Tutorials

I. WHAT YOU NEED

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3. OpenBCI Gold Cup Electrodes and Electrode Paste
4. Your 6V AA Battery Pack & 4 AA Batteries
5. (x4) Plastic Feet

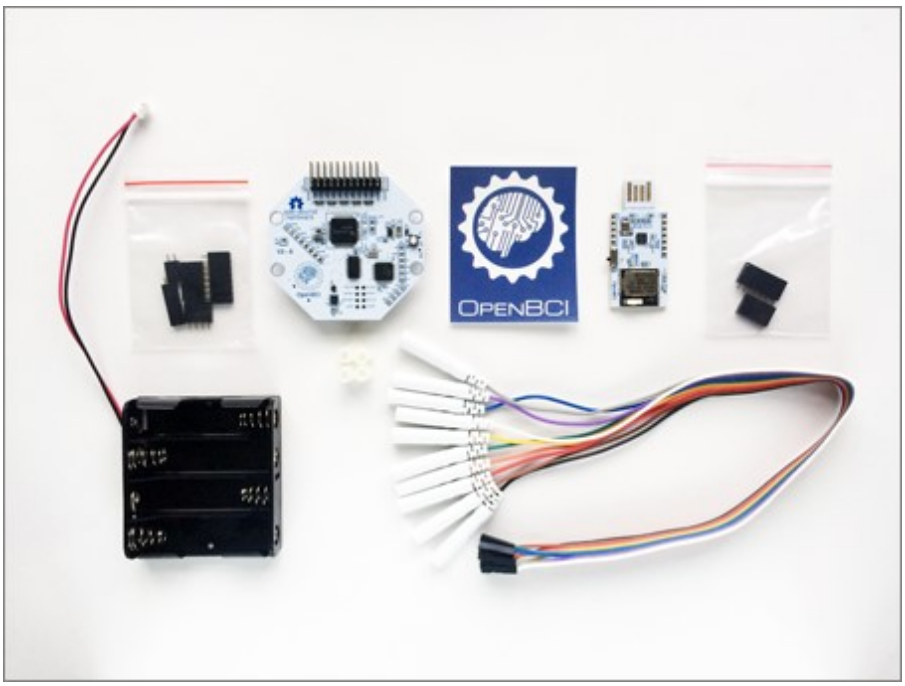
II. DOWNLOAD/INSTALL/RUN THE OPENBCI GUI

III. PREPARE YOUR OPENBCI HARDWARE

1. Make sure your FTDI drivers are installed and up-to-date

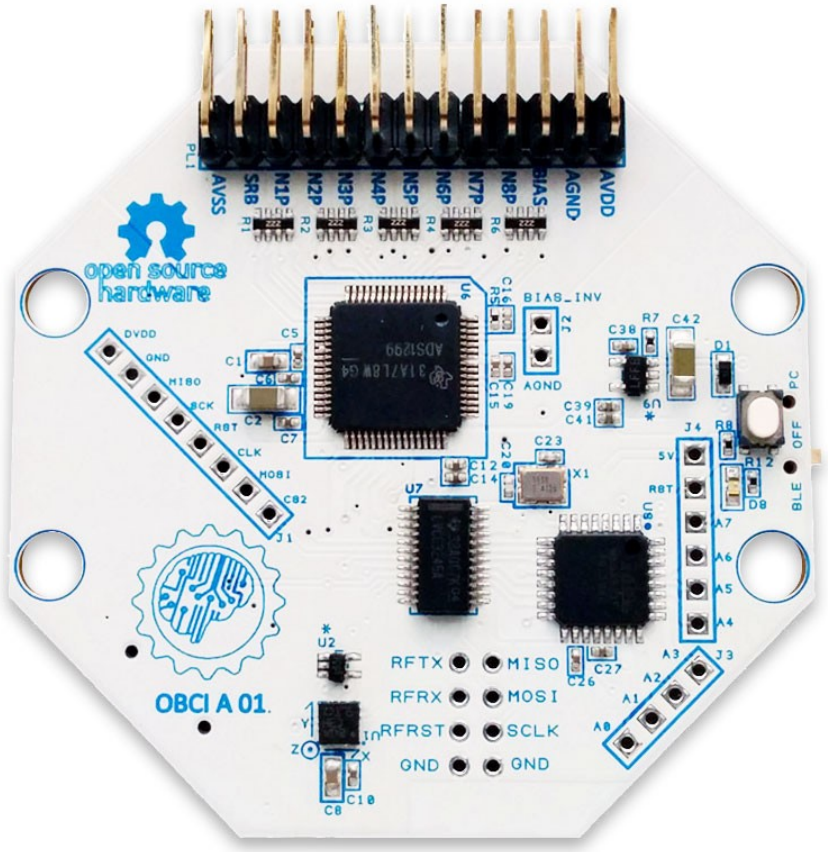
CYTON GETTING STARTED GUIDE

This guide will walk you through setting up your computer to use the Cyton and USB Dongle, using the



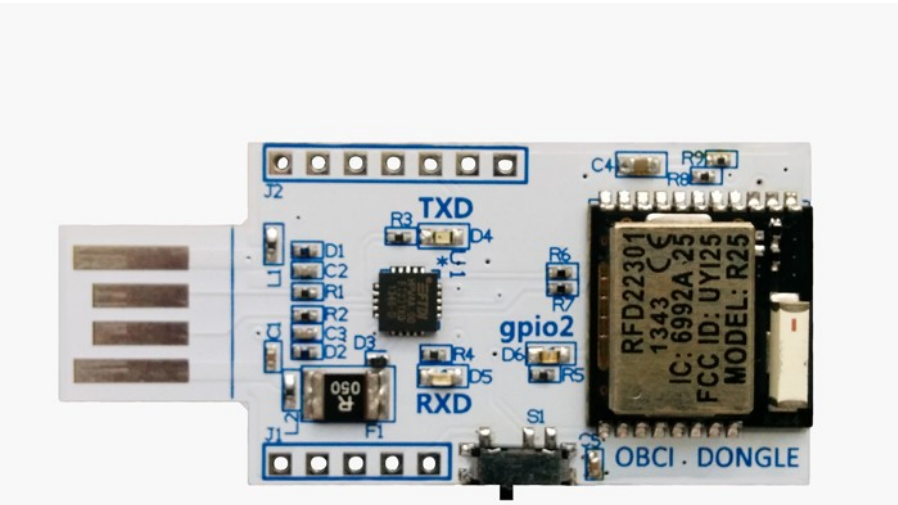
1. OpenBCI Cyton Board
2. OpenBCI Dongle
3. OpenBCI Gold Cup Electrodes and Ten20 Paste
4. 6V AA battery pack & (x4) AA batteries (batteries not included)
5. (x4) plastic feet for board stabilization

1. Your Board



This tutorial can be followed if you are working with any Cyton board (8-bit, Cyton, or Cyton with Daisy). I'll be working with the 8-bit board.

2. Your OpenBCI USB Dongle



The OpenBCI USB Dongle has an integrated RFDuino that communicates with the RFDuino on the Cyton board. The dongle establishes a serial connection with your computer's on-board FTDI chip. The serial port is called /dev/tty* (if you're using Linux or Mac) or COM* (if you're using Windows). You'll be connecting to this serial port from the OpenBCI GUI or whatever other software you want to end up using to interface your Cyton board.

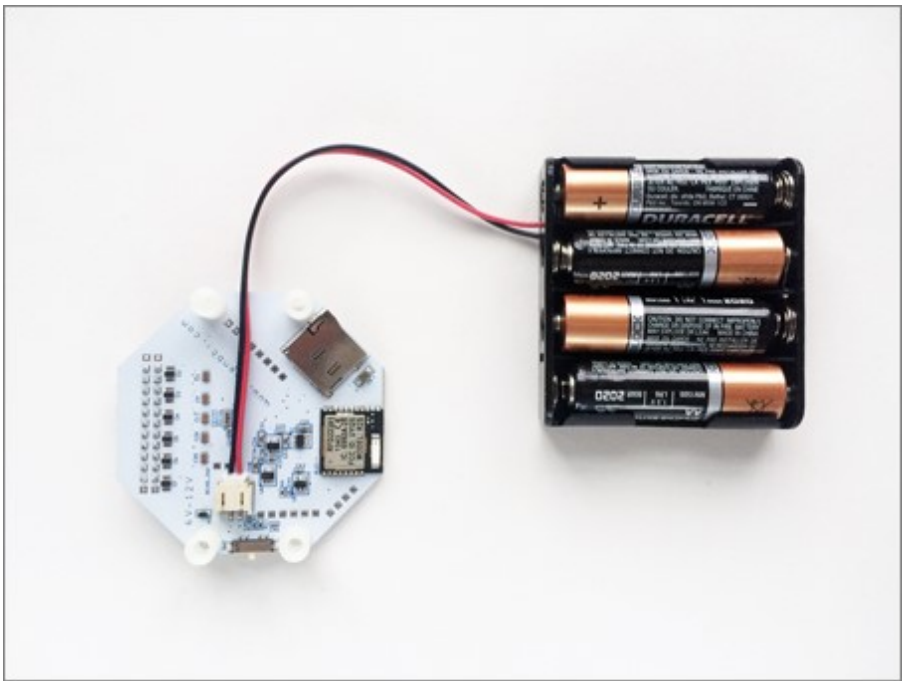
3. OpenBCI Gold Cup Electrodes and Electrode Paste

If you ordered an OpenBCI Gold Cup Electrodes and Ten20 Paste you should have:

- 10 passive, gold cup electrodes on a color-coded ribbon cable
- 3 2oz Jars of Ten20 conductive electrode paste

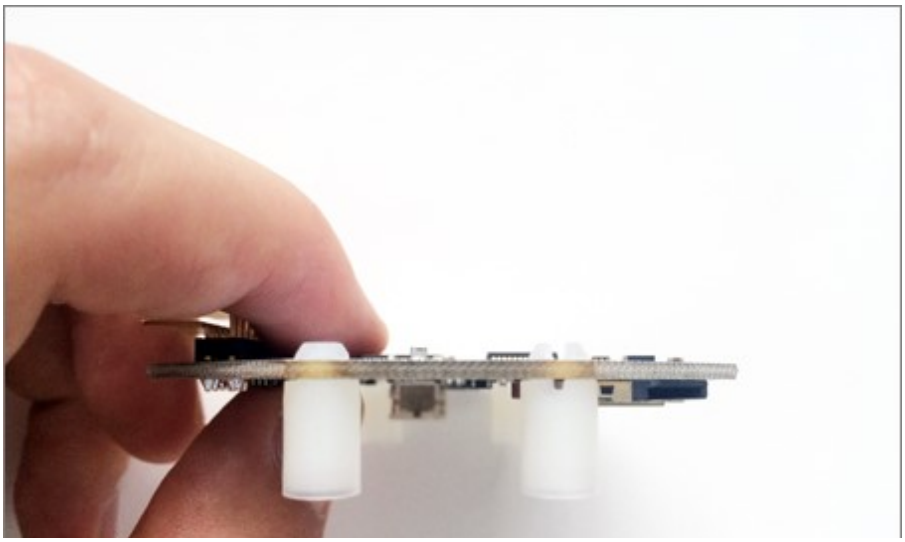
If you plan to work with your own electrodes, the touch-proof adapter may come in handy:

4. Your 6V AA Battery Pack & 4 AA Batteries



Cyton boards have specific input voltage ranges. These input voltage ranges can be found on the back-side of the board, next to the power supply. BE VERY CAREFUL to not supply your board with voltages above these ranges, or else you will damage your board's power supply. For this reason, we recommend that you always use the battery pack that came with your OpenBCI kit.

