



Adafruit MagTag

Created by Kattni Rembor



<https://learn.adafruit.com/adafruit-magtag>

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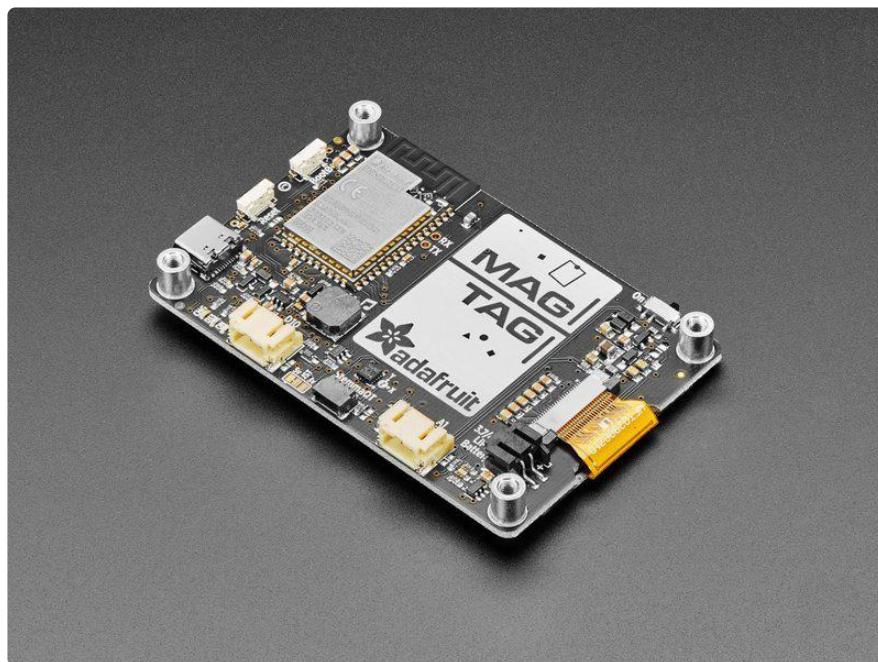
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Overview

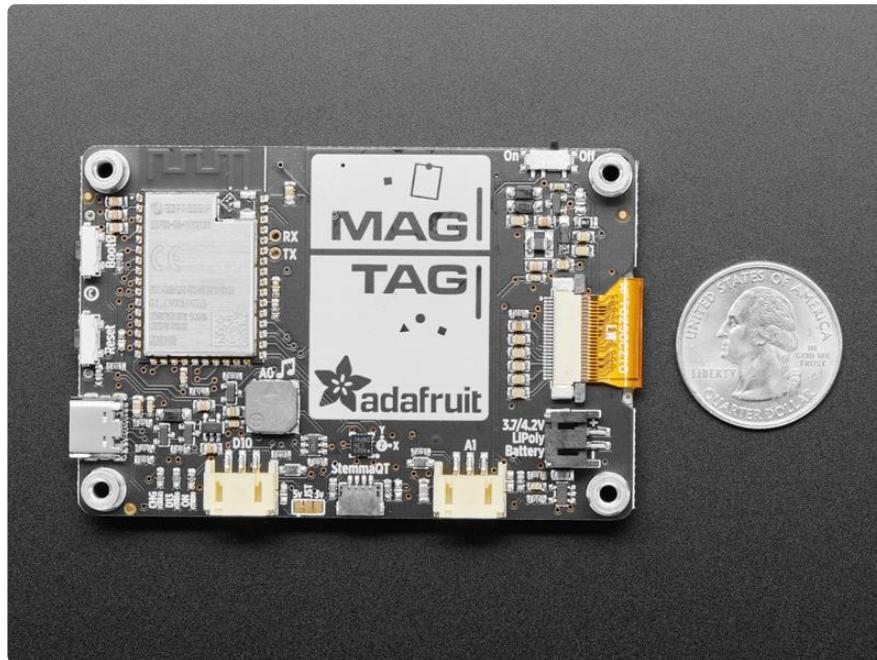


The Adafruit MagTag combines the new ESP32-S2 wireless module and a 2.9" grayscale E-Ink display to make a low-power IoT display that can show data on its screen even when power is removed! The ESP32-S2 is great because it builds on the years of code and support for the ESP32 and also adds native USB support so you can use this board with Arduino or CircuitPython!

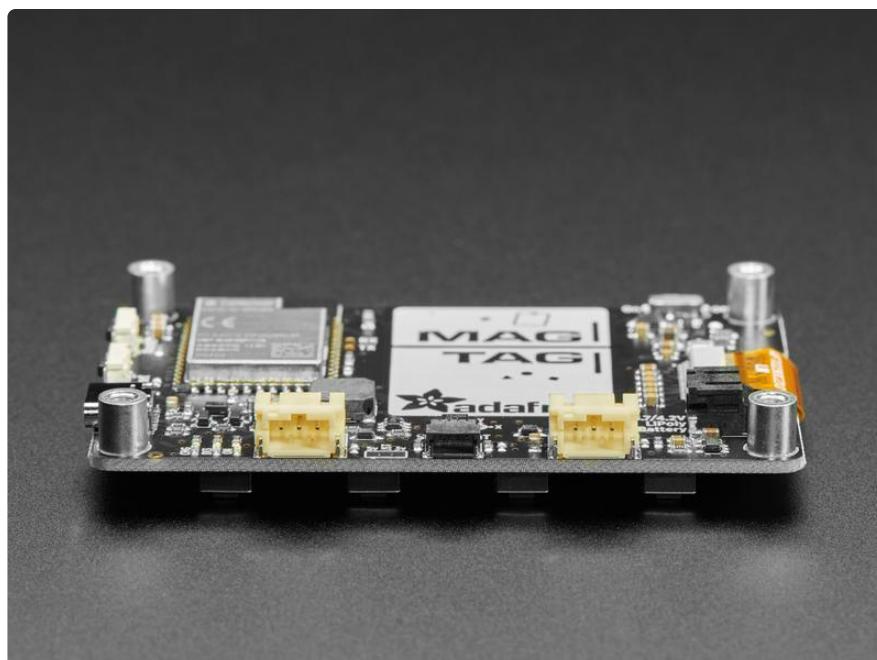


We designed this board to be low-power friendly - with a spot for a 350 or 420 mAh battery and built in battery charging over USB C. During deep sleep, with the

NeoPixels and speaker amplifier disabled, we measured 250uA power draw so you can run for a few weeks between charges.

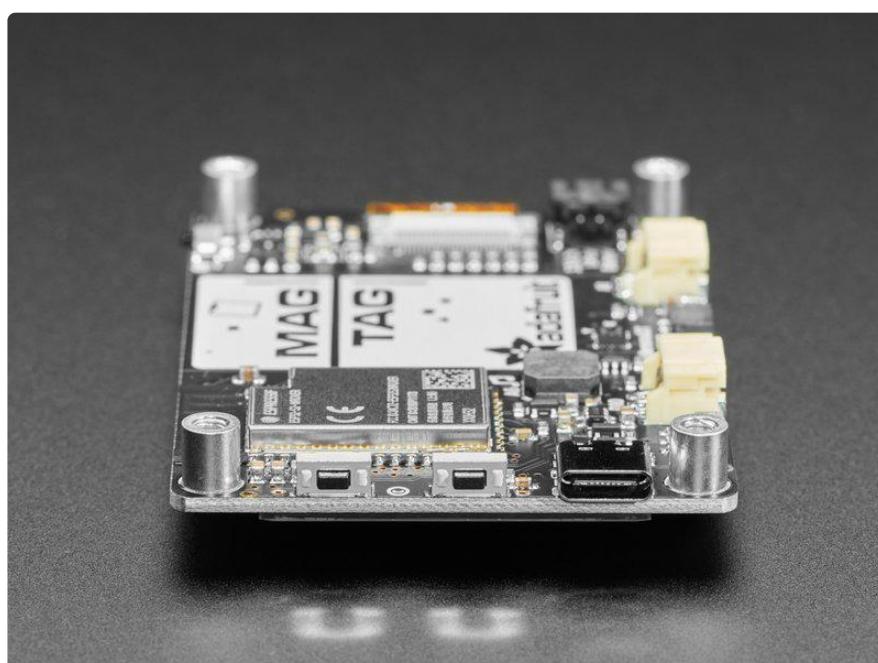


And of course, the Mag in MagTag stands for magnetic. [We have four M3 standoffs that will work perfectly with these mini magnet feet. \(<https://adafru.it/MZA>\)](#) (Originally they're designed for RGB Matrices but they'll do an excellent job here as well). Screw on the feet and you can attach this display to a metallic shelf, fridge, or bench.

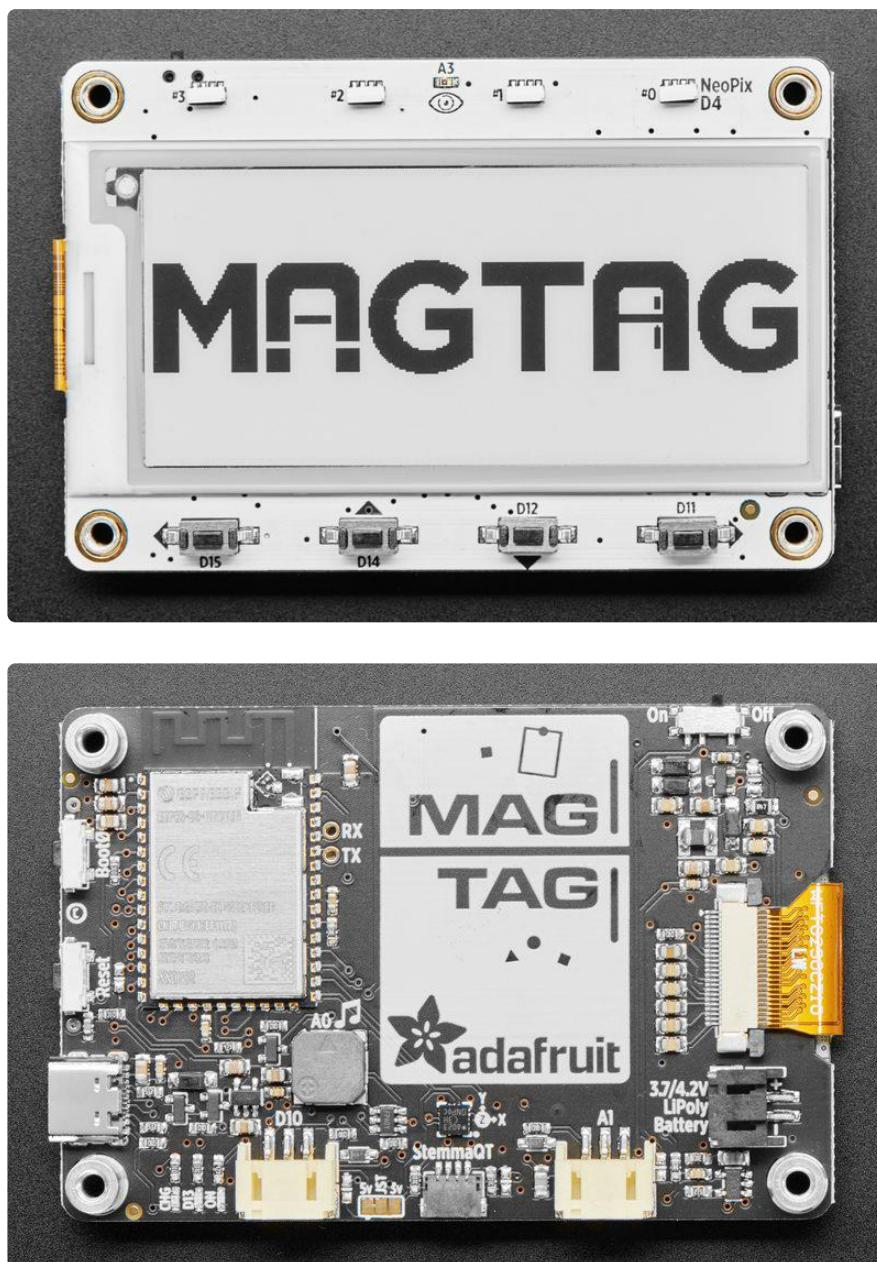


Here's the cool hardware we put together:

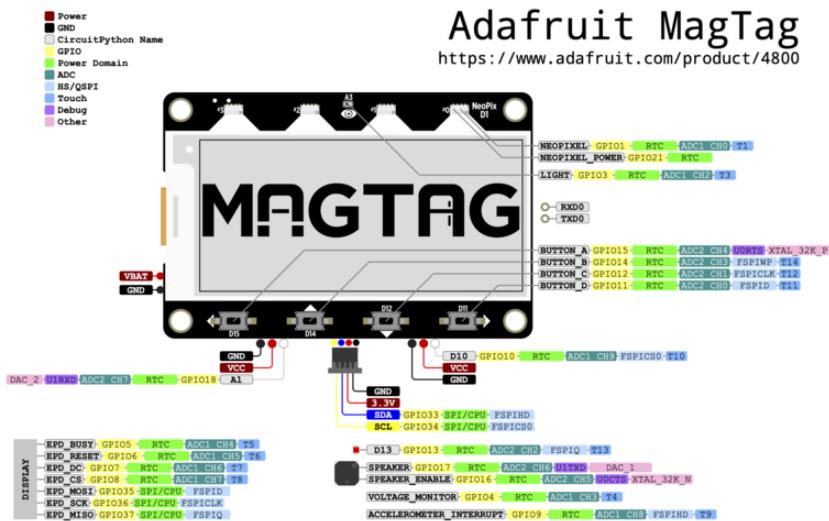
- ESP32-S2 240MHz Tensilica processor - the next generation of ESP32, now with native USB so it can act like a keyboard/mouse, MIDI device, disk drive, etc!
- WROVER module has FCC/CE certification and comes with 4 MByte of Flash and 2 MByte of PSRAM - you can have huge data buffers
- 2.9" grayscale display with 296x128 pixels. Each pixel can be white, light gray, dark gray or black. Compared to 'tri-color' displays with a red pigment, this display takes a lot less time to update, only about a second instead of 15 seconds!
- USB C power and data connector
- Four RGB side-emitting NeoPixels so you can light up the display with any color or pattern
- Four buttons can be used to wake up the ESP32 from deep-sleep, or select different modes
- Triple-axis accelerometer (LIS3DH) can be used to detect orientation of the display
- Speaker/Buzzer with mini class D amplifier on DAC output A0 can play tones or lo-fi audio clips.
- Front facing light sensor
- STEMMA QT port for [attaching all sorts of I2C devices](https://adafru.it/HMF) (<https://adafru.it/HMF>)
- Two STEMMA 3 pin JST connectors for attaching [NeoPixels](https://adafru.it/Cup) (<https://adafru.it/Cup>), [speakers](https://adafru.it/Gpf) (<https://adafru.it/Gpf>), [servos](https://adafru.it/FWq) (<https://adafru.it/FWq>) or [relays](https://adafru.it/NmC) (<https://adafru.it/NmC>).
- On/Off switch
- Boot and Reset buttons for re-programming



Pinouts



The MagTag has a great eInk display. It's also packed with buttons, connectors and sensors. Time to take a tour!



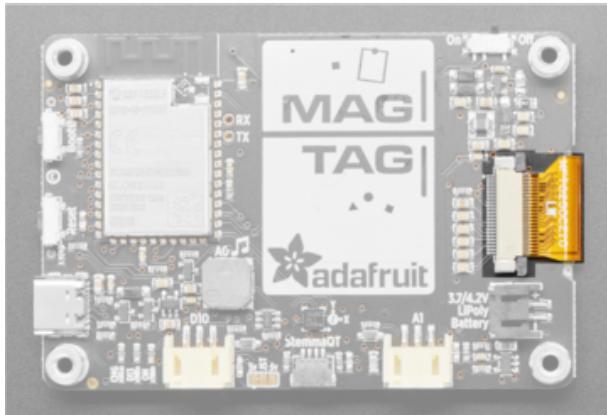
Note that some elements of the MagTag, like the light sensor, NeoPixels, and speaker, require enabling before usage. This is because we optimized for low-power usage. If the light sensor, NeoPixels or speaker aren't working, see below for the enabling pins!

eInk Display and Display Connector

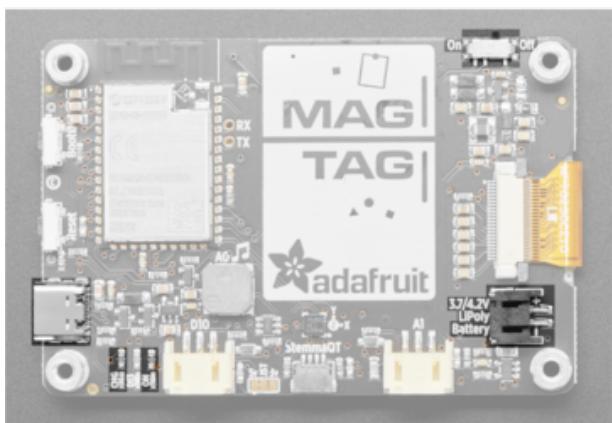


Front and center is a 2.9" grayscale eInk display with 296x128 pixels. Each pixel can be white, light gray, dark gray or black. For use with general Arduino libraries, you can try GxEPD2_290_T5 - the Arduino library Adafruit uses is ThinkInk_290_GrayScale4_T5.

On the back, along the right side, the display cable wraps around the board to the display connector on the back.



Power



There are two ways to power the MagTag board: the USB type C connector or a 3.7/4.2V Lipoly battery.

Power Inputs

- **USB C port** - This is used for both powering and programming the board. You can power it with any USB C cable and will request 5V from a USB C PD. When USB is plugged in it will charge the Lipoly battery. If there is no battery attached, the yellow LED will flicker (it's looking for a battery!)
- **LiPoly connector/charger** - You can plug in any 250mAh or larger 3.7/4.2V Lipoly battery into this JST 2-PH port to both power your MagTag and charge the battery. The battery will charge from the USB, even if the board is powered off via the switch.
If the battery is plugged in and USB is plugged in, the MagTag will power itself from USB and it will charge the battery up.
When the battery is charging, the yellow CHG LED will be lit. When charging is complete, the LED will turn off.

Power Control

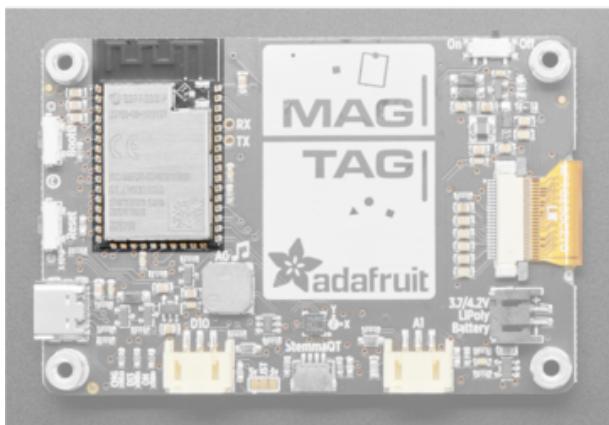
- **On/Off switch** - This switch controls power to the board. If you plug in your board and nothing happens, make sure the switch is flipped to "ON"!

The on-off switch is not very rugged - when switching, push at the 'bottom' of the actuator, not the tip so you don't 'twist' the switch, and don't flick it back and forth. It's not necessary for most uses!

Power LEDs

- OK LED - This green LED indicates the board is powered on, it is connected to the 3.3V power supply. This LED draws 40uA. If you need lower power you can remove this LED with a soldering iron.
- CHG LED - This yellow LED lets you know when the plugged in battery is charging and when it's fully charged. 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.

ESP32-S2 WiFi Module



The ESP32-S2 WROVER module.

The ESP32-S2 is a highly-integrated, low-power, 2.4 GHz Wi-Fi System-on-Chip (SoC) solution that now has built-in native USB as well as some other interesting new technologies like Time of Flight distance measurements. With its state-of-the-art power and RF performance, this SoC is an ideal choice for a wide variety of application scenarios relating to the [Internet of Things \(IoT\)](https://adafru.it/Bwq) (<https://adafru.it/Bwq>), [wearable electronics](https://adafru.it/Osb) (<https://adafru.it/Osb>), and smart homes.

Please note, this is a single-core 240 MHz chip so it won't be as fast as ESP32's with dual-core. Also, there is no Bluetooth support. However, we are super excited about the ESP32-S2's native USB which unlocks a lot of capabilities for advanced interfacing! This WROVER module comes with 4 MB flash and 2 MB PSRAM.

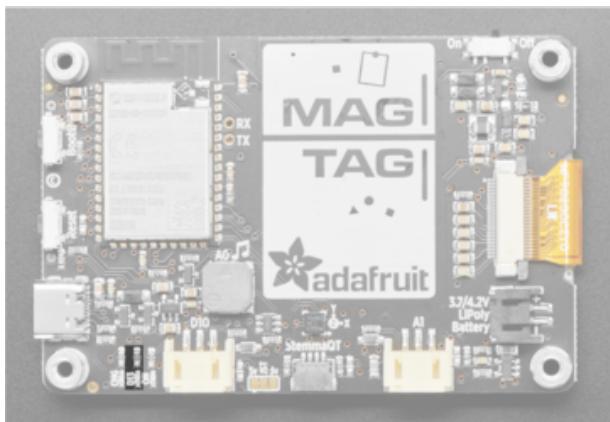
The 4 MB of flash is inside the module and is used for both program firmware and filesystem storage. For example, in CircuitPython, we have 3 MB set aside for program firmware (this includes two OTA option spots as well) and a 1MB section for CircuitPython scripts and files.

NeoPixels and Red LED



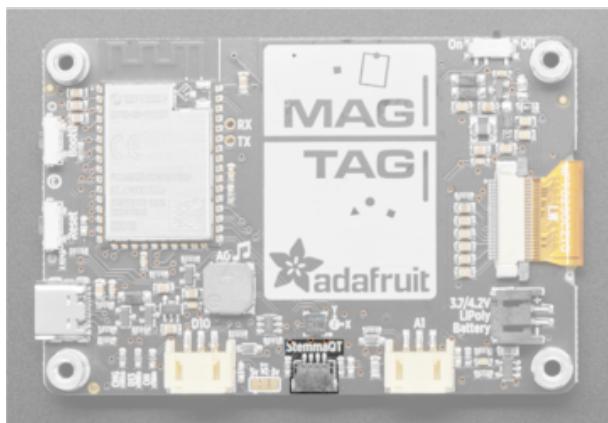
NeoPixel LEDs and red LED.

- On the front of the board, along the top, are four addressable RGB side-emitting NeoPixel LEDs labeled together as NeoPix D1, and individually labeled #0, #1, #2, and #3, so you can light up the display with any color or pattern. You can use GPIO 1 to control the NeoPixels.
- On the back, on the bottom left, is a red LED labeled D13. It is user-controllable for blinky needs. You can blink this at any time.



To use the NeoPixel LEDs you must also set pin 21 to be an output and LOW - this is the NeoPixel power pin. If not using the NeoPixels, keep pin 21 as an input or HIGH output - that will remove the quiescent power usage of the NeoPixels so you can have lower power in sleep mode.

STEMMA QT

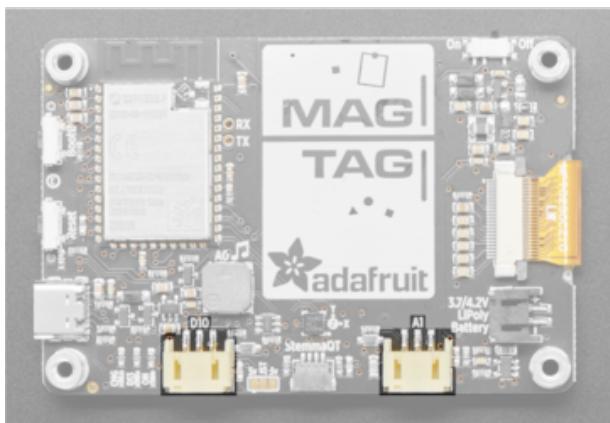


[STEMMA QT](https://adafru.it/Ft4) (<https://adafru.it/Ft4>) - This JST SH 4-pin connector breaks out I2C (SCL, SDA, 3.3V, GND). It allows you to connect to [various breakouts and sensors with STEMMA QT connectors](#) (<https://adafru.it/HMF>) or to other things using [assorted associated accessories](#) (<https://adafru.it/Ft6>).

Works great with any STEMMA QT or Qwiic sensor/device

You can also use it with Grove I2C devices thanks to this handy cable (<https://adafru.it/Ndk>)

Digital/Analog Connectors



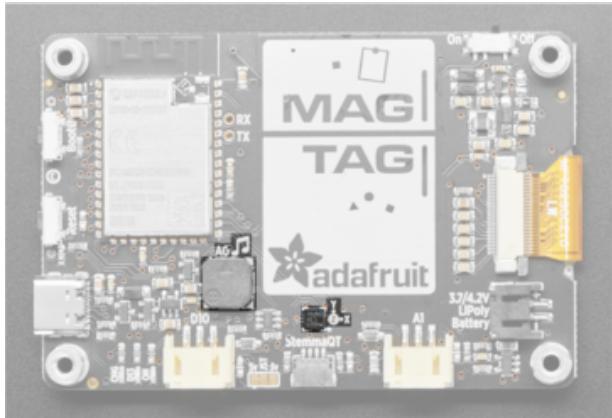
On the bottom are two connectors labeled D10 and A1. These are STEMMA 3 pin JST digital or analog connectors for attaching [NeoPixels](https://adafru.it/Cup) (<https://adafru.it/Cup>), speakers (<https://adafru.it/Gpf>), servos (<https://adafru.it/FWq>) or relays (<https://adafru.it/NmC>). These pins can be analog inputs or digital I/O.

Both connectors have protection 1K resistors + 3.6V zener diodes so you can drive an LED directly from the output. The maximum current from these connectors is 200mA.

A1 is a 'true' analog output. Both can be used for PWM as well as analog inputs. The maximum input voltage is 2.6V, after which the zener diode will kick in to drain excess voltage.

The power output is 5V by default, but a jumper can be cut/soldered to change it to 3.3V.

Speaker and Sensors



- Towards the middle of the board, at the bottom right corner of the ESP32-S2 module, is a speaker/buzzer labeled with A0 and a musical note. This includes a mini class D amplifier on DAC output A0 and can play tones or lo-fi audio clips.
- In the center of the board, towards the bottom, is an LIS3DH accelerometer labeled with X, Y and Z, that can be used to detect the orientation of the display. It is connected to the I2C port and available on I2C address 0x19. The IRQ line is connected to GPIO 9.
- On the front of the board, in the center of the top is a front-facing light sensor labeled with A3 and an eye.

Note that to use the speaker you must also set the speaker shutdown pin IO 16 to be an output and HIGH. If not playing audio, keep this pin as an input or LOW, to reduce the power usage of the amplifier circuit.

To use the light sensor you must also set pin 21 to be an output and LOW to turn on the power supply to it and the NeoPixels. If not using the light sensor or NeoPixels, keep pin 21 as an input or HIGH output - that will remove the quiescent power usage of the NeoPixels and light sensor so you can have lower power in sleep mode.

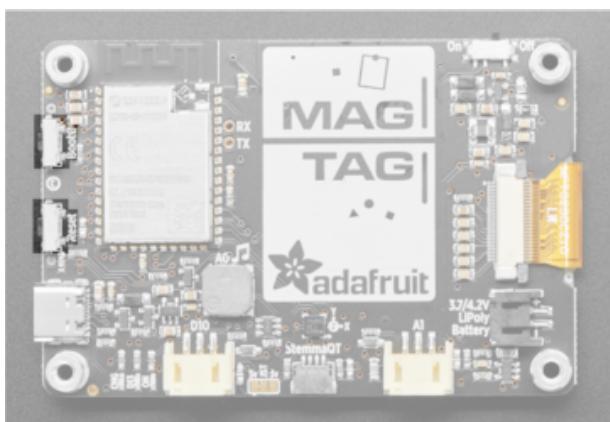
Buttons



On the front of the board, along the bottom, there are four user-controllable buttons labeled both with pin names and a different arrow for each button. The buttons are on D11, D12, D14 and D15. Can be used to wake up the ESP32-S2 from deep-sleep, or select different modes.

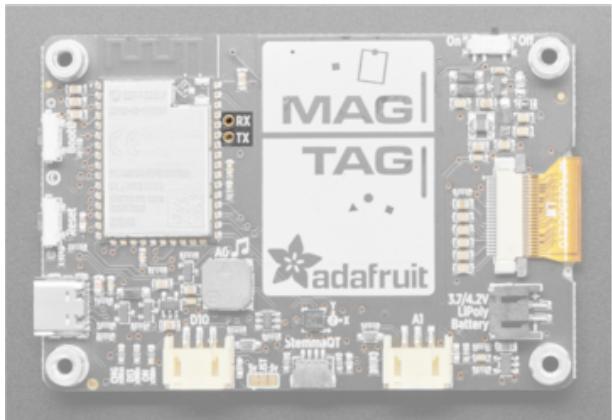
There are no pull-ups on board, use internal pullups for this pins - when the buttons are pressed the IO pin labeled is set to LOW

Reset and Boot0



- Reset button - The reset button in the top left corner is used to reset the board.
- Boot0 button - This is connected to BOOT0 and can be used to put the board into ROM bootloader mode. To enter ROM bootloader mode, hold down the BOOT0 button while clicking reset button mentioned above. When in the ROM bootloader, you can upload code and query the chip using [esptool](#).

UART Debug



The hardware UART debug port has two broken out pins. You can connect these to a USB console cable in order to read the debug output from the ESP32 IDF (<https://adafru.it/dDd>). This is useful if you are writing software and need to see the low level debug output.

This is not where default `Serial.print()` or CircuitPython `print()` outputs go, because those will go through the USB port instead!

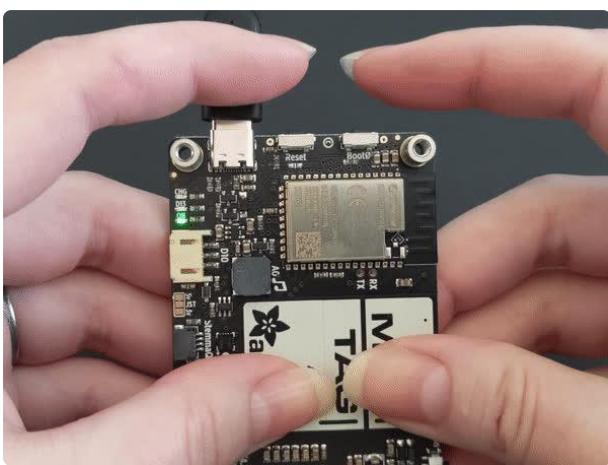
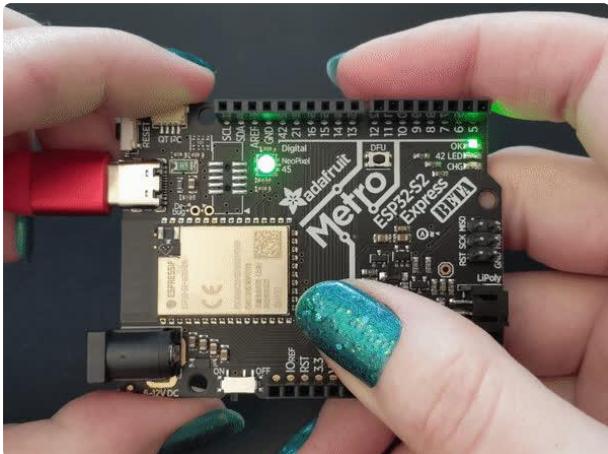
ROM Bootloader

The ESP32-S2 has a built in bootloader, which means you never have to worry about 'bricking' your board. You can use it to load code directly, say CircuitPython or the binary output of an Arduino compilation or you can use it to load a second bootloader on, like UF2 which has a drag-n-drop interface.

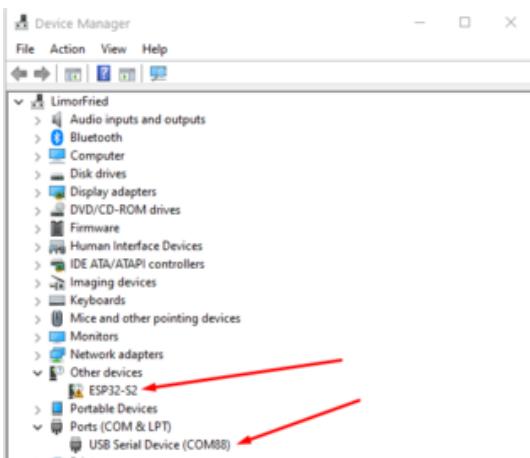
The ROM bootloader can never be disabled or erased, so its always there if you need it!

Enter ROM Bootloader Mode

Entering the bootloader is easy. Complete the following steps.

