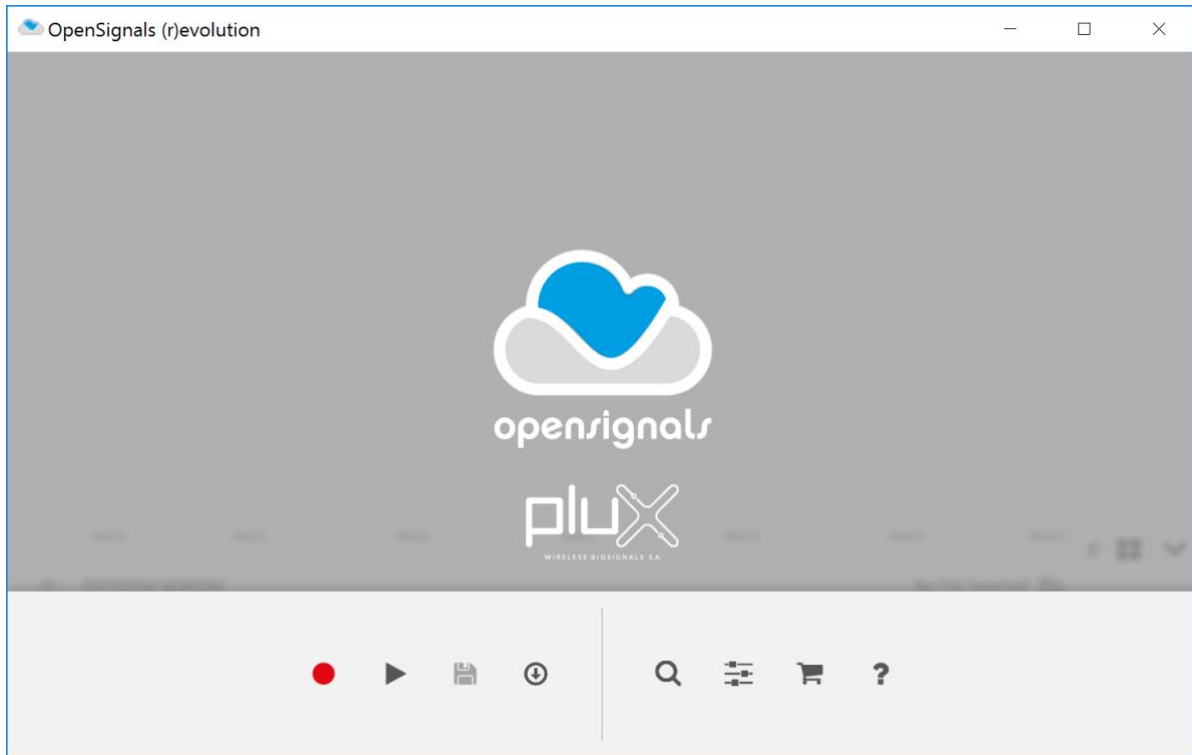




opensignals
(r)evolution

biosignal acquisition tool-kit for high-level research applications

user manual



ATTENTION

Please read this manual before
using your PLUX product(s) and
this software

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DISCLAIMER

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

OpenSignals (r)evolution uses Google Chrome as the rendering engine for the graphical user interface. Google Chrome is a web browser developed by Google Inc. PLUX is neither responsible for its content, nor for its functionality.

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Introduction

PLUX – Wireless Biosignals, S.A. creates innovative products for Physiotherapists and Researchers, by developing advanced biosignal monitoring platforms that integrate wearable body sensors, such as electromyography (EMG) and electrocardiography (ECG), combined with wireless connectivity and software applications to deliver real value recognized by its target markets.

OpenSignals (r)evolution is the software for data acquisition, visualization and processing while using PLUX's biosignal hardware platforms. The purpose of this manual is to introduce the reader on how to fully work with *OpenSignals (r)evolution*, exploring all its features and options. This version of the manual covers the *OpenSignals (r)evolution* version release for all biosignalsplux products and *BITalino (r)evolution*.

OpenSignals allows the user to acquire data from one or multiple devices, setup the desired acquisition parameters (such as sampling frequency and resolution), save standard ASCII text format or in the more efficient Hierarchical Data Format (HDF) for post-processing in third-party tools such as Python or MatLab and visualize and zoom into large datasets over a large number of channels.

It is extendable with add-ons that are either provided with the devices or can be purchased separately. It is even possible to create your own add-ons with specific functions and instruments (if you are interested, contact us and learn how to access the required tools) and share them and your projects with the *BITalino* and *biosignalsplux* communities.



www.plux.info

1 Getting Started

OpenSignals (r)evolution is a Python-powered web-based application. You need to download and to install the Google Chrome browser, if it's not already installed on your computer.

The *OpenSignals (r)evolution* software can be downloaded for free from the *biosignalsplux* and *BITalino* websites. New versions are released on a regular base, reason for which you are invited to check for updates at:

<http://www.bitalino.com/index.php/software>

<http://www.biosignalsplux.com/index.php/software>

After a successful download, follow the steps described in the following sections to install *OpenSignals (r)evolution* and to correctly set up the Bluetooth connection with your device.

1.1 Download & Install Google Chrome Browser

In order to use *OpenSignals (r)evolution*, you need to download and install the Google Chrome browser, as *OpenSignals (r)evolution* uses Google Chrome as the rendering engine for the graphical user interface.

The latest version is available here: <http://www.google.com/chrome/>

If you're using an unsupported version of the Google Chrome browser, *OpenSignals (r)evolution* will display a pop-up to notify you about this issue. In this case, you'll need to update your Google Chrome browser or to download and install the latest version of the browser.

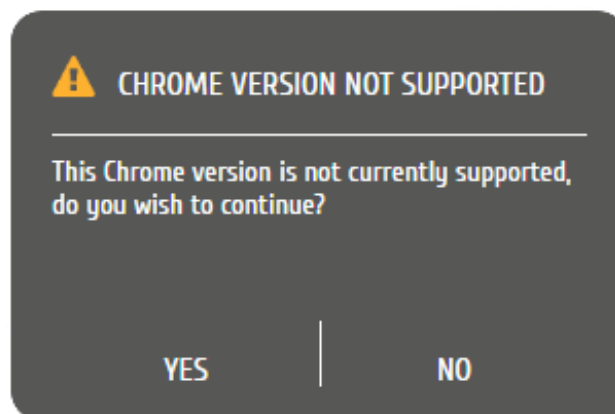


Figure 1: *OpenSignals* pop-up appears when you're using an outdated & unsupported Google Chrome version.

1.2 Download & Install OpenSignals (r)evolution

1.2.1 Download

The *OpenSignals (r)evolution* software can be downloaded for free from the *biosignalsplux* and *BITalino* websites. New versions are released on a regular base, reason for which you are invited to check for updates at:

<http://www.bitalino.com/index.php/software>

<http://www.biosignalsplux.com/index.php/software>

Select and download the *OpenSignals (r)evolution* installer for your operating systems and follow with the instructions below.

1.2.2 Windows Installation



Double click the *OpenSignals (r)evolution* .EXE file that you've downloaded before and follow the steps of the installation wizard to install the software.

OpenSignals (r)evolution will appear on your desktop after a successful installation.

1.2.3 Mac OS X Installation



Double click the *OpenSignals (r)evolution* .PKG file that you've downloaded before and follow the steps of the installation program to install the software.

OpenSignals (r)evolution will appear in your applications folder after a successful installation.

1.2.4 Linux Installation



Select the *OpenSignals_(r)evolution_Linux_amd64_Beta* .TAR.GZ file that you've downloaded before and extract the .tar.gz file (right click on the file, *Extract here...*).

Open the *Terminal* and enter the directory of your extracted *OpenSignals (r)evolution* installation folder usind the *cd* command.

If you are not sure how to determine the correct path to your extracted files, enter the *cd* command into your terminal and drag'n'drop the extracted *OpenSignals* installation folder into the terminal window. If done correctly, the current command in your terminal should be similar to this:

```
plux@ubuntu: ~$ cd /home/plux/Downloads/opensignals-revolution-linux-amd64_2017-09-20
```

Press enter to continue.

To install *OpenSignals (r)evolution* enter *make install* into your terminal and press enter.

```
plux@ubuntu: /home/plux/Downloads/opensignals-revolution-linux-amd64_2017-09-20$ make install
```

Enter your password and *OpenSignals (r)evolution* will be installed on your machine.

You should now be able to find *OpenSignals (r)evolution* in your applications folder.

1.3 OpenSignals (r)evolution Updates

Newer versions of the software will automatically notify you when newer versions are available and download the newest *OpenSignals (r)evolution* version if you decide to do so. If you want to install the newest updates click on *INSTALL* or click on *NOT NOW* to download the software at another time. Uncheck the *Remind me later* box if you do not wish to be notified anymore.

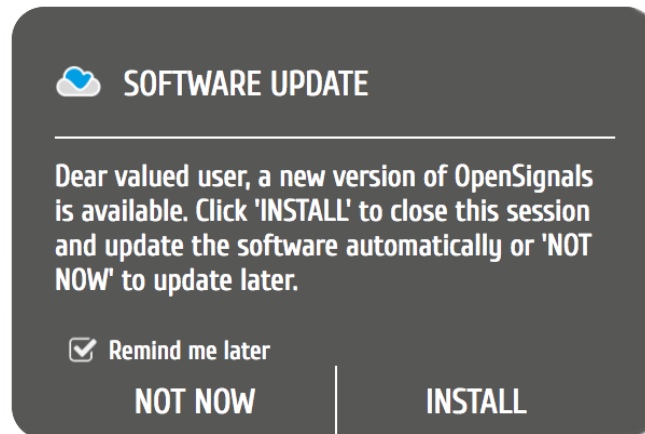


Figure 2: Software update notification.

