

biosignalsplux

FORCE+EMG

biosignal acquisition tool-kit for advanced research applications

user manual



ATTENTION

please read this manual before using your
biosignalsplux product

The information contained in this manual has been carefully checked and we made every effort to ensure its quality. PLUX reserves the right to make changes and improvements to this manual and products referenced at any time without notice.

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Please check your system after receiving and before using it the first time, to confirm if it contains all the ordered sensors, accessories and other components. Contact our customer support if there are any variations from your original order.

DISCLAIMER

biosignalsplux products are intended for use in **life science education and research applications only**; they are **not medical devices**, nor are they intended for medical diagnosis, cure, mitigation, treatment or prevention of disease and is provided to you “as is”.

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1 biosignalsplux Force+EMG Kit



Figure 1: biosignalsplux Force kit.

biosignalsplux Force + EMG comes with 2 biosignalsplux hubs to acquire data from 4 load cell sensors and 4 EMG sensors. The load cell sensors are connected to one 4-channel biosignalsplux hub placed on the back of the aluminum plate to acquire reliable data about force and weight distribution in a wide range of applications including jump analysis, center of mass distribution, weight assessment, force production capacity, and others.

Additionally, this kit comes with a second biosignalsplux hub and 4 EMG sensors which allow the monitoring of different muscles and/or muscle groups during the performed movements. This kit includes the EMG analysis, Force data, and Video Synchronization add-ons for the OpenSignals (r)evolution software to process and synchronize the acquired data with video recordings.

1.1 Kit Content

NOTE

Please review your kit's content carefully before using it the first time, to confirm if it contains all the ordered sensors, accessories, and other components. Contact our customer support if there are any variations from your original order.

E-Mail: support@plux.info

1.1.1 Hardware

- 2x Wireless 4-channel hubs with accessory ports & 16GB internal memory
- 1x Force Platform (sturdy aluminum plate) incl. 4x Load cell sensors (200Kg per sensor)
- 4x EMG sensors
- 1x Bluetooth dongle
- 1x Synchronization kit (incl. sync cable, trigger button, LED)
- 1x pack of 24 disposable electrodes (pre-gelled & self-adhesive)
- 2x Medical-grade charger
- 1x Carrying bag for the force platform and kit contents

1.1.2 Software

- OpenSignals (r)evolution software for real-time acquisition & offline visualization
- OpenSignals (r)evolution add-ons:
 - Force Platform
 - Electromyography (EMG) Analysis
 - Video Synchronization
 - Data logging & offline acquisition scheduling
- Cross-platform APIs

1.1.3 Documentation

- Load Cells' calibration values

1.2 Force Platform

This multipurpose force platform is intended to be used together with our biosignalsplux kits. Its versatile design enables a wide range of applications such as jump analysis, center of mass distribution, weight assessment, force production capacity, and others. Multiple configurations and measurement range options are available.

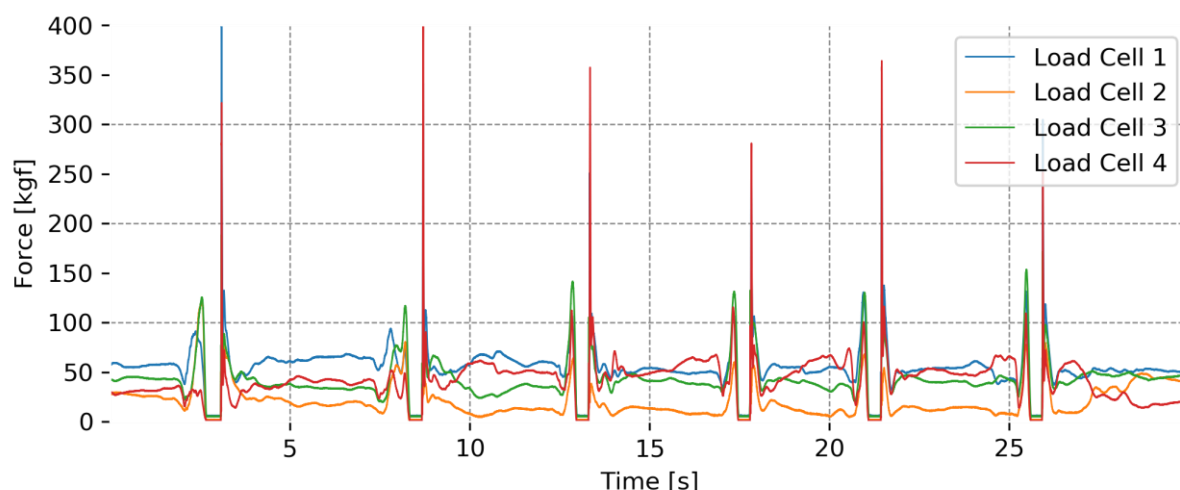


Figure 2: Sample raw data of a 4-channel Force Platform acquisition.

1.3 Electromyography (EMG) Sensors

The biosignalsplux Electromyography (EMG) is designed to monitor muscular activity even in the most extreme conditions. The bipolar configuration is ideal for uncompromised low-noise

data acquisition, and the raw data output provides medical-grade data enabling it to be used for advanced and highly accurate biomedical, biomechanics, and sports research, among many other possible applications.

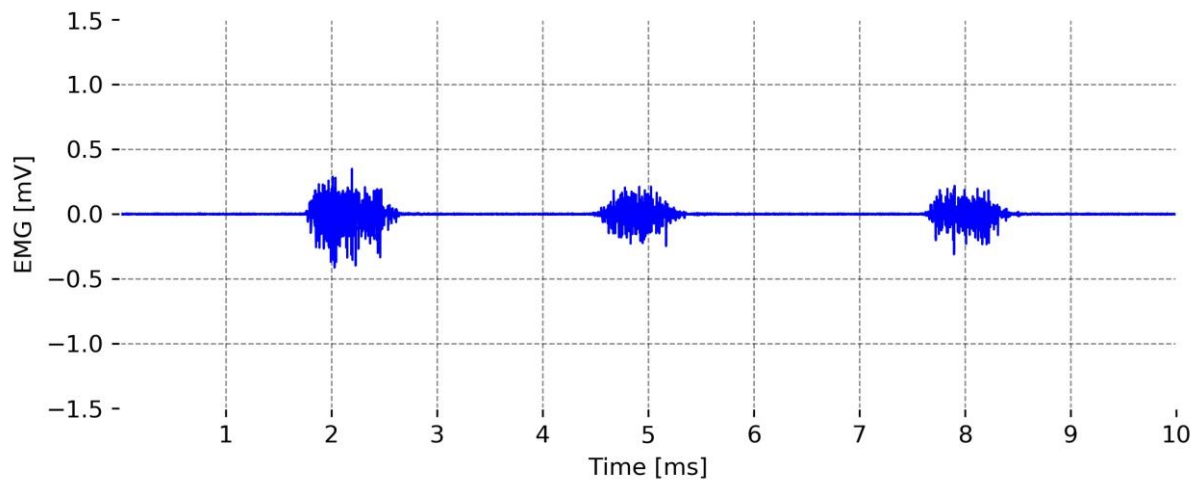


Figure 3: Sample raw data of a single-channel EMG acquisition displaying 3x muscle contractions.

2 biosignalsplux Hub



Figure 4: biosignalsplux hub

The *biosignalsplux* hub are the 4-channel devices of your kit that collect and digitize all signals from the sensors and accessories and transmit them via Bluetooth to the computer, where they are recorded and visualized in real-time. The channels support up to 16-bit resolution and 3000Hz sampling frequency per channel, i.e. up to 4 channels with 3000 16-bit samples per channel per second.

Features

- > Designed for advanced biosignal research
- > Medical-grade raw data acquisition
- > Ready to use in- & out-of-the-lab
- > Sensor auto-detection
- > Bluetooth streaming capability
- > Internal memory for offline acquisitions

Applications

- > Life sciences studies
- > Biomedical research
- > Human-Computer-Interaction
- > Sports sciences & biomechanics
- > Robotics & Cybernetics
- > biomechanics
- > Ergonomics

Specifications

Analog Inputs:	4 (16-bit per channel)
Digital Ports:	none (optionally available)
Common Ground:	1
Sampling Rate:	up to 3000Hz (per channel)
Internal Memory:	16GB (stores up to ~111h)
Communication:	Bluetooth 2.0+EDR (Class II)
Bluetooth Range:	up to ~10m (in line of sight)
Battery:	700mA 3.7V LiPo rechargeable (up to 12h in continuous streaming)
Hub Size:	54x85x10mm
Weight:	45g

2.1 Ports and Peripherals

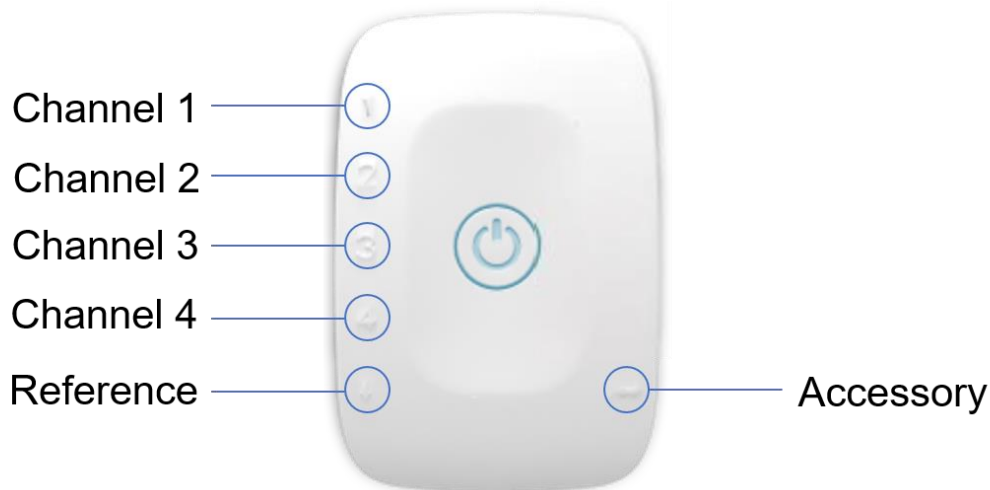


Figure 5: 4-channel biosignalsplux hub ports (Force+EMG Kit Version).

2.1.1 Button

The button is used to turn the device on and off and to display device status' using the built-in LED (see 2.1.6 *Button Behavior*).

2.1.2 Analog Inputs

The *biosignalsplux* hub has 4 ports (channel 1 to 4) to connect up to 4 sensors. All channels are synchronously and simultaneously acquired.

2.1.3 Reference

The reference port allows you to connect one single lead ground cable to share a common reference point for all sensors. However, some sensors (e.g., ECG and EEG) have their own ground/reference electrodes, which can be used instead. A common ground connection is, for example, useful in applications that require multiple sensors that share the same reference point (e.g. multiple EMG sensors).

2.1.4 Accessory Port

The accessory port allows you to connect biosignalsplux accessories to the biosignalsplux hub which come with your kit, including the following:

- Trigger button
- LED
- Synchronization cable

2.1.5 Charging Port

The charging port is designed to charge your device using the medical-grade *biosignalsplux* charger which comes with your kit. Please read the information displayed in the 2.2.4 *Charging* section before using the *biosignalsplux* charger and follow the indicated instructions when charging your *biosignalsplux* device(s) to prevent any damage to the user or the system due to problems occurring during the charging process.

WARNING

Do not use the *biosignalsplux* device during the charging process.

2.1.6 Button Behavior

The button at the center of the *biosignalsplux* hub enables basic control of the device. Please read the *biosignalsplux* hub datasheet to get information about the button behavior:

http://biosignalsplux.com/datasheets/biosignalsplux_hub_Spec_Sheet.pdf

2.2 General Device Functionality

2.2.1 Turning on the Device

In order for the device to work, it must be turned on. Turning on the device can be done by pressing the button in the center of the *biosignalsplux* hub. After being turned on, the LED status light will blink once per second (green).



Figure 6: *biosignalsplux* center button.

2.2.2 Connecting the Sensors

Sensors have to be connected to channel 1 to 4 or 1 to 8 (number of channels depends on each *biosignalsplux* hub) in order to work properly. Do not connect the sensors to the digital or common ground port, unless it is stated otherwise in the sensor datasheet or [biosignalsplux user manual](#). The reference electrode/ground cable should be connected to the common ground port (see *Figure 4* or *Figure 7*).

When connecting the sensors, pay attention to where the cables go to avoid device damages or disrupting the user's movements.

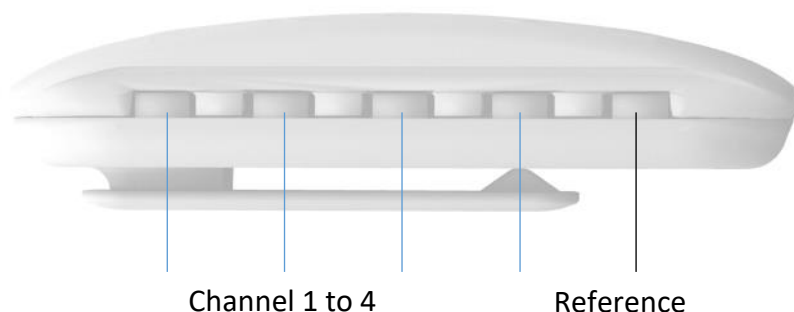


Figure 7: *biosignalsplux* side view.

2.2.3 Disconnecting the Sensors

Disconnect the sensors according to the recommendations displayed below, to avoid damaging the *biosignalsplux* device or the sensors:

- don't twist the sensor while disconnecting
- don't apply upward force or pull the cable
- use minimal force to disconnect
- hold the plug firmly and pull it out
- don't pull the cable

2.2.4 Charging

WARNING

Do not use the *biosignalsplux* device during the charging process.

biosignalsplux has a battery lifetime of up to 12 hours in continuous usage. Note, that the lifetime might vary depending on the number of active sensors and/or accessories. The built-in LED will light up red if the battery is running low until the device stops working.

To recharge, connect the *biosignalsplux* charger to the device's charging port and to a power outlet (see *Figure 8*). The charging process will take approximately 2 ½ hours to fully charge the battery. The button will light red while charging (steady light when turned off, and flashing red when acquiring or in stand by state), and the red color will turn off once the battery is fully charged.



Charging Port

Figure 8: Charging port.

The suitable room temperature when charging the device must be between 10°C and 35°C to prevent device or user related damages during the charging process.

WARNING

Unplug the charger from the wall outlet if the battery/device overheats (reaching 60°C) and immediately get in contact with PLUX's Technical Assistance.

NOTE

The red LED will be switched on if an error occurs during the charging process.

In this case, unplug the charger from the wall outlet and plug it in again to complete the charging process correctly. Please get in contact with our support if the error remains permanently.

2.3 Communication (Bluetooth)

The communication with *biosignalsplux* devices is done via Bluetooth or USB. However, the USB communication is used to download offline acquired data only, while Bluetooth is used to configure the device, to acquire and transmit sensor signals in real-time to the computer, and to download offline acquired data which is stored on the internal memory of the *biosignalsplux* device.

biosignalsplux uses Bluetooth Class II to communicate with the computer and to transmit the acquired sensor data. Since most internal Bluetooth modules are not designed to support high transfer rates as those are needed when acquiring and streaming signals using *biosignalsplux*, we strongly recommend using the PLUX Bluetooth dongle (which comes with your *biosignalsplux* kit) to prevent any communication issues or connection losses. These dongles have been tested and verified by PLUX to work properly with any *biosignalsplux* device.

The Bluetooth dongle can be found in our store if several dongles are needed (e.g. to use *biosignalsplux* on several computers without having to change the Bluetooth dongle every time another computer's being used¹).

<https://store.plux.info/biosignalsplux-accessories/368-bitalino-proven-bluetooth-dongle-820201511.html>

Instructions on how to connect *biosignalsplux* via Bluetooth to the computer can be found in the 0

If you're experiencing a great number of connection loss events, reconnection problems, missing samples or similar problems, your internal Bluetooth module might be being used for data transmission or your Bluetooth dongle might be configured to use the wrong Bluetooth stack. Instructions to set up the correct Bluetooth stack and to solve such problems can be found in the 8.1 Bluetooth section of this manual

See the table on the following page for detailed Bluetooth specifications of the internal Bluetooth module of *biosignalsplux* devices.

¹ biosignalsplux can only be connected to one computer at a time

Operating frequency range	2400 – 2483.5 MHz ISM Band
Modulation method	GFSK (1 Mbps) P/4 DQPSK (2Mbps)
Hopping	1600 hops/s, 1 MHz channel space
Transmission power	Min: -11 dBm Max: +3 dBm
Antenna peak gain (XZ-V)	0.5dBi typical
Average antenna gain (XZ-V)	-0.5 dBi typical
Antenna VSWR	2 max
Certifications	Bluetooth, CE, FCC, IC, Japan and South Korea

Table 1: Specifications of biosignalsplux devices' internal Bluetooth modules.

3 Bluetooth Setup

When connecting the device, you first need to enable Bluetooth on your computer or need to plugin the Bluetooth dongle to your USB port, if Bluetooth is not built in or reliable for your computer. Follow the instructions for your operating system that are displayed on the following pages to connect your *biosignalsplux* to your computer.

3.1 Windows 7

To connect your device to your computer via Bluetooth, click on the start button at the right lower part of the Windows taskbar and click on *Control Panel* to access the control panel of your computer.

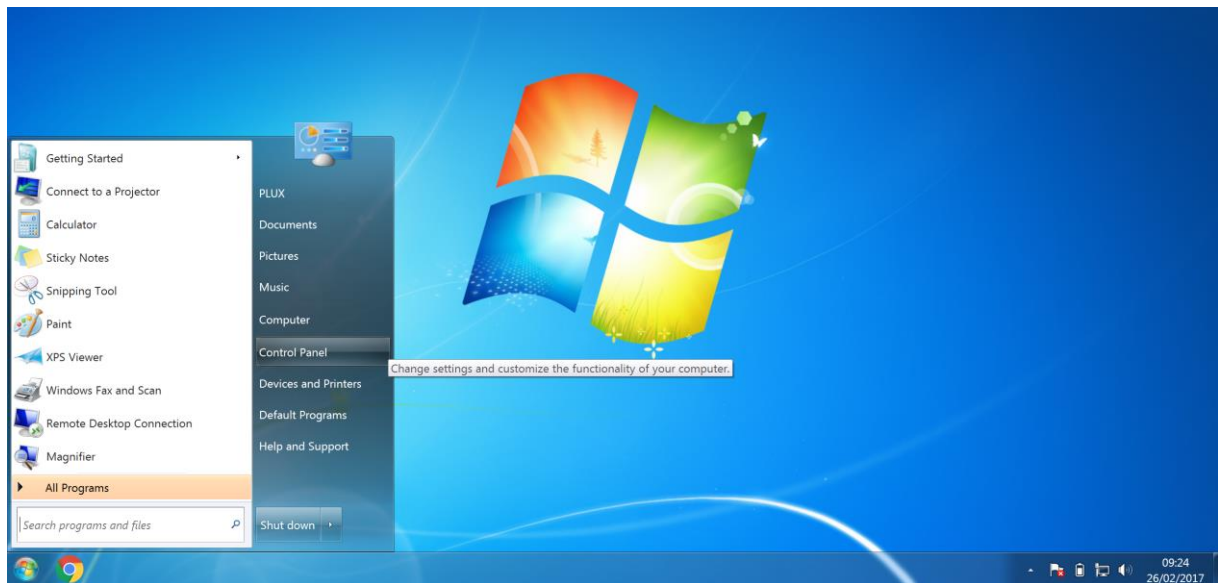


Figure 9: Access the Windows 7 control panel.

In the control panel, select the *Add a device* option in the *Hardware and Sound* section to add your device.

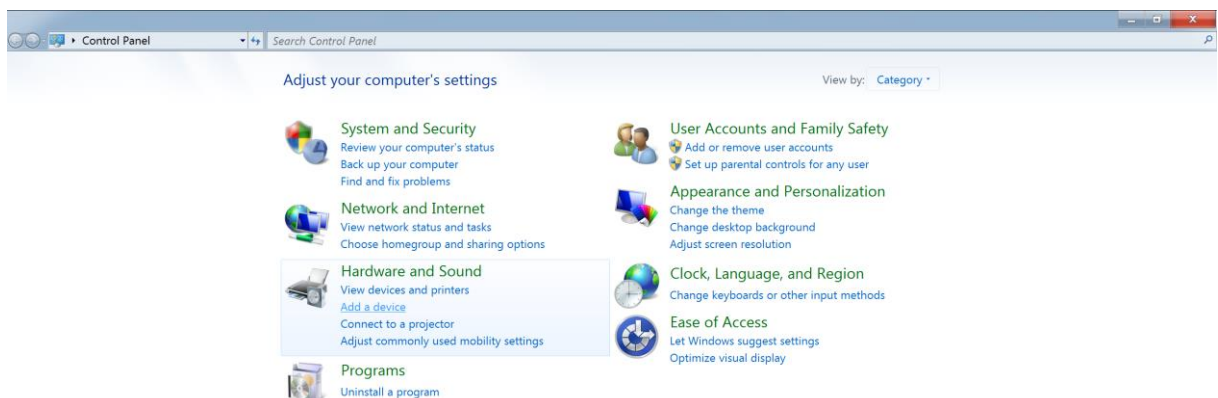


Figure 10: Select Add a device in the Hardware and Sound section.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list available devices. When your device has been found (here: *biosignalsplux*), click on the device and click on *Next* at the lower right corner of the *Add a device* window.

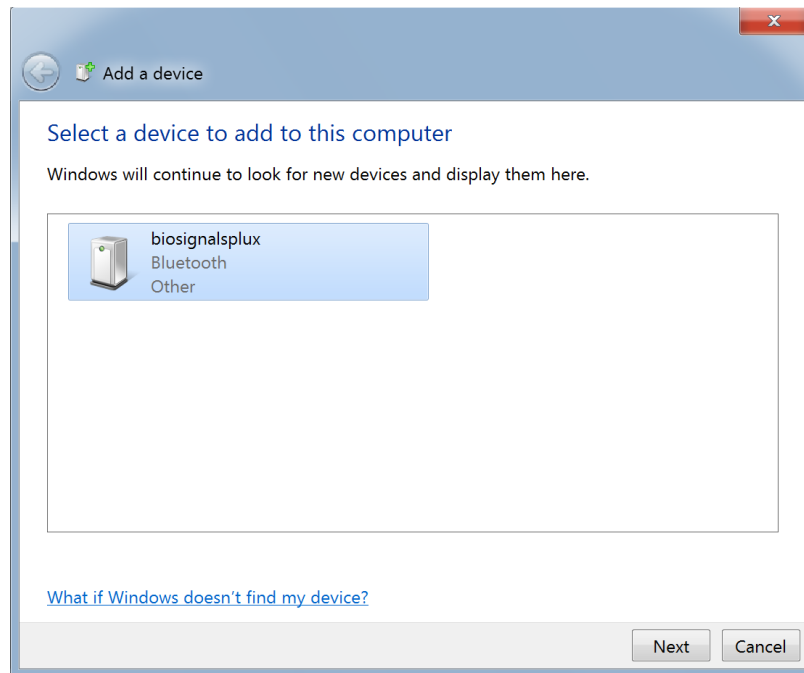


Figure 11: Select your device to add it to your computer.

Click on *Enter the device's pairing code* and click on *Next* at the lower right corner of the window to proceed.

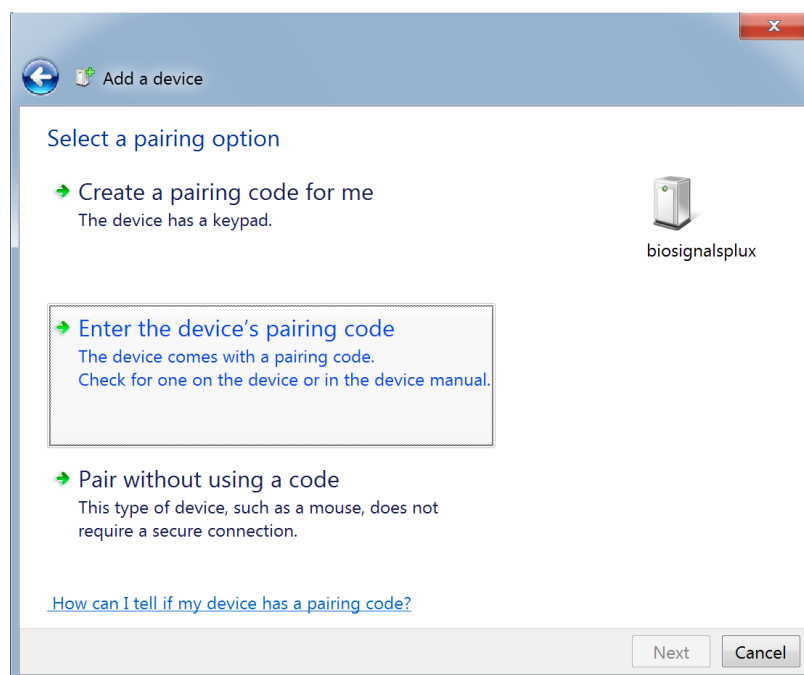


Figure 12: Select Enter the device's pairing code.

For *biosignalsplux* devices enter 123 and click on *Next* to connect to your device. For *BITalino* devices enter 1234 and click on *Next* to connect to your device.

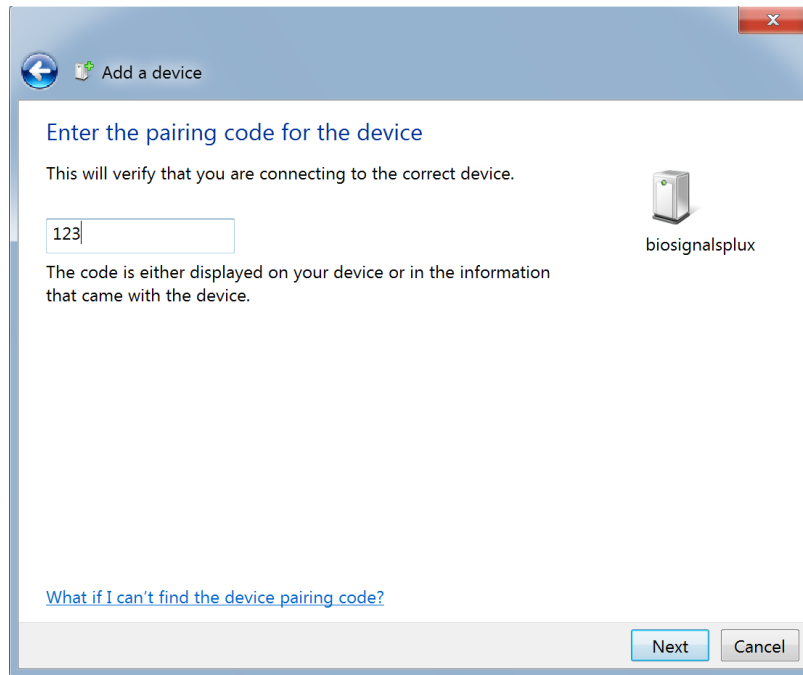


Figure 13: Enter the pairing code to connect to your device.

