Blood Glucose Buddy v1

Introduction

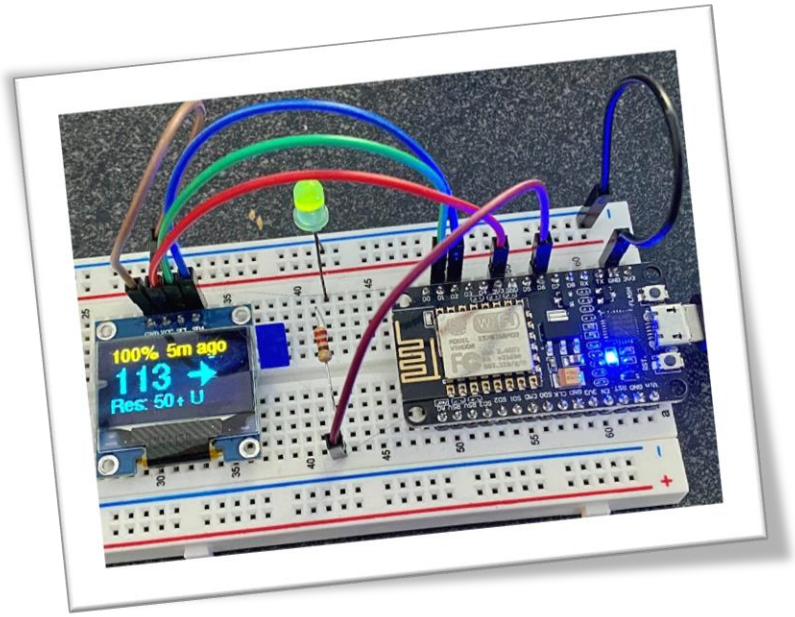
BG Buddy is a blood glucose monitoring project that provides a local IoT-based display for Nightscout users. As such, BG Buddy is currently only usable for people that have a working Nightscout site setup that they are publishing their data to via their CGM or the Loop mobile app. It is beyond the scope of this document to explain Nightscout so please refer to this link: http://www.nightscout.info/

In terms of hardware, BG Buddy leverages the ESP8266 SOC, an inexpensive OLED display, and a few other optional components. It's easy to put together and depending on where you get the components, you can be up-and-running for well under $20 USD!

Version 1 (v1) of BG Buddy simply monitors the Nightscout API and displays 5 key pieces of information. For me, these are the values that would cause me to get up and check on a loved one with diabetes if any of them were out of range. Really, that's what's at the core of BG Buddy - keep those key values top-of-mind and glanceable by creating a simple, inexpensive device that can sit on a desk or shelf [or both] so that these critical values are always visible. In addition, it will also light up an LED approx. every minute when it's refreshing the data.

Looking ahead, the next version of BG Buddy will be adding alerts in the form of both visual (another LED) and audible (buzzer). These alerts will be driven off your Nightscout alarm settings, so no additional setup is needed within BG Buddy itself. You will, however, be able to turn off the alerts [and if your version of BG Buddy doesn't have the extra LED or buzzer, you won't get the alerts anyway].

As is stated on our GitHub site, BG Buddy is a DIY project intended for educational and personal use only. It is not intended for commercial use or to be relied upon for any professional or medical purposes. The creators and contributors of BG Buddy are not responsible for any damages or injuries that may result from the use of this project. By using the BG Buddy software and/or hardware plans, you acknowledge that you understand and assume all risks associated with its use. Please use caution and common sense when working on any DIY project.