1.4 Add-ons Installation

OpenSignals (r)evolution has a range of optional software add-ons for real time and post-processing, which can be used to expand the capabilities of your *OpenSignals* installation. These add-ons are either included in your biosignalsplux kit or can be purchased separately to work with any of your PLUX device(s).

In both cases these add-ons have to be activated by PLUX to be ready to use. An internet connection is only needed for the activation process, as it is done remotely during the start of *OpenSignals (r)evolution*. You can use the software add-ons without a stable Internet connection after the activation.

For more information about Open Signals add-ons check section 4 *Add-Ons*.

1.5 Connecting Bluetooth Devices

NOTE

OpenSignals (r)evolution is able to establish a Bluetooth connection to your device whenever you add a PLUX device in the *OpenSignals (r)evolution* device manager. In this case, it is not needed to manually establish a Bluetooth connection with your device using your operating system's tools.

However, if you are experiencing any kind of connection issues, we recommend to connect your device with your operating system first before adding your device in *OpenSignals (r)evolution's* device manager.

When connecting your device, you first need to enable Bluetooth on your computer or need to plug in the Bluetooth dongle to your USB port, if Bluetooth is not built in your computer or not reliable for high data rate transmissions.

biosignalsplux users may receive this dongle as part of their kits (not included in single purchases of single biosignalsplux hub).

BITalino users can purchase a trialled & tested Bluetooth dongle known to work with BITalino, at the BITalino web store.

However, they can also be bought additionally:

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

<https://store.plux.info/accessories/205-bitalino-proven-bluetooth-dongle-810121501.html>

Follow the instructions for your operating system that are displayed on the following pages to connect your device to your computer.

1.5.1 Windows 7

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

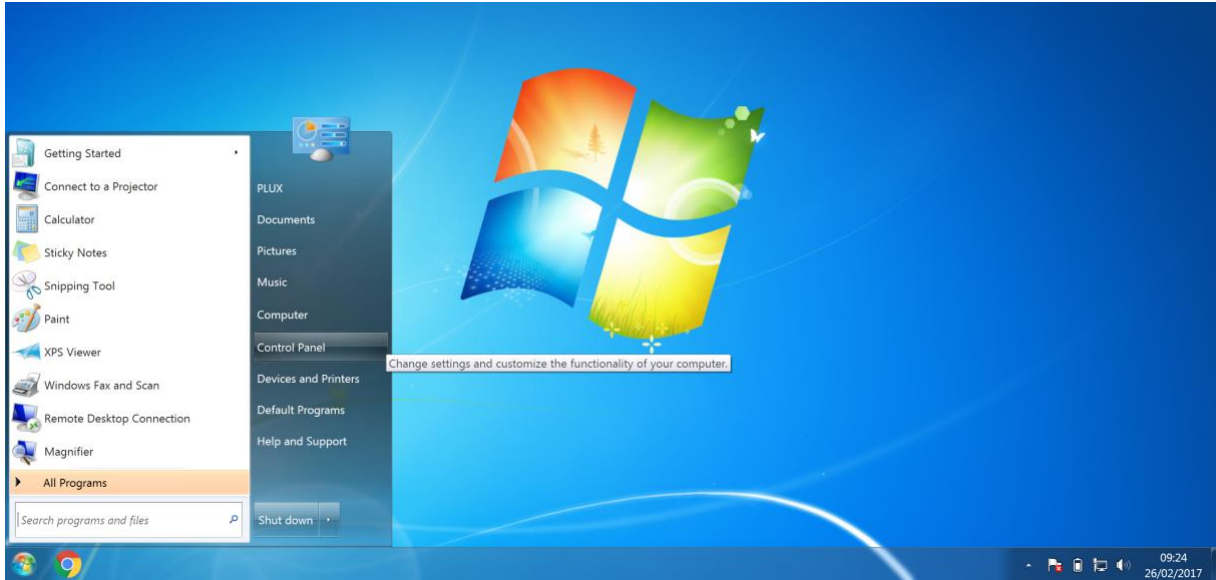


Figure 3: Access the Windows 7 control panel.

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

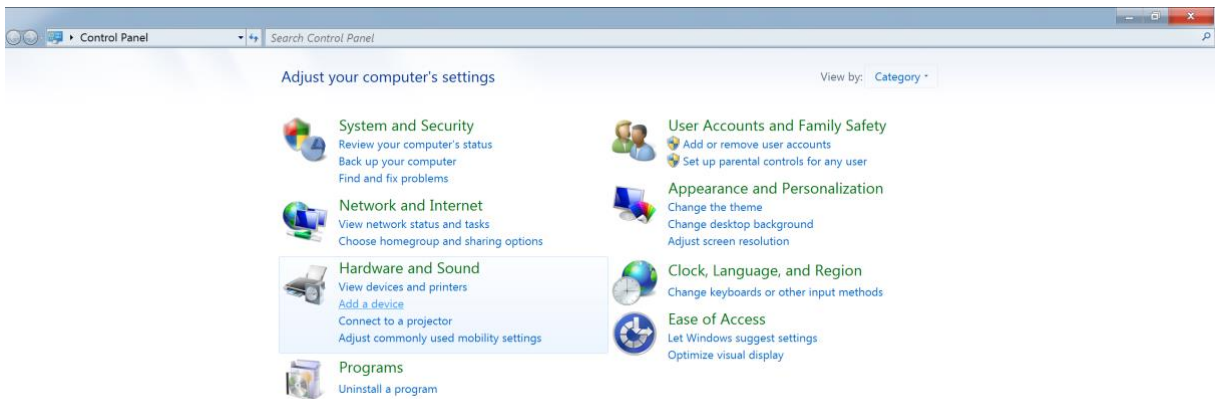


Figure 4: Select Add a device in the Hardware and Sound section.

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

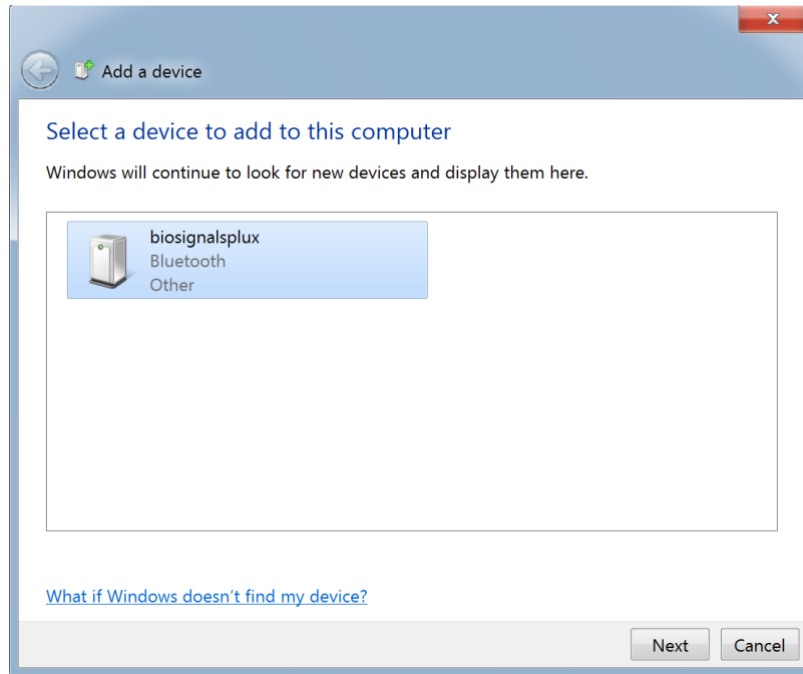


Figure 5: Select your device to add it to your computer.

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

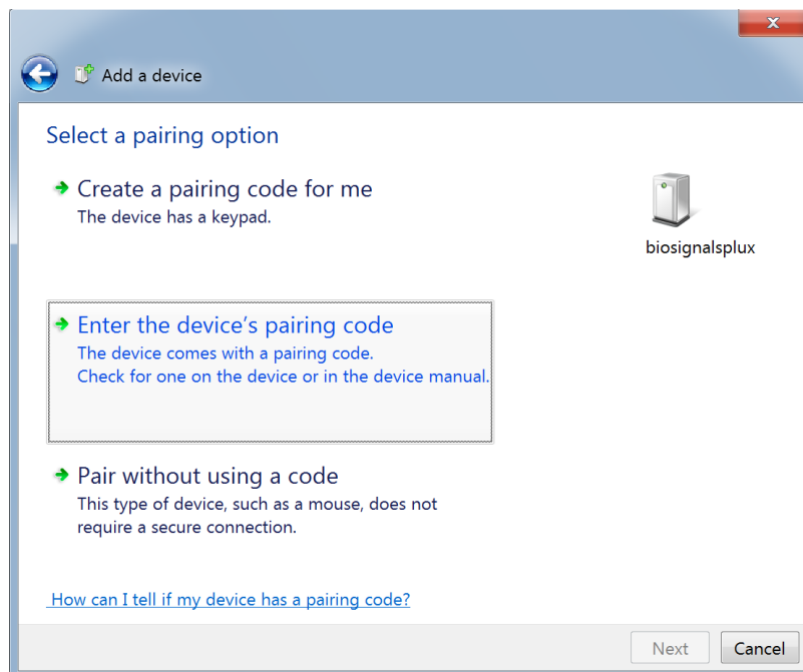


Figure 6: Select *Enter the device's pairing code*.

