



biosignal acquisition tool-kit for advanced research applications

user manual



ATTENTION

please read this manual before using your
biosignalsplux product

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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.

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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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TABLE OF CONTENTS

DISCLAIMER.....	3
1 Your biosignalsplux Kit	7
1.1 biosignalsplux Explorer	8
1.2 biosignalsplux Researcher	10
1.3 biosignalsplux Professional	12
1.4 biosignalsplux Force	14
2 biosignalsplux HUB	16
2.1 4-Channel Hub Specifications	17
2.2 8-Channel Hub Specifications	18
2.3 Ports and Peripherals.....	19
2.3.1 Button.....	19
2.3.2 Analog Inputs.....	19
2.3.3 Reference	19
2.3.4 Digital Port.....	20
2.3.5 Charging Port.....	20
2.3.6 Button Behavior.....	20
2.4 General Device Functionality.....	21
2.4.1 Turning on the Device	21
2.4.2 Connecting the Sensors.....	21
2.4.3 Disconnecting the Sensors	21
2.4.4 Charging.....	22
2.5 Communication	23
2.5.1 Bluetooth.....	23
2.5.2 USB	24
3 biosignalsplux Sensors	25
3.1 Professional Sensors	26
3.1.1 Electromyography (EMG)	26
3.1.2 Electrocardiography (ECG)	29
3.1.3 Electrodermal Activity (EDA)	32
3.1.4 Electroencephalography (EEG).....	35
3.1.5 Accelerometer (ACC)	37
3.1.6 Temperature (TMP)	39
3.1.7 Respiration (PZT)	41
3.1.8 Force (FSR).....	43
3.1.9 Light (LUX)	45
3.2 Advanced Sensors.....	47
3.2.1 Respiration (RIP)	47
3.2.2 Goniometer (GON)	49
3.2.3 Load Cell	51
3.2.4 Vaginal Probe (Pelvic EMG Sensor)	53
3.2.5 RFID Sensor.....	55
3.2.6 Blood Volume Pulse (BVP).....	57
3.2.7 SpO2	59
4 Accessories	61
4.1 Actuators	62
4.1.1 Handheld Switch.....	62

4.1.2	Foot Switch	64
4.1.3	Light-Emitting Diode (LED)	66
4.2	Synchronization & Additional Digital Ports	68
4.2.1	Digital Synchronization Cable	68
4.2.2	Multi Sync Splitter	69
4.3	3rd Party Compatibilities	70
4.3.1	I/O Breakout Cable	70
4.3.2	Sensor Breakout PCB	72
5	Data Logging	73
5.1	Scheduling Offline Acquisitions	74
5.1.1	Control by Trigger	75
5.1.2	Stop When Full	75
5.1.3	Scheduling Start & End Times	76
5.1.4	Setting & Clearing Acquisition Schedules	77
5.2	Downloading Offline Acquired Data	78
5.2.1	Download via Bluetooth	78
5.2.2	Download via Fast USB Data Transfer Cable	79
5.2.3	Deleting Offline Acquired Data	80
6	Bluetooth Setup	81
6.1	Windows 7	81
6.2	Windows 8	84
6.3	Windows 10	86
6.4	Linux	88
6.4.1	Connecting via System Settings	88
6.4.2	Connecting via Terminal	92
6.5	Mac OS X	95
7	Firmware Updates & Upgrades	98
7.1	Checking Firmware Version	98
7.2	Updating or Upgrading Firmware	99
8	Software & APIs	101
8.1	OpenSignals (r)evolution	101
8.2	OpenSignals Mobile	101
8.3	APIs	101
9	Troubleshooting	102
9.1	Bluetooth	102
9.1.1	Windows 7 & Windows 8	103
9.1.2	Windows 10	107
10	Safety & Maintenance	113
10.1	Maintenance Recommendations	114
10.1.1	Transportation and Storage	114
10.1.2	Cleaning	115
11	Regulatory & Legal Information	116
11.1	Disclaimer	116
11.2	Guarantee of Quality & Warranty	116
11.2.1	Warranty Voidance	116
11.3	Contact & Support	117
12	Datasheets	118

1 Your biosignalsplux Kit



Figure 1: biosignalsplux kit.

biosignalsplux systems are available in 4 different kit versions. These versions are listed on the following pages. We recommend you to check and confirm the content of your kit after receiving it and before using it the first time, to identify missing or wrongly shipped components or sensors that vary from your original order. Contact our support if there are any variations from your original order.

1.1 biosignalsplux Explorer



Figure 2: biosignalsplux Explorer Kit

This kit contains:

- 1 wireless 4-channel *biosignalsplux* HUB
- 4 professional sensors of your choice
- 1 PLUX proven Bluetooth dongle
- 24 electrodes
- 1 medical grade charger
- 1 portable and rugged storage case with foam cushioning to house all the parts
- OpenSignals (r)evolution signal acquisition and visualization software (download [here](#))
- OpenSignals (r)evolution Real-Time Event Emulation Add-On

Optional components, features, and add-ons¹:

- 1 digital I/O port
- 8GB internal memory
- Advanced sensors (see 3.2 *Advanced Sensors*)
- Accessories (see 4 *Accessories*)
- OpenSignals (r)evolution Heart Rate Variability (HRV) Add-On
- OpenSignals (r)evolution Electromyography (EMG) Analysis Add-On
- OpenSignals (r)evolution Electrodermal (EDA) Events Add-On
- OpenSignals (r)evolution Respiration (PZT & RIP) Add-On
- OpenSignals (r)evolution Video Synchronization Add-On

¹ OpenSignals (r)evolution add-ons may require specific sensors. Please check the indications given in chapter 8.1 *OpenSignals (r)evolution* to confirm that you have the required sensor(s).

1.2 biosignalsplux Researcher



Figure 3: biosignalsplux Researcher Kit

This kit contains:

- 1 wireless 8-channel *biosignalsplux* HUB
- 8 professional sensors of your choice
- 1 PLUX proven Bluetooth dongle
- 24 electrodes
- 1 medical grade charger
- 1 portable and rugged storage case with foam cushioning to house all the parts
- 8h personalized technical support
- OpenSignals (r)evolution signal acquisition and visualization software (download [here](#))
- OpenSignals (r)evolution Real-Time Event Emulation Add-On
- OpenSignals (r)evolution Video Synchronization plug-in (pre-activated in

OpenSignals)

Optional components, features, and add-ons²:

- 8GB internal memory
- Advanced sensors (see 3.2 *Advanced Sensors*)
- Accessories (see 4 *Accessories*)
- OpenSignals (r)evolution Heart Rate Variability (HRV) Add-On
- OpenSignals (r)evolution Electromyography (EMG) Analysis Add-On
- OpenSignals (r)evolution Electrodermal (EDA) Events Add-On
- OpenSignals (r)evolution Respiration (PZT & RIP) Add-On

² OpenSignals (r)evolution add-ons may require specific sensors. Please check the indications given in chapter 8.1 *OpenSignals (r)evolution* to confirm that you have the required sensor(s).

1.3 biosignalsplux Professional



Figure 4: biosignalsplux Professional Kit.

This kit contains:

- 1 wireless 8-channel *biosignalsplux* HUB
- 8 professional sensors of your choice
- 1 PLUX proven Bluetooth dongle
- 8GB internal memory
- 24 electrodes
- 1 medical grade charger
- 1 portable and rugged storage case with foam cushioning to house all the parts
- 16h personalized technical support
- Fast USB data transfer cable
- OpenSignals (r)evolution signal acquisition and visualization software (download [here](#))

- OpenSignals (r)evolution Real-Time Event Emulation Add-On
- OpenSignals (r)evolution Heart Rate Variability (HRV) Add-On
- OpenSignals (r)evolution Electromyography (EMG) Analysis Add-On
- OpenSignals (r)evolution Electrodermal (EDA) Events Add-On
- OpenSignals (r)evolution Respiration (PZT & RIP) Add-On
- OpenSignals (r)evolution Video Synchronization Add-On

Optional components and features³:

- Advanced sensors (see 3.2 *Advanced Sensors*)
- Accessories (see 4 *Accessories*)

³ OpenSignals (r)evolution add-ons may require specific sensors. Please check the indications given in chapter 8.1 *OpenSignals (r)evolution* to confirm that you have the required sensor(s).

1.4 biosignalsplux Force



Figure 5: biosignals Force

This kit contains:

- 1 wireless 4-channel *biosignalsplux* HUB with 8GB internal memory
- 4 load cell sensors (200Kg per sensor)
- 1 PLUX Bluetooth dongle
- 8GB internal memory
- 1 medical grade charger
- 1 sturdy aluminium plate (45x45cm)
- OpenSignals (r)evolution signal acquisition and visualization software (download [here](#))
- OpenSignals (r)evolution Real-Time Event Emulation Add-On
- OpenSignals (r)evolution Center of Mass Analysis Add-on

Optional components, features, and add-ons:

- 1 digital I/O port
- Advanced sensors (see 3.2 *Advanced Sensors*)
- Accessories (see 4 *Accessories*)
- OpenSignals (r)evolution Video Synchronization Add-On

2 biosignalsplux HUB



Figure 6: biosignalsplux hub

The *biosignalsplux* hub is the 4 or 8-channel device that collects and digitizes all signals from the sensors and accessories and transmits 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 8 channels with 3000 16-bit samples per channel per second.

biosignalsplux is compatible with all available *biosignalsplux* professional sensors (3.1 *Professional Sensors*), advanced sensors (3.2 *Advanced Sensors*), and accessories. Devices with internal memory do also allow options for onboard data logging features, without the need of a permanent Bluetooth connection.

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 for online acquisitions
- > Internal memory for offline acquisitions

Intended Use for Research Applications

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

2.1 4-Channel Hub Specifications



Figure 7: 4-channel biosignalsplux hub.

The 4-channel hub is available in the *biosignalsplux* Explorer and Force Platform kits and enables the usage of up to 4 sensors simultaneously. The standard version of this hub does not have an internal memory and a digital port which allows the usage of *biosignalsplux* accessories (see chapter 4 *Accessories* for more information). However, these features can be added to a 4-channel device. Contact our support for more information if you need to add these features (see 11.3 *Contact & Support*).

For detailed specifications check the table below and the *biosignalsplux* datasheet at the end of this manual (see annexes).

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:	none; 8GB optionally available (stores up to ~111h)
Communication:	Bluetooth 2.0+EDR (Class II); USB cable to download stored data from memory (optional extra)
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

2.2 8-Channel Hub Specifications



Figure 8: 8-channel biosignalsplux hub.

The 8-channel hub is available in the *biosignalsplux* Researcher (see 1.2 *biosignalsplux* Researcher) and *biosignalsplux* Professional (see 1.3 *biosignalsplux* Professional) kits and enables the usage of up to 8 sensors and up to 3 accessories (using the multi sync cable; see 4.2 *Synchronization & Additional Digital Ports* for more information) simultaneously.

The hub included in the *biosignalsplux* Professional kit comes with 8GB of internal memory. Internal memory is optionally available for the hub of the *biosignalsplux* Researcher kit. Contact our support for more information if you need to add internal memory to your device (see 11.3 *Contact & Support*)

For detailed specifications check the table below and the *biosignalsplux* datasheet at the end of this manual (see annexes).

Specifications

Analog Inputs:	8 (16-bit per channel)
Digital Ports:	1
Common Ground:	1
Sampling Rate:	up to 3000Hz (per channel)
Internal Memory:	8GB optionally available (stores up to ~111h) (optional for the <i>biosignalsplux</i> Researcher Kit)
Communication:	Bluetooth 2.0+EDR (Class II); USB cable to download stored data from memory (optional extra)
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

2.3 Ports and Peripherals

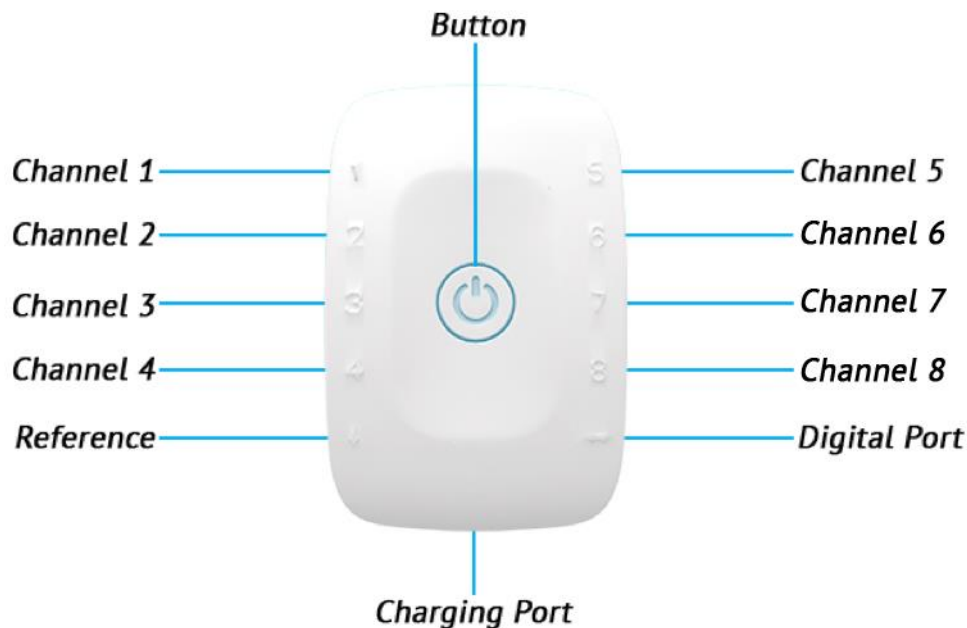


Figure 9: biosignalsplux ports and the button.

2.3.1 Button

The button is used to turn the device on and off and to display device status' using the built-in LED (see 2.3.6 *Button Behavior*).

2.3.2 Analog Inputs

The *biosignalsplux* hub has 4 or 8 analog ports to connect up to 4 or 8 *biosignalsplux* or 3rd party sensors to the hub (see 3 *biosignalsplux* Sensors for more information about the sensors). All channels are synchronously and simultaneously acquired.

2.3.3 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).

Additionally, this port is used to connect the USB adapter for the *fast USB data transfer cable* to download offline acquired signal from the internal memory of *biosignalsplux* devices (see 5 *Data Logging* and 5.2.2 *Download via Fast USB Data Transfer Cable*).

2.3.4 Digital Port

The digital port enables the usage of *biosignalsplux* accessories listed in chapter 4 *Accessories* (e.g., trigger buttons to manually mark events in your acquisitions or a synchronization cables to connect several *biosignalsplux* for synchronized multi-device acquisitions).

2.3.5 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 2.4.4 *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. *biosignalsplux* can be used during the charging process.

2.3.6 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 (see 12 *Datasheets*).

2.4 General Device Functionality

2.4.1 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 10: *biosignalsplux* center button.

2.4.2 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 in the 3 *biosignalsplux* Sensors chapter. The reference electrode/ground cable should be connected to the common ground port (see *Figure 6* or *Figure 11*).

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

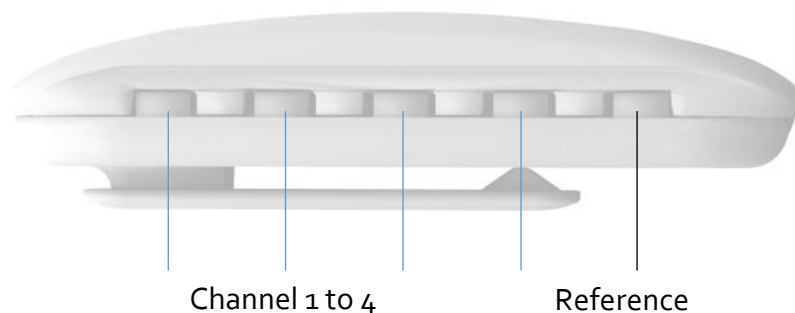


Figure 11: *biosignalsplux* side view.

2.4.3 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

2.4.4 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 12*). 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 12: 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.

2.5 Communication

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.

2.5.1 Bluetooth

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 used⁴).

<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 6 *Bluetooth Setup* section.

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 9.1 Bluetooth section of this manual

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

⁴ 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.

2.5.2 USB

The *biosignalsplux* USB adapter and the fast USB data transfer cable *biosignalsplux* accessories allow downloading offline acquired data stored in the internal memory of biosignalsplux devices. For this purpose, the USB adapter must be connected to the reference port of your *biosignalsplux* device (see 2.3.3 *Reference*).

Full instructions on how to access and download data from the internal memory of your device can be found in the chapters 5.2 *Downloading Offline Acquired Data* and 5.2.2 *Download via Fast USB Data Transfer Cable*.

3 biosignalsplux Sensors

biosignalsplux has a large variety of compatible professional and advanced sensors. While 4 or 8 professional sensors are already included in the *biosignalsplux* kits, advanced sensors can be bought additionally to extend the number of acquirable biosignals.

The entire updated list of *biosignalsplux* sensors can be accessed via the following link:

<http://biosignalsplux.com/index.php/en/products/sensors>

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.

NOTE

Please review the sensor datasheets (see annexes) for more detailed specifications.

NOTE

The sensor configuration for *biosignalsplux* devices are demonstrated by using PLUX's *OpenSignals (r)evolution* software. Please review the software manual for more detailed information about how to configure your device when using *OpenSignals*.

3.1 Professional Sensors

3.1.1 Electromyography (EMG)

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.



Figure 13: EMG sensor.

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

EMG sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This EMG sensor has no built-in reference electrode. We recommend connecting a reference electrode to the reference input of your device (see 2.3.3 *Reference*) which can then be used as reference signal for your EMG signal(s). For optimal signal acquisition, place your ground electrode on a region of the body with low level of muscle activity.

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).

An example configuration is displayed in *Figure 14* (here: EMG connected to channel 1).



Figure 14: EMG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in Figure 15.

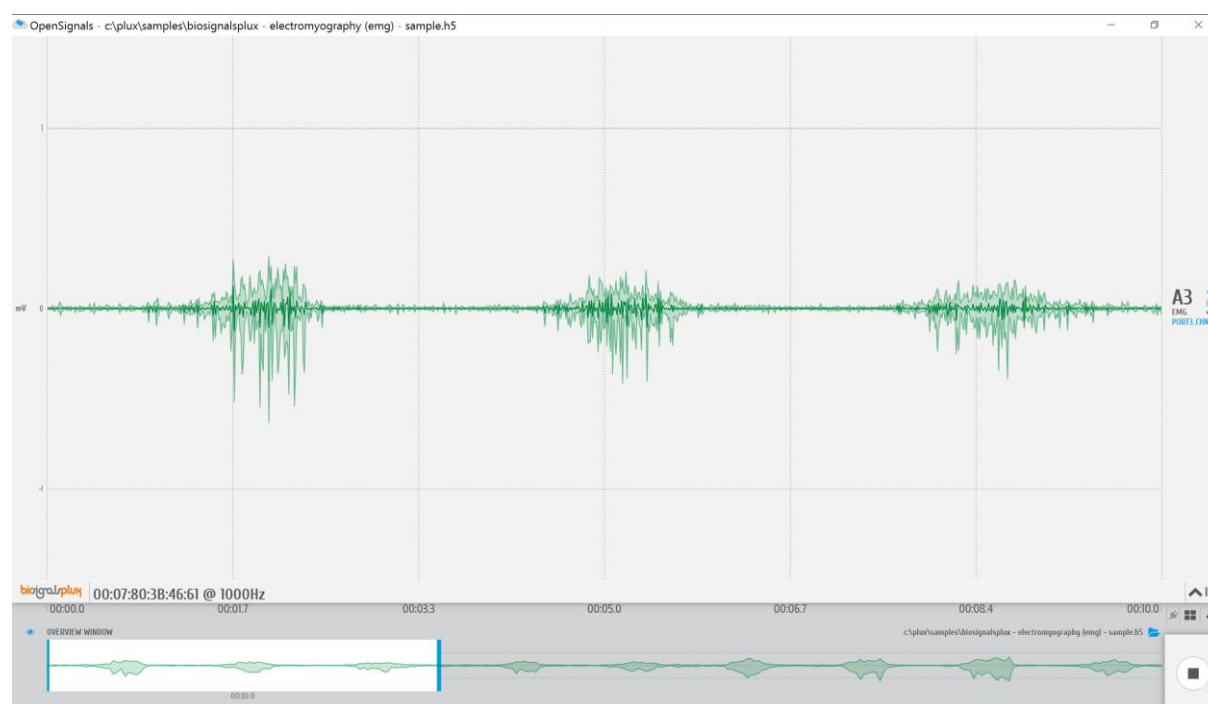


Figure 15: biosignalsplux EMG sensor sample.

OpenSignals (r)evolution Add-On: Electromyography Analysis

The *Electromyography Analysis* add-on is able to extract useful statistical information from EMG data acquired with this EMG sensor. This add-on's automatic onset detection algorithm enables the analysis of each individual muscle action even, in addition to the overall analysis of the recording session. Timings analysis is also done for each activation to a reference muscle.

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and can be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this EMG sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.1.2 Electrocardiography (ECG)

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.



Figure 16: ECG sensor.

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, negative or reference electrode cable (see Table 3).

Electrode Cable	+	-	Reference
Sleeve Color	Red	Black	White

Table 3: Color coding of the electrode cable sleeves.

How to connect your sensor to your biosignalsplux

ECG sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This ECG sensor has a built-in reference electrode. An additional reference electrode which can be connected to the reference input of your device is not needed but can still be used to work with this sensor (see 2.3.3 *Reference*).

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your ECG sensor connected to. Select the channel of your ECG sensor and select *ECG* 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).

An example configuration is displayed in *Figure 17* (here: ECG connected to channel 1).



Figure 17: ECG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 18*.

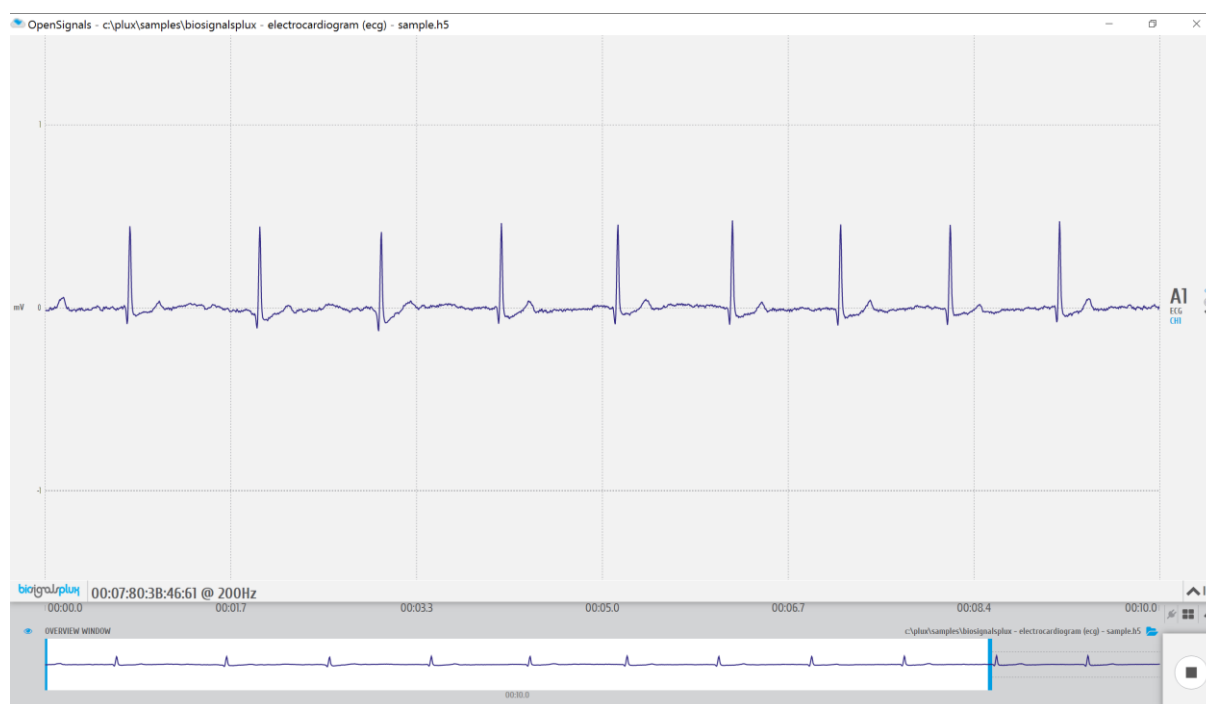


Figure 18: biosignalsplux ECG sensor sample.