If Windows confirms that your device has been successfully added to your computer, the connection has been successfully established.

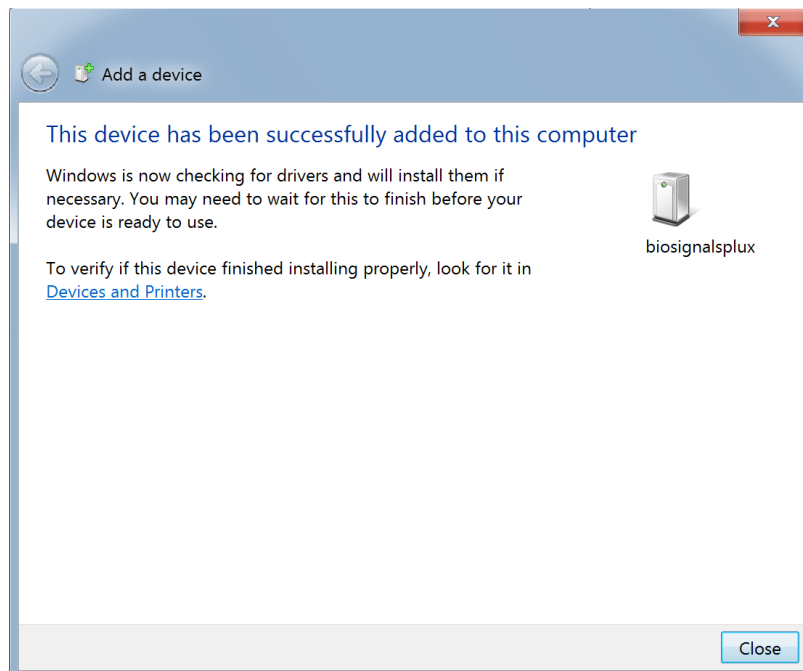


Figure 14: Windows confirmation if the device has been successfully added.

3.2 Windows 8

To connect your *biosignalsplux* device to your computer via Bluetooth, click on the start button at the right lower part of the Windows taskbar, click on the triangle symbol and click on the Bluetooth icon to open the Bluetooth settings panel.



Figure 15: Access to the Bluetooth settings panel in Windows 8.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *biosignalsplux* device has been found, click on the device and click on *Pair* to connect to your device.

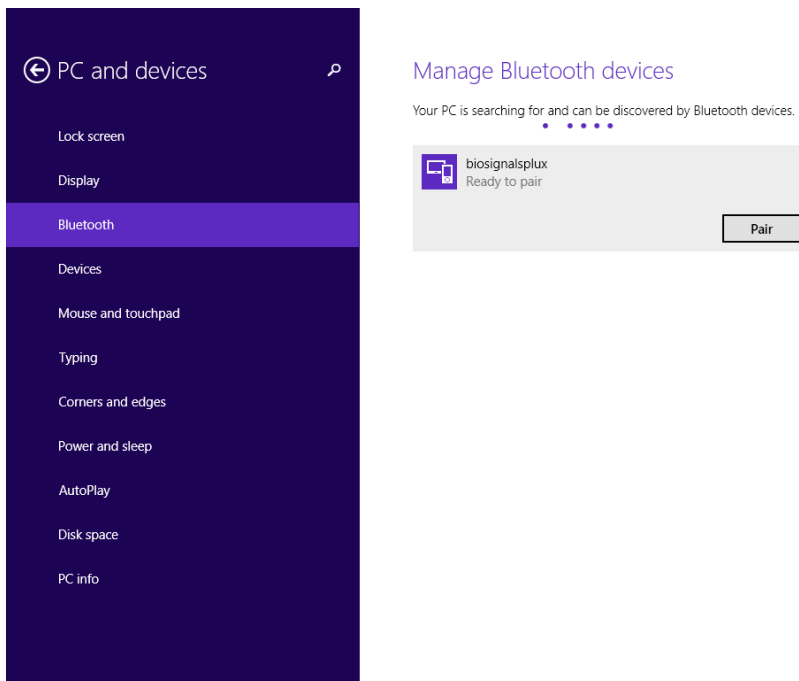


Figure 16: Bluetooth settings panel.

Windows will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on *Next* to connect to *biosignalsplux*.

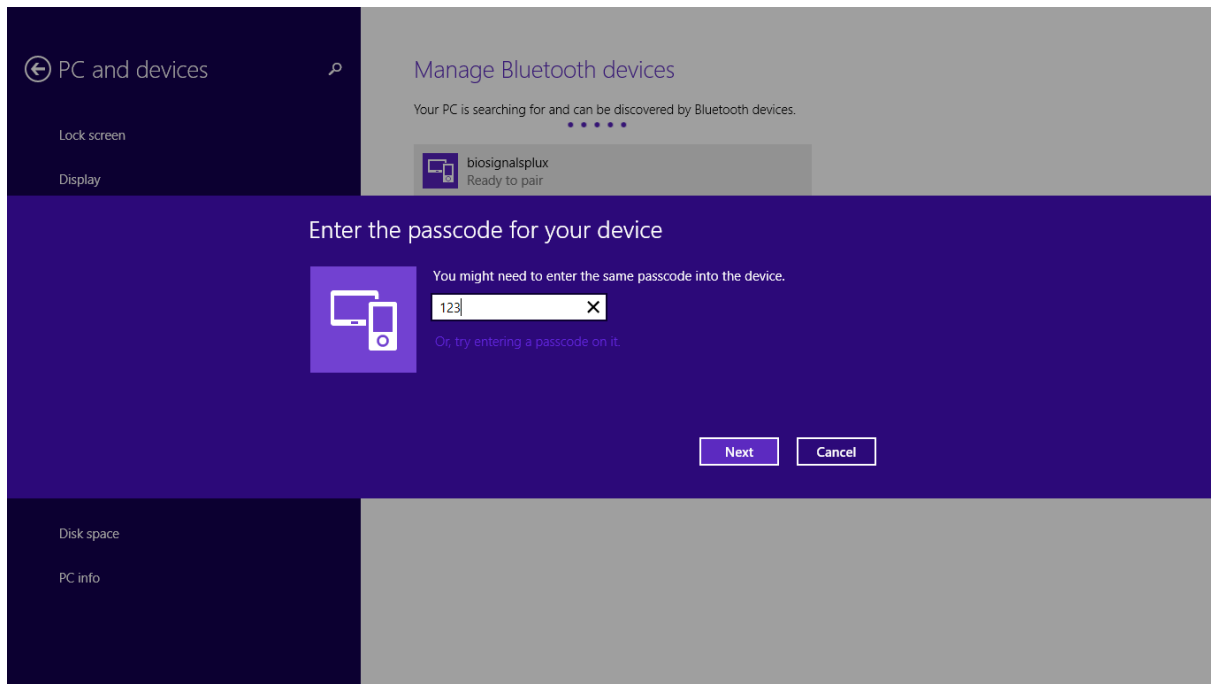


Figure 17: Requesting biosignalsplux' passcode (123).

If *Connected* is displayed under the name of your *biosignalsplux* device in the Bluetooth settings panel, the connection has been successfully established.

3.3 Windows 10

To connect your *biosignalsplux* device to your computer via Bluetooth, click on the start button at the left lower corner in Windows 10 to open the start menu. Click on the gear symbol to open the settings panel of your operating system as can be seen below.

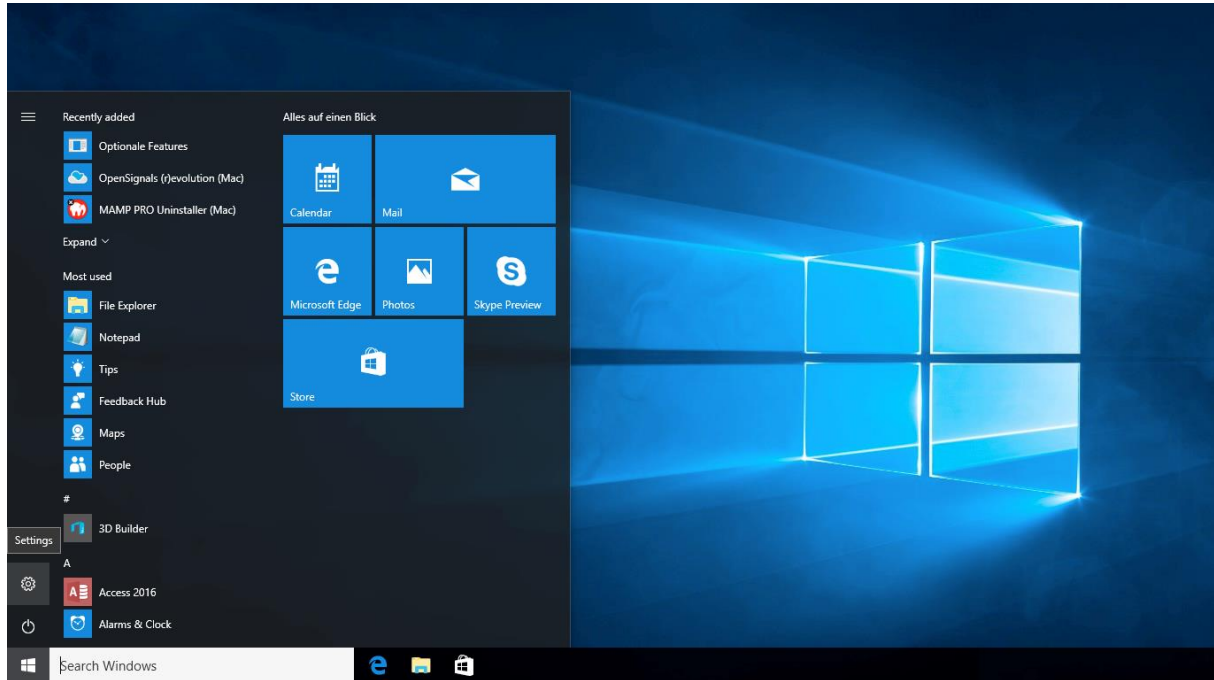


Figure 18: Access to the settings panel in Windows 10.

In the settings panel, click on the *Devices Bluetooth, printers, mouse* field to open the device configurations of your system.

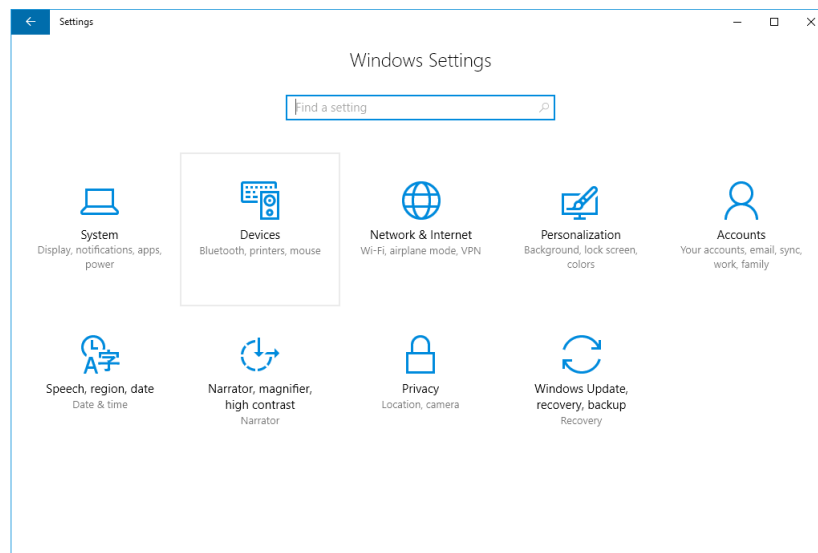


Figure 19: Windows 10 settings panel.

Select *Bluetooth* from the list which is displayed on the left side of your settings window. Note, that in some versions the Bluetooth option might not be available and that Bluetooth devices might be listed under *Other devices* as seen in *Figure 20*.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *biosignalsplux* device has been found, click on the device and click on *Ready to pair* to connect to your device.

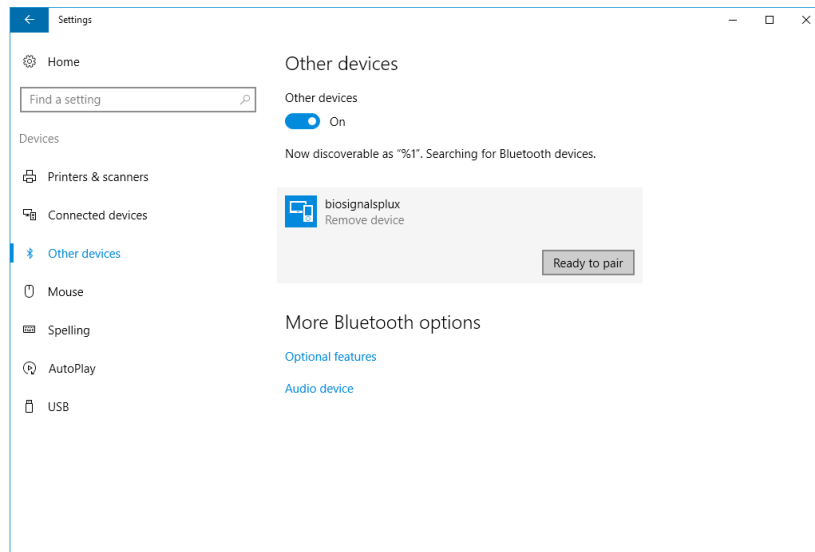


Figure 20: Bluetooth settings panel.

Windows will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on next to connect to *biosignalsplux*.

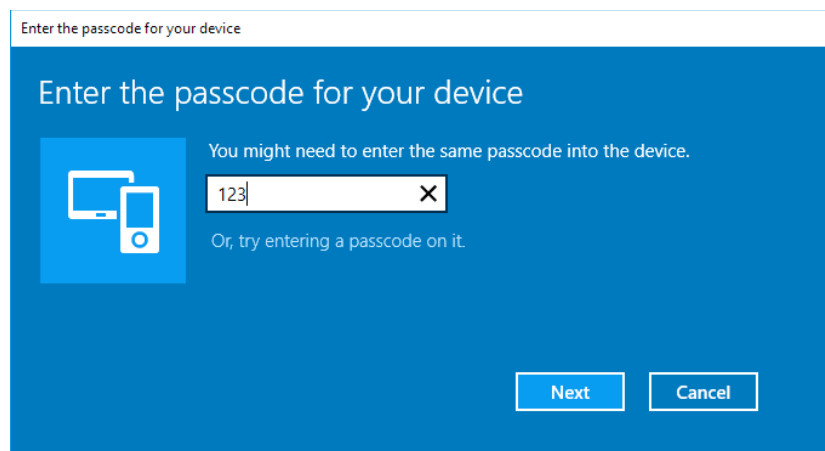


Figure 21: Requesting passcode (123).

If *Pair* is displayed under the name of your *biosignalsplux* device in the Bluetooth settings panel, the connection has been successfully established.

3.4 Linux

Ubuntu offers two options on how to connect your devices via Bluetooth to your computer. The first option allows you to connect the device via Ubuntu's system settings and the graphical interface. The second option allows you to connect the device via the terminal. However, the second option is recommended for advanced users only.

3.4.1 Connecting via System Settings

To connect your device to your computer via Bluetooth, click on the wheel in the top right corner of the display and click on *System Settings*.. to access the settings panel of your computer.

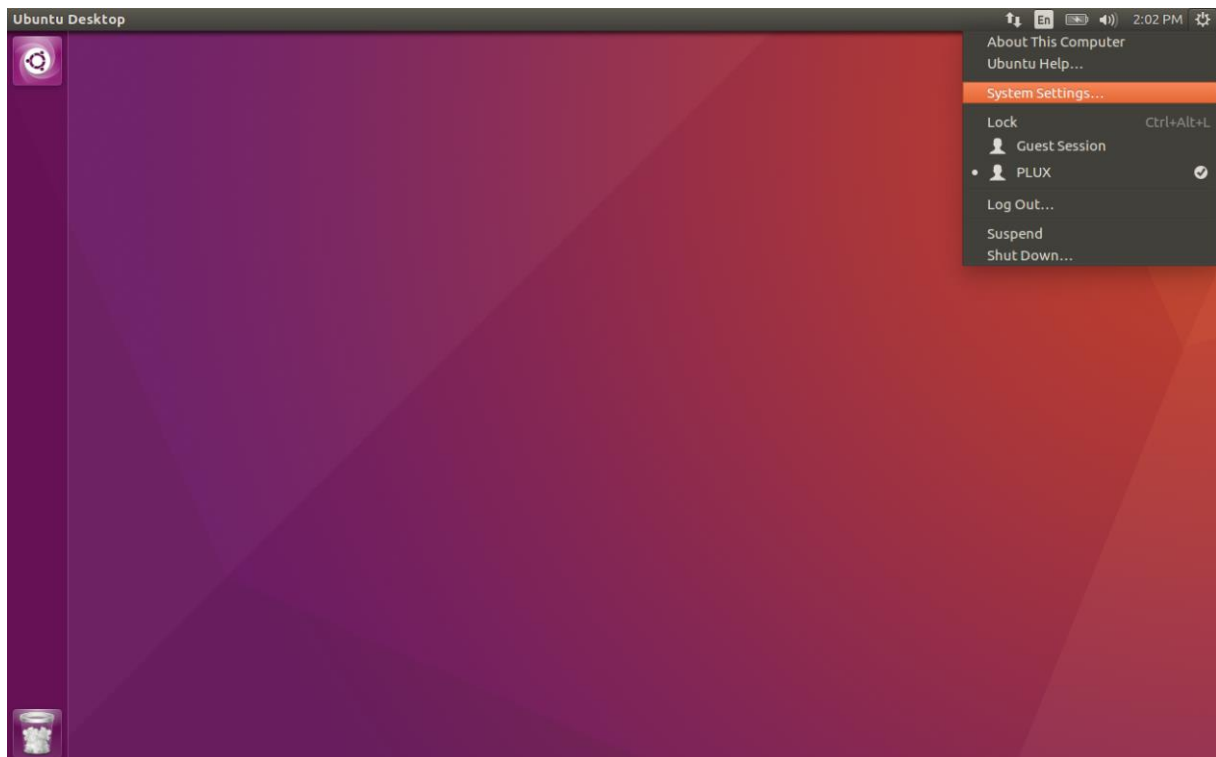


Figure 22: Access the system settings in Ubuntu.

In the settings panel, click on the Bluetooth logo to access the Bluetooth settings panel.

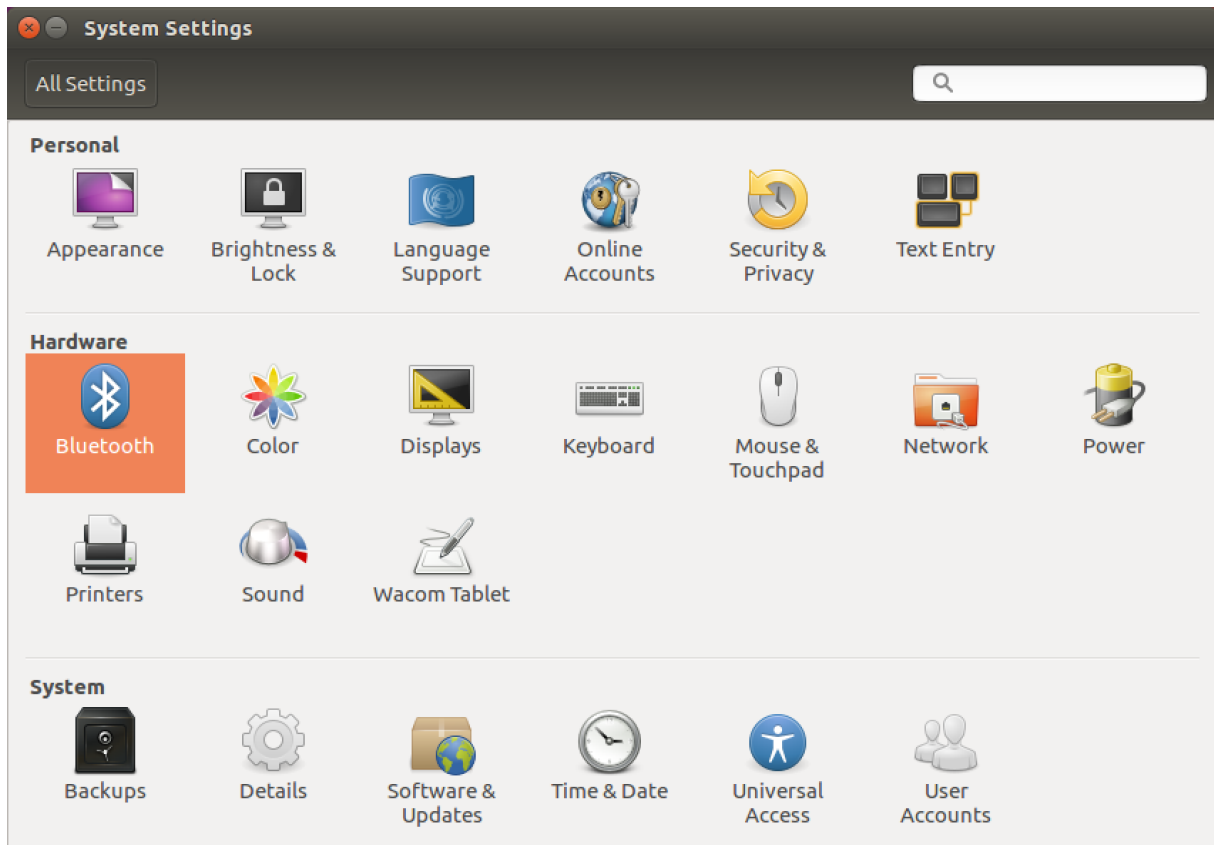


Figure 23: Click on the Bluetooth logo to access the Bluetooth settings.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list available devices. When your device has been found (here: *biosignalsplux*), it will be listed in the *Device Search* window. Click on the device and select *PIN options...* to enter the device's PIN to proceed.

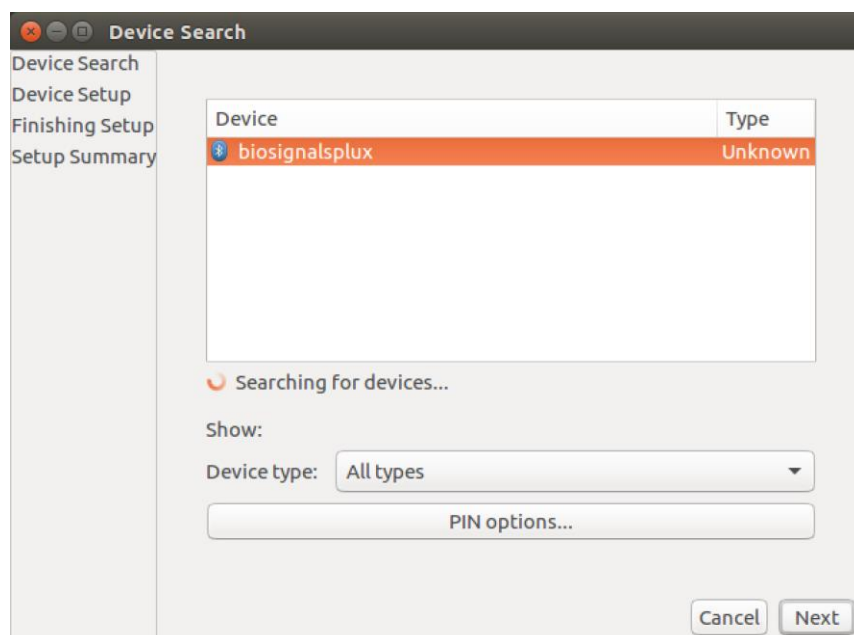


Figure 24: Select your device to add it to your computer.

In the new *PIN Options* window click on *Custom PIN* and enter the device's PIN to connect to your device. For *biosignalsplux* devices enter 123 and click on *Next* to connect to your device.

NOTE

If the *Custom PIN* option is not available in this window, follow up with the instructions in *Connecting via Terminal* to connect your device to your computer using the terminal instead of proceeding with the configuration via the system settings.

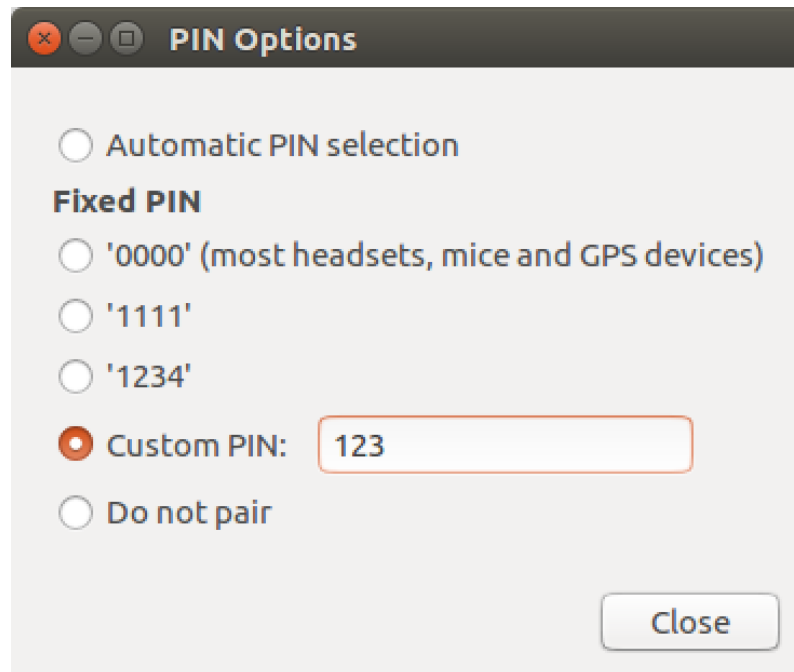


Figure 25: Enter the device's pin to pair.

Click on *Close* to close this window and click on *Next* on the *Device Search* window to connect to your device.

Click on your device in the *Devices* list. If paired is confirmed (*Paired Yes*) your device has been successfully connected to your computer².

