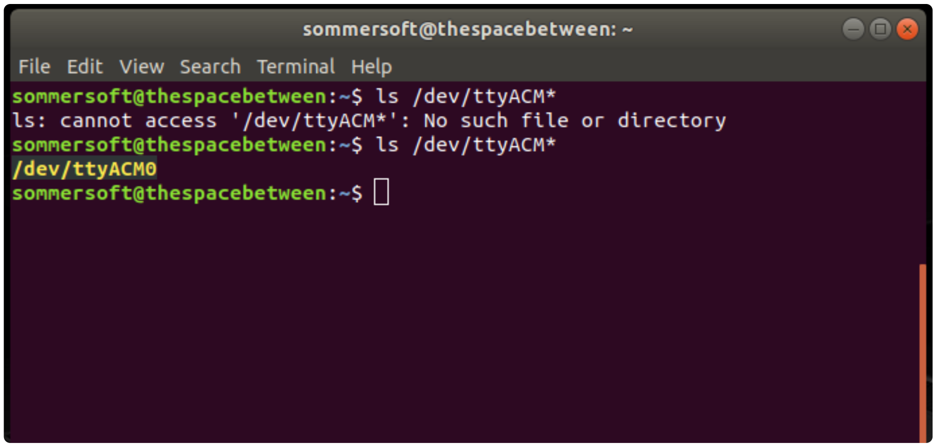
```
Last login: Fri Dec  8 17:55:09 on ttys003

1936 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port

1937 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port /dev/tty.usbmodem141441

1937 kattni@robocrepe:~ $ 
```

Using Mac, a new listing has appeared called `/dev/tty.usbmodem141441`. The `tty.usbmodem141441` part of this listing is the name the example board is using. Yours will be called something similar.

Using Linux, type:

`ls /dev/ttyACM*`

This will show you the current serial connections, which will now include your board.



sommersoft@thespacebetween: ~
File Edit View Search Terminal Help

```
sommersoft@thespacebetween:~$ ls /dev/ttyACM*
ls: cannot access '/dev/ttyACM*': No such file or directory
sommersoft@thespacebetween:~$ ls /dev/ttyACM*
/dev/ttyACM0
sommersoft@thespacebetween:~$
```

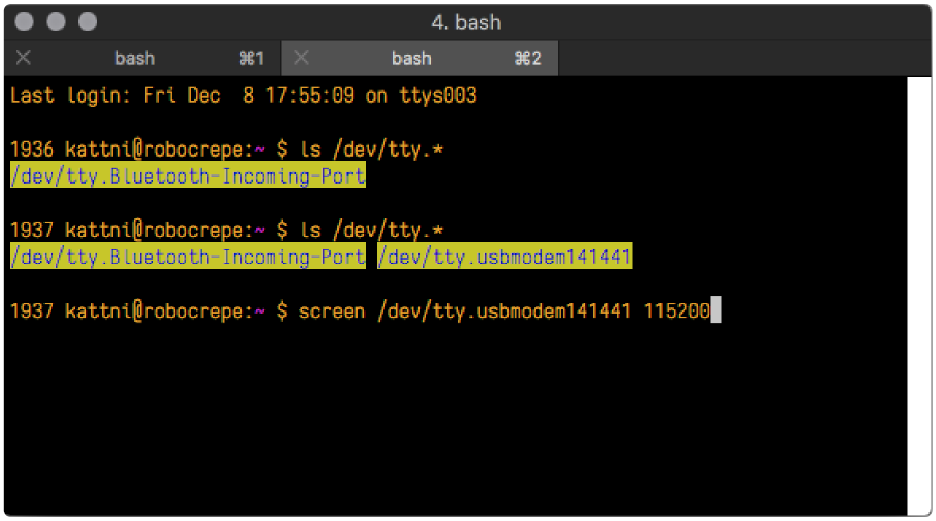
Using Linux, a new listing has appeared called `/dev/ttyACM0`. The `ttyACM0` part of this listing is the name the example board is using. Yours will be called something similar.

Connect with screen

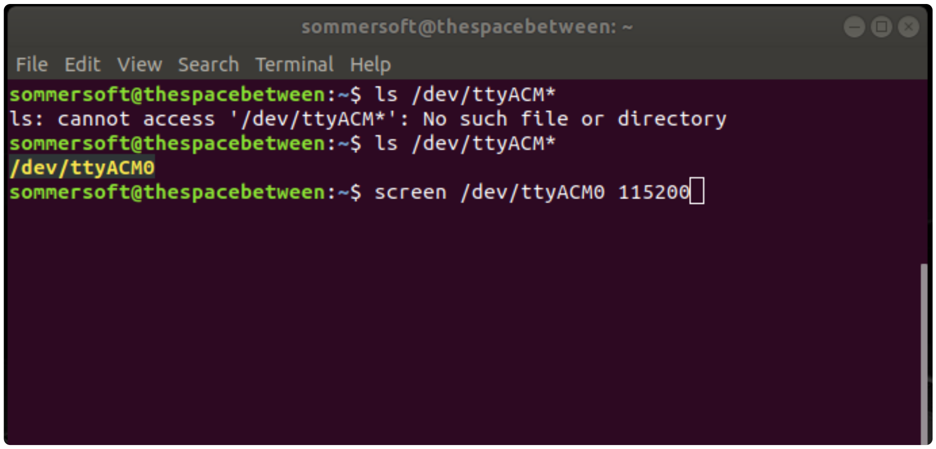
Now that you know the name your board is using, you're ready connect to the serial console. We're going to use a command called `screen`. The `screen` command is included with MacOS. Linux users may need to install it using their package manager. To connect to the serial console, use Terminal. Type the following command, replacing `board_name` with the name you found your board is using:

```
screen /dev/tty.board_name 115200
```

The first part of this establishes using the screen command. The second part tells screen the name of the board you're trying to use. The third part tells screen what baud rate to use for the serial connection. The baud rate is the speed in bits per second that data is sent over the serial connection. In this case, the speed required by the board is 115200 bits per second.



```
Last login: Fri Dec  8 17:55:09 on ttys003

1936 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port

1937 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port /dev/tty.usbmodem141441

1937 kattni@robocrepe:~ $ screen /dev/tty.usbmodem141441 115200
```



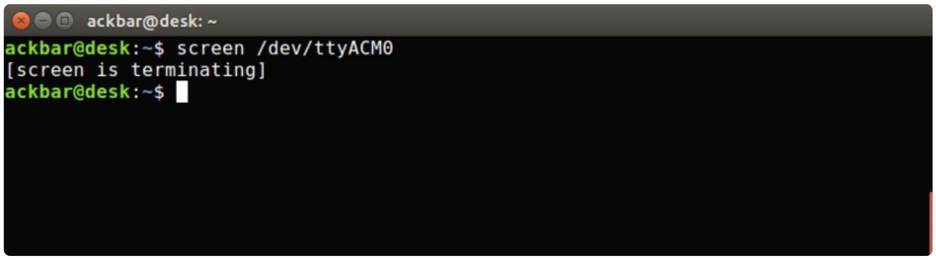
```
sommersoft@thespacebetween: ~
File  Edit  View  Search  Terminal  Help
sommersoft@thespacebetween:~$ ls /dev/ttyACM*
ls: cannot access '/dev/ttyACM*': No such file or directory
sommersoft@thespacebetween:~$ ls /dev/ttyACM*
/dev/ttyACM0
sommersoft@thespacebetween:~$ screen /dev/ttyACM0 115200
```

Press enter to run the command. It will open in the same window. If no code is running, the window will be blank. Otherwise, you'll see the output of your code.

Great job! You've connected to the serial console!

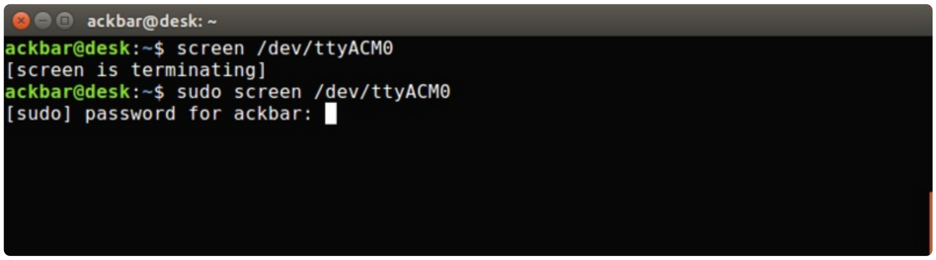
Permissions on Linux

If you try to run `screen` and it doesn't work, then you may be running into an issue with permissions. Linux keeps track of users and groups and what they are allowed to do and not do, like access the hardware associated with the serial connection for running `screen`. So if you see something like this:



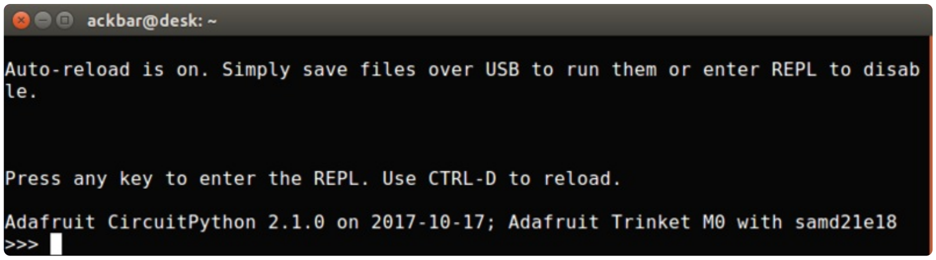
```
ackbar@desk: ~
ackbar@desk:~$ screen /dev/ttyACM0
[screen is terminating]
ackbar@desk:~$
```

then you may need to grant yourself access. There are generally two ways you can do this. The first is to just run `screen` using the `sudo` command, which temporarily gives you elevated privileges.



```
ackbar@desk: ~
ackbar@desk:~$ screen /dev/ttyACM0
[screen is terminating]
ackbar@desk:~$ sudo screen /dev/ttyACM0
[sudo] password for ackbar:
```

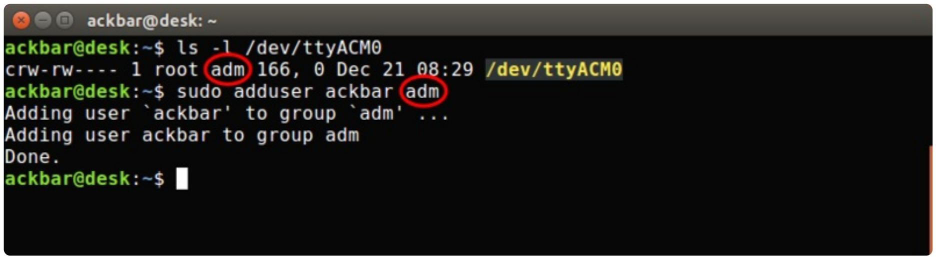
Once you enter your password, you should be in:



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.


