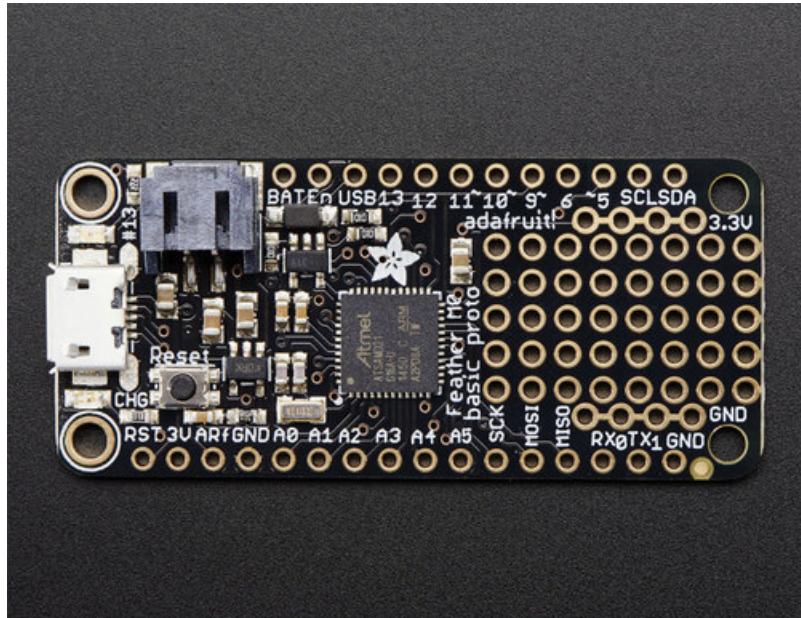




Adafruit Feather M0 Basic Proto

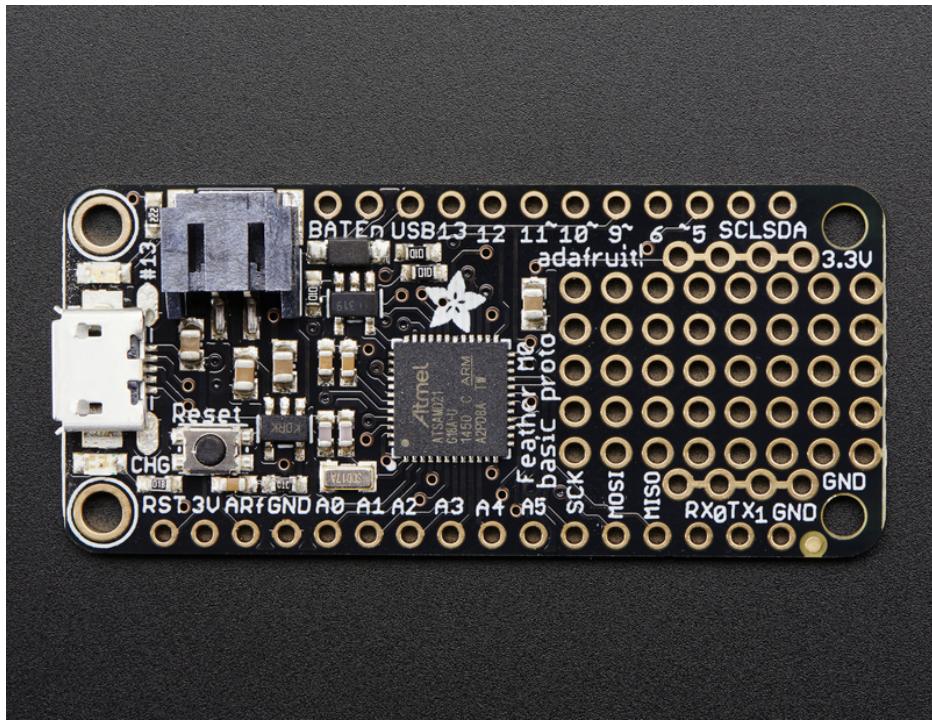
Created by lady ada



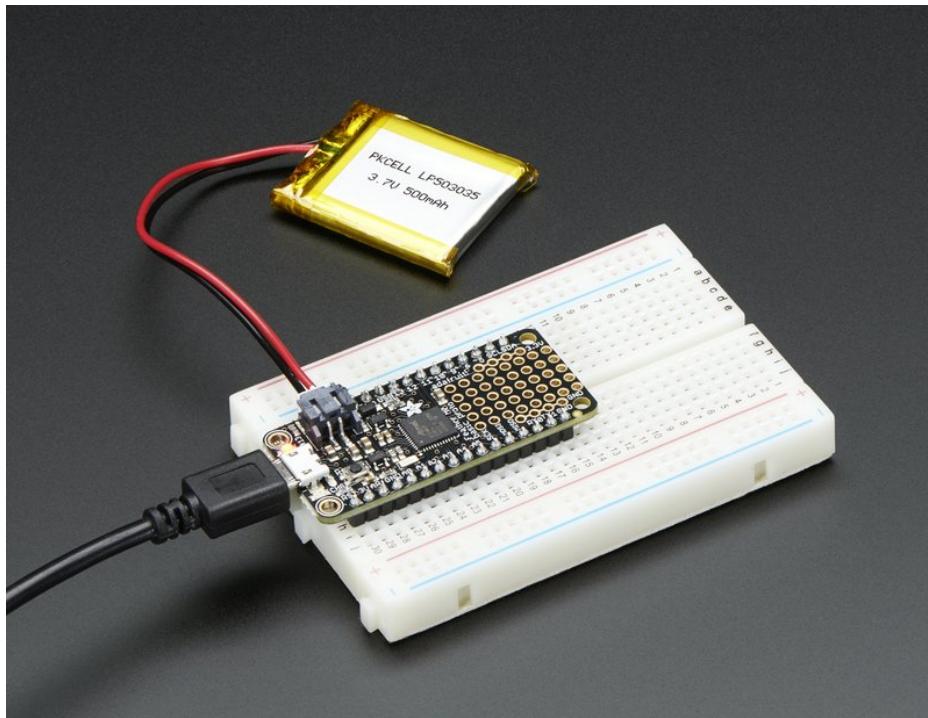
Last updated on 2020-09-30 11:09:12 AM EDT

Overview

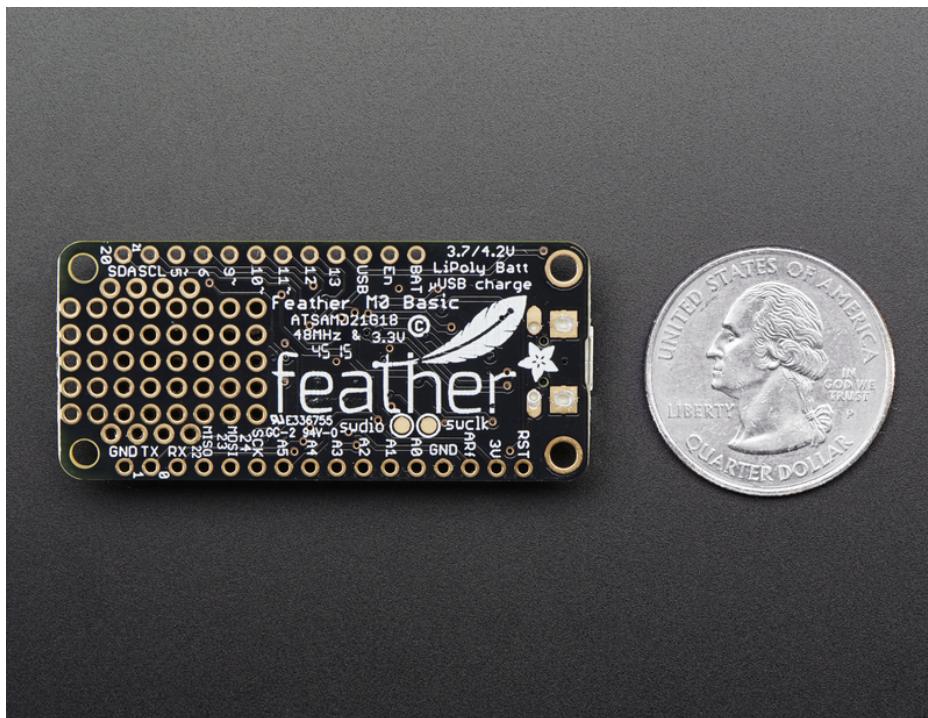
Feather is the new development board from Adafruit, and like its namesake it is thin, light, and lets you fly! We designed Feather to be a new standard for portable microcontroller cores.



At the Feather 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) (<http://adafru.it/2843>). This chip has a whopping 256K of FLASH (8x more than the Atmega328 or 32u4) 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.



To make it easy to use for portable projects, we added a connector for any of our 3.7V Lithium polymer batteries and built in battery charging. You don't need a battery, it will run just fine straight from the micro USB connector. But, if you do have a battery, you can take it on the go, then plug in the USB to recharge. The Feather will automatically switch over to USB power when its available. We also tied the battery thru a divider to an analog pin, so you can measure and monitor the battery voltage to detect when you need a recharge.

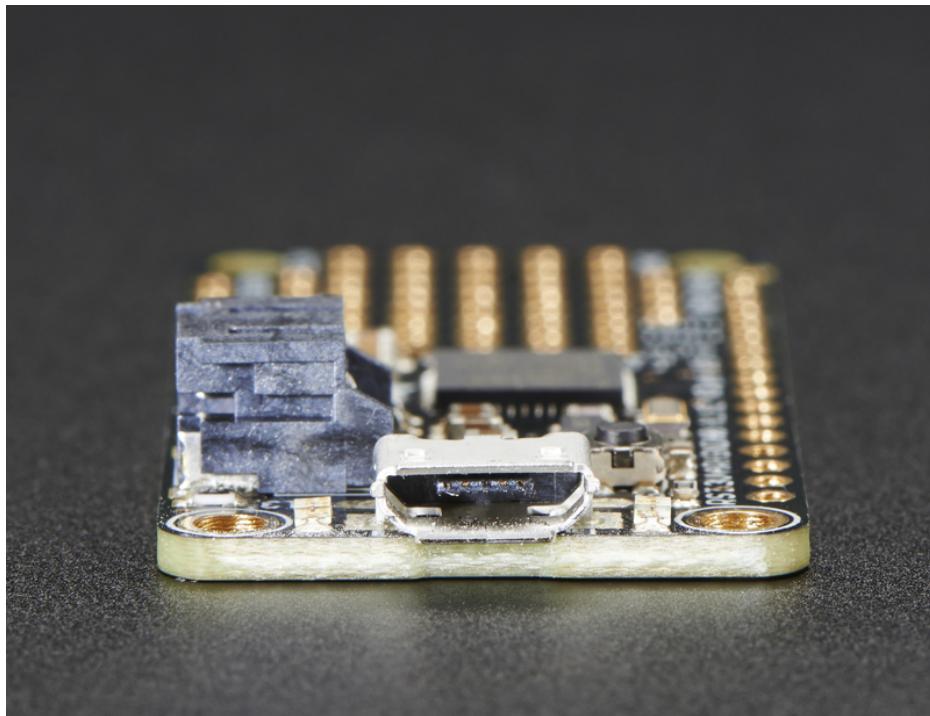


Here's some handy specs!