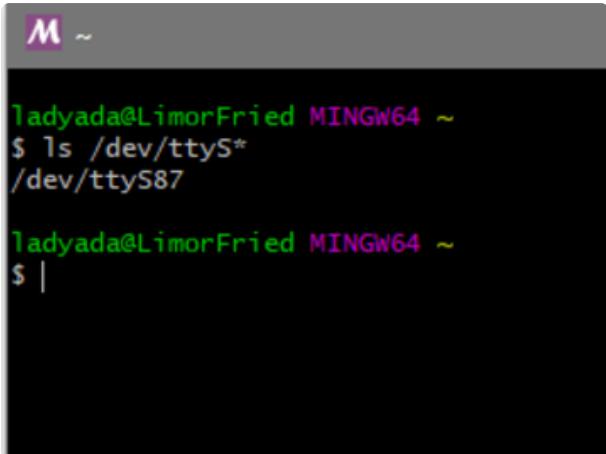


1. Make sure your ESP32-S2 is plugged into USB port to your computer using a data/sync cable. Charge-only cables will not work!
2. Turn on the On/Off switch - check that you see the OK light on so you know the board is powered, a prerequisite!
3. Press and hold the DFU / Boot0 button down. Don't let go of it yet!
4. Press and release the Reset button. You should have the DFU/Boot0 button pressed while you do this.
5. Now you can release the DFU / Boot0 button
6. Check your computer for a new serial / COM port. On windows check the Device manager



On Windows check the Device manager - you will see a COM port, for example here its COM88. You may also see another "Other device" called ESP32-S2

It's best to do this with no other dev boards plugged in so you don't get confused about which COM port is the ESP32-S2



```
ladyada@LimorFried MINGW64 ~
$ ls /dev/ttyS*
/dev/ttyS87
```

```
ladyada@LimorFried MINGW64 ~
$ |
```

On Mac/Linux you will need to find the tty name which lives under /dev

On Linux, try `ls /dev/ttyS*` for example, to find the matching serial port name. In this case it shows up as `/dev/ttyS87`. If you don't see it listed try `ls /dev/ttyA*` on some Linux systems it might show up like `/dev/ttyACM0`

On Mac, try `ls /dev/cu.usbmodem*` for example, to find the matching serial port name. In this case, it shows up as `/dev/cu.usbmodem01`



```
6933 kattni@robocrepe:~ $ ls /dev/cu.usbmodem*
/dev/cu.usbmodem01
```

```
6934 kattni@robocrepe:~ $ |
```

It's best to do this with no other dev boards plugged in so you don't get confused about which serial port is the ESP32-S2

Run esptool and check connection

Once you have entered ROM bootloader mode, you can then [use Espressif's esptool program \(<https://adafru.it/E9p>\)](#) to communicate with the chip! `esptool` is the 'official' programming tool and is the most common/complete way to program an ESP chip.

You will need to use the command line / Terminal to install and run `esptool`.

You will also need to have pip and Python installed (any version!)

Install the latest version using pip (you may be able to run `pip` without the `3` depending on your setup):

```
pip3 install --upgrade esptool
```

Then, you can run:

```
esptool.py
```

Run `esptool.py` in a new terminal/command line and verify you get something like the below:

```
C:\Users\ladyada>python3 C:\ESP32\esp-idf\components\esptool_py\esptool\esptool.py  
esptool.py v3.0-dev  
usage: esptool [-h] [--chip {auto,esp8266,esp32,esp32s2}] [--port PORT] [--baud BAUD]  
              [--before {default_reset,no_reset,no_reset_no_sync}]  
              [--after {hard_reset,soft_reset,no_reset}] [--no-stub] [--trace]  
              [--override-vddsdio {[1.8V,1.9V,OFF]}] [--connect-attempts CONNECT_ATTEMPTS]  
              {load_ram,dump_mem,read_mem,write_mem,write_flash,run,image_info,make_image,elf2image,read  
_mac,chip_id,flash_id,read_flash_status,write_flash_status,read_flash,verify_flash,erase_flash,erase_regi  
on,version,get_security_info}  
              ...
```

Make sure you are running esptool v 3.0 or higher, which adds ESP32-S2 support

Run the following command, replacing the identifier after `--port` with the `COMxx`, `/dev/cu.usbmodemxx` or `/dev/ttysxx` you found above.

```
esptool.py --port COM88 chip_id
```

You should get a notice that it connected over that port and found an ESP32-S2

```
C:\Users\ladyada>python3 C:\ESP32\esp-idf\components\esptool_py\esptool\esptool.py --port COM88 chip_id  
esptool.py v3.0-dev  
Serial port COM88  
Connecting...  
Detecting chip type... ESP32-S2  
Chip is ESP32-S2  
Features: WiFi, ADC and temperature sensor calibration in BLK2 of efuse  
Crystal is 40MHz  
MAC: 7c:df:a1:00:3f:3e  
Uploading stub...  
Running stub...  
Stub running...  
Warning: ESP32-S2 has no Chip ID. Reading MAC instead.  
MAC: 7c:df:a1:00:3f:3e  
Hard resetting via RTS pin...  
ERROR: ESP32-S2 chip was placed into download mode using GPIO0.  
esptool.py can not exit the download mode over USB. To run the app, reset the chip manually.  
To suppress this error, set --after option to 'no_reset'.
```

You can now upload a binary file with the following command

```
esptool.py --port COM88 --after=no_reset write_flash 0x0 firmware.bin
```

don't forget to change the `--port` name to match, and the file name from `firmware.bin` to whatever the firmware file name is.

For example, I downloaded CircuitPython .bin and programmed it thus:

```
C:\Users\ladyada\Desktop>python3 C:\ESP32\esp-idf\components\esptool_py\esptool\esptool.py --port COM88 -  
-after=no_reset write_flash 0x0 adafruit-circuitpython-adafruit_esp32s2_eink_portal-en_US-20201102-58ce4  
e1.bin  
esptool.py v3.0-dev  
Serial port COM88  
Connecting...  
Detecting chip type... ESP32-S2  
Chip is ESP32-S2  
Features: WiFi, ADC and temperature sensor calibration in BLK2 of efuse  
Crystal is 40MHz  
MAC: 7c:df:a1:00:3f:3e  
Uploading stub...  
Running stub...  
Stub running...  
Configuring flash size...  
Auto-detected Flash size: 4MB  
Compressed 1304816 bytes to 843841...  
Wrote 1304816 bytes (843841 compressed) at 0x00000000 in 25.1 seconds (effective 416.6 kbit/s)...  
Hash of data verified.  
Leaving...  
Staying in bootloader.
```

Once the data is verified, press the Reset button once more to launch the code you just programmed in!

Web Serial ESPTool

The WebSerial ESPTool was designed to be a web-capable option for programming ESP32-S2 boards. It allows you to erase the contents of the microcontroller and program up to 4 files at different offsets.

This tool is a good alternative to folks who cannot run Python `esptool.py` on their computer or are having difficulty installing or using `esptool.py`

Enabling Web Serial



You will have to use the Chrome browser for this to work, Safari and Firefox, etc are not supported because we need Web Serial and only Chrome is supporting it to the level needed.

WARNING: EXPERIMENTAL FEATURES AHEAD! By enabling these features, you could lose browser data or compromise your security or privacy. Enabled features apply to all users of this browser.

Interested in cool new Chrome features? Try our [beta channel](#).

[Available](#) [Unavailable](#)

Experimental Web Platform features
Enables experimental Web Platform features that are in development. – Mac, Windows, Linux, Chrome OS, Android
`#enable-experimental-web-platform-features`

Temporarily unexpire M85 flags.
Temporarily unexpire flags that expired as of M85. These flags will be removed soon. – Mac, Windows, Linux, Chrome OS, Android
`#temporarily-unexpire-flags-m85`

Temporarily unexpire M86 flags.
Temporarily unexpire flags that expired as of M86. These flags will be removed soon. – Mac, Windows, Linux, Chrome OS, Android
`#temporarily-unexpire-flags-m86`

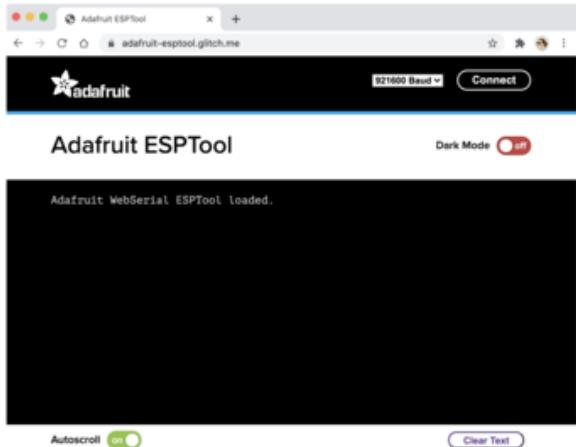
At the time of this tutorial, you'll need to enable the Serial API, which is really easy.

Visit `chrome://flags` from within Chrome. Find and enable the Experimental Web Platform features

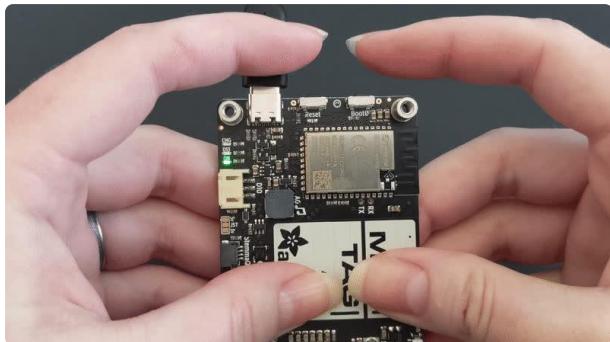
Restart Chrome

Connecting

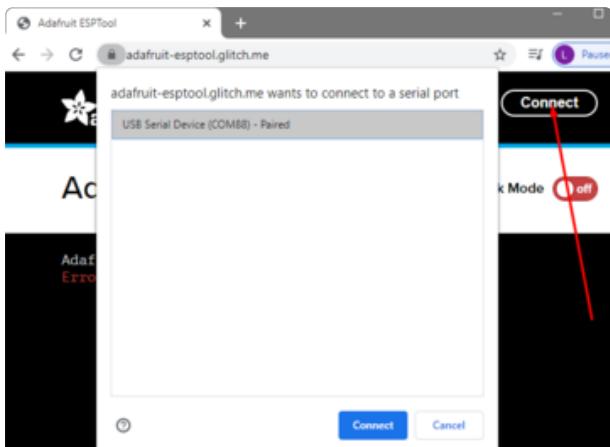
Before you can use the tool, you will need to put your board in bootloader mode and connect. Here are the steps:



In the Chrome browser visit <https://adafruit.github.io/> [Adafruit_WebSerial_ESPTool/ \(https://adafruit.it/PMB\)](https://adafruit.it/PMB) it should look like the image to the left



Enter the ROM bootloader by holding down the BOOT0 button while clicking Reset.



Press the Connect button in the top right of the web browser. You will get a pop up asking you to select the COM or Serial port. You may want to remove all other USB devices so only the ESP32-S2 board is attached, that way there's no confusion over multiple ports!

```
Adafruit WebSerial ESPTool loaded.  
Error: No port selected by the user.  
Error: No port selected by the user.  
Connecting...  
Connected successfully.  
Timed out after 100 milliseconds  
Connected to ESP32-S2  
MAC Address: 93:5B:55:BD:F1:E4
```

The Javascript code will now try to connect to the ROM bootloader. It may timeout for a bit until it succeeds. On success, you will see that it is Connected and will print out a unique MAC address identifying the board.

Adafruit ESPTool

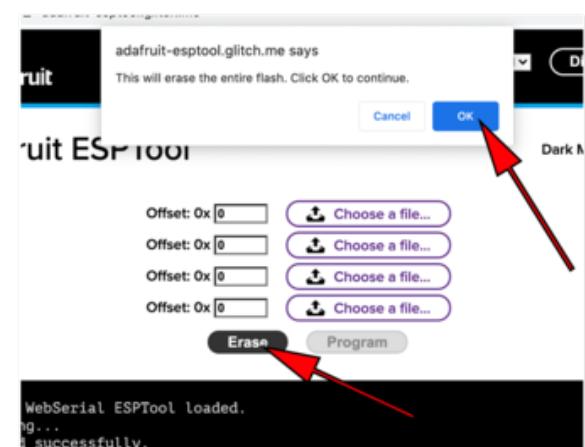
Dark Mode

Adafruit WebSerial ESPTool loaded.
Connecting...
Connected successfully.
Timed out after 100 milliseconds
Changed baud rate to 931600
Connected to ESP32-S2
MAC Address: E6:85:6D:9A:A6:32

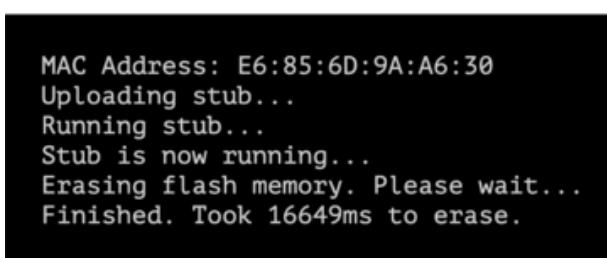
Once you have successfully connected, the command toolbar will appear.

Erasing the Contents

If you would like to erase the entire flash area so that you can start with a clean slate, you can use the erase feature. We recommend doing this if you are having issues.



To erase the contents, click the Erase button. You will be prompted whether you want to continue. Click OK to continue or if you changed your mind, just click cancel.

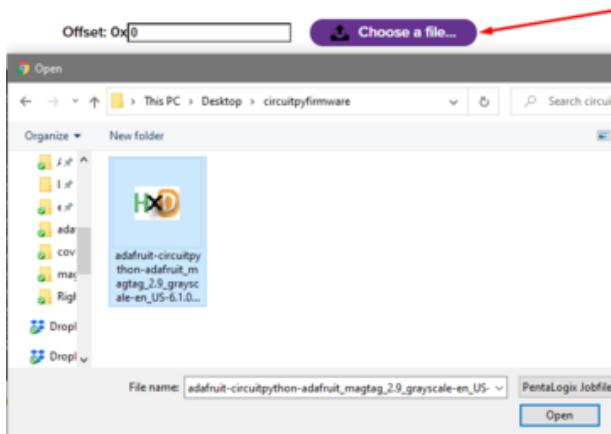


Watch the log messages to see when it has completed. Please do not disconnect until it has finished.



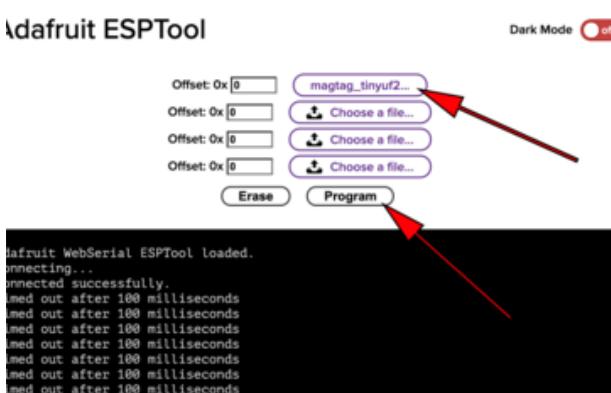
Programming the Microcontroller

Programming the microcontroller can be done with up to 4 files at different locations, but if we use the tinyuf2combo BIN file, which is available on the Install UF2 Bootloader page, we only need to use 1 file.



You can click on Choose a file... from any of the available buttons. It will only attempt to program buttons with a file and a unique location. Then select the Adafruit CircuitPython BIN files (not the UF2 file!).

Verify that the Offset box next to the file location you used is 0x0.



Once you choose a file, the button text will change to match your filename. You can then select the Program button to start flashing.



A progress bar will appear and after a minute or two, you will have written the firmware. Press the Reset button to get out of the ROM bootloader and you should see a MAGTAGBOOT drive (METROS2BOOT for the Metro) appear in your computer file explorer/finder.

You're now ready to copy the CircuitPython UF2 on to the drive which will set up CircuitPython!

After using the tool, press the reset button to get out of bootloader mode and launch the new firmware!

Install UF2 Bootloader

If you're familiar with our other products and chipsets you may be familiar with our drag-n-drop bootloader, a.k.a UF2. We have a UF2 bootloader for the ESP32-S2, that will let you drag firmware on/off a USB disk drive

Unlike the M0 (SAMD21) and M4 (SAMD51) boards, there is no bootloader protection for the UF2 bootloader. That means it is possible to erase or damage the bootloader, especially if you upload Arduino sketches to ESP32S2 boards that doesn't "know" there's a bootloader it should not overwrite!

However, thanks to the ROM bootloader, you don't have to worry about it if the UF2 bootloader is damaged. You can simply re-load the UF2 bootloader (USB-disk-style) with the ROM bootloader (non-USB-drive)

Installing a new bootloader will erase your MagTag! Be sure to back up your data first.

Step 1. Get into the ROM bootloader and install esptool.py

[See the previous page on how to do that! \(\)](#)

Step 2. Download the TinyUF2 release for your board

Choose the right release file from the list below. If your board is not explicitly mentioned, find it in the "all boards" link. These links are to .zip files.

Latest MagTag TinyUF2 release

<https://adafru.it/TSf>

Latest Metro ESP32-S2 TinyUF2 release

<https://adafru.it/TSf>

Latest Adafruit FunHouse TinyUF2
release

<https://adafru.it/TSf>

Look here if your board is not one of the ones above:

Latest TinyUF2 release for all
boards

<https://adafru.it/TSA>

Step 3. Extract the combined.bin file from TinyUF2 release

The file you downloaded in Step 2 is a .zip file. Unzip it and find the combined.bin file. Note that this file is 3MB but that's because the bootloader is near the end of the available flash. It's not actually 3MB of program: most of the file is empty but it's easier to program if we give you one combined 'swiss cheese' file. Save this file to your desktop or wherever you plan to run `esptool` from.

Step 4. Option A) Use esptool.py to upload

- Put the board into bootloader mode (hold down BOOT0/DFU and click reset)
- Determine the serial or COM port of the board

Run this command and replace the serial port name with your matching port and the file you just downloaded

```
esptool.py -p COM88 write_flash 0x0 combined.bin
```

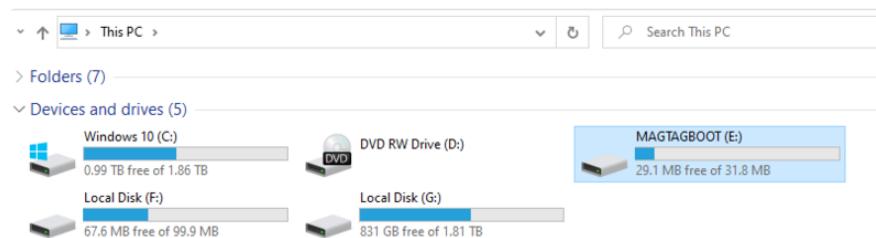
There might be a bit of a 'wait' when programming, where it doesn't seem like its working. Give it a minute, it has to erase the old flash code which can cause it to seem like its not running.

You'll finally get an output like this:

```
esptool.py v3.0-dev
Serial port COM88
Connecting...
Detecting chip type... ESP32-S2
Chip is ESP32-S2
Features: WiFi, ADC and temperature sensor calibration in BLK2 of efuse
Crystal is 40MHz
MAC: 7c:df:a1:05:f8:9a
Uploading stub...
Running stub...
Stub running...
Configuring flash size...
Auto-detected Flash size: 4MB
Compressed 3081264 bytes to 98937...
Wrote 3081264 bytes (98937 compressed) at 0x00000000 in 22.8 seconds (effective 1080.0 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
ERROR: ESP32-S2 chip was placed into download mode using GPIO0.
esptool.py can not exit the download mode over USB. To run the app, reset the chip manually.
To suppress this error, set --after option to 'no_reset'.
```

Click RESET button to launch the bootloader. You'll see a new disk drive on your computer with the name MAGTAGBOOT or similar



Step 4 Option B) Use the Web Serial ESPTool to upload

Another option if you are having trouble getting ESPTool running, is to use the [Web Serial ESPTool](https://adafru.it/Pdq) (<https://adafru.it/Pdq>) in this guide. This tool uses Web Serial to erase or upload firmware to your board.

Install CircuitPython

[CircuitPython](https://adafru.it/tB7) (<https://adafru.it/tB7>) is a derivative of [MicroPython](https://adafru.it/BeZ) (<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.

Set Up CircuitPython

Follow the steps to get CircuitPython installed on your MagTag.

Download the latest CircuitPython
for your board from
circuitpython.org

<https://adafru.it/OBd>

CircuitPython 6.1.0-beta.2

This is the latest unstable release of CircuitPython that will work with the MagTag - 2.9" Grayscale E-Ink WiFi Display.

Unstable builds have the latest features but are more likely to have critical bugs.

[Release Notes for 6.1.0-beta.2](#)



Click the link above and download the latest .BIN and .UF2 file

(depending on how you program the ESP32S2 board you may need one or the other, might as well get both)

Download and save it to your desktop (or wherever is handy).



Plug your MagTag into your computer using a known-good USB cable.

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



Option 1 - Load with UF2 Bootloader

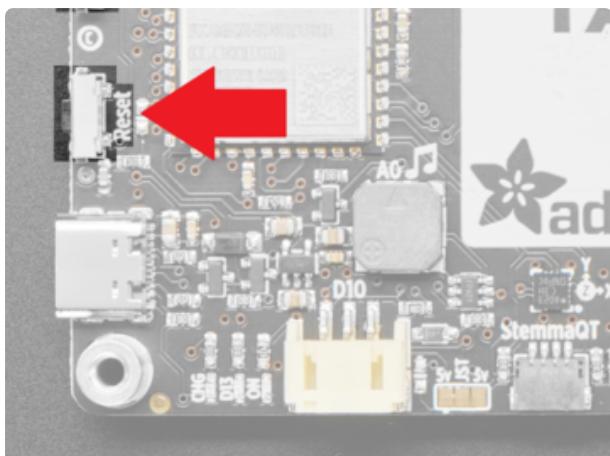
This is by far the easiest way to load CircuitPython. However it requires your board has the UF2 bootloader installed. Some early boards do not (we hadn't written UF2 yet!) - in which case you can load using the built in ROM bootloader.

Still, try this first!

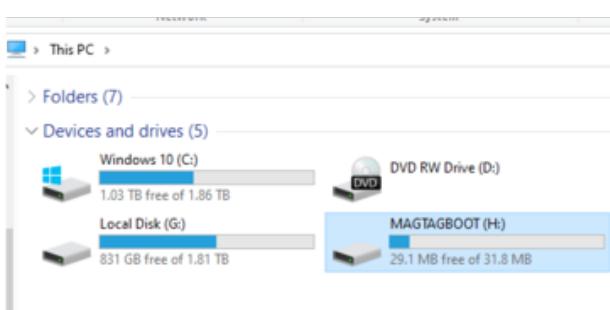


Try Launching UF2 Bootloader

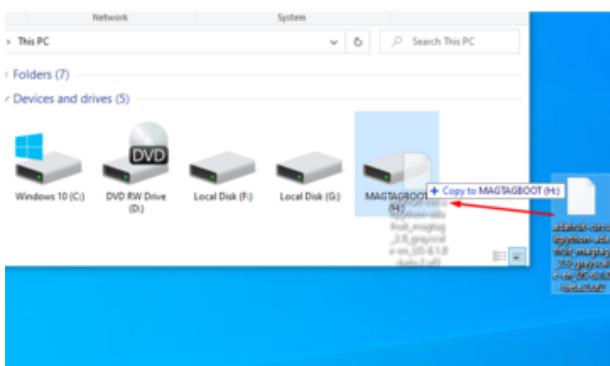
Loading CircuitPython by drag-n-drop UF2 bootloader is the easier way and we recommend it. If you have a MagTag where the front of the board is black, your MagTag came with UF2 already on it.



Launch UF2 by double-clicking the Reset button (the one next to the USB C port). You may have to try a few times to get the timing right.

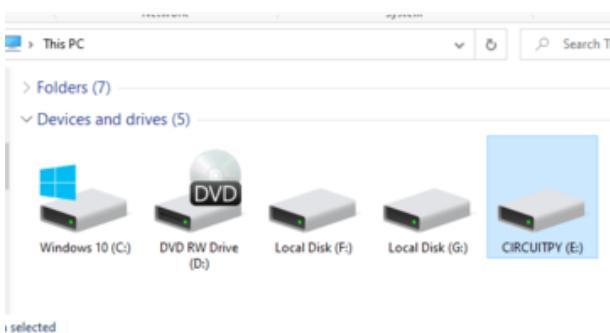


If the UF2 bootloader is installed, you will see a new disk drive appear called MAGTAGBOOT



Copy the UF2 file you downloaded at the first step of this tutorial onto the MAGTAGBOOT drive

If you're using Windows and you get an error at the end of the file copy that says Error from the file copy, Error 0x800701B1: A device which does not exist was specified. You can ignore this error, the bootloader sometimes disconnects without telling Windows, the install completed just fine and you can continue. [If its really annoying, you can also upgrade the bootloader \(the latest version of the UF2 bootloader fixes this warning\) \(<https://adafru.it/Pfk>\)](#)



Your board should auto-reset into CircuitPython, or you may need to press reset. A CIRCUITPY drive will appear. You're done! Go to the next pages.

Option 2 - Use esptool to load BIN file

If you have an original MagTag with white soldermask on the front, we didn't have UF2 written for the ESP32S2 yet so it will not come with the UF2 bootloader.

You can upload with esptool to the ROM (hardware) bootloader instead!

```

$ python ./esptool.py --port /dev/cu.usbmodem1101 --after-reset
write_flash 8xb ~/adafruit-circuitpython-metro.ESP32s2-en-US-20281103-5a07925.bin
esptool.py v3.0-dev
Serial port /dev/cu.usbmodem1101
Connecting...
Detecting chip type... ESP32-S2
Chip is ESP32-S2
Features: WiFi, ADC and temperature sensor calibration in BLK2 of efuse
Crystal is 40MHz
MAC: 7c:df:a1:00:4e:a2
Uploading stub...
Running stub...
Stub running...
Configuring flash size...
Compressed 1305184 bytes to 844014...
Write 1305184 bytes (844014 compressed) at 0x00000000 in 11.9 seconds (effective 878.2 kbit/s)...
Hash of data verified.

Leaving...
Staying in bootloader.

```

Follow the initial steps found in the [Run esptool and check connection](#) section of the ROM Bootloader page (<https://adafru.it/OBc>) to verify your environment is set up, your board is successfully connected, and which port it's using.

In the final command to write a binary file to the board, replace the port with your port, and replace "firmware.bin" with the the file you downloaded above.

The output should look something like the output in the image.

Press reset to exit the bootloader.

Your CIRCUITPY drive should appear!

You're all set! Go to the next pages.



Option 3 - Use Chrome Browser To Upload BIN file

If for some reason you cannot get esptool to run, you can always try using the Chrome-browser version of esptool we have written. This is handy if you don't have Python on your computer, or something is really weird with your setup that makes esptool not run (which happens sometimes and isn't worth debugging!) You can follow along on the [Web Serial ESPTool](#) (<https://adafru.it/Pdq>) page and either load the UF2 bootloader and then come back to Option 1 on this page, or you can download the CircuitPython BIN file directly using the tool in the same manner as the bootloader.

CircuitPython Internet Libraries

To use the internet-connectivity built into your ESP32-S2 with CircuitPython, you must first install a number of libraries. This page covers that process.

Adafruit CircuitPython Library Bundle

Download the Adafruit CircuitPython Bundle. You can find the latest release here:

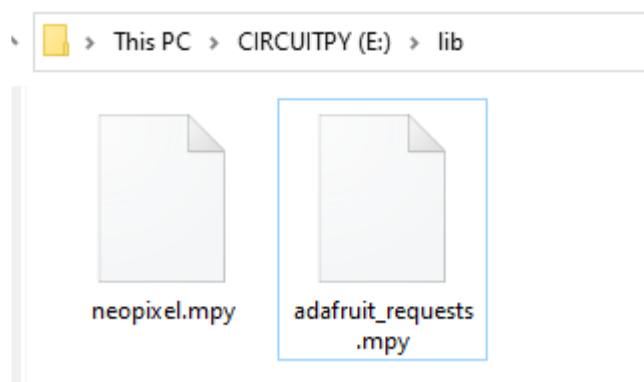
Download latest CircuitPython
Library Bundle

<https://adafru.it/ENC>

Download the adafruit-circuitpython-bundle-version-mpy-*.zip bundle zip file, and unzip a folder of the same name. Inside you'll find a lib folder. The entire collection of libraries is too large to fit on the CIRCUITPY drive. Instead, add each library as you need it, this will reduce the space usage but you'll need to put in a little more effort.

At a minimum we recommend the following libraries, in fact we more than recommend. They're basically required. So grab them and install them into CIRCUITPY/lib now!

- adafruit_requests.mpy - A requests-like library for HTTP commands.
- neopixel.mpy - Helper library to use NeoPixel LEDs, often built into the boards so they're great for quick feedback



Once you have added those files, please continue to the next page to set up and test Internet connectivity

CircuitPython Internet Test

Once you have CircuitPython installed and the minimum libraries installed we can get your board connected to the Internet.

To get connected, you will need to start by creating a secrets.py file.

Secrets File

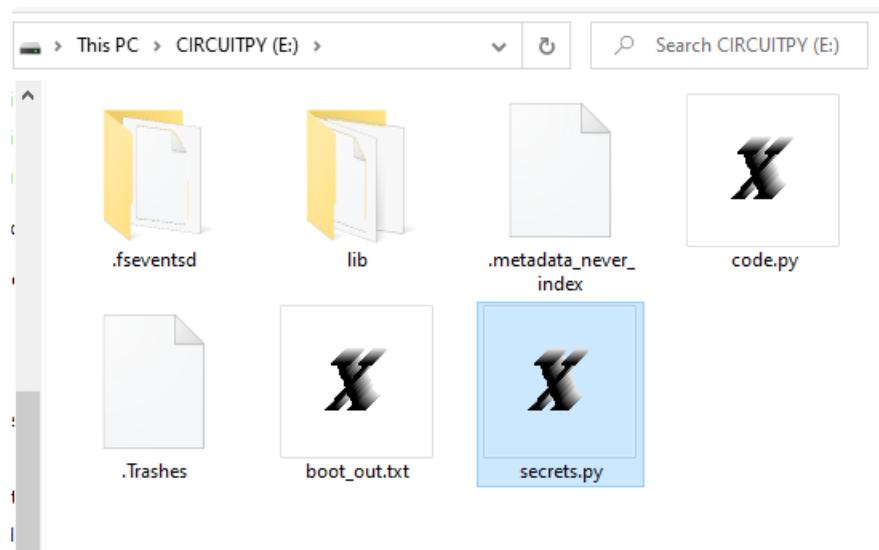
We expect people to share tons of projects as they build CircuitPython WiFi widgets. What we want to avoid is people accidentally sharing their passwords or secret tokens and API keys. So, we designed all our examples to use a secrets.py file, that is in your CIRCUITPY drive, to hold secret/private/custom data. That way you can share your main project without worrying about accidentally sharing private stuff.

Your secrets.py file should look like this:

```
# This file is where you keep secret settings, passwords, and tokens!
# If you put them in the code you risk committing that info or sharing it

secrets = {
    'ssid' : 'home_wifi_network',
    'password' : 'wifi_password',
    'aio_username' : 'my_adafruit_io_username',
    'aio_key' : 'my_adafruit_io_key',
    'timezone' : "America/New_York", # http://worldtimeapi.org/timezones
}
```

Copy and paste that text/code into a file called secrets.py and save it to your CIRCUITPY folder like so:



Inside is a python dictionary named secrets with a line for each entry. Each entry has an entry name (say `'ssid'`) and then a colon to separate it from the entry key `'home ssid'` and finally a comma ,

At a minimum you'll need to adjust the `ssid` and `password` for your local WiFi setup so do that now!

As you make projects you may need more tokens and keys, just add them one line at a time. See for example other tokens such as one for accessing github or the hackaday API. Other non-secret data like your timezone can also go here, just cause its called secrets doesn't mean you can't have general customization data in there!

For the correct time zone string, look at <http://worldtimeapi.org/timezones> (<https://adafru.it/Ecp>) and remember that if your city is not listed, look for a city in the same time zone, for example Boston, New York, Philadelphia, Washington DC, and Miami are all on the same time as New York.

Of course, don't share your secrets.py - keep that out of GitHub, Discord or other project-sharing sites.

Don't share your secrets.py file, it has your passwords and API keys in it!