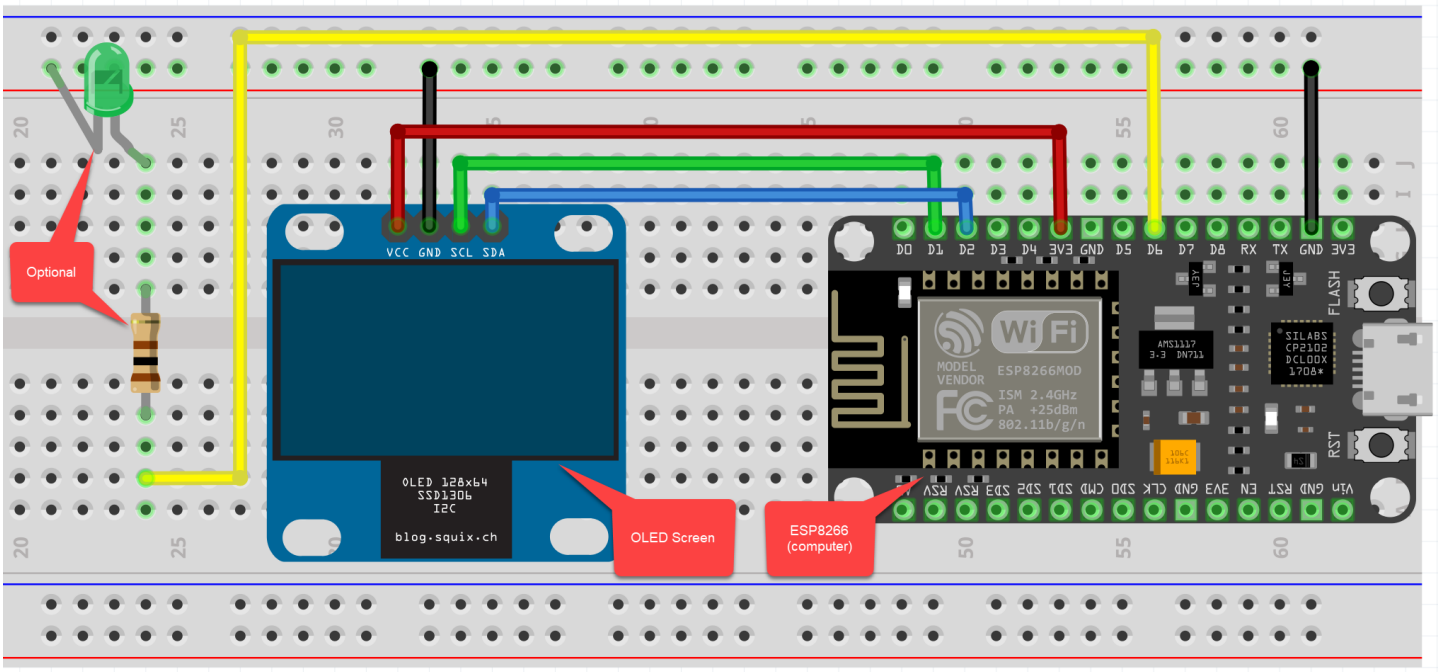


Building BG Buddy

Overview

Now, if you found that photo of a bunch of wires and gadgets plugged into some kind of board with a bunch of holes in it a little bit scary, stay with me – I got you 😊 That's just a project "breadboard"; it's an easy way for DIY tinkerers to play with electronics components and create circuits without having to solder wires together. If you don't have one, and aren't interested in getting one, no worries – we can get by without it, especially if we're just creating a BG Buddy to use [not tinker with].

When we take a more abstract look at what makes up BG Buddy from the hardware perspective, there are just two(2) main parts and two(2) optional parts.



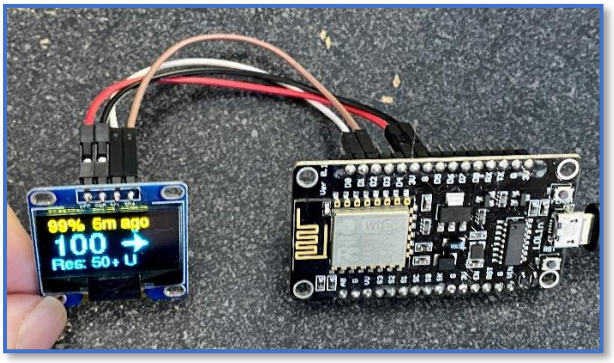
We need the ESP8266 since that's the "computer" (SOC – System On a Chip) and we need the little OLED screen so we can display our BG values. The two optional components, a green LED and a resister, are used together so BG Buddy can light up a green status LED when it's getting fresh data; if you can live without seeing that activity, you can leave those out and, besides, I also light up the blue LED built into the SOC as a secondary busy indicator so you can always refer to that.

The ESP8266 has a micro USB plug on it which is where it gets power from and is how we program it by plugging it into your PC (Windows or Mac). Once programmed, it just needs power and that can come from almost any USB charging adapter you have lying around.

The OLED screen connects to the ESP8266 with just four (4) wires; you'll want to be careful about following the directions here because depending on the manufacturer of these OLED screens, they sometimes rearrange the order of the four(4) pins that the wires connect to so, for example, instead of VCC, GND, SCL, SDA like in the diagram above, they might be GND, VCC, SCL, SDA instead. Also, I'll show you how to do this without any soldering to make it super easy. If you hook everything up and the screen stays blank though, double check the order of those pins first!