Press any key to enter the REPL. Use CTRL-D to reload.

Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit Trinket M0 with samd21e18
>>> 
```

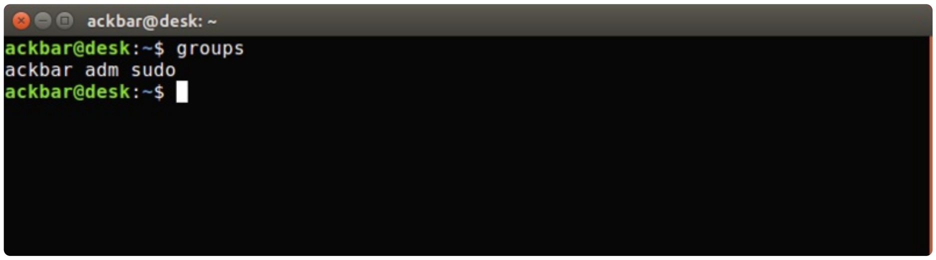
The second way is to add yourself to the group associated with the hardware. To figure out what that group is, use the command `ls -l` as shown below. The group name is circled in red.

Then use the command `adduser` to add yourself to that group. You need elevated privileges to do this, so you'll need to use `sudo`. In the example below, the group is **adm** and the user is **ackbar**.



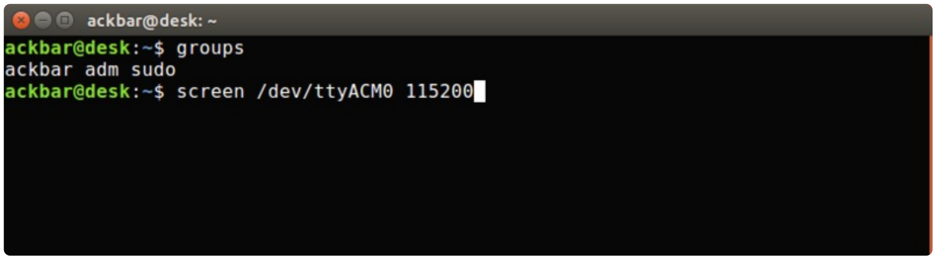
```
ackbar@desk:~$ ls -l /dev/ttyACM0
crw-rw---- 1 root adm 166, 0 Dec 21 08:29 /dev/ttyACM0
ackbar@desk:~$ sudo adduser ackbar adm
Adding user `ackbar' to group `adm' ...
Adding user ackbar to group adm
Done.
ackbar@desk:~$ 
```

After you add yourself to the group, you'll need to logout and log back in, or in some cases, reboot your machine. After you log in again, verify that you have been added to the group using the command `groups`. If you are still not in the group, reboot and check again.



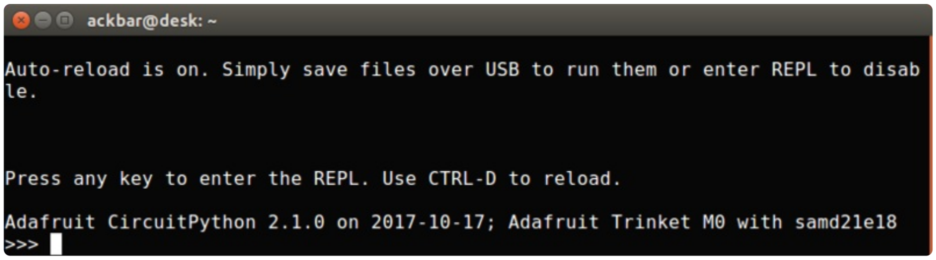
```
ackbar@desk:~$ groups
ackbar adm sudo
ackbar@desk:~$ 
```

And now you should be able to run `screen` without using `sudo`.



```
ackbar@desk:~$ groups
ackbar adm sudo
ackbar@desk:~$ screen /dev/ttyACM0 115200
```

And you're in:



```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disab
le.


Press any key to enter the REPL. Use CTRL-D to reload.