- Measures 2.0" x 0.9" x 0.28" (51mm x 23mm x 8mm) without headers soldered in

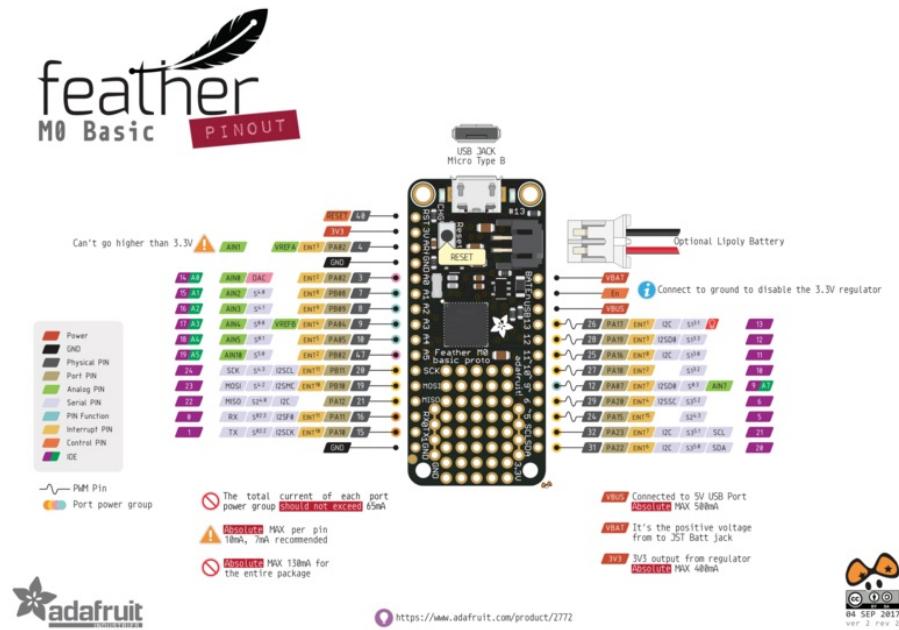
- Light as a (large?) feather - 4.6 grams
- ATSAMD21G18 @ 48MHz with 3.3V logic/power
- 256KB of FLASH + 32KB of RAM
- 32.768 KHz crystal for clock generation & RTC
- 3.3V regulator with 500mA peak current output
- USB native support, comes with USB bootloader and serial port debugging
- You also get tons of pins - 20 GPIO pins
- Hardware Serial, hardware I2C, hardware SPI support
- PWM outputs on all pins
- 6 x 12-bit analog inputs
- 1 x 10-bit analog output (DAC)
- Built in 100mA lipoly charger with charging status indicator LED
- Pin #13 red LED for general purpose blinking
- Power/enable pin
- 4 mounting holes
- Reset button

The **Feather M0 Basic Proto** has some extra space left over, so we give you a tiny little prototyping area. If you just need to attach a button or sensor, you may be able to skip out on a breadboard and wire it directly on there.



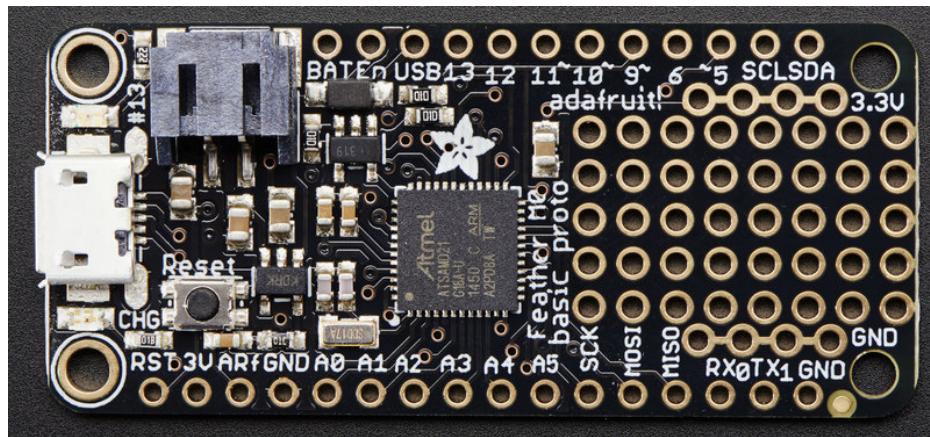
Comes fully assembled and tested, with a USB bootloader that lets you quickly use it with the Arduino IDE. We also toss in some header so you can solder it in and plug into a solderless breadboard. **Lipoly battery and USB cable not included** (but we do have lots of options in the shop if you'd like!)

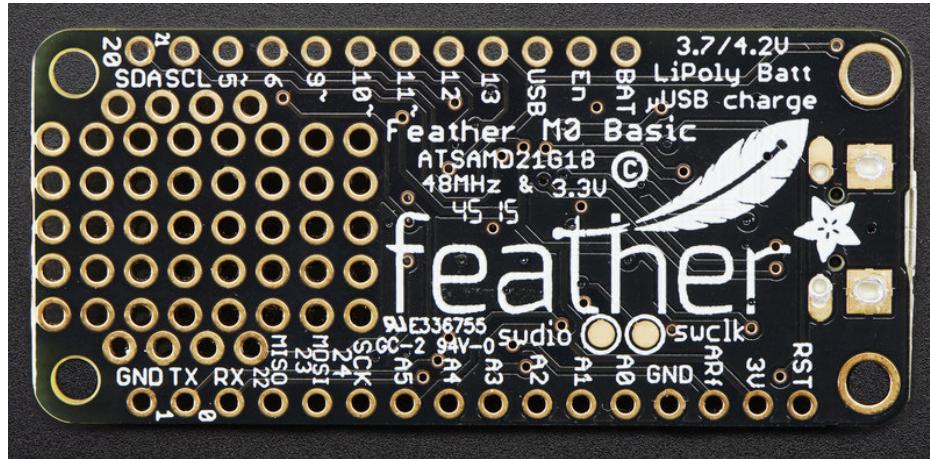
Pinouts



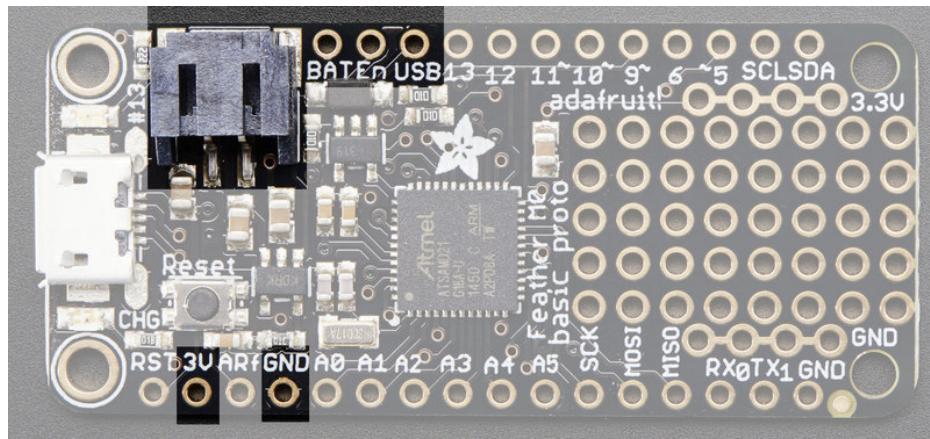
Note AREF in the diagram should be marked PA03 not PA02

The Feather M0 Basic 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 Pins



- **GND** - this is the common ground for all power and logic
- **BAT** - this is the positive voltage to/from the JST jack for the optional Lipoly battery
- **USB** - this is the positive voltage to/from the micro USB jack if connected
- **EN** - this is the 3.3V regulator's enable pin. It's pulled up, so connect to ground to disable the 3.3V regulator
- **3V** - this is the output from the 3.3V regulator, it can supply 500mA peak

Logic pins

This is the general purpose I/O pin set for the microcontroller.

All logic is 3.3V

Nearly all pins can do PWM output

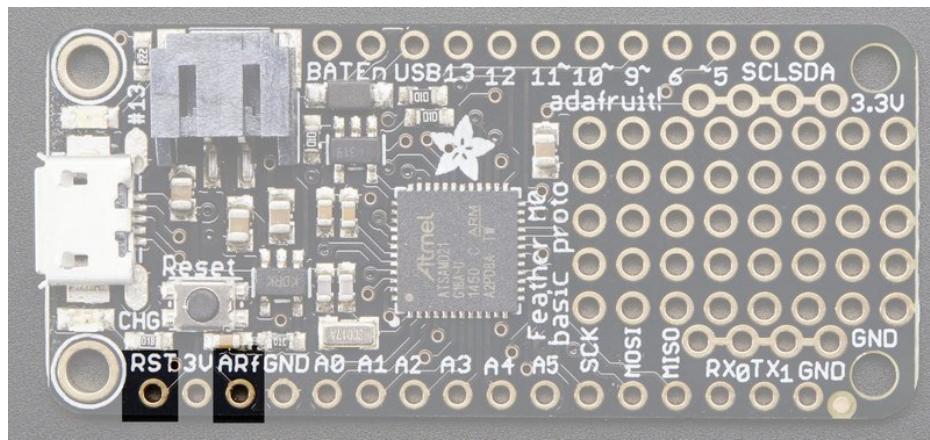
All pins can be interrupt inputs

- **#0 / RX** - GPIO #0, also receive (input) pin for **Serial1** (hardware UART), also can be analog input
- **#1 / TX** - GPIO #1, also transmit (output) pin for **Serial1**, also can be analog input
- **#20 / SDA** - GPIO #20, also 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.
- **#21 / SCL** - GPIO #21, also 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.
- **#5** - GPIO #5
- **#6** - GPIO #6

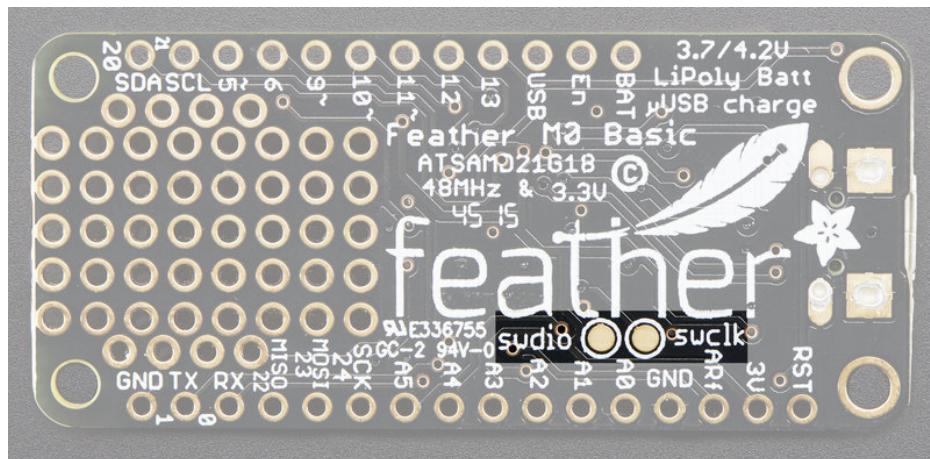
- #9 - GPIO #9, also analog input A7. This analog input is connected to a voltage divider for the lipoly battery so be aware that this pin naturally 'sits' at around 2VDC due to the resistor divider
 - #10 - GPIO #10
 - #11 - GPIO #11
 - #12 - GPIO #12
 - #13 - GPIO #13 and is connected to the red LED next to the USB jack
 - 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.
 - SCK/MOSI/MISO (GPIO 24/23/22)- These are the hardware SPI pins, 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).

Other Pins!

- **RST** - this is the Reset pin, tie to ground to manually reset the AVR, 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!



- **SWCLK & SWDIO** - These pads on the bottom are used to program the chip. They can also be connected to an SWD debugger.