Bill of Materials (BOM)

Alright, as I mentioned above, there are just two things you *need*; the ESP8266 SOC and the OLED. If I'm totally honest, yes, you'll need some wires too…and probably a case…and maybe some hot glue. The point is, you don't need much and you don't need special tools or skills to have a fully functional BG Buddy, just like this one using just.4.wires 😊:



Now for the shopping list, I've tried to give you two options – ordering from Amazon or ordering from AliExpress. I've ordered components from both and will happily do so again; I've had great experiences with AliExpress, and the prices are amazing, but it *will* take longer to get your parts (2-3 weeks usually). You'll also want to pay very close attention to what you're ordering, not because they're trying to scam you but because a single listing sometimes has several product variations, and you'll want to be sure you've selected the one you want. Don't assume that because the picture looks right, that the correct product/variation has been selected. Click it and confirm the price before adding to your cart.

The links and prices I've quoted are in US dollars so if you're outside of the US, check your local sources for equivalent products. Local to me I've also found all of these items at local electronics stores so if you have that option, check it out.

The must have parts:

- ESP8266 SOC [the "computer"]
  - Amazon: (3-pack ~$16USD)
    https://www.amazon.com/KeeYees-Internet-Development-Wireless-Compatible/dp/B07HF44GBT/
  - Ali Express: (1 count ~ $3USD)
    https://www.aliexpress.us/item/2251832478785371.html
- SSD1306 OLED [the display screen]
  - Amazon: (1 count ~ $7USD)
    https://www.amazon.com/UCTRONICS-SSD1306-Self-Luminous-Display-Raspberry/dp/B072Q2X2LL/
  - Ali Express: (1 count ~ $3.50USD - be sure to select the correct **4-pin** yellow/blue display)
    https://www.aliexpress.us/item/2251832709890624.html
- Wires [to directly connect the above components]
  - Amazon: (40 count female-to-female 4" ~ $6USD)
    https://www.amazon.com/dp/B077N58HFK
  - Ali Express: (1 pack 40 count female-to-female 10cm [4"] ~ $2.50USD)
    https://www.aliexpress.us/item/2251832638800607.html

As you can see, there's quite a price difference [between Amazon and AliExpress] and you'll note that in some cases there's a difference in the minimum # of parts you can order (the smallest quantity of ESP8266 devices you can buy on Amazon is a 3-pack). If you're planning to make more than one BG Buddy, probably not a big deal. Otherwise, especially if ordering from Amazon, you may want to see if you can split an order with some other local folks who want their own BG Buddy – you'll certainly have more than enough wire!

When we get into the optional components, like the green LED, things get worse in terms of minimum quality; it's *very* hard to find LEDs in quantities of less than 60 or resisters in packs of less than 100, and you only need one(1) resister per green LED. Now, if you're someone who likes to tinker with electronics and other DIY projects, that's probably not an issue and even these large quantities are still very inexpensive. Of course, if you *are* a DIY sort of person, you probably already have some LEDs and resisters lying around 😉

The optional parts:

- Green LED (constant or blinking variety)
  - Amazon: (60 count, multi-color, non-blinking ~ $6USD) https://www.amazon.com/dp/B01C3ZZT2I
  - Ali Express: (100 count, multi-color, non-blinking ~ $2.50USD) https://www.aliexpress.us/item/2251832545092387.html
- 100-220 Ohm resistor (depends on LED brightness desired)
  - Amazon: (100 count 200ohm ~ $6USD) https://www.amazon.com/EDGELEC-Resistor-Tolerance-Resistance-Optional/dp/B07HDGH1R1
  - Ali Express: (100 count, be sure to select 200R [for 200 ohm] ~ $3USD) https://www.aliexpress.us/item/3256801441680644.html
- Project board (aka Breadboard)
  - Amazon: (board & wires kit, some components won't be needed ~ $11USD) https://www.amazon.com/dp/B09TX9CMG1
  - Ali Express: (board without wires ~ $4USD) https://www.aliexpress.us/item/3256801539488877.html
- Wires for breadboard
  - Amazon: (120 count 4" variety pack of female-to-female, male-to-male & male-female ~$7USD) https://www.amazon.com/dp/B07GD1XFWV?th=1