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

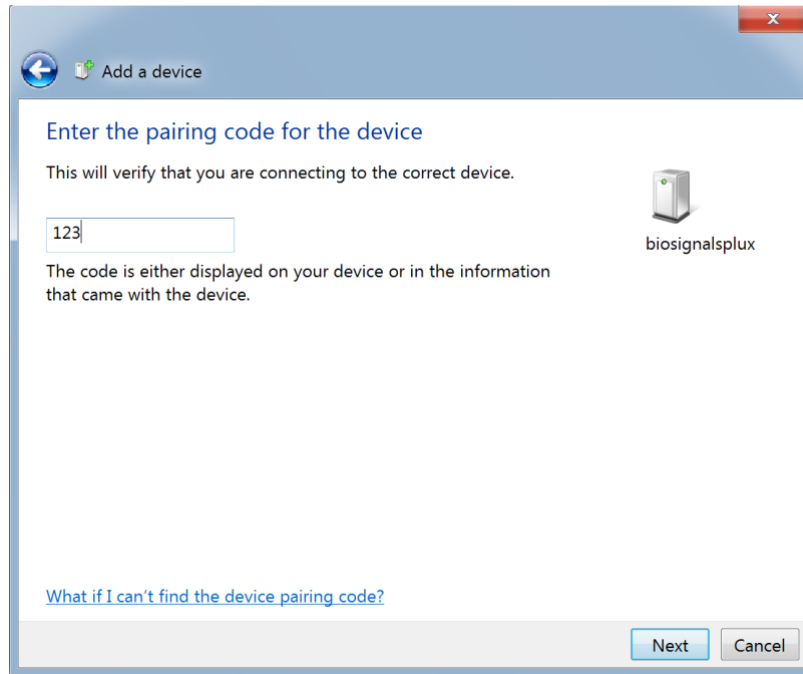


Figure 7: Enter the pairing code to connect to your device.

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

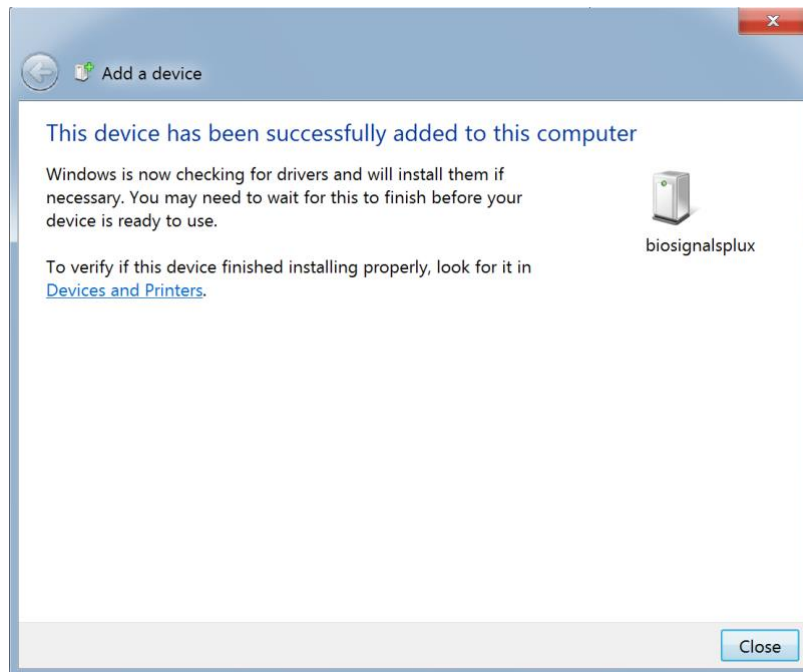


Figure 8: Windows confirmation if the device has been successfully added.

1.5.2 Windows 8

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



Figure 9: Access to the Bluetooth settings panel in Windows 8.

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

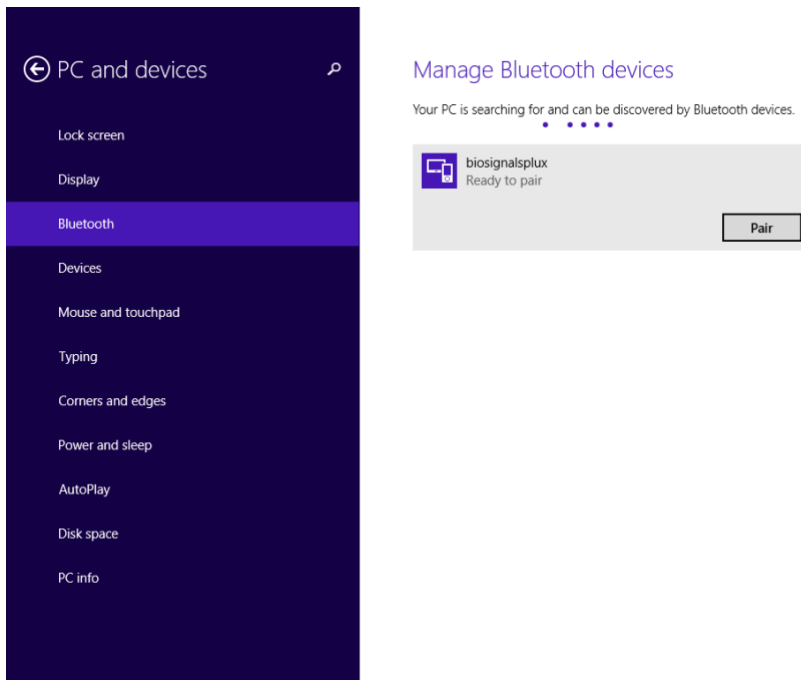


Figure 10: Bluetooth settings panel.

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

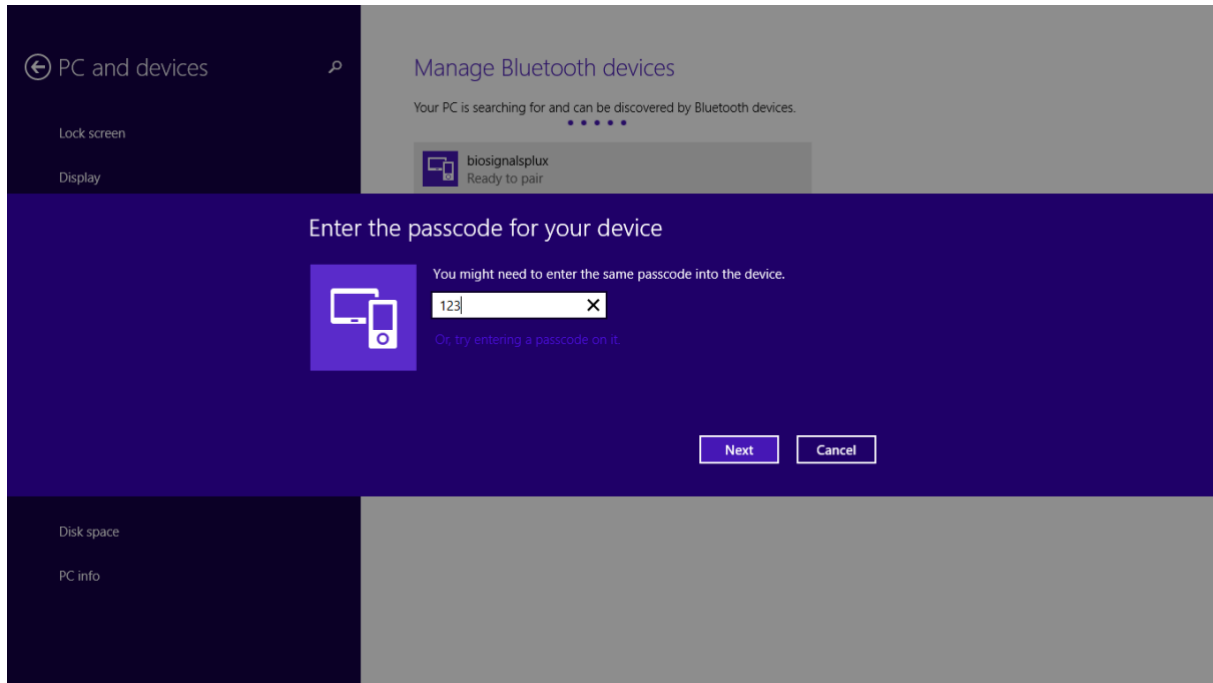


Figure 11: Requesting biosignalsplux' passcode (123).

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

1.5.3 Windows 10

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

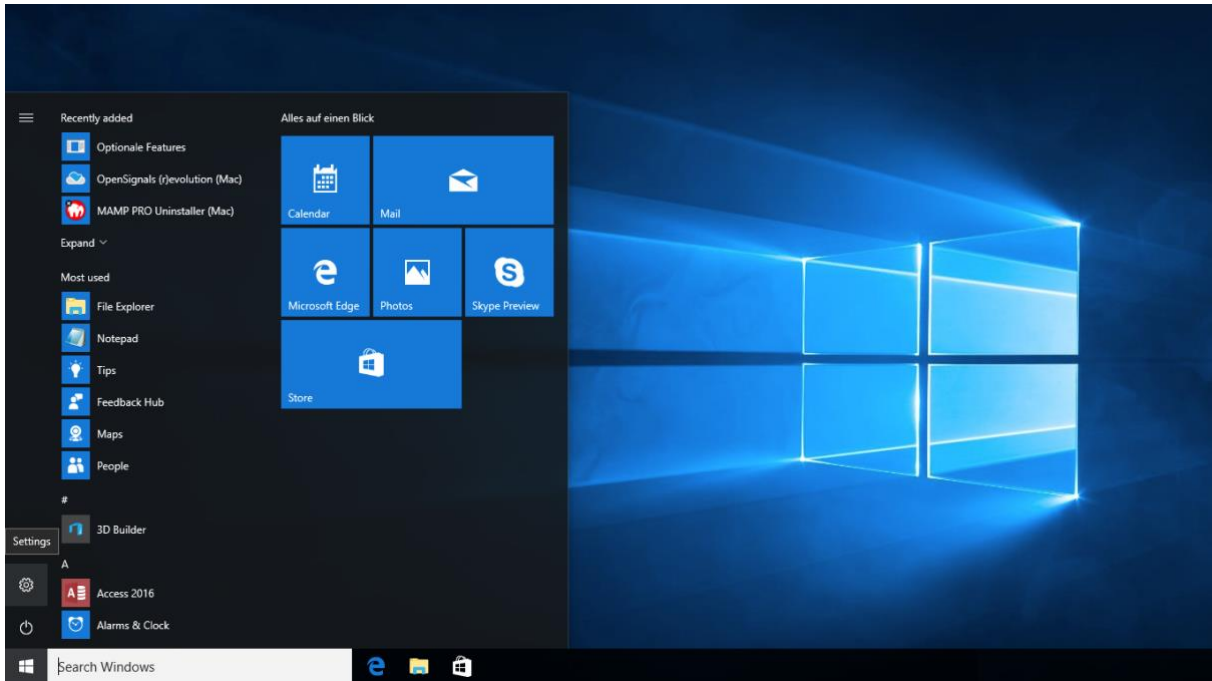


Figure 12: Access to the settings panel in Windows 10.

