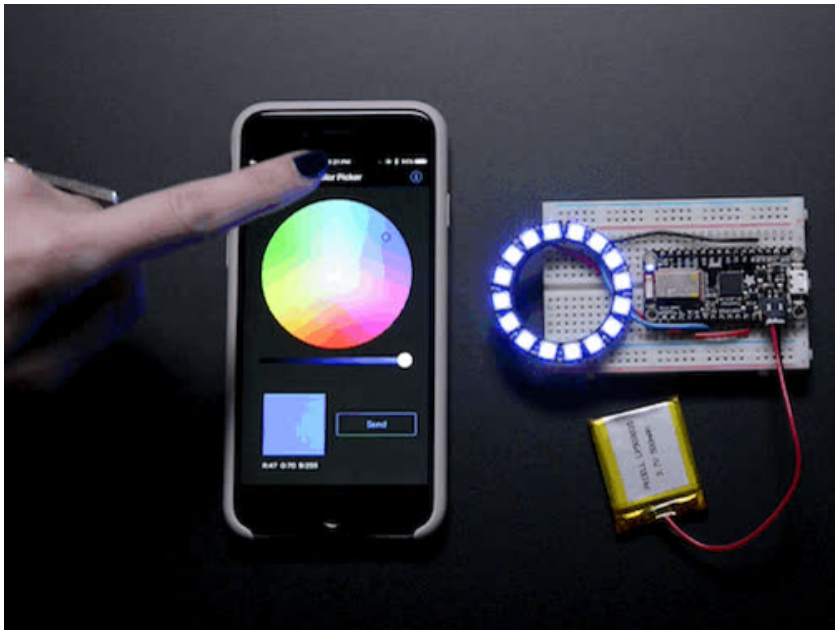
adafruit learning system

Adafruit Feather 32u4 Bluefruit LE

Created by lady ada



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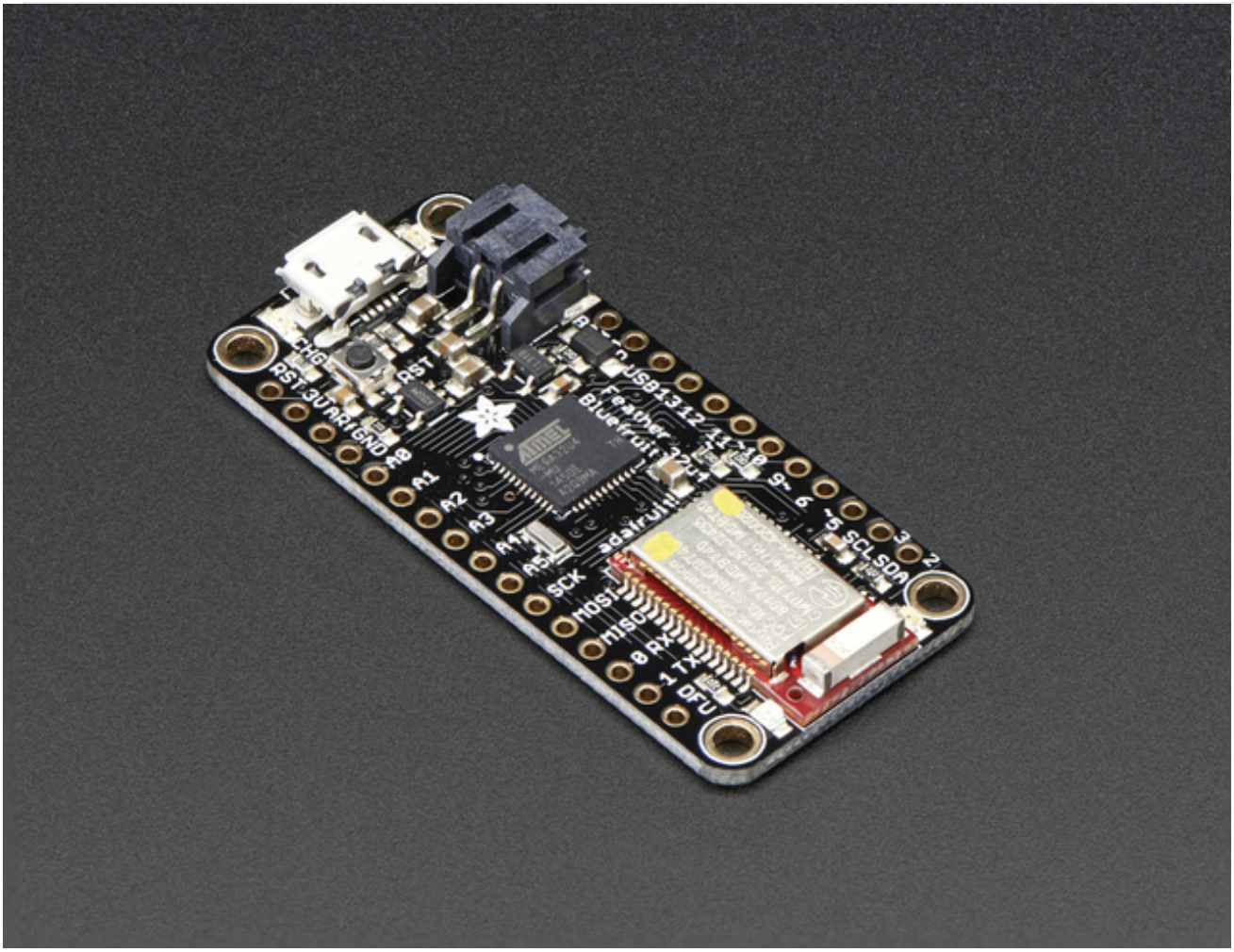
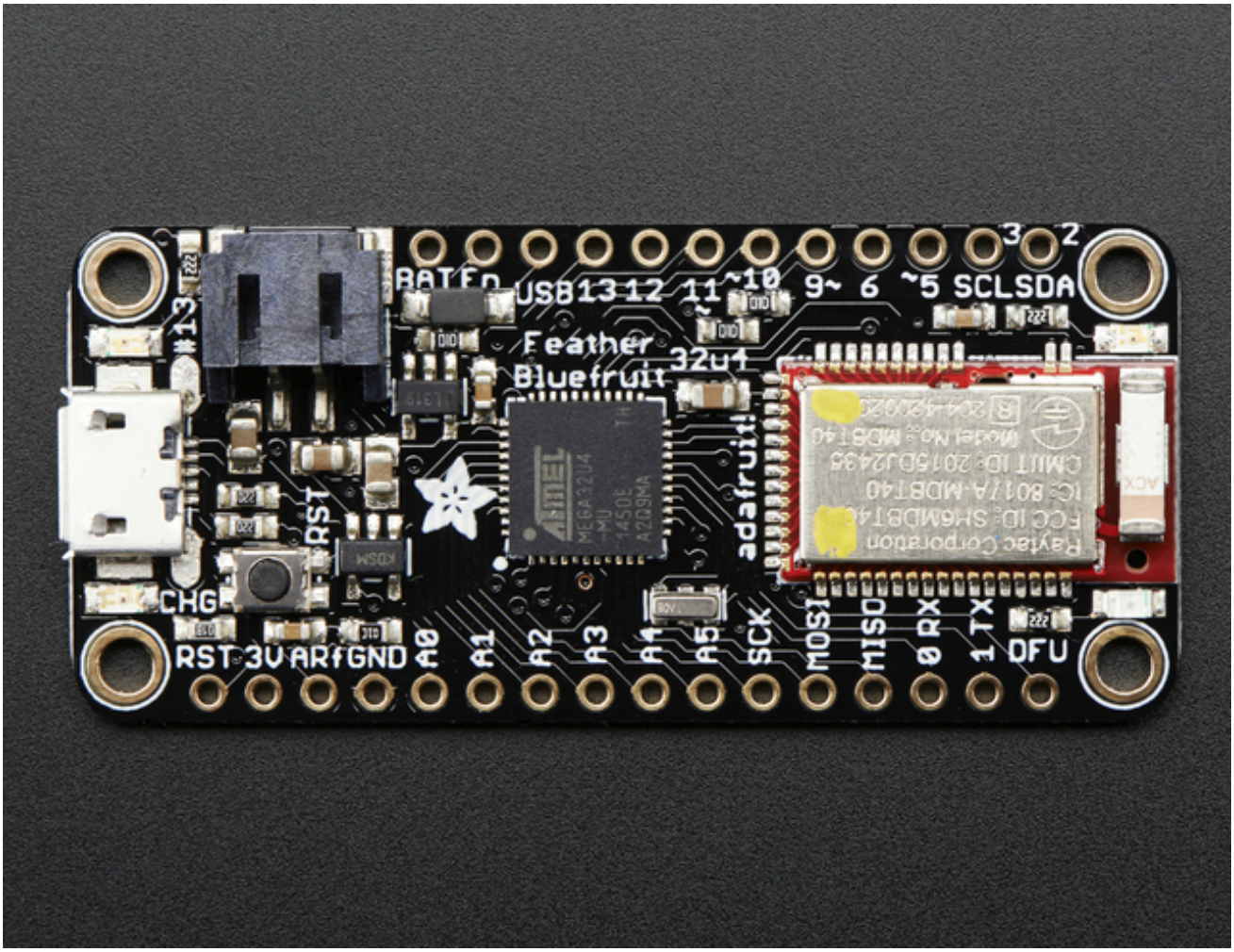
Overview



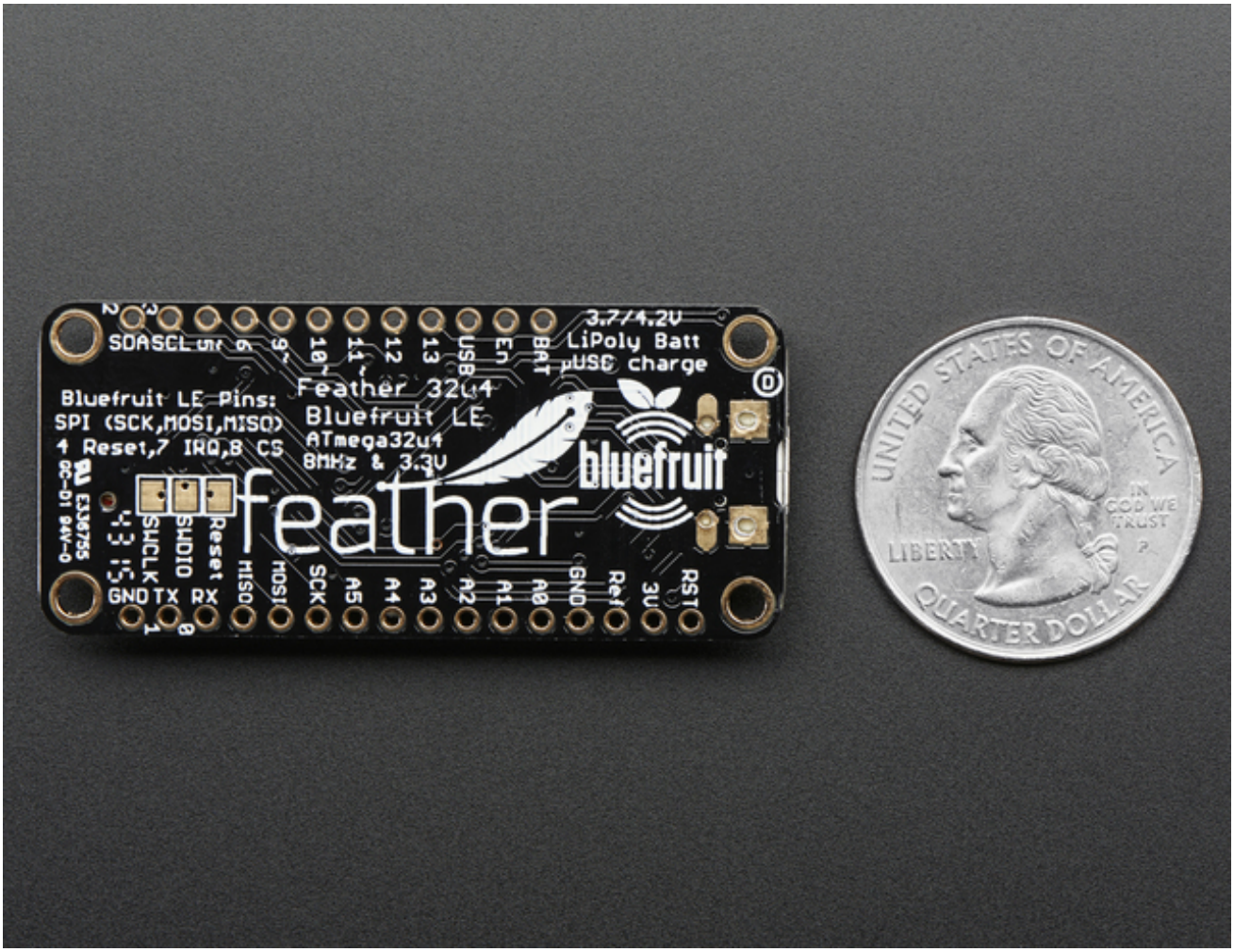
Feather is the new development board from Adafruit, and like it's namesake it is thin, light, and lets you fly! We designed Feather to be a new standard for portable microcontroller cores.

This is the **Adafruit Feather 32u4 Bluefruit** - our take on an 'all-in-one' Arduino-compatible + Bluetooth Low Energy with built in USB and battery charging. Its an Adafruit Feather 32u4 with a BTLE module, ready to rock! We have other boards in the Feather family, check'em out here (http://adafru.it/jAQ)

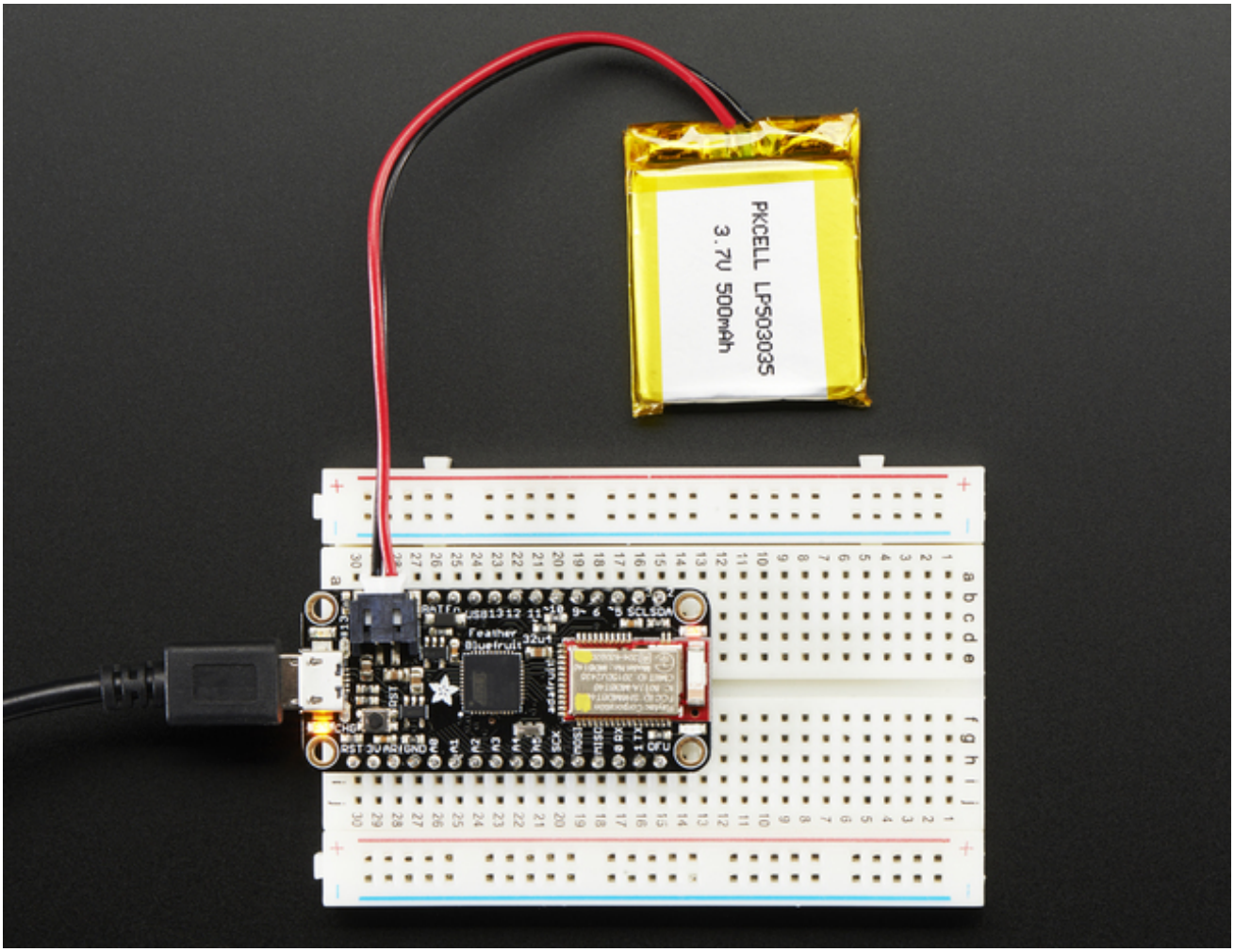
Bluetooth Low Energy is the hottest new low-power, 2.4GHz spectrum wireless protocol. In particular, its the only wireless protocol that you can use with iOS without needing special certification and it's supported by all modern smart phones. This makes it excellent for use in portable projects that will make use of an iOS or Android phone or tablet. It also is supported in Mac OS X and Windows 8+



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



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.

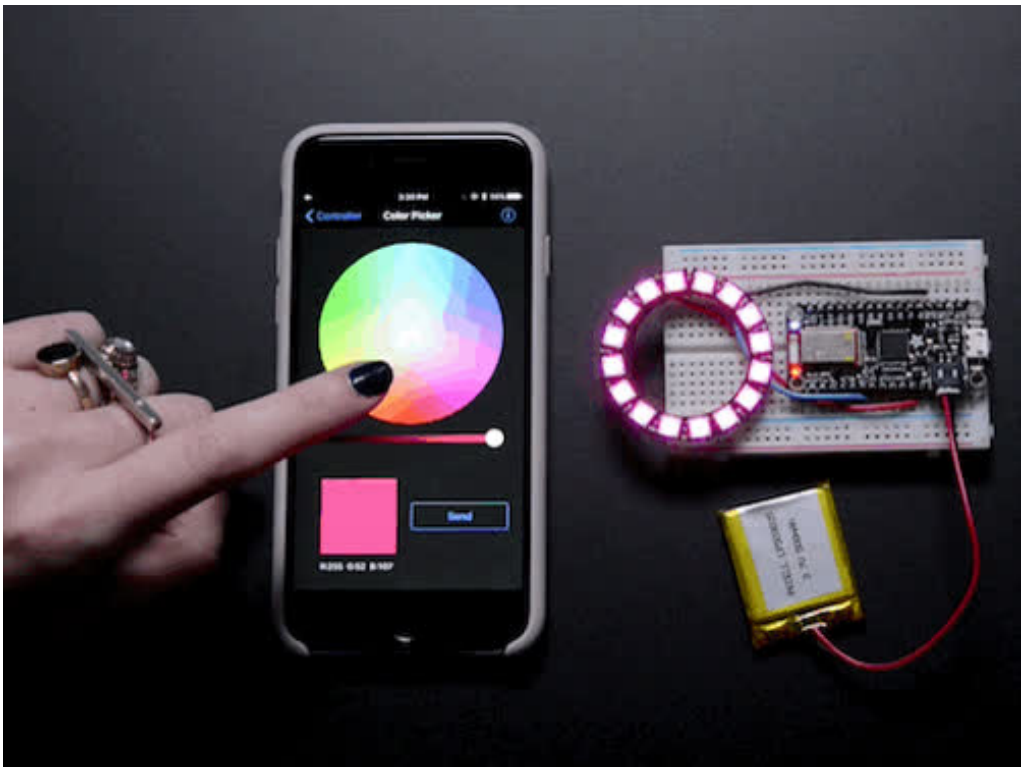


Here's some handy specs! Like all Feather 32u4's you get:

- Measures 2.0" x 0.9" x 0.28" (51mm x 23mm x 8mm) without headers soldered in
- Light as a (large?) feather - 5.7 grams
- ATmega32u4 @ 8MHz with 3.3V logic/power
- 3.3V regulator with 500mA peak current output
- USB native support, comes with USB bootloader and serial port debugging
- You also get tons of pins - 20 GPIO pins
- Hardware Serial, hardware I2C, hardware SPI support
- 8 x PWM pins
- 10 x analog inputs
- Built in 100mA lipoly charger with charging status indicator LED
- Pin #13 red LED for general purpose blinking
- Power/enable pin
- 4 mounting holes
- Reset button

The **Feather 32u4 Bluefruit LE** uses the extra space left over to add our excellent Bluefruit BTLE

module + two status indicator LEDs



The Power of Bluefruit LE

The Bluefruit LE module is an nRF51822 chipset from Nordic, programmed with multi-function code that can do quite a lot! For most people, they'll be very happy to use the standard Nordic UART RX/TX connection profile. In this profile, the Bluefruit acts as a data pipe, that can 'transparently' transmit back and forth from your iOS or Android device. You can use our iOS App (http://adafru.it/iCi) or Android App (http://adafru.it/f4G), or write your own to communicate with the UART service (http://adafru.it/iCF).

The board is capable of much more than just sending strings over the air! Thanks to an easy to learn AT command set (http://adafru.it/iCG), you have full control over how the device behaves, including the ability to define and manipulate your own GATT Services and Characteristics (http://adafru.it/iCH), or change the way that the device advertises itself for other Bluetooth Low Energy devices to see. You can also use the AT commands to query the die temperature, check the battery voltage, and more, check the connection RSSI or MAC address, and tons more. Really, way too long to list here!

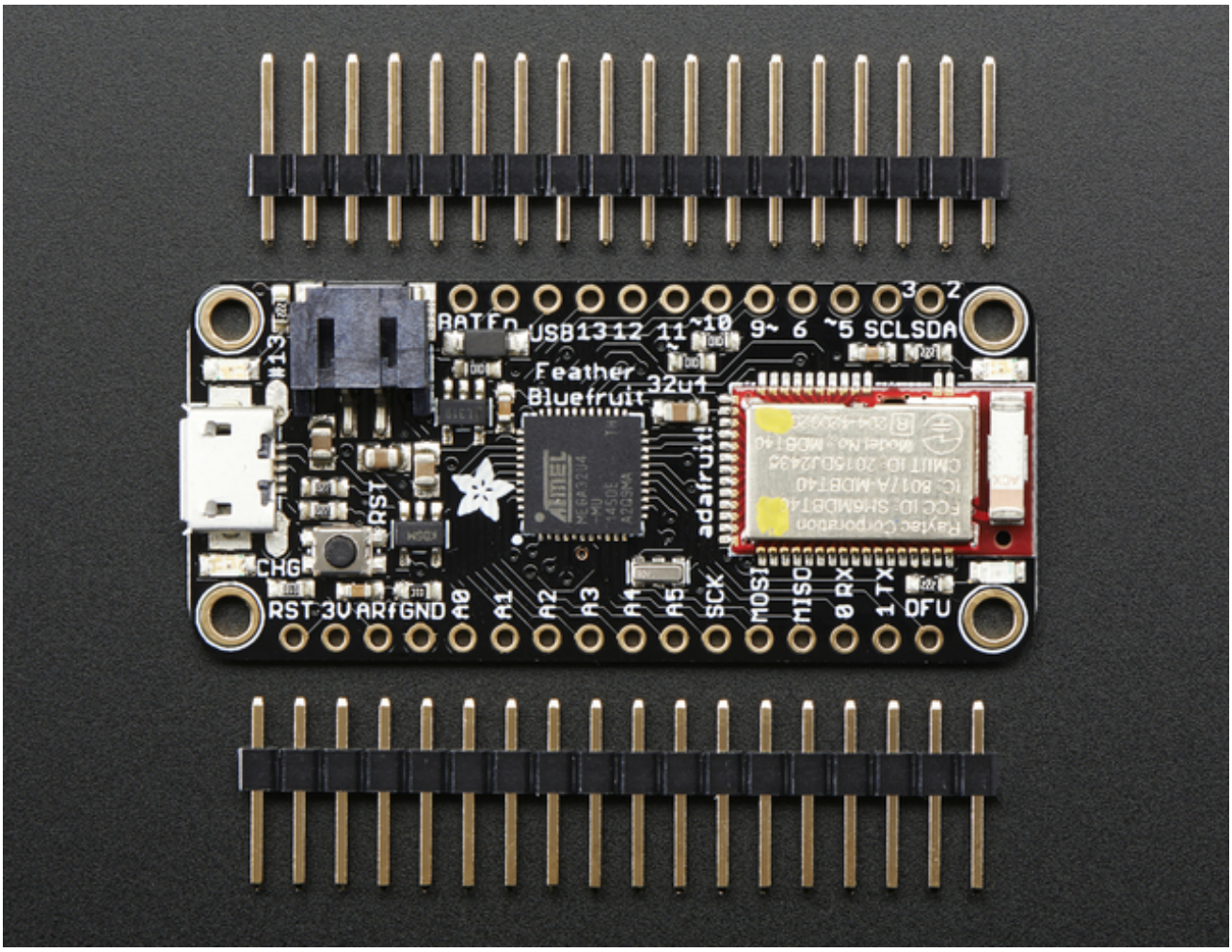
Use the Bluefruit App to get your project started

Using our Bluefruit iOS App (http://adafru.it/iCi) or Android App (http://adafru.it/f4G), you can quickly get your project prototyped by using your iOS or Android phone/tablet as a controller. We have a color picker (http://adafru.it/iCI), quaternion/accelerometer/gyro/magnetometer or location

(GPS) (http://adafru.it/iCI), and an 8-button control game pad (http://adafru.it/iCI). This data can be read over BLE and piped into the ATmega32u4 chip for processing & control

You can do a lot more too!

- The Bluefruit can also act like an HID Keyboard (http://adafru.it/iOA) (for devices that support BLE HID)
- Can become a BLE Heart Rate Monitor (http://adafru.it/iOB) (a standard profile for BLE) - you just need to add the pulse-detection circuitry
- Turn it into a UriBeacon (http://adafru.it/iOC), the Google standard for Bluetooth LE beacons. Just power it and the 'Friend will bleep out a URL to any nearby devices with the UriBeacon app installed.
- Built in over-the-air bootloading capability so we can keep you updated with the hottest new firmware (http://adafru.it/iOD). Use any Android or iOS device to get updates and install them. This will update the native code on the BLE module, to add new wireless capabilities, not program the ATmega chip.

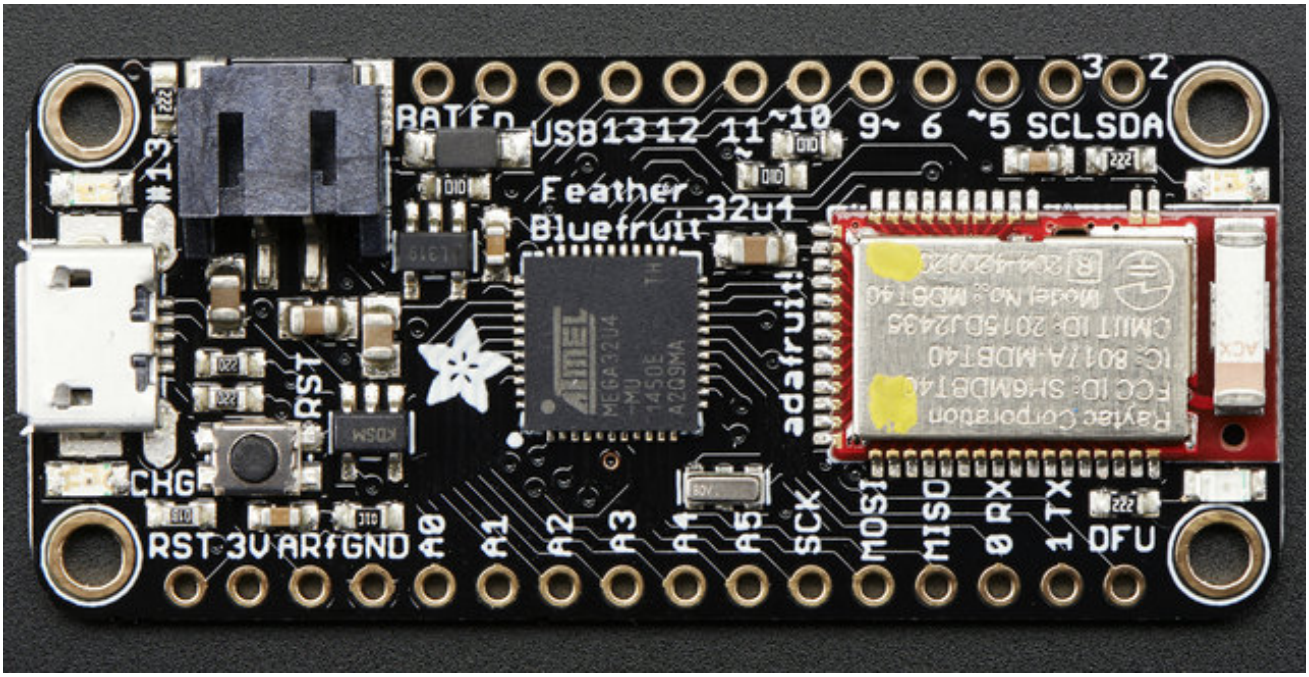


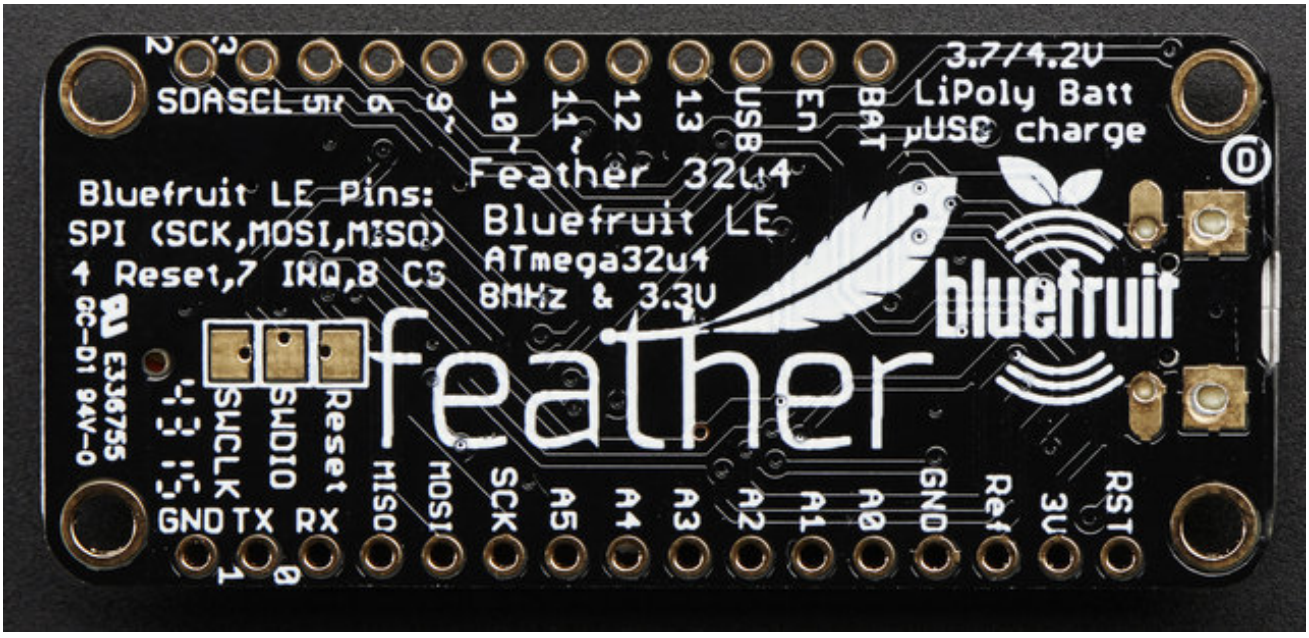
Comes fully assembled and tested, with a USB bootloader that lets you quickly use it with the

Arduino IDE. We also toss in some header so you can solder it in and plug into a solderless breadboard. **Lipoly battery, MicroSD card and USB cable not included** (but we do have lots of options in the shop if you'd like!)

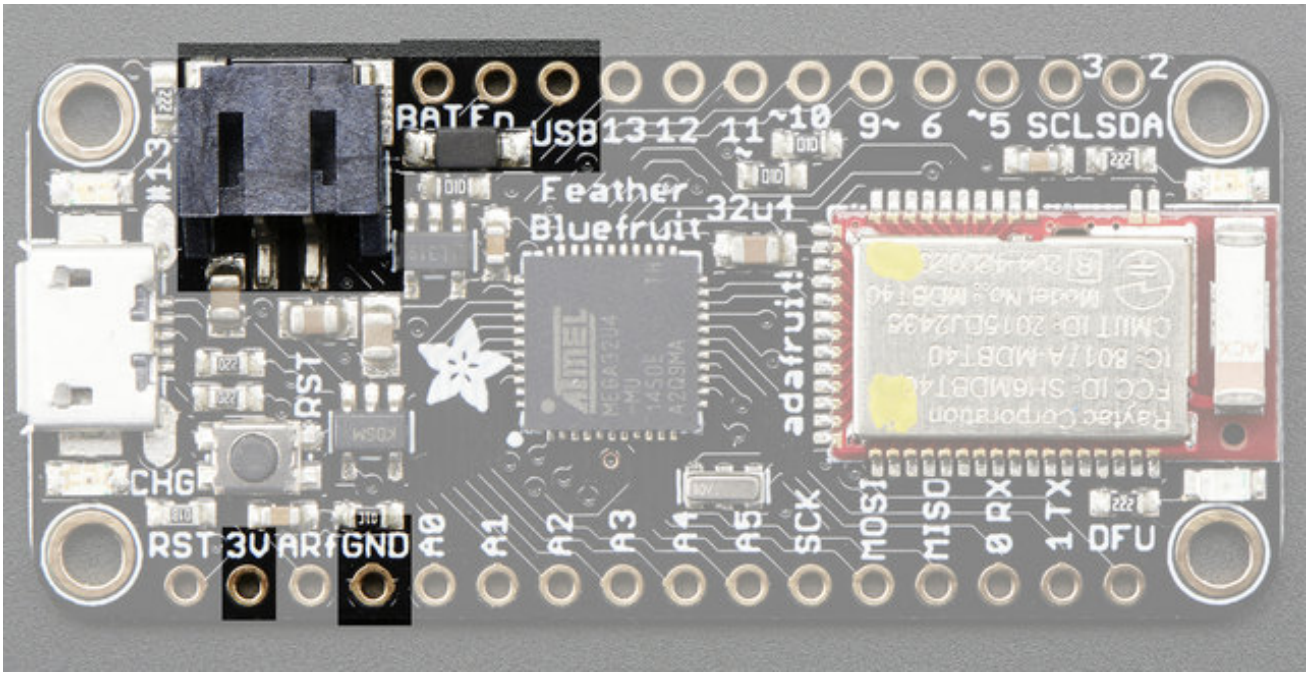
Pinouts

The Feather 32u4 Bluefrit LE 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

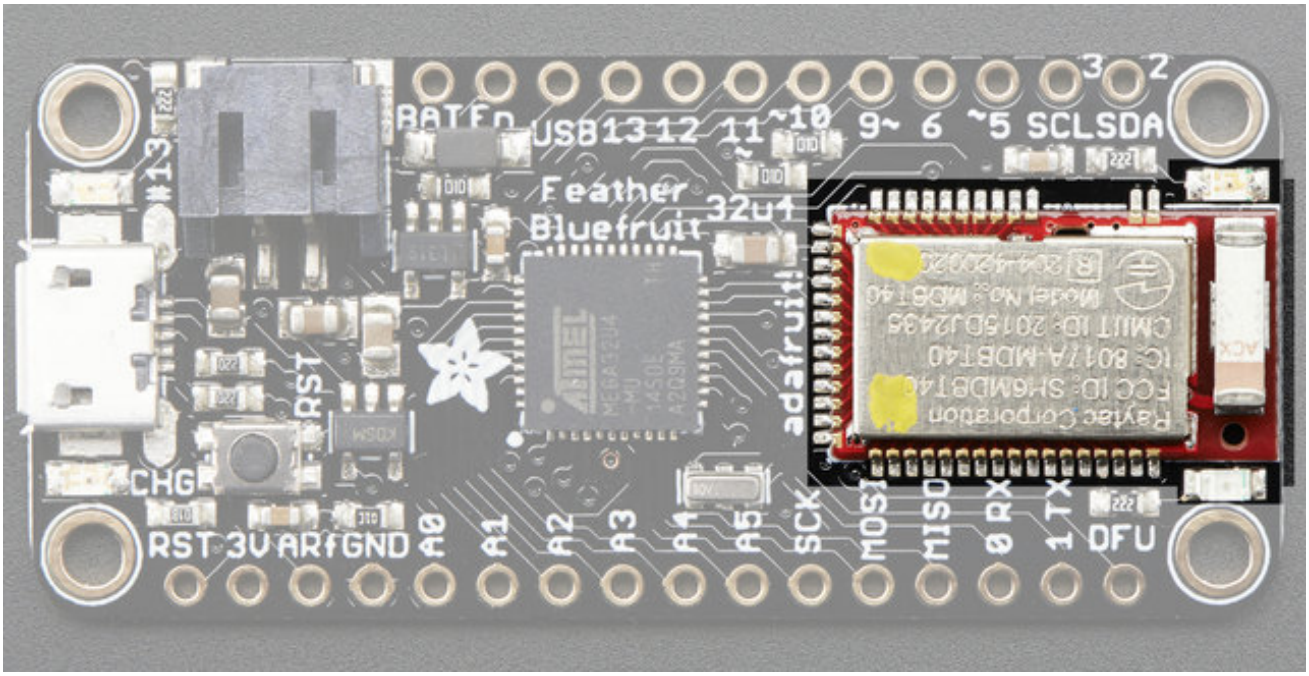
Logic pins

This is the general purpose I/O pin set for the microcontroller. All logic is 3.3V

- **#0** / **RX** - GPIO #0, also receive (input) pin for **Serial1** and Interrupt #2
- **#1** / **TX** - GPIO #1, also transmit (output) pin for **Serial1** and Interrupt #3
- **#2** / **SDA** - GPIO #2, 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. Also Interrupt #1
- **#3** / **SCL** - GPIO #3, 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. Can also do PWM output and act as Interrupt #0.
- **#5** - GPIO #5, can also do PWM output
- **#6** - GPIO #6, can also do PWM output and analog input **A7**
- **#9** - GPIO #9, also analog input **A9** and can do PWM output. 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, also analog input **A10** and can do PWM output.
- **#11** - GPIO #11, can do PWM output.

- **#12** - GPIO #12, also analog input **A11** and can do PWM output.
- **#13** - GPIO #13, can do PWM output and is connected to the **red LED** next to the USB jack
- **A0 thru A5** - These are each analog input as well as digital I/O pins.
- **SCK/MOSI/MISO** - These are the hardware SPI pins, **used by the Bluefruit LE module too!** You can use them as everyday GPIO pins if you don't activate the Bluefruit and keep the BLE CS pin high. However, we really recommend keeping them free as they should be kept available for the Bluefruit. If they are used, make sure its with a device that will kindly share the SPI bus! Also used to reprogram the chip with an AVR programmer if you need.

Bluefruit LE Module + Indicator LEDs



Since not all pins can be brought out to breakouts, due to the small size of the Feather, we use these to control the BLE module

- **#8** - used as the Bluefruit **CS** (chip select) pin
- **#7** - used as the Bluefruit **IRQ** (interrupt request) pin.
- **#4** - used as the Bluefruit **Reset** pin

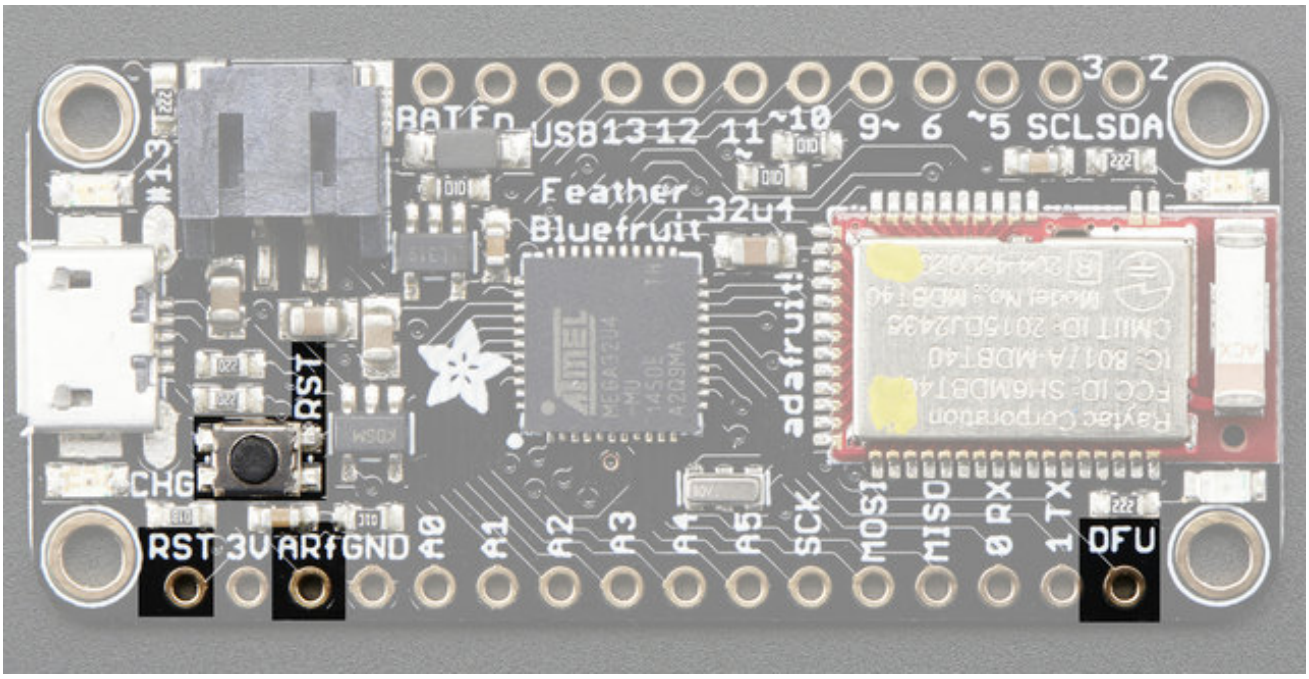
Since these are not brought out there should be no risk of using them by accident!

Other Pins!

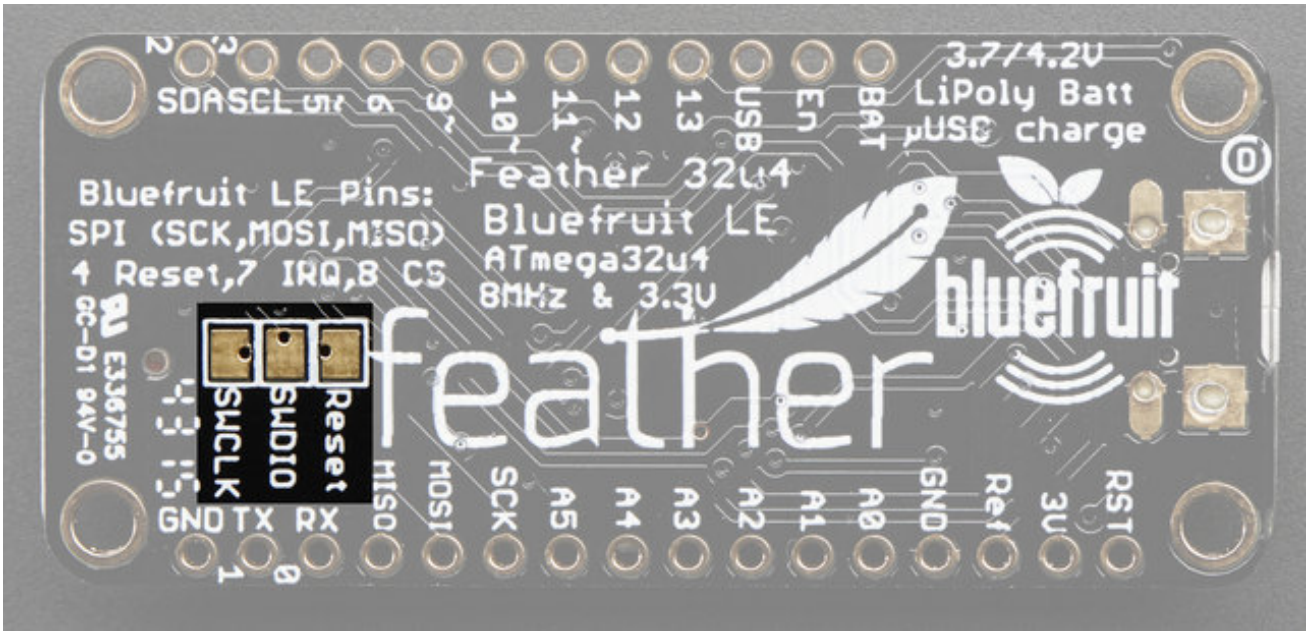
- **RST** - this is the Reset pin, tie to ground to manually reset the AVR, as well as launch the bootloader manually
- **ARef** - the analog reference pin. Normally the reference voltage is the same as the chip logic voltage (3.3V) but if you need an alternative analog reference, connect it to this pin and select

the external AREF in your firmware. Can't go higher than 3.3V!