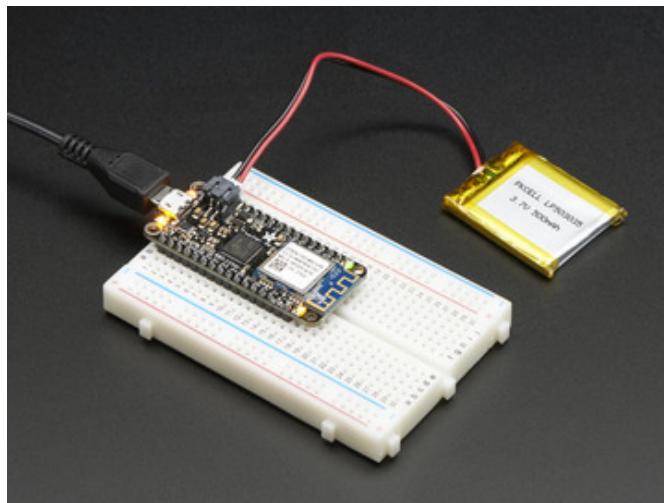


Assembly

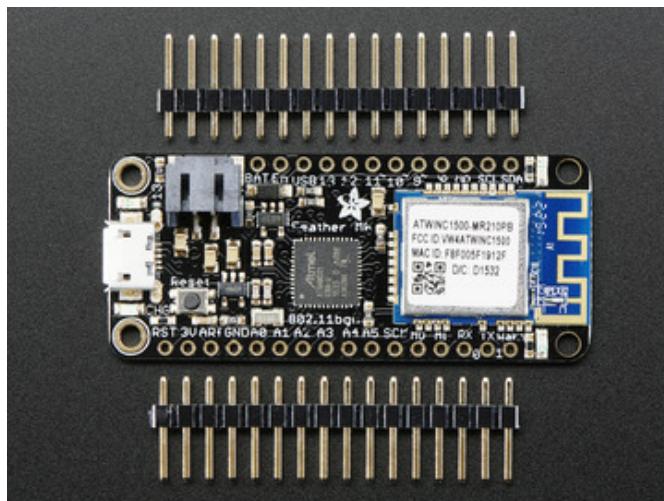
We ship Feathers fully tested but without headers attached - this gives you the most flexibility on choosing how to use and configure your Feather

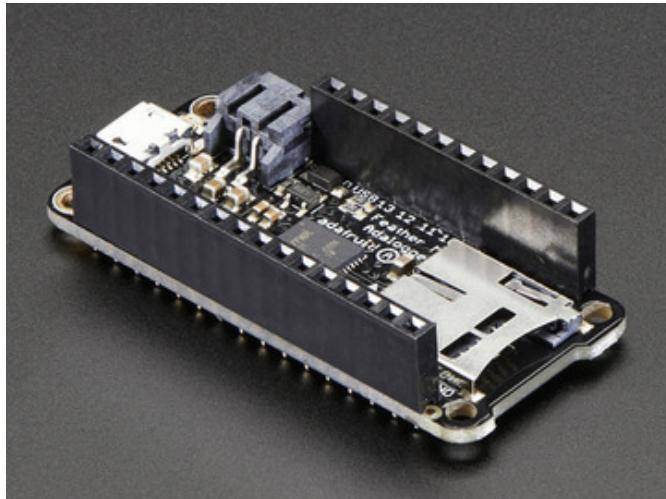
Header Options!

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

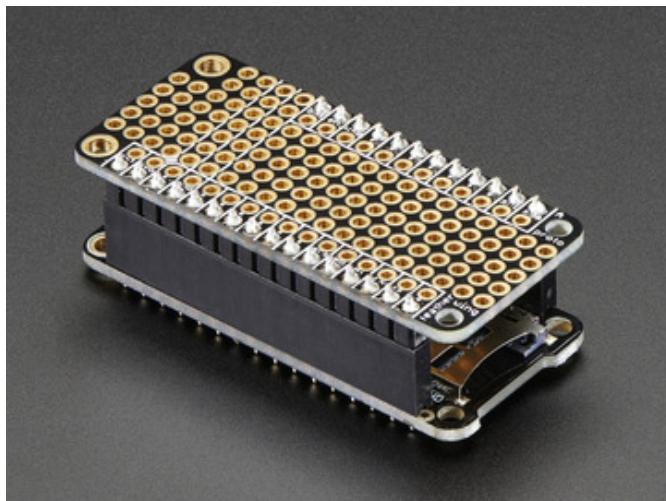


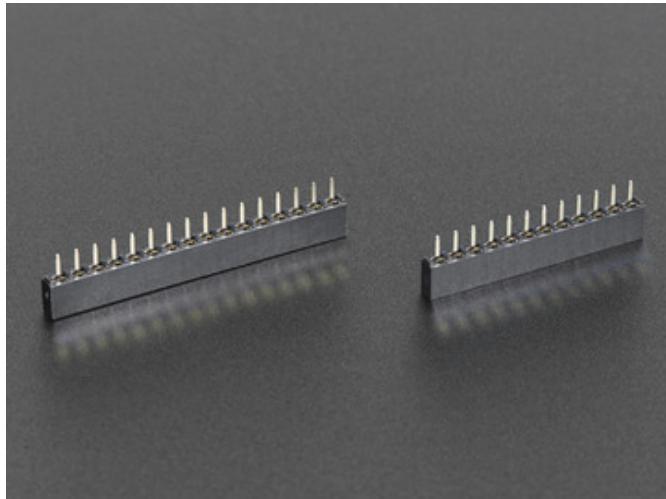
The first option is soldering in plain male headers, this lets you plug in the Feather into a solderless breadboard



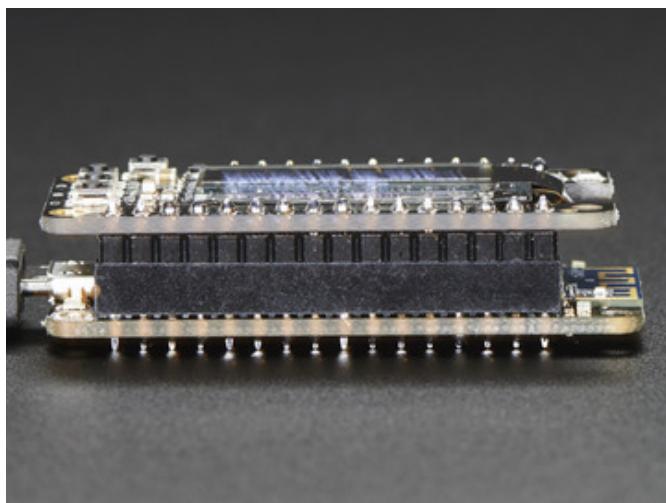


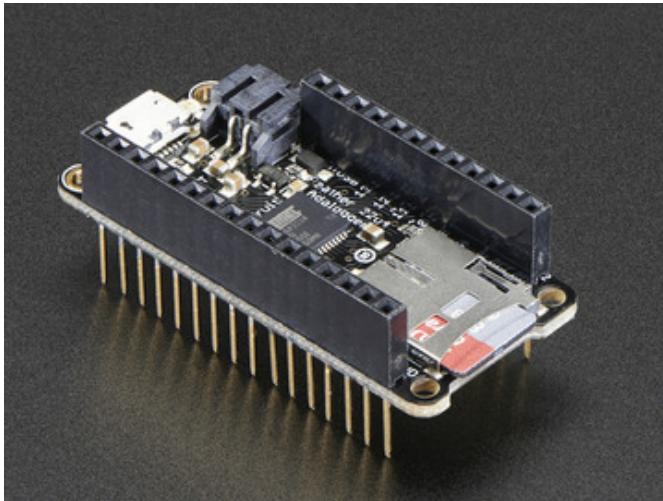
Another option is to go with socket female headers. This won't let you plug the Feather into a breadboard but it will let you attach featherwings very easily



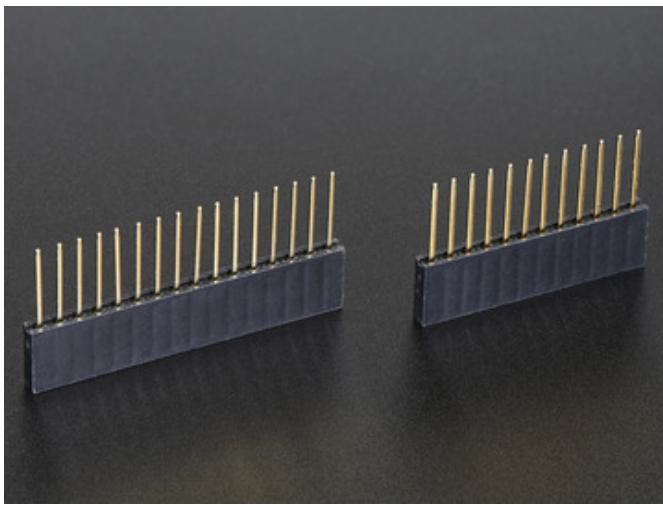


We also have 'slim' versions of the female headers, that are a little shorter and give a more compact shape

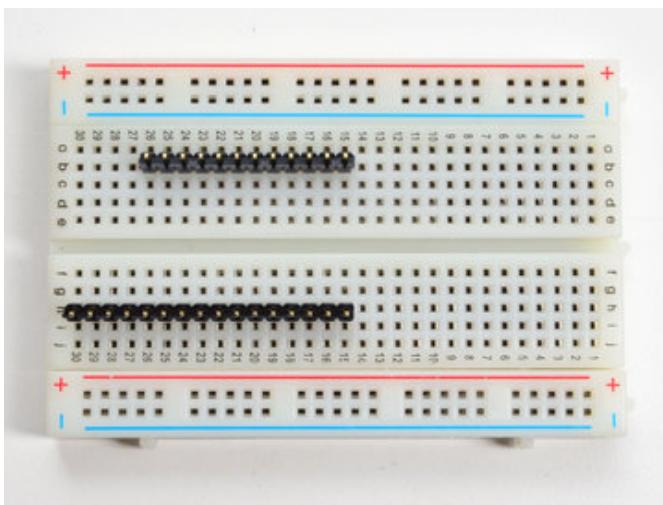




Finally, there's the "Stacking Header" option. This one is sort of the best-of-both-worlds. You get the ability to plug into a solderless breadboard *and* plug a featherwing on top. But it's a little bulky



Soldering in Plain Headers

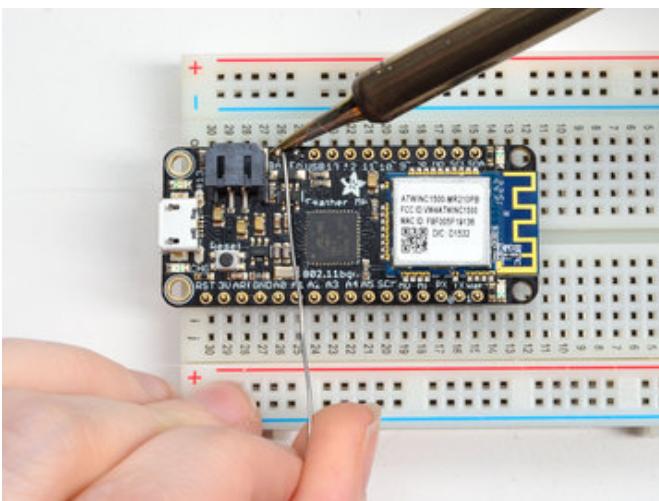


Prepare the header strip:

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

Add the breakout board:

Place the breakout board over the pins so that the short

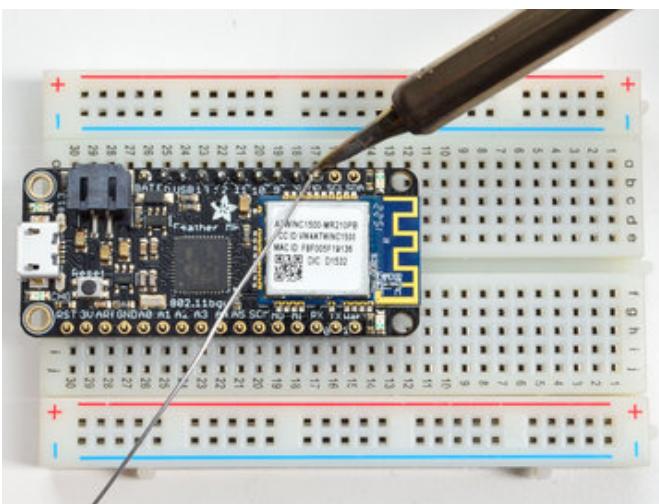
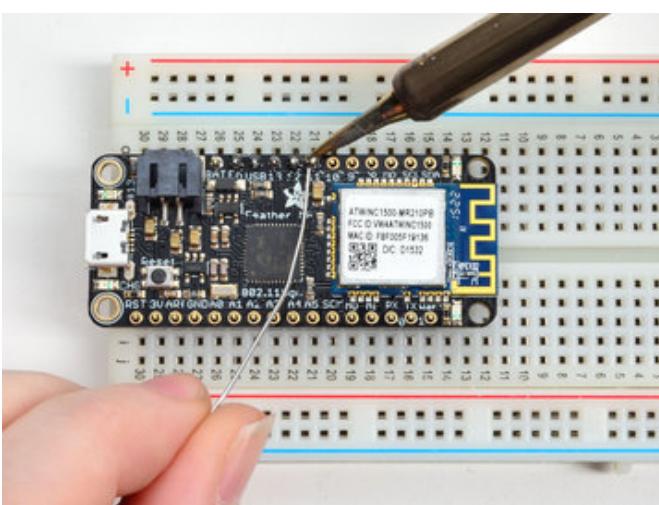


pins poke through the breakout pads

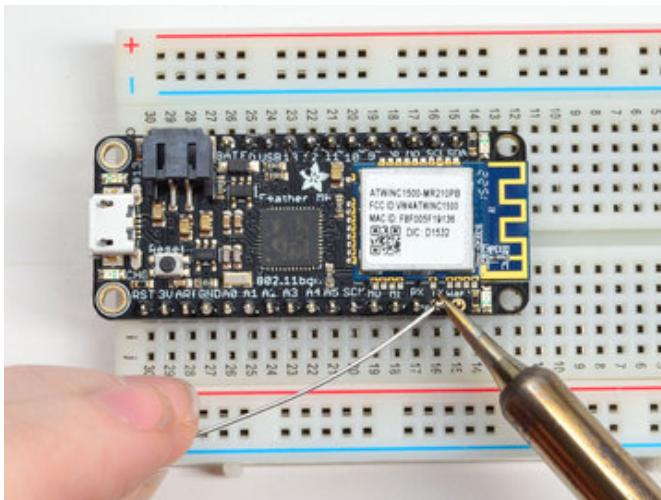
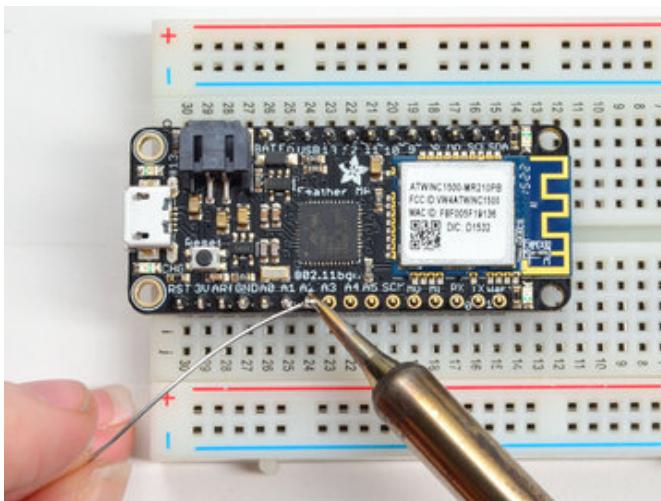
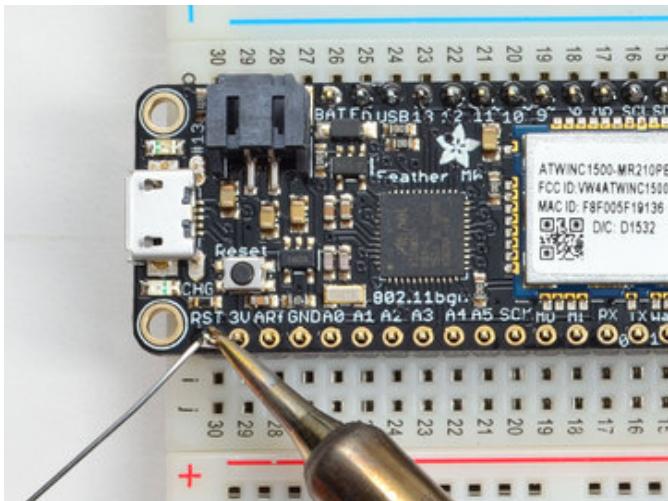
And Solder!

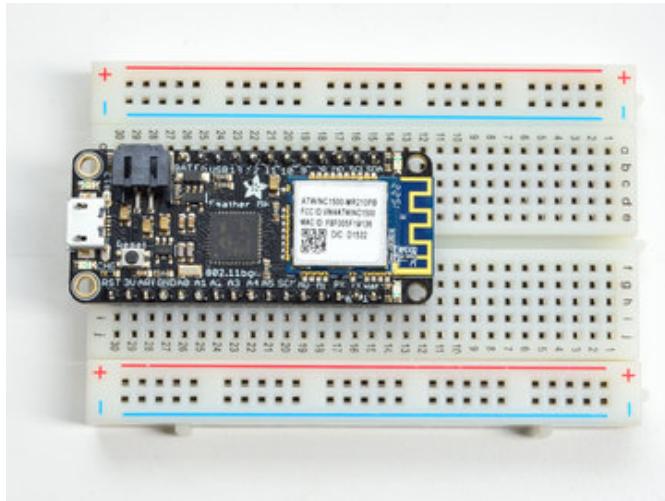
Be sure to solder all pins for reliable electrical contact.

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



Solder the other strip as well.





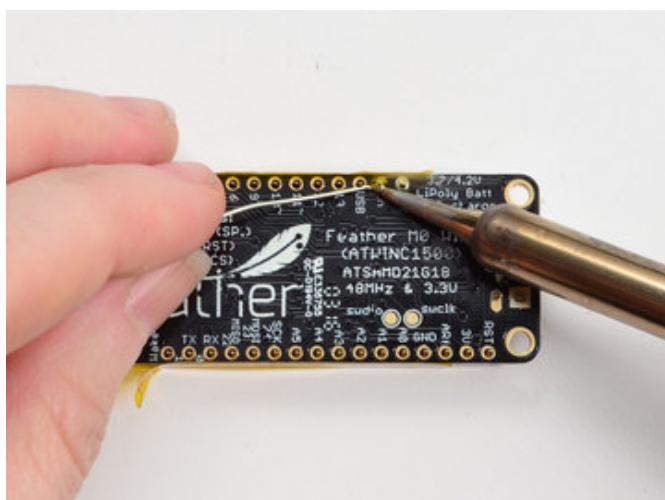
You're done! Check your solder joints visually and continue onto the next steps

Soldering on Female Header



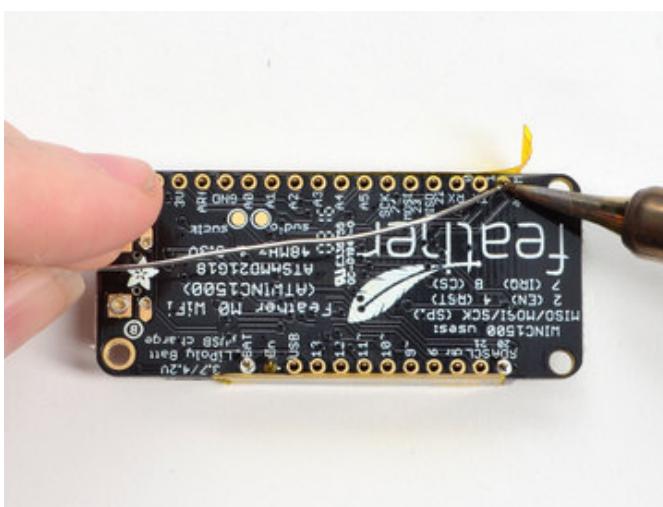
Tape In Place

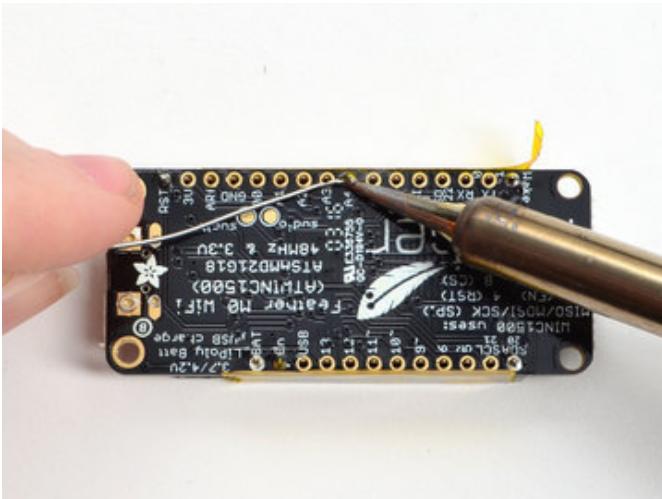
For sockets you'll want to tape them in place so when you flip over the board they don't fall out



Flip & Tack Solder

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

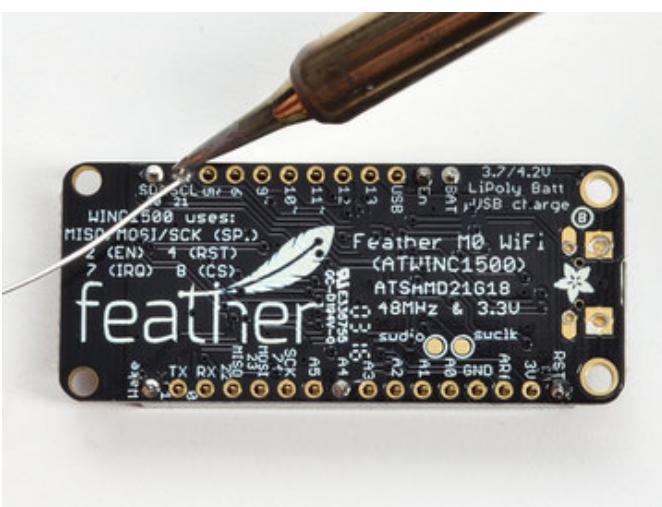




And Solder!

Be sure to solder all pins for reliable electrical contact.

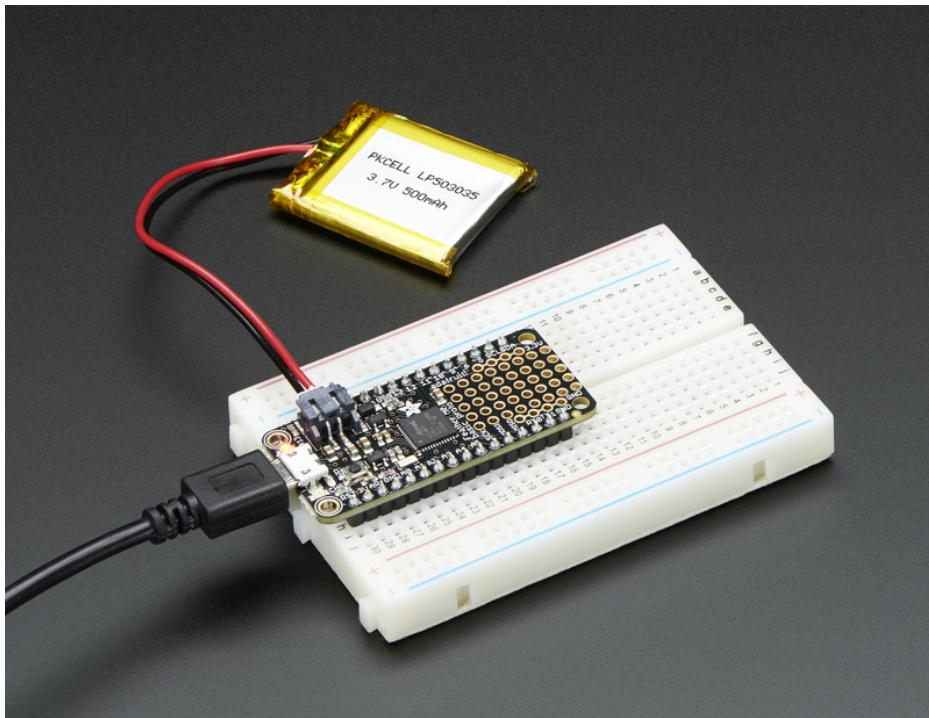
(For tips on soldering, be sure to check out our [Guide to Excellent Soldering](#) (<https://adafru.it/aTk>)).