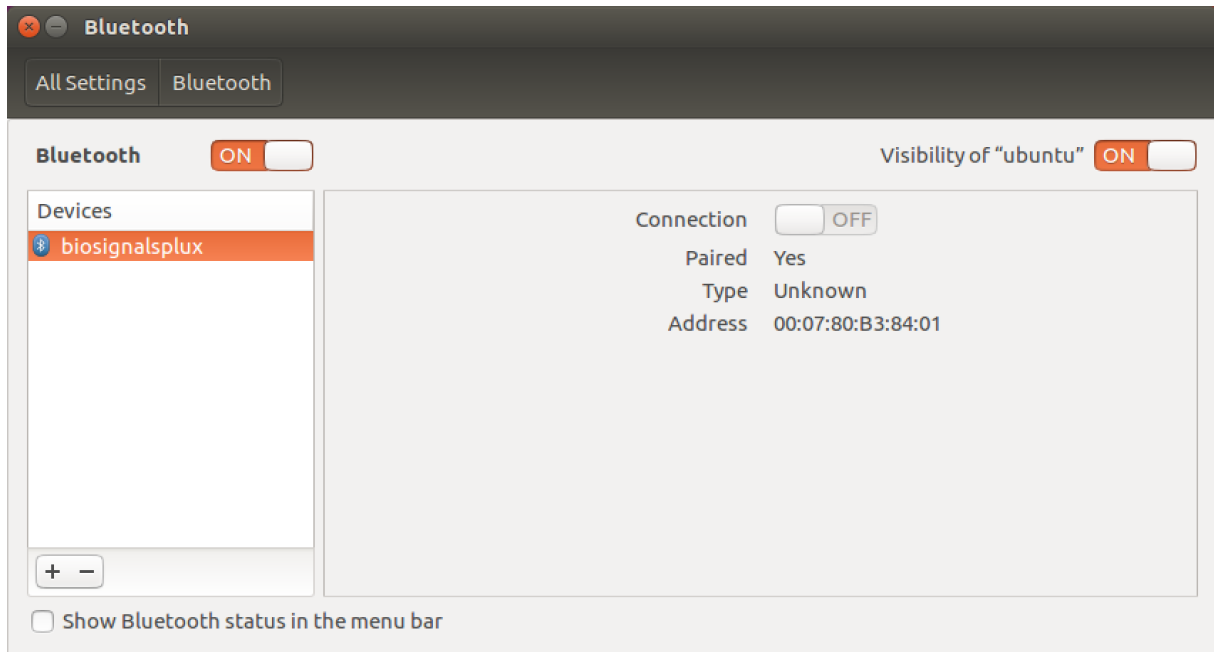


Figure 26: Successfully paired biosignalsplux.

² Do not worry if the connection is set off. It will automatically switch to on when connecting to your device using *OpenSignals* or other custom software for *biosignalsplux*.

3.4.2 Connecting via Terminal

NOTE

Using the terminal may harm your computer if it is not done correctly. Therefore, this method is recommended for advanced users only and following this method is done at your own risk.

To connect your device to your computer via Bluetooth, click on the *Unity Dash* logo in the toolbar on the left to your desktop open the search function. In the search bar, enter terminal (or Terminal) and click on the terminal logo to open the *Terminal*.

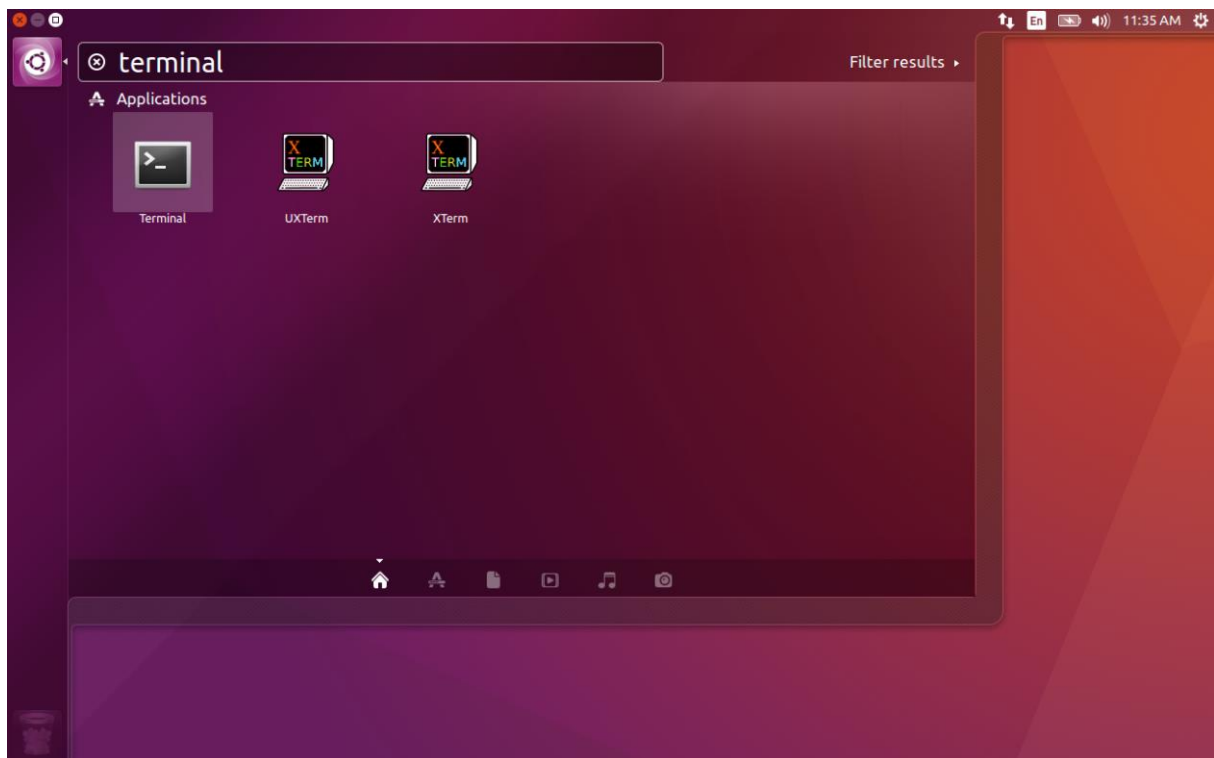


Figure 27: Access the terminal using the search function in Ubuntu.

Enter *bluetoothctl* into the terminal window (without the \$). Terminal should answer to this command with the a line displaying the MAC address of your internal Bluetooth adapter. The response should be similar to this (with AA:BB:CC:DD:EE:FF being replaced with your MAC address):

```
$ bluetoothctl
[NEW] Controller AA:BB:CC:DD:EE:FF ubuntu [default]
[bluetooth]#
```

Next, enter turn on your internal Bluetooth module on (if not done before) by entering *power on* into the Bluetooth prompt line. The response should be similar to this (again, with AA:BB:CC:DD:EE:FF being replaced with your MAC address):

```
[bluetooth]# power on
Changing power on succeeded
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
```

Next, it is needed to turn on a Bluetooth agent. The Bluetooth agents manages the transmission of pin codes (or pairing codes) between devices and is needed here to send the pairing code to the device you want to connect. To do this, enter *agent on*. The terminal response should be similar to this:

```
[bluetooth]# agent on
Agent registered
```

Set up the *default-agent* to proceed with the pairing process.

```
[bluetooth]# default-agent
Default agent request successful
```

At this point, turn on your device (if not done before) and enter *scan on* into the terminal to search for available Bluetooth devices and wait until your device's MAC address appears in the list (here: biosignalsplux, 00:07:80:B3:84:01). Your device's MAC address can be found at the back of the device.

```
[bluetooth]# scan on
Discovery started
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[NEW] Device 00:07:80:B3:84:01 biosignalsplux
```

If your device is listed, enter *pair* followed by the MAC address of your device to start the pairing process which will be respond with requesting the PIN code of your device. For *biosignalsplux* devices enter 123 and click on *Next* to connect to your device. For *BITalino devices* enter 1234 and click on *Next* to connect to your device. The result should be similar to this:

```
[bluetooth]# pair 00:07:80:B3:84:01
Attempting to pair with 00:07:80:B3:84:01
Request PIN code
[agent] Enter PIN code: 123
[CHG] Device 00:07:80:B3:84:01 Connected: yes
[CHG] Device 00:07:80:B3:84:01 Modalias: bluetooth
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 Paired: yes
Pairing successful
[biosignalsplux]
```

If the terminal outputs *Pairing successful* your device has been successfully paired to your computer.

The entire text of your terminal should now be similar to the following:

```
$ bluetoothctl
[NEW] Controller AA:BB:CC:DD:EE:FF ubuntu [default]
[bluetooth]#
[bluetooth]# power on
Changing power on succeeded
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[bluetooth]# agent on
Agent registered
[bluetooth]# default-agent
Default agent request successful
[bluetooth]# default-agent
Default agent request successful
Discovery started
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[NEW] Device 00:07:80:B3:84:01 biosignalsplux
[bluetooth]# pair 00:07:80:B3:84:01
Attempting to pair with 00:07:80:B3:84:01
Request PIN code
[agent] Enter PIN code: 123
[CHG] Device 00:07:80:B3:84:01 Connected: yes
[CHG] Device 00:07:80:B3:84:01 Modalias: bluetooth
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 Paired: yes
Pairing successful
[biosignalsplux]
```

3.5 macOS

To connect your *biosignalsplux* device to your computer via Bluetooth, click on the Apple symbol at the top left corner of your display and select *System Preferences...*

In the system preferences window click on the Bluetooth symbol to open the Bluetooth settings.



Figure 28: Mac OS X system preferences window.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *biosignalsplux* device has been found, click on the device and click on *Pair* to connect to your device.

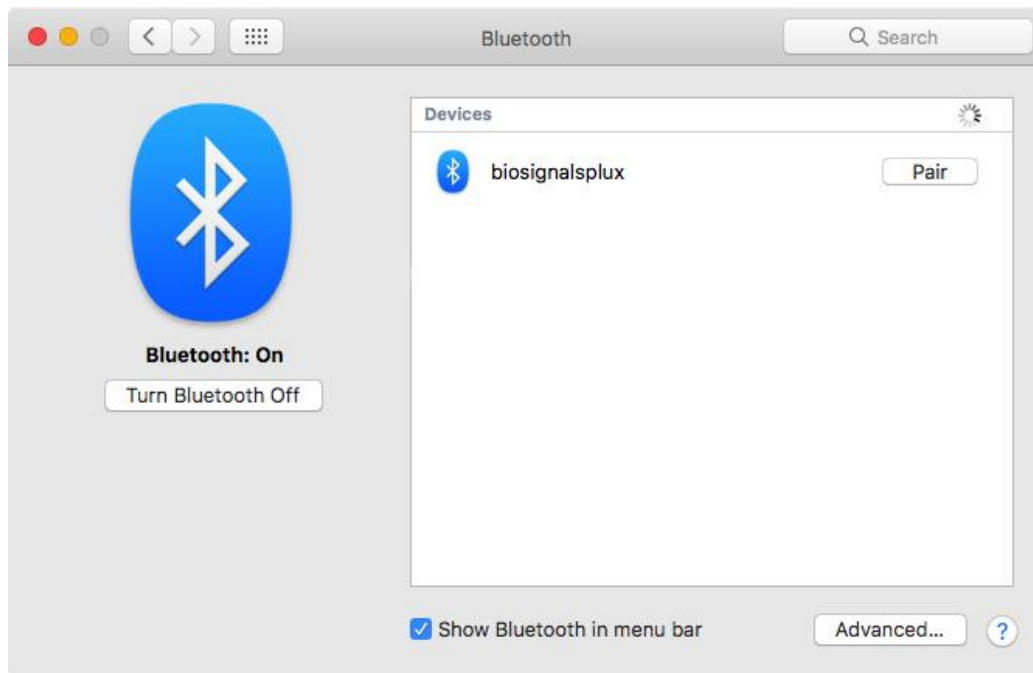


Figure 29: Click on *Pair* to connect to the biosignalsplux.

An error will occur indicating that the connection could not be established due to a mismatching passkey. Click on *Options...* to enter the passkey (pairing code).

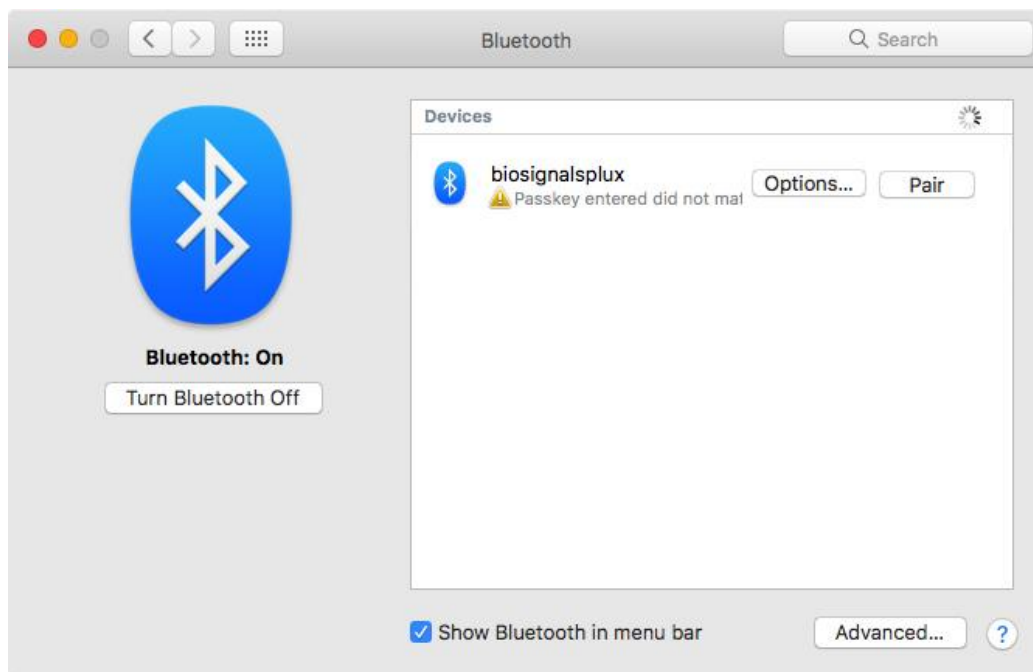


Figure 30: Click on *Options...* to enter the passkey.

Mac OS X will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on *Pair* to connect to *biosignalsplux*.

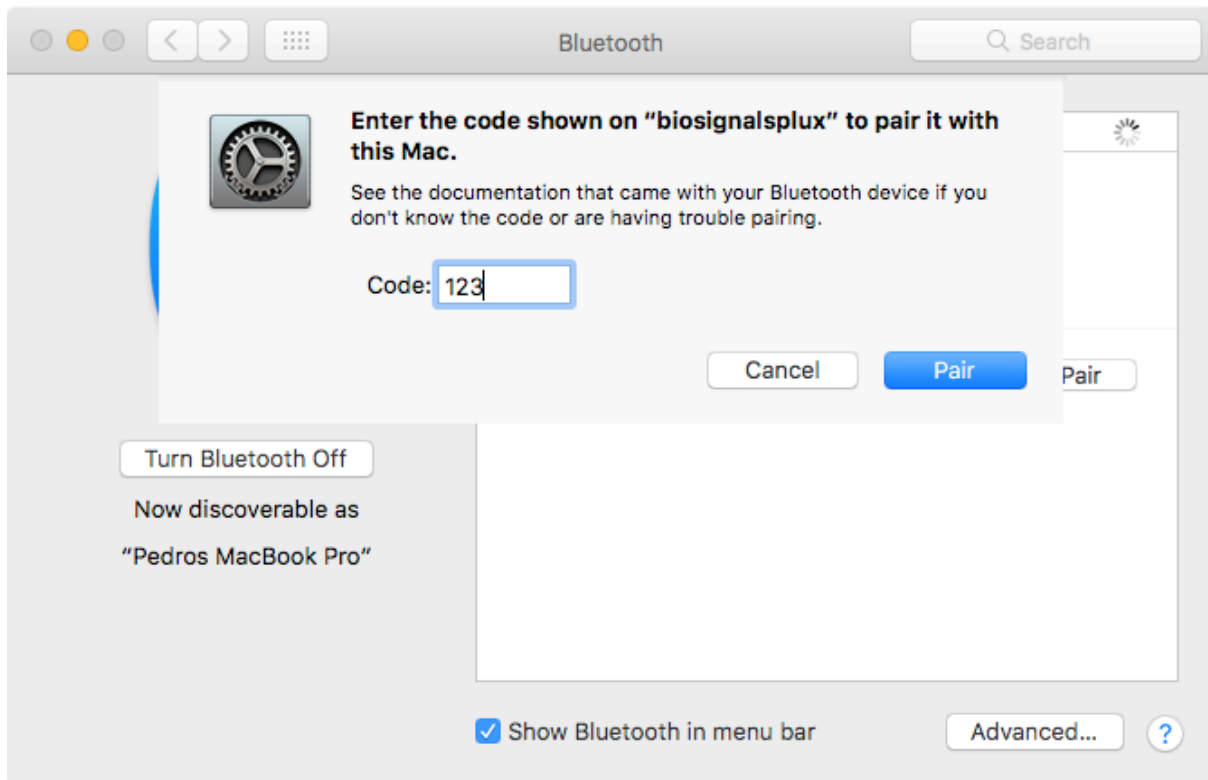


Figure 31: Enter the pairing code

If *Connected* is displayed under the name of your *biosignalsplux* device in the Bluetooth settings panel, the connection has been successfully established.

4 Software & APIs

4.1 OpenSignals (r)evolution

OpenSignals is our easy-to-use, versatile, and scalable software for real-time biosignals visualization, capable of direct interaction with all PLUX devices.

Core functionality includes sensor data acquisition from multiple channels and devices, data visualization and recording, as well as loading of pre-recorded signals. OpenSignals is also a Python-powered web-based software framework, targeted at rapid application development; a bare bone code base is available on [GitHub](#).

In addition, OpenSignals has a suite of data analysis add-ons to create reports from the recorded data and extract features directly from the signals without having to do any coding. *biosignalsplux* Research and Professional lab kits already include some or all of the add-ons upon purchase, although add-ons can also be purchased individually in our web store.

You can download the newest version of OpenSignals (r)evolution here:

<http://biosignalsplux.com/index.php/en/software/opensignals>

4.2 OpenSignals Mobile

OpenSignals Mobile is a slimmed down version of *OpenSignals (r)evolution* specifically designed to run on Android® mobile phones or tablets (iOS coming soon), while preserving the ease-of-use and performance for real-time sensor data visualization and recording.

OpenSignals Mobile is currently in development. However, if you are interested in being one of the first few users to get your hands on a beta version of this app, visit our *OpenSignals* website and fill in the form to subscribe for the early access beta version.

<http://biosignalsplux.com/index.php/en/software/opensignals>

4.3 APIs

It is possible to connect the devices to third party applications including your own custom software. The needed toolkits to start your own biosignal software are delivered by PLUX for free. All the functionalities and features of our high-end research devices can be accessed by developers to integrate PLUX systems in custom and third-party applications.

Visit the official *biosignalsplux* API website to check the list of the available APIs:

<http://biosignalsplux.com/index.php/en/development/apis>

5 Sensor Information & Configuration

WARNING

Do not use damaged sensors, devices or components, as this can cause serious injuries and device damages. Contact PLUX's Technical Assistance to report such issues and report malfunctioning devices or sensors.

This kit comes with our free *OpenSignals (r)evolution* software. Please download the newest version available which you can find on the [OpenSignals website](#) as it is needed to setup and use the devices. Please download and read also the [documentation of the OpenSignals \(r\)evolution software](#) before using the software.

5.1 Force Platform Configuration

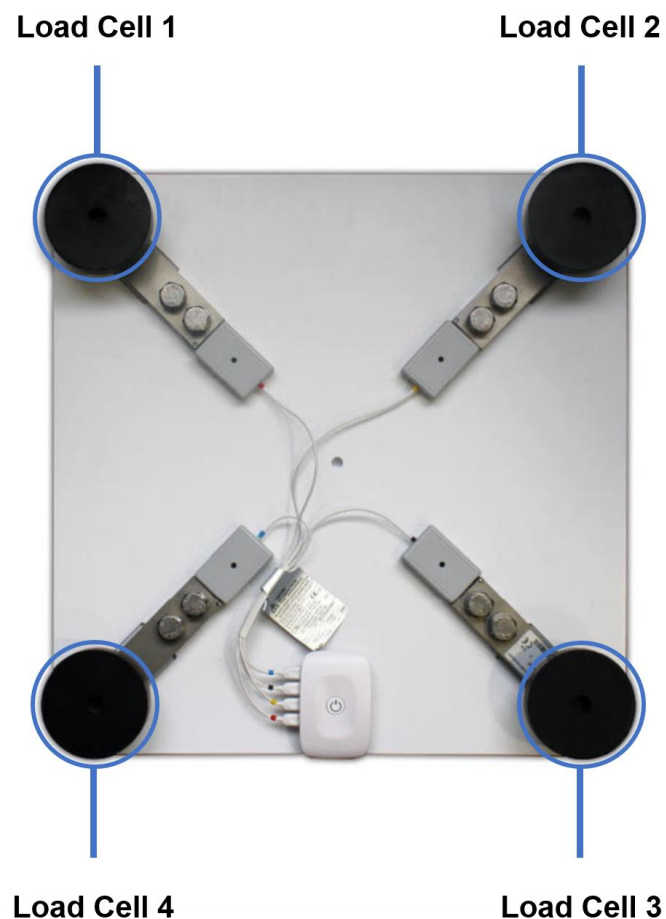


Figure 32: Force Platform Load Cell.

How to connect your Force Platform to your biosignalsplux hub

By default, the biosignalsplux hub of your Force Platform already comes pre-installed on the back of your Force Platform. The load cells of the Force Platform are connected to the 4 of the available analog inputs of your *biosignalsplux* hub (see 2.1.2 Analog Inputs) as shown in the previous page. This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution (Firmware v.3.7 and newer)

Open the *OpenSignals (r)evolution* device manager and select the device of your force platform. Click on the *Read Sensors* option and OpenSignals will automatically setup the force platform.

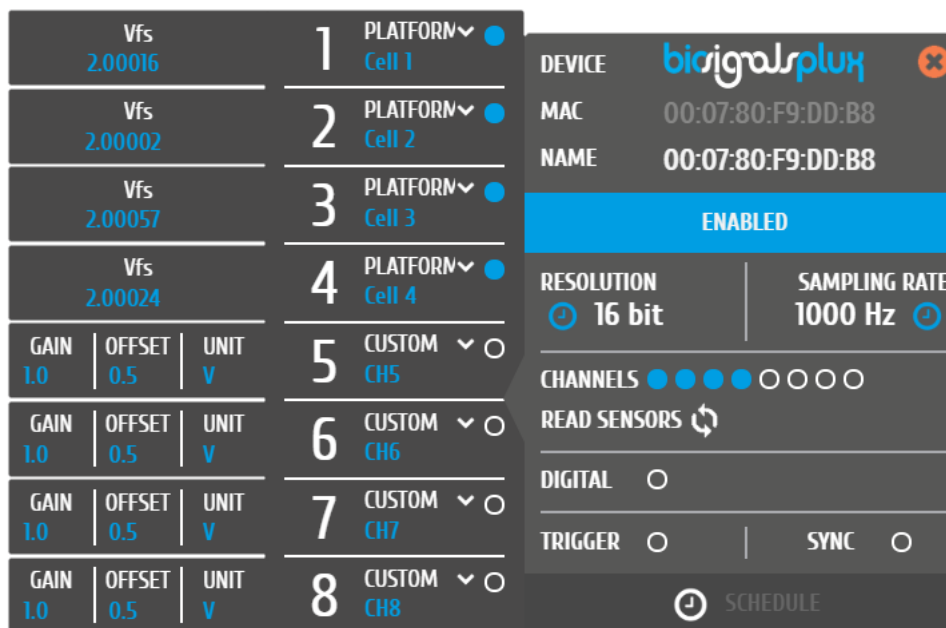


Figure 33: Platform configuration on biosignalsplux firmware v.3.7 and newer.

How to configure your sensor in OpenSignals (r)evolution (Firmware v.3.6 and older)

Open the *OpenSignals (r)evolution* device manager and select the device of your force platform. Individually go through the 4 channels to which the load cells of the Force Platform are connected and select *PLATFORM* from the sensor type dropdown menu (click on the arrow in the channel’s field that appears when you hover over the channel’s field). Enter each cell’s Vfs value into the left field next to the channel number. These values are required to calibrate the Force Platform. You can find the cell-specific values in the documentation provided with your kit or contact our support via e-mail (support@plux.info) in case you do not have access to the documentation.

Activate each channel for signal acquisition by clicking on the circle in the channel field (must be blue). An example configuration is displayed in following screenshot X (here: 4 Force Platform load cells connected to channel 1 to 4).

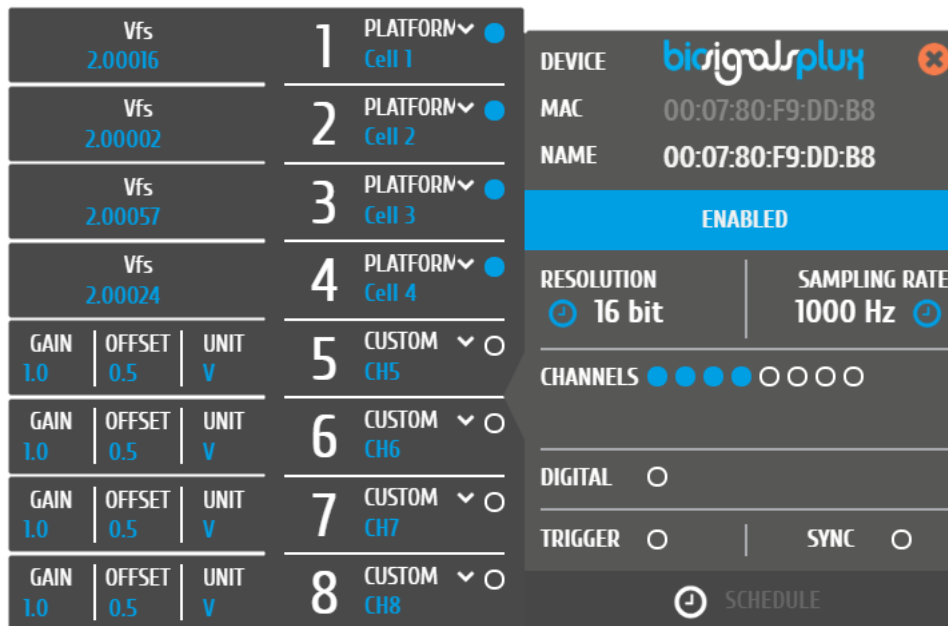


Figure 34: Platform configuration on biosignalsplux firmware v.3.6 and older.

Sensor specifications

Please read the [datasheet of the Force Platform](#) carefully before using it the first time.

5.2 Electromyography (EMG)

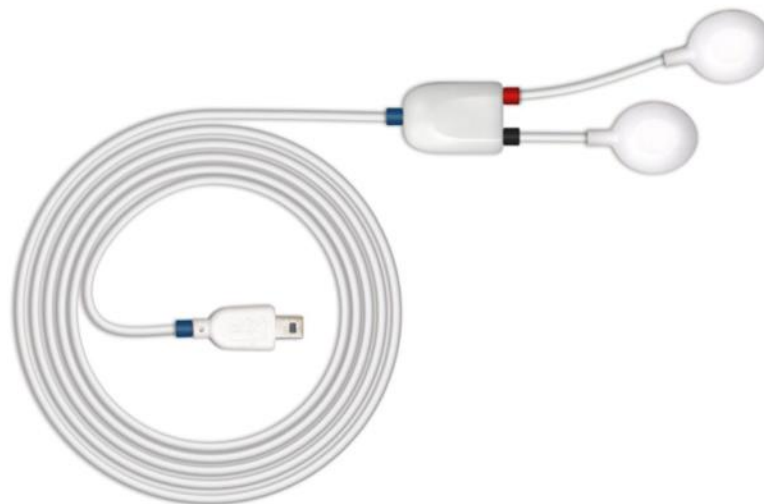


Figure 35: EMG sensor.

