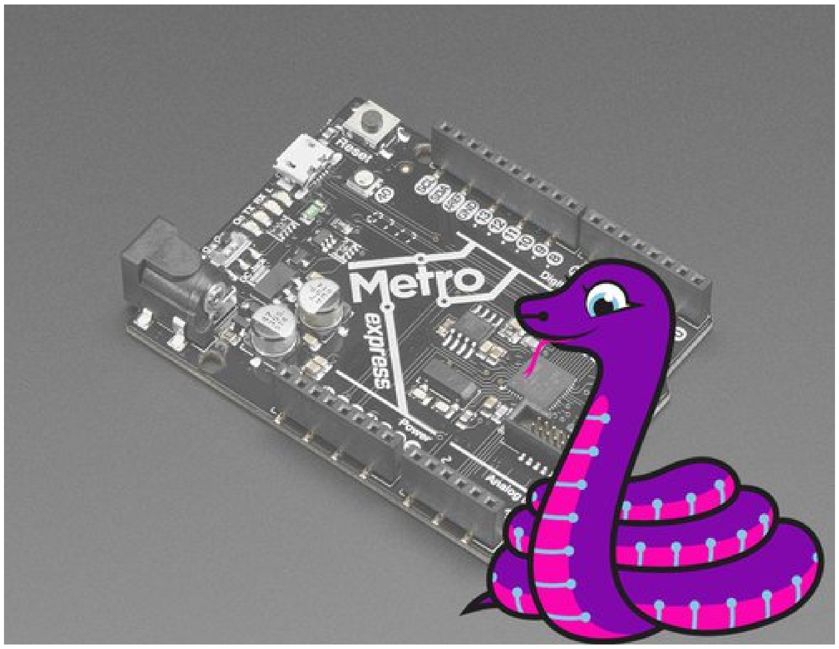
adafruit learning system

Adafruit Metro M0 Express - Designed for CircuitPython

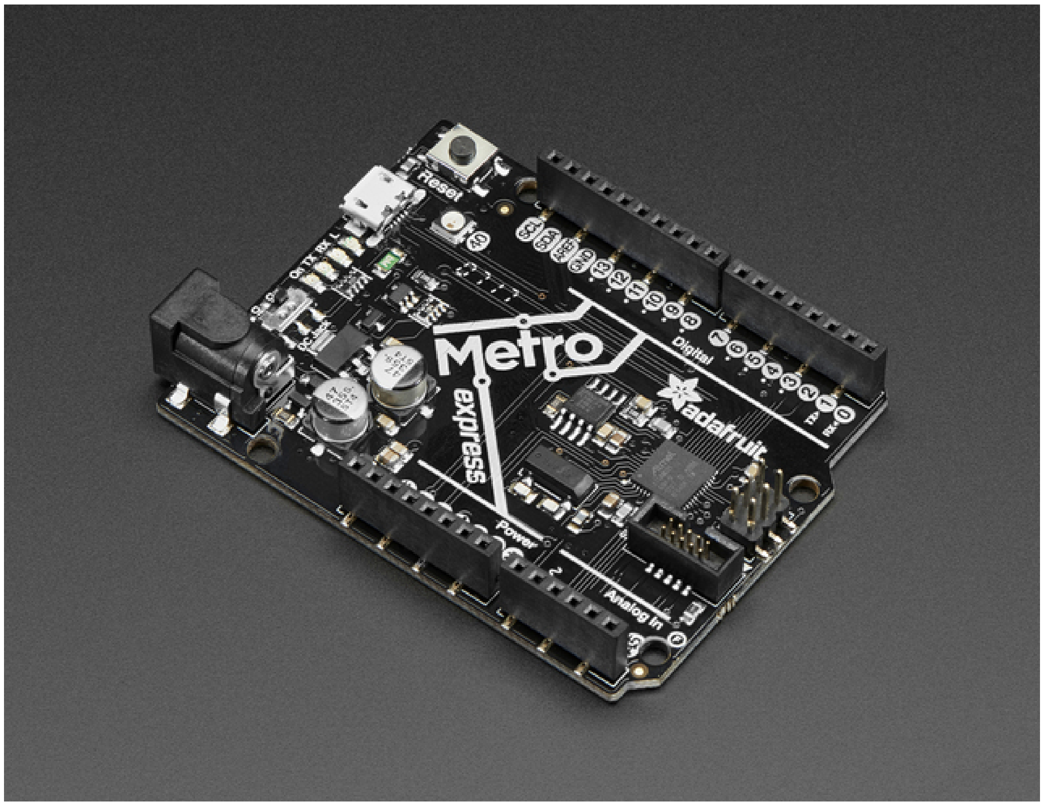
Created by lady ada



Last updated on 2017-06-19 10:35:09 PM UTC

Guide Contents

Overview

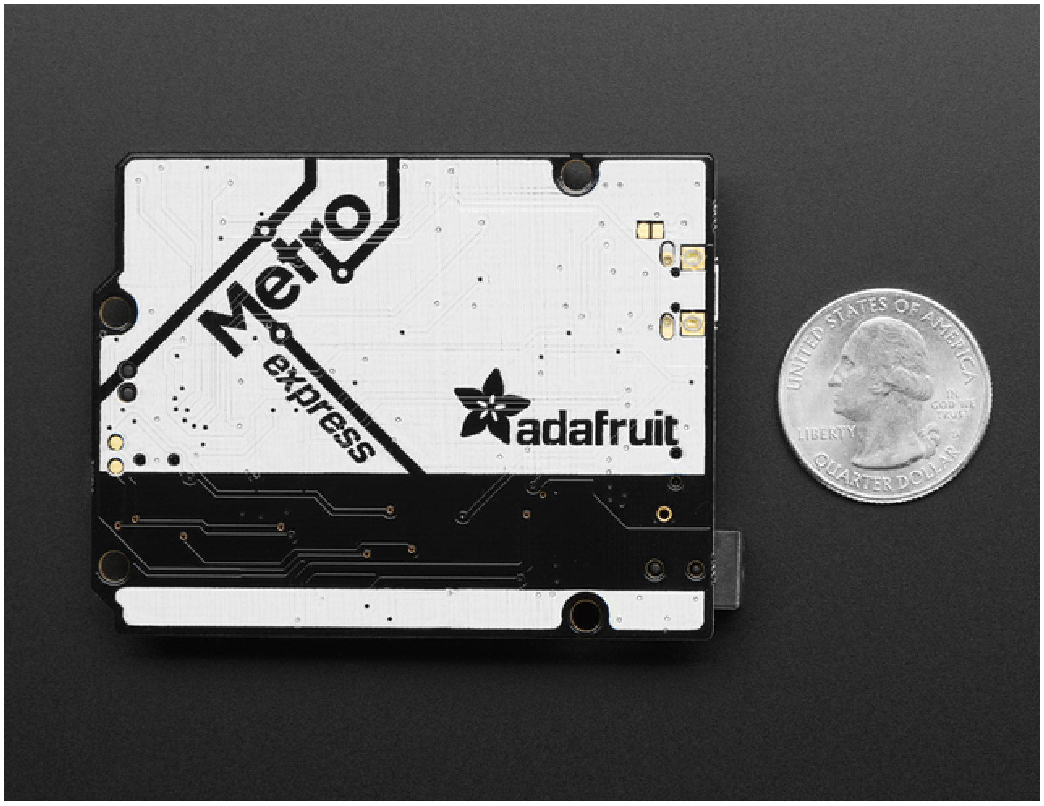


Metro is our series of microcontroller boards for use with the Arduino IDE. This new Metro board looks a whole lot like our original Metro 328 (http://adafru.it/wbr), but with a huge upgrade. Instead of the ATmega328, this Metro features a ATSAMD21G18 chip, an ARM Cortex M0+. It's our first Metro that is designed for use with CircuitPython! CircuitPython is our beginner-oriented flavor of MicroPython - and as the name hints at, its a small but full-featured version of the popular Python programming language specifically for use with circuitry and electronics.

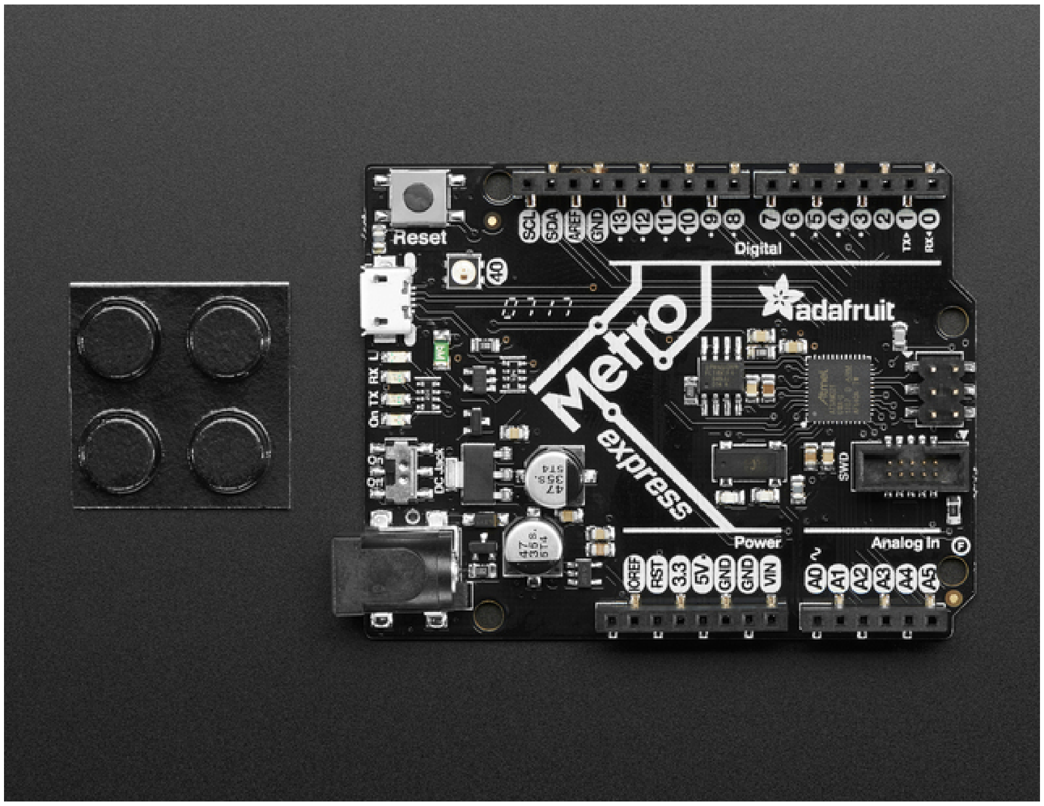
Not only can you use CircuitPython, but the Metro M0 is also usable in the Arduino IDE.

circuit python

At the Metro M0's heart is an ATSAMD21G18 ARM Cortex M0 processor, clocked at 48 MHz and at 3.3V logic, the same one used in the new Arduino Zero (http://adafru.it/2843). This chip has a whopping 256K of FLASH (8x more than the Atmega328) and 32K of RAM (16x as much)! This chip comes with built in USB so it has USB-to-Serial program & debug capability built in with no need for an FTDI-like chip.

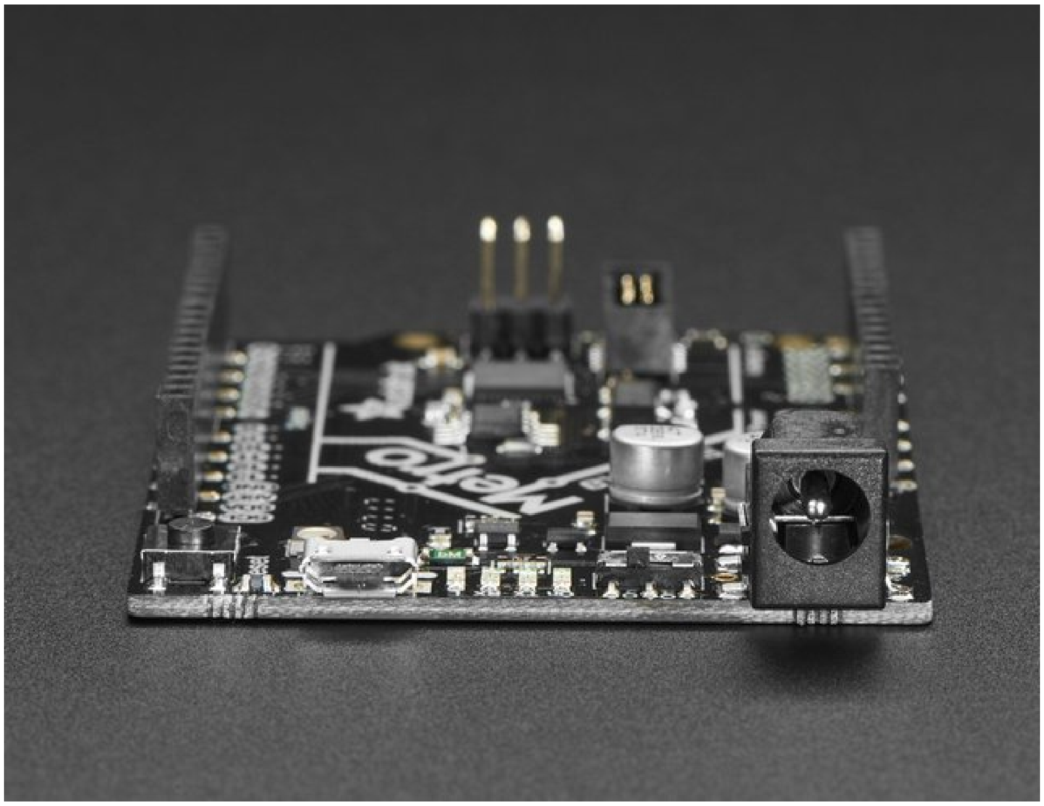


- **Power the METRO** with 7-9V polarity protected DC or the micro USB connector to any 5V USB source. The 2.1mm DC jack has an on/off switch next to it so you can turn off your setup easily. The METRO will automagically switch between USB and DC.
- **METRO has 25 GPIO pins**, 12 of which are analog in, and one of which is a true analog out. There's a hardware SPI port, hardware I2C port and hardware UART. Logic level is 3.3V
- **Native USB**, there's no need for a hardware USB to Serial converter as the Metro M0 has built in USB support. When used to act like a serial device, the USB interface can be used by any computer to listen/send data to the METRO, and can also be used to launch and update code via the bootloader. It can also act like a keyboard, mouse or MIDI device as well.
- **Four indicator LEDs and one NeoPixel**, on the front edge of the PCB, for easy debugging. One green power LED, two RX/TX LEDs for data being sent over USB, and a red LED connected. Next to the reset button there is an RGB NeoPixel that can be used for any purpose.
- **2 MB SPI Flash** storage chip is included on board. You can use the SPI Flash storage like a very tiny hard drive. When used in Circuit Python, the 2 MB flash acts as storage for all your scripts, libraries and files. When used in Arduino, you can read/write files to it, like a little datalogger or SD card, and then with our helper program, access the files over USB.
- **Easy reprogramming**, comes pre-loaded with the UF2 bootloader (http://adafru.it/wbC), which looks like a USB key. Simply drag firmware on to program, no special tools or drivers needed! It can be used by MakeCode or Arduino IDE (in bossa compatibility)



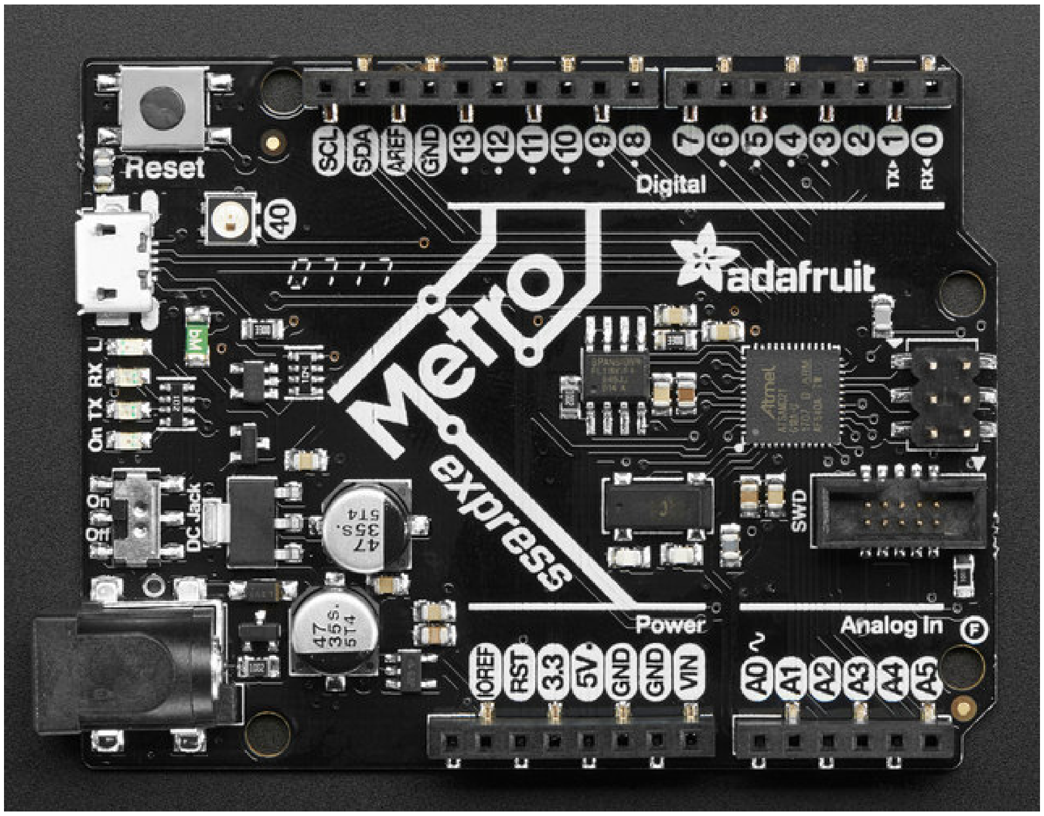
Here's some handy specs!

- Measures 2.8" x 2.1" x 0.28"
- ATSAMD21G18 @ 48MHz with 3.3V logic/power
- 256KB of FLASH + 32KB of RAM
- 4 MB SPI Flash chip
- No EEPROM
- 32.768 KHz crystal for clock generation & RTC
- 3.3V regulator with 500mA peak current output
- USB native support, comes with USB bootloader and serial port debugging
- You also get tons of pins - 25 GPIO pins, 5 more than the Metro 328
- Hardware Serial, hardware I2C, hardware SPI support
- PWM outputs on almost all pins
- 6 x 12-bit analog inputs
- 1 x 10-bit analog output (DAC)
- Built in NeoPixel on pin #40
- Pin #13 red LED for general purpose blinking
- Power on/off switch
- 4 mounting holes
- We also include 4 rubber bumpers to keep it from slipping off your desk
- Reset button



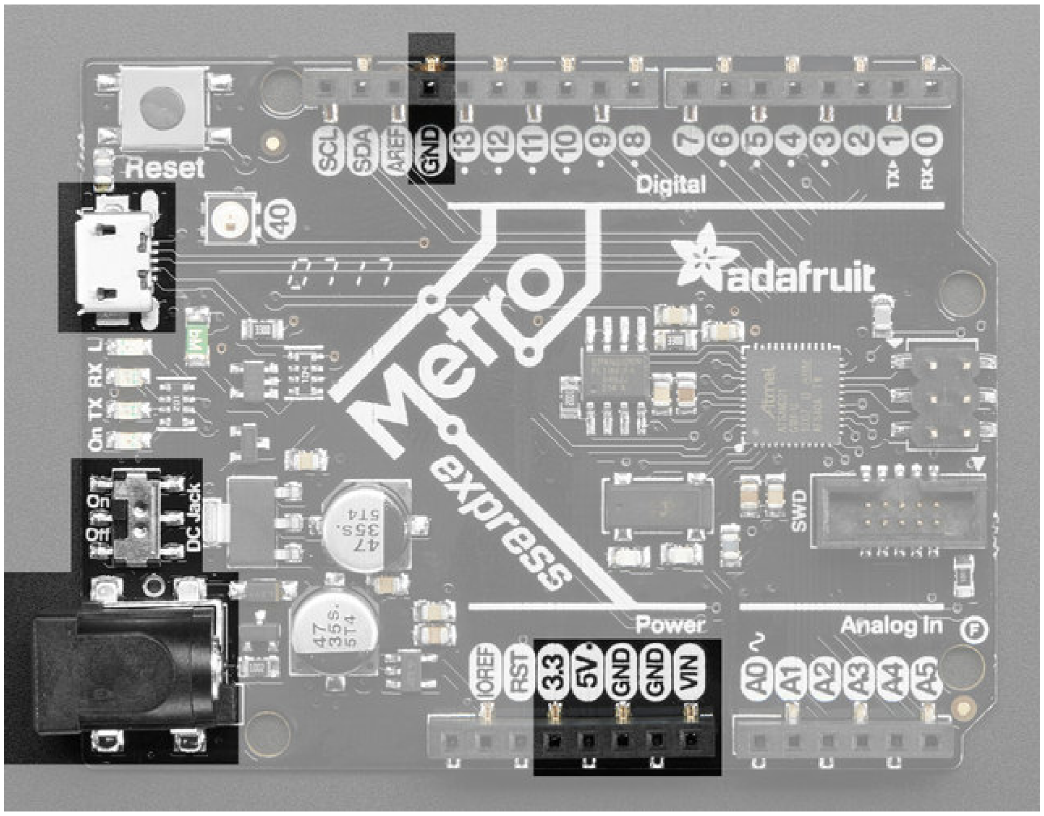
Please note, CircuitPython is still in *beta* and we're working hard to make it awesome! Please pick up one of these Metro M0 Expresses if you want to try it out - maybe even help us find bugs and make improvements!