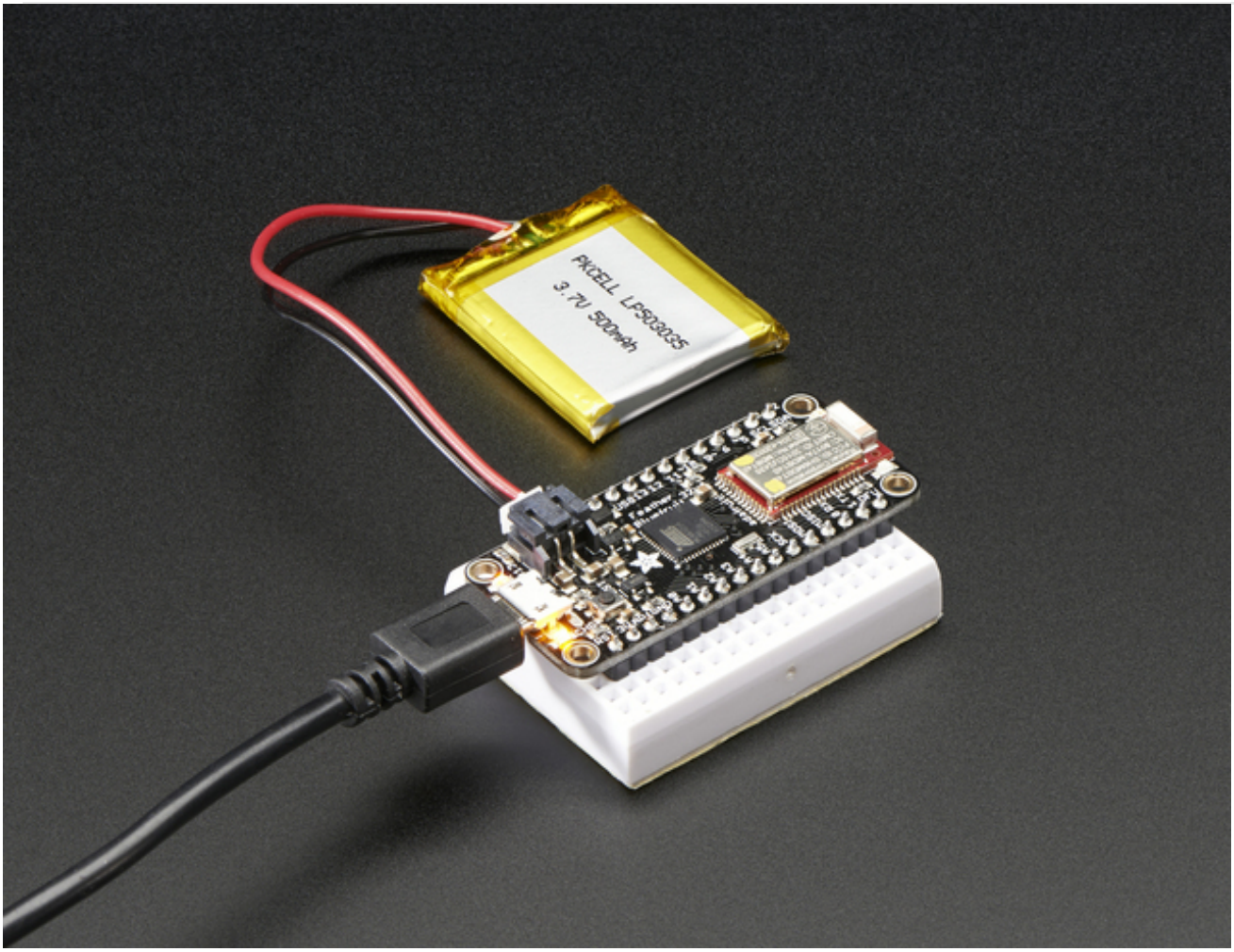
- **DFU** - this is the force-DFU (device firmware upgrade) pin for over-the-air updates to the Bluefruit module. You probably don't need to use this but its available if you need to upgrade! Check out the **DFU Bluefruit Upgrades** page for how to use it. Otherwise, keep it disconnected.



On the back we also have **SWDIO**/**SWCLK**/**RST** pins, these are used for programming the Bluefruit LE module itself. You should not connect to these, unless you want to wipe out the Bluefruit LE module firmware for some reason. The RST pin is the factory reset pin, which is also rarely used, but you can use it to set the module back to the factory default settings if it gets really messed up.

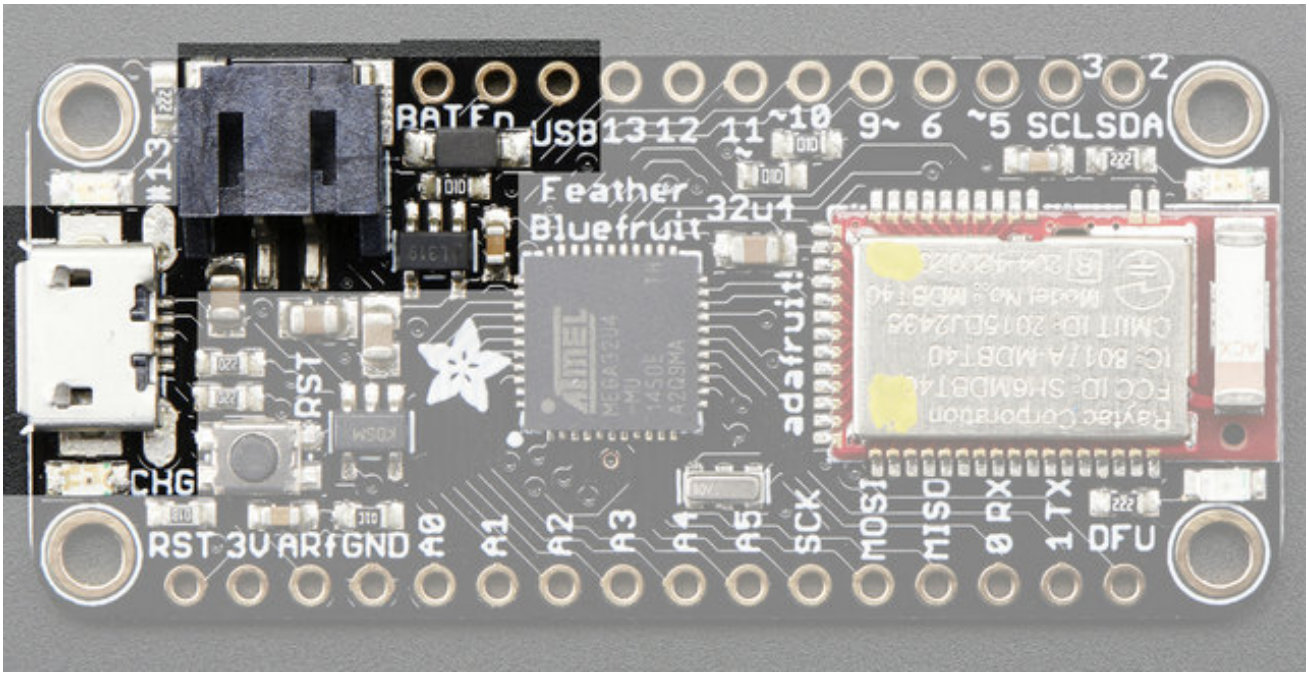


Power Management



Battery + USB Power

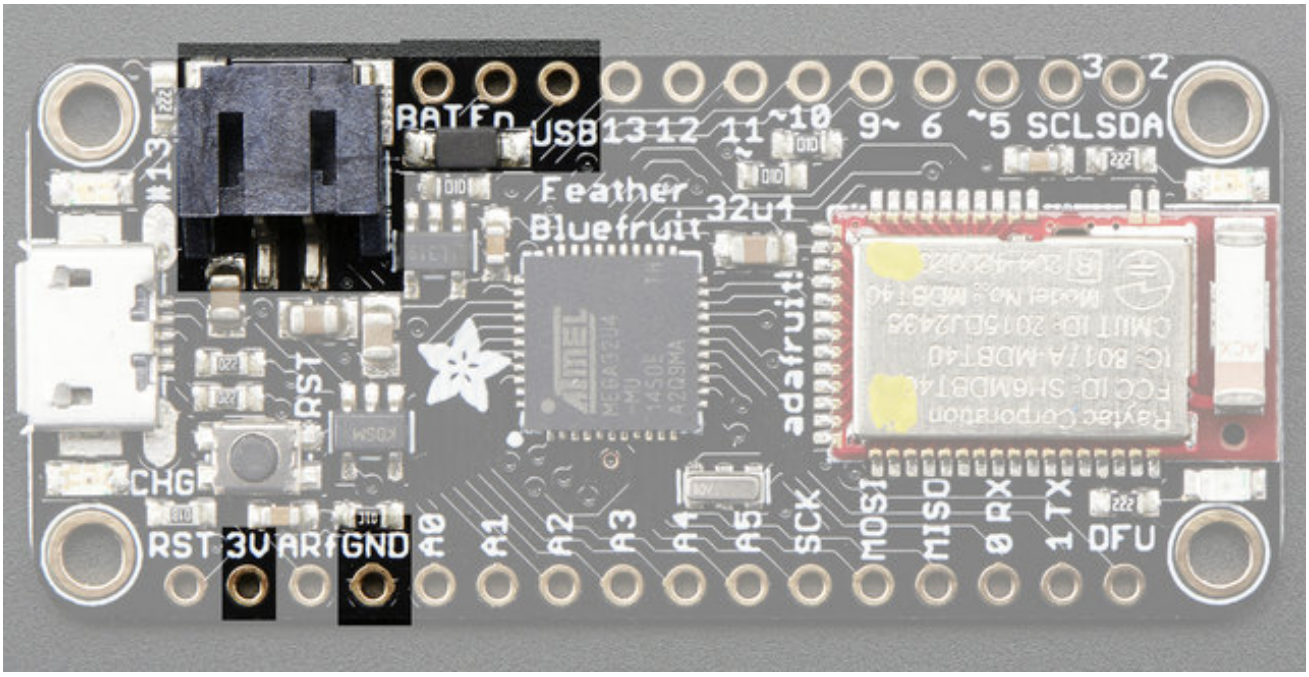
We wanted to make the Feather easy to power both when connected to a computer as well as via battery. There's **two ways to power** a Feather. You can connect with a MicroUSB cable (just plug into the jack) and the Feather will regulate the 5V USB down to 3.3V. You can also connect a 4.2/3.7V Lithium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

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 SPX3819. 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 'spiky' & sporadic.

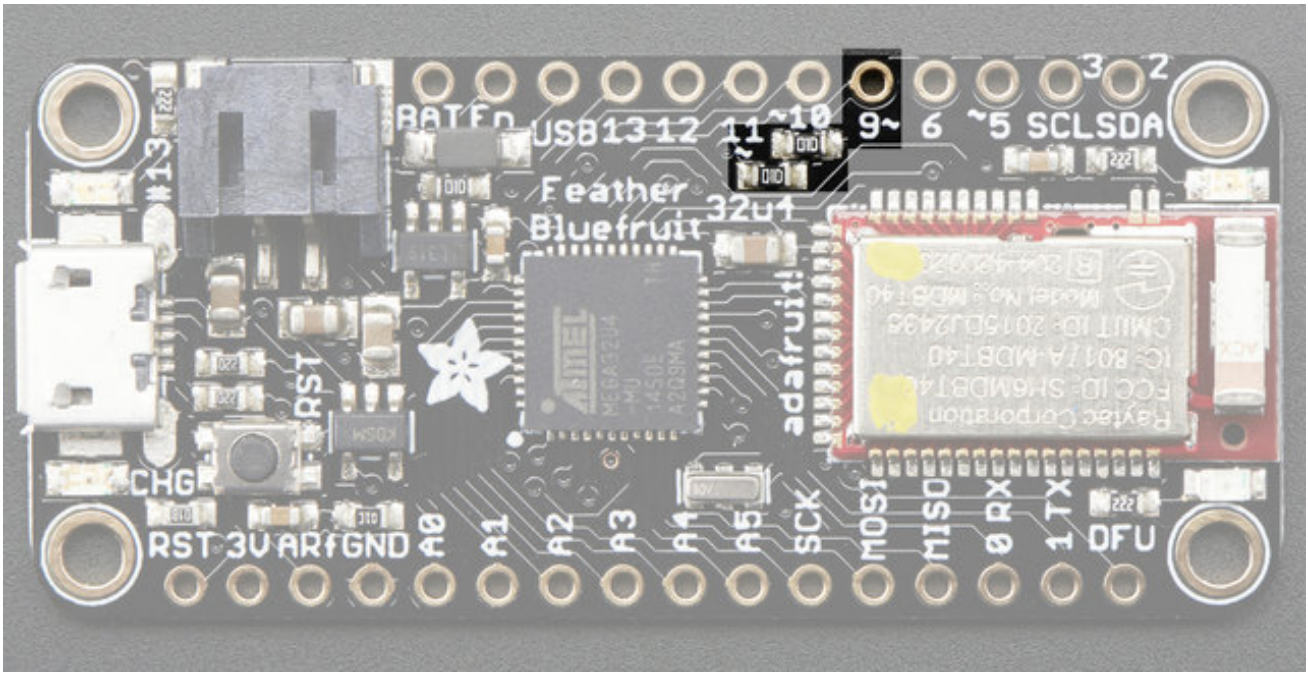


Measuring Battery

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 #9 **A9**). You can read this pin's voltage, then double it, to get the battery voltage.

```
#define VBATPIN A9

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);
```



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

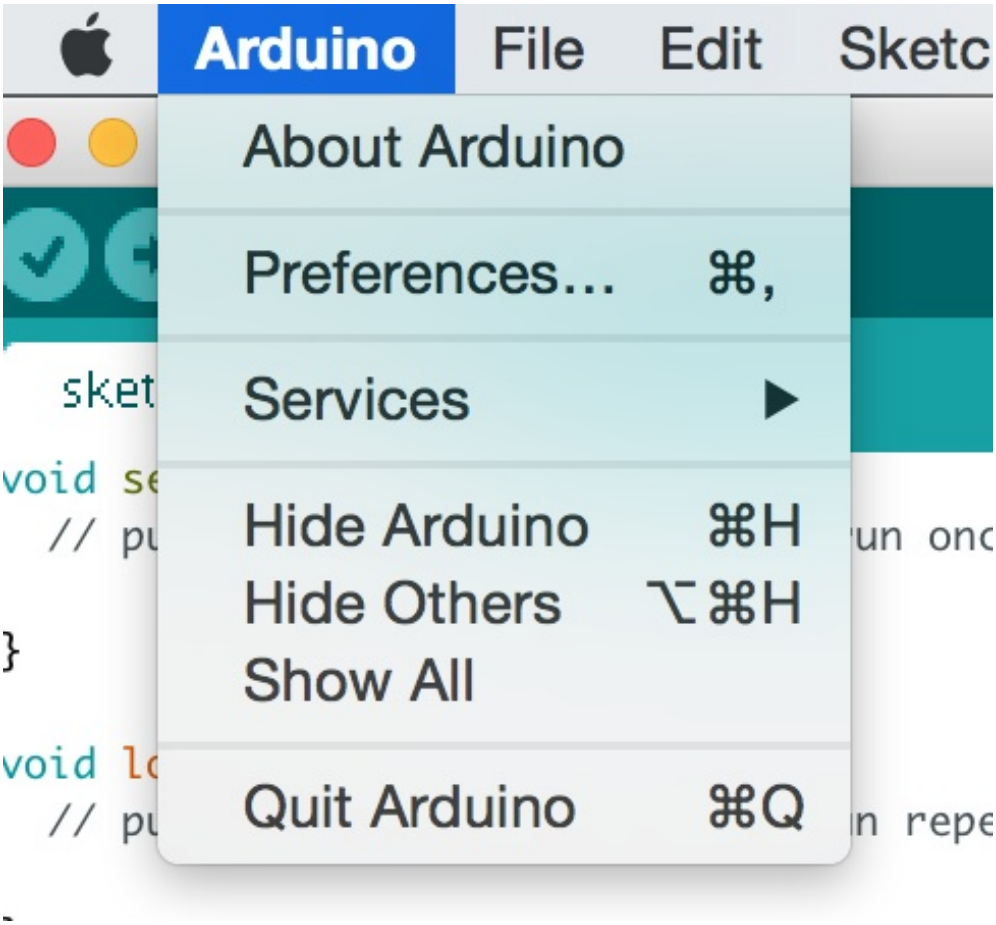
Arduino IDE Setup

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.

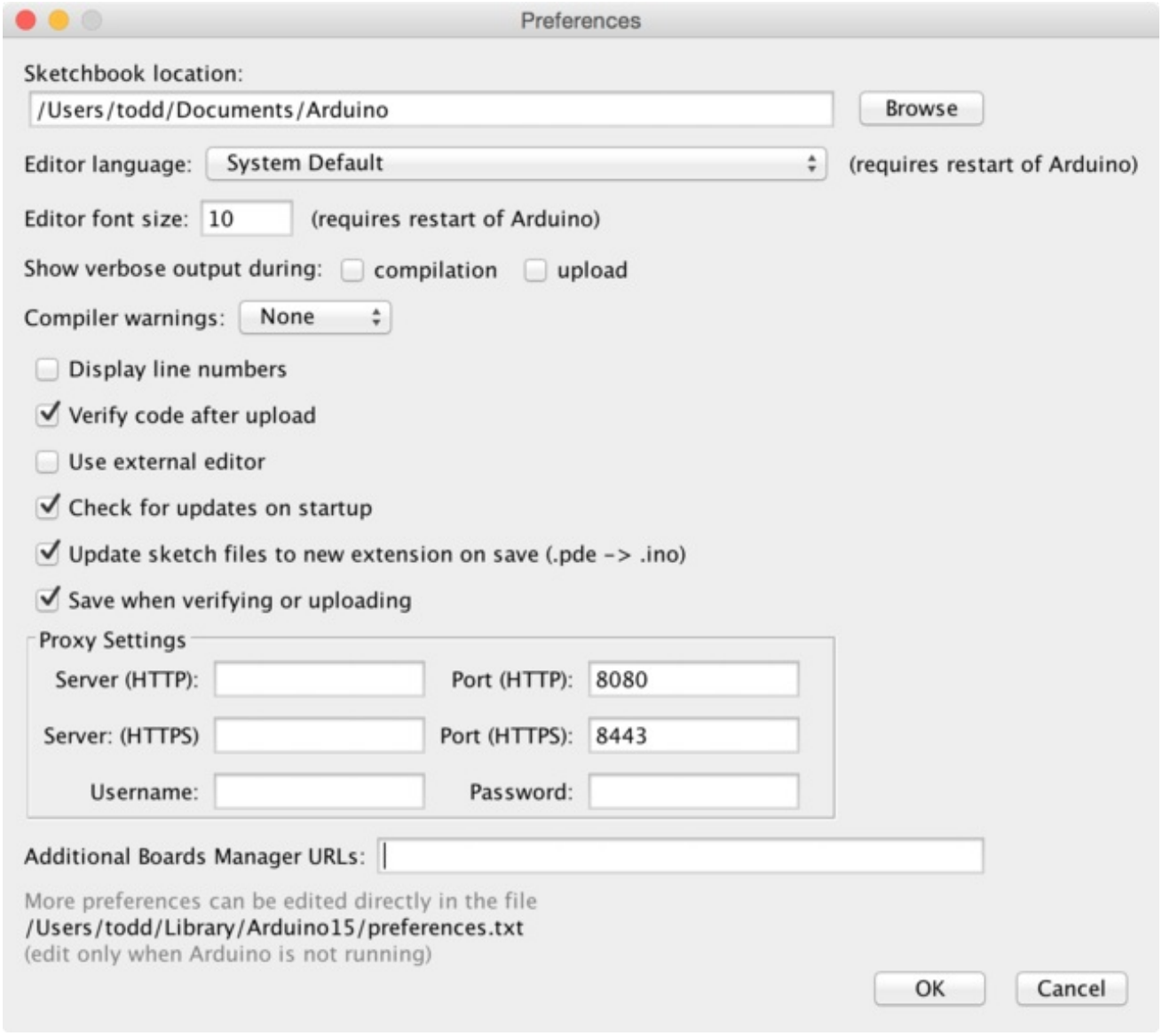
Arduino IDE v1.6.4+ Download

http://adafru.it/f1P

After you have downloaded and installed **v1.6.4**, 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*.



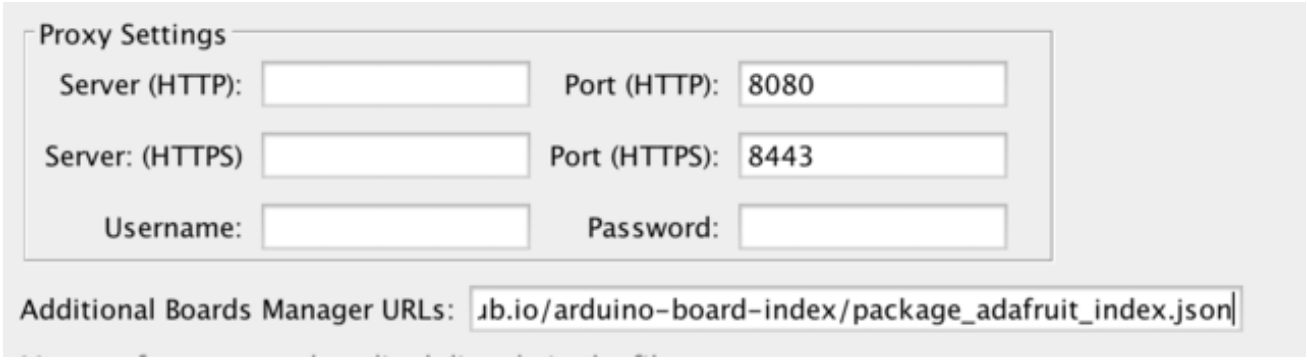
A dialog will pop up just like the one shown below.



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 (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
```



Make sure you remove the apt.adafruit.com proxy setting from the Arduino preferences if you have previously added it.

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:

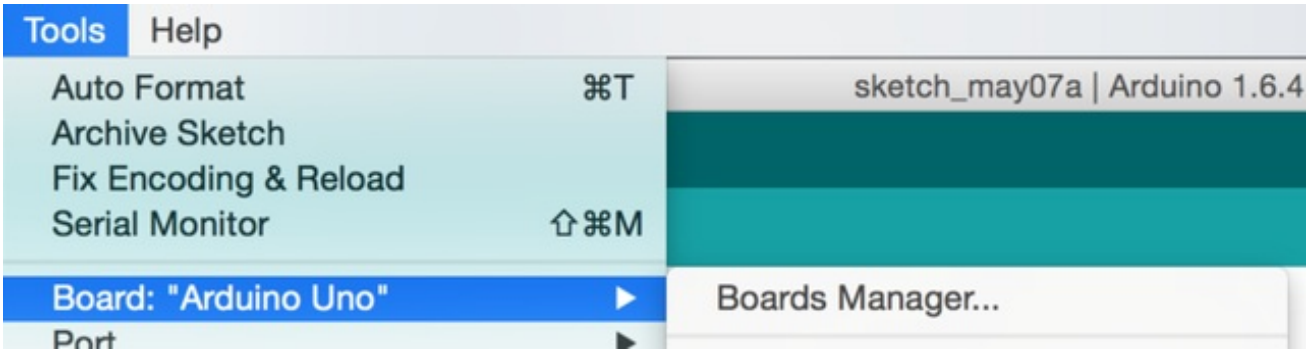
- **Adafruit AVR Boards** - Includes support for Flora, Gemma, Feather 32u4, Trinket, & Trinket Pro.
- **Adafruit SAMD Boards** - Includes support for Feather M0
- **Arduino Leonardo & Micro MIDI-USB** - This adds MIDI over USB support for the Flora, Feather 32u4, Micro and Leonardo using the arcore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

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

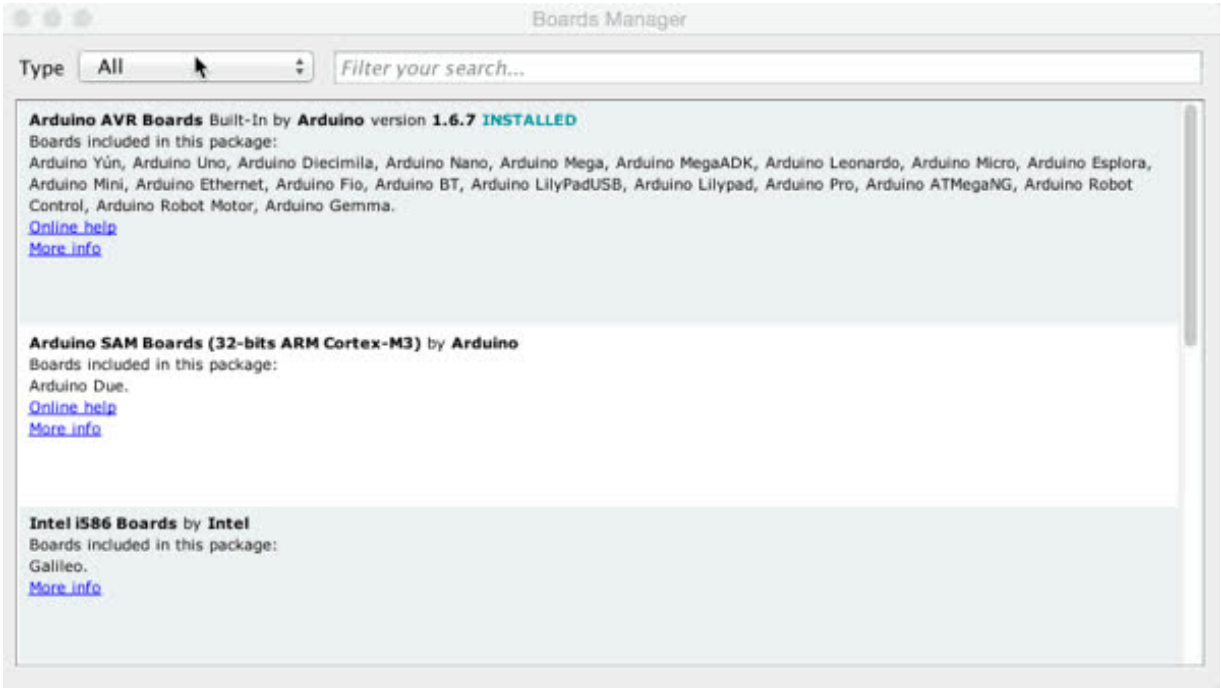
Using with Arduino IDE

Since the Feather 32u4 uses an ATmega32u4 chip running at 8 MHz, you can pretty easily get it working with the Arduino IDE. Many libraries (including the popular ones like NeoPixels and display) work great with the '32u4 and 8 MHz clock speed.

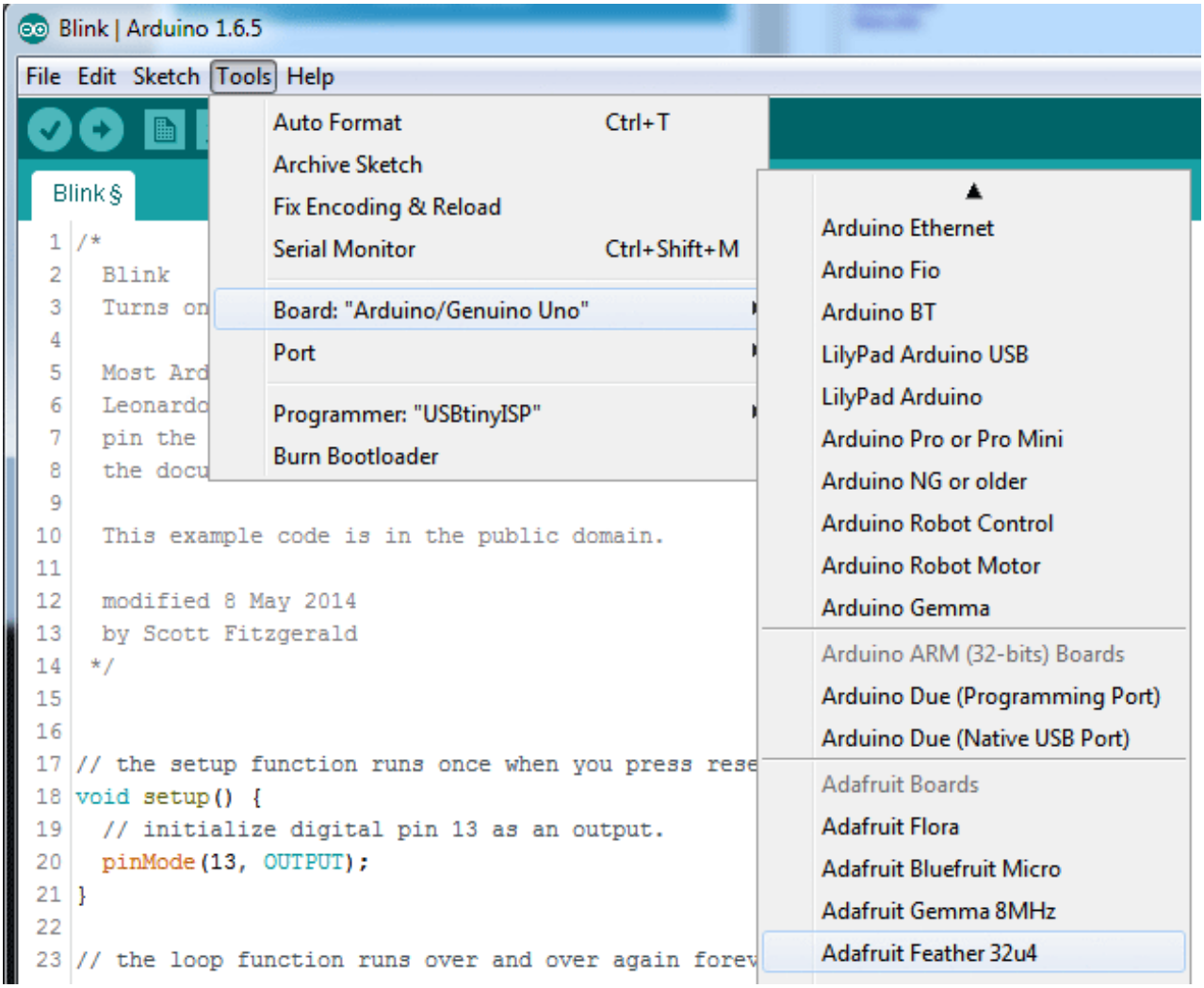
Now that you have added the appropriate URLs to the Arduino IDE preferences, you can open the **Boards Manager** by navigating to the **Tools->Board** menu.



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. In the example below, we are installing support for ***Adafruit AVR Boards***, but the same applies to all boards installed with the Board Manager.



Next, **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.



Install Drivers (Windows Only)

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

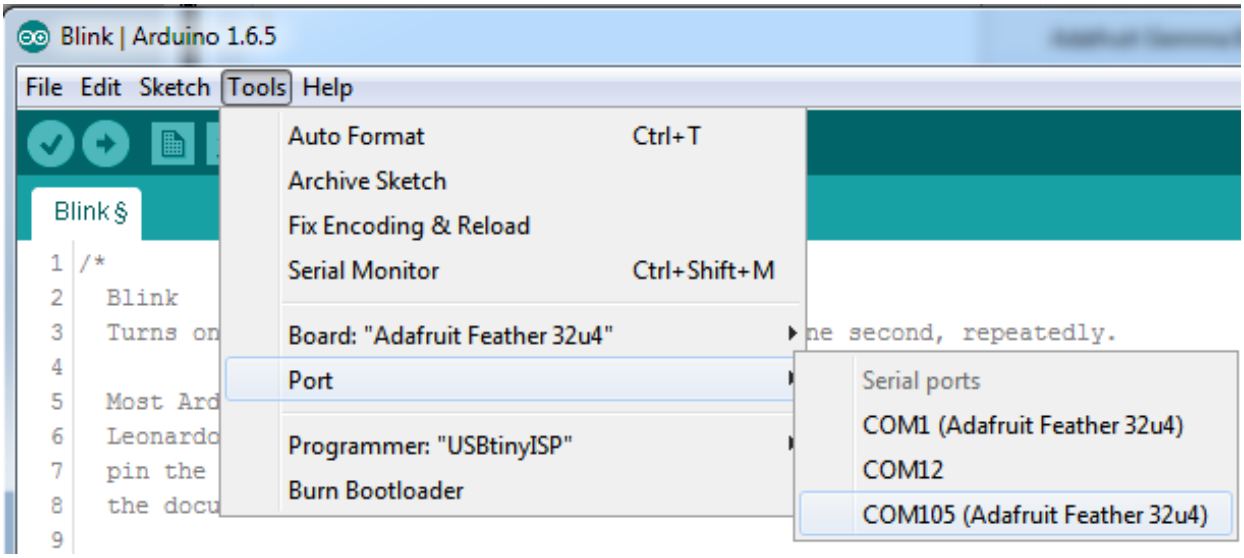
Start out by installing the serial/CDC drivers. We'll be using PJRC's awesome generic CDC drivers, works with all Windows and all CDC devices. (Thanks Paul!) (http://adafru.it/fLA)

Mac/Linux does not need a driver, continue as is!

Blink

Now you can upload your first blink sketch!

Plug in the Feather 32u4 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 Feather 32u4!



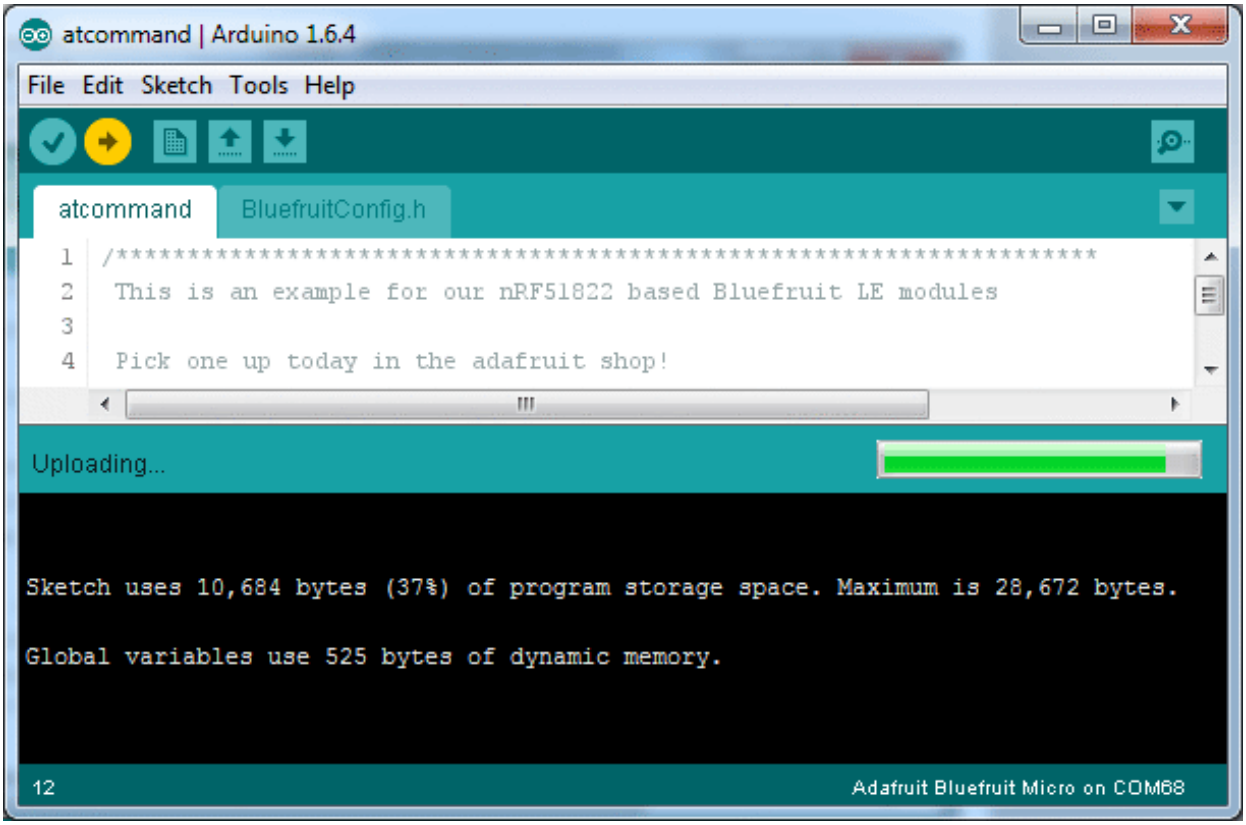
Now load up the Blink example

```
// 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.

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 to get back into the bootloader. The red LED will pulse, so you know that its in bootloader mode. Do the reset button press right as the Arduino IDE says its attempting to upload the sketch, when you see the Yellow Arrow lit and the **Uploading...** text in the status bar.



Don't click the reset button **before** uploading, unlike other bootloaders you want this one to run at the time Arduino is trying to 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/fP6)

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 Bluefruit Micro board and will fix the programming difficulty issue. Follow the steps for installing Adafruit's udev rules on this page. (http://adafru.it/iOE)

Installing BLE Library

Install the Adafruit nRF51 BLE Library

In order to try out our demos, you'll need to download the Adafruit BLE library for the nRF51 based modules such as this one (a.k.a. Adafruit_BluefruitLE_nRF51)

You can check out the code here at github, (http://adafru.it/f4V) but its likely easier to just download by clicking:

Download the Adafruit nRF51 BluefruitLE Library

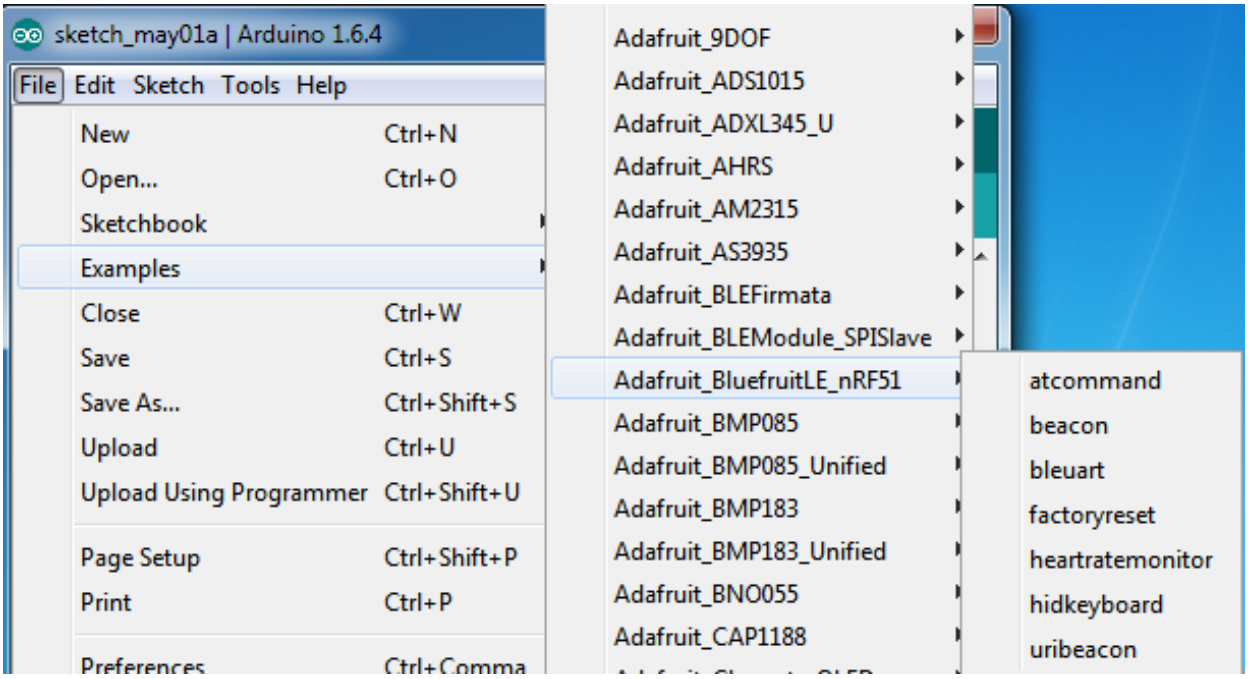
http://adafru.it/f4W

Rename the uncompressed folder **Adafruit_BluefruitLE_nRF51** and check that the **Adafruit_BluefruitLE_nRF51** folder contains **Adafruit_BLE.cpp** and **Adafruit_BLE.h** (as well as a bunch of other files)

Place the **Adafruit_BluefruitLE_nRF51** library folder your ***arduinosketchfolder*/libraries/** folder. You may need to create the **libraries** subfolder if its your first library. Restart the IDE.

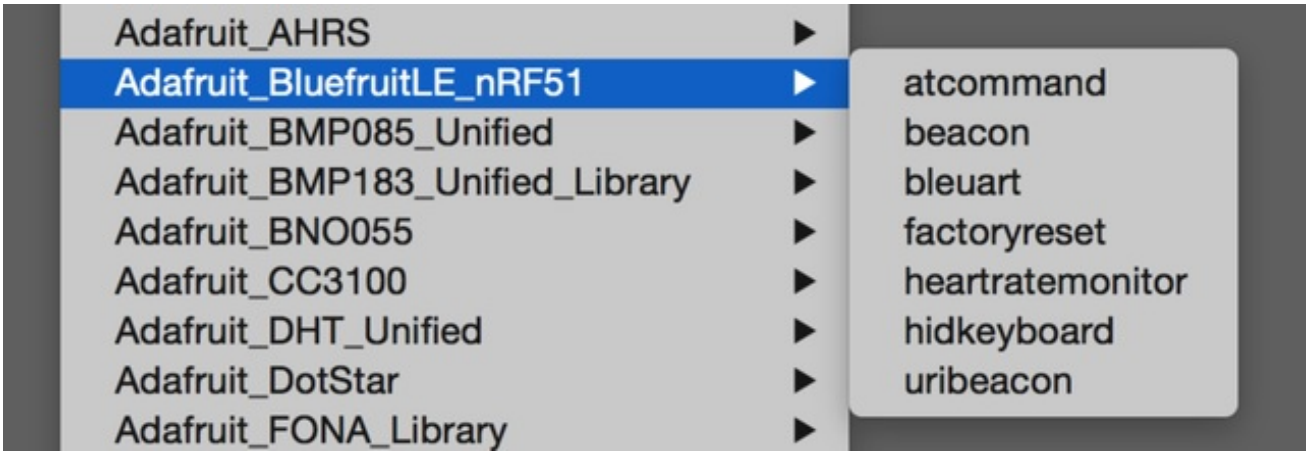
We also have a great tutorial on Arduino library installation at:
http://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use (http://adafru.it/aYM)

After restarting, check that you see the library folder with examples:

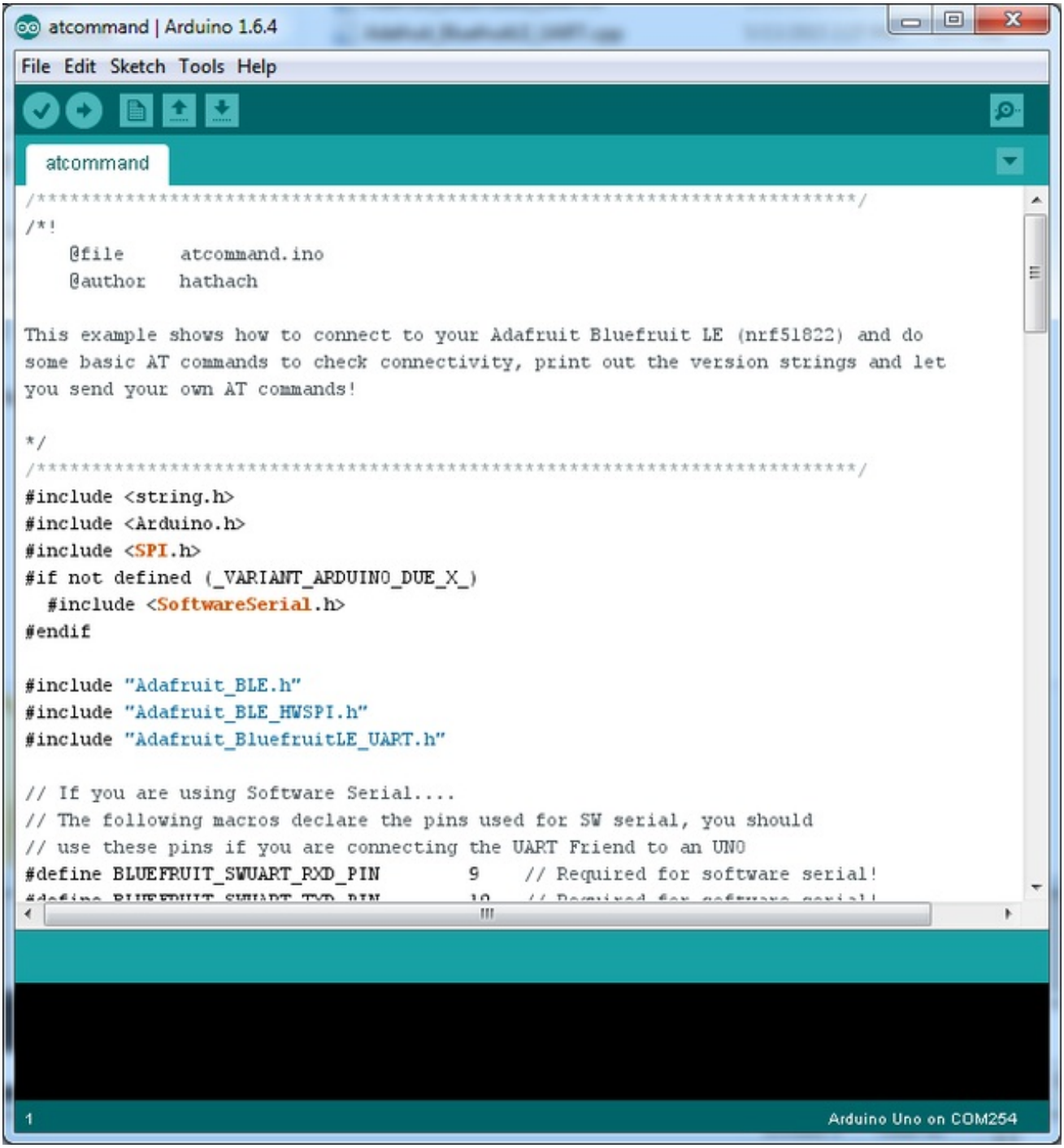


Run first example

Lets begin with the beginner project, which we can use to do basic tests. To open the ATCommand sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **atcommand**:



This will open up a new instance of the example in the IDE, as shown below:



Don't upload the sketch yet! You will have to begin by changing the configuration.

Go to the second tab labeled **BluefruitConfig.h** and find these lines

```
// SHARED SPI SETTINGS
// ----------------------------------------------------------------------------------------
// The following macros declare the pins to use for HW and SW SPI communication.
// SCK, MISO and MOSI should be connected to the HW SPI pins on the Uno when
// using HW SPI.  This should be used with nRF51822 based Bluefruit LE modules
// that use SPI (Bluefruit LE SPI Friend).
// ----------------------------------------------------------------------------------------
#define BLUEFRUIT_SPI_CS               8
#define BLUEFRUIT_SPI_IRQ              7
#define BLUEFRUIT_SPI_RST              6    // Optional but recommended, set to -1 if unused
```

And change the last line to:

```
#define BLUEFRUIT_SPI_RST              4   // Optional but recommended, set to -1 if unused
```

(The Bluefruit Feather has the reset on digital #4 not #6)

Now go back to the main tab **atcommand** and look for this line of code

```
/* ...hardware SPI, using SCK/MOSI/MISO hardware SPI pins and then user selected CS/IRQ/RST */
Adafruit_BluefruitLE_SPI ble(BLUEFRUIT_SPI_CS, BLUEFRUIT_SPI_IRQ, BLUEFRUIT_SPI_RST);
```

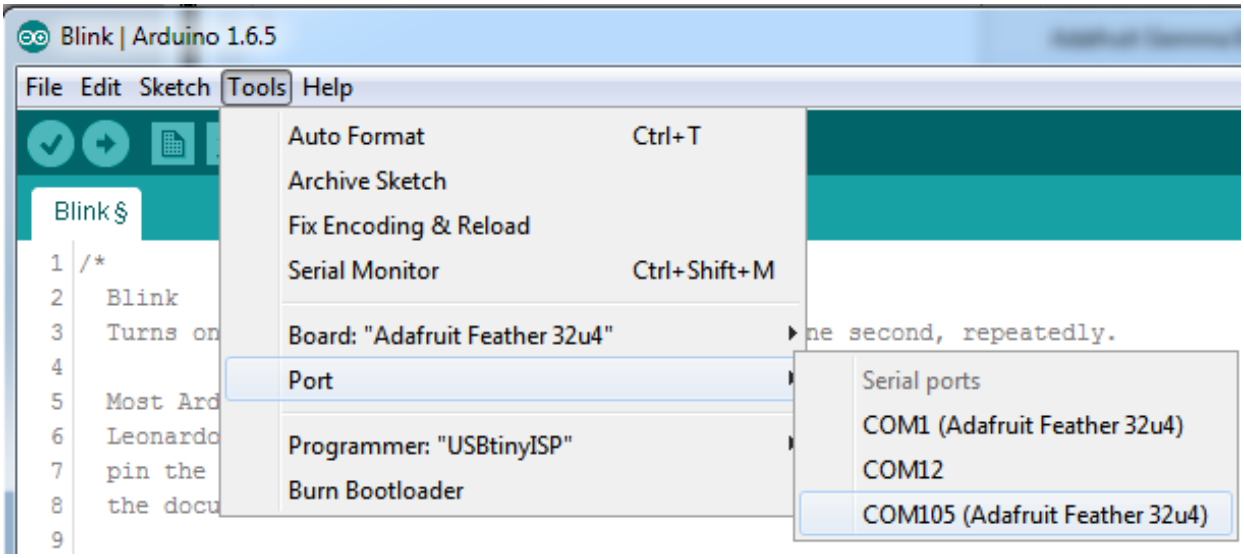
Make sure that the second line is uncommented (it should be)

OK now you can upload to the Bluefruit Feather!