Our low-noise ECG local differential triode configuration enables fast application and unobtrusive data acquisition (although custom electrode cable configurations are available). The state-of-the-art design of the analog frontend on this sensor is specifically targeted at analyzing minutiae in the data. Together with the Heart Rate Variability (HRV) plugin on our OpenSignals software, one can easily record and extract meaningful information.

Electrode cables & sleeves

The electrode cables of this sensor can be connected to electrodes with integrated stud connectors. The colored plastic sleeves on each electrode cable indicate which electrode must be connected to the positive or negative electrode cable (see Table 2).

Electrode Cable	+	-
Sleeve Color	Red	Black

Table 2: Color coding of the electrode cable sleeves.

How to connect your sensor to your biosignalsplux device

EMG sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.1.2 Analog Inputs).

How to configure your sensor in OpenSignals (r)evolution (Firmware v.3.7 and newer)

Open the *OpenSignals (r)evolution* after connecting the EMG sensors to your biosignalsplux and select the device to which you have connected the EMG sensors in the *OpenSignals (r)evolution* device manager. Click on the *Read Sensors* option and OpenSignals will automatically setup the EMG sensors and your device.

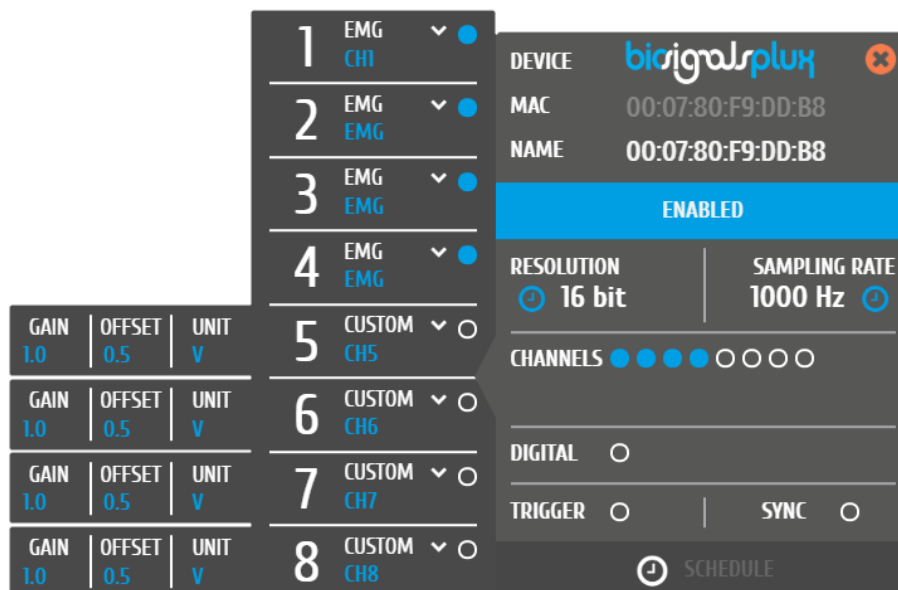


Figure 36: EMG sensor configuration on biosignalsplux firmware v.3.7 and newer.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your EMG sensor connected to. Select the channel of your EMG sensor and select *EMG* out of the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field). No additional set up is needed for the reference electrode inside *OpenSignals (r)evolution*.

Activate this channel for signal acquisition by clicking on the circle in the channel field (must be blue).

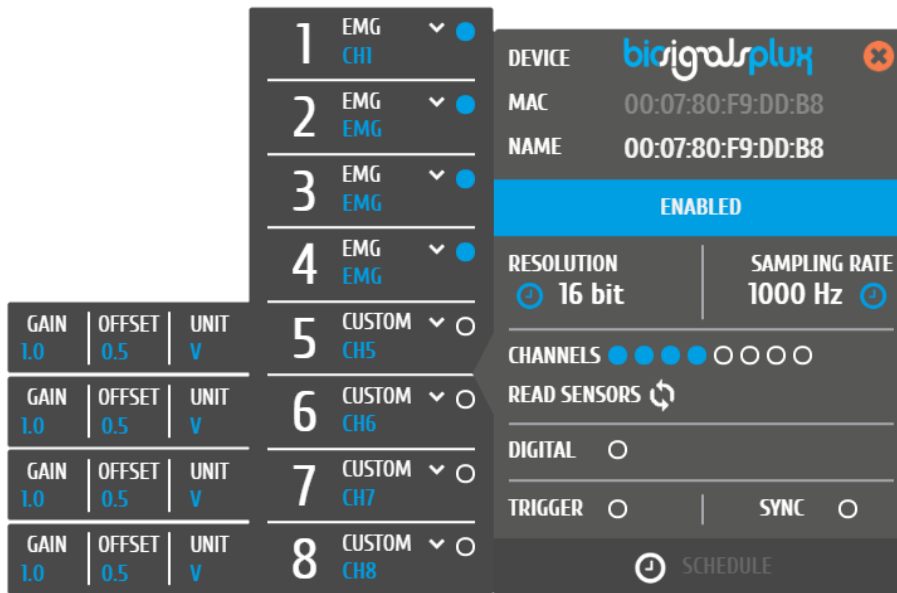


Figure 37: EMG sensor configuration on biosignalsplux firmware v.3.6 and older.

If configured correctly, your acquired signals should be similar to the signal displayed in Figure 38.

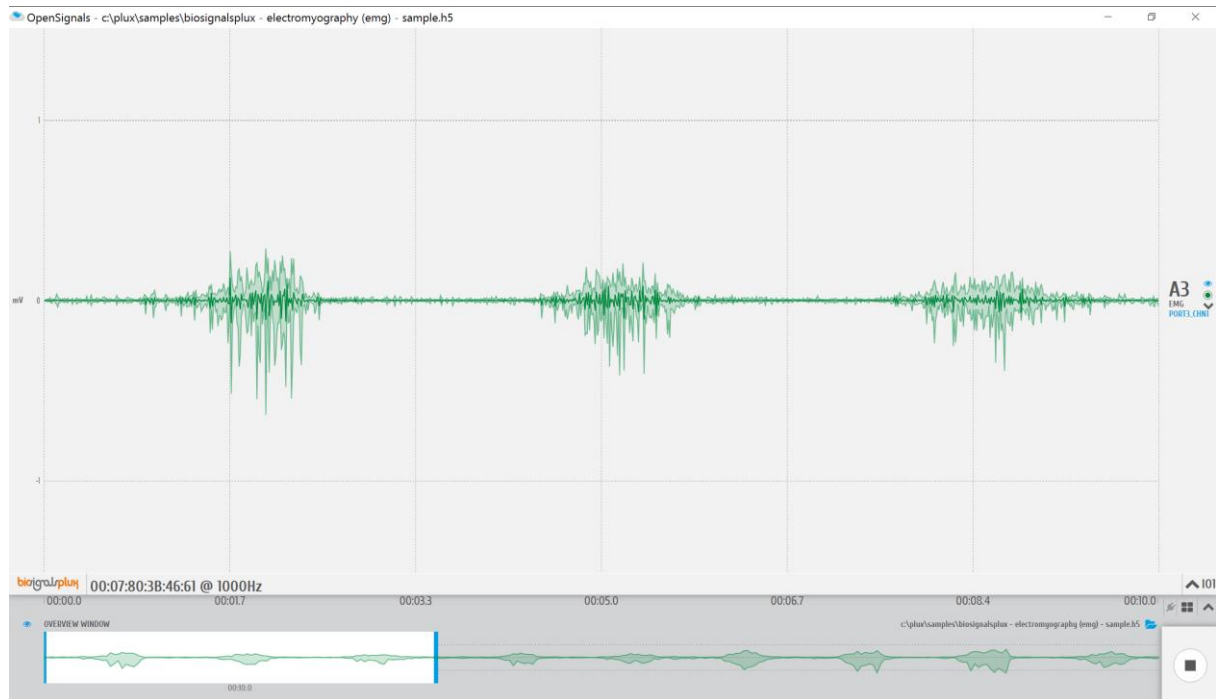


Figure 38: biosignalsplux EMG sensor sample.

Sensor specifications

Please read the [datasheet of the EMG sensor](#) carefully before using it the first time.

6 OpenSignals Add-Ons

This section uses different features of the *OpenSignals (r)evolution* software. Reading the [software's user manual](#) is highly recommended.

6.1 General Information OpenSignals Software Add-Ons

OpenSignals (r)evolution add-ons are signal processing software add-ons that extract meaningful information from your acquired signals. All the available add-ons are split into two types of add-ons which process data during signal acquisitions or after signal acquisitions. A full updated list of available add-ons can be found here:

<http://biosignalsplux.com/en/software/add-ons>

Real-time Add-on

Add-ons process signals during real-time signal acquisitions. These add-ons are available in the real-time visualization mode.

Post-processing Add-on

Add-ons process signals after a finalized acquisition session. These add-ons are available in the signal visualization mode.

After purchasing your add-ons and receiving the order confirmation, restart *OpenSignals* and you will now be able to use the add-on(s) in the live acquisition screen (real-time add-ons) and/or playback mode (post-processing add-ons).

NOTE

The **add-on activation process requires a stable internet connection**, as *OpenSignals* needs to communicate with the PLUX servers. Add-ons will work without an internet connection after a successful activation.

NOTE

Add-ons are linked to your PLUX device. Therefore, it is possible to use them on any computer your device is connected to.

Add-ons which are included in kits are already activated by default and ready-to-use when you receive them; if this is not the case please contact our team (see *10.4 Contact & Support*).

Normally, all add-ons are activated and listed by default in the help interface after a successful purchase. However, if your add-on is not listed in the signal visualization mode you must activate the add-on in the help interface.

? Enable add-ons in the help interface.



Allows you to access the available add-ons on the signal acquisition or visualization mode.

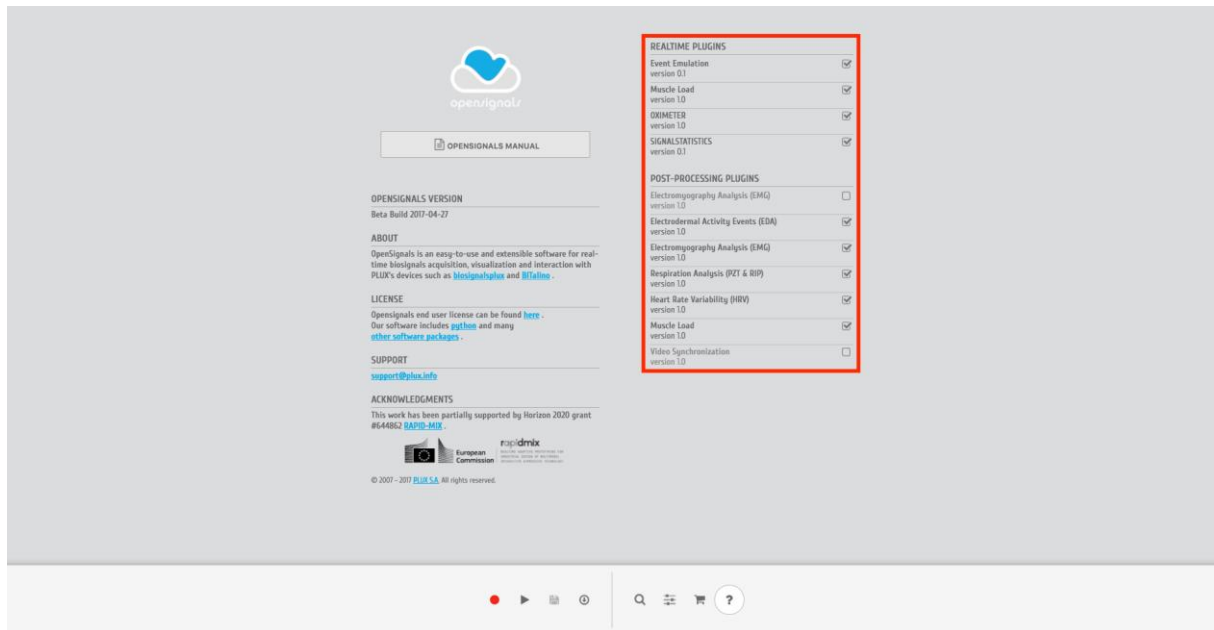


Figure 39: Activate add-ons in the help interface

Activated add-ons can then be selected in the respective modes. Real-time add-ons can be used in the signal acquisition, while visualization add-ons can be used in the signal visualization mode. Click on the add-on of your choice to start using it the add-on.

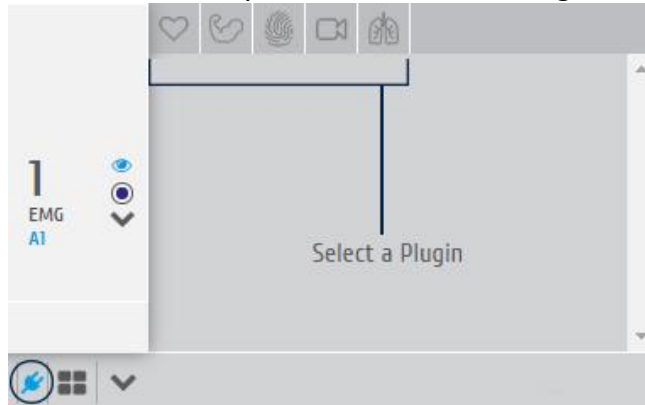


Figure 40: Add-on selection in the visualization mode.

6.2 Force Platform



Force Platform add-on

DESCRIPTION

Force Platform add-on is both an online and post-processing add-on. It is available in the signal acquisition mode and in signal visualization mode. The Force Platform is composed by 4 load cells responsible for the detection of compression forces acting in the Force Platform surface, due to the weight of the volunteer standing or jumping in the area embraced by the platform.

The four load-cells are positioned in a standardized and precise way, equidistant from the center of the platform, ensuring that a punctual/conceptual body located at the center of the platform will originate identical measurements in all load-cell channels, i.e, the weight is equally distributed in the measurement surface.

With the *Force Platform* add-on it is possible to determine the exact mass on the platform, the respective exerted force and the position of the center of pressure (real-time functionalities), while in the post-processing version parameters such as maximum force or flight time/height can be determined.

This add-on is included in the [biosignalsplux Professional Kit](#) and in the [biosignalsplux Force kit](#).

6.2.1 Add-on Configuration

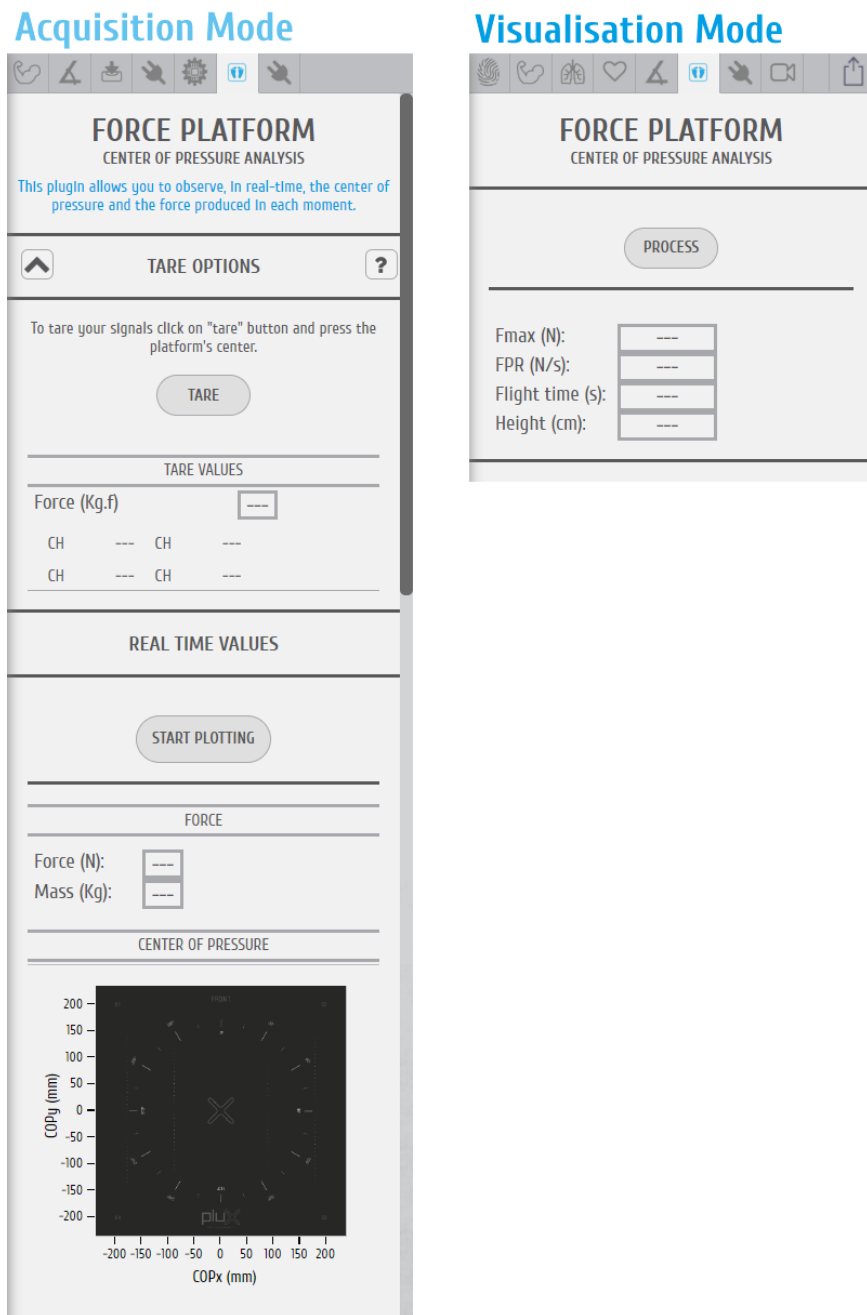


Figure 41: Load Cell Force Analysis add-on.

ACQUISITION MODE

TARE OPTIONS

The *Tare Options* allow you to set baseline values for the Load Cells that compose the Force Platform, i.e. the current force being applied will be set as a calibrated 0kg when clicked on the *TARE* button.

The baseline values being used will then be listed in the *TARE VALUES* section of the add-on.

REAL TIME VALUES

The *Real Time Values* section will show the total force (N) being exerted into the platform, together with the respective mass estimate (kg). These two values are instantaneous parameters. Additionally, the center of pressure position is represented on the graphical object included in the add-on interface.

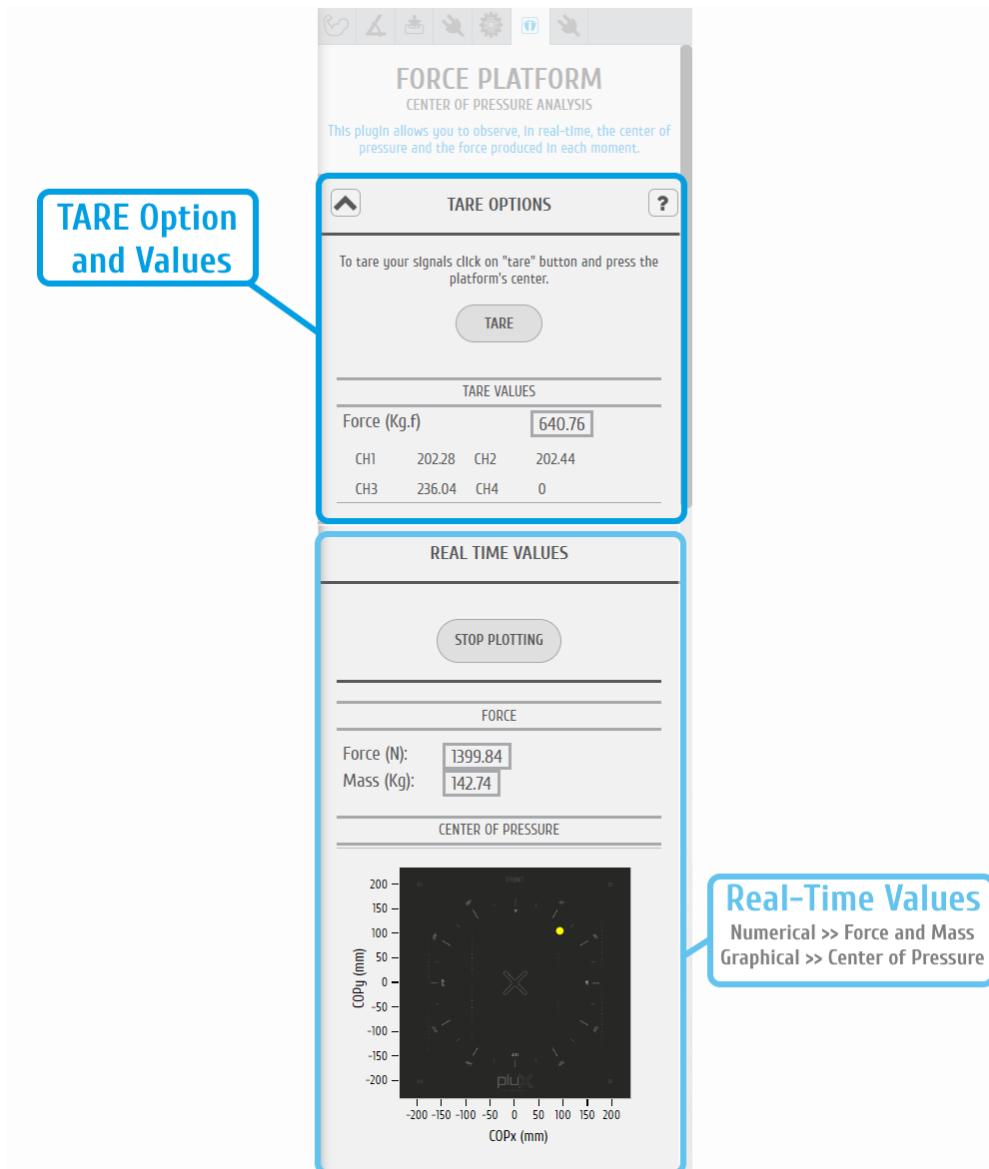


Figure 42: Force Platform Add-on with TARE Option and Real-Time Values.

Computation of the Center of Pressure

Using the add-on during signal acquisition allows you to plot the center of pressure (CoP) (also known as center of gravity) in real-time. For this, click on the *START PLOTTING* button to initialize the visualization of the CoP.

The CoP will be marked as a green dot on the force platform illustration found under *CENTER OF PRESSURE*. Additionally, the converted force and mass values are listed under the *FORCE* section.

The position of the CoP computed based on the measured forces applied on the four load cells positioned at the corners of the Force Platform. The X and Y positions of the CoP are computed according to the following equations:

$$CoP_x(mm) = \frac{W}{2} \times \frac{C2 + C3 - C1 - C4}{C1 + C2 + C3 + C4}$$

$$CoP_y(mm) = \frac{L}{2} \times \frac{C2 + C3 - C1 - C4}{C1 + C2 + C3 + C4}$$

with:

- CoP_x Center of Pressure (x-position) in mm
- CoP_y Center of Pressure (y-position) in mm
- W Width of the Force Platform (450mm)
- L Length of the Force Platform (450mm)
- $C1$ Weight (in kgf) on the channel with the cable marked in blue
- $C2$ Weight (in kgf) on the channel with the cable marked in black
- $C3$ Weight (in kgf) on the channel with the cable marked in yellow
- $C4$ Weight (in kgf) on the channel with the cable marked in red

VISUALISATION MODE

PROCESSING RESULTS

The Visualization version of the *Force Platform* add-on does not include configurable options, so, after pressing the “PROCESS” button the algorithm starts running autonomously and parameters such as maximum force (Fmax), force per second (FPS), flight time and jump height are presented.

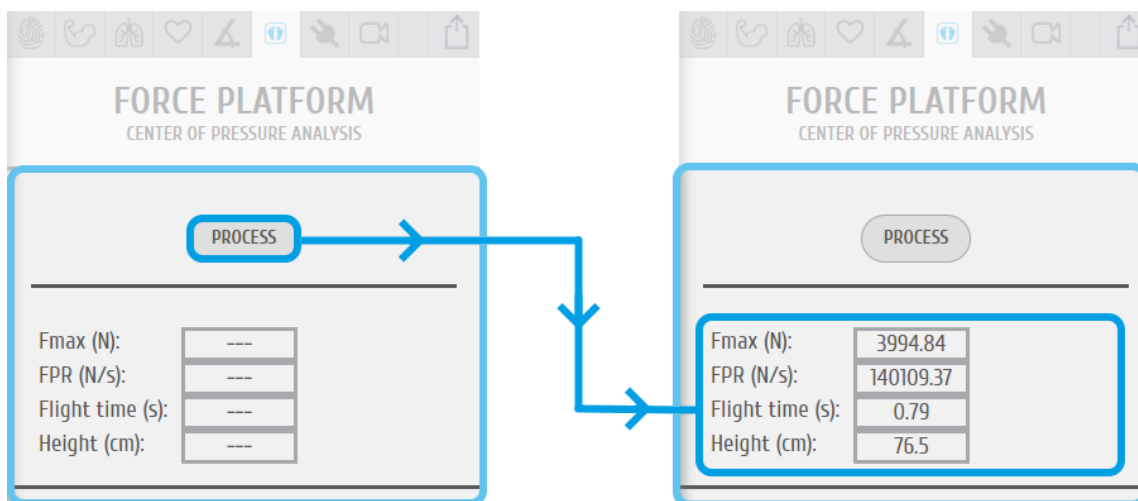


Figure 43: Force Platform Add-on with post-processing results.

Processing the signal conducts an automatic jump detection within the visualized interval. For this, the add-on analyzes the sum of the Force Platform’s force $F_{max}(t)$ visualized in Channel 9 and searches for events where $F_{max}(t)$ goes towards 0 N, stays at ~ 0

6.3 Electromyography (EMG) Analysis



Electromyography Analysis

DESCRIPTION

Muscle activity is usually assessed using temporal and spectral features. With this plugin, you will be able to extract useful statistical information from Electromyography (EMG) sensor data. Its automatic onset detection algorithm enables the analysis of each individual muscle activation event, in addition to the overall analysis of the recording session. Timings analysis can also be done for each activation relative to a reference muscle activation.

Originally, EMG analysis was achieved exclusively on an offline add-on for post processing purposes, with new real-time features being available in OpenSignals releases of 2019 and newer

This add-on is included in the [biosignalsplux Professional](#) and [ergoplux Reseacher](#). It can also be bought in addition to all *biosignalsplux* and *BITalino* devices.