5. (x4) Plastic Feet



Your Cyton kit comes with 4 plastic feet that can be snapped into the holes of your board to provide extra stability while working.

II. DOWNLOAD/INSTALL/RUN THE OPENBCI GUI

Please follow the step by step guide to install the OpenBCI_GUI as a standalone application. Keep an eye out for specific Cyton requirements such as installing the FTDI VCP driver.

Come back to this guide when your GUI is running!

III. PREPARE YOUR OPENBCI HARDWARE

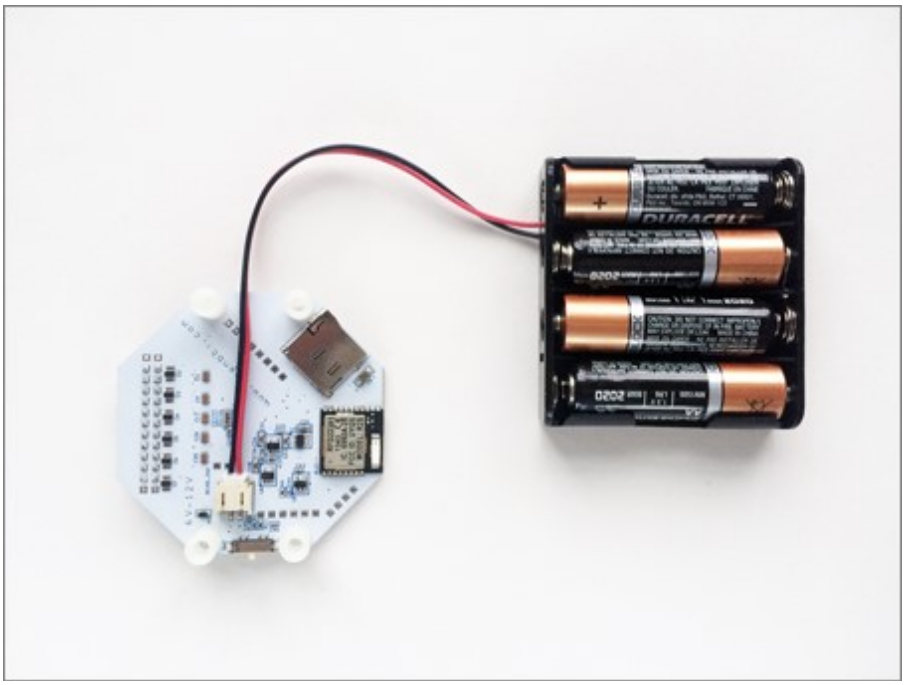
1. Make sure your FTDI drivers are installed and up-to-date

The Cyton will not work without the VCP drivers. Please see how to get and install the VCP driver in the prerequisites section in the the step by step guide

2. Plug in your OpenBCI USB Dongle

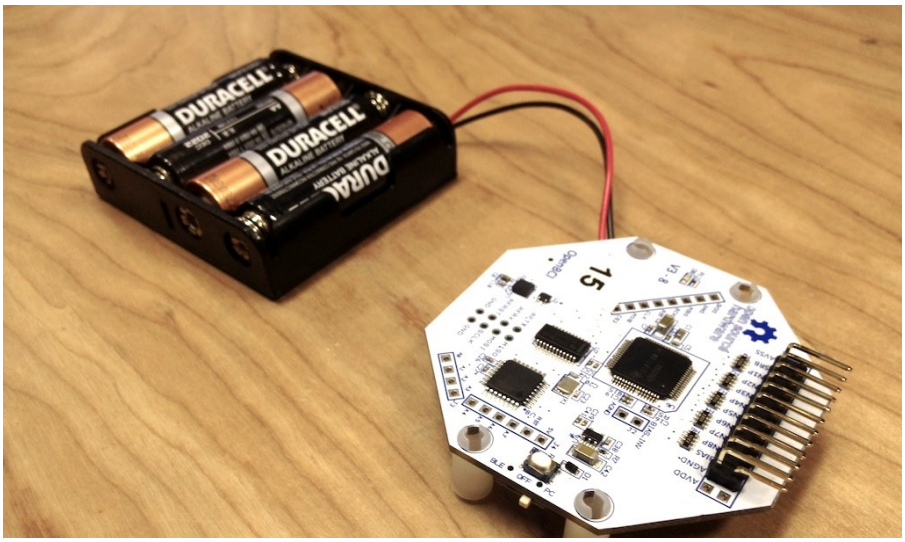
Plug this in (facing upwards!) and you should see a blue LED light up.

3. Plug in your 6V AA battery pack (with batteries)



Cyton boards have specific input voltage ranges. These input voltage ranges can be found on the back-side of the board, next to the power supply. BE VERY CAREFUL to not supply your board with voltages above these ranges, or else you will damage your board's power supply. For this reason, we recommend that you always use the battery pack that came with your OpenBCI kit. There's a good reason we put this notice in here twice!

4. Switch your Cyton board to PC (not OFF or BLE)



Make sure to move the small switch on the right side of the board from "OFF" to "PC". As soon as you do, you should see a blue LED turn on. If you don't, press the reset button just to the left of the switch. If the LED still does not turn on, make sure you have full battery. If you're sure your batteries are fully charged, consult the hardware section of our Forum.

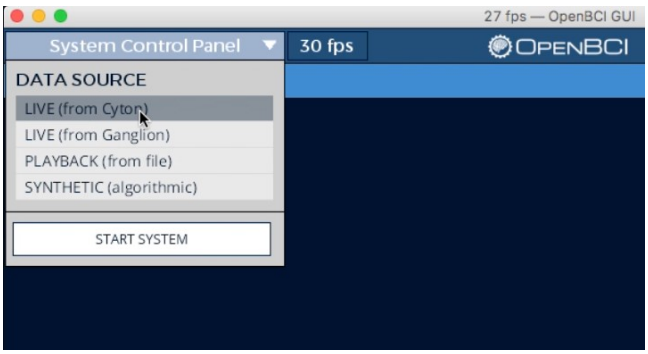
Note: it's important to plug in your Dongle before you turn on your Cyton board. Sometimes, if the data stream seems broken, you may need to unplug your USB Dongle and power down your Cyton board. Make sure to plug your USB Dongle in first, then power up your board afterwards.

IV. CONNECT TO YOUR CYTON BOARD FROM THE GUI

1. Relaunch your OpenBCI GUI

You may need to relaunch the OpenBCI GUI after installing the FTDI drivers.

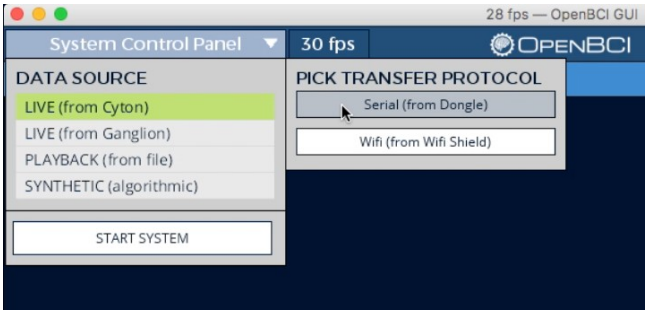
2. Select LIVE (from Cyton)



In order to connect to your Cyton, you must specify the data source to be `LIVE (from Cyton)` in the first section of the System Control Panel. Before hitting the `START SYSTEM` button, you need to configure your Cyton board (follow the steps below).

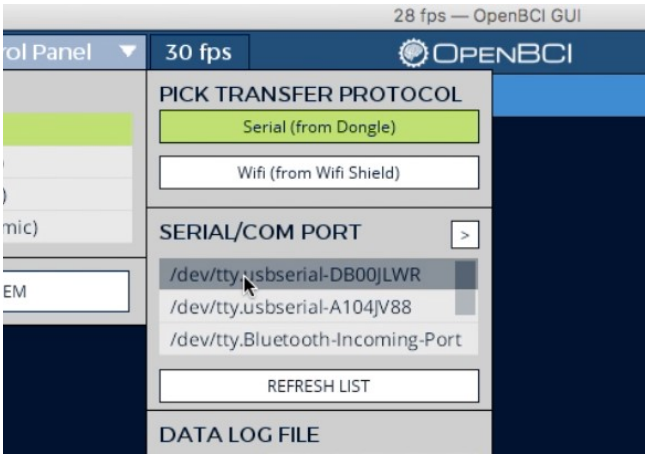
3. Select Serial Transfer Protocol

Next select `Serial (from Dongle)` . If you want to use the WiFi Shield, please see the WiFi Getting Started Guide



4. Find your USB Dongle's Serial/COM port

In the first section of the LIVE (from Cyton) sub-panel, find your Dongle's Serial/COM port name. If you're using a Mac or Linux, its name will be in the following format:



/dev/tty*

If you're using Windows, it will appear as:

COM#

Your USB Dongle's port name will likely be at the top of the list. If you don't see it:

1. Make sure your dongle is plugged in and switched to GPIO 6 (not RESET)
2. Click the REFRESH LIST button in the SERIAL/COM PORT section of the sub-panel
3. Make sure you've installed the latest FTDI drivers, as described in section III.1