OpenSignals (r)evolution Add-On: Heart Rate Variability

The *Heart Rate Variability* add-on provides important quantitative markers related with the sympathetic or vagal activity. This plugin enables the seamless extraction and analysis of temporal, spectral, and non-linear parameters from sensor data acquired with this ECG sensor (or the blood volume pulse sensor; see 3.2.6 *Blood Volume Pulse (BVP)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and in the [cardioBAN wearable](#) but it can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this ECG sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.1.3 Electrodermal Activity (EDA)

Our EDA sensor is capable of accurately measuring the skin activity with high sensitivity in a miniaturized form factor. The low-noise signal conditioning and amplification circuit design provides optimal performance in the detection of even the most feeble electrodermal skin response



Figure 19: EDA sensor.

How to connect your sensor to your biosignalsplux

EDA sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your EDA sensor connected to. Select the channel of your EDA sensor and activate this channel for signal acquisition by clicking on the circle in the channel field (must be blue).

OpenSignals (r)evolution offers two modes that are designed for different applications for EDA sensors that can be selected in the dropdown menu which can be accessed via the channel field (click on the arrow in the channel's field that appears when you hover over the channel's field).

The *EDA* option is designed to work with applications where the EDA sensor is placed, for example, on the hand of the subject. If you plan to use the EDA sensor on the arm of a subject, we recommend selecting the *EDA.ARM* configuration to ensure high quality data acquisition.

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

An example configuration is displayed in *Figure 20* (here: EDA connected to channel 1 and EDA on arm configuration connected to channel 2).

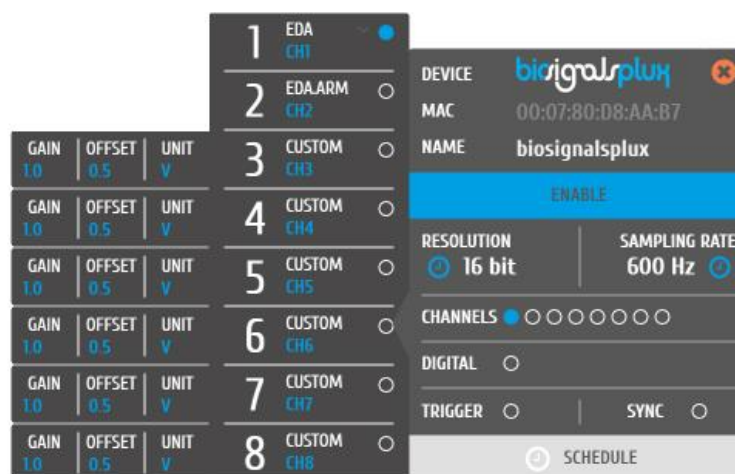


Figure 20: EDA configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 21*.

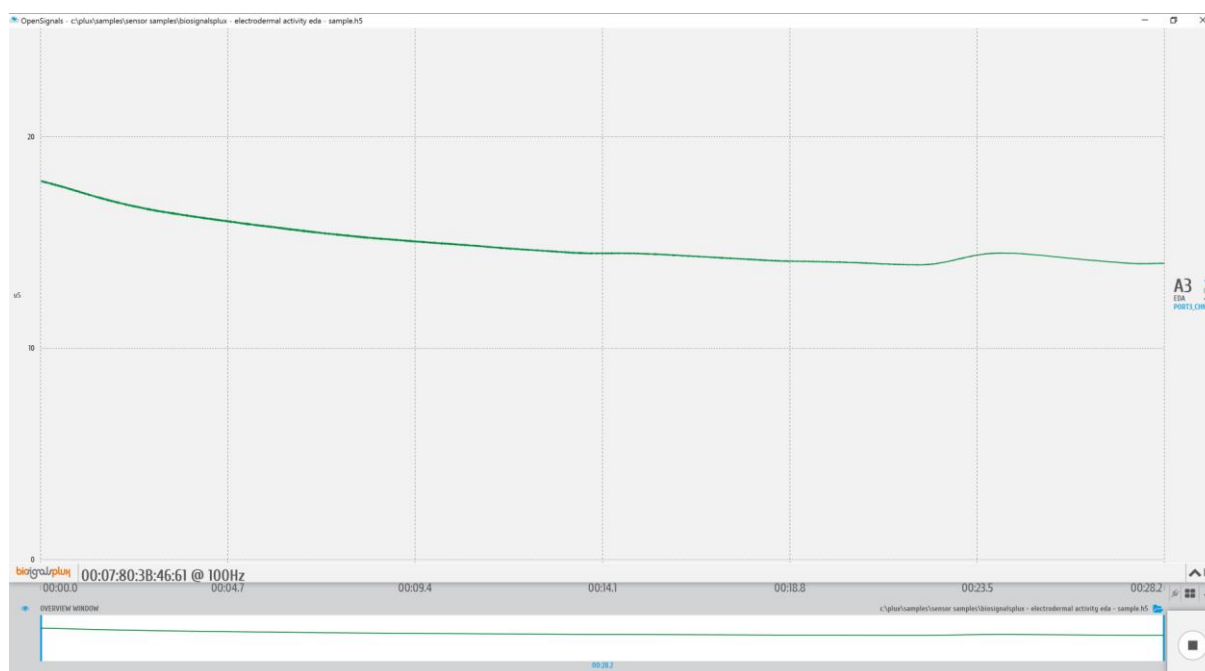


Figure 21: biosignalsplux EDA sensor sample.

OpenSignals (r)evolution Add-On: Electrodermal Activity Events

The *Electrodermal Activity Events* add-on has been designed to compute overall statistics, basic spectral analysis, and extract typical event-related phasic features from sensor data acquired with this EDA sensor.

This add-on is included in the *biosignalsplux Professional* kit (see *1.3 biosignalsplux Professional*) and can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this EDA sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.1.4 Electroencephalography (EEG)

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.



Figure 22: EEG sensor.

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, negative or reference electrode cable (see Table 4).

Electrode Cable	+	-	Reference
Sleeve Color	Red	Black	White

Table 4: Color coding of the electrode cable sleeves.

How to connect your sensor to your biosignalsplux

The EEG sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This EEG sensor has a built-in reference electrode cable. An additional reference electrode which can be connected to the reference input of your device is not needed but can still be used to work with this sensor (see 2.3.3 *Reference*) and useful when using multiple EEG sensors during an acquisition. For optimal signal acquisition, place your reference electrode on a region of the body with low level of muscle activity.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your EEG sensor connected to. Select the channel of your EEG sensor and select *EEG* 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).

An example configuration is displayed in *Figure 23* (here: EEG connected to channel 1).

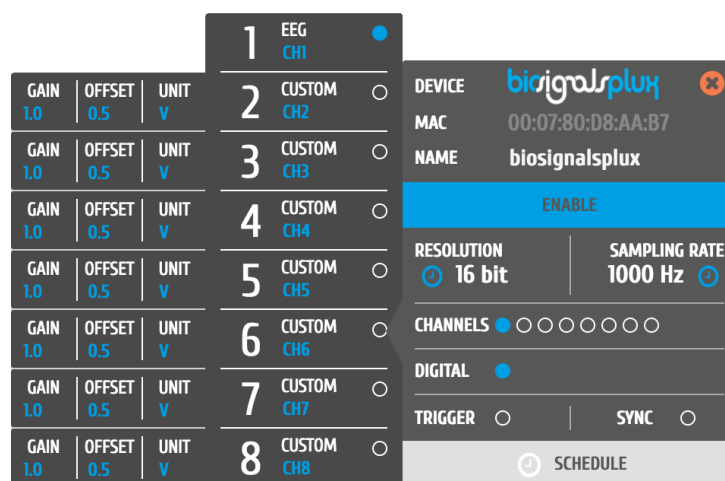


Figure 23: EEG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in Figure 24.

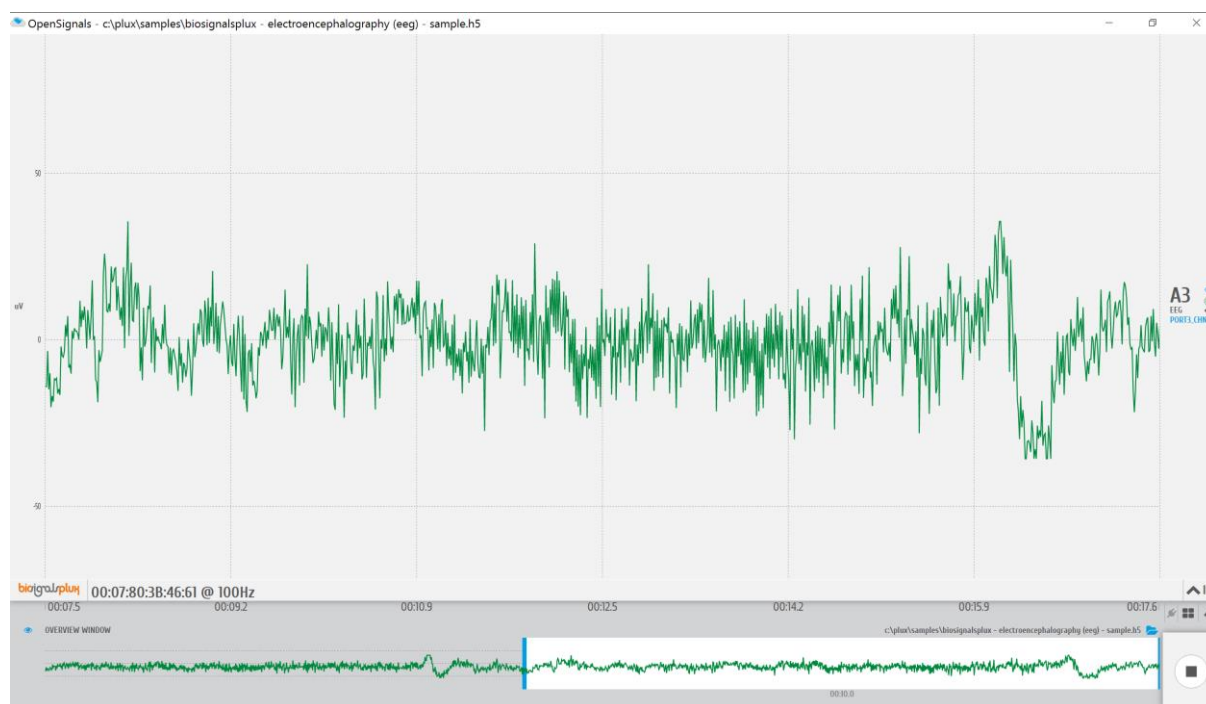


Figure 24: biosignalsplux EEG sensor sample.

Sensor specifications

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

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

3.1.5 Accelerometer (ACC)

Our 3D accelerometer uses Micro Electro-Mechanical Systems (MEMS®) technology, and has been especially designed taking into account the requirements of applications where kinematics and motion measurements are required. Together with our biosignal acquisition hardware, this sensor can measure sub-milliG accelerations and provides the raw data of each axis as an independent quantity giving you full control.



Figure 25: Accelerometer.

How to connect your sensor to your biosignalsplux

The accelerometer can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*). This sensor requires up to 3 analog inputs of your *biosignalsplux* (1 for each axis).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your accelerometer connected to. Select the channel(s) of your ACC sensor and select XYZ from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel field). We recommend labelling your channels accordingly to your accelerometer configuration for better visualization purposes.

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

An example configuration is displayed in *Figure 26* (here: ACC connected to channel 1 to 3; channel 1 = x-axis; channel 2 = y-axis; channel 3 = z-axis).

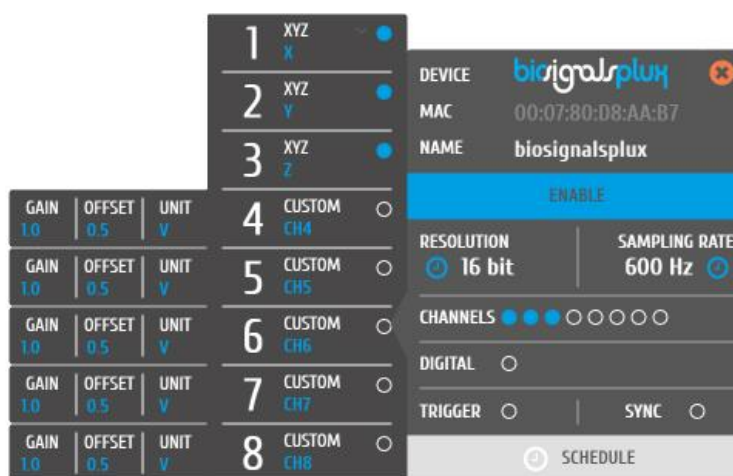


Figure 26: ACC configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 27*.

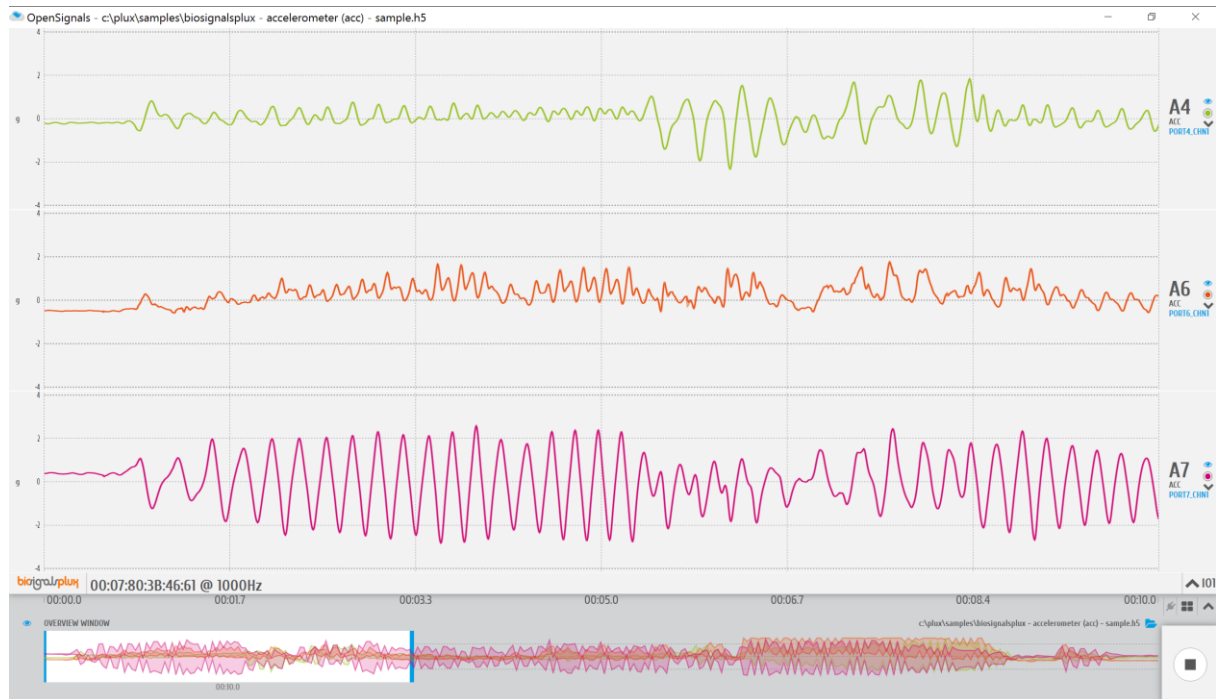


Figure 27: biosignalsplux triaxial ACC sensor sample.

Sensor specifications

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

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

3.1.6 Temperature (TMP)

Our high performance NTC sensors have been specifically developed for biomedical applications and are meant to be used on a range of temperatures suitable for body sensing. These sensors produce a robust, stable, and accurate output with low tolerance values. The geometry and rapid response are also of added value for even the most demanding applications.



Figure 28: Temperature sensor.

How to connect your sensor to your biosignalsplux

The temperature sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*)

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your temperature sensor connected to. Select the channel of your temperature sensor and select *TEMP* out of the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

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

An example configuration is displayed in Figure 29 (here: temperature sensor connected to channel 1).

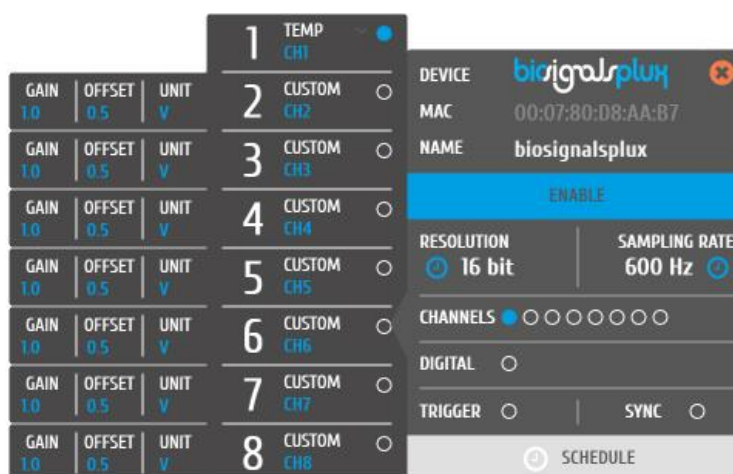


Figure 29: TMP configuration in OpenSignals.

If configured correctly, you should be able to acquire signals similar to the signal displayed in Figure 30.

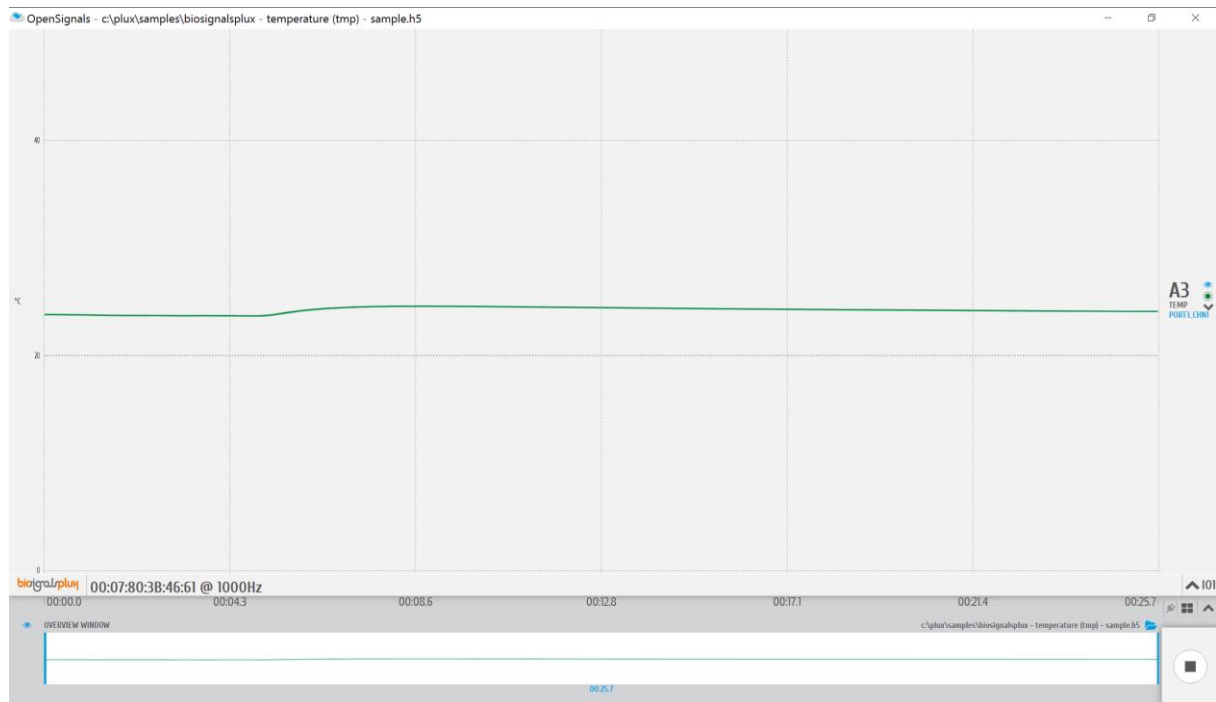


Figure 30: biosignalsplux temperature (TMP) sensor sample.

3.1.7 Respiration (PZT)

Our piezoelectric respiration sensor is an entry-level affordable option for respiratory analysis in a wide range of applications. It has a localized sensing element that measures displacement variations induced by inhaling or exhaling. The elastic strap is provided with the sensor to secure it in place, and can be adjusted in length, enabling the sensor to be applied in different anatomies (e.g. male and/or female) and body locations (e.g. thorax and/or abdomen).



Figure 31: PZT sensor.

How to connect your sensor to your biosignalsplux

The respiration sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your respiration sensor connected to. Select the channel of your respiration sensor and select *RESP* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

Activate the respiration sensor's channel for signal acquisition by clicking on the circle in the channel field (must be blue).

An example configuration is displayed in *Figure 32* (here: respiration sensor connected to channel 1).

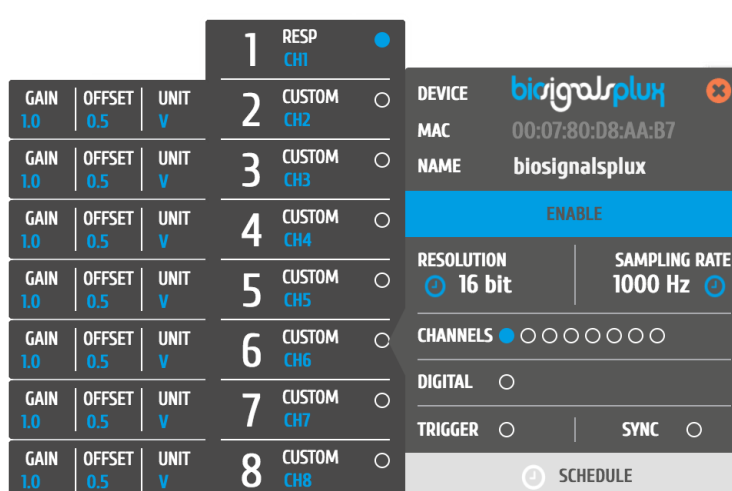


Figure 32: Respiration (PZT) configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 33*.

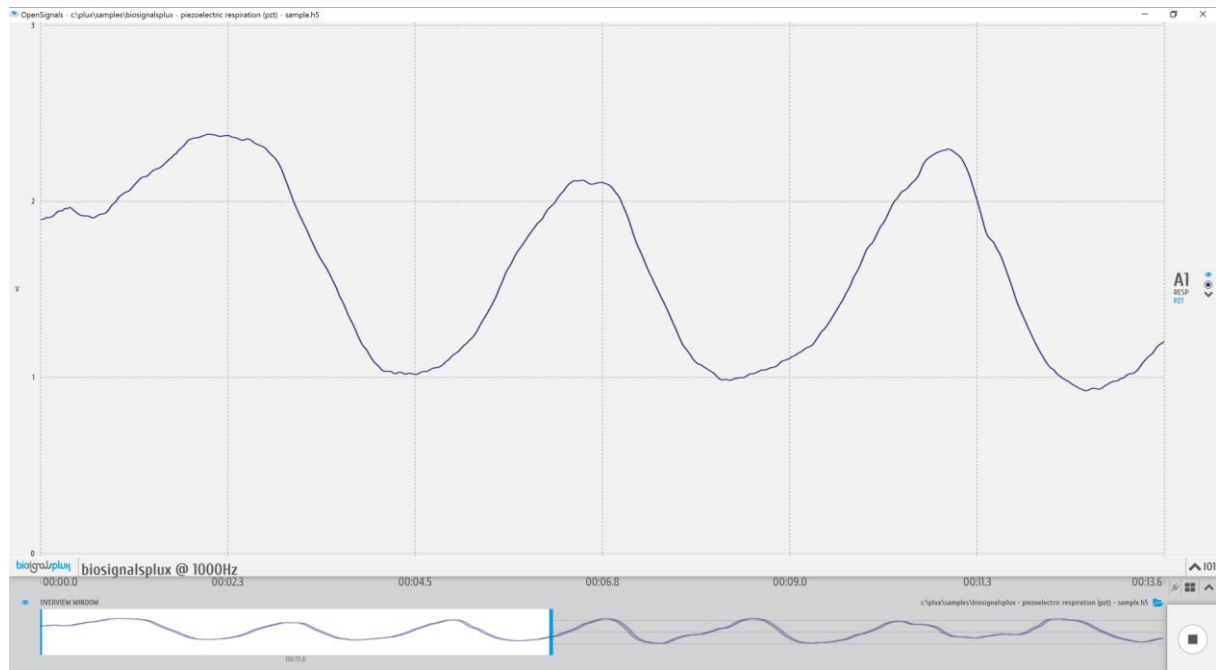


Figure 33: biosignalsplux respiration (PZT) sensor sample.