Adafruit CircuitPython 2.1.0 on 2017-10-17; Adafruit Trinket M0 with samd21e18
>>> 
```

The examples above use `screen`, but you can also use other programs, such as `putty` or `picocom`, if you prefer.

Troubleshooting

From time to time, you will run into issues when working with CircuitPython. Here are a few things you may encounter and how to resolve them.

As we continue to develop CircuitPython and create new releases, we will stop supporting older releases. Visit https://circuitpython.org/downloads to download the latest version of CircuitPython for your board. You must download the CircuitPython Library Bundle that matches your version of CircuitPython. Please update CircuitPython and then visit https://circuitpython.org/libraries to download the latest Library Bundle.

Always Run the Latest Version of CircuitPython and Libraries

As we continue to develop CircuitPython and create new releases, we will stop supporting older releases. **You need to update to the latest CircuitPython. (https://adafru.it/Em8).**

You need to download the CircuitPython Library Bundle that matches your version of CircuitPython. **Please update CircuitPython and then download the latest bundle (https://adafru.it/ENC).**

As we release new versions of CircuitPython, we will stop providing the previous bundles as automatically created downloads on the Adafruit CircuitPython Library Bundle repo. If you must continue to use an earlier version, you can still download the appropriate version of `mpy-cross` from the particular release of CircuitPython on the CircuitPython repo and create your own compatible .mpy library files. **However, it is best to update to the latest for both CircuitPython and the library bundle.**

I have to continue using CircuitPython 5.x or earlier. Where can I find compatible libraries?

We are no longer building or supporting the CircuitPython 5.x or earlier library bundles. We highly encourage you to update CircuitPython to the latest version (https://adafru.it/Em8) and use the current version of the libraries (https://adafru.it/ENC). However, if for some reason you cannot update, here are the last available library bundles for older versions:

- 2.x bundle (https://adafru.it/FJA)
- 3.x bundle (https://adafru.it/FJB)
- 4.x bundle (https://adafru.it/QDL)
- 5.x bundle (https://adafru.it/QDJ)

CPLAYBOOT, TRINKETBOOT, FEATHERBOOT, or GEMMABOOT Drive Not Present

You may have a different board.

Only Adafruit Express boards and the Trinket M0 and Gemma M0 boards ship with the UF2 bootloader (https://adafru.it/zbX)installed. Feather M0 Basic, Feather M0 Adalogger, and similar boards use a regular Arduino-compatible bootloader, which does not show a *boardname*BOOT drive.

MakeCode

If you are running a MakeCode (https://adafru.it/zbY) program on Circuit Playground Express, press the reset button just once to get the CPLAYBOOT drive to show up. Pressing it twice will not work.

MacOS

DriveDx and its accompanything **SAT SMART Driver** can interfere with seeing the BOOT drive. See this forum post (https://adafru.it/sTc) for how to fix the problem.

Windows 10

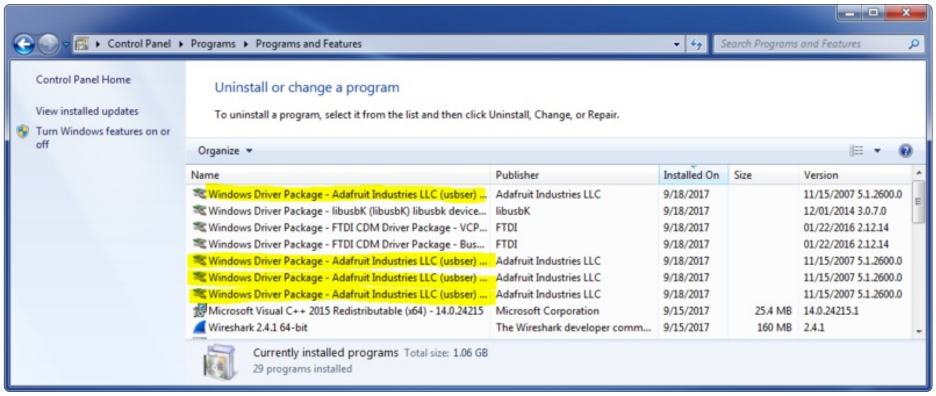
Did you install the Adafruit Windows Drivers package by mistake, or did you upgrade to Windows 10 with the driver package installed? You don't need to install this package on Windows 10 for most Adafruit boards. The old version (v1.5) can interfere with recognizing your device. Go to **Settings** -> **Apps** and uninstall all the "Adafruit" driver programs.

Windows 7 or 8.1

Version 2.5.0.0 or later of the Adafruit Windows Drivers will fix the missing *boardname*BOOT drive problem on Windows 7 and 8.1. To resolve this, first uninstall the old versions of the drivers:

- Unplug any boards. In **Uninstall or Change a Program (Control Panel->Programs->Uninstall a program)**, uninstall everything named "Windows Driver Package - Adafruit Industries LLC ...".

We recommend (https://adafru.it/Amd) that you upgrade to Windows 10 if possible; an upgrade is probably still free for you: see the link (https://adafru.it/Amd).



Control Panel ▸ Programs ▸ Programs and Features

Uninstall or change a program

To uninstall a program, select it from the list and then click Uninstall, Change, or Repair.

Name	Publisher	Installed On	Size	Version
Windows Driver Package - Adafruit Industries LLC (usbser) ...	Adafruit Industries LLC	9/18/2017		11/15/2007 5.1.2600.0
Windows Driver Package - libusbK (libusbK) libusbk device...	libusbK	9/18/2017		12/01/2014 3.0.7.0
Windows Driver Package - FTDI CDM Driver Package - VCP...	FTDI	9/18/2017		01/22/2016 2.12.14
Windows Driver Package - FTDI CDM Driver Package - Bus...	FTDI	9/18/2017		01/22/2016 2.12.14
Windows Driver Package - Adafruit Industries LLC (usbser) ...	Adafruit Industries LLC	9/18/2017		11/15/2007 5.1.2600.0
Windows Driver Package - Adafruit Industries LLC (usbser) ...	Adafruit Industries LLC	9/18/2017		11/15/2007 5.1.2600.0
Windows Driver Package - Adafruit Industries LLC (usbser) ...	Adafruit Industries LLC	9/18/2017		11/15/2007 5.1.2600.0
Microsoft Visual C++ 2015 Redistributable (x64) - 14.0.24215	Microsoft Corporation	9/15/2017	25.4 MB	14.0.24215.1
Wireshark 2.4.1 64-bit	The Wireshark developer comm...	9/15/2017	160 MB	2.4.1

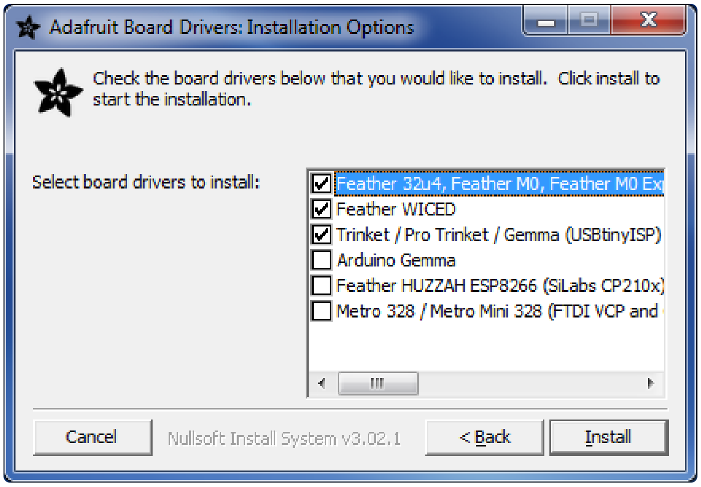
Currently installed programs Total size: 1.06 GB
29 programs installed

- Now install the new 2.5.0.0 (or higher) Adafruit Windows Drivers Package:

https://adafru.it/AB0

https://adafru.it/AB0

- When running the installer, you'll be shown a list of drivers to choose from. You can check and uncheck the boxes to choose which drivers to install.



Adafruit Board Drivers: Installation Options

Check the board drivers below that you would like to install. Click install to start the installation.

Select board drivers to install:

☑ Feather 32u4, Feather M0, Feather M0 Ex
☑ Feather WICED
☑ Trinket / Pro Trinket / Gemma (USBtinyISP)
□ Arduino Gemma
□ Feather HUZZAH ESP8266 (SiLabs CP210x)
□ Metro 328 / Metro Mini 328 (FTDI VCP and

You should now be done! Test by unplugging and replugging the board. You should see the CIRCUITPY drive, and when you double-click the reset button (single click on Circuit Playground Express running MakeCode), you should see the appropriate *boardname*BOOT drive.

Let us know in the Adafruit support forums (https://adafru.it/jIf) or on the Adafruit Discord () if this does not work for you!

Windows Explorer Locks Up When Accessing boardnameBOOT Drive

On Windows, several third-party programs we know of can cause issues. The symptom is that you try to access the **boardnameBOOT** drive, and Windows or Windows Explorer seems to lock up. These programs are known to cause trouble:

- **AIDA64**: to fix, stop the program. This problem has been reported to AIDA64. They acquired hardware to test, and released a beta version that fixes the problem. This may have been incorporated into the latest release. Please let us know in the forums if you test this.
- **Hard Disk Sentinel**
- **Kaspersky anti-virus**: To fix, you may need to disable Kaspersky completely. Disabling some aspects of Kaspersky does not always solve the problem. This problem has been reported to Kaspersky.
- **ESET NOD32 anti-virus**: We have seen problems with at least version 9.0.386.0, solved by uninstallation.

Copying UF2 to boardnameBOOT Drive Hangs at 0% Copied

On Windows, a **Western DIgital (WD) utility** that comes with their external USB drives can interfere with copying UF2 files to the boardnameBOOT drive. Uninstall that utility to fix the problem.

CIRCUITPY Drive Does Not Appear

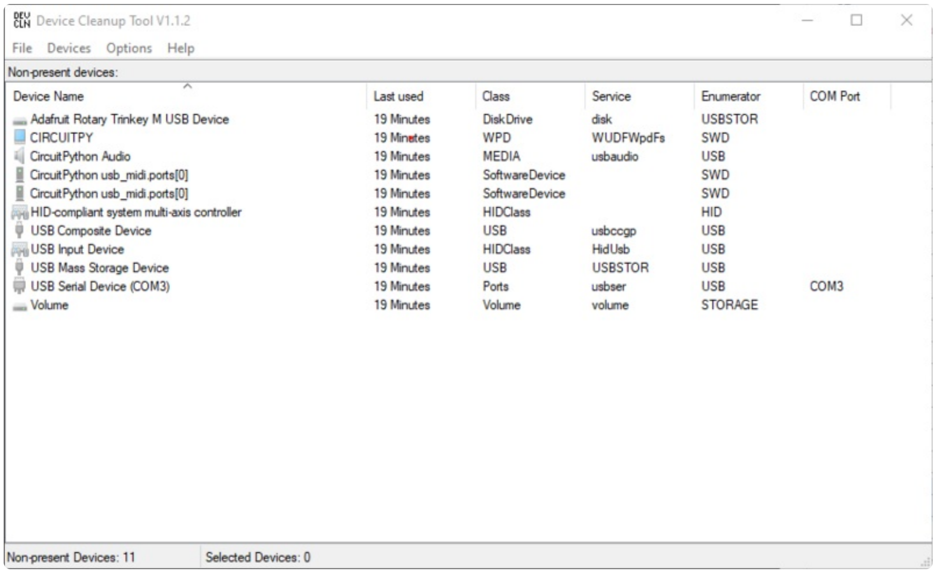
Kaspersky anti-virus can block the appearance of the CIRCUITPY drive. We haven't yet figured out a settings change that prevents this. Complete uninstallation of Kaspersky fixes the problem.

Norton anti-virus can interfere with CIRCUITPY. A user has reported this problem on Windows 7. The user turned off both Smart Firewall and Auto Protect, and CIRCUITPY then appeared.

Device Errors or Problems on Windows

Windows can become confused about USB device installations. This is particularly true of Windows 7 and 8.1. We recommend (https://adafru.it/Amd) that you upgrade to Windows 10 if possible; an upgrade is probably still free for you: see this link (https://adafru.it/V2a).

If not, try cleaning up your USB devices. Use Uwe Sieber's Device Cleanup Tool (https://adafru.it/RWd). Download and unzip the tool. Unplug all the boards and other USB devices you want to clean up. Run the tool as Administrator. You will see a listing like this, probably with many more devices. It is listing all the USB devices that are *not* currently attached.



Non-present devices:

Device Name	Last used	Class	Service	Enumerator	COM Port
Adafruit Rotary Trinkey M USB Device	19 Minutes	DiskDrive	disk	USBSTOR	
CIRCUITPY	19 Minutes	WPD	WUDFWpdFs	SWD	
CircuitPython Audio	19 Minutes	MEDIA	usbaudio	USB	
CircuitPython usb_midi.ports[0]	19 Minutes	SoftwareDevice		SWD	
CircuitPython usb_midi.ports[0]	19 Minutes	SoftwareDevice		SWD	
HID-compliant system multi-axis controller	19 Minutes	HIDClass		HID	
USB Composite Device	19 Minutes	USB	usbccgp	USB	
USB Input Device	19 Minutes	HIDClass	HidUsb	USB	
USB Mass Storage Device	19 Minutes	USB	USBSTOR	USB	
USB Serial Device (COM3)	19 Minutes	Ports	usbser	USB	COM3
Volume	19 Minutes	Volume	volume	STORAGE	

Non-present Devices: 11   Selected Devices: 0

Select all the devices you want to remove, and then press Delete. It is usually safe just to select everything. Any device that is removed will get a fresh install when you plug it in. Using the Device Cleanup Tool also discards all the COM port assignments for the unplugged boards. If you have used many Arduino and CircuitPython boards, you have probably seen higher and higher COM port numbers used, seemingly without end. This will fix that problem.

Serial Console in Mu Not Displaying Anything

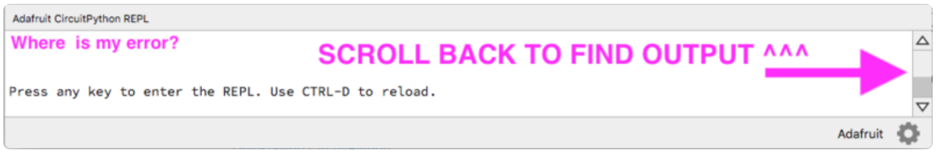
There are times when the serial console will accurately not display anything, such as, when no code is currently running, or when code with no serial output is already running before you open the console. However, if you find yourself in a situation where you feel it should be displaying something like an error, consider the following.

Depending on the size of your screen or Mu window, when you open the serial console, the serial console panel may be very small. This can be a problem. A basic CircuitPython error takes 10 lines to display!

```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disable.
code.py output:
Traceback (most recent call last):
  File "code.py", line 7
SyntaxError: invalid syntax



Press any key to enter the REPL. Use CTRL-D to reload.
```

More complex errors take even more lines!

Therefore, if your serial console panel is five lines tall or less, you may only see blank lines or blank lines followed by `Press any key to enter the REPL. Use CTRL-D to reload.`. If this is the case, you need to either mouse over the top of the panel to utilise the option to resize the serial panel, or use the scrollbar on the right side to scroll up and find your message.