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



Power Management

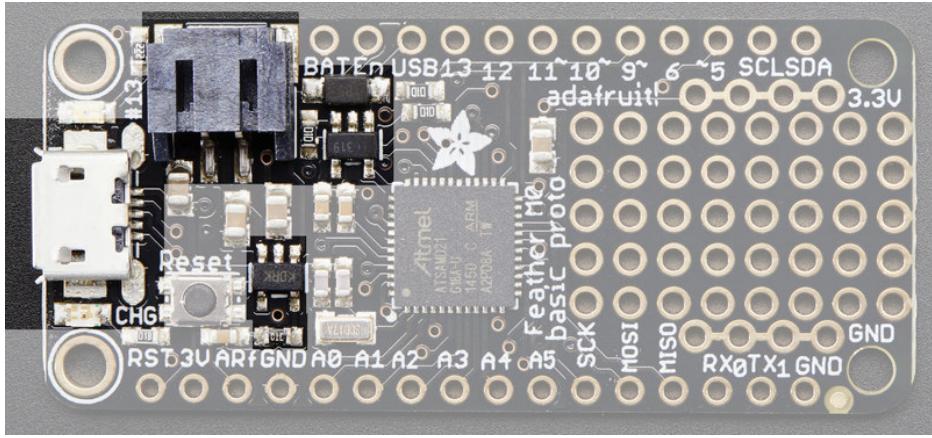


Battery + USB Power

We wanted to make the Feather easy to power both when connected to a computer as well as via battery. There's **two ways to power** a Feather. You can connect with a MicroUSB cable (just plug into the jack) and the Feather will regulate the 5V USB down to 3.3V. You can also connect a 4.2/3.7V Lithium Polymer (Lipo/Lipoly) or Lithium Ion (Lilon) battery to the JST jack. This will let the Feather run on a rechargeable battery. **When the USB power is powered, it will automatically switch over to USB for power, as well as start charging the battery (if attached) at 100mA.** This happens 'hotswap' style so you can always keep the Lipoly connected as a 'backup' power that will only get used when USB power is lost.



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

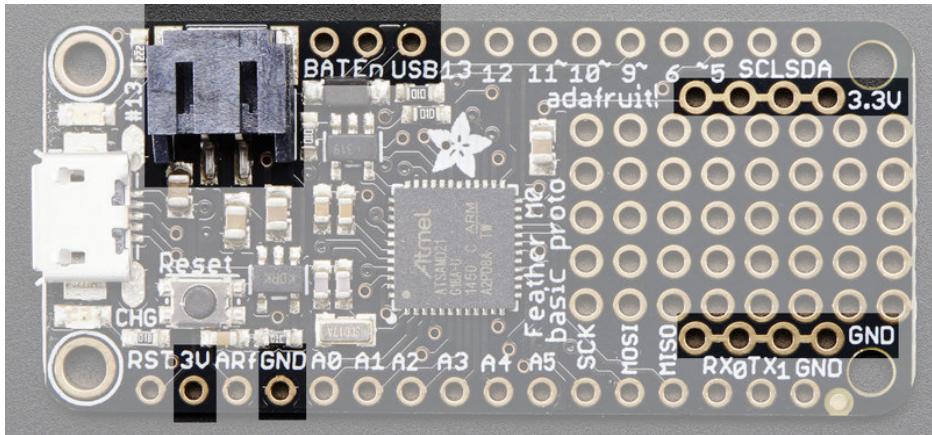


The above shows the Micro USB jack (left), Lipoly JST jack (top left), as well as the 3.3V regulator and changeover diode (just to the right of the JST jack) and the Lipoly charging circuitry (to the right of the Reset button). There's also a **CHG** LED, which will light up while the battery is charging. This LED might also flicker if the battery is not connected.

The charge LED is automatically driven by the Lipoly charger circuit. It will try to detect a battery and is expecting one to be attached. If there isn't one it may flicker once in a while when you use power because it's trying to charge a (non-existent) battery. It's not harmful, and it's totally normal!

Power supplies

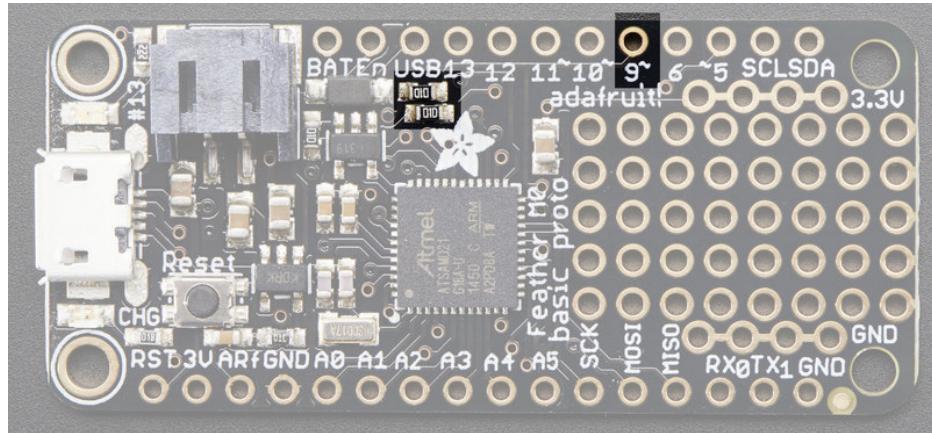
You have a lot of power supply options here! We bring out the **BAT** pin, which is tied to the lipoly JST connector, as well as **USB** which is the +5V from USB if connected. We also have the **3V** pin which has the output from the 3.3V regulator. We use a 500mA peak regulator. While you can get 500mA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



Measuring Battery

If you're running off of a battery, chances are you wanna know what the voltage is at! That way you can tell when the battery needs recharging. Lipoly batteries are 'maxed out' at 4.2V and stick around 3.7V for much of the battery life, then slowly sink down to 3.2V or so before the protection circuitry cuts it off. By measuring the voltage you can quickly tell when you're heading below 3.7V

To make this easy we stuck a double-100K resistor divider on the **BAT** pin, and connected it to **D9** (a.k.a analog #7 **A7**).



In Arduino, you can read this pin's voltage, then double it, to get the battery voltage.

```
// Arduino Example Code

#define VBATPIN A7

float measuredvbat = analogRead(VBATPIN);
measuredvbat *= 2;      // we divided by 2, so multiply back
measuredvbat *= 3.3;    // Multiply by 3.3V, our reference voltage
measuredvbat /= 1024;   // convert to voltage
Serial.print("VBat: " ); Serial.println(measuredvbat);
```

For CircuitPython, we've written a `get_voltage()` helper function to do the math for you. All you have to do is call the function, provide the pin and print the results.

```
import board
import analogio

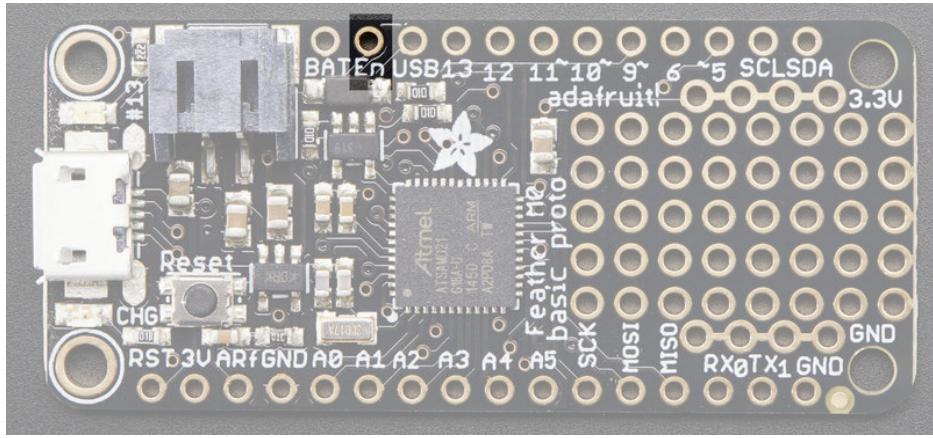
vbat_voltage = analogio.AnalogIn(board.D9)

def get_voltage(pin):
    return (pin.value * 3.3) / 65536 * 2

battery_voltage = get_voltage(vbat_voltage)
print("VBat voltage: {:.2f}".format(battery_voltage))
```

ENable pin

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



Alternative Power Options

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

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

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

Here's what you cannot do:

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

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

- **Connect an external 3.3V power supply to the 3V and GND pins.** Not recommended, this may cause unexpected behavior and the **EN** pin will no longer. Also this doesn't provide power on **BAT** or **USB** and some Feathers/Wings use those pins for high current usages. You may end up damaging your Feather.
- **Connect an external 5V power supply to the USB and GND pins.** Not recommended, this may cause unexpected behavior when plugging in the USB port because you will be back-powering the USB port, which *could* confuse or damage your computer.

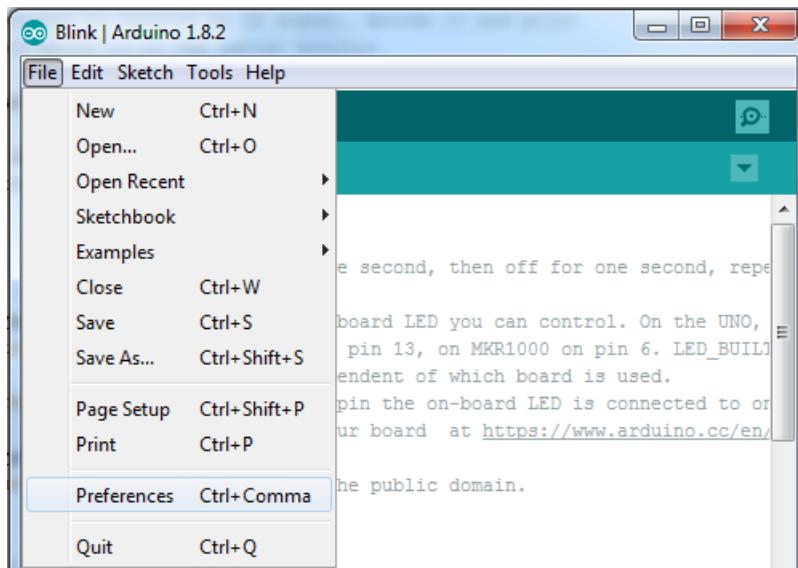
Arduino IDE Setup

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

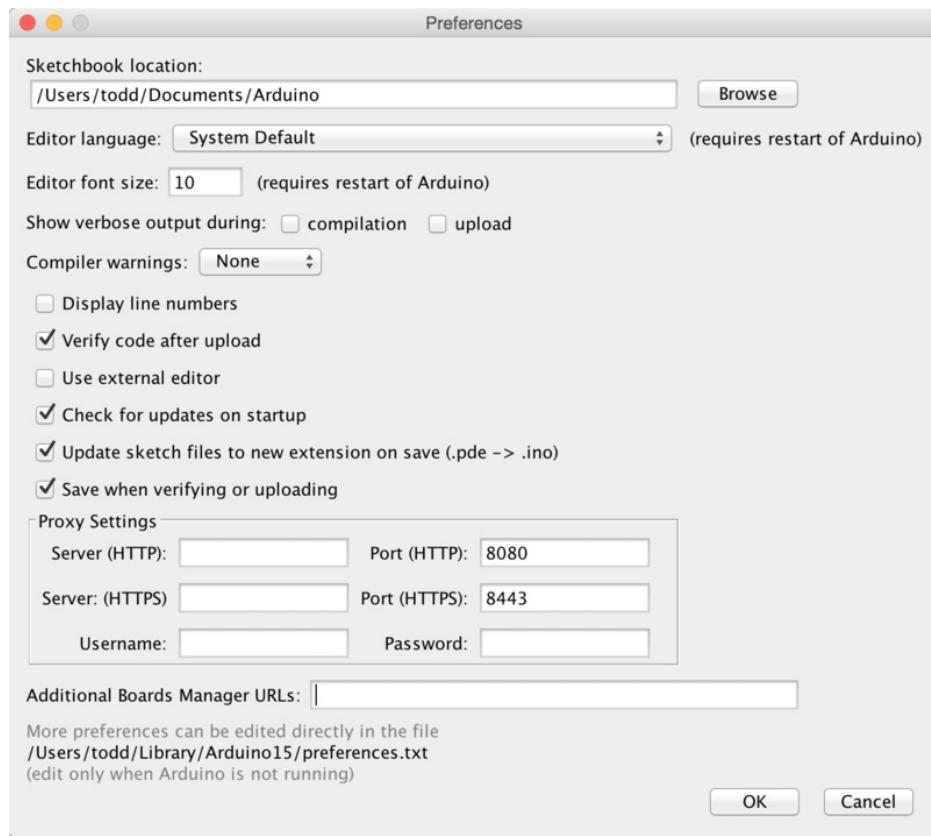
<https://adafru.it/f1P>

<https://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*.