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

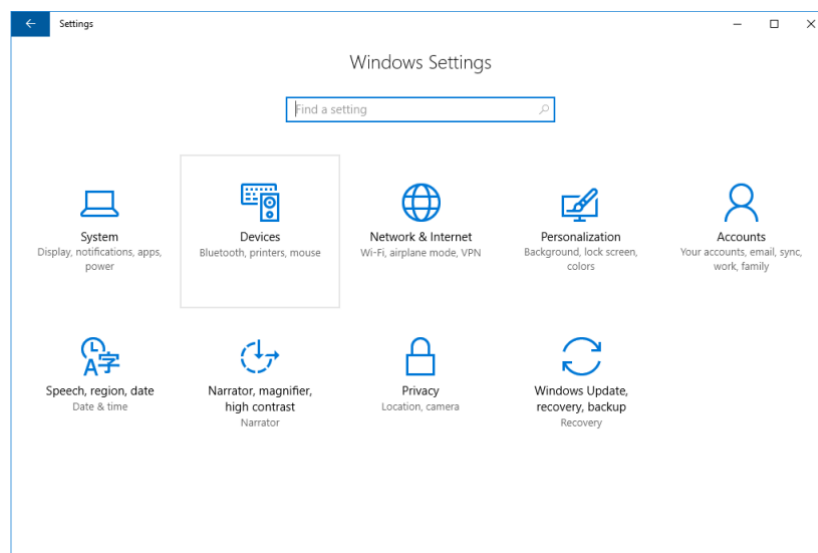


Figure 13: Windows 10 settings panel.

Select *Bluetooth* from the list which is displayed on the left side of your settings window. Note, that in some versions the Bluetooth option might not be available and that Bluetooth devices might be listed under *Other devices* as seen in *Figure 14*.

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

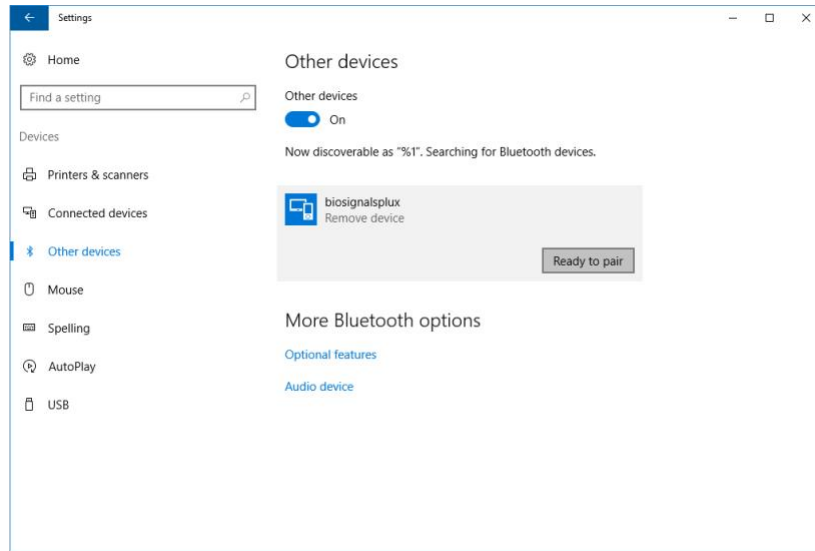


Figure 14: Bluetooth settings panel.

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

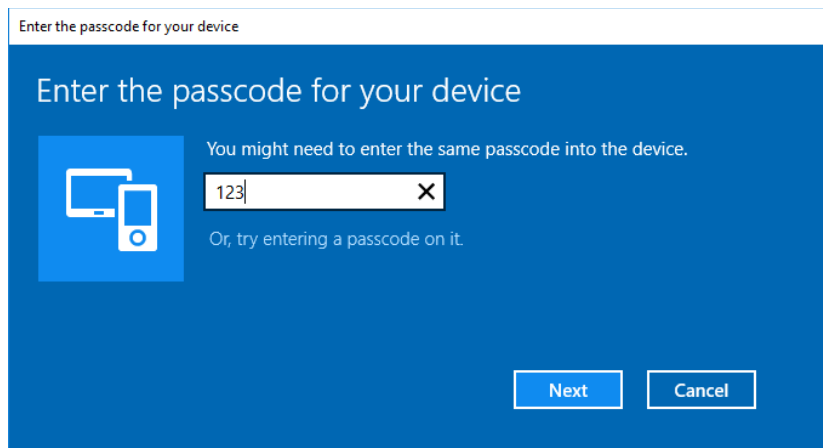


Figure 15: Requesting passcode (123).

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

1.5.4 Linux

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

1.5.4.1 Connecting via System Settings

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



Figure 16: Access the system settings in Ubuntu.

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

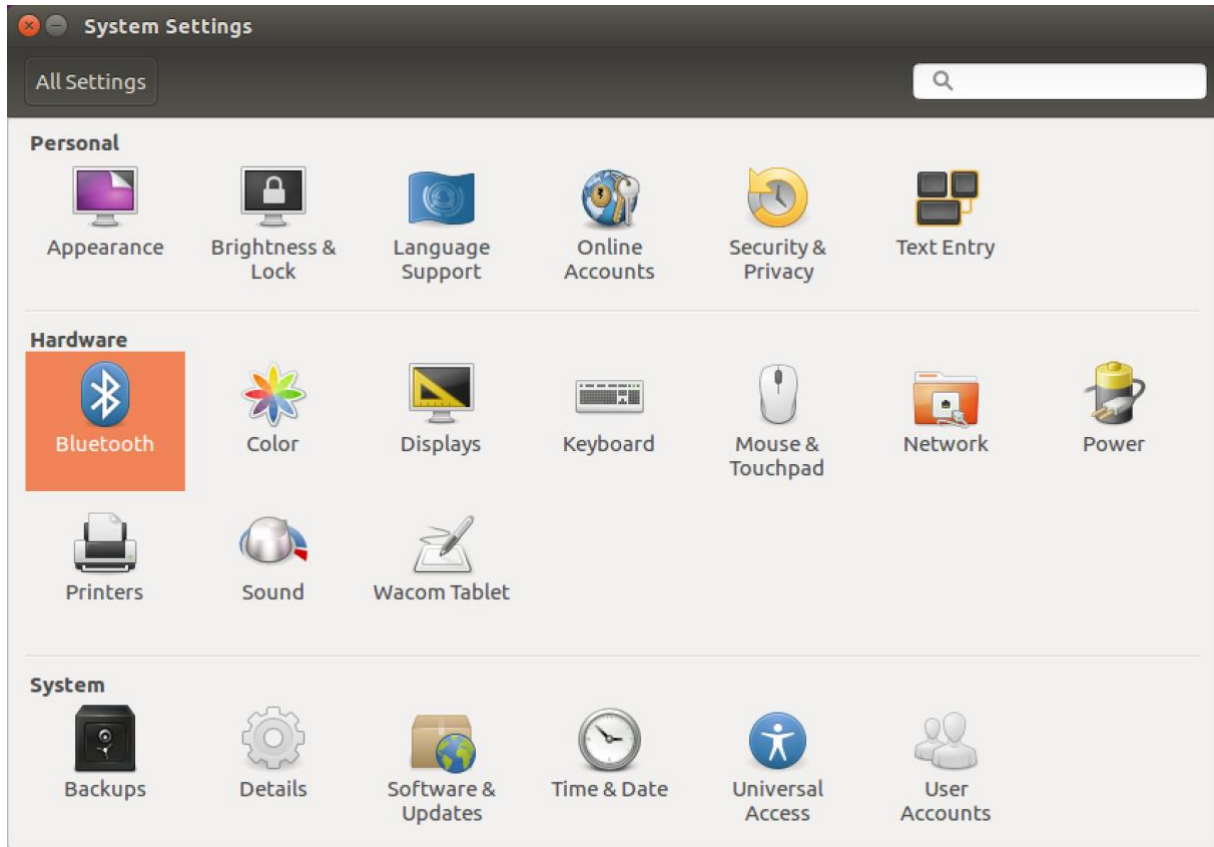


Figure 17: Click on the Bluetooth logo to access the Bluetooth settings.

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

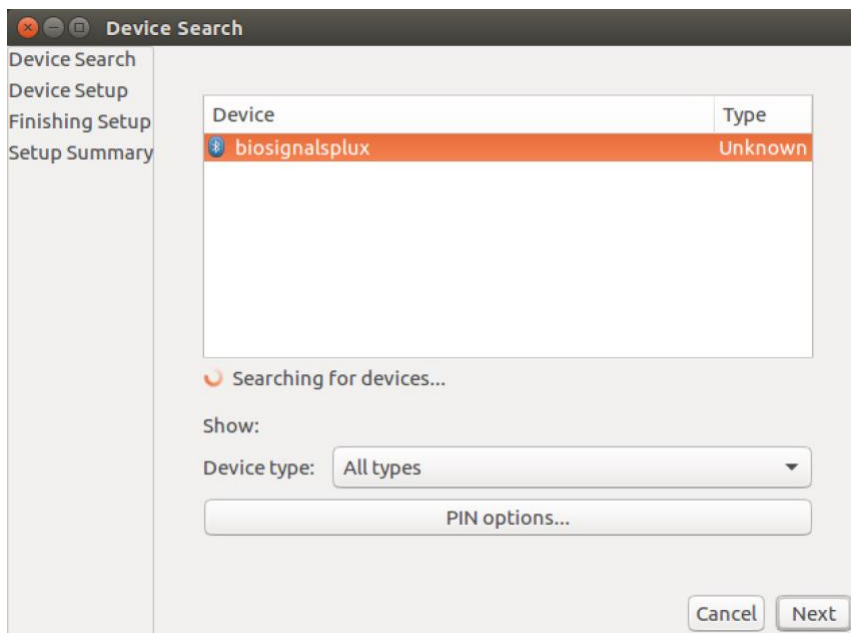


Figure 18: Select your device to add it to your computer.