OpenSignals (r)evolution Add-On: Respiration Analysis

The *Respiration Analysis* add-on is a convenient way to determine respiratory rate and other useful temporal and statistical parameters associated with the respiratory cycles and to provide useful information about the breathing dynamics. It is designed to work with sensor data acquired with this piezoelectric respiration sensor (PZT) (or with the inductive respiration sensor (RIP); see 3.2.1 *Respiration (RIP)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and in the [raspiBAN PRO wearable](#) but it can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this respiration sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.1.8 Force (FSR)

From reaction time measurement to load distribution in shoe insoles, our thin film force sensors offer uncompromised performance in the most demanding applications. The low profile membrane and miniaturized signal conditioning circuitry are ideal for minimally intrusive setups. Multiple sensing area dimensions and measurement ranges are available.



Figure 34: Force sensor.

How to connect your sensor to your biosignalsplux

ECG sensors can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*)

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your force sensor connected to. Select the channel of your force sensor and select *CUSTOM* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field). In the custom field of your channel, adjust the *GAIN* and *OFFSET* that fits best to your application. Testing and readjustments of this parameters might be needed to find the configuration that fits best your needs.

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

An example configuration is displayed in *Figure 35* (here: force sensor connected to channel 1).

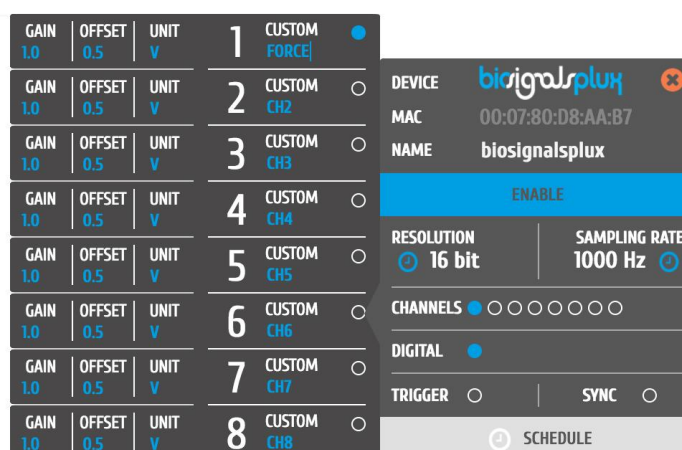


Figure 35: Force sensor configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 36*.

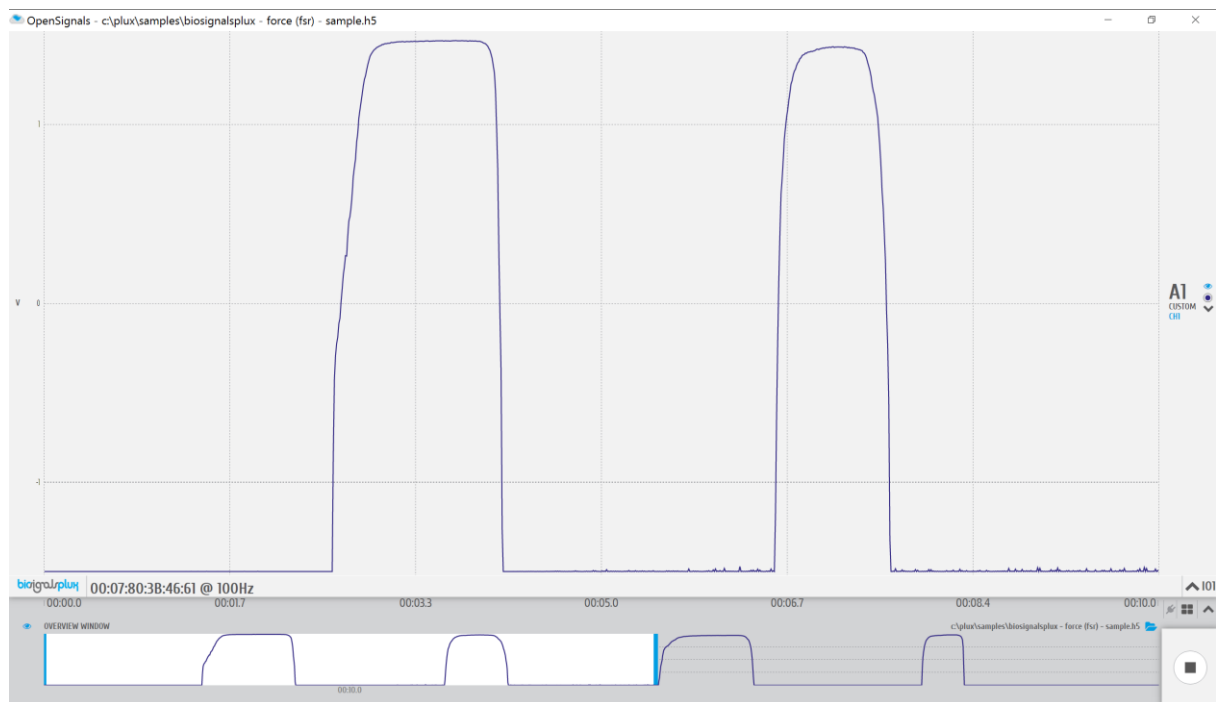


Figure 36: biosignalsplux force (FSR) sensor sample.

3.1.9 Light (LUX)

A common need when working with biosignals is the synchronization of the recorded data with external sources (e.g. a computer screen for visual evoked potentials). If applied to the computer screen, our LUX sensor can be used to detect chromatic changes in the stimuli, hence providing a synchronization source. The LUX sensor can also be useful for optical synchronization with third-party devices (provided that the third-party device can trigger an LED), in applications where it is important to have electrical decoupling between devices.



Figure 37: Light sensor.

How to connect your sensor to your biosignalsplux

The *biosignalsplux* light sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 Analog Inputs)

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Note, that the signal you are acquiring with this light sensor is affected by the ambient light and other light sources that are available at your experiment setup. Therefore, it is needed to adjust the acquired signal to fit to your application and setup.

For this, open the *OpenSignals (r)evolution* device manager and select the device you have your light sensor connected to. Select the channel of your light sensor and select *CUSTOM* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field). In the custom field of your channel, adjust the *GAIN* and *OFFSET* that fits best to your application. Testing and readjustments of this parameters might be needed to find the configuration that fits best your needs.

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

An example configuration is displayed in Figure 38 (here: light sensor connected to channel 1).

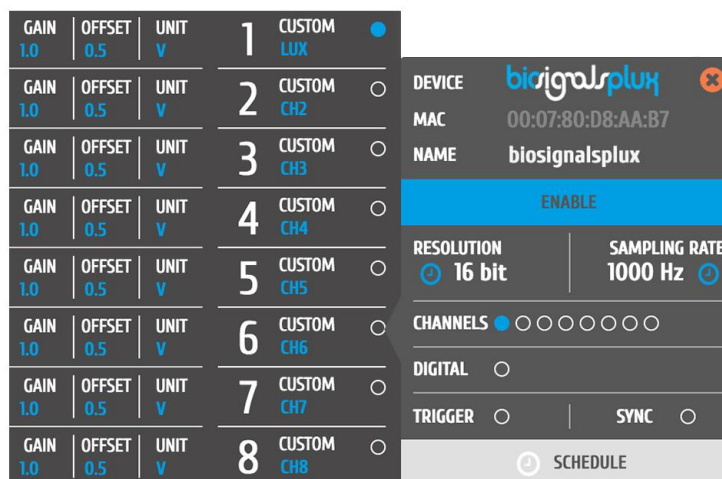


Figure 38: Light sensor configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 39*.

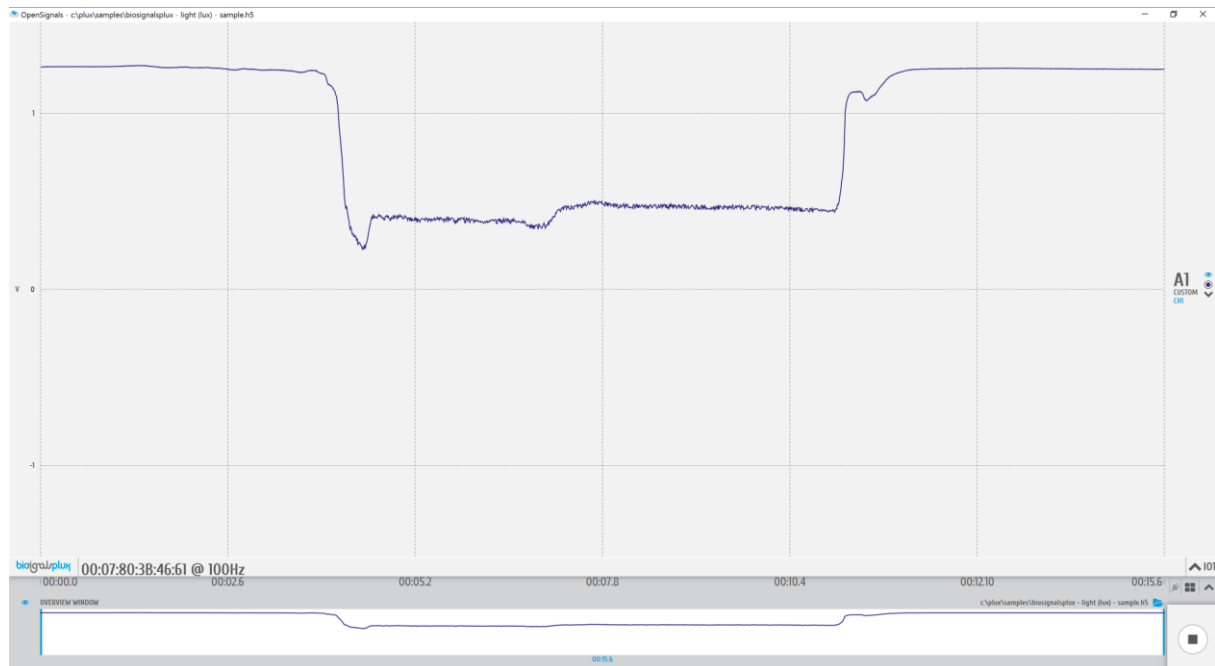


Figure 39: biosignalsplux light (LUX) sensor sample.

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 light sensor (or the *biosignalsplux LED*; see 4.1.3 *Light-Emitting Diode (LED)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and the *biosignalsplux Researcher* kit (see 1.2 *biosignalsplux Researcher*), and can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this light sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.2 Advanced Sensors

3.2.1 Respiration (RIP)

This high-performance inductive respiration sensor has been specifically designed having dynamic conditions in mind (e.g. ambulatory sensing). The sensing element is embedded in the chest strap fabric, and spans its full length. Unlike our affordable piezoelectric (PZT) sensor (which only measures the displacement in a localized manner), the RIP option measures the overall displacement of the thorax or abdomen, making it more immune to motion-induced artefacts.

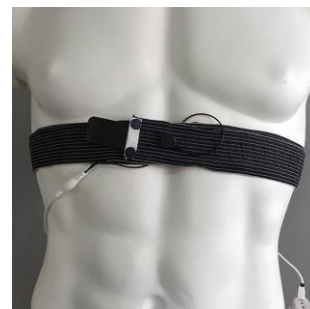


Figure 40: Respiration (RIP) sensor.

How to connect your sensor to your biosignalsplux

The respiration (RIP) sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your respiration sensor connected to. Select the channel of your respiration sensor and select *RESP* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

Activate the respiration sensor's channel for signal acquisition by clicking on the circle in the channel field (must be blue).

An example configuration is displayed in *Figure 41* (here: respiration sensor connected to channel 1).

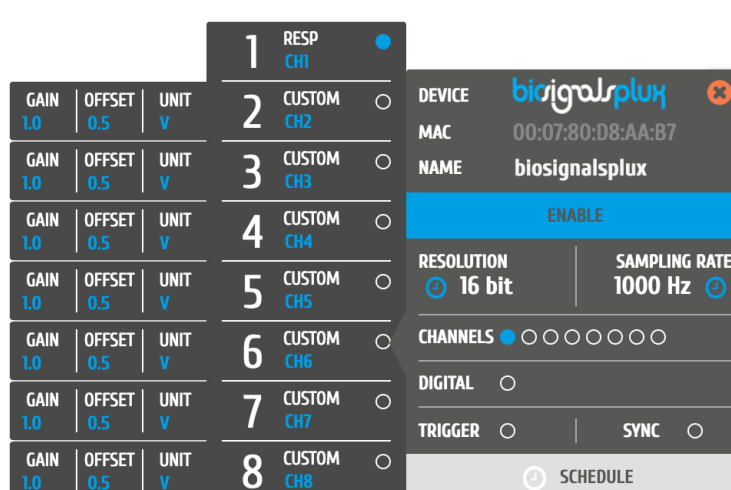


Figure 41: Respiration (RIP) configuration in OpenSignals.

OpenSignals (r)evolution Add-On: Respiration Analysis

The *Respiration Analysis* add-on add-on is a convenient way to determine respiratory rate and other useful temporal and statistical parameters associated with the respiratory cycles and to provide useful information about the breathing dynamics. It is designed to work with sensor data acquired with this inductive respiration sensor (RIP) (or with the piezoelectric respiration sensor (PZT); see 3.1.7 *Respiration (PZT)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and in the [raspiBAN PRO wearable](#) but it can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this respiration sensor.

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.2.2 Goniometer (GON)

This twin-axis goniometer provides accurate data related with flexion/extension and ulnar/radial deviation. With two attachment points to the body and a flexible beam, it enables high-performance uncompromised operation even in dynamic scenarios, without limiting the motion of the monitored subjects. Multiple size options are available, enabling placement in segments ranging from a finger (e.g. intermediate – proximal phalanges) to a leg (e.g. lower part of the femur – upper part of the tibia).

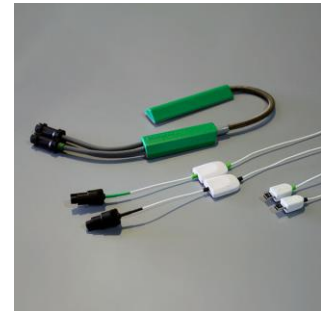


Figure 42: Goniometer.

How to connect your sensor to your biosignalsplux

The goniometer can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*) This sensor requires 2 analog inputs of your *biosignalsplux*.

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your goniometer connected to. Select the channels of your goniometer and select *GONIO* for both channels from of the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

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

An example configuration is displayed in *Figure 43* (here: goniometer connected to channel 1).

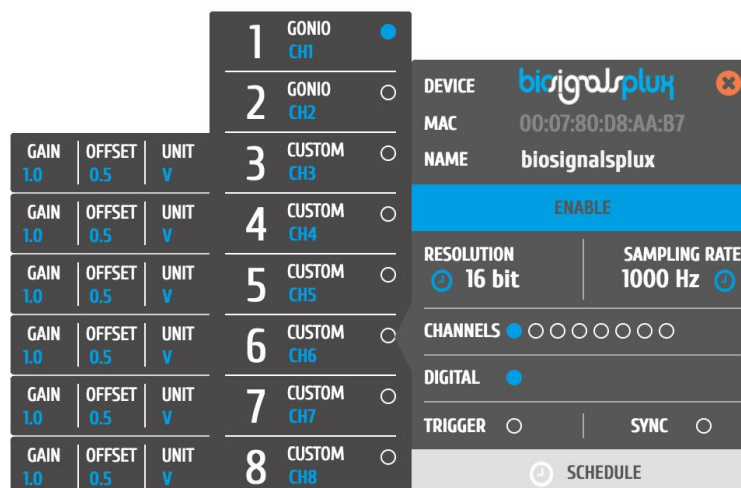


Figure 43: Goniometer configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 44*.

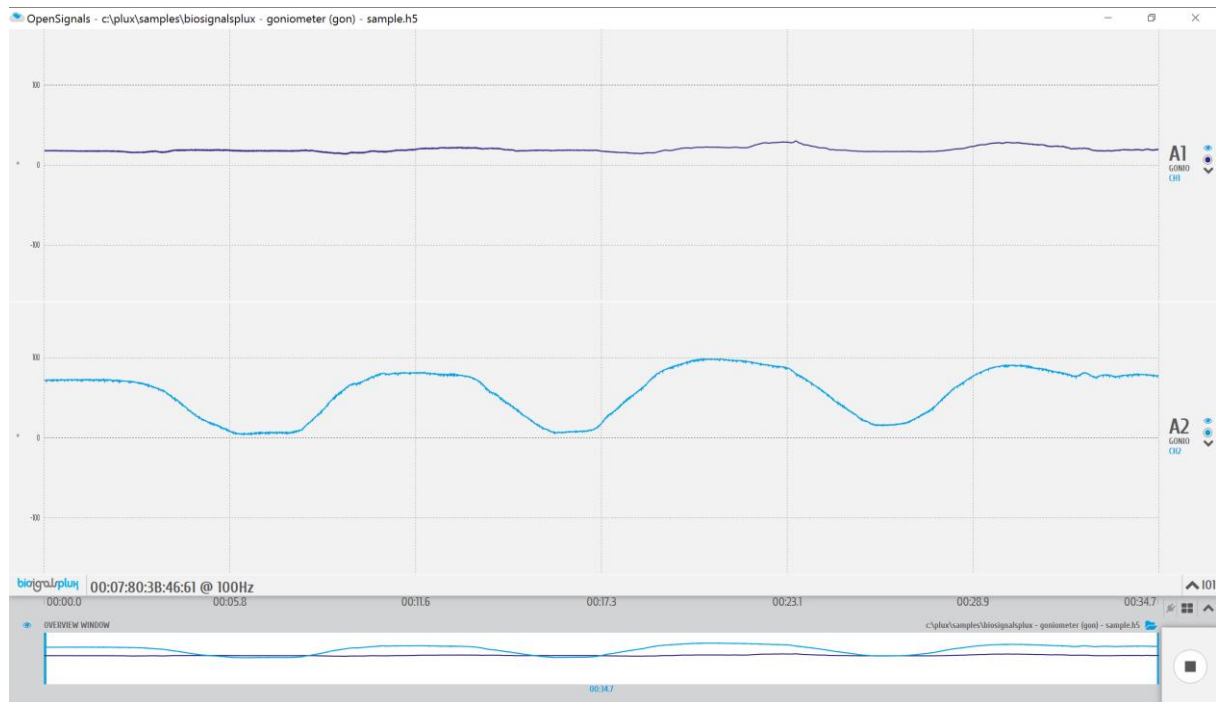


Figure 44: biosignalsplux goniometer sensor sample.

Sensor specifications

Please read the datasheet of the goniometer carefully before using it the first time. The datasheet can be found at the end of this manual or using the following link:

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

3.2.3 Load Cell

This single-axis load cell is particularly suitable for handgrip, traction/compression, and similar applications. Its sturdy design and accessories enable force measurement in many different settings. The plug & play design provides maximum flexibility for use with our biosignal acquisition kits.

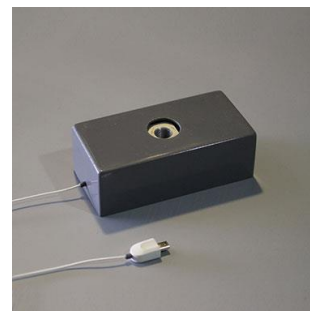


Figure 45: Load cell.

How to connect your sensor to your biosignalsplux

The load cell can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your load cell connected to. Select the channel of your load cell and select *HANDGR* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

Activate the respiration sensor's channel for signal acquisition by clicking on the circle in the channel field (must be blue).

An example configuration is displayed in *Figure 46* (here: load cell connected to channel 1).

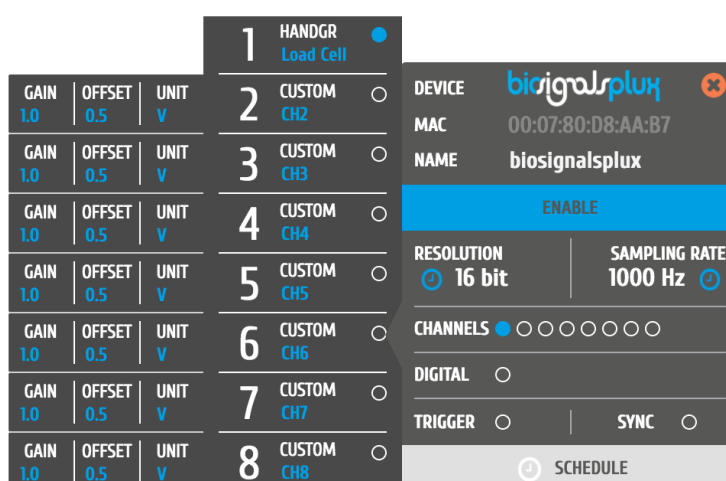


Figure 46: Load cell configuration in OpenSignals.

OpenSignals (r)evolution Add-On: Center of Mass Analysis

The *Center of Mass Analysis* add-on can be used for several applications using 4 of these sensors with the *biosignalsplux Force Platform* (see 1.4 *biosignalsplux Force*). Center of gravity distribution, jump analysis, weight assessment and force production capacity are just some of applications. This plugin allows you to observe, in real-time, the center of gravity and the force produced in each moment.

This add-on is included in the *biosignalsplux Force* kit (see 1.4 *biosignalsplux Force*).

Please visit the following website for more information about this add-on:

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

Sensor specifications

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

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

3.2.4 Vaginal Probe (Pelvic EMG Sensor)

This sensor is especially designed for high performance pelvic floor EMG data acquisition. 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 electrophysiology research.

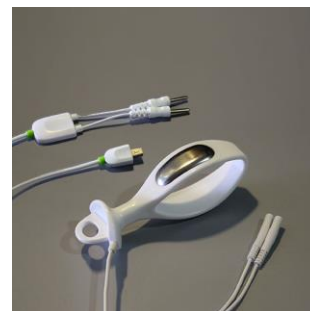


Figure 47: Vaginal probe.

How to connect your sensor to your biosignalsplux

The vaginal probe for applications measuring pelvic EMG can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*)

This EMG sensor has no built-in reference electrode. We recommend connecting a reference electrode to the reference input of your device (see 2.3.3 *Reference*) which can then be used as reference signal for your EMG signal(s). For optimal signal acquisition, place your ground electrode on a region of the body with low level of muscle activity.

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 sensor's channel for signal acquisition by clicking on the circle in the channel field (must be blue).

An example configuration is displayed *Figure 48* (here: vaginal probe connected to channel 1).