Connect to WiFi

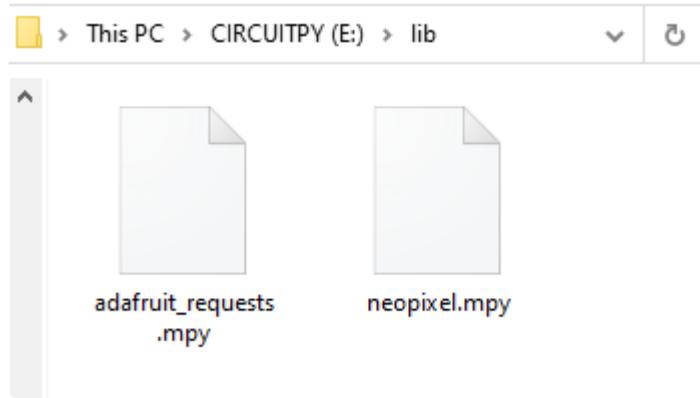
OK now you have your secrets setup - you can connect to the Internet using the Requests module.

First make sure you are running the [latest version of Adafruit CircuitPython](https://adafru.it/Amd) (<https://adafru.it/Amd>) for your board.

Next you'll need to install the necessary libraries to use the hardware--carefully follow the steps to find and install these libraries from [Adafruit's CircuitPython library bundle](https://adafru.it/zdx) (<https://adafru.it/zdx>). Our introduction guide has [a great page on how to install the library bundle](https://adafru.it/ABU) (<https://adafru.it/ABU>).

- adafruit_requests
- neopixel

Before continuing make sure your board's CIRCUITPY/lib folder or root filesystem has the above files copied over.



Once that's done, load up the following example using Mu or your favorite editor:

```
import ipaddress
import ssl
import wifi
import socketpool
import adafruit_requests

# URLs to fetch from
TEXT_URL = "http://wifitest.adafruit.com/testwifi/index.html"
JSON_QUOTES_URL = "https://www.adafruit.com/api/quotes.php"
JSON_STARS_URL = "https://api.github.com/repos/adafruit/circuitpython"

# Get wifi details and more from a secrets.py file
try:
    from secrets import secrets
except ImportError:
    print("WiFi secrets are kept in secrets.py, please add them there!")
    raise

print("ESP32-S2 WebClient Test")

print("My MAC addr:", [hex(i) for i in wifi.radio.mac_address])

print("Available WiFi networks:")
for network in wifi.radio.start_scanning_networks():
    print("\t%s\tRSSI: %d\tChannel: %d" % (str(network.ssid, "utf-8"),
                                              network.rssi, network.channel))
wifi.radio.stop_scanning_networks()

print("Connecting to %s"%secrets["ssid"])
wifi.radio.connect(secrets["ssid"], secrets["password"])
print("Connected to %s!"%secrets["ssid"])
print("My IP address is", wifi.radio.ipv4_address)

ipv4 = ipaddress.ip_address("8.8.4.4")
print("Ping google.com: %f ms" % (wifi.radio.ping(ipv4)*1000))

pool = socketpool.SocketPool(wifi.radio)
requests = adafruit_requests.Session(pool, ssl.create_default_context())

print("Fetching text from", TEXT_URL)
response = requests.get(TEXT_URL)
print("-" * 40)
print(response.text)
print("-" * 40)

print("Fetching json from", JSON_QUOTES_URL)
response = requests.get(JSON_QUOTES_URL)
print("-" * 40)
print(response.json())
```

```

print("-" * 40)

print()

print("Fetching and parsing json from", JSON_STARS_URL)
response = requests.get(JSON_STARS_URL)
print("-" * 40)
print("CircuitPython GitHub Stars", response.json()["stargazers_count"])
print("-" * 40)

print("done")

```

And save it to your board. Make sure the file is named code.py.

Open up your REPL, you should see something like the following:

```

1. screen /Users/brentrubell (screen)
Auto-reload is on. Simply save files over USB to run them or enter REPL to disable.
code.py output:
ESP32-S2 WebClient Test
My MAC addr: ['0x7c', '0xdf', '0xa1', '0x0', '0x52', '0xa0']
Available WiFi networks:
    Brunelleschi      RSSI: -84      Channel: 6
    Transit          RSSI: -54      Channel: 1
    Fios-5dLNb       RSSI: -66      Channel: 1
    disconnected     RSSI: -86      Channel: 1
    SKJFios-ZV007    RSSI: -83      Channel: 11
    Fios-QIVUQ       RSSI: -83      Channel: 11
    Fios-ZV007        RSSI: -85      Channel: 11
    [REDACTED]         RSSI: -58      Channel: 2
    [REDACTED]         RSSI: -76      Channel: 8
    NETGEAR52        RSSI: -81      Channel: 10
Connecting to Transit
Connected to Transit!
None
My IP address is 192.168.1.182
Ping google.com: 0.065000 ms
Fetching text from http://wifitest.adafruit.com/testwifi/index.html
-----
This is a test of Adafruit WiFi!
If you can read this, its working :)

-----
Fetching json from https://www.adafruit.com/api/quotes.php
[{"text": "Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth", "author": "Jules Verne"}]
-----

Fetching and parsing json from https://api.github.com/repos/adafruit/circuitpython
-----
CircuitPython GitHub Stars 1896
-----
done

```

In order, the example code...

Checks the ESP32-S2's MAC address.

```

print("My MAC addr:", [hex(i) for i in wifi.radio.mac_address])

```

Performs a scan of all access points and prints out the access point's name (SSID), signal strength (RSSI), and channel.

```

print("Available WiFi networks:")
for network in wifi.radio.start_scanning_networks():
    print("\t%s\tRSSI: %d\tChannel: %d" % (str(network.ssid, "utf-8"),

```

```
    network.rssi, network.channel))  
wifi.radio.stop_scanning_networks()
```

Connects to the access point you defined in the secrets.py file, prints out its local IP address, and attempts to ping google.com to check its network connectivity.

```
print("Connecting to %s"%secrets["ssid"])  
wifi.radio.connect(secrets["ssid"], secrets["password"])  
print("Connected to %s!"%secrets["ssid"])  
print("My IP address is", wifi.radio.ipv4_address)  
  
ipv4 = ipaddress.ip_address("8.8.4.4")  
print("Ping google.com: %f ms" % wifi.radio.ping(ipv4))
```

The code creates a socketpool using the wifi radio's available sockets. This is performed so we don't need to re-use sockets. Then, it initializes a new instance of the [requests](https://adafruit.it/E9o) (<https://adafruit.it/E9o>) interface - which makes getting data from the internet really really easy.

```
pool = socketpool.SocketPool(wifi.radio)  
requests = adafruit_requests.Session(pool, ssl.create_default_context())
```

To read in plain-text from a web URL, call `requests.get` - you may pass in either a http, or a https url for SSL connectivity.

```
print("Fetching text from", TEXT_URL)  
response = requests.get(TEXT_URL)  
print("-" * 40)  
print(response.text)  
print("-" * 40)
```

Requests can also display a JSON-formatted response from a web URL using a call to `requests.get`.

```
print("Fetching json from", JSON_QUOTES_URL)  
response = requests.get(JSON_QUOTES_URL)  
print("-" * 40)  
print(response.json())  
print("-" * 40)
```

Finally, you can fetch and parse a JSON URL using `requests.get`. This code snippet obtains the `stargazers_count` field from a call to the GitHub API.

```
print("Fetching and parsing json from", JSON_STARS_URL)  
response = requests.get(JSON_STARS_URL)  
print("-" * 40)  
print("CircuitPython GitHub Stars", response.json()["stargazers_count"])  
print("-" * 40)
```

OK you now have your ESP32-S2 board set up with a proper secrets.py file and can connect over the Internet. If not, check that your secrets.py file has the right ssid and password and retrace your steps until you get the Internet connectivity working!

Getting The Date & Time

A very common need for projects is to know the current date and time. Especially when you want to deep sleep until an event, or you want to change your display based on what day, time, date, etc. it is

Determining the correct local time is really really hard. There are various time zones, Daylight Savings dates, leap seconds, etc. Trying to get NTP time and then back-calculating what the local time is, is extraordinarily hard on a microcontroller just isn't worth the effort and it will get out of sync as laws change anyways.

For that reason, we have the free adafruit.io time service. Free for anyone, with a free adafruit.io account. You do need an account because we have to keep accidentally mis-programmed-board from overwhelming adafruit.io and lock them out temporarily. Again, it's free!

There are other services like WorldTimeAPI, but we don't use those for our guides because they are nice people and we don't want to accidentally overload their site. Also, there's a chance it may eventually go down or also require an account.

Step 1) Make an Adafruit account

It's free! Visit <https://accounts.adafruit.com/> (<https://adafru.it/dyy>) to register and make an account if you do not already have one

Step 2) Sign into Adafruit IO

Head over to io.adafruit.com (<https://adafru.it/fsU>) and click Sign In to log into IO using your Adafruit account. It's free and fast to join.

Step 3) Get your Adafruit IO Key

Click on My Key in the top bar



You will get a popup with your Username and Key (In this screenshot, we've covered it with red blocks)

YOUR ADAFRUIT IO KEY

Your Adafruit IO Key should be kept in a safe place and treated with the same care as your Adafruit username and password. People who have access to your Adafruit IO Key can view all of your data, create new feeds for your account, and manipulate your active feeds.

If you need to regenerate a new Adafruit IO Key, all of your existing programs and scripts will need to be manually changed to the new key.

Username

Active Key **REGENERATE KEY**

[Hide Code Sample](#)

Go to your secrets.py file on your CIRCUITPY drive and add three lines for `aio_username`, `aio_key` and `timezone` so you get something like the following:

```
# This file is where you keep secret settings, passwords, and tokens!
# If you put them in the code you risk committing that info or sharing it

secrets = {
    'ssid' : 'home_wifi_network',
    'password' : 'wifi_password',
    'aio_username' : 'my_adafruit_io_username',
    'aio_key' : 'my_adafruit_io_key',
    'timezone' : "America/New_York", # http://worldtimeapi.org/timezones
}
```

The timezone is optional, if you don't have that entry, adafruit.io will guess your timezone based on geographic IP address lookup. You can visit <http://worldtimeapi.org/timezones> (<https://adafru.it/EcP>) to see all the time zones available (even though we do not use worldtimeapi for time-keeping we do use the same time zone table)

Step 4) Upload Test Python Code

This code is like the Internet Test code from before, but this time it will connect to adafruit.io and get the local time

```
import ipaddress
import ssl
import wifi
```

```

import socketpool
import adafruit_requests
import secrets

TEXT_URL = "http://wifitest.adafruit.com/testwifi/index.html"
JSON_QUOTES_URL = "https://www.adafruit.com/api/quotes.php"
JSON_STARS_URL = "https://api.github.com/repos/adafruit/circuitpython"

# Get wifi details and more from a secrets.py file
try:
    from secrets import secrets
except ImportError:
    print("WiFi secrets are kept in secrets.py, please add them there!")
    raise

# Get our username, key and desired timezone
aio_username = secrets["aio_username"]
aio_key = secrets["aio_key"]
location = secrets.get("timezone", None)
TIME_URL = "https://io.adafruit.com/api/v2/%s/integrations/time/strftime?x-aio-\
key=%s" % (aio_username, aio_key)
TIME_URL += "&fmt=%25Y-%25m-%25d+%25H%3A%25M%3A%25S.%25L+%25j+%25u+%25z+%25Z"

print("ESP32-S2 Adafruit IO Time test")

print("My MAC addr:", [hex(i) for i in wifi.radio.mac_address])

print("Available WiFi networks:")
for network in wifi.radio.start_scanning_networks():
    print("\t%s\tRSSI: %d\tChannel: %d" % (str(network.ssid, "utf-8"),
                                             network.rssi, network.channel))
wifi.radio.stop_scanning_networks()

print("Connecting to %s" % secrets["ssid"])
wifi.radio.connect(secrets["ssid"], secrets["password"])
print("Connected to %s!" % secrets["ssid"])
print("My IP address is", wifi.radio.ipv4_address)

ipv4 = ipaddress.ip_address("8.8.4.4")
print("Ping google.com: %f ms" % wifi.radio.ping(ipv4))

pool = socketpool.SocketPool(wifi.radio)
requests = adafruit_requests.Session(pool, ssl.create_default_context())

print("Fetching text from", TIME_URL)
response = requests.get(TIME_URL)
print("-" * 40)
print(response.text)
print("-" * 40)

```

After running this, you will see something like the below text. We have blocked out the part with the secret username and key data!

```

Connecting to adafruit
Connected to adafruit!
My IP address is 10.0.1.148
Ping google.com: 0.008000 ms
Fetching text from https://io.adafruit.com/api/v2/[REDACTED]/integrations/time/strftime?x-aio-\
key=[REDACTED]&fmt=%25Y-%25m-%25d+%25H%3A%25M%3A%25S.%25L+%25j+%25u+%25z+%25Z
-----
2020-12-05 18:51:32.145 340 6 -0500 EST
-----
```

Note at the end you will get the date, time, and your timezone! If so, you have correctly configured your secrets.py and can continue to the next steps!

MagTag-Specific CircuitPython Libraries

To use all the amazing features of your MagTag with CircuitPython, you must first install a number of libraries. This page covers that process.

Get Latest Adafruit CircuitPython Bundle

Download the Adafruit CircuitPython Library Bundle. You can find the latest release here:

Download the latest Library Bundle
from circuitpython.org

<https://adafru.it/ENC>

Download the adafruit-circuitpython-bundle-version-mpy-*.zip bundle zip file, and unzip a folder of the same name. Inside you'll find a lib folder. The entire collection of libraries is too large to fit on the CIRCUITPY drive. Therefore, you'll need to copy the necessary libraries to your board individually.

At a minimum, the following libraries are required. Copy the following folders or .mpy files to the lib folder on your CIRCUITPY drive. If the library is a folder, copy the entire folder to the lib folder on your board.

Library folders (copy the whole folder over to lib):

- adafruit_magtag - This is a helper library designed for using all of the features of the MagTag, including networking, buttons, NeoPixels, etc.
- adafruit_portalbase - This library is the base library that adafruit_magtag is built on top of.
- adafruit_bitmap_font - There is fancy font support, and it's easy to make new fonts. This library reads and parses font files.
- adafruit_display_text - This library displays text on the screen.
- adafruit_io - This library helps connect the MagTag to our free data logging and viewing service

Library files:

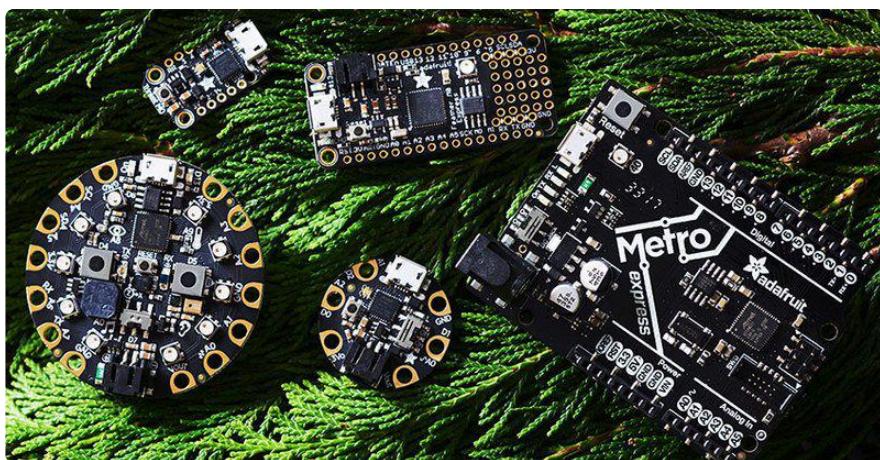
- adafruit_requests.mpy - This library allows us to perform HTTP requests and get responses back from servers. GET/POST/PUT/PATCH - they're all in here!

- adafruit_fakerequests.mpy - This library allows you to create fake HTTP requests by using local files.
- adafruit_minิqr.mpy - QR creation library lets us add easy-to-scan 2D barcodes to the E-Ink display
- neopixel.mpy - This library is used to control the onboard NeoPixels.
- simpleio.mpy - This library is used for tone generation.

Secrets

Even if you aren't planning to go online with your MagTag, you'll need to have a secrets.py file in the root directory (top level) of your CIRCUITPY drive. If you do not intend to connect to wireless, it does not need to have valid data in it. [Here's more info on the secrets.py file \(<https://adafru.it/P3b>\)](#).

Welcome To CircuitPython



So, you've got a new CircuitPython compatible board. You plugged it in. Maybe it showed up as a disk drive called CIRCUITPY. Maybe it didn't! Either way, you need to know where to go from here. Well, this guide has you covered!

This guide will get you started with CircuitPython!

There are many amazing things about your new board. One of them is the ability to run CircuitPython. You may have seen that name on the [Adafruit site \(<https://adafru.it/dAR>\)](#) somewhere. Not sure what it is? This guide can help!

"But I've never coded in my life. There's no way I do it!" You absolutely can! CircuitPython is designed to help you learn from the ground up. If you're new to everything, this is the place to start!

This guide will walk you through how to get started with CircuitPython. You'll learn how to install CircuitPython, get updated to the newest version of CircuitPython, setup a serial connection, and edit your code. You'll learn some basics of how CircuitPython works, and about the CircuitPython libraries. You'll also find a list of frequently asked questions, and a series of troubleshooting steps if you run into any issues.

Welcome to CircuitPython!

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



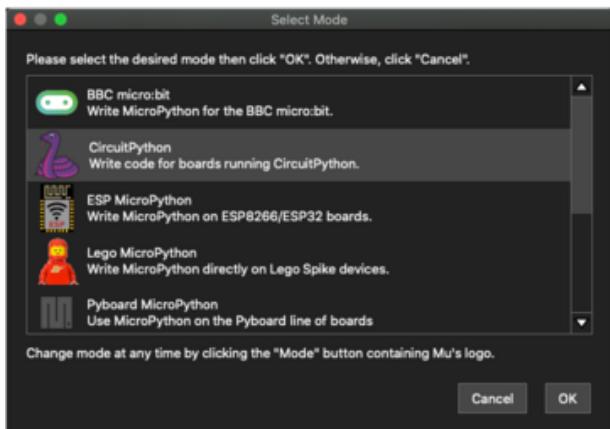
Download Mu from <https://codewith.mu> (<https://adafru.it/Be6>).

Click the Download link for downloads and installation instructions.

Click Start Here to find a wealth of other information, including extensive tutorials and how-to's.

Windows users: due to the nature of MSI installers, please remove old versions of Mu before installing the latest version.

Starting Up 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.

Mu attempts to auto-detect your board on startup, so if you do not have a CircuitPython board plugged in with a CIRCUITPY drive available, Mu will inform you where it will store any code you save until you plug in a board.

To avoid this warning, plug in a board and ensure that the CIRCUITPY drive is mounted before starting Mu.

Using 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.



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

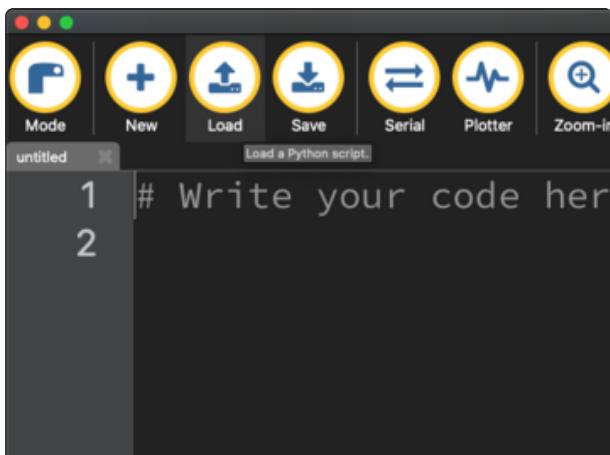
Creating and Editing Code

One of the best things about CircuitPython is how simple it is to get code up and running. This section covers 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. Adafruit strongly recommends 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 a number of other editors that work quite well. The [Recommended Editors page](https://adafru.it/Vue) (<https://adafru.it/Vue>) has more details. Otherwise, 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



Installing CircuitPython generates a code.py file on your CIRCUITPY drive. To begin your own program, open your editor, and load the code.py file from the CIRCUITPY drive.

If you are using Mu, click the Load button in the button bar, navigate to the CIRCUITPY drive, and choose code.py.

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 KB2040, 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 KB2040, QT Py or the Trinkeys!

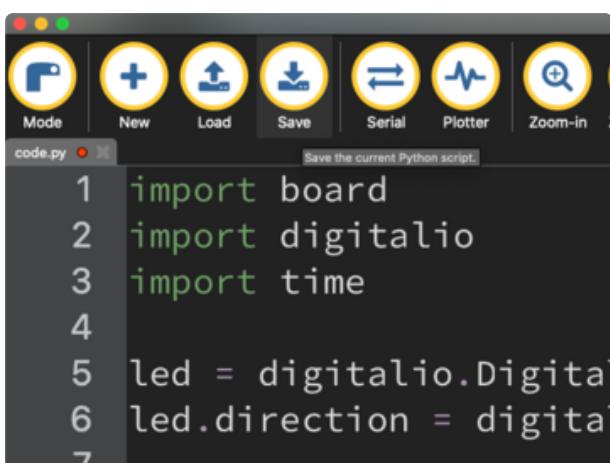
If you're using a KB2040, QT Py or a Trinkey, please download the [NeoPixel blink example \(https://adafruit.io/UDU\)](https://adafruit.io/UDU).

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.



```
code.py
1 import board
2 import digitalio
3 import time
4
5 led = digitalio.DigitalInOut(board.LED)
6 led.direction = digitalio.Direction.OUTPUT
7
8 while True:
9     led.value = True
10    time.sleep(0.5)
11    led.value = False
12    time.sleep(0.5)
13
```

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



```
code.py
1 import board
2 import digitalio
3 import time
4
5 led = digitalio.DigitalInOut(board.LED)
6 led.direction = digitalio.Direction.OUTPUT
7
```

Save the code.py file on your CIRCUITPY drive.

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

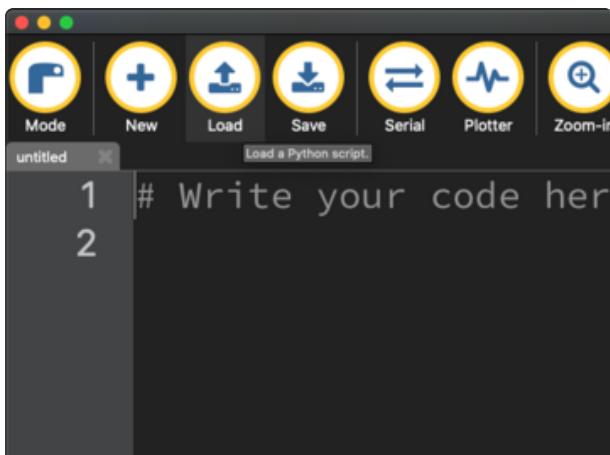
Congratulations, you've just run your first CircuitPython program!

On most boards you'll find a tiny red LED.

On the ItsyBitsy nRF52840, you'll find a tiny blue LED.

On QT Py M0, QT Py RP2040, and the Trinkey series, you will find only an RGB NeoPixel LED.

Editing Code



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 one warning before you continue...

Don't click reset or unplug your board!

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. 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 couple of ways to avoid filesystem corruption.

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

Check out the [Recommended Editors page](https://adafru.it/Vue) (<https://adafru.it/Vue>) for details on different editing options.

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 \(<https://adafru.it/Den>\)](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. You'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?

You 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 `code.py` is the recommended name for 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 (and Python) looks like this:

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

This line in your `code.py` 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 display those too.

The serial console requires an editor that has a built in terminal, or a separate terminal program. A terminal is a program that gives you a text-based interface to perform various tasks.

Are you using Mu?

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

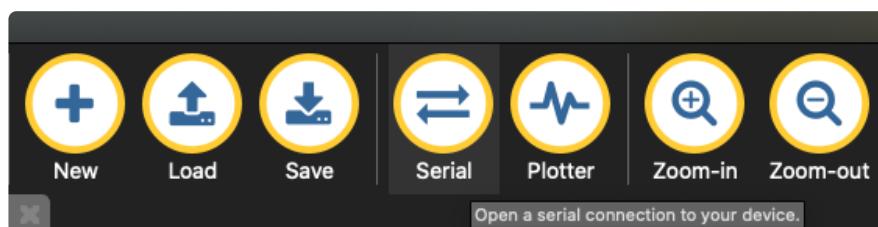


First, make sure your CircuitPython board is plugged in.

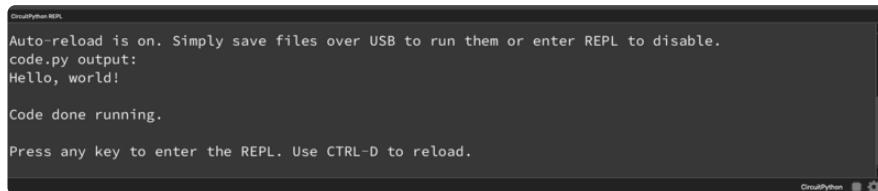
If you open Mu without a board plugged in, you may encounter the error seen here, letting you know no CircuitPython board was found and indicating where your code will be stored until you plug in a board.

If you are using Windows 7, make sure you installed the drivers (<https://adafru.it/VuB>).

Once you've opened Mu with your board plugged in, look for the Serial button in the button bar and click it.



The Mu window will split in two, horizontally, and display the serial console at the bottom.



CircuitPython REPL
Auto-reload is on. Simply save files over USB to run them or enter REPL to disable.
code.py output:
Hello, world!

Code done running.

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

If nothing appears in the serial console, it may mean your code is done running or has no print statements in it. Click into the serial console part of Mu, and press **CTRL+D** to reload.

Serial Console Issues or Delays on Linux

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 **modemmanager**, type the following command at a shell:

```
sudo apt purge modemmanager
```

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.



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 the [Advanced](#)

[Serial Console on Linux](https://adafru.it/VAO) (<https://adafru.it/VAO>) 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 from a separate program.

Windows requires you to download a terminal program. [Check out the Advanced Serial Console on Windows page for more details.](https://adafru.it/AAH) (<https://adafru.it/AAH>)

MacOS has Terminal built in, though there are other options available for download. [Check the Advanced Serial Console on Mac page for more details.](https://adafru.it/AAl) (<https://adafru.it/AAl>)

Linux has a terminal program built in, though other options are available for download. [Check the Advanced Serial Console on Linux page for more details.](https://adafru.it/VAO) (<https://adafru.it/VAO>)

Once connected, you'll see something like the following.

```
Auto-reload is on. Simply save files over USB to run them or enter REPL to disable.  
code.py output:  
Hello, world!  
  
Code done running.  
  
Press any key to enter the REPL. Use CTRL-D to reload.
```

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, you'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:

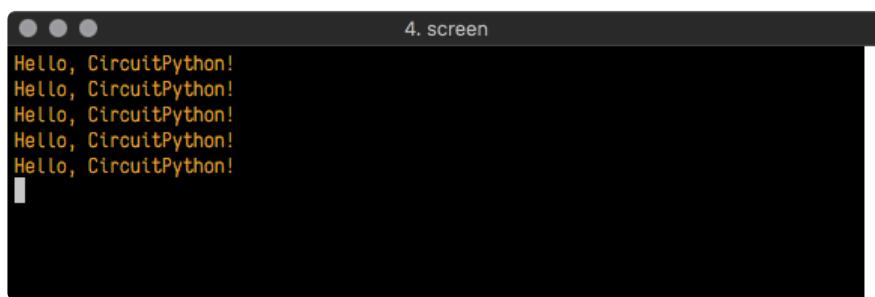
```
import board  
import digitalio  
import time
```

```
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.



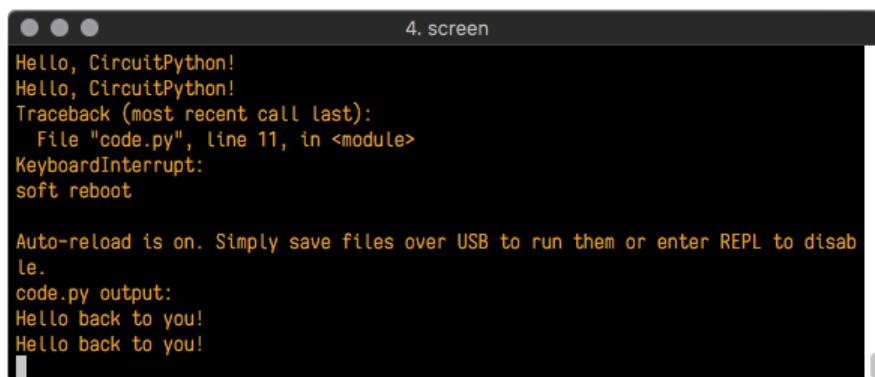
Excellent! Our print statement is showing up in our console! Try changing the printed text to something else.

```
import board
import digitalio
import time

led = digitalio.DigitalInOut(board.LED)
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!



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 you 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.LED)
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. You 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!

The screenshot shows a terminal window titled "5. screen". The terminal output is as follows:

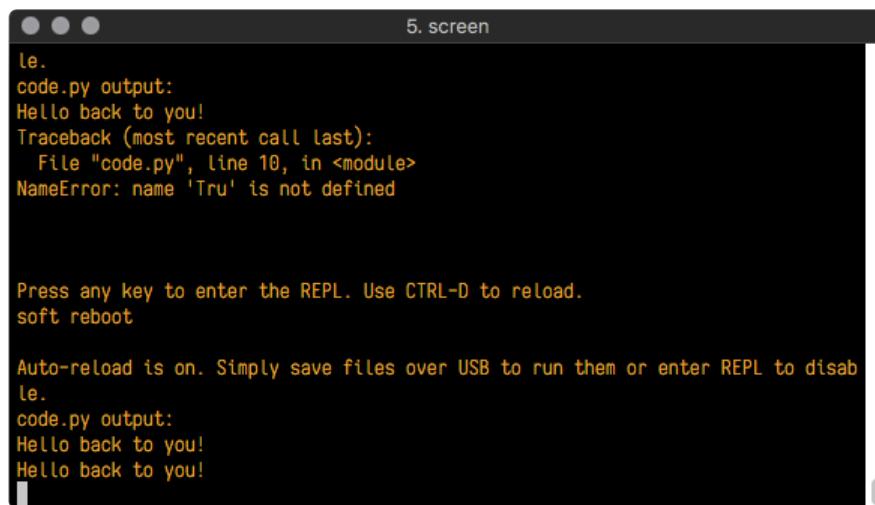
```
Hello back to you!
Traceback (most recent call last):
  File "code.py", line 13, in <module>
KeyboardInterrupt:
soft reboot

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



```
5. screen
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 disable.
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, which is called "print debugging". Essentially, 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 Read-Evaluate-Print-Loop, 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.

Entering the REPL

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, in this case code measuring distance, 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.



```
Distance: 14.8 cm
Distance: 6.7 cm
Distance: 3.9 cm
Distance: 3.4 cm
Distance: 6.5 cm
Traceback (most recent call last):
  File "code.py", line 43, in <module>
KeyboardInterrupt:

Code done running.

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

If your code.py file is empty or does not contain a loop, it will show an empty output and `Code done running.`. 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 disable.
code.py output:

Code done running.

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

If you have no code.py on your CIRCUITPY drive, you will enter the REPL immediately after pressing CTRL+C. Again, 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 disable.

Code done running.

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

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



A screenshot of a Mac OS X terminal window titled "Default (tio)". The window contains the text "Adafruit CircuitPython 7.0.0 on 2021-10-26; Adafruit Feather RP2040 with rp2040" followed by a yellow `>>>` prompt.

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 7.0.0 on 2021-10-26; Adafruit Feather RP2040 with rp2040
```

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.

```
>>>
```

Interacting with the REPL

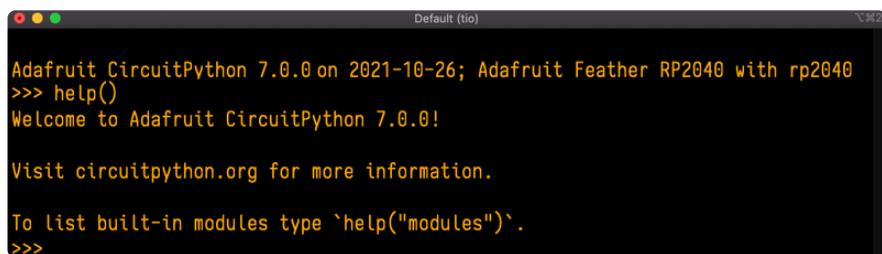
From this prompt you can run all sorts of commands and code. The first thing you'll do is run `help()`. This will tell you where to start exploring the REPL. To run code in the REPL, type it in next to the REPL prompt.

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



A screenshot of a Mac OS X terminal window titled "Default (tio)". The window contains the text "Adafruit CircuitPython 7.0.0 on 2021-10-26; Adafruit Feather RP2040 with rp2040" followed by a yellow `>>> help()` command.

Then press enter. You should then see a message.