Pinouts



The Metro M0 is chock-full of microcontroller goodness. There's also a lot of pins and ports. We'll take you a tour of them now!

Power Connections



There's a lot of ways to power the Metro M0 Express, and a lot of ways to *get* power out as well.

There are two primary ways to power the Metro:

- Through the Micro USB port up at the top left
- Through the DC jack at the bottom left

The MicroUSB jack provides 5V at 500mA or so, there is a fuse that will shut off temporarily when more than 1000mA is drawn, this is to protect a computer USB port. You can plug this into any computer or USB charger with a USB cable. You can draw up to 500mA between the Vin, 5V and 3.3V supplies (combined).

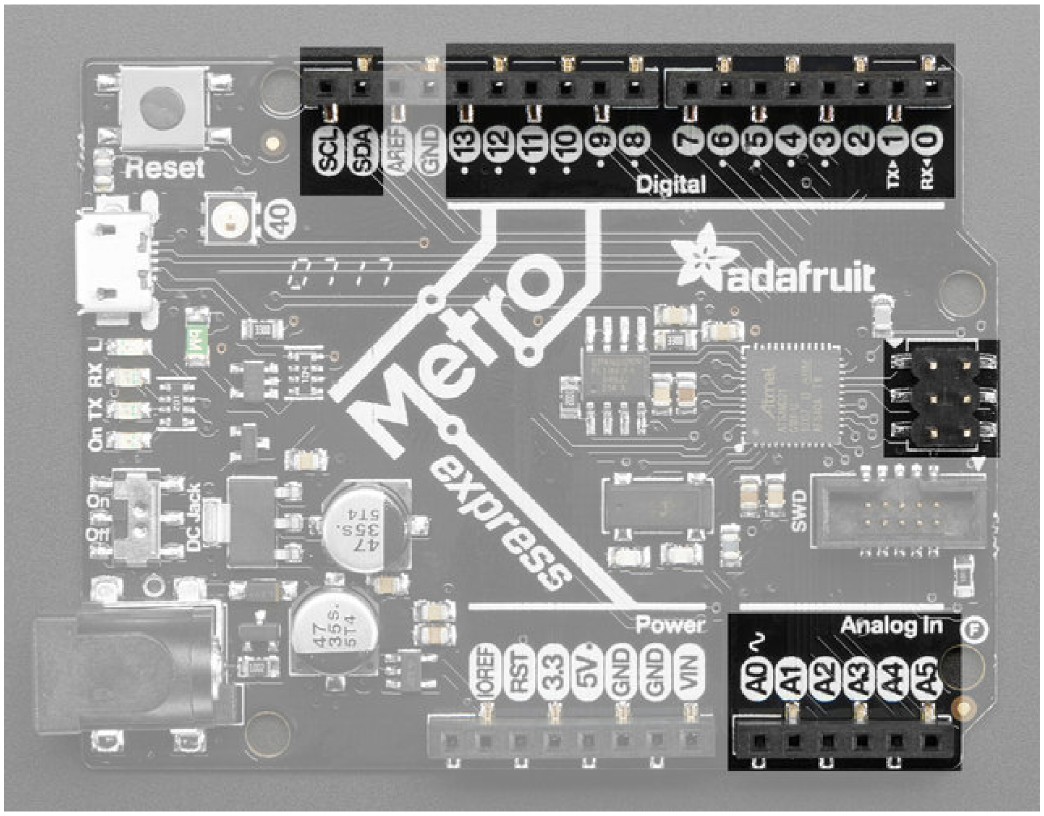
The DC Jack is a 5.5mm/2.1mm center-positive DC connector, which is the most common available. Provide about 6V-12V here to power the Metro. There is no fuse on this connection so you can draw more current, up to 800mA between the **5V** and **3.3V** supplies, and 2A from **Vin**.

Onboard regulators take the USB or DC power and linearly convert it to **3.3V** and **5V**:

- **3V -** this is the output from the 3.3V regulator, it can supply 500mA peak
- **5V -** this is the output from the 5V regulator (when DC jack is used), or from USB. It can supply ~500mA peak from USB and ~800mA peak from DC
- **GND** - this is the common ground for all power and logic
- **Vin** - this is the *higher* of the DC jack or USB voltage. So if the DC jack is plugged in and 9V, Vin is 9V. If only USB connected, this will be 5V.

There is also an on/off switch. This switch is only for the DC jack and does not affect powering via USB

Logic pins



This is the general purpose I/O pin set for the microcontroller.
All logic is 3.3V
Most pins can do PWM output
All pins can be interrupt inputs

Top Row

- **#0** / **RX** - GPIO #0, also receive (input) pin for**Serial1** (hardware UART)
- **#1** / **TX** - GPIO #1, also transmit (output) pin for**Serial1**
- **#2** through **#12** - These are general purpose GPIO. If there's a dot next to the pad it can act as a PWM output.
- **#13** - GPIO #13 and is connected to the**red LED** marked **L** next to the USB jack
- **SDA** - the I2C (Wire) data pin. There's no pull up on this pin by default so when using with I2C, you may need a 2.2K-10K pullup.
- **SCL** - the I2C (Wire) clock pin. There's no pull up on this pin by default so when using with I2C, you may need a 2.2K-10K pullup.

Bottom Row

- **A0** - This pin is analog *input* **A0** but is also an analog *output* due to having a DAC (digital-to-analog converter). You can set the raw voltage to anything from 0 to 3.3V, unlike PWM outputs this is a true analog output
- **A1 thru A5** - These are each analog input as well as digital I/O pins.

Right side

- **SCK**/**MOSI**/**MISO** - These are the hardware SPI pins, are are connected to the 2x3 header on the right hand side. you can use them as everyday GPIO pins (but recommend keeping them free as they are best used for hardware SPI connections for high speed.)

Additional analog inputs

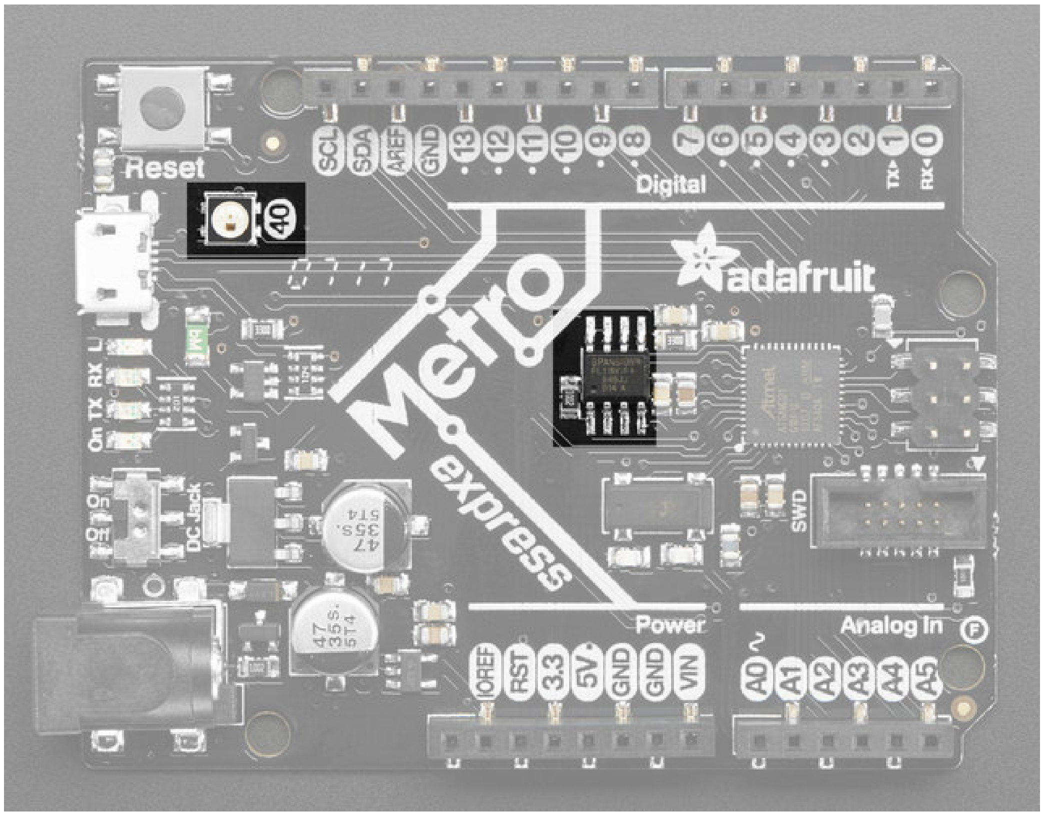
In addition to the A0-A5 pins, there are extra analog inputs available

- Digital #0 is also A6
- Digital #1 is also A7
- Digital #4 is also A8
- Digital #5 is also A9
- Digital #8 is also A10
- Digital #9 is also A11

These pins are available in CircuitPython under the board module. Names that start with # are prefixed with D and other names are as is. So **#0** / **RX** above is available as board.D0 and board.RX for example.

SPI Flash and NeoPixel

As part of the 'Express' series of boards, the Metro M0 Express is designed for use with CircuitPython. To make that easy, we have added two extra parts to this Metro M0: a mini NeoPixel (RGB LED) and a 2 MB SPI Flash chip

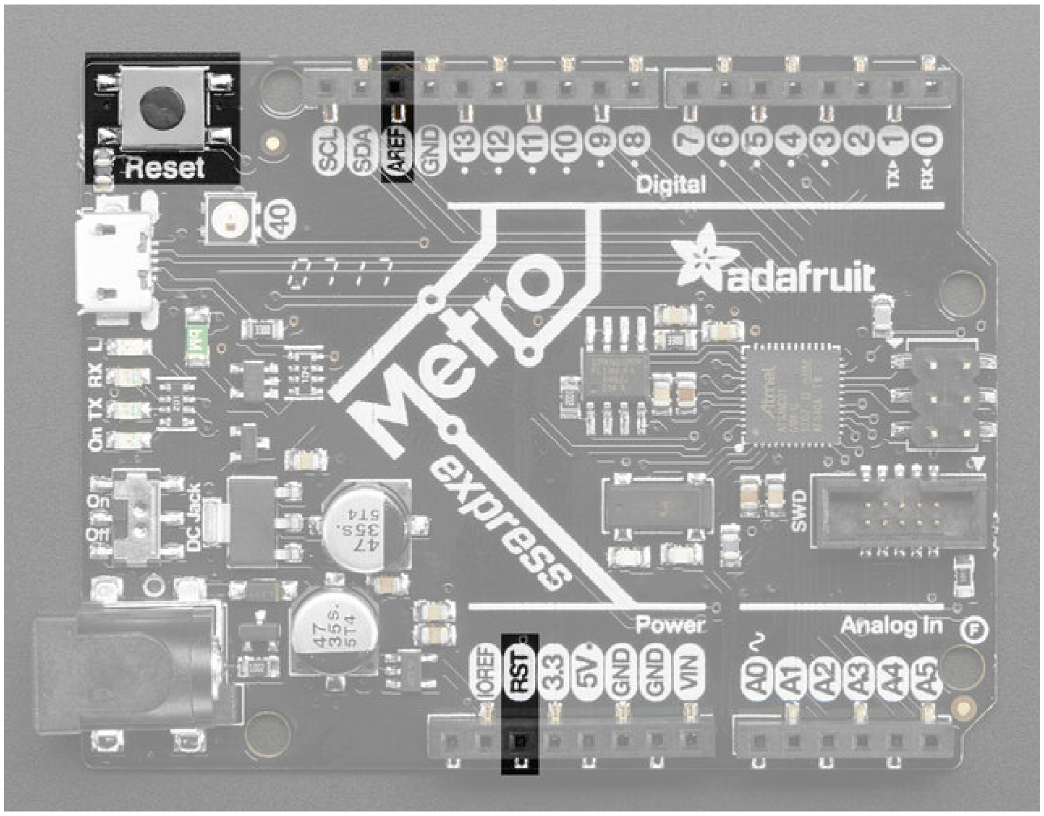


The **NeoPixel** is connected to pin #40 in Arduino, so [just use our NeoPixel library](http://adafru.it/dhw) (http://adafru.it/dhw) and set it up as a single-LED strand on pin 40. In CircuitPython, the NeoPixel is board.NEOPIXEL and the library for it is [here](http://adafru.it/wby) (http://adafru.it/wby) and in [the bundle](http://adafru.it/uap) (http://adafru.it/uap). The NeoPixel is powered by the 3.3V power supply but that hasn't shown to make a big difference in brightness or color. The NeoPixel is also used by the bootloader to let you know if the device has enumerated correctly (green) or USB failure (red). In CircuitPython, the LED is used to indicate the runtime status.

The SPI Flash is connected to 4 pins that are not brought out on the GPIO pads. This way you don't have to worry about the SPI flash colliding with other devices on the main SPI connection. Under Arduino, the FLASH **SCK** pin is

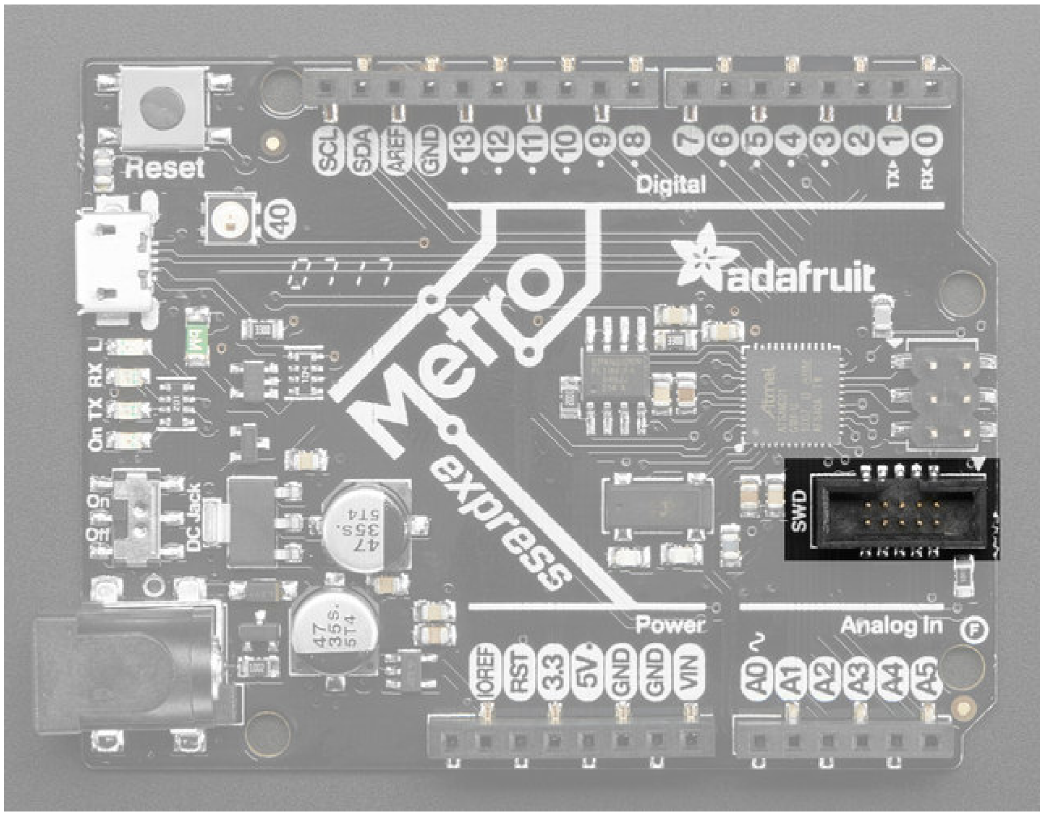
#38, **MISO** is #36, **MOSI** is #37, and **CS** is #39. If you use **Metro M0 Express** as your board type, you'll be able to access the Flash SPI port under **SPI1** - this is a fully new hardware SPI device separate from the GPIO pins on the outside edge of the Feather. In CircuitPython, the SPI flash is used natively by the interpretter and is read-only to user code, instead the Flash just shows up as the writeable disk drive!

Other Pins!



- **RST** - this is the Reset pin, tie to ground to manually reset the ATSAMD21, as well as launch the bootloader manually
- **ARef** - the analog reference pin. Normally the reference voltage is the same as the chip logic voltage (3.3V) but if you need an alternative analog reference, connect it to this pin and select the external AREF in your firmware. Can't go higher than 3.3V!

Debug Interface



If you'd like to do more advanced development, trace-debugging, or not use the bootloader, we have the SWD interface exposed.

You can use any 2x5 0.05" pitch SWD interface to connect. We suggest a J-Link. Since the SWCLK pin is shared between the NeoPixel, and the bootloader takes control of the pin, you need to reset the board *right before* beginning debug. OpenOCD and some other debug interfaces may not be able to do this. That's why we really really suggest a JLink!

SEGGER J-Link EDU - JTAG/SWD Debugger

PRODUCT ID: 1369
The SEGGER J-Link EDU is identical to the more expensive J-Link BASE model except for the terms of use . If you're going to use your debugger strictly for personal, non-commercial...
http://adafru.it/e9G
$69.95
IN STOCK

SEGGER J-Link BASE - JTAG/SWD Debugger

PRODUCT ID: 2209
The SEGGER J-Link BASE is identical to the cheaper J-Link EDU model except for the terms of use . If you're going to use your debugger strictly for personal, non-commercial...
http://adafru.it/e5q
$399.95
IN STOCK

You'll need an adapter and cable to convert the 2x10 JTAG cable to SWD

JTAG (2x10 2.54mm) to SWD (2x5 1.27mm) Cable Adapter Board

PRODUCT ID: 2094
This adapter board is designed for adapting a 'classic' 2x10 (0.1"/2.54mm pitch) JTAG cable to a slimmer 2x5 (0.05"/1.27mm pitch) SWD Cable. It's helpful for using products like the...
http://adafru.it/wbz
$4.95
IN STOCK

10-pin 2x5 Socket-Socket 1.27mm IDC (SWD) Cable - 150mm long

PRODUCT ID: 1675
These little cables are handy when programming or debugging a tiny board that uses 10-pin 1.27mm (0.05") pitch SWD programming connectors. We see these connectors often on ARM Cortex...
http://adafru.it/wbA
$2.95
IN STOCK

UF2 Bootloader Details

This is an information page for advanced users who are curious how we get code from your computer into your Express board!

Adafruit Express boards feature an improved bootloader that makes it easier than ever to flash different code onto the microcontroller. This bootloader makes it easy to switch between Microsoft MakeCode, CircuitPython and Arduino.

Instead of needing drivers or a separate program for flashing (say, bossac, jlink or avrdude), one can simply ***drag a file onto a removable drive***.

The format of the file is a little special. Due to 'operating system woes' you cannot just drag a binary or hex file (trust us, we tried it, it isn't cross-platform compatible). Instead, the format of the file has extra information to help the bootloader know where the data goes. The format is called UF2 (USB Flashing Format). Microsoft MakeCode generates UF2s for flashing and CircuitPython releases are also available as UF2. You can also create your own UF2s from binary files using uf2tool, available here. (http://adafru.it/vPE)

The bootloader is ***also BOSSA compatible***, so it can be used with the Arduino IDE which expects a BOSSA bootloader on ATSAMD-based boards

For more information about UF2, you can read a bunch more at the MakeCode blog(http://adafru.it/w5A), then check out the UF2 file format specification(http://adafru.it/vPE) and to build your *own* bootloader for ATSAMD-based boards, visit Microsoft UF2-SAMD github repository (http://adafru.it/vPF).