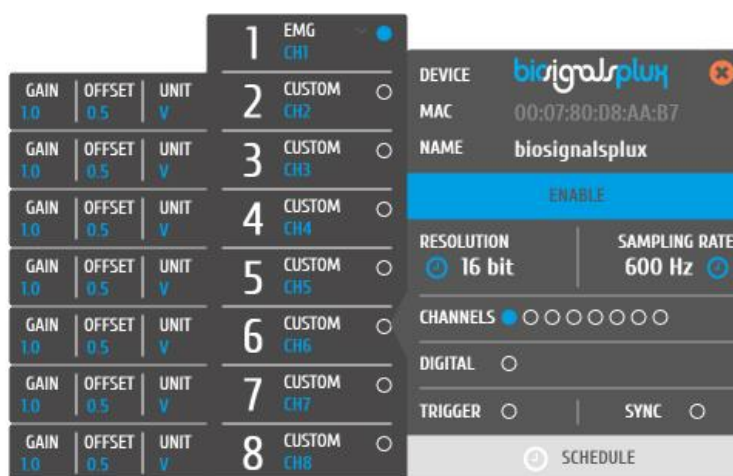


Figure 48: Vaginal probe configuration in OpenSignals.

Sensor specifications

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

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

3.2.5 RFID Sensor

This sensor is useful for synchronous recording of biosignal data and ID-mappable events. Usage examples include token detection and reaction time analysis in object manipulation tasks, and also differentiated event annotation.



Figure 49: RFID sensor.

How to connect your sensor to your biosignalsplux

The RFID sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*).

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your RFID sensor connected to. Select the channel of your RFID sensor and select *CUSTOM* from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field). In the custom field of your channel, adjust the *GAIN* and *OFFSET* that fits best to your application. Testing and readjustments of this parameters might be needed to find the configuration that fits best your needs.

Alternatively, you can also use the *RAW* option, which will display the raw digital signals that are received from the *biosignalsplux*.

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

An example configuration is displayed in *Figure 50* (here: RFID sensor connected to channel 1).

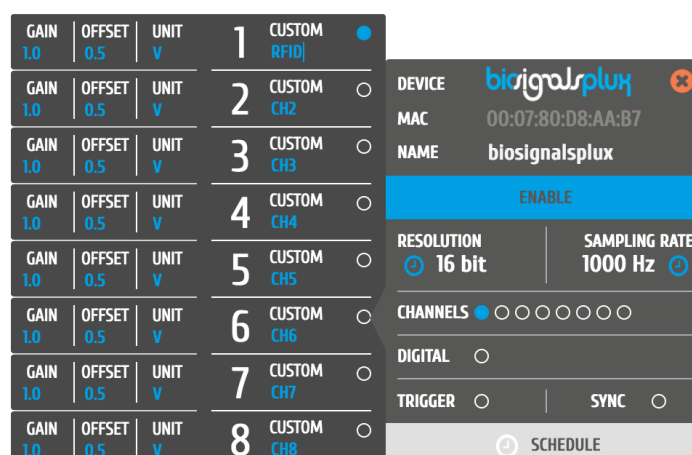


Figure 50: Load cell configuration in OpenSignals.

Sensor specifications

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

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

3.2.6 Blood Volume Pulse (BVP)

This Blood Volume Pulse (BVP) sensor is an optical, non-invasive sensor that measures cardiovascular dynamics by detecting changes in the arterial translucency. When the heart pumps blood the arteries become more opaque, allowing less light to pass from the emitter on the sensor through to the receiver. The BVP sensor has a plastic clip-on housing for placement on the finger, which houses the light emitter and detector, and also minimizes interferences from external light sources.



Figure 51: BVP sensor.

How to connect your sensor to your biosignalsplux

The blood volume pulse sensor can be connected to any of the available analog inputs of your *biosignalsplux* device (see 2.3.2 *Analog Inputs*)

This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your blood volume pulse sensor connected to. Select the channels of your sensor and select *BVP* for the channel from of the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

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

An example configuration is displayed in *Figure 52* (here: blood volume pulse sensor connected to channel 1).

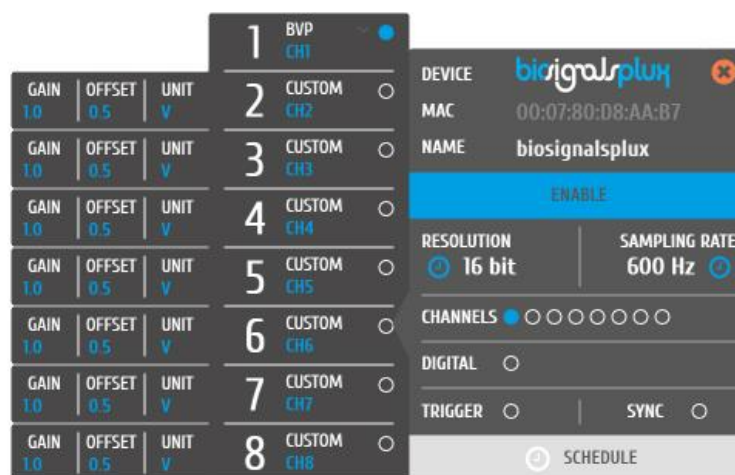


Figure 52: Blood volume pulse sensor configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 53*.

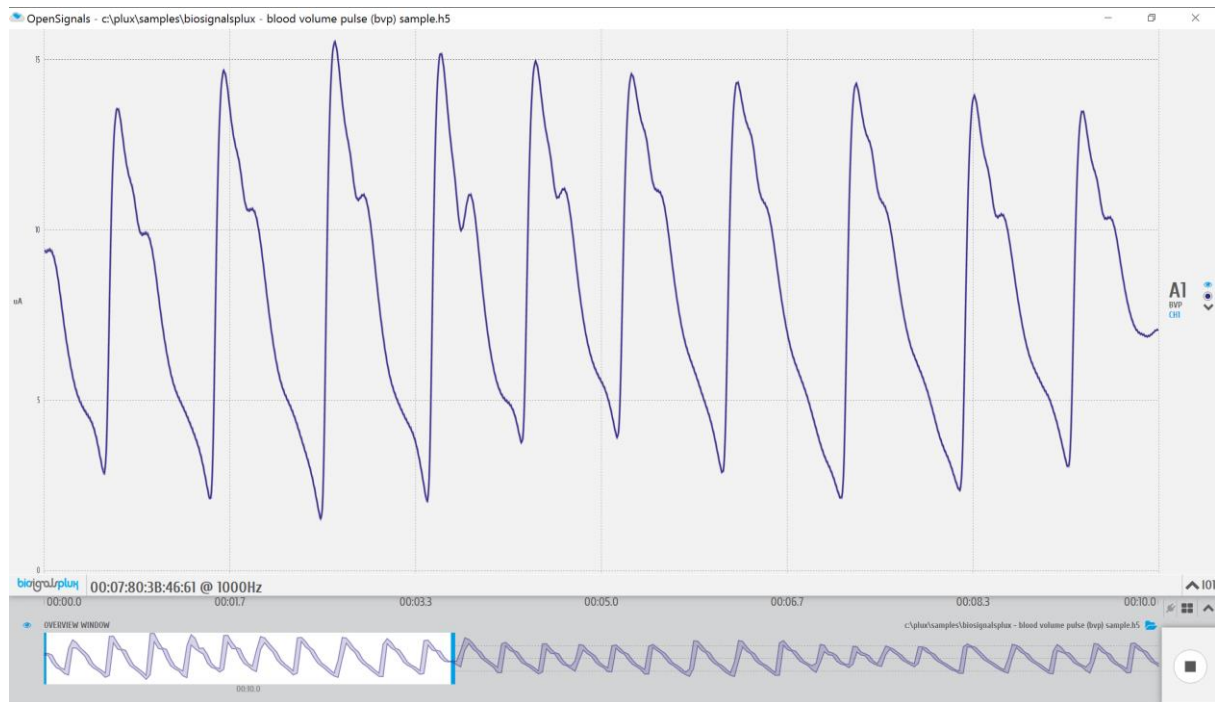


Figure 53: biosignalsplux blood volume pulse (BVP) sensor sample.

OpenSignals (r)evolution Add-On: Heart Rate Variability

The *Heart Rate Variability* add-on provides important quantitative markers related with the sympathetic or vagal activity. This plugin enables the seamless extraction and analysis of temporal, spectral, and non-linear parameters from sensor data acquired with this BVP sensor (or the ECG sensor; see 3.1.2 *Electrocardiography (ECG)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and in the [cardioBAN wearable](#) but it can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this BVP sensor. Please visit the following website for more information:

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

Sensor specifications

Please read the datasheet of the blood volume pulse sensor carefully before using it the first time. The datasheet can be downloaded here:

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

3.2.7 SpO₂

The SpO₂ (peripheral capillary oxygen saturation) sensor uses two emitting LED's one in the red region and the other in the infrared region of the spectrum. The reflected light of each one of these LED's is absorbed by a photodiode that converts this current into a digital value that is sent via SPI. This sensor can be used to estimate the oxygen saturation level on the blood with +/- 2% accuracy compared to a medical sensor.



Figure 54: SpO₂ sensor.

NOTE

This sensor needs to be connected to the digital port of *biosignalsplux* devices. Please check if your device does have a digital port before considering using this sensor (4-channel *biosignalsplux* devices do not have a digital port (can be added additionally); 8-channel *biosignalsplux* devices do have a digital port).

NOTE

Please confirm your device is running on a firmware which is compatible with this sensor (*Firmware v.3.4_SpO₂*). For this, please follow the instructions in chapter 7 *Firmware Updates & Upgrades*) or contact our technical support for more information.

How to connect your sensor to your biosignalsplux

The SpO₂ sensor needs to be connected to the digital port of your device (see 2.3.4 *Digital Port*). Connecting this sensor to an analog input of your device will not work. This sensor does not require an additional reference electrode.

How to configure your sensor in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select the device you have your respiration sensor connected to. In the device's panel, select channel 9 (digital port) and select one of the available SpO₂ options from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

The available SpO₂ options in this dropdown menu are designed for different placement areas of the SpO₂ sensor. We recommend selecting the available configuration that fits best your needs. The following configurations are available:

- *SPO₂.ARM* for applications where the sensor is placed on the subject's arm
- *SPO₂.FING* for applications where the sensor is placed on the subject's finger
- *SPO₂.HEAD* for applications where the sensor is placed on the subject's head

After selecting the best configuration, activate the sensor's channel for signal acquisition by clicking on the circle in the channel field (must be blue).

If configured correctly, your acquired signals should be similar to the signal displayed *Figure 55*.

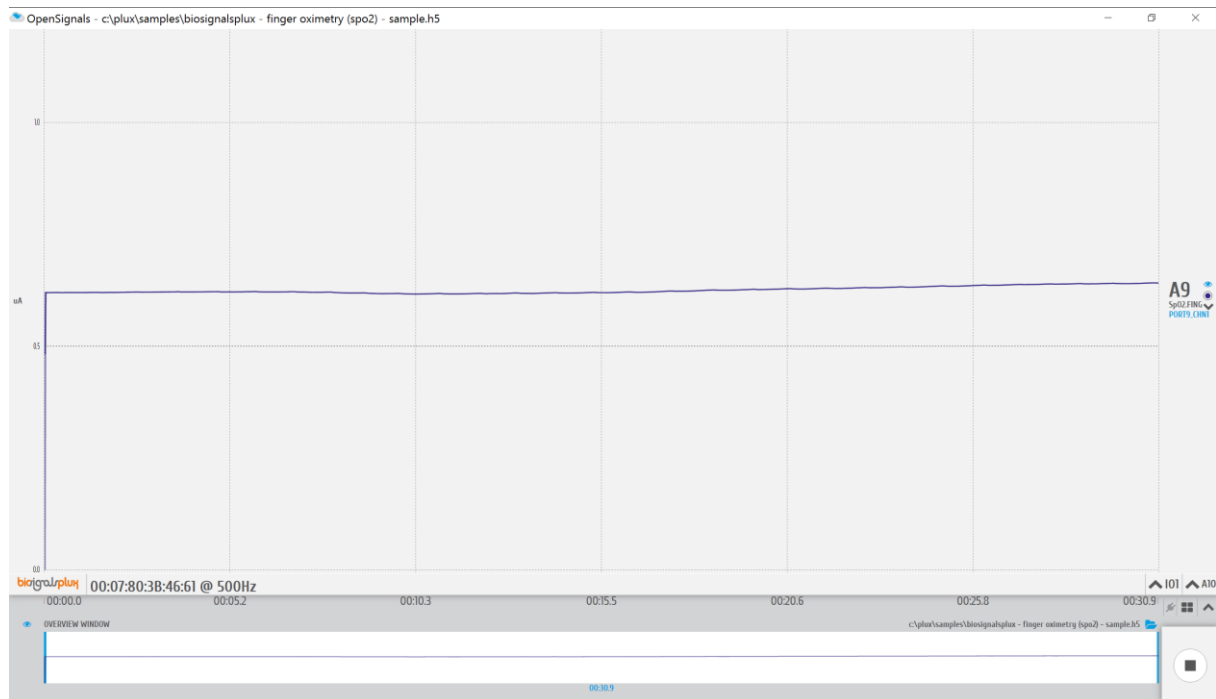


Figure 55: biosignalsplux SpO2sensor sample.

Sensor specifications

Please read the datasheet of the SpO₂ sensor carefully before using it the first time. The datasheet can be downloaded here:

[http://www.biosignalsplux.com/datasheets/SpO₂_Sensor_Datasheet.pdf](http://www.biosignalsplux.com/datasheets/SpO2_Sensor_Datasheet.pdf)

4 Accessories

NOTE

biosignalsplux Accessories need to be connected to the digital port of *biosignalsplux* devices. Please check if your device does have a digital port before considering using one of the following accessories (4-channel *biosignalsplux* devices do not have a digital port (can be added additionally); 8-channel *biosignalsplux* devices do have a digital port).

NOTE

The configurations for *biosignalsplux* accessories are demonstrated by using PLUX's *OpenSignals (r)evolution* software. Please review the software manual for more detailed information about how to configure your device when using *OpenSignals*.

4.1 Actuators

4.1.1 Handheld Switch

This trigger device is useful to begin acquisition via Bluetooth to OpenSignals (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 56: Handheld switch.

How to connect your accessory to your biosignalsplux

The handheld switch needs to be connected to the digital port of your device (see 2.3.4 *Digital Port*).

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'* real-time acquisition mode in the information bare located right below the acquired signals (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 57)

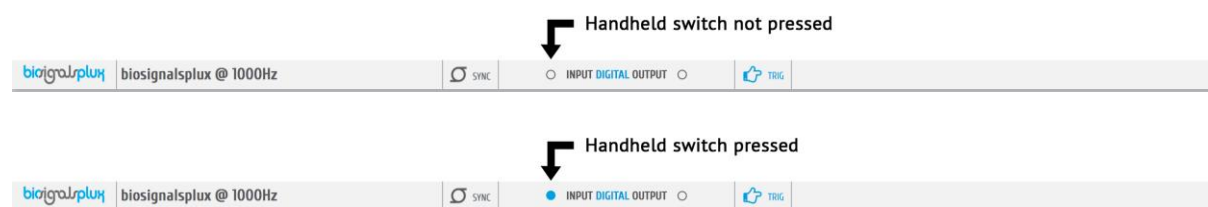


Figure 57: Digital input states.

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 58).

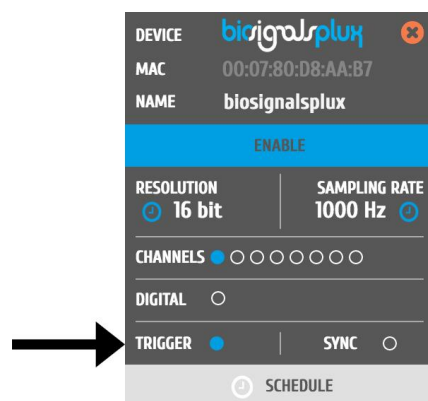


Figure 58: Trigger configuration.

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 59).



Figure 59: 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

4.1.2 Foot Switch

This trigger device is useful to begin acquisition via Bluetooth to OpenSignals (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 60: Foot switch.

How to connect your accessory to your biosignalsplux

The foot switch needs to be connected to the digital port of your device (see 2.3.4 *Digital Port*).

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

Input devices, such as the foot 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'* real-time acquisition mode in the information bare located right below the acquired signals (circle to the left of *INPUT DIGITAL*). The digital input circle will turn blue if a digital input has been received (foot switch pressed) or be kept empty if no digital input has been received (foot switch not pressed; see Figure 61).

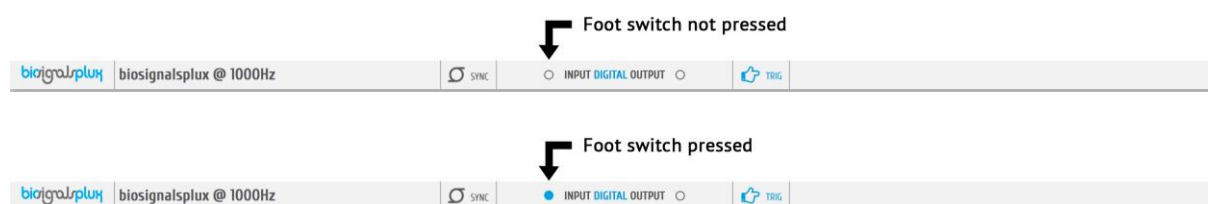


Figure 61: Digital input states.

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

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

If the intended use of the foot 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 foot 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 62).

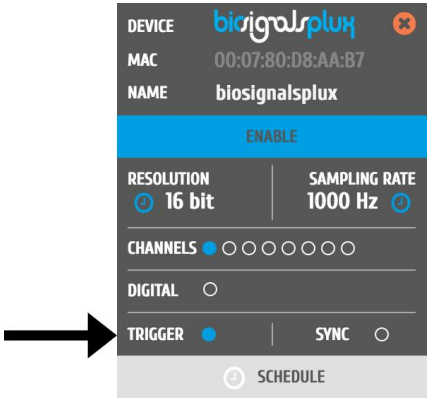


Figure 62: Trigger configuration.

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 63*).



Figure 63: Trigger state.

4.1.3 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.

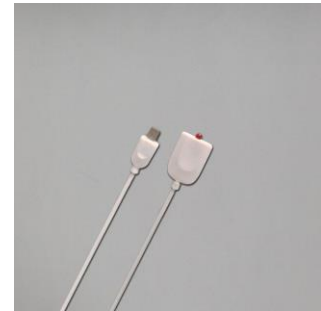


Figure 64: LED.

How to connect your accessory to your biosignalsplux

The LED needs to be connected to the digital port of your device (see 2.3.4 *Digital Port*).

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 (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 65).

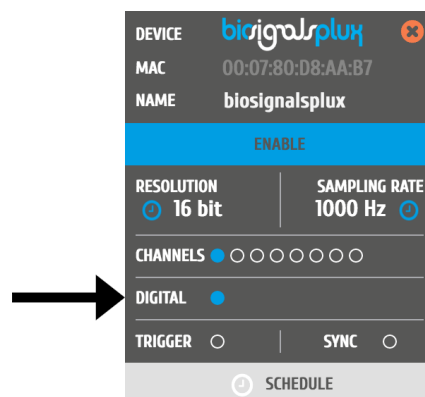


Figure 65: Initial state of the digital output (here: on).

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 66).

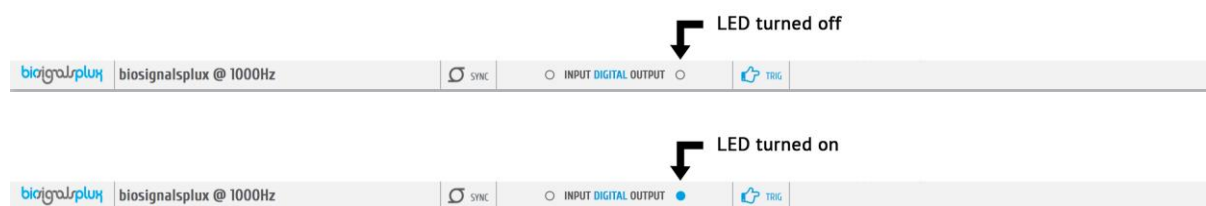


Figure 66: Digital output states for LED.

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 (or the light sensor (LUX); see 3.1.9 *Light (LUX)*).

This add-on is included in the *biosignalsplux Professional* kit (see 1.3 *biosignalsplux Professional*) and the *biosignalsplux Researcher* kit (see 1.2 *biosignalsplux Researcher*), and can also be bought additionally for the use with *biosignalsplux* hubs and wearables which can be used with this light sensor.

Please visit the following website for more information about this add-on:

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

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

4.2 Synchronization & Additional Digital Ports

4.2.1 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 67: Sync cable & kit.

NOTE

If you are using more than 2 devices, follow the instructions provided in 4.2.2 *Multi Sync Splitter*).

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 2.3.4 *Digital Port*).

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 68). 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.

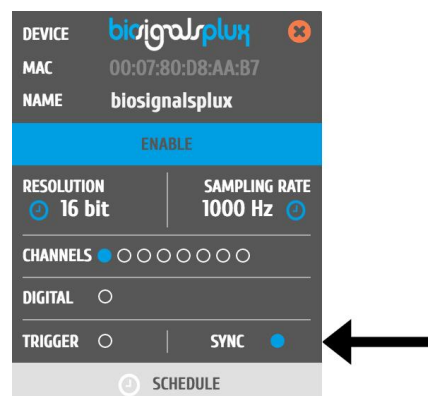


Figure 68: Activate synchronization feature.

4.2.2 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 69: 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 2.3.4 *Digital Port*). When done, link the other device(s) with the multi sync splitter by connecting digital synchronization cable(s) (see 4.2.1 *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 70). 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.

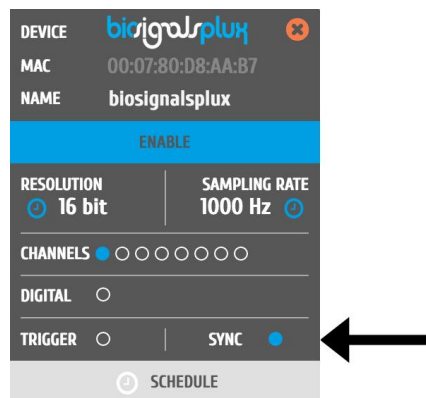


Figure 70: Activate synchronization feature.

4.3 3rd Party Compatibilities

biosignalsplux devices allow the usage and acquisition of data from 3rd party sensors, using the available [biosignalsplux breakout PCB](#). This accessory allows to connect analog or digital third party sensors to the *biosignalsplux* hub or *biosignalsplux* wearables that lie within the **specified and compatible electric values of the *biosignalsplux* HUB**. Please read [the breakout PCB section of this manual before](#) before trying to use any 3rd party sensor with *biosignalsplux*.

4.3.1 I/O Breakout Cable

WARRANTY WARNING

Usage of this breakout cable input interface **VOIDS THE ELECTRICAL WARRANTY** of your device and sensors.

DISCLAIMER

BEWARE when using this accessory as to preserve electrical isolation of the user.

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.

This accessory allows the connection, within the specified electric values, of a wide range of analog or digital third party sensors to the *biosignalsplux* hub. This allows, for instance, the acquisition and visualization in real time on OpenSignals of a third party sensor, using the *biosignalsplux* hub.



Specifications

Maximum Output Current: 200mA (with no other sensors connected to the hub)
Input Voltage Range: 0 – 3V
Output Voltage Range: 0 – 3V or ± 1.5 V (if reference is GND)

Check the table below and the breakout cable datasheet (see annexes) for detailed information about the pinout configuration for the analog ports (standard sensor channels) and digital ports (8-channel *biosignalsplux* devices only) **BEFORE CONNECTING YOUR SENSOR TO YOUR DEVICE** to avoid damaging your PLUX device.

ANALOG PORT	
V-	0V
GND	1.5V
V+	3V
IN	Analog input

DIGITAL PORT	
V-	0V
GND	Digital output
V+	3V
IN	Digital input

Table 5: Pinout configuration for analog & digital ports.

4.3.2 Sensor Breakout PCB

WARRANTY WARNING

Usage of this breakout cable input interface **VOIDS THE ELECTRICAL WARRANTY** of your device and sensors.

DISCLAIMER

BEWARE when using this accessory as to preserve electrical isolation of the user.