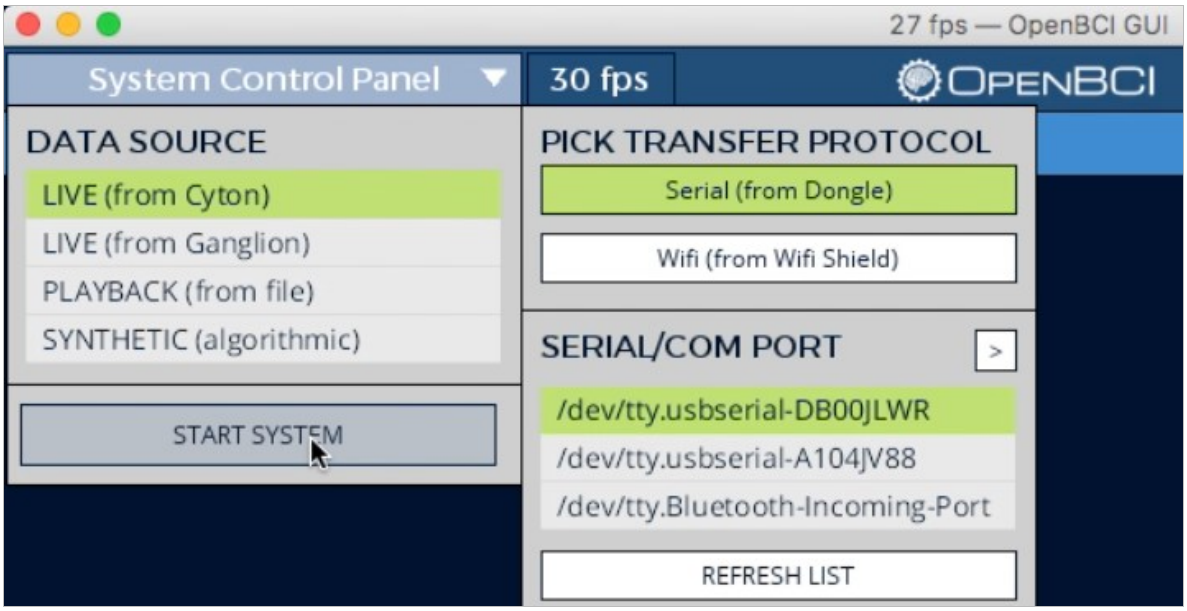
If you're still having trouble finding your USB Dongle's port name, refer to the Forum about debugging your hardware connection.

The CHANNEL COUNT setting is defaulted to 8. If you are working with an OpenBCI Daisy Module and Cyton board (16-channel) system, be sure to click the 16 CHANNELS button before starting your system.

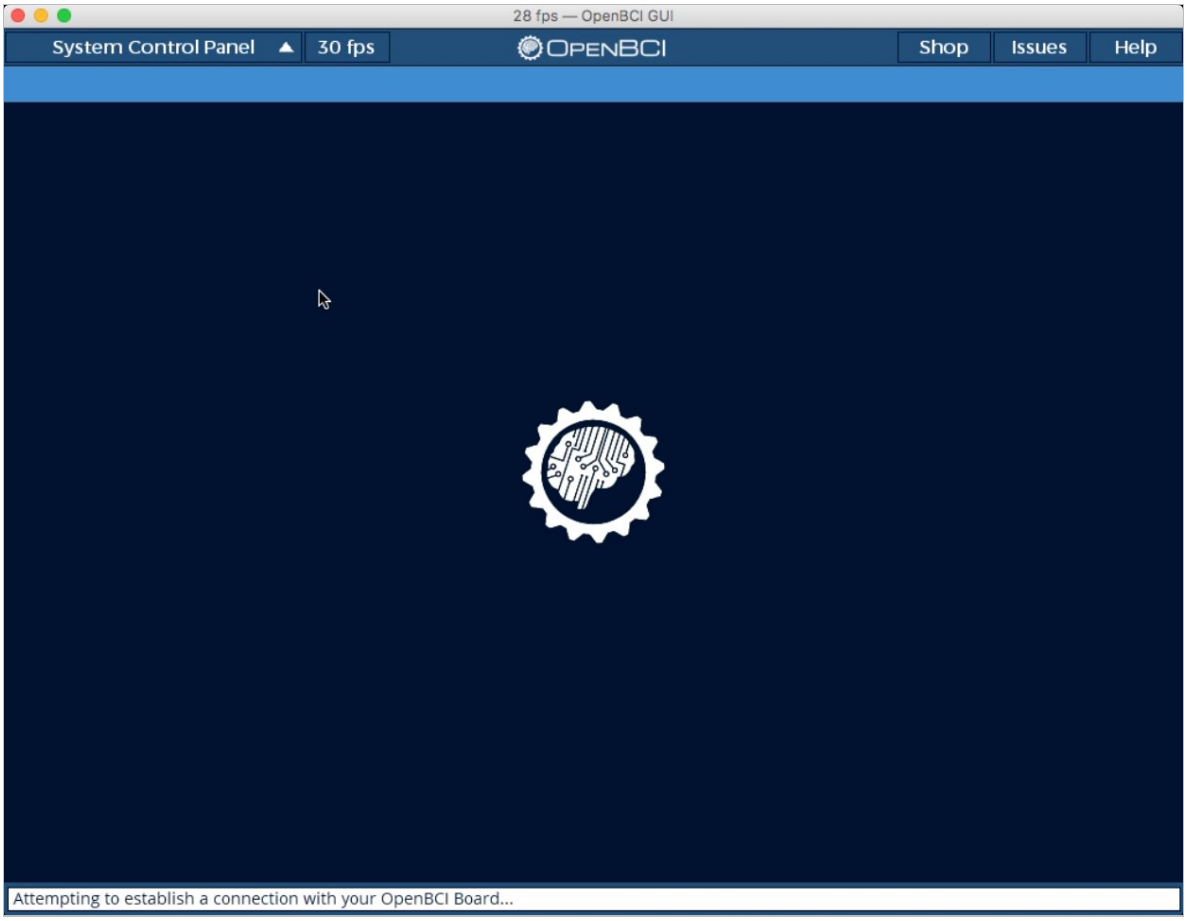
6. Optional Settings

▶ If you're comfortable using the GUI, use the optional settings in this dropdown section. Otherwise, skip to step 7!

7. Press "START SYSTEM"



Now you're ready to start the system! Press the START SYSTEM button and wait for the OpenBCI GUI to establish a connection with your Cyton board. This usually takes ~5 seconds.



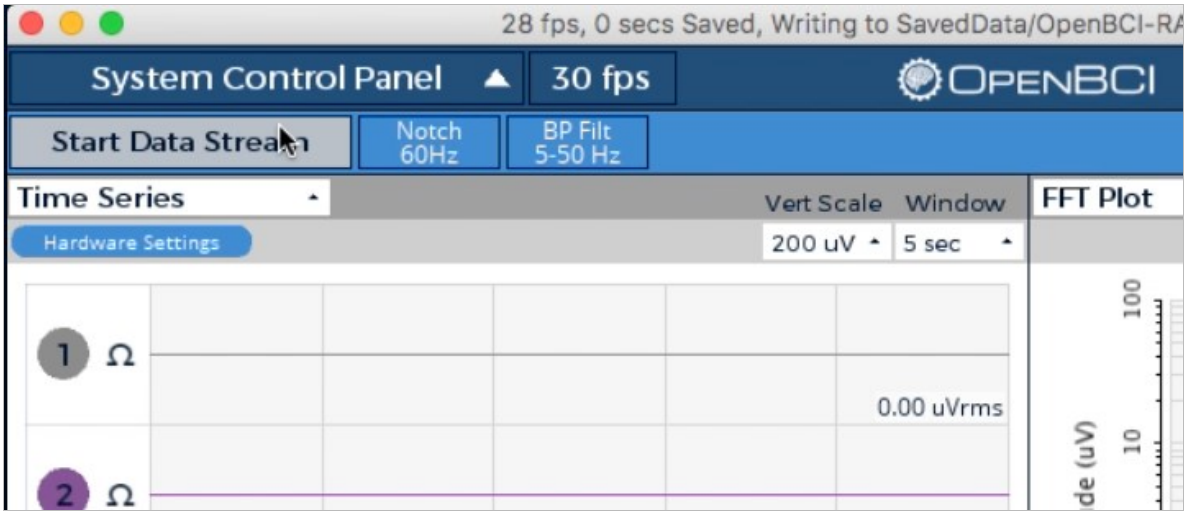
During this time, the help line at the bottom of the OpenBCI GUI should be blinking the words: "Attempting to establish a connection with your OpenBCI Board..."

TROUBLESHOOTING

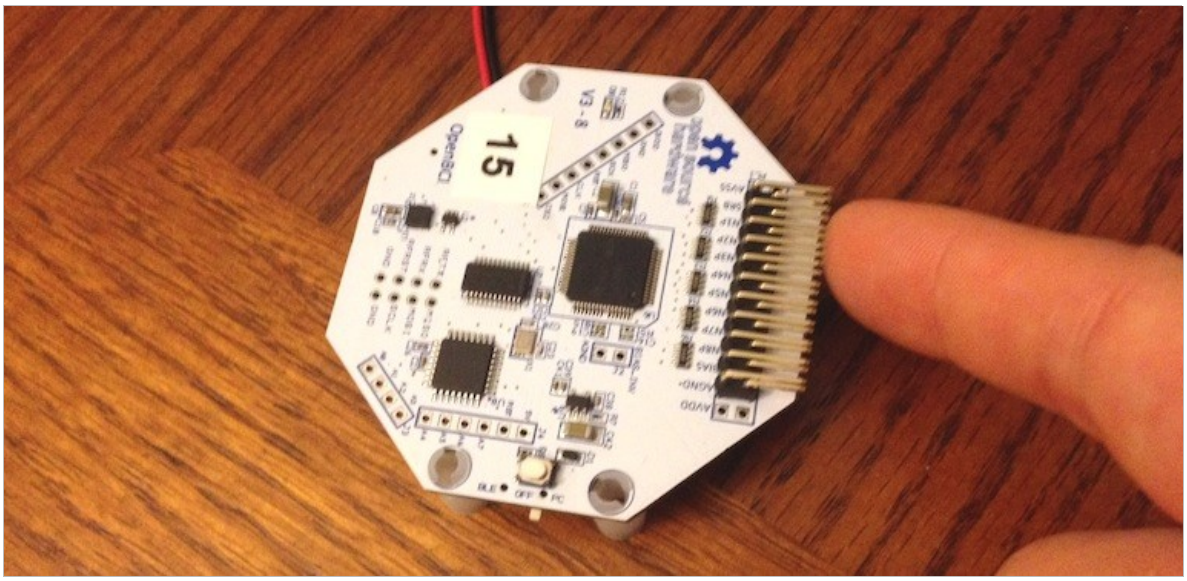
If the initialization fails, try the following steps in order:

1. Making sure you've selected the correct serial/COM port
2. Power down your Cyton board and unplug your USB Dongle. Then, plug back in your USB Dongle and power up your Cyton board in that order. Then try restarting the system, but pressing the START SYSTEM button again.
3. If this does not work, try relaunching the OpenBCI GUI application and redo step 2 above. Then reconfigure the SYSTEM CONTROL PANEL settings, and retry START SYSTEM.
4. Make sure that your batteries are fully charged and then retry the steps above.
5. If the channel number is not being displayed, select "AUTOSCAN" from the RADIO CONFIGURATION settings.
6. If you are still having troubles connecting to your Cyton board, refer to the Forum for extra troubleshooting advice.

