biosignal acquisition tool-kit for advanced research applications

user manual

ATTENTION
please read this manual before using your
biosignalsplux product

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

The word Bluetooth and its logo are trademarks of Bluetooth SIG Inc. and any use of such marks is under license. Other trademarks are the property of their respective own.

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.

For any other support, visit our support page: www.support.pluxbiosignals.com

PLUX Wireless Biosignals S.A.
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DISCLAIMER

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

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.

TABLE OF CONTENTS

1 Your biosignalsplux Kit

biosignalsplux systems are available in multiple versions.

Click the links below for details on all available versions and the latest kit contents:

Webstore
biosignalsplux Explorer (4-channel system)
biosignalsplux Researcher (8-channel system)
biosignalsplux Pro (8-channel system)

You can alos set up your own biosignalsplux kit using our Kit Builder:

https://www.pluxbiosignals.com/apps/builder/biosignalsplux-kit-builder

2 biosignalsplux

Figure 1: biosignalsplux hub

he *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, or 4000Hz sampling frequency per channel when using only up to 3 channels simultaneously.

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

2.1 4-Channel Hub Specifications

Figure 2: 4-channel biosignalsplux hub.

The 4-channel enables the usage of up to 4 sensors simultaneously. Internal memory can be added optionally. Accessories (e.g., trigger button, foot switch, and synchronization accessories) are not supported on this device.

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); 4000Hz for up to 3 channels
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 3: 8-channel biosignalsplux hub.

The 8-channel device 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.

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); 4000Hz for up to 3 channels
Internal Memory:	8GB optionally available (stores up to ~111h) (optional for the *biosignalsplux* 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 Peripheries

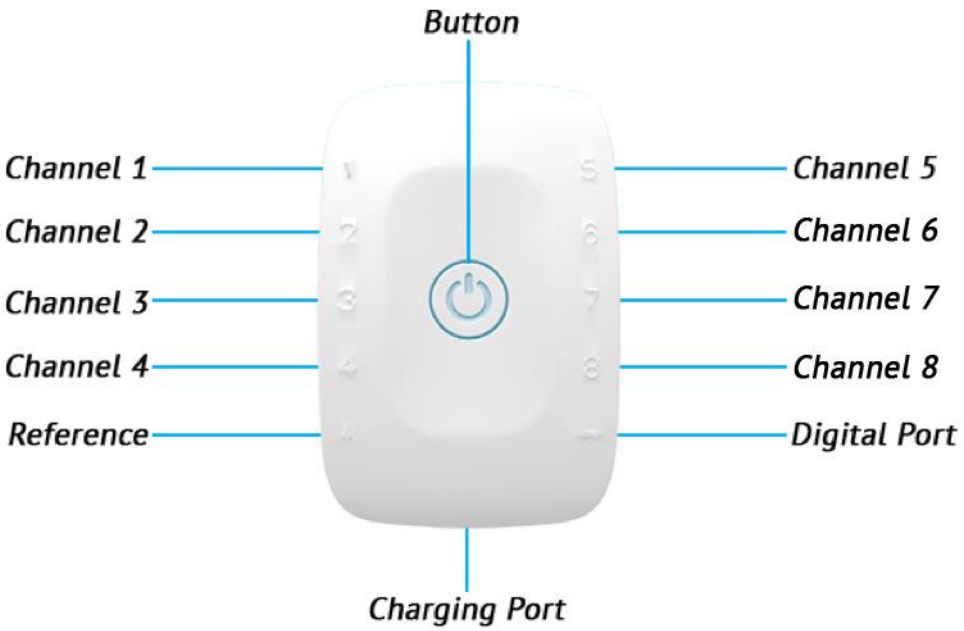


Figure 4: biosignalsplux ports and the button.

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 Accessory port Port

The digital port enables the usage of *biosignalsplux* accessories (e.g., trigger buttons to manually mark events in your acquisitions or a synchronization cable 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.

WARNING
Do not use the *biosignalsplux* device 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.

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 5: 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 1* or *Figure 6*).

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

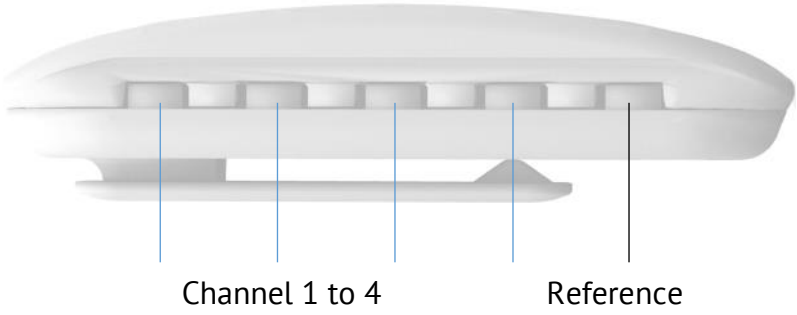


Figure 6: biosignalsplux side view.

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 7*). 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.

Figure 7: 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 used[1]).

Webstore
Bluetooth Dongle

You might also check the following support articles.

? Relevant Support Articles
How can I pair my PLUX devices with my computer?
How do I configure my Bluetooth Dongle?
Bluetooth Connection Troubleshooting

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

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

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

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.

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 Electromyography (EMG)

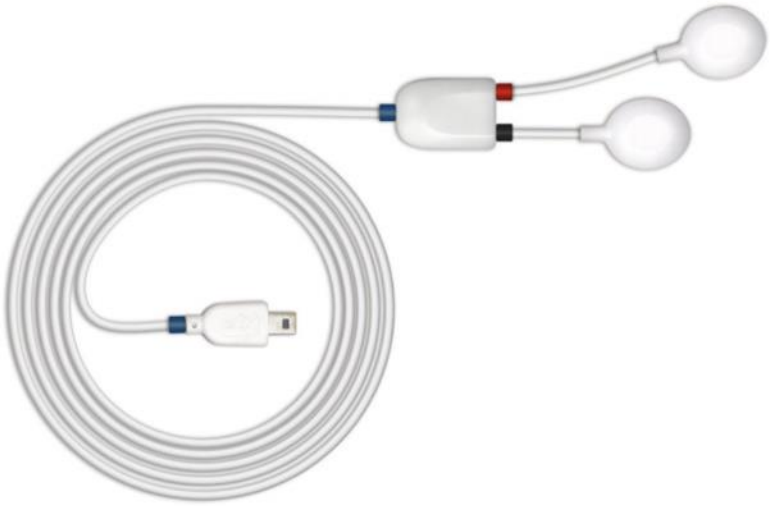


Figure 8: EMG sensor.

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

Electrode cables & sleeves

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

Electrode Cable	+	-
Sleeve Color	Red	Black

Table 2: Color coding of the electrode cable sleeves.

How to connect your sensor to your biosignalsplux

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 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 9* (here: EMG connected to channel 1).

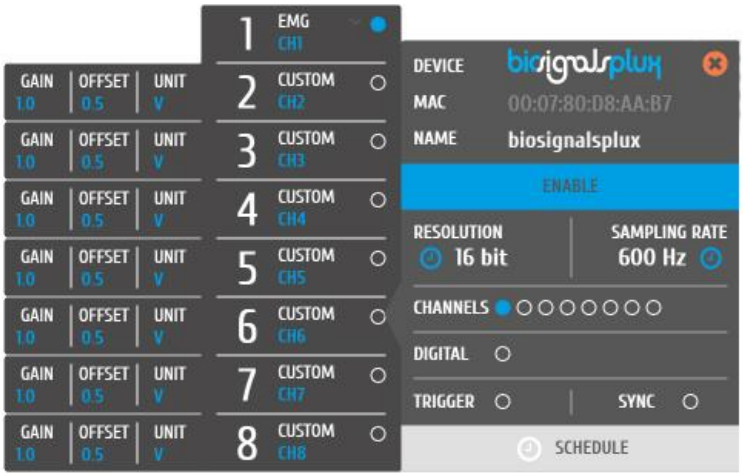


Figure 9: EMG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 10*.

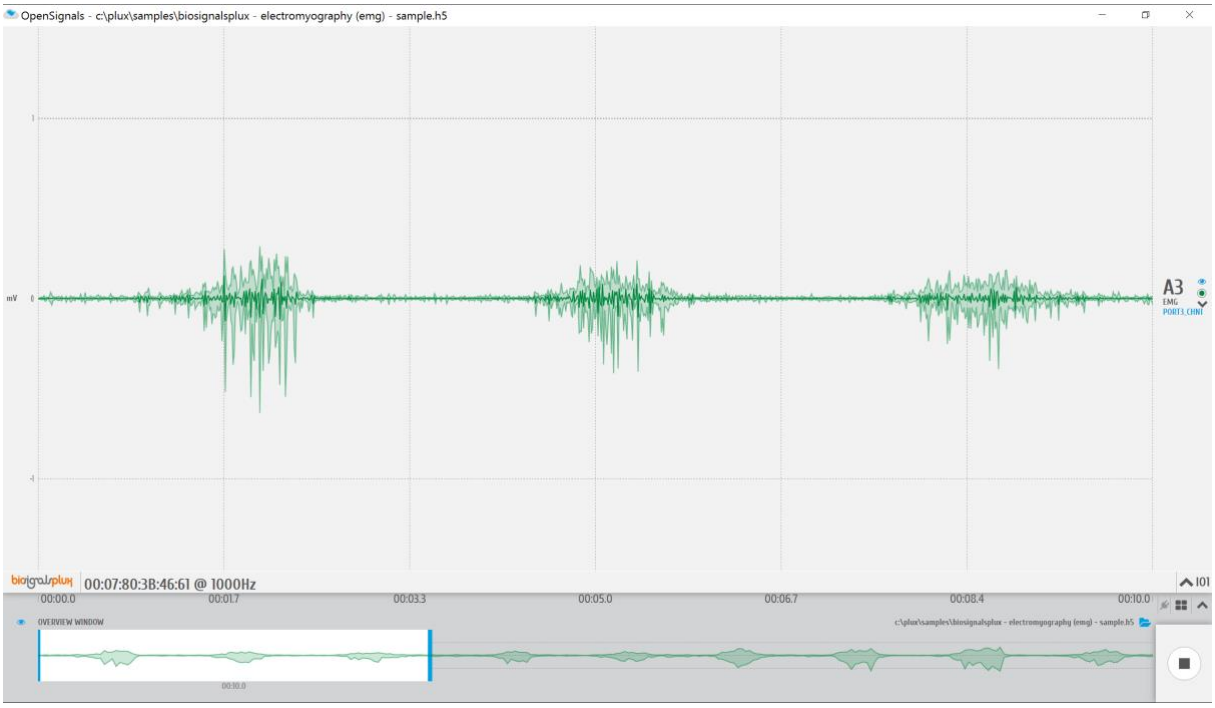


Figure 10: biosignalsplux EMG sensor sample.

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-ons' 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.

Sensor specifications

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

https://support.pluxbiosignals.com/knowledge-base/biosignalsplux-documentation/?swpmtx=3b3925a1a237225c69b9983611242f0d&swpmtxnonce=be913991a9

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

3.2 Electrocardiography (ECG)

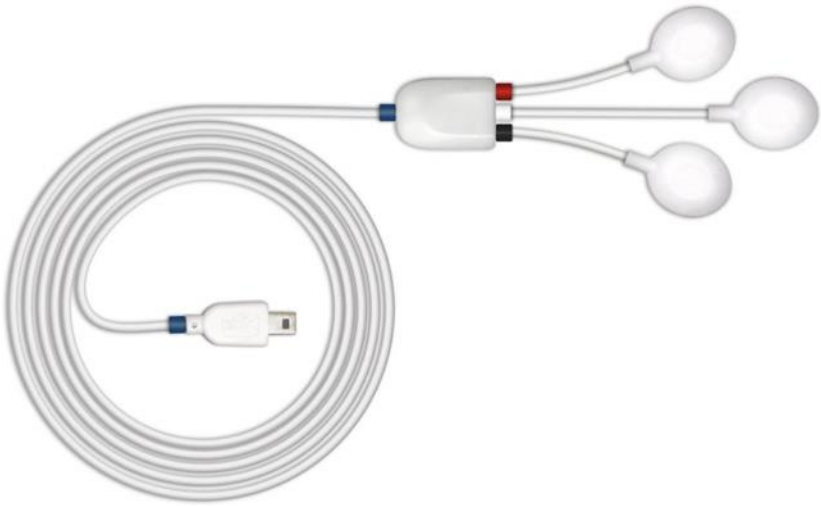


Figure 11: ECG sensor.

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

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 12* (here: ECG connected to channel 1).

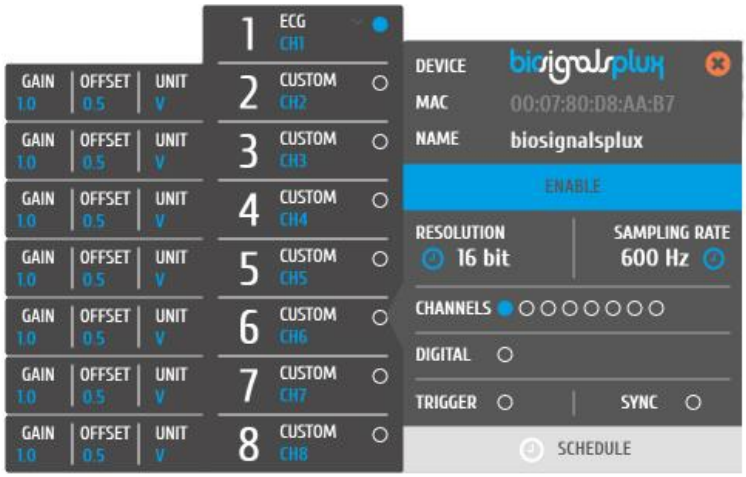


Figure 12: ECG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 13*.