If you're using Ubuntu 15.04 or other Linux distributions and run into errors attempting to upload a program to the board, scroll up to the Ubuntu and Linux issue fix in the previous section

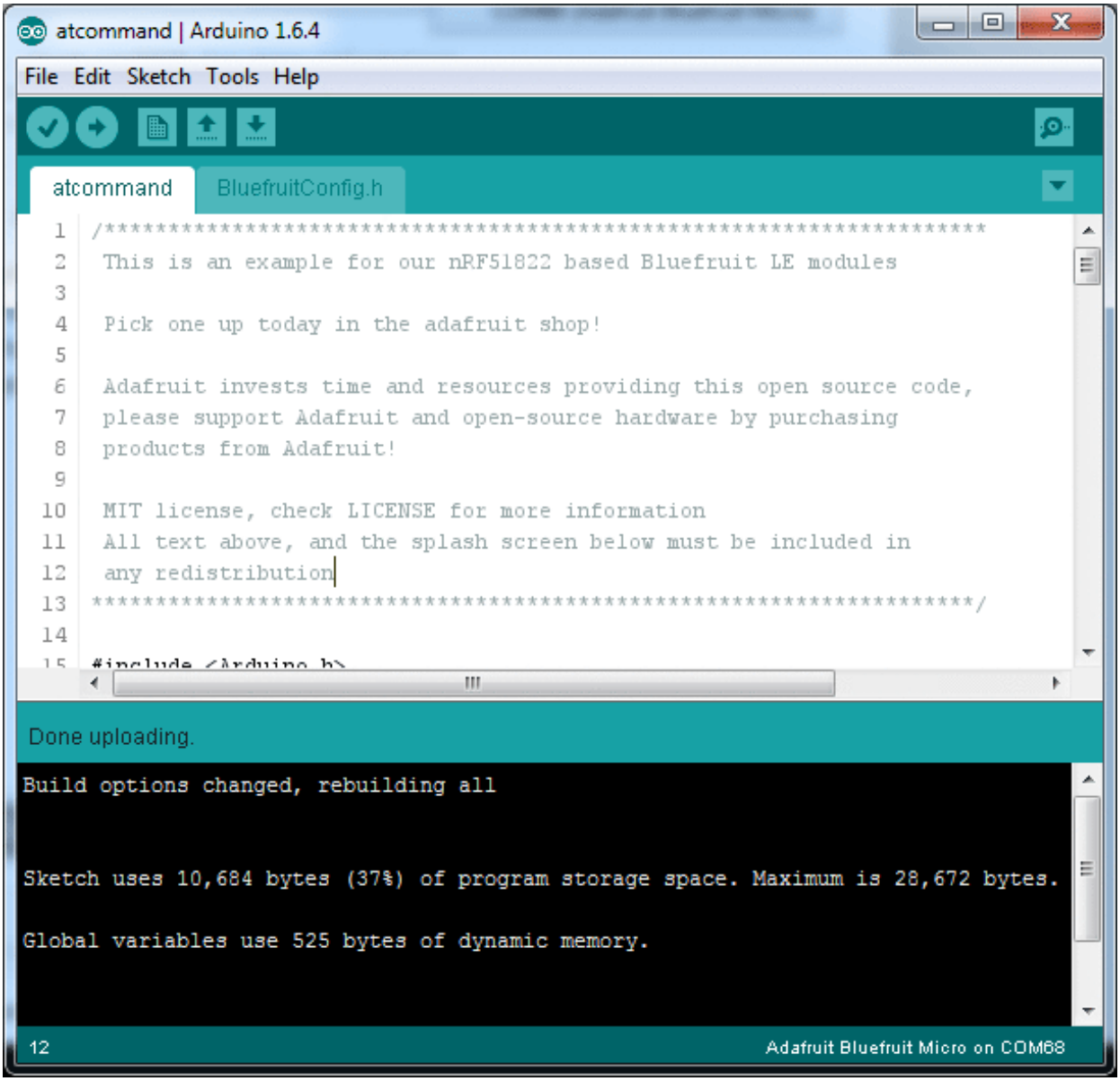
Uploading to the Feather Bluefruit LE

It's pretty easy to upload, first up make sure you have **Adafruit Feather 32u4** selected on the boards dropdown as above. Also, in the **Ports** menu, look for the port labeled as such:



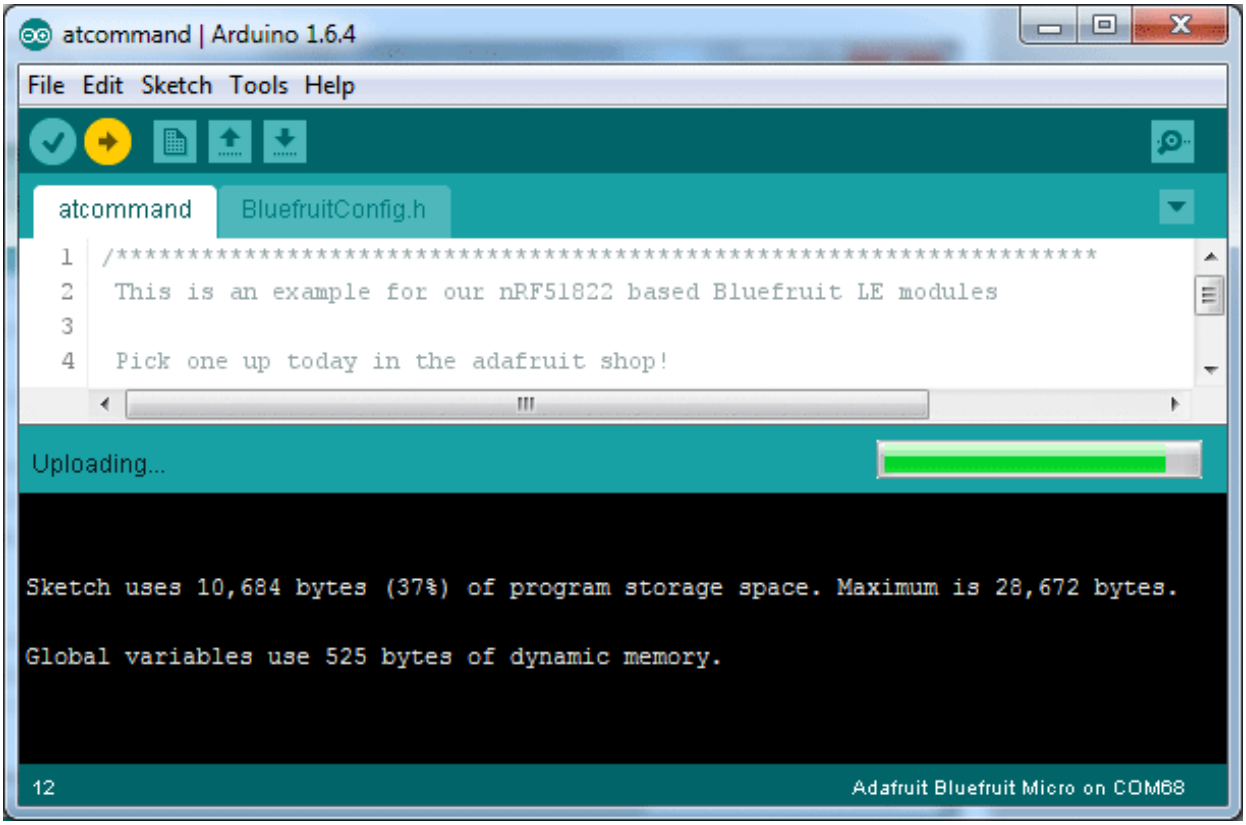
Now click the upload button on the Arduino IDE (or **File Menu -> Upload**)

If all is good you will see **Done Uploading** in the status bar



Uploading to a brand new board/Upload failures

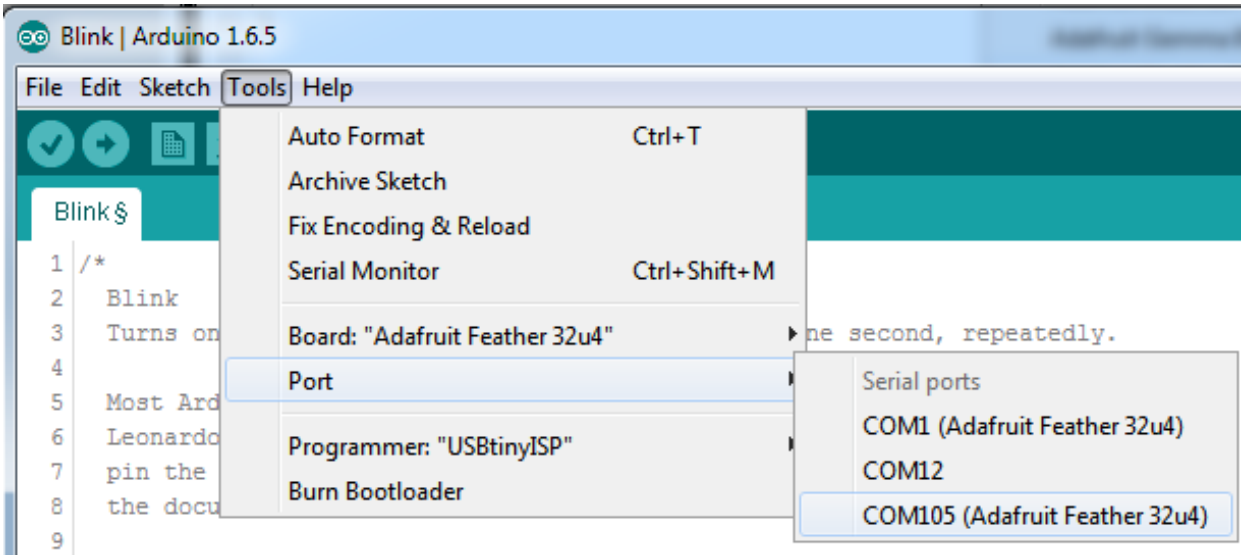
If you are uploading for the first time to a new board, or if upload fails, pres the **RESET** mini button on the Feather 32u4 Bluefruit when you see the Yellow Arrow lit and the **Uploading...** text in the status bar. When you see the red LED pulsing on and off, you know the bootloader is running.



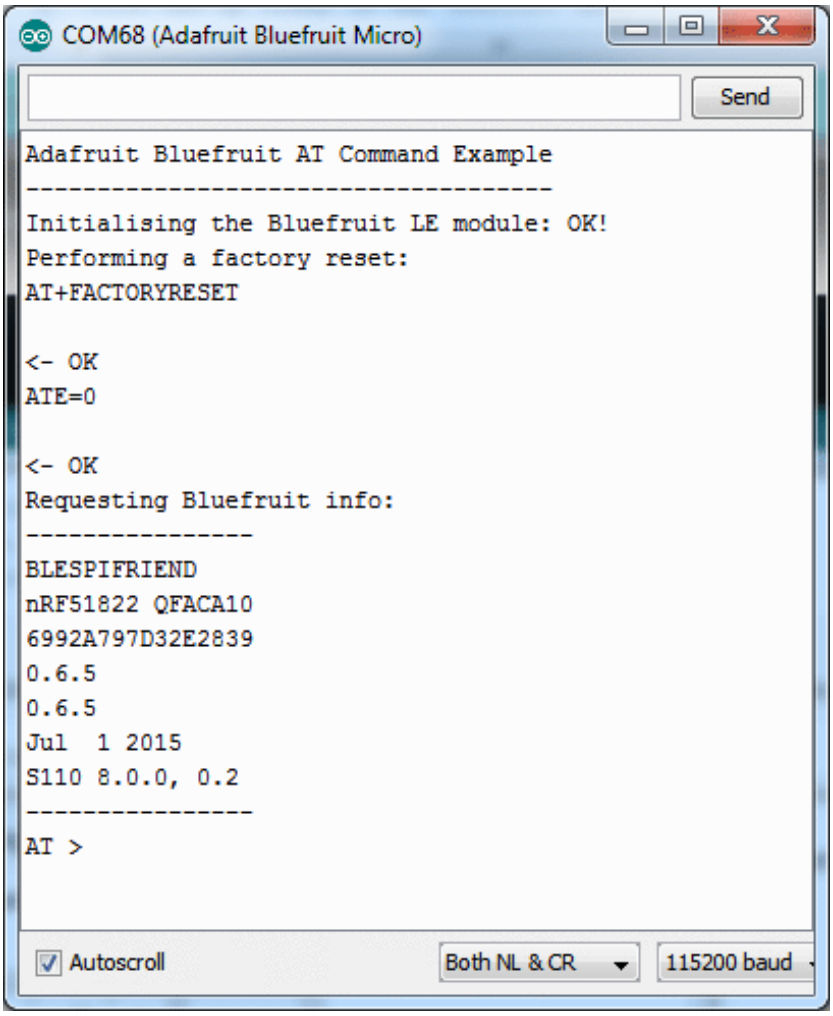
Don't click the reset button **before** uploading, unlike other bootloaders you want this one to run at the time Arduino is trying to upload

Run the sketch

OK check again that the correct port is selected



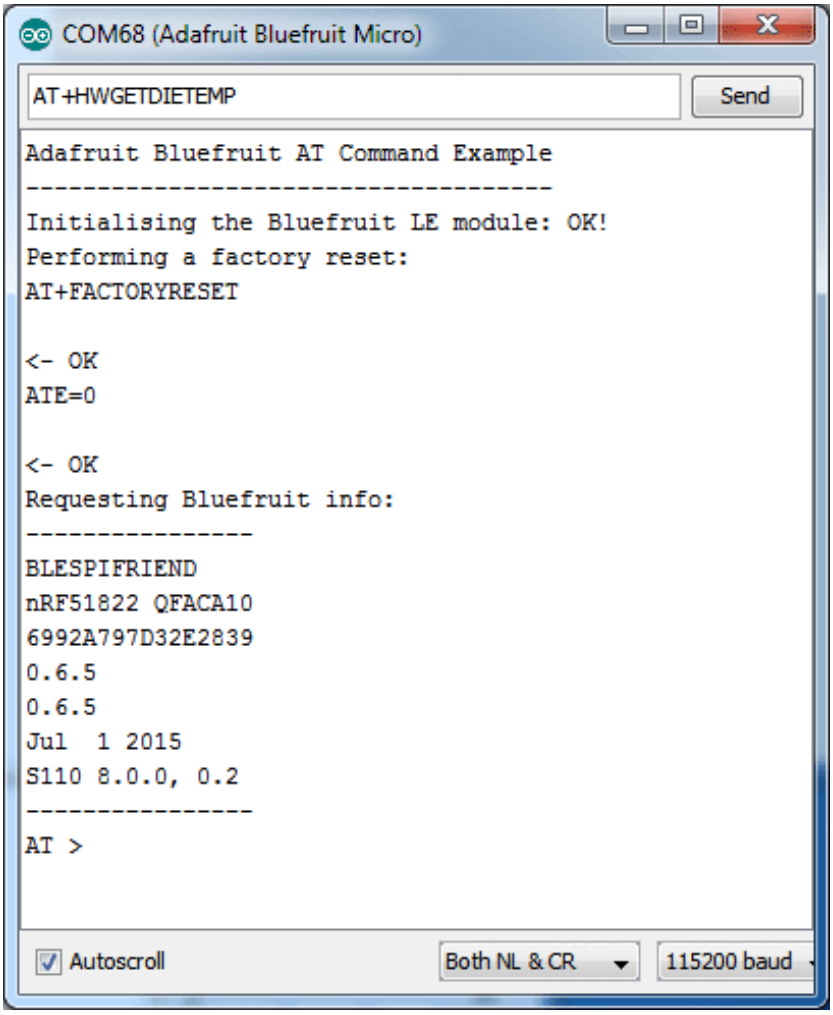
Then open up the Serial console. You will see the following:

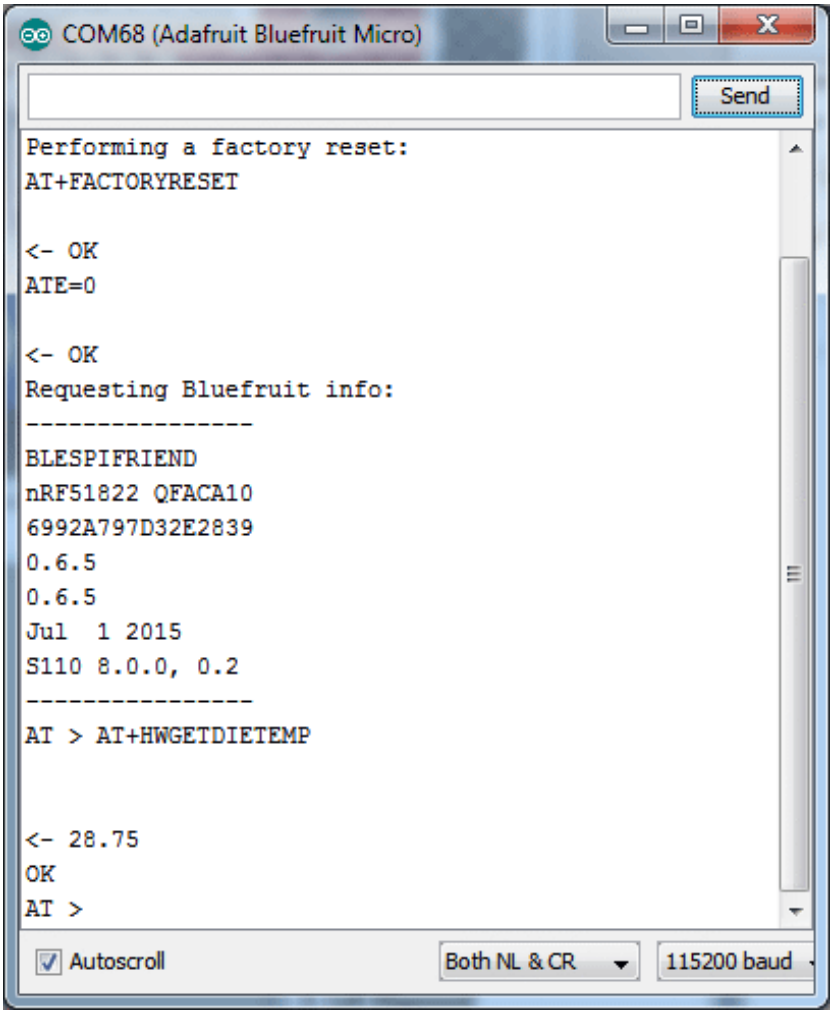


This sketch starts by doing a factory reset, then querying the BLE radio for details. These details will be useful if you are debugging the radio. If you see the information as above, you're working! (Note that the dates and version numbers may vary)

AT command testing

Now you can try out some **AT commands** - check the rest of the learn guide for a full list. We'll just start with **AT+HWGETDIETEMP** which will return the approximate ambient temperature of the BLE chipset


COM68 (Adafruit Bluefruit Micro)
AT+HWGETDIETEMP
Send
Adafruit Bluefruit AT Command Example
Initialising the Bluefruit LE module: OK!
Performing a factory reset:
AT+FACTORYRESET
<- OK
ATE=0
<- OK
Requesting Bluefruit info:
BLESPIFRIEND
nRF51822 QFACA10
6992A797D32E2839
0.6.5
0.6.5
Jul 1 2015
S110 8.0.0, 0.2
AT >
Autoscroll
Both NL & CR
115200 baud



OK now you know how to upload/test/communicate with your Feather 32u4 Bluefruit. Next up we have a bunch of tutorials who can follow for checking out the bluetooth le radio and apps.

For all the following examples, we share the same code between various modules so **don't forget to make sure you have the RESET pin set to 4 in BluefruitConfig.h for each sketch before uploading, and that Hardware SPI mode is selected by checking for**

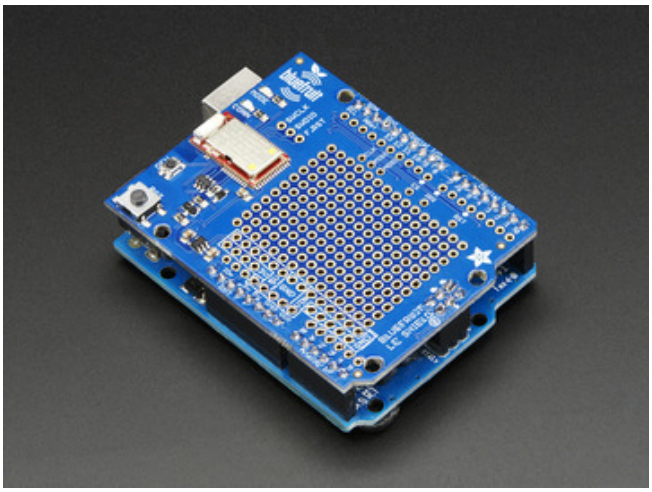
```
/* ...hardware SPI, using SCK/MOSI/MISO hardware SPI pins and then user selected CS/IRQ/RST */
Adafruit_BluefruitLE_SPI ble(BLUEFRUIT_SPI_CS, BLUEFRUIT_SPI_IRQ, BLUEFRUIT_SPI_RST);
```

Configuration!

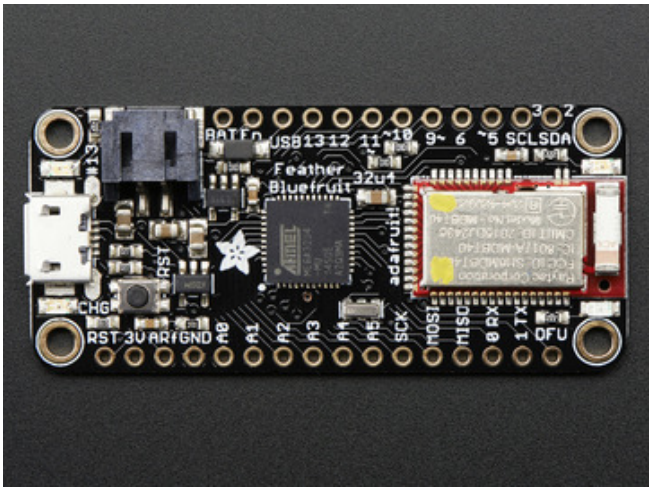
Before you start uploading any of the example sketches, you'll need to CONFIGURE the Bluefruit interface - there's a lot of options so pay close attention!

Which board do you have?

There's a few products under the Bluefruit name:



If you are using the Bluefruit LE Shield then you have an **SPI-connected NRF51822** module. You can use this with **Atmega328** (Arduino UNO or compatible)**, ATmega32u4** (Arduino Leonardo, compatible) or **ATSAMD21** (Arduino Zero, compatible) and possibly others.
Your pinouts are **Hardware SPI, CS = 8, IRQ = 7, RST = 4**

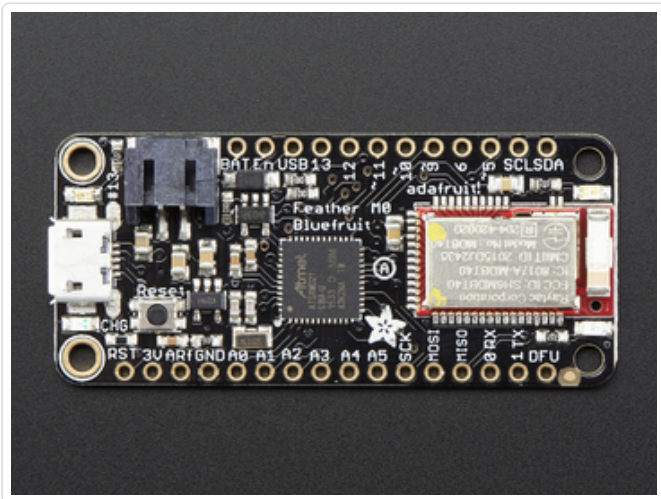


Bluefruit Micro or Feather 32u4 Bluefruit

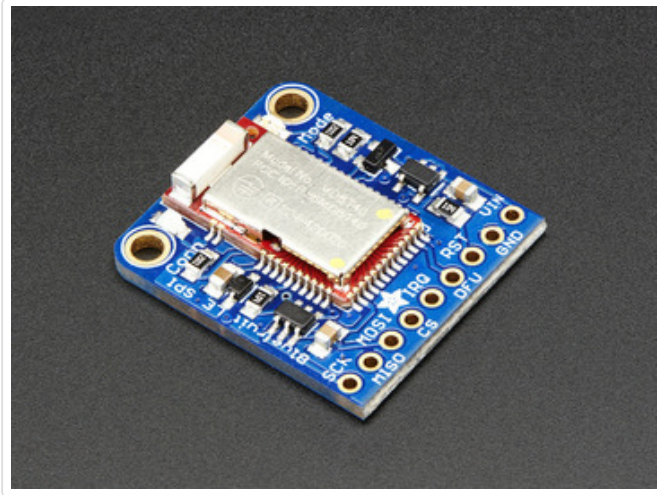
If you have a Bluefruit Micro or Feather 32u4 Bluefruit LE then you have an **ATmega32u4** chip with **Hardware SPI**, CS = **8**, IRQ = **7**, RST = **4**

Feather M0 Bluefruit LE

If you have a Feather M0 Bluefruit LE then you have an **ATSAMD21** chip with **Hardware SPI**, CS =



8, IRQ = **7**, RST = **4**



Bluefruit LE SPI Friend

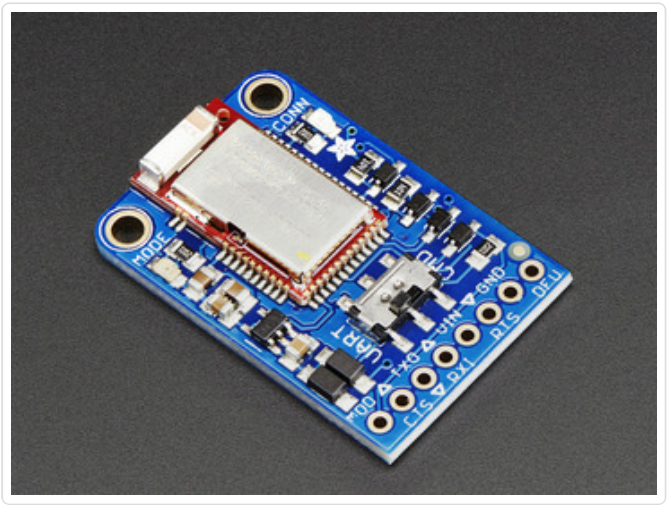
If you have a stand-alone module, you have a bit of flexibility with wiring however we strongly recommend **Hardware SPI**, CS = **8**, IRQ = **7**, RST = **4**

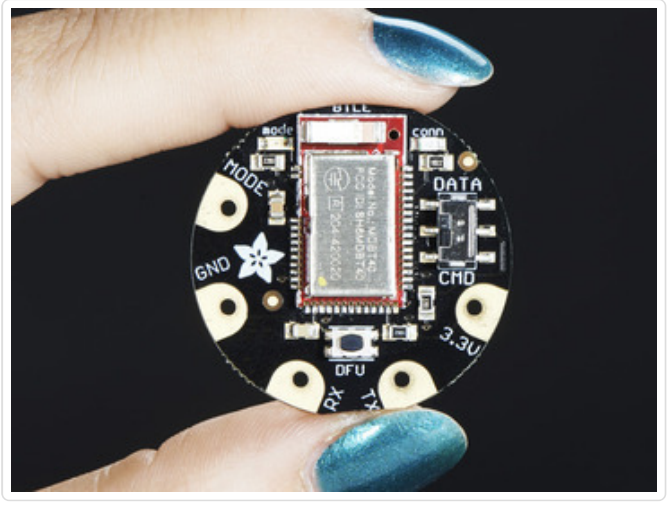
You can use this with just about any microcontroller with 5 or 6 pins

Bluefruit LE UART Friend or Flora BLE

If you have a stand-alone UART module you have some flexibility with wiring. However we suggest **hardware UART** if possible. You will likely need to use the flow control **CTS** pin if you are not using hardware UART. There's also a **MODE** pin

You can use this with just about any microcontroller with at least 3 pins, but best used with a Hardware Serial/UART capable chip!

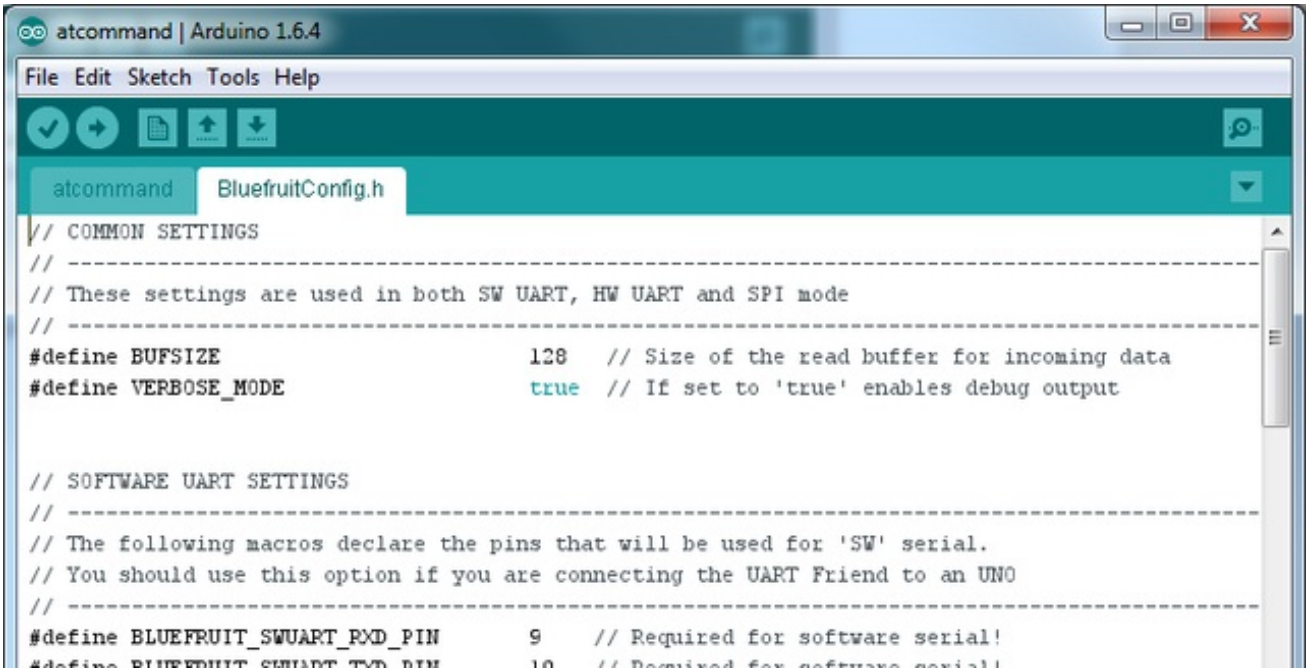




Configure the Pins Used

You'll want to check the Bluefruit Config to set up the pins you'll be using for UART or SPI

Each example sketch has a secondary tab with configuration details. You'll want to edit and save the sketch to your own documents folder once set up.



Common settings:

You can set up how much RAM to set aside for a communication buffer and whether you want to have full debug output. Debug output is 'noisy' on the serial console but is handy since you can see all communication between the micro and the BLE

```
// ------------------------------------------------------------------------------
// These settings are used in both SW UART, HW UART and SPI mode
// ------------------------------------------------------------------------------
#define BUFSIZE                   128   // Size of the read buffer for incoming data
#define VERBOSE_MODE              true  // If set to 'true' enables debug output
```

Software UART

If you are using Software UART, you can set up which pins are going to be used for RX, TX, and CTS flow control. Some microcontrollers are limited on which pins can be used! Check the SoftwareSerial library documentation for more details

```
// SOFTWARE UART SETTINGS
#define BLUEFRUIT_SWUART_RXD_PIN      9   // Required for software serial!
#define BLUEFRUIT_SWUART_TXD_PIN      10  // Required for software serial!
#define BLUEFRUIT_UART_CTS_PIN        11  // Required for software serial!
#define BLUEFRUIT_UART_RTS_PIN        -1  // Optional, set to -1 if unused
```

Hardware UART

If you have Hardware Serial, there's a 'name' for it, usually Serial1 - you can set that up here:

```
// HARDWARE UART SETTINGS
#ifdef Serial1    // this makes it not complain on compilation if there's no Serial1
  #define BLUEFRUIT_HWSERIAL_NAME      Serial1
#endif
```

Mode Pin

For both hardware and software serial, you will likely want to define the MODE pin. There's a few sketches that dont use it, instead depending on commands to set/unset the mode. Its best to use the MODE pin if you have a GPIO to spare!

```
#define BLUEFRUIT_UART_MODE_PIN      12    // Set to -1 if unused
```

SPI Pins

For both Hardware and Software SPI, you'll want to set the **CS** (chip select) line, **IRQ** (interrupt request) line and if you have a pin to spare, **RST** (Reset)

```
// SHARED SPI SETTINGS
#define BLUEFRUIT_SPI_CS             8
#define BLUEFRUIT_SPI_IRQ            7
#define BLUEFRUIT_SPI_RST            4    // Optional but recommended, set to -1 if unused
```

Software SPI Pins

If you don't have a hardware SPI port available, you can use any three pins...its a tad slower but very flexible

```
// SOFTWARE SPI SETTINGS
#define BLUEFRUIT_SPI_SCK            13
#define BLUEFRUIT_SPI_MISO           12
#define BLUEFRUIT_SPI_MOSI           11
```

Refer to the table above to determine whether you have SPI or UART controlled Bluefruits!

Select the Serial Bus

Once you've configured your pin setup in the BluefruitConfig.h file, you can now check and adapt the example sketch.

The Adafruit_BluefruitLE_nRF51 library supports four different serial bus options, depending on the HW you are using: **SPI** both hardware and software type, and **UART** both hardware and software type.

UART Based Boards (Bluefruit LE UART Friend & Flora BLE)

This is for Bluefruit LE UART Friend & Flora BLE boards. You can use *either* software serial or hardware serial. Hardware serial is higher quality, and less risky with respect to losing data. However, you may not have hardware serial available! Software serial does work just fine with flow-control and we do have that available at the cost of a single GPIO pin.

For software serial (Arduino Uno, Adafruit Metro) you should uncomment the software serial contructor below, and make sure the other three options (hardware serial & SPI) are commented out.

```
// Create the bluefruit object, either software serial...uncomment these lines
SoftwareSerial bluefruitSS = SoftwareSerial(BLUEFRUIT_SWUART_TXD_PIN, BLUEFRUIT_SWUART_RXD_P

Adafruit_BluefruitLE_UART ble(bluefruitSS, BLUEFRUIT_UART_MODE_PIN,
                      BLUEFRUIT_UART_CTS_PIN, BLUEFRUIT_UART_RTS_PIN);
```

For boards that require hardware serial (Adafruit Flora, etc.), uncomment the hardware serial constructor, and make sure the other three options are commented out

```
/* ...or hardware serial, which does not need the RTS/CTS pins. Uncomment this line */
Adafruit_BluefruitLE_UART ble(BLUEFRUIT_HWSERIAL_NAME, BLUEFRUIT_UART_MODE_PIN);
```

SPI Based Boards (Bluefruit LE SPI Friend)

For SPI based boards, you should uncomment the hardware SPI constructor below, making sure the other constructors are commented out:

```
/* ...hardware SPI, using SCK/MOSI/MISO hardware SPI pins and then user selected CS/IRQ/RST */
Adafruit_BluefruitLE_SPI ble(BLUEFRUIT_SPI_CS, BLUEFRUIT_SPI_IRQ, BLUEFRUIT_SPI_RST);
```

If for some reason you can't use HW SPI, you can switch to software mode to bit-bang the SPI transfers via the following constructor:

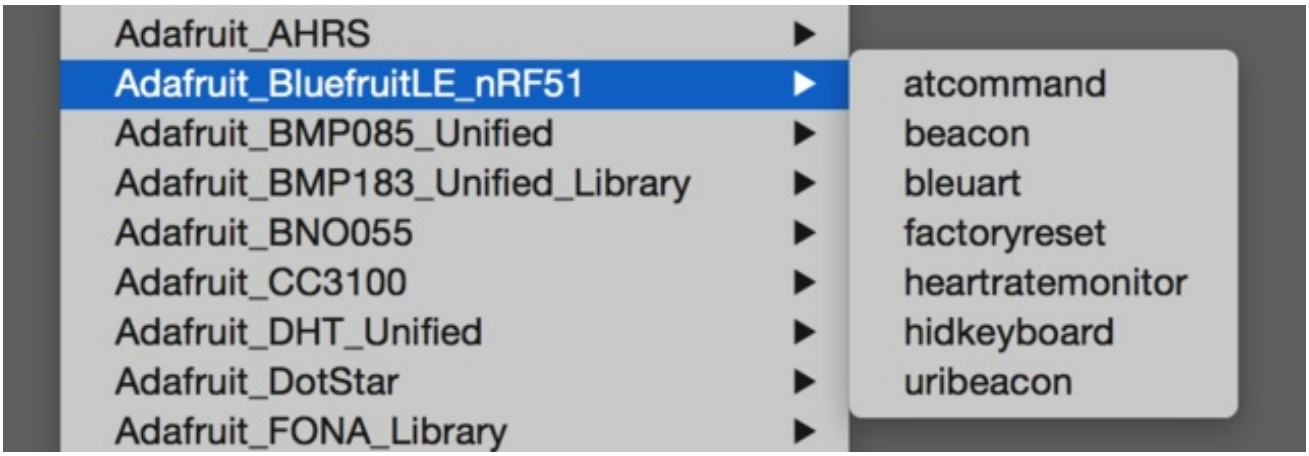
```
/* ...software SPI, using SCK/MOSI/MISO user-defined SPI pins and then user selected CS/IRQ/RST */
Adafruit_BluefruitLE_SPI ble(BLUEFRUIT_SPI_SCK, BLUEFRUIT_SPI_MISO,
                             BLUEFRUIT_SPI_MOSI, BLUEFRUIT_SPI_CS,
                             BLUEFRUIT_SPI_IRQ, BLUEFRUIT_SPI_RST);
```

BLEUart

The **BLEUart** example sketch allows you to send and receive text data between the Arduino and a connected Bluetooth Low Energy Central device on the other end (such as you mobile phone using the **Adafruit Bluefruit LE Connect** application for Android (http://adafru.it/f4G) or iOS (http://adafru.it/f4H) in UART mode).

Opening the Sketch

To open the ATCommand sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **bleuart_cmdmode**:



This will open up a new instance of the example in the IDE, as shown below:

Configuration

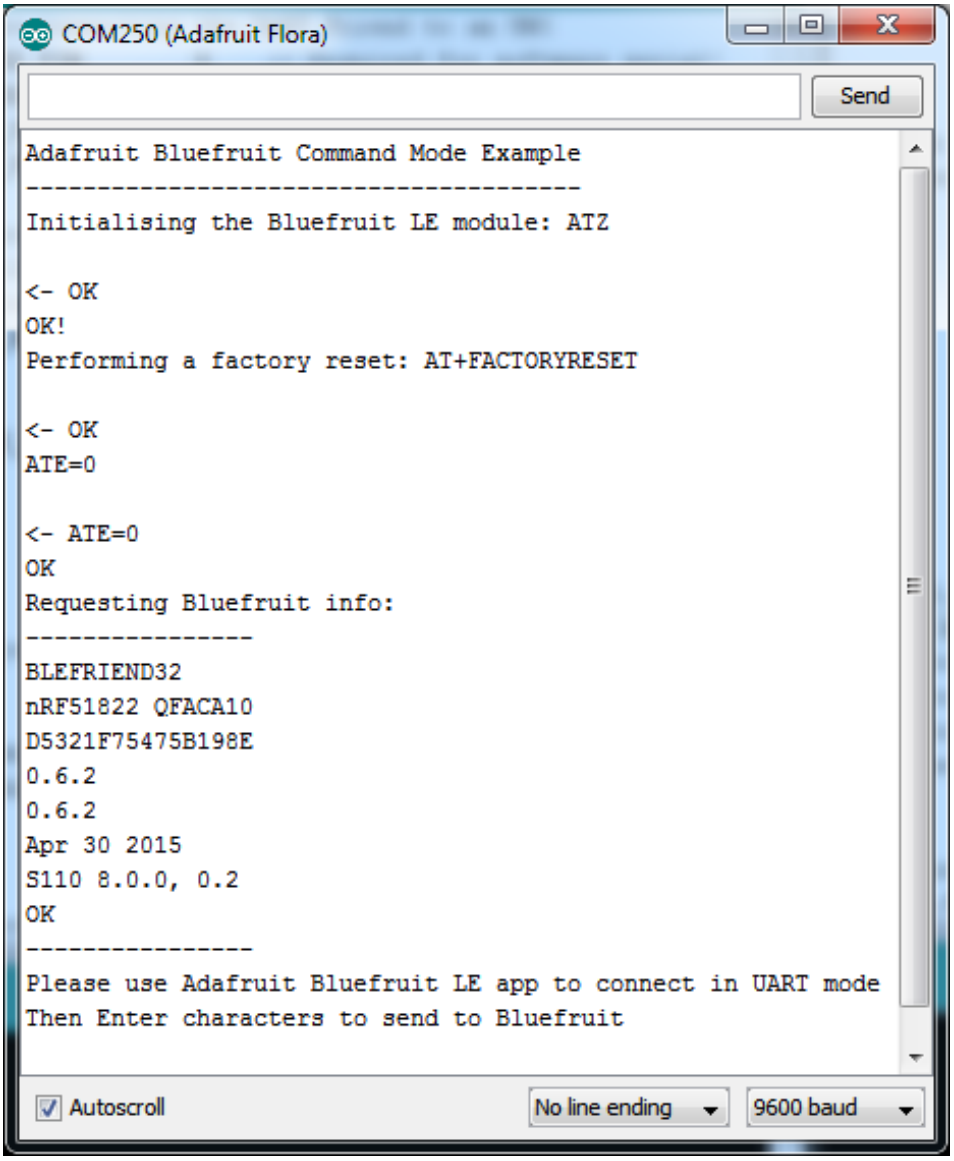
Check the **Configuration!** page earlier to set up the sketch for Software/Hardware UART or Software/Hardware SPI. The default is hardware SPI

If using software or hardware Serial UART:

- This tutorial does not need to use the MODE pin, **make sure you have the mode switch in CMD mode** if you do not configure & connect a MODE pin
- Don't forget to also **connect the CTS pin on the Bluefruit to ground if you are not using it!** (The Flora has this already done)

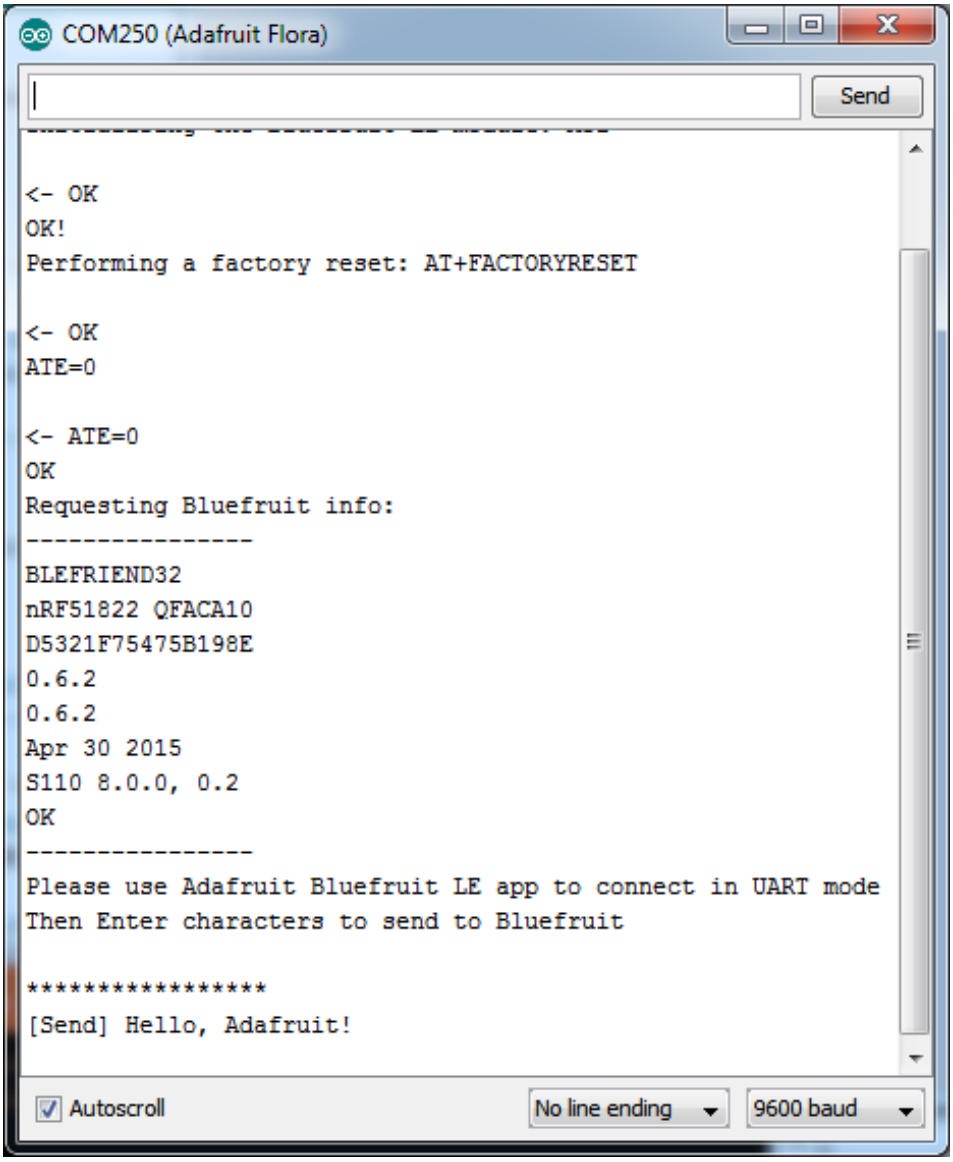
Running the Sketch

Once you upload the sketch to your board (via the arrow-shaped upload icon), and the upload process has finished, open up the Serial Monitor via **Tools > Serial Monitor**, and make sure that the baud rate in the lower right-hand corner is set to **115200**:

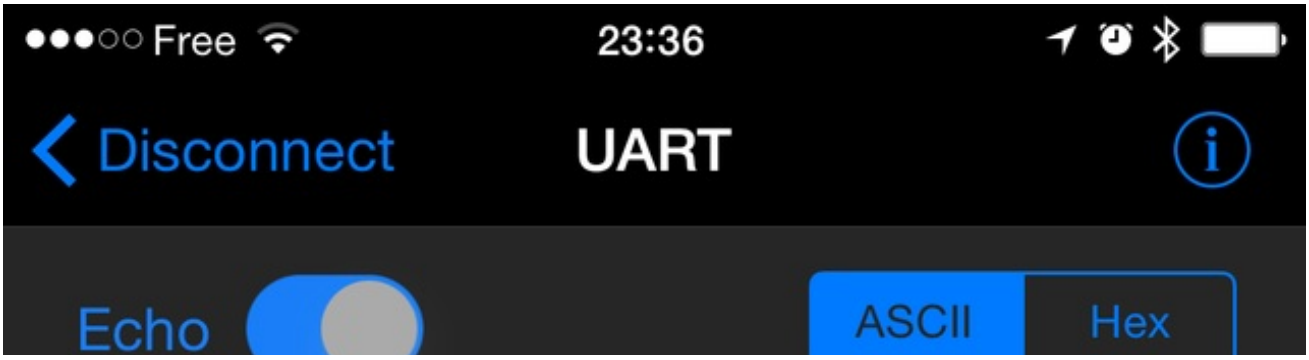


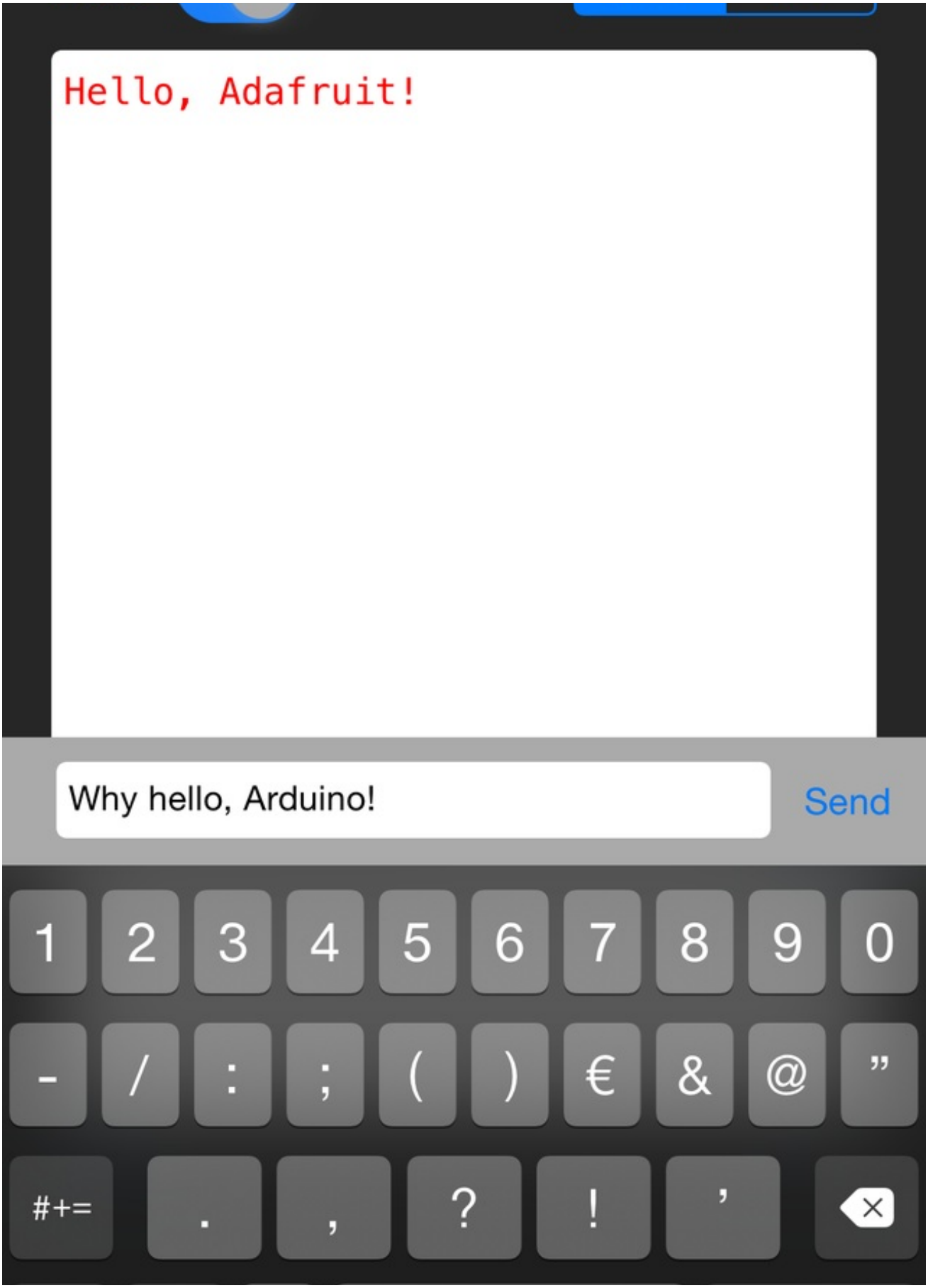
Once you see the request, use the App to connect to the Bluefruit LE module in **UART** mode so you get the text box on your phone

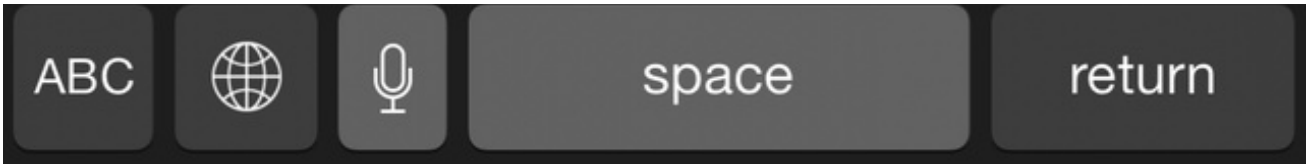
Any text that you type in the box at the top of the Serial Monitor will be sent to the connected phone, and any data sent from the phone will be displayed in the serial monitor:



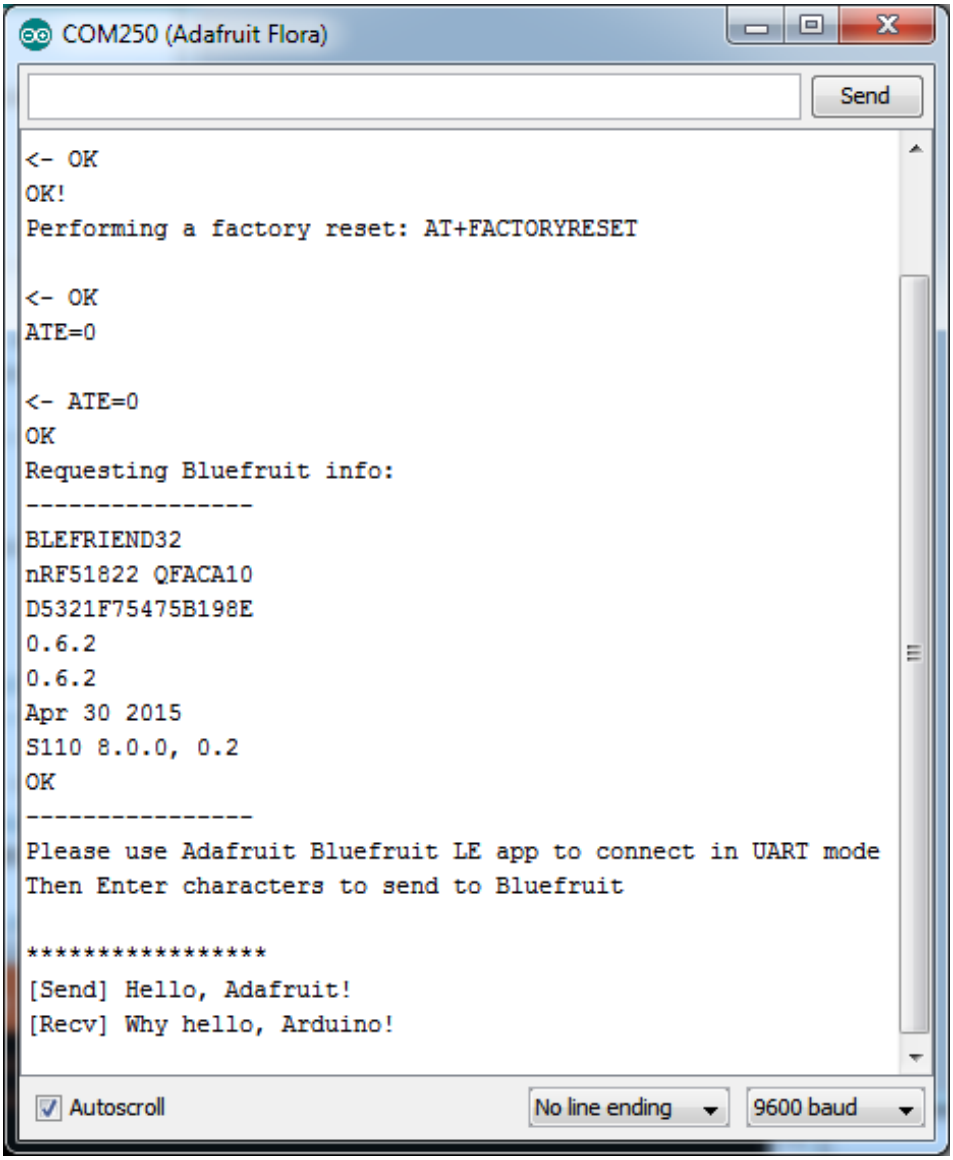
You can see the incoming string here in the Adafruit Bluefruit LE Connect app below (iOS in this case):




Hello, Adafruit!
Why hello, Arduino!
Send
1 2 3 4 5 6 7 8 9 0
- / : ; ( ) € & @ ”
#+= . , ? ! ’



The response text ('Why hello, Arduino!') can be seen below:

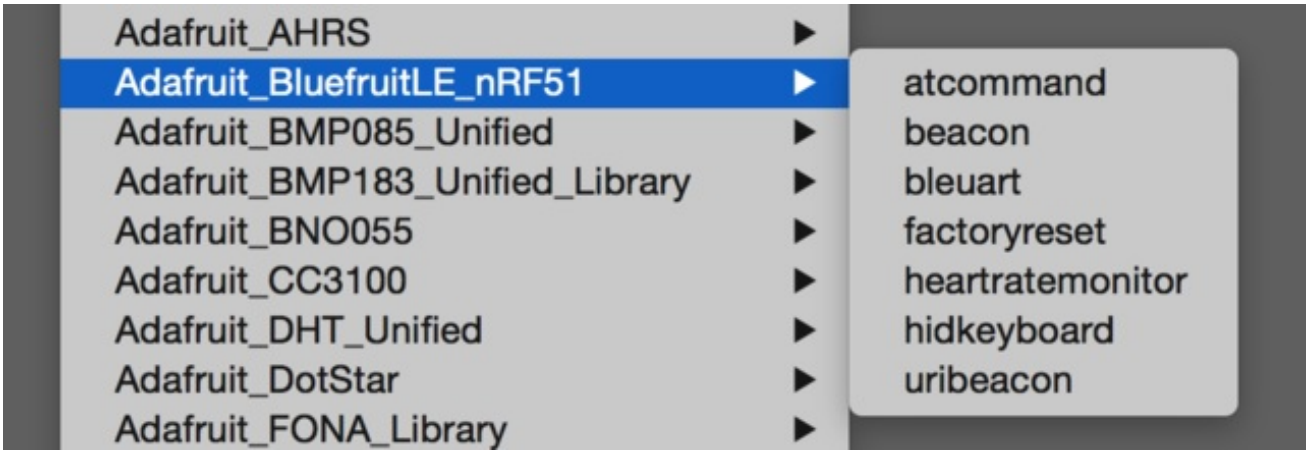


HIDKeyboard

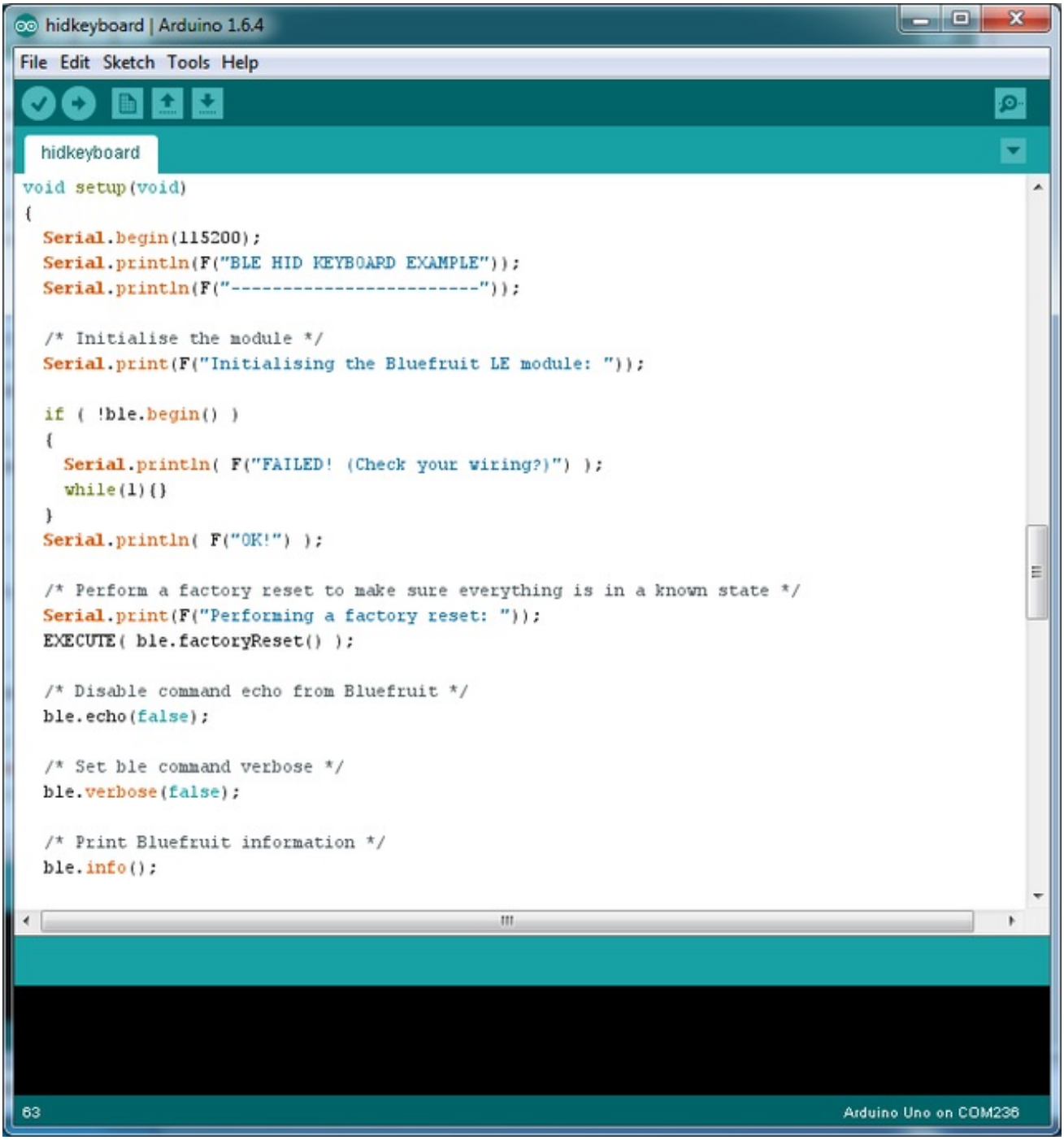
The **HIDKeyboard** example shows you how you can use the built-in HID keyboard AT commands to send keyboard data to any BLE-enabled Android or iOS phone, or other device that supports BLE HID peripherals.

Opening the Sketch

To open the ATCommand sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **hidkeyboard**:



This will open up a new instance of the example in the IDE, as shown below:



Configuration

Check the **Configuration!** page earlier to set up the sketch for Software/Hardware UART or Software/Hardware SPI. The default is hardware SPI

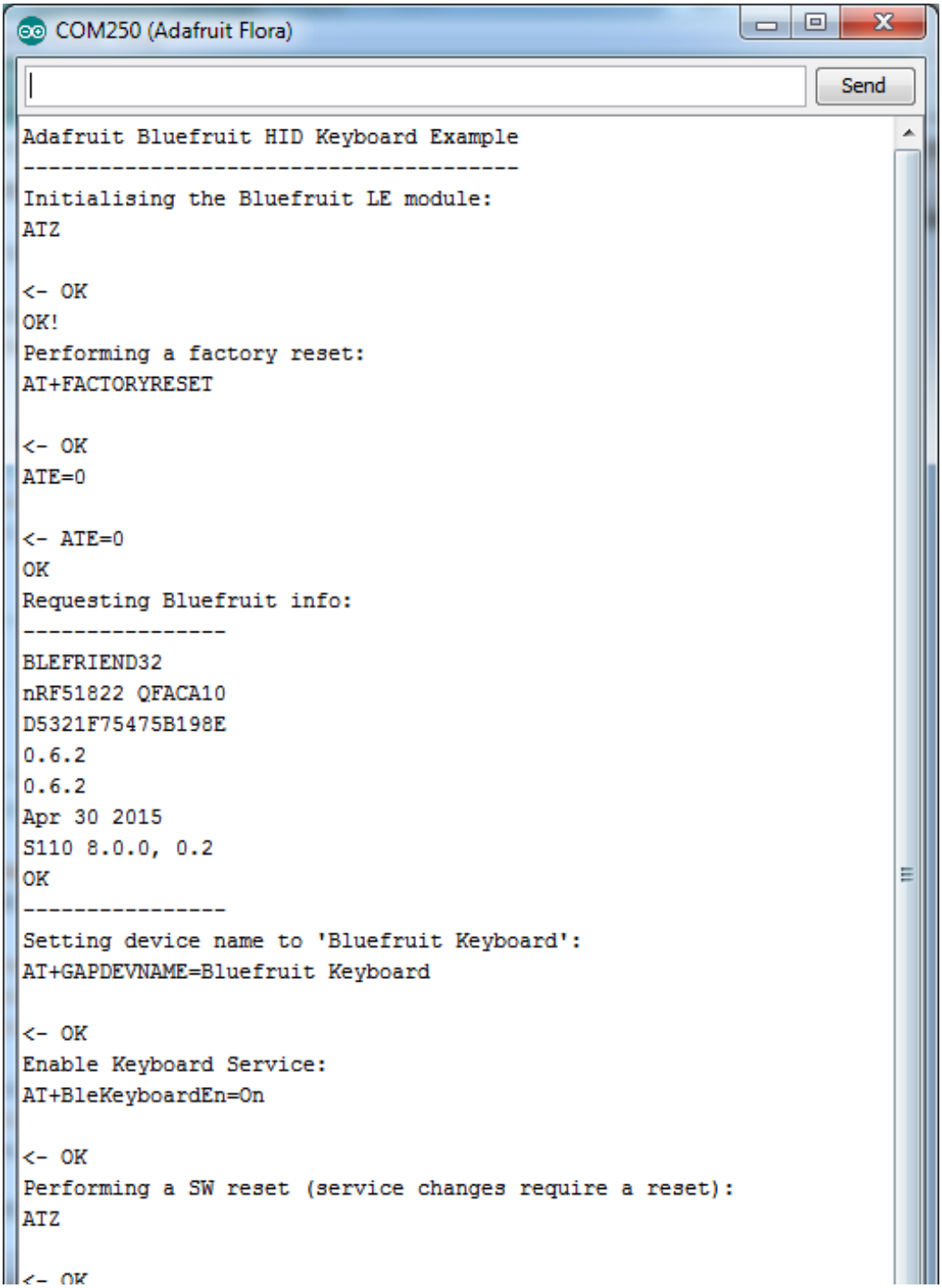
If using software or hardware Serial UART:

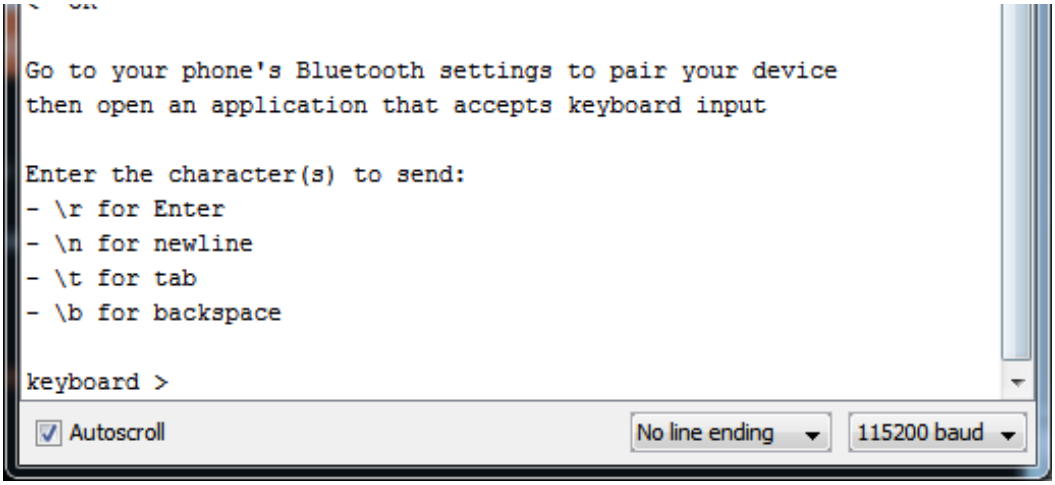
- This tutorial does not need to use the MODE pin, **make sure you have the mode switch in CMD mode!**

- Don't forget to also **connect the CTS pin on the Bluefruit to ground if you are not using it!** (The Flora has this already done)

Running the Sketch

Once you upload the sketch to your board (via the arrow-shaped upload icon), and the upload process has finished, open up the Serial Monitor via **Tools > Serial Monitor**, and make sure that the baud rate in the lower right-hand corner is set to **115200**:





To send keyboard data, type anything into the textbox at the top of the Serial Monitor and click the **Send** button.

Bonding the HID Keyboard

Before you can use the HID keyboard, you will need to 'bond' it to your phone or PC. The bonding process establishes a permanent connection between the two devices, meaning that as soon as your phone or PC sees the Bluefruit LE module again it will automatically connect.

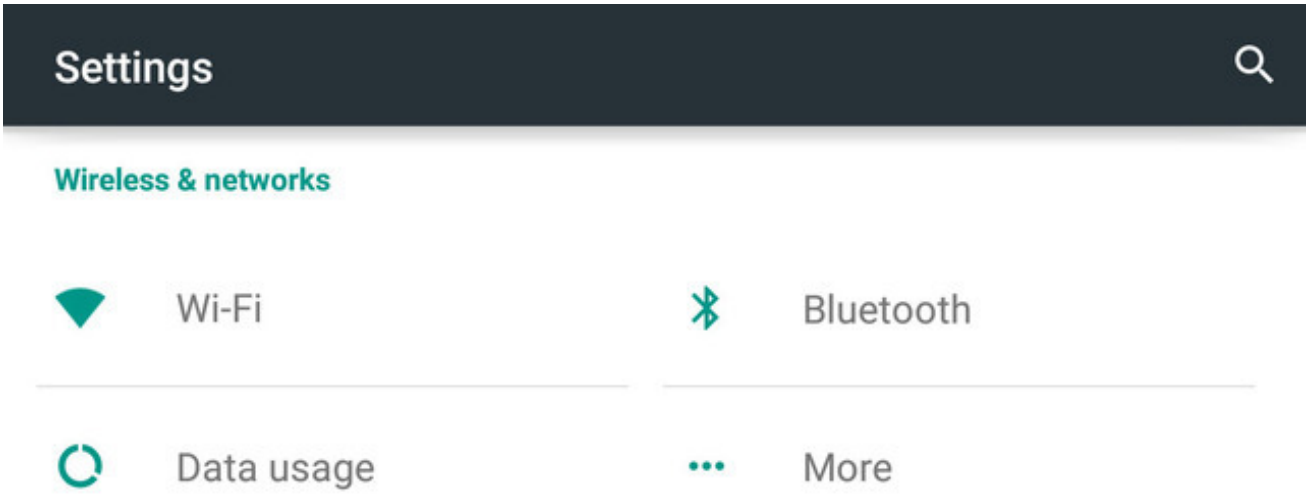
The exact procedures for bonding the keyboard will varying from one platform to another.

> When you no longer need a bond, or wish to bond the Bluefruit LE module to another device, be sure to delete the bonding information on the phone or PC, otherwise you may not be able to connect on a new device!

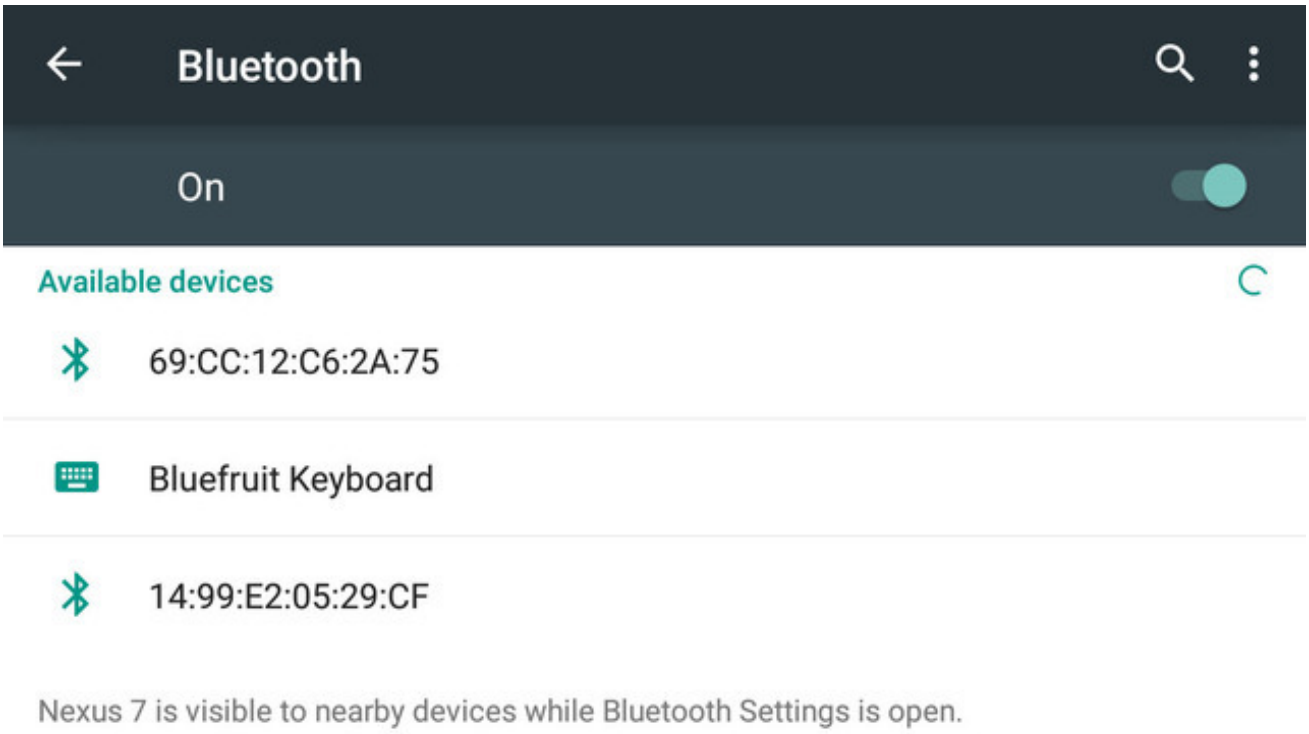
Android

To bond the keyboard on a Bluetooth Low Energy enabled Android device, go to the **Settings** application and click the **Bluetooth** icon.

> These screenshots are based on Android 5.0 running on a Nexus 7 2013. The exact appearance may vary depending on your device and OS version.

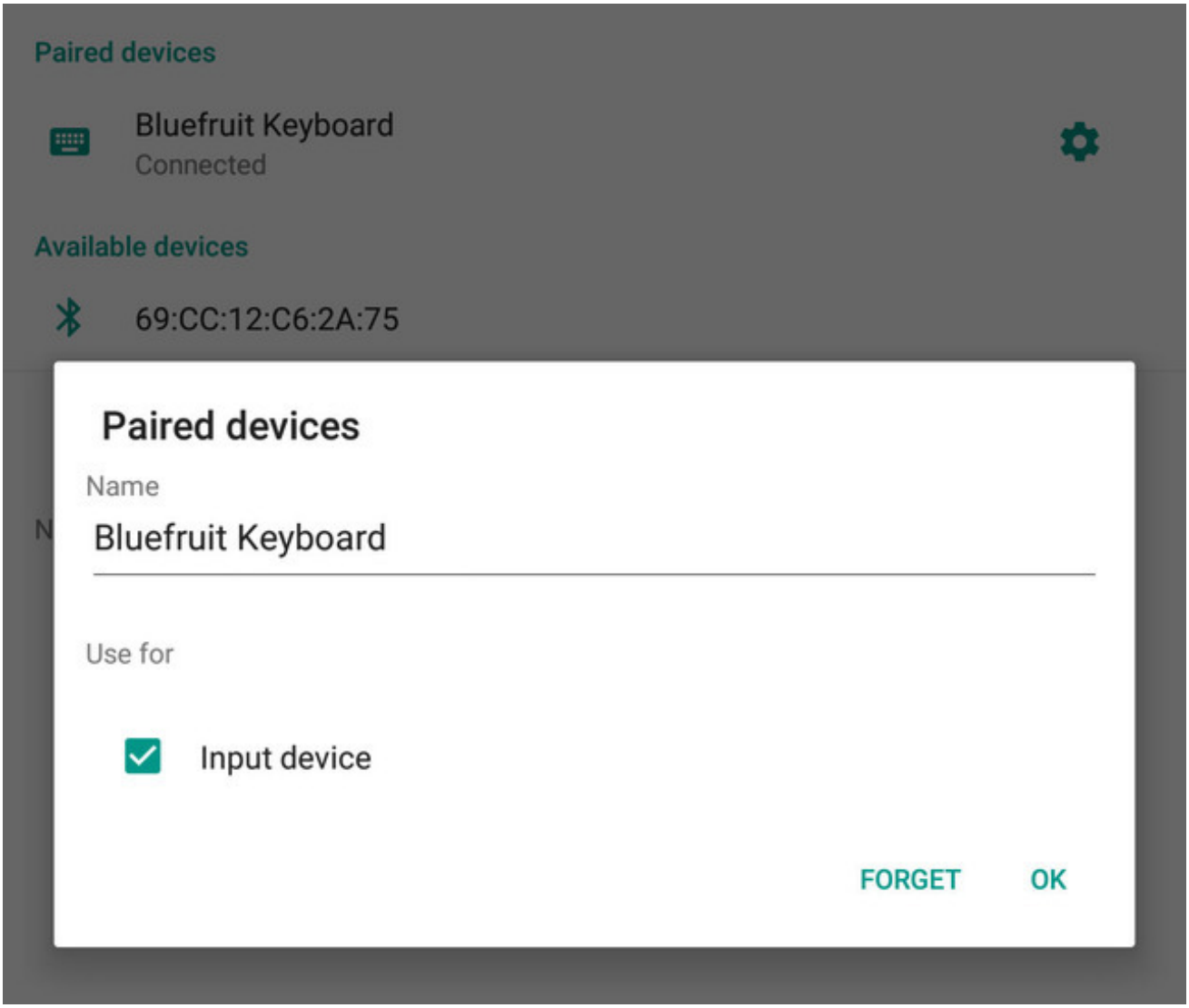


Inside the Bluetooth setting panel you should see the Bluefruit LE module advertising itself as **Bluefruit Keyboard** under the 'Available devices' list:



Tapping the device will start the bonding process, which should end with the Bluefruit Keyboard device being moved to a new 'Paired devices' list with 'Connected' written underneath the device name:

To delete the bonding information, click the gear icon to the right of the device name and the click the **Forget** button:

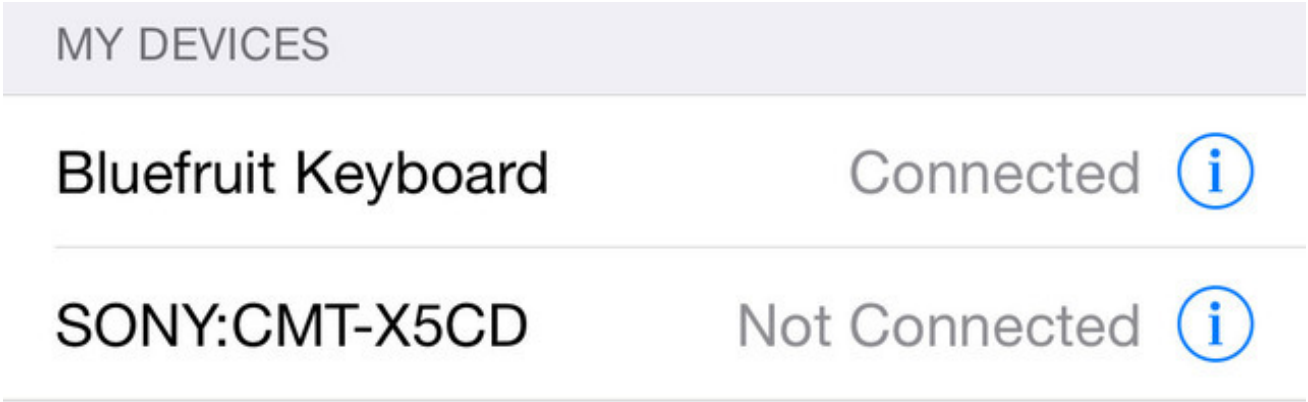


iOS

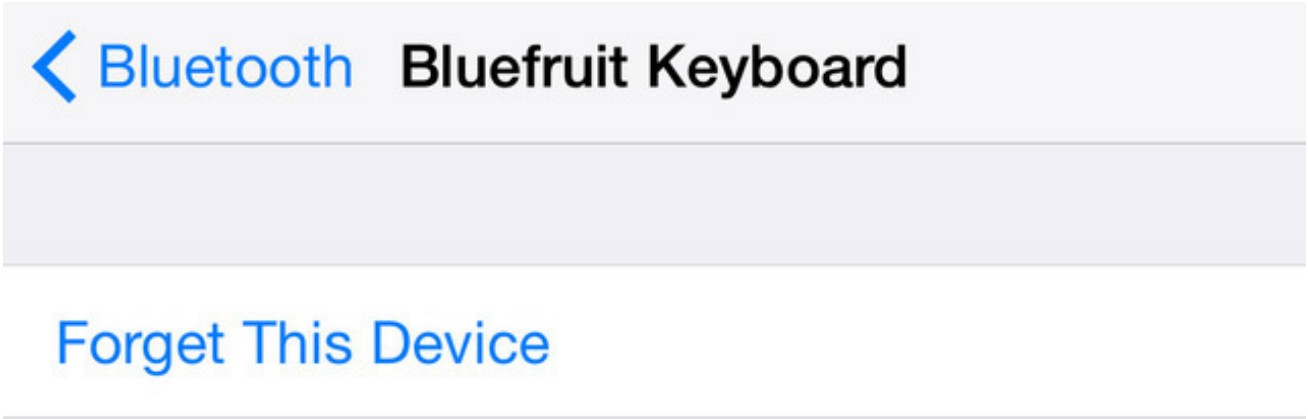
To bond the keyboard on an iOS device, go to the **Settings** application on your phone, and click the **Bluetooth** menu item.

The keyboard should appear under the **OTHER DEVICES** list:

Once the bonding process is complete the device will be moved to the **MY DEVICES** category, and you can start to use the Bluefruit LE module as a keyboard:

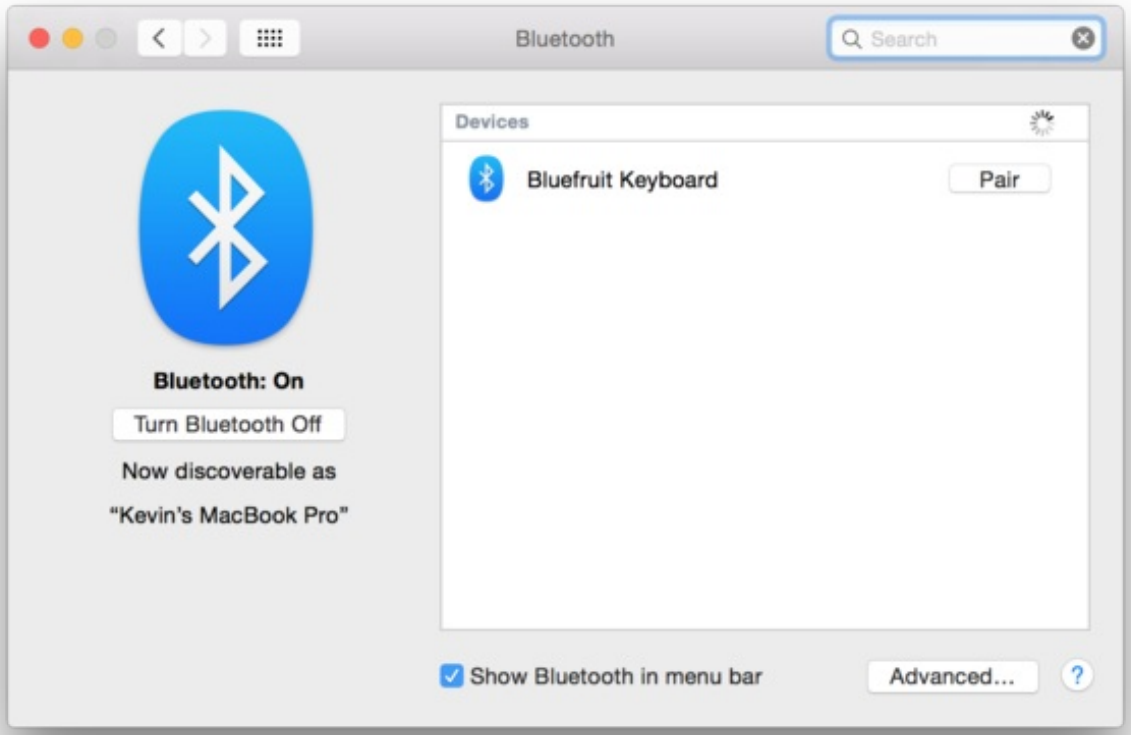


To unbond the device, click the 'info' icon and then select the **Forget this Device** option in the menu:

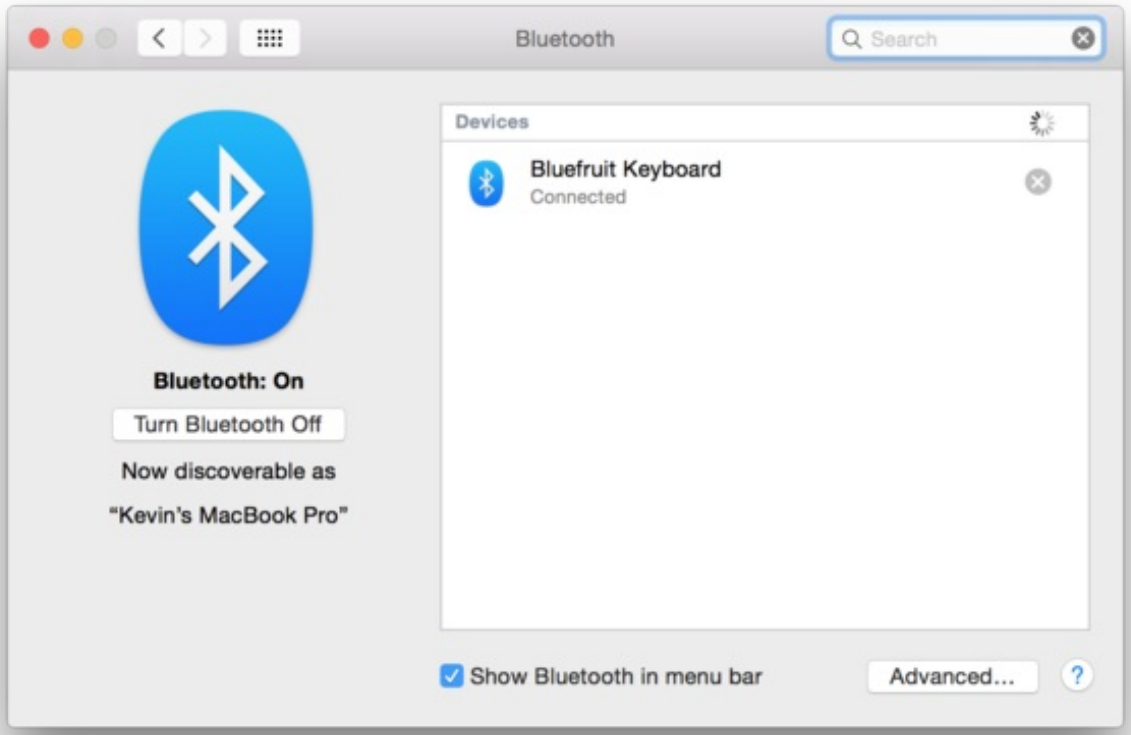


OS X

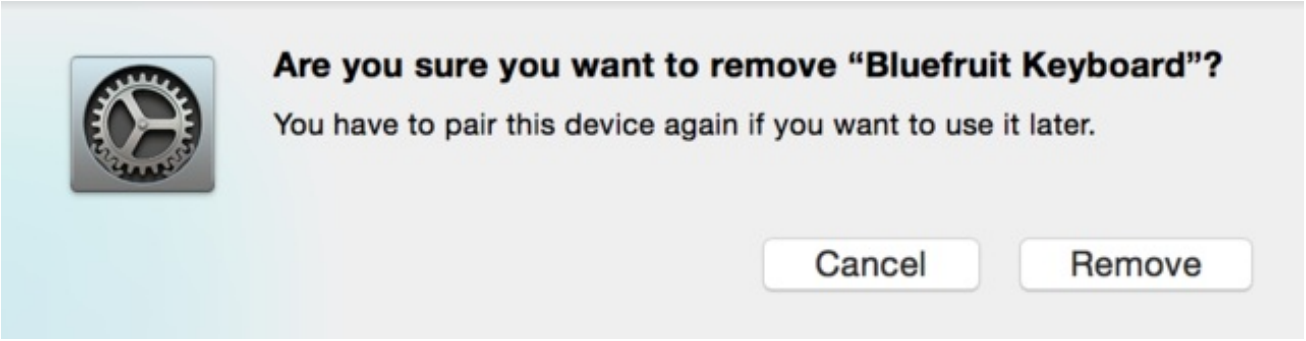
To bond the keyboard on an OS X device, go to the **Bluetooth Preferences** window and click the **Pair** button beside the **Bluefruit Keyboard** device generated by this example sketch:



To unbond the device once it has been paired, click the small 'x' icon beside **Bluefruit Keyboard**:



... and then click the **Remove** button when the confirmation dialogue box pops up:



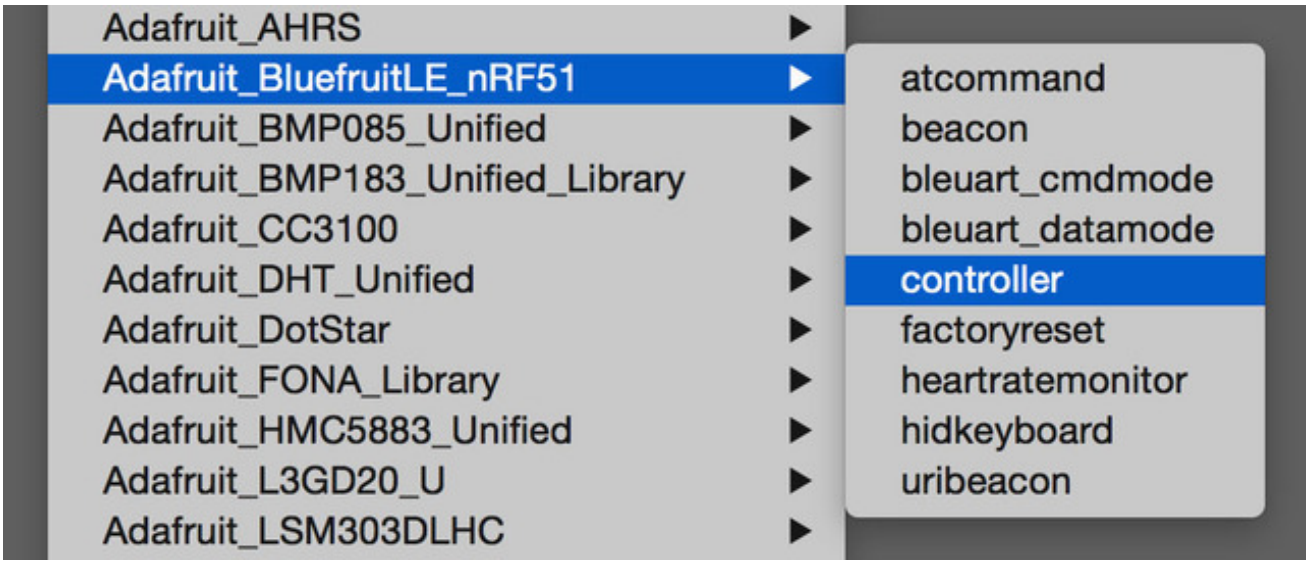
Controller

The **Controller** sketch allows you to turn your BLE-enabled iOS or Android device in a hand-held controller or an external data source, taking advantage of the wealth of sensors on your phone or tablet.