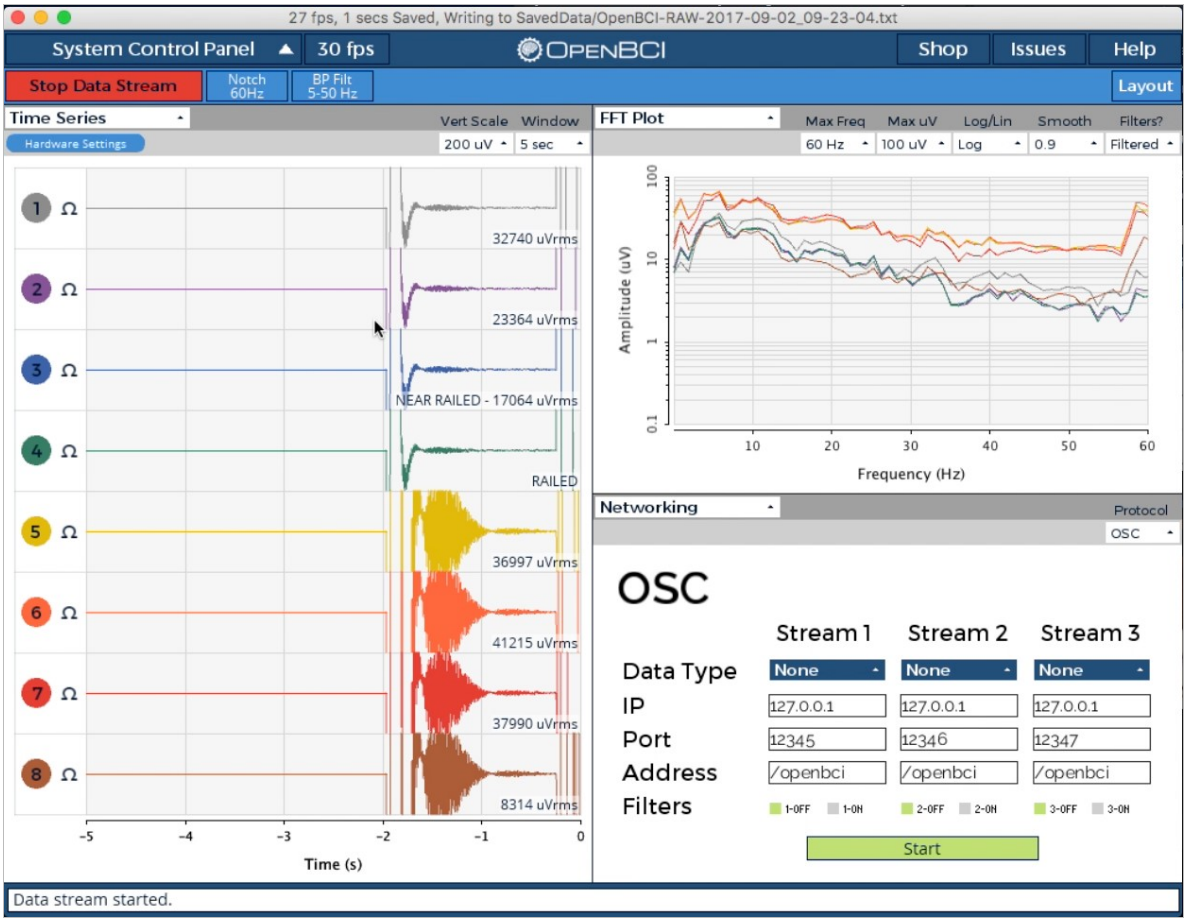
hand corner.



You should see data streaming into the GUI, try running your fingers along the electrode pins at the top of your board.



You should see the 8 (or 16 if you're using a Daisy module) channels on the *Time Series* widget behave chaotically in response to you touching the pins and all the traces of the FFT graph on the upper right should instantly shift upwards.



If this is the case, congratulations; you are now connected to your Cyton board. It's time to see some brain waves!

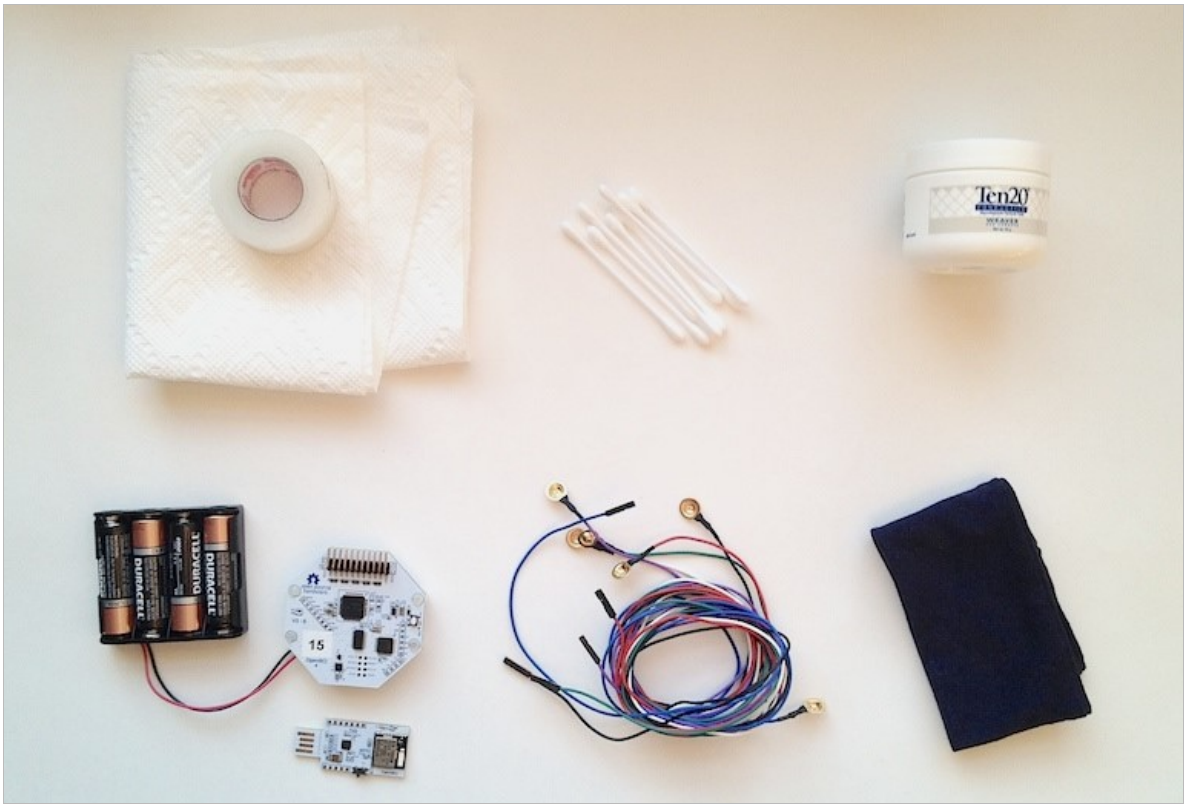
V. CONNECT YOURSELF TO OPENBCI

In this quick demo, we'll be showing you how to set up 3 channels of electrophysiological data that reveal your heart activity (EKG or ECG), muscle activity (EMG), and brain activity (EEG)!

For more information on these three signals, refer to wikipedia:

- Heart Acitivity - Electrocardiography (EKG or ECG)
- Muscle Acitivity - Electromyography (EMG)
- Brain Activity - Electroencephalography (EEG)

1. What you need

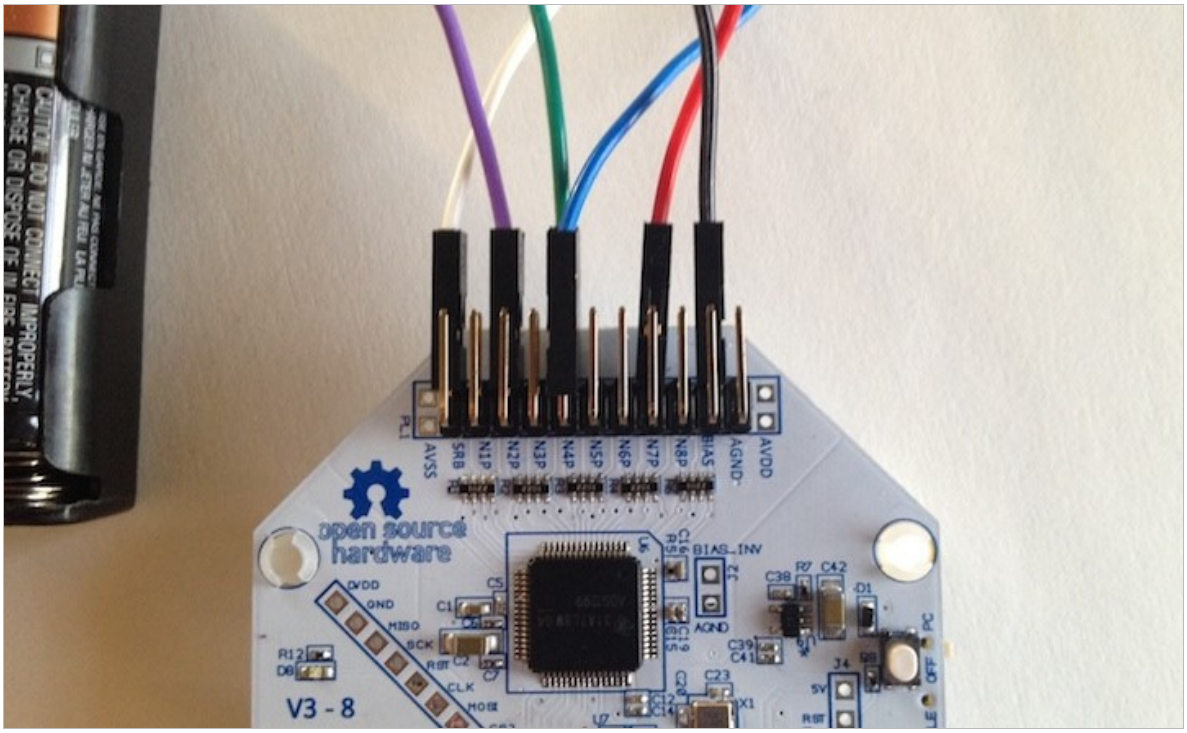


Necessary:

- Ten20 conductive electrode paste (or other conductive electrode gel)
- Your Cyton board, USB Dongle, battery pack, and x4 AA batteries
- x6 gold cup electrodes (from your OpenBCI electrode starter kit or other). If you are using an OpenBCI electrode starter kit, use the following electrodes so as to be consistent with the GUI's color-coding protocol:
  1. Black
  2. White
  3. Purple
  4. Green
  5. Blue
  6. Red