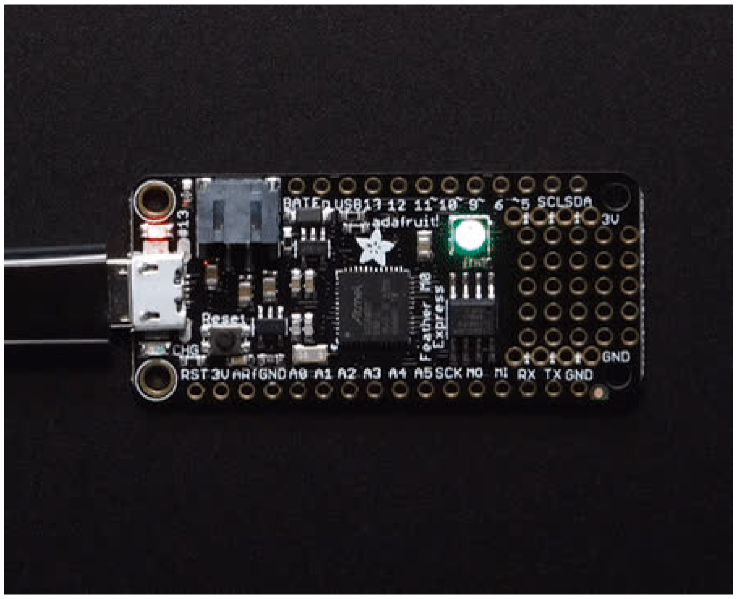
The bootloader is not needed when changing your CircuitPython code. Its only needed when upgrading the CircuitPython core or changing between CircuitPython, Arduino and Microsoft MakeCode.

Entering Bootloader Mode

The first step to loading new code onto your board is triggering the bootloader. It is easily done by double tapping the reset button. Once the bootloader is active you will see the small red LED fade in and out and a new drive will appear on your computer with a name ending in **BOOT**. For example, feathers show up as **FEATHERBOOT** while the new CircuitPlayground shows up as **CPLAYBOOT**.

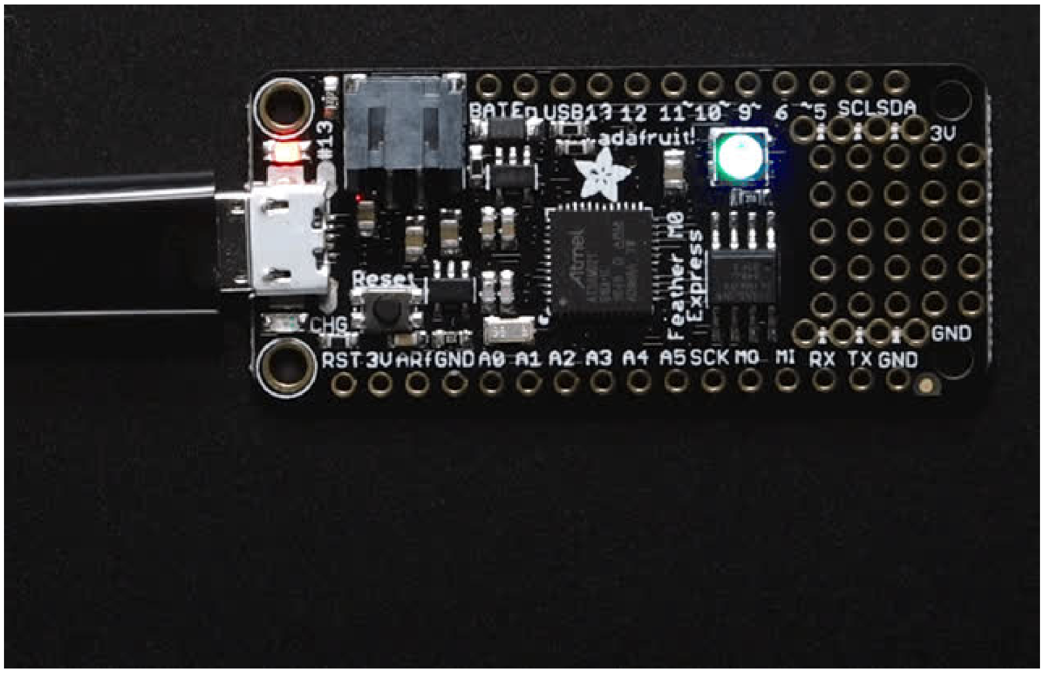
Furthermore, when the bootloader is active, it will change the color of one or more onboard neopixels to indicate the connection status, red for disconnected and green for connected. If the board is plugged in but still showing that its disconnected, try a different USB cable. Some cables only provide power with no communication.

For example, here is a Feather M0 Express running a colorful Neopixel swirl. When the reset button is double clicked (about half second between each click) the NeoPixel will stay green to let you know the bootloader is active. When the reset button is clicked once, the 'user program' (NeoPixel color swirl) restarts.



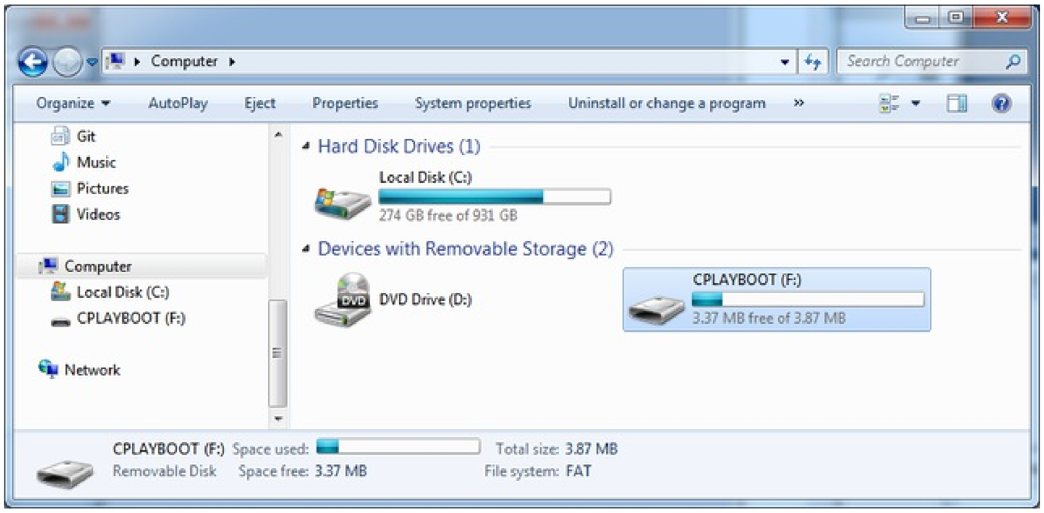
If the bootloader couldn't start, you will get a red NeoPixel LED.

That could mean that your USB cable is no good, it isn't connected to a computer, or maybe the drivers could not enumerate. Try a new USB cable first. Then try another port on your computer!



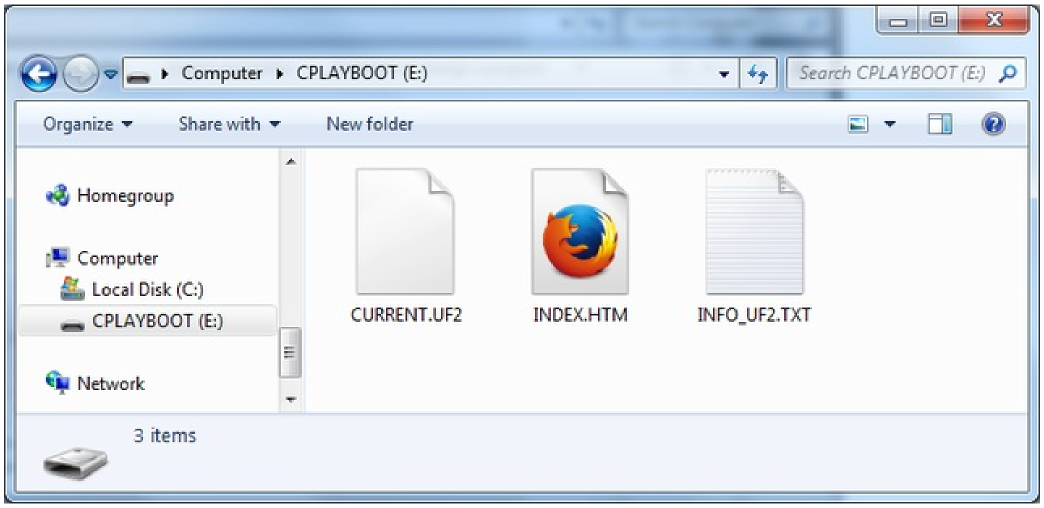
The first versions of the Feather M0 Express have a bootloader that may be unreliable, especially when used through a USB Hub. If the board doesn't connect through a USB hub or connects but then disconnects, then please update the bootloader with the instructions below.

Once the bootloader is running, check your computer. You should see a USB Disk drive...



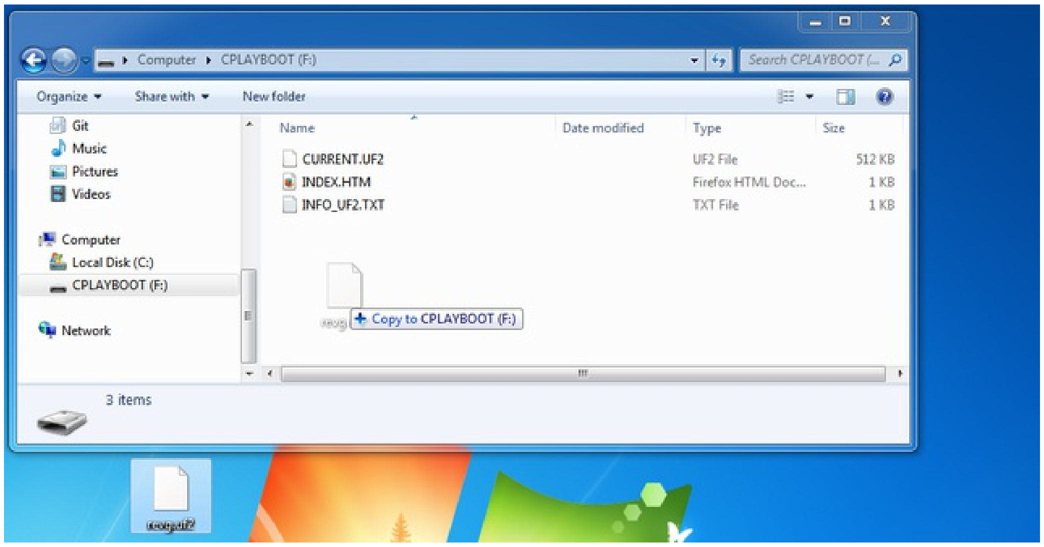
Once the bootloader is successfully connected you can open the drive and browse the virtual filesystem. This isn't the same filesystem as you use with CircuitPython or Arduino. It should have three files:

- **CURRENT.UF2** - The current contents of the microcontroller flash.
- **INDEX.HTM** - Links to Microsoft MakeCode.
- **INFO_UF2.TXT** - Includes bootloader version info. Please include it on bug reports.

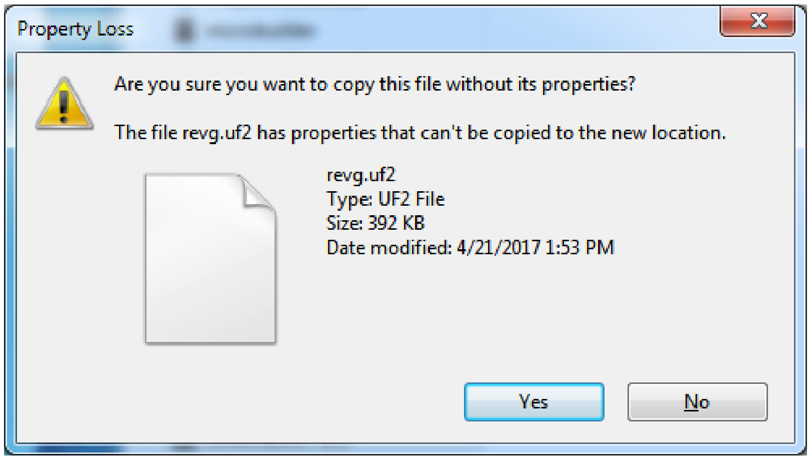


Using the Mass Storage Bootloader

To flash something new, simply drag any UF2 onto the drive. After the file is finished copying, the bootloader will automatically restart. This usually causes a warning about an unsafe eject of the drive. However, its not a problem. The bootloader knows when everything is copied successfully.



You may get an alert from the OS that the file is being copied without it's properties. You can just click **Yes**



Property Loss

Are you sure you want to copy this file without its properties?

The file revg.uf2 has properties that can't be copied to the new location.

revg.uf2
Type: UF2 File
Size: 392 KB
Date modified: 4/21/2017 1:53 PM

You may also get get a complaint that the drive was ejected without warning. Don't worry about this. The drive only ejects once the bootloader has verified and completed the process of writing the new code

Using the BOSSA Bootloader

As mentioned before, the bootloader is also compatible with BOSSA, which is the standard method of updating boards when in the Arduino IDE. It is a command-line tool that can be used in any operating system. We won't cover the full use of the **bossac** tool, suffice to say it can do quite a bit! More information is available at ShumaTech (http://adafru.it/vQa).

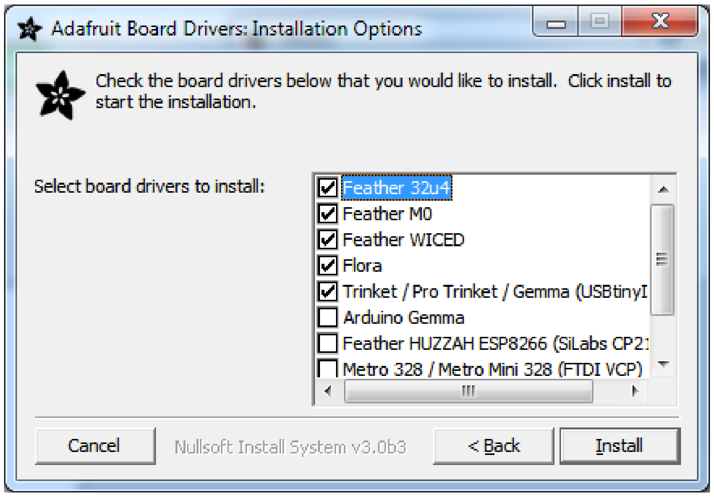
Windows 7 Drivers

If you are running Windows 7 (or, goodness, something earlier?) You will need a Serial Port driver file. Windows 10 users do not need this so skip this step.

You can download our full driver package here:

Download Adafruit Driver Installer v1.1
http://adafru.it/vA7

Download and run the installer. We recommend just selecting all the serial port drivers available (no harm to do so) and installing them.


Adafruit Board Drivers: Installation Options

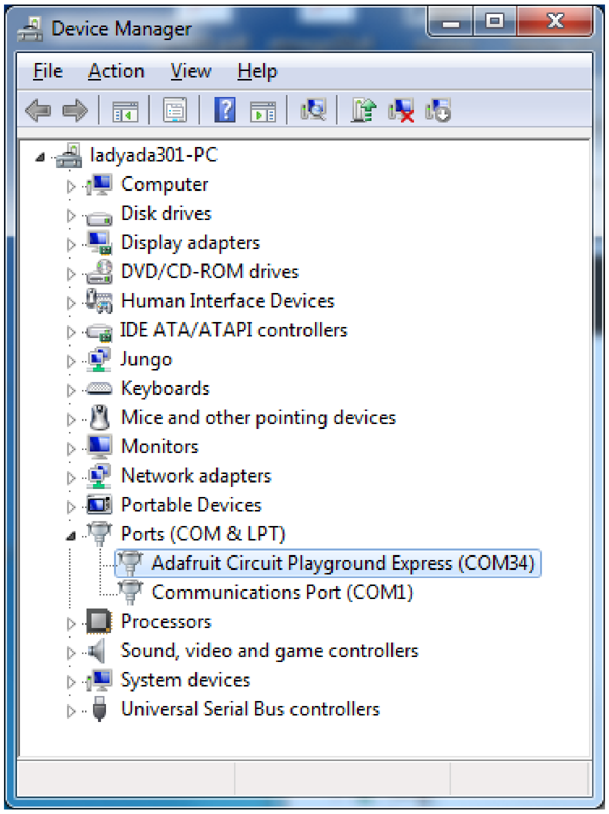
Check the board drivers below that you would like to install. Click install to start the installation.

Select board drivers to install:

- [✓] Feather 32u4
- [✓] Feather M0
- [✓] Feather WICED
- [✓] Flora
- [✓] Trinket / Pro Trinket / Gemma (USBtinyI
- [ ] Arduino Gemma
- [ ] Feather HUZZAH ESP8266 (SiLabs CP21
- [ ] Metro 328 / Metro Mini 328 (FTDI VCP)

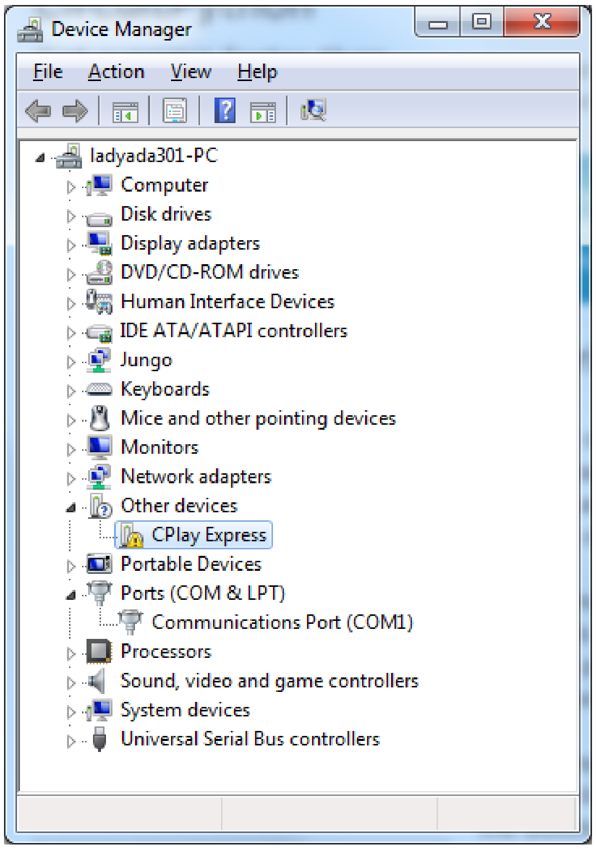
Verifying Serial Port in Device Manager

If you're running Windows, its a good idea to verify the device showed up. Open your Device Manager from the control panel and look under **Ports (COM & LPT)** for a device called **Feather M0** or **Circuit Playground** or whatever!


Device Manager

```
ladyada301-PC
    Computer
    Disk drives
    Display adapters
    DVD/CD-ROM drives
    Human Interface Devices
    IDE ATA/ATAPI controllers
    Jungo
    Keyboards
    Mice and other pointing devices
    Monitors
    Network adapters
    Portable Devices
    Ports (COM & LPT)
        Adafruit Circuit Playground Express (COM34)
        Communications Port (COM1)
    Processors
    Sound, video and game controllers
    System devices
    Universal Serial Bus controllers
```

If you see something like this, it means you did not install the drivers. Go back and try again, then remove and re-plug the USB cable for your board



ladyada301-PC
- Computer
- Disk drives
- Display adapters
- DVD/CD-ROM drives
- Human Interface Devices
- IDE ATA/ATAPI controllers
- Jungo
- Keyboards
- Mice and other pointing devices
- Monitors
- Network adapters
- Other devices
  - CPlay Express
- Portable Devices
- Ports (COM & LPT)
  - Communications Port (COM1)
- Processors
- Sound, video and game controllers
- System devices
- Universal Serial Bus controllers

Running bossac on the command line

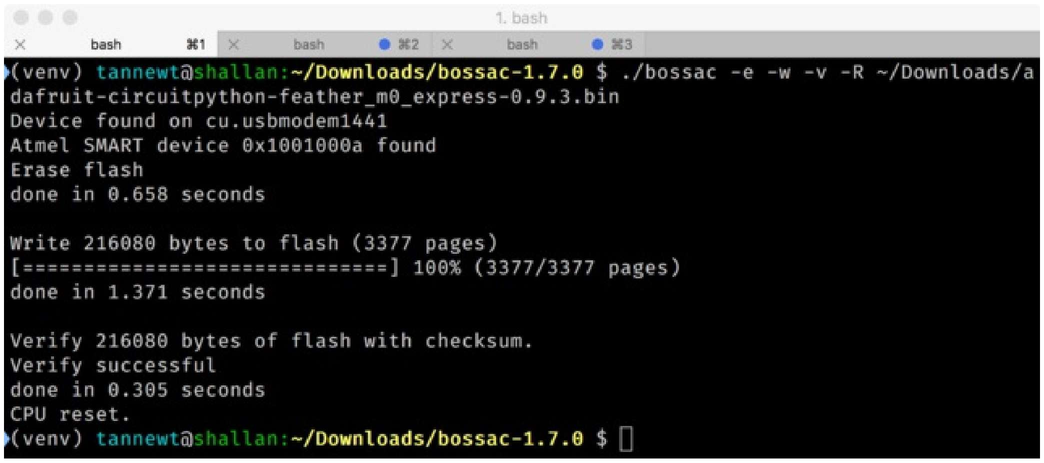
If you are using the Arduino IDE, this step is not required. But sometimes you want to read/write custom binary files, say for loading CircuitPython or your own code. We recommend using bossac v 1.7.0 (or greater), which has been tested. The Arduino branch is most recommended (http://adafru.it/vQb).