As mentioned above, you only need the green LED if you want to have a "busy" status light that you can locate wherever you'd like (handy if you want to poke it through the outside of a case). To use it, and the resister [do *not* try and use the LED without a resister … bad things will happen], you will almost certainly need to solder things together so be prepared for that. I'll also point out that if you decide to upgrade to the v2 BG Buddy later, the one with alerts, you'll be adding a red LED to the kit for the visual alert. So, if you *do* decide to buy a pack of LEDs, maybe make it a variety pack so you have both the green and red LEDs … just in case 😉

The breadboard listed here is only needed if you want to start tinkering with this DIY electronics stuff – if your goal is to just assemble BG Buddy and pop it in a case, you don't need the breadboard. Also, if you *do* decide to get the breadboard, you'll need some wires in addition to those in the "must have" list – you need wires with exposed ends you can poke into the holes in the breadboard. Because of that, I've listed a breadboard on Amazon that comes with a set of appropriate wires for about the same price as buying a breadboard and set of wires separately.

BTW, a quick note regarding the OLED screen; you'll see a number of varieties of this little display, some with a mix of yellow and blue text, some with all blue and some with white text. While I've chosen to use the yellow/blue variety in my example, they all behave the same, so it really comes down to your personal preference. The only difference that you *do* want to watch out for is the number of pins sticking out the back; we want the 4-pin variety, not the 7-pin version.

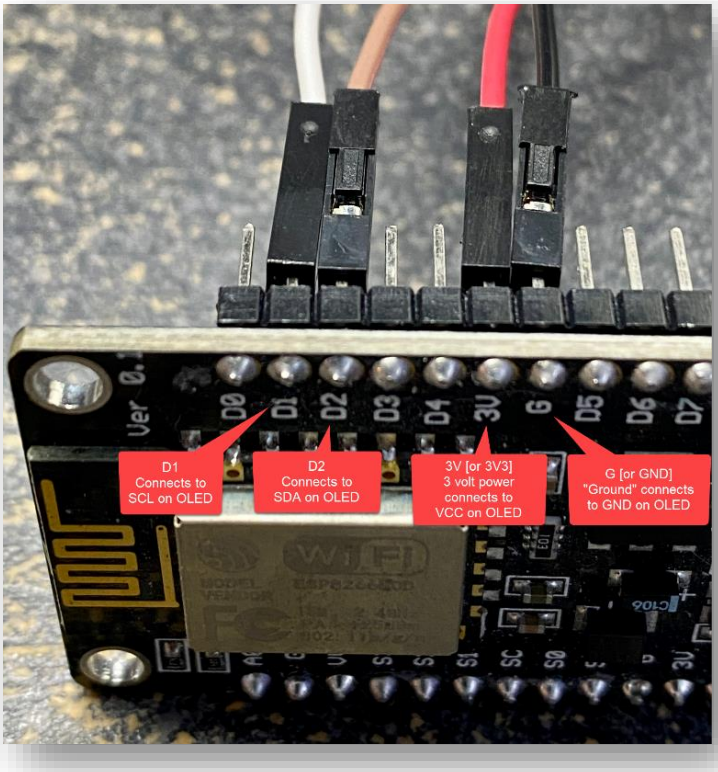
Hardware Step-by-Step

The “bare bones” BG Buddy

I’m going to assume that most readers are here to just *build the darn thing already* and call it a day. If that’s you, and you’ve got your wires, ESP8266, and OLED display in hand, I’ll need about 5min of your time because we’re going to take it slow and easy.

To make the four(4) connections we need, we’re going to slip the ends of those wires over the pins on our two devices, pressing them in as far as they’ll go so they cover the pins completely. Which color wires you use for this really doesn’t matter but for clarity, I’ll use Red, Black, White and Brown to represent Power, Ground, Clock and Data respectively. The following table shows which color wire goes where on each device:

Wire	Purpose	ESP8266 SOC Connection	SSD1366 OLED Connection
Red	Power – 3 volts from the SOC	3V (sometimes 3V3)	VCC
Black	Ground (GND)	G (sometimes GND)	GND
White	Clock	D1	SCL
Brown	Data	C2	SDA