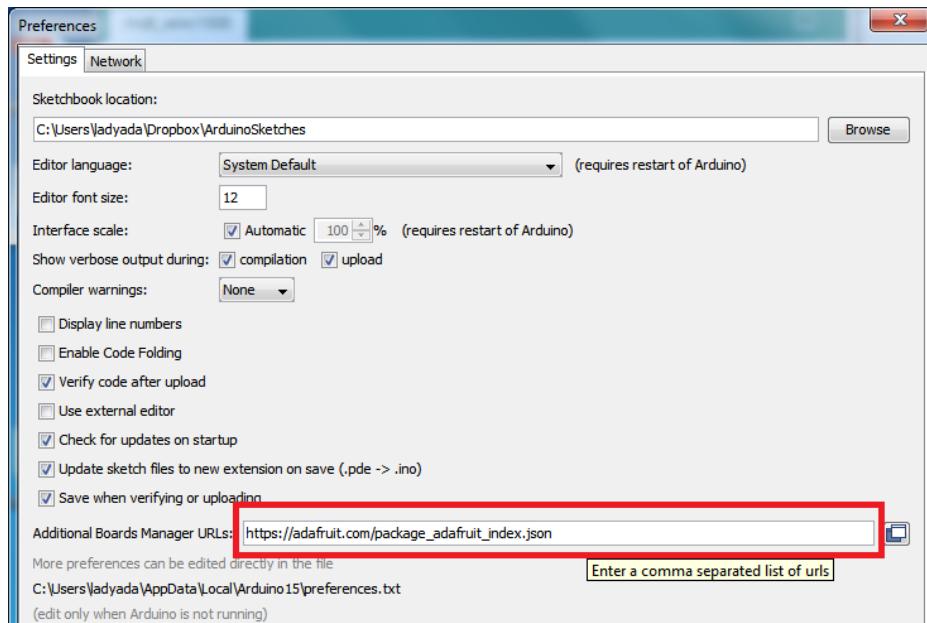
A dialog will pop up just like the one shown below.



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://adafruit.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



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 and M4, Metro M0 and M4, ItsyBitsy M0 and M4, Circuit Playground Express, Gemma M0 and Trinket M0
- **Arduino Leonardo & Micro MIDI-USB** - This adds MIDI over USB support for the Flora, Feather 32u4, Micro and Leonardo using the [arcore project \(https://adafru.it/eSI\)](https://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 (,)

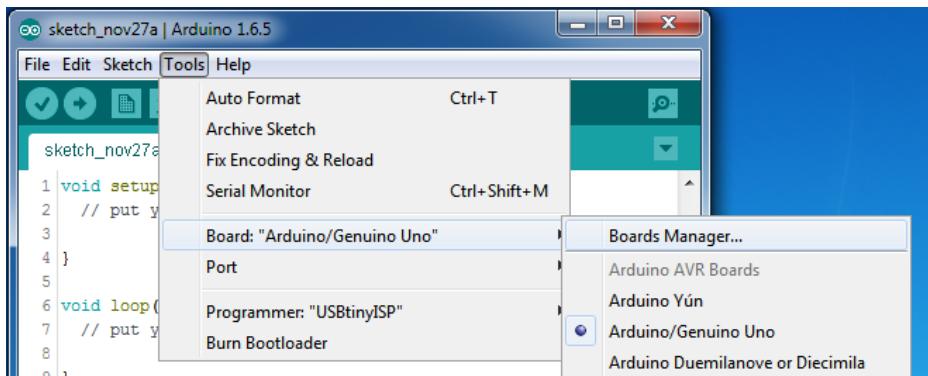
Once done click **OK** to save the new preference settings. Next we will look at installing boards with the Board Manager.

Now continue to the next step to actually install the board support package!

Using with Arduino IDE

The Feather/Metro/Gemma/QTPy/Trinket M0 and M4 use an ATSAMD21 or ATSAMD51 chip, and 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 and M4, especially devices & sensors that use I2C or SPI.

Now that you have added the appropriate URLs to the Arduino IDE preferences in the previous page, 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 **All**. You will then be able to select and install the boards supplied by the URLs added to the preferences.

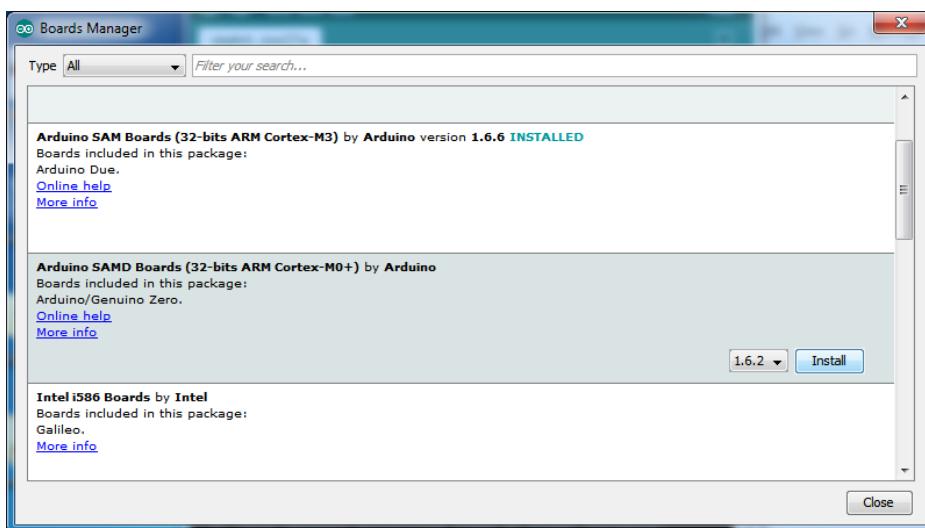


Remember you need SETUP the Arduino IDE to support our board packages - see the previous page on how to add adafruit's URL to the preferences

Install SAMD Support

First up, install the latest **Arduino SAMD Boards** (version **1.6.11** or later)

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

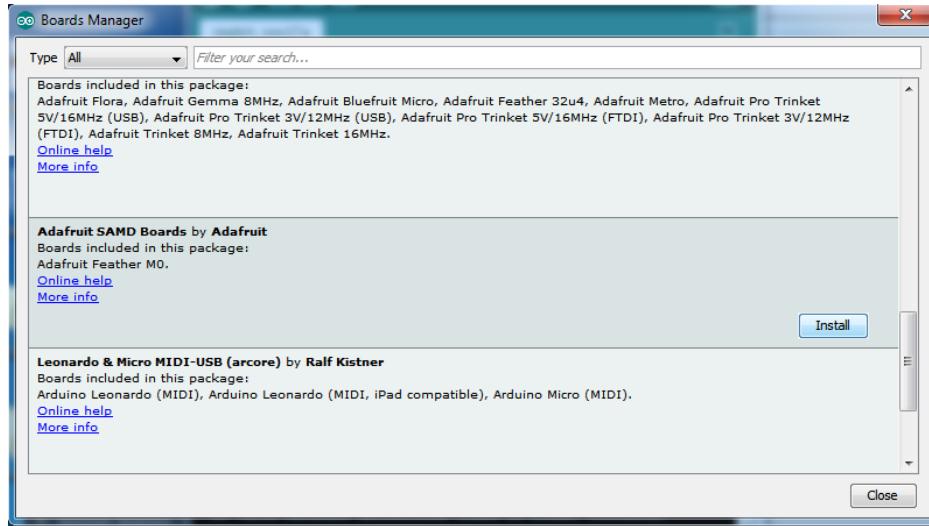


Install Adafruit SAMD

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

Make sure you have **Type All** selected to the left of the *Filter your search...* box

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



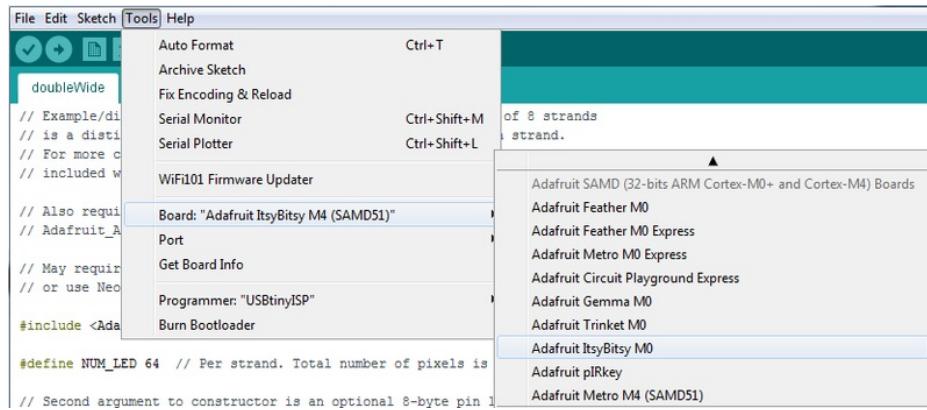
Even though in theory you don't need to - I recommend rebooting the IDE

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**
- **Gemma M0**
- **Trinket M0**
- **QT Py M0**
- **ItsyBitsy M0**
- **Hallowing M0**
- **Crickit M0** (this is for direct programming of the Crickit, which is probably not what you want! For advanced hacking only)
- **Metro M4 Express**
- **Grand Central M4 Express**
- **ItsyBitsy M4 Express**
- **Feather M4 Express**
- **Trellis M4 Express**
- **PyPortal M4**
- **PyPortal M4 Titano**
- **PyBadge M4 Express**
- **Metro M4 Airlift Lite**

- PyGamer M4 Express
- MONSTER M4SK
- Hallowing M4
- MatrixPortal M4
- BLM Badge



Install Drivers (Windows 7 & 8 Only)

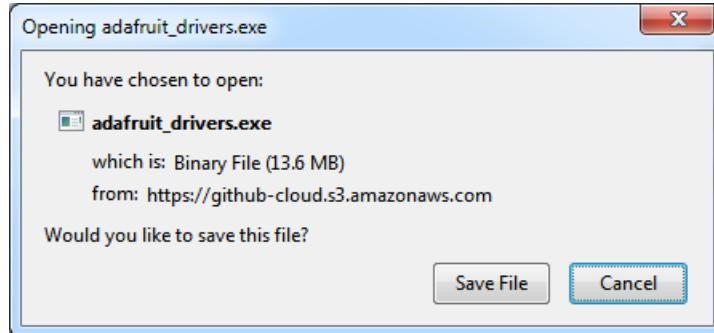
When you plug in the board, you'll need to possibly install a driver