You can download the latest builds here.(http://adafru.it/s1B) The mingw32 version is for Windows, apple-darwin for Mac OSX and various linux options for Linux. Once downloaded, extract the files from the zip and open the command line to the directory with bossac

For example here's the command line you probably want to run:

```
bossac -e -w -v -R ~/Downloads/adafruit-circuitpython-feather_m0_express-0.9.3.bin
```

This will -erase the chip, -write the given file, -verify the write and -Reset the board. After reset, CircuitPython should be running. Express boards may cause a warning of an early eject of a USB drive but just ignore it. Nothing important was being written to the drive. A hard power-reset is also recommended after **bossac**, just in case.



```
(venv) tannewt@shallan:~/Downloads/bossac-1.7.0 $ ./bossac -e -w -v -R ~/Downloads/a
dafruit-circuitpython-feather_m0_express-0.9.3.bin
Device found on cu.usbmodem1441
Atmel SMART device 0x1001000a found
Erase flash
done in 0.658 seconds

Write 216080 bytes to flash (3377 pages)
[==============================] 100% (3377/3377 pages)
done in 1.371 seconds

Verify 216080 bytes of flash with checksum.
Verify successful
done in 0.305 seconds
CPU reset.
(venv) tannewt@shallan:~/Downloads/bossac-1.7.0 $ 
```

Updating the bootloader

The UF2 bootloader is still in beta, and while we've done a ton of testing, it may contain bugs. Usually these bugs effect reliability rather than fully preventing the bootloader from working. If the bootloader is flaky then you can try updating the bootloader itself to potentially improve reliability.

Updating the bootloader is as easy as flashing CircuitPython, Arduino or MakeCode. Simply enter the bootloader as above and then drag the *update bootloader uf2* file below. This uf2 contains a program which will unlock the bootloader section, update the bootloader, and re-lock it. It will overwrite your existing code such as CircuitPython or Arduino so make sure everything is backed up!

After the file is copied over, the bootloader will be updated and appear again. The**INFO_UF2.TXT** file should show the newer version number inside.

For example:

UF2 Bootloader v1.20.0 SFHR
Model: Adafruit Feather M0
Board-ID: SAMD21G18A-Feather-v0

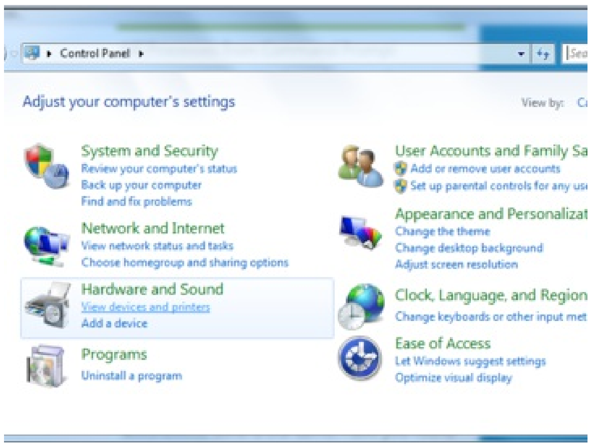
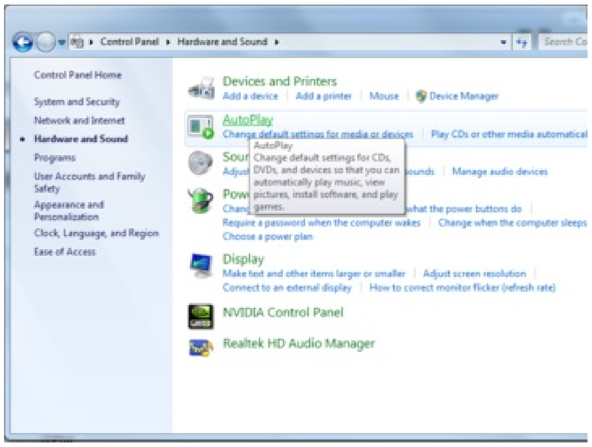
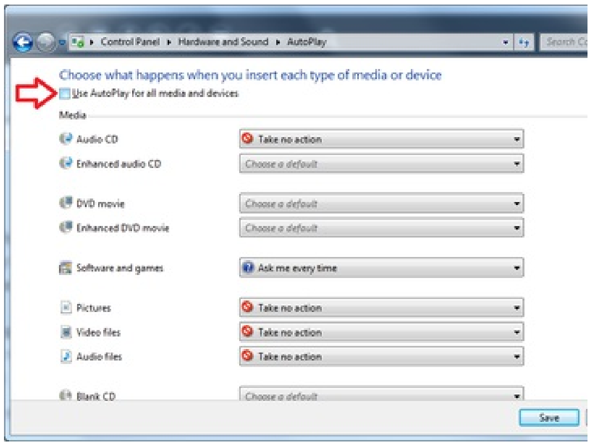
Lastly, reload your code from Arduino or MakeCode or flash thelatest CircuitPython core (http://adafru.it/tBa).

The latest updater for Feather M0 Express:

Feather M0 v1.22.0 Update UF2
http://adafru.it/wJf
Metro M0 v1.22.0 Update UF2
http://adafru.it/wJA

Getting Rid of Windows Pop-ups

If you do a *lot* of development on Windows with the UF2 bootloader, you may get annoyed by the constant "Hey you inserted a drive what do you want to do" pop-ups.

- 
Control Panel
Adjust your computer's settings
View by:
System and Security
Review your computer's status
Back up your computer
Find and fix problems
Network and Internet
View network status and tasks
Choose homegroup and sharing options
Hardware and Sound
View devices and printers
Add a device
Programs
Uninstall a program
User Accounts and Family Sa
Add or remove user accounts
Set up parental controls for any us
Appearance and Personalizat
Change the theme
Change desktop background
Adjust screen resolution
Clock, Language, and Region
Change keyboards or other input met
Ease of Access
Let Windows suggest settings
Optimize visual display
Go to the Control Panel. Click on the **Hardware and Sound** header
- 
Control Panel ▸ Hardware and Sound ▸
Control Panel Home
System and Security
Network and Internet
Hardware and Sound
Programs
User Accounts and Family Safety
Appearance and Personalization
Clock, Language, and Region
Ease of Access
Devices and Printers
Add a device | Add a printer | Mouse | Device Manager
AutoPlay
Change default settings for media or devices | Play CDs or other media automatical
AutoPlay
Change default settings for CDs, DVDs, and devices so that you can automatically play music, view pictures, install software, and play games.
Manage audio devices
Require a password when the computer wakes | Change when the computer sleeps
Choose a power plan
Display
Make text and other items larger or smaller | Adjust screen resolution
Connect to an external display | How to correct monitor flicker (refresh rate)
NVIDIA Control Panel
Realtek HD Audio Manager
Click on the **Autoplay** header
- 
Control Panel ▸ Hardware and Sound ▸ AutoPlay
Choose what happens when you insert each type of media or device
Use AutoPlay for all media and devices
Media
Audio CD — Take no action
Enhanced audio CD — Choose a default
DVD movie — Choose a default
Enhanced DVD movie — Choose a default
Software and games — Ask me every time
Pictures — Take no action
Video files — Take no action
Audio files — Take no action
Blank CD — Choose a default
Save
Uncheck the box at the top, labeled **Use Autoplay for all devices**

Making your own UF2

Making your own UF2 is easy! All you need is a .bin file of a program you wish to flash and the Python conversion script (http://adafru.it/vZb). Make sure that your program was compiled to start at 0x2000 (8k) because the bootloader takes the first 8k. CircuitPython's linker script (http://adafru.it/vZc) is an example on how to do that.

Once you have a .bin file, you simply need to run the Python conversion script over it. Here is an example from the directory with uf2conv.py:

```
uf2conv.py -c -o build-circuitplayground_express/revg.uf2 build-circuitplayground_express/revg.bin
```

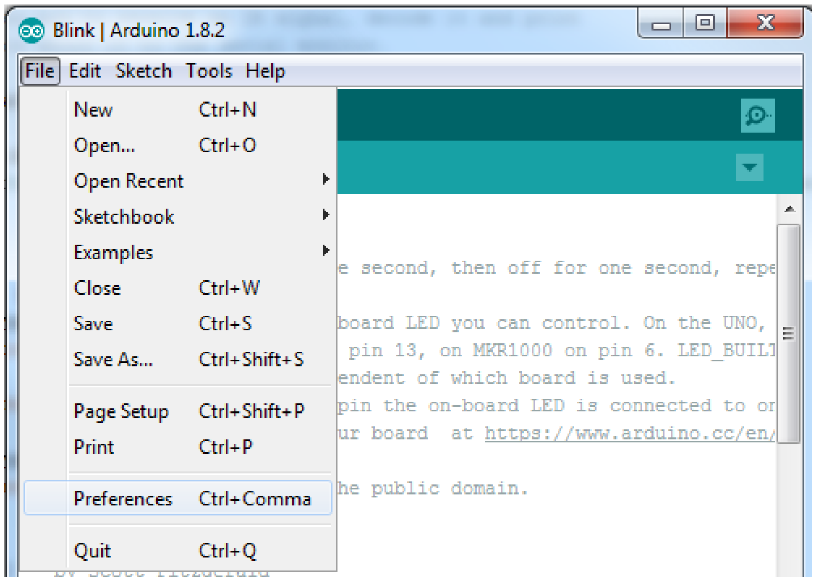
This will produce a revg.uf2 file in the same directory as the source revg.bin. The uf2 can then be flashed in the same way as above.

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 1.6.4** or higher for this guide.

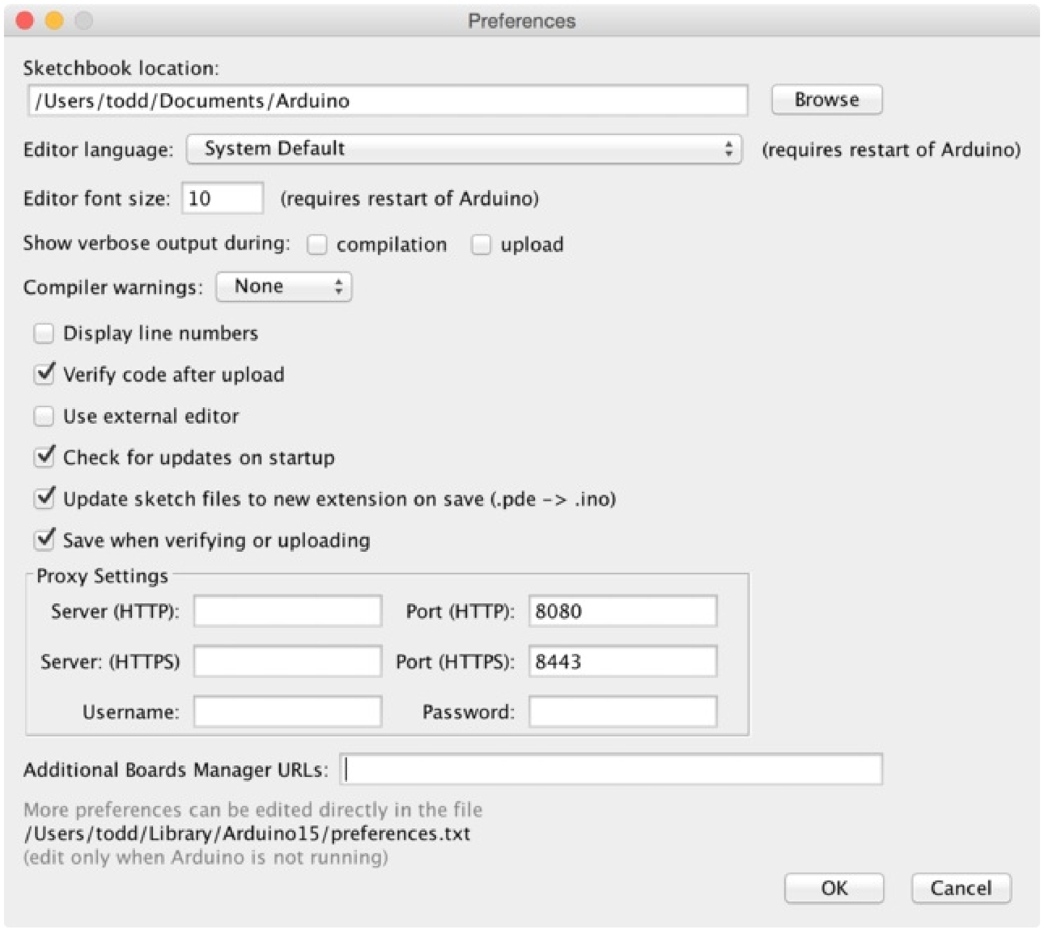
Arduino IDE Download
http://adafru.it/f1P

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*.



```
e second, then off for one second, repe

board LED you can control. On the UNO,
 pin 13, on MKR1000 on pin 6. LED_BUILT
endent of which board is used.
pin the on-board LED is connected to or
ur board  at https://www.arduino.cc/en/

he public domain.
```

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



Sketchbook location: /Users/todd/Documents/Arduino

Editor language: System Default (requires restart of Arduino)

Editor font size: 10 (requires restart of Arduino)

Show verbose output during: ☐ compilation ☐ upload

Compiler warnings: None

☐ Display line numbers

✓ Verify code after upload

☐ Use external editor

✓ Check for updates on startup

✓ Update sketch files to new extension on save (.pde -> .ino)

✓ Save when verifying or uploading

Proxy Settings

Server (HTTP):		Port (HTTP):	8080
Server: (HTTPS)		Port (HTTPS):	8443
Username:		Password:	

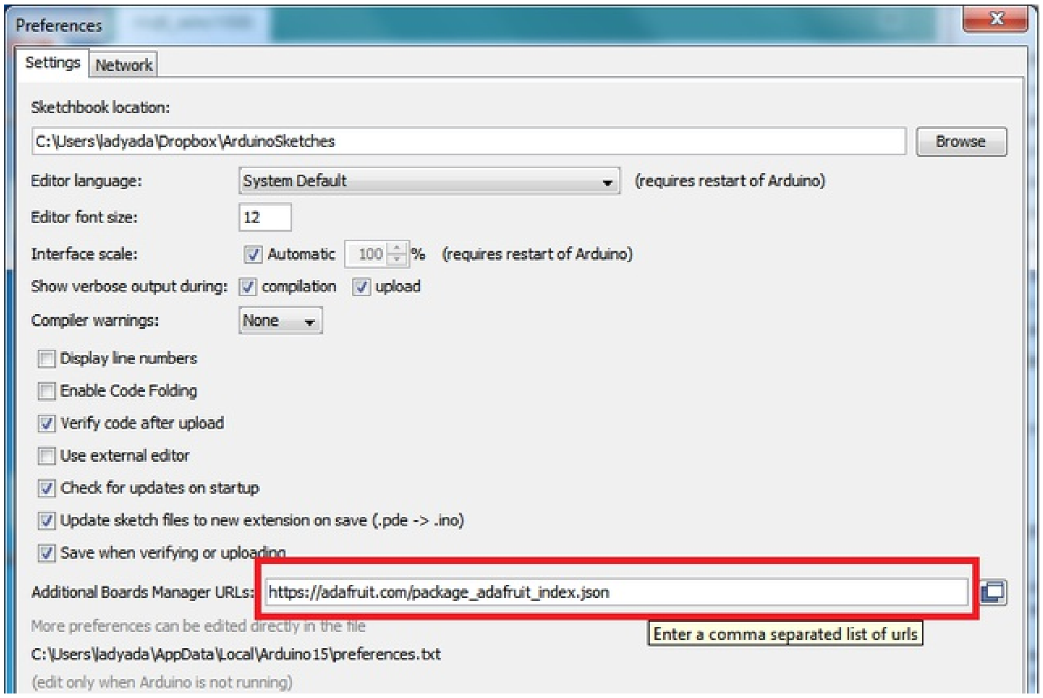
Additional Boards Manager URLs:

More preferences can be edited directly in the file
/Users/todd/Library/Arduino15/preferences.txt
(edit only when Arduino is not running)

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 (http://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://adafruit.github.io/arduino-board-index/package_adafruit_index.json


Preferences

Settings | Network

Sketchbook location: C:\Users\ladyada\Dropbox\ArduinoSketches

Editor language: System Default (requires restart of Arduino)

Editor font size: 12

Interface scale: ☑ Automatic 100 % (requires restart of Arduino)

Show verbose output during: ☑ compilation ☑ upload

Compiler warnings: None

☐ Display line numbers

☐ Enable Code Folding

☑ Verify code after upload

☐ Use external editor

☑ Check for updates on startup

☑ Update sketch files to new extension on save (.pde -> .ino)

☑ Save when verifying or uploading

Additional Boards Manager URLs: https://adafruit.com/package_adafruit_index.json

Enter a comma separated list of urls

More preferences can be edited directly in the file

C:\Users\ladyada\AppData\Local\Arduino15\preferences.txt

(edit only when Arduino is not running)

Here's a short description of each of the Adafruit supplied packages that will be available in the Board Manager when you add the URL:

- **Adafruit AVR Boards** - Includes support for Flora, Gemma, Feather 32u4, Trinket, & Trinket Pro.
- **Adafruit SAMD Boards** - Includes support for Feather M0
- **Arduino Leonardo & Micro MIDI-USB** - This adds MIDI over USB support for the Flora, Feather 32u4, Micro and Leonardo using the arcore project (http://adafru.it/eSI).

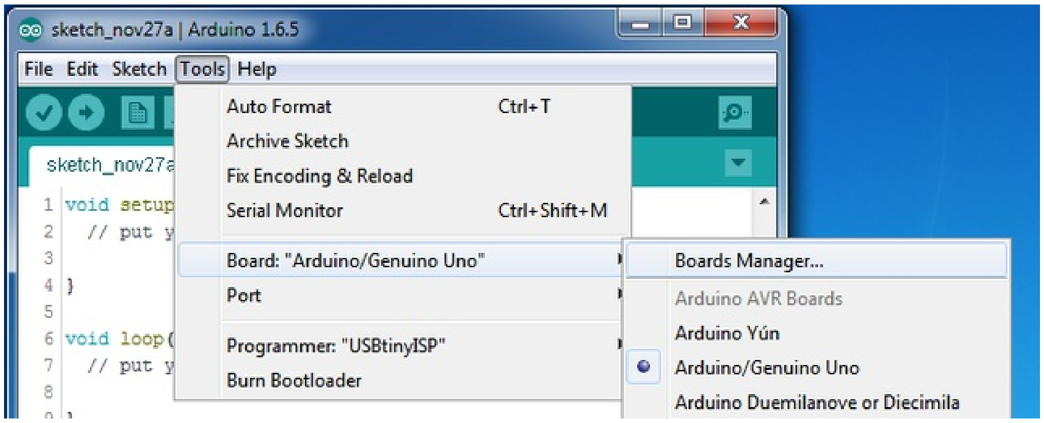
If you have multiple boards you want to support, say ESP8266 and Adafruit, have both URLs in the text box separated by a comma (,)

Once done click **OK** to save the new preference settings. Next we will look at installing boards with the Board Manager.

Using with Arduino IDE

Since the Feather/Metro M0 uses an ATSAMD21 chip running at 48 MHz, you can pretty easily get it working with the Arduino IDE. Most libraries (including the popular ones like NeoPixels and display) will work with the M0, especially devices & sensors that use i2c or SPI.

Now that you have added the appropriate URLs to the Arduino IDE preferences, you can open the **Boards Manager** by navigating to the **Tools->Board** menu.