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.

This accessory allows easy access, within the specified electric values, to the pins on *biosignalsplux* sensors and actuators for interfacing them with third-party systems.

Check the sensor datasheets **before** using this accessory to avoid any damage of your system or your sensor(s).



ANALOG SENSOR	
V-	GND
GND	1.5V (to sensor)
V+	3V (to sensor)
IN	Sensor output

DIGITAL SENSOR	
V-	GND
GND	Sensor output
V+	3V (to sensor)
IN	1.5V (to sensor)

Table 6: Pinout configuration for analog & digital ports.

5 Data Logging

NOTE

The following *biosignalsplux* features are demonstrated by using PLUX's *OpenSignals (r)evolution* software. Please review the software manual for more detailed information for general software use.

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*
- *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 71*). These devices are compatible with all data logging features.

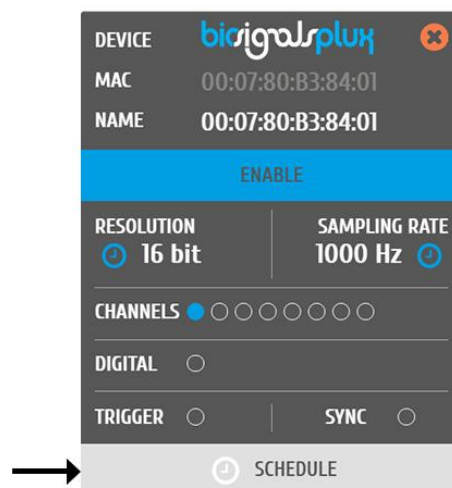


Figure 71: Data logging feature for devices with internal memory.

5.1 Scheduling Offline Acquisitions

NOTE

Before scheduling offline acquisitions, we recommend setting up the device and channels first. To do so, configure your device to fit your sensors and channel configuration according to the instructions in chapter 3 *biosignalsplux Sensors* before entering the schedule panel.

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 72*).

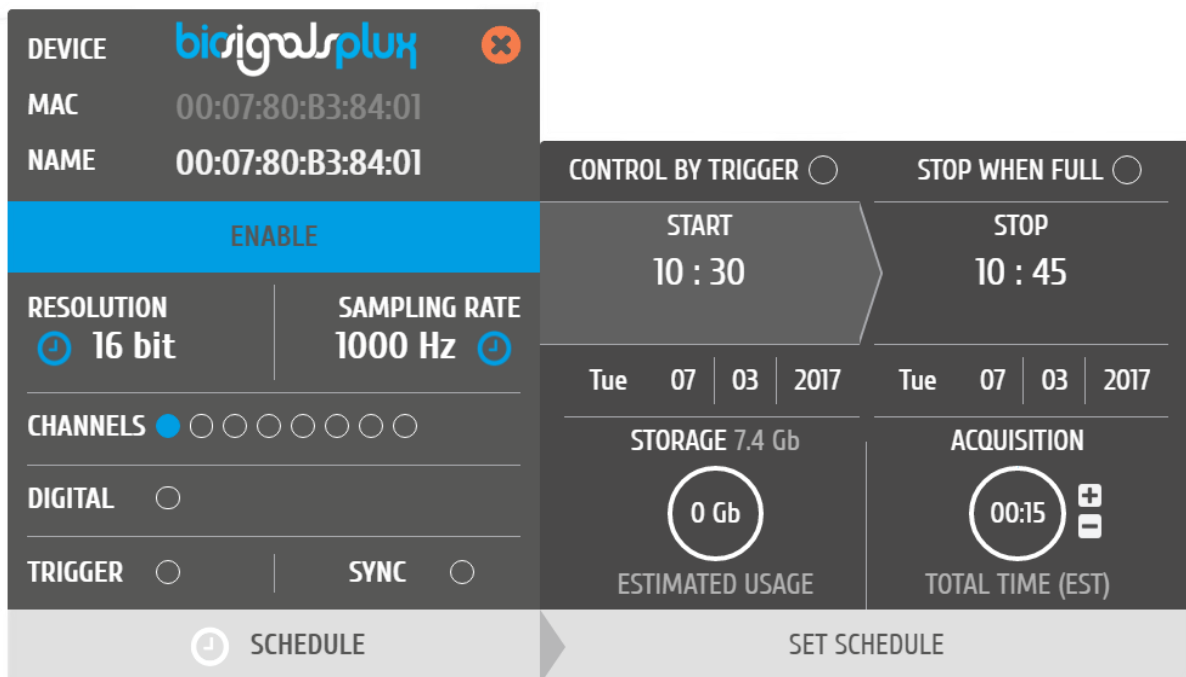


Figure 72: Scheduling panel.

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 behaviour.

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 lifetime 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.

To check if your device is acquiring data, check the LED information of your device as listed in chapter ***Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden..***

5.1.1 Control by Trigger

This option allows you to start your acquisition manually using one of the available trigger accessories for *biosignalsplux* (see 4.1.1 *Handheld Switch* or 4.1.2 *Foot Switch*). 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 fix 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.

5.1.2 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 fixed 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 73*).

The screenshot shows the 'Scheduling' panel of the biosignalsplux application. On the left, a dark grey sidebar contains device information: 'DEVICE' with the biosignalsplux logo and a red 'X' icon, 'MAC' as '00:07:80:B3:84:01', and 'NAME' as '00:07:80:B3:84:01'. Below this is a blue 'ENABLE' button. Further down are settings for 'RESOLUTION' (16 bit), 'SAMPLING RATE' (1000 Hz), 'CHANNELS' (7 channels, with the first selected), 'DIGITAL' (off), 'TRIGGER' (off), and 'SYNC' (off). At the bottom of the sidebar is a 'SCHEDULE' button with a clock icon. The main panel on the right is divided into several sections. At the top, 'CONTROL BY TRIGGER' is set to 'OFF' and 'STOP WHEN FULL' is set to 'ON'. Below these are 'START' and 'STOP' time fields. The 'START' field shows '11 : 00' and the 'STOP' field shows '20 : 34' with 'ESTIMATED' text below it. Below the times are date pickers for 'Tue 07 | 03 | 2017' and 'Sat 25 | 03 | 2017'. The 'STORAGE' section shows '7.4 Gb' with a circular progress indicator and 'ESTIMATED USAGE' text. The 'ACQUISITION' section shows '441:34' with a circular progress indicator and 'TOTAL TIME (EST)' text. At the bottom of the main panel is a 'SET SCHEDULE' button.

Figure 73: Scheduling panel displaying the estimated end of the acquisition.

5.1.3 Scheduling Start & End Times

The screenshot shows the 'Time schedule' interface. At the top, there's a blue header with 'March 2017' and navigation arrows. Below is a calendar grid for the month of March 2017. The days of the week are listed at the top: Sun, Mon, Tue, Wed, Thu, Fri, Sat. The calendar shows dates from 1 to 31. The date '7' is highlighted in blue. Below the calendar is a 'Time' section with a digital display showing '10:15'. Underneath are sliders for 'Hour' and 'Minute'. At the bottom are 'Now' and 'Done' buttons.

Figure 74: Time schedule for start and end points for offline acquisitions.

Alternatively, you can also set up a fix 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.

5.1.4 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 75*; here: Tuesday 19:00h).

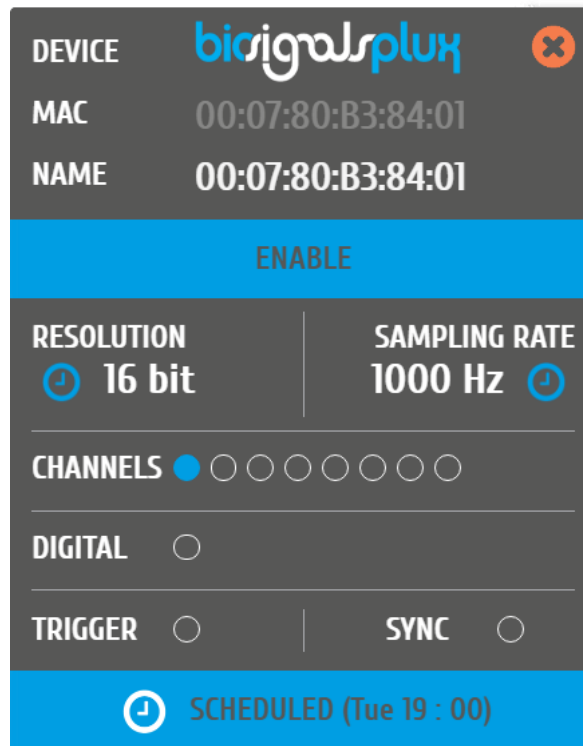


Figure 75: Device panel with a scheduled acquisition.

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.

5.2 Downloading Offline Acquired Data

After your offline acquisition has 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 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.

5.2.1 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 76*) 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.

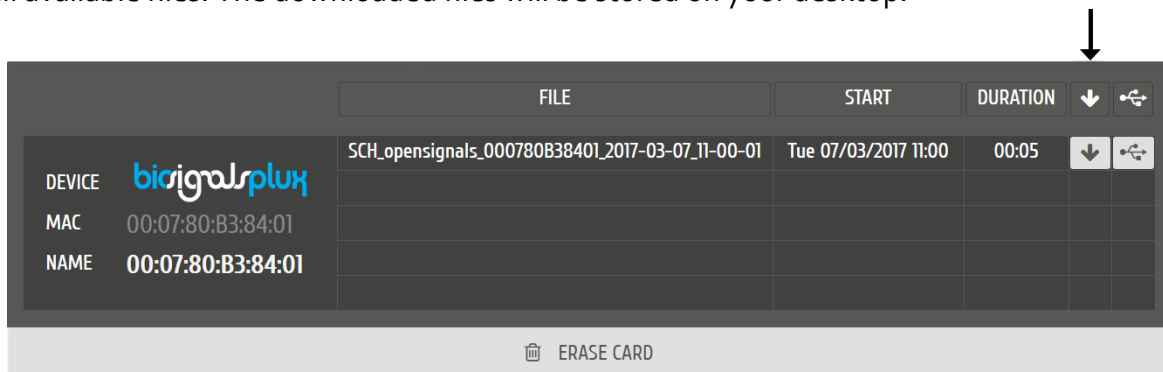


Figure 76: Downloading offline acquired data via Bluetooth.

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.

5.2.2 Download via Fast USB Data Transfer Cable

NOTE

This method requires accessories which have to be bought additionally (in some kits). 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>

Make sure your *biosignalsplux* is turned on and connected to your computer via USB with the *biosignalsplux* USB adapter. Connect the *USB adapter* to the reference port of your *biosignalsplux* (see 2.3.3 Reference) 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 USB symbol in a file's row to download the selected file (see Figure 77) 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.

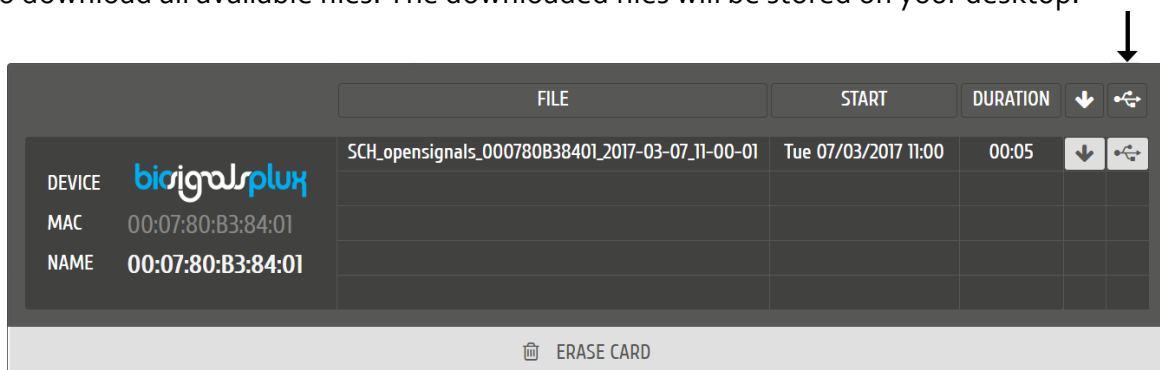


Figure 77: Downloading offline acquired data via USB.

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.

5.2.3 Deleting Offline Acquired Data

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.

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

6 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.

6.1 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.

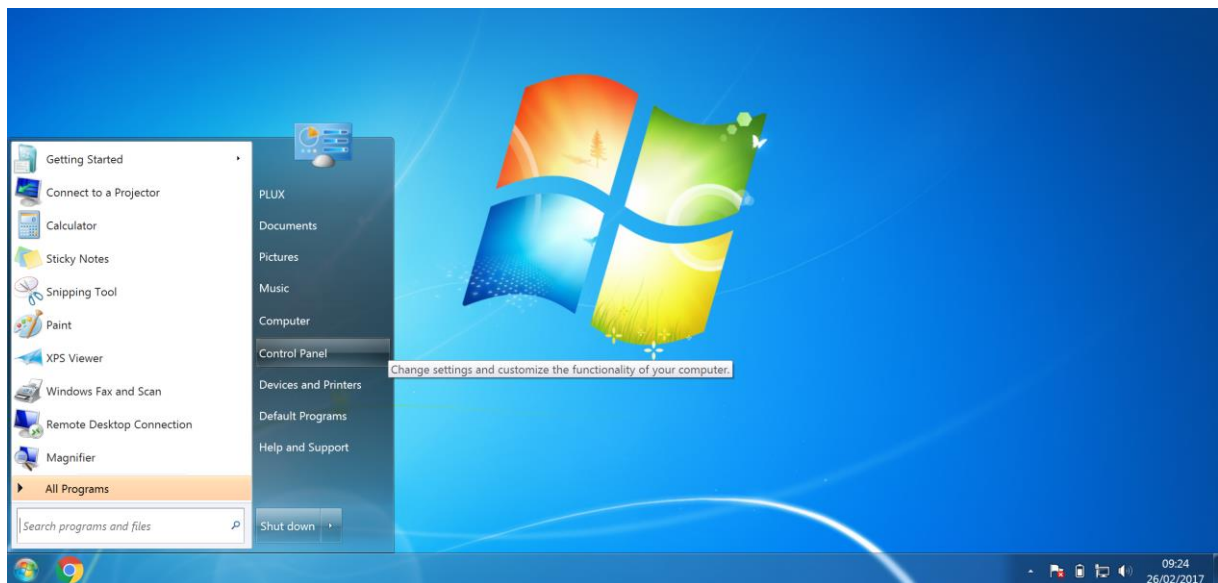


Figure 78: Access the Windows 7 control panel.

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



Figure 79: 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.

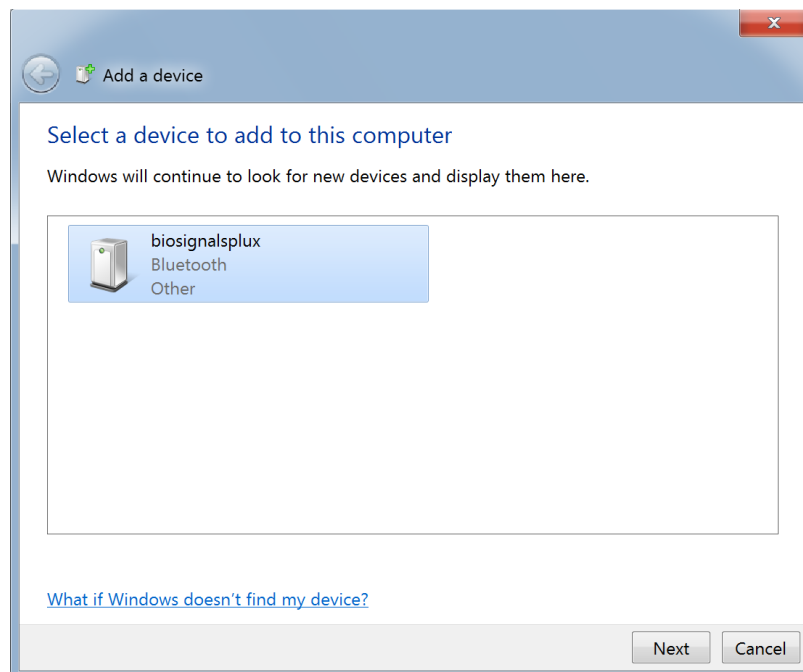


Figure 80: Select your device to add it to your computer.

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

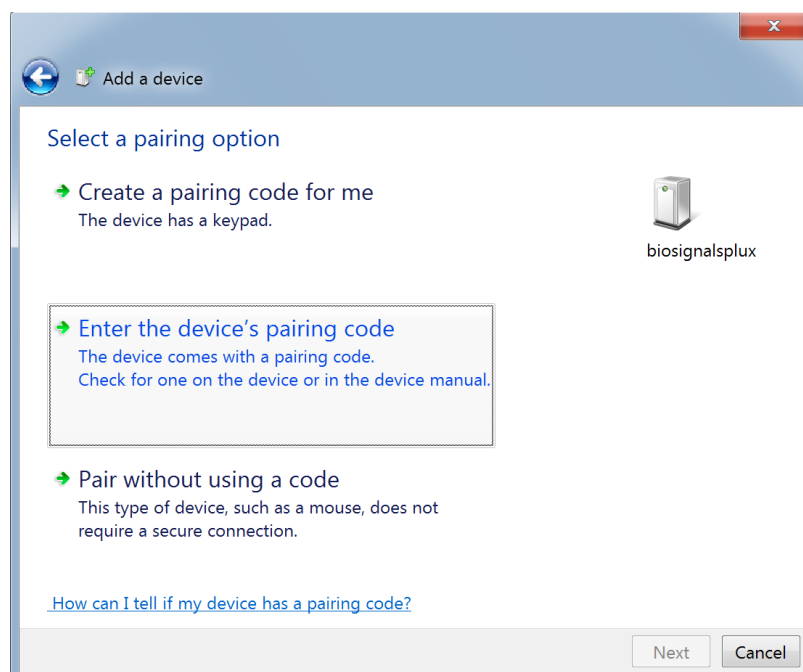


Figure 81: Select Enter the device's pairing code.

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.

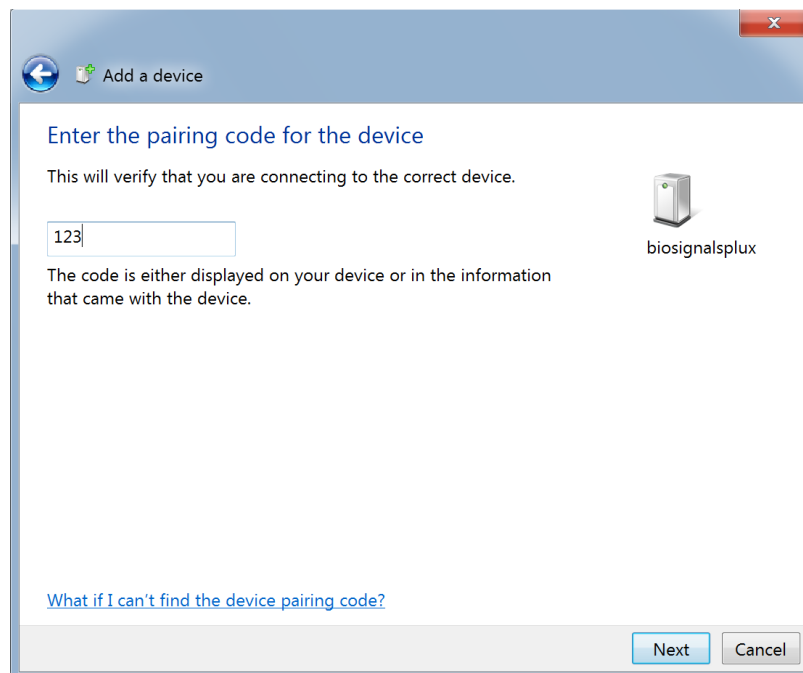


Figure 82: Enter the pairing code to connect to your device.

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

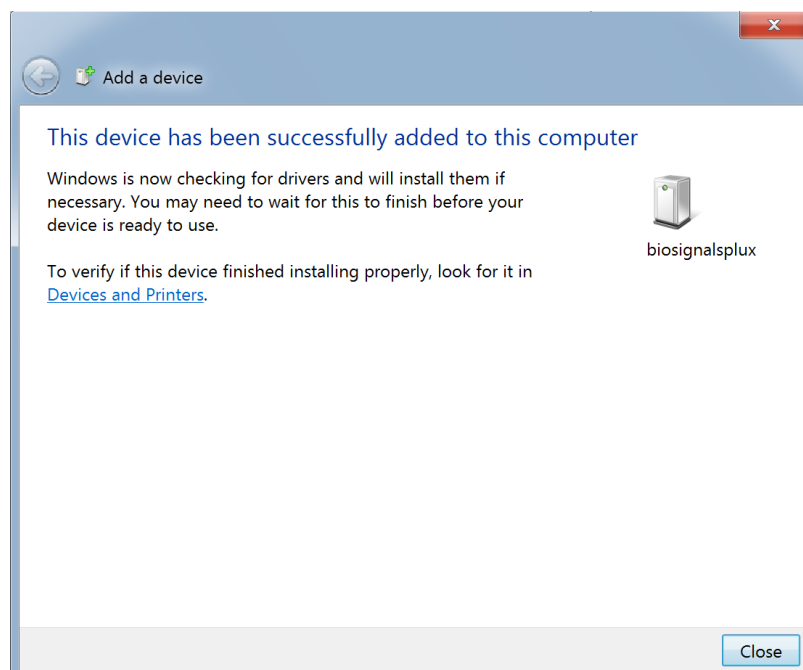


Figure 83: Windows confirmation if the device has been successfully added.

6.2 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 84: 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.

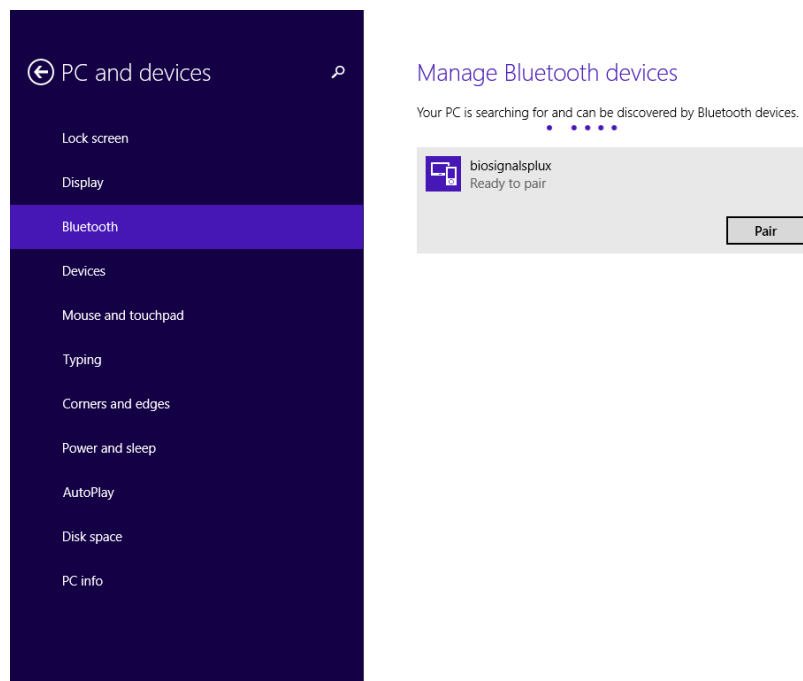


Figure 85: Bluetooth settings panel.

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*.