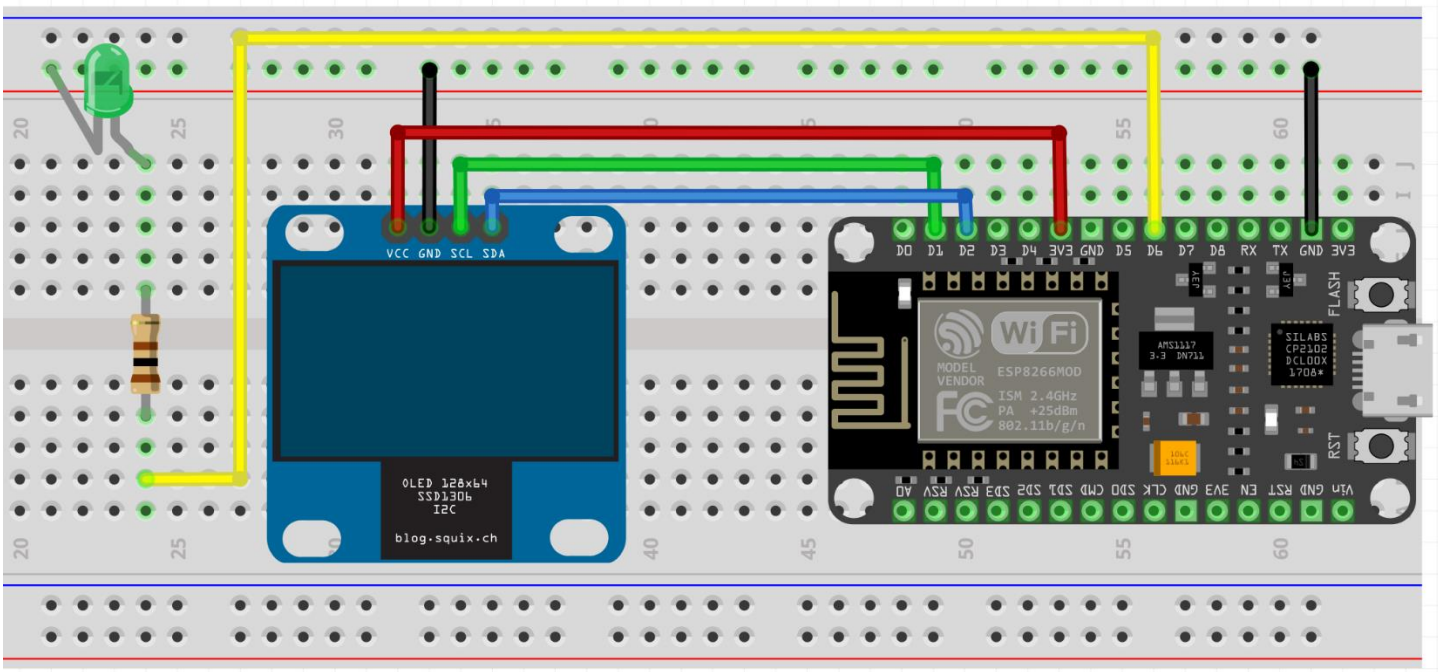
Note that for the power (3V) and ground (G/GND) on the SOC, you’ll find there are two or more sets of pins with the same labels. They’re interchangeable so you can pick any 3V pin and any G/GND pin, whichever is most convenient.

With those wires connected, and ***double check*** the power and ground (VCC->3v and GND->G) to make sure they’re not reversed (it’s not you, it’s the manufacturers…tricky tricksters), we’re about ready to get this programmed, setup and operation! If you plug it in right now for a “smoke test” (meaning, we *really* don’t want to see any smoke), not much is going to happen and the screen will likely stay blank. The only sign of life you might see would be a brief flicker from the blue LED on the SOC – not much reward for your hard work!

So, jump down to the Software section and we’ll breathe life into your new creation!

The “fancy” BG Buddy

Everything that we did in the “bare bones” version still applies here; we’re just adding the green LED to mix and connecting it following the diagram below:



Now, there’s a right way and a wrong way to connect an LED; one wire goes to G/GND (“ground”) similar to the pin on our OLED screen. The other LED wire need to connect to power that can be switched on/off by our program at the appropriate times. However, it can’t connect ***directly*** to power; it has to go through a resister in order to limit the amount of power it gets (“current”) so it doesn’t burn out. The value of a resistor is measured in OHMs and for this project any value between 100 and 220 OHMs will be fine (even a little higher is okay but *much* higher, like 1000 OHMs, could make the LED too dim). Also, while the LED has a right way and wrong way to hook it up, the resister doesn’t; there’s no way to connect it “backwards”.