```
Press any key to enter the REPL. Use CTRL-D to reload.
```

This applies to any kind of serial output whether it be error messages or print statements. So before you start trying to debug your problem on the hardware side, be sure to check that you haven't simply missed the serial messages due to serial output panel height.

CircuitPython RGB Status Light

Nearly all Adafruit CircuitPython-capable boards have a single NeoPixel or DotStar RGB LED on the board that indicates the status of CircuitPython. A few boards designed before CircuitPython existed, such as the Feather M0 Basic, do not.

Circuit Playground Express and Circuit Playground Bluefruit have multiple RGB LEDs, but do NOT have a status LED. The LEDs are all green when in the bootloader. In versions before 7.0.0, they do NOT indicate any status while running CircuitPython.

CircuitPython 7.0.0 and Later

The status LED blinks were changed in CircuitPython 7.0.0 in order to save battery power and simplify the blinks. These blink patterns will occur on single color LEDs when the board does not have any RGB LEDs. Speed and blink count also vary for this reason.

On start up, the LED will blink **YELLOW** multiple times for 1 second. Pressing reset during this time will restart the board and then enter safe mode. On Bluetooth capable boards, after the yellow blinks, there will be a set of faster blue blinks. Pressing reset during the **BLUE** blinks will clear Bluetooth information and start the device in discoverable mode, so it can be used with a BLE code editor.

Once started, CircuitPython will blink a pattern every 5 seconds when no user code is running to indicate why the code stopped:

- 1 **GREEN** blink: Code finished without error.
- 2 **RED** blinks: Code ended due to an exception. Check the serial console for details.
- 3 **YELLOW** blinks: CircuitPython is in safe mode. No user code was run. Check the serial console for safe mode reason.

When entering the REPL, CircuitPython will set the status LED to **WHITE**. You can change the status LED color from the REPL. The status indicator will not persist on non-NeoPixel or DotStar LEDs.

CircuitPython 6.3.0 and earlier

Here's what the colors and blinking mean:

- steady **GREEN**: `code.py` (or `code.txt`, `main.py`, or `main.txt`) is running
- pulsing **GREEN**: `code.py` (etc.) has finished or does not exist
- steady **YELLOW** at start up: (4.0.0-alpha.5 and newer) CircuitPython is waiting for a reset to indicate that it should start in safe mode
- pulsing **YELLOW**: Circuit Python is in safe mode: it crashed and restarted
- steady **WHITE**: REPL is running
- steady **BLUE**: boot.py is running

Colors with multiple flashes following indicate a Python exception and then indicate the line number of the error. The color of the first flash indicates the type of error:

- **GREEN**: IndentationError
- **CYAN**: SyntaxError
- **WHITE**: NameError
- **ORANGE**: OSError
- **PURPLE**: ValueError
- **YELLOW**: other error

These are followed by flashes indicating the line number, including place value. **WHITE** flashes are thousands' place, **BLUE** are hundreds' place, **YELLOW** are tens' place, and **CYAN** are one's place. So for example, an error on line 32 would flash **YELLOW** three times and then **CYAN** two times. Zeroes are indicated by an extra-long dark gap.

ValueError: Incompatible `.mpy` file.

This error occurs when importing a module that is stored as a `mpy` binary file that was generated by a different version of CircuitPython than the one its being loaded into. In particular, the `mpy` binary format changed between CircuitPython versions 6.x and 7.x, 2.x and 3.x, and 1.x and 2.x.

So, for instance, if you upgraded to CircuitPython 7.x from 6.x you'll need to download a newer version of the library that triggered the error on `import`. They are all available in the [Adafruit bundle](https://adafru.it/y8E) (https://adafru.it/y8E).

CIRCUITPY Drive Issues

You may find that you can no longer save files to your `CIRCUITPY` drive. You may find that your

CIRCUITPY stops showing up in your file explorer, or shows up as NO_NAME. These are indicators that your filesystem has issues.

First check - have you used Arduino to program your board? If so, CircuitPython is no longer able to provide the USB services. Reset the board so you get a *boardnameBOOT* drive rather than a CIRCUITPY drive, copy the latest version of CircuitPython (.uf2) back to the board, then Reset. This may restore CIRCUITPY functionality.

If still broken - When the CIRCUITPY disk is not safely ejected before being reset by the button or being disconnected from USB, it may corrupt the flash drive. It can happen on Windows, Mac or Linux.

In this situation, the board must be completely erased and CircuitPython must be reloaded onto the board.

> You WILL lose everything on the board when you complete the following steps. If possible, make a copy of your code before continuing.

Easiest Way: Use storage.erase_filesystem()

Starting with version 2.3.0, CircuitPython includes a built-in function to erase and reformat the filesystem. If you have an older version of CircuitPython on your board, you can update to the newest version (https://adafru.it/Amd) to do this.

1. Connect to the CircuitPython REPL (https://adafru.it/Bec) using Mu or a terminal program.
2. Type:

```
>>> import storage
>>> storage.erase_filesystem()
```

CIRCUITPY will be erased and reformatted, and your board will restart. That's it!

Old Way: For the Circuit Playground Express, Feather M0 Express, and Metro M0 Express:

If you can't get to the REPL, or you're running a version of CircuitPython before 2.3.0, and you don't want to upgrade, you can do this.

1. Download the correct erase file:

https://adafru.it/AdI

https://adafru.it/AdI

https://adafru.it/AdJ

https://adafru.it/AdJ

https://adafru.it/EVK

https://adafru.it/EVK

https://adafru.it/AdK

https://adafru.it/AdK

https://adafru.it/EoM

https://adafru.it/EoM

https://adafru.it/DjD

https://adafru.it/DjD

https://adafru.it/DBA

https://adafru.it/DBA

https://adafru.it/Eca

https://adafru.it/Eca

https://adafru.it/Gnc

https://adafru.it/Gnc

https://adafru.it/GAN

https://adafru.it/GAN

https://adafru.it/GAO

https://adafru.it/GAO

https://adafru.it/Jat

https://adafru.it/Jat

https://adafru.it/Q5B

https://adafru.it/Q5B

2. Double-click the reset button on the board to bring up the `boardnameBOOT` drive.
3. Drag the erase `.uf2` file to the `boardnameBOOT` drive.
4. The onboard NeoPixel will turn yellow or blue, indicating the erase has started.

5. After approximately 15 seconds, the mainboard NeoPixel will light up green. On the NeoTrellis M4 this is the first NeoPixel on the grid
6. Double-click the reset button on the board to bring up the *boardname*BOOT drive.
7. Drag the appropriate latest release of CircuitPython (https://adafru.it/Amd) .uf2 file to the *boardname*BOOT drive.

It should reboot automatically and you should see CIRCUITPY in your file explorer again.

If the LED flashes red during step 5, it means the erase has failed. Repeat the steps starting with 2.

If you haven't already downloaded the latest release of CircuitPython for your board, check out the installation page (https://adafru.it/Amd). You'll also need to install your libraries and code!

Old Way: For Non-Express Boards with a UF2 bootloader (Gemma M0, Trinket M0):

If you can't get to the REPL, or you're running a version of CircuitPython before 2.3.0, and you don't want to upgrade, you can do this.

1. Download the erase file:

https://adafru.it/AdL

https://adafru.it/AdL

2. Double-click the reset button on the board to bring up the *boardname*BOOT drive.
3. Drag the erase .uf2 file to the *boardname*BOOT drive.
4. The boot LED will start flashing again, and the *boardname*BOOT drive will reappear.
5. Drag the appropriate latest release CircuitPython (https://adafru.it/Amd) .uf2 file to the *boardname*BOOT drive.

It should reboot automatically and you should see CIRCUITPY in your file explorer again.

If you haven't already downloaded the latest release of CircuitPython for your board, check out the installation page (https://adafru.it/Amd) You'll also need to install your libraries and code!

Old Way: For non-Express Boards without a UF2 bootloader (Feather M0 Basic Proto, Feather Adalogger, Arduino Zero):

If you are running a version of CircuitPython before 2.3.0, and you don't want to upgrade, or you can't get to the REPL, you can do this.

Just follow these directions to reload CircuitPython using bossac (https://adafru.it/Bed), which will erase and re-create CIRCUITPY.

Running Out of File Space on Non-Express Boards

The file system on the board is very tiny. (Smaller than an ancient floppy disk.) So, its likely you'll run out of space but don't panic! There are a couple ways to free up space.

The board ships with the Windows 7 serial driver too! Feel free to delete that if you don't need it or have already installed it. Its ~12KiB or so.

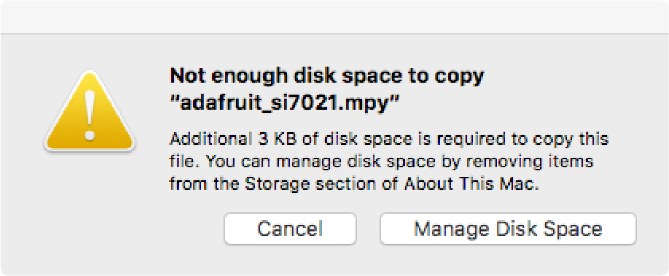
Delete something!

The simplest way of freeing up space is to delete files from the drive. Perhaps there are libraries in the `lib` folder that you aren't using anymore or test code that isn't in use. Don't delete the `lib` folder completely, though, just remove what you don't need.

Use tabs

One unique feature of Python is that the indentation of code matters. Usually the recommendation is to indent code with four spaces for every indent. In general, we recommend that too. **However**, one trick to storing more human-readable code is to use a single tab character for indentation. This approach uses 1/4 of the space for indentation and can be significant when we're counting bytes.

MacOS loves to add extra files.



Not enough disk space to copy "adafruit_si7021.mpy"

Additional 3 KB of disk space is required to copy this file. You can manage disk space by removing items from the Storage section of About This Mac.

Luckily you can disable some of the extra hidden files that MacOS adds by running a few commands to disable search indexing and create zero byte placeholders. Follow the steps below to maximize the amount of space available on MacOS:

Prevent & Remove MacOS Hidden Files

First find the volume name for your board. With the board plugged in run this command in a terminal to list all the volumes:

```
ls -l /Volumes
```

Look for a volume with a name like `CIRCUITPY` (the default for CircuitPython). The full path to the volume is the `/Volumes/CIRCUITPY` path.

Now follow the steps from this question (https://adafru.it/u1c) to run these terminal commands that stop hidden files from being created on the board:

```
mdutil -i off /Volumes/CIRCUITPY
cd /Volumes/CIRCUITPY
rm -rf .{,_.}{fseventsd,Spotlight-V*,Trashes}
mkdir .fseventsd
touch .fseventsd/no_log .metadata_never_index .Trashes
cd -
```

Replace `/Volumes/CIRCUITPY` in the commands above with the full path to your board's volume if it's different. At this point all the hidden files should be cleared from the board and some hidden files will be prevented from being created.

Alternatively, with CircuitPython 4.x and above, the special files and folders mentioned above will be created automatically if you erase and reformat the filesystem. **WARNING: Save your files first!** Do this in the REPL:

`>>> import storage`
`>>> storage.erase_filesystem()`

However there are still some cases where hidden files will be created by MacOS. In particular if you copy a file that was downloaded from the internet it will have special metadata that MacOS stores as a hidden file. Luckily you can run a copy command from the terminal to copy files **without** this hidden metadata file. See the steps below.

Copy Files on MacOS Without Creating Hidden Files

Once you've disabled and removed hidden files with the above commands on MacOS you need to be careful to copy files to the board with a special command that prevents future hidden files from being created. Unfortunately you **cannot** use drag and drop copy in Finder because it will still create these hidden extended attribute files in some cases (for files downloaded from the internet, like Adafruit's modules).

To copy a file or folder use the **-X** option for the **cp** command in a terminal. For example to copy a `foo.mpy` file to the board use a command like:

```
    cp -X foo.mpy /Volumes/CIRCUITPY
```

(Replace `foo.mpy` with the name of the file you want to copy.) Or to copy a folder and all of its child files/folders use a command like:

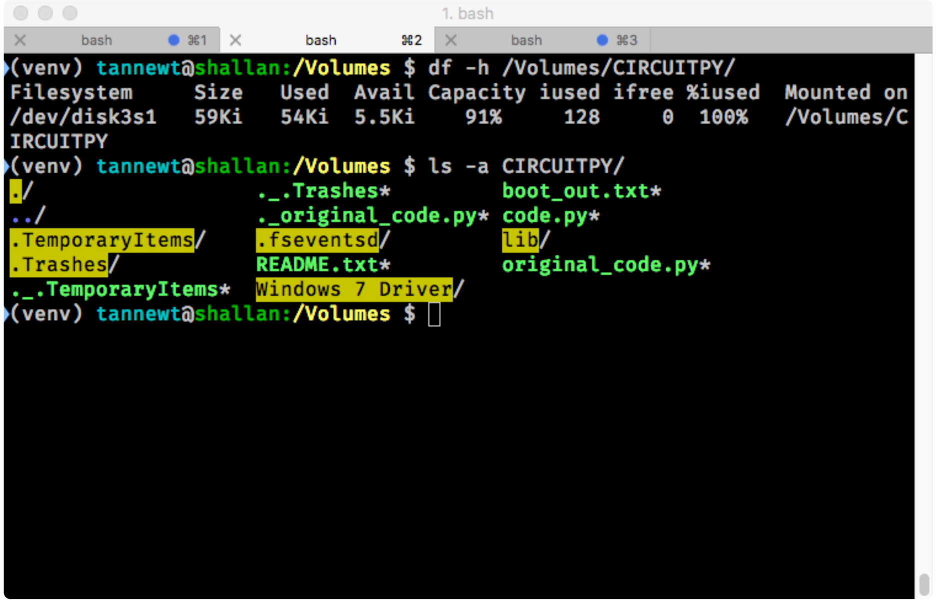
```
cp -rX folder_to_copy /Volumes/CIRCUITPY
```

If you are copying to the lib folder, or another folder, make sure it exists before copying.

```
# if lib does not exist, you'll create a file named lib !
cp -X foo.mpy /Volumes/CIRCUITPY/lib
# This is safer, and will complain if a lib folder does not exist.
cp -X foo.mpy /Volumes/CIRCUITPY/lib/
```

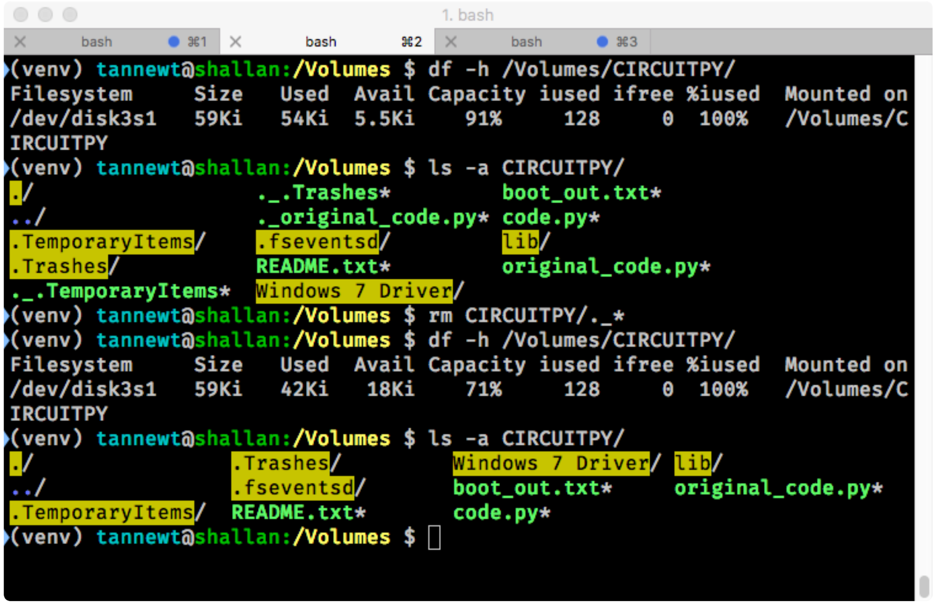
Other MacOS Space-Saving Tips

If you'd like to see the amount of space used on the drive and manually delete hidden files here's how to do so. First list the amount of space used on the CIRCUITPY drive with the **df** command:



```
(venv) tannewt@shallan:/Volumes $ df -h /Volumes/CIRCUITPY/
Filesystem     Size   Used  Avail Capacity iused ifree %iused  Mounted on
/dev/disk3s1   59Ki   54Ki  5.5Ki    91%     128     0  100%   /Volumes/C
IRCUITPY
(venv) tannewt@shallan:/Volumes $ ls -a CIRCUITPY/
./                  ._.Trashes*         boot_out.txt*
../                 ._original_code.py* code.py*
.TemporaryItems/    .fseventsd/         lib/
.Trashes/           README.txt*         original_code.py*
._.TemporaryItems*  Windows 7 Driver/
(venv) tannewt@shallan:/Volumes $ 
```

Lets remove the ._ files first.



```
(venv) tannewt@shallan:/Volumes $ df -h /Volumes/CIRCUITPY/
Filesystem     Size   Used  Avail Capacity iused ifree %iused  Mounted on
/dev/disk3s1   59Ki   54Ki  5.5Ki    91%     128     0  100%   /Volumes/C
IRCUITPY
(venv) tannewt@shallan:/Volumes $ ls -a CIRCUITPY/
./                  ._.Trashes*         boot_out.txt*
../                 ._original_code.py* code.py*
.TemporaryItems/    .fseventsd/         lib/
.Trashes/           README.txt*         original_code.py*
._.TemporaryItems*  Windows 7 Driver/
(venv) tannewt@shallan:/Volumes $ rm CIRCUITPY/._*
(venv) tannewt@shallan:/Volumes $ df -h /Volumes/CIRCUITPY/
Filesystem     Size   Used  Avail Capacity iused ifree %iused  Mounted on
/dev/disk3s1   59Ki   42Ki   18Ki    71%     128     0  100%   /Volumes/C
IRCUITPY
(venv) tannewt@shallan:/Volumes $ ls -a CIRCUITPY/
./                .Trashes/          Windows 7 Driver/ lib/
../               .fseventsd/        boot_out.txt*     original_code.py*
.TemporaryItems/  README.txt*        code.py*
(venv) tannewt@shallan:/Volumes $ 
```

Whoa! We have 13Ki more than before! This space can now be used for libraries and code!

Device Locked Up or Boot Looping

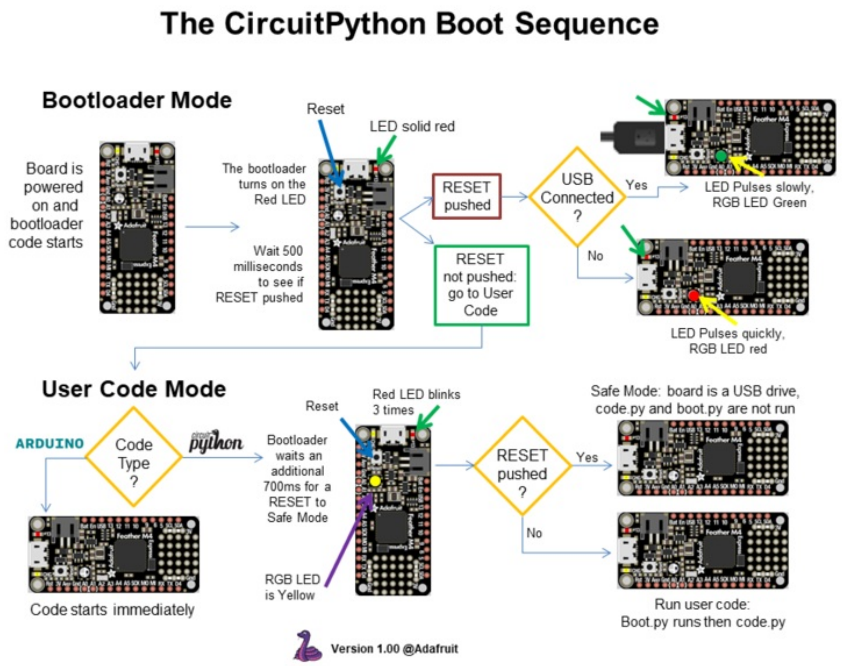
In rare cases, it may happen that something in your **code.py** or **boot.py** files causes the device to get locked up, or even go into a boot loop. These are not your everyday Python exceptions, typically it's the result of a deeper problem within CircuitPython. In this situation, it can be difficult to recover your device if **CIRCUITPY** is not allowing you to modify the **code.py** or **boot.py** files. Safe mode is one recovery option. When the device boots up in safe mode it will not run the **code.py** or **boot.py** scripts, but will still connect the **CIRCUITPY** drive so that you can remove or modify those files as needed.

The method used to manually enter safe mode can be different for different devices. It is also very similar to the method used for getting into bootloader mode, which is a different thing. So it can take a few tries to get the timing right. If you end up in bootloader mode, no problem, you can try again without needing to do anything else.

For most devices:
Press the reset button, and then when the RGB status LED blinks yellow, press the reset button again. Since your reaction time may not be that fast, try a "slow" double click, to catch the yellow LED on the second click.

For ESP32-S2 based devices:
Press and release the reset button, then press and release the boot button about 3/4 of a second later.

Refer to the following diagram for boot sequence details:


The CircuitPython Boot Sequence
Bootloader Mode
Board is powered on and bootloader code starts
Reset
LED solid red
The bootloader turns on the Red LED
Wait 500 milliseconds to see if RESET pushed
RESET pushed
RESET not pushed: go to User Code
USB Connected ?
Yes
LED Pulses slowly, RGB LED Green
No
LED Pulses quickly, RGB LED red
User Code Mode
ARDUINO
Code Type ?
python
Reset
Red LED blinks 3 times
Bootloader waits an additional 700ms for a RESET to Safe Mode
RGB LED is Yellow
Code starts immediately
RESET pushed ?
Yes
Safe Mode: board is a USB drive, code.py and boot.py are not run
No
Run user code: Boot.py runs then code.py
Version 1.00 @Adafruit

CircuitPython Essentials

You've been introduced to CircuitPython, and worked through getting everything set up. What's next? CircuitPython Essentials!

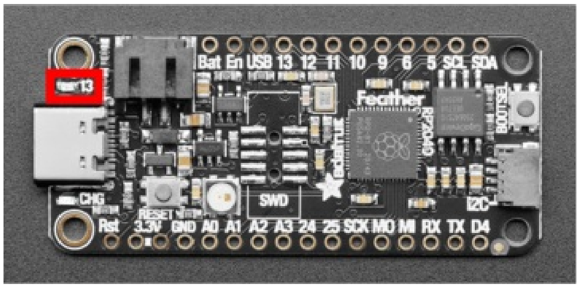
There are a number of core modules built into CircuitPython, which can be used along side the many CircuitPython libraries available. The following pages demonstrate some of these modules. Each page presents a different concept including a code example with an explanation. All of the examples are designed to work with your microcontroller board.

Time to get started learning the CircuitPython essentials!

Blink

In learning any programming language, you often begin with some sort of Hello, World! program. In CircuitPython, Hello, World! is blinking an LED. Blink is one of the simplest programs in CircuitPython. It involves three built-in modules, two lines of set up, and a short loop. Despite its simplicity, it shows you many of the basic concepts needed for most CircuitPython programs, and provides a solid basis for more complex projects. Time to get blinky!

LED Location


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
Feather
RP2040
BOOT
CHG
RESET
SWD
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

The built-in LED, indicated by the red box in the image, is labeled "13", and located above the USB Type-C connector next to the JST battery connector.

Blinking an LED

Save the following as **code.py** on your **CIRCUITPY** drive.