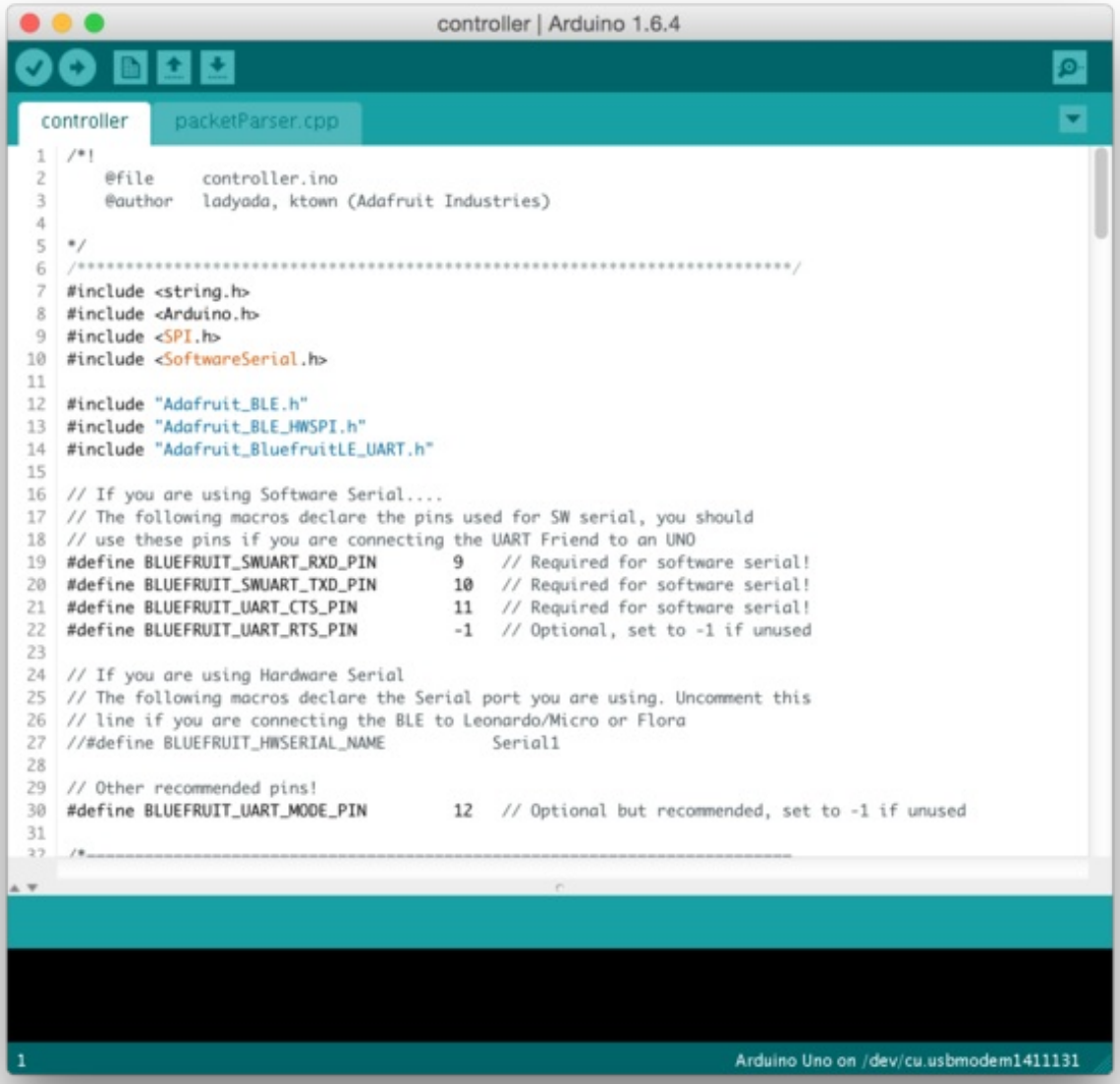
You can take accelerometer or quaternion data from your phone, and push it out to your Arduino via BLE, or get the latest GPS co-ordinates for your device without having to purchase (or power!) any external HW.

Opening the Sketch

To open the Controller sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **controller**:



This will open up a new instance of the example in the IDE, as shown below:



Configuration

Check the Configuration! page earlier to set up the sketch for Software/Hardware UART or Software/Hardware SPI. The default is hardware SPI

If using software or hardware Serial UART:

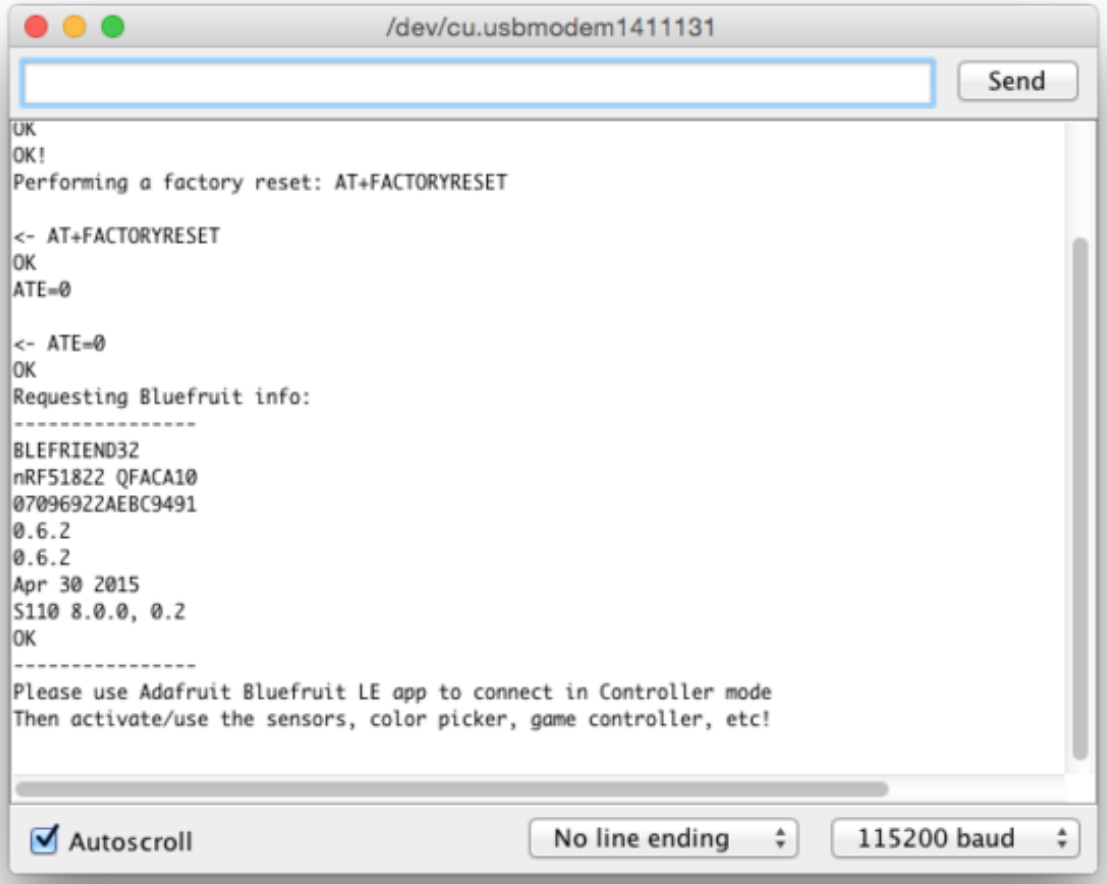
- This tutorial will also be easier to use if you wire up the MODE pin, you can use any pin but our tutorial has pin 12 by default. You can change this to any pin. If you do not set the MODE pin then **make sure you have the mode switch in CMD** mode
- If you are using a Flora or otherwise don't want to wire up the Mode pin, set the BLUEFRUIT_UART_MODE_PIN to -1 in the configuration tab so that the sketch will use the

+++ method to switch between Command and Data mode!

- Don't forget to also **connect the CTS pin on the Bluefruit to ground if you are not using it!** (The Flora has this already done)

Running the Sketch

Once you upload the sketch to your board (via the arrow-shaped upload icon), and the upload process has finished, open up the Serial Monitor via **Tools > Serial Monitor**, and make sure that the baud rate in the lower right-hand corner is set to **115200**:

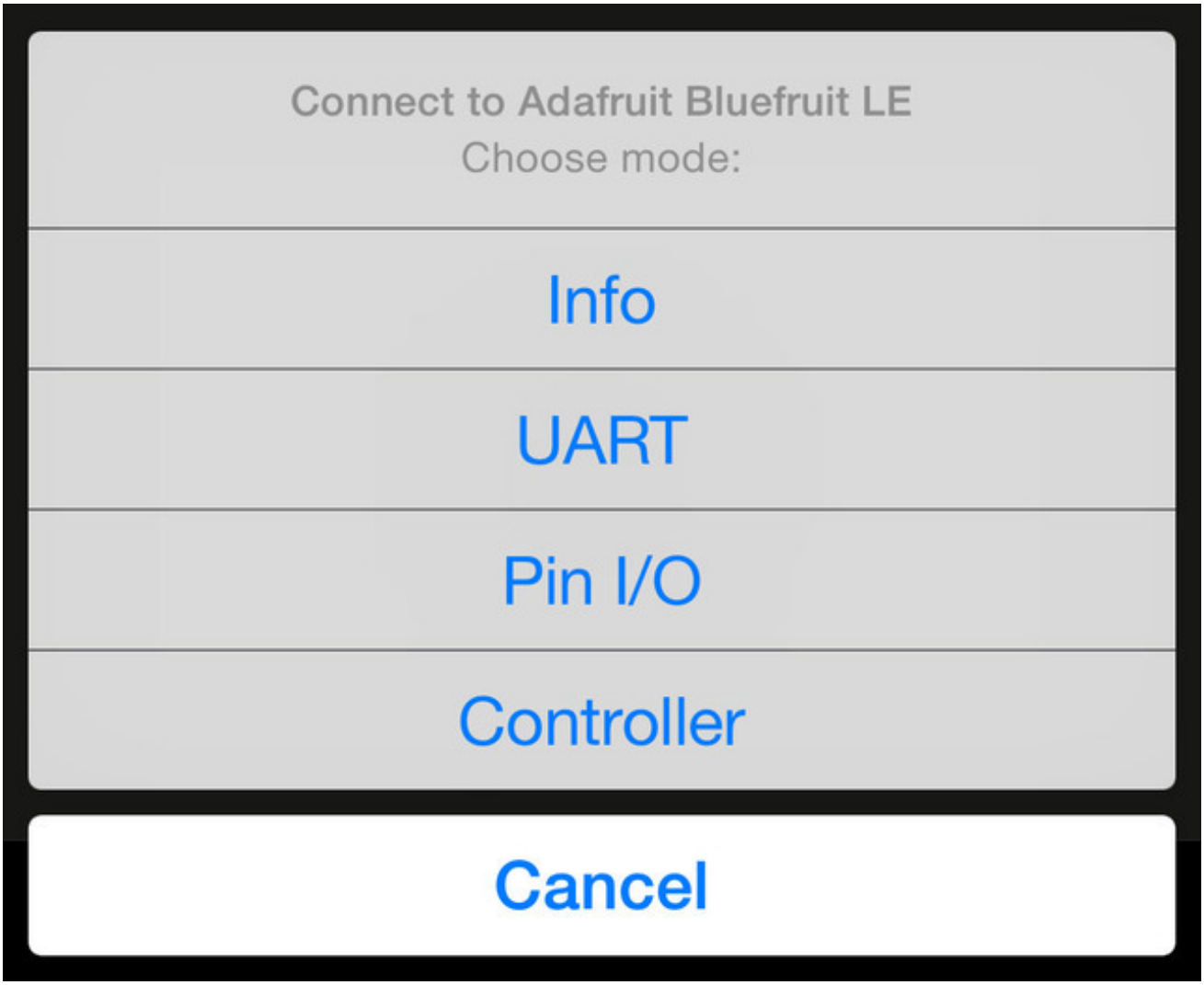


Using Bluefruit LE Connect in Controller Mode

Once the sketch is running you can open Adafruit's Bluefruit LE Connect application (available for Android (http://adafru.it/f4G) or iOS (http://adafru.it/f4H)) and use the **Controller** application to interact with the sketch. (If you're new to Bluefruit LE Connect, have a look at our dedicated Bluefruit LE Connect learning guide (http://adafru.it/iCm).)

On the welcome screen, select the **Adafruit Bluefruit LE** device from the list of BLE devices in range:

Then from the activity list select **Controller**:

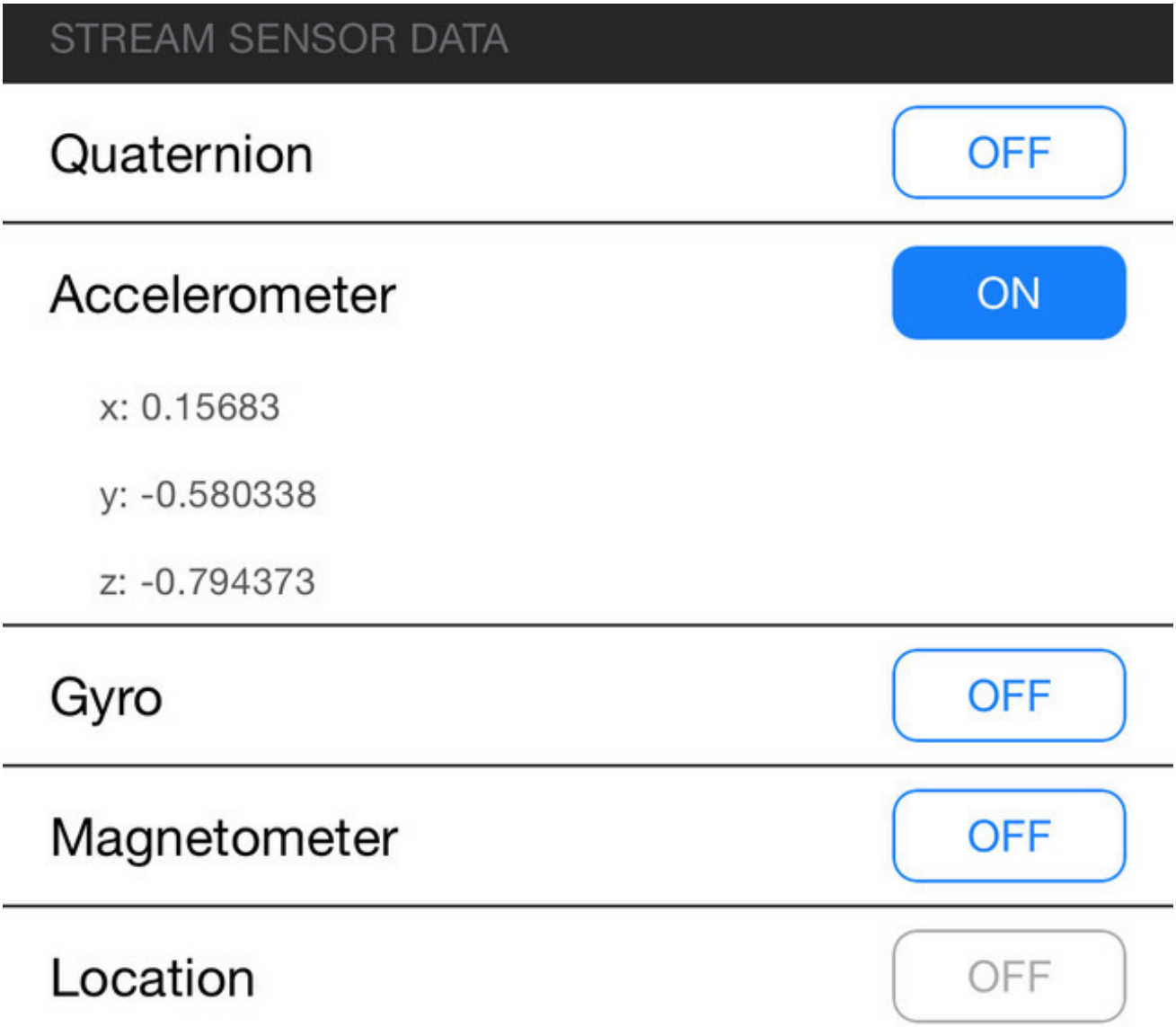


This will bring up a list of data points you can send from your phone or tablet to your Bluefruit LE module, by enabling or disabling the appropriate sensor(s).

Streaming Sensor Data

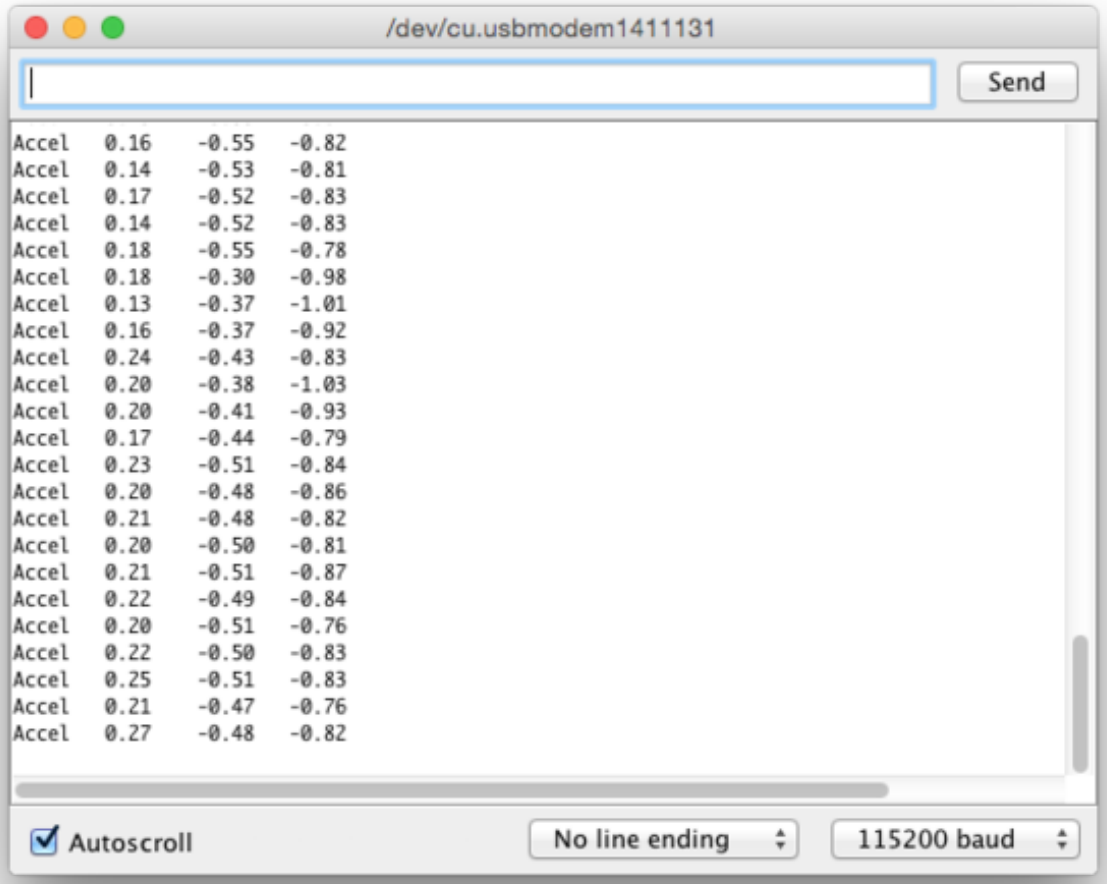
You can take Quaternion (absolute orientation), Accelerometer, Gyroscope, Magnetometer or GPS Location data from your phone and send it directly to your Arduino from the Controller activity.

By enabling the **Accelerometer** field, for example, you should see accelerometer data update in the app:



The data is parsed in the example sketch and output to the Serial Monitor as follows:

```
Accel 0.20 -0.51 -0.76
Accel 0.22 -0.50 -0.83
Accel 0.25 -0.51 -0.83
Accel 0.21 -0.47 -0.76
Accel 0.27 -0.48 -0.82
```

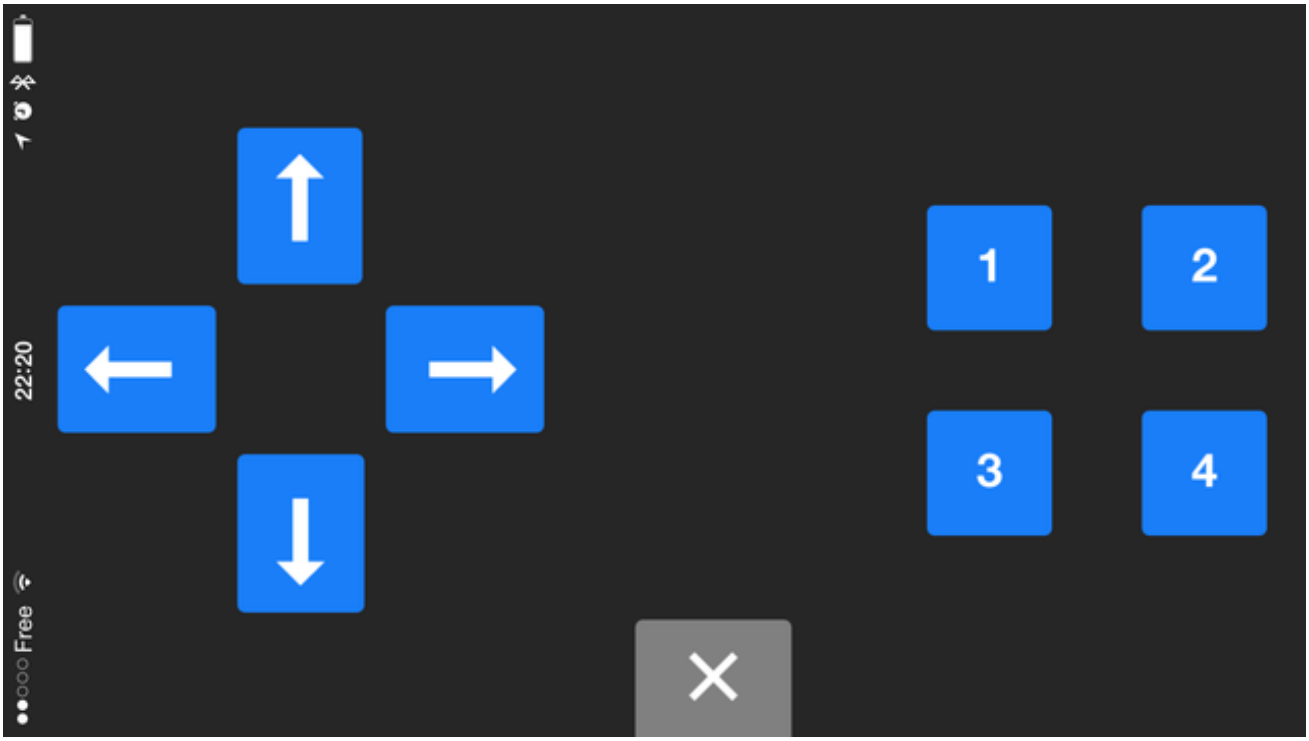


Note that even though we only print 2 decimal points, the values are received from the App as a full 4-byte floating point.

Control Pad Module

You can also use the **Control Pad Module** to capture button presses and releases by selecting the appropriate menu item:

This will bring up the Control Pad panel, shown below:

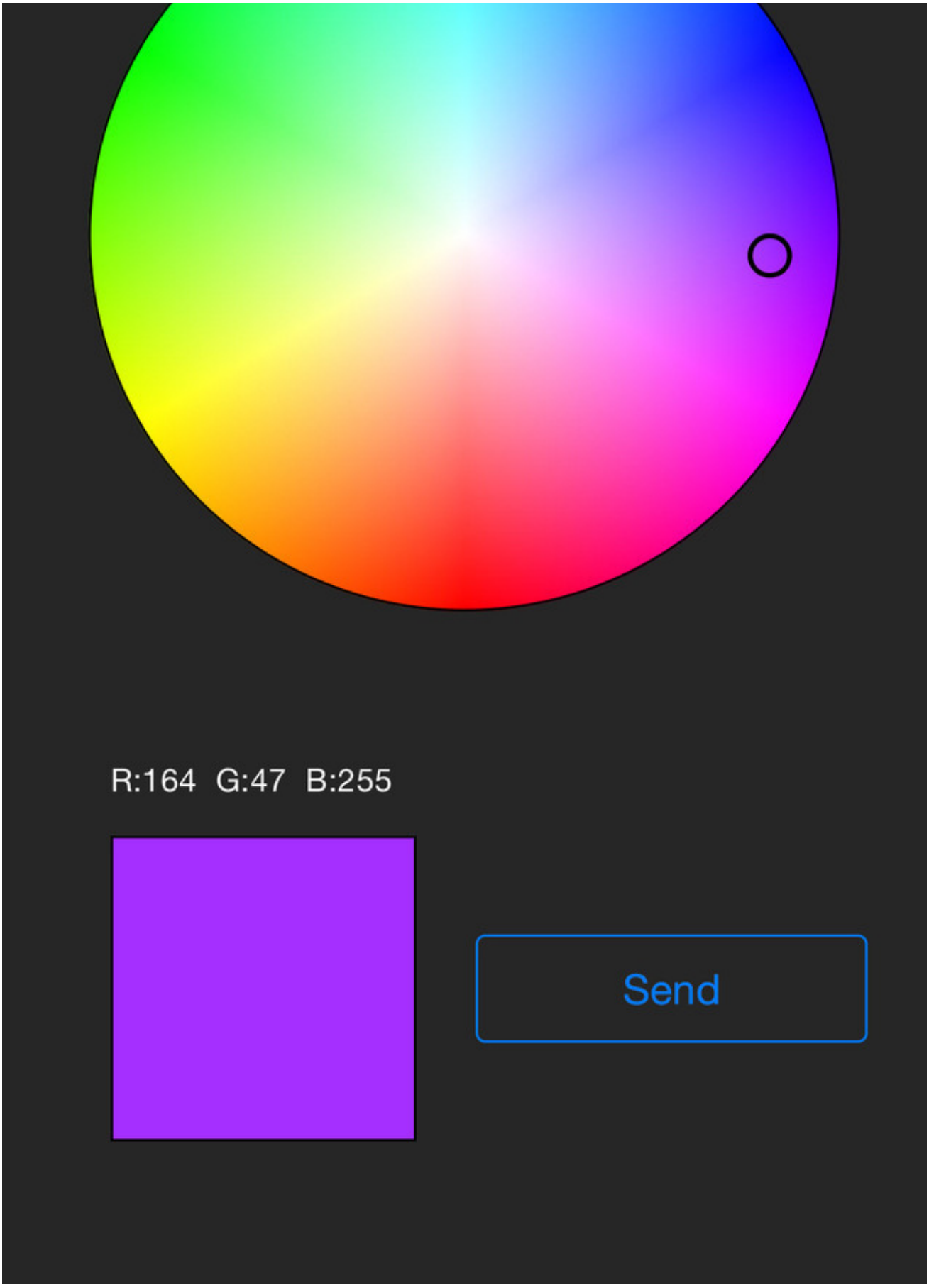


Button presses and releases will all be logged to the Serial Monitor with the ID of the button used:

```
Button 8 pressed
Button 8 released
Button 3 pressed
Button 3 released
```

Color Picker Module

You can also send RGB color data via the **Color Picker** module, which presents the following color selection dialogue:


R:164 G:47 B:255
Send

This will give you Hexadecimal color data in the following format:

```
RGB #A42FFF
```

You can combine the color picker and controller sample sketches to make color-configurable animations triggered by buttons in the mobile app-- very handy for wearables! Download this combined sample code (configured for Feather but easy to adapt to FLORA, BLE Micro, etc.) to get started:

feather_bluefruit_neopixel_animation_controller.zip

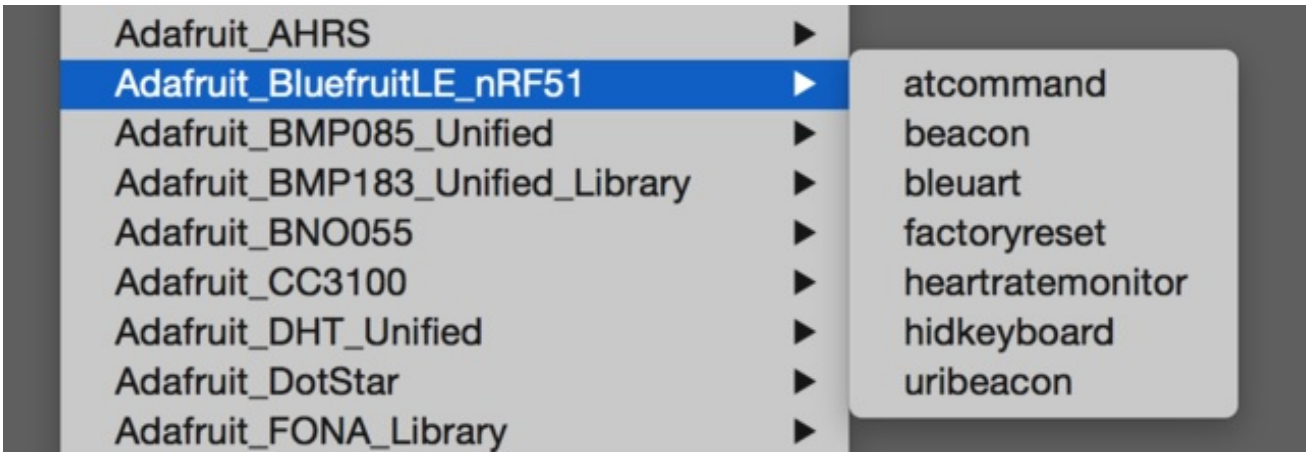
http://adafru.it/kzF

HeartRateMonitor

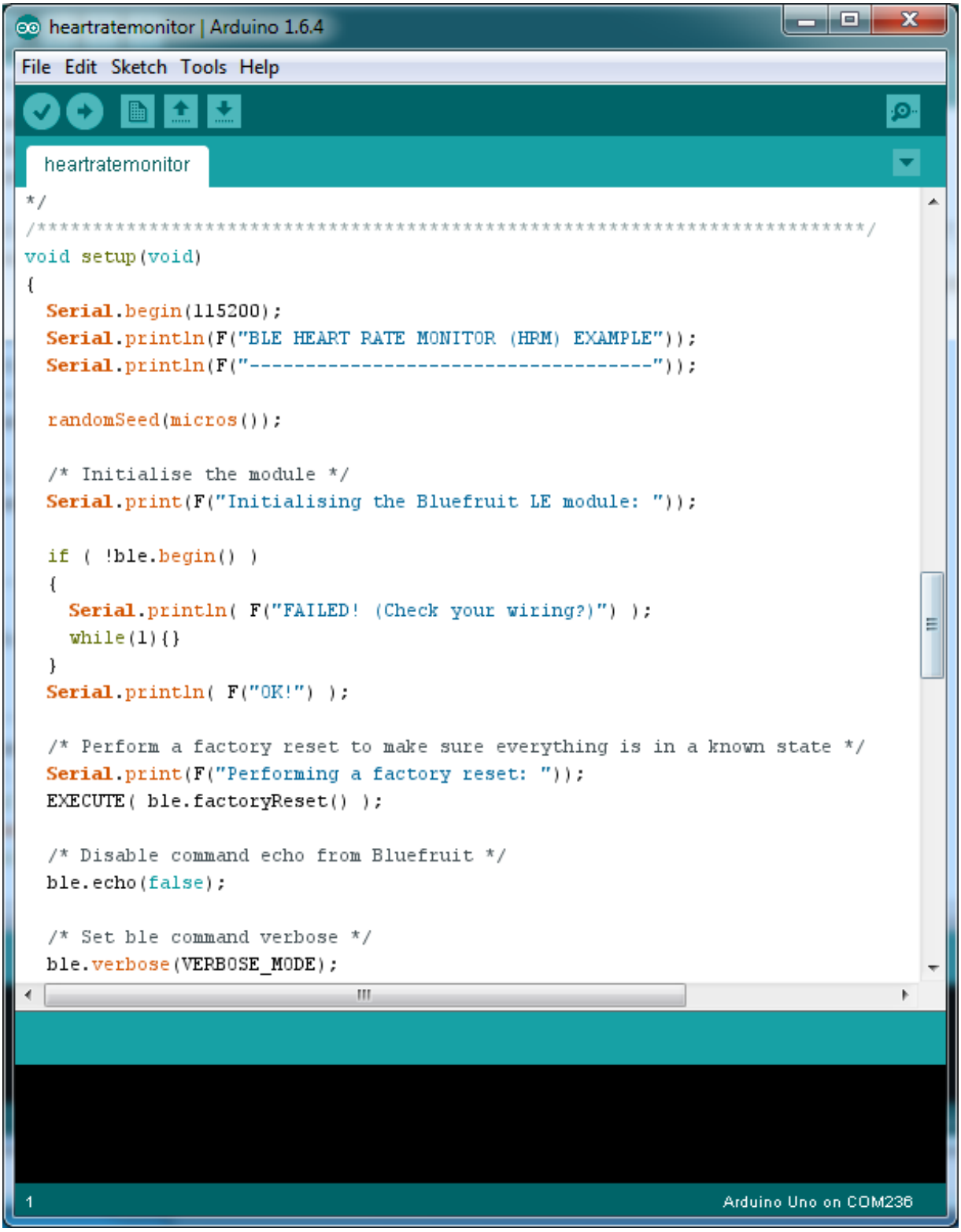
The **HeartRateMonitor** example allows you to define a new GATT Service and associated GATT Characteristics, and update the characteristic values using standard AT commands.

Opening the Sketch

To open the ATCommand sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **heartratemonitor**:



This will open up a new instance of the example in the IDE, as shown below:



Configuration

Check the **Configuration!** page earlier to set up the sketch for Software/Hardware UART or Software/Hardware SPI. The default is hardware SPI

If Using Hardware or Software UART

This tutorial does not need to use the MODE pin, **make sure you have the mode switch in CMD mode** if you do not configure & connect a MODE pin

This demo uses some long data transfer strings, so we recommend defining and connecting both CTS and RTS to pins, even if you are using hardware serial.

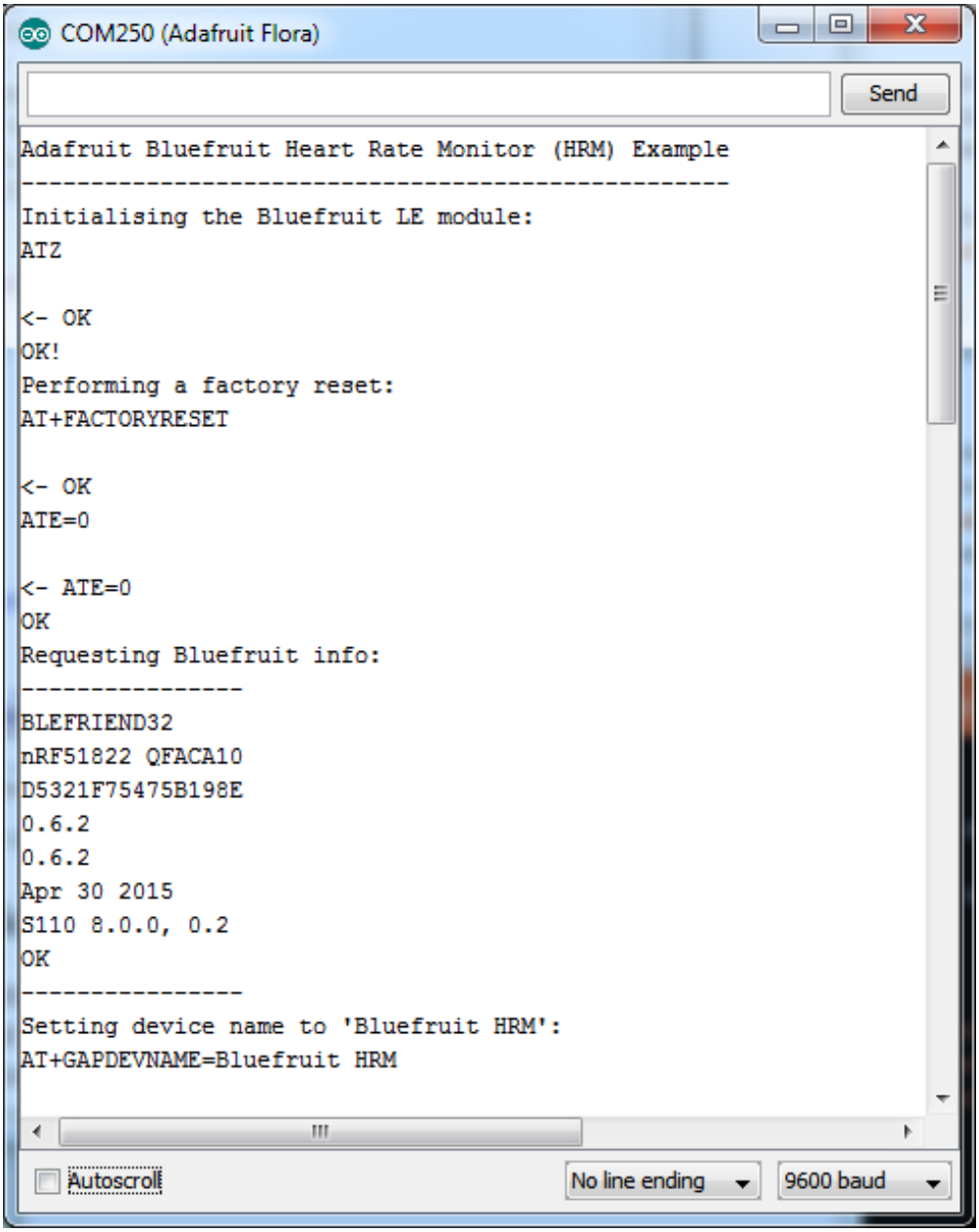
If you are using a Flora or just dont want to connect CTS or RTS, set the pin #define's to -1 and **Don't forget to also connect the CTS pin on the Bluefruit to ground!** (The Flora has this already done)

If you are using RTS and CTS, you can remove this line below, which will slow down the data transmission

```
// this line is particularly required for Flora, but is a good idea
  // anyways for the super long lines ahead!
  ble.setInterCharWriteDelay(5); // 5 ms
```

Running the Sketch

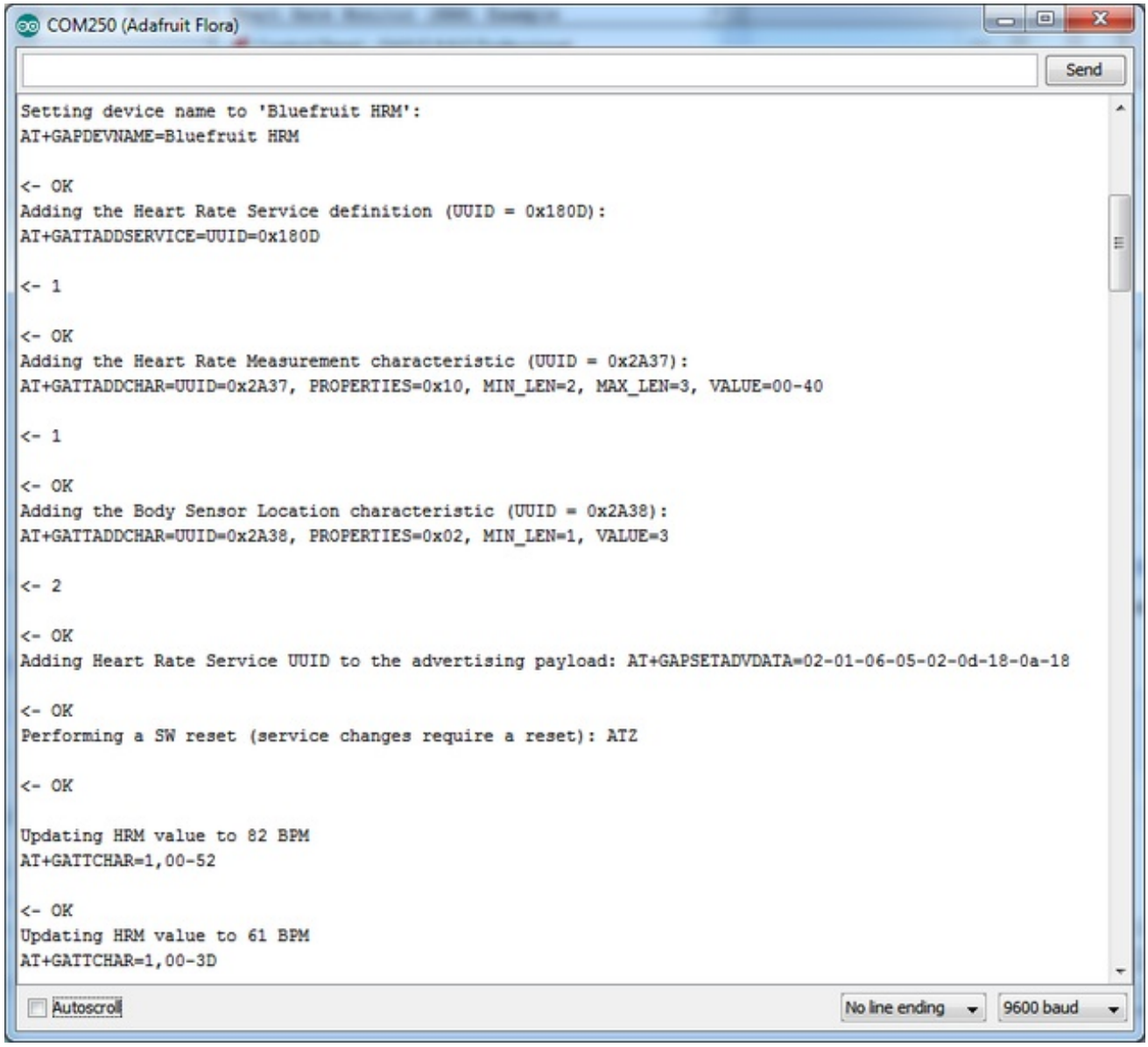
Once you upload the sketch to your board (via the arrow-shaped upload icon), and the upload process has finished, open up the Serial Monitor via **Tools > Serial Monitor**, and make sure that the baud rate in the lower right-hand corner is set to **115200**:


COM250 (Adafruit Flora)
Send
Adafruit Bluefruit Heart Rate Monitor (HRM) Example

Initialising the Bluefruit LE module:
ATZ
<- OK
OK!
Performing a factory reset:
AT+FACTORYRESET
<- OK
ATE=0
<- ATE=0
OK
Requesting Bluefruit info:

BLEFRIEND32
nRF51822 QFACA10
D5321F75475B198E
0.6.2
0.6.2
Apr 30 2015
S110 8.0.0, 0.2
OK

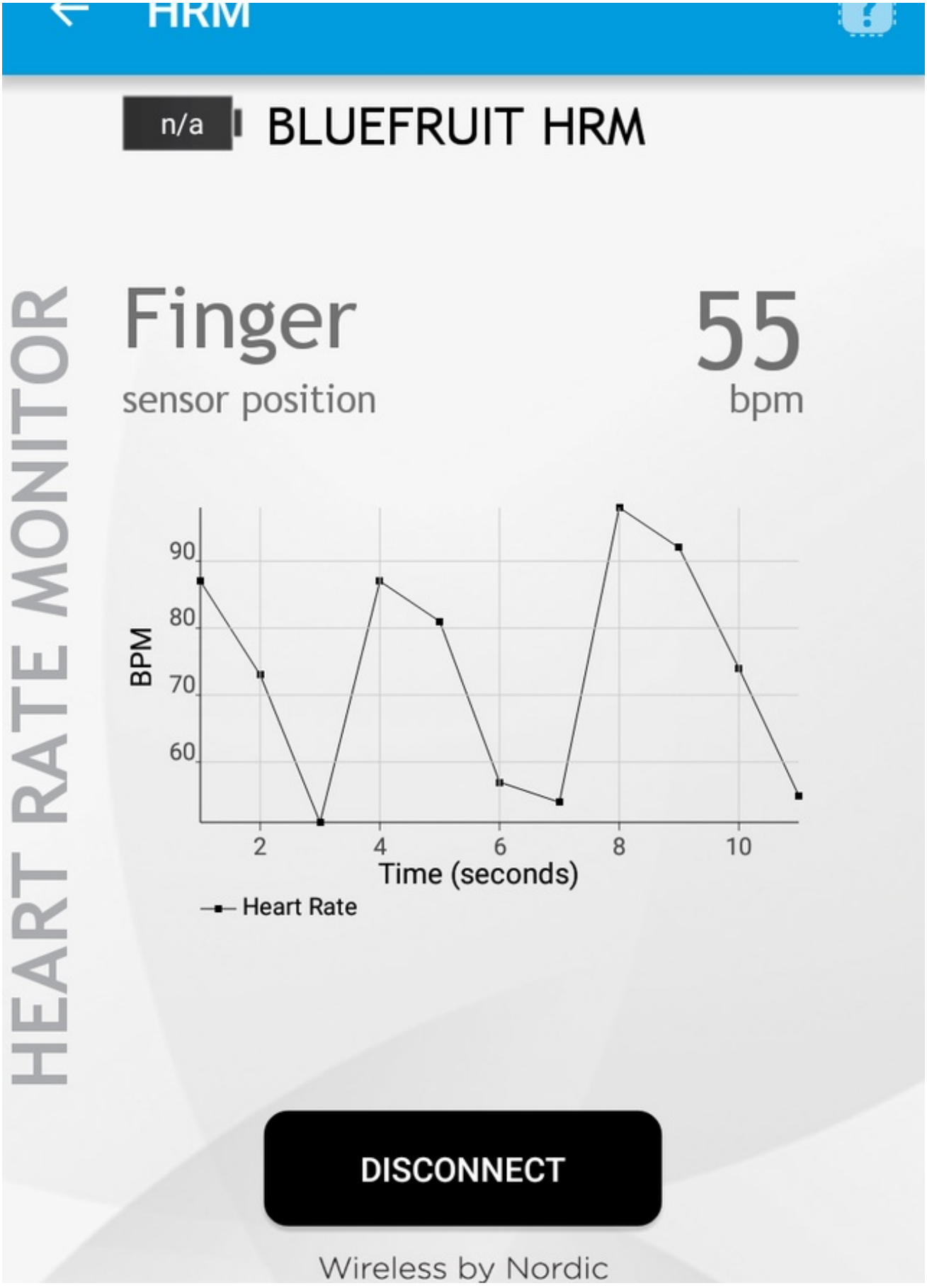
Setting device name to 'Bluefruit HRM':
AT+GAPDEVNAME=Bluefruit HRM
Autoscroll
No line ending
9600 baud