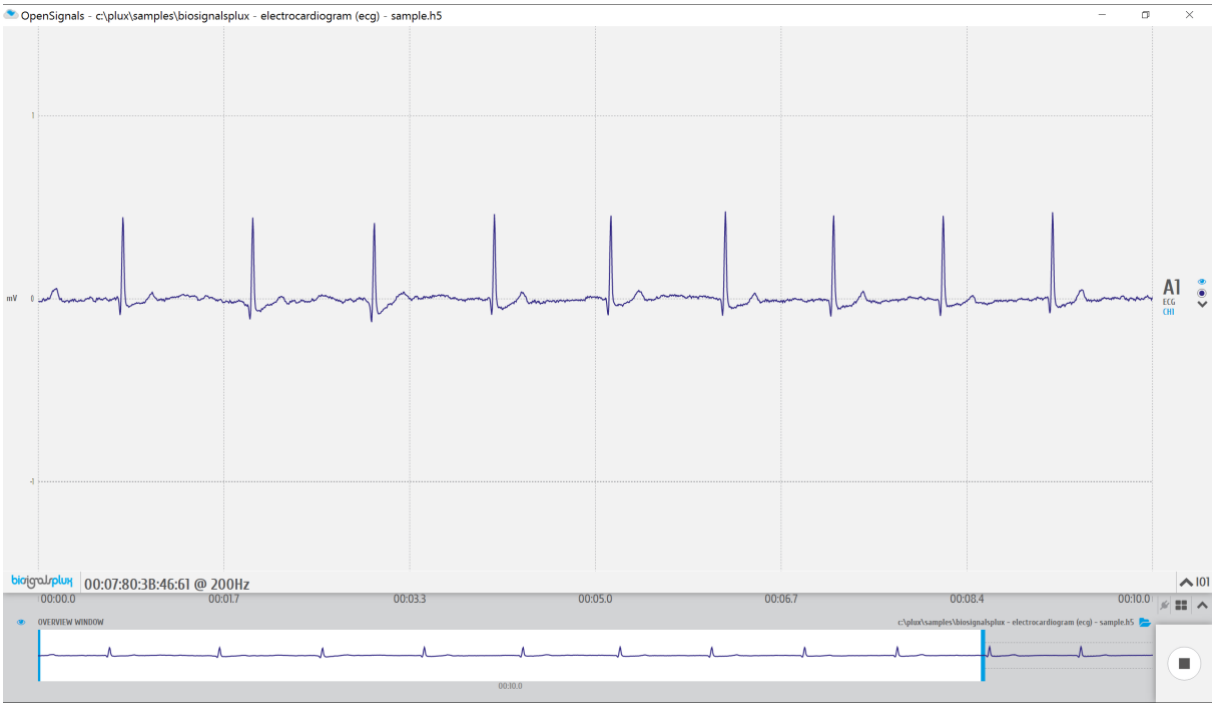


Figure 13: biosignalsplux ECG sensor sample.

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 *3.13 Blood Volume Pulse* (BVP)).

3.3 Electrodermal Activity (EDA)

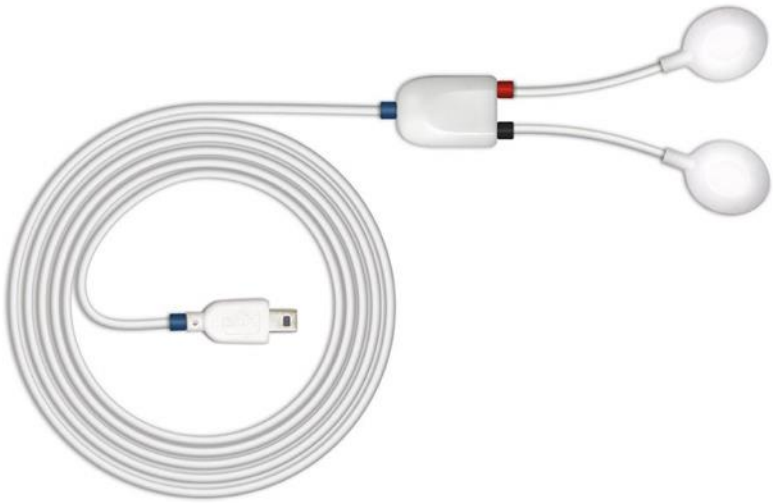


Figure 14: EDA sensor.

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

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 15* (here: EDA connected to channel 1 and EDA on arm configuration connected to channel 2).

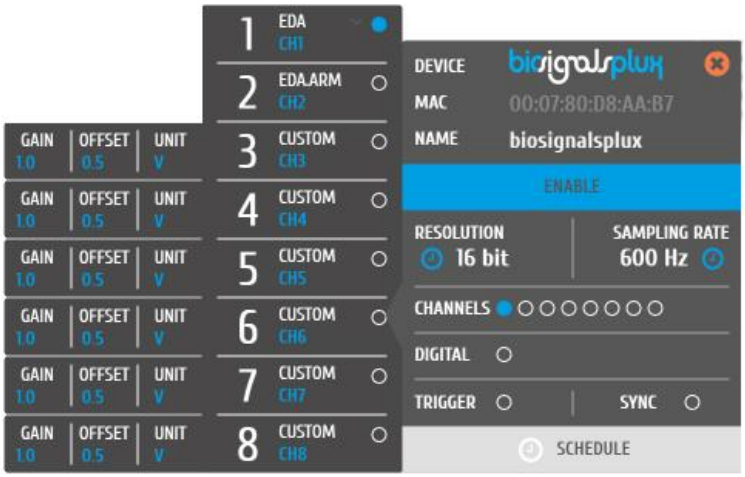


Figure 15: EDA configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 16*.

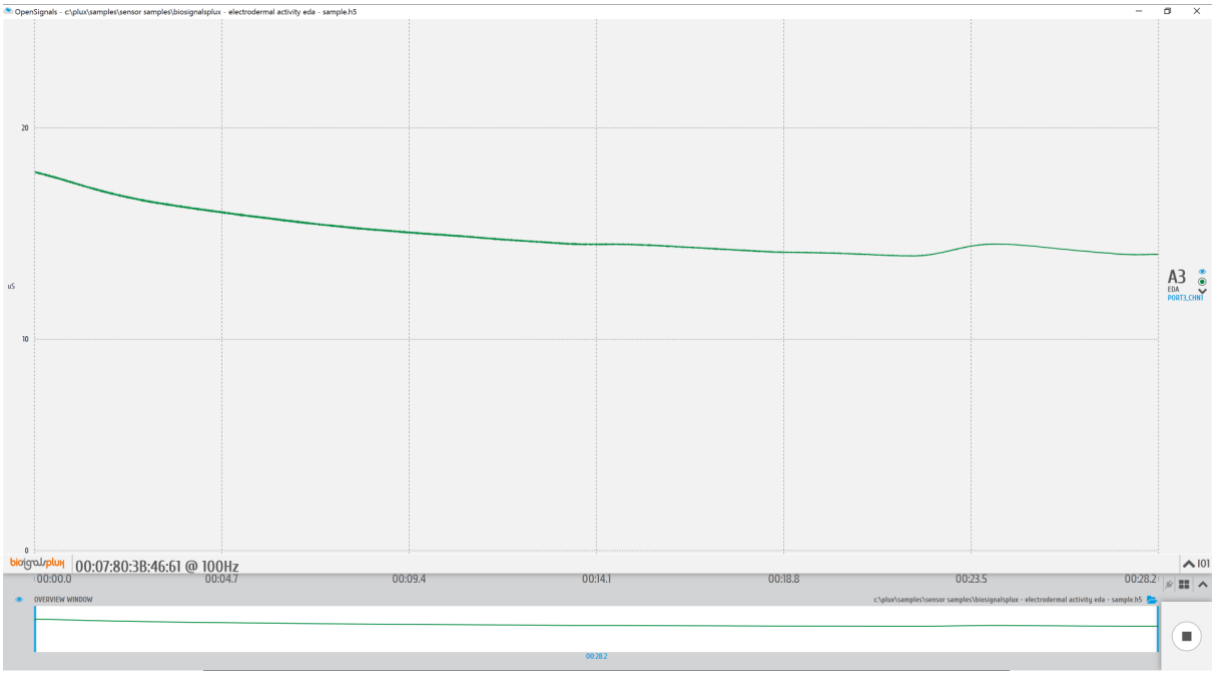


Figure 16: biosignalsplux EDA sensor sample.

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.

3.4 Electroencephalography (EEG)

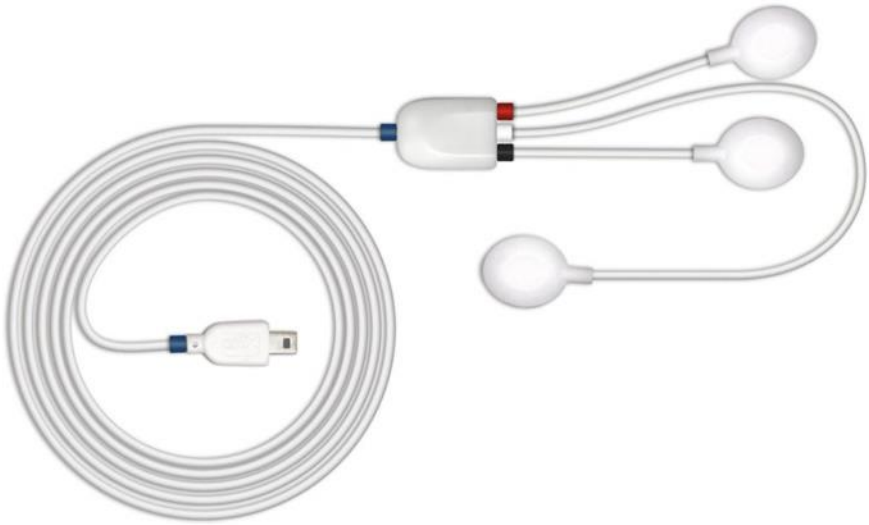


Figure 17: EEG sensor.

Our electroencephalography (EEG) sensor has been especially designed for both classic and localized EEG measurement. When a cap is too intrusive, only a limited number of channels are needed, or you'd like to synchronously record EEG and non-EEG biosignals, this is the perfect solution. The bipolar configuration, with two measurement electrodes detects the electrical potentials in the specific scalp region with respect to a reference electrode, which should be placed in a region of low muscular activity.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 18* (here: EEG connected to channel 1).

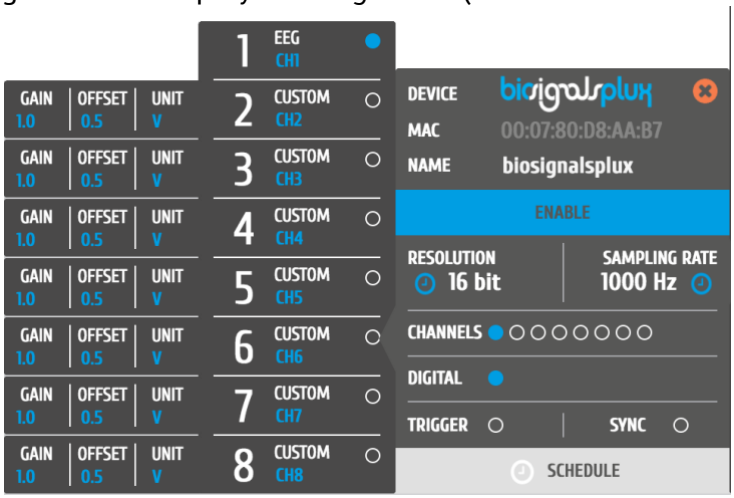


Figure 18: EEG configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 19*.

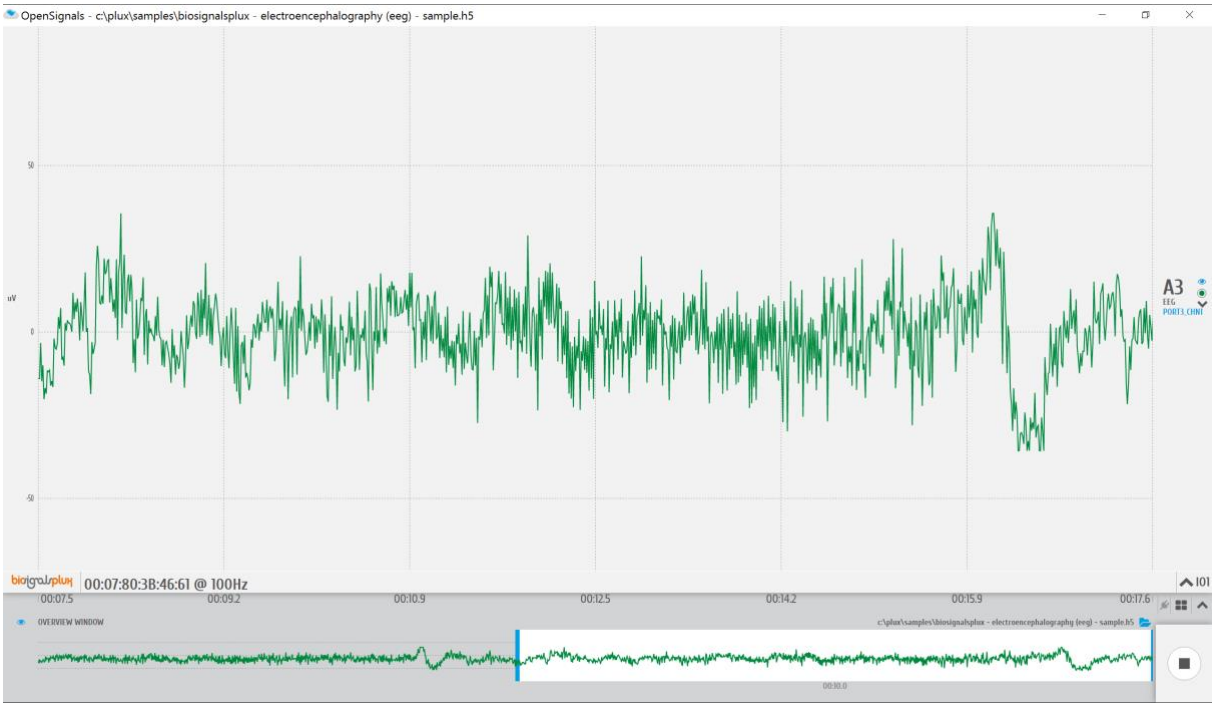


Figure 19: biosignalsplux EEG sensor sample.