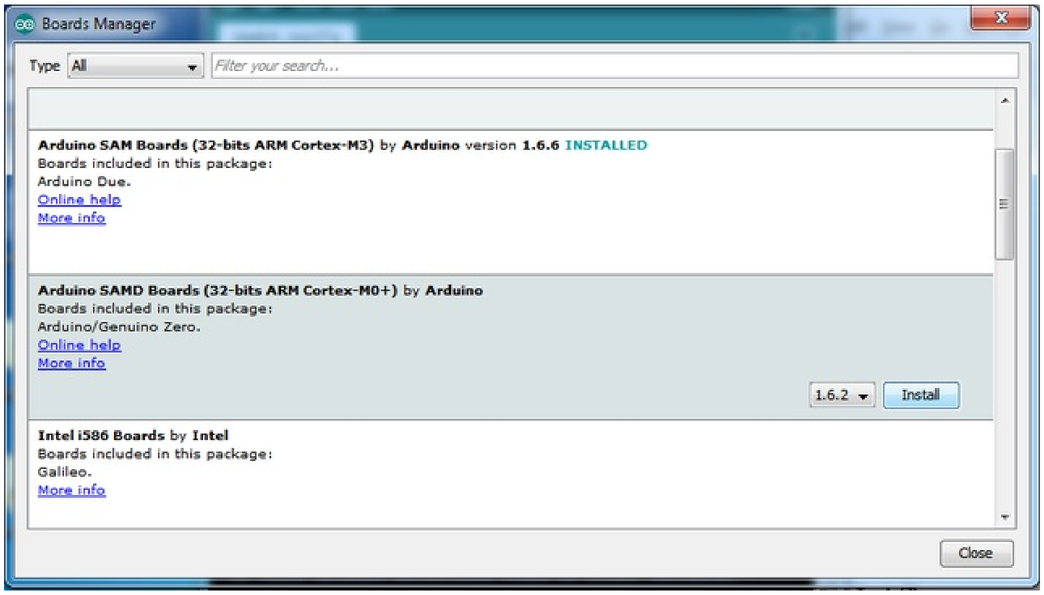


Once the Board Manager opens, click on the category drop down menu on the top left hand side of the window and select **Contributed**. You will then be able to select and install the boards supplied by the URLs added to the prefrences.

Install SAMD Support

First up, install the **Arduino SAMD Boards** version **1.6.2** or later

You can type **Arduino SAMD** in the top search bar, then when you see the entry, click **Install**



Arduino SAM Boards (32-bits ARM Cortex-M3) by Arduino version 1.6.6 INSTALLED
Boards included in this package:
Arduino Due.
Online help
More info

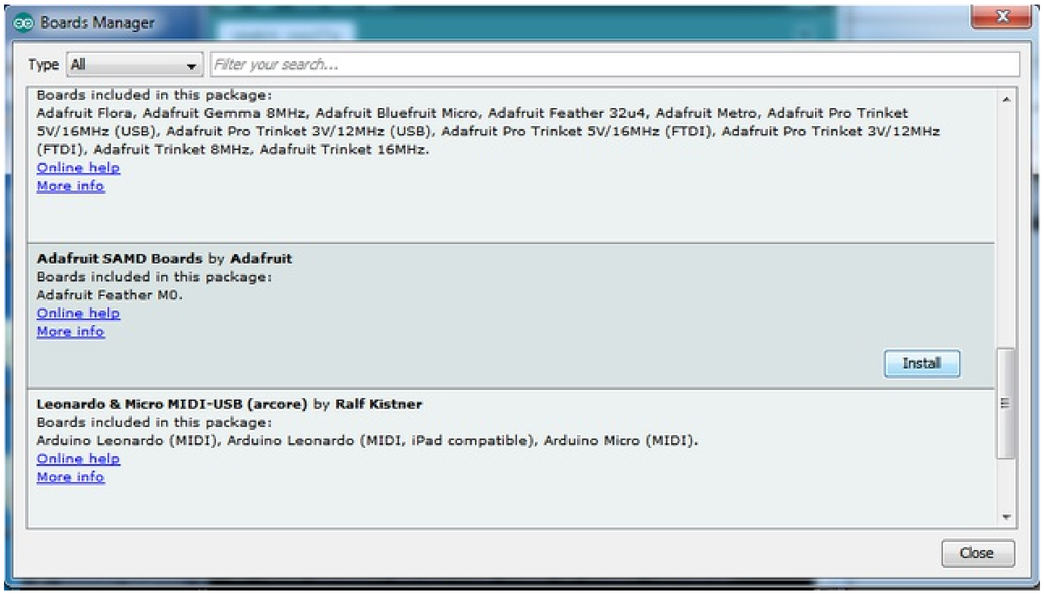
Arduino SAMD Boards (32-bits ARM Cortex-M0+) by Arduino
Boards included in this package:
Arduino/Genuino Zero.
Online help
More info

Intel i586 Boards by Intel
Boards included in this package:
Galileo.
More info

Install Adafruit SAMD

Next you can install the Adafruit SAMD package to add the board file definitions

You can type **Adafruit SAMD** in the top search bar, then when you see the entry, click **Install**



Boards included in this package:
Adafruit Flora, Adafruit Gemma 8MHz, Adafruit Bluefruit Micro, Adafruit Feather 32u4, Adafruit Metro, Adafruit Pro Trinket 5V/16MHz (USB), Adafruit Pro Trinket 3V/12MHz (USB), Adafruit Pro Trinket 5V/16MHz (FTDI), Adafruit Pro Trinket 3V/12MHz (FTDI), Adafruit Trinket 8MHz, Adafruit Trinket 16MHz.
Online help
More info

Adafruit SAMD Boards by **Adafruit**
Boards included in this package:
Adafruit Feather M0.
Online help
More info

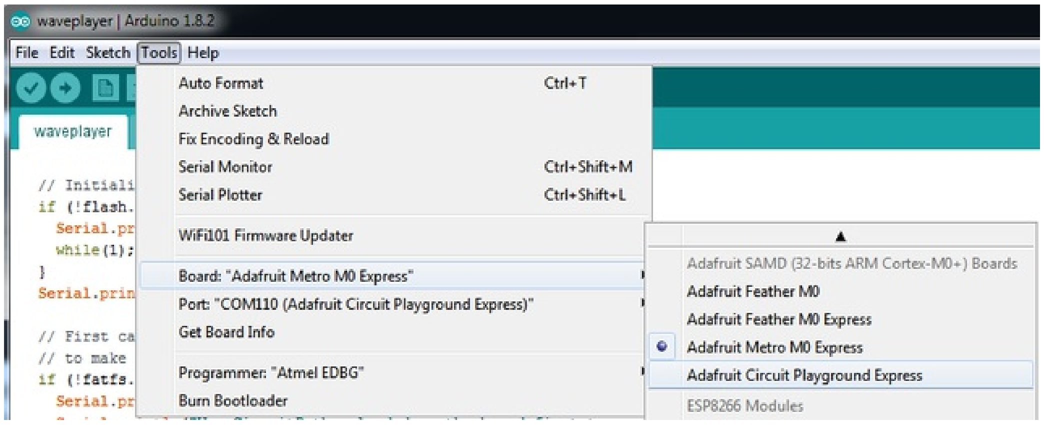
Leonardo & Micro MIDI-USB (arcore) by **Ralf Kistner**
Boards included in this package:
Arduino Leonardo (MIDI), Arduino Leonardo (MIDI, iPad compatible), Arduino Micro (MIDI).
Online help
More info

Even though in theory you don't need to - I recommend rebooting the IDE

Quit and reopen the Arduino IDE to ensure that all of the boards are properly installed. You should now be able to select and upload to the new boards listed in the **Tools->Board** menu.

Select the matching board, the current options are:

- **Feather M0** (for use with any Feather M0 other than the Express)
- **Feather M0 Express**
- **Metro M0 Express**
- **Circuit Playground Express**


waveplayer | Arduino 1.8.2
File Edit Sketch Tools Help
waveplayer
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 Firmware Updater
Get Board Info
Burn Bootloader
Adafruit SAMD (32-bits ARM Cortex-M0+) Boards
Adafruit Feather M0
Adafruit Feather M0 Express
Adafruit Metro M0 Express
Adafruit Circuit Playground Express
ESP8266 Modules

```
// Initiali
if (!flash.
  Serial.pr
  while(1);
}
Serial.prin

// First ca
// to make
if (!fatfs.
  Serial.pr
```

Board: "Adafruit Metro M0 Express"
Port: "COM110 (Adafruit Circuit Playground Express)"
Programmer: "Atmel EDBG"

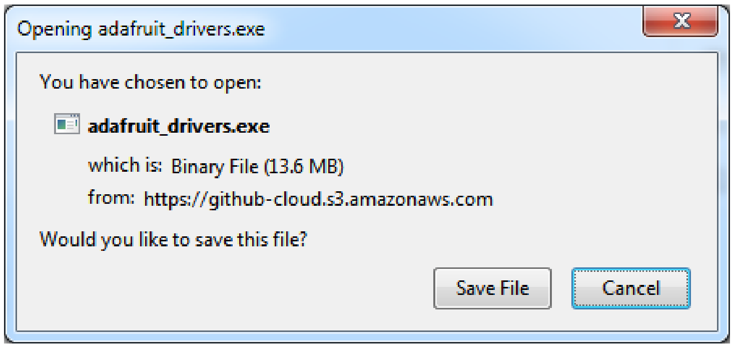
Install Drivers (Windows 7 Only)

When you plug in the Feather, you'll need to possibly install a driver

Click below to download our Driver Installer

[Download Adafruit Driver Installer v1.3](http://adafru.it/x2d)
http://adafru.it/x2d

Download and run the installer



Opening adafruit_drivers.exe

You have chosen to open:

adafruit_drivers.exe

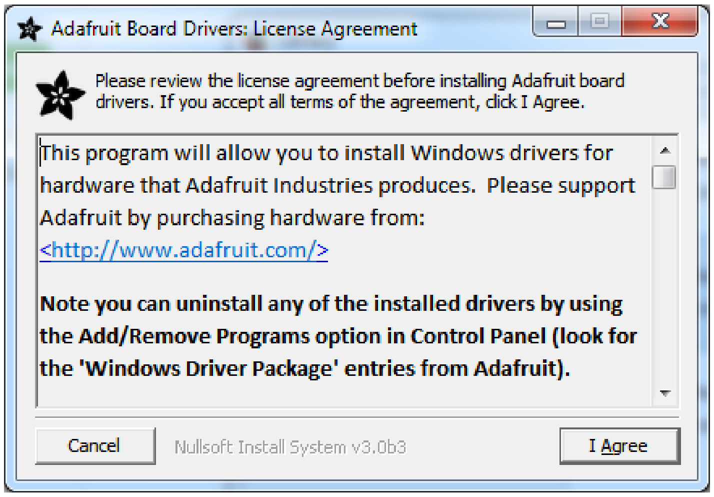
which is: Binary File (13.6 MB)

from: https://github-cloud.s3.amazonaws.com

Would you like to save this file?

Save File | Cancel

Run the installer! Since we bundle the SiLabs and FTDI drivers as well, you'll need to click through the license



Adafruit Board Drivers: License Agreement

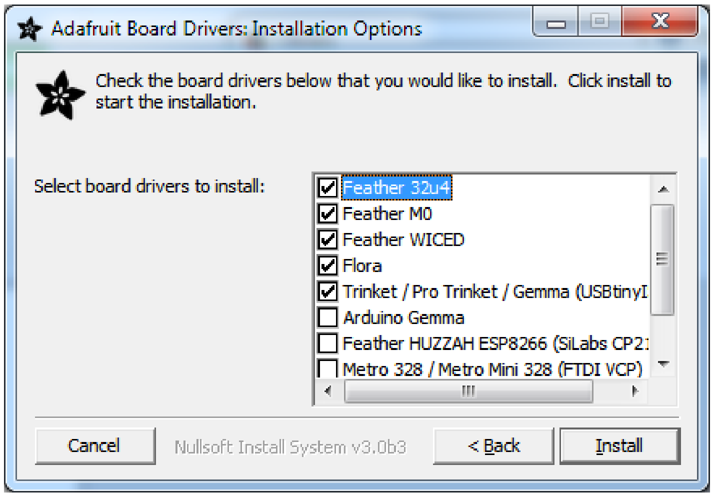
Please review the license agreement before installing Adafruit board drivers. If you accept all terms of the agreement, click I Agree.

This program will allow you to install Windows drivers for hardware that Adafruit Industries produces. Please support Adafruit by purchasing hardware from: <http://www.adafruit.com/>

Note you can uninstall any of the installed drivers by using the Add/Remove Programs option in Control Panel (look for the 'Windows Driver Package' entries from Adafruit).

Cancel | Nullsoft Install System v3.0b3 | I Agree

Select which drivers you want to install, the defaults will set you up with just about every Adafruit board!



Adafruit Board Drivers: Installation Options

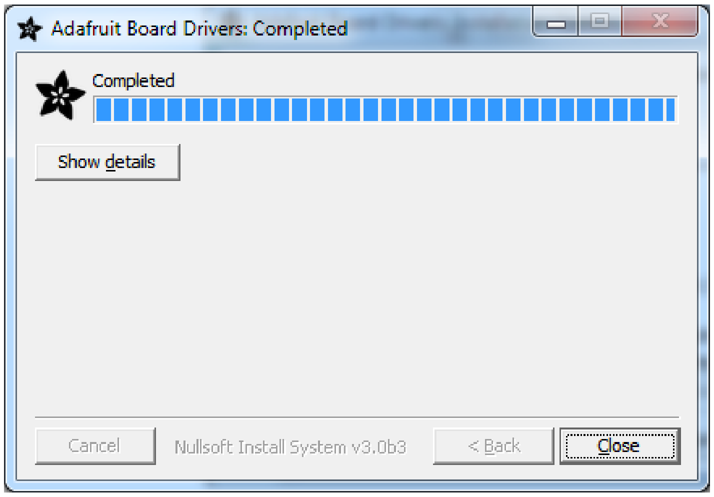
Check the board drivers below that you would like to install. Click install to start the installation.

Select board drivers to install:

- [x] Feather 32u4
- [x] Feather M0
- [x] Feather WICED
- [x] Flora
- [x] Trinket / Pro Trinket / Gemma (USBtinyI
- [ ] Arduino Gemma
- [ ] Feather HUZZAH ESP8266 (SiLabs CP2
- [ ] Metro 328 / Metro Mini 328 (FTDI VCP)

Cancel | Nullsoft Install System v3.0b3 | < Back | Install

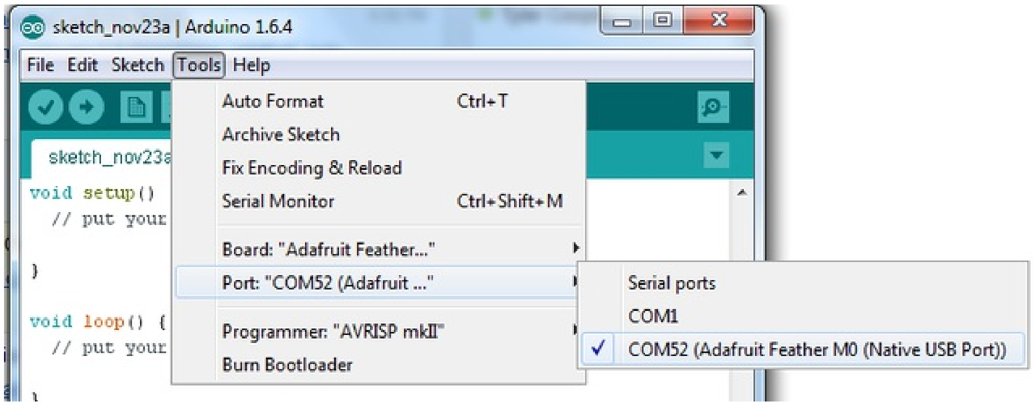
Click **Install** to do the installin'


Adafruit Board Drivers: Completed
Completed
Show details
Cancel
Nullsoft Install System v3.0b3
< Back
Close

Blink

Now you can upload your first blink sketch!

Plug in the Metro or Feather M0 and wait for it to be recognized by the OS (just takes a few seconds). It will create a serial/COM port, you can now select it from the dropdown, it'll even be 'indicated' as Metro or Feather M0!


sketch_nov23a | Arduino 1.6.4
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board: "Adafruit Feather..."
Port: "COM52 (Adafruit ..."
Programmer: "AVRISP mkII"
Burn Bootloader
Serial ports
COM1
✓ COM52 (Adafruit Feather M0 (Native USB Port))
sketch_nov23a
void setup()
// put your
}
void loop() {
// put your

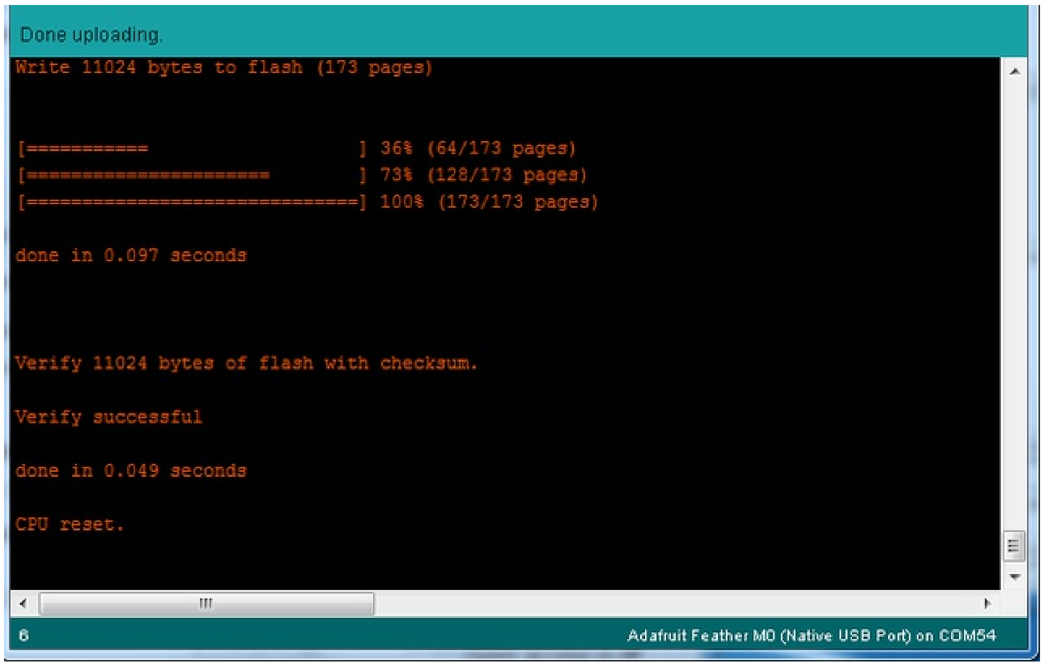
Now load up the Blink example

```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```

And click upload! That's it, you will be able to see the LED blink rate change as you adapt the **delay()** calls.

Sucessful Upload

If you have a successful upload, you'll get a bunch of red text that tells you that the device was found and it was programmed, verified & reset



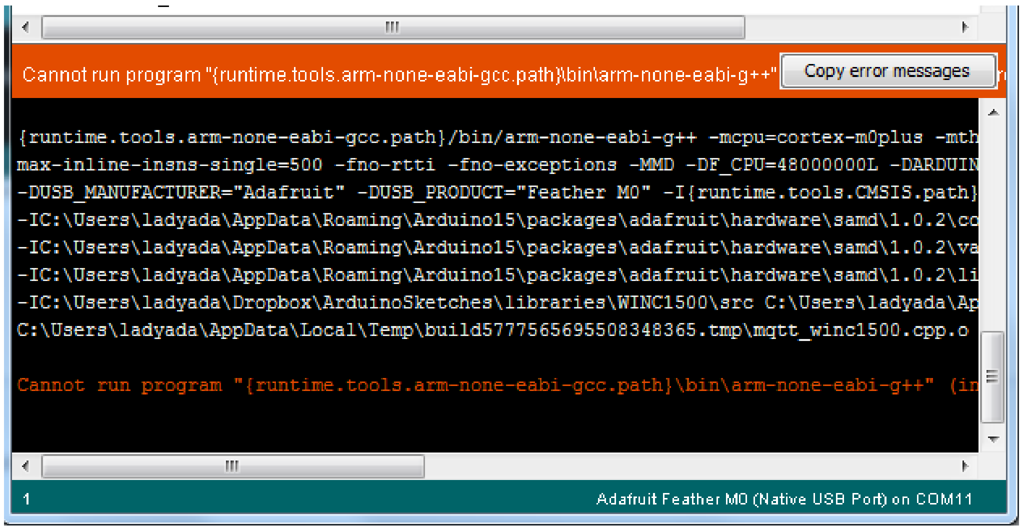
```
Done uploading.
Write 11024 bytes to flash (173 pages)


[===========                   ] 36% (64/173 pages)
[======================        ] 73% (128/173 pages)
[==============================] 100% (173/173 pages)

done in 0.097 seconds



Verify 11024 bytes of flash with checksum.

Verify successful

done in 0.049 seconds

CPU reset.