A screenshot of a Mac OS X terminal window titled "Default (tio)". The window contains the text "Adafruit CircuitPython 7.0.0 on 2021-10-26; Adafruit Feather RP2040 with rp2040", a yellow `>>> help()` command, and a yellow message "Welcome to Adafruit CircuitPython 7.0.0!". It also includes the text "Visit circuitpython.org for more information." and "To list built-in modules type `help('modules')`." followed by a yellow `>>>` prompt.

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 type `help("modules")`**. Remember the modules 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.

```
>>> help("modules")
__main__      board          micropython    storage
_bleio        builtins       msgpack         struct
adafruit_bus_device   collections  busio          neopixel_write supervisor
adafruit_pixelbuf   countio       onewireio     synthio
aesio          digitalio     os              sys
alarm          displayio     paralleldisplay terminalio
analogio       errno         pulseio        time
array          fontio        pwmio          touchio
atexit         framebufferio  qrio           traceback
audiobusio     gc            rainbowio     ulab
audiocore      getpass       random         usb_cdc
audiomixer     imagecapture  re              usb_hid
audiomp3       io            rgbmatrix     usb_midi
audiopwmio    json          rotaryio      vectorio
binascii       keypad        rp2pio        watchdog
bitbangio      keypad        rtc            sdcardio
bitmaptools    math          microcontroller sharpdisplay
bitops         microcontroller
Plus any modules on the filesystem
>>>
```

This is a list of all the core modules built into CircuitPython, including `board`. Remember, `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__', '__name__', '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', 'board_id']
>>> |
```

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." You'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. 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 modules are available and explore those modules.

Try typing more into the REPL to see what happens!

Everything typed into the REPL is ephemeral. Once you reload the REPL or return to the serial console, nothing you typed will be retained in any memory space. So be sure to save any desired code you wrote somewhere else, or you'll lose it when you leave the current REPL instance!

Returning to the Serial Console

When you're ready to leave the REPL and return to the serial console, simply press CT RL+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!



Advanced Serial Console on Windows

Windows 7 and 8.1

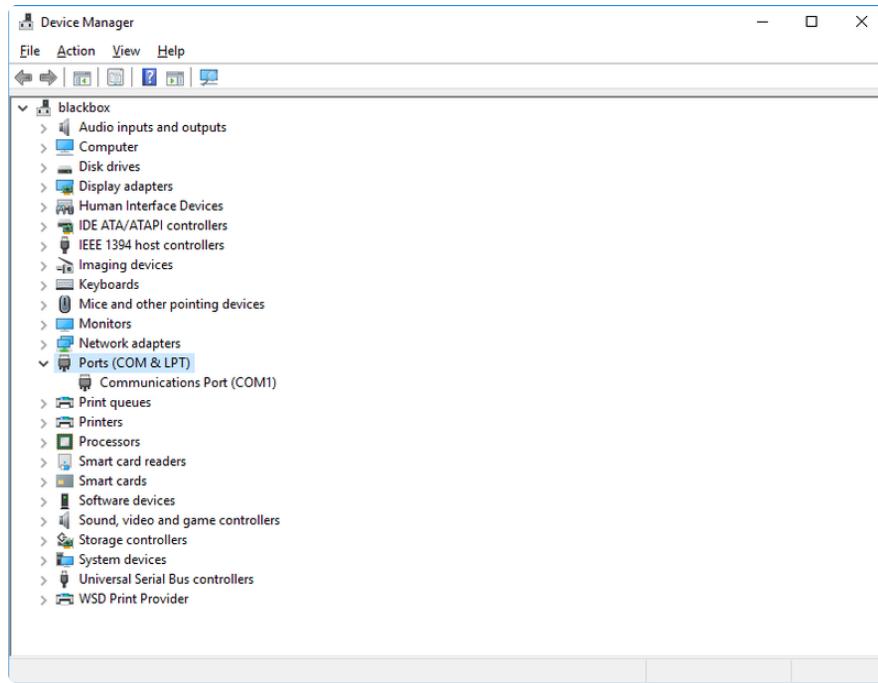
If you're using Windows 7 (or 8 or 8.1), you'll need to install drivers. See the [Windows 7 and 8.1 Drivers page](https://adafru.it/VuB) (<https://adafru.it/VuB>) for details. You will not need to install drivers on Mac, Linux or Windows 10.

You are strongly encouraged 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/RWc>).

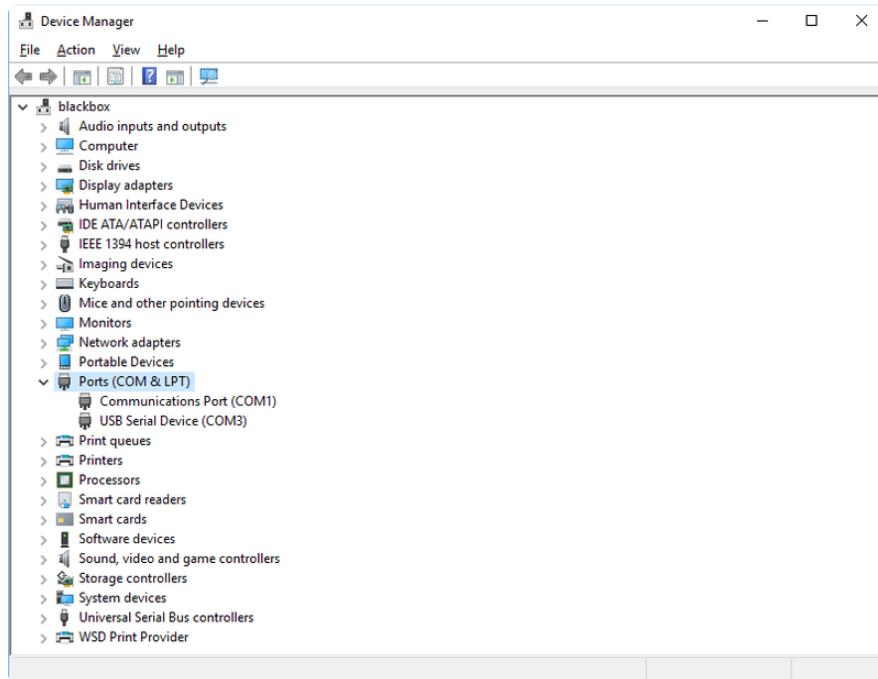
What's the COM?

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.

You'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.



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.



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. You're going to use PuTTY.

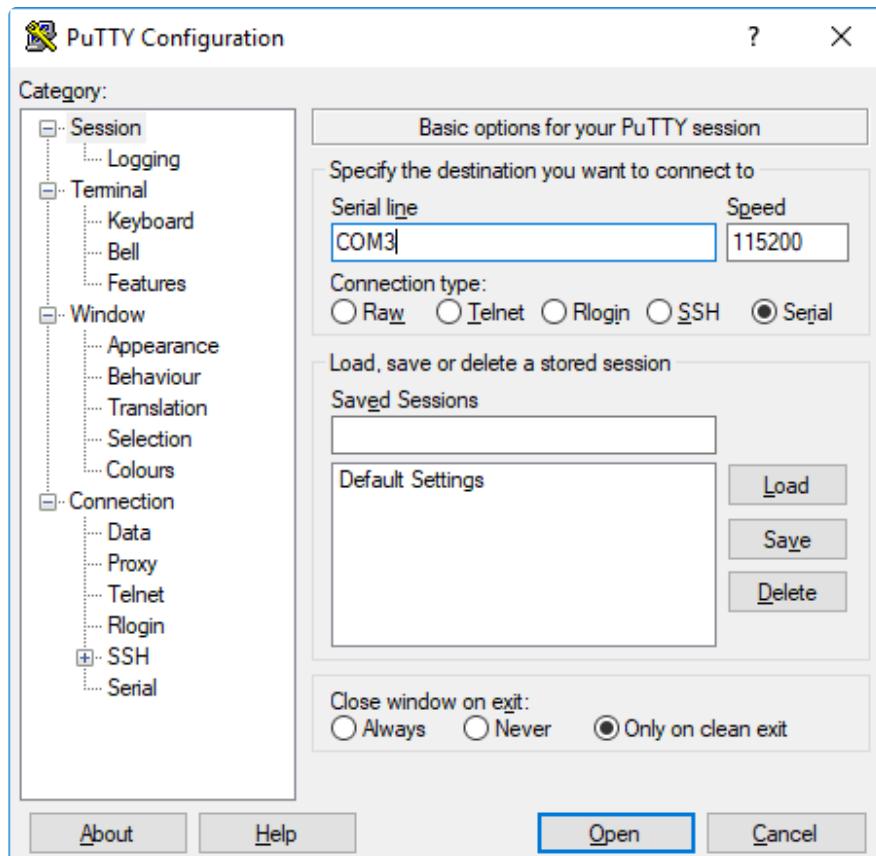
The first thing to do is download the [latest version of PuTTY](https://adafruit.it/Bf1) (<https://adafruit.it/Bf1>).

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.

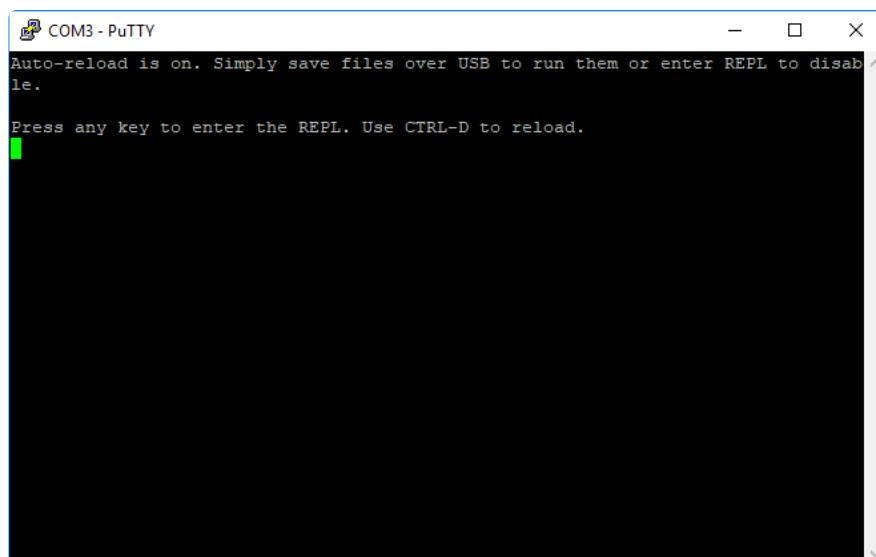
Now you need to open PuTTY.

- 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.



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.



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.

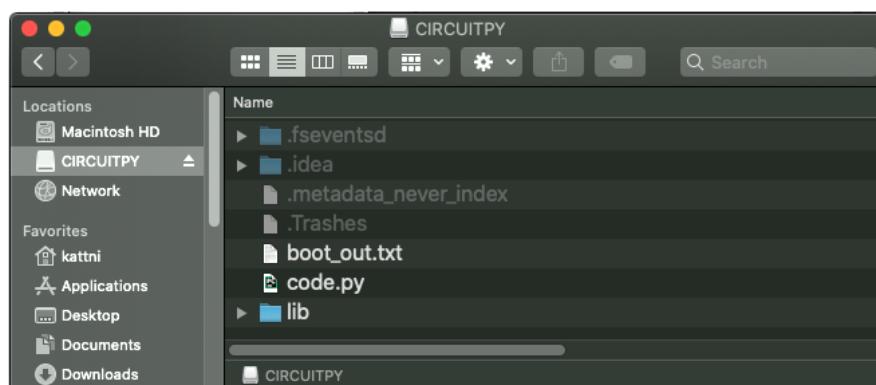
Great job! You've connected to the serial console!

CircuitPython Libraries

As CircuitPython development continues and there are new releases, Adafruit 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 great 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 an excellent reference for how it all should work. In Python terms, you 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, there is a library bundle.

The bundle and the library releases on GitHub 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.

Due to the regular updates and space constraints, Adafruit does not ship boards with the entire bundle. Therefore, you will need to load the libraries you need when you begin working with your board. You can find example code in the guides for your board that depends on external libraries.

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

The Adafruit CircuitPython Library Bundle

Adafruit provides CircuitPython libraries for much of the hardware they provide, including sensors, breakouts and more. To eliminate the need for searching for each library individually, the libraries are available together in the Adafruit CircuitPython Library Bundle. The bundle contains all the files needed to use each library.

Downloading the Adafruit CircuitPython Library Bundle

You can download the latest Adafruit CircuitPython Library Bundle release by clicking the button below. The libraries are being constantly updated and improved, so you'll always want to download the latest bundle.

Match up the bundle version with the version of CircuitPython you are running. For example, you would download the 6.x library bundle if you're running any version of CircuitPython 6, or the 7.x library bundle if you're running any version of CircuitPython 7, etc. If you mix libraries with major CircuitPython versions, you will get incompatible mpy errors due to changes in library interfaces possible during major version changes.

Click to visit circuitpython.org for the
latest Adafruit CircuitPython Library
Bundle

<https://adafru.it/ENC>

Download the bundle version that matches your CircuitPython firmware version. If you don't know the version, check the version info in boot_out.txt file on the CIRCUITPY drive, or the initial prompt in the CircuitPython REPL. For example, if you're running v7.0.0, download the 7.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.

The CircuitPython Community Library Bundle

The CircuitPython Community Library Bundle is made up of libraries written and provided by members of the CircuitPython community. These libraries are often written when community members encountered hardware not supported in the Adafruit Bundle, or to support a personal project. The authors all chose to submit these libraries to the Community Bundle make them available to the community.

These libraries are maintained by their authors and are not supported by Adafruit. As you would with any library, if you run into problems, feel free to file an issue on the GitHub repo for the library. Bear in mind, though, that most of these libraries are supported by a single person and you should be patient about receiving a response. Remember, these folks are not paid by Adafruit, and are volunteering their personal time when possible to provide support.

Downloading the CircuitPython Community Library Bundle

You can download the latest CircuitPython Community Library Bundle release by clicking the button below. The libraries are being constantly updated and improved, so you'll always want to download the latest bundle.

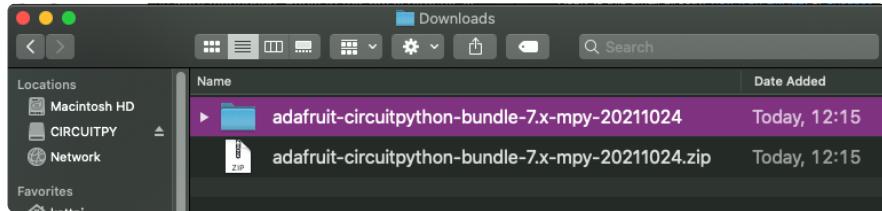
Click for the latest CircuitPython
Community Library Bundle release

<https://adafru.it/VCn>

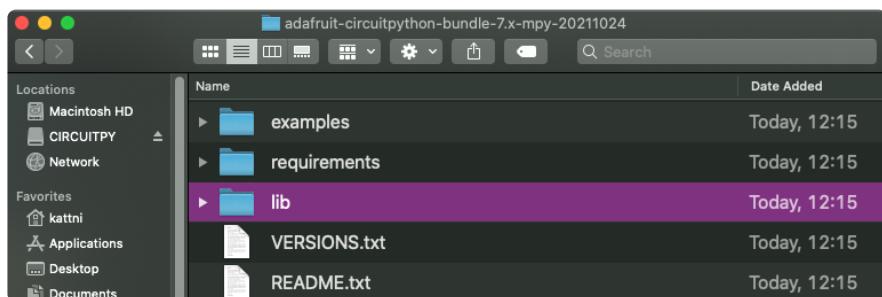
The link takes you to the latest release of the CircuitPython Community Library Bundle on GitHub. There are multiple versions of the bundle available. Download the bundle version that matches your CircuitPython firmware version. If you don't know the version, check the version info in boot_out.txt file on the CIRCUITPY drive, or the initial prompt in the CircuitPython REPL. For example, if you're running v7.0.0, download the 7.x library bundle.

Understanding the Bundle

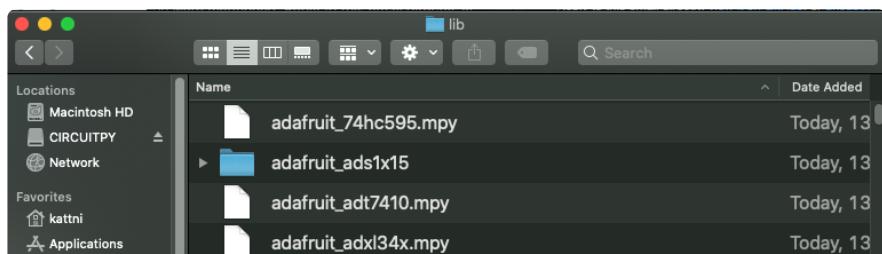
After downloading the zip, extract its contents. This is usually done by double clicking on the zip. On Mac OSX, it places the file in the same directory as the zip.



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.



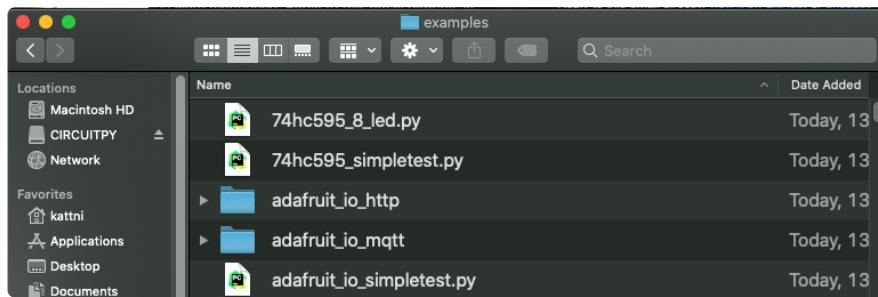
Now open the lib folder. When you open the folder, you'll see a large number of .mpy files, and folders.



Example Files

All example files from each library are now included in the bundles in an examples directory (as seen above), 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.



Copying Libraries to Your Board

First open the lib folder on your CIRCUITPY drive. 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.

If the library is a directory with multiple .mpy files in it, be sure to copy the entire folder to CIRCUITPY/lib.

This also applies to example files. Open the examples folder you extracted from the downloaded zip, and copy the applicable file to your CIRCUITPY drive. Then, rename it to code.py to run it.

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

Understanding Which Libraries to Install

You now know how to load libraries on to your CircuitPython-compatible microcontroller board. You may now be wondering, how do you know which libraries you need to install? Unfortunately, it's not always straightforward. Fortunately, there is an obvious place to start, and a relatively simple way to figure out the rest. First up: the best place to start.

When you look at most CircuitPython examples, you'll see they begin with one or more `import` statements. These typically look like the following:

- `import library_or_module`

However, `import` statements can also sometimes look like the following:

- `from library_or_module import name`

- `from library_or_module.subpackage import name`
- `from library_or_module import name as local_name`

They can also have more complicated formats, such as including a `try / except` block, etc.

The important thing to know is that an `import` statement will always include the name of the module or library that you're importing.

Therefore, the best place to start is by reading through the `import` statements.

Here is an example import list for you to work with in this section. There is no setup or other code shown here, as the purpose of this section involves only the import list.

```
import time
import board
import neopixel
import adafruit_lis3dh
import usb_hid
from adafruit_hid.consumer_control import ConsumerControl
from adafruit_hid.consumer_control_code import ConsumerControlCode
```

Keep in mind, not all imported items are libraries. Some of them are almost always built-in CircuitPython modules. How do you know the difference? Time to visit the REPL.

In the [Interacting with the REPL section](https://adafru.it/Awz) (<https://adafru.it/Awz>) on [The REPL page](http://adafru.it/Awz) (<http://adafru.it/Awz>) in this guide, the `help("modules")` command is discussed. This command provides a list of all of the built-in modules available in CircuitPython for your board. So, if you connect to the serial console on your board, and enter the REPL, you can run `help("modules")` to see what modules are available for your board. Then, as you read through the `import` statements, you can, for the purposes of figuring out which libraries to load, ignore the statement that import modules.

The following is the list of modules built into CircuitPython for the Feather RP2040. Your list may look similar or be anything down to a significant subset of this list for smaller boards.

```
>>> help("modules")
__main__      board      micropython    storage
_bleio        builtins   msgpack       struct
adafruit_bus_device  collections  busio        neopixel_write supervisor
adafruit_pixelbuf  countio     onewireio   synthio
alarm         digitalio  os           sys
analogio     displayio  paralleldisplay terminalio
array         errno      pulseio     time
atexit        fontio     pwmio      touchio
audiobusio   framebufferio rainbowio   traceback
audiocore    gc          random     ubl
audiomixer   getpass    re          usb_cdc
audiomixer   imagecapture  rgbmatrix  usb_hid
audiomp3     io          rotaryio   usb_midi
audiopwmio   json       rp2pio     vectorio
binascii     keypad    rtc        watchdog
bitbangio   math       sdcardio
bitmaptools  microcontroller sharpdisplay
```

Now that you know what you're looking for, it's time to read through the import statements. The first two, `time` and `board`, are on the modules list above, so they're built-in.

The next one, `neopixel`, is not on the module list. That means it's your first library! So, you would head over to the bundle zip you downloaded, and search for neopixel. There is a neopixel.mpy file in the bundle zip. Copy it over to the lib folder on your CIRCUITPY drive. The following one, `adafruit_lis3dh`, is also not on the module list. Follow the same process for adafruit_lis3dh, where you'll find adafruit_lis3dh.mpy, and copy that over.

The fifth one is `usb_hid`, and it is in the modules list, so it is built in. Often all of the built-in modules come first in the import list, but sometimes they don't! Don't assume that everything after the first library is also a library, and verify each import with the modules list to be sure. Otherwise, you'll search the bundle and come up empty!

The final two imports are not as clear. Remember, when `import` statements are formatted like this, the first thing after the `from` is the library name. In this case, the library name is `adafruit_hid`. A search of the bundle will find an adafruit_hid folder. When a library is a folder, you must copy the entire folder and its contents as it is in the bundle to the lib folder on your CIRCUITPY drive. In this case, you would copy the entire adafruit_hid folder to your CIRCUITPY/lib folder.

Notice that there are two imports that begin with `adafruit_hid`. Sometimes you will need to import more than one thing from the same library. Regardless of how many times you import the same library, you only need to load the library by copying over the adafruit_hid folder once.

That is how you can use your example code to figure out what libraries to load on your CircuitPython-compatible board!

There are cases, however, where libraries require other libraries internally. The internally required library is called a dependency. In the event of library dependencies, the easiest way to figure out what other libraries are required is to connect to the serial console and follow along with the `ImportError` printed there. The following is a very simple example of an `ImportError`, but the concept is the same for any missing library.

Example: `ImportError` Due to Missing Library

If you choose to load libraries as you need them, or you're starting fresh with an existing example, you may end up with code that tries to use a library you haven't yet loaded. This section will 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 Blink example.

```
import board
import time
import simpleio

led = simpleio.DigitalOut(board.LED)

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.



A screenshot of a terminal window titled "Default (tio)". The window displays the following text:

```
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 3, in <module>
    ImportError: no module named 'simpleio'

Code done running.

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

You have an `ImportError`. It says there is `no module named 'simpleio'`. That's the one you just included in your 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 you'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 disable.
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 an M0 non-Express board such as Trinket M0, Gemma M0, QT Py M0, or one of the M0 Trinkeys, you'll want to follow the same steps in the example above to install libraries as you need them. Remember, you don't need to wait for an **ImportE
rror** if you know what library you added to your code. Open the library bundle you downloaded, find the library you need, and drag it to the lib folder on your CIRCUITPY drive.

You can still end up running out of space on your M0 non-Express board 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 suggestions on the [Troubleshooting page \(https://adafru.it/Den\)](https://adafru.it/Den).

Updating CircuitPython Libraries and 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.

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. You may have a different board, and this list will vary, based on the board.

```
>>> 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? \(<https://adafruit.it/QkA>\)](https://adafruit.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',
'I01', 'I010', 'I011', 'I012', 'I013', 'I014', 'I015', 'I016', 'I017', 'I018',
'I02', 'I021', 'I03', 'I033', 'I034', 'I035', 'I036', 'I037', 'I04', 'I042', 'I045',
'I05', 'I06', 'I07', 'I08', 'I09', '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())
```

The `board.I2C()`, `board.SPI()`, and `board.UART()` singletons do not exist on all boards. They exist if there are board markings for the default pins for those devices.

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`. 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 a comprehensive list of built-in CircuitPython modules and the technical details of their functionality from CircuitPython [here](https://adafru.it/QkB) (<https://adafru.it/QkB>) and the Python-like modules included [here](https://adafru.it/QkC) (<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 \(https://adafru.it/N2a\)](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    pwmio        pulseio      terminalio
analogio      errno         random       time
array          fontio        re           touchio
audiocore     gamepad      rotaryio    usb_hid
audioio       gc            rtc          usb_midi
board         math          storage     vectorio
builtins       microcontroller struct
busio         micropython
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.

Advanced Serial Console on Mac

Connecting to the serial console on Mac does not require installing any drivers or extra software. You'll use a terminal program to find your board, and `screen` to connect to it. Terminal and `screen` both come installed by default.

What's the Port?

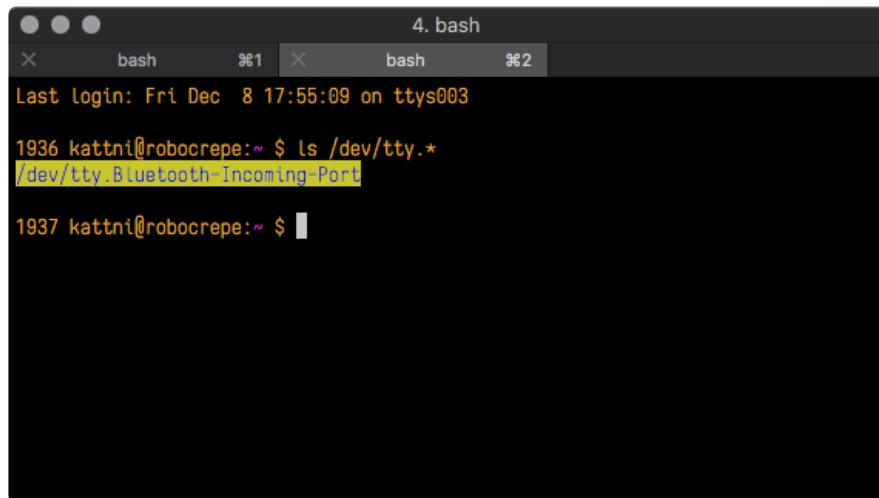
First you'll want to find out which serial port your board is using. When you plug your board in to USB on your computer, it connects to a serial port. The port is like a door through which your board can communicate with your computer using USB.

The easiest way to determine which port the board is using is to first check without the board plugged in. 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, you'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.



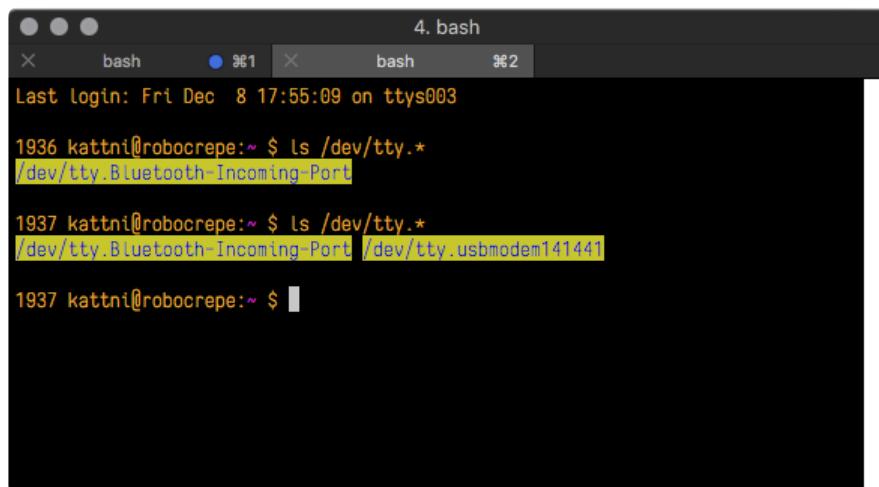
A screenshot of a Mac OS X terminal window titled "4. bash". It shows two tabs: "bash" and "%2". The terminal output is as follows:

```
Last login: Fri Dec 8 17:55:09 on ttys003
1936 kattni@robocrepe:~ $ ls /dev/tty.*
/dev/tty.Bluetooth-Incoming-Port
```

Now, plug your board. In Terminal, type:

```
ls /dev/tty.*
```

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



A screenshot of a Mac OS X terminal window titled "4. bash". It shows two tabs: "bash" and "%2". The terminal output is as follows:

```
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
```

A new listing has appeared called `/dev/tty.usbmodem141441`. The `tty.usbmodem 141441` part of this listing is the name the example board is using. Yours will be called something similar.

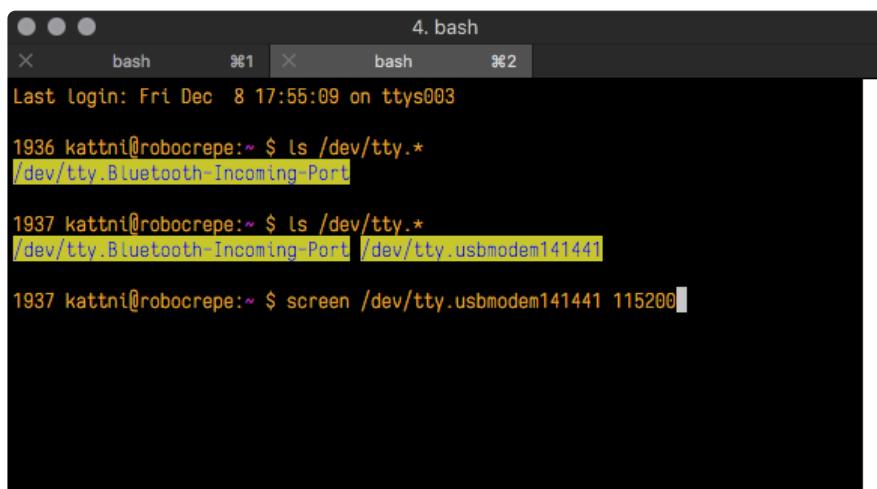
Using Linux, a new listing has appeared called `/dev/ttyACM0`. The `ttyACM0` part of this listing is the name the example board is using. Yours will be called something similar.

Connect with screen

Now that you know the name your board is using, you're ready connect to the serial console. You're going to use a command called `screen`. The `screen` command is included with MacOS. 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.



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!

Frequently Asked Questions

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

As CircuitPython development continues and there are new releases, Adafruit 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 CircuitPython 6.x or earlier. Where can I find compatible libraries?

We are no longer building or supporting the CircuitPython 6.x or earlier library bundles. We highly encourage you to [update CircuitPython to the latest version \(https://adafru.it/Em8\)](https://adafru.it/Em8) and use [the current version of the libraries \(https://adafru.it/ENC\)](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 \(https://adafru.it/FJA\)](https://adafru.it/FJA)
- [3.x bundle \(https://adafru.it/FJB\)](https://adafru.it/FJB)
- [4.x bundle \(https://adafru.it/QDL\)](https://adafru.it/QDL)
- [5.x bundle \(https://adafru.it/QDJ\)](https://adafru.it/QDJ)
- [6.x bundle \(https://adafru.it/Xmf\)](https://adafru.it/Xmf)

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 \(https://adafru.it/CiG\)](https://adafru.it/CiG)!

We do not support ESP32 because it does not have native USB.

We do support ESP32-S2, which has native USB.

How do I connect to the Internet with CircuitPython?

If you'd like to include WiFi in your project, check out [this guide \(https://adafru.it/F5X\)](https://adafru.it/F5X) on using AirLift with CircuitPython. For further project examples, and guides about using AirLift with specific hardware, check out [the Adafruit Learn System \(https://adafru.it/VBr\)](https://adafru.it/VBr).

Is there asyncio support in CircuitPython?

There is preliminary support for asyncio starting with CircuitPython 7.1.0. Read about using it in the [Cooperative Multitasking in CircuitPython \(https://adafru.it/XnA\)](https://adafru.it/XnA) Guide.

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! \(https://adafru.it/Den\)](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.

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 [here \(https://adafru.it/QDK\)](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?

Run the following to see the number of bytes available for use:

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

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 \(https://adafru.it/KJD\)](https://adafru.it/KJD)

CPC = [Circuit Playground Classic \(https://adafru.it/ncE\)](https://adafru.it/ncE)

CPX = [Circuit Playground Express \(https://adafru.it/wpF\)](https://adafru.it/wpF)

CPB = [Circuit Playground Bluefruit \(https://adafru.it/Gpe\)](https://adafru.it/Gpe)

ESP32-S2 Bugs & Limitations

Nobody likes bugs, but all nontrivial software and hardware has some. The master list of problems is the [Issues list on github](https://adafru.it/PEk) (<https://adafru.it/PEk>).

Adafruit considers CircuitPython for the ESP32-S2 to be beta quality software.

Cannot reinitialize certain peripherals (especially busio.I2C)

If you create a `busio.I2C` object, call `.deinit()` on it, and then create another one, CircuitPython will lock up.

Workaround: Do not deinitialize I2C objects, except by soft reload or entering deep sleep.

No DAC-based audio output

Current versions of esp-idf do not have the required APIs for DAC-based audio output. Once a future version of esp-idf that adds it, it will be possible to implement DAC-based AudioOut in CircuitPython.

Workaround: PWMOut can create tones and buzzes.

Workaround: I2SOut audio is currently being developed and will work with boards such as the [Adafruit I2S Stereo Decoder - UDA1334A Breakout](https://adafru.it/PEI) (<https://adafru.it/PEI>).

Deep Sleep & Wake-up sources

ESP32-S2 has hardware limitations on what kind of "pin alarms" can wake it. The following combinations are possible:

- EITHER one or two pins that wake from deep sleep when they are pulled LOW
- OR an arbitrary number of pins that wake from deep sleep when they are pulled HIGH, and optionally one pin that wakes from deep sleep when pulled LOW

This means that "wake" buttons should be wired so that pressing them pulls HIGH and a pull DOWN resistor is used with the pin. However, in some hardware designs

including the original MagTag, the integrated buttons are pulled LOW when pressed and so only 1 or 2 buttons can be selected to wake the MagTag.

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 CircuitPython development continues and there are new releases, Adafruit 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 CircuitPython development continues and there are new releases, Adafruit will stop supporting older releases. You need to [update to the latest CircuitPython. \(https://adafru.it/Em8\)](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 \(http://adafru.it/ENC\)](http://adafru.it/ENC).

As new versions of CircuitPython are released, Adafruit 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?

Adafruit is no longer building or supporting the CircuitPython 5.x or earlier library bundles. You are highly encouraged to [update CircuitPython to the latest version](https://adafru.it/Em8) ([http://adafru.it/Em8](https://adafru.it/Em8)) and use [the current version of the libraries](https://adafru.it/ENC) (<https://adafru.it/ENC>). However, if for some reason you cannot update, links to the previous bundles are available in the [FAQ](https://adafru.it/FwY) (<https://adafru.it/FwY>).

Bootloader (boardnameBOOT) Drive Not Present

You may have a different board.

Only Adafruit Express boards and the SAMD21 non-Express boards ship with the [UF2 bootloader](https://adafru.it/zbX) (<https://adafru.it/zbX>). The Feather M0 Basic, Feather M0 Adalogger, and similar boards use a regular Arduino-compatible bootloader, which does not show a boardnameBOOT drive.

MakeCode

If you are running a [MakeCode](https://adafru.it/zbY) (<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 accompanying SAT SMART Driver can interfere with seeing the BOOT drive. [See this forum post](https://adafru.it/sTc) (<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

To use a CircuitPython-compatible board with Windows 7 or 8.1, you must install a driver. Installation instructions are available [here](https://adafru.it/VuB) (<https://adafru.it/VuB>).

It is [recommended](https://adafru.it/Amd) (<https://adafru.it/Amd>) that you upgrade to Windows 10 if possible; an upgrade is probably still free for you. Check [here](https://adafru.it/Amd) (<https://adafru.it/Amd>).

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.

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 boar dnameBOOT drive.

Let us know in the [Adafruit support forums](https://adafru.it/jlf) (<https://adafru.it/jlf>) 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 that 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: There have been 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. There has not yet been settings change discovered 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. It is [recommended](https://adafru.it/Amd) (<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) (<https://adafru.it/V2a>).

If not, try cleaning up your USB devices. Use [Uwe Sieber's Device Cleanup Tool](http://adafru.it/RWd) (<http://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		
CIRCUITYPY	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	HidLab	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.

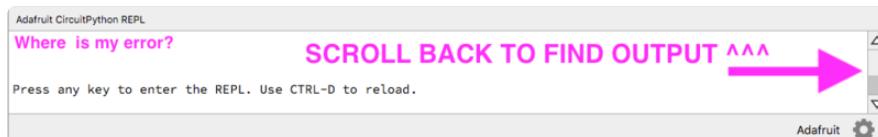
Depending on the size of your screen or Mu window, when you open the serial console, the serial console panel may be very small. This can be a problem. A basic CircuitPython error takes 10 lines to display!