3.5 Accelerometer (ACC)

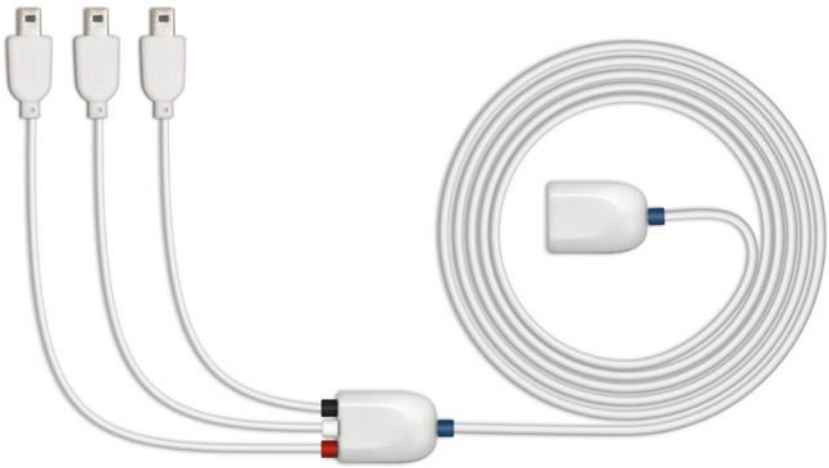


Figure 20: ACC sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 21* (here: ACC connected to channel 1 to 3; channel 1 = x-axis; channel 2 = y-axis; channel 3 = z-axis).

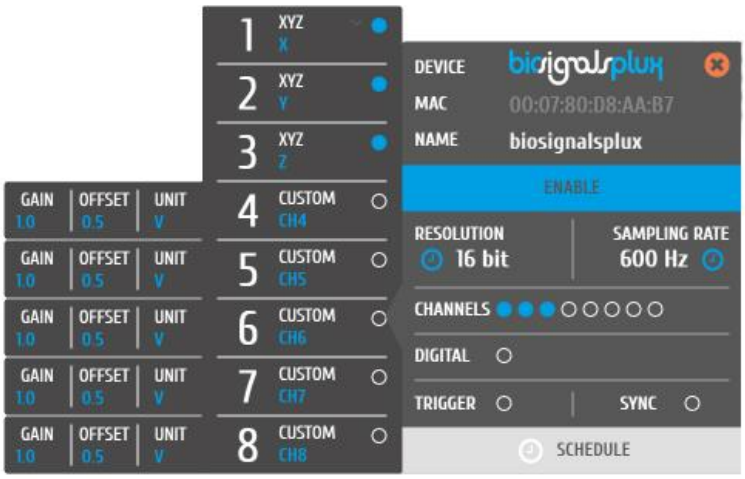


Figure 21: ACC configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 22*.

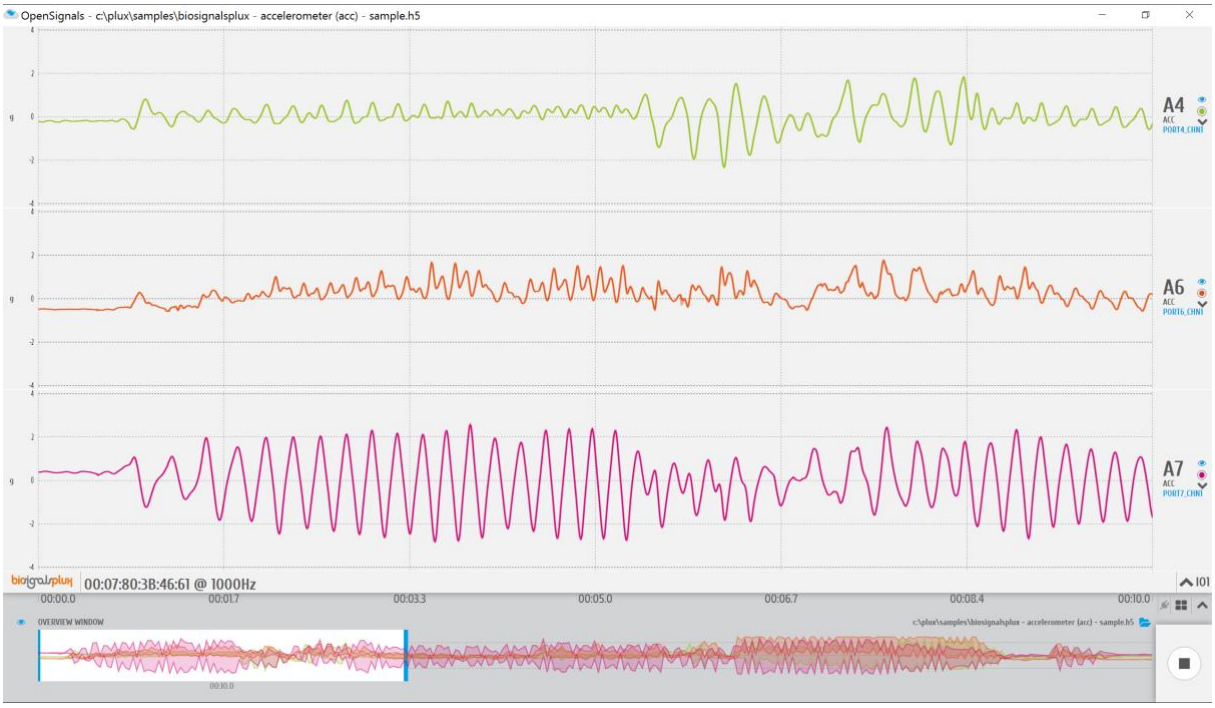


Figure 22: biosignalsplux triaxial ACC sensor sample.

3.6 Temperature (TMP)

Figure 23: TMP sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 24* (here: temperature sensor connected to channel 1).

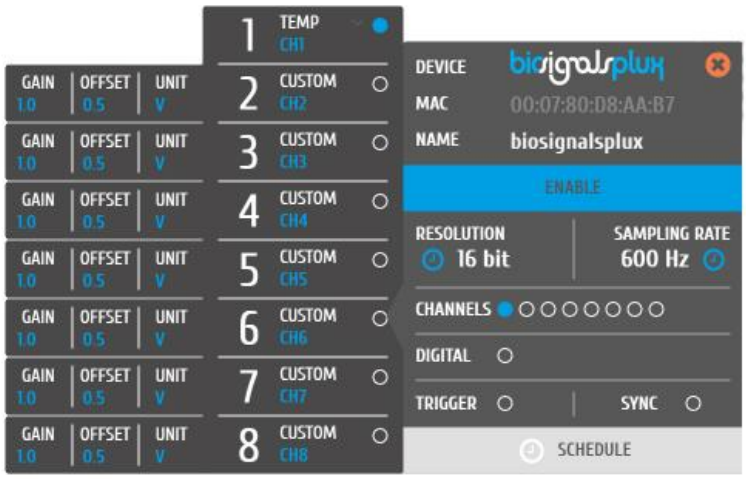


Figure 24: TMP configuration in OpenSignals.

If configured correctly, you should be able to acquire signals similar to the signal displayed in *Figure 25*.

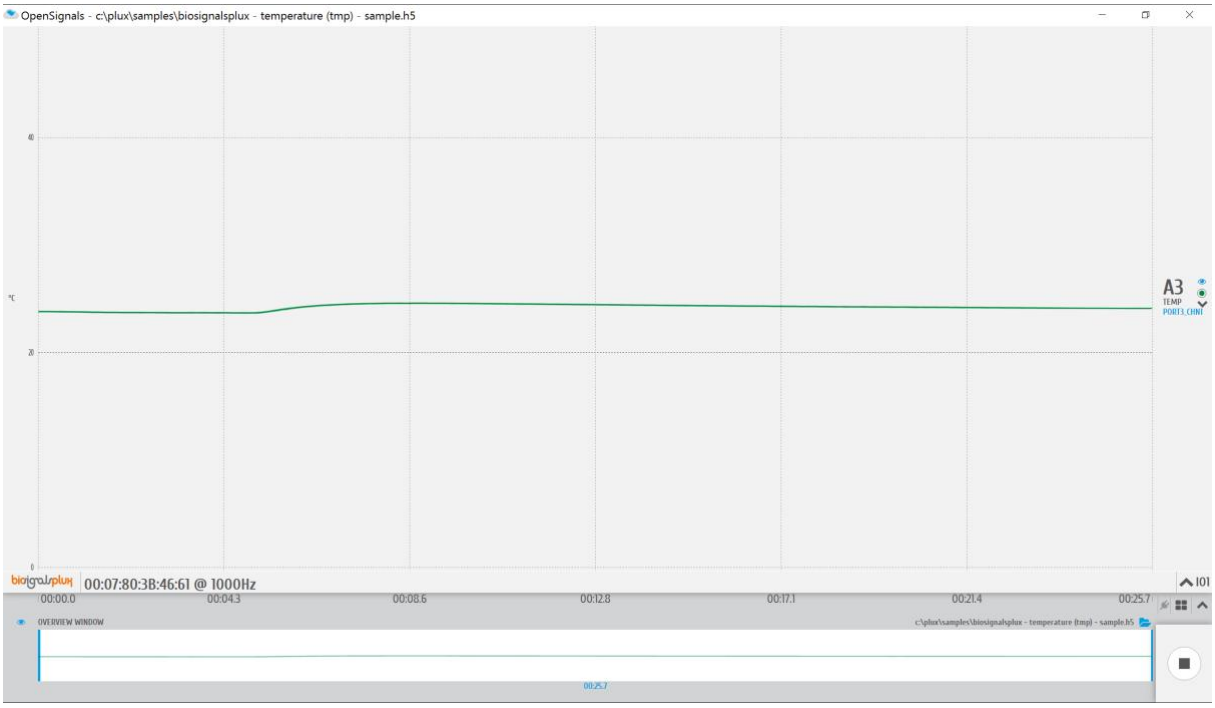


Figure 25: biosignalsplux temperature (TMP) sensor sample.

3.7 Respiration (PZT)

Figure 26: Respiration (PZT) sensor.

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).

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

How to use this sensor

This respiration sensor is a piezoelectric sensor and the membrane is centered on the flexible strip from where the cable comes out. As it measures respiration by means of the bending of the strip, the more the center of the strip is over the chest contour the better. Also, make sure the sensor fastened firmly to the chest to increase the signal quality and reliability. Signal quality will increase if the sensor it too loose.

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 27* (here: respiration sensor connected to channel 1).

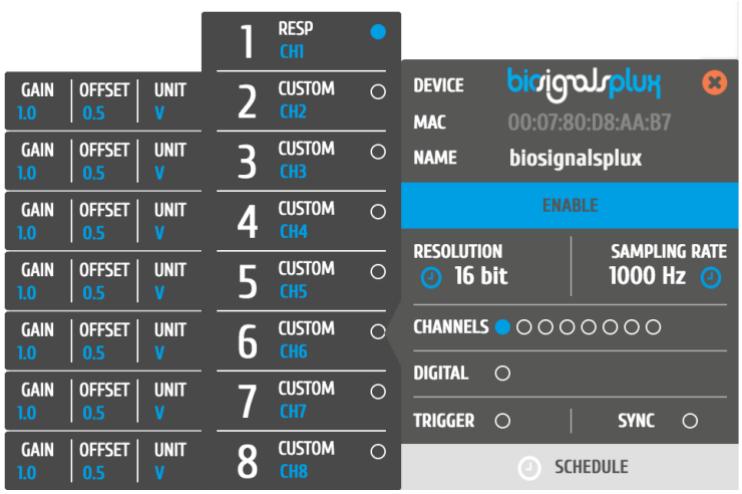


Figure 27: Respiration (PZT) configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 28*.

? Relevant Support Articles
biosignalsplux Documentation

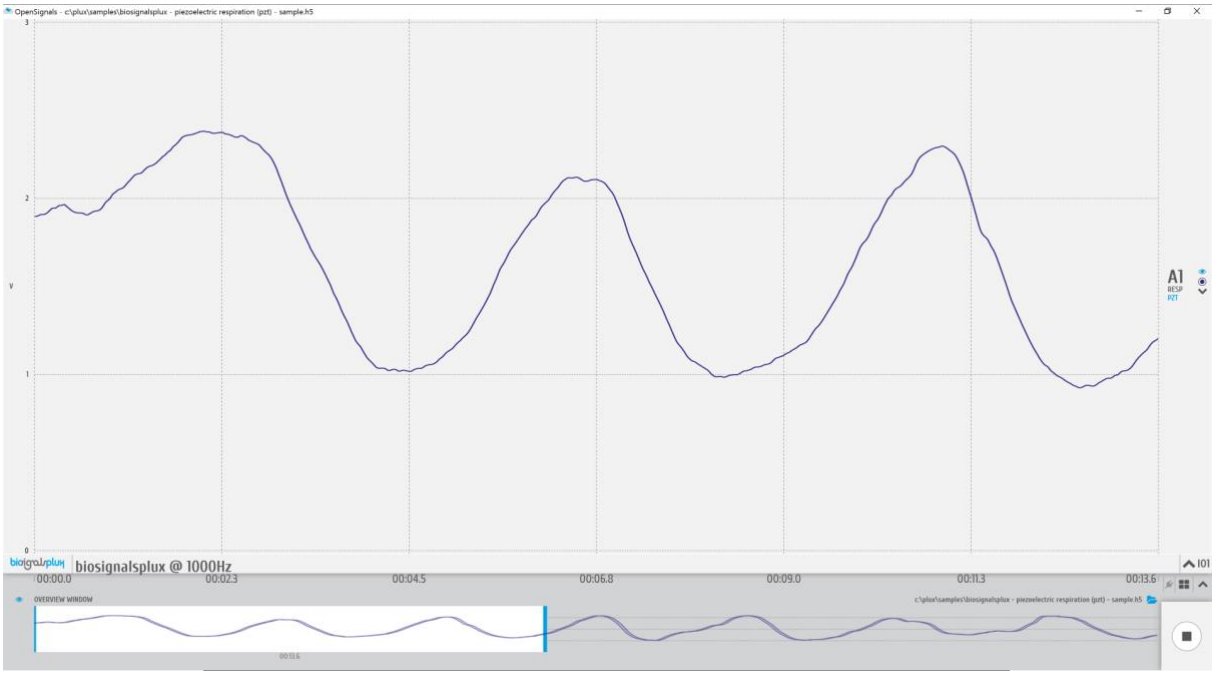


Figure 28: biosignalsplux respiration (PZT) sensor sample.

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 piezoelectric respiration sensor (PZT) (or with the inductive respiration sensor (RIP); see *3.10 Respiration (RIP)*).

3.8 Force (FSR)

Figure 29: FSR sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 *FSR-I, FSR-II, FSR-III* or *FSR-IV* (depending on the type of sensor you have; please review the datasheet to determine the correct type) from the dropdown menu (click on the arrow in the channel's field that appears when you hover over the channel's field).

An example configuration with all available FSR channel types is displayed in *Figure 30* (here: force sensor connected to channel 1).