```
"""CircuitPython Blink Example - the CircuitPython 'Hello, World!'"""
import time
import board
import digitalio

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

while True:
    led.value = True
    time.sleep(0.5)
    led.value = False
    time.sleep(0.5)
```

The built-in LED begins blinking!

Note that the code is a little less "Pythonic" than it could be. It could also be written as led.value = not led.value with a single time.sleep(0.5). That way is more difficult to understand if you're new to programming, so the example is a bit longer than it needed to be to make it easier to read.

It's important to understand what is going on in this program.

First you `import` three modules: `time`, `board` and `digitalio`. This makes these modules available for use in your code. All three are built-in to CircuitPython, so you don't need to download anything to get started.

Next, you set up the LED. To interact with hardware in CircuitPython, your code must let the board know where to look for the hardware and what to do with it. So, you create a `digitalio.DigitalInOut()` object, provide it the LED pin using the `board` module, and save it to the variable `led`. Then, you tell the pin to act as an `OUTPUT`.

Finally, you create a `while True:` loop. This means all the code inside the loop will repeat indefinitely. Inside the loop, you set `led.value = True` which powers on the LED. Then, you use `time.sleep(0.5)` to tell the code to wait half a second before moving on to the next line. The next line sets `led.value = False` which turns the LED off. Then you use another `time.sleep(0.5)` to wait half a second before starting the loop over again.

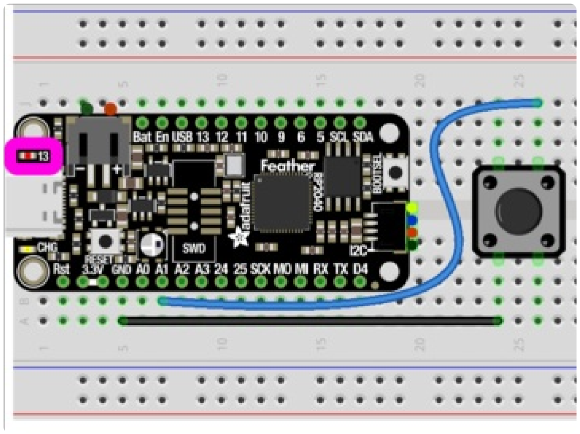
With only a small update, you can control the blink speed. The blink speed is controlled by the amount of time you tell the code to wait before moving on using `time.sleep()`. The example uses `0.5`, which is one half of one second. Try increasing or decreasing these values to see how the blinking changes.

That's all there is to blinking an LED using CircuitPython!

Digital Input

The CircuitPython `digitalio` module has many applications. The basic Blink program sets up the LED as a digital output. You can just as easily set up a **digital input** such as a button to control the LED. This example builds on the basic Blink example, but now includes setup for a button switch. Instead of using the `time` module to blink the LED, it uses the status of the button switch to control whether the LED is turned on or off.

LED and Button



13
Bat En USB 13 12 11 10 9 6 5 SCL SDA
Feather
RP2040
Adafruit
BOOTSEL
SWD
I2C
CHG
RESET
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4
1
5
10
15
20
25

Built-in LED:

- The **built-in red LED** (indicated by the magenta box in the image), labeled 13 on the silk, is located above the USB connector.

Button wiring:

- **One leg of button** to **Feather GND**
- **Opposite leg of button** to **Feather A1**

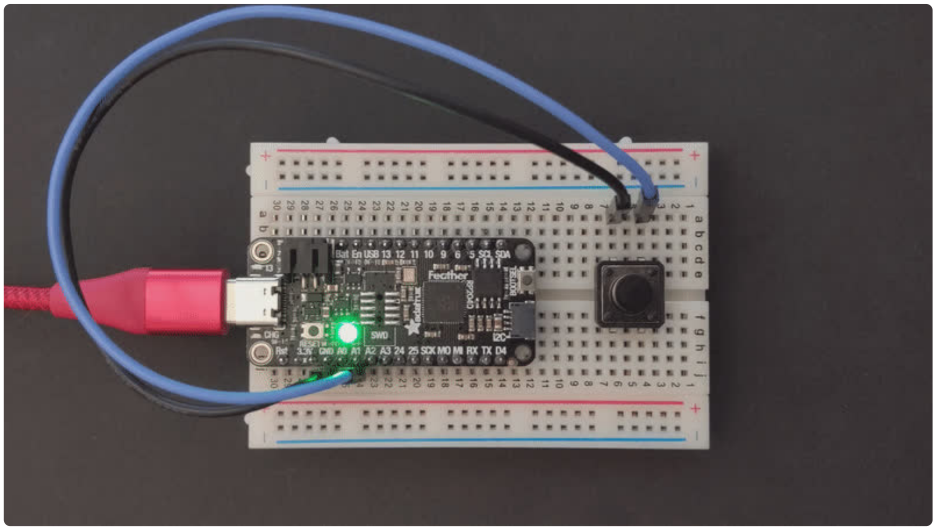
If you're unsure of which legs on a button are "opposite", you can guarantee you're using the proper legs if you connect the wires up to two legs located diagonally across the button, like in the diagram.

Controlling the LED with a Button

Save the following as **code.py** on your **CIRCUITPY** drive.

```
"""CircuitPython Digital Input example for Feather RP2040"""
import board
import digitalio

led = digitalio.DigitalInOut(board.LED)
led.direction = digitalio.Direction.OUTPUT

button = digitalio.DigitalInOut(board.A1)
button.switch_to_input(pull=digitalio.Pull.UP)

while True:
    if not button.value:
        led.value = True
    else:
        led.value = False
```

Now, press the button. The LED lights up! Let go of the button and the LED turns off.



Note that the code is a little less "Pythonic" than it could be. It could also be written as `led.value = not button.value`. That way is more difficult to understand if you're new to programming, so the example is a bit longer than it needed to be to make it easier to read.

First you `import` two modules: `board` and `digitalio`. This makes these modules available for use in your code. Both are built-in to CircuitPython, so you don't need to download anything to get started.

Next, you set up the LED. To interact with hardware in CircuitPython, your code must let the board know where to look for the hardware and what to do with it. So, you create a `digitalio.DigitalInOut()` object, provide it the LED pin using the `board` module, and save it to the variable `led`. Then, you tell the pin to act as an `OUTPUT`.

You include setup for the button as well. It is similar to the LED setup, except the button is an `INPUT`, and requires a pull up.

Inside the loop, you check to see if the button is pressed, and if so, turn on the LED. Otherwise the LED is off.

That's all there is to controlling an LED with a button switch!

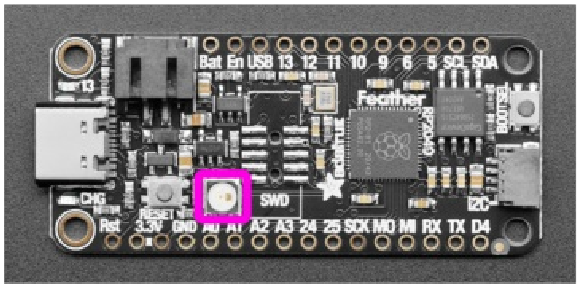
Built-In NeoPixel LED

Your board has a built-in RGB NeoPixel status LED. You can use CircuitPython code to control the color and brightness of this LED. It is also used to indicate the bootloader status and errors in your CircuitPython code.

A NeoPixel is what Adafruit calls the WS281x family of addressable RGB LEDs. It contains three LEDs - a red one, a green one and a blue one - along side a driver chip in a tiny package controlled by a single pin. They can be used individually (as in the built-in LED on your board), or chained together in strips or other creative form factors. NeoPixels do not light up on their own; they require a microcontroller. So, it's super convenient that the NeoPixel is built in to your microcontroller board!

This page will cover using CircuitPython to control the status RGB NeoPixel built into your microcontroller. You'll learn how to change the color and brightness, and how to make a rainbow. Time to get started!

NeoPixel Location



The **NeoPixel LED** (indicated by the magenta box in the image) is located above the A0 and A1 labels on the silk.

NeoPixel Color and Brightness

To use the built-in NeoPixel on your board, you need to first install the NeoPixel library into the **lib** folder on your **CIRCUITPY** drive.

Then you need to update **code.py**.

Click the **Download Project Bundle** button below to download the necessary libraries and the code.py file in a zip file. Extract the contents of the zip file, and copy the **entire lib folder** and the **code.py file** to your **CIRCUITPY** drive.