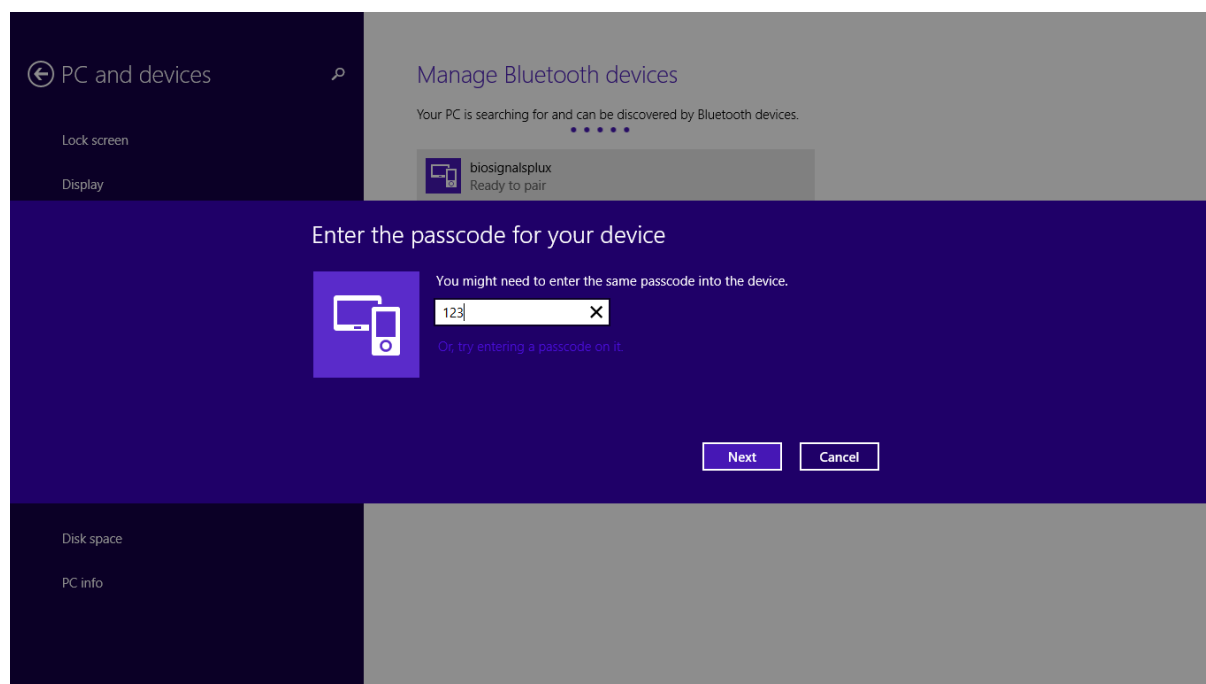


Figure 86: Requesting biosignalsplux' passcode (123).

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

6.3 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.

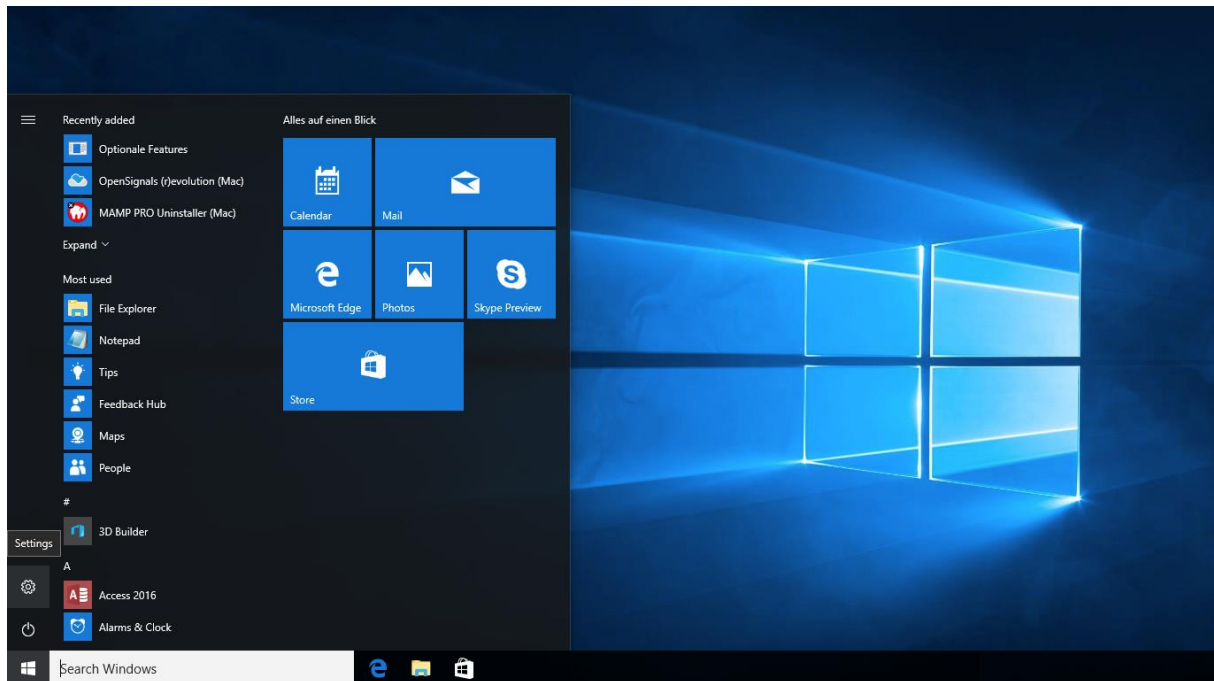


Figure 87: Access to the settings panel in Windows 10.

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

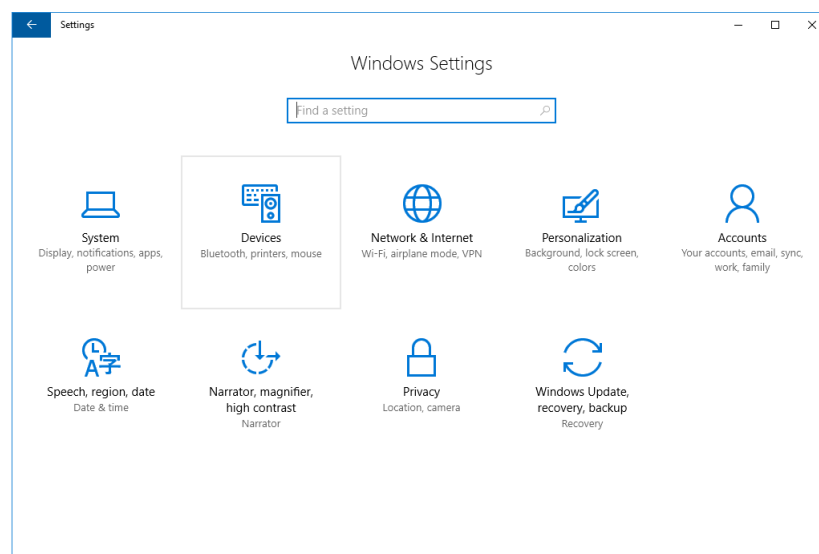


Figure 88: Windows 10 settings panel.

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 89.

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.

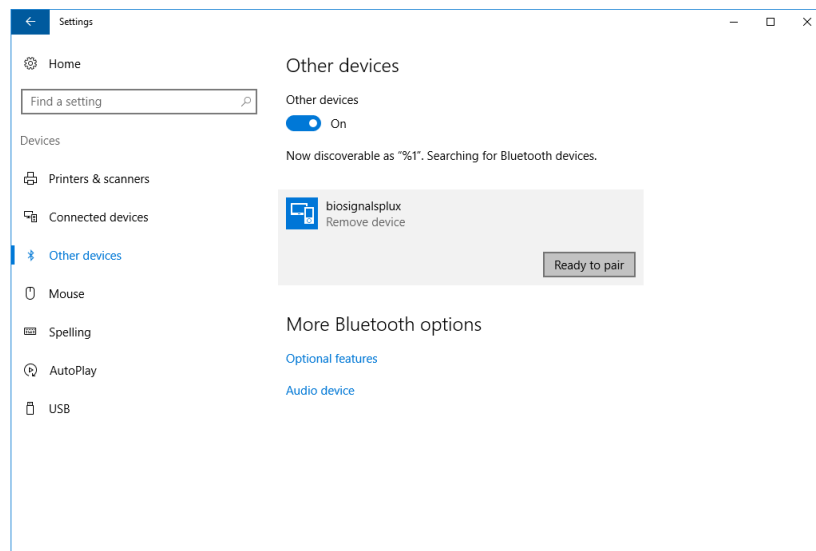


Figure 89: Bluetooth settings panel.

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*.

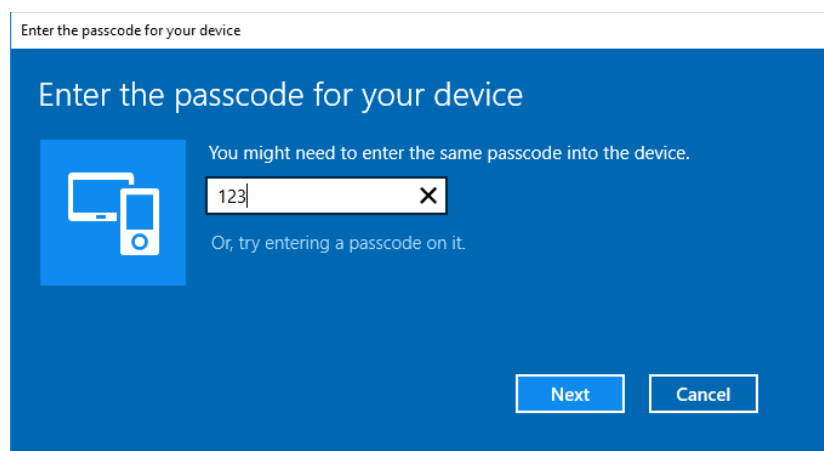


Figure 90: Requesting passcode (123).

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

6.4 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.

6.4.1 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.

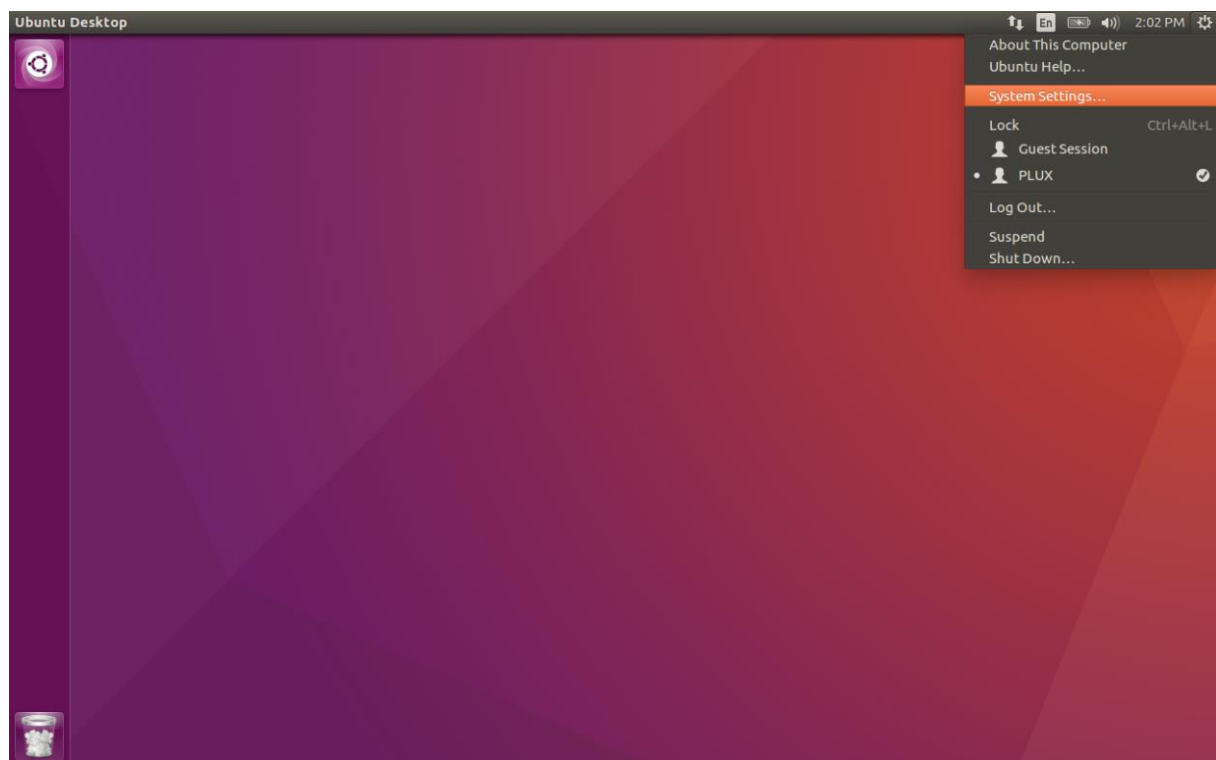


Figure 91: Access the system settings in Ubuntu.

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

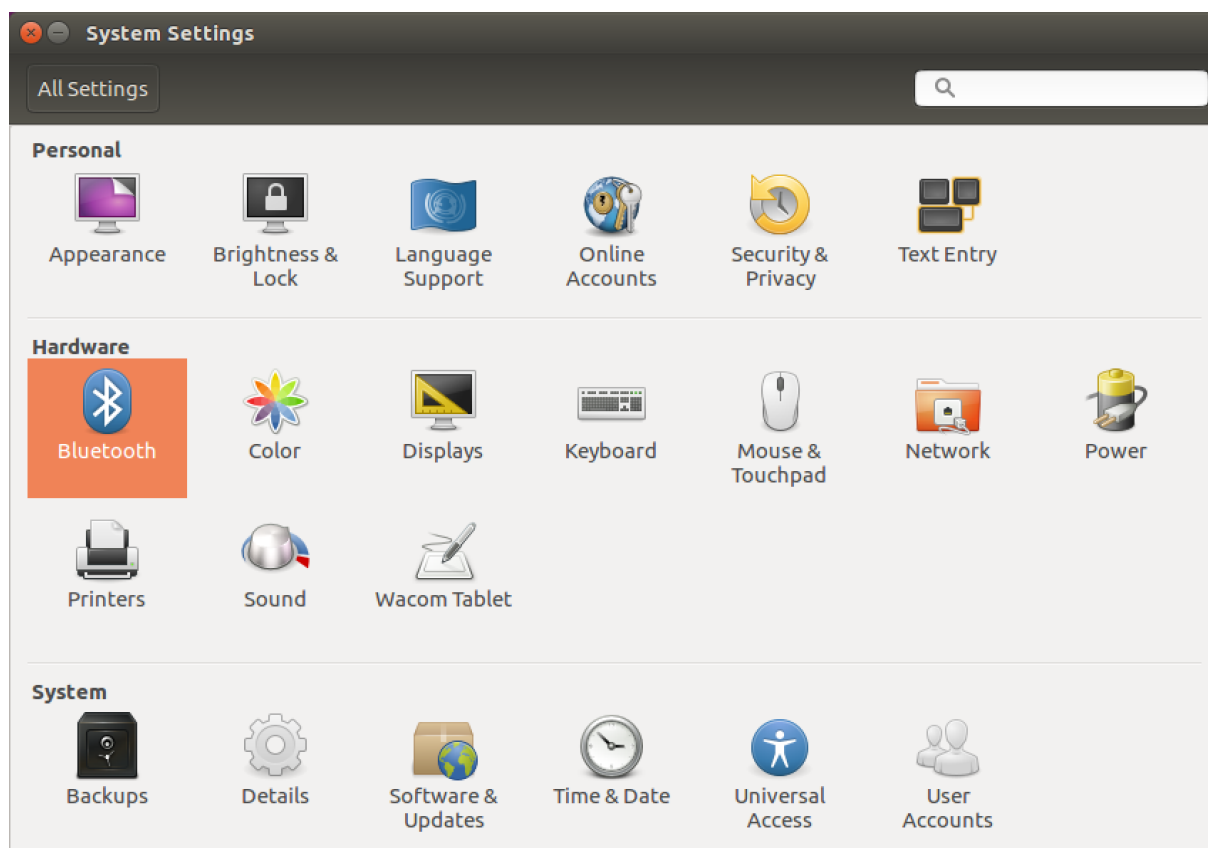


Figure 92: Click on the Bluetooth logo to access the Bluetooth settings.

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.

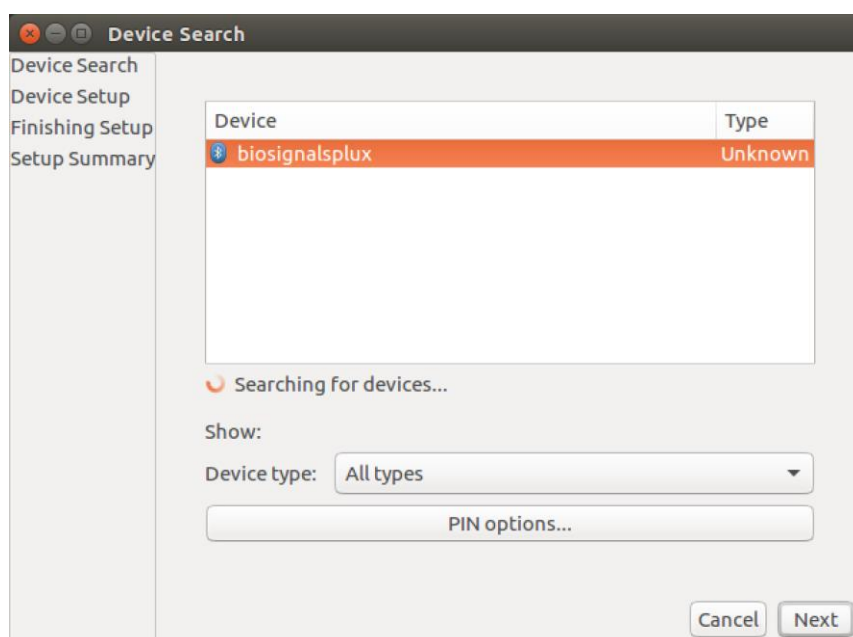


Figure 93: Select your device to add it to your computer.

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.

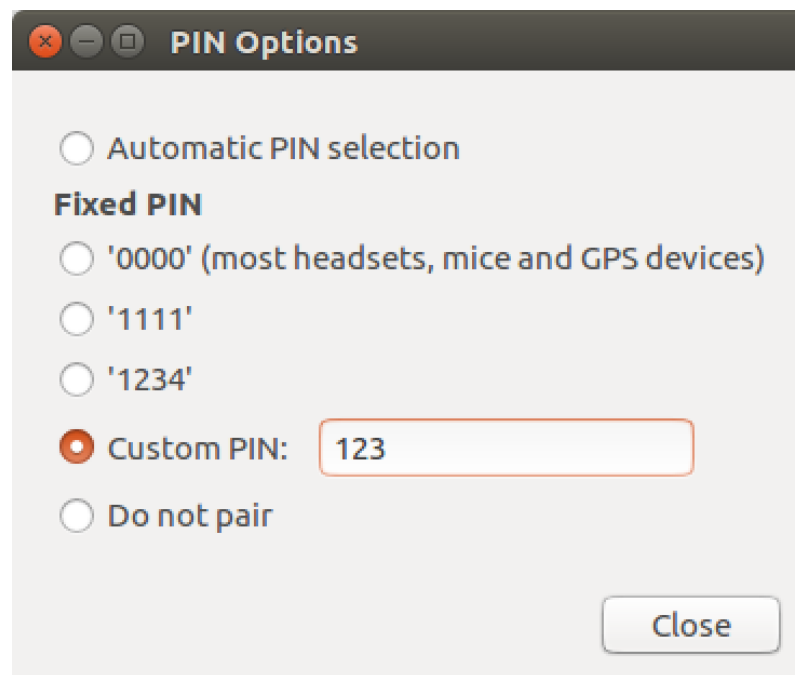


Figure 94: Enter the device's pin to pair.

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 computer⁵.

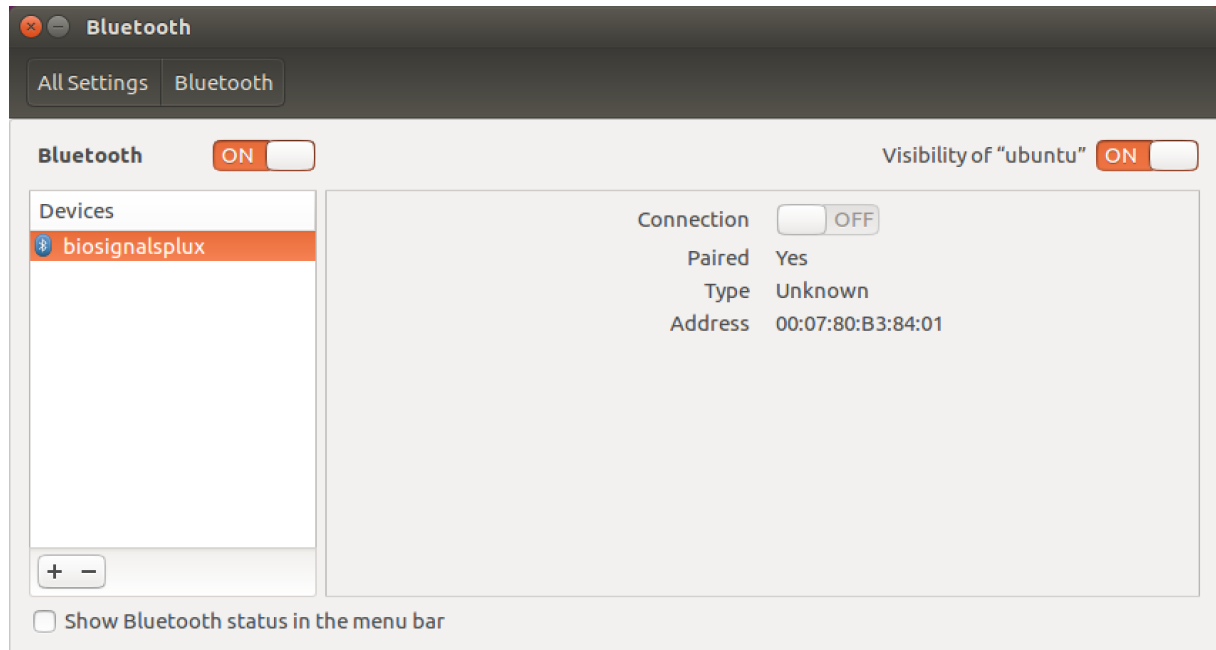


Figure 95: Successfully paired biosignalsplux.

⁵ 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*.

6.4.2 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*.

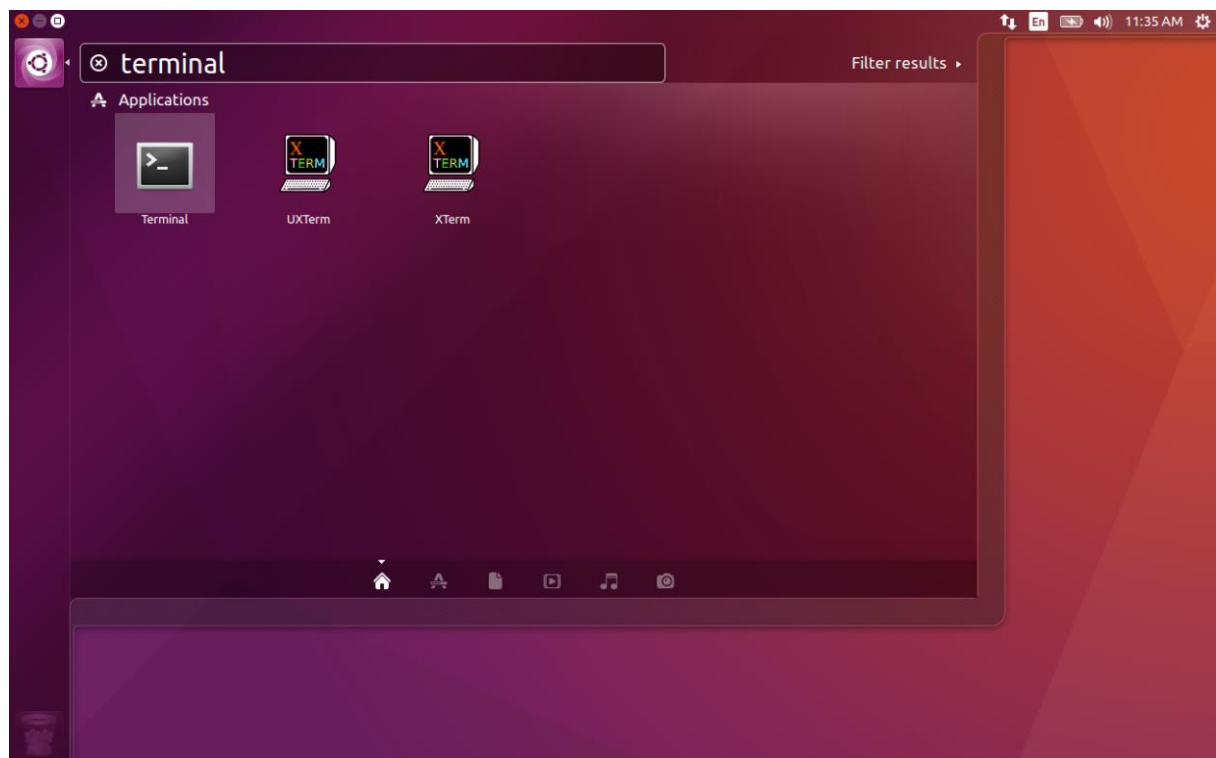


Figure 96: Access the terminal using the search function in Ubuntu.