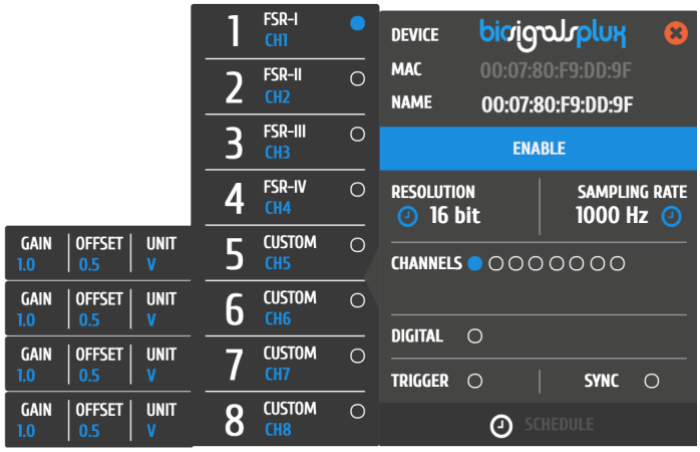


Figure 30: Force sensor configuration in OpenSignals (select between the 4 available FSR-X types depending on your sensor's type).

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 31*.

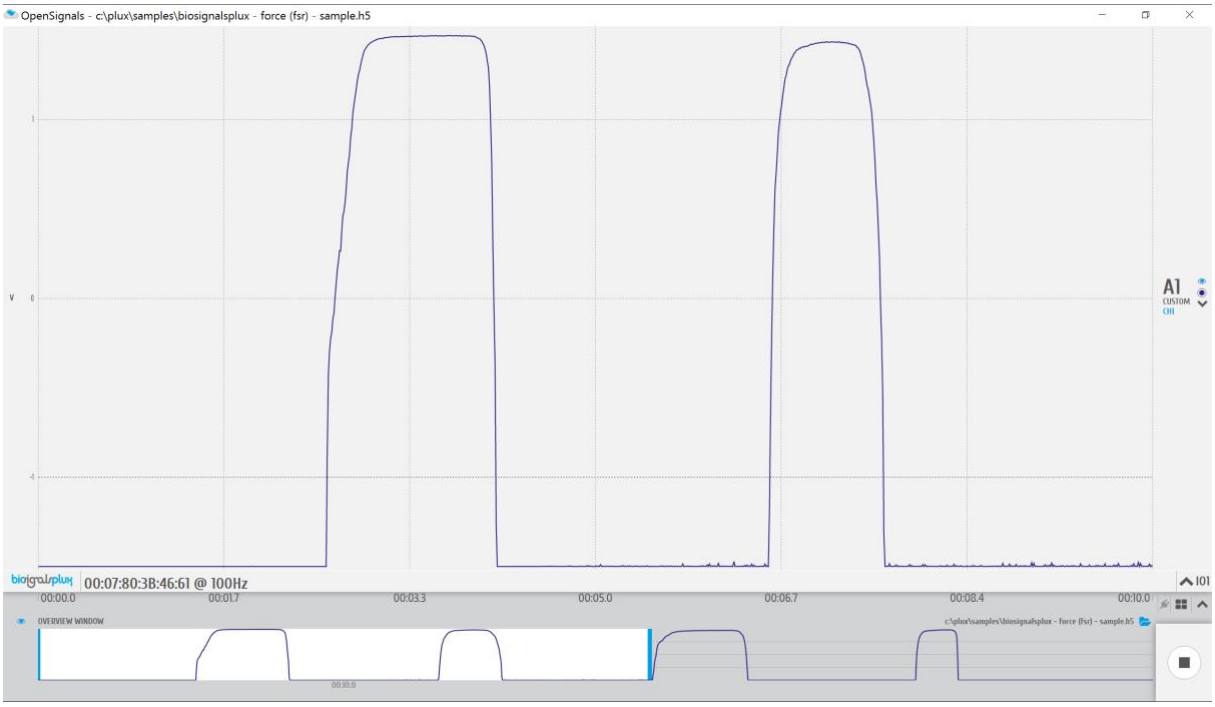


Figure 31: biosignalsplux force (FSR) sensor sample.

3.9 Light (LUX)

Figure 32: LUX sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 33* (here: light sensor connected to channel 1).

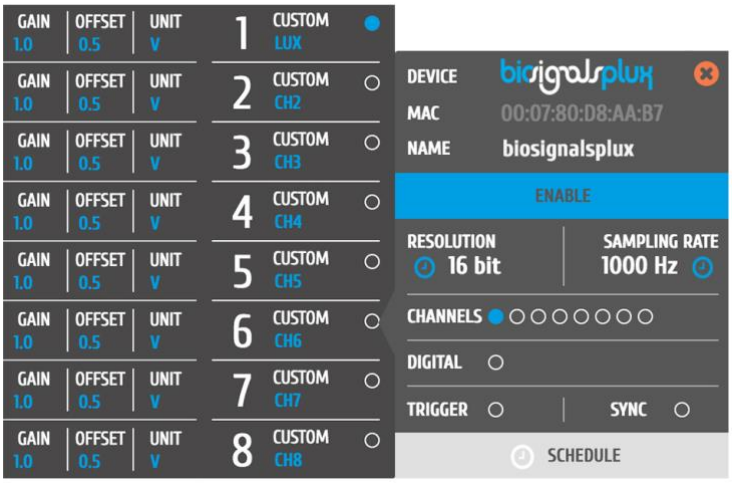


Figure 33: Light sensor configuration in OpenSignals.

If configured correctly, your acquired signals should be similar to the signal displayed in *Figure 34*.

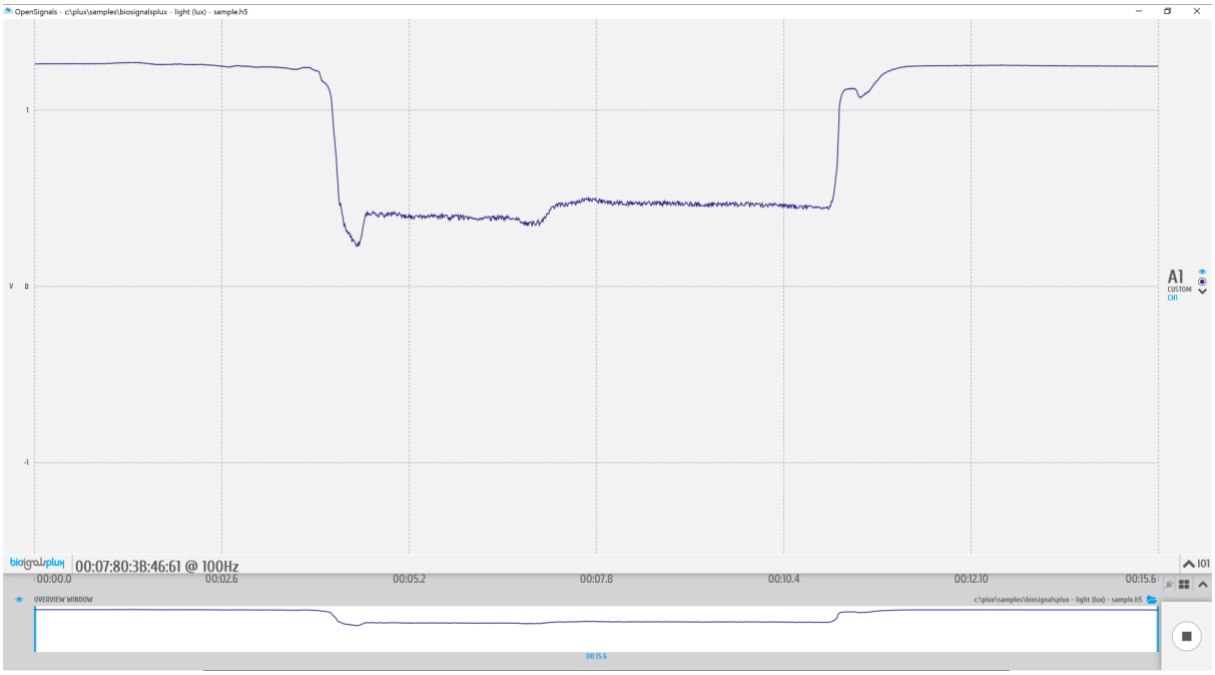


Figure 34: biosignalsplux light (LUX) sensor sample.

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)*).

3.10 Respiration (RIP)

Figure 35: Respiration (RIP) sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 36* (here: respiration sensor connected to channel 1).

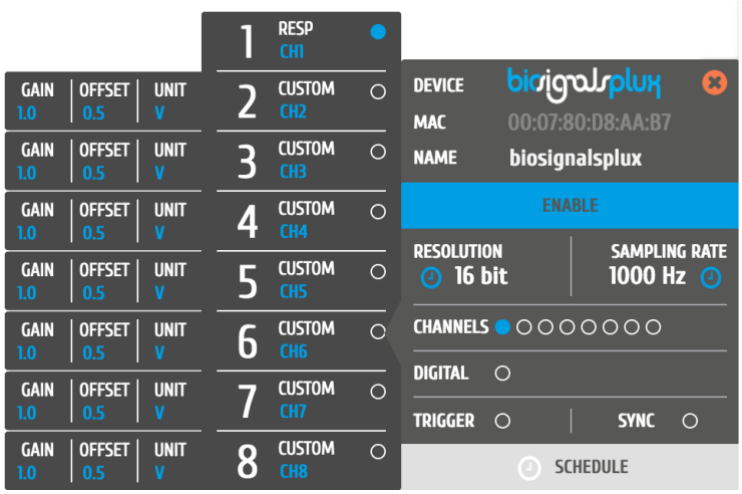


Figure 36: Respiration (RIP) configuration in OpenSignals.

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 *3.7 Respiration (PZT)*).

3.11 Goniometer (GON)

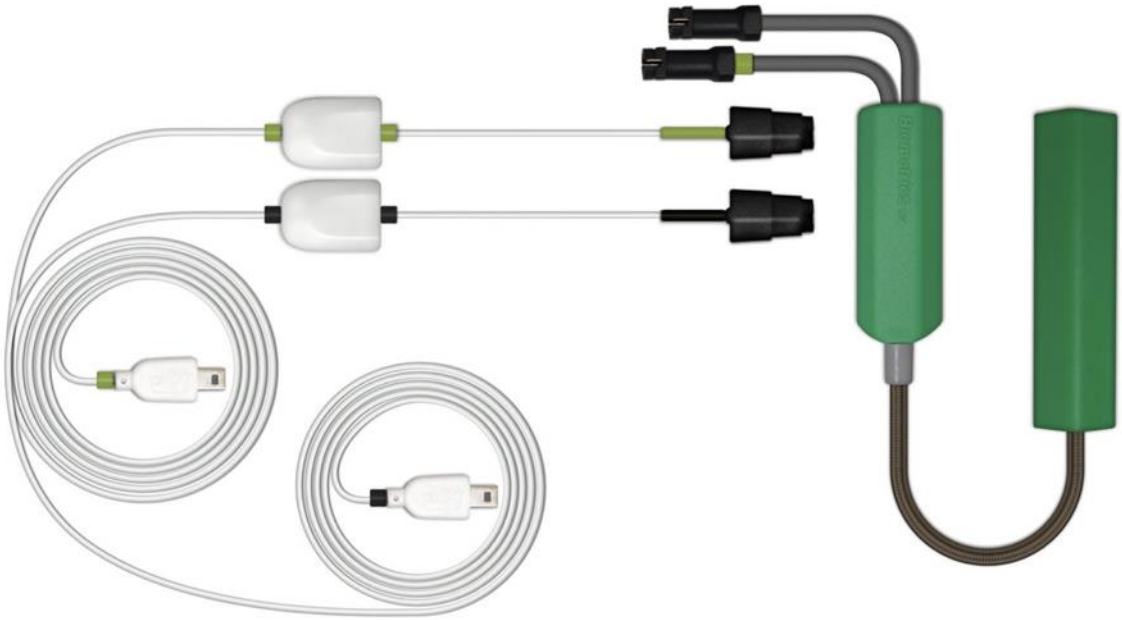


Figure 37: Goniometer.

?	Find relevant sensor information in the biosignalsplux documentation
	biosignalsplux Documentation

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 38* (here: goniometer connected to channel 1).

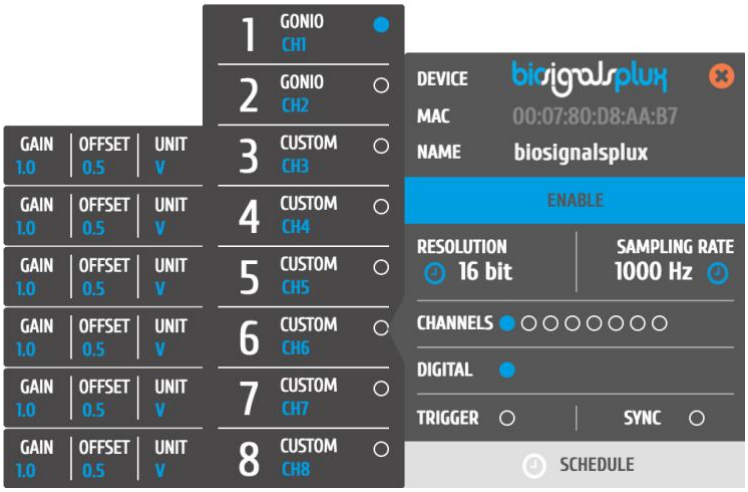


Figure 38: Goniometer configuration in OpenSignals.