```
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.



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.

code.py Restarts Constantly

CircuitPython will restart code.py if you or your computer writes to something on the CIRCUITPY drive. This feature is called auto-reload, and lets you test a change to your program immediately.

Some utility programs, such as backup, anti-virus, or disk-checking apps, will write to the CIRCUITPY as part of their operation. Sometimes they do this very frequently, causing constant restarts.

Acronis True Image and related Acronis programs on Windows are known to cause this problem. It is possible to prevent this by [disabling the "Acronis Managed Machine Service Mini"](https://adafru.it/XDZ) (<https://adafru.it/XDZ>).

If you cannot stop whatever is causing the writes, you can disable auto-reload by putting this code in boot.py or code.py:

```
import supervisor
supervisor.disable_autoreload()
```

CircuitPython RGB Status Light

Nearly all 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.

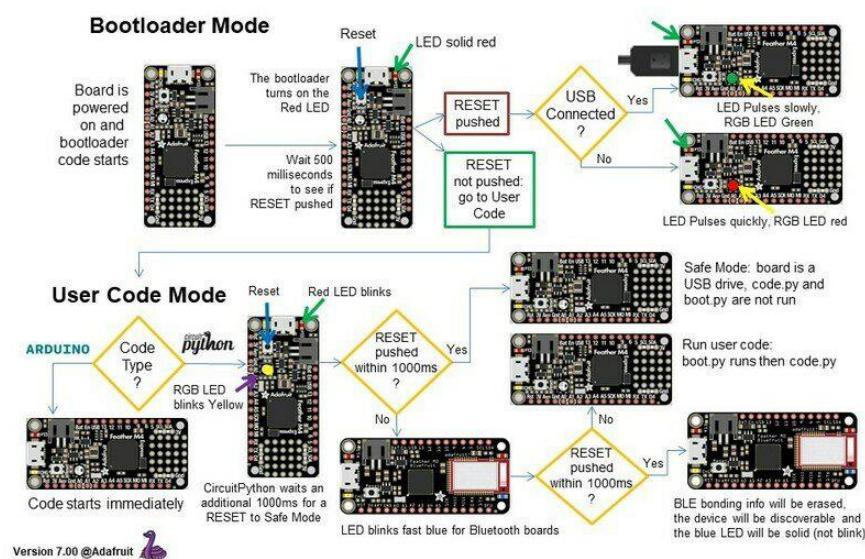
Once started, CircuitPython will blink a pattern every 5 seconds when no user code is running to indicate why the code stopped:

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

The CircuitPython Boot Sequence

Version 7.0 and later



CircuitPython 6.3.0 and earlier

Here's what the colors and blinking mean:

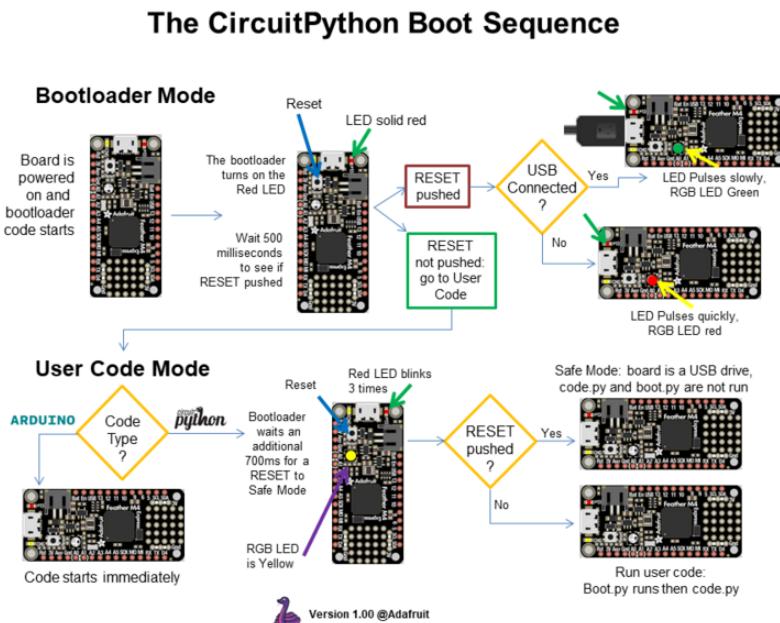
- steady GREEN: code.py (or code.txt, main.py, or main.txt) is running
- pulsing GREEN: code.py (etc.) has finished or does not exist
- steady YELLOW at start up: (4.0.0-alpha.5 and newer) CircuitPython is waiting for a reset to indicate that it should start in safe mode
- pulsing YELLOW: Circuit Python 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. Zeros are indicated by an extra-long dark gap.



Serial console showing **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`. All libraries are available in the [Adafruit bundle \(`https://adafru.it/yE`\)](https://adafru.it/yE).

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. 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, though it is more common on Windows.

Be aware, if you have used Arduino to program your board, CircuitPython is no longer able to provide the USB services. You will need to reload CircuitPython to resolve this situation.

The easiest first step is to reload CircuitPython. Double-tap reset on the board so you get a `boardnameBOOT` drive rather than a `CIRCUITPY` drive, and copy the latest version of CircuitPython (`.uf2`) back to the board. This may restore `CIRCUITPY` functionality.

If reloading CircuitPython does not resolve your issue, the next step is to try putting the board into safe mode.

Safe Mode

Whether you've run into a situation where you can no longer edit `code.py` on your `CIRCUITPY` drive, your board has gotten into a state where `CIRCUITPY` is read-only, or you have turned off the `CIRCUITPY` drive altogether, 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 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 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.)

Entering Safe Mode in CircuitPython 6.x

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.)

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.

At this point, you'll want to remove any user code in code.py and, if present, the boot.py file from CIRCUITPY. Once removed, tap the reset button, or unplug and plug in your board, to restart CircuitPython. This will restart the board and may resolve your drive issues. If resolved, you can begin coding again as usual.

If safe mode does not resolve your issue, 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.

To erase CIRCUITPY: `storage.erase_filesystem()`

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

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

```
&gt;&gt;&gt; import storage  
&gt;&gt;&gt; storage.erase_filesystem()
```

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

Erase CIRCUITPY Without Access to the REPL

If you can't access the REPL, or you're running a version of CircuitPython previous to 2.3.0 and you don't want to upgrade, there are options available for some specific boards.

The options listed below are considered to be the "old way" of erasing your board. The method shown above using the REPL is highly recommended as the best method for erasing your board.

If at all possible, it is recommended to use the REPL to erase your CIRCUITPY drive. The REPL method is explained above.

For the specific boards listed below:

If the board you are trying to erase is listed below, follow the steps to use the file to erase your board.

1. Download the correct erase file:

Circuit Playground Express

<https://adafru.it/Adl>

Feather M0 Express

<https://adafru.it/AdJ>

Feather M4 Express

<https://adafru.it/EVK>

Metro M0 Express

<https://adafru.it/AdK>

Metro M4 Express QSPI Eraser

<https://adafru.it/EoM>

Trellis M4 Express (QSPI)

<https://adafru.it/DjD>

Grand Central M4 Express (QSPI)

<https://adafru.it/DBA>

PyPortal M4 Express (QSPI)

<https://adafru.it/Eca>

Circuit Playground Bluefruit (QSPI)

<https://adafru.it/Gnc>

Monster M4SK (QSPI)

<https://adafru.it/GAN>

PyBadge/PyGamer QSPI Eraser.UF2

<https://adafru.it/GAO>

CLUE_Flash_Erase.UF2

<https://adafru.it/Jat>

Matrix_Portal_M4_(QSPI).UF2

<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 status LED will turn yellow or blue, indicating the erase has started.
5. After approximately 15 seconds, the status LED 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 boardnameBOOT drive.
7. Drag the appropriate latest release of CircuitPython (<https://adafru.it/Em8>) .uf2 file to the boardnameBOOT 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 load your code and reinstall your libraries!

For SAMD21 non-Express boards that have a UF2 bootloader:

Any SAMD21-based microcontroller that does not have external flash available is considered a SAMD21 non-Express board. Non-Express boards that have a UF2 bootloader include Trinket M0, GEMMA M0, QT Py M0, and the SAMD21-based Trinkey boards.

If you are trying to erase a SAMD21 non-Express board, follow these steps to erase your board.

1. Download the erase file:

SAMD21 non-Express Boards

<https://adafru.it/VB->

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 boot LED will start flashing again, and the boardnameBOOT drive will reappear.
5. Drag the appropriate latest release CircuitPython (<https://adafru.it/Em8>) .uf2 file to the boardnameBOOT 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 load your code and reinstall your libraries!

For SAMD21 non-Express boards that do not have a UF2 bootloader:

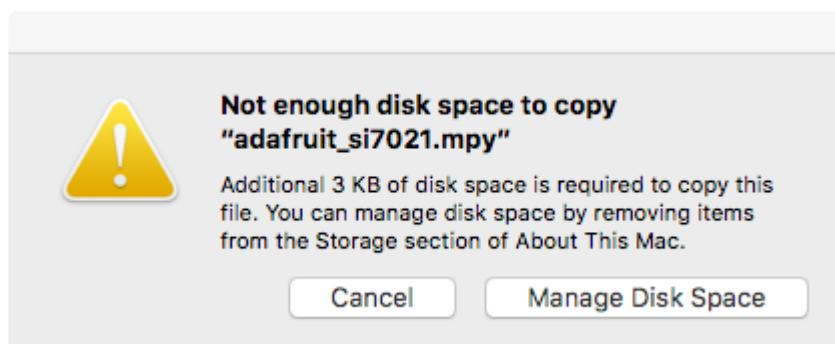
Any SAMD21-based microcontroller that does not have external flash available is considered a SAMD21 non-Express board. Non-Express boards that do not have a UF2 bootloader include the Feather M0 Basic Proto, Feather Adalogger, or the Arduino Zero.

If you are trying to erase a non-Express board that does not have a UF2 bootloader, 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 SAMD21 Non-Express Boards

Any SAMD21-based microcontroller that does not have external flash available is considered a SAMD21 non-Express board. This includes boards like the Trinket M0, GEMMA M0, QT Py M0, and the SAMD21-based Trinkey boards.

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



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.

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. It's ~12KiB or so.

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, that is recommended 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 you're counting bytes.

On MacOS?

MacOS loves to generate hidden files. 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) (<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 .{,_}{fsevents,Spotlight-V*,Trashes}
```

```
mkdir .fsevents.d  
touch .fsevents.d/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 file_name.mpy file to the board use a command like:

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

(Replace file_name.mpy with the name of the file you want to copy.)

Or to copy a folder and all of the files and folders contained within, use a command like:

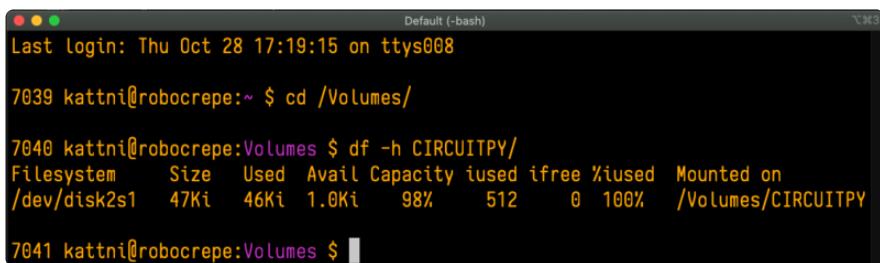
```
cp -rX folder_to_copy /Volumes/CIRCUITPY
```

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 file_name.mpy /Volumes/CIRCUITPY/lib
# This is safer, and will complain if a lib folder does not exist.
cp -X file_name.mpy /Volumes/CIRCUITPY/lib/
```

Other MacOS Space-Saving Tips

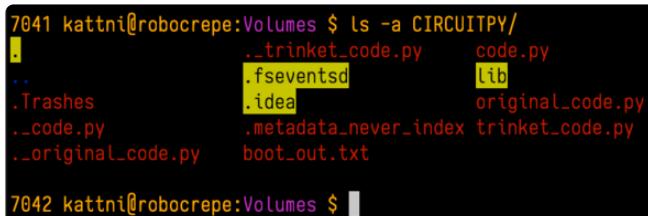
If you'd like to see the amount of space used on the drive and manually delete hidden files here's how to do so. First, move into the Volumes/ directory with `cd /Volumes/`, and then list the amount of space used on the CIRCUITPY drive with the `df` command.



A screenshot of a Mac OS X terminal window titled "Default (-bash)". The window shows the following command-line session:

```
Last login: Thu Oct 28 17:19:15 on ttys008
7039 kattni@robocrepe:~ $ cd /Volumes/
7040 kattni@robocrepe:Volumes $ df -h CIRCUITPY/
Filesystem      Size   Used  Avail Capacity iused ifree %iused Mounted on
/dev/disk2s1    47Ki   46Ki   1.0Ki   98%     512     0  100%  /Volumes/CIRCUITPY
7041 kattni@robocrepe:Volumes $
```

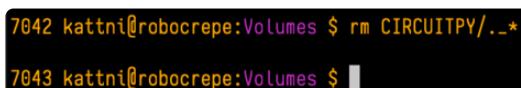
That's not very much space left! The next step is to show a list of the files currently on the CIRCUITPY drive, including the hidden files, using the `ls` command. You cannot use Finder to do this, you must do it via command line!



A screenshot of a Mac OS X terminal window titled "Default (-bash)". The window shows the following command-line session:

```
7041 kattni@robocrepe:Volumes $ ls -a CIRCUITPY/
.
..          ._trinket_code.py      code.py
.Trashes    .fsevents.d        lib
..code.py    .idea              original_code.py
..original_code.py  boot.out.txt
7042 kattni@robocrepe:Volumes $
```

There are a few of the hidden files that MacOS loves to generate, all of which begin with a `._` before the file name. Remove the `._` files using the `rm` command. You can remove them all once by running `rm CIRCUITPY/._*`. The `*` acts as a wildcard to apply the command to everything that begins with `._` at the same time.



A screenshot of a Mac OS X terminal window titled "Default (-bash)". The window shows the following command-line session:

```
7042 kattni@robocrepe:Volumes $ rm CIRCUITPY/._*
7043 kattni@robocrepe:Volumes $
```

Finally, you can run `df` again to see the current space used.

```
7043 kattni@robocrepe:Volumes $ df -h CIRCUITPY/
Filesystem      Size   Used  Avail Capacity iused %iused Mounted on
/dev/disk2s1    47Ki   34Ki  13Ki    73%     512    0  100%  /Volumes/CIRCUITPY

7044 kattni@robocrepe:Volumes $
```

Nice! You have 12Ki 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. A boot loop occurs when the board reboots repeatedly and never fully loads. These are not caused by 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:

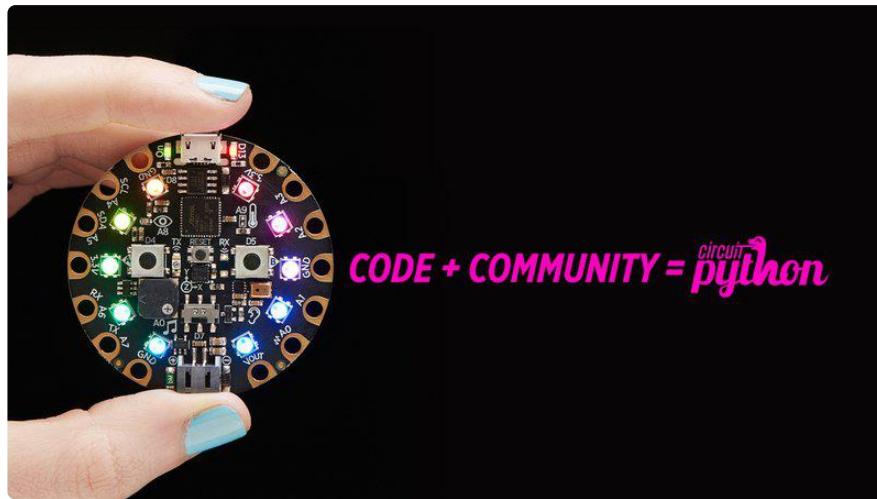
Press the reset button, and then when the RGB status LED blinks yellow, press the reset button again. Since your reaction time may not be that fast, try a "slow" double click, to catch the yellow LED on the second click.

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 diagrams above for boot sequence details.

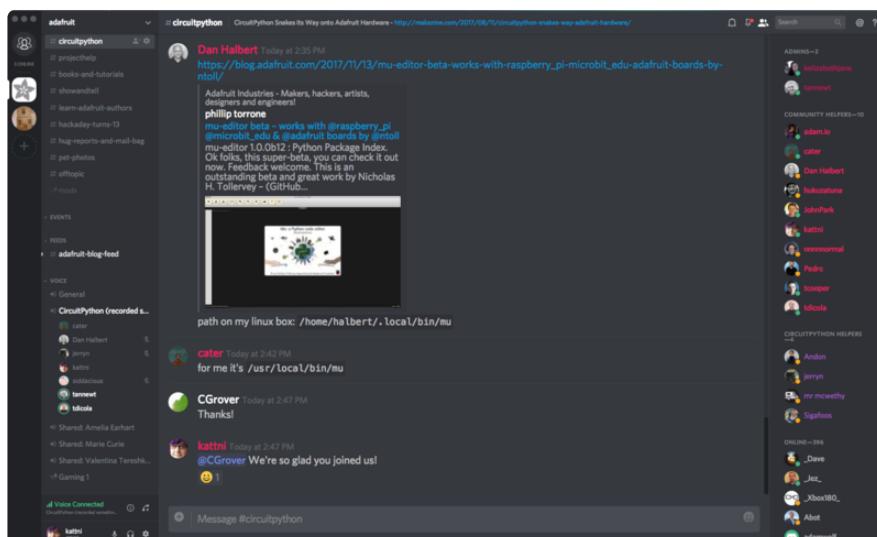
Welcome to the Community!



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. Whether this is your first microcontroller board or you're a seasoned software engineer, you have something important to offer the Adafruit CircuitPython community. This page highlights some of the many ways you can be a part of it!

Adafruit Discord



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 #show-and-tell 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.

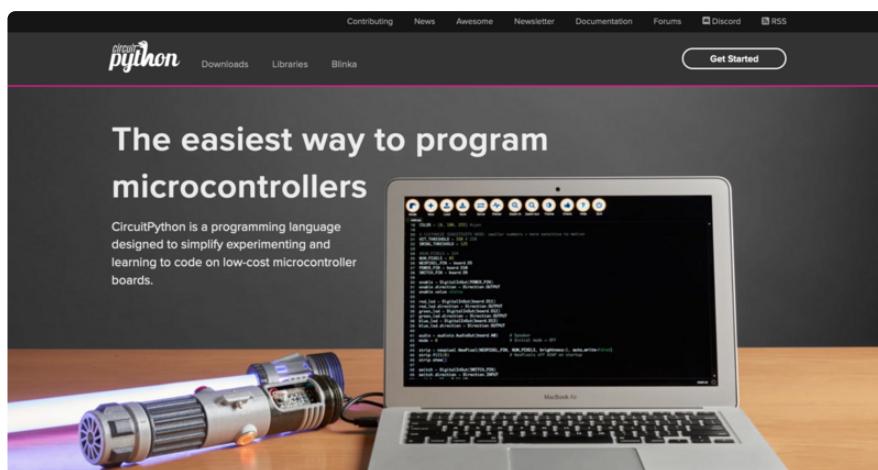
The help with CircuitPython channel is where to go with your CircuitPython questions. #help-with-circuitpython is there for new users and developers alike so feel free to ask a question or post a comment! Everyone of any experience level is welcome to join in on the conversation. Your contributions are important! The #circuitpython-dev 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. Everyone is looking forward to meeting you!

CircuitPython.org



Beyond the Adafruit Learn System, which you are viewing right now, the best place to find information about CircuitPython is circuitpython.org (<https://adafru.it/KJD>). Everything you need to get started with your new microcontroller and beyond is available. You can do things like [download CircuitPython for your microcontroller](https://adafru.it/Em8) (<https://adafru.it/Em8>) or [download the latest CircuitPython Library bundle](https://adafru.it/ENC) (<https://adafru.it/ENC>), or check out [which single board computers support Blinka](https://adafru.it/EA8) (<https://adafru.it/EA8>). You can also get to various other CircuitPython related things like Awesome CircuitPython or the Python for Microcontrollers newsletter. This is all incredibly useful, but it isn't necessarily community related. So why is it included here? The [Contributing page](https://adafru.it/VD7) (<https://adafru.it/VD7>).

Contributing

If you'd like to contribute to the CircuitPython project, the CircuitPython libraries are a great way to begin. This page is updated with daily status information from the CircuitPython libraries, including open pull requests, open issues and library infrastructure issues.

Do you write a language other than English? Another great way to contribute to the project is to contribute new localizations (translations) of CircuitPython, or update current localizations, using [Weblate](#).

If this is your first time contributing, or you'd like to see our recommended contribution workflow, we have a guide on [Contributing to CircuitPython with Git and Github](#). You can also find us in the #circuitpython channel on the [Adafruit Discord](#).

Have an idea for a new driver or library? [File an issue on the CircuitPython repo!](#)

CircuitPython itself is written in C. However, all of the Adafruit CircuitPython libraries are written in Python. If you're interested in contributing to CircuitPython on the Python side of things, check out circuitpython.org/contributing (<https://adafru.it/VD7>). You'll find information pertaining to every Adafruit CircuitPython library GitHub repository, giving you the opportunity to join the community by finding a contributing option that works for you.

Note the date on the page next to Current Status for:

Current Status for Tue, Nov 02, 2021

If you submit any contributions to the libraries, and do not see them reflected on the Contributing page, it could be that the job that checks for new updates hasn't yet run for today. Simply check back tomorrow!

Now, a look at the different options.

Pull Requests

The first tab you'll find is a list of open pull requests.

This is the current status of open pull requests and issues across all of the library repos.

Open Pull Requests

- Adafruit_CircuitPython_AdafruitIO
 - Call wifi.connect() after wifi.reset() (Open 113 days)
- Adafruit_CircuitPython_ADDS1x15
 - Supress f-string recommendation in .pylintrc (Open 1 days)
- Adafruit_CircuitPython_ADT7410
 - Adding critical temp features (Open 168 days)

GitHub pull requests, or PRs, are opened when folks have added something to an Adafruit CircuitPython library GitHub repo, and are asking for Adafruit to add, or merge, their changes into the main library code. For PRs to be merged, they must first be reviewed. Reviewing is a great way to contribute! Take a look at the list of open pull requests, and pick one that interests you. If you have the hardware, you can test code changes. If you don't, you can still check the code updates for syntax. In the case of documentation updates, you can verify the information, or check it for spelling and grammar. Once you've checked out the update, you can leave a comment letting us know that you took a look. Once you've done that for a while, and you're more comfortable with it, you can consider joining the CircuitPythonLibrarians review team. The more reviewers we have, the more authors we can support. Reviewing is a crucial part of an open source ecosystem, CircuitPython included.

Open Issues

The second tab you'll find is a list of open issues.

Sort by issue labels [All](#)

Open Issues

- Adafruit_CircuitPython_74HC595
 - Missing Type Annotations (Open 34 days)
- Adafruit_CircuitPython_AdafruitIO
 - Missing Type Annotations (Open 34 days)
 - use of . and dot and groups (using circuitpython) (Open 125 days)

GitHub issues are filed for a number of reasons, including when there is a bug in the library or example code, or when someone wants to make a feature request. Issues are a great way to find an opportunity to contribute directly to the libraries by updating code or documentation. If you're interested in contributing code or documentation, take a look at the open issues and find one that interests you.

If you're not sure where to start, you can search the issues by label. Labels are applied to issues to make the goal easier to identify at a first glance, or to indicate the difficulty level of the issue. Click on the dropdown next to "Sort by issue labels" to see the list of available labels, and click on one to choose it.

Sort by issue labels

Open Issues

- Adafruit_CircuitPython_74HC595
 - Missing Type Annotations (Open 34 days)
- Adafruit_CircuitPython_AdafruitIO
 - Missing Type Annotations (Open 34 days)
 - use of . and dot and groups (using circuitpython) (Open 125 days)
- Adafruit_CircuitPython_DHT
 - ad1115 to DHT22 (Open 1 day)

- ✓ All
- Good first issue
- Documentation
- Hacktoberfest
- None
- Bug
- Enhancement
- Hacktoberfest
- Question
- Support
- Help wanted
- Duplicate
- Needs retest

If you're new to everything, new to contributing to open source, or new to contributing to the CircuitPython project, you can choose "Good first issue". Issues with that label are well defined, with a finite scope, and are intended to be easy for someone new to figure out.

If you're looking for something a little more complicated, consider "Bug" or "Enhancement". The Bug label is applied to issues that pertain to problems or failures found in the library. The Enhancement label is applied to feature requests.

Don't let the process intimidate you. If you're new to Git and GitHub, there is [a guide](#) (<https://adafru.it/Dkh>) to walk you through the entire process. As well, there are always folks available on [Discord](#) () to answer questions.

Library Infrastructure Issues

The third tab you'll find is a list of library infrastructure issues.

Pull Requests Open Issues **Library Infrastructure Issues** CircuitPython Localization

Library Infrastructure Issues

The following are issues with the library infrastructure. Having a standard library structure greatly improves overall maintainability. Accordingly, we have a series of checks to ensure the standard is met. Most of these are changes that can be made via a pull request, however there are a few checks reported here that require changes to GitHub settings. If you are interested in addressing any of these issues, please feel free to contact us with any questions.

This section is generated by a script that runs checks on the libraries, and then reports back where there may be issues. It is made up of a list of subsections each containing links to the repositories that are experiencing that particular issue. This page is available mostly for internal use, but you may find some opportunities to contribute on this page. If there's an issue listed that sounds like something you could help with, mention it on Discord, or file an issue on GitHub indicating you're working to resolve that issue. Others can reply either way to let you know what the scope of it might be, and help you resolve it if necessary.

CircuitPython Localization

The fourth tab you'll find is the CircuitPython Localization tab.

Pull Requests Open Issues **Library Infrastructure Issues** CircuitPython Localization

CircuitPython Translation with Weblate

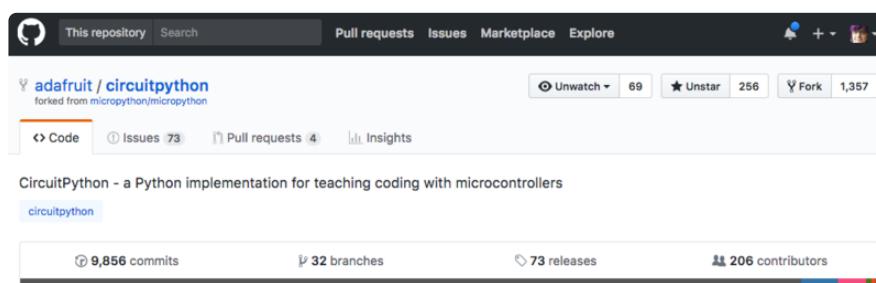


If you speak another language, you can help translate CircuitPython! The translations apply to informational and error messages that are within the CircuitPython core. It means that folks who do not speak English have the opportunity to have these messages shown to them in their own language when using CircuitPython. This is

incredibly important to provide the best experience possible for all users. CircuitPython uses Weblate to translate, which makes it much simpler to contribute translations. You will still need to know some CircuitPython-specific practices and a few basics about coding strings, but as with any CircuitPython contributions, folks are there to help.

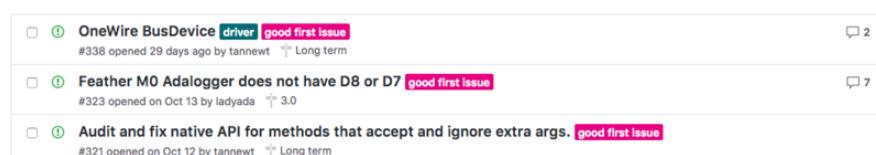
Regardless of your skill level, or how you want to contribute to the CircuitPython project, there is an opportunity available. The [Contributing page](https://adafru.it/VD7) (<https://adafru.it/VD7>) is an excellent place to start!

Adafruit GitHub



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 the CircuitPython project. The CircuitPython core is written in C. The libraries are written in Python. GitHub is the best source of ways to contribute to the [CircuitPython core](https://adafru.it/tB7) (<https://adafru.it/tB7>), and the [CircuitPython libraries](https://adafru.it/VFv) (<https://adafru.it/VFv>). 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. For the CircuitPython core, head over to the CircuitPython repository on GitHub, click on "[Issues](https://adafru.it/tBb) (<https://adafru.it/tBb>)", and you'll find a list that includes issues labeled "[good first issue](https://adafru.it/Bef) (<https://adafru.it/Bef>)". For the libraries, head over to the [Contributing page Issues list](https://adafru.it/VFv) (<https://adafru.it/VFv>), and use the drop down menu to search for "[good first issue](https://adafru.it/VFw) (<https://adafru.it/VFw>)". These issues are things that have been 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. If you need help getting started with GitHub, there is an excellent guide on [Contributing to CircuitPython with Git and GitHub](https://adafru.it/Dkh) (<https://adafru.it/Dkh>).



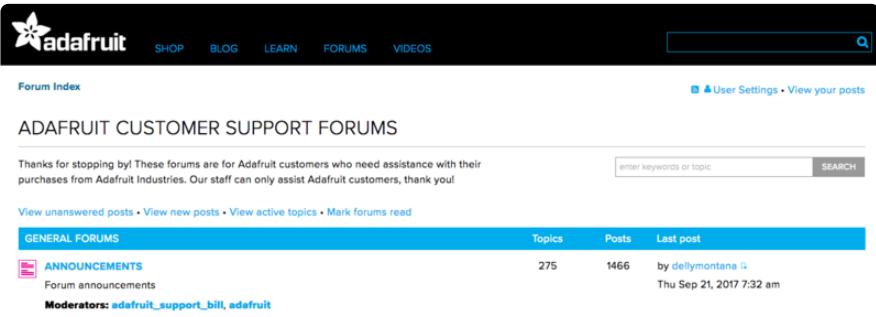
Already experienced and looking for a challenge? Checkout the rest of either issues list and you'll find plenty of ways to contribute. You'll find all sorts of things, from new driver requests, to library bugs, to core module updates. There's plenty of opportunities for everyone at any level!

When working with or using CircuitPython or the CircuitPython libraries, you may find problems. If you find a bug, that's great! The team loves bugs! Posting a detailed issue to GitHub is an invaluable way to contribute to improving CircuitPython. For CircuitPython itself, file an issue [here](https://adafru.it/tBb) (<https://adafru.it/tBb>). For the libraries, file an issue on the specific library repository on GitHub. 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 stable and unstable releases is a very important part of contributing CircuitPython. The developers can't possibly find all the problems themselves! They 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!

Adafruit Forums

A screenshot of the Adafruit Customer Support Forums homepage. At the top, there's a navigation bar with links for SHOP, BLOG, LEARN, FORUMS (which is highlighted in blue), and VIDEOS. To the right of the navigation is a search bar with a magnifying glass icon. Below the navigation, there's a link to 'Forum Index' and a user settings link 'User Settings • View your posts'. The main title 'ADAFRUIT CUSTOMER SUPPORT FORUMS' is centered above a message: '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!'. Below this message are links for 'View unanswered posts', 'View new posts', 'View active topics', and 'Mark forums read'. A table lists forum categories: 'GENERAL FORUMS' (Topics: 275, Posts: 1466, Last post: Thu Sep 21, 2017 7:32 am), 'ANNOUNCEMENTS' (Forum announcements), and 'Moderators: adafruit_support_bill, adafruit'. There's also a link to 'enter keywords or topic' and a 'SEARCH' button.

The [Adafruit Forums](https://adafru.it/jlf) (<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](https://adafru.it/xXA) (<https://adafru.it/xXA>) category under "Supported Products & Projects" is the best place to post your CircuitPython questions.

The screenshot shows the Adafruit CircuitPython forum category. At the top, there are links for 'Forum Index', 'Supported Products & Projects', and 'Adafruit CircuitPython'. On the right, there are links for 'User Settings', 'View your posts', and 'View unread replies'. Below the header, it says 'Moderators: adafruit_support_bill, adafruit'. There are two main sections: 'ANNOUNCEMENTS' and 'TOPICS'. The 'ANNOUNCEMENTS' section contains three posts:

Post	Replies	Views	Last post
CIRCUITYTHON 7.2.0 ALPHA 1 RELEASED!	0	20	by danhalbert · Tue Dec 28, 2021 11:55 pm
CIRCUITYTHON 7.1.0 RELEASED!	1	32	by danhalbert · Wed Dec 29, 2021 5:53 am
SAMD51 (M4) BOARD USERS: UPDATE YOUR BOOTLOADERS TO >=V3.9.0	10	2428	by Guest · Sat Aug 15, 2020 11:28 pm

The 'TOPICS' section is currently empty.

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!

Read the Docs

The screenshot shows the Adafruit CircuitPython Read the Docs page for the `audioio` module. The page title is "audioio – Support for audio input and output". It includes a sidebar with "Core Modules" and "API and Usage" sections. The main content area has the following sections:

- audioio – Support for audio input and output**: Describes the `audioio` module and its classes for audio IO.
- Libraries**: Lists the `AudioOut` class.
- Notes**: A note about class lifetime and deinitialization.
- Previous** and **Next** navigation buttons.

[Read the Docs](https://adafru.it/Beg) (<https://adafru.it/Beg>) is an excellent resource for a more detailed look at the CircuitPython core and the CircuitPython libraries. This is where you'll find

things like API documentation and example code. For an in depth look at viewing and understanding Read the Docs, check out the [CircuitPython Documentation](https://adafru.it/VFx) (<https://adafru.it/VFx>) page!

Here is blinky:

```
import time
import digitalio
import board

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

Arduino IDE Setup

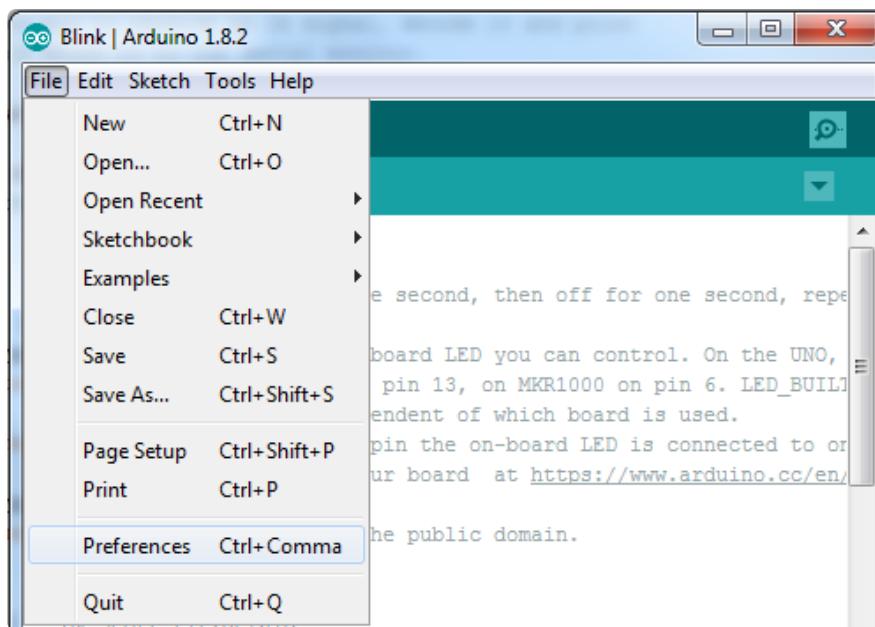
The first thing you will need to do is to download the latest release of the Arduino IDE. You will need to be using version 1.8 or higher for this guide

Arduino IDE Download

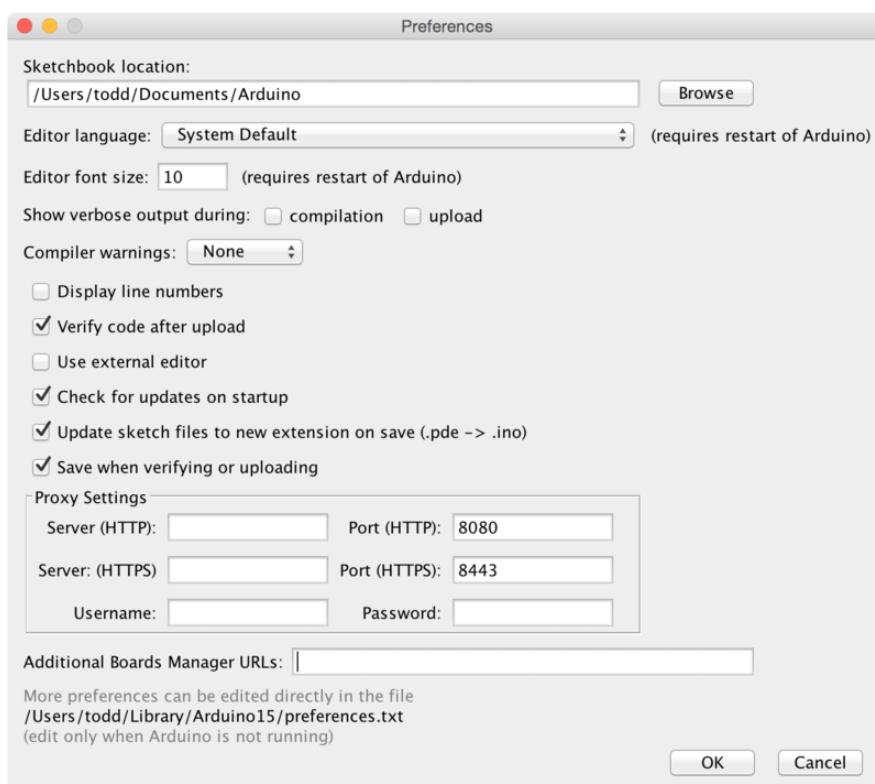
<https://adafru.it/f1P>

The ESP32-S2 Arduino board support package is currently part of the 2.0.0 or later release. To use the ESP32-S2 with Arduino, you'll need to follow the steps below for your operating system. You can also [check out the Espressif Arduino repository for the most up to date details on how to install it](#) (<https://adafru.it/weF>).

After you have downloaded and installed the latest version of Arduino IDE, you will need to start the IDE and navigate to the Preferences menu. You can access it from the File menu in Windows or Linux, or the Arduino menu on OS X.



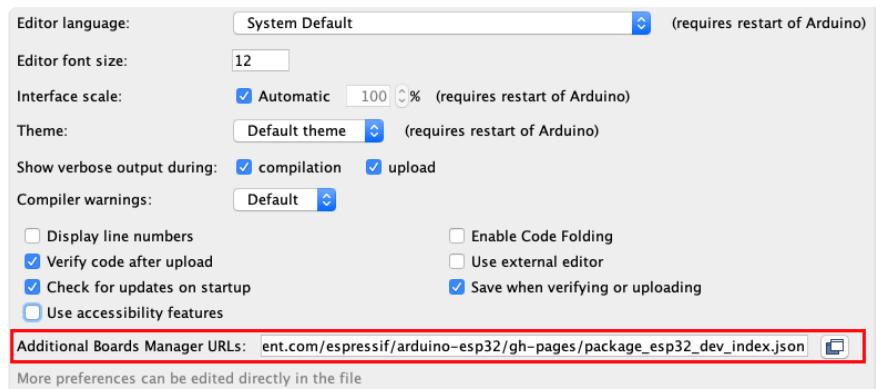
A dialog will pop up just like the one shown below.



We will be adding a URL to the new Additional Boards Manager URLs option. The list of URLs is comma separated, and you will only have to add each URL once. New Adafruit boards and updates to existing boards will automatically be picked up by the Board Manager each time it is opened. The URLs point to index files that the Board Manager uses to build the list of available & installed boards.

To find the most up to date list of URLs you can add, you can visit the list of [third party board URLs on the Arduino IDE wiki](#) (<https://adafru.it/f7U>). We will only need to add one URL to the IDE in this example, but you can add multiple URLs by separating them with commas. Copy and paste the link below into the Additional Boards Manager URLs option in the Arduino IDE preferences.

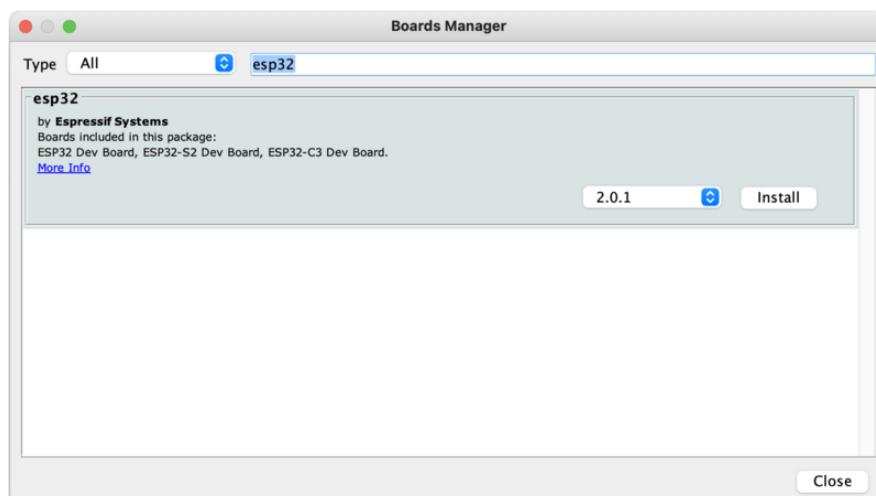
https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_dev_index.json



If you have multiple boards you want to support, say ESP8266 and Adafruit, have both URLs in the text box separated by a comma (,)

Once done click OK to save the new preference settings.

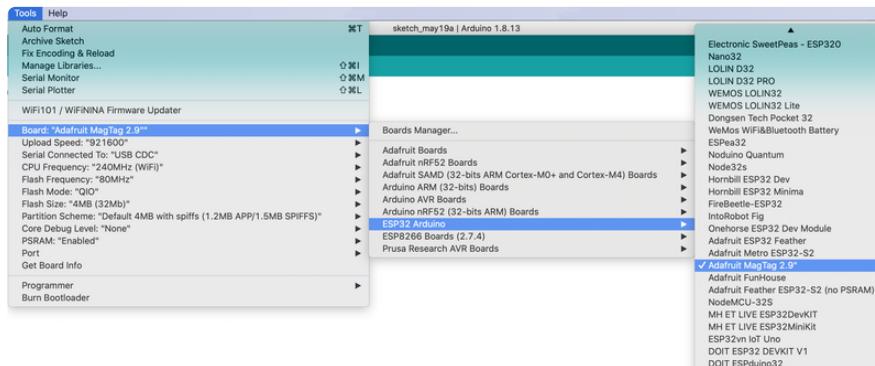
The next step is to actually install the Board Support Package (BSP). Go to the Tools → Board → Board Manager submenu. A dialog should come up with various BSPs. Search for esp32.



Click the Install button and wait for it to finish. Once it is finished, you can close the dialog.

In the Tools → Board submenu you should see ESP32 Arduino and in that dropdown it should contain the ESP32 boards along with all the latest ESP32-S2 boards.

Look for the board called Adafruit MagTag 2.9".



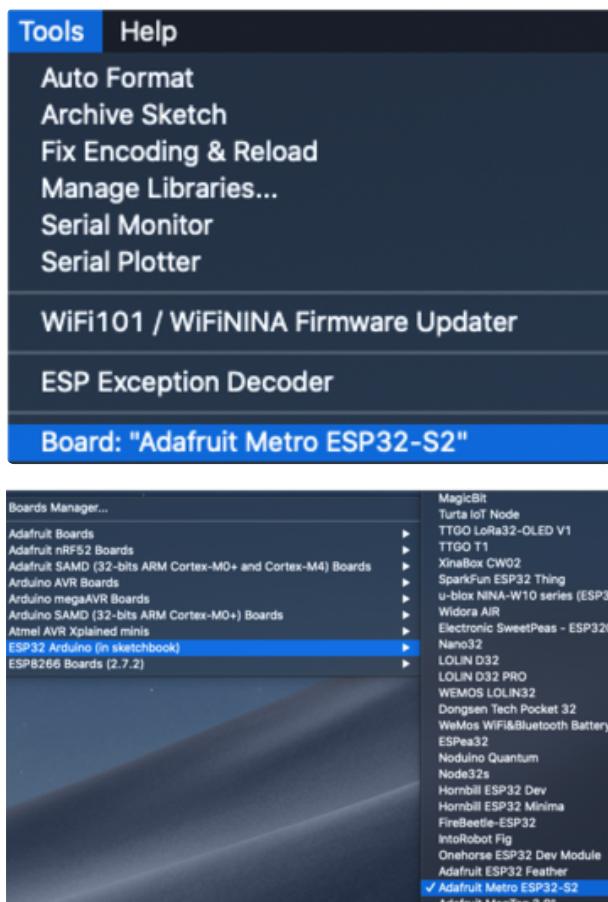
Using with Arduino IDE

Blink

Now you can upload your first blink sketch!

Plug in the ESP32-S2 board and wait for it to be recognized by the OS (just takes a few seconds).

Select ESP32-S2 Board in Arduino IDE



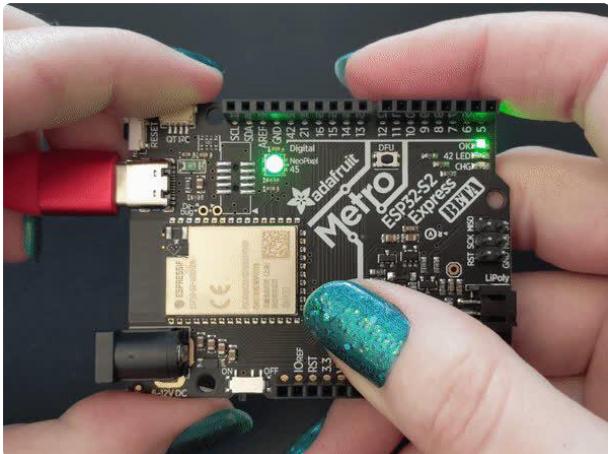
On the Arduino IDE, click:

Tools -> Board -> ESP32 Arduino -> Your Adafruit ESP32-S2 board

The screenshot shows Metro S2 but you may have a different board. Make sure the name matches the exact product you purchased. If you don't see your board, make sure you have the latest version of the ESP32 board support package

Launch ESP32-S2 ROM Bootloader

ESP32-S2 support in Arduino uses native USB which can crash. If you ever DON'T see a serial/COM port, you can always manually enter bootloading mode. This bootloader is in ROM, it is 'un-brickable' so you can always use this technique to get into the bootloader. However, after uploading your Arduino code you MUST press reset to start the sketch



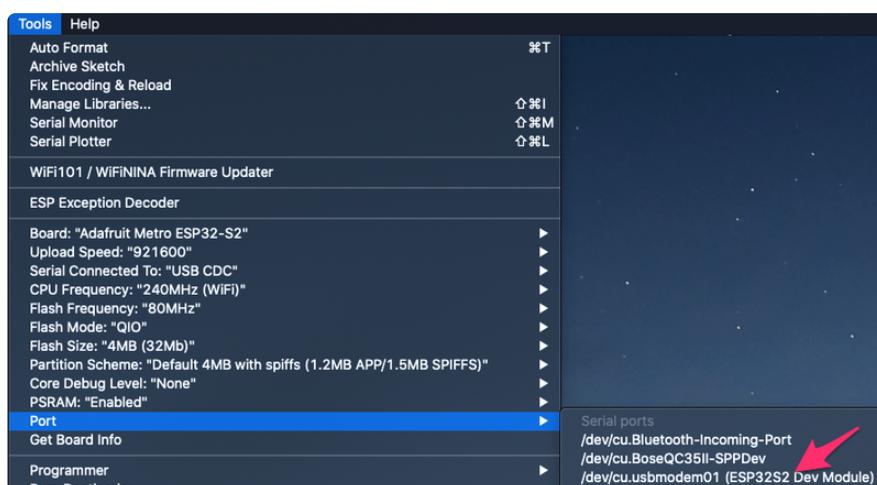
Before we upload a sketch, place your ESP32-S2 board into ROM bootloader mode (<https://adafru.it/OsC>).

Look for the Reset button and a second DFU / BOOT0 button

HOLD down the DFU/Boot0 button while you click Reset. Then release DFU/Boot0 button

The GIF shows a Metro S2 but your board may look different. It will still have BOOT and Reset buttons somewhere

It should appear under Tools -> Port as ESP32-S2 Dev Module.



Do not select any other port than the one that is called "ESP32S2 Dev Module"

Load Blink Sketch

Now open up this Blink example in a new sketch window

```
// the setup function runs once when you press reset or power the board
void setup() {
    // initialize built in LED pin as an output.
    pinMode(LED_BUILTIN, OUTPUT);
    // initialize USB serial converter so we have a port created
    Serial.begin();
}

// the loop function runs over and over again forever
void loop() {
    digitalWrite(LED_BUILTIN, HIGH);      // turn the LED on (HIGH is the voltage level)
```

```

delay(1000);           // wait for a second
digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
delay(1000);           // wait for a second
}

```

Note that we use LED_BUILTIN not pin 13 for the LED pin. That's because we don't always use pin 13 for the LED on boards. For example, on the Metro ESP32-S2 the LED is on pin 42!

And click upload! After uploading, you may see something like this:

And click upload! After uploading, you may see something like this, warning you that we could not get out of reset.

This is normal! Press the RESET button on your board to launch the sketch

That's it, you will be able to see the red LED blink. You will also see a new serial port created.

You may call `Serial.begin();` in your sketch to create the serial port so don't forget it, it is not required for other Arduinos or previous ESP boards!



You can now select the new serial port name which will be different than the bootloader serial port. Arduino IDE will try to use auto-reset to automatically put the board into bootloader mode when you ask it to upload new code

If you ever DON'T see a serial port, or something is not working out with upload you can always manually enter bootloader mode:

- Reset board into ROM bootloader with DFU/BOOT0 + Reset buttons

- Select the ESP32S2 Dev Board ROM bootloader serial port in Tools->Port menu
 - Upload sketch
 - Click reset button to launch code
-

Arduino Basics

Arduino support for the ESP32-S2 is very challenging right now, we don't recommend it. Please use CircuitPython!

Once you have Arduino installed and set up and you can upload simple blink sketches, you can move on to using each element of the MagTag board.

Using the Red LED

It's always good to blink the LED when you want to verify if something is happening on your board. The LED is on IO #13, but we recommend you use the `LED_BUILTIN` macro and you can use this simple sketch example to blink the LED:

```
void setup() {  
    // initialize built in LED pin as an output.  
    pinMode(LED_BUILTIN, OUTPUT);  
    // initialize USB serial converter so we have a port created  
    Serial.begin();  
}  
  
// the loop function runs over and over again forever  
void loop() {  
    digitalWrite(LED_BUILTIN, HIGH);    // turn the LED on (HIGH is the voltage level)  
    delay(1000);                      // wait for a second  
    digitalWrite(LED_BUILTIN, LOW);     // turn the LED off by making the voltage LOW  
    delay(1000);                      // wait for a second  
}
```

Reading the Buttons

There are four buttons on the front of the MagTag - they're connected to digital pins IO 11, 12, 14, and 15. (Note we skip 13 since that's the built in Red LED). However, we recommend you use the constants `BUTTON_A`, `BUTTON_B`, `BUTTON_C`, `BUTTON_D`.

```
void setup() {  
    Serial.begin(115200);  
  
    pinMode(BUTTON_A, INPUT_PULLUP);  
    pinMode(BUTTON_B, INPUT_PULLUP);  
    pinMode(BUTTON_C, INPUT_PULLUP);  
    pinMode(BUTTON_D, INPUT_PULLUP);  
}
```

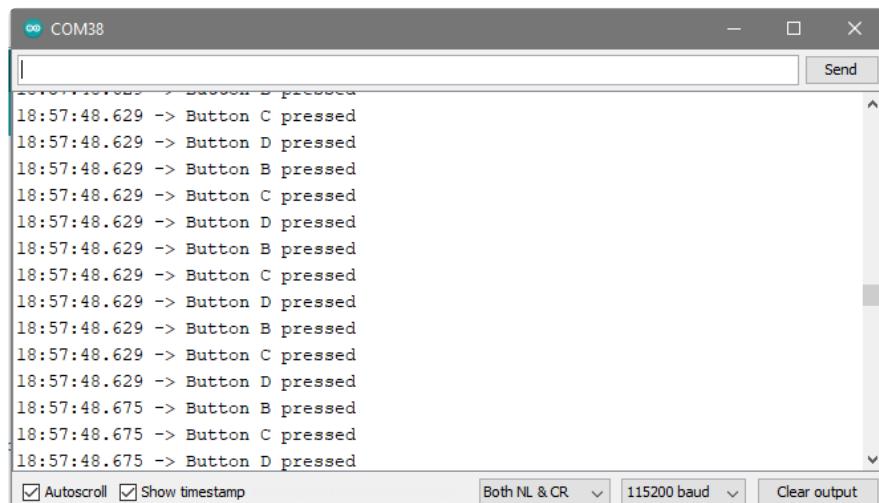
```

void loop() {
    if (! digitalRead(BUTTON_A)) {
        Serial.println("Button A pressed");
    }
    if (! digitalRead(BUTTON_B)) {
        Serial.println("Button B pressed");
    }
    if (! digitalRead(BUTTON_C)) {
        Serial.println("Button C pressed");
    }
    if (! digitalRead(BUTTON_D)) {
        Serial.println("Button D pressed");
    }

    // small debugging delay
    delay(10);
}

```

Open the serial console and press buttons to see the serial output printed!



Using On-board Speaker

A small buzzer on the back of the MagTag can be used to create tones!

Note that, by default, the speaker amplifier is disabled so you have to enable it like so:

```

// set speaker enable pin to output
pinMode(SPEAKER_SHUTDOWN, OUTPUT);
// and immediately disable it to save power
digitalWrite(SPEAKER_SHUTDOWN, LOW);

```

You can then turn it back on with

```
digitalWrite(SPEAKER_SHUTDOWN, HIGH);
```

when you're ready to play tones or short audio clips

Using On-Board NeoPixels

There are 4 NeoPixels on pin IO #1 (we recommend using the macro `PIN_NEOPIXEL`), they also have a power enable pin on `NEOPIXEL_POWER` you will need to set it to be an OUTPUT and LOW before writing data to the NeoPixels. If you turn the power pin off (by setting it HIGH) you will need to re-send your NeoPixel data after re-enabling power because the pixels will forget their setting when they lose power.

Start by installing NeoPixel library support for Arduino (<https://adafruit.it/nBF>).

Here's an example sketch that builds on the button press example to turn the LEDs different colors when you press the buttons.

Note we fill the NeoPixels after we turn on the power and then turn them off when no buttons are pressed.

```
#include <Adafruit_NeoPixel.h>

Adafruit_NeoPixel pixels = Adafruit_NeoPixel(4, PIN_NEOPIXEL, NEO_GRB + NEO_KHZ800);

void setup() {
    //Initialize serial
    Serial.begin(115200);

    pinMode(BUTTON_A, INPUT_PULLUP);
    pinMode(BUTTON_B, INPUT_PULLUP);
    pinMode(BUTTON_C, INPUT_PULLUP);
    pinMode(BUTTON_D, INPUT_PULLUP);

    // Neopixel power
    pinMode(NEOPIXEL_POWER, OUTPUT);
    digitalWrite(NEOPIXEL_POWER, LOW); // on

    pixels.begin();
    pixels.setBrightness(50);
    pixels.fill(0xFF00FF);
    pixels.show(); // Initialize all pixels to 'off'
}

void loop() {
    if (!digitalRead(BUTTON_A)) {
        Serial.println("Button A pressed");
        digitalWrite(NEOPIXEL_POWER, LOW); // on
        pixels.fill(0xFFFF00);
        pixels.show();
    }
    else if (!digitalRead(BUTTON_B)) {
        Serial.println("Button B pressed");
        digitalWrite(NEOPIXEL_POWER, LOW); // on
        pixels.fill(0x00FF00);
        pixels.show();
    }
    else if (!digitalRead(BUTTON_C)) {
        Serial.println("Button C pressed");
        digitalWrite(NEOPIXEL_POWER, LOW); // on
        pixels.fill(0x0000FF);
        pixels.show();
    }
}
```

```

}
else if (! digitalRead(BUTTON_D)) {
    Serial.println("Button D pressed");
    digitalWrite(NEOPixel_POWER, LOW); // on
    pixels.fill(0xFF00FF);
    pixels.show();
}
else {
    // No buttons pressed! turn em off
    digitalWrite(NEOPixel_POWER, HIGH);
}
}

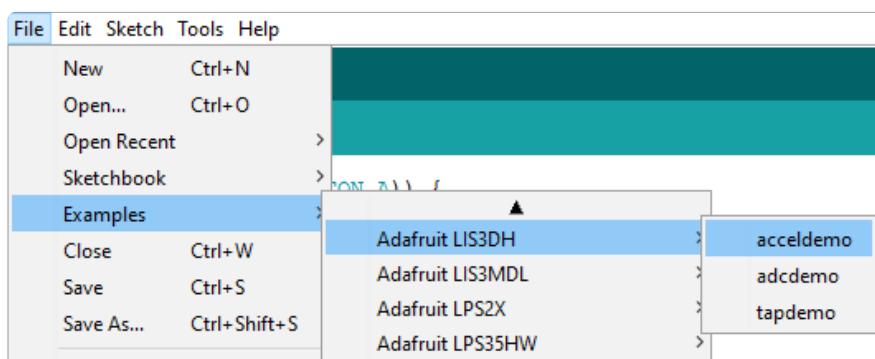
```

Using On-board Accelerometer

There's a pre-soldered accelerometer that you can use to detect orientation or motion.

Start by installing the Arduino LIS3DH library (<https://adafru.it/OkE>)

You can test the LIS3DH by loading the included acceldemo in the Arduino library



Before you upload, go down to find this section:

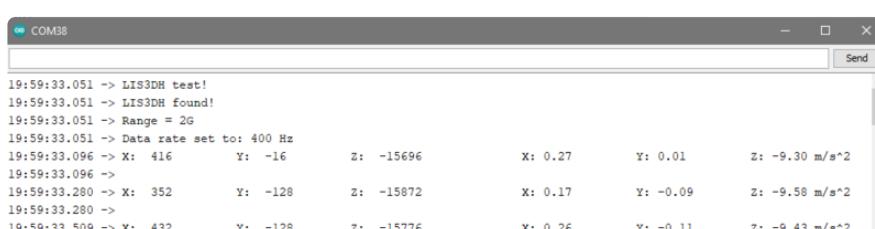
```

if (! lis.begin(0x18)) { // change this to 0x19 for alternative i2c address
    Serial.println("Couldnt start");
    while (1) yield();
}

```

And change `lis.begin(0x18)` to `lis.begin(0x19)`

Now you can upload, reset, and check the serial port for acceleration data!

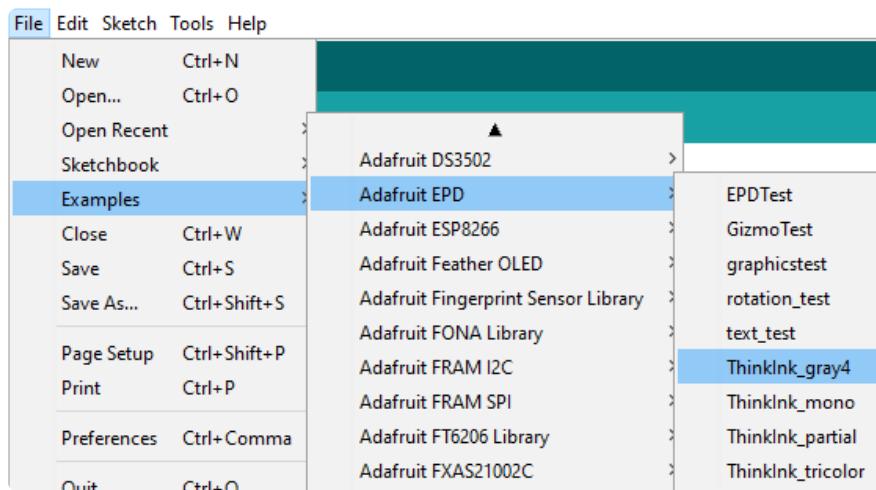


Using the E-Ink Display

You've been so patient, it's time to draw to the display!

Install the Adafruit EPD / ThinkInk library and helper libraries as shown here (<https://adafru.it/OCh>), and then return once installed.