6.3.1 Add-on Configuration

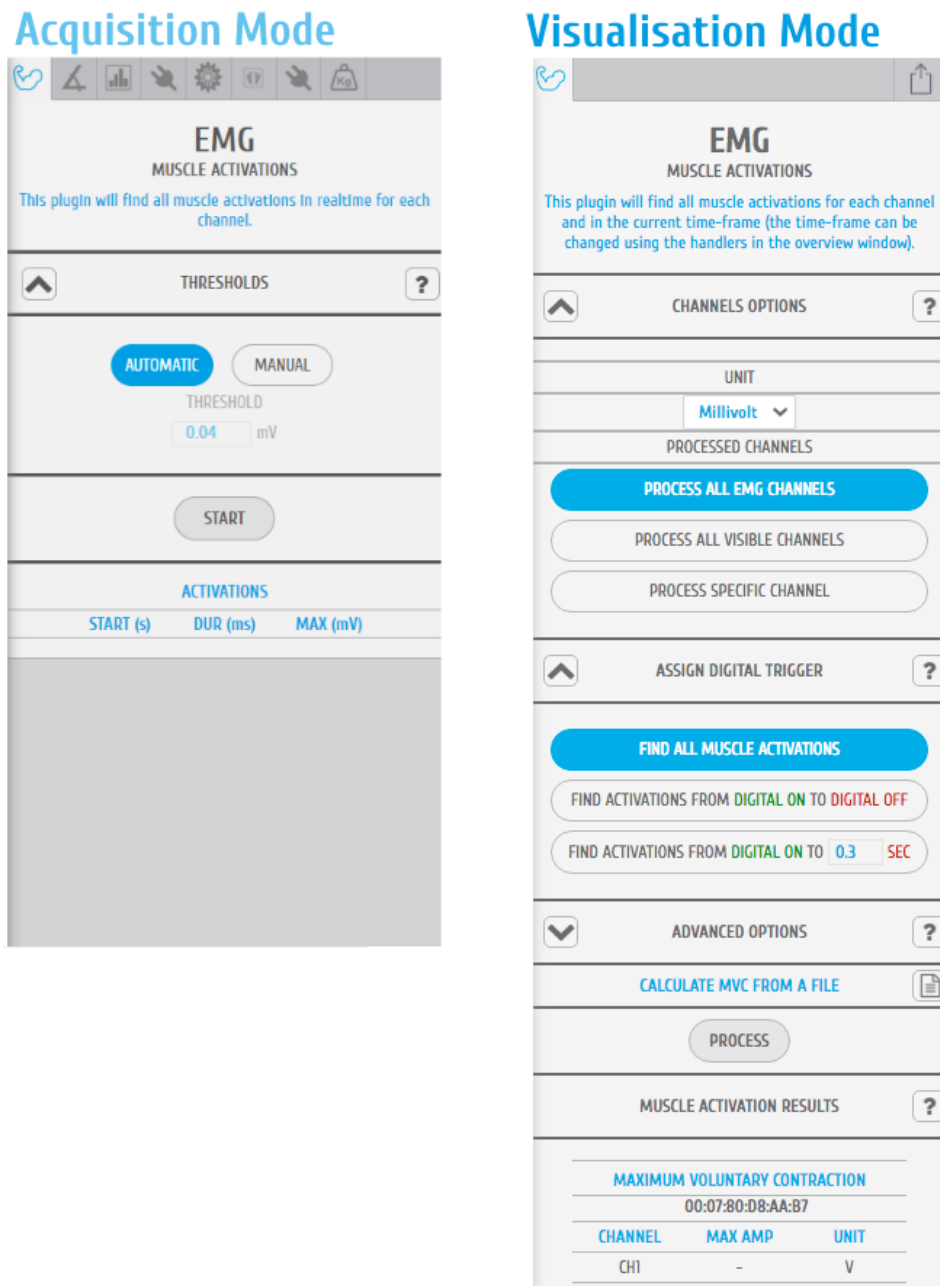


Figure 44: EMG add-on (acquisition mode @left and visualization mode @right).

ACQUISITION MODE

THRESHOLDS

After clicking on the “START” button the algorithm responsible for detecting muscular activations starts to run.

There are two available modes of function, i.e., it can execute their internal code without any interference/input from the user (AUTOMATIC threshold option) or it can act accordingly to the user specification/fixed threshold (MANUAL threshold option), where all sample values above the defined threshold will be considered as a potential start of a muscular activation period.

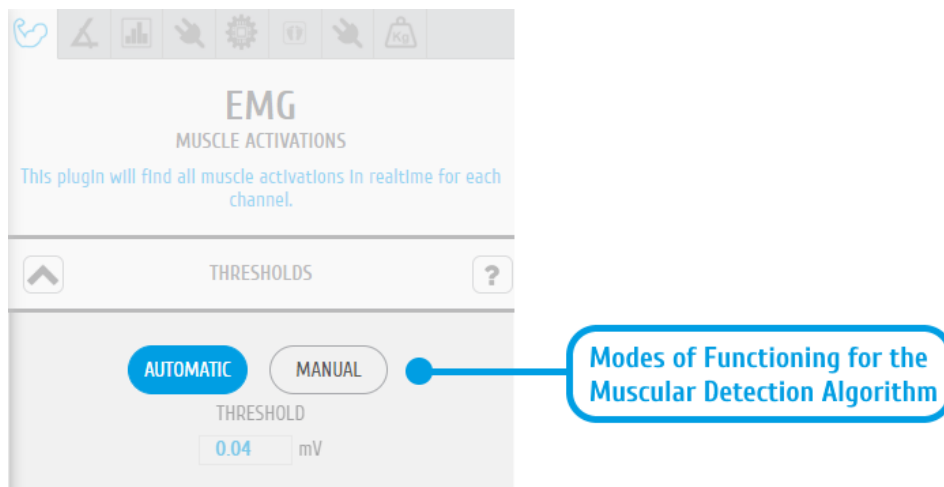


Figure 45: Section containing the inputs that will define the mode of functioning of the muscular detection algorithm.

MUSCLE ACTIVATION RESULTS

The results produced by the EMG plugin consists in the duration and maximum amplitude of each detected muscular activation, presented into a textual format, through a dynamic table and also in a graphical way with the muscular activation being highlighted by the application through a translucent rectangle in the signal acquisition section of *OpenSignals (r)evolution* interface.

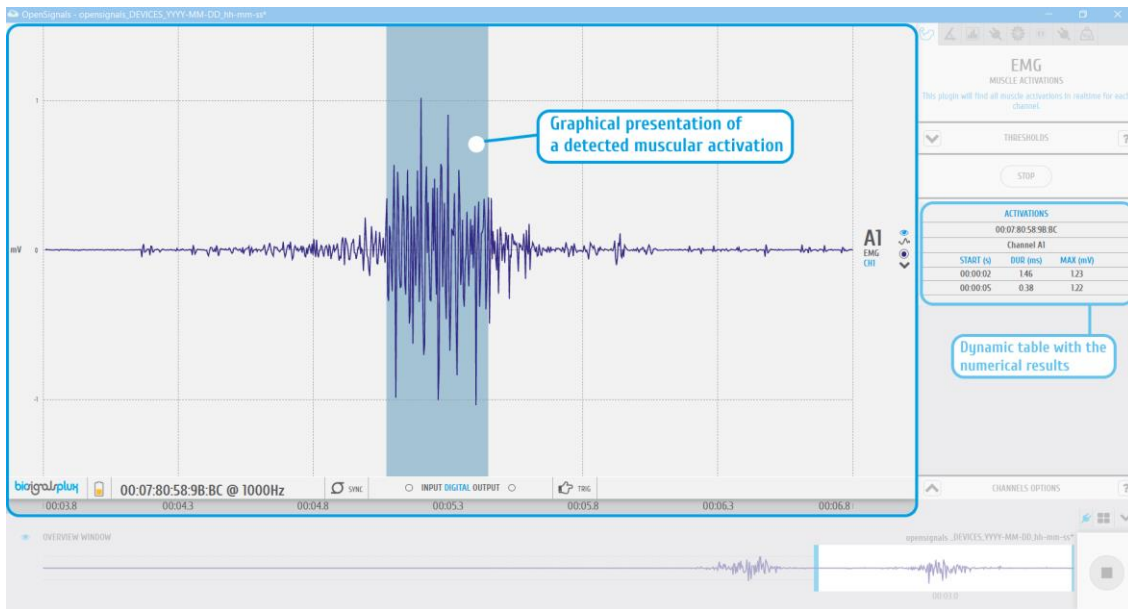


Figure 46: EMG plugin | numerical and graphical results

VISUALISATION MODE

DEVICES & CHANNELS

The EMG analysis add-on offers the possibility to process all available EMG channels (hidden and visible channels), all visible channels of the acquisition, or to select a specific device and channel to be processed by this add-on. Note that processing all visible channels will also process non-EMG sensor data, however, this can be useful to process RAW EMG channels.

Additionally, it can be selected when the channels units should be set to microvolt or millivolt in the *UNIT* dropdown menu (Figure 47).

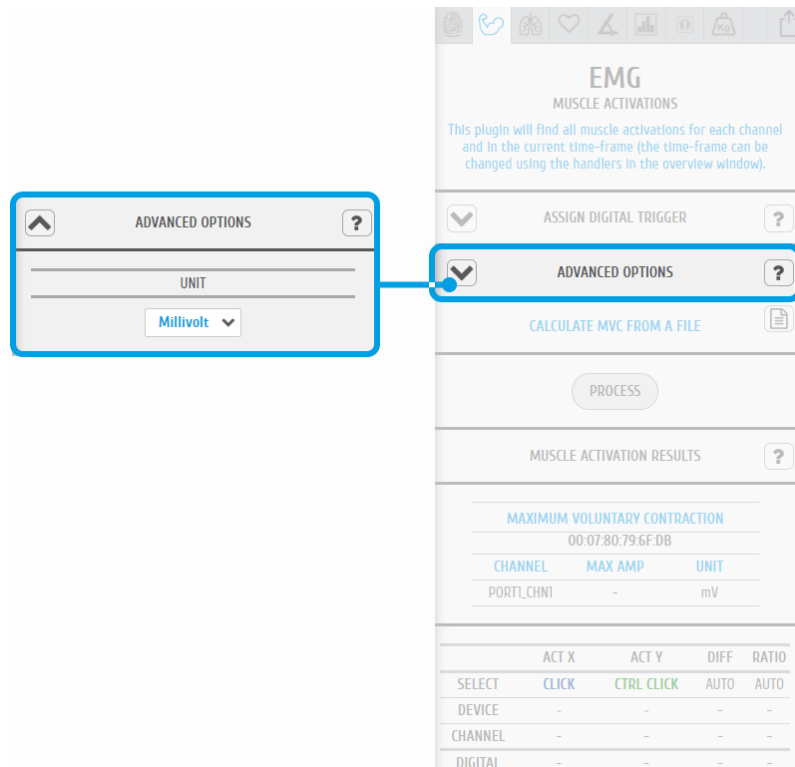


Figure 47: EMG plugin | unit specification

PROCESSING INTERVAL

In order to specify the processing time-window/interval it is needed to select the interval of interest in the overview window.

ASSIGN DIGITAL TRIGGER

In the *ASSIGN DIGITAL TRIGGER* option it is possible to select if the add-on should find all available muscle activations or if it should find activations depending on digital input and output signals, i.e. trigger signals.

The *FIND ACTIVATIONS FROM DIGITAL ON TO DIGITAL OFF* option will find all activations within the time frames where digital inputs have been received, for example, during the time frame a pushbutton has been being pressed (see also *7.1 Trigger*).

The *FIND ACTIVATIONS FROM DIGITAL ON TO ... SEC* will find all activations within the specified duration after the first digital inputs received, for example, beginning at the moment a pushbutton has been pressed (see also *7.1 Trigger*).

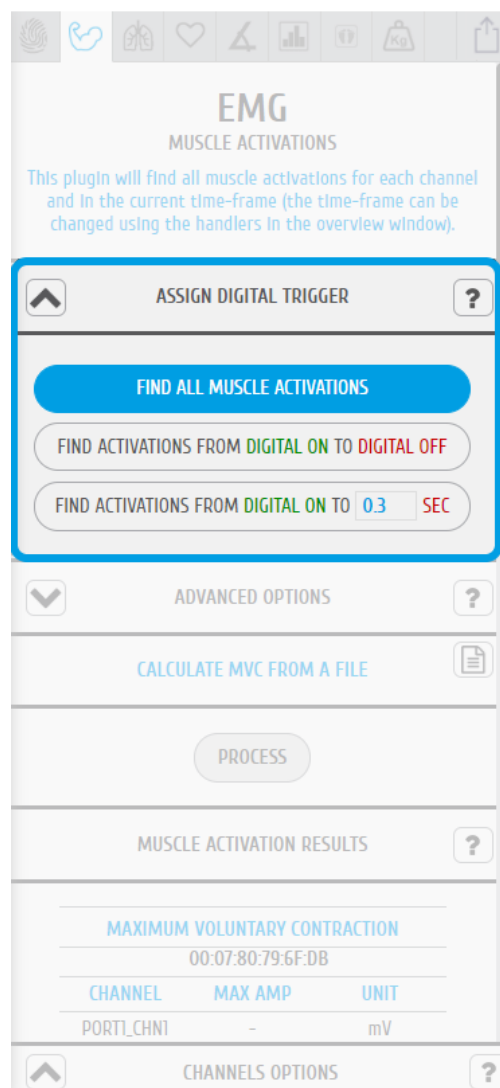


Figure 48: EMG plugin | digital trigger options

ADVANCED OPTIONS - Filters

The advanced options allows you to change the parameters which are being used in the activation detection algorithm to adjust the processing stage of your acquisition. In this option, you can select if you want to use a lowpass, highpass or a bandpass filter to be applied on your signal and set the respective cutoff frequencies for the selected filter.

To use a lowpass filter, click on the *LOWPASS* button and enter the preferred cutoff frequency for this filter in the *CUTOFF – LOW* field and enter the order of the filter in the *ORDER* field.

To use a highpass filter, click on the *HIGHPASS* button and enter the preferred cutoff frequency for this filter in the *CUTOFF – HIGH* field and enter the order of the filter in the *ORDER* field.

To use a bandpass filter, click on the *BANDPASS* button and enter the preferred cutoff frequency for the lowpass component of this filter in the *CUTOFF – LOW* field and enter the preferred cutoff frequency for the highpass component of this filter in the *CUTOFF – HIGH*. Enter the order of the filter in the *ORDER* field.

ADVANCED OPTIONS – Signal Smooth Window

In order to ensure an effective detection of muscular activations, the EMG signals needs to be smoothed, using a moving average window, taking into consideration that the signal envelope is morphologically simpler, and the inexistence of abrupt transitions is ideal to apply a single-threshold detection algorithm.

The size of the moving window can be configured on the “ADVANCED OPTIONS” panel.

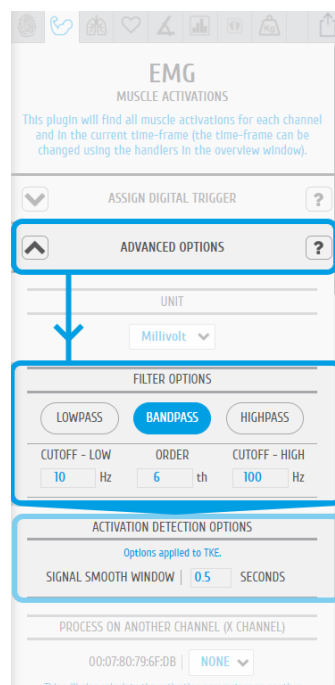


Figure 49: EMG plugin | signal filtering options

ADVANCED OPTIONS – Process X Channel

This option allows you to apply the statistical algorithms of this add-on to a selected channel X within the same time intervals of another channel without any activation dependency of channel X. The add-on will search for activations on a selected EMG channel (click on the

channel to select) and analyze the selected channel X at the same time intervals where activations have been found in the selected EMG channel even if there are no activations or activation triggering activities within these time intervals in channel X (e.g. muscle is relaxed during this interval).

With this option it is possible to compare two EMG signals within the same time intervals without any activation dependencies.

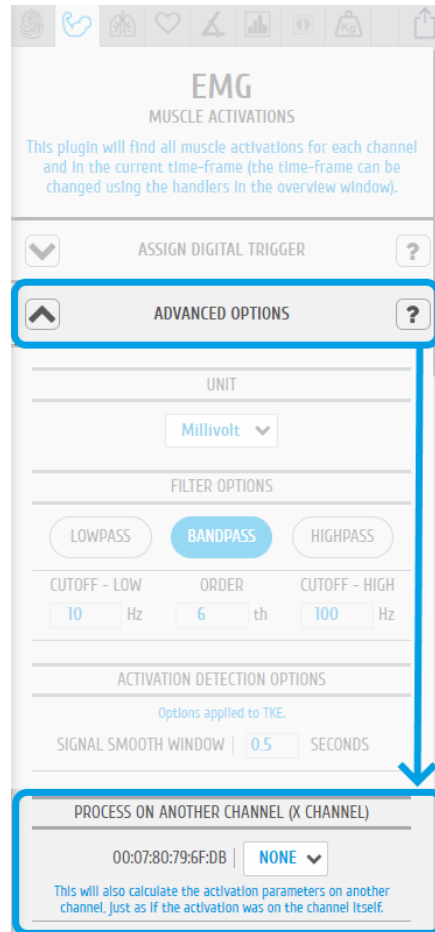


Figure 50: EMG plugin | definition of an additional signal to process

MCV – MAXIMUM VOLUNTARY CONTRACTION

The maximum voluntary contraction (MVC) will be calculated for each channel based on the EMG maxima of your selected EMG signals.

The MVC acquisition can also be done in a separate signal acquisition session/file. This can be useful to use when doing several signal acquisitions to ensure that the analysis of all files and signals are done with the same reference values – the MVC values.

For this, start an acquisition and acquire your data which are being used as MVC values for later analysis and save your acquisition. To use the MVC data from this acquisition in another acquisition, click on the document icon in the *CALCULATE FROM A FILE INSTEAD* field and select the *OpenSignals (r)evolution* file which contains the MVC signal data. *OpenSignals (r)evolution* will then calculate the MVC value from the selected file.



Select *OpenSignals (r)evolution* file to calculate MVC values from file

Each channel's MVC value are listed in the table below *MAXIMUM VOLUNTARY CONTRACTION*.

MUSCLE ACTIVATION RESULTS

Click on the *PROCESS* button to process all signals according to the set configuration and all found activations will be visualized in the processed channels (white frames).

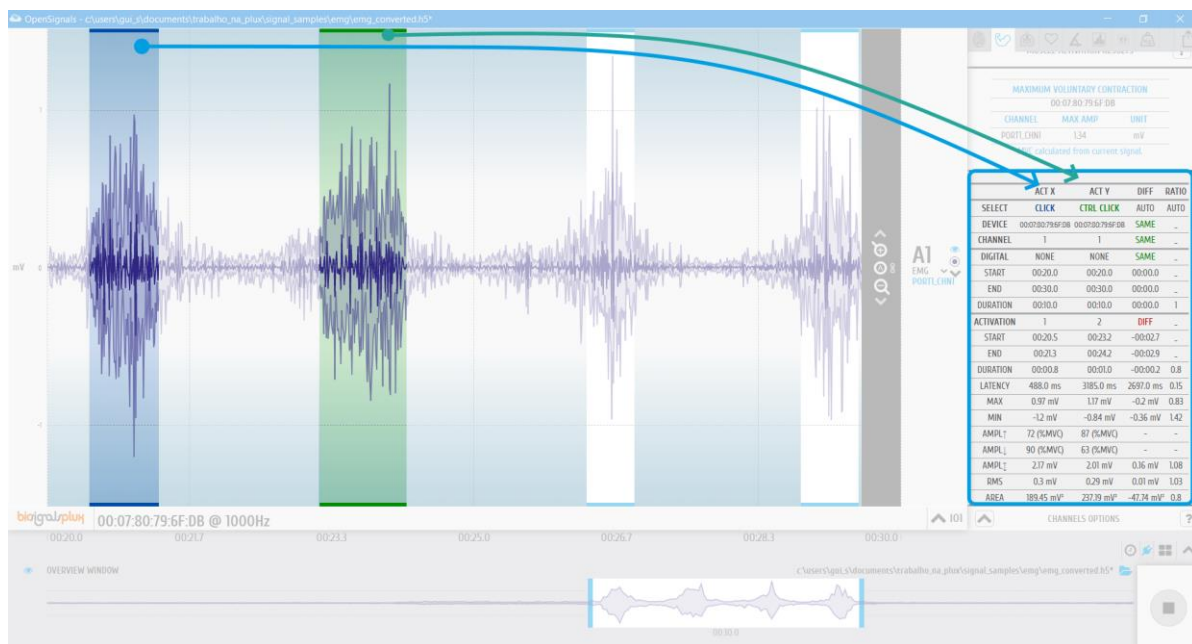


Figure 51: EMG plugin | muscular activation results

To display all statistical information about one or two specific activations, click on the first activation (left mouse button). The white frame turns into a blue frame and all statistical information about this activation will be listed in the *ACT X* column of the analysis results. When done, select the second activation of your choice by holding the *CTRL* key of your keyboard and click on the activation (left mouse button). The white frame turns into a green frame and all statistical information about this activation will be listed in the *ACT Y* column of the analysis results.

The results table displays general information about the source of this signal (device & channel) as well as general information about the duration and times of your acquisition. All activation specific data is displayed below the given general information (e.g., activation number, duration).

6.4 Video Synchronization

Video synchronization add-on

DESCRIPTION

Multimodal data acquisition in human studies usually involves recording data from sources other than the biosignal acquisition hardware devices (e.g. video camera). Given that the biosignal hardware and the camera are independent recording sources, a common problem when replaying the recording session is the synchronization of both. This plugin was created to provide an easy way to replay biosignal data synchronously with video using for example our LED accessory to provide a common event to both devices.

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode.

This add-on is included in the [biosignalsplux Researcher](#), [biosignalsplux Professional](#), [ergoplux Explorer](#) and [ergoplux Researcher](#). It can also be bought in addition to all *biosignalsplux* and *BITalino* devices.

6.4.1 Add-on Configuration

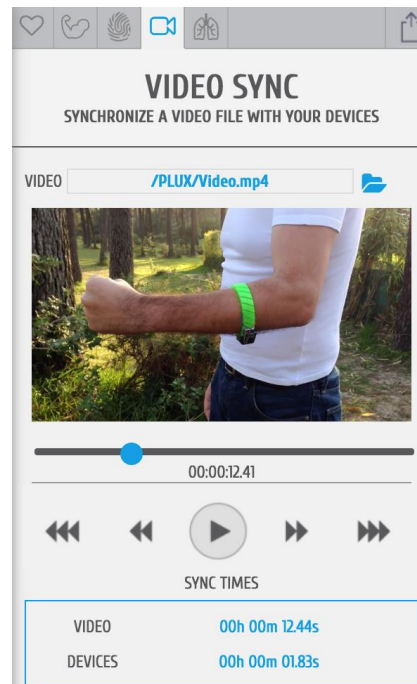


Figure 52: Video Synchronization add-on.

DEVICES & CHANNELS

The video synchronization add-on does not have to be configured to a specific channel or device. The video mark that synchronizes the video will match all available signals. It affects all acquisition channels equally.

VIDEO PATH

Click on the folder next to the video field and select the acquisition video.

SYNC TIMES

Sync times displays the information of the video mark which synchronizes the video at the indicated time with a selected point in the acquired signals (see detailed information below).

Video: Locked synchronization point in the video timeline

Devices: Locked synchronization point in the acquired signals



Locked synchronization point

The lock marks the synchronization point between the video and the acquired signals. Stop the video at the time point where the synchronization input (e.g. visual input via LED) was set in the video. Move the lock to the time point in your acquisition where the acquired signal overlap with your recorded video and click on the lock fix this point as the synchronization point between your video and your acquisitions.



Current position

The aim icon uses the locked synchronization point as a reference point and displays the current position of your acquired signals compared to the acquisition video. It will only be displayed in the signal window if the displayed signals lie within the synchronized video interval.

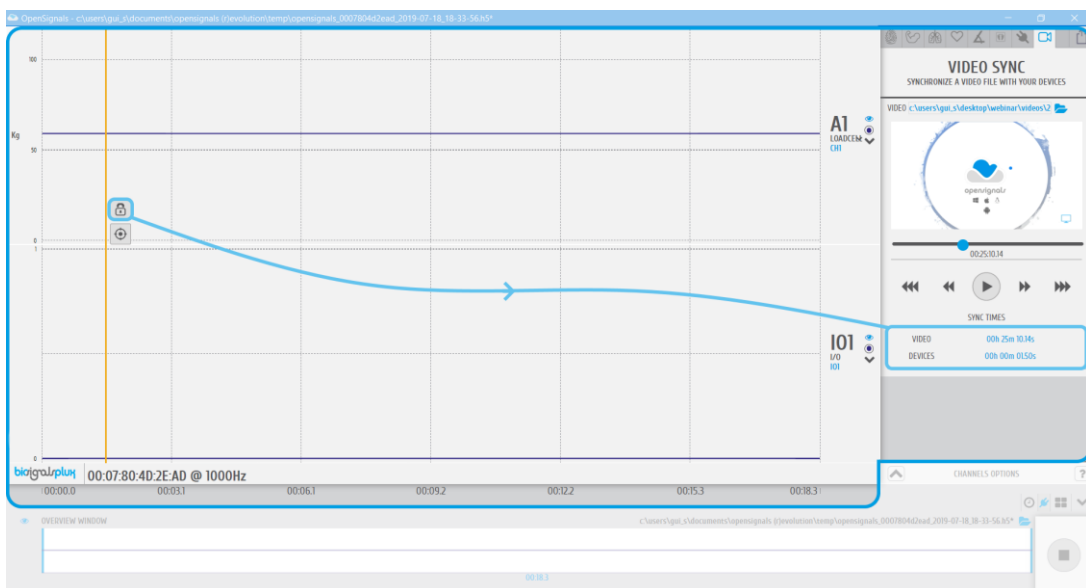


Figure 53: Synchronization button and respective sync time instants.

6.5 Data Logging

biosignalsplux devices with internal memory allow you to schedule and manage offline acquisitions which can be initialized and conducted without the requirement of a Bluetooth connection with your computer and *OpenSignals (r)evolution*.

The following devices are compatible with data logging features (scheduling, recording, and downloading recorded data):

- biosignalsplux Professional
- biosignalsplux Force
- MotionBAN
- RespiBAN Professional

Internal memory can also be added additionally for all *biosignalsplux* devices. Please contact our support via e-mail at support@plux.info if you'd like to add internal memory to your device to use all data logging features.

Devices with internal memory are displayed with an additional *SCHEDULE* button at the end of their device panels (see Figure 54). These devices are compatible with all data logging features.

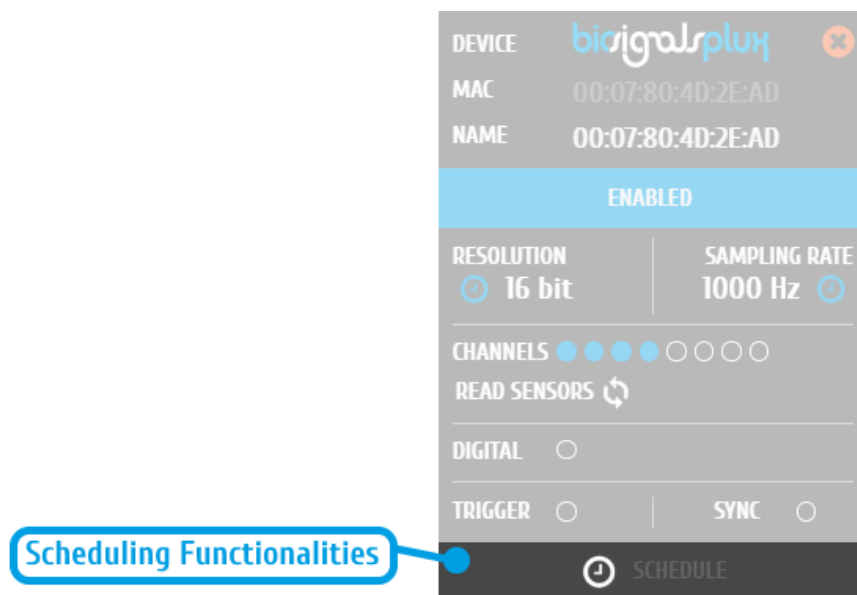


Figure 54: Data logging feature for devices with internal memory.