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

NOTE

If the *Custom PIN* option is not available in this window, follow up with the instructions in *1.5.4.2 Connecting via Terminal* to connect your device to your computer using the terminal instead of proceeding with the configuration via the system settings.

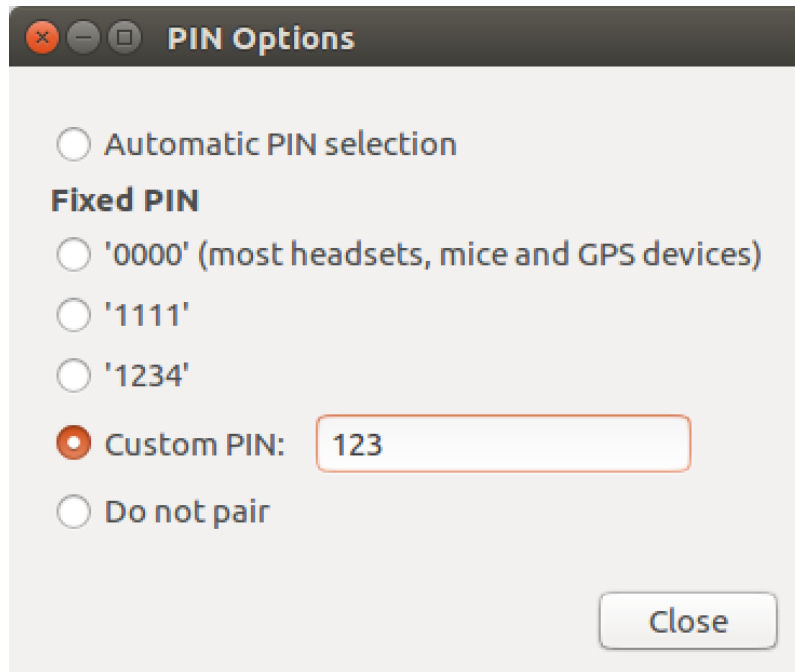


Figure 19: Enter the device's pin to pair.

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

Click on your device in the *Devices* list. If paired is confirmed (*Paired Yes*) your device has been successfully connected to your computer¹.

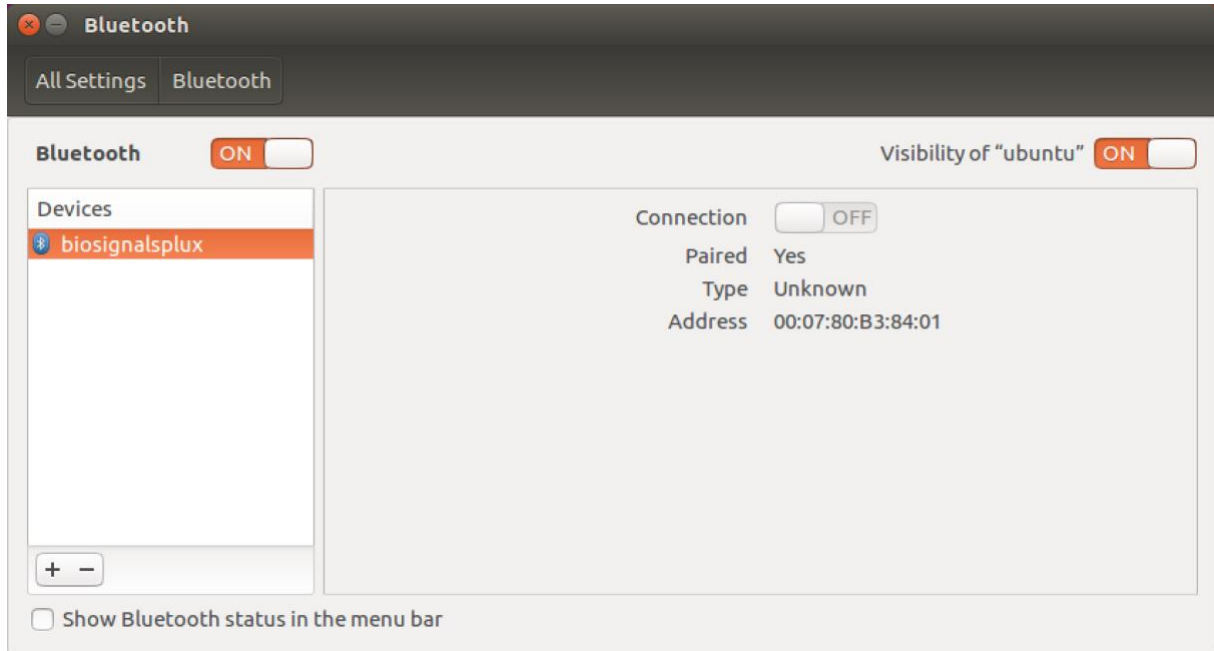


Figure 20: Successfully paired biosignalsplx.

¹ Do not worry if the connection is set off. It will automatically switch to on when connecting to your device using *OpenSignals* or other custom software for *biosignalsplx*.

1.5.4.2 Connecting via Terminal

NOTE

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

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

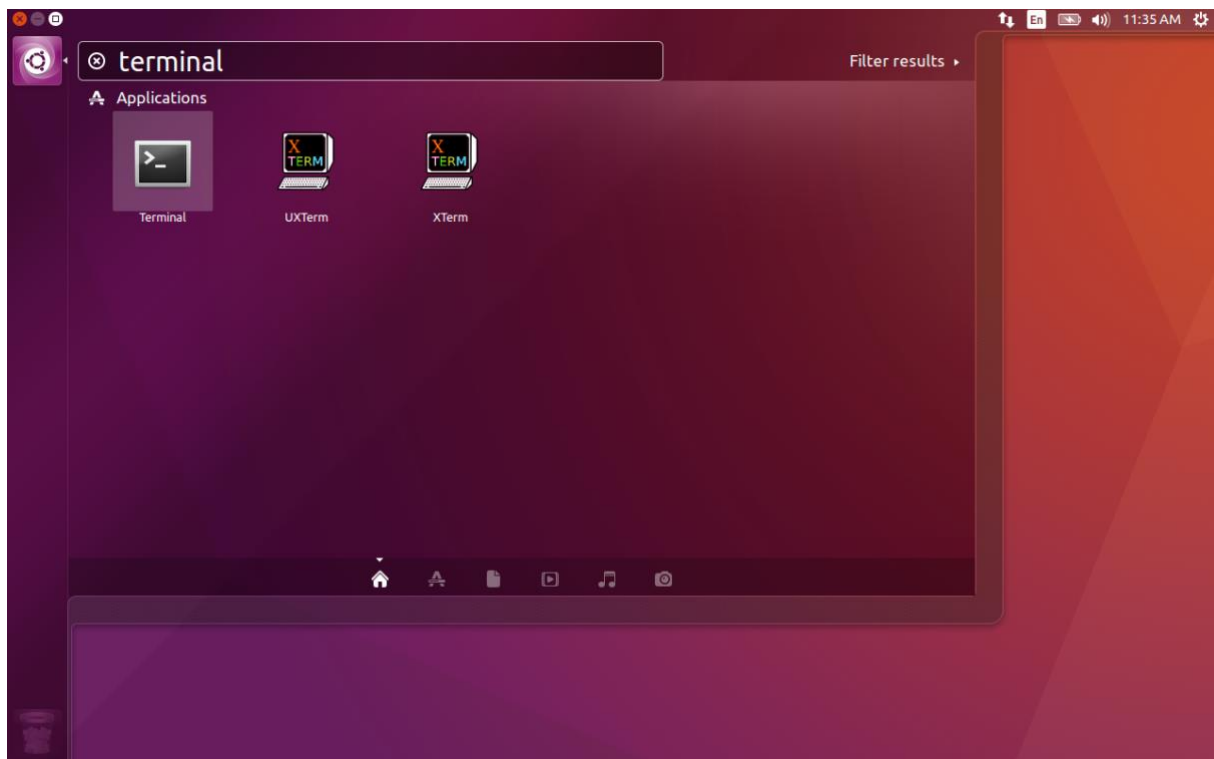


Figure 21: Access the terminal using the search function in Ubuntu.

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

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

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

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

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

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

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

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

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

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

If your device is listed, enter *pair* followed by the MAC address of your device to start the pairing process which will be respond with requesting the PIN code of your device.

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

The result should be similar to this:

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

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

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

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

1.5.5 Mac OS X

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

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



Figure 22: Mac OS X system preferences window.