Open the ThinkInk_gray4 example



Change the pin definitions near the top to:

```
#define EPD_DC      7  
#define EPD_CS      8  
#define EPD_BUSY    -1  
#define SRAM_CS     -1  
#define EPD_RESET   6
```

Make sure this line near the top is uncommented, for the **ThinkInk_290_Grayscale_T5** type of display (there are a lot of different displays!)

```
// 2.9" Grayscale Featherwing, MagTag or Breakout:  
ThinkInk_290_Grayscale4_T5 display(EPD_DC, EPD_RESET, EPD_CS, SRAM_CS, EPD_BUSY);
```

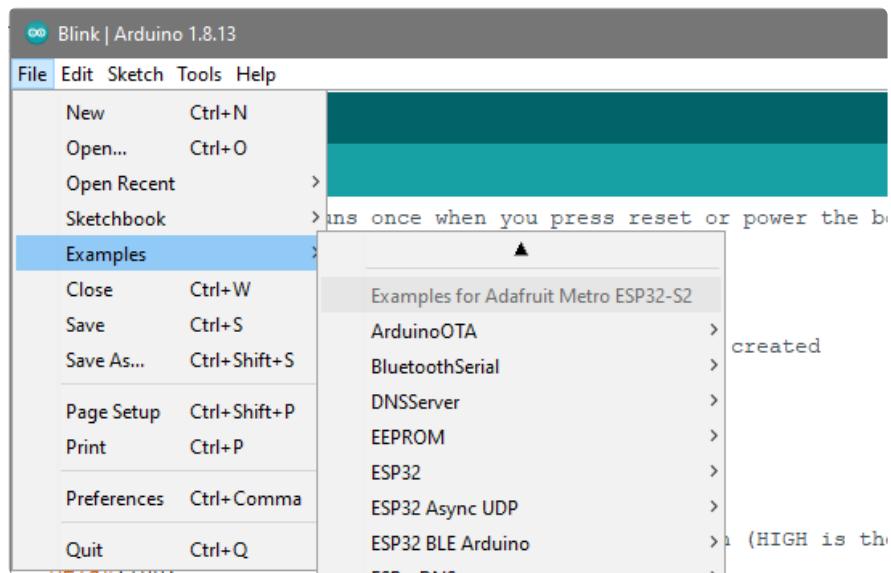
You can now upload the example to your MagTag to see it display various graphics and text in monochrome and grayscale.

For more information on E-Ink displays, [check out our detailed guide \(https://adafru.it/GOc\)](https://adafru.it/GOc)

For more information on how to [display graphics, and text, check out the Adafruit GFX guide \(https://adafru.it/doL\)](https://adafru.it/doL)

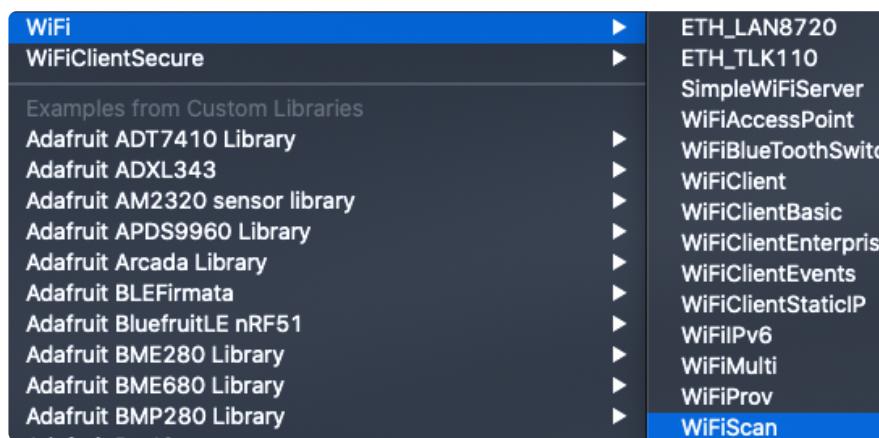
WiFi Test

Thankfully if you have ESP32 sketches, they'll 'just work' with ESP32-S2. You can find a wide range of examples in the File->Examples->Examples for Adafruit Metro ESP32-S2 subheading (the name of the board may vary so it could be "Examples for Adafruit MagTag" etc)



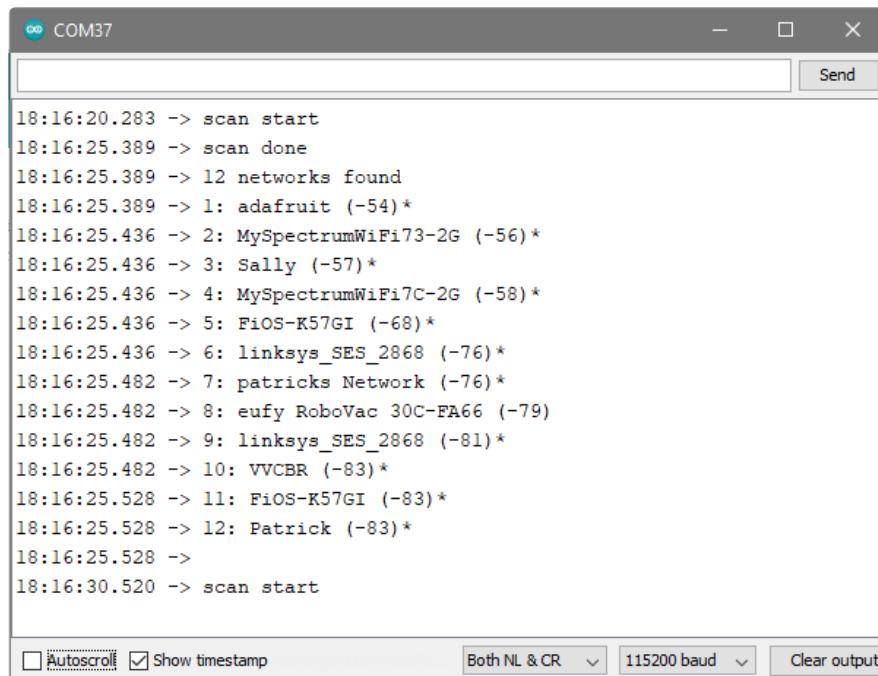
Let's start by scanning the local networks.

Load up the WiFiScan example under Examples->Examples for Adafruit Metro ESP32-S2->WiFi->WiFiScan



And upload this example to your board. The ESP32-S2 should scan and find WiFi networks around you.

Don't forget you have to click Reset after uploading through the ROM bootloader. Then select the new USB Serial port created by the ESP32-S2. It will take a few seconds for the board to complete the scan.



The screenshot shows a terminal window titled "COM3". The window displays a log of WiFi network scans. The log includes timestamps, network names, and signal strengths. The text in the terminal is as follows:

```
18:16:20.283 -> scan start
18:16:25.389 -> scan done
18:16:25.389 -> 12 networks found
18:16:25.389 -> 1: adafruit (-54)*
18:16:25.436 -> 2: MySpectrumWiFi73-2G (-56)*
18:16:25.436 -> 3: Sally (-57)*
18:16:25.436 -> 4: MySpectrumWiFi7C-2G (-58)*
18:16:25.436 -> 5: FIOS-K57GI (-68)*
18:16:25.436 -> 6: linksys_SES_2868 (-76)*
18:16:25.482 -> 7: patricks Network (-76)*
18:16:25.482 -> 8: eufy RoboVac 30C-FA66 (-79)
18:16:25.482 -> 9: linksys_SES_2868 (-81)*
18:16:25.482 -> 10: VVCBR (-83)*
18:16:25.528 -> 11: FIOS-K57GI (-83)*
18:16:25.528 -> 12: Patrick (-83)*
18:16:25.528 ->
18:16:30.520 -> scan start
```

At the bottom of the terminal window, there are several configuration options: "Autoscroll" (unchecked), "Show timestamp" (checked), "Both NL & CR" (dropdown), "115200 baud" (dropdown), and "Clear output" (button).

If you can not scan any networks, check your power supply. You need a solid power supply in order for the ESP32-S2 to not brown out. A skinny USB cable or drained battery can cause issues.

WiFi Connection Test

Now that you can scan networks around you, its time to connect to the Internet!

Copy the example below and paste it into the Arduino IDE:

```
/*
Web client

This sketch connects to a website (wifitest.adafruit.com/testwifi/index.html)
using the WiFi module.

This example is written for a network using WPA encryption. For
WEP or WPA, change the Wifi.begin() call accordingly.

This example is written for a network using WPA encryption. For
WEP or WPA, change the Wifi.begin() call accordingly.

created 13 July 2010
by dlf (Metodo2 srl)
modified 31 May 2012
by Tom Igoe
*/

#include <WiFi.h>
```

```

// Enter your WiFi SSID and password
char ssid[] = "YOUR_SSID"; // your network SSID (name)
char pass[] = "YOUR_SSID_PASSWORD"; // your network password (use for WPA, or
use as key for WEP)
int keyIndex = 0; // your network key Index number (needed
only for WEP)

int status = WL_IDLE_STATUS;
// if you don't want to use DNS (and reduce your sketch size)
// use the numeric IP instead of the name for the server:
//IPAddress server(74,125,232,128); // numeric IP for Google (no DNS)

char server[] = "wifitest.adafruit.com"; // name address for adafruit test
char path[] = "/testwifi/index.html";

// Initialize the Ethernet client library
// with the IP address and port of the server
// that you want to connect to (port 80 is default for HTTP):
WiFiClient client;

void setup() {
    //Initialize serial and wait for port to open:
    Serial.begin(9600);
    while (!Serial) {
        ; // wait for serial port to connect. Needed for native USB port only
    }

    // attempt to connect to Wifi network:
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(ssid);

    WiFi.begin(ssid, pass);
    while (WiFi.status() != WL_CONNECTED) {
        delay(500);
        Serial.print(".");
    }

    Serial.println("");
    Serial.println("Connected to WiFi");
    printWifiStatus();

    Serial.println("\nStarting connection to server...");
    // if you get a connection, report back via serial:
    if (client.connect(server, 80)) {
        Serial.println("connected to server");
        // Make a HTTP request:
        client.print("GET "); client.print(path); client.println(" HTTP/1.1");
        client.print("Host: "); client.println(server);
        client.println("Connection: close");
        client.println();
    }
}

void loop() {
    // if there are incoming bytes available
    // from the server, read them and print them:
    while (client.available()) {
        char c = client.read();
        Serial.write(c);
    }

    // if the server's disconnected, stop the client:
    if (!client.connected()) {
        Serial.println();
        Serial.println("disconnecting from server.");
        client.stop();

        // do nothing forevermore:
    }
}

```

```

        while (true);
    }

void printWifiStatus() {
    // print the SSID of the network you're attached to:
    Serial.print("SSID: ");
    Serial.println(WiFi.SSID());

    // print your board's IP address:
    IPAddress ip = WiFi.localIP();
    Serial.print("IP Address: ");
    Serial.println(ip);

    // print the received signal strength:
    long rssi = WiFi.RSSI();
    Serial.print("signal strength (RSSI):");
    Serial.print(rssi);
    Serial.println(" dBm");
}

```

NOTE: You must change the **SECRET_SSID** and **SECRET_PASS** in the example code to your WiFi SSID and password before uploading this to your board.

```

// Enter your WiFi SSID and password
char ssid[] = "YOUR_SSID";           // your network SSID (name)
char pass[] = "YOUR_SSID_PASSWORD"; // your network password (use for WPA, or use as key for WEP)
int keyIndex = 0;                   // your network key Index number (needed only for WEP)

```

After you've set it correctly, upload and check the serial monitor. You should see the following. If not, go back, check wiring, power and your SSID/password

```

Attempting to connect to SSID: Transit
.....
Connected to WiFi
SSID: Transit
IP Address: 192.168.1.182
signal strength (RSSI):-57 dBm

Starting connection to server...
connected to server
HTTP/1.1 200 OK
Server: nginx/1.10.3 (Ubuntu)
Date: Wed, 11 Nov 2020 20:51:30 GMT
Content-Type: text/html
Content-Length: 70
Last-Modified: Thu, 16 May 2019 18:21:16 GMT
Connection: close
ETag: "5cddaa1c-46"
Accept-Ranges: bytes

This is a test of Adafruit WiFi!
If you can read this, its working :)

disconnecting from server.

```

Secure Connection Example

Many servers today do not allow non-SSL connectivity. Lucky for you the ESP32-S2 has a great TLS/SSL stack so you can have that all taken care of for you. Here's an example of using a secure WiFi connection to connect to the Twitter API.

Copy and paste it into the Arduino IDE:

```

/*
This example creates a client object that connects and transfers
data using always SSL.

It is compatible with the methods normally related to plain
connections, like client.connect(host, port).

Written by Arturo Guadalupi
last revision November 2015

*/
#include <WiFiClientSecure.h>

// Enter your WiFi SSID and password
char ssid[] = "YOUR_SSID";           // your network SSID (name)
char pass[] = "YOUR_SSID_PASSWORD";   // your network password (use for WPA, or
use as key for WEP)
int keyIndex = 0;                     // your network key Index number (needed

```

```

only for WEP)

int status = WL_IDLE_STATUS;
// if you don't want to use DNS (and reduce your sketch size)
// use the numeric IP instead of the name for the server:
//IPAddress server(74,125,232,128); // numeric IP for Google (no DNS)

#define SERVER "cdn.syndication.twimg.com"
#define PATH "/widgets/followbutton/info.json?screen_names=adafruit"

// Initialize the SSL client library
// with the IP address and port of the server
// that you want to connect to (port 443 is default for HTTPS):
WiFiClientSecure client;

void setup() {
    //Initialize serial and wait for port to open:
    Serial.begin(9600);
    while (!Serial) {
        ; // wait for serial port to connect. Needed for native USB port only
    }

    // attempt to connect to Wifi network:
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(ssid);

    WiFi.begin(ssid, pass);
    while (WiFi.status() != WL_CONNECTED) {
        delay(500);
        Serial.print(".");
    }

    Serial.println("");
    Serial.println("Connected to WiFi");
    printWifiStatus();

    Serial.println("\nStarting connection to server...");
    // if you get a connection, report back via serial:
    if (client.connect(SERVER, 443)) {
        Serial.println("connected to server");
        // Make a HTTP request:
        client.println("GET " PATH " HTTP/1.1");
        client.println("Host: " SERVER);
        client.println("Connection: close");
        client.println();
    }
}

uint32_t bytes = 0;

void loop() {
    // if there are incoming bytes available
    // from the server, read them and print them:
    while (client.available()) {
        char c = client.read();
        Serial.write(c);
        bytes++;
    }

    // if the server's disconnected, stop the client:
    if (!client.connected()) {
        Serial.println();
        Serial.println("disconnecting from server.");
        client.stop();
        Serial.print("Read "); Serial.print(bytes); Serial.println(" bytes");

        // do nothing forevermore:
        while (true);
    }
}

```

```

}

void printWifiStatus() {
    // print the SSID of the network you're attached to:
    Serial.print("SSID: ");
    Serial.println(WiFi.SSID());

    // print your board's IP address:
    IPAddress ip = WiFi.localIP();
    Serial.print("IP Address: ");
    Serial.println(ip);

    // print the received signal strength:
    long rssi = WiFi.RSSI();
    Serial.print("signal strength (RSSI):");
    Serial.print(rssi);
    Serial.println(" dBm");
}

```

As before, update the ssid and password first, then upload the example to your board.

Note we use `WiFiClientSecure client` instead of `WiFiClient client;` to require a SSL connection! This example will connect to a twitter server to download a JSON snippet that says how many followers adafruit has

```

Attempting to connect to SSID: Transit
.....
Connected to WiFi
SSID: Transit
IP Address: 192.168.1.182
signal strength (RSSI):-52 dBm

Starting connection to server...
connected to server
HTTP/1.1 200 OK
Accept-Ranges: bytes
Access-Control-Allow-Origin: platform.twitter.com
Access-Control-Allow-Methods: GET
Age: 12
cache-control: must-revalidate, max-age=600
content-disposition: attachment; filename=json.json
Content-Type: application/json; charset=utf-8
Date: Wed, 11 Nov 2020 20:58:39 GMT
expires: Wed, 11 Nov 2020 21:08:39 GMT
Last-Modified: Wed, 11 Nov 2020 20:58:27 GMT
Server: ECS (agb/52BA)
strict-transport-security: max-age=631138519
timing-allow-origin: *
X-Cache: HIT
x-connection-hash: a50988a9020759ec70520caef6c38bcf
x-content-type-options: nosniff
x-frame-options: SAMEORIGIN
x-response-time: 12
x-transaction: 003d88570028acec
x-tw-cdn: VZ
x-tw-cdn: VZ
x-xss-protection: 0
Content-Length: 197
Connection: close

[{"following":false,"id":"20731304","screen_name":"adafruit","name":"adafruit industries",
disconnecting from server.
Read 966 bytes

```

JSON Parsing Demo

This example is a little more advanced - many sites will have API's that give you JSON data. We will build on the previous SSL example to connect to twitter and get that JSON data chunk

Then we'll use [ArduinoJSON](https://adafru.it/Evn) (<https://adafru.it/Evn>) to convert that to a format we can use and then display that data on the serial port (which can then be re-directed to a display of some sort)

First up, [use the Library manager to install ArduinoJSON](#) (<https://adafru.it/Evo>).

Then load the example JSONdemo by copying the code below and pasting it into your Arduino IDE.

```
/*
This example creates a client object that connects and transfers
data using always SSL, then shows how to parse a JSON document in an HTTP response.

It is compatible with the methods normally related to plain
connections, like client.connect(host, port).

Written by Arturo Guadalupi + Copyright Benoit Blanchon 2014-2019
last revision November 2015

*/
#include <WiFiClientSecure.h>
#include <ArduinoJson.h>

// uncomment the next line if you have a 128x32 OLED on the I2C pins
//#define USE_OLED

#if defined(USE_OLED)
#include <Adafruit_SSD1306.h>
Adafruit_SSD1306 display = Adafruit_SSD1306(128, 32, &Wire);
#endif

// Enter your WiFi SSID and password
char ssid[] = "YOUR_SSID";           // your network SSID (name)
char pass[] = "YOUR_SSID_PASSWORD";   // your network password (use for WPA, or
use as key for WEP)
int keyIndex = 0;                    // your network key Index number (needed
only for WEP)

int status = WL_IDLE_STATUS;
// if you don't want to use DNS (and reduce your sketch size)
// use the numeric IP instead of the name for the server:
//IPAddress server(74,125,232,128); // numeric IP for Google (no DNS)

#define SERVER "cdn.syndication.twimg.com"
#define PATH   "/widgets/followbutton/info.json?screen_names=adafruit"

// Initialize the SSL client library
// with the IP address and port of the server
// that you want to connect to (port 443 is default for HTTPS):
WiFiClientSecure client;
```

```

void setup() {
    //Initialize serial and wait for port to open:
    Serial.begin(9600);

    #if defined(USE_OLED)
        if(!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) { // Address 0x3C for 128x32
            Serial.println(F("SSD1306 allocation failed"));
            for(;;) // Don't proceed, loop forever
        }
        display.display();
        display.setTextSize(1);
        display.setTextColor(WHITE);
        display.clearDisplay();
        display.setCursor(0,0);
    #else
        // Don't wait for serial if we have an OLED
        while (!Serial) {
            delay(10); // wait for serial port to connect. Needed for native USB port
only
        }
    #endif
    // attempt to connect to Wifi network:
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(ssid);
    #if defined(USE_OLED)
        display.clearDisplay(); display.setCursor(0,0);
        display.print("Connecting to SSID\n"); display.println(ssid);
        display.display();
    #endif

    // Connect to WPA/WPA2 network. Change this line if using open or WEP network:
    WiFi.begin(ssid, pass);
    while (WiFi.status() != WL_CONNECTED) {
        delay(500);
        Serial.print(".");
    }

    Serial.println("");
    Serial.println("Connected to WiFi");

    #if defined(USE_OLED)
        display.print("...OK!");
        display.display();
    #endif

    printWifiStatus();
}

uint32_t bytes = 0;

void loop() {
    Serial.println("\nStarting connection to server...");
    #if defined(USE_OLED)
        display.clearDisplay(); display.setCursor(0,0);
        display.print("Connecting to "); display.print(SERVER);
        display.display();
    #endif

    // if you get a connection, report back via serial:
    if (client.connect(SERVER, 443)) {
        Serial.println("connected to server");
        // Make a HTTP request:
        client.println("GET " PATH " HTTP/1.1");
        client.println("Host: " SERVER);
        client.println("Connection: close");
        client.println();
    }
}

```

```

// Check HTTP status
char status[32] = {0};
client.readBytesUntil('\r', status, sizeof(status));
if (strcmp(status, "HTTP/1.1 200 OK") != 0) {
    Serial.print(F("Unexpected response: "));
    Serial.println(status);
#if defined(USE_OLED)
    display.print("Connection failed, code: "); display.println(status);
    display.display();
#endif

return;
}

// wait until we get a double blank line
client.find("\r\n\r\n", 4);

// Allocate the JSON document
// Use arduinojson.org/v6/assistant to compute the capacity.
const size_t capacity = JSON_ARRAY_SIZE(1) + JSON_OBJECT_SIZE(8) + 200;
DynamicJsonDocument doc(capacity);

// Parse JSON object
DeserializationError error = deserializeJson(doc, client);
if (error) {
    Serial.print(F("deserializeJson() failed: "));
    Serial.println(error.c_str());
    return;
}

// Extract values
JsonObject root_0 = doc[0];
Serial.println(F("Response:"));
const char* root_0_screen_name = root_0["screen_name"];
long root_0_followers_count = root_0["followers_count"];

Serial.print("Twitter username: "); Serial.println(root_0_screen_name);
Serial.print("Twitter followers: "); Serial.println(root_0_followers_count);
#if defined(USE_OLED)
    display.clearDisplay(); display.setCursor(0,0);
    display.setTextSize(2);
    display.println(root_0_screen_name);
    display.println(root_0_followers_count);
    display.display();
    display.setTextSize(1);
#endif

// Disconnect
client.stop();

delay(10000);
}

void printWifiStatus() {
    // print the SSID of the network you're attached to:
    Serial.print("SSID: ");
    Serial.println(WiFi.SSID());

    // print your board's IP address:
    IPAddress ip = WiFi.localIP();
    Serial.print("IP Address: ");
    Serial.println(ip);

    // print the received signal strength:
    long rssi = WiFi.RSSI();
    Serial.print("signal strength (RSSI):");
}

```

```
    Serial.print(rssi);
    Serial.println(" dBm");
}
```

By default it will connect to the Twitter banner image API, parse the username and followers, and display them.

```
Attempting to connect to SSID: Transit
.....
Connected to WiFi
SSID: Transit
IP Address: 192.168.1.182
signal strength (RSSI):-54 dBm

Starting connection to server...
connected to server
Response:
Twitter username: adafruit
Twitter followers: 176400
```

Arduino Sleep

Once you have hardware tested and working, and you've also got WiFi connected - its time to explore deep sleep modes. When in deep sleep, the ESP32-S2 is basically completely off, it uses a tiny amount of power just to keep track of time so you can wake up after some amount of time.

When the ESP32-S2 comes back from deep-sleep it essentially does a hard-reset and begins over from scratch, so you don't get to keep your WiFi connection active. However, its pretty fast to re-connect so as long as you are only waking up about once a minute, your battery will last a lot longer!

Good Quality Sleep

Before you go into deep sleep, make sure you shut down the E-Ink display, NeoPixels, light sensor, and speaker with the following instructions:

```
display.powerDown();
digitalWrite(EPD_RESET, LOW); // hardware power down mode
digitalWrite(SPEAKER_SHUTDOWN, LOW); // off
digitalWrite(NEOPixel_POWER, HIGH); // off
```

Then enter deep sleep mode with

```
esp_sleep_enable_timer_wakeup(10000000);
esp_deep_sleep_start();
```

the `esp_sleep_enable_timer_wakeup(10000000);` line tells the ESP32-S2 to restart in 10000000 microseconds, a.k.a 10000 milliseconds or 10 seconds

Here's an example sketch that wakes up, turns on the speaker and NeoPixels, draws a bitmap onto the EPD and then goes to sleep for one second. We use this demo to do power monitoring tests.

```
#include <Adafruit_ThinkInk.h>
#include <Adafruit_NeoPixel.h>
#include "magtaglogo.h"

Adafruit_NeoPixel intneo = Adafruit_NeoPixel(4, PIN_NEOPIXEL, NEO_GRB + NEO_KHZ800);
ThinkInk_290_GrayScale4_T5 display(EPD_DC, EPD_RESET, EPD_CS, -1, -1);

void setup() {
    //Initialize serial and wait for port to open:
    Serial.begin(115200);

    pinMode(BUTTON_A, INPUT_PULLUP);
    pinMode(BUTTON_B, INPUT_PULLUP);
    pinMode(BUTTON_C, INPUT_PULLUP);
    pinMode(BUTTON_D, INPUT_PULLUP);
    pinMode(13, OUTPUT);
    digitalWrite(13, LOW);

    // Neopixel power
    pinMode(NEOPIXEL_POWER, OUTPUT);
    pinMode(SPEAKER_SHUTDOWN, OUTPUT);
    digitalWrite(NEOPIXEL_POWER, LOW); // on
    digitalWrite(SPEAKER_SHUTDOWN, HIGH); // on

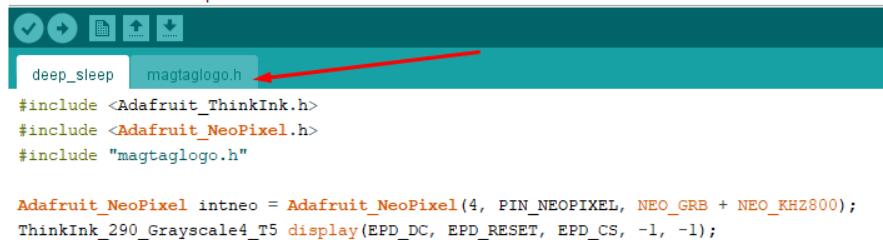
    intneo.begin();
    intneo.setBrightness(50);
    intneo.fill(100, 0, 100);
    intneo.show();

    display.begin(THINKINK_MONO);
    display.clearBuffer();
    display.drawBitmap(0, 38, magtaglogo_mono, MAGTAGLOGO_WIDTH, MAGTAGLOGO_HEIGHT,
EPD_BLACK);
    display.display();
    delay(1500);
    display.powerDown();
    digitalWrite(EPD_RESET, LOW); // hardware power down mode

    digitalWrite(SPEAKER_SHUTDOWN, LOW); // off
    digitalWrite(NEOPIXEL_POWER, HIGH); // off
    esp_sleep_enable_timer_wakeup(10000000);
    esp_deep_sleep_start();
}

void loop() {
```

Be sure to download the sketch including the logo header file by clicking Download Project Zip and verify that in the Arduino IDE you have both tabs:



```
deep_sleep  magtaglogo.h
#include <Adafruit_ThinkInk.h>
#include <Adafruit_NeoPixel.h>
#include "magtaglogo.h"

Adafruit_NeoPixel intneo = Adafruit_NeoPixel(4, PIN_NEOPIXEL, NEO_GRB + NEO_KHZ800);
ThinkInk_290_Grayscale4_T5 display(EPD_DC, EPD_RESET, EPD_CS, -1, -1);
```

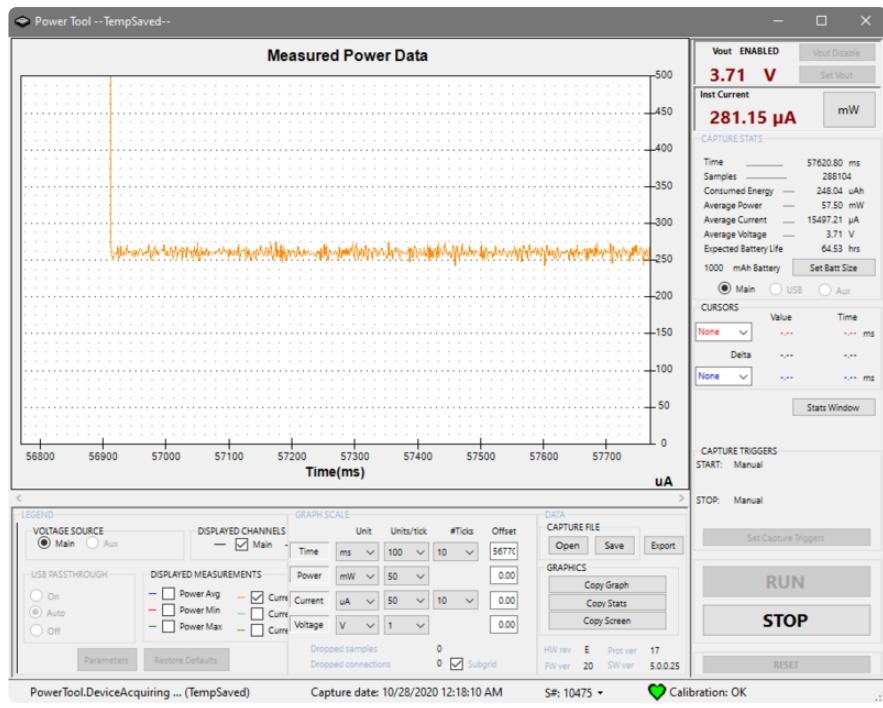
This example will go to deep sleep for only one second, you can change that by adjusting the number in this line:

```
esp_sleep_enable_timer_wakeup(1000000);
```

When using deep sleep, the power draw drops to about 250uA. These are the approximate current uses:

- 40uA are used by the onboard green OK LED (you can remove the LED with a soldering iron)
- 120uA are used by the EPD in deepsleep/reset mode (we couldnt figure out how to reduce this any more but tested suggestions are welcome!)
- 50uA are used by the 3.3V regulator
- 10uA are used by the VBat resistor divider
- 30uA are used by the ESP32-S2 in deep sleep

USB power will be higher than this number because under USB power, we also power the battery charger. These current draws are only for battery usage and assume you have disabled NeoPixels, speaker, and EPD.



Shipping Demo

The board ships with a demo that tests out the buttons, LEDs, EPD, accelerometer, and speaker. It may be handy if you ever need to verify your hardware is fully working!