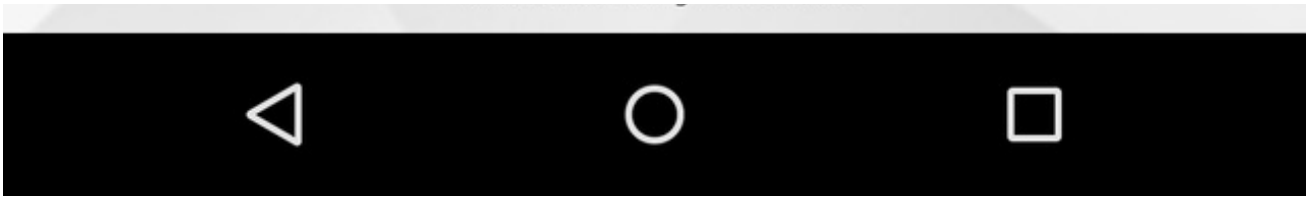


If you open up an application on your mobile device or laptop that support the standard Heart Rate Monitor Service (http://adafru.it/f4I), you should be able to see the heart rate being updated in sync with the changes seen in the Serial Monitor:

nRF Toolbox HRM Example

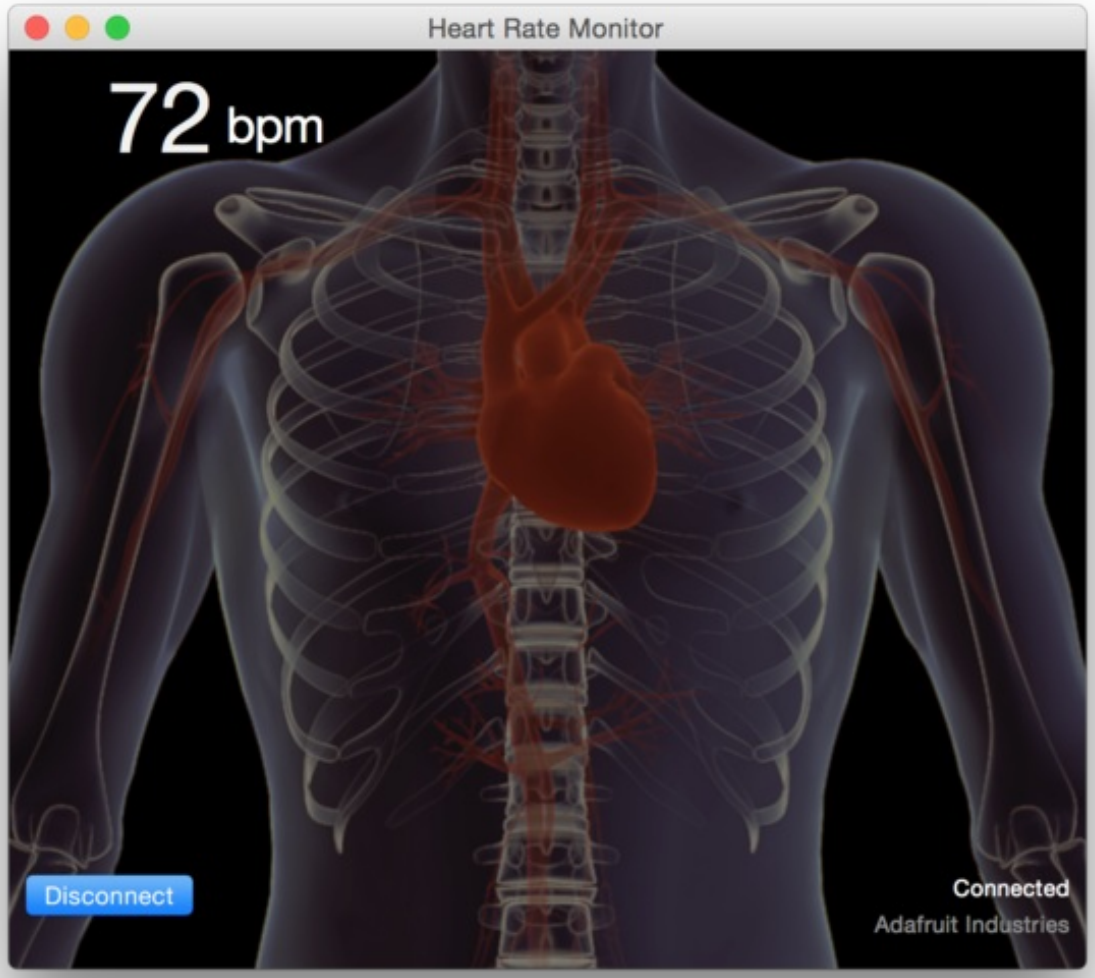
The image below is a screenshot from the free nRF Toolbox (http://adafru.it/e9M) application from Nordic on Android (also available on iOS (http://adafru.it/f4J)), showing the incoming Heart Rate Monitor data:


HRM
n/a
BLUEFRUIT HRM
HEART RATE MONITOR
Finger
sensor position
55
bpm
BPM
90
80
70
60
2
4
6
8
10
Time (seconds)
Heart Rate
DISCONNECT
Wireless by Nordic



CoreBluetooth HRM Example

The image below is from a freely available CoreBluetooth sample application (http://adafru.it/f4K) from Apple showing how to work with Bluetooth Low Energy services and characteristics:

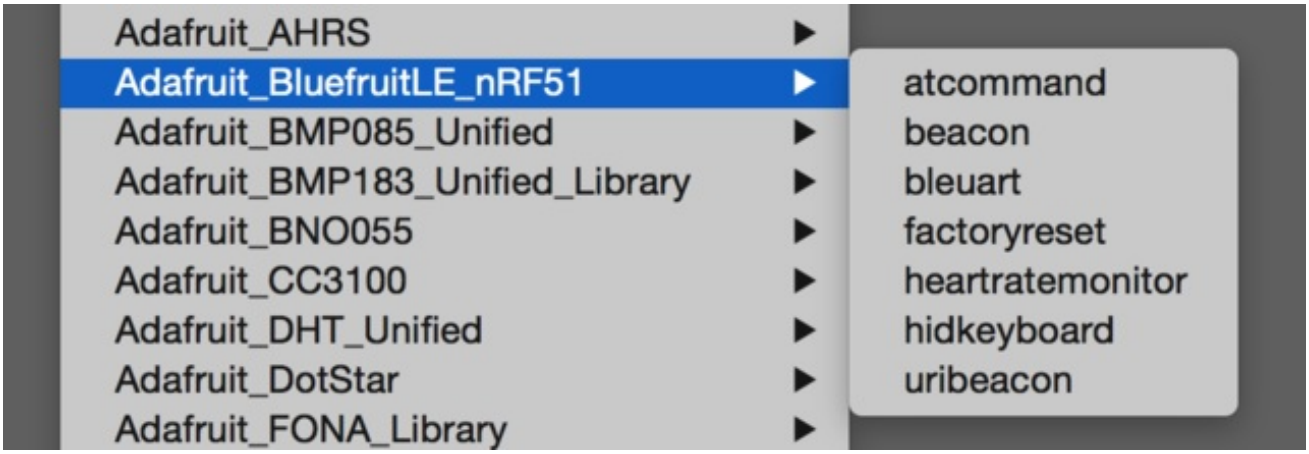


UriBeacon

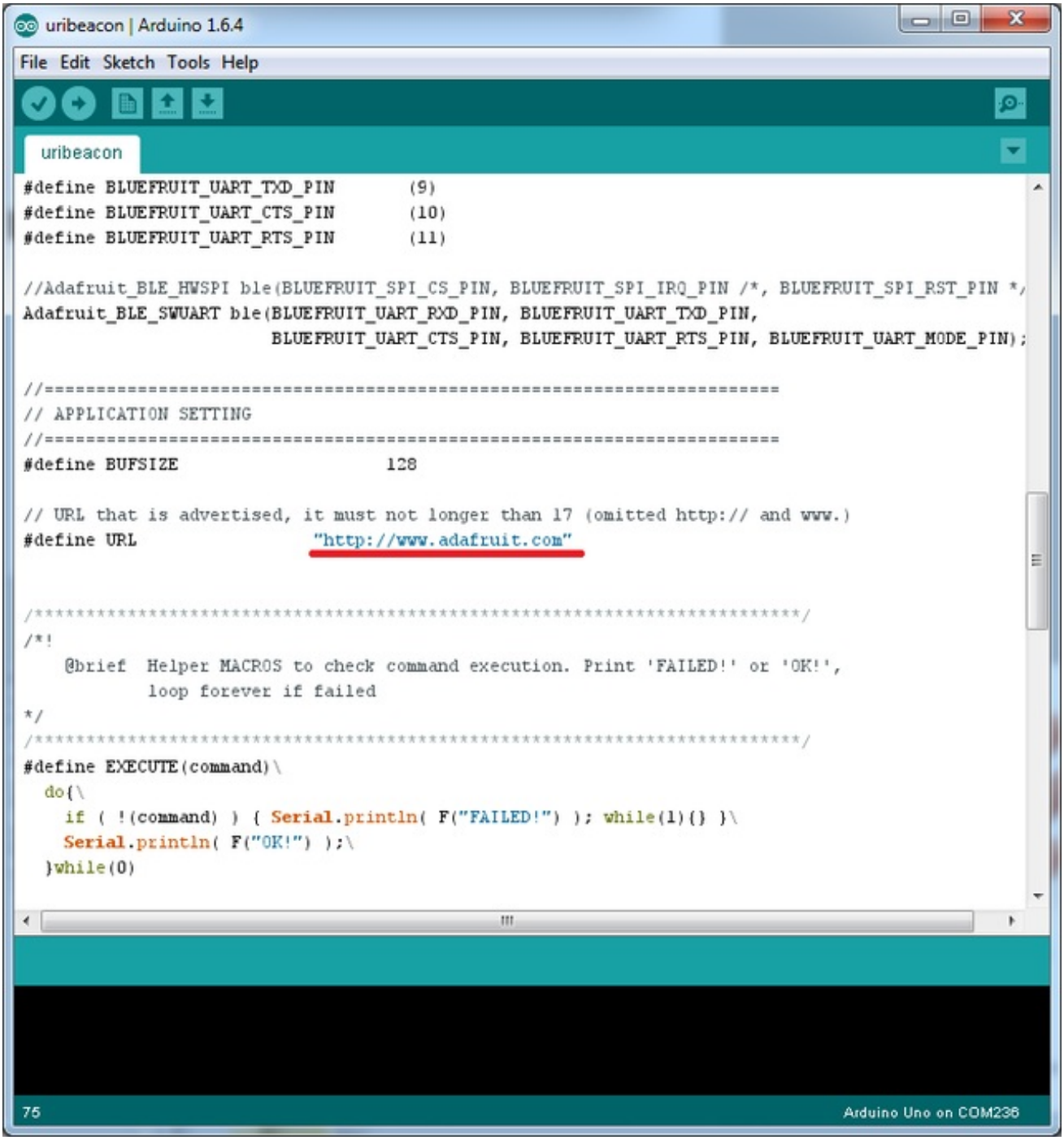
The **UriBeacon** example shows you how to use the built-in UriBeacon AT commands to configure the Bluefruit LE module as a UriBeacon advertiser, following Google's Physical Web UriBeacon (http://adafru.it/edk) specification.

Opening the Sketch

To open the ATCommand sketch, click on the **File > Examples > Adafruit_BluefruitLE_nRF51** folder in the Arduino IDE and select **uribeacon**:



This will open up a new instance of the example in the IDE, as shown below. You can edit the URL that the beacon will point to, from the default **http://www.adafruit.com** or just upload as is to test



Configuration

Check the **Configuration!** page earlier to set up the sketch for Software/Hardware UART or Software/Hardware SPI. The default is hardware SPI

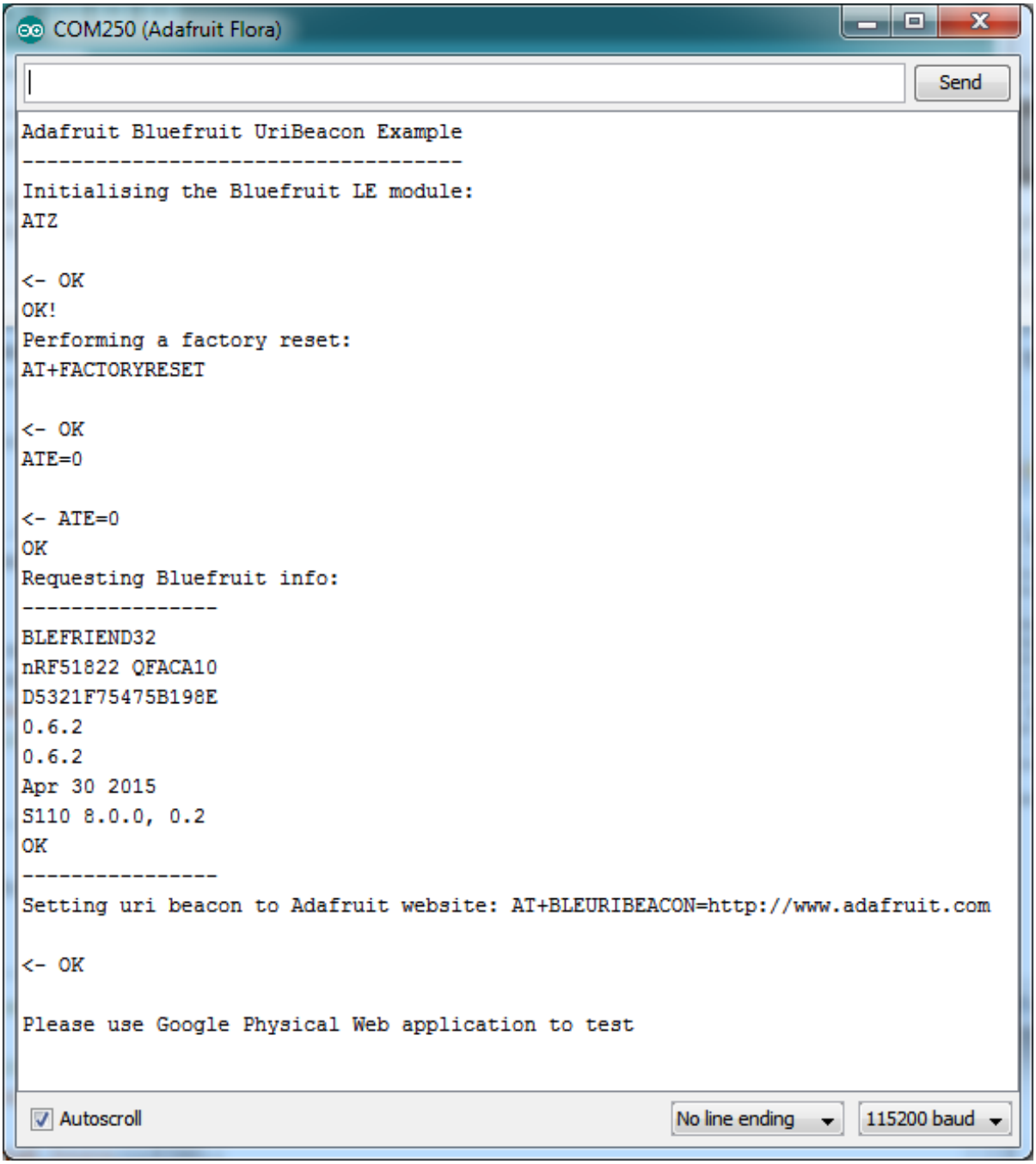
If using software or hardware Serial UART:

- This tutorial does not need to use the MODE pin, **make sure you have the mode switch in CMD mode** if you do not configure & connect a MODE pin

- Don't forget to also **connect the CTS pin on the Bluefruit to ground if you are not using it!** (The Flora has this already done)

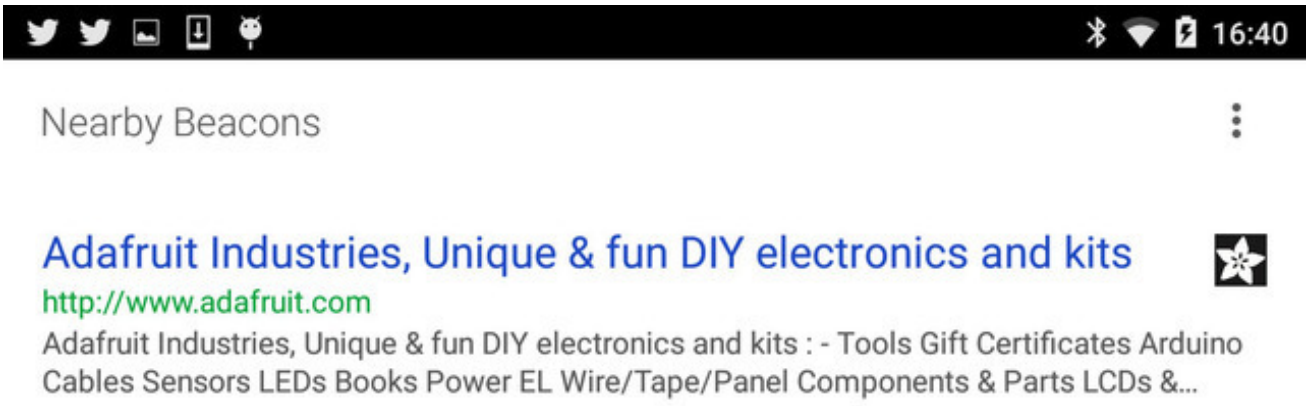
Running the Sketch

Once you upload the sketch to your board (via the arrow-shaped upload icon), and the upload process has finished, open up the Serial Monitor via **Tools > Serial Monitor**, and make sure that the baud rate in the lower right-hand corner is set to **115200**:



At this point you can open the Physical Web Application for Android (http://adafru.it/edi) or for

iOS (http://adafru.it/edj), and you should see a link advertising Adafruit's website:



HALP!

When using the Bluefruit Micro or a Bluefruit LE with Flora/Due/Leonardo/Micro the examples dont run?

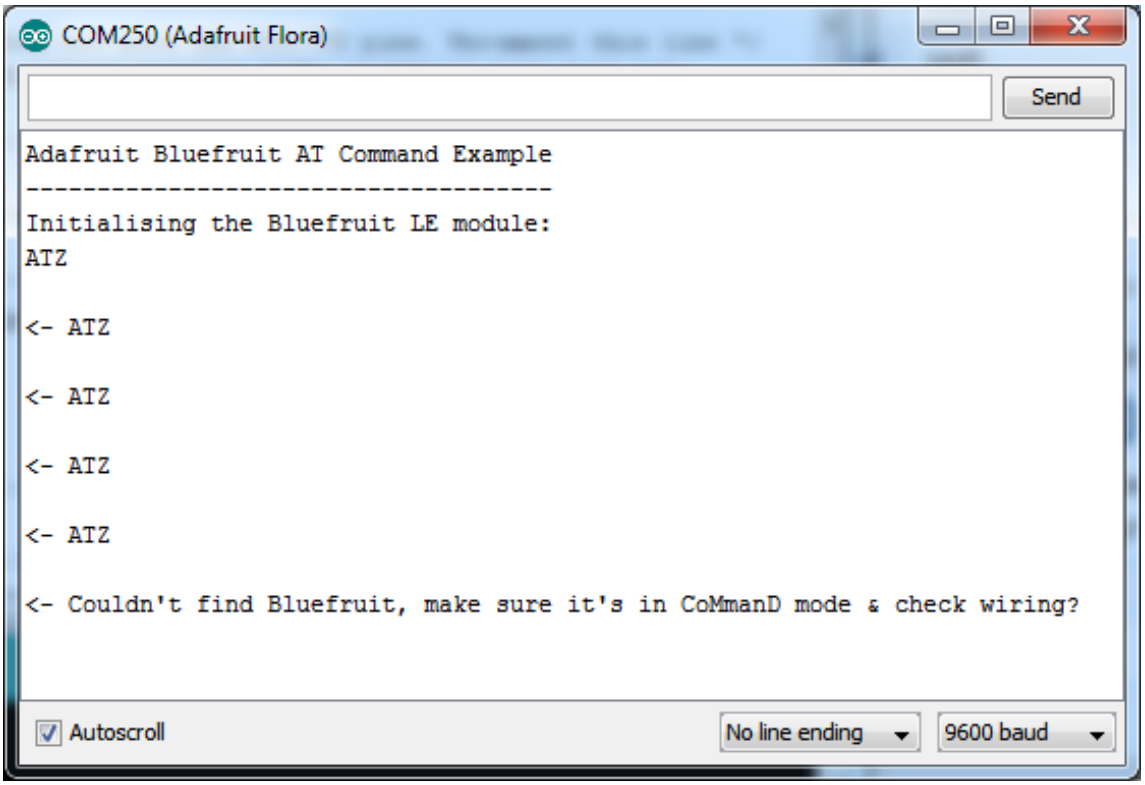
We add a special line to **setup()** to make it so the Arduino will halt until it sees you've connected over the Serial console. This makes debugging great but makes it so you cannot run the program disconnected from a computer.

Solution? Once you are done debugging, remove these two lines from setup()

```
while (!Serial);
delay(500);
```

I can't seem to "Find" the Bluefruit LE!

Getting something like this?



For UART/Serial Bluefruits:

- Check you have the **MODE** switch in CMD and the MODE pin not wired to anything if it isnt used!
- If you are trying to control the **MODE** from your micro, make sure you set the MODE pin in the sketch
- Make sure you have **RXI** and **TXO** wired right! They are often swapped by accident

- Make sure **CTS** is tied to GND if you are using hardware serial and not using CTS
- Check the MODE red LED, is it blinking? If its blinking continuously, you might be in DFU mode, power cycle the module!
- If you are using Hardware Serial/Software Serial make sure you know which one and have that set up

If using SPI Bluefruit:

- Make sure you have all 5 (or 6) wires connected properly.
- If using hardware SPI, you need to make sure you're connected to the hardware SPI port, which differs depending on the main chipset.

If using Bluefruit Micro:

- Make sure you change the **RESET** pin to #4 in any Config file. Also be sure you are using hardware SPI to connect!

AT Commands

The Bluefruit LE modules use a Hayes AT-style command set (http://adafru.it/ebJ)to configure the device.

The advantage of an AT style command set is that it's easy to use in machine to machine communication, while still being somewhat user friendly for humans.

Test Command Mode '=?'

'Test' mode is used to check whether or not the specified command exists on the system or not.

Certain firmware versions or configurations may or may not include a specific command, and you can determine if the command is present by taking the command name and appending **'=?'** to it, as shown below

```
AT+BLESTARTADV=?
```

If the command is present, the device will reply with **'OK'**. If the command is not present, the device will reply with **'ERROR'**.

```
AT+BLESTARTADV=?
OK\r\n
AT+MISSINGCMD=?
ERROR\r\n
```

Write Command Mode '=xxx'

'Write' mode is used to assign specific value(s) to the command, such as changing the radio's transmit power level using the command we used above.

To write a value to the command, simple append an **'='** sign to the command followed by any paramater(s) you wish to write (other than a lone **'?'** character which will be interpretted as tet mode):

```
AT+BLEPOWERLEVEL=-8
```

If the write was successful, you will generally get an **'OK'** response on a new line, as shown below:

```
AT+BLEPOWERLEVEL=-8
OK\r\n
```

If there was a problem with the command (such as an invalid parameter) you will get an **'ERROR'** response on a new line, as shown below:

```
AT+BLEPOWERLEVEL=3
ERROR\r\n
```

Note: This particular error was generated because '3' is not a valid value for the AT+BLEPOWERLEVEL command. Entering '-4', '0' or '4' *would* succeed since these are all valid values for this command.

Execute Mode

'Execute' mode will cause the specific command to 'run', if possible, and will be used when the command name is entered with no additional parameters.

```
AT+FACTORYRESET
```

You might use execute mode to perform a factory reset, for example, by executing the AT+FACTORYRESET command as follows:

```
AT+FACTORYRESET
OK\r\n
```

NOTE: Many commands that are means to be read will perform the same action whether they are sent to the command parser in 'execute' or 'read' mode. For example, the following commands will produce identical results:

```
AT+BLEGETPOWERLEVEL
-4\r\n
OK\r\n
AT+BLEGETPOWERLEVEL?
-4\r\n
OK\r\n
```

If the command doesn't support execute mode, the response will normally be **'ERROR'** on a new line.

Read Command Mode '?'

'Read' mode is used to read the current value of a command.

Not every command supports read mode, but you generally use this to retrieve information like the current transmit power level for the radio by appending a **'?'** to the command, as shown below:

```
AT+BLEPOWERLEVEL?
```

If the command doesn't support read mode or if there was a problem with the request, you will normally get an **'ERROR'** response.

If the command read was successful, you will normally get the read results followed by **'OK'** on a new line, as shown below:

```
AT+BLEPOWERLEVEL?
-4\r\n
OK\r\n
```

Note: For simple commands, 'Read' mode and 'Execute' mode behave identically.

Standard AT

The following standard Hayes/AT commands are available on Bluefruit LE modules:

AT

Acts as a ping to check if we are in command mode. If we are in command mode, we should receive the 'OK' response.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
AT
OK
```

ATI

Displays basic information about the Bluefruit module.

Codebase Revision: 0.3.0

Parameters: None

Output: Displays the following values:

- Board Name
- Microcontroller/Radio SoC Name
- Unique Serial Number
- Core Bluefruit Codebase Revision
- Project Firmware Revision
- Firmware Build Date
- Softdevice, Softdevice Version, Bootloader Version (0.5.0+)

```
ATI
BLEFRIEND
nRF51822 QFAAG00
FB462DF92A2C8656
0.5.0
0.5.0
Feb 24 2015
S110 7.1.0, 0.0
OK
```

Updates:

- Version **0.4.7+** of the firmware adds the chip revision after the chip name if it can be detected (ex. 'nRF51822 QFAAG00').
- Version **0.5.0+** of the firmware adds a new 7th record containing the softdevice, softdevice version and bootloader version (ex. 'S110 7.1.0, 0.0').

ATZ

Performs a system reset.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
ATZ
OK
```

ATE

Enables or disables echo of input characters with the AT parser

Codebase Revision: 0.3.0

Parameters: '1' = enable echo, '0' = disable echo

Output: None

```
# Disable echo support
ATE=0
OK
#Enable echo support
ATE=1
OK
```

+++

Dynamically switches between DATA and COMMAND mode without changing the physical CMD/UART select switch.

When you are in COMMAND mode, entering '+++\n' or '+++\r\n' will cause the module to switch to DATA mode, and anything typed into the console will go direct to the BLUE UART service.

To switch from DATA mode back to COMMAND mode, simply enter '+++\n' or '+++\r\n' again (be sure to include the new line character!), and a new 'OK' response will be displayed letting you know that you are back in COMMAND mode (see the two 'OK' entries in the sample code below).

Codebase Revision: 0.4.7

Parameters: None

Output: None

> Note that +++ can also be used on the mobile device to send and receive AT command on iOS or Android, though this should always be used with care.

```
ATI
BLEFRIEND
nRF51822 QFAAG00
B122AAC33F3D2296
0.4.6
0.4.6
Dec 22 2014
OK
+++
OK
OK
```

General Purpose

The following general purpose commands are available on all Bluefruit LE modules:

AT+FACTORYRESET

Clears any user config data from non-volatile memory and performs a factory reset before resetting the Bluefruit module.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
AT+FACTORYRESET
OK
```

> As of version 0.5.0+ of the firmware, you can perform a factory reset by holding the DFU button down for 10s until the blue CONNECTED LED lights up, and then releasing the button.

AT+DFU

Forces the module into DFU mode, allowing over the air firmware updates using a dedicated DFU app on iOS or Android.

Codebase Revision: 0.3.0

Parameters: None

Output: None

> The AT parser will no longer responsd after the AT+DFU command is entered, since normal program execution effectively halts and a full system reset is performed to start the bootloader code

```
AT+DFU
OK
```

AT+HELP

Displays a comma-separated list of all AT parser commands available on the system.

Codebase Version: 0.3.0

Parameters: None

Output: A comma-separated list of all AT parser commands available on the system.

> The sample code below may not match future firmware releases and is provided for illustration purposes only

```
AT+HELP
AT+FACTORYRESET,AT+DFU,ATZ,ATI,ATE,AT+DBGMEMRD,AT+DBGNVMRD,AT+HWLEDPOLARITY,AT-
OK
```

Hardware

The following commands allow you to interact with the low level HW on the Bluefruit LE module, such as reading or toggling the GPIO pins, performing an ADC conversion ,etc.:

AT+HWADC

Performs an ADC conversion on the specified ADC pin

Codebase Revision: 0.3.0

Parameters: The ADC channel (0..7)

Output: The results of the ADC conversion

```
AT+HWADC=0
178
OK
```

AT+HWGETDIETEMP

Gets the temperature in degree celcius of the BLE module's die. This can be used for debug purposes (higher die temperature generally means higher current consumption), but does not corresponds to ambient temperature and can nto be used as a replacement for a normal temperature sensor.

Codebase Revision: 0.3.0

Parameters: None

Output: The die temperature in degrees celcius

```
AT+HWGETDIETEMP
32.25
OK
```

AT+HWGPIO

Gets or sets the value of the specified GPIO pin (depending on the pin's mode).

Codebase Revision: 0.3.0

Parameters: The parameters for this command change depending on the pin mode.

OUTPUT MODE: The following comma-separated parameters can be used when updating a pin that is set as an output:

- Pin numbers
- Pin state, where:
    - 0 = clear the pin (logic low/GND)
    - 1 = set the pin (logic high/VCC)

INPUT MODE: To read the current state of an input pin or a pin that has been configured as an output, enter the pin number as a single parameter.

Output: The pin state if you are reading an input or checking the state of an input pin (meaning only 1 parameter is supplied, the pin number), where:

- 0 means the pin is logic low/GND
- 1 means the pin is logic high/VCC

Trying to set the value of a pin that has not been configured as an output will produce an 'ERROR' response.

Some pins are reserved for specific functions on Bluefruit modules and can not be used as GPIO. If you try to make use of a reserved pin number an 'ERROR' response will be generated.

```
# Set pin 14 HIGH
AT+HWGPIO=14,1
OK

# Set pin 14 LOW
AT+HWGPIO=14,0
OK

# Read the current state of pin 14
AT+HWGPIO=14
0
OK

# Try to update a pin that is not set as an output
AT+HWGPIOMODE=14,0
OK
AT+HWGPIO=14,1
ERROR
```

AT+HWGPIOMODE

This will set the mode for the specified GPIO pin (input, output, etc.).

Codebase Revision: 0.3.0

Parameters: This command one or two values (comma-separated in the case of two parameters being used):

- The pin number
- The new GPIO mode, where:
    - 0 = Input
    - 1 = Output
    - 2 = Input with pullup enabled
    - 3 = Input with pulldown enabled

Output: If a single parameters is passed (the GPIO pin number) the current pin mode will be returned.

> Some pins are reserved for specific functions on Bluefruit modules and can not be used as GPIO. If you try to make use of a reserved pin number an 'ERROR' response will be generated.

```
# Configure pin 14 as an output
AT+HWGPIOMODE=14,0
OK

# Get the current mode for pin 14
AT+HWPGIOMODE=14
0
OK
```

AT+HWI2CSCAN

Scans the I2C bus to try to detect any connected I2C devices, and returns the address of devices that were found during the scan process.

Codebase Revision: 0.3.0

Parameters: None

Output: A comma-separated list of any I2C address that were found while scanning the valid address range on the I2C bus, or nothing is no devices were found.

```
# I2C scan with two devices detected
AT+HWI2CSCAN
0x23,0x35
OK

# I2C scan with no devices detected
AT+HWI2CSCAN
OK
```

AT+HWVBAT

Returns the main power supply voltage level in millivolts

Codebase Revision: 0.3.0

Parameters: None

Output: The VBAT level in millivolts

```
AT+HWVBAT
3248
OK
```

AT+HWRANDOM

Generates a random 32-bit number using the HW random number generator on the nRF51822 (based on white noise).

Codebase Revision: 0.4.7

Parameters: None

Output: A random 32-bit hexadecimal value (ex. '0x12345678')

```
AT+HWRANDOM
0x769ED823
OK
```

AT+HWMODELED

Allows you to override the default behaviour of the MODE led (which indicates the operating mode by default).

Codebase Revision: 0.6.6

Parameters: LED operating mode, which can be one of the following values:

- **disable** or **DISABLE** or **0** - Disable the MODE LED entirely to save power
- **mode** or **MODE** or **1** - Default behaviour, indicates the current operating mode
- **hwuart** or **HWUART** or **2** - Toggles the LED on any activity on the HW UART bus (TX or RX)
- **bleuart** or **BLEUART** or **3** - Toggles the LED on any activity on the BLE UART Service (TX or RX characteristic)
- **spi** or **SPI** or **4** - Toggles the LED on any SPI activity
- **manual** or **MANUAL** or **5** - Manually sets the state of the MODE LED via a second comma-separated parameter, which can be **on**, **off**, or **toggle**.

Output: If run with no parameters, returns an upper-case string representing the current MODE LED operating mode from the fields above

```
# Get the curent MODE LED setting
AT+HWMODELED
MODE
OK

# Change the MODE LED to indicate BLE UART activity
AT+HWMODELED=BLEUART
OK

# Manually toggle the MODE LED
AT+HWMODELED=MANUAL,TOGGLE
OK
```

Beacon

Adafruit's Bluefruit LE modules currently support the following 'Beacon' technologies:

- Beacon (Apple) via AT+BLEBEACON
- UriBeacon (Google) via AT+BLEURIBEACON (**deprecated**)
- Eddystone (Google) via AT+EDDYSTONE*

Modules can be configured to act as 'Beacons' using the following commands:

AT+BLEBEACON

Codebase Revision: 0.3.0

Parameters: The following comma-separated parameters are required to enable beacon mode:

- Bluetooth Manufacturer ID (uint16_t)
- 128-bit UUID
- Major Value (uint16_t)
- Minor Value (uint16_t)
- RSSI @ 1m (int8_t)

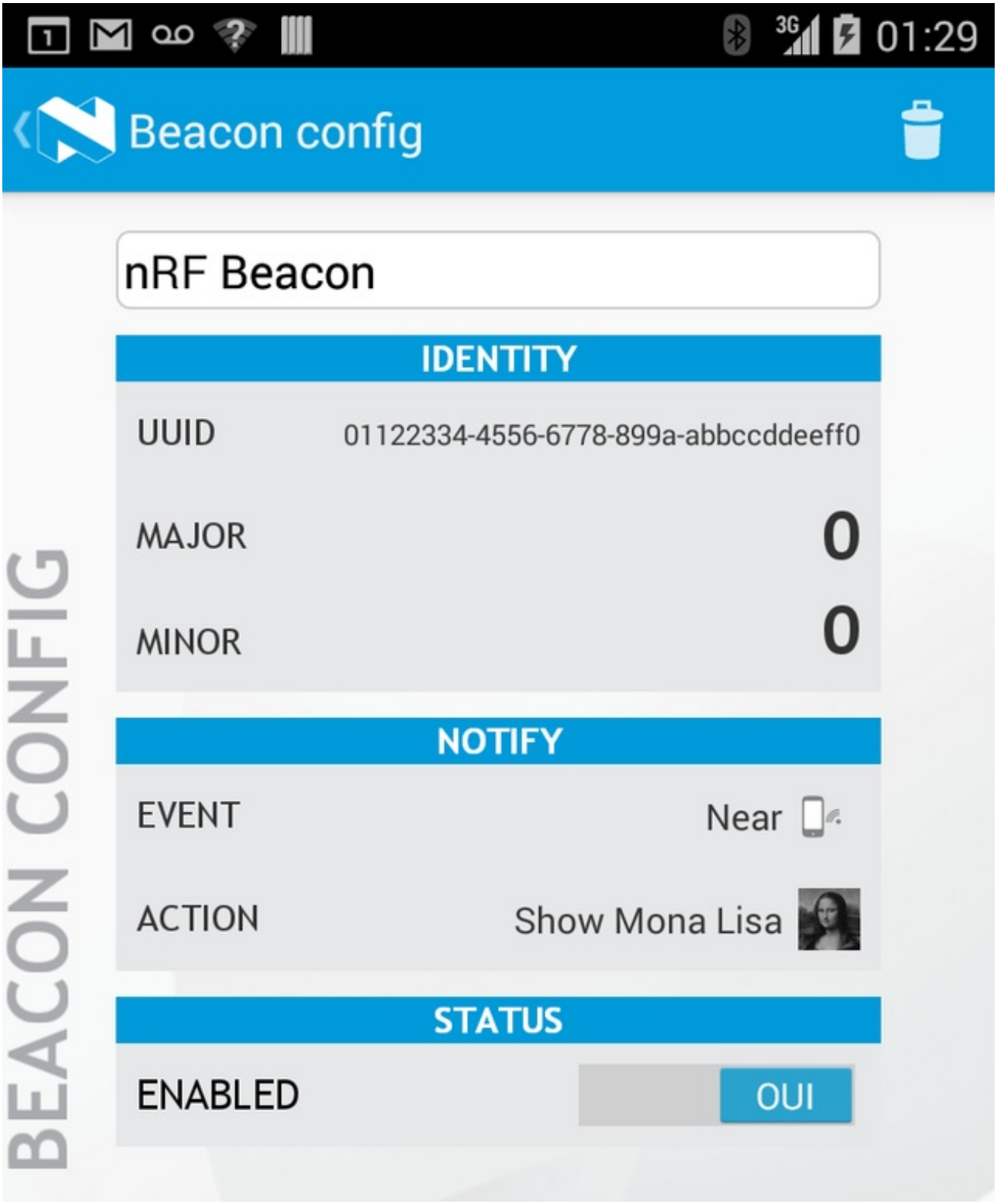
Output: None

```
# Enable Apple iBeacon emulation
# Manufacturer ID = 0x004C
AT+BLEBEACON=0x004C,01-12-23-34-45-56-67-78-89-9A-AB-BC-CD-DE-EF-F0,0x0000,0x0000,-59
OK
# Reset to change the advertising data
ATZ
OK

# Enable Nordic Beacon emulation
# Manufacturer ID = 0x0059
AT+BLEBEACON=0x0059,01-12-23-34-45-56-67-78-89-9A-AB-BC-CD-DE-EF-F0,0x0000,0x0000,-59
OK
# Reset to change the advertising data
ATZ
OK
```

AT+BLEBEACON will cause the beacon data to be stored in non-volatile config memory on the Bluefruit LE module, and these values will be persisted across system resets and power cycles. To remove or clear the beacon data you need to enter the 'AT+FACTORYRESET'

command in command mode.

Entering Nordic Beacon emulation using the sample code above, you can see the simulated beacon in Nordic's 'Beacon Config' tool below:



AT+BLEURIBEACON

Converts the specified URI into a UriBeacon (http://adafru.it/edk) advertising packet, and configures the module to advertise as a UriBeacon (part of Google's Physical Web (http://adafru.it/ehZ) project).

To view the UriBeacon URIs you can use one of the following mobile applications:

- Android 4.3+: Physical Web (http://adafru.it/edi) on the Google Play Store
- iOS: Physical Web (http://adafru.it/edj) in Apple's App Store

Codebase Revision: 0.4.7

Parameters: The URI to encode (ex. http://www.adafruit.com/blog (http://adafru.it/ei0))

Output: None of a valid URI was entered (length is acceptable, etc.).

```
AT+BLEURIBEACON=http://www.adafruit.com/blog
OK

# Reset to change the advertising data
ATZ
OK
```

If the supplied URI is too long you will get the following output:

```
AT+BLEURIBEACON=http://www.adafruit.com/this/uri/is/too/long
URL is too long
ERROR
```

If the URI that you are trying to encode is too long, try using a shortening service like bit.ly, and encode the shortened URI.

UriBeacon should be considered deprecated as a standard, and EddyStone should be used for any future development. No further development will happen in the Bluefruit LE firmware around UriBeacon.

AT+EDDYSTONEENABLE

This command will enable Eddystone (http://adafru.it/fSA) support on the Bluefruit LE module. Eddystone support must be enabled before the other related commands can be used.

Codebase Revision: 0.6.6

Parameters: 1 or 0 (1 = enable, 0 = disable)

Output: The current state of Eddystone support if no parameters are provided (1 = enabled, 0 = disabled)

```
# Enable Eddystone support
AT+EDDYSTONEENABLE=1
OK

# Check the current Eddystone status on the module
AT+EDDYSTONEENABLE
1
OK
```

AT+EDDYSTONEURL

This command will set the URL for the Eddystone-URL (http://adafru.it/fSB) protocol.

Codebase Revision: 0.6.6

Parameters:

- The URL to encode (mandatory)
- An optional second parameter indicates whether to continue advertising the Eddystone URL even when the peripheral is connected to a central device
- Firmware **0.6.7** added an optional third parameter for the RSSI at 0 meters value. This should be measured by the end user by checking the RSSI value on the receiving device at 1m and then adding 41 to that value (to compensate for the signal strength loss over 1m), so an RSSI of -62 at 1m would mean that you should enter -21 as the RSSI at 0m. Default value is -18dBm.

Output: Firmware <= 0.6.6: none. With firmware >= **0.6.7** running this command with no parameters will return the current URL.

```
# Set the Eddystone URL to adafruit
AT+EDDYSTONEURL=http://www.adafruit.com
OK

# Set the Eddystone URL to adafruit and advertise it even when connected
AT+EDDYSTONEURL=http://www.adafruit.com,1
OK
```

AT+EDDYSTONECONFIGEN

This command causes the Bluefruit LE module to enable the Eddystone URL config service for the specified number of seconds.

This command should be used in combination with the Physical Web application from Google, available for Android (http://adafru.it/edi) or iOS (http://adafru.it/edj). Run this command then select the 'Edit URL' option from the app to change the destination URL over the air.

Codebase Revision: 0.6.6

Parameters: The number of seconds to advertised the config service UUID

Output: None

```
# Start advertising the Eddystone config service for 5 minutes (300s)
AT+EDDYSTONECONFIGEN=300
OK
```

BLE Generic

The following general purpose BLE commands are available on Bluefruit LE modules:

AT+BLEPOWERLEVEL

Gets or sets the current transmit power level for the module's radio (higher transmit power equals better range, lower transmit power equals better battery life).

Codebase Revision: 0.3.0

Parameters: The TX power level (in dBm), which can be one of the following values (from lowest to higher transmit power):

- -40
- -20
- -16
- -12
- -8
- -4
- 0
- 4

Output: The current transmit power level (in dBm)

> The updated power level will take affect as soon as the command is entered. If the device isn't connected to another device, advertising will stop momentarily and then restart once the new power level has taken affect.

```
# Get the current TX power level (in dBm)
AT+BLEPOWERLEVEL
0
OK

# Set the TX power level to 4dBm (maximum value)
AT+BLEPOWERLEVEL=4
OK

# Set the TX power level to -12dBm (better battery life)
AT+BLEPOWERLEVEL=-12
OK

# Set the TX power level to an invalid value
AT+BLEPOWERLEVEL=-3
ERROR
```

AT+BLEGETADDRTYPE

Gets the address type (for the 48-bit BLE device address).

Normally this will be '1' (random), which means that the module uses a 48-bit address that was randomly generated during the manufacturing process and written to the die by the manufacturer.

Random does not mean that the device address is randomly generated every time, only that a one-time random number is used.

Codebase Revision: 0.3.0

Parameters: None

Output: The address type, which can be one of the following values:

- 0 = public
- 1 = random

```
AT+BLEGETADDRTYPE
1
OK
```

AT+BLEGETADDR

Gets the 48-bit BLE device address.

Codebase Revision: 0.3.0

Parameters: None

Output: The 48-bit BLE device address in the following format: 'AA:BB:CC:DD:EE:FF'

```
AT+BLEGETADDR
E4:C6:C7:31:95:11
OK
```

AT+BLEGETPEERADDR

Gets the 48-bit address of the peer (central) device we are connected to.

Codebase Revision: 0.6.5

Parameters: None

Output: The 48-bit address of the connected central device in hex format. The command will return **ERROR** if we are not connected to a central device.

> Please note that the address returned by the central device is almost always a random value that will change over time, and this value should generally not be trusted. This command is provided for certain edge cases, but is not useful in most day to day scenarios.

```
AT+BLEGETPEERADDR
48:B2:26:E6:C1:1D
OK
```

AT+BLEGETRSSI

Gets the RSSI value (Received Signal Strength Indicator), which can be used to estimate the reliability of data transmission between two devices (the lower the number the better).

Codebase Revision: 0.3.0

Parameters: None

Output: The RSSI level (in dBm) if we are connected to a device, otherwise '0'

```
# Connected to an external device
AT+BLEGETRSSI
-46
OK

# Not connected to an external device
AT+BLEGETRSSI
0
OK
```

BLE Services

The following commands allow you to interact with various GATT services present on Bluefruit LE modules when running in Command Mode.

AT+BLEUARTTX

This command will transmit the specified text message out via the UART Service (http://adafru.it/iCn) while you are running in Command Mode.

Codebase Revision: 0.3.0

Parameters: The message payload to transmit. The payload can be up to 240 characters (since AT command strings are limited to a maximum of 256 bytes total).

Output: This command will produce an **ERROR** message if you are not connected to a central device, or if the internal TX FIFO on the Bluefruit LE module is full.

As of firmware release **0.6.2** and higher, AT+BLEUARTTX can accept a limited set of escape code sequences:

- \r = carriage return
- \n = new line
- \t = tab
- \b = backspace
- \\ = backward slash

As of firmware release **0.6.7** and higher, AT+BLEUARTTX can accept the following escape code sequence since AT+BLEUARTTX=? has a specific meaning to the AT parser:

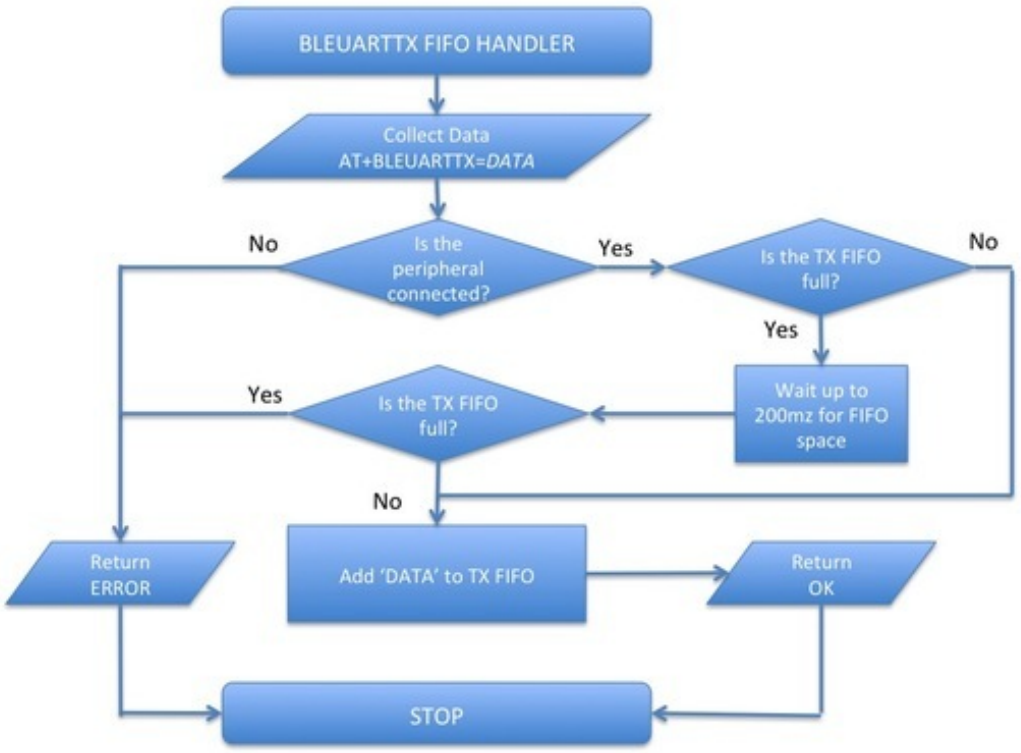
- \? = transmits a single question mark

You must be connected to another device for this command to execute

```
# Send a string when connected to another device
AT+BLEUARTTX=THIS IS A TEST
OK

# Send a string when not connected
AT+BLEUARTTX=THIS IS A TEST
ERROR
```

TX FIFO Buffer Handling

Starting with firmware version **0.6.7**, when the TX FIFO buffer is full a 200ms blocking delay will be used to see if any free space becomes available in the FIFO before returning ERROR. The exact process is detailed in the flow chart below:



Note: The TX FIFO full check will happen for each GATT transaction (of up to 20 bytes of data each), so large data transfers may have multiple 200ms wait states.

You can use the AT+BLEUARTFIFO=TX (http://adafru.it/id3) command to check the size of the TX FIFO before sending data to ensure that you have enough free space available in the buffer.

The TX FIFO has the following size, depending on the firmware version used:

- Firmware <=0.6.6: **160 characters wide**
- Firmware >=0.6.7: **1024 characters wide**

It IS possible with large data transfers that part of the payload can be transmitted, and the command can still produce an ERROR if the FIFO doesn't empty in time in the middle of the payload transfer (since data is transmitted in maximum 20 byte chunks). If you need to ensure reliable data transfer, you should always check the TX FIFO size before sending data, which you can do using the AT+BLEUARTFIFO command. If not enough space is available for the entire payload, add a SW delay until enough space is available. Any single AT+BLEUARTTX command can fit into the FIFO, but multiple large instances of this command may cause the FIFO to fill up mid transfer.

AT+BLEUARTRX

This command will dump the UART service (http://adafru.it/iCn)'s RX buffer to the display if any data has been received from from the UART service while running in Command Mode. The data will be removed from the buffer once it is displayed using this command.

Any characters left in the buffer when switching back to Data Mode will cause the buffered characters to be displayed as soon as the mode switch is complete (within the limits of available buffer space, which is 1024 bytes on current black 32KB SRAM devices, or 160 bytes for the blue first generation BLEFriend board based on 16KB SRAM parts).

Codebase Revision: 0.3.0

Parameters: None

Output: The RX buffer's content if any data is available, otherwise nothing.

You can also use the AT+BLEUARTFIFO=RX command to check if any incoming data is available or not.