6                                          Adafruit Feather M0 (Native USB Port) on COM54
```

Compilation Issues

If you get an alert that looks like

Cannot run program "{runtime.tools.arm-none-eabi-gcc.path}\bin\arm-non-eabi-g++"

Make sure you have installed the **Arduino SAMD** boards package, you need *both* Arduino & Adafruit SAMD board packages



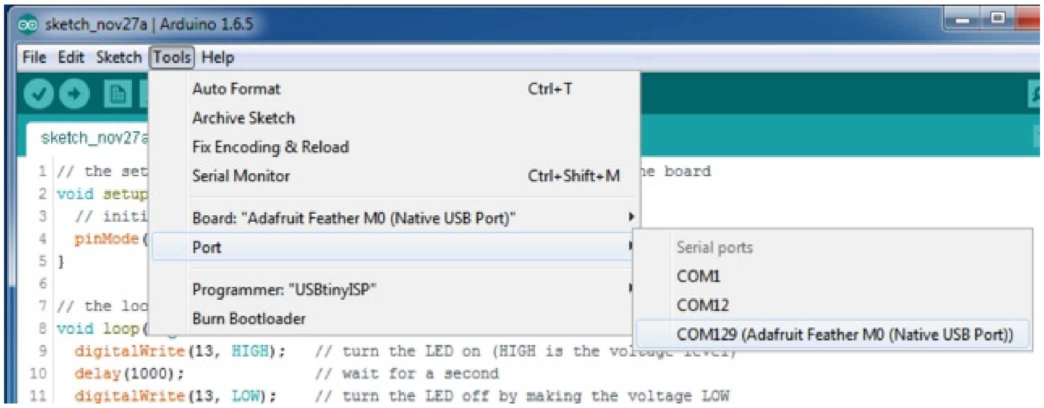
```
Cannot run program "{runtime.tools.arm-none-eabi-gcc.path}\bin\arm-none-eabi-g++"   Copy error messages

{runtime.tools.arm-none-eabi-gcc.path}/bin/arm-none-eabi-g++ -mcpu=cortex-m0plus -mth
max-inline-insns-single=500 -fno-rtti -fno-exceptions -MMD -DF_CPU=48000000L -DARDUIN
-DUSB_MANUFACTURER="Adafruit" -DUSB_PRODUCT="Feather M0" -I{runtime.tools.CMSIS.path}
-IC:\Users\ladyada\AppData\Roaming\Arduino15\packages\adafruit\hardware\samd\1.0.2\co
-IC:\Users\ladyada\AppData\Roaming\Arduino15\packages\adafruit\hardware\samd\1.0.2\va
-IC:\Users\ladyada\AppData\Roaming\Arduino15\packages\adafruit\hardware\samd\1.0.2\li
-IC:\Users\ladyada\Dropbox\ArduinoSketches\libraries\WINC1500\src C:\Users\ladyada\Ap
C:\Users\ladyada\AppData\Local\Temp\build5777565695508348365.tmp\mqtt_winc1500.cpp.o

Cannot run program "{runtime.tools.arm-none-eabi-gcc.path}\bin\arm-none-eabi-g++" (in

1                                          Adafruit Feather M0 (Native USB Port) on COM11
```

Manually bootloading

If you ever get in a 'weird' spot with the bootloader, or you have uploaded code that crashes and doesn't auto-reboot into the bootloader, click the **RST** button **twice** (like a double-click)to get back into the bootloader.

The red LED will pulse, so you know that its in bootloader mode.

Once it is in bootloader mode, you can select the newly created COM/Serial port and re-try uploading.


sketch_nov27a | Arduino 1.6.5
File
Edit
Sketch
Tools
Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board: "Adafruit Feather M0 (Native USB Port)"
Port
Programmer: "USBtinyISP"
Burn Bootloader
Serial ports
COM1
COM12
COM129 (Adafruit Feather M0 (Native USB Port))

```
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
```

You may need to go back and reselect the 'normal' USB serial port next time you want to use the normal upload.

Ubuntu & Linux Issue Fix

Note if you're using Ubuntu 15.04 (or perhaps other more recent Linux distributions) there is an issue with the modem manager service which causes the Bluefruit LE micro to be difficult to program. If you run into errors like "device or resource busy", "bad file descriptor", or "port is busy" when attempting to program then you are hitting this issue. (http://adafru.it/sHE)

The fix for this issue is to make sure Adafruit's custom udev rules are applied to your system. One of these rules is made to configure modem manager not to touch the Feather board and will fix the programming difficulty issue. Follow the steps for installing Adafruit's udev rules on this page.(http://adafru.it/iOE)

Adapting Sketches to M0

The ATSAMD21 is a very nice little chip but its fairly new as Arduino-compatible cores go**Most** sketches & libraries will work but here's a few things we noticed!

Analog References

If you'd like to use the **ARef** pin for a non-3.3V analog reference, the code to use is`analogReference(AR_EXTERNAL)` (it's AR_EXTERNAL not EXTERNAL)

Pin Outputs & Pullups

The old-style way of turning on a pin as an input with a pullup is to use

```
pinMode(pin, INPUT)
digitalWrite(pin, HIGH)
```

This is because the pullup-selection register is the same as the output-selection register.

For the M0, you can't do this anymore! Instead, use

```
pinMode(pin, INPUT_PULLUP)
```

which has the benefit of being backwards compatible with AVR.

Serial vs SerialUSB

99.9% of your existing Arduino sketches use**Serial.print** to debug and give output. For the Official Arduino SAMD/M0 core, this goes to the Serial5 port, which isn't exposed on the Feather. The USB port for the Official Arduino M0 core, is called **SerialUSB** instead.

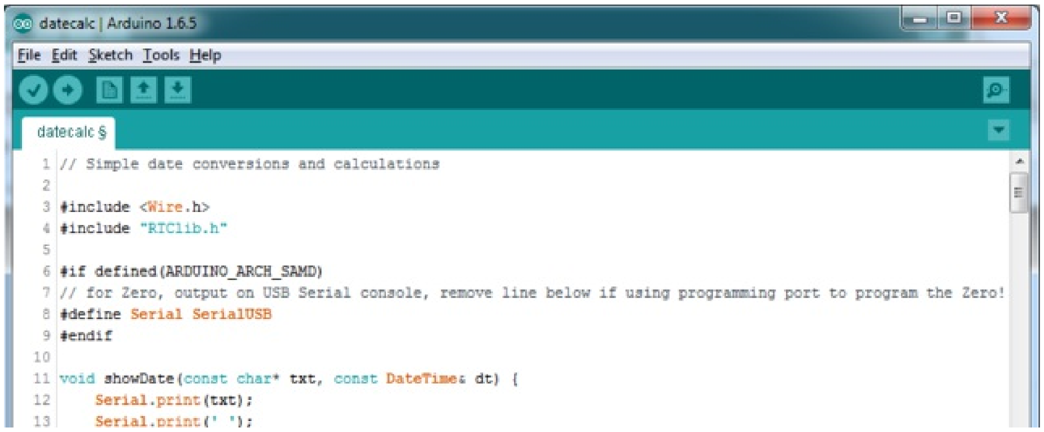
In the Adafruit M0 Core, we fixed it so that Serial goes to USB when you use a Feather M0 so it will automatically work just fine.

However, on the off chance you are using the official Arduino SAMD core & you want your Serial prints and reads to use the USB port, use **SerialUSB** instead of Serial in your sketch

If you have existing sketches and code and you want them to work with the M0 without a huge find-replace, put

```
#if defined(ARDUINO_SAMD_ZERO) && defined(SERIAL_PORT_USBVIRTUAL)
  // Required for Serial on Zero based boards
  #define Serial SERIAL_PORT_USBVIRTUAL
#endif
```

right above the first function definition in your code. For example:



```
// Simple date conversions and calculations

#include <Wire.h>
#include "RTClib.h"

#if defined(ARDUINO_ARCH_SAMD)
// for Zero, output on USB Serial console, remove line below if using programming port to program the Zero!
#define Serial SerialUSB
#endif

void showDate(const char* txt, const DateTime& dt) {
    Serial.print(txt);
    Serial.print(' ');
```

AnalogWrite / PWM

After looking through the SAMD21 datasheet, we've found that some of the options listed in the multiplexer table don't exist on the specific chip used in the Feather M0.

For all SAMD21 chips, there are two peripherals that can generate PWM signals: The Timer/Counter (TC) and Timer/Counter for Control Applications (TCC). Each SAMD21 has multiple copies of each, called 'instances'.

Each TC instance has one count register, one control register, and two output channels. Either channel can be enabled and disabled, and either channel can be inverted. The pins connected to a TC instance can output identical versions of the same PWM waveform, or complementary waveforms.

Each TCC instance has a single count register, but multiple compare registers and output channels. There are options for different kinds of waveform, interleaved switching, programmable dead time, and so on.

The biggest members of the SAMD21 family have five TC instances with two 'waveform output' (WO) channels, and three TCC instances with eight WO channels:

- TC[0-4],WO[0-1]
- TCC[0-2],WO[0-7]

And those are the ones shown in the datasheet's multiplexer tables.

The SAMD21G used in the Feather M0 only has three TC instances with two output channels, and three TCC instances with eight output channels:

- **TC[3-5],WO[0-1]**
- **TCC[0-2],WO[0-7]**

Tracing the signals to the pins broken out on the Feather M0, the following pins can't do PWM at all:

- **Analog pin A5**

The following pins can be configured for PWM without any signal conflicts as long as the SPI, I2C, and UART pins keep their protocol functions:

- **Digital pins 5, 6, 9, 10, 11, 12, and 13**
- **Analog pins A3 and A4**

If only the SPI pins keep their protocol functions, you can also do PWM on the following pins:

- **TX and SDA (Digital pins 1 and 20)**

Missing header files

there might be code that uses libraries that are not supported by the M0 core. For example if you have a line with

```
#include <util/delay.h>
```

you'll get an error that says

```
fatal error: util/delay.h: No such file or directory
  #include <util/delay.h>
                        ^
compilation terminated.
Error compiling.
```

In which case you can simply locate where the line is (the error will give you the file name and line number) and 'wrap it' with #ifdef's so it looks like:

```
#if !defined(ARDUINO_ARCH_SAM) && !defined(ARDUINO_ARCH_SAMD) && !defined(ESP8266) && !defined(ARDUINO_ARCH_STM32F2)
 #include <util/delay.h>
#endif
```

The above will also make sure that header file isn't included for other architectures

If the #include is in the arduino sketch itself, you can try just removing the line.

Bootloader Launching

For most other AVRs, clicking **reset** while plugged into USB will launch the bootloader manually, the bootloader will time out after a few seconds. For the M0, you'll need to *double click* the button. You will see a pulsing red LED to let you know you're in bootloader mode. Once in that mode, it wont time out! Click reset again if you want to go back to launching code

Aligned Memory Access

This is a little less likely to happen to you but it happened to me! If you're used to 8-bit platforms, you can do this nice thing where you can typecast variables around. e.g.

```
uint8_t mybuffer[4];
float f = (float)mybuffer;
```

You can't be guaranteed that this will work on a 32-bit platform because **mybuffer** might not be aligned to a 2 or 4-byte boundary. The ARM Cortex-M0 can only directly access data on 16-bit boundaries (every 2 or 4 bytes). Trying to access an odd-boundary byte (on a 1 or 3 byte location) will cause a Hard Fault and stop the MCU. Thankfully, there's an easy work around ... just use memcpy!

```
uint8_t mybuffer[4];
float f;
memcpy(f, mybuffer, 4)
```

Floating Point Conversion

Like the AVR Arduinos, the M0 library does not have full support for converting floating point numbers to ASCII strings. Functions like sprintf will not convert floating point. Fortunately, the standard AVR-LIBC library includes the dtostrf function which can handle the conversion for you.

Unfortunately, the M0 run-time library does not have dtostrf. You may see some references to using **#include <avr/dtostrf.h>** to get dtostrf in your code. And while it will compile, it does **not** work.

Instead, check out this thread to find a working dtostrf function you can include in your code:

http://forum.arduino.cc/index.php?topic=368720.0 (http://adafru.it/IFS)

How Much RAM Available?

The ATSAMD21G18 has 32K of RAM, but you still might need to track it for some reason. You can do so with this handy function:

```
extern "C" char *sbrk(int i);

int FreeRam () {
  char stack_dummy = 0;
  return &stack_dummy - sbrk(0);
}
```

Thx to http://forum.arduino.cc/index.php?topic=365830.msg2542879#msg2542879 (http://adafru.it/m6D) for the tip!

Storing data in FLASH

If you're used to AVR, you've probably used **PROGMEM** to let the compiler know you'd like to put a variable or string in flash memory to save on RAM. On the ARM, its a little easier, simply add **const** before the variable name:

const char str[] = "My very long string";

That string is now in FLASH. You can manipulate the string just like RAM data, the compiler will automatically read from FLASH so you dont need special progmem-knowledgeable functions.

You can verify where data is stored by printing out the address:
Serial.print("Address of str $"); Serial.println((int)&str, HEX);

If the address is $2000000 or larger, its in SRAM. If the address is between $0000 and $3FFFF Then it is in FLASH

Using SPI Flash

One of the best features of the M0 express board is a small SPI flash memory chip built into the board. This memory can be used for almost any purpose like storing data files, Python code, and more. Think of it like a little SD card that is always connected to the board, and in fact with Arduino you can access the memory using a library that is very similar to the Arduino SD card library (http://adafru.it/ucu). You can even read and write files that CircuitPython stores on the flash chip!

To use the flash memory with Arduino you'll need to install theAdafruit SPI Flash Memory library (http://adafru.it/wbt) in the Arduino IDE. Click the button below to download the source for this library, open the zip file, and then copy it into an **Adafruit_SPIFlash** folder (remove the -master GitHub adds to the downloaded zip and folder) in the Arduino library folder on your computer (http://adafru.it/dNR):

Download Adafruit_SPIFlash
http://adafru.it/wbu

Once the library is installed open the Arduino IDE and look for the following examples in the library:

- **fatfs_circuitpython**
- **fatfs_datalogging**
- **fatfs_format**
- **fatfs_full_usage**
- **fatfs_print_file**
- **flash_erase**

These examples allow you to format the flash memory with a FAT filesystem (the same kind of filesystem used on SD cards) and read and write files to it just like a SD card.

Read & Write CircuitPython Files

The **fatfs_circuitpython** example shows how to read and write files on the flash chip so that they're accessible from CircuitPython. This means you can run a CircuitPython program on your board and have it store data, then run an Arduino sketch that uses this library to interact with the same data.

Note that before you use the **fatfs_circuitpython** example you **must** have loaded CircuitPython on your board. Load the latest version of CircuitPython as explained in this guide(http://adafru.it/wbv) first to ensure a CircuitPython filesystem is initialized and written to the flash chip. Once you've loaded CircuitPython then you can run the **fatfs_circuitpython** example sketch.

To run the sketch load it in the Arduino IDE and upload it to the Feather M0 board. Then open the serial monitor at 115200 baud. You should see the serial monitor display messages as it attempts to read files and write to a file on the flash chip. Specifically the example will look for a **boot.py** and **main.py** file (like what CircuitPython runs when it starts) and print out their contents. Then it will add a line to the end of a **data.txt** file on the board (creating it if it doesn't exist already). After running the sketch you can reload CircuitPython on the board and open the **data.txt** file to read it from CircuitPython!

To understand how to read & write files that are compatible with CircuitPython let's examine the sketch code. First notice an instance of the **Adafruit_M0_Express_CircuitPython** class is created and passed an instance of the flash chip class in the last line below:

```
#define FLASH_SS       SS1                    // Flash chip SS pin.
```

```
#define FLASH_SPI_PORT SPI1                    // What SPI port is Flash on?

Adafruit_SPIFlash flash(FLASH_SS, &FLASH_SPI_PORT);     // Use hardware SPI

// Alternatively you can define and use non-SPI pins!
//Adafruit_SPIFlash flash(SCK1, MISO1, MOSI1, FLASH_SS);

// Finally create an Adafruit_M0_Express_CircuitPython object which gives
// an SD card-like interface to interacting with files stored in CircuitPython's
// flash filesystem.
Adafruit_M0_Express_CircuitPython pythonfs(flash);
```

By using this **Adafruit_M0_Express_CircuitPython** class you'll get a filesystem object that is compatible with reading and writing files on a CircuitPython-formatted flash chip. This is very important for interoperability between CircuitPython and Arduino as CircuitPython has specialized partitioning and flash memory layout that isn't compatible with simpler uses of the library (shown in the other examples).

Once an instance of the **Adafruit_M0_Express_CircuitPython** class is created (called **pythonfs** in this sketch) you can go on to interact with it just like if it were the SD card library in Arduino (http://adafru.it/wbw). You can open files for reading & writing, create directories, delete files and directories and more. Here's how the sketch checks if a **boot.py** file exists and prints it out a character at a time:

```
  // Check if a boot.py exists and print it out.
  if (pythonfs.exists("boot.py")) {
    File bootPy = pythonfs.open("boot.py", FILE_READ);
    Serial.println("Printing boot.py...");
    while (bootPy.available()) {
      char c = bootPy.read();
      Serial.print(c);
    }
    Serial.println();
  }
  else {
    Serial.println("No boot.py found...");
  }
```

Notice the **exists** function is called to check if the boot.py file is found, and then the **open** function is used to open it in read mode. Once a file is opened you'll get a reference to a File class object which you can read and write from as if it were a Serial device (again just like the SD card library, all of the same File class functions are available (http://adafru.it/wbw)). In this case the **available** function will return the number of bytes left to read in the file, and the **read** function will read a character at a time to print it to the serial monitor.

Writing a file is just as easy, here's how the sketch writes to **data.txt**:

```
  // Create or append to a data.txt file and add a new line
  // to the end of it.  CircuitPython code can later open and
  // see this file too!
  File data = pythonfs.open("data.txt", FILE_WRITE);
  if (data) {
    // Write a new line to the file:
    data.println("Hello CircuitPython from Arduino!");
    data.close();
    // See the other fatfs examples like fatfs_full_usage and fatfs_datalogging
    // for more examples of interacting with files.
    Serial.println("Wrote a new line to the end of data.txt!");
  }
  else {
    Serial.println("Error, failed to open data file for writing!");
  }
```

Again the **open** function is used but this time it's told to open the file for writing. In this mode the file will be opened for appending (i.e. data added to the end of it) if it exists, or it will be created if it doesn't exist. Once the file is open print functions like **print** and **println** can be used to write data to the file (just like writing to the serial monitor). Be sure to **close** the file when finished writing!

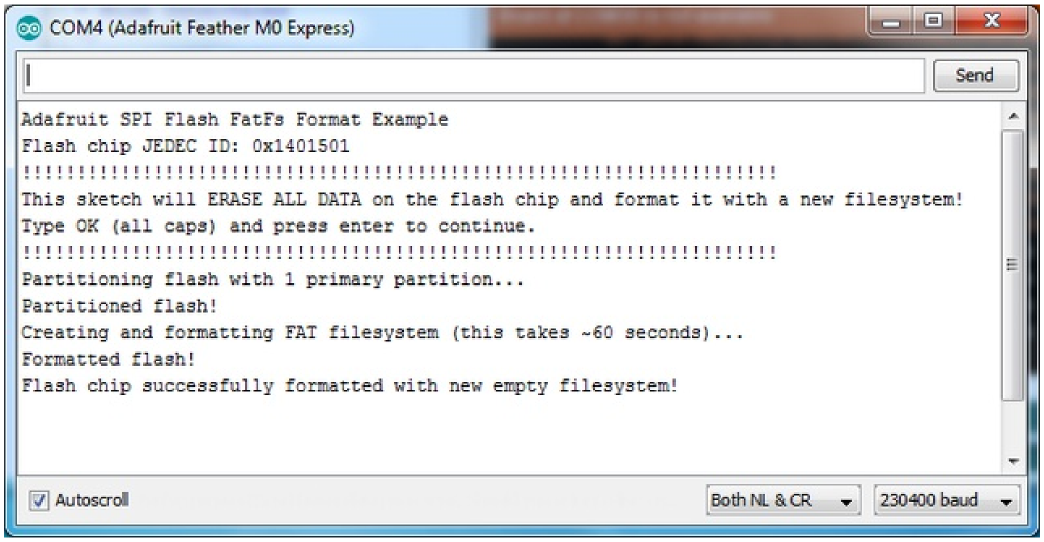
That's all there is to basic file reading and writing. Check out the**fatfs_full_usage** example for examples of even more functions like creating directories, deleting files & directories, checking the size of files, and more! Remember though to interact with CircuitPython files you need to use the **Adafruit_Feather_M0_CircuitPython** class as shown in the **fatfs_circuitpython** example above!

Format Flash Memory

The **fatfs_format** example will format the SPI flash with a new blank filesystem. **Be warned this sketch will delete all data on the flash memory, including any Python code or other data you might have stored!** The format sketch is useful if you'd like to wipe everything away and start fresh, or to help get back in a good state if the memory should get corrupted for some reason.

Be aware too the fatfs_format and examples below are not compatible with a CircuitPython-formatted flash chip! If you need to share data between Arduino & CircuitPython check out the**fatfs_circuitpython** example above.

To run the format sketch load it in the Arduino IDE and upload it to the Feather M0 board. Then open the serial monitor at 115200 baud. You should see the serial monitor display a message asking you to confirm formatting the flash. If you don't see this message then close the serial monitor, press the board's reset button, and open the serial monitor again.