- The NeoPixels will light up in a rainbow design
- When button A, B, C are pressed, the LEDs will turn to a solid color red, green or blue
- When button D is pressed, a chime sounds
- Red LED blinks on and off
- Display shows bitmap MagTag logo. When the accelerometer detects that the board is 'upside down' the display is rotated
- In serial console, light sensor reading and accelerometer XYZ is output
- In serial console, I2C port on STEMMA QT is scanned and visible I2C device addresses are printed

You can put your board into UF2 Bootloader mode and drag-n-drop this file on to load it:

mag_tag_shipping_demo.UF2

<https://adafru.it/PfK>

You can download the full example code for compilation by clicking Download Project Zip on this sketch to get all the files (there are two header files, `coin.h` with 8-bit audio and `magtaglogo.h` with the bitmap logo)

Before uploading to your magtag make sure you downloaded the full project and got the two header files!



```
#include <Adafruit_NeoPixel.h>
#include <Wire.h>
#include <Adafruit_ThinkInk.h>
#include <Adafruit_LIS3DH.h>
#include "coin.h"
#include "magtaglogo.h"

Adafruit_NeoPixel intneo = Adafruit_NeoPixel(4, PIN_NEOPIXEL, NEO_GRB + NEO_KHZ800);
ThinkInk_290_Grayscale4_T5 display(EPD_DC, EPD_RESET, EPD_CS, -1, -1);
Adafruit_LIS3DH lis = Adafruit_LIS3DH();

uint8_t j = 0;
void setup() {
    Serial.begin(115200);
    //while (!Serial) { delay(10); }
    delay(100);
    Serial.println("Adafruit EPD Portal demo");

    intneo.begin();
    intneo.setBrightness(50);
    intneo.show(); // Initialize all pixels to 'off'

    pinMode(BUTTON_A, INPUT_PULLUP);
    pinMode(BUTTON_B, INPUT_PULLUP);
    pinMode(BUTTON_C, INPUT_PULLUP);
    pinMode(BUTTON_D, INPUT_PULLUP);

    pinMode(SPEAKER_SHUTDOWN, OUTPUT);
    digitalWrite(SPEAKER_SHUTDOWN, LOW);

    // Red LED
    pinMode(13, OUTPUT);

    // Neopixel power
    pinMode(NEOPIXEL_POWER, OUTPUT);
    digitalWrite(NEOPIXEL_POWER, LOW); // on

    display.begin(THINKINK_MONO);

    if (!lis.begin(0x19)) {
        Serial.println("Couldnt start LIS3DH");
        display.clearBuffer();
        display.setTextSize(3);
        display.setTextColor(EPD_BLACK);
        display.setCursor(20, 40);
        display.print("No LIS3DH?");
    }
}
```

```

    display.display();
    while (1) delay(100);
}

analogReadResolution(12); //12 bits
analogSetAttenuation(ADC_11db); //For all pins
display.clearBuffer();
display.drawBitmap(0, 38, magtaglogo_mono, MAGTAGLOGO_WIDTH, MAGTAGLOGO_HEIGHT,
EPD_BLACK);
display.display();
}

uint8_t rotation = 0;

void loop() {
    j++;
    if (j == 0) {
        Serial.print("Rotation: "); Serial.println(rotation);
        if (rotation == 0 || rotation == 2) {
            display.setRotation(rotation);
            display.clearBuffer();
            display.drawBitmap(0, 38, magtaglogo_mono, MAGTAGLOGO_WIDTH,
MAGTAGLOGO_HEIGHT, EPD_BLACK);
            display.display();
        }
    }
    // Red LED On
    digitalWrite(13, HIGH);

    //Serial.print(".");
    if (j % 10 == 0) {
        sensors_event_t event;
        lis.getEvent(&event);

        /* Display the results (acceleration is measured in m/s^2) */
        Serial.print("X: "); Serial.print(event.acceleration.x);
        Serial.print("\tY: "); Serial.print(event.acceleration.y);
        Serial.print("\tZ: "); Serial.print(event.acceleration.z);
        Serial.println(" m/s^2 ");
        if ((event.acceleration.x < -5) && (abs(event.acceleration.y) < 5)) {
            rotation = 1;
        }
        if ((abs(event.acceleration.x) < 5) && (event.acceleration.y > 5)) {
            rotation = 0;
        }
        if ((event.acceleration.x > 5) && (abs(event.acceleration.y) < 5)) {
            rotation = 3;
        }
        if ((abs(event.acceleration.x) < 5) && (event.acceleration.y < -5)) {
            rotation = 2;
        }

        int light = analogRead(LIGHT_SENSOR);
        Serial.print("Light sensor: ");
        Serial.println(light);

        Serial.print("I2C scanner: ");
        for (int i = 0x07; i <= 0x77; i++) {
            Wire.beginTransmission(i);
            bool found (Wire.endTransmission() == 0);
            if (found) {
                Serial.printf("0x%02x, ", i);
            }
        }
        Serial.println();
    }
}

```

```

if (! digitalRead(BUTTON_A)) {
    Serial.println("Button A pressed");
    intneo.fill(0xFF0000);
    intneo.show();
}
else if (! digitalRead(BUTTON_B)) {
    Serial.println("Button B pressed");
    intneo.fill(0x00FF00);
    intneo.show();
}
else if (! digitalRead(BUTTON_C)) {
    Serial.println("Button C pressed");
    intneo.fill(0x0000FF);
    intneo.show();
}
else if (! digitalRead(BUTTON_D)) {
    intneo.fill(0x0);
    intneo.show();
    Serial.println("Button D pressed");
    digitalWrite(SPEAKER_SHUTDOWN, HIGH);
    play_tune(audio, sizeof(audio));
    digitalWrite(SPEAKER_SHUTDOWN, LOW);
} else {
    // neopixelate
    for (int i = 0; i < intneo.numPixels(); i++) {
        intneo.setPixelColor(i, Wheel(((i * 256 / intneo.numPixels()) + j) & 255));
    }
    intneo.show();
}

// Red LED off
digitalWrite(13, LOW);

delay(10);
}

void play_tune(const uint8_t *audio, uint32_t audio_length) {
    uint32_t t;
    uint32_t prior, usec = 1000000L / SAMPLE_RATE;

    for (uint32_t i=0; i<audio_length; i++) {
        while((t = micros()) - prior < usec);
        dacWrite(A0, audio[i]);
        prior = t;
    }
}

// Input a value 0 to 255 to get a color value.
// The colours are a transition r - g - b - back to r.
uint32_t Wheel(byte WheelPos) {
    WheelPos = 255 - WheelPos;
    if (WheelPos < 85) {
        return intneo.Color(255 - WheelPos * 3, 0, WheelPos * 3);
    }
    if (WheelPos < 170) {
        WheelPos -= 85;
        return intneo.Color(0, WheelPos * 3, 255 - WheelPos * 3);
    }
    WheelPos -= 170;
    return intneo.Color(WheelPos * 3, 255 - WheelPos * 3, 0);
}

```

Quotes Example

OK now that we have the onboard elements, WiFi and deep sleep all worked out, we can now create a full demo!

This example connects to the online Adafruit Quotes service, and displays an inspiring quote once a minute with deep sleep in between.

Don't forget to update the SSID and password!



```
/*
Wifi secure connection example for ESP32
Running on TLS 1.2 using mbedTLS
2017 - Evandro Copercini - Apache 2.0 License.
*/

#include <WiFiClientSecure.h>
#include <ArduinoJson.h>
#include "Adafruit_ThinkInk.h"
#include "Adafruit_NeoPixel.h"
#include <Fonts/FreeSans9pt7b.h>

const char* ssid      = "adafruit";      // your network SSID (name of wifi network)
const char* password = "ffffffff"; // your network password

const char* server = "www.adafruit.com";
const char* path   = "/api/quotes.php";

WiFiClientSecure client;
ThinkInk_290_Grayscale4_T5 display(EPD_DC, EPD_RESET, EPD_CS, -1, -1);
Adafruit_NeoPixel intneo = Adafruit_NeoPixel(4, PIN_NEOPixel, NEO_GRB + NEO_KHZ800);

void deepSleep() {
    pinMode(NEOPIXEL_POWER, OUTPUT);
    pinMode(SPEAKER_SHUTDOWN, OUTPUT);
```

```

digitalWrite(SPEAKER_SHUTDOWN, LOW); // off
digitalWrite(NEOPIXEL_POWER, HIGH); // off
digitalWrite(EPD_RESET, LOW); // off (yes required to save a few mA)
pinMode(13, OUTPUT);
digitalWrite(13, LOW);

esp_sleep_enable_timer_wakeup(60 * 1000000); // 60 seconds
esp_deep_sleep_start();
}

void setup() {
//Initialize serial and wait for port to open:
Serial.begin(115200);
//while (!Serial) delay(10);

pinMode(BUTTON_A, INPUT_PULLUP);
pinMode(BUTTON_B, INPUT_PULLUP);
pinMode(BUTTON_C, INPUT_PULLUP);
pinMode(BUTTON_D, INPUT_PULLUP);
pinMode(EPD_BUSY, INPUT);
pinMode(13, OUTPUT);
digitalWrite(13, HIGH);

display.begin(THINKINK_GRAYSCALE4);

Serial.print("Attempting to connect to SSID: ");
Serial.println(ssid);

display.clearBuffer();
display.setFont(&FreeSans9pt7b);
display.setTextSize(1);
display.setTextColor(EPD_BLACK);
display.setCursor(10, 30);
display.print("Connecting to SSID ");
display.println(ssid);
display.display();

WiFi.begin(ssid, password);

// attempt to connect to Wifi network:
while (WiFi.status() != WL_CONNECTED) {
  Serial.print(".");
  delay(100);
}

Serial.print("Connected to ");
Serial.println(ssid);

//client.setCACert(test_root_ca);
//client.setCertificate(test_client_key); // for client verification
//client.setPrivateKey(test_client_cert); // for client verification

// Neopixel power
pinMode(NEOPIXEL_POWER, OUTPUT);
digitalWrite(NEOPIXEL_POWER, LOW); // on
intneo.fill(25, 0, 0);
intneo.show();

Serial.println("\nStarting connection to server...");
if (!client.connect(server, 443)) {
  Serial.println("Connection failed!");
  deepSleep();
}

intneo.fill(25, 25, 0);
intneo.show();

Serial.println("Connected to server!");
}

```

```

// Make a HTTP request:
client.print("GET "); client.print(path); client.println(" HTTP/1.1");
client.print("Host: "); client.println(server);
client.println("Connection: close");
client.println();

// Check HTTP status
char status[32] = {0};
client.readBytesUntil('\r', status, sizeof(status));
if (strcmp(status, "HTTP/1.1 200 OK") != 0) {
    Serial.print(F("Unexpected response: "));
    Serial.println(status);
    deepSleep();
}

intneo.fill(0, 25, 0);
intneo.show();
while (client.connected()) {
    String line = client.readStringUntil('\n');
    if (line == "\r") {
        Serial.println("headers received");
        break;
    }
}

intneo.fill(0, 25, 25);
intneo.show();
while (client.peek() != '[') {
    client.read();
}

intneo.fill(0, 0, 25);
intneo.show();

// Allocate the JSON document
// Use arduinojson.org/v6/assistant to compute the capacity.
const size_t capacity = JSON_ARRAY_SIZE(1) + JSON_OBJECT_SIZE(8) + 200;
DynamicJsonDocument doc(capacity);

// Parse JSON object
DeserializationError error = deserializeJson(doc, client);
if (error) {
    Serial.print(F("deserializeJson() failed: "));
    Serial.println(error.c_str());
    deepSleep();
}

intneo.fill(0, 25, 25);
intneo.show();

// Extract values
JsonObject root_0 = doc[0];
Serial.println(F("Response:"));
const char* root_0_text = root_0["text"];
const char* root_0_author = root_0["author"];

Serial.print("Quote: "); Serial.println(root_0_text);
Serial.print("Author: "); Serial.println(root_0_author);

display.clearBuffer();
display.setFont(&FreeSans9pt7b);
display.setTextSize(1);
display.setTextWrap(true);
display.setTextColor(EPD_BLACK);
display.setCursor(10, 30);
display.println(root_0_text);
display.setTextColor(EPD_DARK);
display.setCursor(40, 120);
display.println(root_0_author);

```

```

display.display();
while (!digitalRead(EPD_BUSY)) {
    delay(10);
}

while (client.available() > 0)
{
    //read back one line from the server
    String line = client.readStringUntil('\r');
    Serial.println(line);
}

// disconnect
client.stop();
deepSleep();
}

void loop() {
}

```

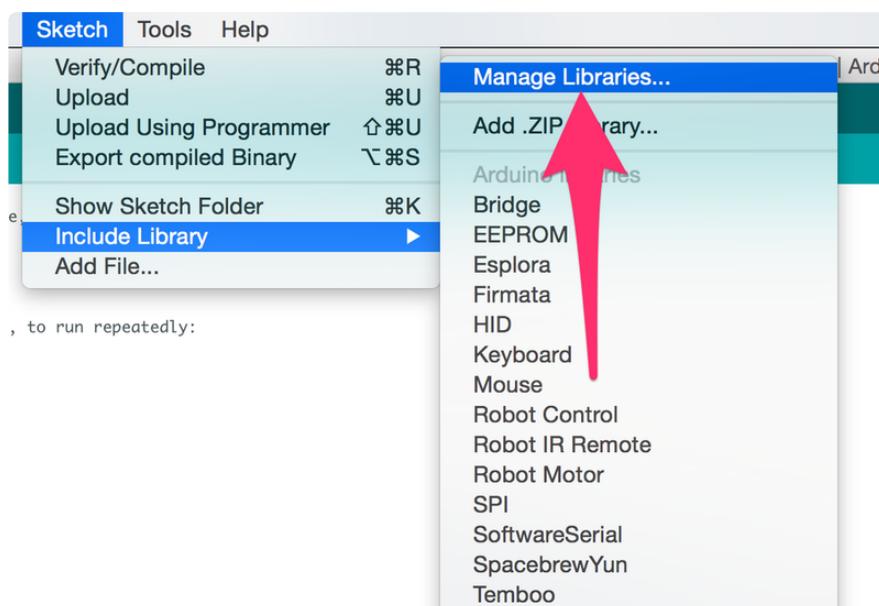
Usage with Adafruit IO

The ESP32-S2 is an affordable, all-in-one, option for connecting your projects to the internet [using our IoT platform, Adafruit IO \(https://adafru.it/Eg2\)](https://adafru.it/Eg2).

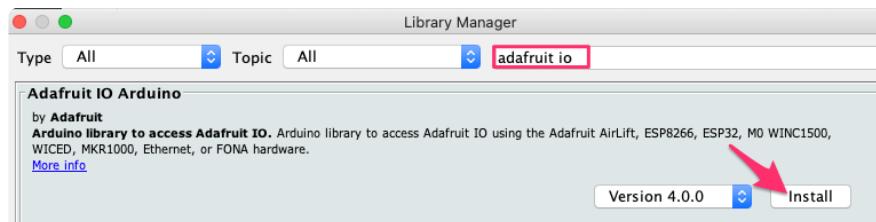
- For more information and guides about Adafruit IO, check out the [Adafruit IO Basics Series. \(https://adafru.it/iDX\)](https://adafru.it/iDX)

Install Libraries

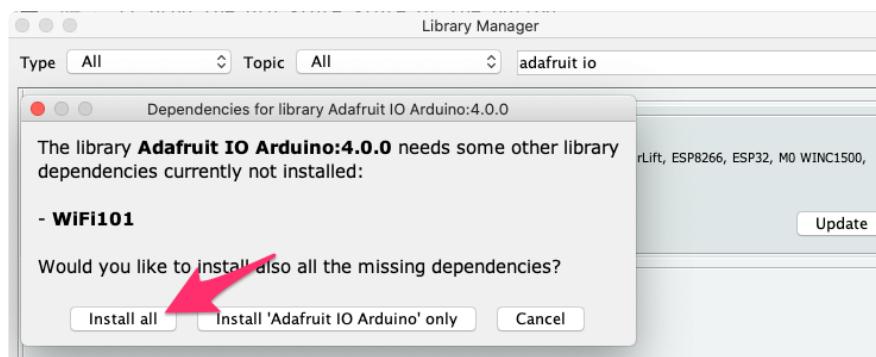
In the Arduino IDE, navigate to Sketch -> Include Library->Manage Libraries...



Enter Adafruit IO Arduino into the search box, and click Install on the Adafruit IO Arduino library option to install version 4.0.0 or higher.



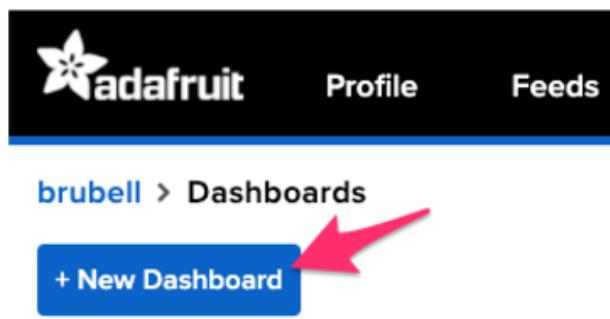
When asked to install dependencies, click Install all.



Adafruit IO Setup

If you do not already have an Adafruit IO account, [create one now](https://adafru.it/fH9) (<https://adafru.it/fH9>). Next, navigate to the Adafruit IO Dashboards page.

We'll create a dashboard to visualize and interact with the data being sent between your ESP32-S2 board and Adafruit IO.

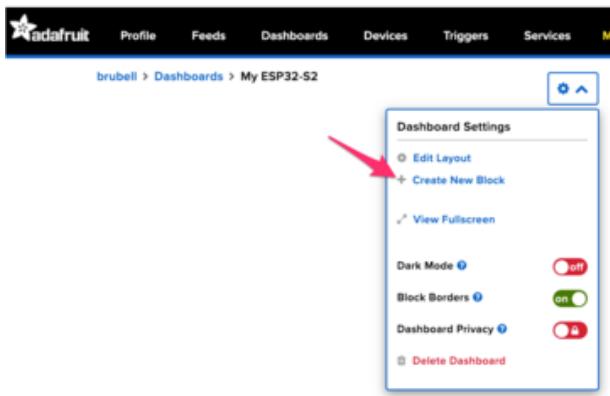


- Click the New Dashboard button.
- Name your dashboard My ESP32-S2.
- Your new dashboard should appear in the list.
- Click the link to be brought to your new dashboard.

A screenshot of the 'Create a new Dashboard' dialog box. It has fields for 'Name' (containing 'My ESP32-S2'), 'Description', and 'Show Header Image' (unchecked). There's also a 'Header Image' section with a 'Choose File' button and a note about sample header images. At the bottom are 'Cancel' and 'Create' buttons, with a red arrow pointing to the 'Create' button.

<input type="checkbox"/> LoRa Feather Network	lora-feather-network
<input type="checkbox"/> My Air Quality Sensor	my-air-quality-sensor
<input checked="" type="checkbox"/> My ESP32-S2	my-esp32-s2
<input type="checkbox"/> My Garage	my-garage

We'll want to turn the board's LED on or off from Adafruit IO. To do this, we'll need to add a toggle button to our dashboard.



- Click the cog at the top right hand corner of your dashboard.
- In the dashboard settings dropdown, click Create New Block.
- Select the toggle block.
- Under My Feeds, enter led as a feed name. Click Create.
- Choose the led feed to connect it to the toggle block. Click Next step.

Create a new block

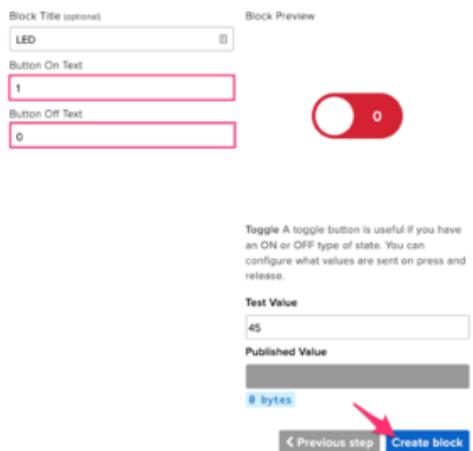
Click on the block you would like to add to your dashboard. You can always switch the block type later if you change your mind.

ON

<input type="checkbox"/> led	HIGH	9 minutes
<input type="checkbox"/> lwill	rip	over 1 year
<input type="checkbox"/> moisture	2	1 day
<input type="checkbox"/> neopixel		2 days
<input type="checkbox"/> outdoor-lights	#000000	about 2 years
<input type="checkbox"/> relay	morning	about 3 hours
<input type="checkbox"/> temperature	72	1 day
<input type="checkbox"/> test	66	2 days
<input type="checkbox"/> timecube	4.5	almost 2 years
<input type="checkbox"/> zapemail	Gary Thompson...	1 day

led Create

My Feeds		
Feed Name	Last value	Recorded
<input type="checkbox"/> battery	55	1 day
<input type="checkbox"/> digital	1	about 17 hours
<input type="checkbox"/> humidity	10	2 days
<input type="checkbox"/> image	/9j/4QAWRXhp...	5 months
<input type="checkbox"/> indoor-lights	#000000	about 2 years
<input checked="" type="checkbox"/> led		less than a minute...
<input type="checkbox"/> lwill	rip	over 1 year
<input type="checkbox"/> moisture	2	1 day
<input type="checkbox"/> neopixel		2 days
<input type="checkbox"/> outdoor-lights	#000000	about 2 years

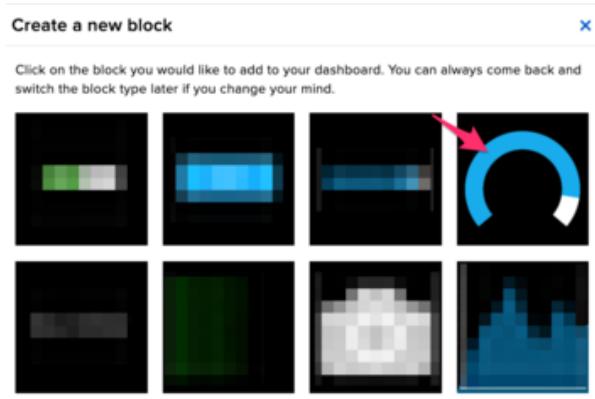


Under Block Settings,

- Change Button On Text to 1
- Change Button Off Text to 0
- Click Create block

The screenshot shows the Adafruit IO dashboard interface. At the top, there's a navigation bar with links for Profile, Feeds, Dashboards, Devices, Triggers, Services, and My Key. Below the navigation bar, the URL 'brubell > Dashboards > My ESP32-S2' is visible. The main content area displays a single block titled 'LED', which is a toggle switch. The switch is currently in the 'off' position, labeled '0'. To the right of the switch is a small status indicator showing '0 bytes'. At the bottom of the block's configuration area, there are two buttons: '< Previous step' and a blue 'Create block' button, with a red arrow pointing to the 'Create block' button.

Next up, we'll want to display button press data from your board on Adafruit IO. To do this, we'll add a gauge block to the Adafruit IO dashboard. A gauge is a read only block type that shows a fixed range of values.



<input type="checkbox"/> Image	/9j/4QAWRXhp...	5 months	
<input type="checkbox"/> indoor-lights	#000000	about 2 years	
<input type="checkbox"/> led		16 minutes	
<input type="checkbox"/> iwill	rip	over 1 year	
<input type="checkbox"/> moisture	2	1 day	
<input type="checkbox"/> neopixel		2 days	
<input type="checkbox"/> outdoor-lights	#000000	about 2 years	
<input type="checkbox"/> relay	morning	about 3 hours	
<input type="checkbox"/> temperature	72	1 day	
<input type="checkbox"/> test	66	2 days	
<input type="checkbox"/> timecube	4.5	almost 2 years	
<input type="checkbox"/> zapemail	Gary Thompson...	1 day	
<input type="checkbox"/> button			
	Create		

Create a Gauge Block

A gauge is a read only block type that shows a fixed range o

Choose a single feed you would like to connect to this gauge feed within a group.

Search for a feed

My Feeds

Feed Name	Last value
<input type="checkbox"/> battery	55
<input checked="" type="checkbox"/> button	55

Search for a feed

Block settings

In this final step, you can give your block a title and see a preview of how it will look. Customize the look and feel of your block with the remaining settings. When you are ready, click the "Create Block" button to send it to your dashboard.

Block Title (optional)	Block Preview
<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> Button Value	
Gauge Min Value	<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> 0
Gauge Max Value	<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> 1
Gauge Width	<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> 50px
Gauge Label	<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> Value
Low Warning Value	<input style="width: 100%; height: 20px; border: 1px solid #ccc; border-radius: 5px; padding: 2px 5px; margin-bottom: 5px;" type="text"/> Value

Gauge A gauge is a read only block type that shows a fixed range of values.

- Click the cog at the top right hand corner of your dashboard.

- In the dashboard settings dropdown, click Create New Block.

- Select the gauge block.

- Under My Feeds, enter button as a feed name.

- Click Create.

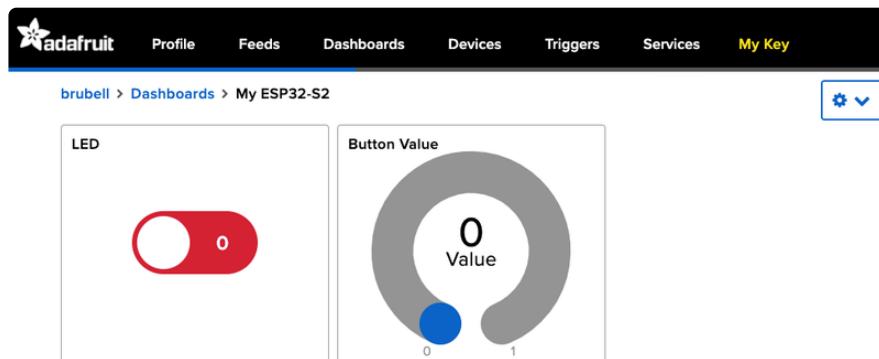
- Choose the button feed to connect it to the toggle block.

- Click Next step.

Under block settings,

- Change Block Title to Button Value
- Change Gauge Min Value to 0, the button's state when it's off
- Change Gauge Max Value to 1, the button's state when it's on
- Click Create block

Your dashboard should look like the following:

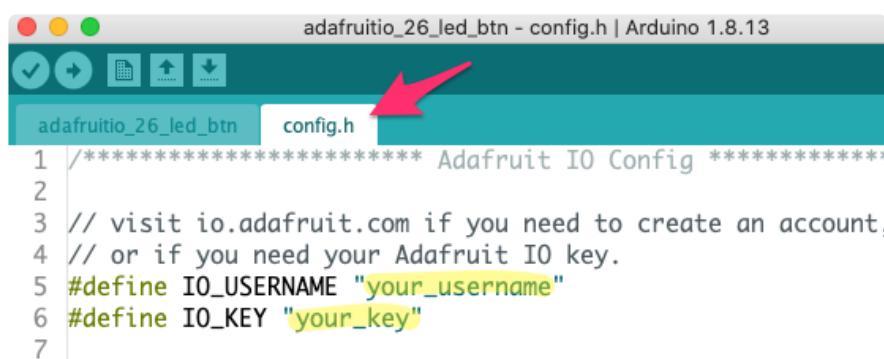


Code Usage

For this example, you will need to open the adafruitio_26_led_btn example included with the Adafruit IO Arduino library. In the Arduino IDE, navigate to File -> Examples -> Adafruit IO Arduino -> adafruitio_26_led_btn.

Before uploading this code to the ESP32-S2, you'll need to add your network and Adafruit IO credentials. Click on the config.h tab in the sketch.

Obtain your Adafruit IO Credentials from [navigating to io.adafruit.com and clicking My Key \(<https://adafru.it/fsU>\)](#). Copy and paste these credentials next to `IO_USERNAME` and `IO_KEY`.



Enter your network credentials next to `WIFI_SSID` and `WIFI_PASS`.

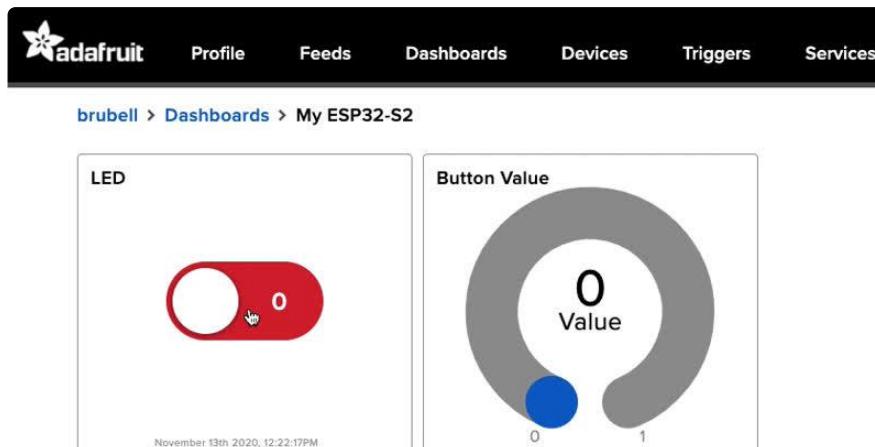
```

adafruitio_26_led_btn config.h
20
21 #define WIFI_SSID "your_ssid"
22 #define WIFI_PASS "your_pass"
23
24 // uncomment the following line if you are using airlift
25 // #define USE_AIRLIFT
26
27 // uncomment the following line if you are using winc1500
28 // #define USE_WINC1500
29

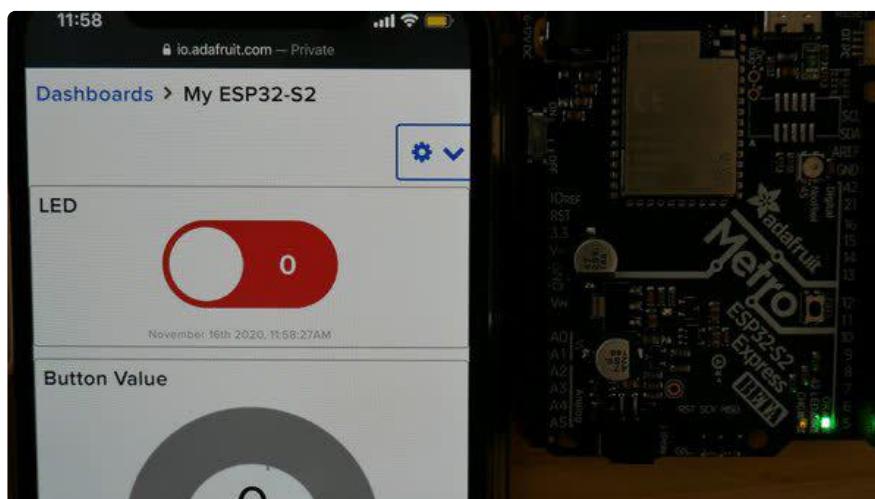
```

Click the Upload button to upload your sketch to the ESP32-S2. After uploading, press the RESET button on your board to launch the sketch.

Open the Arduino Serial monitor and navigate to the Adafruit IO dashboard you created. You should see the gauge response to button press and the board's LED light up in response to the Toggle Switch block.



You should also see the ESP32-S2's LED turning on and off when the LED is toggled:



Downloads

Files:

- [ESP32-S2 product page with resources](https://adafru.it/OpE) (<https://adafru.it/OpE>)
- [ESP32-S2 datasheet](https://adafru.it/OpF) (<https://adafru.it/OpF>)
- [ESP32-S2 WROVER datasheet](https://adafru.it/Oqa) (<https://adafru.it/Oqa>)
- [ESP32-S2 Technical Reference](https://adafru.it/Oqb) (<https://adafru.it/Oqb>)
- [EagleCAD files on GitHub](https://adafru.it/OB2) (<https://adafru.it/OB2>)
- [3D Models on GitHub](https://adafru.it/OCB) (<https://adafru.it/OCB>)
- [Fritzing object in the Adafruit Fritzing Library](https://adafru.it/OB3) (<https://adafru.it/OB3>)

All In One Shipping Demo

This file can be burned to your MagTag using the ROM bootloader (address 0x0) to install the TinyUF2 bootloader plus shipping demo

Download the file to your computer, enter ROM bootloader mode, then run after changing the COM/Serial port:

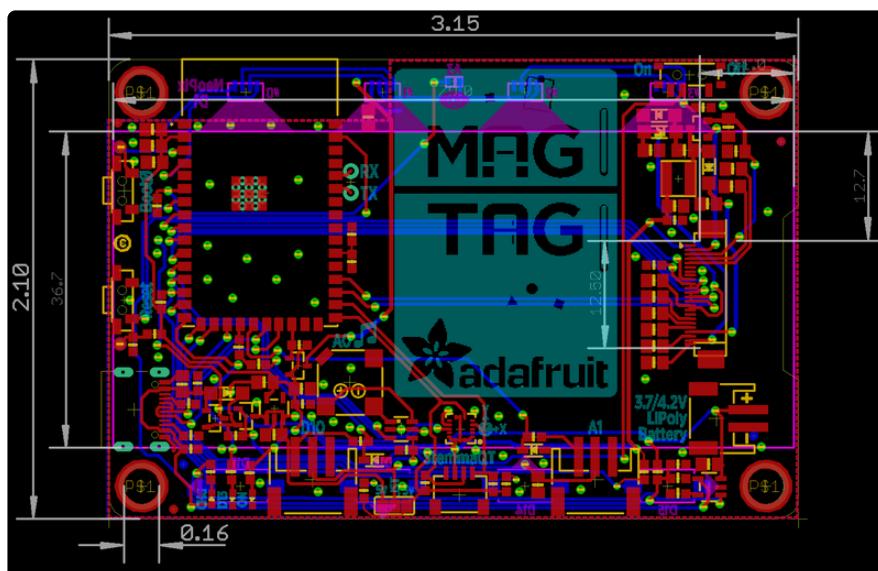
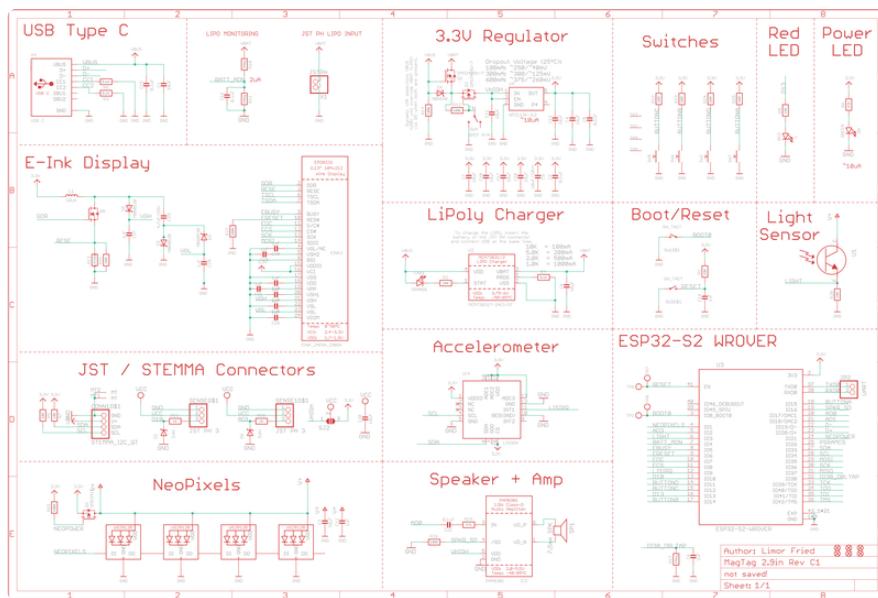
```
esptool.py -p COM88 write_flash 0x0 magtag_demoboot.bin
```

note that esptool will seem to 'hang' for a bit...that's normal, a lot of the file is empty and it doesn't tell you its skipping ahead.

magtag_demoboot.bin

<https://adafru.it/OFW>

Schematic and Fab Print



Acrylic Front and Back Plates

Suitable for laser cutting. There are two front designs (cloud and arrow) and a back piece (for using MagTag as a wearable badge rather than the magnetic feet). These can be secured with 8mm M3 screws.

Adobe Illustrator or SVG file formats:

MagTag_Acrylic.ai

<https://adafru.it/U2a>

MagTag_Acrylic.svg

<https://adafru.it/U2b>