Optional:

- Paper towels for cleaning excess Ten20 paste
- Medical tape (or other tape) for adding extra stability to electrodes
- Ear swabs for cleaning paste from electrodes, once you're finished

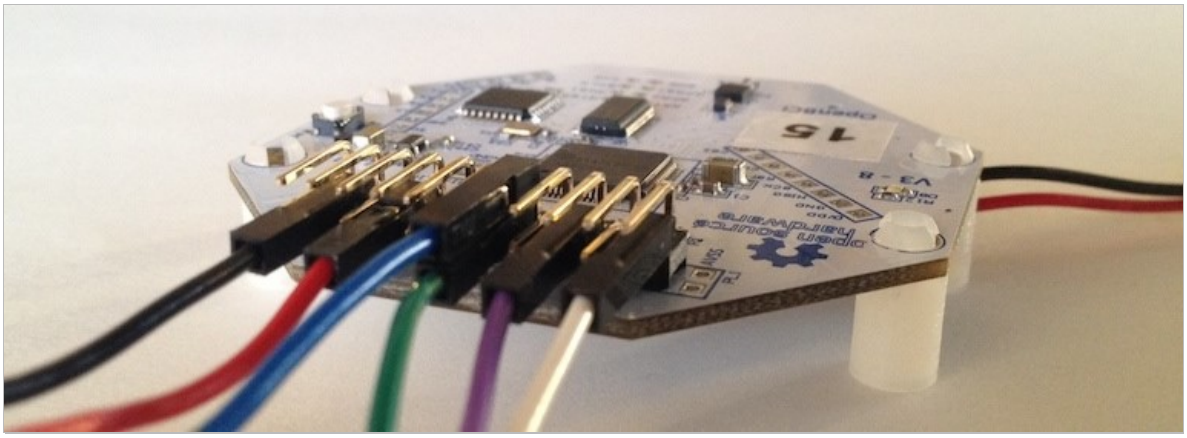


Electrode Wire Color	Cyton Board Pin
white	SRB2 (bottom SRB pin)
black	bottom BIAS pin
purple	2N (bottom N2P pin)
green	4N (bottom N4P pin)
blue	4P (top N4P pin)
red	7N (bottom N7P pin)

The white and black electrodes must always connect to the SRB2 pin and the bottom BIAS pin. Also, the green and blue wires must be connected to two pins of the same channel (like 4N and 4P). But the purple, red, and green/blue wires can be connected to any of the N1P through N8P channels. We decided to use channels 2, 4, and 7 for this tutorial.

How Cyton Board Pins are Connected (Optional)

Below is a perspective view of the electrode inputs that we are working with in this tutorial:

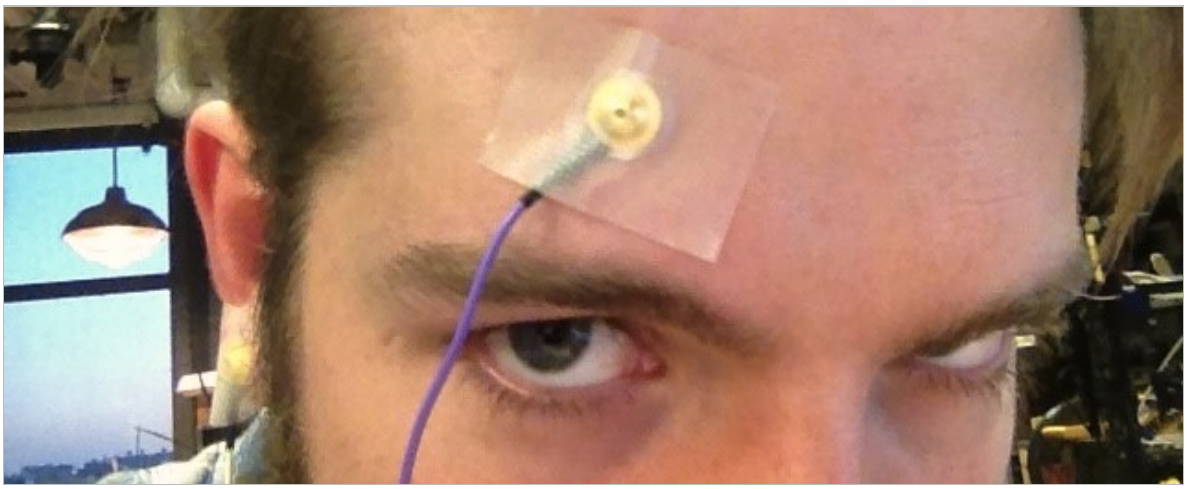


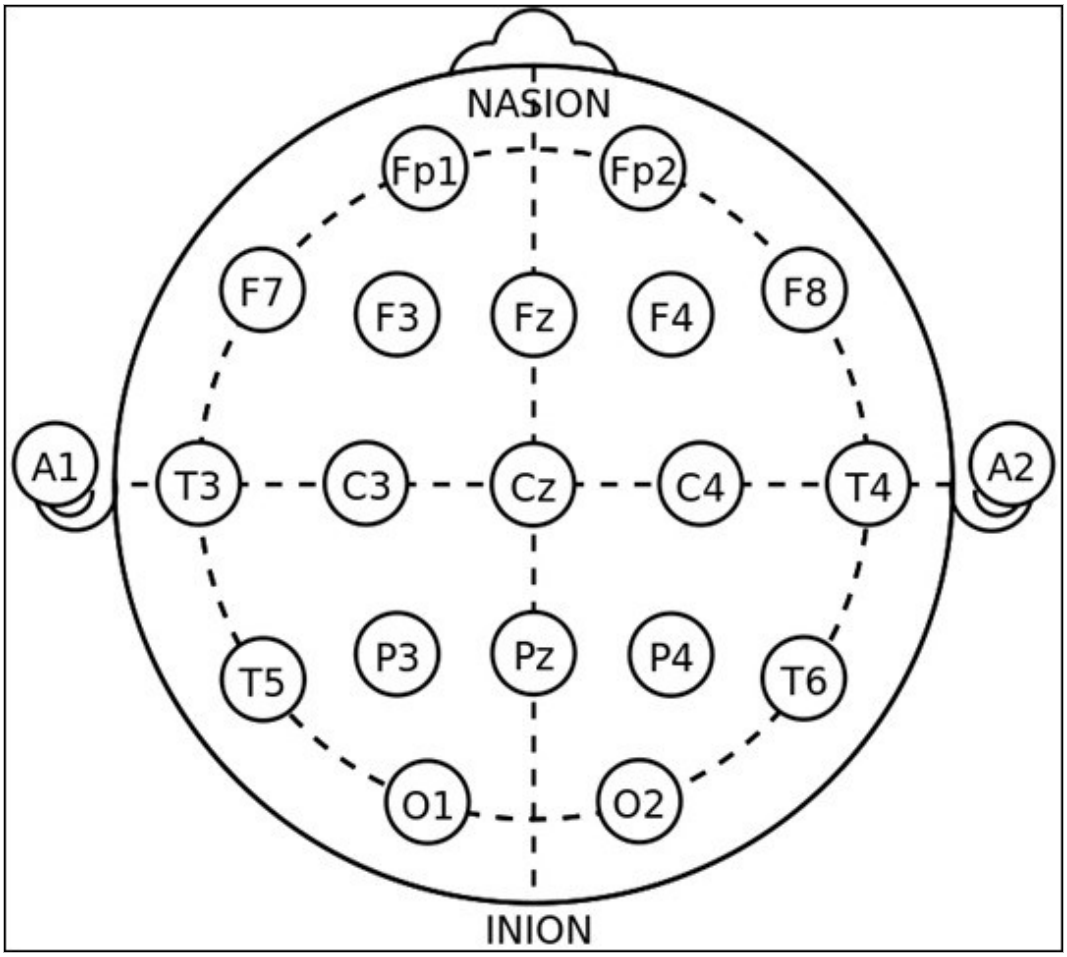
The bottom pins are (N) inputs, and the top pins are (P) inputs. The default board settings look at all N channels in reference to SRB2 (the bottom SRB pin). SRB1 (the top SRB pin) can also be used as a reference, but when it is activated, it is activated for ALL channels. If using SRB1 as the reference electrode, P inputs (the top pin inputs) must be used as the other input of the potential difference measurement. On the contrary, individual channels can be removed from SRB2. If a channel is removed from SRB2, it can be examined as a unique voltage potential, between the N and P pins of that channel. We will be doing this for the heart measurement in this tutorial, while examining 2 EEG channels in reference to SRB2, using the channel 2 and 7 N pins. For more information on this, refer to page 16 of the ADS1299 datasheet. The ADS1299 chip is the analog front-end at the core of the Cyton board.

3. Connect your electrodes to your head and body

Note: Use a paper towl or napkin to remove excess electrode paste as you are applying your electrodes.

b) Now apply this electrode to either one of your earlobes (either A1 or A2 as seen on the 10-20 system image below). You can use some medical tape (or electric tape!) to give this electrode some extra stability, ensuring that it does not fall off. This electrode is the reference that all of the EEG electrodes on your head will be measured in comparison to. The uV reading that will appear in the GUI's EEG DATA montage is a measure of the potential difference between each electrode and this reference electrode (SRB2). SRB1 (the top SRB pin) can also be used as a reference pin, but we won't discuss that here. Check out the other docs on how to maximize the usage of the other pins!



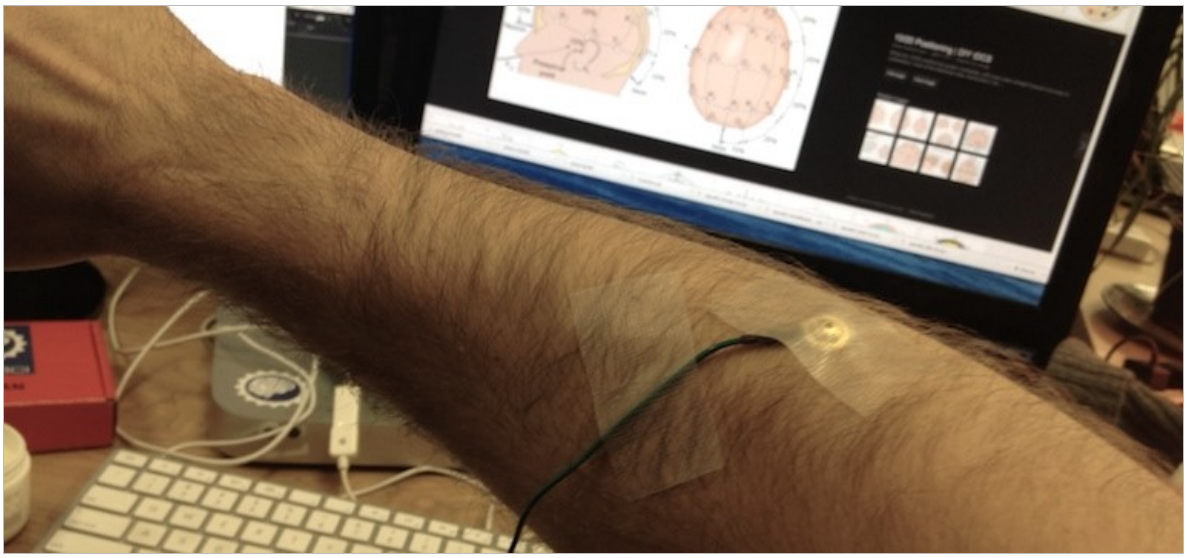


This electrode location is Fp2 on the 10-20 System. The 10-20 System international standard for electrode placement in the context of EEG. Fp indicates the a "frontal polar" site.