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

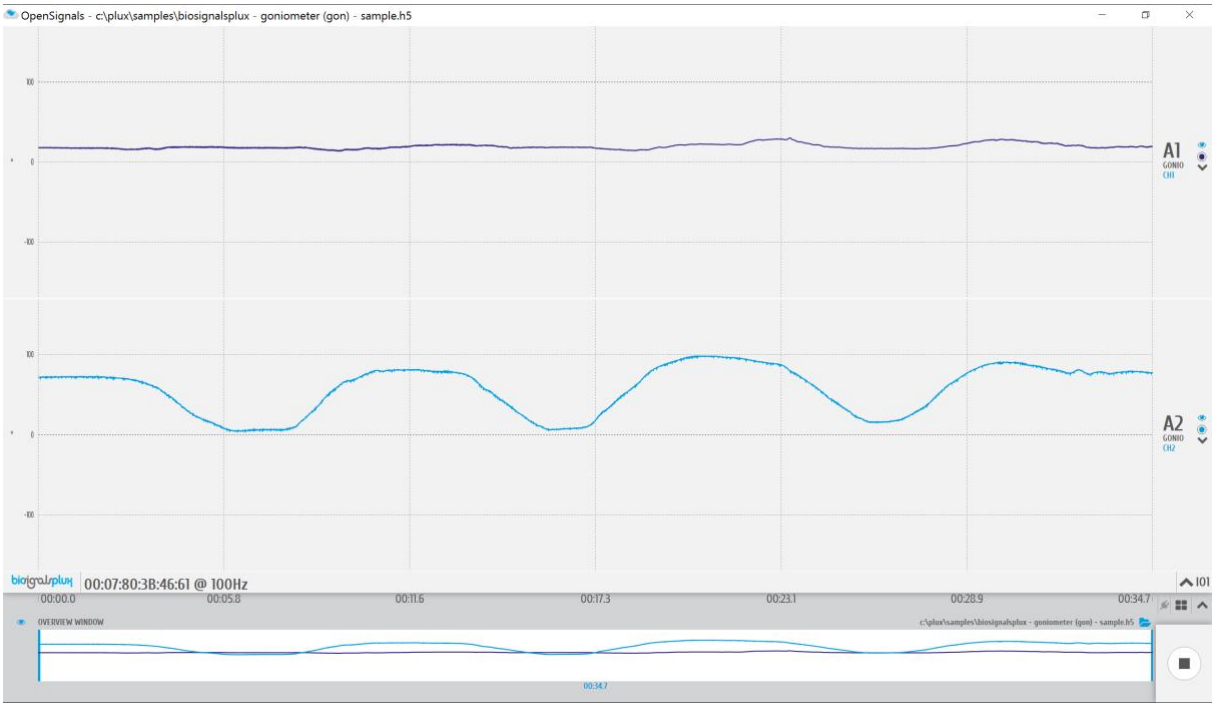


Figure 39: biosignalsplux goniometer sensor sample.

3.12 Load Cell

Figure 40: Load cell.

?	Find relevant sensor information in the biosignalsplux documentation
	biosignalsplux Documentation

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 41* (here: load cell connected to channel 1).

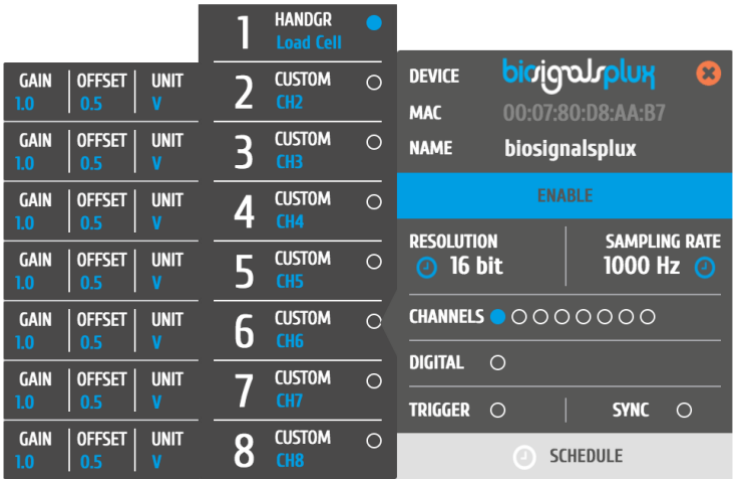


Figure 41: Load cell configuration in OpenSignals.

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*. 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.

3.13 Blood Volume Pulse (BVP)

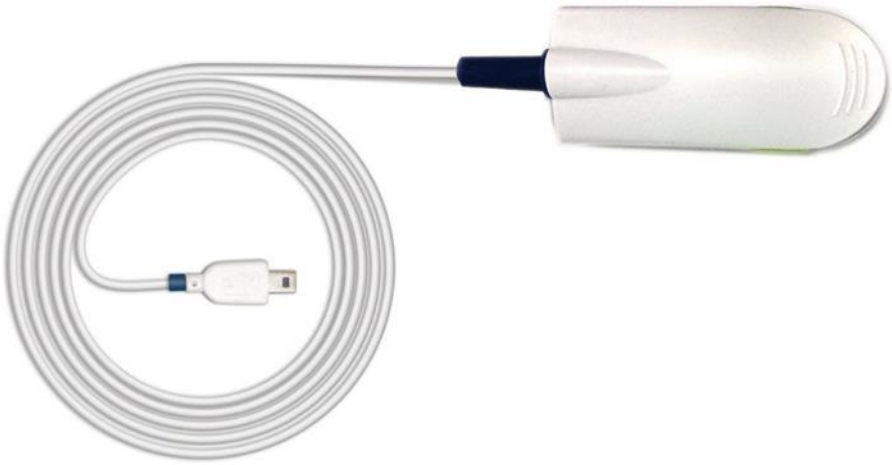


Figure 42: BVP sensor.

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.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

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 43* (here: blood volume pulse sensor connected to channel 1).

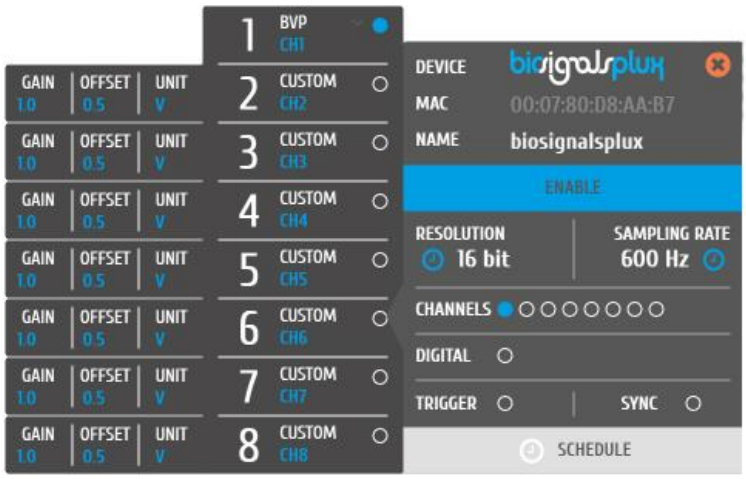


Figure 43: Blood volume pulse sensor configuration in OpenSignals.

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

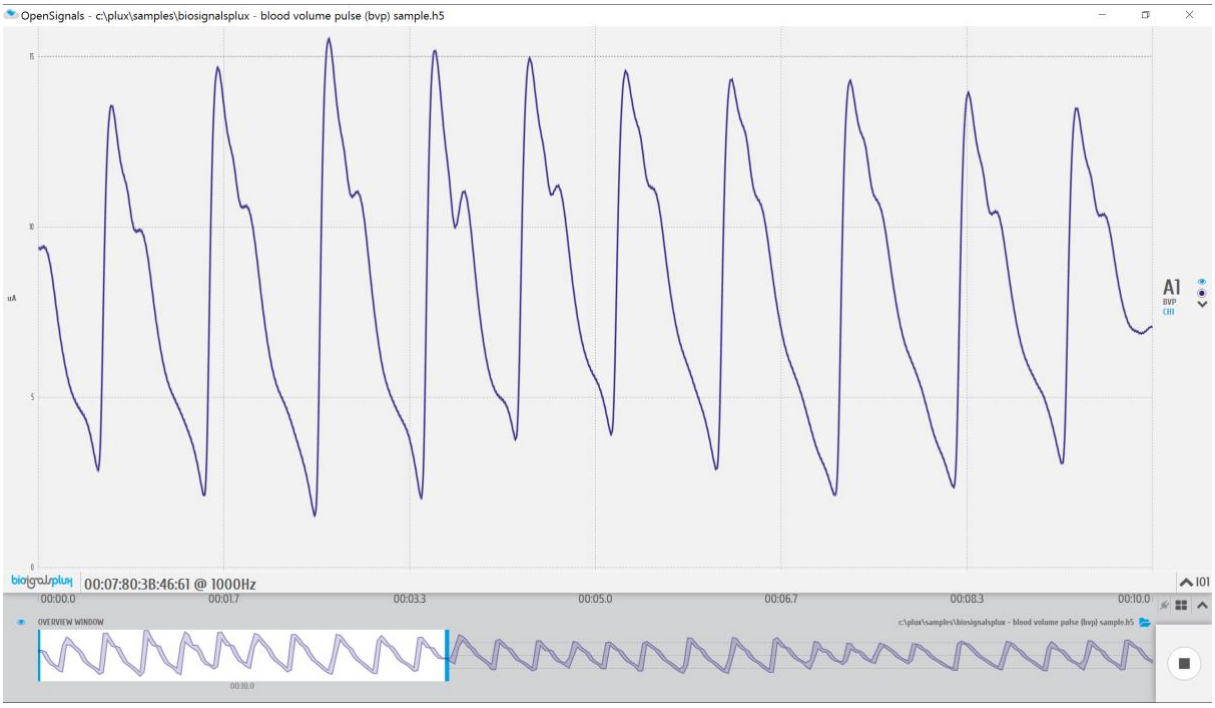


Figure 44: biosignalsplux blood volume pulse (BVP) sensor sample.

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 *3.2 Electrocardiography* (ECG)).

3.14 SpO2

Figure 45: SpO2 sensor (versatile).

Figure 46: SpO2 sensor (finger clip).

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.

?	Find relevant sensor information in the biosignalsplux documentation

[biosignalsplux Documentation]

How to connect your sensor to your biosignalsplux

The SpO2 sensor(s) have to be connected to the ground port of your device. Connecting this sensor to an analog input of your device will not work.

How to configure your sensor in OpenSignals (r)evolution

Open the OpenSignals (r)evolution device manager and select the device you have your SpO2 sensor connected to.

In the device's panel, set up channel 9 for signal acquisition, set the port (P) to 9 and the channel (C) to 1 and select one of the available SpO2 options in the channel's dropdown menu. The different options 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

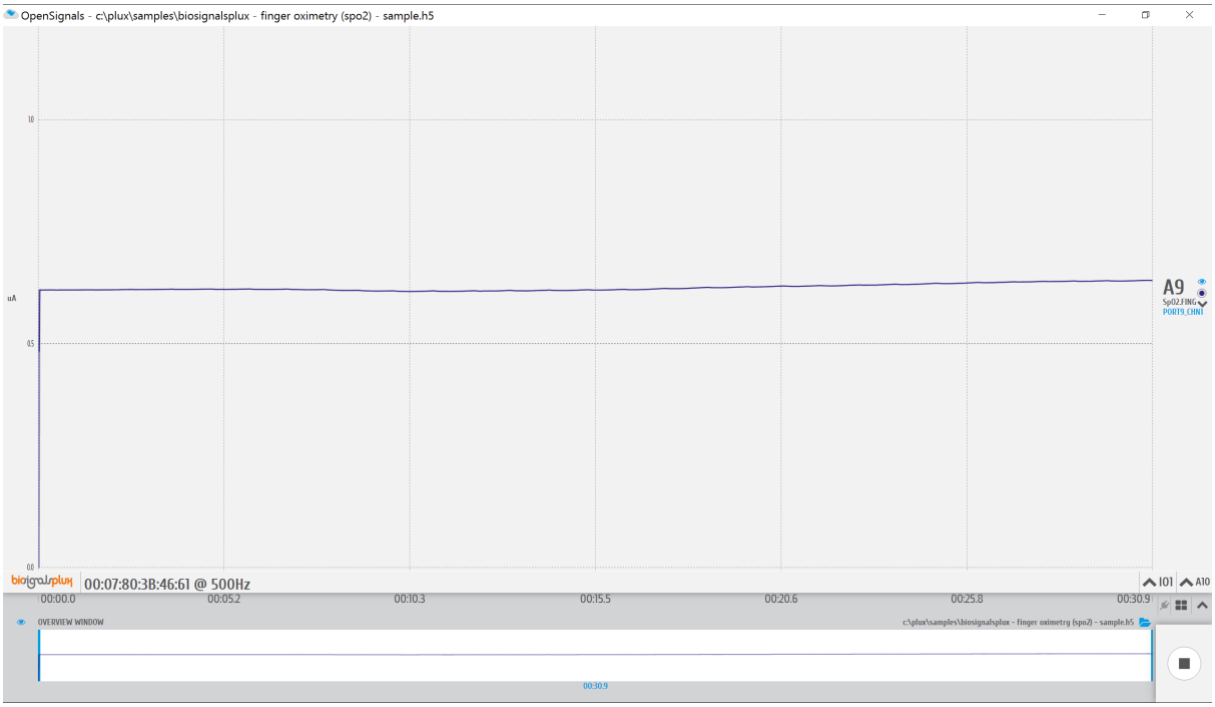


Figure 47: biosignalsplux SpO2sensor sample.

3.15 fNIRS

Figure 48: fNIRS sensor.

The fNIRS (functional near-infrared spectroscopy) sensor measures the red and infrared light reflectance in the cortical tissue. This sensor is typically applied on the forehead and it can be used to estimate the blood oxygen saturation level in the brain tissue. Possible applications include brain activity monitoring, functional neuroimaging and advanced BCI systems.

? Find relevant sensor information in the biosignalsplux documentation
biosignalsplux Documentation

How to connect your sensor to your biosignalsplux

The fNIRS sensor needs to be connected to the ground port of your device. Connecting this sensor to an analog input of your device will not work.

How to configure your sensor in OpenSignals (r)evolution

Open the OpenSignals (r)evolution device manager and select the device you have your fNIRS sensor connected to.

In the device's panel, set up the channels 9 and 10 for signal acquisition and set the sensor type to fSpO2 or, if not available, to SpO2.HEAD (click on the arrow in the channel's field that appears when you hover over the channel's field). For channel 9, set the port

(P) to 9 and the channel (C) to 1. For channel 10, set the port (P) to 9 and the channel to (C) 2.

Channel 9 visualizes the reflected light of the red LED, while channel 10 visualizes the reflected light of the IR. The intensities of the LEDs can be configured individually by changing the sliders at the left side next to the channel configuration panels. If configured correctly, the device panel should be similar to Figure 60.