6.5.1 Scheduling Offline Acquisitions

NOTE

Before scheduling offline acquisitions, we recommend to set up the device and channels first.

Click on the *SCHEDULE* button of your device with internal memory in the device panel to access the scheduling panel to schedule and configure your offline acquisition (see Figure 55).

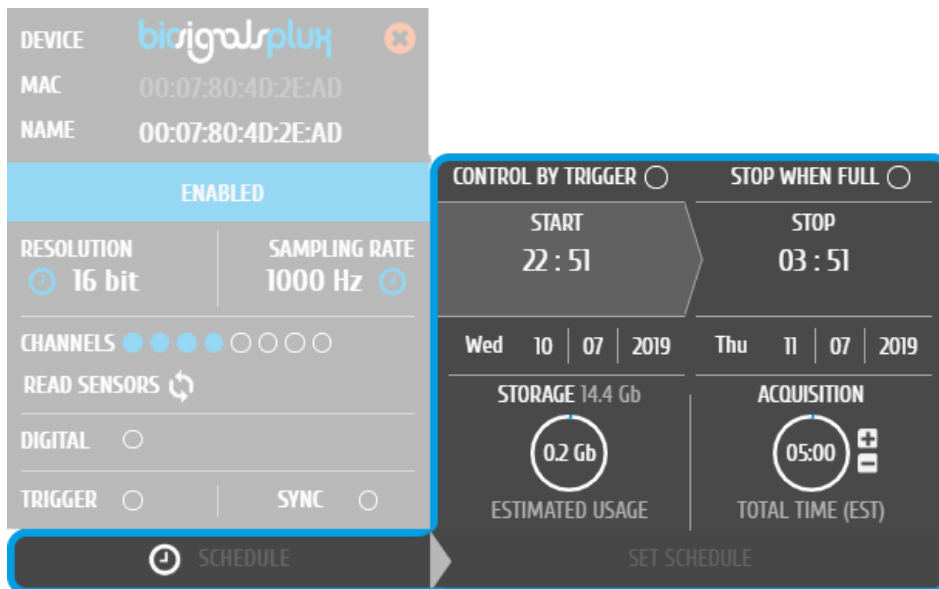


Figure 55: Scheduling panel.

The scheduling panel allows to configure your offline acquisition by defining the type of initiator for the start of your acquisition (timed or triggered), to stop the acquisition when the limits of the internal memory are reached (*STOP WHEN FULL*), to time acquisition at a specific time or duration (*STOP* and *ACQUISITION*), and displays information about the available free memory and the estimated memory usage of your scheduled acquisition.

NOTE

The indications of the estimated end of the acquisitions are calculated estimations and might vary from real-life behavior.

NOTE

It is recommended to fully charge your device's battery before using offline acquisitions as the acquisitions can be of longer period than the battery life-time of your device, for example when using the *STOP WHEN FULL* option. The estimated end will not be reached if the battery runs out before.

NOTE:

Your device does not have to be turned on before your scheduled acquisition starts, as it will automatically be turned on at the scheduled start-point.

Control by Trigger

This option allows you to manually start your acquisition using one of the available trigger accessories for *biosignalsplux* (footswitch or trigger button). To activate this feature, click on the circle next to *CONTROL BY TRIGGER* and make sure that your trigger accessory is correctly connected to the digital port of your *biosignalsplux* device.

This feature is activated if this circle is filled blue and inactive if the circle is empty. Activating this feature will also remove every time information in the *START* and *STOP* fields.

To set up a fixed duration of your offline acquisition, set up your preferred duration in the *ACQUISITION* field by using the '+' and '-' buttons. The acquisition will then stop when the duration has been passed, with the duration starting at the point where the trigger signal has been given.

Click on the *STOP WHEN FULL* option to stop the acquisition only when there is no memory left on your device. Read the following section for more information about this option.

Stop When Full

The *STOP WHEN FULL* option will stop your offline acquisition when the internal memory of your device has run out of available memory. This function can both used with trigger-based or timer-based initiated offline acquisitions. If a fix time has been selected for the start of the acquisition, the estimated end of the acquisition will be calculated based on the available free memory and will be displayed in the *STOP* field of the scheduling panel (see Figure 56).

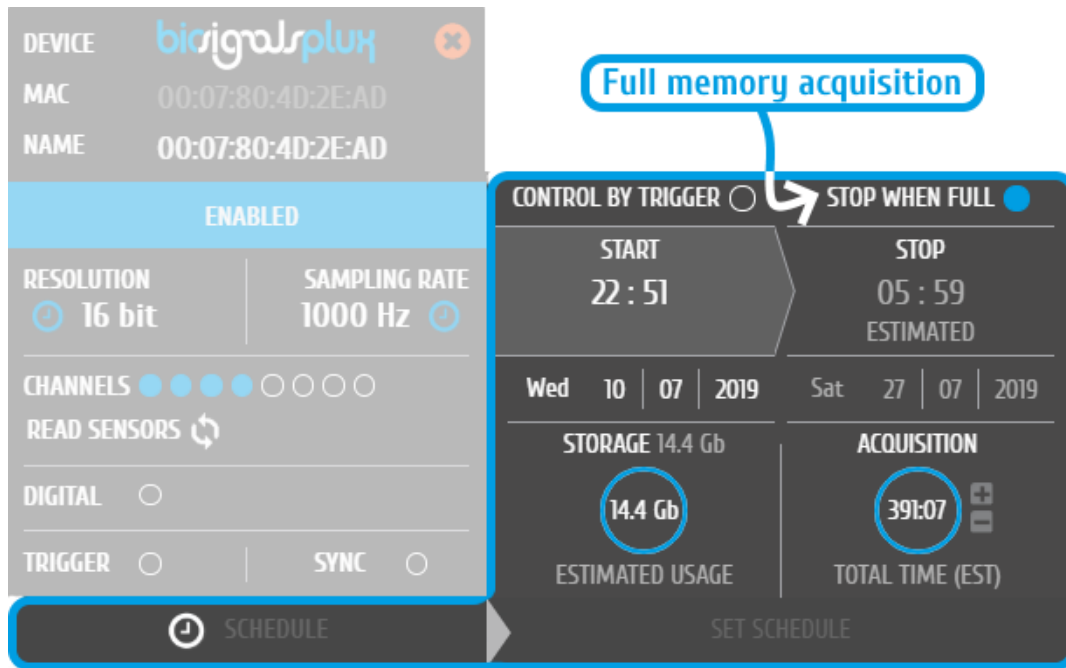


Figure 56: Scheduling panel displaying the estimated end of the acquisition

Scheduling Start & End Times

Click on the displayed time in the *START* or *STOP* fields to change the preferred start or end of your acquisition. In the new pop-up, select the date and time of the start or end of the acquisition. To select the date, click on the day of your choice in the calendar. To select the time, use the *Hour* and *Minute* sliders to configure your preferred time. By clicking the *NOW* button, the current date and time will be configured automatically.

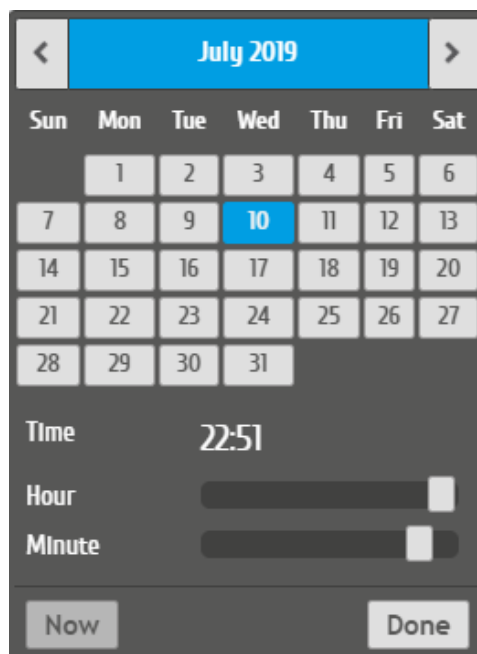


Figure 57: Time schedule for start and end points for offline acquisitions.

Alternatively, you can also set up a fixed duration for your acquisition instead of configuring an end time. To do so, set up your preferred duration in the *ACQUISITION* field by using the '+' and '-' buttons. The acquisition will then stop when the duration has been passed, with the duration starting at the scheduled time configured in the *START* field.

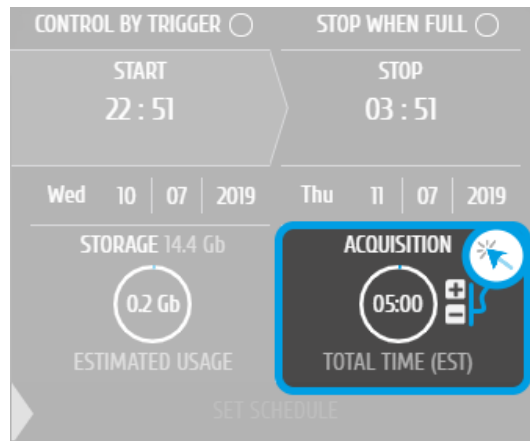


Figure 58: Configuring an acquisition with fixed duration.

Setting & Clearing Acquisition Schedules

If you've finished configuring your device and your offline acquisition, click on the *SET SCHEDULE* button at the bottom of the scheduling panel to transmit all the configurations to your device. The transmission and configuration has been successful if the button at the bottom of your device panel in *OpenSignals (r)evolution* has changed from *SCHEDULE* to *SCHEDULED* followed by the day and time when the acquisition has been configured to start (non-triggered acquisitions only) (see Figure 59; here: Wednesday 22:51h).

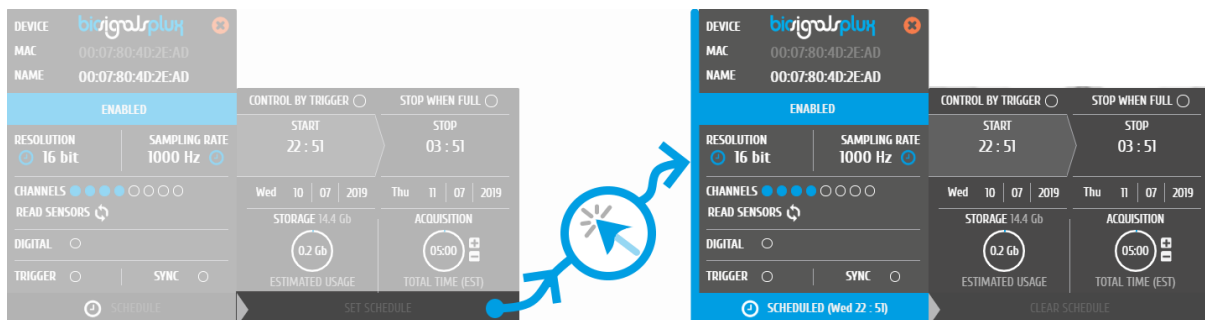


Figure 59: Completing the scheduling procedure.

To clear a scheduled acquisition, click on the *SCHEDULED* button and click on the *CLEAR SCHEDULE* of the scheduling panel. The scheduled offline acquisition will be removed and your device can now be configured for a new offline acquisition.

6.5.2 Downloading Offline Acquired Data

After your offline acquisition have finished, you can download the recording by clicking on the download data button in the *OpenSignals (r)evolution* main screen:

- Download an acquisition from the memory card

The offline data can be downloaded from your device’s internal memory within *OpenSignals (r)evolution* via Bluetooth or via the *fast USB data transfer* cable (additional accessory). The following sections provide the instructions on how to download data using both methods.

Download via Bluetooth

Make sure your *biosignalsplux* is turned on and click on the download button in the *OpenSignals (r)evolution* main screen to access the download panel. In this panel, all the available offline acquisitions which are available for download from your device’s internal memory are listed.

Each offline acquisition creates its own file where the acquired data is stored. In the download panel, the files are listed with their file name (*FILE*) their start time (*START*) and their entire duration (*DURATION*). Click on the indicated arrow in a file’s row to download the selected file (see Figure 60) or click on the arrow in the top row of the downloading panel to download all available files. The downloaded files will be stored on your desktop.

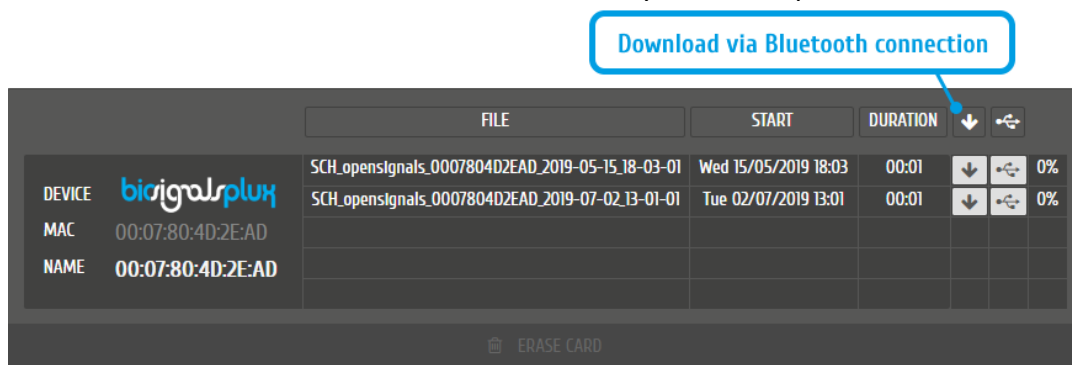


Figure 60: Downloading offline acquired data via Bluetooth.

NOTE

The time needed to download an acquisition file depends on the size of the file and, therefore, on the duration of your scheduled acquisition. The download process might need several minutes to end. Do not use nor turn off your device when *OpenSignals (r)evolution* is downloading data, as doing so might make the downloaded file unreadable.

Download via Fast USB Data Transfer Cable

NOTE

This method requires accessories which have to be bought additionally. These accessories are available in our store.

biosignalsplux USB Adapter & fast USB data transfer cable:

<https://store.plux.info/biosignalsplux-accessories/371-fast-usb-data-transfer-cable-for-biosignalsplux-820201514.html>

We should refer that, currently, this accessory is only compatible with *Microsoft Windows* operating system.

Make sure your *biosignalsplux* is turned on and connected to your computer via USB with the *biosignalsplux USB adapter*. Click on the download button in the *OpenSignals (r)evolution* main screen to access the download panel. In this panel, all the available offline acquisitions which are ready for download from your device's internal memory are listed.

Click on the indicated USB symbol in a file's row to download the selected file (see Figure 61) or click on the USB symbol in the top row of the downloading panel to download all available files. The downloaded files will be stored on your desktop.

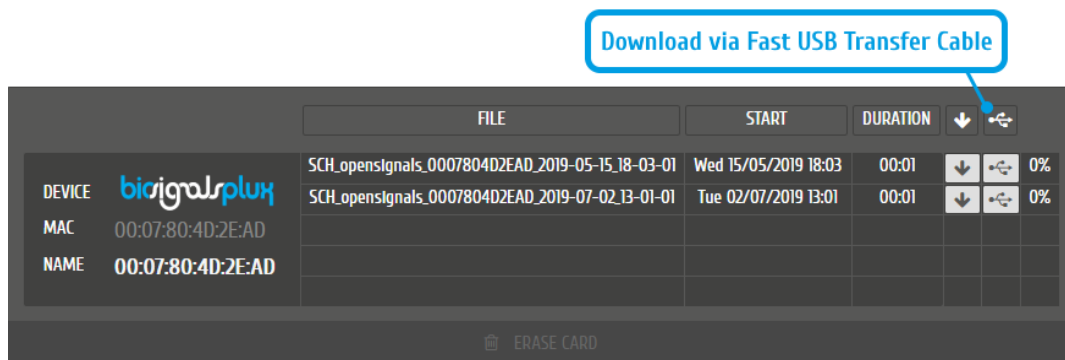


Figure 61: Downloading offline acquired data via USB.

NOTE

The time needed to download an acquisition file depends on the size of the file and, therefore, on the duration of your scheduled acquisition. The download process might need several minutes to end.

Do not use nor turn off your device when *OpenSignals (r)evolution* is downloading data, as doing so might make the downloaded file unreadable.

6.5.3 Deleting Offline Acquired Data

To delete all files stored on the internal memory of your device, click on the *ERASE CARD* button at the bottom of the download panel.

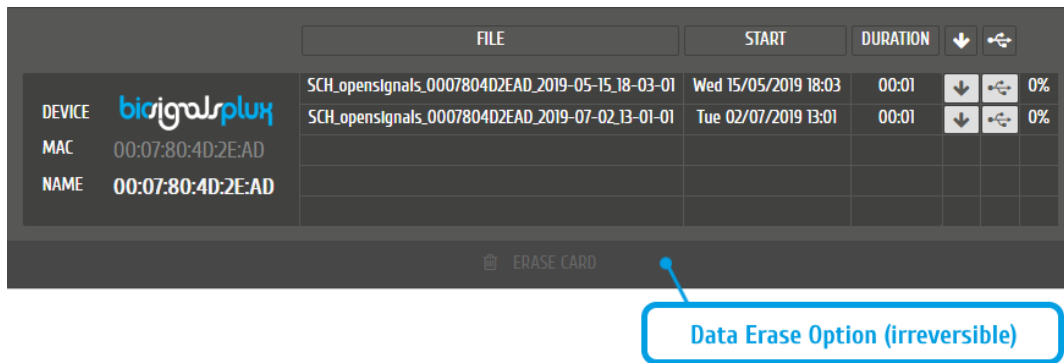


Figure 62: Available option to erase all data inside the internal memory of the device.

NOTE

Deleted files **cannot be restored**. Make sure you have downloaded all the needed files **before** deleting or erasing the internal memory of your device to prevent accidental data loss.

6.6 Synchronization

One of *OpenSignals (r)evolution's* features is the possibility of executing synchronized multi-device data acquisitions. This feature allows together up to three 8-channel biosignalsplux devices with each other using the biosignalsplux [sync-cables](#) and the [multi-sync splitter cable](#) to acquire signals from all devices simultaneously in a synchronized acquisition, preventing signal drifts between the single devices (time based differences) which could occur in non-synchronized long-time acquisitions.

NOTE

Signal drift may still occur when using accessories to synchronize PLUX devices with other devices (e.g. LED).

NOTE

The *biosignalsplux* synchronization cable/kit is needed for the use of this function. This additional accessory can be found here:

<https://store.plux.info/sensors/322-synchronization-kit-820201211.html>

6.6.1 Connecting Devices

NOTE

Components that are used for this feature require a digital port to synchronize the acquisition. By default, only the 8-channel *biosignalsplux* has a digital port that works with these accessories and this feature. A digital port can additionally be added to 4-channel *biosignalsplux* devices (contact our support for more information).

Connect the sync-cable to the digital ports of your devices. The digital port is the last input on the right side of the *biosignalsplux* device as marked in Figure 63. The devices should be connected as displayed in Figure 64.



Figure 63: Digital port of the 8-channel biosignalsplux.



Figure 64: biosignalsplux devices connected with a sync-cable.

When using 3 *biosignalsplux* devices, connect the single end of the multi-splitter to the digital port of one *biosignalsplux* device and connect two sync-cables to 2 of the available 3 inputs of the multi-sync splitter. Connect the other ends of the sync cables to the digital ports of the two *biosignalsplux* devices which are going to be used in the synchronized acquisition.

6.6.2 Device Configurations in OpenSignals (r)evolution

Configure all your devices as needed. When done, enable all devices which will be used during the acquisition by clicking on the *ENABLED* field of each device, click on their device panels and activate the sync-function (*SYNC*; circle must be blue) if it is not activated. When done, your device panel should look similar to the one seen in Figure 65.

NOTE

Variations in resolution, sampling rate, active channels, and/or trigger function of your configuration compared to the one displayed in Figure 65 will not influence your synchronized acquisition.

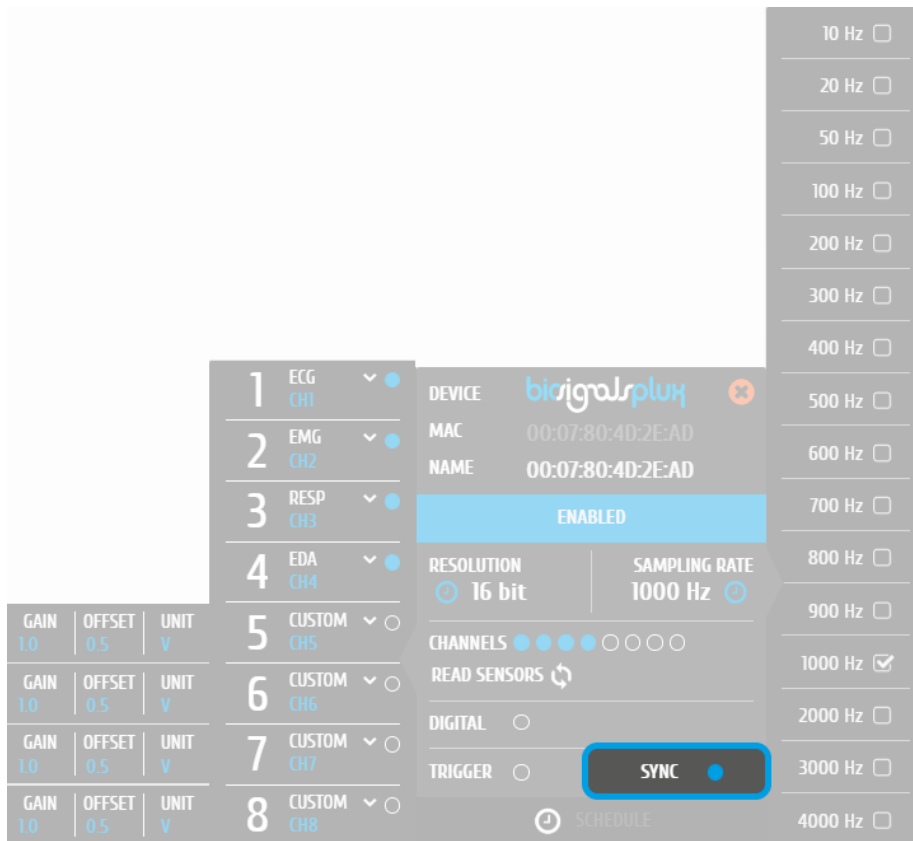


Figure 65: Activated sync-function.

When acquiring from several devices with a correctly set up synchronized acquisition, the sync-function symbol should be displayed in blue in the signal acquisition mode (see Figure 66).

If the sync-function is not active (symbol is displayed in gray), restart the configuration of your devices by following the instructions above.

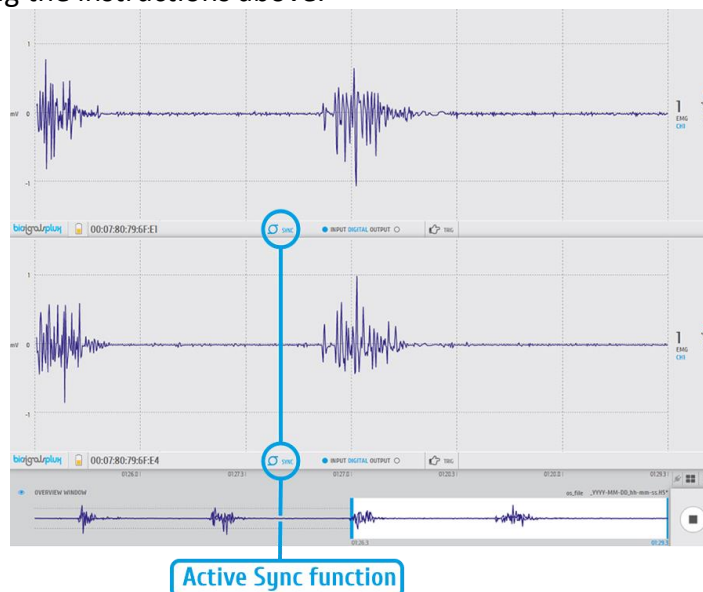


Figure 66: Synchronized acquisition with active sync-function.

7 Accessories

OpenSignals (r)evolution is compatible with all PLUX devices and sensors, as well as the following accessories which are available for most devices.

NOTE

biosignalsplux Accessories need to be connected to the accessory port of *biosignalsplux* devices.

7.1 Trigger

This trigger device is useful to begin acquisition via Bluetooth to *OpenSignals (r)evolution* (or any other custom software) or to manually start offline acquisitions stored in the hub's internal memory when no Bluetooth connection is available.



Figure 67: Handheld switch.

How to connect your handheld switch to your biosignalsplux

The handheld switch needs to be connected to the digital port of your device.

How to configure your handheld switch in OpenSignals (r)evolution to mark events

Input devices, such as the handheld switch, do not require to be configured in *OpenSignals (r)evolution* if their intended use is to mark specific actions during an acquisition. In this case, their input state can be seen in *OpenSignals'* signal acquisition mode in the information bar located right below the acquired signals (see Figure 68; circle to the left of *INPUT DIGITAL*). The digital input circle will turn blue if a digital input has been received (handheld switch pressed) or be kept empty if no digital input has been received (handheld switch not pressed; see Figure 68).

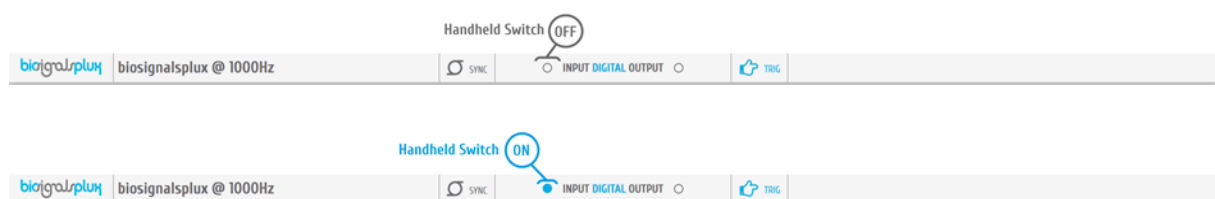


Figure 68: Digital input states.

The received inputs will be visualized in an extra channel named *IO1* in the visualization mode.

How to configure your handheld switch in OpenSignals (r)evolution to trigger acquisitions

If the intended use of the handheld switch is supposed to trigger the start of an acquisition, it is needed to turn on this feature in the device manager. For this, open the *OpenSignals (r)evolution* device manager and select the device you have your handheld switch connected to. In the device's panel, click on the circle next to *TRIGGER* to activate the trigger feature (circle must be blue; see Figure 69).