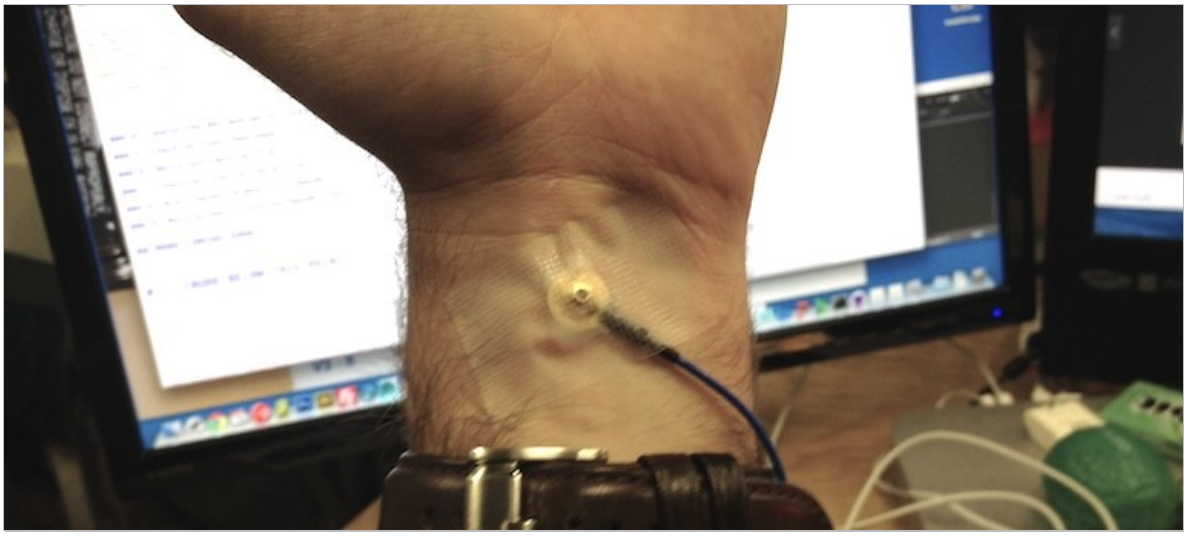
d) Now follow the same procedure for the red electrode and place it on the back of your head, 1 inch above the inion (as seen on the 10-20 system), and 1 inch to the left. This electrode location is O1 on the 10-20 system

e) Now follow the same procedure as step 2 above to apply the black electrode to your other earlobe (either A1 or A2 from the 10-20 system). The black electrode is connected to the BIAS pin, which is used for noise cancelling. It is similar to a GROUND pin, which establishes a common ground between the Cyton board and your body, but it has some extra destructive interference noise cancelling techniques built in!

You're now done connecting electrodes to your noggin! I like to use a cheap cotton hairband to add extra stability to all of the electrodes connected to my head, by placing it gently on top of all of the electrodes.



f) Now connect the green electrode to your right forearm, somewhere on top of a muscle that you can flex easily. With this electrode we will be looking at both heart activity and muscle activity. I also like to use tape to



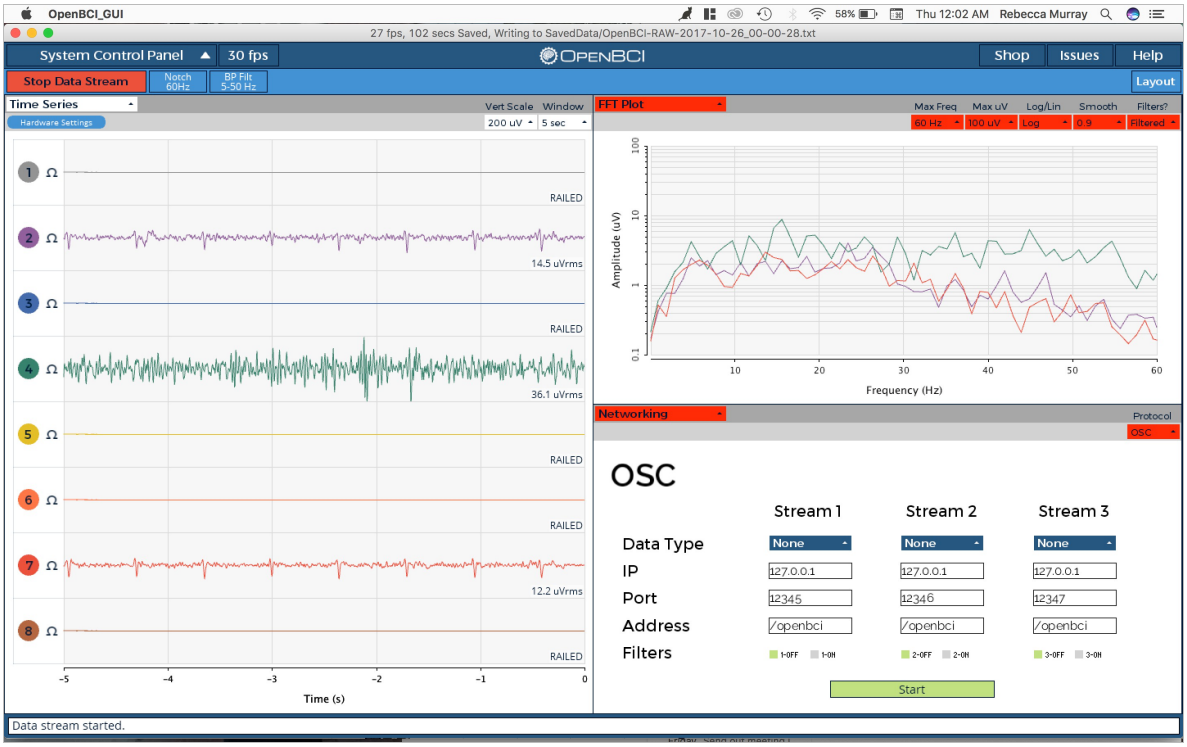
g) Finally, connect the blue electrode to your wrist on the opposite arm with the green electrode. The blue electrode will serve as the reference electrode for the green electrode. If you noticed, the blue electrode is on the pin above the green electrode. We will be removing pin 4 from SRB2 so that it is not included in the same reference signal being used to measure brain waves. The main reason for this is because the microvolt (uV) values produced by your heart and muscles are much stronger than the signals we can detect from your brain, so we don't want these signals to interfere. I'll go into more detail about this later on, when it comes time to adjust the channel settings in the GUI.

4. Launch the GUI and adjust your channel settings

a) If your OpenBCI GUI is not already running, relaunch it and configure the DATA SOURCE mode to LIVE (from Cyton) and Serial (from Dongle). Select your Cyton board from the list of devices, set the Channel Count to 8, and click START SYSTEM. Refer to section IV of this guide for more information on this process.

If you're using the Daisy Cyton board, still set the Channel Count to 8, even though the Daisy has 16 channels. Nothing will go wrong if you start the system with 16 channels, except the `Time Series` display will be unnecessarily cluttered.

b) Click START DATA STREAM to begin streaming data from your board. You should see live data from your body (and the unattached channels) streaming into the `Time Series` montage on the left side of the GUI.

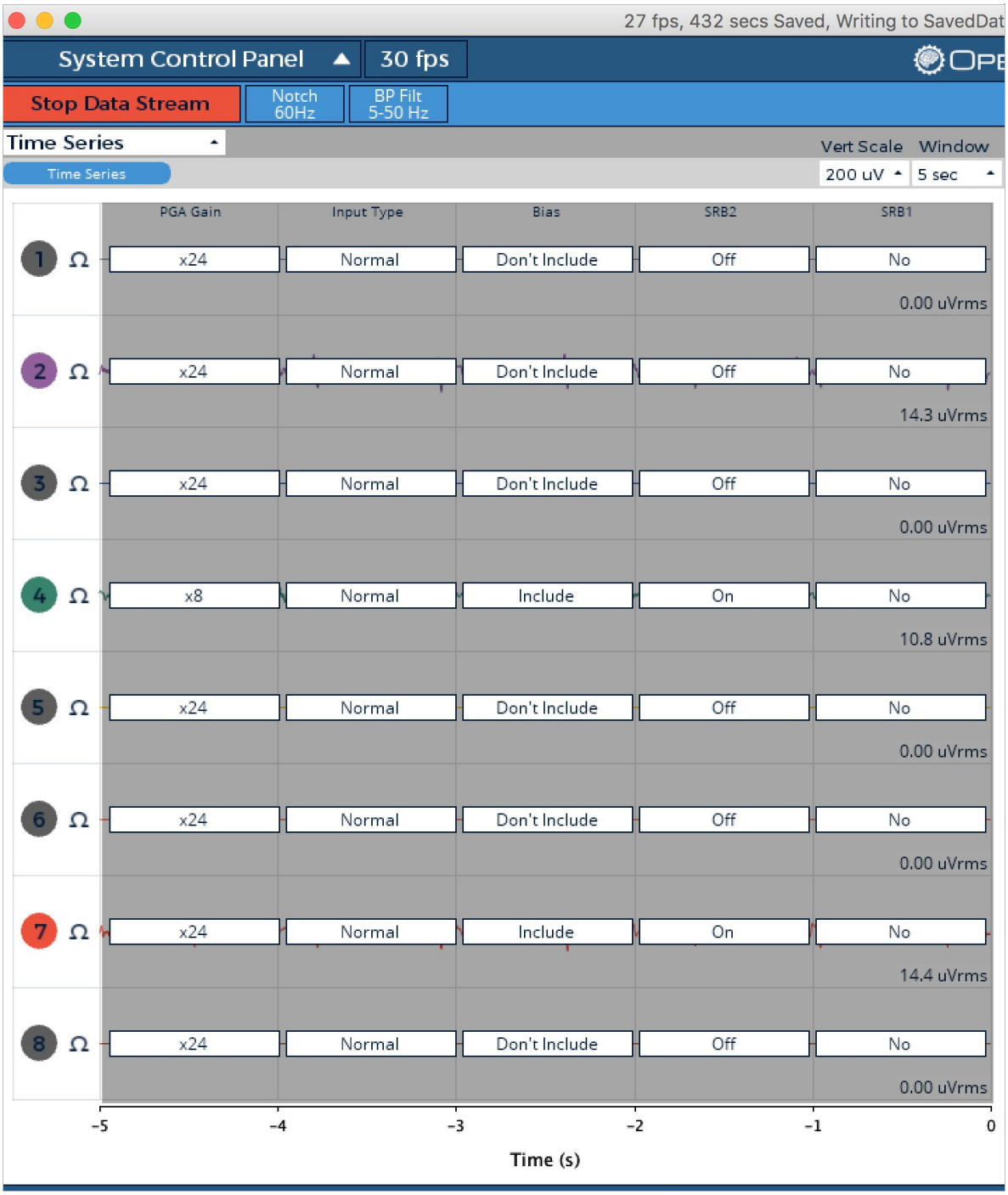


c) Now we are going to power down the channels we aren't using. Do this by clicking the circular channel number buttons outside of the left side of the `Time Series` montage. Each time you power down a channel, the channel will show a burst of signal and then settle at 0 mV.