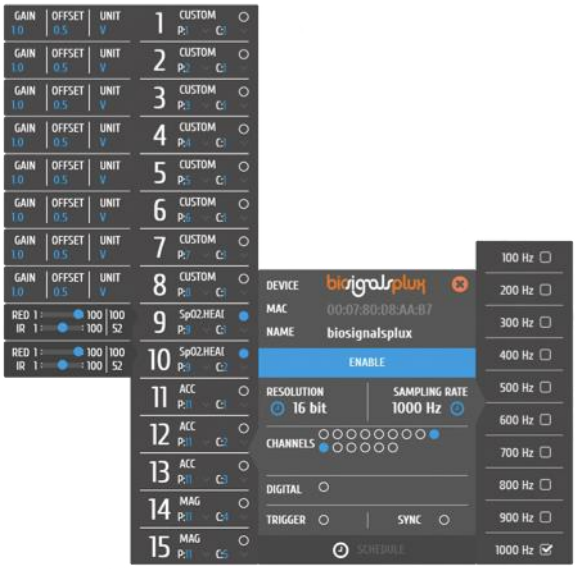
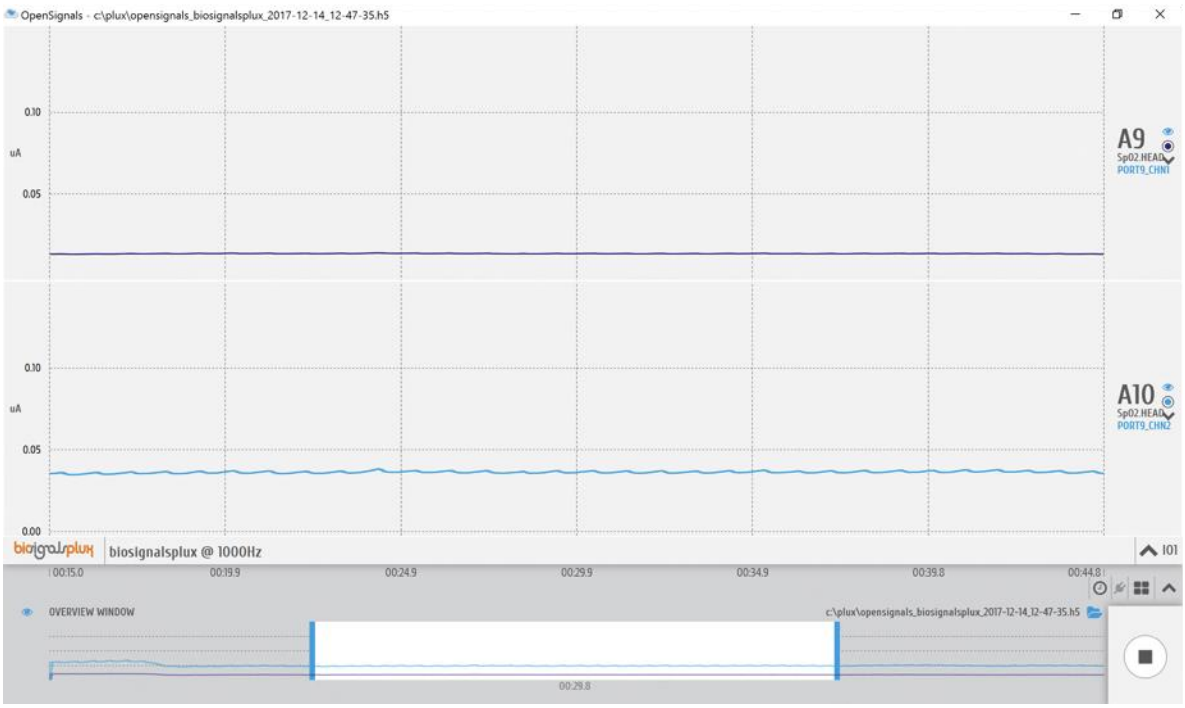


Figure 49: Configuration of the fNIRS in OpenSignals.



3.16 Blood Pressure Reader (BPR)

This sensor has been discontinued.

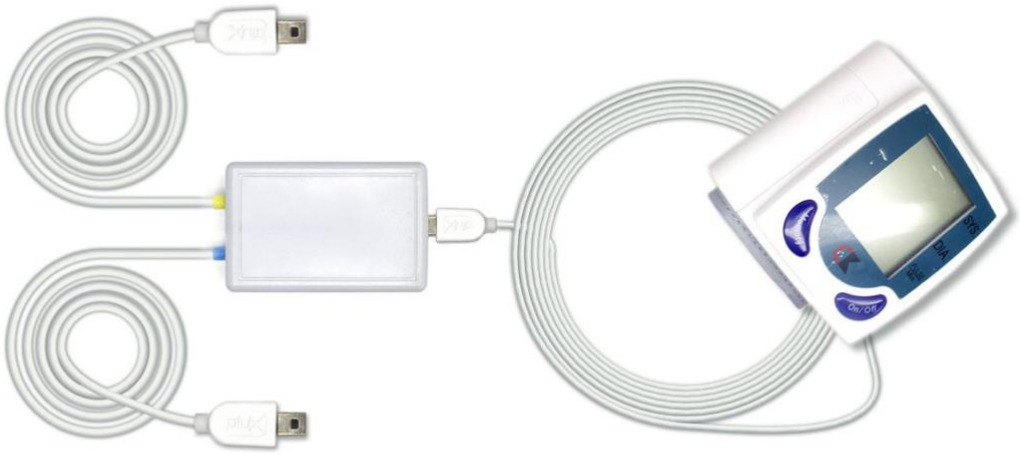


Figure 50: BPR sensor.

This user-friendly upper arm cuff-based blood pressure monitor measures systolic & diastolic blood pressure levels (in mmHg) with ± 3mmHg accuracy. The built-in colour LCD display displays all measured blood pressure values and additional heart rate information (bpm) and allows this sensor to be used both as standalone device or as biosignalsplux sensor within our OpenSignals (r)evolution software.

NOTE
This sensor is an adaptation of the 3rd party CK101 Wrist Blood Pressure Monitor which provides compatibility with biosignalsplux devices. It can be used both as standalone device or as biosignalsplux sensor.

Please do also read the datasheet of the standalone device before using this sensor:

http://biosignalsplux.com/datasheets/telemedicine/Goodwill_Studio_Ver1.pdf

How to connect your sensor to your biosignalsplux

Connect the BPR sensor to the adapter box. When done, connect the outgoing cables to

any available analog inputs of your biosignalsplux (see 2.3.2 Analog Inputs). Note that this sensor has individual channels for the diastolic and systolic signals.

How to configure your sensor in OpenSignals (r)evolution

Open the OpenSignals (r)evolution device manager and select the device you have your BPR sensor connected to. Select the channel of your diastolic signal channel and set the

sensor type to DIA (click on the arrow in the channel's field that appears when you hover over the channel's field and select DIA from the dropdown menu). Select the channel of your systolic signal channel and set the sensor type to SYS[2].

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

How to use your sensor

This sensor is designed to measure blood pressure levels at the wrist. Place the sensor at the wrist of the user (ideally the left wrist) such that both the sensor's display and the hand palm are facing towards the user. Please do also check the instructions provided on the cuff to ensure optimal acquisition results.

Signal acquisitions in OpenSignals (r)evolution are done by initializing the signal acquisition in OpenSignals and pressing the On/off button on your sensor. The cuff will start to fill itself with air and the sensor will conduct the blood pressure measurement.

If configured correctly, your acquired signals should be similar to the signal displayed in Figure 63. Note that the sensor will achieve different states during the measurement which can be seen in the acquires signal:

A. Sensor is not turned on but not conducting a measurement

B. Sensor cuff is being filled with air; ongoing blood pressure measurement

C. Sensor results for diastolic and systolic blood pressure values

[2] The sensor types SYS (systolic) and DIA (diastolic) are only supported by OpenSignals (r)evolution versions of 30.01.2018 or newer.

Figure 51: Blood pressure reader sample data.

3.17 SpO2 Reader (OSL)

This sensor has been discontinued.

Figure 52: SpO2 reader.

This comfortable and user-friendly finger clip sensor was designed to measure reliable oxygen saturation levels (%) and heart rate (bpm) information. The built-in colour LCD display displays all measured values and signals and allows this sensor to be used both as standalone device or as biosignalsplux sensor within our OpenSignals (r)evolution software.

NOTE
This sensor is an adaptation of the 3rd party CMS-50D Plus which provides compatibility with biosignalsplux devices. It can be used both as standalone device or as biosignalsplux sensor.

Please do also read the datasheet of the standalone device before using this sensor:

http://biosignalsplux.com/datasheets/telemedicine/CMS-50D_Plus.pdf

How to connect your sensor to your biosignalsplux
Connect the sensor to the adapter box using the micro-USB cable which comes pre-connected to the adapter box. When done, connect the outgoing cables to any of the

available analog inputs of your biosignalsplux (see 2.3.2 Analog Inputs). Note that this sensor has individual channels for the SpO2 and heart rate signals.

How to configure your sensor in OpenSignals (r)evolution

Open the OpenSignals (r)evolution device manager and select the device you have your OSL sensor connected to. Select the channel of your SpO2 signal and set the sensor type to OXI (click on the arrow in the channel's field that appears when you hover over the channel's field and select OXI from the dropdown menu). Select the channel of your heart rate signal channel and set the sensor type to HR[3].

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

How to use your sensor

This sensor is designed to measure oxygen saturation levels and heart rate on the index finger.

To start acquiring a signal with this sensor when using OpenSignals (r)evolution, start the signal acquisition in OpenSignals and hold the On/off button at the top side of your sensor until the display is turned on. The sensor data will no be visible in OpenSignals (r)evolution.

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

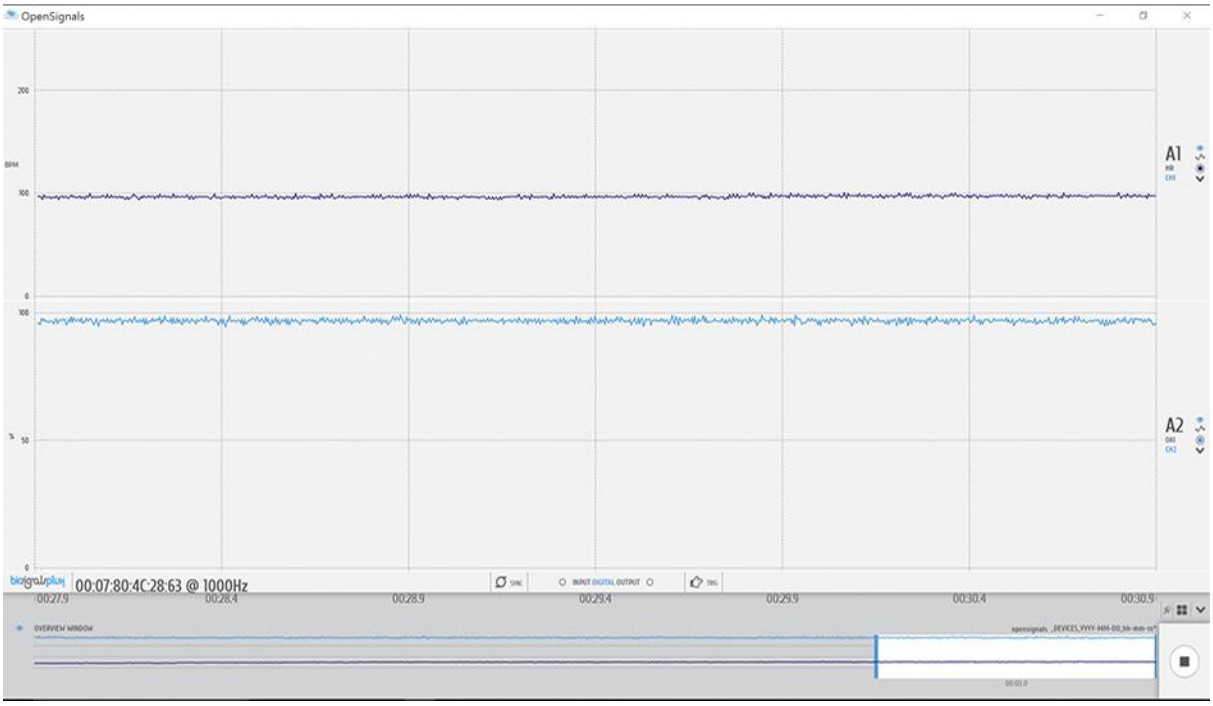


Figure 53: SpO2 reader sample.

[3] The sensor types OXI (oxygen saturation) and HR (heart rate) are only supported by OpenSignals (r)evolution versions of 30.01.2018 or newer.

3.18 Glucose Meter Reader (GMR)

This sensor has been discontinued.

Figure 54: GMR sensor.

This user-friendly glucose meter measures reliable glucose level data (mg/dL) using blood samples taken from fingertips, palms, forearms, upper arms, or calves. The built-in colour LCD display displays the measured glucose level and allows this sensor to be used both as standalone device or as biosignalsplux sensor within OpenSignals (r)evolution software. This sensor comes with 10 disposable single-use lancets and test strips to take and prepare the needed blood samples.

NOTE

This sensor is an adaptation of the 3rd party CareSensTM II Blood Glucose Monitoring System (i-SENSO, Inc) which provides compatibility with biosignalsplux devices. It can be used both as standalone device or as biosignalsplux sensor.

Please do also read the datasheet of the standalone device before using this sensor:

http://biosignalsplux.com/datasheets/telemedicine/caresens_ii.pdf

How to connect your sensor to your biosignalsplux

Connect the sensor to the adapter box using the 3.5mm connector which comes pre-connected to the adapter box. When done, connect the outgoing UC-E6 cable to any of the available analog inputs of your biosignalsplux (see 2.3.2 Analog Inputs).

How to configure your sensor in OpenSignals (r)evolution
Open the OpenSignals (r)evolution device manager and select the device you have your GMR sensor connected to. Select the channel of your sensor and set the sensor type to

GLUC[4] (click on the arrow in the channel's field that appears when you hover over the channel's field and select GLUC from the dropdown menu).

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

How to use your sensor
This sensor is designed to measure the glucose concentration in 5µL blood samples taken from fingertips, palms, forearms, thighs, upper arms, or calves.

WARNING
The test strips, lancets, and the disinfection cloths which come with your sensor are disposables and are intended for single use only.

Do not reuse test strips, lancets, and the disinfection cloths and dispose them after being used.

To start acquiring a signal with this sensor in OpenSignals (r)evolution, disconnect the sensor from your biosignalsplux and start the signal acquisition to avoid starting with measurement results from previous acquisitions (for more details see also the indications on the next page).

Follow the application instructions on the flyer provided with your sensor to ensure a correct and harmless use of this sensor during the preparation of the blood sample and the measurement.

Prepare your blood sample and use the test strip, as indicated on the flyer to measure the glucose level of the blood sample. The sensor requires 5 seconds to measure the glucose level; a countdown will be shown on the device display. The test strip must be held in the blood sample during the entire 5 seconds of the measurement process. If no error occurred, the device will now show the measured value on its display.