When you look at the LED you’ll notice that there’s a long wire and a short wire, and if you look closely at plastic part of the LED, you’ll notice that there’s a flat edge on the same side as the short wire. This is the side we want connected to ground. The other side, with the long wire, will connect to one side of the resister and the other side of the resister will connect to pin D6 on the SOC. Note that for maximum flexibility in terms of where you’ll be able to mount that LED in your case, you’ll probably want to connect a couple wires to the SOC [one for ground and one for D6], and then strip and solder the other ends of those wires to the LED and resister, as well as soldering the LED ***to*** the resister (feel free to cut the length of the resister and LED wires if you find them too long or awkward to work with).

This is the point in the instructions where I say that I have to assume you have some soldering experience already and that if I say “strip and tin the wires”, you’ll know what that means. If you don’t, that’s okay, but you’ll want to get just a little practice with those steps first – we’re not doing anything complicated but using a soldering iron arounds wires and electronics can cause an unexpected burn to you or overheat and damage a component if you’re not careful. This link will cover the basics so you can continue here safely: https://www.makerspaces.com/how-to-solder/

Software

We're almost there! Similar to the hardware build discussion though, there are two possible paths for getting the software built and installed on your new BG Buddy; let's call them the Easy Path and the Geek Path. Also, just for the record and speaking as the geek who wrote the software, I recommend ***everyone*** take the Easy Path and then if you're just curious or if you want to help me make BG Buddy even better, then step onto the Geek Path.

Easy Path

The easy path is simply this; I've already compiled the BG Buddy software into something called a "binary image" and so you can quickly and easily install that onto your SOC with no programming knowledge, complicated tools, or much of any setup. The only things you'll need to do are:

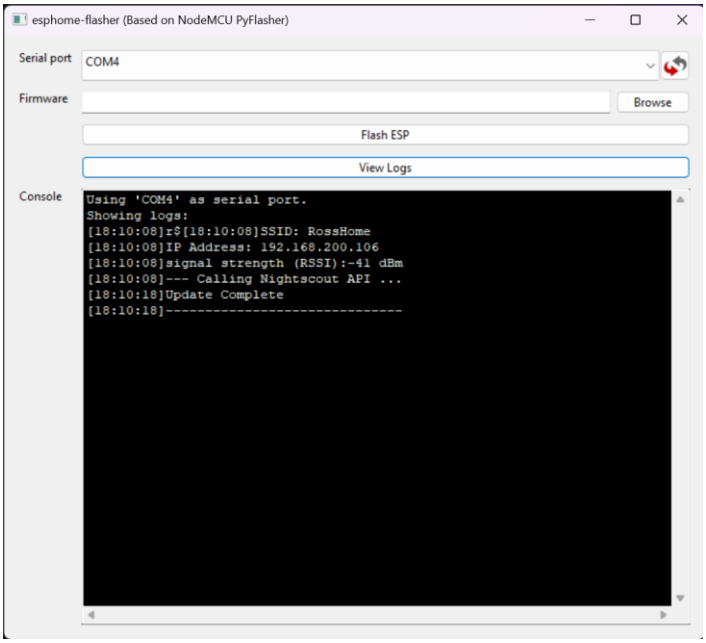
1. Download the latest version of the binary file from the GitHub repository where it's stored.
2. Download a "flasher" program that will take that binary file and load it ("flash" it) onto the SOC.

For step 1, you can download the binary file from here: https://github.com/VeryKross/BGBuddy/tree/main/v1/bin