We are only using channels 2, 4, and 7, so power down every other channel. You can also power down the channels with keyboard shortcuts (1-8). Power them back up with [SHIFT] + 1-8. If you are working with a daisy module, channels 9-16 can be powered down with q, w, e, r, t, y, u, i, respectively. You can power those channels back up with [SHIFT] + the same key.

Don't bother with the ohm symbols to the right of the buttons with numbers; they are used for impedance

montage:

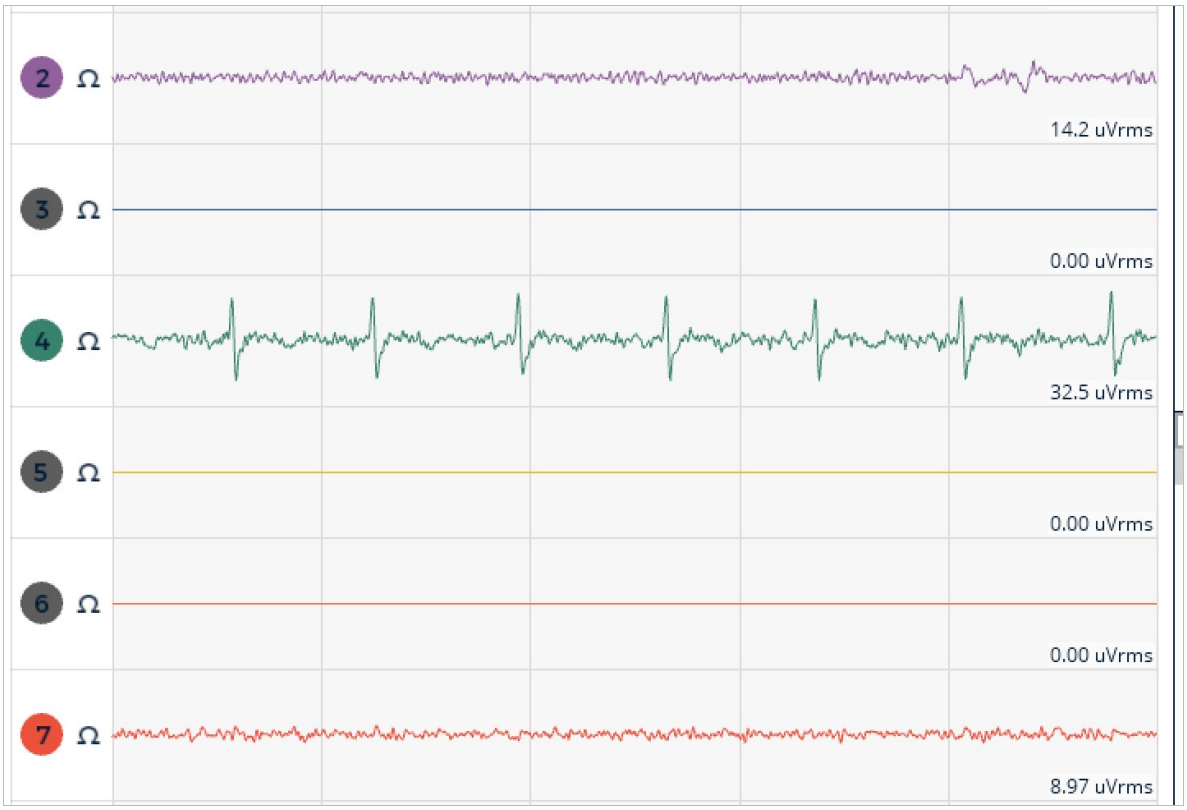


These buttons indicate the current settings of the ADS1299 registers on your Cyton board. For more information on these settings, refer to pages 39-47 of the ADS1299 datasheet.

We have simplified the interface through the OpenBCI firmware and OpenBCI GUI to allow easy, real-time

EMG and EKG. Begin by clicking the PGA Gain button for channel 4 until it is set to x8. Then remove it from the BIAS and SRB2. The reason we do this is because the uV values for EMG and EKG are much bigger (and easier to pick up) than the EEG signals on channels 2 and 7. As a result, we want to prevent channel 4 from influencing the common mode noise rejection of the BIAS, as well as remove it from the EEG reference channel (SRB2).

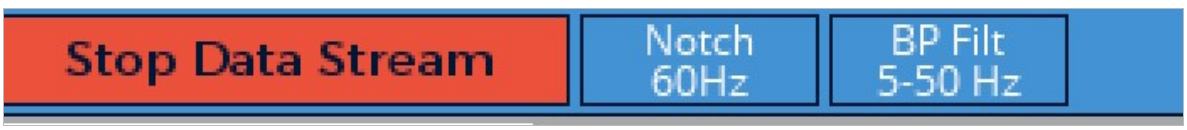
f) After updating these settings, click the `Time Series` button again, and your `Time Series` montage should now appear similar to the image below:



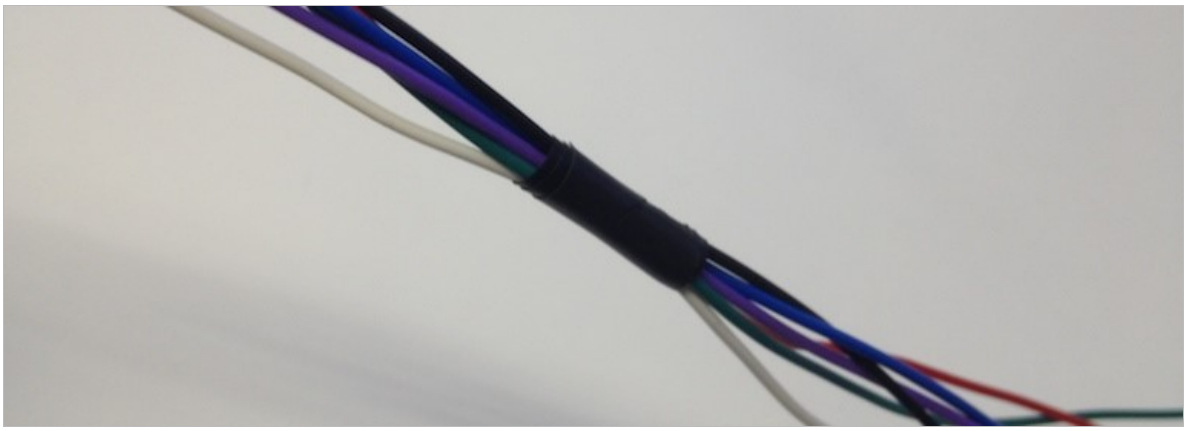
Notice that you no longer see the heart beat artifacts in channels 2 and 7. Additionally, the heart beat signal in channel 4 should be more steady, looking more like a typical EKG signal.

5. Minimizing noise

So there's a good chance your current setup isn't showing clean data like the screenshots above. There are a number of possible reasons for this. We'll go through troubleshooting them here.



Hz by clicking the "Notch 60 Hz" button. Additionally, if your Cyton board is on a table with any power chords or devices that are plugged into a wall outlet, move it to a location away from any electronic devices plugged into the wall. This will drastically reduce the alternating current (AC) influence on your signal.



Stabilize your electrodes

Make sure your electrode cables are steady. If you shake the electrodes that are dangling from your head/body, you'll notice that it severely affects the signals. This movement noise is something that could be greatly improved with "active" electrodes, but when using the "passive" electrodes that come with the OpenBCI electrode starter kit, you have to be very careful to remain steady while using the system, in order to produce the best signal. Sometimes, I'll bind all of the electrode cables together with a piece of electric tape to secure them and minimize cable movement. If you do this, don't worry about including the blue and green electrodes in the bundle, since movement noise doesn't affect the EMG/EKG signal as significantly.

Ensure that your electrodes are securely connected

Ensure that your electrodes are connected securely (especially your reference)!

Make sure your OpenBCI hardware is streaming data properly

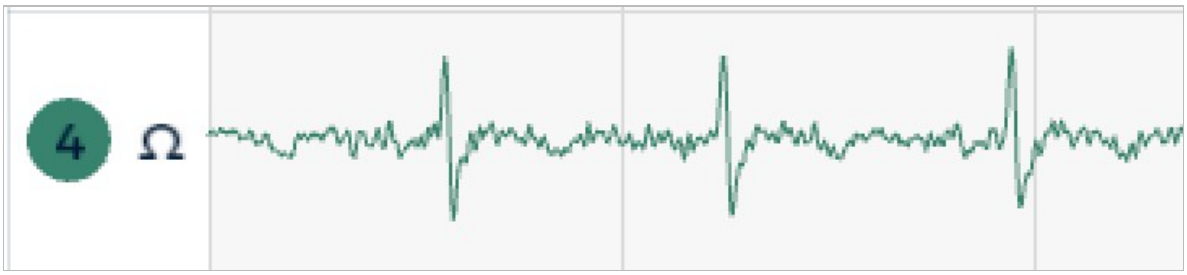
Every so often, an error will occur with the wireless communication between your OpenBCI Dongle and board. If you've followed all of the steps above, and the data that you are seeing in the GUI interface is still illegible, try the following:

Power down your Cyton board and unplug your USB Dongle. Then, plug back in your USB Dongle and power up your Cyton board in that order. Then try restarting the system, but pressing the START SYSTEM button again.