After a successful measurement, plug-in the biosignalsplux connector to your glucose meter reader. The device's display should now be displaying "Pc" and the signal in

[4] The sensor types GLUC is only supported by OpenSignals (r)evolution versions of 30.01.2018 or newer.

OpenSignals will now be at the measured value.

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

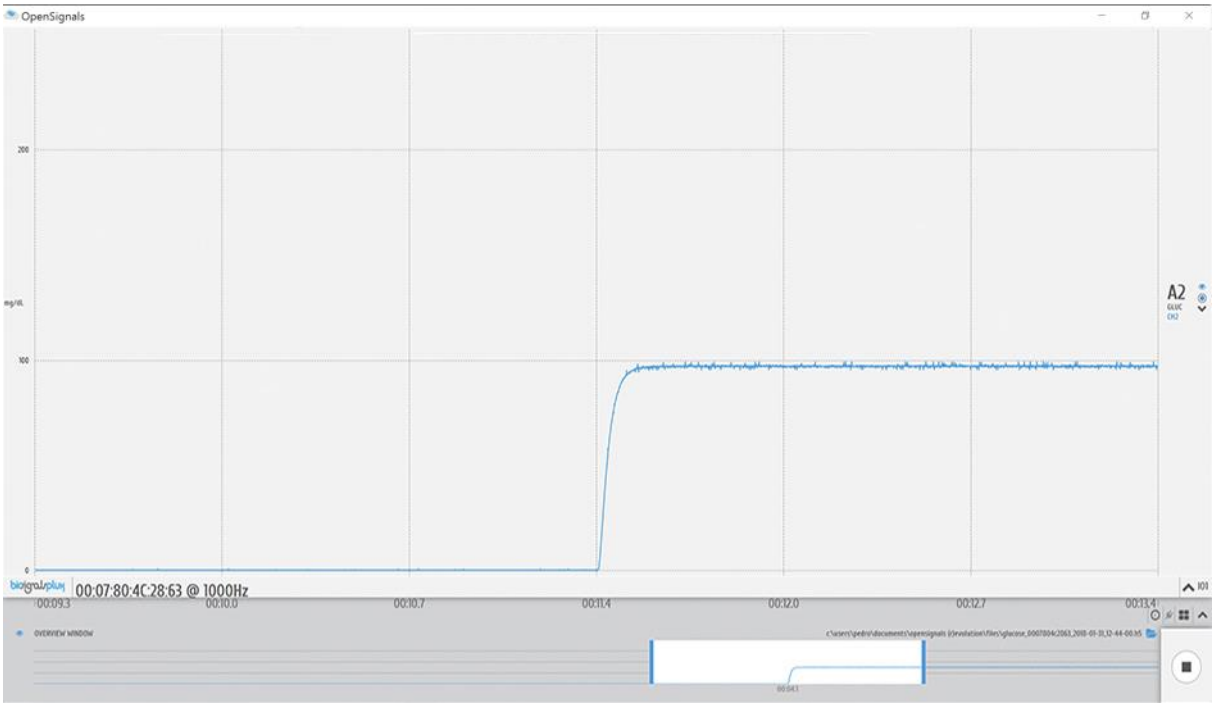


Figure 55: Glucose meter reader sample.

Important Notes & Troubleshooting

Initial values & effects of previous acquisitions

When using this sensor with biosignalsplux, the value of the last measurement will be provided by the sensor and displayed in OpenSignals (r)evolution. The signal stays constant on the last measured value and only changes when new measurements are made.

This can cause your signal to start at the value of a previous measurement even if no actual measurement has been made during the acquisition session. To prevent initial values of previous acquisitions, disconnect the adapter of this sensor from the biosignalsplux and the sensor, measure the glucose level in your blood samples as indicated on the previous page, and connect the biosignalsplux and the sensor when done.

This will cause the sensor signal to start at 0 and rise to the newly measured result. Results of previous measurements will not be displayed in the current signal.

Signal does not change in OpenSignals (r)evolution after new measurements

After a successful measurement, the device should be displaying the measured value on

its display. Connect the sensor with biosignalsplux using the adapter for this sensor. The display of the sensor should now be showing "Pc" and the signal in OpenSignals (r)evolution should be adjusted to the newly measured value.

If you are experiencing no signal changes after new measurements, disconnect the sensor from the adapter (the adapter can stay connected to the biosignalsplux). Restart your sensor by pressing the "M" two times and wait until the last measured value is displayed on its display. Reconnect the sensor with the biosignalsplux adapter (sensor display should be showing "Pc") and the signal will now be adjusted according to the last measured value.

Error Codes

The sensor will provide error codes if measurements could not be made correctly. Depending on the type of error, the sensor will display one of the different error codes below:

Error Code	Issue	Solution
Er1	The test strip you are trying to use has already been used.	Dispose the used test strip and use a new test strip. Dispose the used lancet and use a new one for the new measurement.
Er2	The blood sample has been applied before the sensor has been ready for measurements.	Dispose the used test strip and Use a new test strip and wait for the lancet symbol to appear at the bottom of the display before applying your blood sample. Dispose the used lancet and use a new one for the new measurement.
Er3	Temperature recommended system range during test.	Take the system where the temperature is within the operating range (10-40°) and repeat test after 30 minutes.
Er4	The blood sample has an abnormally high viscosity or insufficient volume.	Repeat the test with a new test strip and adequate blood sample. Dispose the used lancet and use a new one for the new measurement. If required, increase the depth of the lancet and massage the fingertip before taking the blood sample, to increase the size of the blood sample.

Table 5: Glucose meter reader error codes.

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

Figure 56: 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.

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 Accessory port* 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*)

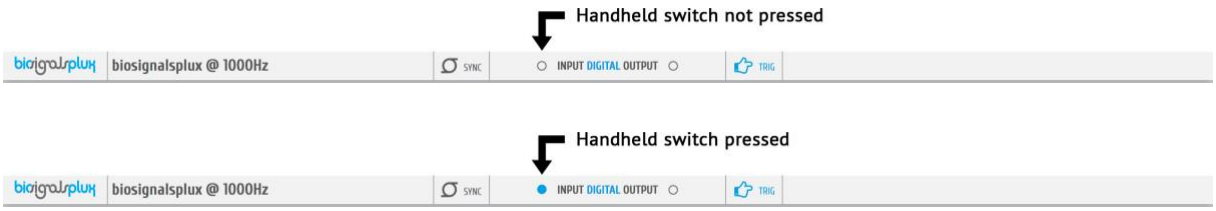


Figure 57: Digital input states.

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*).

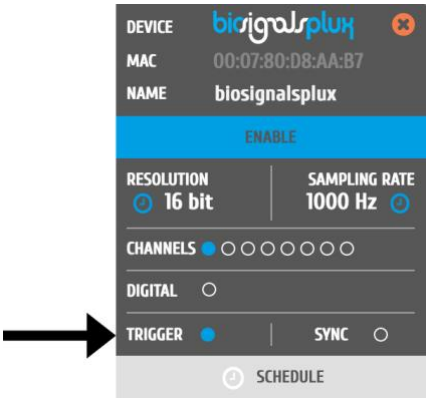


Figure 58: Trigger configuration.

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

Figure 60: 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.

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 Accessory port* 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*).

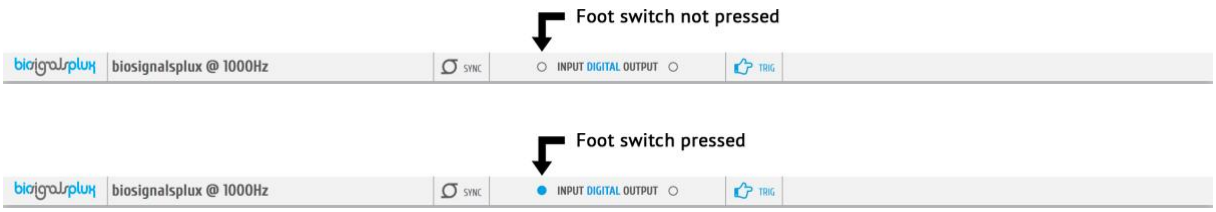


Figure 61: Digital input states.

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*).

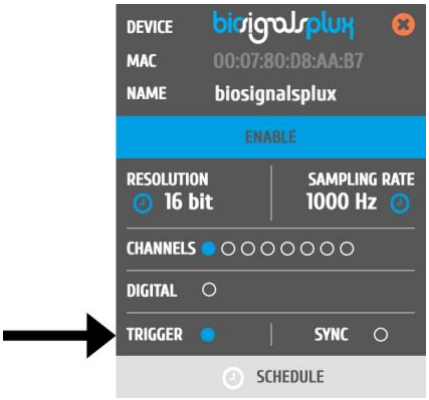


Figure 62: Trigger configuration.

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)

Figure 64: 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.

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 Accessory port* 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*).

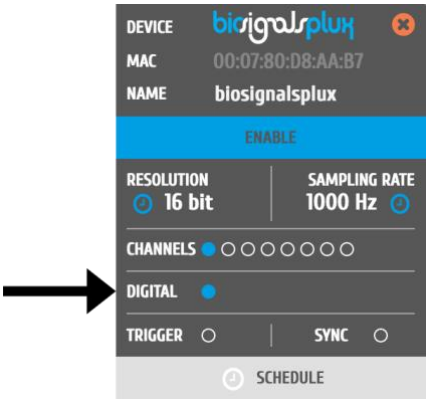


Figure 65: Initial state of the digital output (here: on).

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 is the circle is empty (see *Figure 66*).

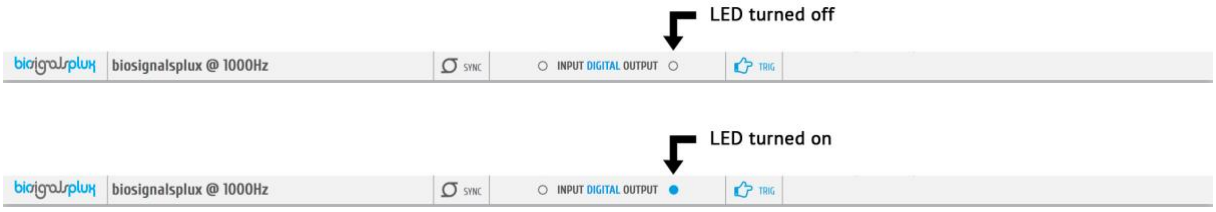


Figure 66: Digital output states for LED.

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 *3.9 Light (LUX)*).

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

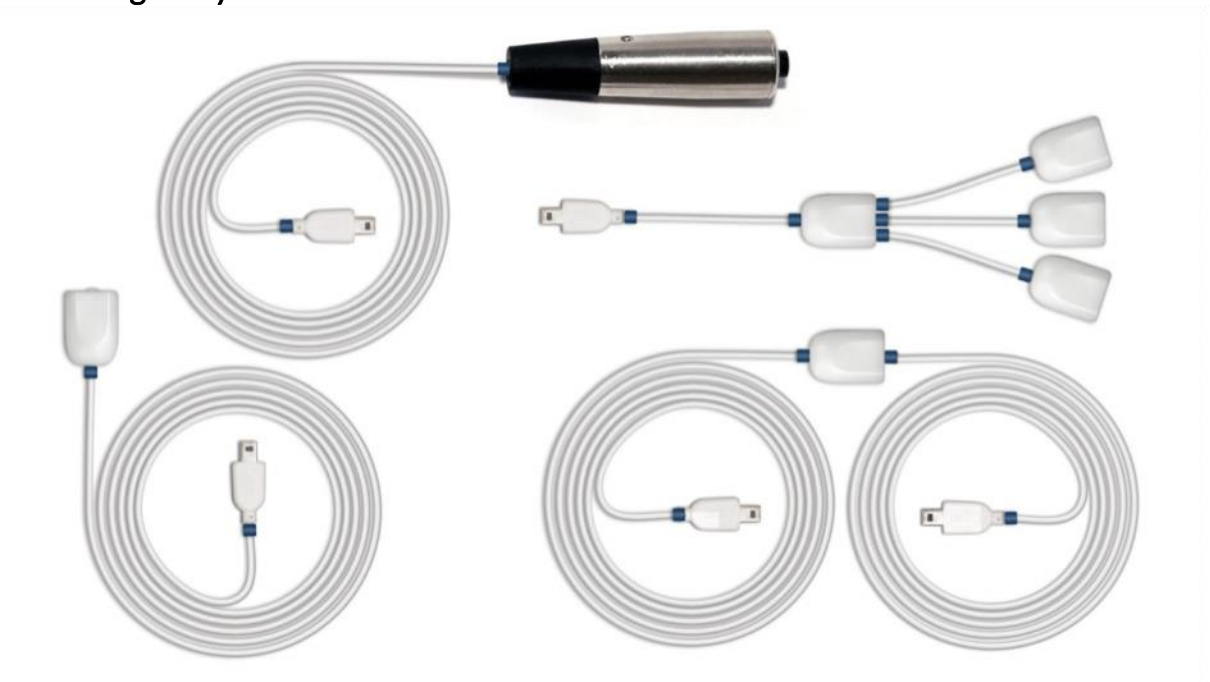


Figure 67: Multi sync splitter.

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).

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 Accessory port* 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.

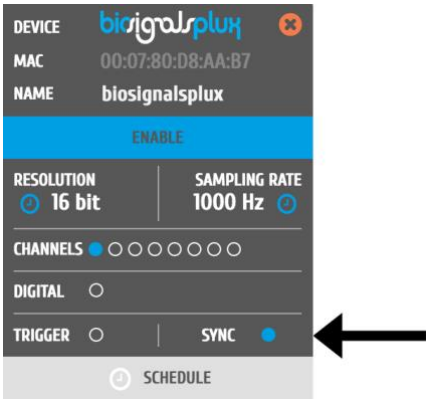


Figure 68: Activate synchronization feature.

Accessory specifications

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

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

4.2.2 Multi Sync Splitter

Figure 69: 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).

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 Accessory port* 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.

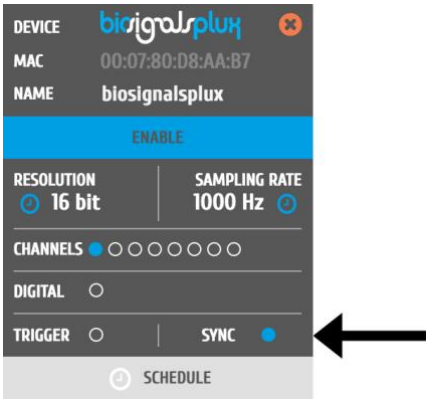


Figure 70: Activate synchronization feature.