```
Adafruit SPI Flash FatFs Format Example
Flash chip JEDEC ID: 0x1401501
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
This sketch will ERASE ALL DATA on the flash chip and format it with a new filesystem!
Type OK (all caps) and press enter to continue.
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Partitioning flash with 1 primary partition...
Partitioned flash!
Creating and formatting FAT filesystem (this takes ~60 seconds)...
Formatted flash!
Flash chip successfully formatted with new empty filesystem!
```

Type **OK** and press enter in the serial monitor input to confirm that you'd like to format the flash memory.**You need to enter OK in all capital letters!**

Once confirmed the sketch will format the flash memory. The format process takes about a minute so be patient as the data is erased and formatted. You should see a message printed once the format process is complete. At this point the flash chip will be ready to use with a brand new empty filesystem.

Datalogging Example

One handy use of the SPI flash is to store data, like datalogging sensor readings. The**fatfs_datalogging** example shows basic file writing/datalogging. Open the example in the Arduino IDE and upload it to your Feather M0 board.

Then open the serial monitor at 115200 baud. You should see a message printed every minute as the sketch writes a new line of data to a file on the flash filesystem.

To understand how to write to a file look in the loop function of the sketch:

```
// Open the datalogging file for writing.  The FILE_WRITE mode will open
// the file for appending, i.e. it will add new data to the end of the file.
File dataFile = fatfs.open(FILE_NAME, FILE_WRITE);
// Check that the file opened successfully and write a line to it.
if (dataFile) {
  // Take a new data reading from a sensor, etc.  For this example just
  // make up a random number.
  int reading = random(0,100);
  // Write a line to the file.  You can use all the same print functions
  // as if you're writing to the serial monitor.  For example to write
  // two CSV (commas separated) values:
  dataFile.print("Sensor #1");
  dataFile.print(",");
  dataFile.print(reading, DEC);
  dataFile.println();
  // Finally close the file when done writing.  This is smart to do to make
  // sure all the data is written to the file.
  dataFile.close();
  Serial.println("Wrote new measurement to data file!");
}
```

Just like using the Arduino SD card library you create a **File** object by calling an **open** function and pointing it at the name of the file and how you'd like to open it (**FILE_WRITE** mode, i.e. writing new data to the end of the file). Notice however instead of calling open on a global SD card object you're calling it on a **fatfs** object created earlier in the sketch (look at the top after the #define configuration values).

Once the file is opened it's simply a matter of calling **print** and **println** functions on the file object to write data inside of it. This is just like writing data to the serial monitor and you can print out text, numeric, and other types of data. Be sure to close the file when you're done writing to ensure the data is stored correctly!

Reading and Printing Files

The **fatfs_print_file** example will open a file (by default the data.csv file created by running the **fatfs_datalogging** example above) and print all of its contents to the serial monitor. Open the **fatfs_print_file** example and load it on your Feather M0 board, then open the serial monitor at 115200 baud. You should see the sketch print out the contents of data.csv (if you don't have a file called data.csv on the flash look at running the datalogging example above first).

To understand how to read data from a file look in the **setup** function of the sketch:

```
// Open the file for reading and check that it was successfully opened.
// The FILE_READ mode will open the file for reading.
File dataFile = fatfs.open(FILE_NAME, FILE_READ);
if (dataFile) {
  // File was opened, now print out data character by character until at the
  // end of the file.
  Serial.println("Opened file, printing contents below:");
  while (dataFile.available()) {
    // Use the read function to read the next character.
    // You can alternatively use other functions like readUntil, readString, etc.
    // See the fatfs_full_usage example for more details.
    char c = dataFile.read();
    Serial.print(c);
  }
}
```

Just like when writing data with the datalogging example you create a **File** object by calling the **open** function on a fatfs object. This time however you pass a file mode of **FILE_READ** which tells the filesystem you want to read data.

After you open a file for reading you can easily check if data is available by calling the **available** function on the file, and then read a single character with the **read** function. This makes it easy to loop through all of the data in a file by checking if it's available and reading a character at a time. However there are more advanced read functions you can use too--see the **fatfs_full_usage** example or even the Arduino SD library documentation (http://adafru.it/ucu) (the SPI flash library implements the same functions).

Full Usage Example

For a more complete demonstration of reading and writing files look at the **fatfs_full_usage** example. This examples uses every function in the library and demonstrates things like checking for the existence of a file, creating directories, deleting files, deleting directories, and more.

Remember the SPI flash library is built to have the same functions and interface as the Arduino SD library (http://adafru.it/ucu) so if you have code or examples that store data on a SD card they should be easy to adapt to use the SPI flash library, just create a fatfs object like in the examples above and use its open function instead of the global SD object's open function. Once you have a reference to a file all of the functions and usage should be the same between the SPI flash and SD libraries!

Metro M0 HELP!

My Metro M0 stopped working when I unplugged the USB!

A lot of our example sketches have a

```
while (!Serial);
```

line in setup(), to keep the board waiting until the USB is opened. This makes it a lot easier to debug a program because you get to see all the USB data output. If you want to run your Metro M0 without USB connectivity, delete or comment out that line

My Metro never shows up as a COM or Serial port in the Arduino IDE

A vast number of Metro 'failures' are due to charge-only USB cables

We get upwards of 5 complaints a day that turn out to be due to charge-only cables!

Use only a cable that you **know** is for data syncing

If you have any charge-only cables, cut them in half throw them out. We are serious! They tend to be low quality in general, and will only confuse you and others later, just get a good data+charge USB cable

Ack! I "did something" and now when I plug in the Metro, it doesn't show up as a device anymore so I cant upload to it or fix it...

No problem! You can 'repair' a bad code upload easily. Note that this can happen if you set a watchdog timer or sleep mode that stops USB, or any sketch that 'crashes' your Metro

1. Turn on **verbose upload** in the Arduino IDE preferences
2. Plug in Metro M0, it won't show up as a COM/serial port that's ok
3. Open up the Blink example (Examples->Basics->Blink)
4. Select the correct board in the Tools menu, e.g. Metro M0 (check your board to make sure you have the right one selected!)
5. Compile it (make sure that works)
6. Click Upload to attempt to upload the code
7. The IDE will print out a bunch of COM Ports as it tries to upload. **During this time, double-click the reset button, you'll see the red pulsing LED and the NeoPixel will be green that tells you its now in bootloading mode**
8. The Metro will show up as the Bootloader COM/Serial port
9. The IDE should see the bootloader COM/Serial port and upload properly

I can't get the Metro USB device to show up - I get "USB Device Malfunctioning" errors!

This seems to happen when people select the wrong board from the Arduino Boards menu.

If you have a Metro M0 (look on the board to read what it is you have) Make sure you select **Metro M0** - do not use Feather M0 or Arduino Zero

I'm having problems with COM ports and my Metro M0

Theres **two** COM ports you can have with the M0, one is the **user port** and one is the **bootloader port**. They are not the same COM port number!

When you upload a new user program it will come up with a user com port, particularly if you use Serial in your user program.

If you crash your user program, or have a program that halts or otherwise fails, the user com port can disappear.

When the user COM port disappears, Arduino will not be able to automatically start the bootloader and upload new software.

So you will need to help it by performing the click-during upload procedure to re-start the bootloader, and upload something that is known working like "Blink"

I don't understand why the COM port disappears, this does not happen on my Arduino UNO!

UNO-type Arduinos have a *seperate* serial port chip (aka "FTDI chip" or "Prolific PL2303" etc etc) which handles all serial port capability seperately than the main chip. This way if the main chip fails, you can always use the COM port.

M0 and 32u4-based Arduinos do not have a seperate chip, instead the main processor performs this task for you. It allows for a lower cost, higher power setup...but requires a little more effort since you will need to 'kick' into the bootloader manually once in a while

I'm trying to upload to my 32u4, getting "avrdude: butterfly_recv(): programmer is not responding" errors

This is likely because the bootloader is not kicking in and you are accidentally **trying to upload to the wrong COM port**

The best solution is what is detailed above: manually upload Blink or a similar working sketch by hand by manually launching the bootloader

I'm trying to upload to my Metro M0, and I get this error "Connecting to programmer: .avrdude: butterfly_recv(): programmer is not responding"

You probably don't have Metro M0 selected in the boards drop-down. Make sure you selected **Metro M0**.

I'm trying to upload to my Metro and i get this error "avrdude: ser_recv(): programmer is not responding"

You probably don't have Metro M0 selected in the boards drop-down. Make sure you selected **Metro M0**

CircuitPython Setup

CircuitPython is a derivative of MicroPython 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 download CircuitPython and drag it onto the drive that appears (only available on Express boards currently). Once installed, simply copy and edit files on the drive to iterate.

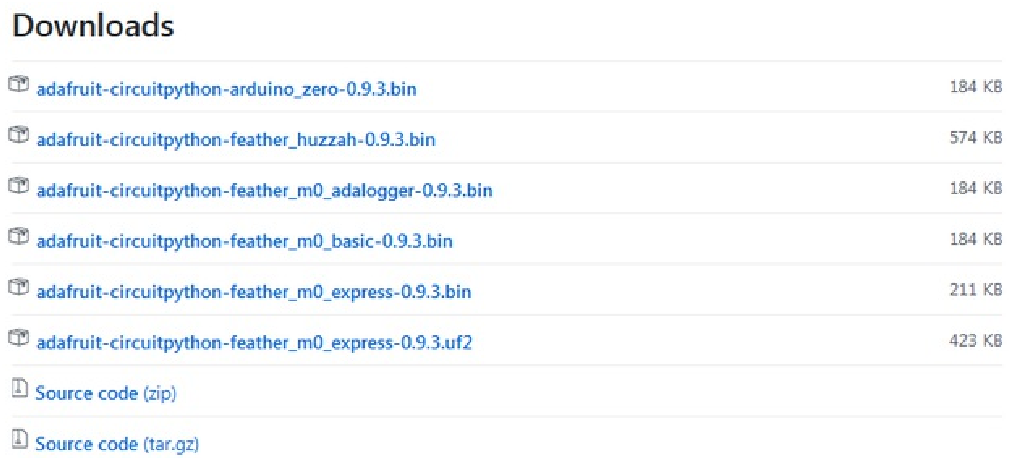
Downloading

The latest builds of CircuitPython are available from the GitHub release page. Binaries for different boards are listed under the Downloads section. Pick the one that matches your board such as adafruit-circuitpython-feather_m0_express-0.9.3.bin for the Feather M0 Express or adafruit-circuitpython-metro_m0_express-0.9.3.bin for the Metro M0 Express.

Files that end with .bin can be flashed with esptool.py or bossac. Files ending in .uf2 can be flashed onto a virtual drive when in bootloader mode.

Click here to see the latest CircuitPython Releases
http://adafru.it/vIF

You will see a list of all available *flavors* of CircuitPython. Since we support a lot of different hardware, we have a long list of available downloads!



Downloads

adafruit-circuitpython-arduino_zero-0.9.3.bin	184 KB
adafruit-circuitpython-feather_huzzah-0.9.3.bin	574 KB
adafruit-circuitpython-feather_m0_adalogger-0.9.3.bin	184 KB
adafruit-circuitpython-feather_m0_basic-0.9.3.bin	184 KB
adafruit-circuitpython-feather_m0_express-0.9.3.bin	211 KB
adafruit-circuitpython-feather_m0_express-0.9.3.uf2	423 KB
Source code (zip)	
Source code (tar.gz)	

See below for which file to download!

Flashing

Flashing is the process of updating the CircuitPython core. It isn't needed for updating your own code.**There are two available methods: UF2 and bossac** UF2 flashing is only available on Express boards, they have a UF2-capable beta bootloader. Flashing via bossac is possible with both the Express bootloader and the original "Arduino" one. We recommend using UF2 if you can. If UF2 fails, or is not available, try bossac.

Regardless of what method you use, you must first get the board into the bootloader mode. This is done by double clicking the reset button. The board is in bootloader mode when the red led fades in and out. Boards with the status neopixel will also show USB status while the red led fades. Green means USB worked while red means the board couldn't talk to the computer. The first step to troubleshooting a red neopixel is trying a different USB cable to make sure its not a charge-only cable.

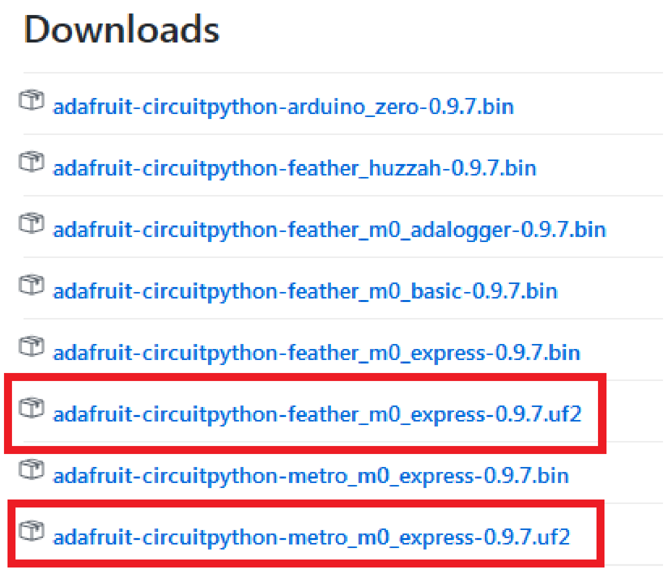
Flashing UF2

Adafruit Express boards come with a new beta bootloader called UF2 that makes flashing CircuitPython even easier than before. This beta bootloader allows you to drag so-called ".uf2" type files onto the BOOT drive. For more information, check out our UF2 bootloader page. (http://adafru.it/vQd)

Start by double-clicking the reset button while it is plugged into your computer. You should see a new disk drive 'pop up' called **METROBOOT** or **FEATHERBOOT** or similar, and the NeoPixel on your board glow green.

The drive will contain a few files. If you want to make a 'backup' of the current firmware on the device, drag-off and save the **CURRENT.UF2** file. Other that that you can ignore the index.htm and info_uf2.txt files. They cannot be deleted and are only for informational purposes.

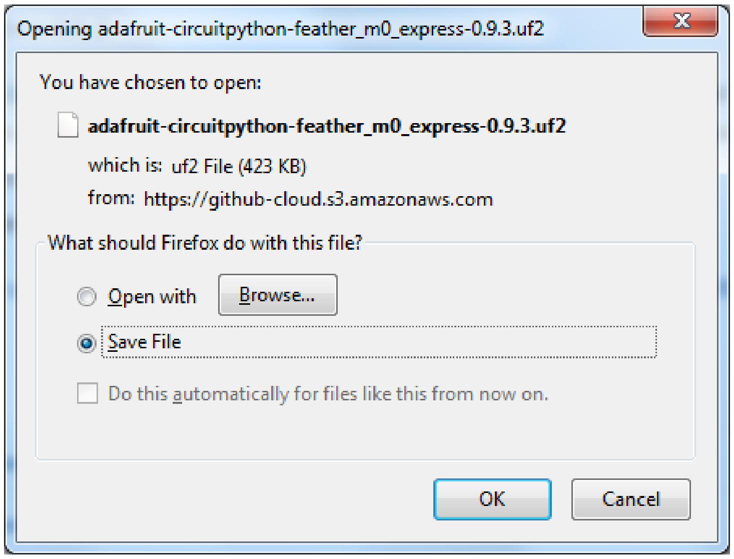
Next up, find the **Feather M0 Express UF2** or **Metro M0 Express UF2** file in the github downloads list:



Downloads

adafruit-circuitpython-arduino_zero-0.9.7.bin
adafruit-circuitpython-feather_huzzah-0.9.7.bin
adafruit-circuitpython-feather_m0_adalogger-0.9.7.bin
adafruit-circuitpython-feather_m0_basic-0.9.7.bin
adafruit-circuitpython-feather_m0_express-0.9.7.bin
adafruit-circuitpython-feather_m0_express-0.9.7.uf2
adafruit-circuitpython-metro_m0_express-0.9.7.bin
adafruit-circuitpython-metro_m0_express-0.9.7.uf2

Click to download and save the file onto your Desktop or somewhere else you can find it


Opening adafruit-circuitpython-feather_m0_express-0.9.3.uf2

You have chosen to open:

adafruit-circuitpython-feather_m0_express-0.9.3.uf2

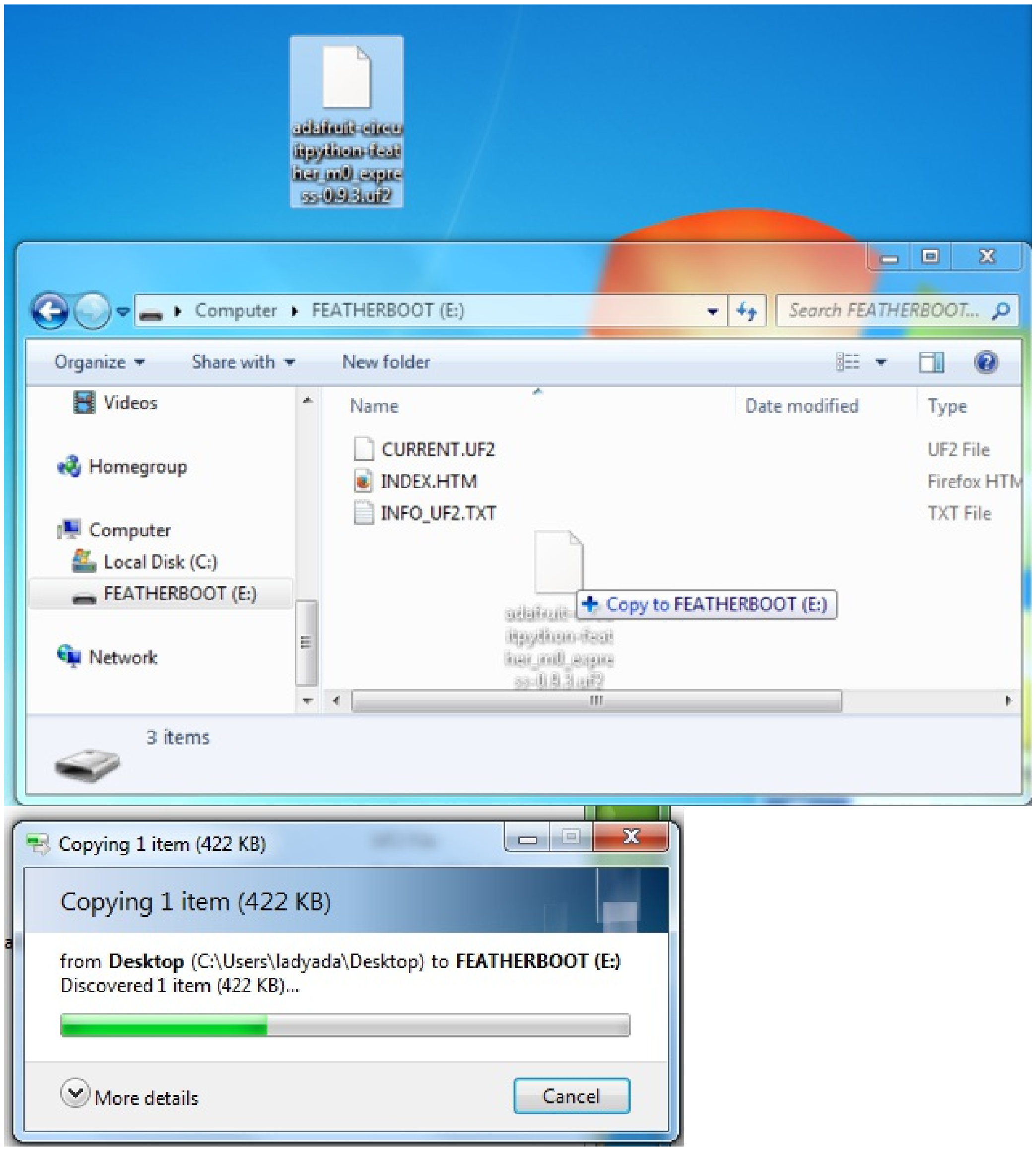
which is: uf2 File (423 KB)

from: https://github-cloud.s3.amazonaws.com

What should Firefox do with this file?

- Open with Browse...
- [✓ Save File]
- Do this automatically for files like this from now on.

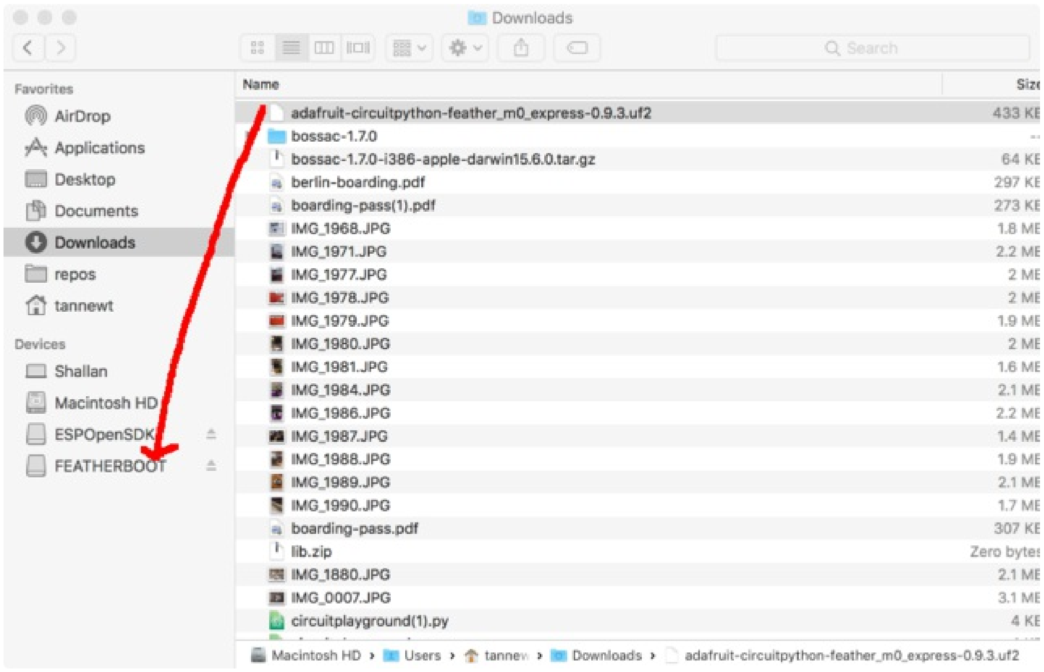
Then drag the **uf2** file into the BOOT drive



Name	Date modified	Type
CURRENT.UF2		UF2 File
INDEX.HTM		Firefox HTM
INFO_UF2.TXT		TXT File

Copying 1 item (422 KB)

from **Desktop** (C:\Users\ladyada\Desktop) to **FEATHERBOOT (E:)**
Discovered 1 item (422 KB)...



Name	Size
adafruit-circuitpython-feather_m0_express-0.9.3.uf2	433 KE
bossac-1.7.0	--
bossac-1.7.0-i386-apple-darwin15.6.0.tar.gz	64 KE
berlin-boarding.pdf	297 KE
boarding-pass(1).pdf	273 KE
IMG_1968.JPG	1.8 ME
IMG_1971.JPG	2.2 ME
IMG_1977.JPG	2 ME
IMG_1978.JPG	2 ME
IMG_1979.JPG	1.9 ME
IMG_1980.JPG	2 ME
IMG_1981.JPG	1.6 ME
IMG_1984.JPG	2.1 ME
IMG_1986.JPG	2.2 ME
IMG_1987.JPG	1.4 ME
IMG_1988.JPG	1.9 ME
IMG_1989.JPG	2.1 ME
IMG_1990.JPG	1.7 ME
boarding-pass.pdf	307 KE
lib.zip	Zero bytes
IMG_1880.JPG	2.1 ME
IMG_0007.JPG	3.1 ME
circuitplayground(1).py	4 KE

Once the full file has been received, the board will automatically restart into CircuitPython. Your computer may warn about ejecting the drive early, if it does, simply ignore it because the board made sure the file was received ok.

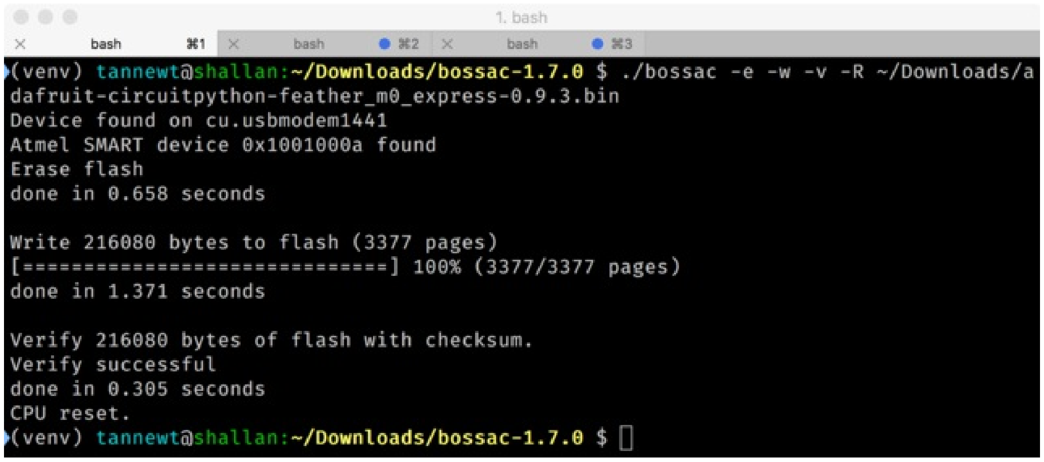
Flashing with BOSSAC

This method is only recommended if you can't use UF2 for some reason!

To flash with bossac (BOSSA's command line tool) first download the latest version fromhere. The mingw32 version is for Windows, apple-darwin for Mac OSX and various linux options for Linux. Once downloaded, extract the files from the zip and open the command line to the directory with bossac.