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]
```

6.5 Mac OS X

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 97: 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.

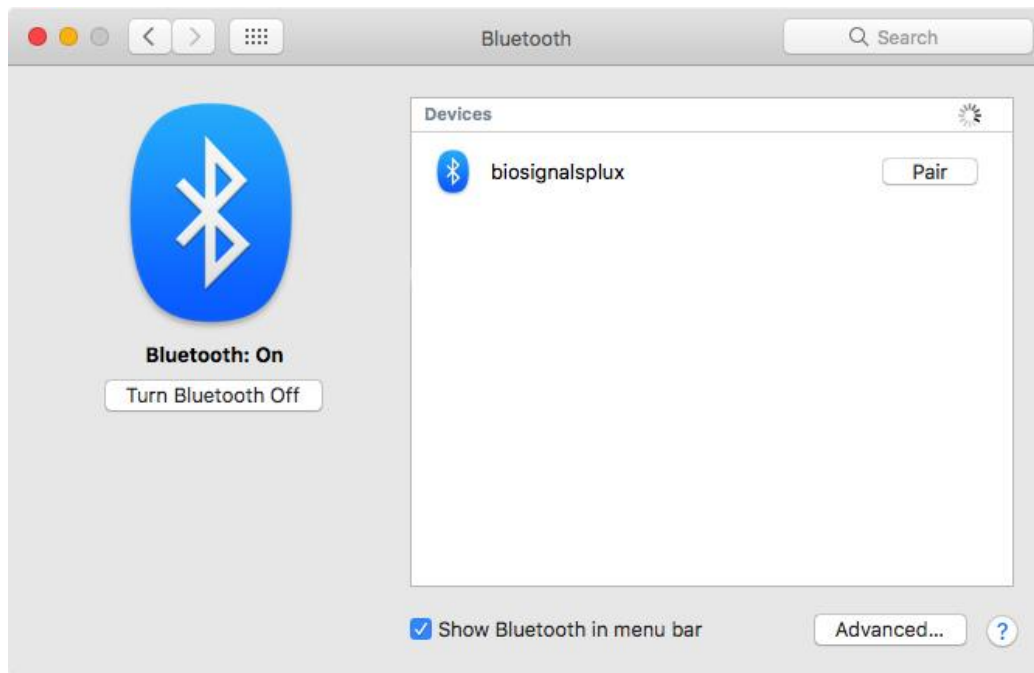


Figure 98: Click on Pair to connect to the biosignalsplux.

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).

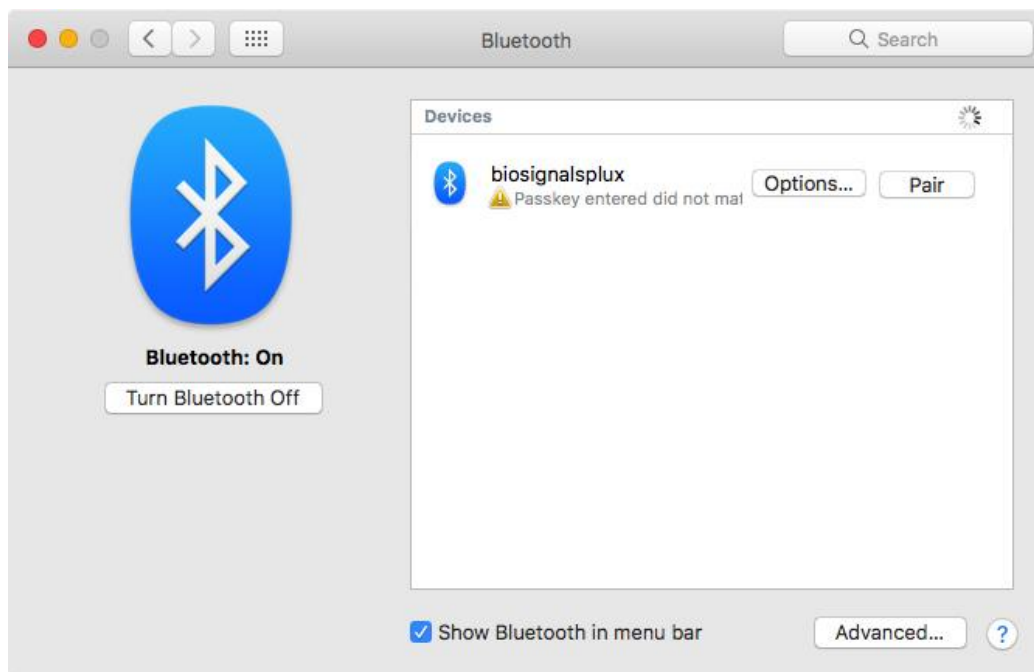


Figure 99: Click on Options... to enter the passkey.

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*.

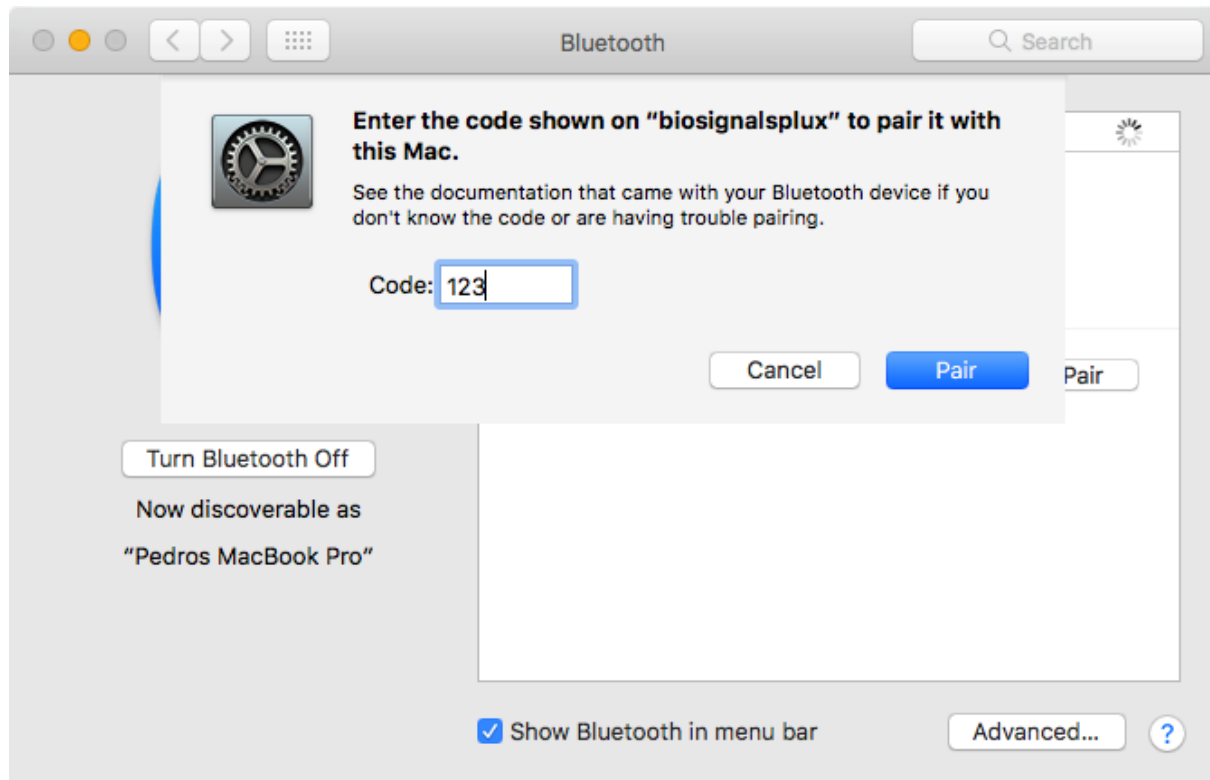


Figure 100: Enter the pairing code

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

7 Firmware Updates & Upgrades

biosignalsplux firmware updates are not done automatically. We recommend to frequently check if newer firmware versions are available and to upgrade or update the firmware on your device when newer versions are available to ensure full functionality and compatibility with all *biosignalsplux* sensors and accessories.

Updating the *biosignalsplux* firmware lets you also take advantage of all the newest recording resolutions and offline scheduling features.

Check the following website to see if newer firmware versions are available, and download and extract all the required tools to update or upgrade your firmware:

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

NOTE

biosignalsplux devices can be used on Windows, Linux and Mac OSX operating systems. However, at the time being, the firmware update software does only run on Windows operating system.

For Mac OS X and Linux users, the firmware update software can be used in virtual machines running a compatible Windows version (Windows 7 or newer).

7.1 Checking Firmware Version

Before updating the firmware of your *biosignalsplux* device, it is recommended to check the current device's firmware version to see whether a firmware update is required or not.

To do so, make sure that your device is charged and turned on (LED must blink green). If you haven't connected your device to your computer via Bluetooth before, connect your device following the instructions in *Bluetooth Setup* before following the next steps.

Open the *Updater.exe* you've just downloaded and extracted. A new window will appear. Click on the *Find Devices* button and wait for your MAC address to appear in the *Device Mac Address Field*.

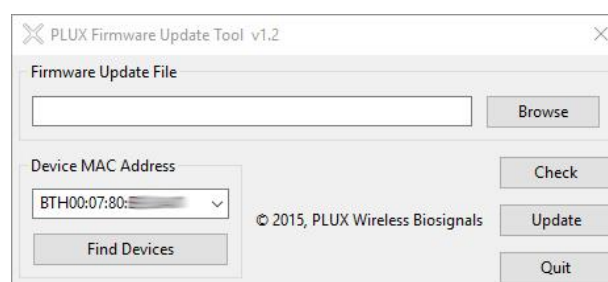


Figure 101: PLUX firmware update tool has found one *biosignalsplux*.

Check if the MAC address that is listed in the dialog matches the MAC address of the *biosignalsplux* device you want to update or upgrade. The MAC address of the device is placed on its back. Click on the *Check* button.

The firmware update software will check the current version of the *biosignalsplux* and display it in the dialog field.

7.2 Updating or Upgrading Firmware

If your device is running on an older firmware⁶ it is recommended to update or upgrade the firmware for compatibility reasons with new features and to ensure that your device works properly with the newest version of the *OpenSignals (r)evolution* software.

To do so, make sure that your device is charged and turned on (LED must blink green). If you haven't connected your device to your computer via Bluetooth before, connect your device following the instructions in *Bluetooth Setup* before following the next steps.

Open the *Updater.exe* you've downloaded and extracted. A new window will appear. Click on the *Find Devices* button and wait for your MAC address to appear in the dialog bellows. Check if the MAC address that is listed in the dialog matches the MAC address of the *biosignalsplux* device you want to update or upgrade. The MAC address of the device is placed on its back.

Click on *Browse* and browse the folder where the firmware .ENC file from the downloaded package is placed and select the .ENC file. The firmware updater should now be similar to the firmware updater in and click the *Update* button.

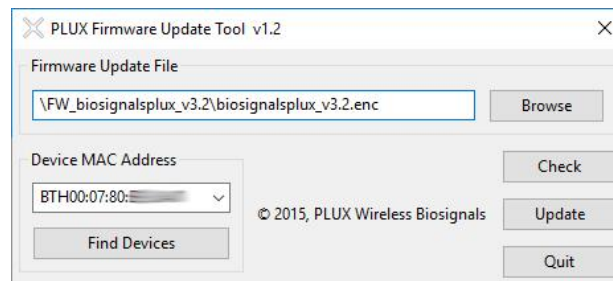


Figure 102: Firmware update tool is ready to update the firmware.

biosignalsplux will turn itself off two times during the firmware update or upgrade. Wait for the *biosignalsplux* to turn itself on again after the first time (this may take some seconds). The *biosignalsplux* firmware will now be installed on the *biosignalsplux* and the device will automatically turn itself off for the second time after the installation is finished. This time, check for the indications of the update software, and, if no different indications are given, turn your device back on and confirm the dialog of the update software by clicking on the *OK* button.

When the firmware update/upgrade has finished, a dialog will pop up displaying the old and the new version of the *biosignalsplux* firmware. new firmware was successfully installed if the

⁶ or if you need to upload another firmware to run with specific sensors (e.g. beta versions of new sensors)

version of the new firmware matches your selected .ENC file and if it is superior to the version of the displayed old firmware.