Click below to download our Driver Installer

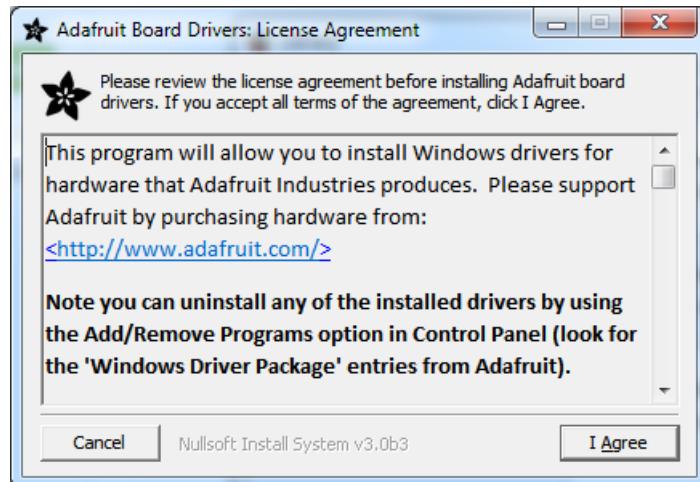
<https://adafru.it/EC0>

<https://adafru.it/EC0>

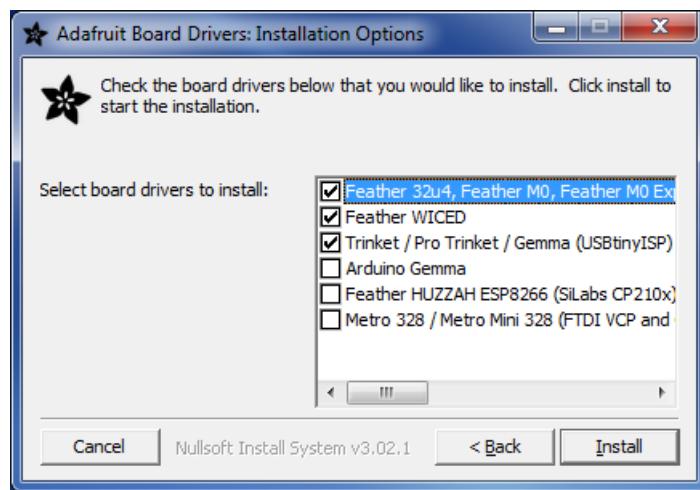
Download and run the installer



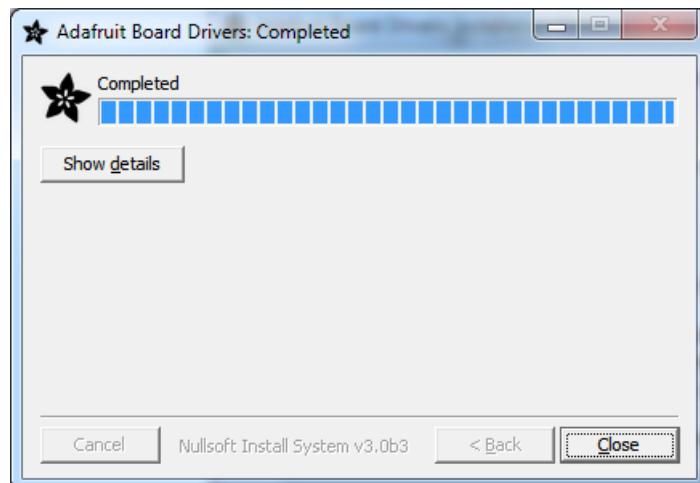
Run the installer! Since we bundle the SiLabs and FTDI drivers as well, you'll need to click through the license



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



Click **Install** to do the installin'

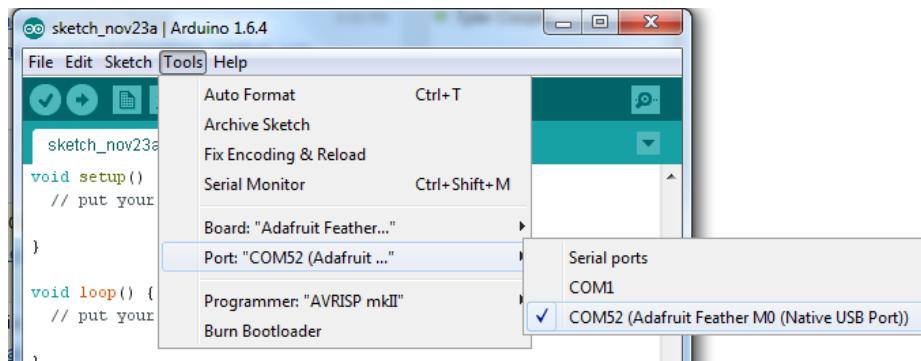


Blink

Now you can upload your first blink sketch!

Plug in the M0 or M4 board, 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 drop-down, it'll even be 'indicated' as Trinket/Gemma/Metro/Feather/ItsyBitsy/Trellis!

Please note, the QT Py and Trellis M4 Express are two of our very few boards that does not have an onboard pin 13 LED so you can follow this section to practice uploading but you wont see an LED blink!



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.



If you are having issues, make sure you selected the matching Board in the menu that matches the hardware you have in your hand.

Successful 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.

Adafruit Feather M0 (Native USB Port) on COM54

```

After uploading, you may see a message saying "Disk Not Ejected Properly" about the ...BOOT drive. You can ignore that message: it's an artifact of how the bootloader and uploading work.

Compilation Issues

If you get an alert that looks like

Cannot run program "{runtime.tools.arm-none-eabi-gcc.path}\bin\arm-none-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 -mtf
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\ve
-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.o

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

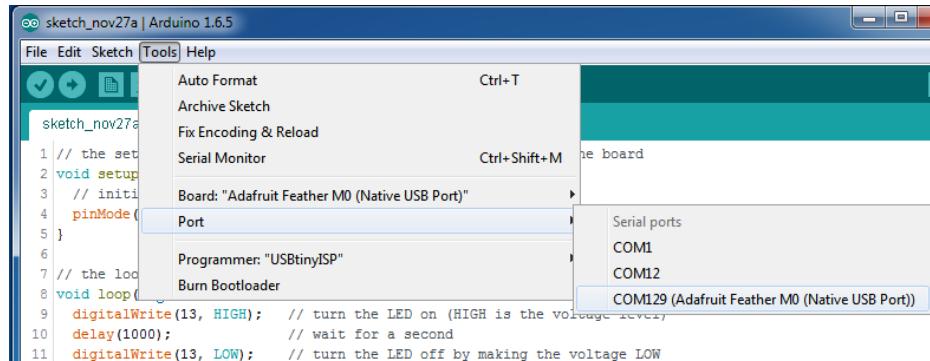
```

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 and/or RGB LED will be green, 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.



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

Follow the steps for installing Adafruit's udev rules on this page. (<https://adafru.it/iOE>)

Adapting Sketches to M0 & M4

The ATSAMD21 and 51 are very nice little chips, but fairly new as Arduino-compatible cores go. **Most** sketches & libraries will work but here's a collection of things we noticed.

The notes below cover a range of Adafruit M0 and M4 boards, but not every rule will apply to every board (e.g. Trinket and Gemma M0 do not have ARef, so you can skip the Analog References note!).

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 on 8-bit AVR chips is the same as the output-selection register.

For M0 & M4 boards, you can't do this anymore! Instead, use:

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

Code written this way still has the benefit of being *backwards compatible with AVR*. You don't need separate versions for the different board types.

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/M4 Core, we fixed it so that `Serial` goes to `USB` so it will automatically work just fine.

However, on the off chance you are using the official Arduino SAMD core and *not* the Adafruit version (which really, we recommend you use our version because it's been tuned to our boards), and 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:



The screenshot shows the Arduino IDE interface with a sketch titled "datecalc". The code in the editor is as follows:

```
datecalc $  
1 // Simple date conversions and calculations  
2  
3 #include <Wire.h>  
4 #include "RTClib.h"  
5  
6 #if defined(ARDUINO_ARCH_SAMD)  
7 // for Zero, output on USB Serial console, remove line below if using programming port to program the Zero!  
8 #define Serial SerialUSB  
9 #endif  
10  
11 void ShowDate(const char* txt, const DateTime& dt) {  
12     Serial.print(txt);  
13     Serial.print(' ');
```

AnalogWrite / PWM on Feather/Metro M0

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)

analogWrite() PWM range

On AVR, if you set a pin's PWM with `analogWrite(pin, 255)` it will turn the pin fully HIGH. On the ARM cortex, it will set it to be 255/256 so there will be very slim but still-existing pulses-to-0V. If you need the pin to be fully on, add test code that checks if you are trying to `analogWrite(pin, 255)` and, instead, does a `digitalWrite(pin, HIGH)`

analogWrite() DAC on A0

If you are trying to use `analogWrite()` to control the DAC output on **A0**, make sure you do **not** have a line that sets the pin to output. **Remove:** `pinMode(A0, OUTPUT)`.

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/M4, 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 won't 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> (<https://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> (<https://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 \$3FFF Then it is in FLASH

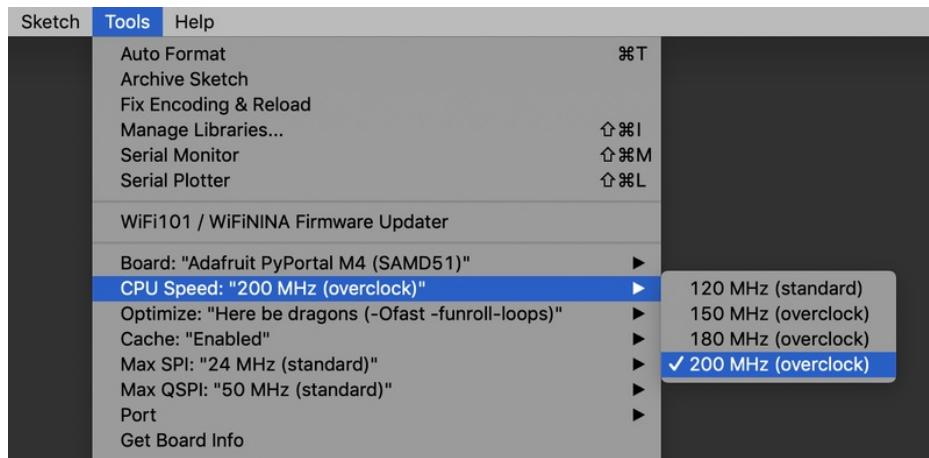
Pretty-Printing out registers

There's a *lot* of registers on the SAMD21, and you often are going through ASF or another framework to get to them. So having a way to see exactly what's going on is handy. This library from drewfish will help a ton!

<https://github.com/drewfish/arduino-ZeroRegs> (<https://adafru.it/Bet>)

M4 Performance Options

As of version 1.4.0 of the *Adafruit SAMD Boards* package in the Arduino Boards Manager, some options are available to wring extra performance out of M4-based devices. These are in the *Tools* menu.



All of these performance tweaks involve a degree of uncertainty. There's no guarantee of improved performance in any given project, and *some may even be detrimental*, failing to work in part or in whole. If you encounter trouble, select the default performance settings and re-upload.

Here's what you get and some issues you might encounter...

CPU Speed (overclocking)

This option lets you adjust the microcontroller core clock...the speed at which it processes instructions...beyond the official datasheet specifications.

Manufacturers often rate speeds conservatively because such devices are marketed for harsh industrial environments...if a system crashes, someone could lose a limb or worse. But most creative tasks are less critical and operate in more comfortable settings, and we can push things a bit if we want more speed.

There is a small but nonzero chance of code **locking up** or **failing to run** entirely. If this happens, try **dialing back the speed by one notch and re-upload**, see if it's more stable.

Much more likely, **some code or libraries may not play well** with the nonstandard CPU speed. For example, currently the NeoPixel library assumes a 120 MHz CPU speed and won't issue the correct data at other settings (this will be worked on). Other libraries may exhibit similar problems, usually anything that strictly depends on CPU timing...you might encounter problems with audio- or servo-related code depending how it's written. **If you encounter such code or libraries, set the CPU speed to the default 120 MHz and re-upload.**

Optimize

There's usually more than one way to solve a problem, some more resource-intensive than others. Since Arduino got its start on resource-limited AVR microcontrollers, the C++ compiler has always aimed for the **smallest compiled program size**. The “Optimize” menu gives some choices for the compiler to take different and often faster approaches, at the expense of slightly larger program size...with the huge flash memory capacity of M4 devices, that's rarely a problem now.

The “**Small**” setting will compile your code like it always has in the past, aiming for the smallest compiled program size.