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

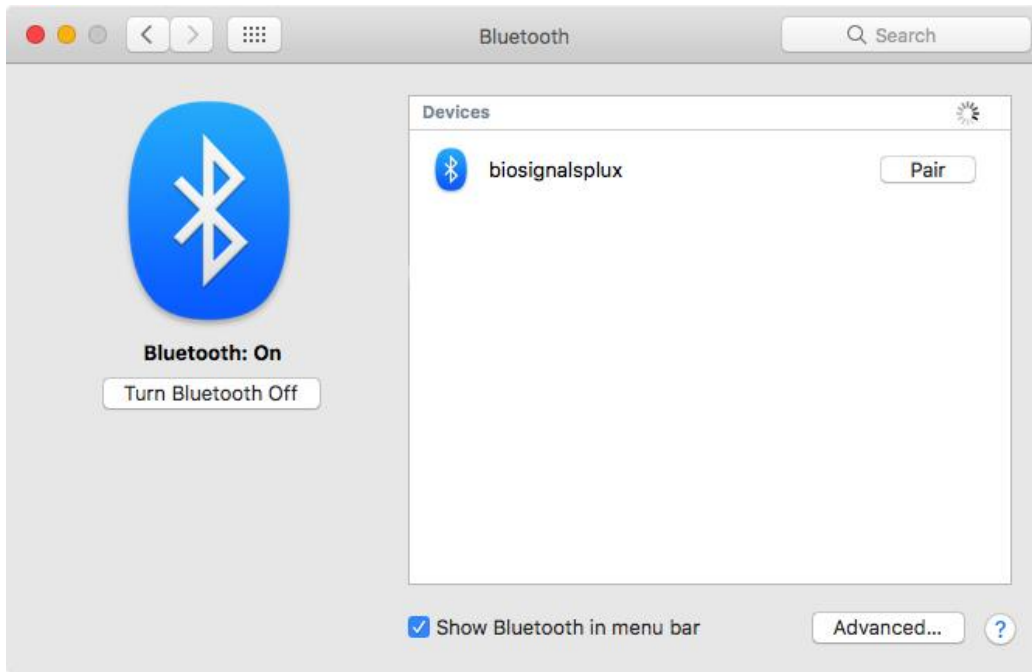


Figure 23: Click on Pair to connect to the biosignalsplux.

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

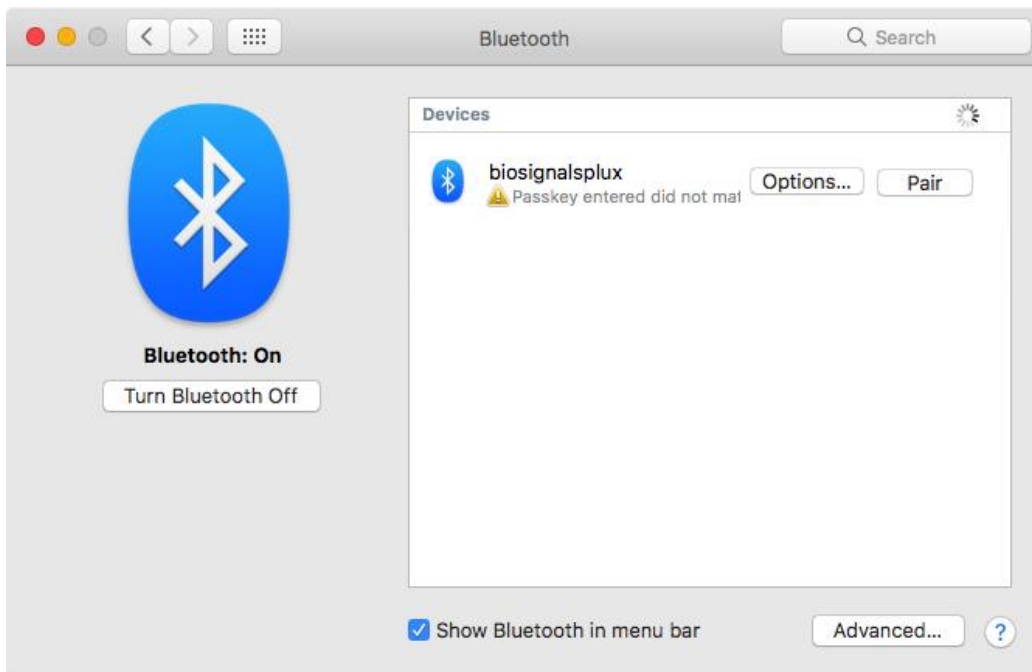


Figure 24: Click on Options... to enter the passkey.

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

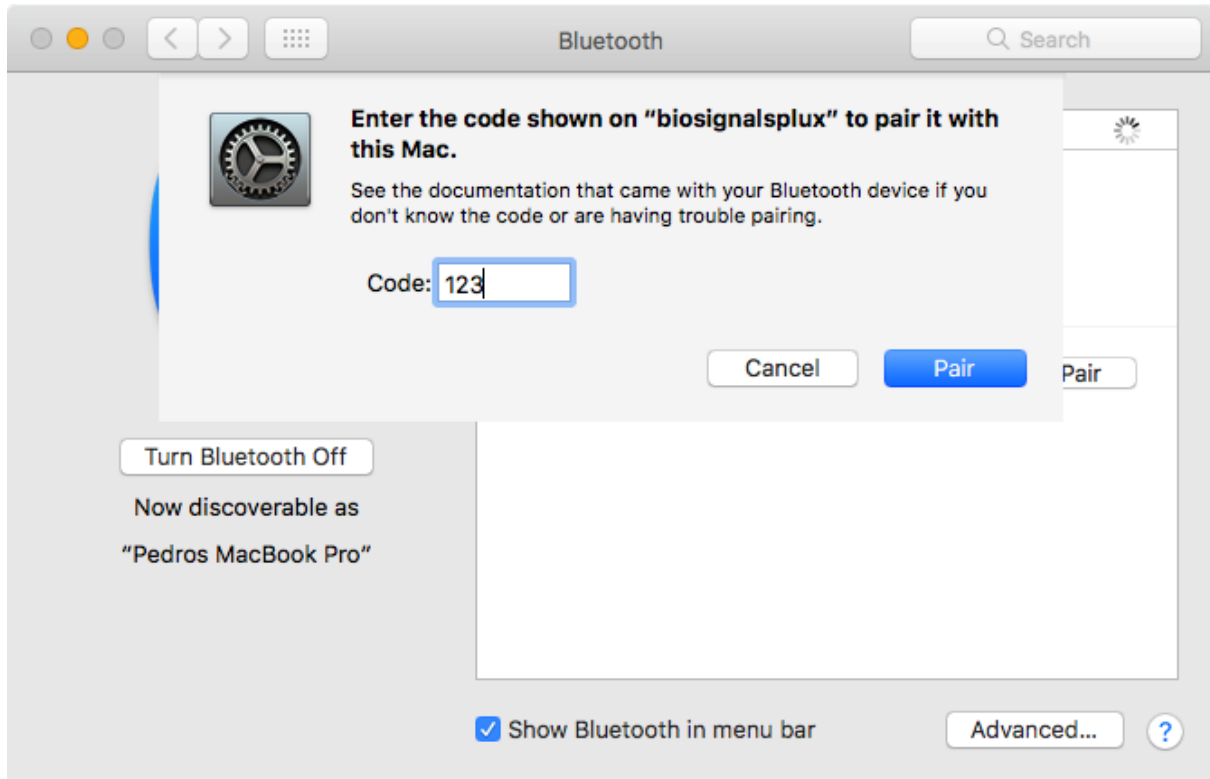


Figure 25: Enter the pairing code

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

1.6 OpenSignals Help

? contact information, license information, add-on activation, and about

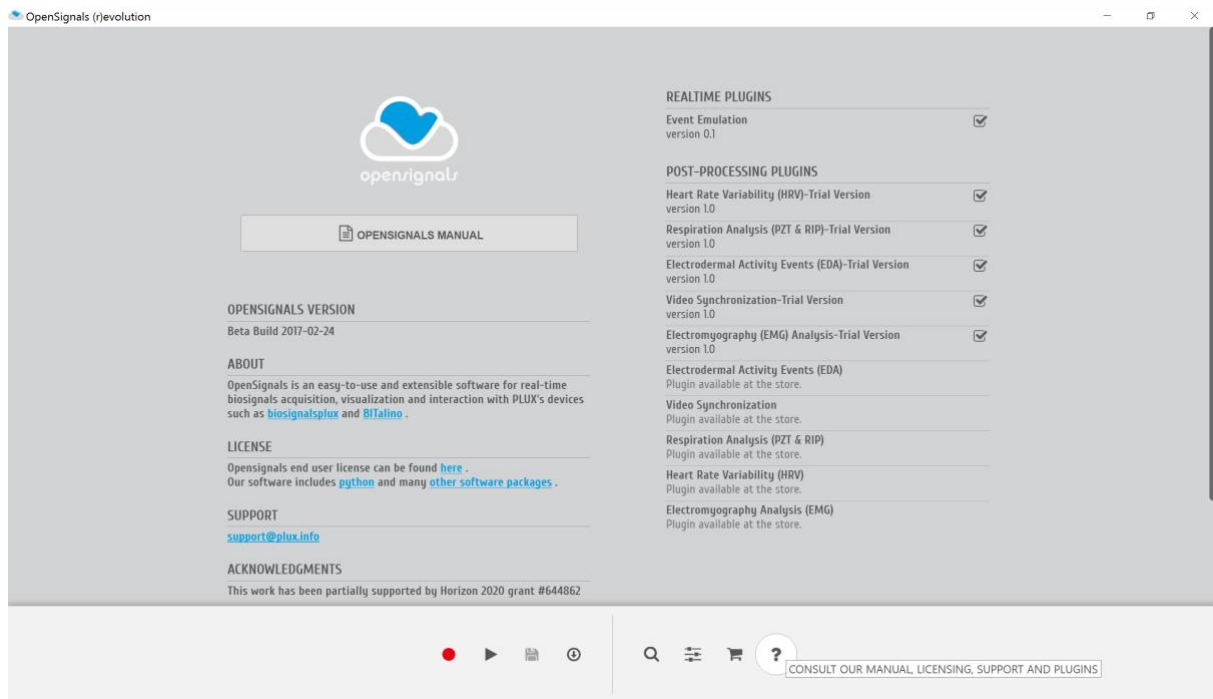


Figure 26: OpenSignals help interface

The help interface offers useful information and documents regarding *OpenSignals (r)evolution*. Here you can also check which plugins are activated for your device.