```
"""CircuitPython status NeoPixel red, green, blue example."""
import time
import board
import neopixel

pixel = neopixel.NeoPixel(board.NEOPIXEL, 1)

pixel.brightness = 0.3

while True:
    pixel.fill((255, 0, 0))
    time.sleep(0.5)
    pixel.fill((0, 255, 0))
    time.sleep(0.5)
    pixel.fill((0, 0, 255))
    time.sleep(0.5)
```

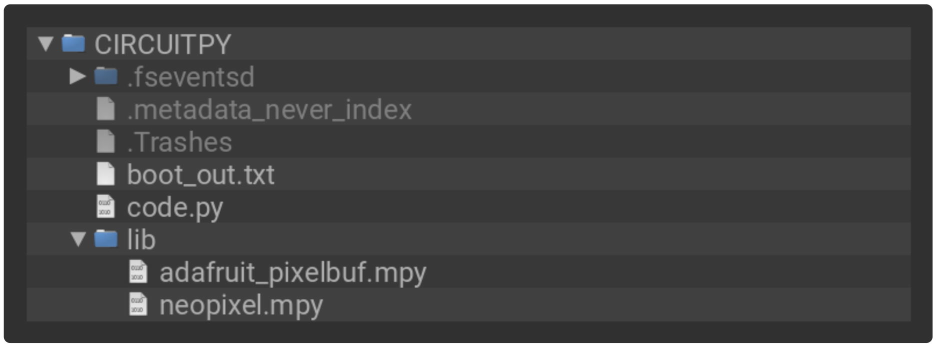
Your **CIRCUITPY** drive contents should resemble the image below.

You should have in / of the **CIRCUITPY** drive:

- **code.py**

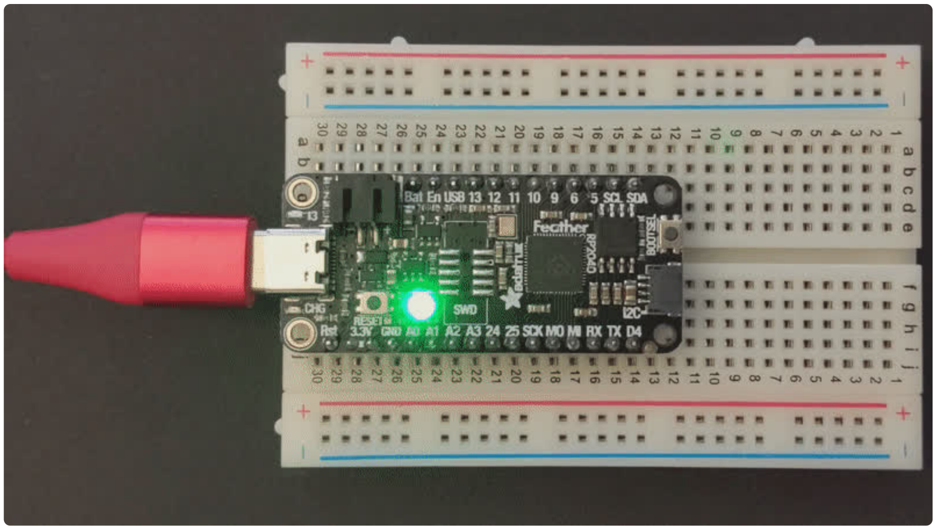
And in the **lib** folder on your **CIRCUITPY** drive:

- **adafruit_pixelbuf.mpy**
- **neopixel.mpy**



```
▼ CIRCUITPY
    ▶ .fseventsd
      .metadata_never_index
      .Trashes
      boot_out.txt
      code.py
    ▼ lib
        adafruit_pixelbuf.mpy
        neopixel.mpy
```

The built-in NeoPixel begins blinking red, then green, then blue, and repeats!



First you import two modules, `time` and `board`, and one library, `neopixel`. This makes these modules and libraries available for use in your code. The first two are modules built-in to CircuitPython, so you don't need to download anything to use those. The `neopixel` library is separate, which is why you needed to install it before getting started.

Next, you set up the NeoPixel LED. To interact with hardware in CircuitPython, your code must let the board know where to look for the hardware and what to do with it. So, you create a `neopixel.NeoPixel()` object, provide it the NeoPixel LED pin using the `board` module, and tell it the number of LEDs. You save this object to the variable `pixel`.

Then, you set the NeoPixel brightness using the `brightness` attribute. `brightness` expects float between `0` and `1.0`. A *float* is essentially a number with a decimal in it. The brightness value represents a percentage of maximum brightness; `0` is 0% and `1.0` is 100%. Therefore, setting `pixel.brightness = 0.3` sets the brightness to 30%. The default brightness, which is to say the brightness if you don't explicitly set it, is `1.0`. The default is really bright! That is why there is an option available to easily change the brightness.

Inside the loop, you turn the NeoPixel red for 0.5 seconds, green for 0.5 seconds, and blue for 0.5 seconds.

To turn the NeoPixel red, you "fill" it with an RGB value. Check out the section below for details on RGB colors. The RGB value for red is `(255, 0, 0)`. Note that the RGB value includes the parentheses. The `fill()` attribute expects the full RGB value including those parentheses. That is why there are two pairs of parentheses in the code.

You can change the RGB values to change the colors that the NeoPixel cycles through. Check out the list below for some examples. You can make any color of the rainbow with the right RGB value combination!

That's all there is to changing the color and setting the brightness of the built-in NeoPixel LED!

RGB LED Colors

RGB LED colors are set using a combination of **r**ed, **g**reen, and **b**lue, in the form of an (**R**, **G**, **B**) tuple. Each member of the tuple is set to a number between 0 and 255 that determines the amount of each color present. Red, green and blue in different combinations can create all the colors in the rainbow! So, for example, to set an LED to red, the tuple would be `(255, 0, 0)`, which has the maximum level of red, and no green or blue. Green would be `(0, 255, 0)`, etc. For the colors between, you set a combination, such as cyan which is `(0, 255, 255)`, with equal amounts of green and blue. If you increase all values to the same level, you get white! If you decrease all the values to 0, you turn the LED off.

Common colors include:

- red: `(255, 0, 0)`
- green: `(0, 255, 0)`
- blue: `(0, 0, 255)`
- cyan: `(0, 255, 255)`
- purple: `(255, 0, 255)`
- yellow: `(255, 255, 0)`
- white: `(255, 255, 255)`
- black (off): `(0, 0, 0)`

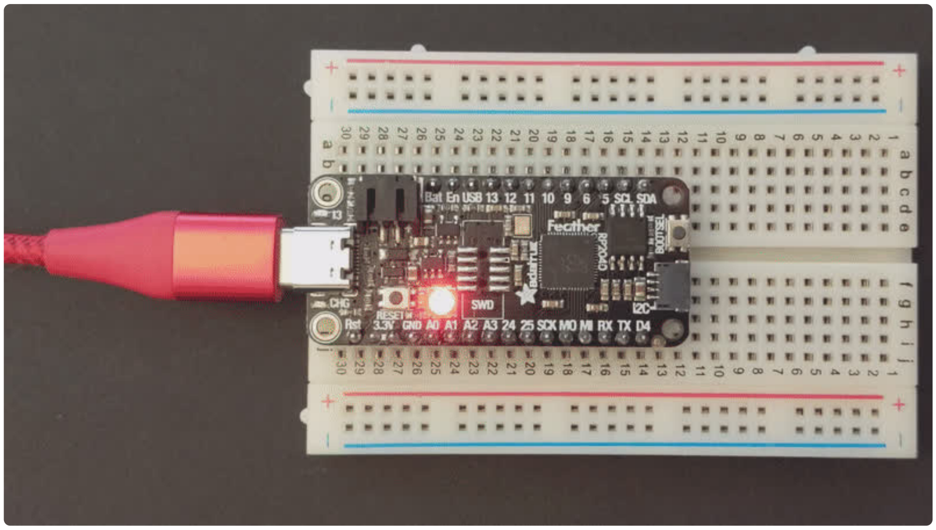
NeoPixel Rainbow

You should have already installed the library necessary to use the built-in NeoPixel LED. If not, follow the steps at the beginning of the NeoPixel Color and Brightness section to install it.

Update your **code.py** to the following, and save.

```
"""CircuitPython status NeoPixel rainbow example."""
import time
import board
from rainbowio import colorwheel
import neopixel

pixel = neopixel.NeoPixel(board.NEOPIXEL, 1, auto_write=False)

pixel.brightness = 0.3


def rainbow(delay):
    for color_value in range(255):
        for led in range(1):
            pixel_index = (led * 256 // 1) + color_value
            pixel[led] = colorwheel(pixel_index & 255)
        pixel.show()
        time.sleep(delay)


while True:
    rainbow(0.02)
```

The NeoPixel displays a rainbow cycle!


Feather
RP2040
BOOTSEL
RESET
SWD
Bat En USB 13 12 11 10 9 6 5 SCL SDA
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

This example builds on the previous example.

First, you import the same three modules and libraries. In addition to those, you import `colorwheel`.

The NeoPixel hardware setup is similar, but you now also set `auto_write` to `False`. This means that now the NeoPixel won't change unless you explicitly tell it to by calling `show()`. This is necessary for this example to speed up the rainbow animation. Brightness setting is the same.

Next, you have the `rainbow()` helper function. This helper displays the rainbow cycle. It expects a `delay` in seconds. The higher the number of seconds provided for `delay`, the slower the rainbow will cycle. The helper cycles through the values of the color wheel to create a rainbow of colors.

Inside the loop, you call the rainbow helper with a 0.2 second delay, by including `rainbow(0.2)`.

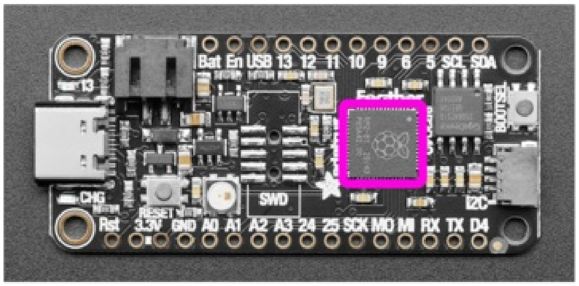
That's all there is to making rainbows using the built-in NeoPixel LED!

CPU Temperature

There is a temperature sensor built into the CPU on your microcontroller board. It reads the internal CPU temperature, which varies depending on how long the board has been running or how intense your code is.

CircuitPython makes it really simple to read this data from the temperature sensor built into the microcontroller. Using the built-in `microcontroller` module, you can easily read the temperature.

Microcontroller Location


Bat En USB 13 12 11 10 9 6 5 SCL SDA
13
BOOTSEL
SWD
CHG
RESET
I2C
Rst 3.3V GND A0 A1 A2 A3 24 25 SCK MO MI RX TX D4

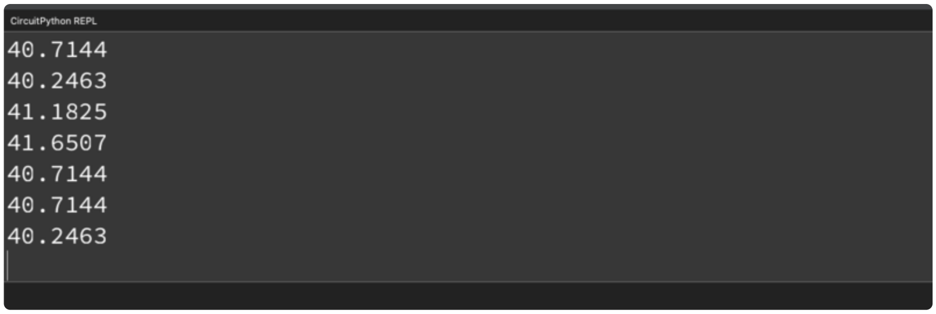
The microcontroller on the Feather RP2040 is located to the right-center of the board, nested between the Adafruit Feather RP2040 label on the silk.

Reading the Microcontroller Temperature

The data is read using two lines of code. All necessary modules are built into CircuitPython, so you don't need to download any extra files to get started.

Connect to the serial console (https://adafru.it/Bec), and then update your **code.py** to the following and save.