```
# Command results when data is available
AT+BLEUARTRX
Sent from Android
OK

# Command results when no data is available
AT+BLEUARTRX
OK
```

AT+BLEUARTFIFO

This command will return the free space available in the BLE UART TX and RX FIFOs. If you are transmitting large chunks of data, you may want to check if you have enough free space in the TX FIFO before sending, keeping in mind that individual GATT packets can contain up to 20 user bytes each.

Codebase Revision: 0.6.7

Parameters: Running this command with no parameters will return two comma-separated values indicating the free space in the TX buffer, following by the RX buffer. To request a specific buffer, you can execute the command with either a "TX" or "RX" value (For example: "AT+BLEUARTFIFO=TX").

Output: The free space remaining in the TX and RX FIFO buffer if no parameter is present, otherwise the free space remaining in the specified FIFO buffer.

```
AT+BLEUARTFIFO
1024,1024
OK

AT+BLEUARTFIFO=TX
1024
OK

AT+BLEUARTFIFO=RX
1024
OK
```

AT+BLEKEYBOARDEN

This command will enable GATT over HID (GoH) keyboard support, which allows you to emulate a keyboard on supported iOS and Android devices. By default HID keyboard support is disabled, so you need to set BLEKEYBOARDEN to 1 and then perform a system reset before the keyboard will be enumerated and appear in the Bluetooth preferences on your phone, where if can be bonded as a BLE keyboard.

Codebase Revision: 0.5.0

Parameters: 1 or 0 (1 = enable, 0 = disable)

Output: None

As of firmware version 0.6.6 this command is now an alias for AT+BLEHIDEN

You must perform a system reset (ATZ) before the changes take effect!

Before you can use your HID over GATT keyboard, you will need to bond your mobile device with the Bluefruit LE module in the Bluetooth preferences panel.

```
# Enable BLE keyboard support then reset
AT+BLEKEYBOARDEN=1
OK
ATZ
OK

# Disable BLE keyboard support then reset
AT+BLEKEYBOARDEN=0
OK
ATZ
OK
```

AT+BLEKEYBOARD

Sends text data over the BLE keyboard interface (if it has previously been enabled via AT+BLEKEYBOARDEN).

Any valid alpha-numeric character can be sent, and the following escape sequences are also supported:

- \r - Carriage Return
- \n - Line Feed
- \b - Backspace
- \t - Tab
- \\ - Backslash

As of version 0.6.7 you can also use the following escape code when sending a single character ('AT+BLEKEYBOARD=?' has another meaning for the AT parser):

- \? - Question mark

Codebase Revision: 0.5.0

Parameters: The text string (optionally including escape characters) to transmit

Output: None

```
# Send a URI with a new line ending to execute in Chrome, etc.
AT+BLEKEYBOARD=http://www.adafruit.com\r\n
OK

# Send a single question mark (special use case, 0.6.7+)
AT+BLEKEYBOARD=\?
OK
```

AT+BLEKEYBOARDCODE

Sends a raw hex sequence of USB HID keycodes to the BLE keyboard interface including key modifiers and up to six alpha-numeric characters.

This command accepts the following ascii-encoded HEX payload, matching the way HID over GATT sends keyboard data:

- **Byte 0**: Modifier
- **Byte 1**: Reserved (should always be 00)
- **Bytes 2..7**: Hexadecimal values for ASCII-encoded characters (if no character is used you can enter '00' or leave trailing characters empty)

After a keycode sequence is sent with the AT+BLEKEYBOARDCODE command, **you must send a second AT+BLEKEYBOARDCODE command with at least two 00 characters to indicate the keys were released!**

Modifier Values

The modifier byte can have one or more of the following bits set:

- **Bit 0 (0x01)**: Left Control
- **Bit 1 (0x02)**: Left Shift
- **Bit 2 (0x04)**: Left Alt
- **Bit 3 (0x08)**: Left Window
- **Bit 4 (0x10)**: Right Control
- **Bit 5 (0x20)**: Right Shift
- **Bit 6 (0x40)**: Right Alt
- **Bit 7 (0x80)**: Right Window

Codebase Revision: 0.5.0

Parameters: A set of hexadecimal values separated by a hyphen ('-'). Note that these are HID scan code values, not standard ASCII values!

Output: None

> HID key code values don't correspond to ASCII key codes! For example, 'a' has an HID keycode value of '04', and there is no keycode for an upper case 'A' since you use the modifier to set upper case values. For details, google 'usb hid keyboard scan codes', and see the example below.

A list of HID keyboard codes can be found here (http://adafru.it/cQV) (see section 7).

```
# send 'abc' with shift key --> 'ABC'
AT+BLEKEYBOARDCODE=01-00-04-05-06-00-00
OK
# Indicate that the keys were released (mandatory!)
AT+BLEKEYBOARDCODE=00-00
OK
```

AT+BLEHIDEN

This command will enable GATT over HID (GoH) support, which allows you to emulate a keyboard, mouse or media controll on supported iOS, Android, OSX and Windows 10 devices. By default HID support is disabled, so you need to set BLEHIDEN to 1 and then perform a system reset before the HID devices will be enumerated and appear in on your central device.

Codebase Revision: 0.6.6

Parameters: 1 or 0 (1 = enable, 0 = disable)

Output: None

> You normally need to 'bond' the Bluefruit LE peripheral to use the HID commands, and the exact bonding process will change from one operating system to another.

> If you have previously bonded to a device and need to clear the bond, you can run the AT+FACTORYRESET command which will erase all stored bond data on the Bluefruit LE module.

```
# Enable GATT over HID support on the Bluefruit LE module
AT+BLEHIDEN=1
OK

# Reset so that the changes take effect
ATZ
OK
```

AT+BLEHIDMOUSEMOVE

Moves the HID mouse or scroll wheen position the specified number of ticks.

All parameters are signed 8-bit values (-128 to +127). Positive values move to the right or down, and origin is the top left corner.

Codebase Revision: 0.6.6

Parameters: X Ticks (+/-), Y Ticks (+/-), Scroll Wheel (+/-), Pan Wheel (+/-)

Output: None

```
# Move the mouse 100 ticks right and 100 ticks down
AT+BLEHIDMOUSEMOVE=100,100
OK

# Scroll down 20 pixels or lines (depending on context)
AT+BLEHIDMOUSEMOVE=,,20,
OK

# Pan (horizontal scroll) to the right (exact behaviour depends on OS)
AT+BLEHIDMOUSEMOVE=0,0,0,100
```

AT+BLEHIDMOUSEBUTTON

Manipulates the HID mouse buttons via the specific string(s).

Codebase Revision: 0.6.6

Parameters: Button Mask String [L][R][M][B][F], Action [PRESS][CLICK][DOUBLECLICK][HOLD]

- L = Left Button
- R = Right Button
- M = Middle Button

- B = Back Button
- F = Forward Button
- If the second parameter (Action) is "HOLD", an optional third parameter can be passed specifying how long the button should be held in milliseconds.

Output: None

```
# Double click the left mouse button
AT+BLEHIDMOUSEBUTTON=L,doubleclick
OK

# Press the left mouse button down, move the mouse, then release L
# This is required to perform 'drag' then stop type operations
AT+BLEHIDMOUSEBUTTON=L
OK
AT+BLEHIDMOUSEMOVE=-100,50
OK
AT+BLEHIDMOUSEBUTTON=0
OK

# Hold the backward mouse button for 200 milliseconds (OS dependent)
AT+BLEHIDMOUSEBUTTON=B,hold,200
OK
```

AT+BLEHIDCONTROLKEY

Sends HID media control commands for the bonded device (adjust volume, screen brightness, song selection, etc.).

Codebase Revision: 0.6.6

Parameters: The HID control key to send, followed by an optional delay in ms to hold the button

The control key string can be one of the following values:

- System Controls (works on most systems)
  - BRIGHTNESS+
  - BRIGHTNESS-
- Media Controls (works on most systems)
  - PLAYPAUSE
  - MEDIANEXT
  - MEDIAPREVIOUS

    - MEDIASTOP
- Sound Controls (works on most systems)
    - VOLUME
    - MUTE
    - BASS
    - TREBLE
    - BASS_BOOST
    - VOLUME+
    - VOLUME-
    - BASS+
    - BASS-
    - TREBLE+
    - TREBLE-
- Application Launchers (Windows 10 only so far)
    - EMAILREADER
    - CALCULATOR
    - FILEBROWSER
- Browser/File Explorer Controls (Firefox on Windows/Android only)
    - SEARCH
    - HOME
    - BACK
    - FORWARD
    - STOP
    - REFRESH
    - BOOKMARKS

You can also send a raw 16-bit hexadecimal value in the '0xABCD' format. A full list of 16-bit 'HID Consumer Control Key Codes' can be found here (http://adafru.it/cQV)(see section 12).

Output: Normally none.

> If you are not bonded and connected to a central device, this command will return ERROR. Make sure you are connected and HID support is enabled before running these commands.

```
# Toggle the sound on the bonded central device
AT+BLEHIDCONTROLKEY=MUTE
OK

# Hold the VOLUME+ key for 500ms
AT+BLEHIDCONTROLKEY=VOLUME+,500
OK

# Send a raw 16-bit Consumer Key Code (0x006F = Brightness+)
AT+BLEHIDCONTROLKEY=0x006F
OK
```

BLE GAP

GAP (http://adafru.it/iCo), which stands for the *Generic Access Profile*, governs advertising and connections with Bluetooth Low Energy devices.

The following commands can be used to configure the GAP settings on the BLE module.

You can use these commands to modify the advertising data (for ex. the device name that appears during the advertising process), to retrieve information about the connection that has been established between two devices, or the disconnect if you no longer wish to maintain a connection.

AT+GAPGETCONN

Diplays the current connection status (if we are connected to another BLE device or not).

Codebase Revision: 0.3.0

Parameters: None

Output: 1 if we are connected, otherwise 0

```
# Connected
AT+GAPGETCONN
1
OK

# Not connected
AT+GAPGETCONN
0
OK
```

AT+GAPDISCONNECT

Disconnects to the external device if we are currently connected.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
AT+GAPDISCONNECT
OK
```

AT+GAPDEVNAME

Gets or sets the device name, which is included in the advertising payload for the Bluefruit LE module

Codebase Revision: 0.3.0

Parameters:

- None to read the current device name
- The new device name if you want to change the value

Output: The device name if the command is executed in read mode

> Updating the device name will persist the new value to non-volatile memory, and the updated name will be used when the device is reset. To reset the device to factory settings and clean the config data from memory run the AT+FACTORYRESET command.

```
# Read the current device name
AT+GAPDEVNAME
UART
OK

# Update the device name to 'BLEFriend'
AT+GAPDEVNAME=BLEFriend
OK
# Reset to take effect
ATZ
OK
```

AT+GAPDELBONDS

Deletes and bonding information stored on the Bluefruit LE module.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
AT+GAPDELBONDS
OK
```

AT+GAPINTERVALS

Gets or sets the various advertising and connection intervals for the Bluefruit LE module.

Be extremely careful with this command since it can be easy to cause problems changing the intervals, and depending on the values selected some mobile devices may no longer recognize the module or refuse to connect to it.

Codebase Revision: 0.3.0

Parameters: If updating the GAP intervals, the following comma-separated values can be entered:

- Minimum connection interval (in milliseconds)
- Maximum connection interval (in milliseconds)
- Advertising interval (in milliseconds)
- Advertising timeout (in milliseconds)

> If you only wish to update one interval value, leave the other comma-separated values empty (ex. ',,110,' will only update the third value, advertising interval).

Output: If reading the current GAP interval settings, the following comma-separated information will be displayed:

- Minimum connection interval (in milliseconds)
- Maximum connection interval (in milliseconds)
- Advertising interval (in milliseconds)
- Advertising timeout (in milliseconds)

> Updating the GAP intervals will persist the new values to non-volatile memory, and the updated values will be used when the device is reset. To reset the device to factory settings and clean the config data from memory run the AT+FACTORYRESET command.

```
# Read the current GAP intervals
AT+GAPINTERVALS
20,100,100,30

# Update all values
AT+GAPINTERVALS=20,200,200,30
OK

# Update only the advertising interval
AT+GAPINTERVALS=,,150,
OK
```

AT+GAPSTARTADV

Causes the Bluefruit LE module to start transmitting advertising packets if this isn't already the case (assuming we aren't already connected to an external device).

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
# Command results when advertising data is not being sent
AT+GAPSTARTADV
OK

# Command results when we are already advertising
AT+GAPSTARTADV
ERROR

# Command results when we are connected to another device
AT+GAPSTARTADV
ERROR
```

AT+GAPSTOPADV

Stops advertising packets from being transmitted by the Bluefruit LE module.

Codebase Revision: 0.3.0

Parameters: None

Output: None

```
AT+GAPSTOPADV
OK
```

AT+GAPSETADVDATA

Sets the raw advertising data payload to the specified byte array (overriding the normal advertising data), following the guidelines in the Bluetooth 4.0 or 4.1 Core Specification (http://adafru.it/ddd).

In particular, **Core Specification Supplement (CSS) v4** contains the details on common advertising data fields like 'Flags' (Part A, Section 1.3) and the various Service UUID lists (Part A, Section 1.1). A list of all possible GAP Data Types is available on the Bluetooth SIG's Generic Access Profile (http://adafru.it/cYs) page.

The Advertising Data payload consists of Generic Access Profile (http://adafru.it/cYs) data that is inserted into the advertising packet in the following format: [U8:LEN] [U8:Data Type Value] [n:Value]

> WARNING: This command requires a degree of knowledge about the low level details of the Bluetooth 4.0 or 4.1 Core Specification, and should only be used by expert users. Misuse of this command can easily cause your device to be undetectable by central devices in radio range.

> WARNING: This command will override the normal advertising payload and may prevent some services from acting as expected.

> To restore the advertising data to the normal default values use the AT+FACTORYRESET command.

For example, to insert the 'Flags' Data Type (Data Type Value 0x01), and set the value to 0x06/0b00000110 (BR/EDR Not Supported and LE General Discoverable Mode) we would use the following byte array:

```
02-01-06
```

- 0x02 indicates the number of bytes in the entry

- 0x01 is the 'Data Type Value (http://adafru.it/cYs)' and indicates that this is a '**Flag**'
- 0x06 (0b00000110) is the Flag value, and asserts the following fields (see Core Specification 4.0, Volume 3, Part C, 18.1):
    - **LE General Discoverable Mode** (i.e. anyone can discover this device)
    - **BR/EDR Not Supported** (i.e. this is a Bluetooth Low Energy only device)

If we also want to include two 16-bit service UUIDs in the advertising data (so that listening devices know that we support these services) we could append the following data to the byte array:

```
05-02-0D-18-0A-18
```

- 0x05 indicates that the number of bytes in the entry (5)
- 0x02 is the 'Data Type Value (http://adafru.it/cYs)' and indicates that this is an '**Incomplete List of 16-bit Service Class UUIDs**'
- 0x0D 0x18 is the first 16-bit UUID (which translates to **0x180D**, corresponding to the Heart Rate Service (http://adafru.it/ddB)).
- 0x0A 0x18 is another 16-bit UUID (which translates to **0x180A**, corresponding to the Device Information Service (http://adafru.it/ecj)).

> Including the service UUIDs is important since some mobile applications will only work with devices that advertise a specific service UUID in the advertising packet. This is true for most apps from Nordic Semiconductors, for example.

Codebase Revision: 0.3.0

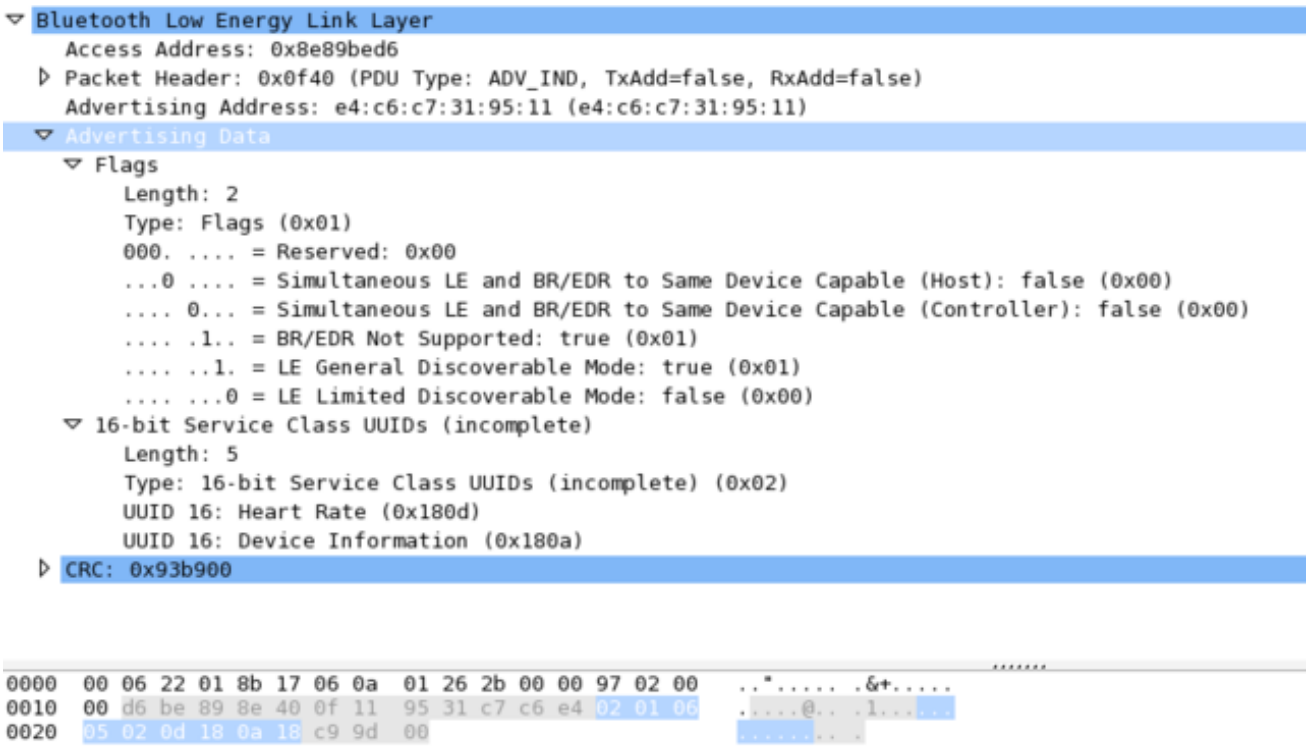
Parameters: The raw byte array that should be inserted into the advertising data section of the advertising packet, being careful to stay within the space limits defined by the Bluetooth Core Specification.

Response: None

```
# Advertise as Discoverable and BLE only with 16-bit UUIDs 0x180D and 0x180A
AT+GAPSETADVDATA=02-01-06-05-02-0d-18-0a-18
OK
```

The results of this command can be seen in the screenshot below, taken from a sniffer analyzing the advertising packets in Wireshark. The advertising data payload is higlighted in blue in the raw

byte array at the bottom of the image, and the packet analysis is in the upper section:



BLE GATT

GATT (http://adafru.it/iCp), which standards for the *Generic ATTribute Profile*, governs data organization and data exchanges between connected devices. One device (the peripheral) acts as a GATT Server, which stores data in *Attribute* records, and the second device in the connection (the central) acts as a GATT Client, requesting data from the server whenever necessary.

The following commands can be used to create custom GATT services and characteristics on the BLEFriend, which are used to store and exchange data.

Please note that any characteristics that you define here will automatically be saved to non-volatile FLASH config memory on the device and re-initialised the next time the device starts. **You need to perform a system reset before most of the commands below will take effect!**

If you want to clear any previous config value, enter the '**AT+FACTORYRESET**' command before working on a new peripheral configuration.

AT+GATTCLEAR

Clears any custom GATT services and characteristics that have been defined on the device.

Codebase Revision: 0.3.0

Parameters: None

Response: None

```
AT+GATTCLEAR
OK
```

AT+GATTADDSERVICE

Adds a new custom service definition to the device.

Codebase Revision: 0.3.0

Parameters: This command accepts a set of comma-separated key-value pairs that are used to define the service properties. The following key-value pairs can be used:

- **UUID**: The 16-bit UUID to use for this service. 16-bit values should be in hexadecimal format (0x1234).
- **UUID128**: The 128-bit UUID to use for this service. 128-bit values should be in the following format: 00-11-22-33-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF

Response: The index value of the service in the custom GATT service lookup table. (It's important to keep track of these index values to work with the service later.)

Note: Key values are not case-sensitive

Only one UUID type can be entered for the service (either UUID or UUID128)

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a battery service (UUID = 0x180F) to the peripheral
AT+GATTADDSERVICE=UUID=0x180F
1
OK

# Add a battery measurement characteristic (UUID = 0x2A19), notify enabled
AT+GATTADDCHAR=UUID=0x2A19,PROPERTIES=0x10,MIN_LEN=1,VALUE=100
1
OK
```

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a custom service to the peripheral
AT+GATTADDSERVICE=UUID128=00-11-00-11-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF
1
OK

# Add a custom characteristic to the above service (making sure that there
# is no conflict between the 16-bit UUID and bytes 3+4 of the 128-bit service UUID)
AT+GATTADDCHAR=UUID=0x0002,PROPERTIES=0x02,MIN_LEN=1,VALUE=100
1
OK
```

AT+GATTADDCHAR

Adds a custom characteristic to the last service that was added to the peripheral (via AT+GATTADDSERVICE).

AT+GATTADDCHAR must be run AFTER AT+GATTADDSERVICE, and will add the new characteristic to the last service definition that was added.

As of version 0.6.6 of the Bluefruit LE firmware you can now use custom 128-bit UUIDs with this command. See the example at the bottom of this command description.

Codebase Revision: 0.3.0

Parameters: This command accepts a set of comma-separated key-value pairs that are used to define the characteristic properties. The following key-value pais can be used:

- **UUID**: The 16-bit UUID to use for the characteristic (which will be insert in the 3rd and 4th bytes of the parent services 128-bit UUID). This value should be entered in hexadecimal format (ex. 'UUID=0x1234'). This value must be unique, and should not conflict with bytes 3+4 of the parent service's 128-bit UUID.
- **PROPERTIES**: The 8-bit characteristic properties field, as defined by the Bluetooth SIG. The following values can be used:
    - 0x02 - Read
    - 0x04 - Write Without Response
    - 0x08 - Write
    - 0x10 - Notify
    - 0x20 - Indicate
- **MIN_LEN**: The minimum size of the values for this characteristic (in bytes, min = 1, max = 20, default = 1)
- **MAX_LEN**: The maximum size of the values for the characteristic (in bytes, min = 1, max = 20, default = 1)
- **VALUE**: The initial value to assign to this characteristic (within the limits of 'MIN_LEN' and 'MAX_LEN'). Value can be an integer ("-100", "27"), a hexadecimal value ("0xABCD"), a byte array ("aa-bb-cc-dd") or a string ("GATT!").

Response: The index value of the characteristic in the custom GATT characteristic lookup table. (It's important to keep track of these characteristic index values to work with the characteristic later.)

Note: Key values are not case-sensitive

Make sure that the 16-bit UUID is unique and does not conflict with bytes 3+4 of the 128-bit

service UUID

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a battery service (UUID = 0x180F) to the peripheral
AT+GATTADDSERVICE=UUID=0x180F
1
OK

# Add a battery measurement characteristic (UUID = 0x2A19), notify enabled
AT+GATTADDCHAR=UUID=0x2A19,PROPERTIES=0x10,MIN_LEN=1,VALUE=100
1
OK
```

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a custom service to the peripheral
AT+GATTADDSERVICE=UUID128=00-11-00-11-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF
1
OK

# Add a custom characteristic to the above service (making sure that there
# is no conflict between the 16-bit UUID and bytes 3+4 of the 128-bit service UUID)
AT+GATTADDCHAR=UUID=0x0002,PROPERTIES=0x02,MIN_LEN=1,VALUE=100
1
OK
```

Version **0.6.6** of the Bluefruit LE firmware added the ability to use a new '**UUID128**' flag to add custom 128-bit UUIDs that aren't related to the parent service UUID (which is used when passing the 16-bit '**UUID**' flag).

To specify a 128-bit UUID for your customer characteristic, enter a value resembling the following syntax:

```
# Add a custom characteristic to the above service using a
# custom 128-bit UUID
AT+GATTADDCHAR=UUID128=00-11-22-33-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF,PROPERTIES=0x02,MI
1
OK
```

AT+GATTCHAR

Gets or sets the value of the specified custom GATT characteristic (based on the index ID returned when the characteristic was added to the system via AT+GATTADDCHAR).

Codebase Revision: 0.3.0

Parameters: This function takes one or two comma-separated functions (one parameter = read, two parameters = write).

- The first parameter is the characteristic index value, as returned from the AT+GATTADDCHAR function. This parameter is always required, and if no second parameter is entered the current value of this characteristic will be returned.
- The second (optional) parameter is the new value to assign to this characteristic (within the MIN_SIZE and MAX_SIZE limits defined when creating it).

Response: If the command is used in read mode (only the characteristic index is provided as a value), the response will display the current value of the characteristics. If the command is used in write mode (two comma-separated values are provided), the characteristics will be updated to use the provided value.

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a battery service (UUID = 0x180F) to the peripheral
AT+GATTADDSERVICE=UUID=0x180F
1
OK

# Add a battery measurement characteristic (UUID = 0x2A19), notify enabled
AT+GATTADDCHAR=UUID=0x2A19,PROPERTIES=0x10,MIN_LEN=1,VALUE=100
1
OK

# Read the battery measurement characteristic (index ID = 1)
AT+GATTCHAR=1
0x64
OK

# Update the battery measurement characteristic to 32 (hex 0x20)
AT+GATTCHAR=1,32
OK

# Verify the previous write attempt
AT+GATTCHAR=1
0x20
OK
```

AT+GATTLIST

Lists all custom GATT services and characteristics that have been defined on the device.

Codebase Revision: 0.3.0

Parameters: None

Response: A list of all custom services and characteristics defined on the device.

```
# Clear any previous custom services/characteristics
AT+GATTCLEAR
OK

# Add a battery service (UUID = 0x180F) to the peripheral
AT+GATTADDSERVICE=UUID=0x180F
1
OK

# Add a battery measurement characteristic (UUID = 0x2A19), notify enabled
AT+GATTADDCHAR=UUID=0x2A19,PROPERTIES=0x10,MIN_LEN=1,VALUE=100
1
OK

# Add a custom service to the peripheral
AT+GATTADDSERVICE=UUID128=00-11-00-11-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF
2
OK

# Add a custom characteristic to the above service (making sure that there
# is no conflict between the 16-bit UUID and bytes 3+4 of the 128-bit service UUID)
AT+GATTADDCHAR=UUID=0x0002,PROPERTIES=0x02,MIN_LEN=1,VALUE=100
2
OK

# Get a list of all custom GATT services and characteristics on the device
AT+GATTLIST
ID=01,UUID=0x180F
  ID=01,UUID=0x2A19,PROPERTIES=0x10,MIN_LEN=1,MAX_LEN=1,VALUE=0x64
ID=02,UUID=0x11, UUID128=00-11-00-11-44-55-66-77-88-99-AA-BB-CC-DD-EE-FF
  ID=02,UUID=0x02,PROPERTIES=0x02,MIN_LEN=1,MAX_LEN=1,VALUE=0x64
OK
```

Debug

The following debug commands are available on Bluefruit LE modules:

> Use these commands with care since they can easily lead to a HardFault error on the ARM core, which will cause the device to stop responding.

AT+DBGMEMRD

Displays the raw memory contents at the specified address.

Codebase Revision: 0.3.0

Parameters: The following comma-separated parameters can be used with this command:

- The starting address to read memory from (in hexadecimal form, with or without the leading '0x')
- The word size (can be 1, 2, 4 or 8)
- The number of words to read

Output: The raw memory contents in hexadecimal format using the specified length and word size (see examples below for details)

```
# Read 12 1-byte values starting at 0x10000009
AT+DBGMEMRD=0x10000009,1,12
FF FF FF FF FF FF FF 00 04 00 00 00
OK

# Try to read 2 4-byte values starting at 0x10000000
AT+DBGMEMRD=0x10000000,4,2
55AA55AA 55AA55AA
OK

# Try to read 2 4-byte values starting at 0x10000009
# This will fail because the Cortex M0 can't perform misaligned
# reads, and any non 8-bit values must start on an even address
AT+DBGMEMRD=0x10000009,4,2
MISALIGNED ACCESS
ERROR
```

AT+DBGNVMREAD

Displays the raw contents of the config data section of non-volatile memory

Codebase Revision: 0.3.0

Properties: None

Output: The raw config data from non-volatile memory

```
AT+DBGNVMRD
FE CA 38 05 00 03 00 00 01 12 01 00 55 41 52 54 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0
OK
```

AT+DBGSTACKSIZE

Returns the current stack size, to help detect stack overflow or detect stack memory usage when optimising memory usage on the system.

Codebase Revision: 0.4.7

Parameters: None

Output: The current size of stack memory in bytes

```
AT+DBGSTACKSIZE
1032
OK
```

AT+DBGSTACKDUMP

Dumps the current stack contents. Unused sections of stack memory are filled with '0xCAFEFOOD' to help determine where stack usage stops.

This command is purely for debug and development purposes.

Codebase Revision: 0.4.7

Parameters: None

Output: The memory contents of the entire stack region

```
AT+DBGSTACKDUMP
```

```
AT+DBGSTACKDUMP
0x20003800: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003810: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003820: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003830: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003840: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003850: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003860: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003870: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003880: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003890: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038A0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038B0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038C0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038D0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038E0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200038F0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003900: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003910: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003920: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003930: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003940: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003950: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003960: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003970: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003980: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003990: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039A0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039B0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039C0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039D0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039E0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x200039F0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A00: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A10: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A20: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A30: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A40: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A50: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A60: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A70: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A80: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003A90: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003AA0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003AB0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003AC0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003AD0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
```

```
0x20003AE0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003AF0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B00: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B10: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B20: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B30: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B40: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B50: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B60: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B70: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B80: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003B90: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BA0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BB0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BC0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BD0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BE0: CAFEF00D CAFEF00D CAFEF00D CAFEF00D
0x20003BF0: CAFEF00D CAFEF00D 00000000 CAFEF00D
0x20003C00: 00000004 20001D04 CAFEF00D FFFFEF68
0x20003C10: CAFEF00D 00001098 CAFEF00D CAFEF00D
0x20003C20: CAFEF00D CAFEF00D 00001006 200018D8
0x20003C30: 00000001 200018D8 20001C50 00000004
0x20003C40: 20001BB0 000134A5 0000100D 20001D28
0x20003C50: 00000006 00000006 20001C38 20001D44
0x20003C60: 20001C6C 20001D44 00000006 00000005
0x20003C70: 20001D38 00000005 20001D38 00000000
0x20003C80: 00000001 00012083 200018C8 000013D3
0x20003C90: 00550000 00000001 80E80000 4FC40000
0x20003CA0: 000080E8 00000009 60900000 000080E8
0x20003CB0: 60140000 20002764 0009608F 000080E8
0x20003CC0: 80000000 000080E8 00000000 00129F5F
0x20003CD0: 00000000 0001E4D9 80E80000 200018C8
0x20003CE0: 200018D4 00000000 80E80000 000000FF
0x20003CF0: 0000011C 0001BCE1 0000203A 0001BC1D
0x20003D00: 00000000 0001BC1D 80E80000 0001BCE1
0x20003D10: 0000011C 0001BDA9 80E80000 0001BDA9
0x20003D20: 0000011C FFFFFFF9 008B8000 0001BC1D
0x20003D30: 00000048 00000010 0000A000 00000009
0x20003D40: 0001E326 00000001 80E80000 51538000
0x20003D50: 000080E8 0001E9CF 00000000 00000009
0x20003D60: 61C78000 000080E8 00000048 00000504
0x20003D70: 0000A1FC 0002125C 00000000 000080E8
0x20003D80: 00000000 0012A236 00000000 0001E4D9
0x20003D90: 000080E8 00000009 00004998 000080E8
0x20003DA0: 622C8000 0012A29B 00000042 0001E479
0x20003DB0: 40011000 000185EF 00006E10 00000000
0x20003DC0: 00000000 00000004 0000000C 00000000
```

```
0x20003DD0: 62780000 00018579 2000311B 0001ACDF
0x20003DE0: 00000000 20003054 20002050 00000001
0x20003DF0: 20003DF8 0002085D 00000001 200030D4
0x20003E00: 00000200 0001F663 00000001 200030D4
0x20003E10: 00000001 2000311B 0001F631 00020A6D
0x20003E20: 00000001 00000000 0000000C 200030D4
0x20003E30: 2000311B 00000042 200030D4 00020AD7
0x20003E40: 20002050 200030D4 20002050 00020833
0x20003E50: 20002050 20003F1B 20002050 0001FF89
0x20003E60: 20002050 0001FFA3 00000005 20003ED8
0x20003E70: 20002050 0001FF8B 00000010 00020491
0x20003E80: 00000001 0012A54E 00000020 00022409
0x20003E90: 00000000 20002050 200030D4 0001FF8B
0x20003EA0: 00021263 00000005 0000000C 20003F74
0x20003EB0: 20003ED8 20002050 200030D4 00020187
0x20003EC0: 20003ED4 20003054 00000000 20003F75
0x20003ED0: 00000008 20003F64 00000084 FFFFFFFF
0x20003EE0: FFFFFFFF 00000008 00000001 00000008
0x20003EF0: 20302058 2000311B 0001F631 00020A6D
0x20003F00: 20002050 00000000 0000000C 200030D4
0x20003F10: 32002050 32303032 00323330 000258D7
0x20003F20: 20002050 200030D4 20002050 00020833
0x20003F30: 00000000 20002050 00000020 000001CE
0x20003F40: 20003F40 200030D4 00000004 0001ED83
0x20003F50: 200030D4 20003F60 000001D6 000001D7
0x20003F60: 000001D8 00016559 0000000C 00000000
0x20003F70: 6C383025 00000058 200030D4 FFFFFFFF
0x20003F80: 1FFF4000 00000028 00000028 000217F8
0x20003F90: 200020C7 000166C5 000166AD 00017ED9
0x20003FA0: FFFFFFFF 200020B8 2000306C 200030D4
0x20003FB0: 200020B4 000180AD 1FFF4000 200020B0
0x20003FC0: 200020B0 200020B0 1FFF4000 0001A63D
0x20003FD0: CAFEF00D CAFEF00D 200020B4 00000002
0x20003FE0: FFFFFFFF FFFFFFFF 1FFF4000 00000000
0x20003FF0: 00000000 00000000 00000000 00016113
OK
```

History

This page tracks additions or changes to the AT command set based on the firmware version number (which you can obtain via the 'ATI' command):

Version 0.6.7

The following AT commands were added in the 0.6.7 release:

- AT+BLEUARTFIFO
  Returns the number of free bytes available in the TX and RX FIFOs for the Bluetooth UART Service.

The following commands were changed in the 0.6.7 release:

- AT+BLEUARTTX
  If the TX FIFO is full, the command will wait up to 200ms to see if the FIFO size decreases before exiting and returning an ERROR response due to the FIFO being full.
- AT+BLEURIBEACON
  This command will go back to using the old (deprecated) UriBeacon UUID (0xFED8), and only the AT+EDDYSTONEURL command will use the newer Eddystone UUID (0xFEAA).
- AT+BLEKEYBOARD and AT+BLEUARTTX
  These commands now accept '\?' as an escape code since 'AT+BLEKEYBOARD=?' has another meaning for the AT parser. To send a single question mark the following command should be used: 'AT+BLEKEYBOARD=\?' or 'AT+BLEUARTTX=\?'
- AT+EDDYSTONEURL
  This command now accepts an optional third parameter for RSSI at 0m value (default is -18dBm).
  Running this command with no parameters ('AT+EDDYSTONEURL\r\n') will now return the current URL.

Key bug fixes in this release:

- The FIFO handling for the Bluetooth UART Service was improved for speed and stability, and the TX and RF FIFOs were increased to 1024 bytes each.
- An issue where a timer overflow was causing factory resets every 4 hours or so has been resolved.
- Fixed a problem with the GATT server where 'value_len' was being incorrectly parsed for integer values in characteristics where 'max_len' >4

Version 0.6.6

The following AT commands were added in the 0.6.6 release:

- AT+EDDYSTONEURL
  Update the URL for the beacon and switch to beacon mode
- AT+EDDYSTONEENABLE
  Enable/disable beacon mode using the configured url
- AT+EDDYSTONECONFIGEN
  Enable advertising for the the Eddystone configuration service for the specified number of seconds
- AT+HWMODELED
  Allows the user to override the default MODE LED behaviour with one of the following options: DISABLE, MODE, HWUART, BLEUART, SPI, MANUAL
- AT+BLECONTROLKEY
  Allows HID media control values to be sent to a bonded central device (volume, screen brightness, etc.)
- AT+BLEHIDEN
  Enables or disables BLE HID support in the Bluefruit LE firmware (mouse, keyboard and media control)
- AT+BLEMOUSEMOVE
  To move the HID mouse
- AT+BLEMOUSEBUTTON
  To set the state of the HID mouse buttons

The following commands were changed in the 0.6.6 release:

- AT+BLEKEYBOARDEN - Now an alias for AT+BLEHIDEN
- AT+GATTADDCHAR - Added a new UUID128 field to allow custom UUIDs

Key bug fixes in this release:

- Fixed issues with long beacon URLs
- Fixed big endian issue in at+blebeacon for major & minor number

Known issues with this release:

- Windows 10 seems to support a limited number of characteristics for the DIS service. We had to disable the Serial Number characteristic to enable HID support with windows 10.

Version 0.6.5

The following AT commands were added in the 0.6.5 release:

- AT+BLEGETPEERADDR (http://adafru.it/iCq)

The following commands were changed in the 0.6.5 release:

- Increased the UART buffer size (on the nRF51) from 128 to 256 bytes
- +++ now responds with the current operating mode
- Fixed a bug with AT+GATTCHAR values sometimes not being saved to NVM
- Fixed a bug with AT+GATTCHAR max_len value not being taken into account after a reset (min_len was always used when repopulating the value)

Version 0.6.2

This is the first release targetting **32KB SRAM parts (QFAC)**. 16KB SRAM parts can't be used with this firmware due to memory management issues, and should use the earlier 0.5.0 firmware.

The following AT commands were changed in the 0.6.2 release:

- AT+BLEUARTTX (http://adafru.it/iCr)
  Basic escape codes were added for new lines, tabs and backspace
- AT+BLEKEYBOARD (http://adafru.it/iCr)
  Also works with OS X now, and *may* function with other operating systems that support BLE HID keyboards

Version 0.5.0

The following AT commands were added in the 0.5.0 release:

- AT+BLEKEYBOARDEN (http://adafru.it/iCr)
- AT+BLEKEYBOARD (http://adafru.it/iCr)
- AT+BLEKEYBOARDCODE (http://adafru.it/iCr)

The following AT commands were changed in the 0.5.0 release:

- ATI (http://adafru.it/iCs)
  The SoftDevice, SoftDevice version and bootloader version were added as a new (7th) record. For Ex: "S110 7.1.0, 0.0" indicates version 7.1.0 of the S110 softdevice is used with the 0.0 bootloader (future boards will use a newer 0.1 bootloader).

Other notes concerning 0.5.0:

Starting with version 0.5.0, you can execute the **AT+FACTORYRESET** command at any point (and without a terminal emulator) by holding the DFU button down for 10 seconds until the blue CONNECTED LED starts flashing, then releasing it.

Version 0.4.7

The following AT commands were added in the 0.4.7 release:

- +++ (http://adafru.it/iCs)
- AT+HWRANDOM (http://adafru.it/iCt)
- AT+BLEURIBEACON (http://adafru.it/iCu)
- AT+DBGSTACKSIZE (http://adafru.it/iCv)
- AT+DBGSTACKDUMP (http://adafru.it/iCv)

The following commands were changed in the 0.4.7 release:

- ATI (http://adafru.it/iCs)The chip revision was added after the chip name. Whereas ATI would previously report 'nRF51822', it will now add the specific HW revision if it can be detected (ex 'nRF51822 QFAAG00')

Version 0.3.0

- First public release

Command Examples

The following code snippets can be used when operating in Command Mode to perform specific tasks.

Heart Rate Monitor Service

The command list below will add a Heart Rate (http://adafru.it/ddB) service to the BLEFriend's attribute table, with two characteristics:

- Heart Rate Measurement (http://adafru.it/ddD)
- Body Sensor Location (http://adafru.it/eck)

```
# Perform a factory reset to make sure we get a clean start
AT+FACTORYRESET
OK

# Add the Heart Rate service entry
AT+GATTADDSERVICE=UUID=0x180D
1
OK

# Add the Heart Rate Measurement characteristic
AT+GATTADDCHAR=UUID=0x2A37, PROPERTIES=0x10, MIN_LEN=2, MAX_LEN=3, VALUE=00-40
1
OK

# Add the Body Sensor Location characteristic
AT+GATTADDCHAR=UUID=0x2A38, PROPERTIES=0x02, MIN_LEN=1, VALUE=3
2
OK

# Create a custom advertising packet that includes the Heart Rate service UUID
AT+GAPSETADVDATA=02-01-06-05-02-0d-18-0a-18
OK

# Reset the device to start advertising with the custom payload
ATZ
OK

# Update the value of the heart rate measurement (set it to 0x004A)
AT+GATTCHAR=1,00-4A
OK
```

Python Script

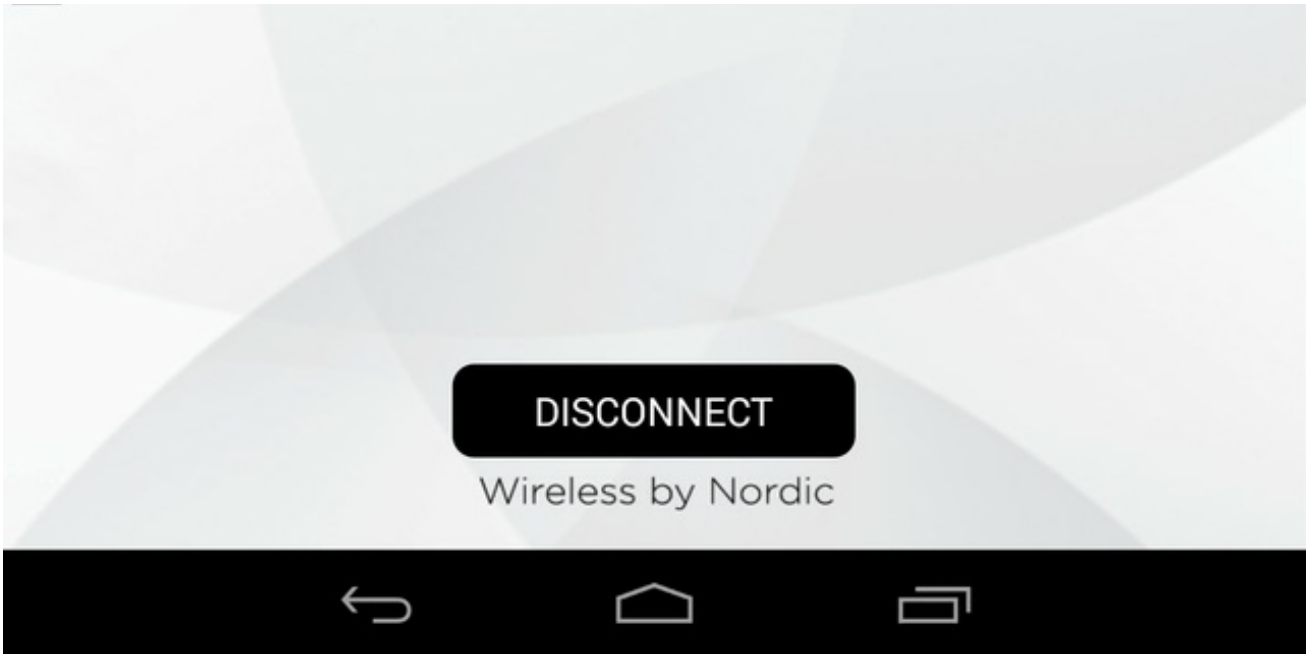
The following code performs the same function, but has been placed inside a Python wrapper using PySerial (http://adafru.it/cLU) to show how you can script actions for the AT parser.