8 Software & APIs

8.1 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>

8.2 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>

8.3 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>

9 Troubleshooting

9.1 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.

9.1.1 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 103)

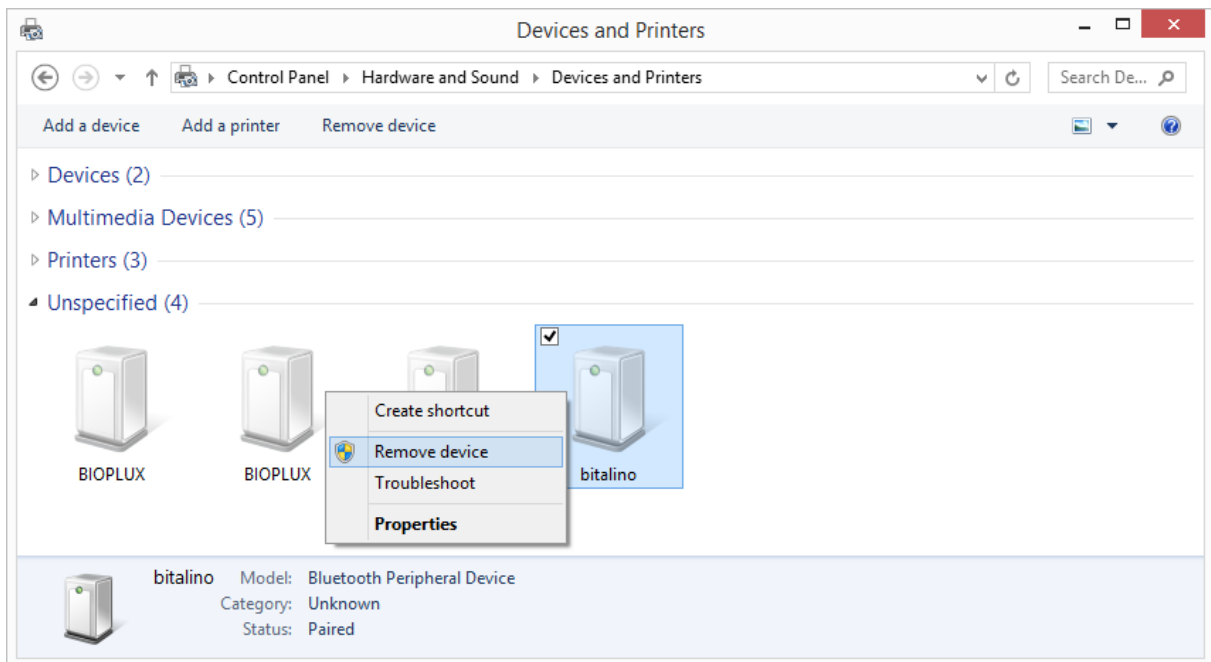


Figure 103: Windows 7 "Devices and Printers" window.

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.

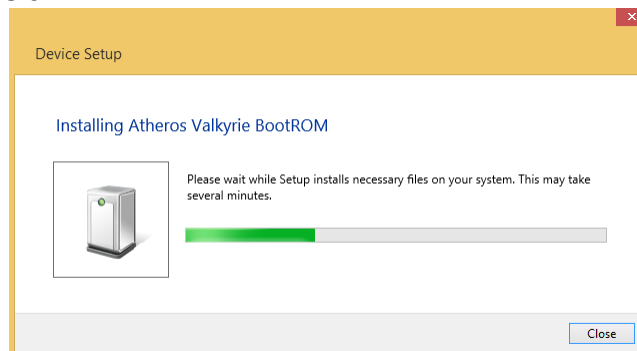


Figure 104: Wait for Windows to install your Bluetooth dongle.

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 105*). 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*.

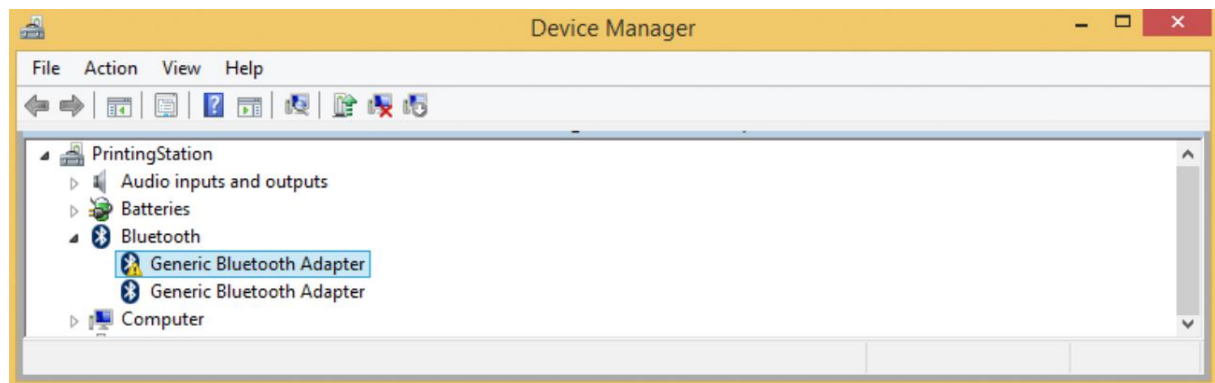


Figure 105: Bluetooth dongle listed in the device manager.

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).

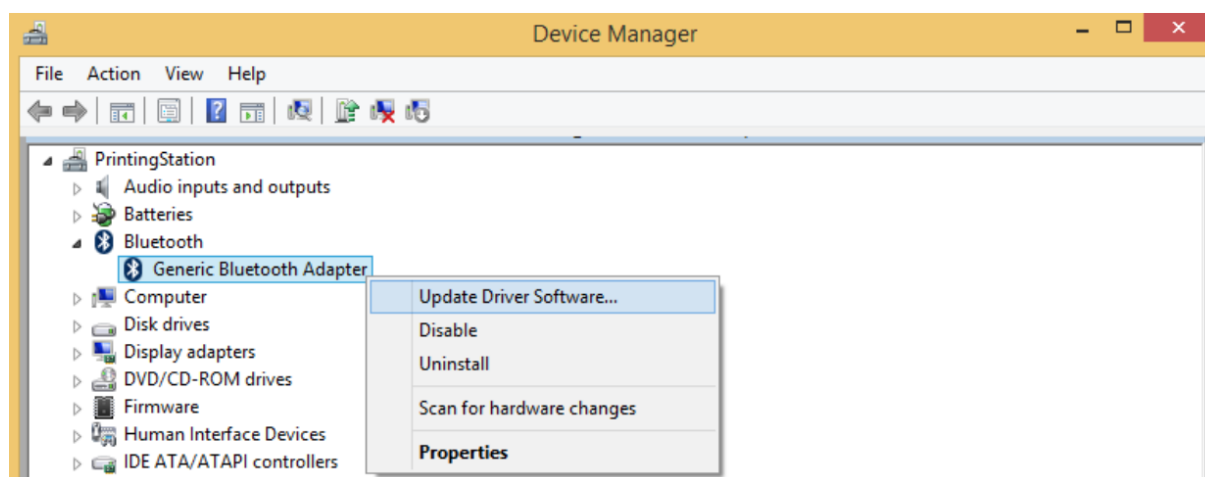


Figure 106: First step to update the driver of the Bluetooth dongle.

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

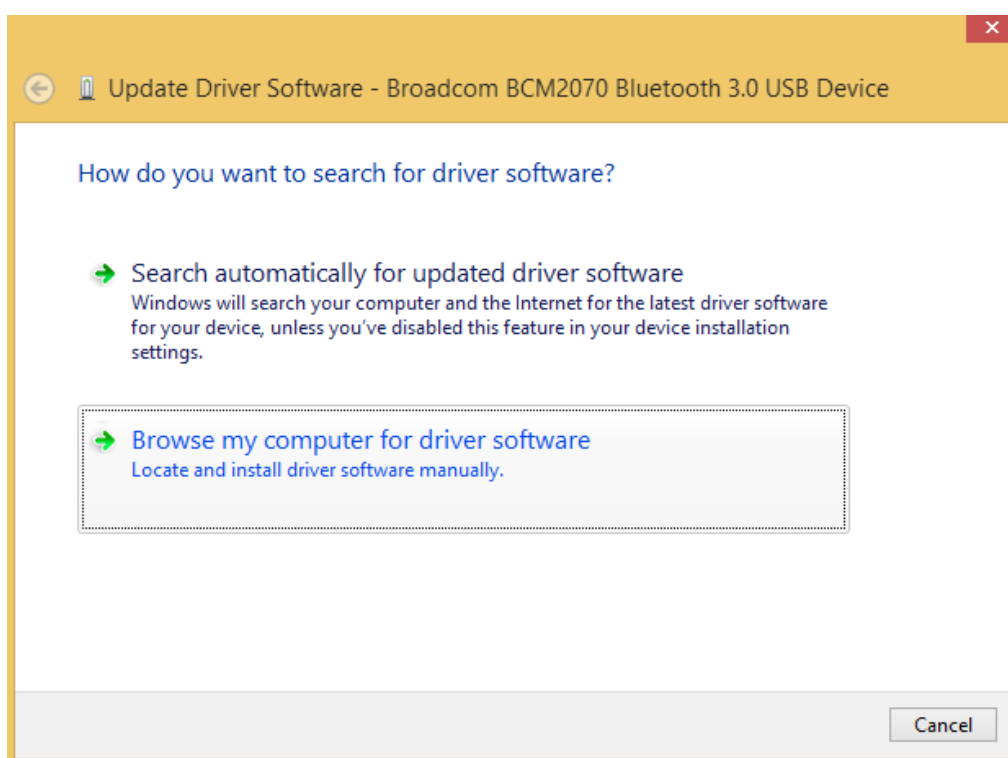


Figure 107: Browse for driver software.

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

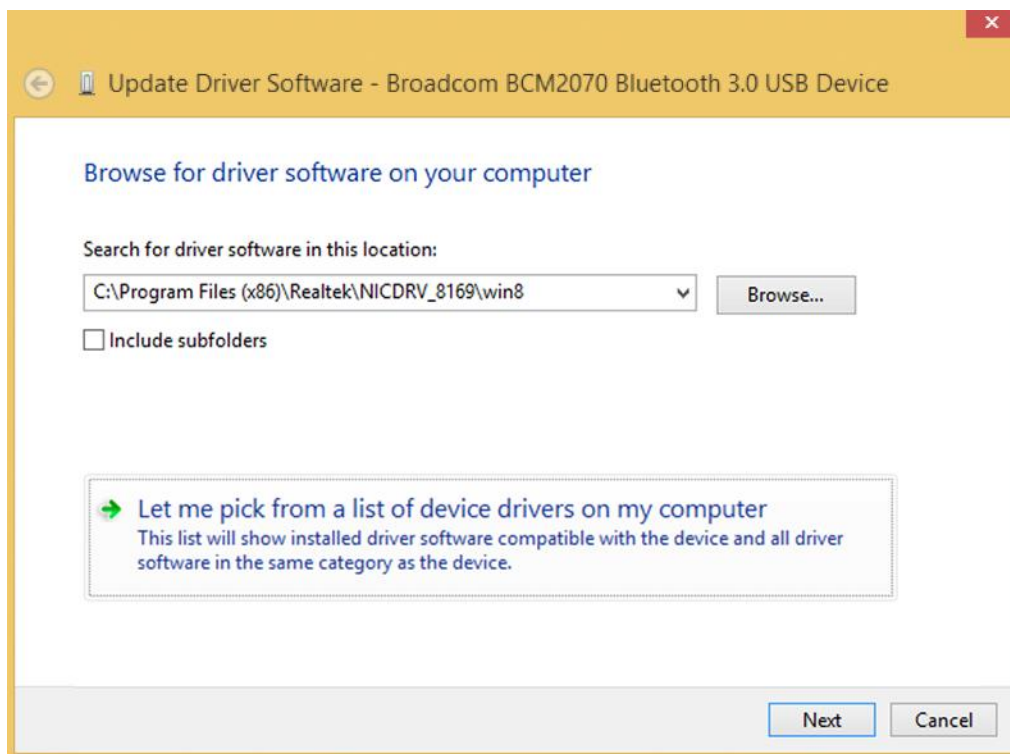


Figure 108: Pick driver from list of device drivers on the computer.

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.

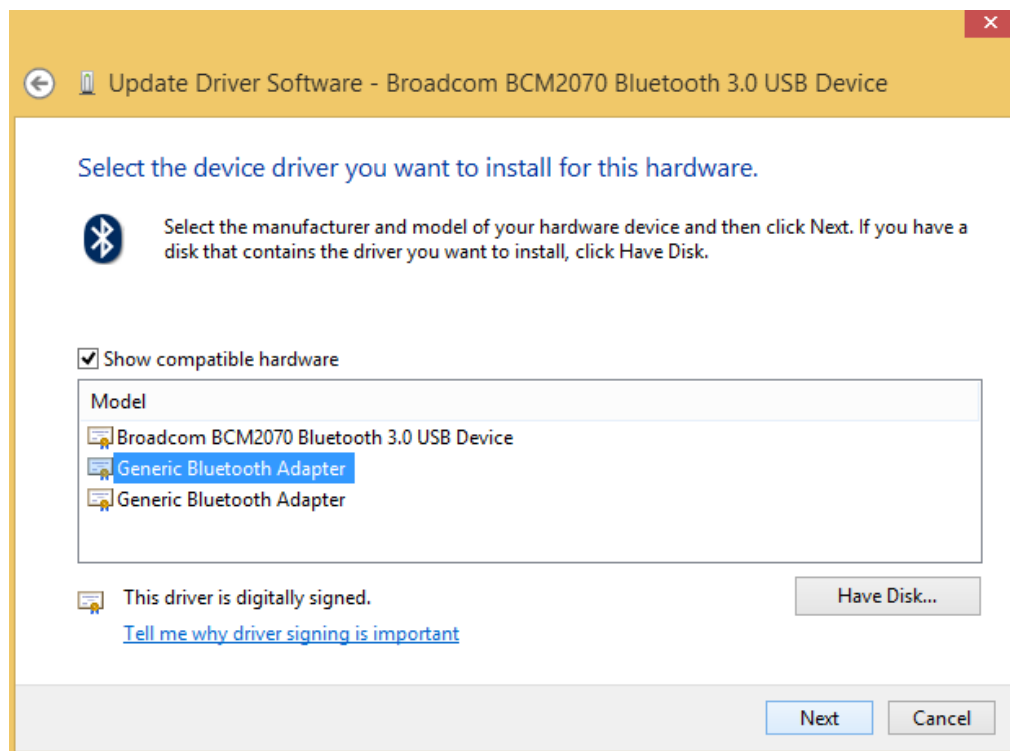


Figure 109: Select Generic Bluetooth Adapter

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

9.1.2 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.

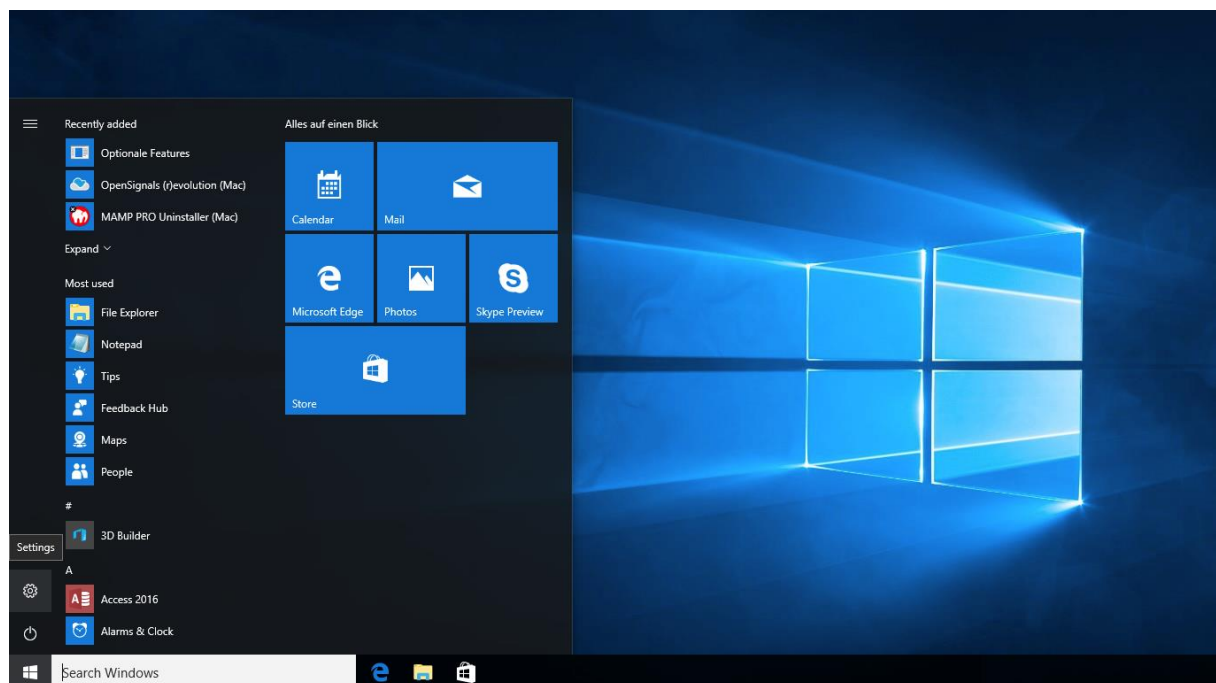


Figure 110: Access to the settings panel in Windows 10.

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

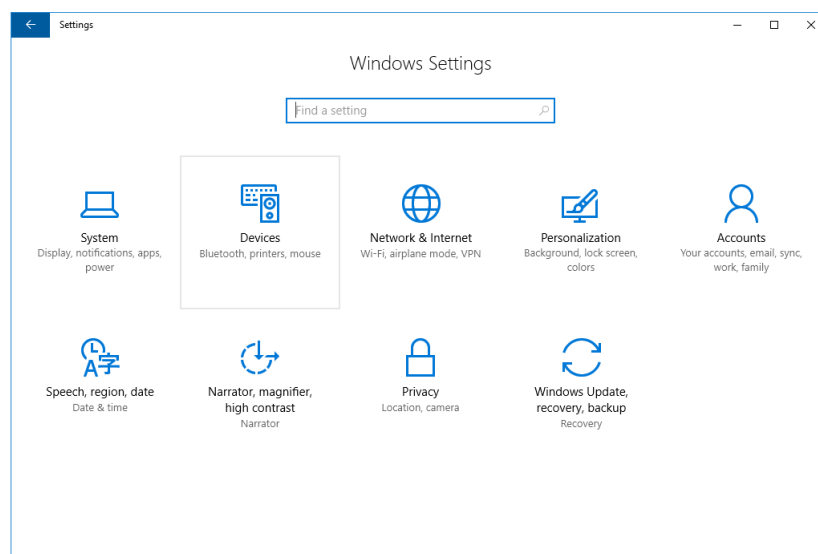


Figure 111: Windows 10 settings panel.

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.

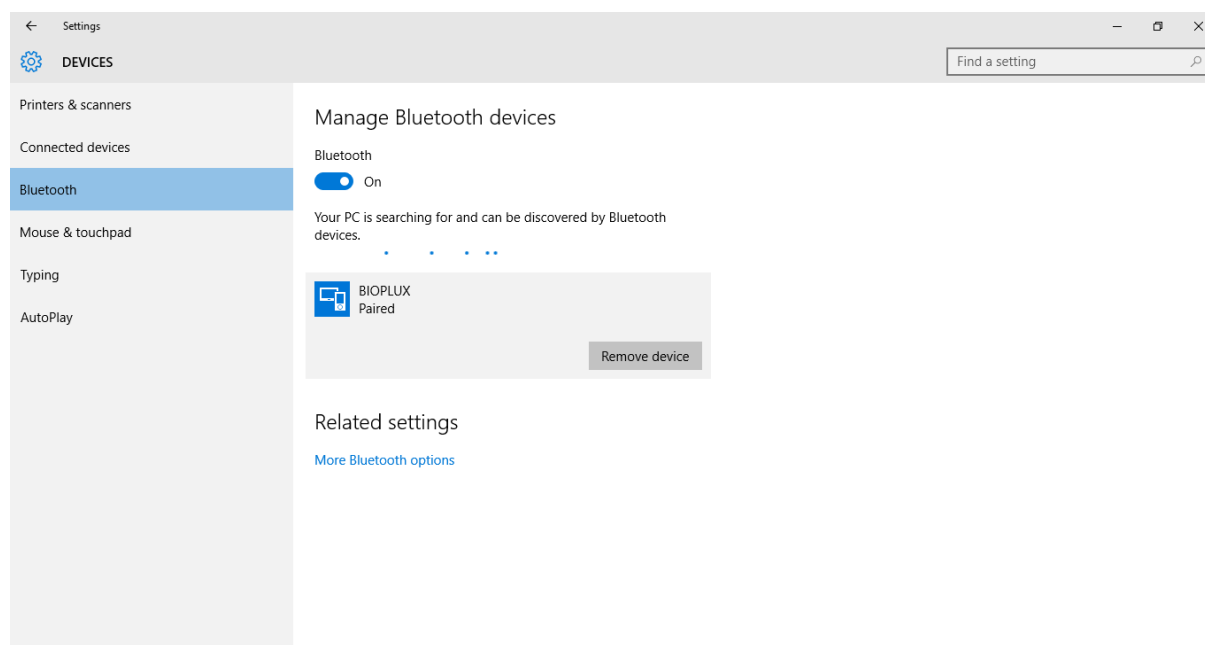


Figure 112: Windows 10 Bluetooth devices

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.

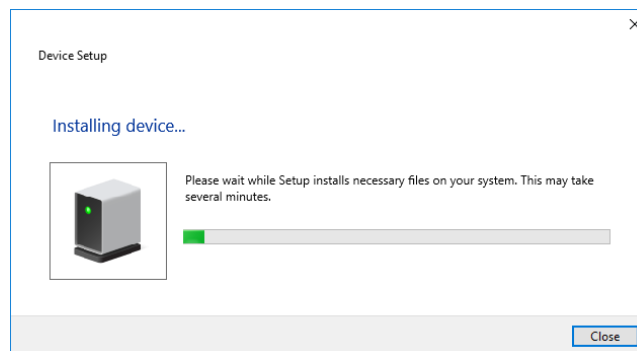


Figure 113: Wait for Windows to install your Bluetooth dongle.

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*.

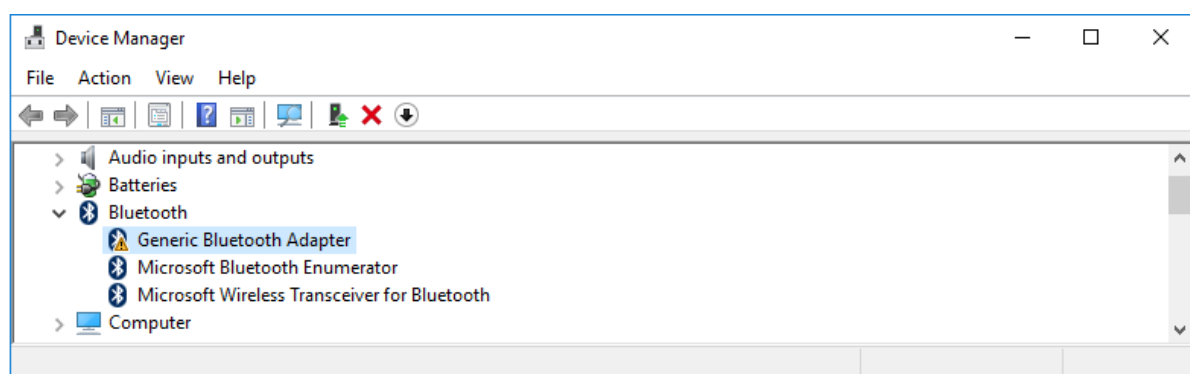


Figure 114: Bluetooth dongle listed in the device manager.

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).

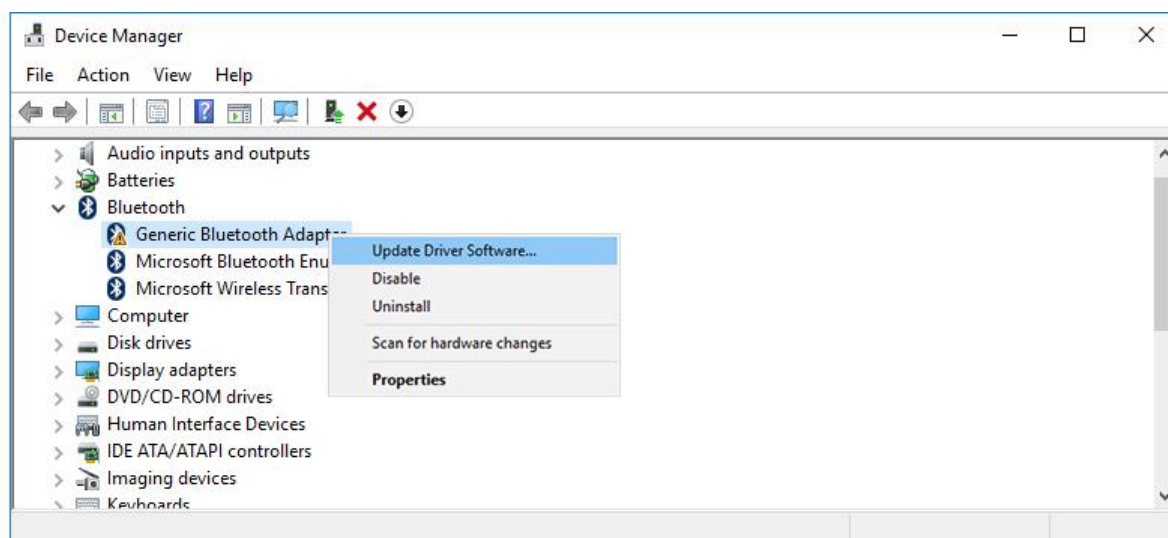


Figure 115: First step to update the driver of the Bluetooth dongle.

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

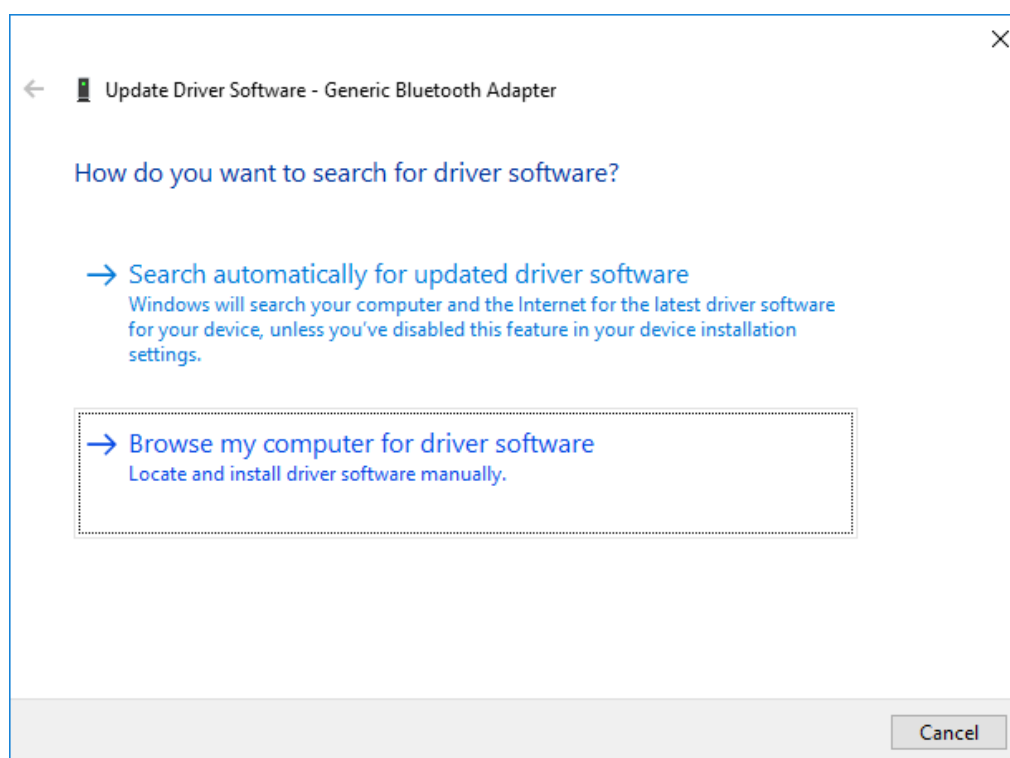


Figure 116: Browse for driver software.

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

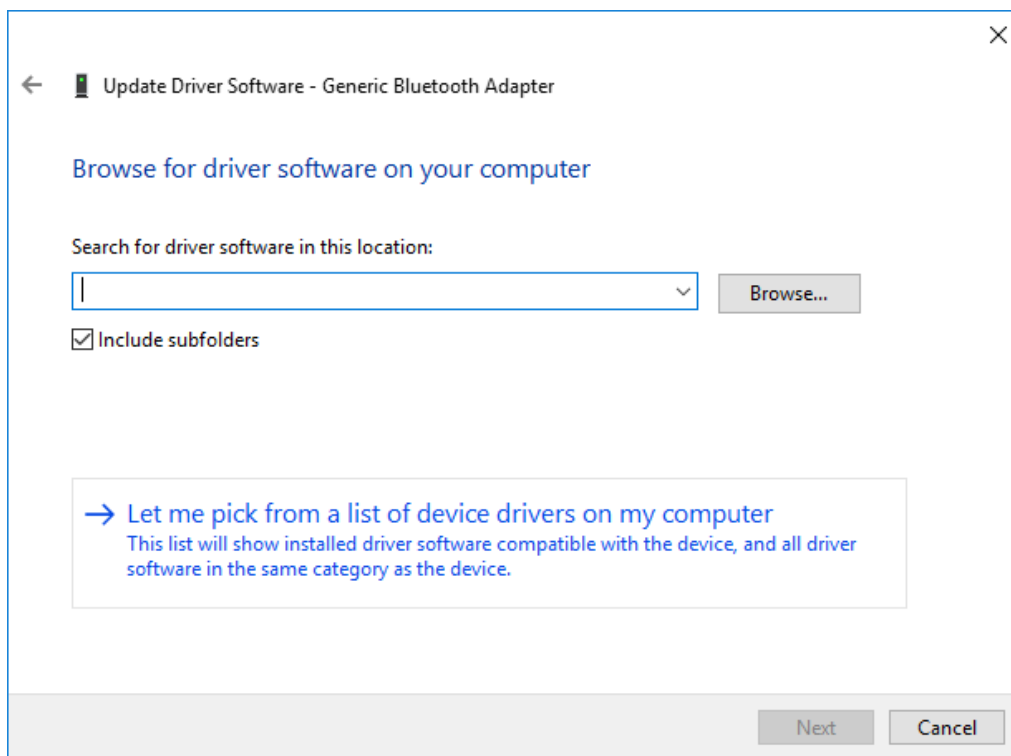


Figure 117: Pick driver from list of device drivers on the computer.

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.

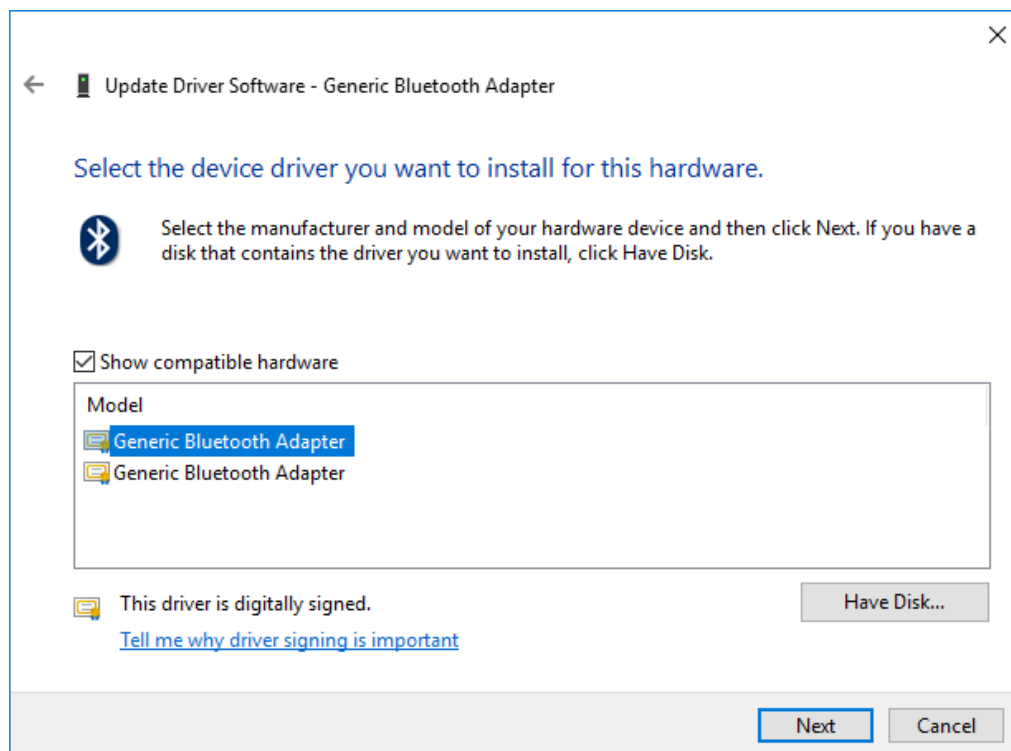


Figure 118: Select Generic Bluetooth Adapter

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

10 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.

10.1 Maintenance Recommendations

10.1.1 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.

10.1.2 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.

11 Regulatory & Legal Information

11.1 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.

11.2 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.

Notice: This manufacturer warranty does not limit your statutory warranty rights.

11.2.1 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.

11.3 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.

12 Datasheets

The information displayed in this manual is taken from the official *biosignalsplux* datasheets. Please read the datasheets of your hub, sensors, and/or accessories before using them. The datasheets can be accessed via the links below.

biosignalsplux Hub

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

Accelerometer (ACC)

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

Blood Volume Pulse (BVP)

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

Breakout Cable

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

Electrocardiography (ECG)

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

Electrodermal Activity (EDA)

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

Electroencephalography (EEG)

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

Electromyography (EMG)

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

Goniometer (GON)

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

Handheld Switch

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

LED

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

Light (LUX)

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

Load Cell

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

Respiration (RIP)

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

Respiration (PZT)

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

Synchronization Kit (SYNC) (incl. Digital Synchronization Cable & Multi Sync Splitter)

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