```
"""CircuitPython CPU temperature example in Celsius"""
import time
import microcontroller

while True:
    print(microcontroller.cpu.temperature)
    time.sleep(0.15)
```



```
40.7144
40.2463
41.1825
41.6507
40.7144
40.7144
40.2463
```

The CPU temperature in Celsius is printed out to the serial console!

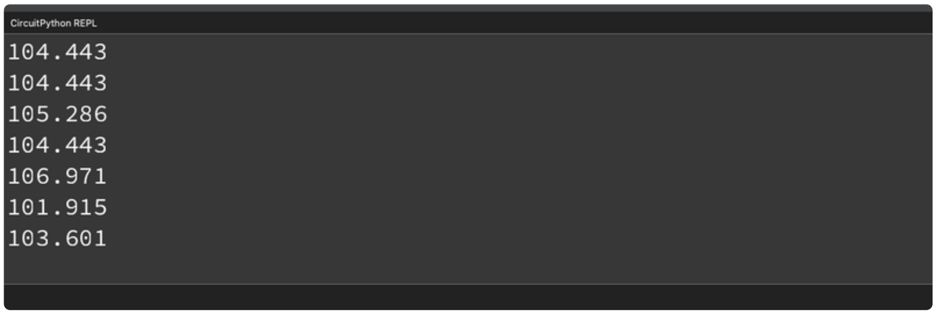
Try putting your finger on the microcontroller to see the temperature change.

The code is simple. First you import two modules: `time` and `microcontroller`. Then, inside the loop, you prin the microcontroller CPU temperature, and the `time.sleep()` slows down the print enough to be readable. That's it!

You can easily print out the temperature in Fahrenheit by adding a little math to your code, using this simple formula: Celsius * (9/5) + 32.

Update your **code.py** to the following, and save.

```
"""CircuitPython CPU temperature example in Fahrenheit"""
import time
import microcontroller

while True:
    print(microcontroller.cpu.temperature * (9 / 5) + 32)
    time.sleep(0.15)
```



```
104.443
104.443
105.286
104.443
106.971
101.915
103.601
```

The CPU temperature in Fahrenheit is printed out to the serial console!

That's all there is to reading the CPU temperature using CircuitPython!

Downloads

Files:

- RP2040 Datasheet (https://adafru.it/QTf)
- EagleCAD PCB Files on GitHub (https://adafru.it/R1F)
- 3D Models on GitHub (https://adafru.it/ScV)
- Fritzing object in the Adafruit Fritzing Library (https://adafru.it/R2a)
- Feather RP2040 pinout diagram SVG (https://adafru.it/Rdm)

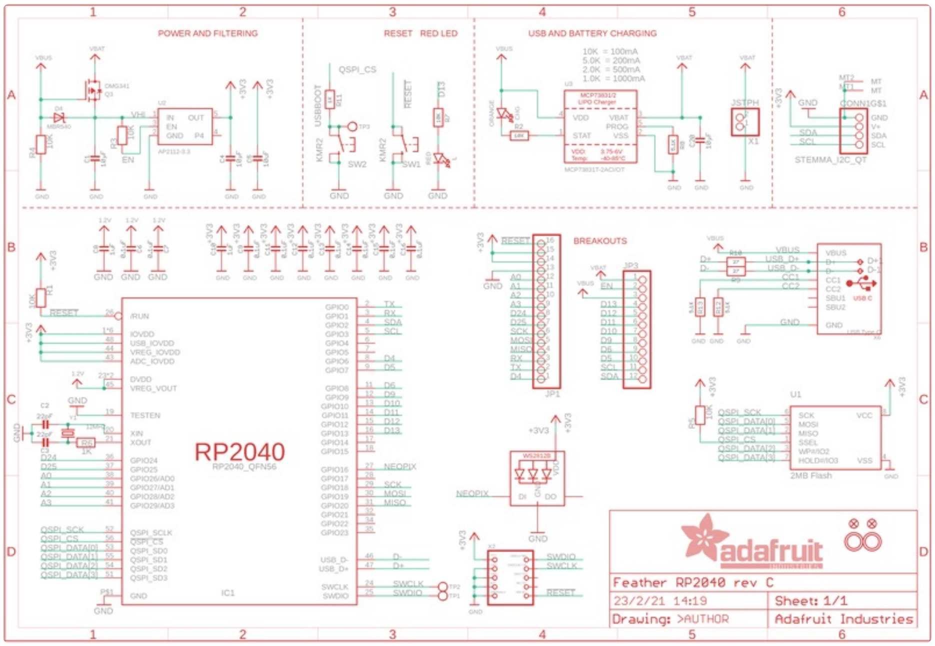
The **Feather_RP2040.uf2** file below is the code that ships on the Feather RP2040.

https://adafru.it/Sd9

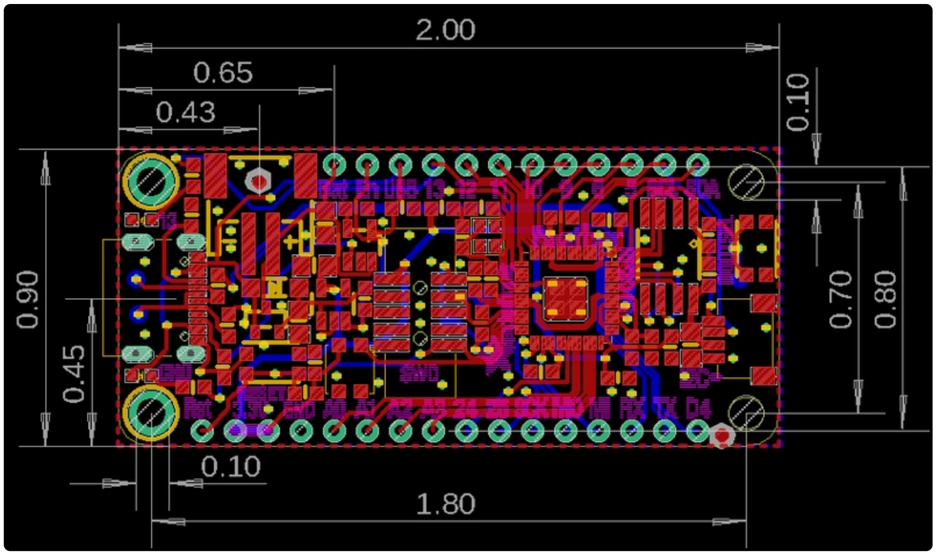
https://adafru.it/Sd9

Schematic

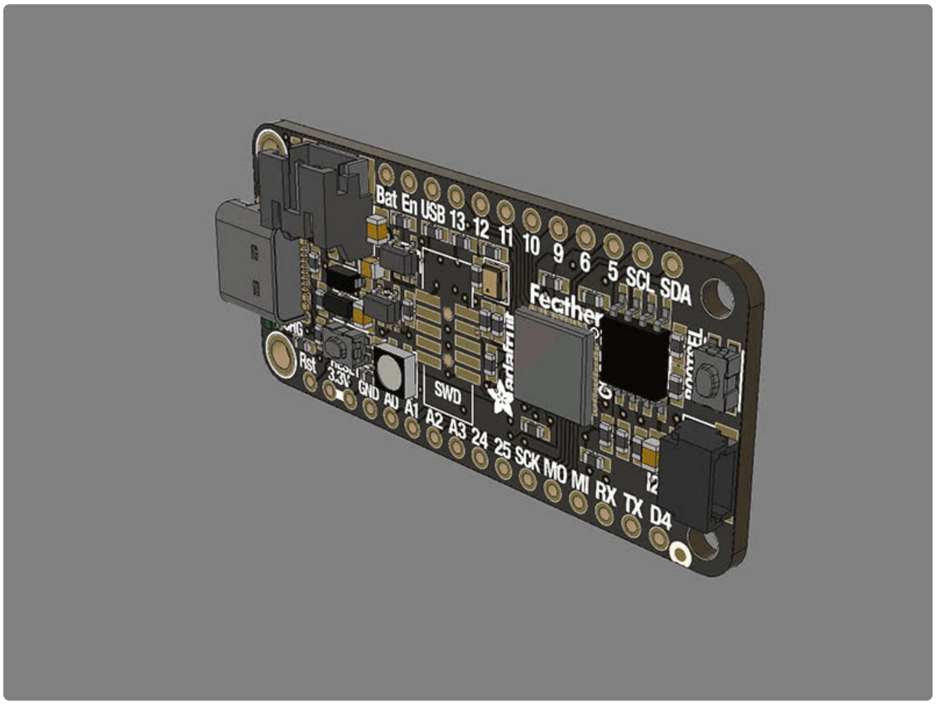
Note: The schematic references 2MB Flash. The Feather RP2040 ships with 8MB flash. The pinouts are the same.



Fab Print


2.00
0.65
0.43
0.10
0.90
0.45
0.70
0.80
0.10
1.80

3D Model


Bat
En
USB
13
12
11
10
9
6
5
SCL
SDA
Feather
SWD
Rst
3.3V
GND
A0
A1
A2
A3
24
25
SCK
MO
MI
RX
TX
D4