1.6.1 User Manual

The newest version of this manual can be accessed at any time by clicking on the *OPENSIGNALS MANUAL* button. We recommend to access this manual via the *OpenSignals (r)evolution* help screen or by downloading it at:

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

or

<http://bitalino.com/index.php/software> .

1.6.2 Support

Don't hesitate to contact us if you're struggling with any kind of problems that cannot be solved with the information displayed in this manual. Send us an e-mail with a brief description of your problem to support@plux.info and we'll get back to you as soon as possible. Please do not forget to mention which version of OpenSignals you're using.

1.6.3 Access License Information

Access the *Open Signals Terms of Use* and license information and find out more about Python, the programming language behind *OpenSignals (r)evolution*, on the official Python homepage).

1.6.4 Activating & Deactivating Add-ons

Activate and deactivate add-ons that are available for your device (see section 4 *Add-Ons* for further information).

2 OpenSignals (r)evolution

After the successfully installing Google Chrome, *OpenSignals (r)evolution* and successfully connecting a PLUX device to your computer, *OpenSignals (r)evolution* is ready to use.

We recommend to follow these steps in order to prepare and to start your acquisitions.

1. Turn on your device.
2. Start *OpenSignals (r)evolution*.
3. Open the device manager in *OpenSignals (r)evolution*.
4. Enable your device for acquisition and set up your preferred acquisitions settings (sampling rate, channels configuration, and sampling resolution).
5. Set up your general acquisitions settings (file name, save location(s)).
6. Start the acquisition.

These steps are listed in the following sections in further detail to guide you through all the steps.

2.1 OpenSignals Main Screen

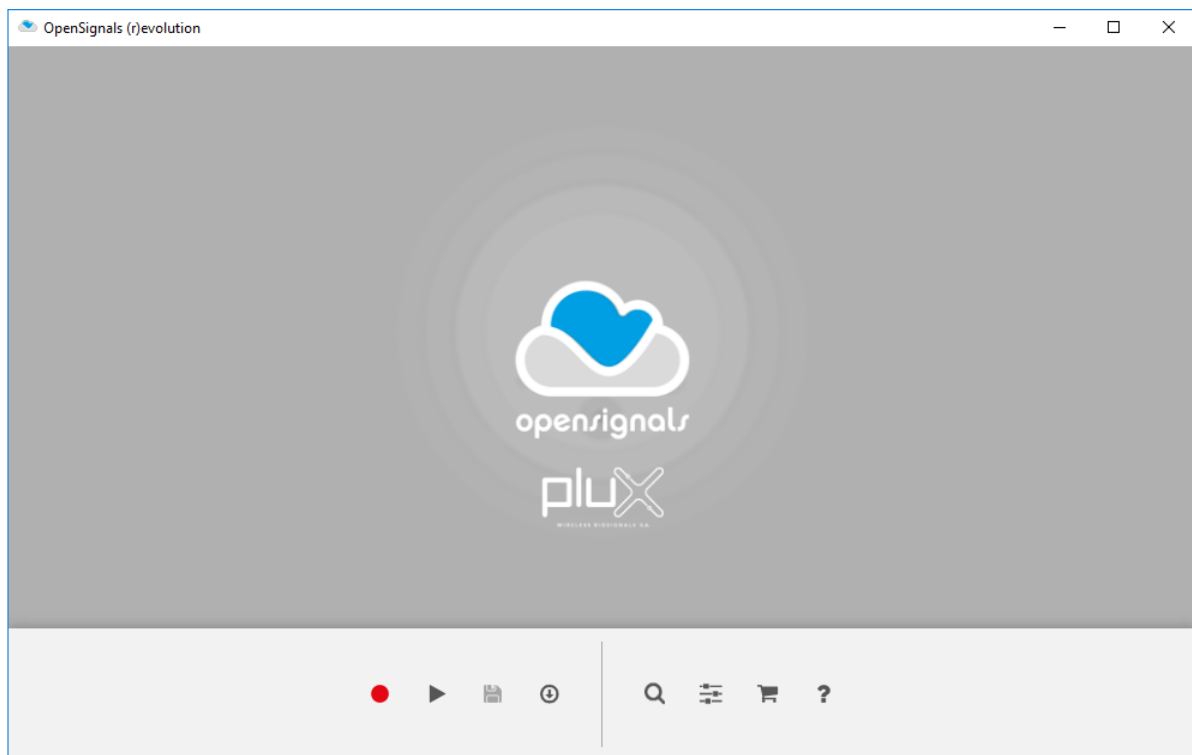









Figure 27: OpenSignals main interface.

All *OpenSignals* windows, settings, and signal related modes are accessible via the main Screen.


 Live (or Real-Time Acquisition) Mode

-  Playback (or Visualization and Post-processing) Mode
-  Save Last Recording
-  Download Logged Data from Device¹
-  Device Manager – Find and configure your devices
-  Change *OpenSignals* settings
-  Check our online store
-  Help - Consult our manual, licensing, support, and add-ons

Active and inactive options are marked by blue at gray colors:

 Activate

2.2 Device Manager

 select device(s), channels, channel labels, trigger, sample rate & resolution

The *OpenSignals (r)evolution* device manager lists and manages all known and available *OpenSignals* compatible PLUX devices and their acquisition configurations.

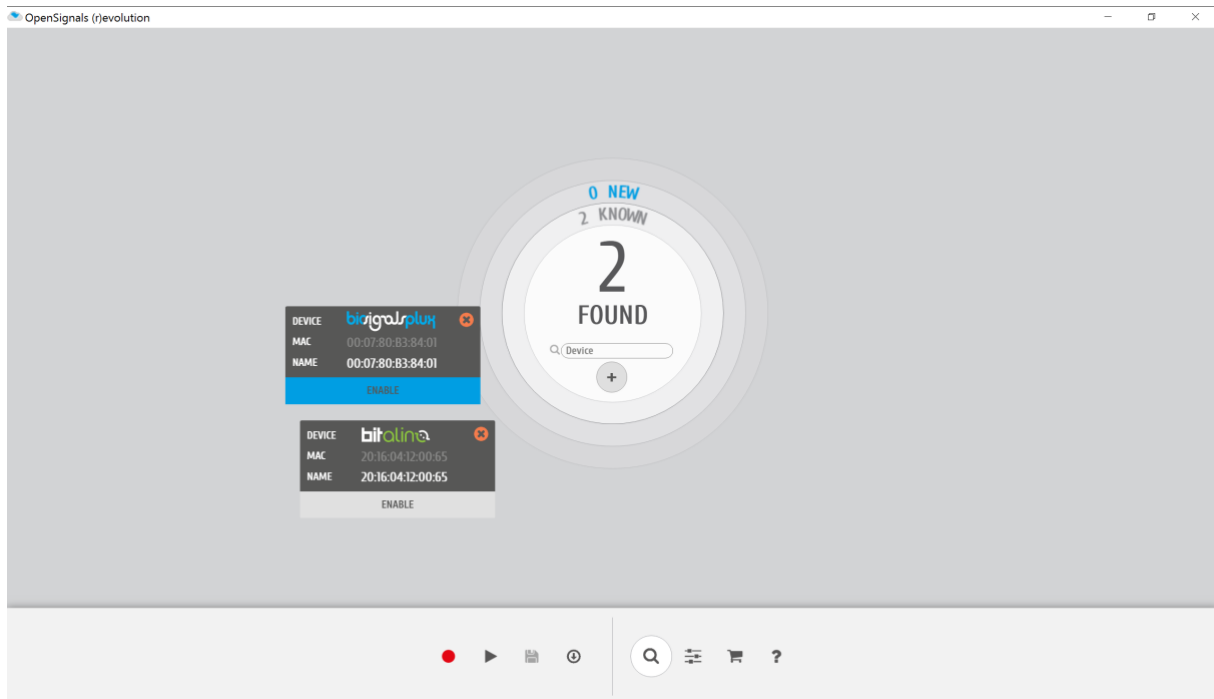


Figure 28: The device manager displays all the available PLUX devices

NOTE

OpenSignals (r)evolution is able to establish a Bluetooth connection to your device whenever you add a PLUX device in the *OpenSignals (r)evolution* device manager. In this case, it is not needed to manually establish a Bluetooth connection with your device using your operating system's tools.

However, if you are experiencing any kind of connection issues or if your device cannot be found and listed in the device manager, we recommend to connect your device with your operating system first before adding your device in *OpenSignals (r)evolution's* device manager by following the instructions in *1.5 Connecting Bluetooth Devices*.

2.2.1 Connecting Devices

Click on the device manager to search for available devices. *OpenSignals (r)evolution* will automatically search for available devices and display them in the device manager. Newly found devices will be displayed in blue with a loading circle in the top right corner of the device panel, indicating that *OpenSignals (r)evolution* is building up a connection to this device.

o

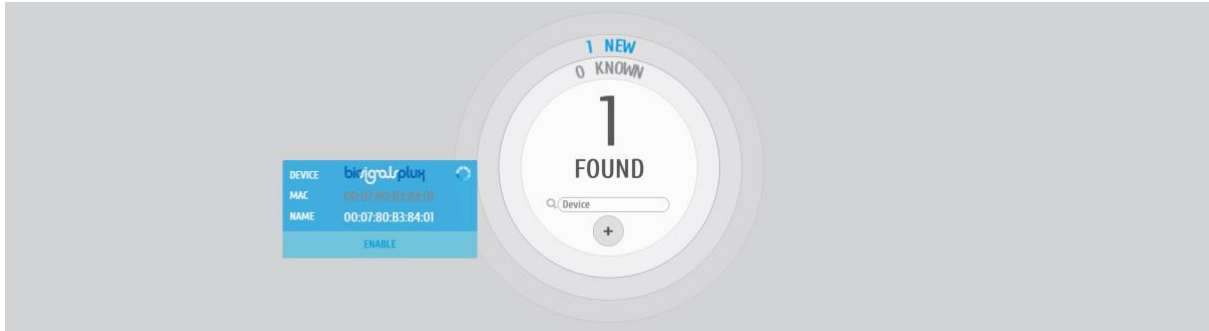


Figure 29: Building up connection with biosignalsplux.