Accessory specifications

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

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

5 Data Logging

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

? Relevant Support Articles
How can I schedule biosignalsplux acquisitions onto the internal memory using OpenSignals?

Internal memory can also be added additionally for all *biosignalsplux* devices. Contact our sales team for further details (sales@pluxbiosignals.com).

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.

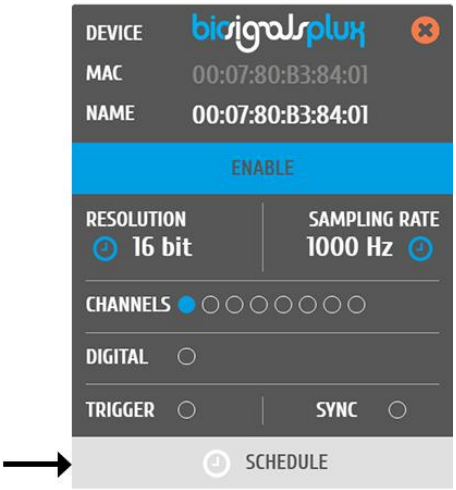


Figure 71: Data logging feature for devices with internal memory.

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*).

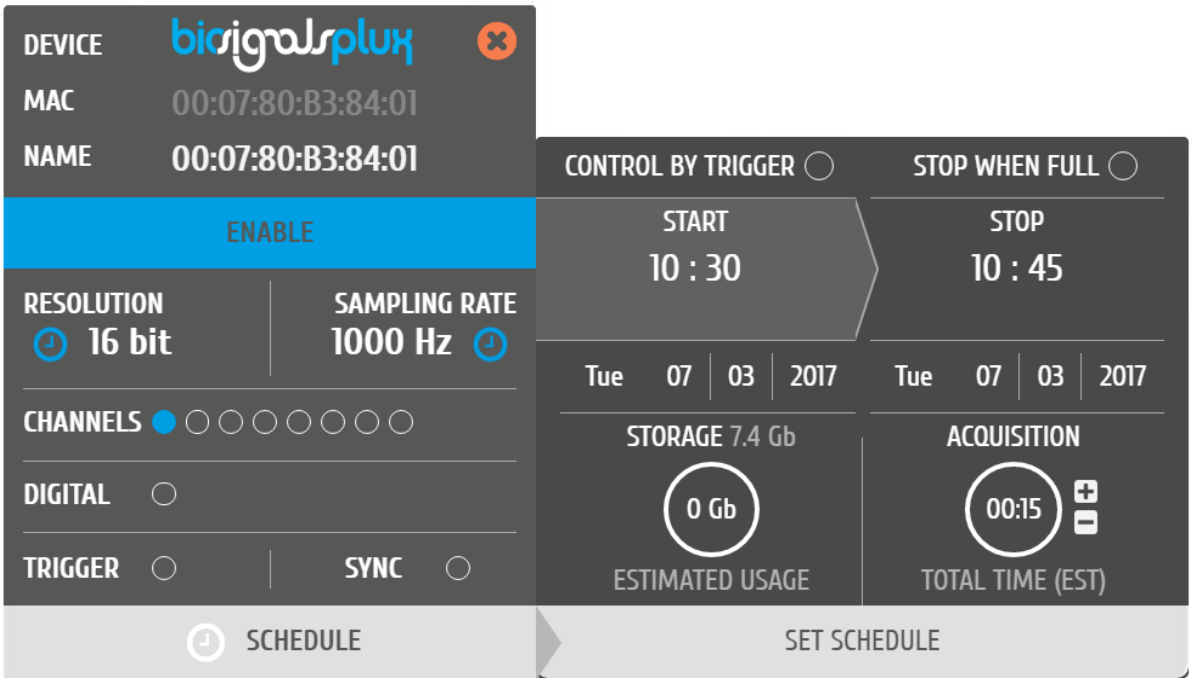


Figure 72: Scheduling panel.

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 *4.1.3 Light-Emitting Diode (LED)*.

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*).

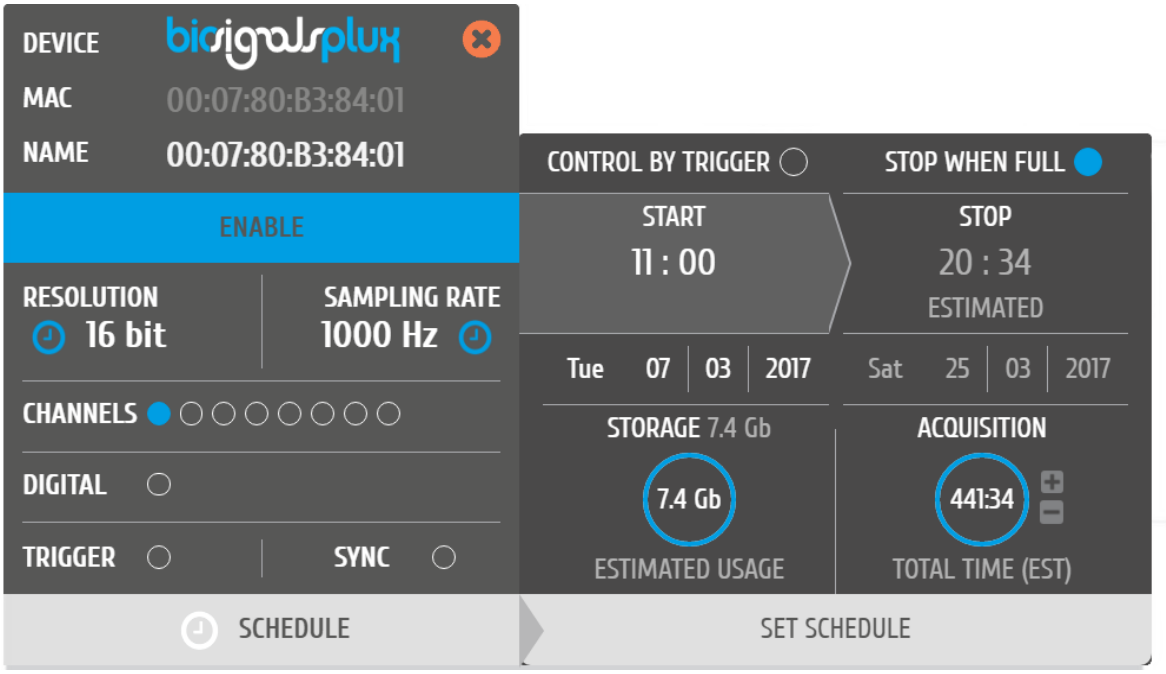


Figure 73: Scheduling panel displaying the estimated end of the acquisition.

5.1.3 Scheduling Start & End Times

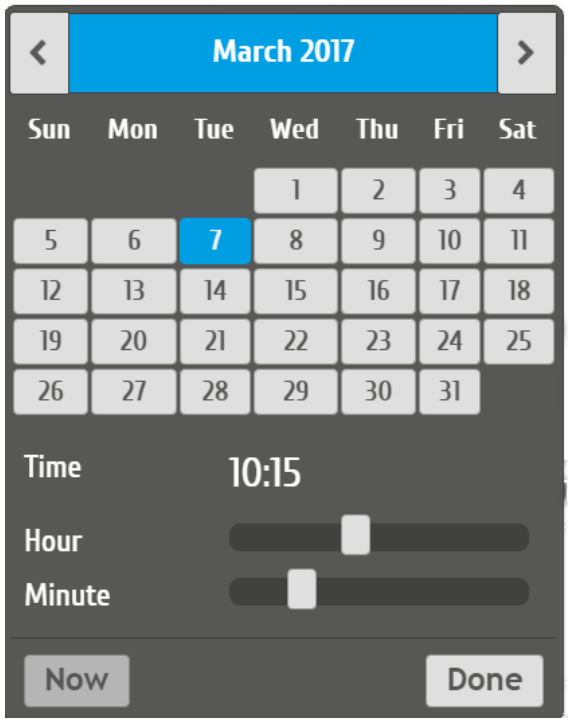


Figure 74: Time schedule for start and end points for offline acquisitions.

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).

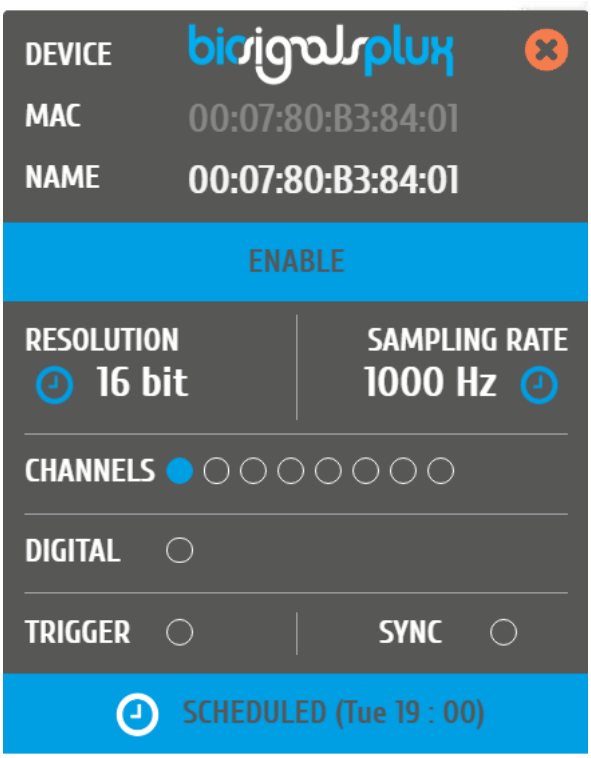


Figure 75: Device panel with a scheduled acquisition.

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*) ant 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.

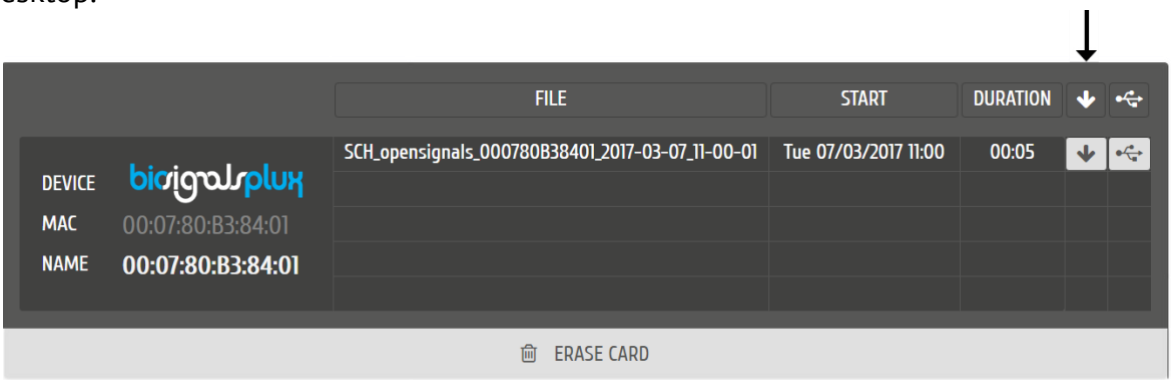


Figure 76: Downloading offline acquired data via Bluetooth.

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*) ant 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.

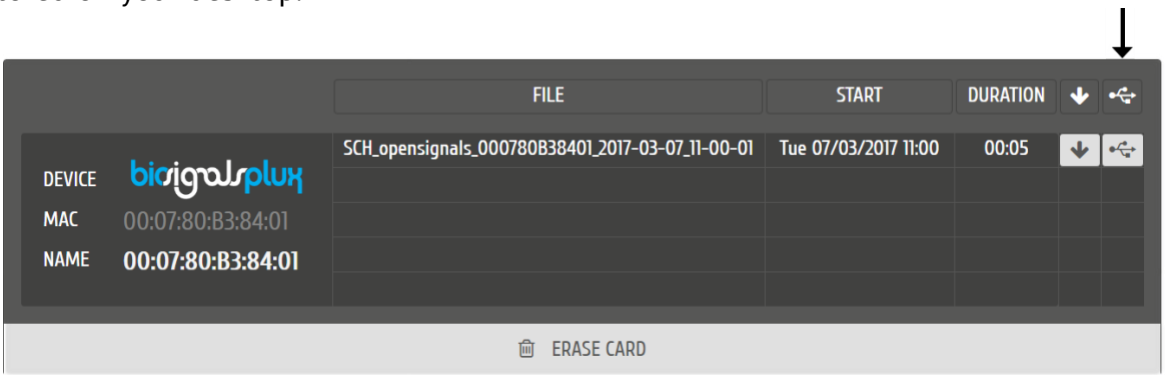


Figure 77: Downloading offline acquired data via USB.

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

You can find up-to-date instructions and help in our Bluetooth-specific support articles in our support page.

? Relevant Support Articles
How can I pair my PLUX devices with my computer?
How do I configure my Bluetooth Dongle?
Bluetooth Connection Troubleshooting

7 Firmware Updates & Upgrades

You can find up-to-date information about how to update your biosignalsplux software and changelos about the newest firmware updates on our support page.

https://support.pluxbiosignals.com/knowledge-base/biosignalsplux-firmware-updates-changelogs/

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.

Download OpenSignals from our support page.

Download

OpenSignals (r)evolution

8.2 Application Programming Interfaces (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 our support page for the list of the available APIs:

? Relevant Support Articles

Application Programming Interfaces (APIs)

9 Troubleshooting

We recommend visiting our support page for articles on the most common issues that occur during the use of our products.

Visit https://www.support.pluxbiosignals.com for more information.

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 sur- faces 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

? Relevant Support Articles
How do I clean my PLUX products?

11 Regulatory & Legal Information

Find all up-to-date regulatory information on our support page:

? Relevant Support Articles
biosignalsplux Certifications & Regulatory Information

11.1 Disclaimer

***biosignalsplux* products are intended for use in life science education and research applications only; *biosignalsplux* products are not medical device**s, 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

? Relevant Support Articles
What are the standard warranty terms? What will void my warranty? How can I report a warranty or replacement case?

11.3 Contact & Support

If you need any help or if you're experiencing any problems that cannot be solved with the information given in the *biosignalsplux* or OpenSignals (r)evolution manual, check our support page for further help.

https://support.pluxbiosignals.com/

12 Documentation

You can find all the latest biosignalsplux documentation on our support page.

? Relevant Support Articles
biosignalsplux Documentation