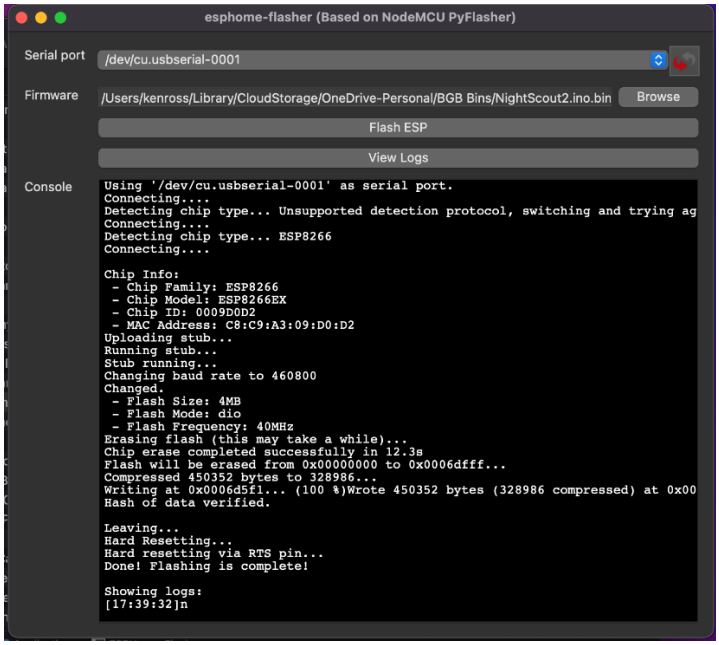
- Click on the "BGBuddy_V1.bin" file listed there and on the subsequent screen, click on the "Download" button and save the file somewhere on your local computer that will be easy to find 😊

For step 2, I recommend using the free ESPHome-Flasher utility. They have versions available for Windows, Mac and Linux and there's really nothing to install; just download it and run it whenever you need to flash a program into memory [which we do]. You can get all versions of the utility from this page, just scroll down until you see the "Assets" section and pick the file that's right for you (note that if you're running Windows, it will be the ESPHome-Flasher-1.4.0-Windows-x64.exe file): https://github.com/esphome/esphome-flasher/releases

Okay, now that you have the utility we're just about ready to go! If you haven't done so already, make sure you have your ESP8266 SOC plugged into your PC with a USB cable. Then run the ESPHome-Flasher utility and you should see a screen something like this:



Windows version



macOS version

So, first things first – we need to select which communications "port" your SOC is connected to. On Windows, this will show up as "COM" followed by a number (e.g. COM4). On Mac and Linux, the port shows up as a numbered device (see the screen shot above). It's unlikely that you'll see more than one listed but if you do, just pick one to try and if it doesn't work, try again with the other (not very scientific, but you'll find the right one pretty quickly).

Once you've selected the port, click the Browse button and locate the BG Buddy binary file you downloaded earlier. With that selected, just click the "Flash ESP" button and you should see it run through a series of steps similar to what you see on the Mac screenshot above. The blue LED on the SOC will also flicker while this is going on. It may take a minute or so to complete so just be patient. If it's going to fail, it will likely do so immediately, and that will probably be from having the wrong port selected; if that's the case, pick a different port and try again.

When the flash process has completed, the SOC will automatically reset and start running the BG Buddy application! Next stop, setting up the software!

Geek Path

Who are we kidding? If you want the geek path, check out the src folder in the repo and load the sketch into your favorite Arduino IDE 😊 Be sure to add the ESP8266 devices if you haven't already, and when selecting the board type, select "NodeMCU 1.0 (ESP-12E Module)".

Other than that, it should all build and install onto your device without any issues. If you're an experienced C/C++ developer, please excuse some of my code structure choices – it's not always the most elegant as I've been dusting off yearly 30yrs of C/C++ neglect from my little grey cells while simultaneously learning the Arduino / ESP8266 platform and ecosystem 😊

https://github.com/VeryKross/BGBuddy

BG Buddy Setup for 1st Run

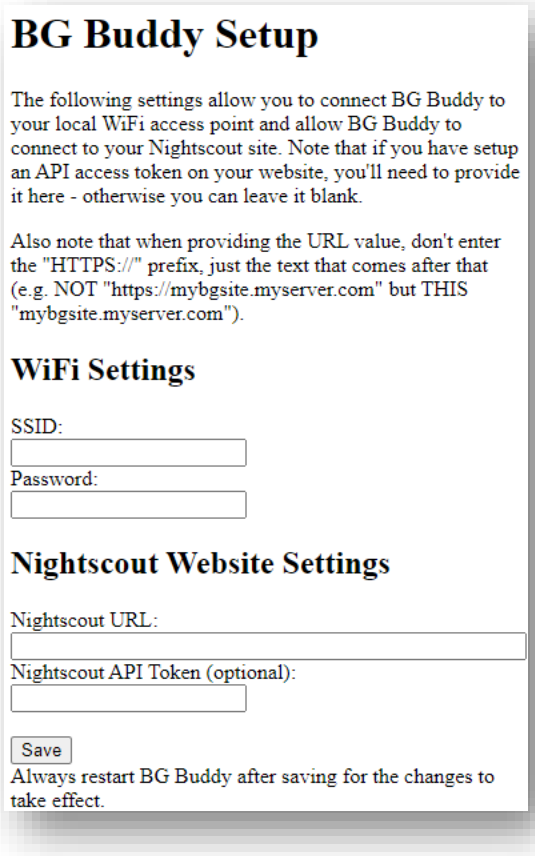
Setting up BG Buddy the first time requires a few manual steps but the device will prompt you through it and all you'll need is your smartphone. Completing the following steps will have your BG Buddy talking to Nightscout in no time:

1. Connect your phone to BG Buddy's Wi-Fi Access Point
2. Open the BG Buddy setup web page from a web browser on your phone
3. Fill in your Wi-Fi SSID and password so it knows how to connect to your network
4. Fill in your Nightscout URL (without the HTTPS:// prefix)
5. Tap Save and reboot BG Buddy (just unplug and plug back in works too)

When BG Buddy first woke up after being flashed, you should see something like this on the OLED display:

This not only tells us that the software is installed and running correctly (yay!) but it's also telling you the next steps; open the Settings in your phone, go do the Wi-Fi settings, and look for a new network called "BG Buddy Portal" and connect to it; you'll need to provide the super-secret "12345678" password. Sometimes the connection can take up to a minute to complete so be patient.

Once you're fully connected, open a web browser on your phone and connect to http://10.10.10.10 – this is the address for the configuration web page during the initial setup.

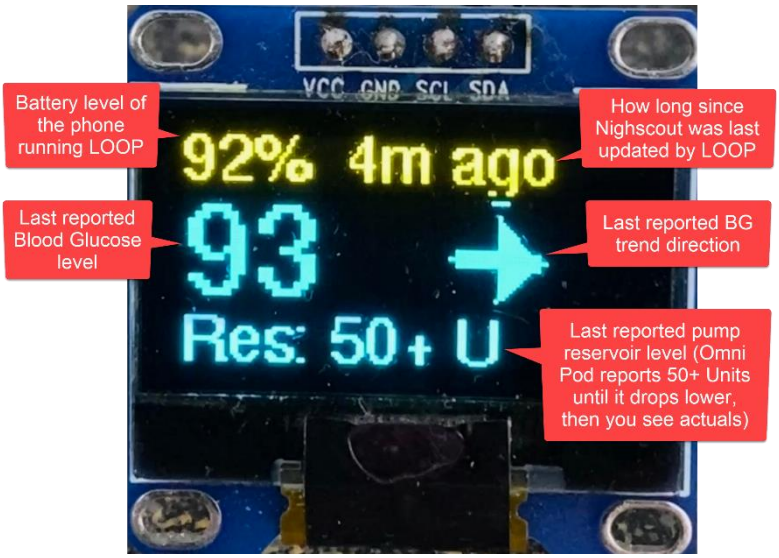


You should see a web page very much like this one to the left. As long as you know your Wi-Fi name (the SSID) and the password, this should be pretty easy.

Also, just be sure when entering your Nightscout web address that you leave off the “https://” part – it won’t work if you leave it on.

For the Nightscout API Token, you can leave this blank unless you’ve specifically set up access restrictions in your Nightscout installation that requires a Token for the API. If you didn’t set up anything like that, it’s not there by default and so you can ignore that bit.

Once you’ve filled in the necessary fields you can tap Save, restart BG Buddy, and you should be seeing your current BG values on the display!



That really is all there is to it. I mean, putting BG Buddy into a nice case of some sort is probably a good idea so be creative there – you can use almost anything for a case whether that’s just a small box from a craft store, a repurposed toy, or something you design and 3D print. Just make sure you have a cutout for the OLED screen and a smaller opening to plug the USB cable into your SOC. Mounting with hot glue is perfectly fine!

Once you’re up and running, post a picture of your BG Buddy creations to social media and spread the word! If you found this useful, I’m certain others will too, and they’ll appreciate hearing about your experience putting it all together.

If you run into any trouble that restarting BG Buddy doesn’t automatically fix, send along an email to bgbuddy@hotkrossbits.com and I’ll do my best to help out.

Ugly Case Assembly – Bonus(?) Content

Just so you can see the finished monitor in some form, I present my very ugly 3D printed case (I was in a hurry) and hot-glue assembly steps. It doesn't look like much, and I know you all will be ***much*** more creative, but this hopefully helps alleviate any remaining concerns or nervousness about final assembly 😊