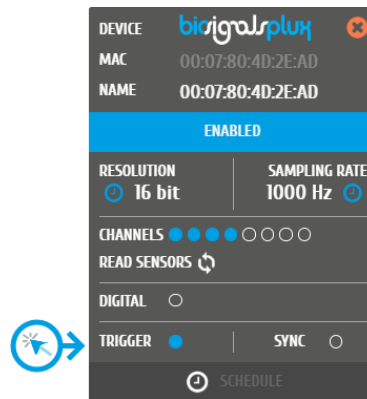


Figure 69: Trigger configuration.

In the information bar of *OpenSignals'* real-time acquisition mode (located right below the acquired signals), the state of the trigger feature is displayed (see Figure 70).

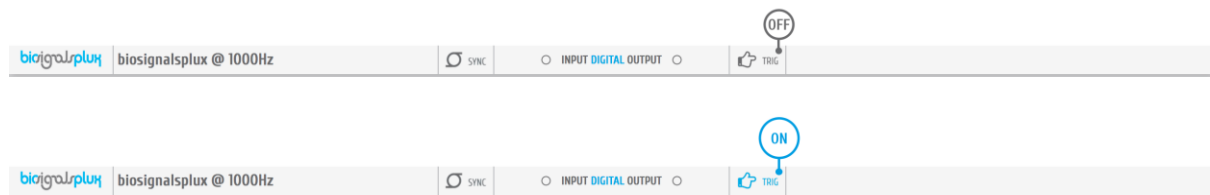


Figure 70: Trigger state.

Accessory specifications

Please read the datasheet of handheld switch carefully before using it the first time. The datasheet can be downloaded here:

http://biosignalsplux.com/datasheets/BTN_Sensor_Datasheet.pdf

7.2 Light-Emitting Diode (LED)

The LED is typically used to provide visual feedback to the user. A common need when working with biosignals is the synchronization of the recorded data with external recording devices (e.g. a video camera). If applied to a camera lens, the LED sensor can be used to introduce common markers in the recording, hence providing a synchronization source. The LED sensor can also be useful for optical synchronization with third-party devices (provided that the third-party device has a photo detector), in applications where it is important to have electrical decoupling between devices.

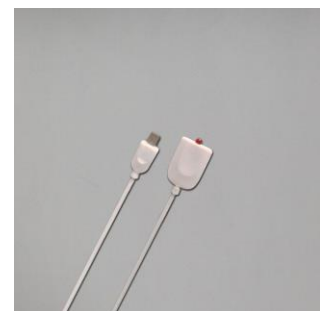


Figure 71: LED.

How to connect your accessory to your biosignalsplux

The LED needs to be connected to the digital port of your device.

How to control your LED in OpenSignals (r)evolution

Output devices, such as the LED, do not require to be configured in *OpenSignals (r)evolution*. However, it is possible to select their initial state which can later be changed in the information bar of *OpenSignals*' real-time acquisition mode which is located right below the acquired signals (see Figure 73; circle to the right of *DIGITAL OUTPUT*).

To select an initial state, open the *OpenSignals (r)evolution* device manager and select the device you have your LED connected to. In the device's panel, click on the circle next to *DIGITAL* to turn on (blue circle) or off (empty circle) the LED for the start of your signal acquisition (see Figure 72).

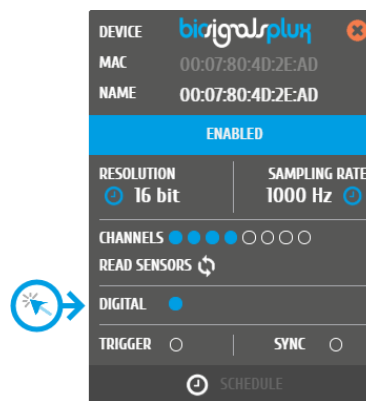


Figure 72: Initial state of the digital output (here: on).

To change the output state of the LED during the acquisition, click on the circle next to *DIGITAL OUTPUT* in the information bar of the real-time acquisition mode. Here, again, the LED will be turned on if the circle is blue and off if the circle is empty (see Figure 73).

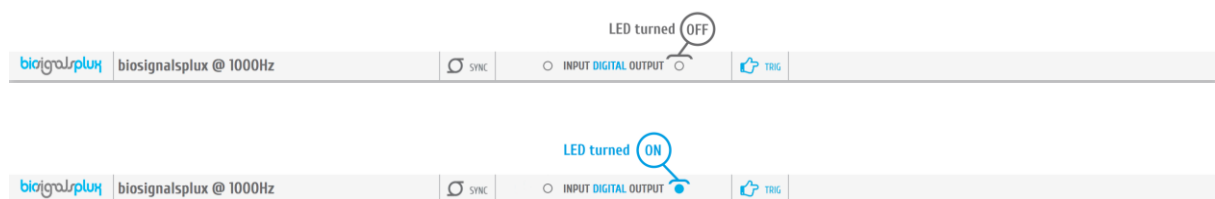


Figure 73: Digital output states for LED.

OpenSignals (r)evolution Add-On: Video Synchronization

The *Video Synchronization* add-on has been designed for research applications which involve recording data from sources other than the biosignal acquisition hardware devices (e.g. video camera). Given that the biosignal hardware and the camera are independent recording sources, a common problem when replaying the recording session is the synchronization of both. This plugin was created to provide an easy way to replay biosignal data synchronously with video using this LED.

Accessory specifications

Please read the datasheet of LED carefully before using it the first time. The datasheet can be downloaded here:

http://biosignalsplux.com/datasheets/LED_Actuator_Datasheet.pdf

7.3 Digital Synchronization Cable

The multi sync splitter accessory meets your multi-device acquisition needs. By using digital synchronization cable(s), this accessory allows you to connect *biosignalsplux* devices with digital ports together to collect up to 24 channels at the same time (by connecting up to 3 HUBs together).

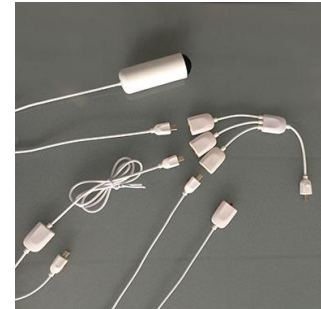


Figure 74: Sync cable & kit.

How to connect your accessory to your biosignalsplux

The digital synchronization cable needs to be connected to the digital ports of the devices that are being used for the multi-device acquisition (see 6.6 Synchronization).

How to configure synchronized acquisitions in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select one of the devices you want to use for the multi-device acquisition. In the device's panel, click on the circle next to SYNC to turn on (blue circle) or off (empty circle) the synchronization function to synchronize the acquisition of your devices (see Figure 75). This function must be active to ensure synchronized multi-device acquisitions without signal drifts. Repeat this step for the second device that is being used for the multi-device acquisition.

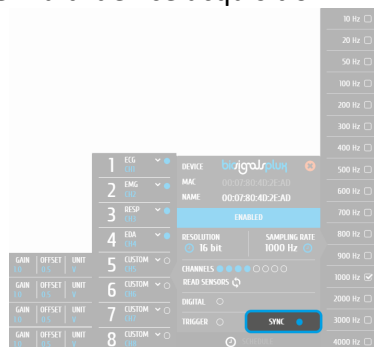


Figure 75: Activate synchronization feature.

7.4 Multi Sync Splitter

The multi sync splitter accessory meets your multi-device acquisition needs. By using digital synchronization cable(s), this accessory allows you to connect *biosignalsplux* devices with digital ports together to collect up to 24 channels at the same time (by connecting up to 3 HUBs together).



Figure 76: Multi sync splitter.

How to connect your accessory to your biosignalsplux

The multi sync splitter needs to be connected to the digital port of one of the devices that are being used for the multi-device acquisition (see 6.6 *Synchronization*). When done, link the other device(s) with the multi sync splitter by connecting digital synchronization cable(s) (see 0

Digital Synchronization Cable) to the digital port(s) of the other *biosignalsplux* devices and to the one of the three available inputs of the multi sync splitter.

How to configure synchronized acquisitions in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select one of the devices you want to use for the multi-device acquisition. In the device's panel, click on the circle next to SYNC to turn on (blue circle) or off (empty circle) the synchronization function to synchronize the acquisition of your devices (see Figure 77). This function must be active to ensure synchronized multi-device acquisitions without signal drifts. Repeat this step for all devices that are used for signal acquisition.

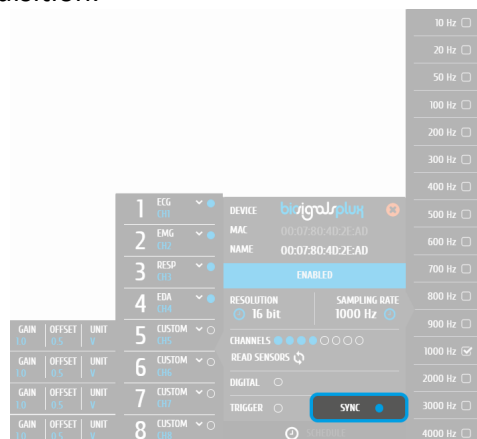


Figure 77: Activate synchronization feature.

8 Troubleshooting

8.1 Bluetooth

Most internal Bluetooth adapters are compatible with PLUX devices. However, if you're experiencing a great number of connection loss events, reconnection problems, missing samples or similar problems, your internal Bluetooth module might not have enough performance to deal with the data throughput of the device you are using. In this case, reducing the sampling frequency or the sample resolution might solve this issue, if a change of these parameters is possible.

For this reason, PLUX has identified Bluetooth dongles that have been tested and are known to work with our devices. We recommend that you use one of these PLUX-tested Bluetooth dongles, which are either already shipped with your device (e.g. in the case of *biosignalsplux* kits) or can be purchased separately from our store. These dongles are compatible to work with data rates up to 24 Mbps.

The solution is to exchange the internal Bluetooth Adapter for an **external Bluetooth USB dongle that uses the Windows native Bluetooth stack**. For this, you'll need to install the Bluetooth dongle properly, as described in the following steps, which are explained in more detail throughout the next pages for the supported operating systems:

- Step 1: Removing already paired devices from your operating system
- Step 2: Installing PLUX-proven Bluetooth dongle
- Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

NOTE

If you're already using PLUX devices with the old Bluetooth stack, please remove your device(s) from your computer **before** changing the Bluetooth drivers/changing to Microsoft Bluetooth Stack.

NOTE

We recommend going through all the following steps to set up your Bluetooth dongle correctly, even if Windows may automatically install and set up your dongle.

NOTE

Installing the Bluetooth dongle and changing the Bluetooth stack is only required for Windows computers only. Computers with a Mac OS X operating system do not need to go through these steps and use the internal Bluetooth adapter instead.

8.1.1 Windows 7 & Windows 8

Step 1: Removing already paired devices from your operating system

To remove Bluetooth devices, it is needed to access the *Device Manager* on your computer and view the list of connected devices. The device list can be found following these steps:

Start Button > Control Panel > Hardware and Sound > View devices and printers

In the *Device and Printers* window, PLUX devices can be found in the *Unspecified* section. Right-click on the device you want to remove and select *Remove device* (see *Figure 78*)

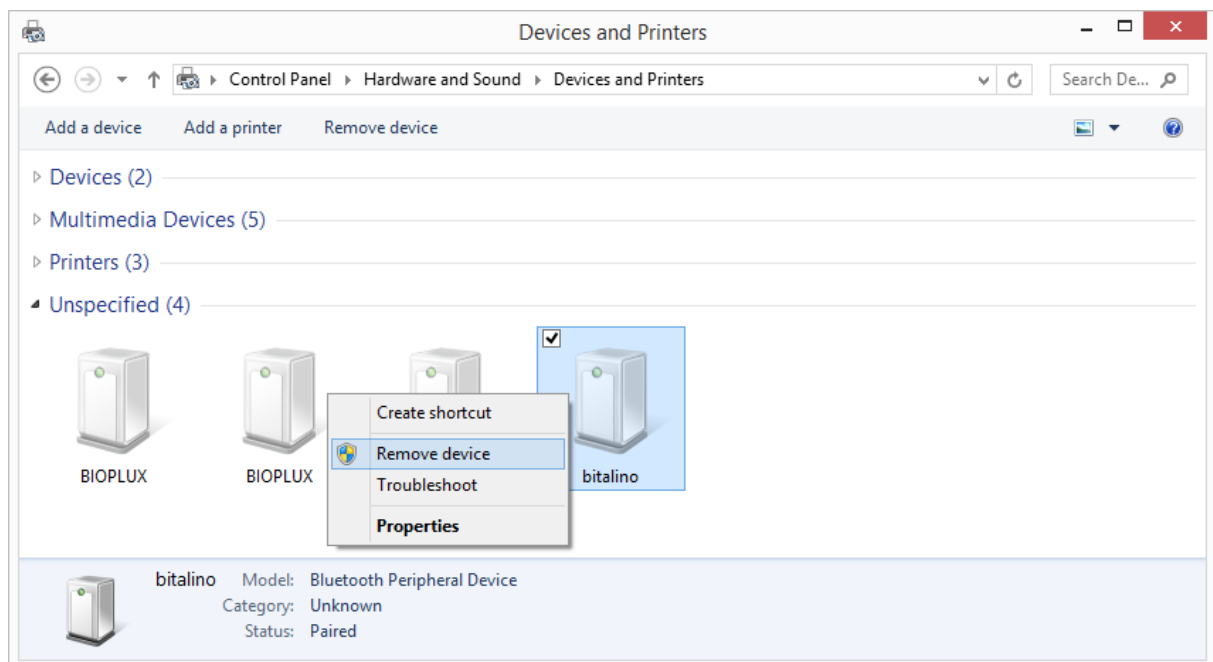


Figure 78: Windows 7 "Devices and Printers" window.

If the device is not listed under *Unspecified* anymore, it has been successfully removed from your system.

Step 2: Installing PLUX-proven Bluetooth dongle

To install the PLUX-proven Bluetooth dongle, plug it in and install all the necessary drivers for the Bluetooth dongle to work (an Internet connection is advisable). Windows should display the window below.

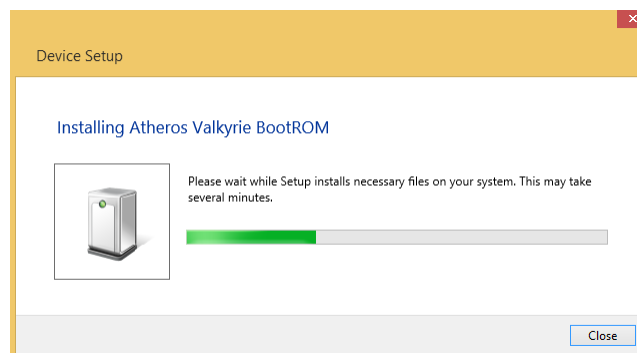


Figure 79: Wait for Windows to install your Bluetooth dongle.

Make sure you wait until your Bluetooth Dongle is installed. Windows will issue a notification and you'll be ready to configure the correct Bluetooth stack following the next step.

Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

To configure the Bluetooth stack of the Bluetooth dongle, you have to connect your Bluetooth dongle to your computer and access the *Device Manager* on your computer. The device manager can be found following these steps:

Start Button > Control Panel > System and Maintenance > Device Manager

In the device manager, the Bluetooth dongle should be listed as *Generic Bluetooth Adapter* (see *Figure 80*). If your machine already has an internal Bluetooth Adapter and you have just plugged in the PLUX-proven Bluetooth Dongle, keep in mind that the last one will be automatically disabled by Windows. This is why one of your Bluetooth adapters under Bluetooth in the device manager shows a yellow warning icon (⚠) stating: *Code 10 - This device cannot start*.

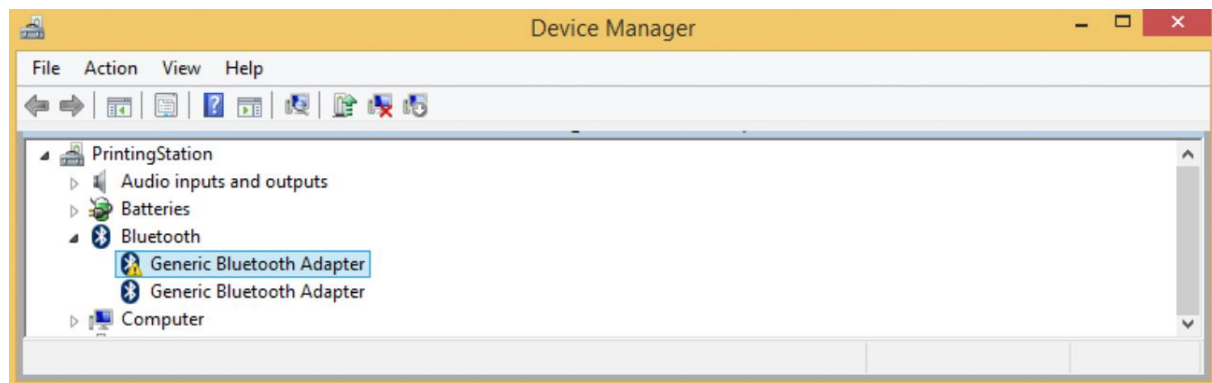


Figure 80: Bluetooth dongle listed in the device manager.

If your Bluetooth dongle is the one disabled, you can manually disable your internal Bluetooth adapter by right-clicking on it in the device manager and selecting *Disable*. This action will enable your Bluetooth dongle by default.

If, after this action, your Bluetooth Dongle continues to display a yellow warning icon (⚠), it means that it is not installed correctly and you should try to update the drivers by right-clicking on it and selecting *Update Driver Software...* or fix the problem displayed under *Device Status* in the device properties (right-click the Bluetooth device and select *Properties*; see screenshot below).

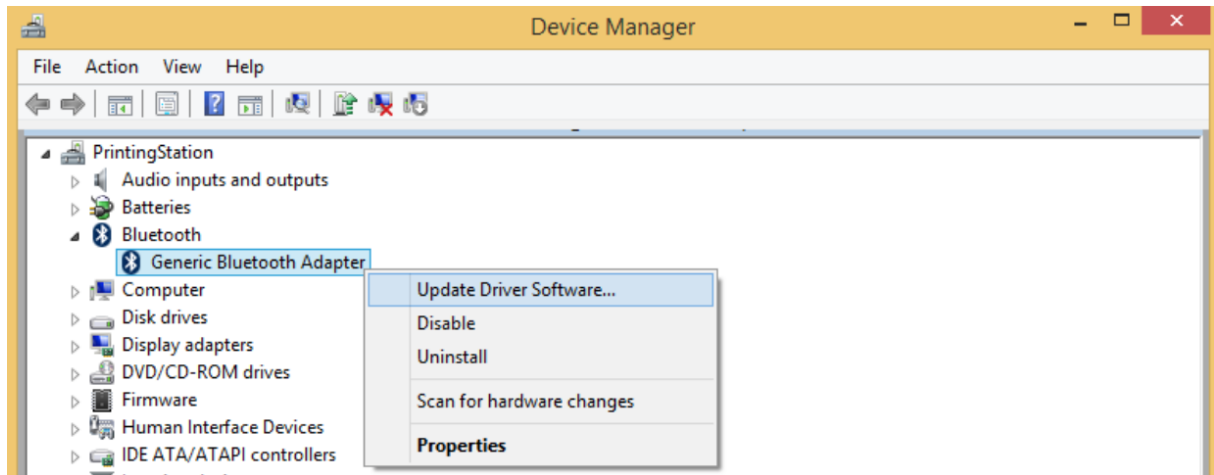


Figure 81: First step to update the driver of the Bluetooth dongle.

Select *Browse my computer for driver software* from the new window.

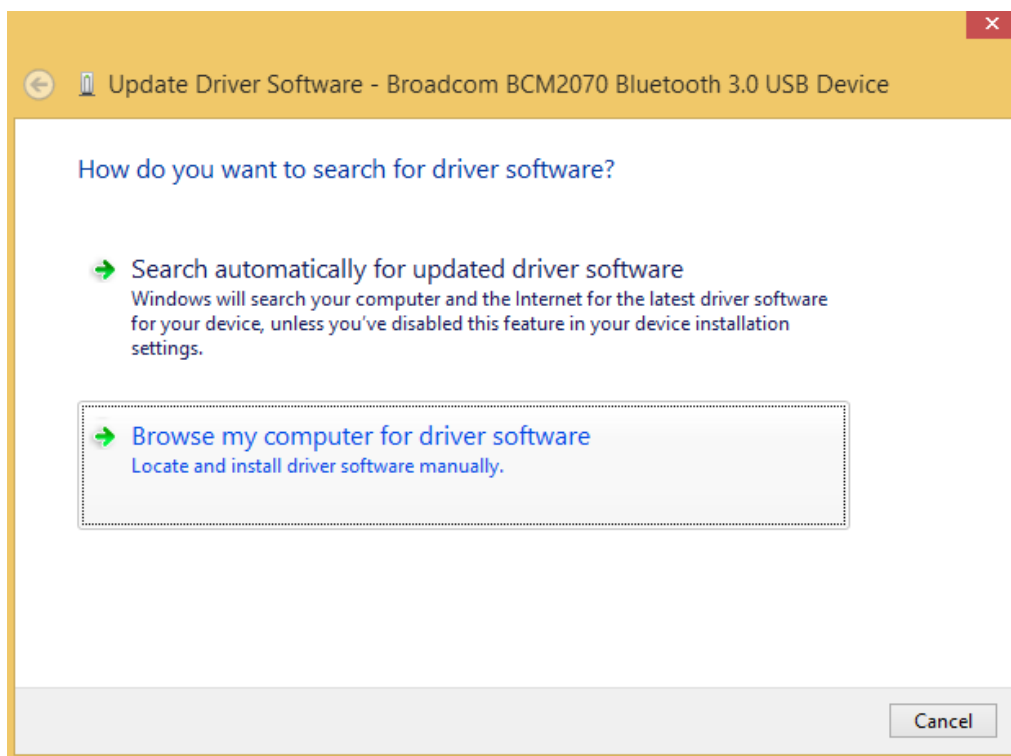


Figure 82: Browse for driver software.

Select *Let me pick from a list of device drivers on my computer*.

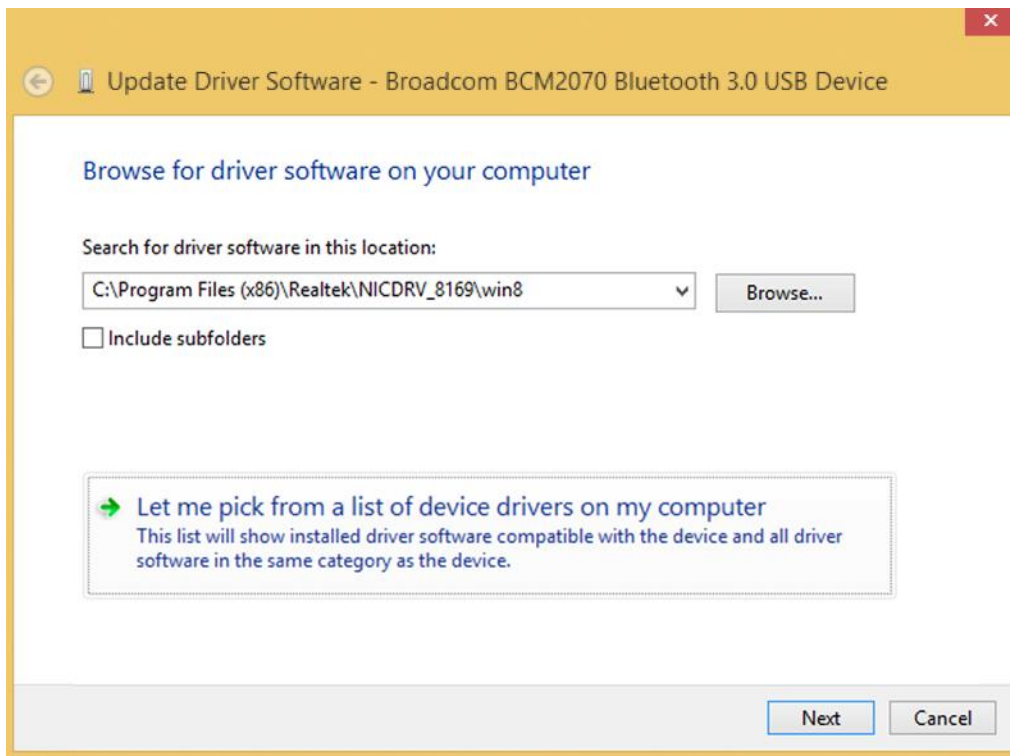


Figure 83: Pick driver from list of device drivers on the computer.

Select *Generic Bluetooth Adapter* and click on *Next* to install the Microsoft Bluetooth Stack. Of several models of *Generic Bluetooth Adapter* are available you can select any of them. It will not make any difference.

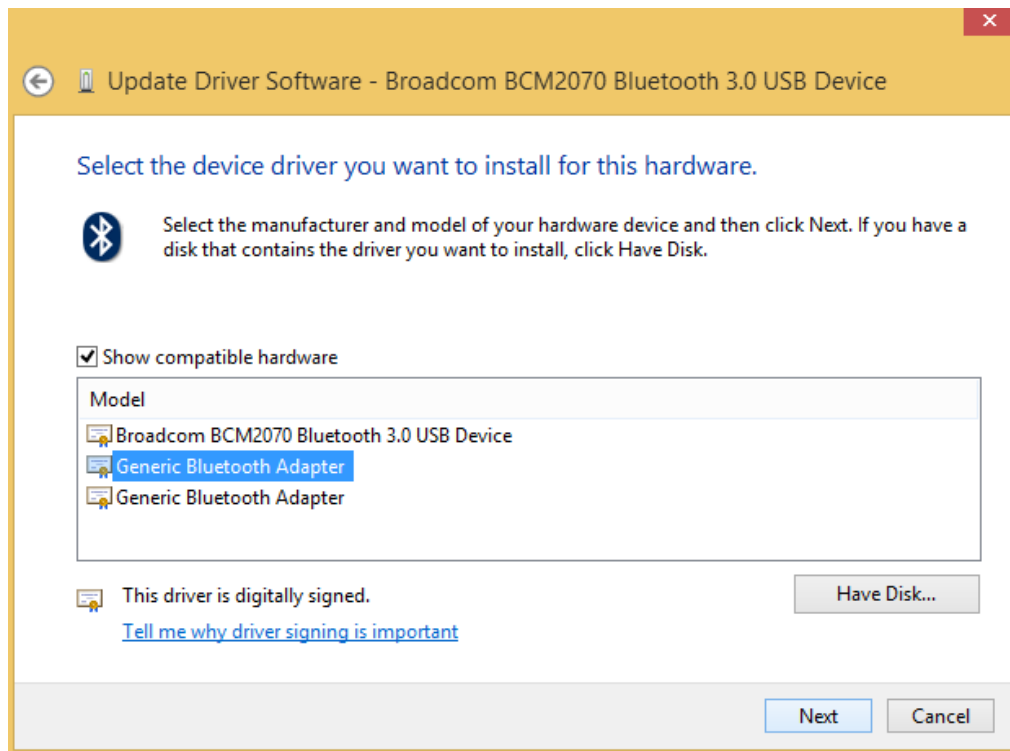


Figure 84: Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your *biosignalsplux* device (see *Bluetooth Setup Windows 7*) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

8.1.2 Windows 10

Step 1: Removing already paired devices from your operating system

To remove Bluetooth devices, it is needed to access the Bluetooth configuration of your operating system. Click on the start button at the left lower corner in of your desktop to open the start menu. Click on the gear symbol to open the settings panel of your operating system as can be seen below.