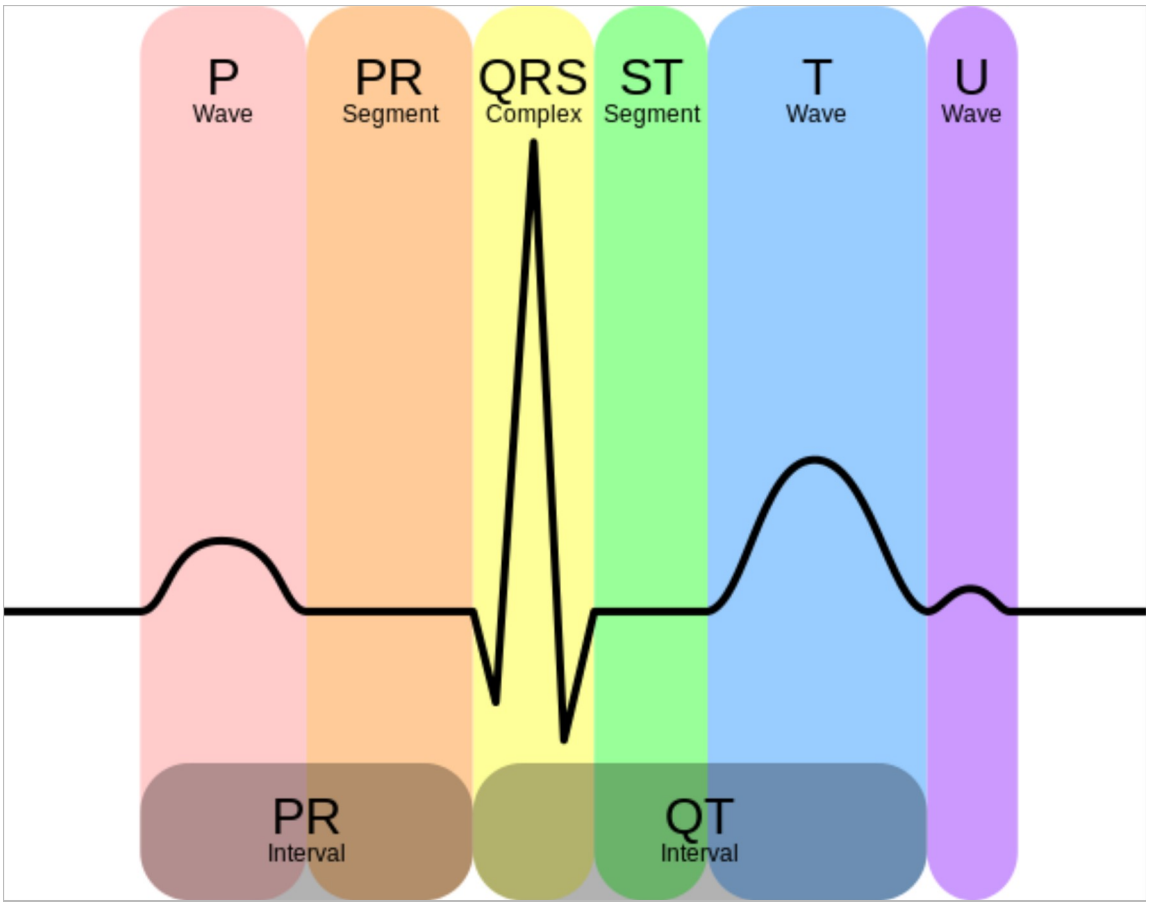
Further troubleshooting

Congratulations! If you've made it this far, it's finally time to check out your body's electrophysiological signals!

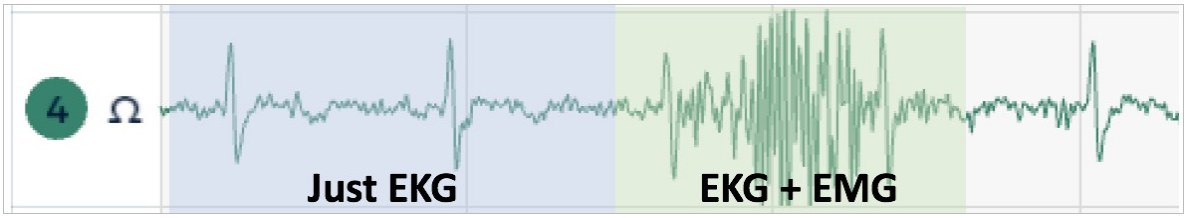
1. Check out your heart activity (EKG)



Channel 4 in the GUI should now be producing a nice steady succession of uV spikes. This is your heart beating! Try taking slow, deep breaths and watch how it influences your heart rate. If you look carefully, you may notice your heart beat more rapidly as your inhaling, and more slowly as you're exhaling.



For more information on how to analyze an electrocardiography (EKG) signal, or on how to set up a full EKG (with 10 electrodes), check out the wikipedia page on EKG. The image to the right (pulled from the Wikipedia



Now, try flexing your forearm or whatever muscle you placed the green electrode on top of. You should see a high-amplitude, high-frequency signal introduced into channel 4. This is the electric potential created by you activating your muscle!

If you relax your muscle again, you should see the channel 4 signal return to your heart beat (just EKG). The picture on the right shows this transition. When you're flexing your muscle, the electrode is picking up EMG and EKG at the same time. After you relax your muscle, the high-frequency signal disappears, and you're able to see just EKG.

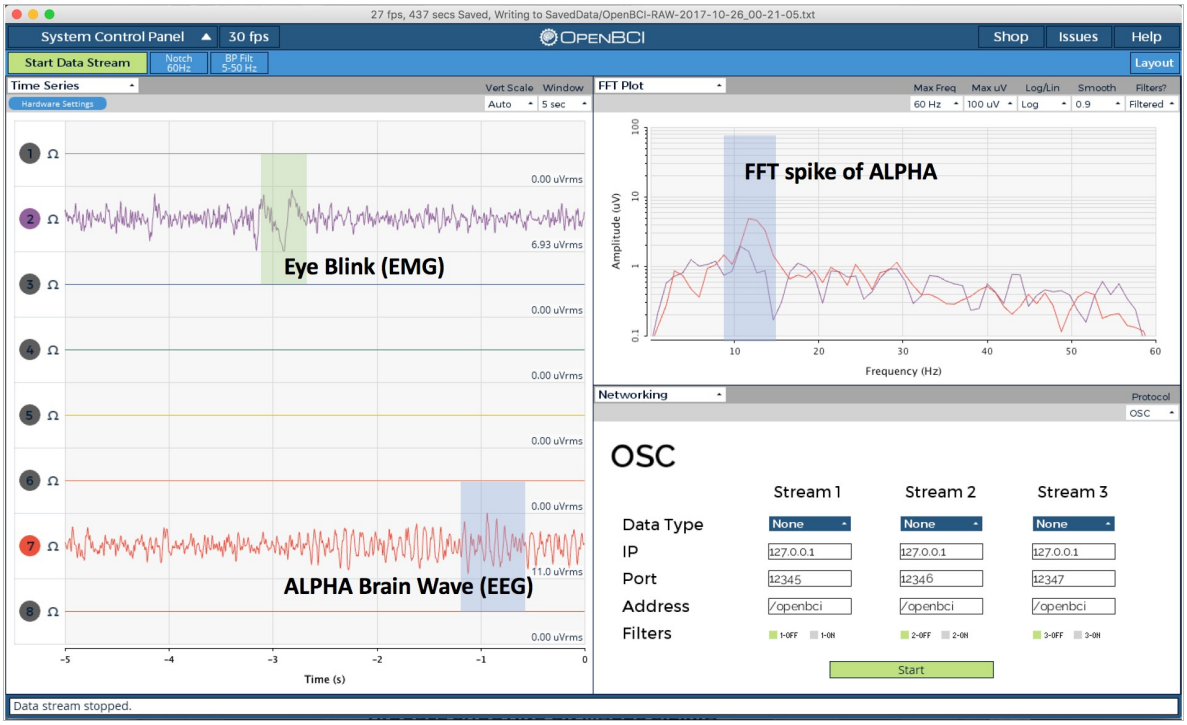
3. Eye blinks and jaw clenching (more EMG)

Now blink your eyes a few times. Each time you blink you should see a strong spike on the EEG DATA montage. It should be most visible in channel 2, the channel for the electrode directly above your eye! This uV spike is a result of the muscles in your forehead that make your eyes blink.

Now try clenching your jaw. You should see a big uV spike in both channels 2 and 7. Each time you clench your jaw, you are introducing a strong EMG artifact into any electrodes on your scalp. If you put your fingers on the side of your head (above your ear) and clench your teeth, you should be able to feel the muscles in your head flexing.

In the photo above, you can see what these signals look like the green highlighted region shows a single eye blink. The two blue sections show an extended period of jaw clenching.

It's interesting to note that these signals are not picked up in channel 4. This is because channel 4 is only looking at the potential difference across your body—from your right forearm to your left wrist. As a result the EMG/EEG artifacts being produced on your head (in reference to SRB2) are not visible in this channel.



Now, for what we've all been waiting for... let's check out some brain waves!

Firstly, deactivate channel 4 so that you are only looking at the EEG channels (2 and 7).

It's best to do this portion of the tutorial with a friend. You'll understand why in a second. It just so happens that the easiest way to consciously produce brain waves is by closing your eyes. When you do this, your occipital lobe (the part of your brain responsible for processing visual information) enters into an alpha wave state at a frequency between 7.5-12.5 Hz. Alpha brain waves are the strongest EEG brain signal! Historically, they are thought to represent the activity of the visual cortex in an idle state. An alpha-like variant called mu (μ) can be found over the motor cortex (central scalp) that is reduced with movement, or the intention to move [Wikipedia].

For more information on Alpha waves check out Wikipedia and Chip's EEG Hacker blog post about detecting alpha waves with OpenBCI V3.

Once you've closed your eyes, have your friend press the 'm' key on your keyboard to take screenshots. Tell him or her to wait until a strong alpha spike emerges on the Fast Fourier Transform (FFT) Graph, the graph in the lower-right of the GUI. The spike should be somewhere between 7.5-12.5 on the the x-asix of the FFT graph, indicating that there is a strong presence of waves in that frequency range.

After you've taken a few good screenshots, open up the .JPGs and take a look. Note: the screenshots are located in the root directory of your application, or in the OpenBCI_GUI directory if you are working from Processing.

OpenBCI!

5. What's next?

For more ideas on what to do next, check out the OpenBCI Community Page and the other OpenBCI Docs pages.

Also, if you have a great follow-up tutorial to this getting started guide or something else you want to share, feel free to create your own by following format we have in the Docs repo of our Github. It's really easy to create your own Docs page with a Markdown editor like Mou or MacDown. If you do so, send us a pull request on Github and we'll add your tutorial to the Docs!

If you have troubleshooting questions be sure to visit the OpenBCI Forum. For all other inquiries, contact us at contact@openbci.com.