The “**Fast**” setting invokes various speed optimizations. The resulting program should produce the same results, is slightly larger, and usually (but not always) noticeably faster. It's worth a shot!

“**Here be dragons**” invokes some more intensive optimizations...code will be larger still, faster still, but there's a possibility these optimizations could cause unexpected behaviors. *Some code may not work the same as before.* Hence the name. Maybe you'll discover treasure here, or maybe you'll sail right off the edge of the world.

Most code and libraries will continue to function regardless of the optimizer settings. If you do encounter problems, **dial it back one notch and re-upload**.

Cache

This option allows a small collection of instructions and data to be accessed more quickly than from flash memory, boosting performance. It's enabled by default and should work fine with all code and libraries. But if you encounter some esoteric situation, the cache can be disabled, then recompile and upload.

Max SPI and Max QSPI

These should probably be left at their defaults. They're present mostly for our own experiments and can cause serious headaches.

Max SPI determines the clock source for the M4's SPI peripherals. Under normal circumstances this allows transfers up to 24 MHz, and should usually be left at that setting. But...if you're using write-only SPI devices (such as TFT or OLED displays), this option lets you drive them faster (we've successfully used 60 MHz with some TFT screens). The caveat is, if using *any* read/write devices (such as an SD card), *this will not work at all*...SPI reads *absolutely* max out at the default 24 MHz setting, and anything else will fail. **Write = OK. Read = FAIL.** This is true even if your code is using a *lower bitrate setting*...just having the different clock source prevents SPI reads.

Max QSPI does similarly for the extra flash storage on M4 “Express” boards. *Very few* Arduino sketches access this storage at all, let alone in a bandwidth-constrained context, so this will benefit next to nobody. Additionally, due to the way clock dividers are selected, this will only provide some benefit when certain “CPU Speed” settings are active. Our [PyPortal Animated GIF Display](https://adafru.it/EkO) (<https://adafru.it/EkO>) runs marginally better with it, if using the QSPI flash.

Enabling the Buck Converter on some M4 Boards

If you want to reduce power draw, some of our boards have an inductor so you can use the 1.8V buck converter instead of the built in linear regulator. If the board does have an inductor (see the schematic) you can add the line **SUPC->VREG.bit.SEL = 1;** to your code to switch to it. Note it will make ADC/DAC reads a bit noisier so we don't use it by default. [You'll save ~4mA](https://adafru.it/FOH) (<https://adafru.it/FOH>).

Feather HELP!



Even though this FAQ is labeled for Feather, the questions apply to ItsyBitsy's as well!

My ItsyBitsy/Feather 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 Feather without USB connectivity, delete or comment out that line

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

A vast number of Itsy/Feather '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!

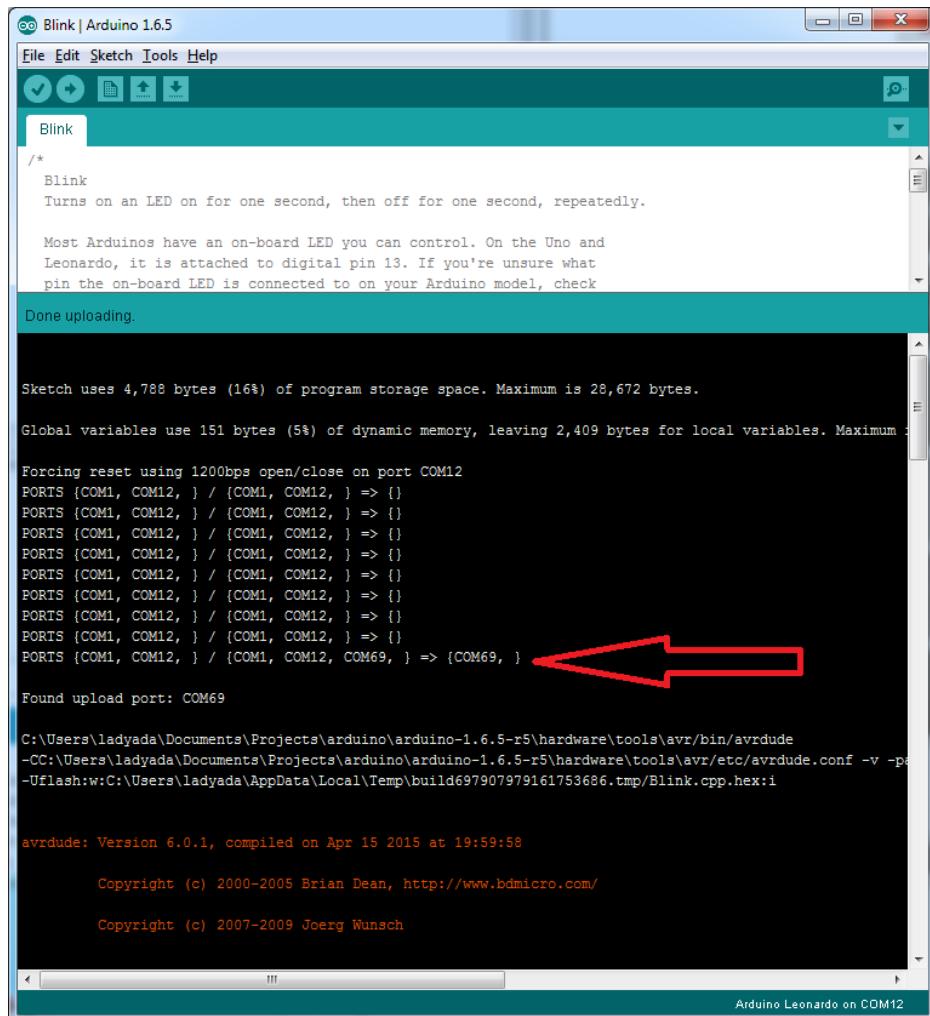
Use only a cable that you **know** is for data syncing

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 Itsy/Feather, it doesn't show up as a device anymore so I can't 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 board

1. Turn on **verbose upload** in the Arduino IDE preferences
2. Plug in Itsy or Feather 32u4/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. Feather 32u4, Feather M0, Itsy 32u4 or M0 (*physically 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 that tells you its now in bootloading mode**
8. The board will show up as the Bootloader COM/Serial port
9. The IDE should see the bootloader COM/Serial port and upload properly



The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** Blink | Arduino 1.6.5
- Menu Bar:** File Edit Sketch Tools Help
- Sketch Area:** Displays the `Blink` sketch code:

```
/*
Blink
Turns on an LED on for one second, then off for one second, repeatedly.

Most Arduinos have an on-board LED you can control. On the Uno and
Leonardo, it is attached to digital pin 13. If you're unsure what
pin the on-board LED is connected to on your Arduino model, check
the Arduino pins reference at http://www.arduino.cc/en/Hardware/Pins
```
- Status Bar:** Done uploading.
- Output Window:** Shows the upload process and the serial monitor output:

```
Sketch uses 4,788 bytes (16%) of program storage space. Maximum is 28,672 bytes.

Global variables use 151 bytes (5%) of dynamic memory, leaving 2,409 bytes for local variables. Maximum is 2,432 bytes.

Forcing reset using 1200bps open/close on port COM12
PORIS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORIS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}
PORTS {COM1, COM12, } / {COM1, COM12, } => {}

Found upload port: COM69

C:\Users\ladyada\Documents\Projects\arduino\arduino-1.6.5-r5\hardware\tools\avr\bin\avrdude
-CC:\Users\ladyada\Documents\Projects\arduino\arduino-1.6.5-r5\hardware\tools\avr\etc\avrdude.conf -v -pa
-Uflash:w:C:\Users\ladyada\AppData\Local\Temp\build697907979161753686.tmp\Blink.cpp.hex:i

avrdude: Version 6.0.1, compiled on Apr 15 2015 at 19:59:58
Copyright (c) 2000-2005 Brian Dean, http://www.bdmicro.com/
Copyright (c) 2007-2009 Joerg Wunsch
```
- Bottom Status:** Arduino Leonardo on COM12

☐ I can't get the Itsy/Feather 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 Feather 32u4 (look on the board to read what it is you have) Make sure you select **Feather 32u4** for ATMega32u4 based boards! Do not use anything else, do not use the 32u4 breakout board line.

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

use 32u4 or Arduino Zero

If you have a ItsyBitsy M0 (look on the board to read what it is you have) Make sure you select **ItsyBitsy M0** - do not use 32u4 or Arduino Zero

□ I'm having problems with COM ports and my Itsy/Feather 32u4/M0

Theres **two** COM ports you can have with the 32u4/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 separately 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 separate 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 "avrduude: 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 Feather M0, and I get this error "Connecting to programmer: .avrdude: butterfly_recv(): programmer is not responding"

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

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

You probably don't have Feather M0 / Feather 32u4 selected in the boards drop-down. Make sure you selected Feather M0 (or Feather 32u4).

□ I attached some wings to my Feather and now I can't read the battery voltage!

Make sure your Wing doesn't use pin #9 which is the analog sense for the lipo battery!

□ The yellow LED Is flickering on my Feather, but no battery is plugged in, why is that?

The charge LED is automatically driven by the Lipoly charger circuit. It will try to detect a battery and is expecting one to be attached. If there isn't one it may flicker once in a while when you use power because it's trying to charge a (non-existant) battery.

It's not harmful, and its totally normal!

Downloads

Datasheets

- [ATSAMD21 Datasheet](https://adafru.it/kUf) (<https://adafru.it/kUf>) (the main chip on the Feather M0)
- Fritzing object in the Adafruit Fritzing Library (<https://adafru.it/aP3>)
- EagleCAD PCB files in GitHub (<https://adafru.it/kFh>)

<https://adafru.it/z3f>

<https://adafru.it/z3f>

Note AREF in the diagram should be marked PA03 not PA02

Firmware

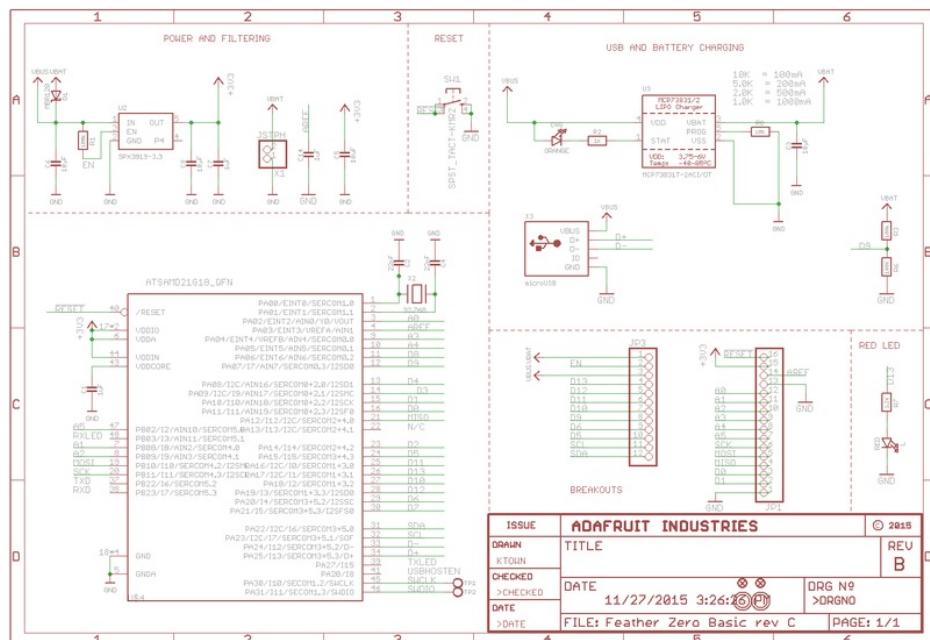
Feather M0 Bootloader - You'll need to program it in using an ST-Link, JLink or other SWD-capable programmer.[HEX available in the github repo](#) (<https://adafru.it/kFh>)

<https://adafru.it/BuO>

<https://adafru.it/BuO>

Schematic

Click to enlarge



Fabrication Print

Dimensions in inches