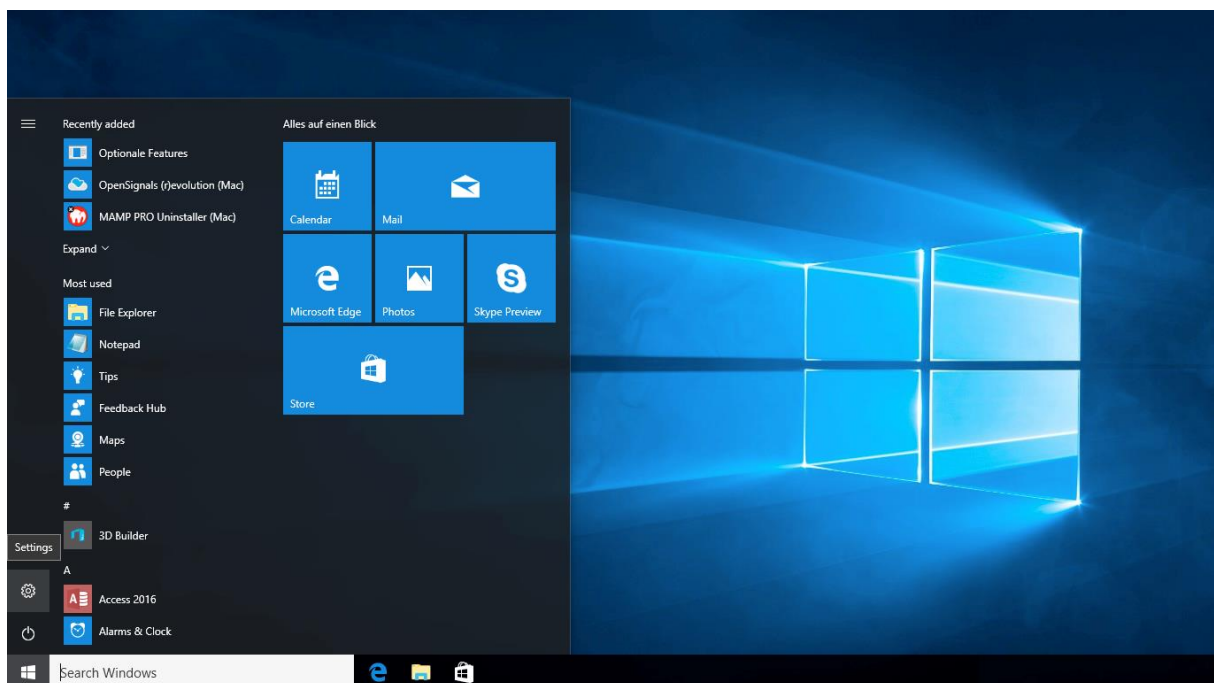


Figure 85: Access to the settings panel in Windows 10.

In the settings panel, click on the *Devices Bluetooth, printers, mouse* field to open the device configurations of your system.

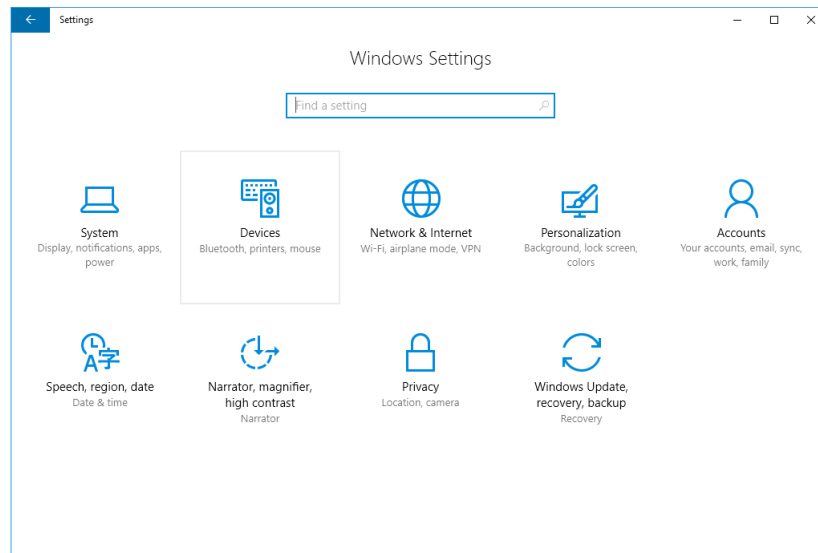


Figure 86: Windows 10 settings panel.

Select *Bluetooth* from the list which is displayed on the left side of your settings window. Note, that in some versions the Bluetooth option might not be available and that Bluetooth devices might be listed under *Other devices*.

Click on your *biosignalsplux* and click on *Remove device* to remove this Bluetooth connection from your computer and confirm the *Are you sure you want to remove this device?* message that will be shown on your screen. Repeat this step with every *biosignalsplux* if you're using several devices.

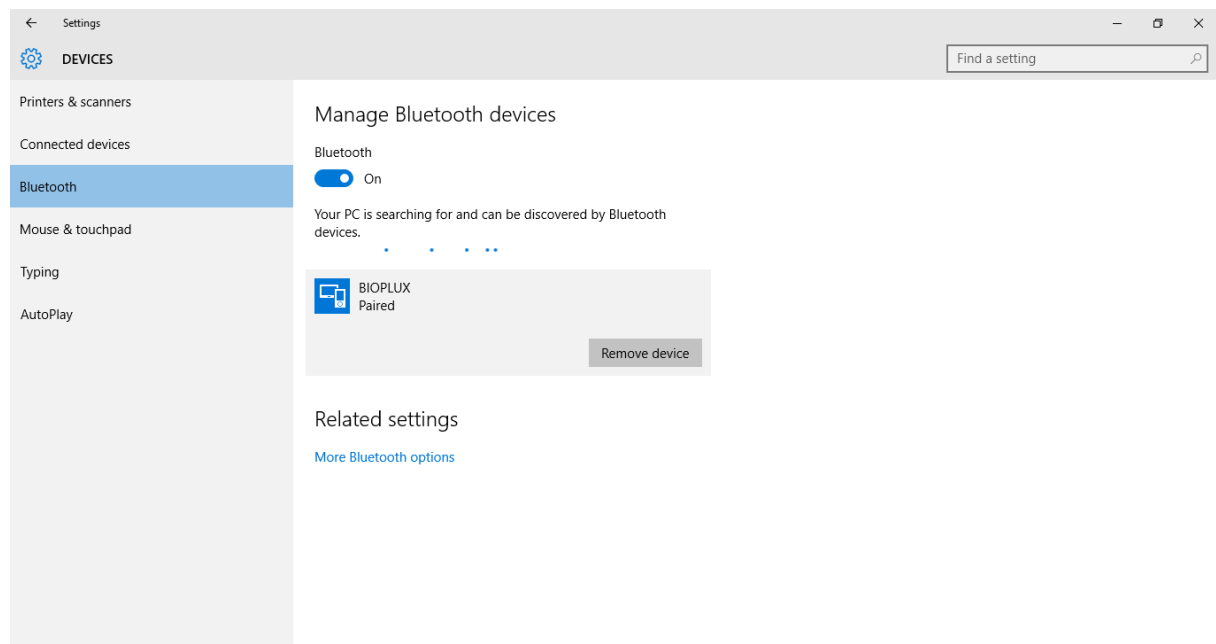


Figure 87: Windows 10 Bluetooth devices

If, after this step, your device is not listed in the list of Bluetooth devices anymore, the device has been successfully removed.

Step 2: Installing PLUX-proven Bluetooth dongle

To install the PLUX-proven Bluetooth dongle, plug it into your computer. Windows will install the Bluetooth dongle and display the window below.

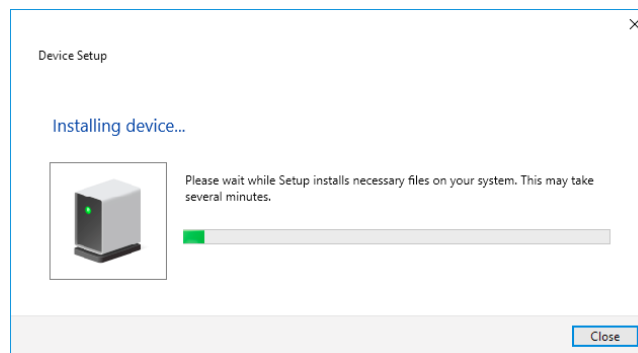


Figure 88: Wait for Windows to install your Bluetooth dongle.

Make sure you wait until your Bluetooth Dongle is installed. Windows will issue a notification and you'll be ready to configure the correct Bluetooth stack following the next step. Note, that this step might require a restart of your system. Make sure to close all your open work and programs properly before restarting the system to prevent data losses or other issues.

Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

To configure the Bluetooth stack of the Bluetooth dongle, you have to connect your Bluetooth dongle to your computer and access the *Device Manager* on your computer. Enter *Device Manager* into the search field of your taskbar and click on the listed device manager.

In the device manager, the Bluetooth dongle should be listed as *Generic Bluetooth Adapter* (see). If your machine already has an internal Bluetooth Adapter and you have just plugged in the PLUX-proven Bluetooth Dongle, keep in mind that the last one will be automatically disabled by Windows. This is why one of your Bluetooth adapters under Bluetooth in the device manager shows a yellow warning icon (⚠) stating: *Code 10 - This device cannot start*.

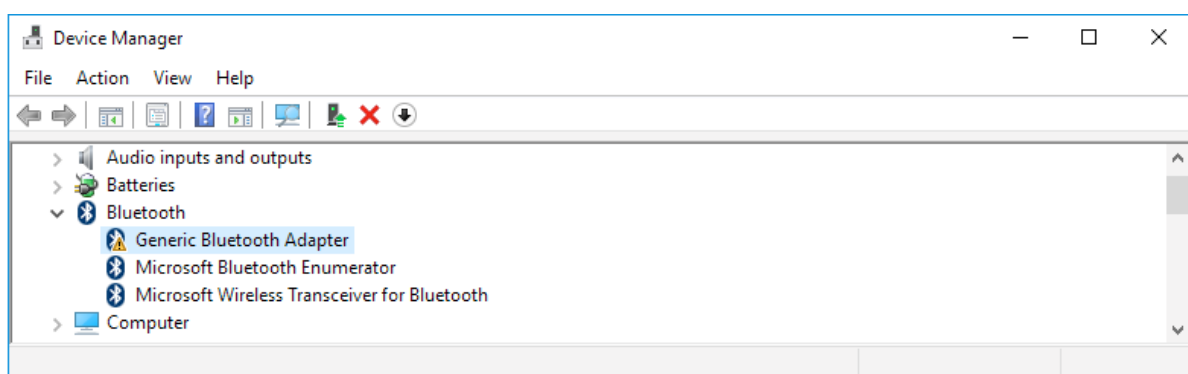


Figure 89: Bluetooth dongle listed in the device manager.

If, after this action, your Bluetooth Dongle continues to display a yellow warning icon (⚠), it means that it is not installed correctly and you should try to update the drivers by right-clicking on it and selecting *Update Driver Software...* or fix the problem displayed under *Device Status* in the device properties (right-click the Bluetooth device and select Properties; see screenshot below).

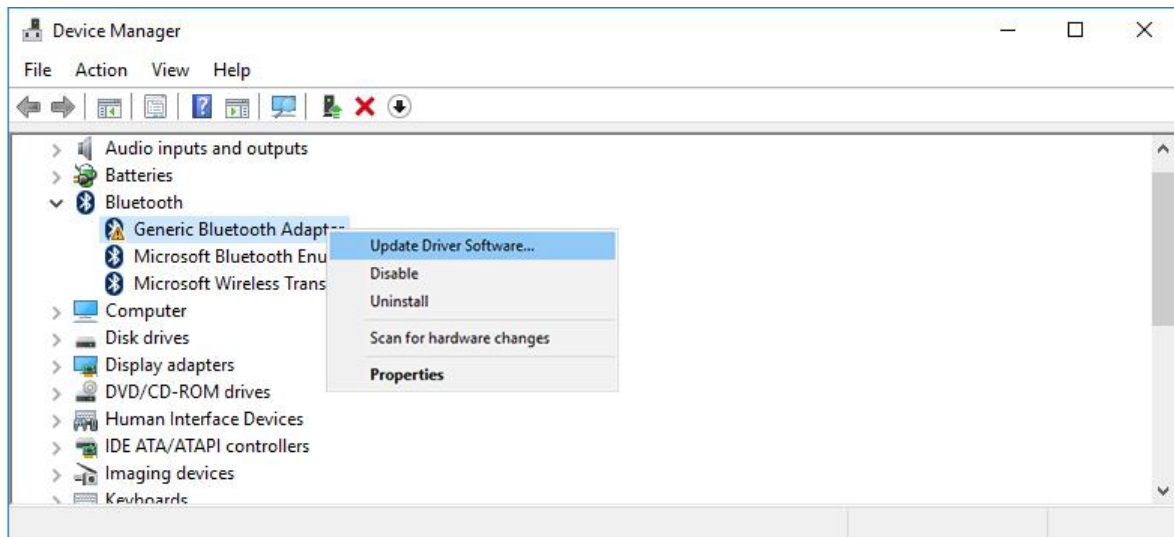


Figure 90: First step to update the driver of the Bluetooth dongle.

Select *Browse my computer for driver software* from the new window.

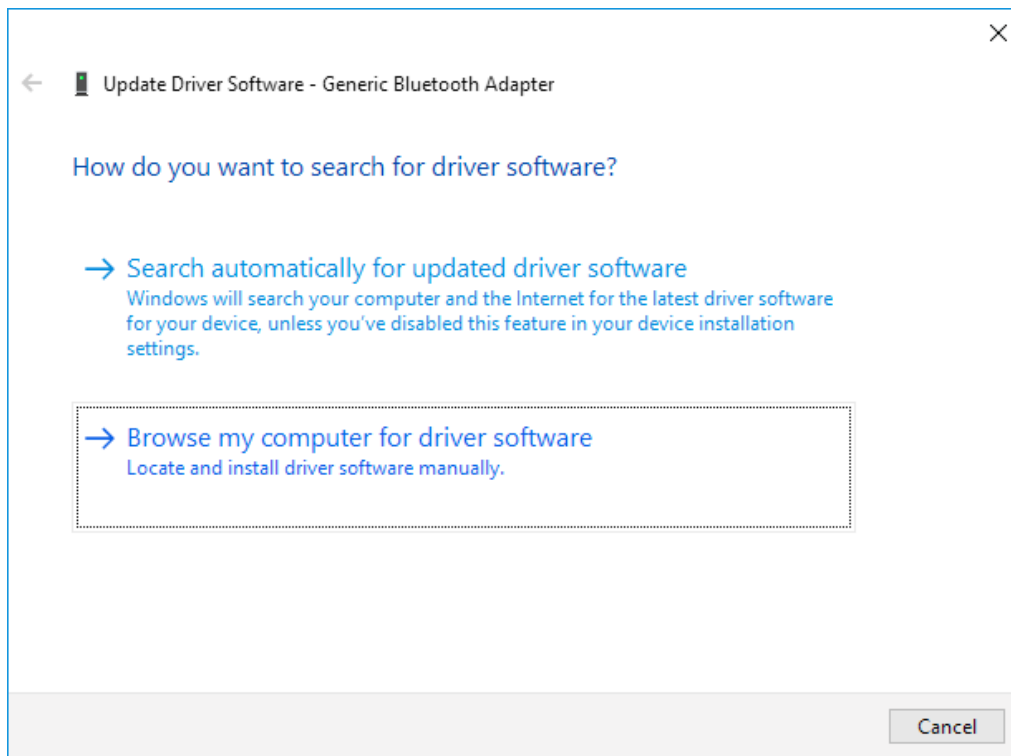


Figure 91: Browse for driver software.

Select *Let me pick from a list of device drivers on my computer*.

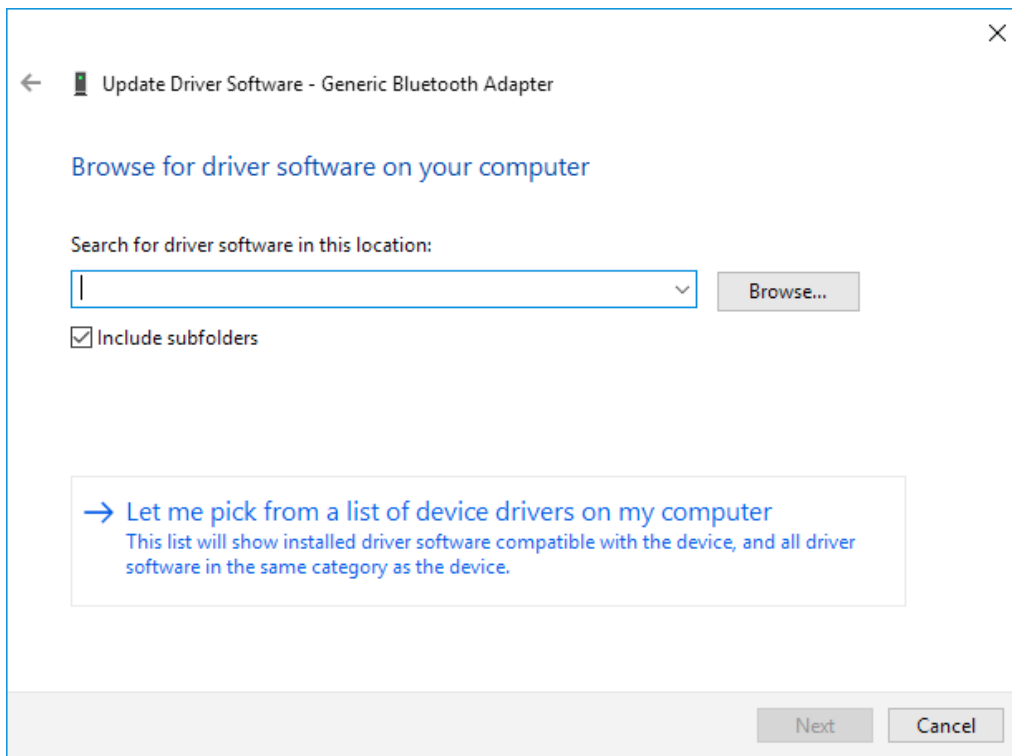


Figure 92: Pick driver from list of device drivers on the computer.

Select *Generic Bluetooth Adapter* and click on *Next* to install the Microsoft Bluetooth Stack. Of several models of *Generic Bluetooth Adapter* are available you can select any of them. It will not make any difference.

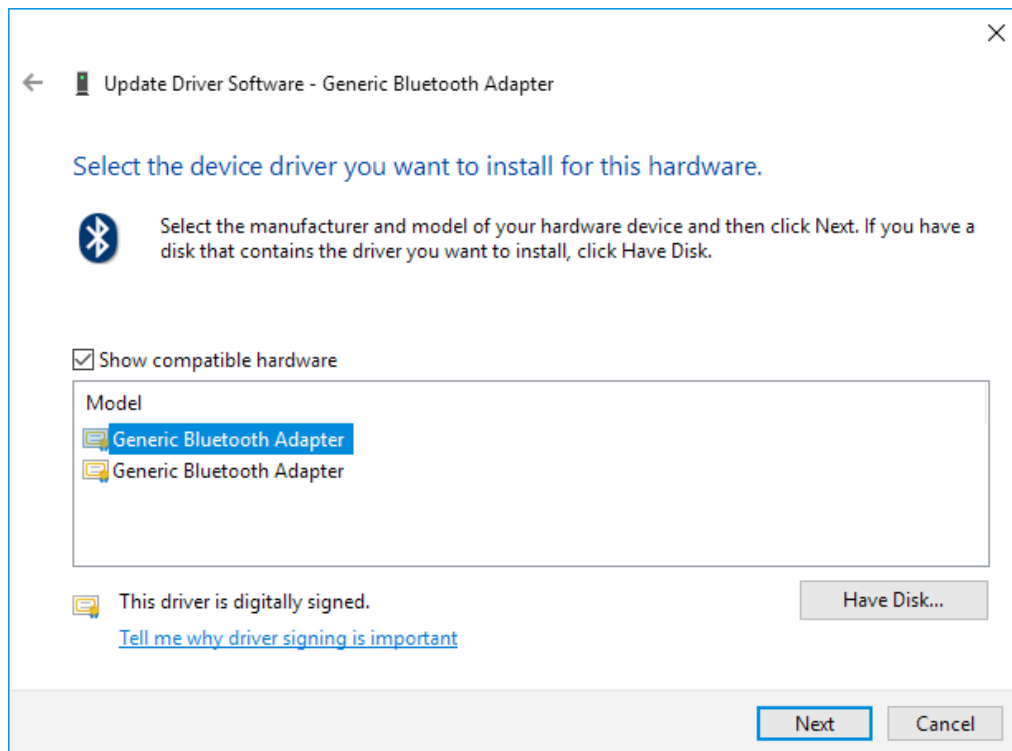


Figure 93: Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your *biosignalsplux* device (see *Bluetooth Setup Windows 10*) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

9 Safety & Maintenance

Please read the following safety instructions **before** using your *biosignalsplux* system to prevent any damages or problems with the user, test persons and/or *biosignalsplux* devices. Violations of these instructions can lead to inferior signal quality and/or damages to the *biosignalsplux* system and user.

- ! The user should always keep the device and its accessories dry.
- ! The user must turn off the *biosignalsplux* device and contact Technical Support if the system or accessories reach uncomfortable temperatures.
- ! The user should not use the *biosignalsplux* device in noisy environments (environments with microwaves and other similar equipment). Doing so will lead to noise increase in the acquired signals and Bluetooth connectivity issues.
- ! The user must not use the device near the fire or in potentially explosive atmospheres, such as atmospheres with flammable gas.
- ! The user should only use the detection surfaces or other approved accessories purchased from PLUX or by a PLUX agent.
- ! The user should inspect the sensors on a regular basis to ensure that they remain in good working order.
- ! The user should stop using the *biosignalsplux* device if experience any kind of discomfort or skin irritation.
- ! The user should not use the *biosignalsplux* device continuously for periods of time above 60 minutes. Do not use the system on persons with allergies to silver.
- ! The user should dispose detection surfaces after using the *biosignalsplux* device. Detection surfaces are single-user and disposable. Reusable electrodes should be reused by the same user. Do not use reusable electrodes on several users.
- ! The user must not place the device in the microwave.
- ! The user must not insert objects into the holes of the device.
- ! The user should not open the *biosignalsplux* device or its accessories. The repair of the same should be only done by properly authorized PLUX personnel.
- ! The user should make sure the cables do not obstruct the passage of people.
- ! The user should use the sensor cables with extreme caution to avoid risk of strangulation.

- ! The user should keep a safe distance between the *biosignalsplux* device and other devices to ensure their proper functioning.
- ! The user should only send the device to repair to qualified PLUX personnel.
- ! The user should not immerse the sensors or the *biosignalsplux* device, nor clean with liquid or abrasives.
- ! The user should handle the *biosignalsplux* device with caution and not expose the device or accessories to high accelerations and vibrations.
- ! *biosignalsplux* devices should not be used in patients with implanted electronic devices of any kind, including pace-makers, electronic infusion pumps, stimulators, defibrillators or similar.
- ! Do not apply electrodes over damaged or irritated skin.
- ! Do not use your device while charging its internal battery.

9.1 Maintenance Recommendations

9.1.1 Transportation and Storage

Please follow these recommendations to ensure safe transportation and storage of your *biosignalsplux* equipment and sensors to prevent any damaging of your system.

- The *biosignalsplux* equipment and sensors should be stored in the original box in a dry place when those are not being used.
 - Relative humidity: up to 95% with no condensation
 - Ambient temperature: 10°C to 30°C
 - Atmospheric pressure between 500hPa and 1060hPa
- Whenever the equipment needs to be transported, it should be placed in the original box, since this was designed and tested to ensure the equipment and accessories are securely stored.
- Take care while handling the bac and avoid dropping it, since the device is not shock-proof and should not be placed under stress or sudden acceleration.

9.1.2 Cleaning

Please follow these cleaning instructions to prevent any damage of the system or the user because of conducting cleaning methods that may cause any damage.

- The *biosignalsplux* and sensors should be visually checked before each use and cleaning process to ensure that no mechanical damage occurred.
- The *biosignalsplux* equipment and sensors (including the cables) should be cleaned with a slightly damp cloth or suitable absorbent paper, ensuring no liquid enters the equipment of sensors. Do not use detergent or any type of cleaning liquid as these may damage your equipment and/or sensor.
- Do not clean or re-use detection surfaces (electrodes). They are only suitable for single use, and should be disposed of after usage except indicated otherwise.

10 Regulatory & Legal Information

10.1 Disclaimer

***biosignalsplux* products are intended for use in life science education and research applications only; *biosignalsplux* products are not medical devices**, nor medical software solutions, nor are they intended for medical diagnosis, cure, mitigation, treatment or prevention of disease and is provided to you “as is”.

We expressly disclaim any liability whatsoever for any direct, indirect, consequential, incidental or special damages, including, without limitation, lost revenues, lost profits, losses resulting from business interruption or loss of data, regardless of the form of action or legal theory under which the liability may be asserted, even if advised of the possibility of such damages.

10.2 Guarantee of Quality & Warranty

The *biosignalsplux* acquisition system has a two years quality guarantee from the date of purchase. *biosignalsplux* sensors have three months quality guarantee from the date of purchase. PLUX guarantees that the system, sensors and accessories will be free from material or manufacturing defects for the mentioned time periods following date of purchase.

If PLUX receives notification of any such defects within the guarantee period, it will repair or substitute with the same unit\model, any products with proven defects at no cost to the client. During the repair period PLUX promises to provide a temporary replacement under the same specification. Repairs will be carried out at PLUX’s premises after the equipment has been received.

10.3 Warranty Voidance

Usage of the device that is not in accordance with the handling instructions indicated in the manual, or use with accessories other than those manufactured by PLUX will invalidate the warranty of your devices.

Be careful when connecting your *biosignalsplux* devices, sensors and/or accessories to any third party device including the usage of the 3rd party connection components that are available for *biosignalsplux* systems as **the usage of these components will void the electrical warranty of your *biosignalsplux* device** and sensors and, if not indicated otherwise, the warranty of the 3rd party system you’re connecting to the device. Check the electrical specifications of both systems you want to connect to prevent any damage of the user(s) or the systems.

In the case of warranty voidance, the same applies that we expressly disclaim any liability whatsoever for any direct, indirect, consequential, incidental or special damages, including, without limitation, lost revenues, lost profits, losses resulting from business interruption or loss of data, regardless of the form of action or legal theory under which the liability may be asserted, even if advised of the possibility of such damages.

10.4 Contact & Support

Contact us if you're experiencing any problems that cannot be solved with the information given in the *biosignalsplux* or OpenSignals (r)evolution manual. We'll get back to you as soon as possible to find the best solution for your problem.

Please send us an e-mail with precise information about the error occurrence, device configuration, and, if possible, screenshots of the problem to support@plux.info.