```
bossac -e -w -v -R ~/Downloads/adafruit-circuitpython-feather_m0_express-0.9.3.bin
```

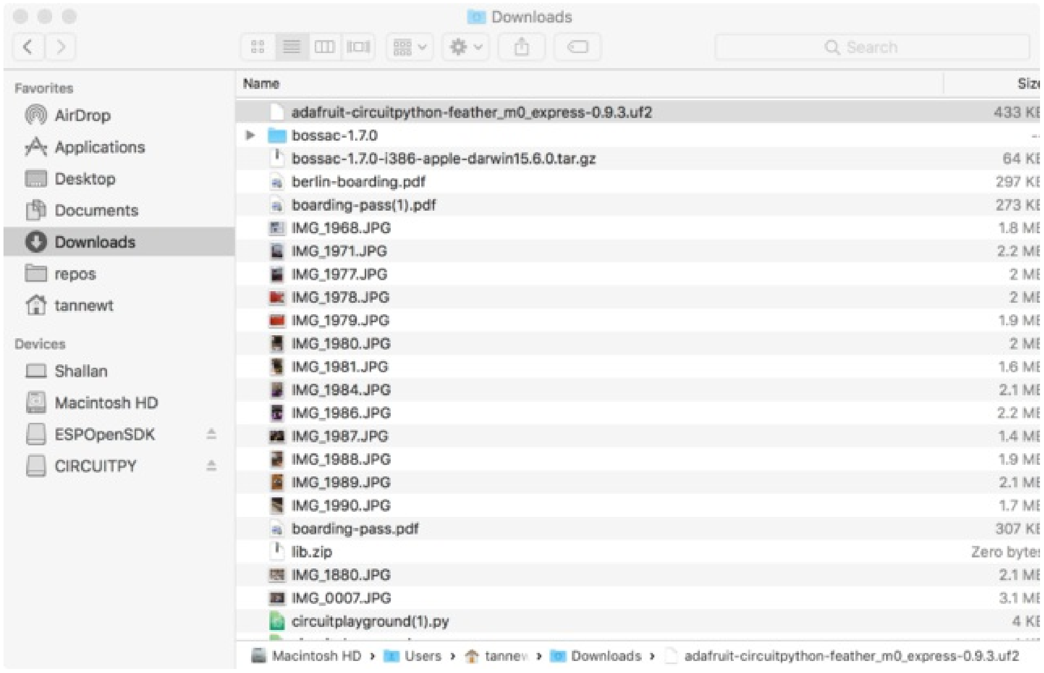
This will erase the chip, write the given file, verify the write and Reset the board. After reset, CircuitPython should be running. Express boards may cause a warning of an early eject of a USB drive but just ignore it. Nothing important was being written to the drive.



```
(venv) tannewt@shallan:~/Downloads/bossac-1.7.0 $ ./bossac -e -w -v -R ~/Downloads/a
dafruit-circuitpython-feather_m0_express-0.9.3.bin
Device found on cu.usbmodem1441
Atmel SMART device 0x1001000a found
Erase flash
done in 0.658 seconds

Write 216080 bytes to flash (3377 pages)
[==============================] 100% (3377/3377 pages)
done in 1.371 seconds

Verify 216080 bytes of flash with checksum.
Verify successful
done in 0.305 seconds
CPU reset.
(venv) tannewt@shallan:~/Downloads/bossac-1.7.0 $ 
```

After flashing

After a successful flash by `bossac` or UF2 you should see a CIRCUITPY drive appear.


Downloads

Favorites
- AirDrop
- Applications
- Desktop
- Documents
- Downloads
- repos
- tannewt

Devices
- Shallan
- Macintosh HD
- ESPOpenSDK
- CIRCUITPY

Name	Siz
adafruit-circuitpython-feather_m0_express-0.9.3.uf2	433 K
bossac-1.7.0	--
bossac-1.7.0-i386-apple-darwin15.6.0.tar.gz	64 K
berlin-boarding.pdf	297 K
boarding-pass(1).pdf	273 K
IMG_1968.JPG	1.8 M
IMG_1971.JPG	2.2 M
IMG_1977.JPG	2 M
IMG_1978.JPG	2 M
IMG_1979.JPG	1.9 M
IMG_1980.JPG	2 M
IMG_1981.JPG	1.6 M
IMG_1984.JPG	2.1 M
IMG_1986.JPG	2.2 M
IMG_1987.JPG	1.4 M
IMG_1988.JPG	1.9 M
IMG_1989.JPG	2.1 M
IMG_1990.JPG	1.7 M
boarding-pass.pdf	307 K
lib.zip	Zero byte
IMG_1880.JPG	2.1 M
IMG_0007.JPG	3.1 M
circuitplayground(1).py	4 K

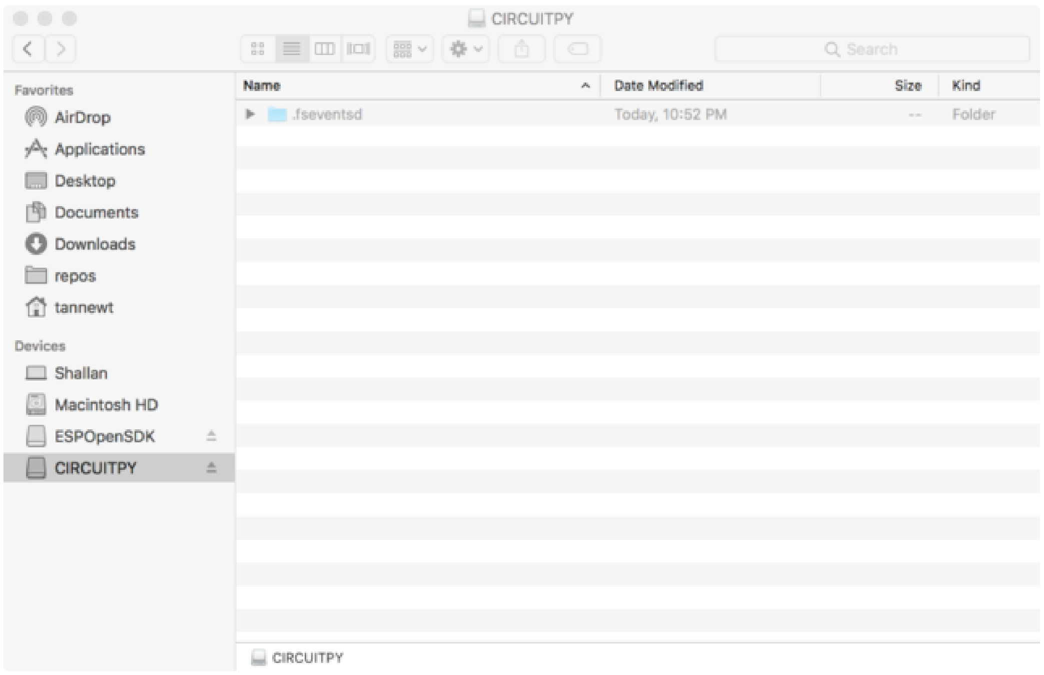
Macintosh HD › Users › tannew › Downloads › adafruit-circuitpython-feather_m0_express-0.9.3.uf2

CircuitPython Blinky

Let's get blinky going with CircuitPython to explore the way we can write code and confirm everything is working as expected.

code.py

After plugging in a board with CircuitPython into your computer a CIRCUITPY drive will appear. At first, the drive may be empty but you can create and edit files on it just like you would on a USB drive. On here, you can save a code.py (code.txt and main.py also work) file to run every time the board resets. This is the CircuitPython equivalent of an Arduino sketch. However, all of the compiling is done on the board itself. All you need to do is edit the file.



So, fire up your favorite text editor, such as Notepad on Windows, TextEdit on Mac ordownload Atom (my favorite), and create a new file. In the file copy this:

```
import digitalio
import board
import time

led = digitalio.DigitalInOut(board.D13)
led.switch_to_output()
while True:
    led.value = not led.value
    time.sleep(0.5)
```

Now, save the file to the drive as`code.txt` (`code.py` also works). After a brief time, the board's red LED should begin to flash every second.

Status LED

While code.py is running the status neopixel will be solid green. After it is finished, the neopixel will fade green on success or flash an error code on failure. Red flashes happen when data is written to the drive.

Debugging

Did the status LED flash a bunch of colors at you? You may have an error in your code. Don't worry it happens to everyone. Python code is checked when you run it rather than before like Arduino does when it compiles. To see the CircuitPython error you'll need to connect to the serial output (like Arduino's serial monitor).

See this guide for detailed instructions.

If you are new to Python try googling the error first, if that doesn't find an answer feel free to drop by the support forum.

Libraries

Using libraries with CircuitPython is also super easy. Simply drag and drop libraries onto the CIRCUITPY drive or into a `lib` folder on the drive to keep it tidy.

Find CircuitPython libraries on GitHub using the topic and through our tutorials.

Make sure the libraries are for CircuitPython and not MicroPython. There are some differences that may cause it to not work as expected.

More info

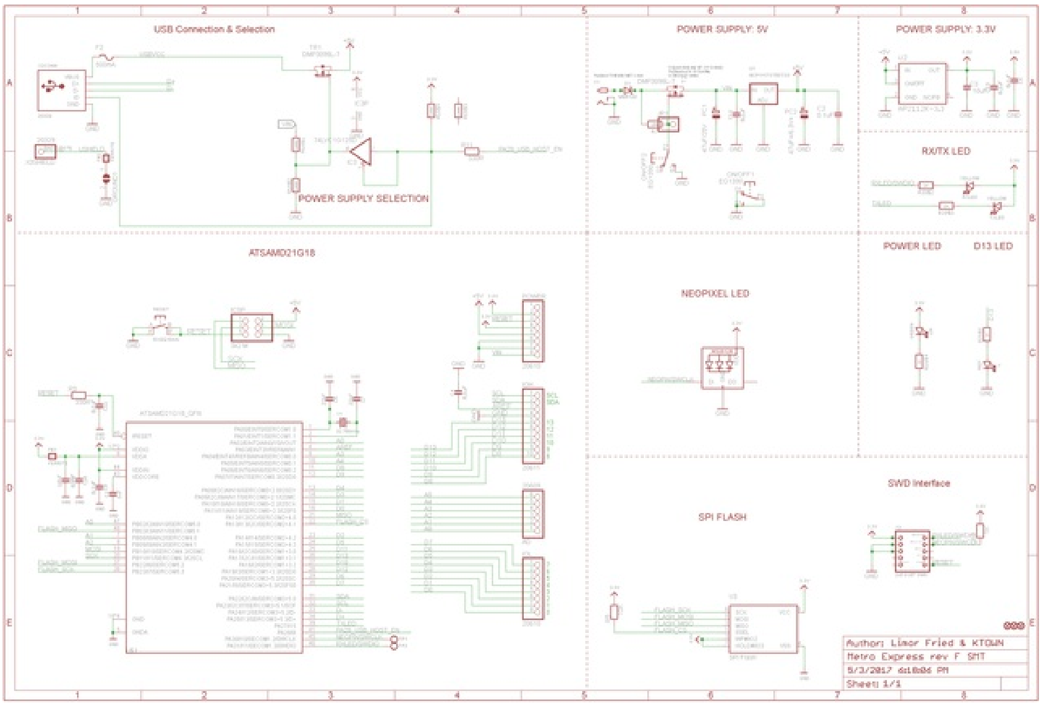
- Guides and Tutorials
- API Reference
- Adafruit forum
- Libraries

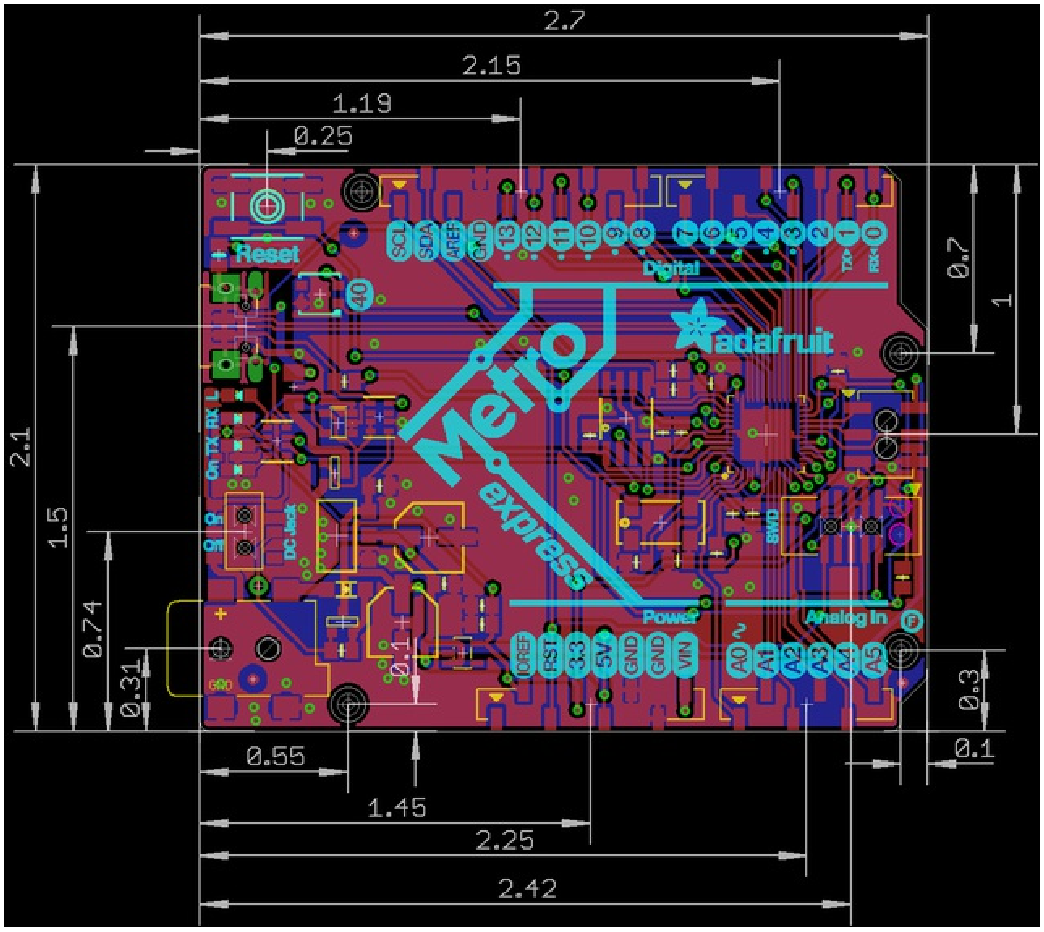
Downloads

Datasheets

- ATSAMD21 Datasheet (http://adafru.it/kUf) (the main chip on the Metro M0)
- Fritzing object in the Adafruit Fritzing Library (http://adafru.it/aP3)

Schematic & Fabrication Print




2.7
2.15
1.19
0.25
2.1
1.5
0.74
0.31
0.7
1
0.3
0.1
0.55
1.45
2.25
2.42
0.1
Reset
Digital
Power
Analog In
Metro
express
adafruit
DC Jack
SWD
SCL
SDA
AREF
GND
13
12
11
10
9
8
7
6
5
4
3
2
1
0
IOREF
RST
3.3
5V
GND
GND
VIN
A0
A1
A2
A3
A4
A5