```
import io
import sys
import serial
import random
from time import sleep

filename = "hrm.py"
ser = None
serio = None
verbose = True  # Set this to True to see all of the incoming serial data


def usage():
    """Displays information on the command-line parameters for this script"""
    print "Usage: " + filename + " <serialPort>\n"
    print "For example:\n"
    print "  Windows : " + filename + " COM14"
    print "  OS X    : " + filename + " /dev/tty.usbserial-DN009WNO"
    print "  Linux   : " + filename + " /dev/ttyACM0"
    return


def checkargs():
    """Validates the command-line arguments for this script"""
    if len(sys.argv) < 2:
        print "ERROR: Missing serialPort"
        usage()
        sys.exit(-1)
    if len(sys.argv) > 2:
        print "ERROR: Too many arguments (expected 1)."
        usage()
        sys.exit(-2)


def errorhandler(err, exitonerror=True):
    """Display an error message and exit gracefully on "ERROR\r\n" responses"""
    print "ERROR: " + err.message
    if exitonerror:
        ser.close()
        sys.exit(-3)
```

```
def atcommand(command, delayms=0):
    """Executes the supplied AT command and waits for a valid response"""
    serio.write(unicode(command + "\n"))
    if delayms:
        sleep(delayms/1000)
    rx = None
    while rx != "OK\r\n" and rx != "ERROR\r\n":
        rx = serio.readline(2000)
        if verbose:
            print unicode(rx.rstrip("\r\n"))
    # Check the return value
    if rx == "ERROR\r\n":
        raise ValueError("AT Parser reported an error on '" + command.rstrip() + "'")


if __name__ == '__main__':
    # Make sure we received a single argument (comPort)
    checkargs()

    # This will automatically open the serial port (no need for ser.open)
    ser = serial.Serial(port=sys.argv[1], baudrate=9600, rtscts=True)
    serio = io.TextIOWrapper(io.BufferedRWPair(ser, ser, 1),
                             newline='\r\n',
                             line_buffering=True)

    # Add the HRM service and characteristic definitions
    try:
        atcommand("AT+FACTORYRESET", 1000)  # Wait 1s for this to complete
        atcommand("AT+GATTCLEAR")
        atcommand("AT+GATTADDSERVICE=UUID=0x180D")
        atcommand("AT+GATTADDCHAR=UUID=0x2A37, PROPERTIES=0x10, MIN_LEN=2, MAX_LEN=3, VAL
        atcommand("AT+GATTADDCHAR=UUID=0x2A38, PROPERTIES=0x02, MIN_LEN=1, VALUE=3")
        atcommand("AT+GAPSETADVDATA=02-01-06-05-02-0d-18-0a-18")
        # Perform a system reset and wait 1s to come back online
        atcommand("ATZ", 1000)
        # Update the value every second
        while True:
            atcommand("AT+GATTCHAR=1,00-%02X" % random.randint(50, 100), 1000)
    except ValueError as err:
        # One of the commands above returned "ERROR\n"
        errorhandler(err)
    except KeyboardInterrupt:
        # Close gracefully on CTRL+C
        ser.close()
        sys.exit()
```

The results of this script can be seen below in the 'HRM' app of Nordic's nRF Toolbox application:

> Please note that nRF Toolbox will only display HRM data if the value changes, so you will need to update the Heart Rate Measurement characteristic at least once after opening the HRM app and connecting to the BLEFriend


DISCONNECT
Wireless by Nordic

SDEP (SPI Data Transport)

In order to facilitate switching between UART and SPI based Bluefruit LE modules, the Bluefruit LE SPI Friend and Shield uses the same AT command set at the UART modules (`ATI` , `AT+HELP` , etc.).

These text-based AT commands are encoded as binary messages using a simple binary protocol we've named **SDEP** (Simple Data Exhange Protocol).

> Most of the time, you never need to deal with SDEP directly, but we've documented the protocol here in case you need understand the Bluefruit LE SPI interface in depth!

SDEP Overview

SDEP was designed as a *bus neutral* protocol to handle binary commands and responses -- including error responses -- in a standard, easy to extend manner. 'Bus neutral' means that we can use SDEP regardless of the transport mechanism (USB HID, SPI, I2C, Wireless data over the air, etc.).

All SDEP messages have a **four byte header**, and in the case of the Bluefruit LE modules **up to a 16 byte payloads**. Larger messages are broken up into several 4+16 bytes message chunks which are rebuilt at either end of the transport bus. The 20 byte limit (4 byte header + 16 byte payload) was chosen to take into account the maximum packet size in Bluetooth Low Energy 4.0 (20 bytes per packet).

SPI Setup

While SDEP is bus neutral, in the case of the Bluefruit LE SPI Friend or Shield, an SPI transport is used with the following constraints and assumptions, largely to take into account the HW limitations of the nRF51822 system on chip:

SPI Hardware Requirements

- The SPI clock should run <=4MHz
- A 100us delay should be added between the moment that the CS line is asserted, and before any data is transmitted on the SPI bus
- The CS line must remain asserted for the entire packet, rather than toggling CS every byte

IRQ Pin

The IRQ line is asserted by the Bluefruit LE SPI Friend/Shield as long as an entire SDEP packet is available in the buffer on the nRF51822, at which point you should read the packet, keeping the CS line asserted for the entire transaction (as detailed above).

The IRQ line will remain asserted as long as one or more packets are available, so the line may stay high after reading a packet, meaning that more packets are still available in the FIFO on the SPI slave side.

SDEP Packet and SPI Error Identifier

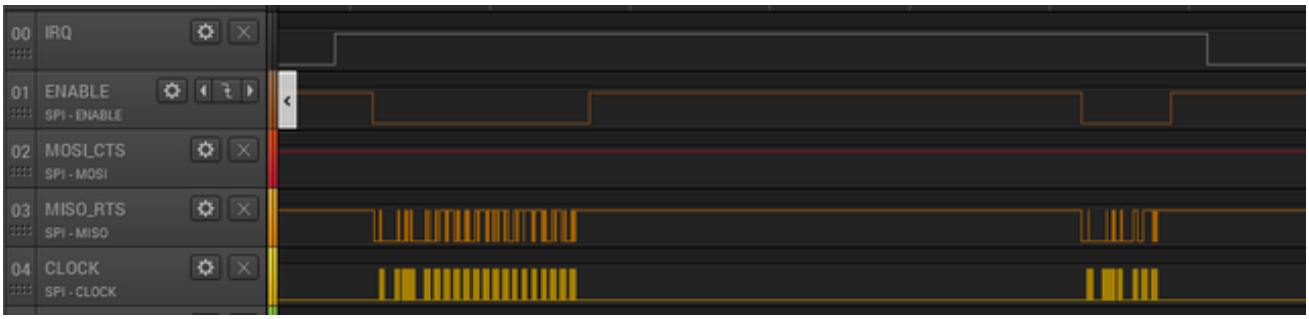
Once CS has been asserted and the mandatory 100us delay has passed, a single byte should be read from the SPI bus which will indicate the type of payload available on the nRF51822 (see Message Type Indicator below for more information on SDEP message types). Keep CS asserted after this byte has been read in case you need to continue reading the rest of the frame.

If a standard SDEP message type indicator (0x10, 0x20, 0x40 or 0x80) is encountered, keep reading as normal. There are two other indicators that should be taken into account, though, which indicate a problem on the nRF51822 SPI slave side:

- **0xFE**: Slave device not ready (wait a bit and try again)
- **0xFF**: Slave device read overflow indicator (you've read more data than is available)

Sample Transaction

The following image shows a sample SDEP response that is spread over two packets (since the response is > 20 bytes in size). Notice that the IRQ line stays asserted between the packets since more than one was available in the FIFO on the Bluefruit LE SPI side:



SDEP (Simple Data Exchange Protocol)

The Simple Data Exchange Protocol (SDEP) can be used to send and receive binary messages between two connected devices using any binary serial bus (USB HID, USB Bulk, SPI, I2C, Wireless, etc.), exchanging data using one of four distinct message types (Command, Response, Alert and Error messages).

The protocol is designed to be flexible and extensible, with the only requirement being that **individual messages are 20 bytes or smaller,** and that the first byte of every message is a one byte (U8) identifier that indicates the message type, which defines the format for the remainder of the payload.

Endianness

All values larger than 8-bits are encoded in little endian format. Any deviation from this rule should be clearly documented.

Message Type Indicator

The first byte of every message is an 8-bit identifier called the **Message Type Indicator**. This value indicates the type of message being sent, and allows us to determine the format for the remainder of the message.

Message Type	**ID (U8)**
Command	0x10
Response	0x20
Alert	0x40
Error	0x80

SDEP Data Transactions

Either connected device can initiate SDEP transactions, though certain transport protocols imposes restrictions on who can initiate a transfer. The master device, for example, always initiates transactions with Bluetooth Low Energy or USB, meaning that slave devices can only reply to incoming commands.

Every device that receives a *Command Message* must reply with a *Response Message*, *Error Message* or *Alert message*.

Message Types

Command Messages

Command messages (Message Type = 0x10) have the following structure:

Name	Type	Meaning
Message Type	U8	Always '0x10'
Command ID	U16	Unique Command Identifier
Payload Length	U8	[7] More data [6-5] Reserved [4-0] Payload length (0..16)
Payload	...	Optional command payload (parameters, etc.)

Command ID (bytes 1-2) and **Payload Length** (byte 3) are mandatory in any command message. The message payload is optional, and will be ignored if Payload Length is set to 0 bytes. When a message payload is present, it's length can be anywhere from 1..16 bytes, to stay within the 20-byte maximum message length.

A long command (>16 bytes payload) must be divided into multiple packets. To facilitate this, the **More data** field (bit 7 of byte 3) is used to indicate whether additional packets are available for the same command. The SDEP receiver must continue to reads packets until it finds a packet with **More data == 0**, then assemble all sub-packets into one command if necessary.

The contents of the payload are user defined, and can change from one command to another.

A sample command message would be:

```
10 34 12 01 FF
```

0: Message Type (U8)	0x10	
1+2: Command ID (U16)	0x34 0x12	
3: Payload Len (U8)	0x01	
4: Payload (...)	0xFF	

- The first byte is the Message Type (0x10), which identifies this as a command message.
- The second and third bytes are 0x1234 (34 12 in little-endian notation), which is the unique command ID. This value will be compared against the command lookup table and redirected to an appropriate command handler function if a matching entry was found.
- The fourth byte indicates that we have a message payload of 1 byte
- The fifth byte is the 1 byte payload: 0xFF

Response Messages

Response messages (Message Type = 0x20) are generated in response to an incoming command, and have the following structure:

Name	Type	Meaning
Message Type	U8	Always '0x20'
Command ID	U16	Command ID this message is a response to
Payload Length	U8	[7] More data [6-5] Reserved [4-0] Payload length (0..16)
Payload		Optional response payload (parameters, etc.)

By including the **Command ID** that this response message is related to, the recipient can more easily correlate responses and commands. This is useful in situations where multiple commands are sent, and some commands may take a longer period of time to execute than subsequent commands with a different command ID.

Response messages can only be generate in response to a command message, so the Command ID field should always be present.

A long response (>16 bytes payload) must be divided into multiple packets. Similar to long commands, the **More data** field (bit 7 of byte 3) is used to indicate whether additional packets are available for the same response. On responses that span more than one packet, the **More data** bit on the final packet will be set to 0 to indicate that this is the last packet in the sequence. The SDEP receiver must re-assemble all sub-packets in into one payload when necessary.

If more precise command/response correlation is required a custom protocol should be developed, where a unique message identifier is included in the payload of each command/response, but this is beyond the scope of this high-level protocol definition.

A sample response message would be:

```
20 34 12 01 FF
```

0: Message Type (U8)	0x20	
1+2: Command ID (U16)	0x34 0x12	
3: Payload Len (U8)	0x01	
4: Payload	0xFF	

- The first byte is the Message Type (0x20), which identifies this as a response message.
- The second and third bytes are 0x1234, which is the unique command ID that this response is related to.
- The fourth byte indicates that we have a message payload of 1 byte.
- The fifth byte is the 1 byte payload: 0xFF

Alert Messages

Alert messages (Message Type = 0x40) are sent whenever an alert condition is present on the system (low battery, etc.), and have the following structure:

Name	Type	Meaning
Message Type	U8	Always '0x40'
Alert ID	U16	Unique ID for the Alert Condition
Payload Length	U8	Payload Length (0..16)
Payload	...	Optional response payload

A sample alert message would be:

```
40 CD AB 04 42 07 00 10
```

0: Message Type (U8)	0x40	
1+2: Alert ID (U16)	0xCD 0xAB	
3: Payload Length	0x04	
4+5+6+7: Payload	0x42 0x07 0x00 0x10	

- The first byte is the Message Type (0x40), which identifies this as an alert message.
- The second and third bytes are 0xABCD, which is the unique alert ID.

- The fourth byte indicates that we have a message payload of 4 bytes.
- The last four bytes are the actual payload: 0x10000742 in this case, assuming we were transmitting a 32-bit value in little-endian format.

Standard Alert IDs

Alert IDs in the range of 0x0000 to 0x00FF are reserved for standard SDEP alerts, and may not be used by custom alerts.

The following alerts have been defined as a standard part of the protocol:

ID	Alert	Description
0x0000	Reserved	Reserved for future use
0x0001	System Reset	The system is about to reset
0x0002	Battery Low	The battery level is low
0x0003	Battery Critical	The battery level is critically low

Error Messages

Error messages (Message Type = 0x80) are returned whenever an error condition is present on the system, and have the following structure:

Name	Type	Meaning
Message Type	U8	Always '0x80'
Error ID	U16	Unique ID for the error condition
Reserved	U8	Reserved for future use

Whenever an error condition is present and the system needs to be alerted (such as a failed request, an attempt to access a non-existing resource, etc.) the system can return a specific error message with an appropriate Error ID.

A sample error message would be:

```
80 01 00 00
```

0: Message ID (U8)	0x80	
1+2: Error ID (U16)	0x01 0x00	
3: Reserved (U8)	0x00	

Standard Error IDs

Error IDs in the range of 0x0000 to 0x00FF are reserved for standard SDEP errors, and may not be used by custom errors.

The following errors have been defined as a standard part of the protocol:

ID	Error	Description
0x0000	Reserved	Reserved for future use
0x0001	Invalid CMD ID	CMD ID wasn't found in the lookup table
0x0003	Invalid Payload	The message payload was invalid

GATT Service Details

Data in Bluetooth Low Energy is organized around units called 'GATT Services (http://adafru.it/iCp)' and 'GATT Characteristics'. To expose data to another device, you must instantiate at least one service on your device.

Adafruit's Bluefruit LE Pro modules support some 'standard' services, described below (more may be added in the future).

UART Service

The UART Service is the standard means of sending and receiving data between connected devices, and simulates a familiar two-line UART interface (one line to transmit data, another to receive it).

The service is described in detail on the dedicated UART Service (http://adafru.it/iCn) page.

UART Service

Base UUID: 6E40**0001**-B5A3-F393- E0A9- E50E24DCCA9E

This service simulates a basic UART connection over two lines, TXD and RXD.

It is based on a proprietary UART service specification by Nordic Semiconductors. Data sent to and from this service can be viewed using the nRFUART apps from Nordic Semiconductors for Android and iOS.

> This service is available on every Bluefruit LE module and is automatically started during the power-up sequence.

Characteristics

Nordic's UART Service includes the following characteristics:

Name	Mandatory	UUID	Type	R	W	N	I
TX	Yes	0x0002	U8[20]		X		
RX	Yes	0x0003	U8[20]	X		X	

R = Read; W = Write; N = Notify; I = Indicate

> Characteristic names are assigned from the point of view of the Central device

TX (0x0002)

This characteristic is used to send data back to the sensor node, and can be written to by the connected Central device (the mobile phone, tablet, etc.).

RX (0x0003)

This characteristic is used to send data out to the connected Central device. Notify can be enabled by the connected device so that an alert is raised every time the TX channel is updated.

Software Resources

To help you get your Bluefruit LE module talking to other Central devices, we've put together a number of open source tools for most of the major platforms supporting Bluetooth Low Energy.

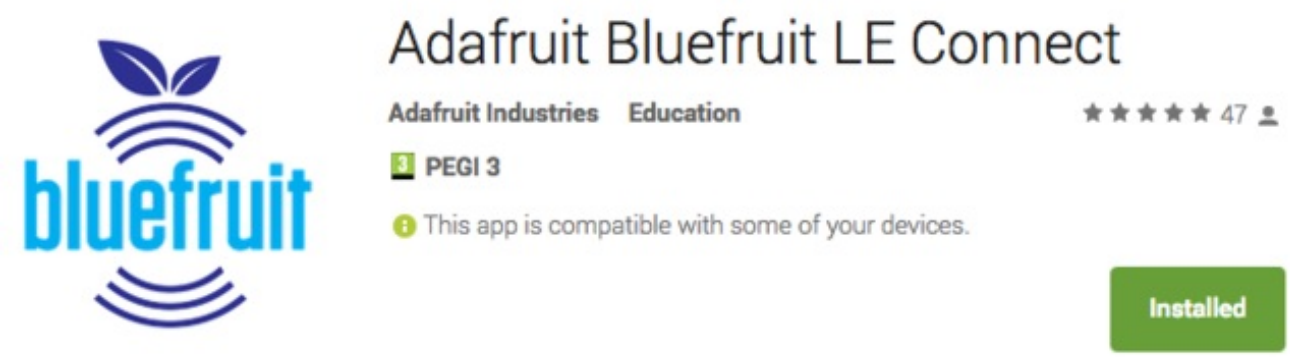
Bluefruit LE Client Apps and Libraries

Adafruit has put together the following mobile or desktop apps and libraries to make it as easy as possible to get your Bluefruit LE module talking to your mobile device or laptop, with full source available where possible:

Bluefruit LE Connect (http://adafru.it/f4G) (Android/Java)

Bluetooth Low Energy support was added to Android starting with Android 4.3 (though it was only really stable starting with 4.4), and we've already released Bluefruit LE Connect to the Play Store (http://adafru.it/f4G).

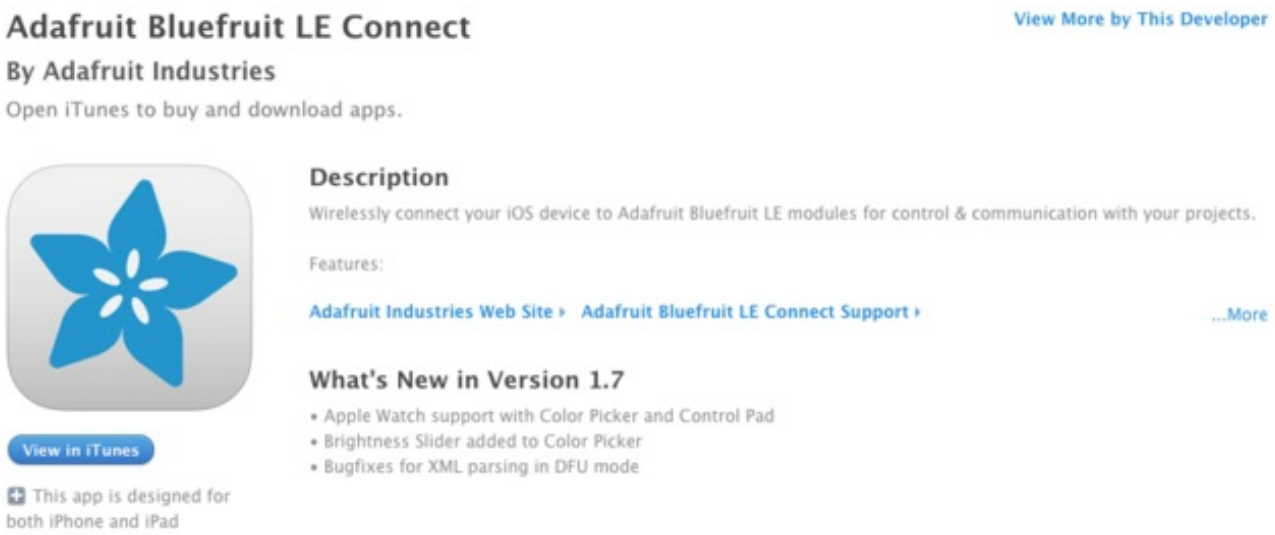
The full source code (http://adafru.it/fY9) for Bluefruit LE Connect for Android is also available on Github to help you get started with your own Android apps. You'll need a recent version of Android Studio (http://adafru.it/fYa) to use this project.



Bluefruit LE Connect (http://adafru.it/f4H) (iOS/Swift)

Apple was very early to adopt Bluetooth Low Energy, and we also have an iOS version of the Bluefruit LE Connect (http://adafru.it/f4H) app available in Apple's app store.

The full Swift source code (http://adafru.it/ddv) for Bluefruit LE Connect for iOS is also available on Github. You'll need XCode and access to Apple's developper program to use this project.



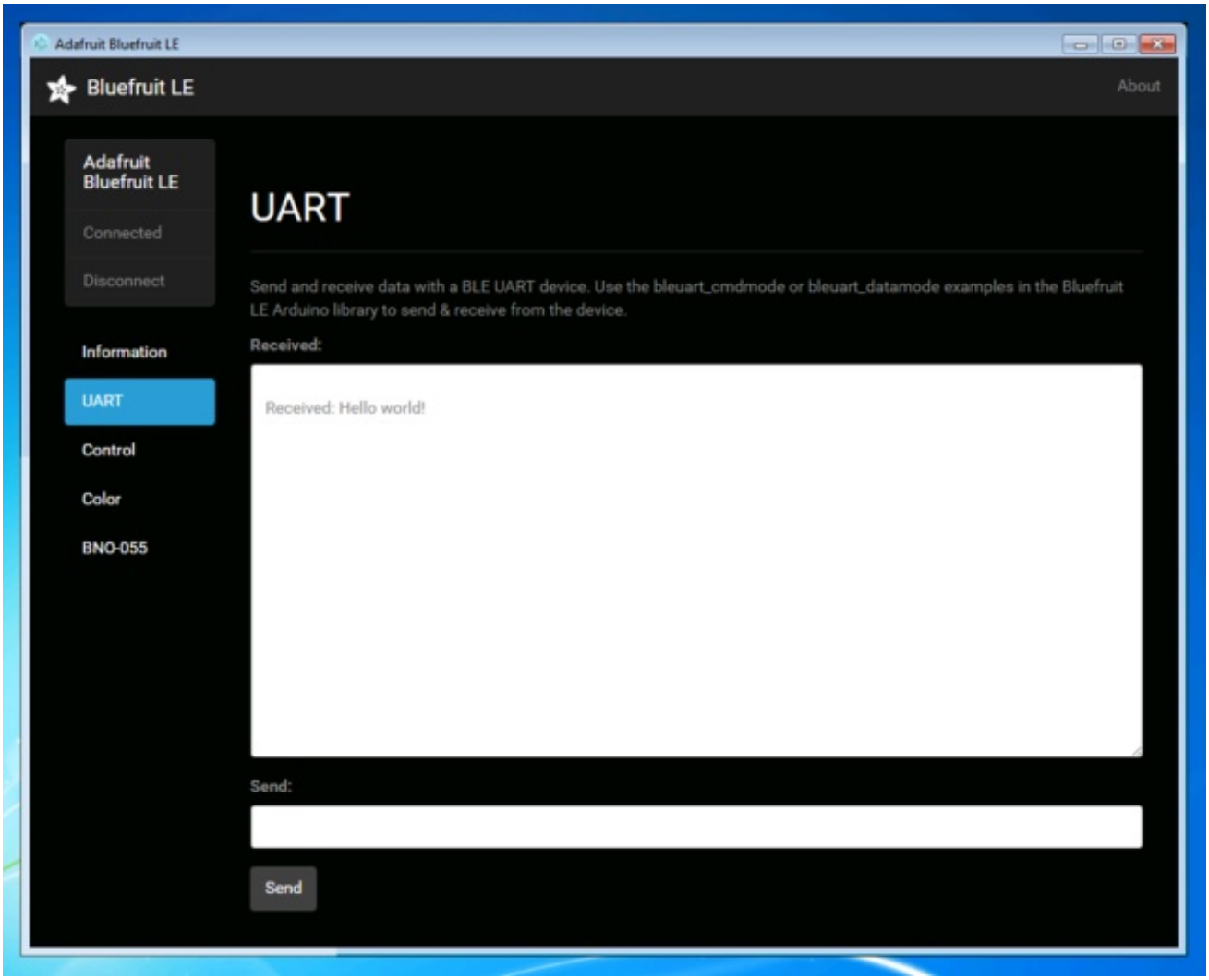
ABLE (http://adafru.it/ijB) (Cross Platform/Node+Electron)

ABLE (http://adafru.it/ijB) (Adafruit Bluefruit LE Desktop) is a cross-platform desktop application based on Sandeep Misty's noble library (http://adafru.it/ijC) and the Electron (http://adafru.it/ijD) project from Github (used by Atom).

It runs on OS X, Windows 7+ and select flavours of Linux (Ubuntu tested locally). Windows 7 support is particularly interesting since Windows 7 has no native support for Bluetooth Low Energy but the noble library talks directly to supported Bluetooth 4.0 USB dongles (http://adafru.it/1327) to emulate BLE on the system (though at this stage it's still in early BETA and drops the connection and takes more care to work with).

This app allows you to collect sensor data or perform many of the same functionality offered by the mobile Bluefruit LE Connect apps, but on the desktop.

The app is still in BETA, but full source (http://adafru.it/ijE) is available in addition to the easy to use pre-compiled binaries (http://adafru.it/ijB).



Bluefruit LE Python Wrapper (http://adafru.it/fQF)

As a proof of concept, we've played around a bit with getting Python working with the native Bluetooth APIs on OS X and the latest version of Bluez on certain Linux targets.

There are currently example sketches showing how to retreive BLE UART data as well as some basic details from the Device Information Service (DIS).

This isn't an actively support project and was more of an experiment, but if you have a recent Macbook or a Raspberry Pi and know Python, you might want to look at Adafruit_Python_BluefruitLE (http://adafru.it/fQF) in our github account.

Debug Tools

If your sense of adventure gets the better of you, and your Bluefruit LE module goes off into the weeds, the following tools might be useful to get it back from unknown lands.

These debug tools are provided purely as a convenience for advanced users for device recovery purposes, and are not recommended unless you're OK with potentially bricking your board. Use them at your own risk.

AdaLink (http://adafru.it/fPq) (Python)

This command line tool is a python-based wrapper for programming ARM MCUs using either a Segger J-Link (http://adafru.it/fYU) or an STLink/V2 (http://adafru.it/ijF). You can use it to reflash your Bluefruit LE module using the latest firmware from the Bluefruit LE firmware repo (http://adafru.it/edX).

Details on how to use the tool are available in the readme.md file on the main Adafruit_Adalink (http://adafru.it/fPq) repo on Github.

Completely reprogramming a Bluefruit LE module with AdaLink would require four files, and would look something like this (using a JLink):

```
adalink nrf51822 --programmer jlink --wipe
  --program-hex "Adafruit_BluefruitLE_Firmware/softdevice/s110_nrf51_8.0.0_softdevice.hex"
  --program-hex "Adafruit_BluefruitLE_Firmware/bootloader/bootloader_0002.hex"
  --program-hex "Adafruit_BluefruitLE_Firmware/0.6.7/blefriend32/blefriend32_s110_xxac_0_6_7_150917_blefrie
  --program-hex "Adafruit_BluefruitLE_Firmware/0.6.7/blefriend32/blefriend32_s110_xxac_0_6_7_150917_blefrie
```

You can also use the AdaLink tool to get some basic information about your module, such as which SoftDevice is currently programmed or the IC revision (16KB SRAM or 32KB SRAM) via the --info command:

```
$ adalink nrf51822 -p jlink --info
Hardware ID : QFACA10 (32KB)
Segger ID   : nRF51822_xxAC
SD Version  : S110 8.0.0
Device Addr : **:**:**:**:**:**
Device ID   : ***************
```

Adafruit nRF51822 Flasher (http://adafru.it/fVL) (Python)

Adafruit's nRF51822 Flasher is an internal Python tool we use in production to flash boards as they go through the test procedures and off the assembly line, or just testing against different firmware releases when debugging.

It relies on AdaLink or OpenOCD beneath the surface (see above), but you can use this command line tool to flash your nRF51822 with a specific SoftDevice, Bootloader and Bluefruit firmware combination.

It currently supports using either a Segger J-Link or STLink/V2 via AdaLink, or GPIO on a Raspberry Pi (http://adafru.it/fVL) if you don't have access to a traditional ARM SWD debugger. (A pre-built version of OpenOCD for the RPi is included in the repo since building it from scratch takes a long time on the original RPi.)

We don't provide active support for this tool since it's purely an internal project, but made it public just in case it might help an adventurous customer debrick a board on their own.

```
$ python flash.py --jtag=jlink --board=blefriend32 --softdevice=8.0.0 --bootloader=2 --firmware=0.6.7
jtag        : jlink
softdevice  : 8.0.0
bootloader  : 2
board       : blefriend32
firmware    : 0.6.7
Writing Softdevice + DFU bootloader + Application to flash memory
adalink -v nrf51822 --programmer jlink --wipe --program-hex "Adafruit_BluefruitLE_Firmware/softdevice/s110_nrf
...
```

BLE FAQ

Can I talk to Classic Bluetooth devices with a Bluefruit LE modules?

No. Bluetooth Low Energy and 'Classic' Bluetooth are both part of the same Bluetooth Core Specification -- defined and maintained by the Bluetooth SIG -- but they are completely different protocols operating with different physical constraints and requirements. The two protocols can't talk to each other directly.

Can my Bluefruit LE module connect to other Bluefruit LE peripherals

No, the Bluefruit LE firmware from Adafruit is currently peripheral only, and doesn't run in Central mode, which would cause the module to behave similar to your mobile phone or BLE enabled laptop.

At some point we might consider a new firmware image offering this, but since 98% of the uses cases for BLE involved running as a peripheral we've concentrated all of our development effort there for now.

Why are none of my changes persisting when I reset with the sample sketches?

In order to ensure that the Bluefruit LE modules are in a known state for the Adafruit demo sketches, most of them perform a factory reset at the start of the sketch.

This is useful to ensure that the sketch functions properly, but has the side effect of erasing any custom user data in NVM and setting everything back to factory defaults every time your board comes out of reset and the sketch runs.

To disable factory reset, open the demo sketch and find the **FACTORYRESET_ENABLE** flag and set this to '0', which will prevent the factory reset from happening at startup.

If you don't see the 'FACTORYRESET_ENABLE' flag in your .ino sketch file, you probably have an older version of the sketches and may need to update to the latest version via the Arduino library manager.

Do I need CTS and RTS on my UART based Bluefruit LE Module?

Using CTS and RTS isn't strictly necessary when using HW serial, but they should both be used with SW serial, or any time that a lot of data is being transmitted.

The reason behind the need for CTS and RTS is that the UART block on the nRF51822 isn't very robust, and early versions of the chip had an extremely small FIFO meaning that the UART peripheral was quickly overwhelmed.

Using CTS and RTS significantly improves the reliability of the UART connection since these two pins tell the device on the other end when they need to wait while the existing buffered data is processed.

To enable CTS and RTS support, go into the BluefruitConfig.h file in your sketch folder and simply assign an appropriate pin to the macros dedicated to those functions (they may be set to -1 if they aren't currently being used).

Enabling both of these pins should solve any data reliability issues you are having with large commands, or when transmitting a number of commands in a row.

How can I update to the latest Bluefruit LE Firmware?

The easiest way to keep your Bluefruit LE modules up to date is with our Bluefruit LE Connect app for Android (http://adafru.it/f4G) or Bluefruit LE Connect for iOS (http://adafru.it/f4H). Both of these apps include a firmware update feature that allows you to automatically download the latest firmware and flash your Bluefruit LE device in as safe and painless a manner as possible. You can also roll back to older versions of the Bluefruit LE firmware using these apps if you need to do some testing on a previous version.

Which firmware version supports 'xxx'?

We regularly release Bluefruit LE firmware images (http://adafru.it/edX) with bug fixes and new features. Each AT command in this learning guide lists the minimum firmware version required to use that command, but for a higher level overview of the changes from one firmware version to the next, consult the firmware history page (http://adafru.it/iCw).

Does my Bluefruit LE device support ANCS?

ANCS is on the roadmap for us (most likely in the 0.7.x release family), but we don't currently support it since there are some unusual edge cases when implementing it as a service.

My Bluefruit LE device is stuck in DFU mode ... what can I do?

If your device is stuck in DFU mode for some reason and the firmware was corrupted, you have several options.

First, try a factory reset by holding down the DFU button for about 10 seconds until the CONN LED starts flashing, then release the DFU button to perform a factory reset.

If this doesn't work, you may need to reflash your firmware starting from DFU mode, which can be done in one of the following ways:

Bluefruit LE Connect (Android)

- Place the module in DFU mode (constant LED blinky)
- Open Bluefruit LE Connect
- Connect to the 'DfuTarg' device
- Once connected, you will see a screen with some basic device information. Click the '...' in the top-right corner and select **Firmware Updates**
- Click the **Use Custom Firmware** button
- Select the appropriate .hex and .init files (copied from the Bluefruit LE Firmware

repo (http://adafru.it/edX)) ... for the BLEFRIEND32 firmware version 0.6.7, this would be:
    - Hex File: blefriend32_s110_xxac_0_6_7_150917_blefriend32.hex
    - Init File: blefriend32_s110_xxac_0_6_7_150917_blefriend32_init.dat
- Click **Start Update**

Unfortunately, the iOS app doesn't yet support custom firmware updates from DFU mode yet, but we will get this into the next release.

Nordic nRF Toolbox

You can also use Nordic's nRF Toolbox application to update the firmware using the OTA bootloader.

On **Android**:

- Open nRF Toolbox (using the latest version)
- Click the **DFU** icon
- Click the **Select File** button
- Select **Application** from the radio button list, then click **OK**
- Find the appropriate .hex file (ex. 'blefriend32_s110_xxac_0_6_7_150917_blefriend32.hex')
- When asked about the '**Init packet**', indicate **Yes**, and select the appropriate *_init.dat file (for example: 'blefriend32_s110_xxac_0_6_7_150917_blefriend32_init.dat').
- Click the **Select Device** button at the bottom of the main screen and find the **DfuTarg** device, clicking on it
- Click the **Upload** button, which should now be enabled on the home screen
- This will begin the DFU update process which should cause the firmware to be updated or restored on your Bluefruit LE module

On **iOS**:

- Create a .zip file containing the .hex file and init.dat file that you will use for the firmware update. For example:
    - Rename 'blefriend32_s110_xxac_0_6_7_150917_blefriend32.hex' to **application.hex**
    - Rename 'blefriend32_s110_xxac_0_6_7_150917_blefriend32_init.dat' to **application.dat**
- Upload the **.zip file** containing the application.hex and application.dat files to your iPhone using uTunes, as described here (http://adafru.it/iCx)
- Open the nRF Toolbox app (using the latest version)
- Click the **DFU** icon
- Click the **Select File** text label
- Switch to **User Files** to see the .zip file you uploaded above
- Select the .zip file (ex. blefriend32_065.zip)

- On the main screen select **Select File Type**
- Select **application**
- On the main screen select **SELECT DEVICE**
- Select **DfuTarg**
- Click the **Upload** button which should now be enabled
- This will begin the DFU process and your Bluefruit LE module will reset when the update is complete
- If you get the normal 2 or 3 pulse blinky pattern, the update worked!

Adafruit_nRF51822_Flasher

As a last resort, if you have access to a Raspberry Pi, a Segger J-Link or a STLink/V2, you can also try manually reflashing the entire device, as described in the FAQ above (http://adafru.it/iCy), with further details on the Software Resources (http://adafru.it/iCz) page.

How do I reflash my Bluefruit LE module over SWD?

Reflashing Bluefruit LE modules over SWD (ex. switching to the sniffer firmware and back) is **at your own risk and can lead to a bricked device, and we can't offer any support for this operation!** You're on your own here, and there are unfortunately 1,000,000 things that can go wrong, which is why we offer two separate Bluefruit LE Friend boards -- the sniffer and the normal Bluefruit LE Friend board with the non-sniffer firmware, which provides a bootloader with fail safe features that prevents you from ever bricking boards via OTA updates.

AdaLink (SWD/JTAG Debugger Wrapper)

Transitioning between the two board types (sniffer and Bluefruit LE module) is unfortunately not a risk-free operation, and requires external hardware, software and know-how to get right, which is why it isn't covered by our support team.

That said ... if you're determined to go down that lonely road, and you have a Segger J-Link (http://adafru.it/fYU) (which is what we use internally for production and development), or have already erased your Bluefruit LE device, you should have a look at AdaLink (http://adafru.it/fPq), which is the tool we use internally to flash the four files required to restore a Bluefruit LE module. (Note: recent version of AdaLink also support the cheaper STLink/V2 (http://adafru.it/2548), though the J-Link is generally more robust if you are going to purchase a debugger for long term use.)

The mandatory Intel Hex files are available in the Bluefruit LE Firmware repo (http://adafru.it/edX). You will need to flash:

- An appropriate bootloader image
- An appropriate SoftDevice image
- The Bluefruit LE firmware image
- The matching signature file containing a CRC check so that the bootloader accepts the

firmware image above (located in the same folder as the firmware image)

The appropriate files are generally listed in the version control .xml file (http://adafru.it/fPr) in the firmware repository.

If you are trying to flash the sniffer firmware (at your own risk!), you only need to flash a single .hex file, which you can find here (http://adafru.it/fYV). The sniffer doesn't require a SoftDevice image, and doesn't use the fail-safe bootloader -- which is why changing is a one way and risky operation if you don't have a supported SWD debugger.

Adafruit_nF51822_Flasher

We also have an internal python tool available that sits one level higher than AdaLink (referenced above), and makes it easier to flash specific versions of the official firmware to a Bluefruit LE module. For details, see the Adafruit_nRF51822_Flasher (http://adafru.it/fVL) repo.

Can I access BETA firmware releases?

The latest versions of the Bluefruit LE Connect applications for iOS and Android allow you to optionally update your Bluefruit LE modules with pre-release or BETA firmware.

This functionality is primarilly provided as a debug and testing mechanism for support issues in the forum, and should only be used when trying to identify and resolve specific issues with your modules!

Enabling BETA Releases on iOS

- Make sure you have at least **version 1.7.1** of Bluefruit LE Connect
- Go to the Settings page
- Scroll to the bottom of the Settings page until you find **Bluefruit LE**
- Click on the Bluefruit LE icon and enable the **Show beta releases** switch
- You should be able to see any BETA releases available in the firmware repo now when you use Bluefruit LE Connect

Enabling BETA Releases on Android

- Make sure you have the latest version of Bluefruit LE Connect
- Open the Bluefruit LE Connect application
- Click the "..." icon in the top-right corner of the app's home screen
- Select **Settings**
- Scroll down to the **Software Updates** section and enable **Show beta releases**
- You should be able to see any BETA releases available in the firmware repo now when you use Bluefruit LE Connect

Why can't I see my Bluefruit LE device after upgrading to Android 6.0?

In Android 6.0 there were some important security changes (http://adafru.it/jcU) that affect

Bluetooth Low Energy devices. If location services are unavailable (meaning the GPS is turned off) you won't be able to see Bluetooth Low Energy devices advertising either. See this issue (http://adafru.it/jcV) for details.

Be sure to enable location services on your Android 6.0 device when using Bluefruit LE Connect or other Bluetooth Low Energy applications with your Bluefruit LE modules.

What is the theoretical speed limit for BLE?

This depends on a variety of factors, and is determined by the capabilities of the central device (the mobile phone, etc.) as much as the peripheral.

Taking the HW limits on the nR51822 into account (max 6 packets per connection interval, and a minimum connection interval of 7.5ms) you end up with the following theoretical limits on various mobile operating systems:

- **iPhone 5/6 + IOS 8.0/8.1**
  6 packets * 20 bytes * 1/0.030 s = 4 kB/s = 32 kbps
- **iPhone 5/6 + IOS 8.2/8.3**
  3 packets * 20 bytes * 1/0.030 s = 2 kB/s = 16 kbps
- **iPhone 5/6 + IOS 8.x with nRF8001**
  1 packet * 20 bytes * 1/0.030 s = 0.67 kB/s = 5.3 kbps
- **Nexus 4**
  4 packets * 20 bytes * 1/0.0075 s = 10.6 kB/s = 84 kbps
- **Nordic Master Emulator Firmware (MEFW) with nRF51822 0.9.0**
  1 packet * 20 bytes * 1/0.0075 = 2.67 kB/s = 21.33 kbps
- **Nordic Master Emulator Firmware (MEFW) with nRF51822 0.11.0**
  6 packets * 20 bytes * 1/0.0075 = 16 kB/s = 128 kbps

There are also some limits imposed by the Bluefruit LE firmware, but we are actively working to significantly improve the throughput in the upcoming 0.7.0 release, which will be available Q1 2015. The above figures are useful as a theoretical maximum to decide if BLE is appropriate for you project or not.

DFU Bluefruit Updates

You can reprogram the Bluefruit LE module itself over-the-air using an Android or iOS phone/tablet. This doesn't reprogram the ATmega32u4 in the Bluefruit Micro, only the BLE module itself. Since its not a common thing to do, its a little challenging to do.

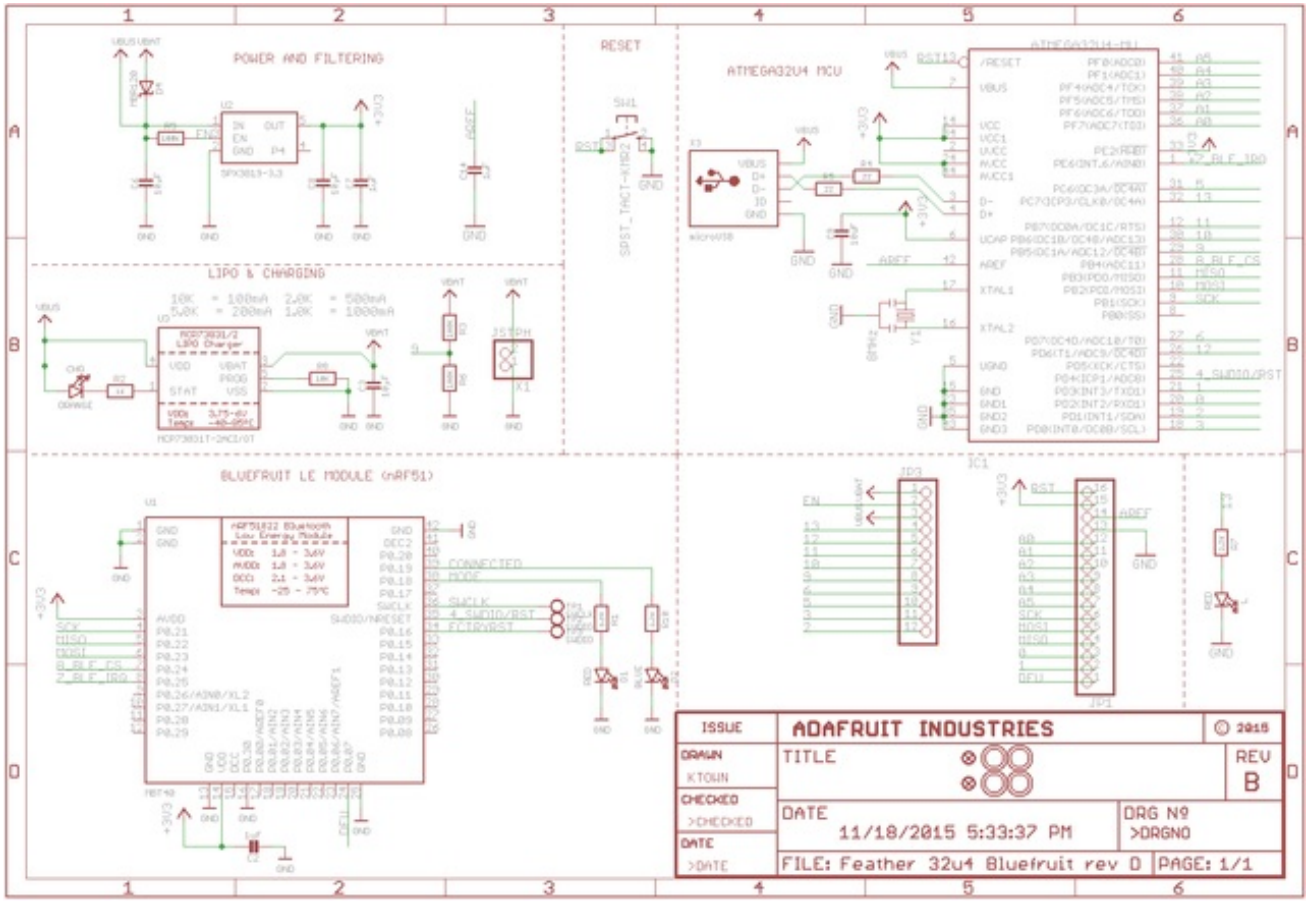
You will need to disconnect/unpower the Bluefruit Micro, connect a wire temporarily between the **DFU** pin and **GND** and then power up the board via USB or battery.

The red LED will blink continuously, letting you know it's in DFU mode. Then follow our guide for field updating the firmware (http://adafru.it/iCQ)

Downloads

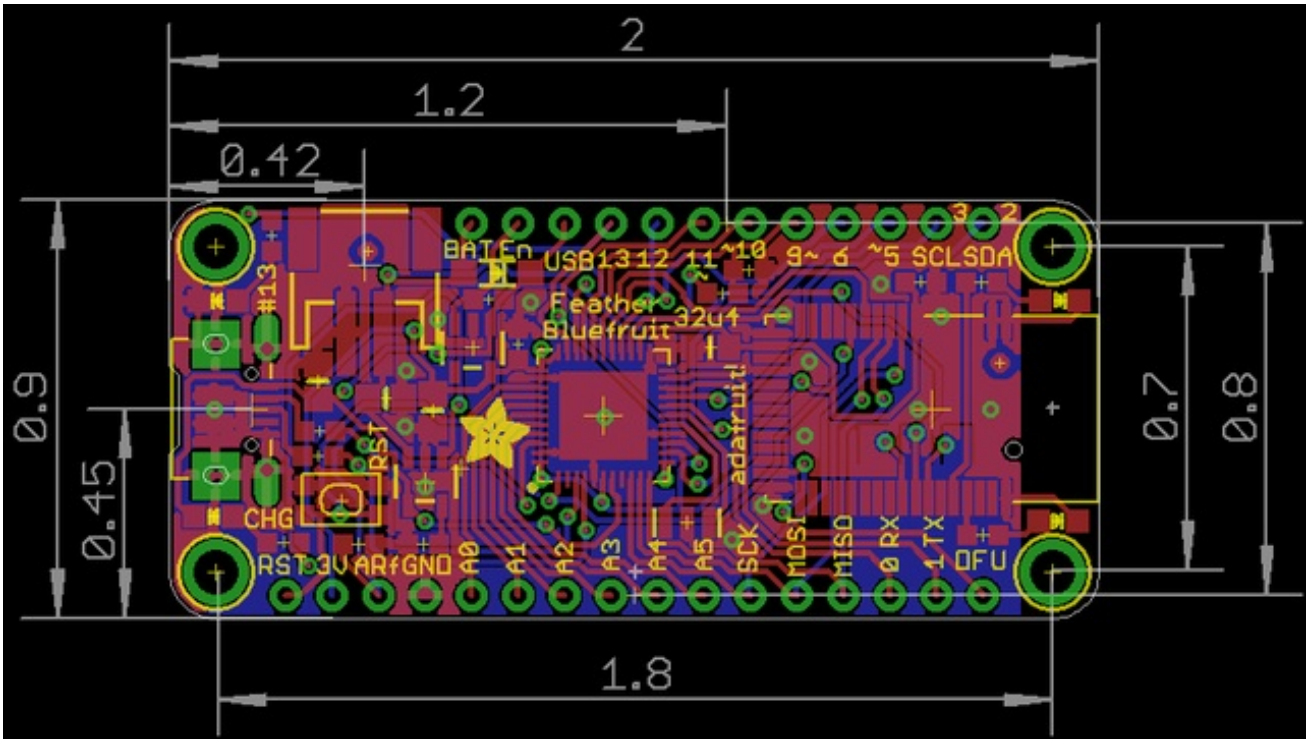
Schematic

Click to embiggen



Fabrication Print

Dimensions in inches


2
1.2
0.42
0.9
0.45
0.7
0.8
1.8
BAT EN
USB
13 12 11 ~10 9~ 6 ~5 SCL SDA
3 2
#13
Feather
Bluefruit
32u4
RST
CHG
adafruit
RST 3V AREF GND A0 A1 A2 A3 A4 A5 SCK MOSI MISO 0 RX 1 TX OFU