If you haven't connected the device to your computer before using your operating system's device manager, a new window will pop up requesting the device's pairing code. For *biosignalsplux* devices enter 123 and click on *Next* to connect to your device. For *BITalino* devices enter 1234 and click on *Next* to connect to your device.

2.2.2 Connecting Devices Manually

If your device is not listed as an available device to be used in *OpenSignals* click on the '+' button in the center of the device manager to manually add your device using its MAC address.

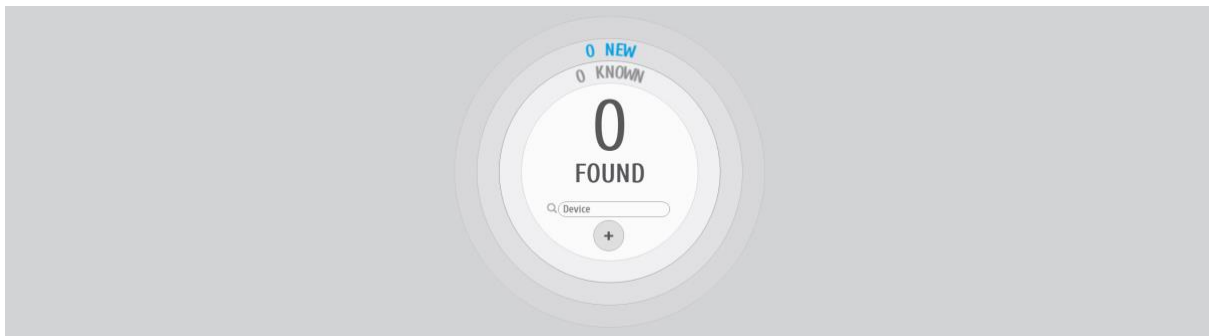


Figure 30: Click on '+' to add non-listed devices.

Add the MAC address of your device which can be found at the back of your device into the field below *Add your BITalino device manually* and click on the enter-arrow below.

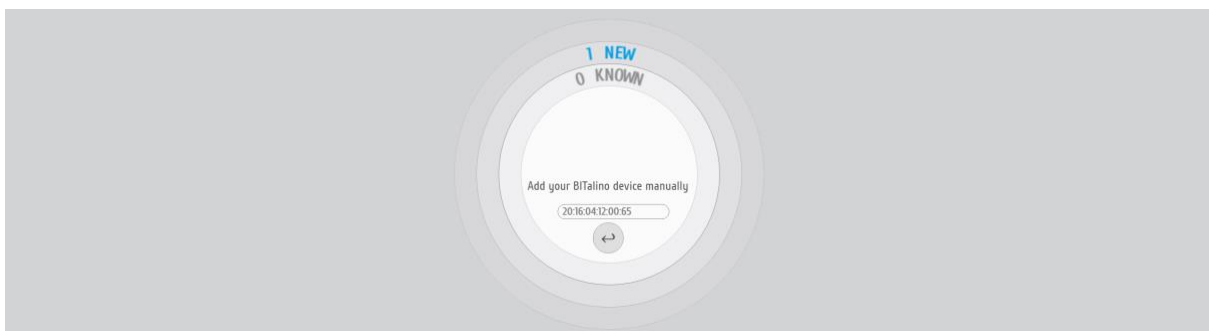


Figure 31: Enter the MAC address and confirm.

Your device should now appear and be available in the device manager.



Figure 32: Manually added BITalino.

2.2.3 Device States

Newly found devices are displayed entirely in blue in the device manager (here: *biosignalsplux*). Additionally, the number of all new and known devices are displayed in the center of the device manager (here: 1 new and 0 known).

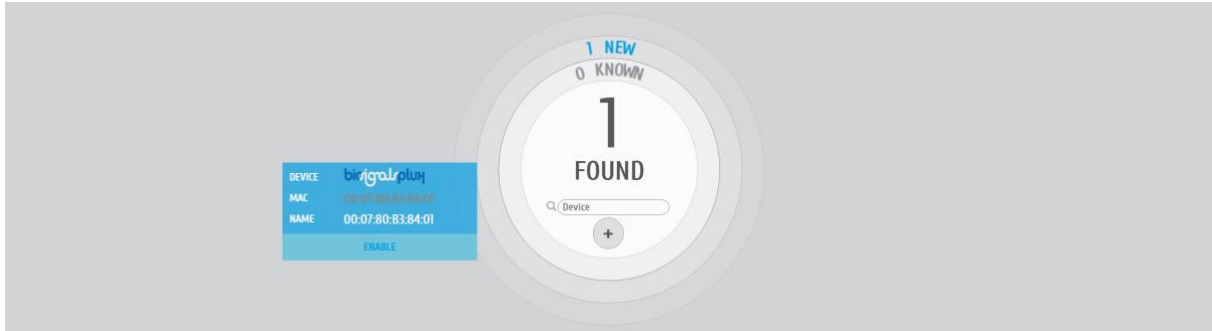


Figure 33: One newly found biosignalsplux device.

PLUX devices can be displayed in the device manager without having any effect or being used in acquisitions. This happens when devices are turned on and available, but not activated nor configured for signal acquisitions. These devices are displayed with a gray *ENABLE* field in the device manager. *OpenSignals (r)evolution* will only acquire signals from active devices and ignore communication with deactivated devices.

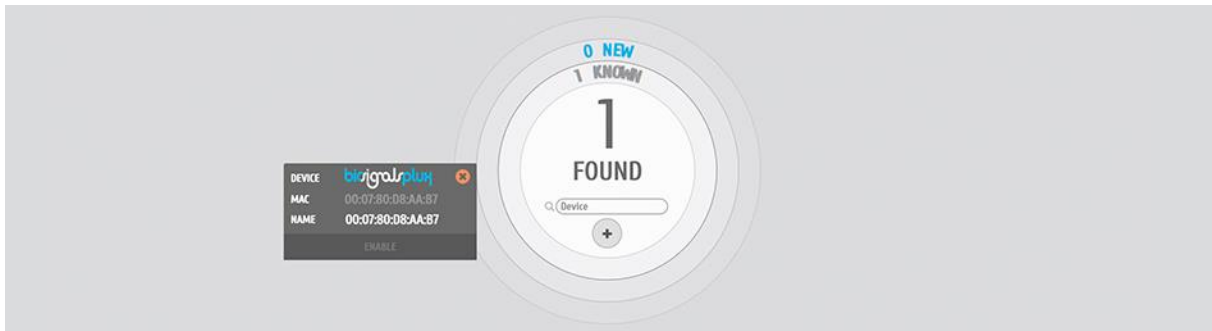


Figure 34: Deactivated biosignalsplux device.

Active devices will be used during the next acquisition with *OpenSignals (r)evolution*. To select and activate a device for signal acquisitions, click on the gray *ENABLE* field on the device. The *ENABLE* field will turn blue, indicating that the selected device is both available and configured for signal acquisition.

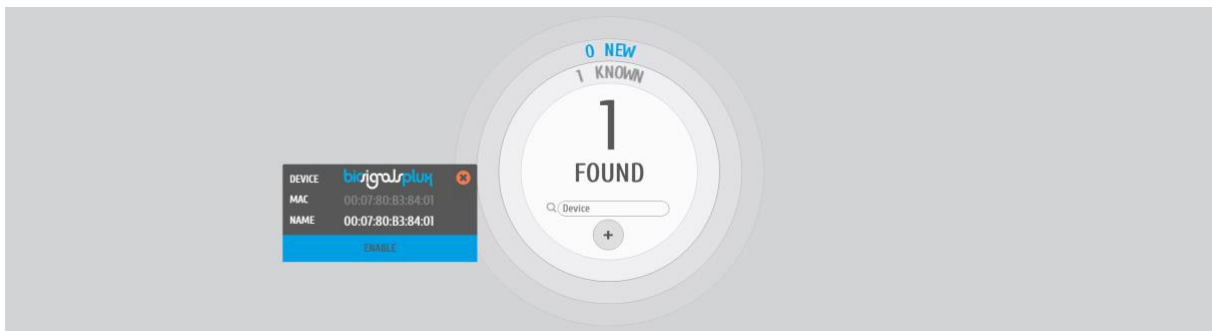


Figure 35: Activated biosignalsplux device.

2.2.4 Device Configuration

Click on the device you would like to set up in the *OpenSignals (r)evolution* device manager to open the device's configuration window.

NOTE

Please check section 5 *Advanced Device Configuration* for detailed information about the specific configuration options of your PLUX device.

2.2.4.1 Device Panel

The device panel displays the device's logo, MAC address and name (which can be user-defined; see Figure 36).

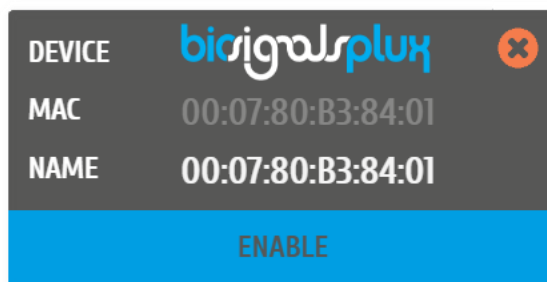


Figure 36: Available device in the *OpenSignals (r)evolution* device manager.

Click on the device panel of the device you would like to set up for signal acquisition. The device panel will expand and show all the available parameters that can be configured for acquisition.

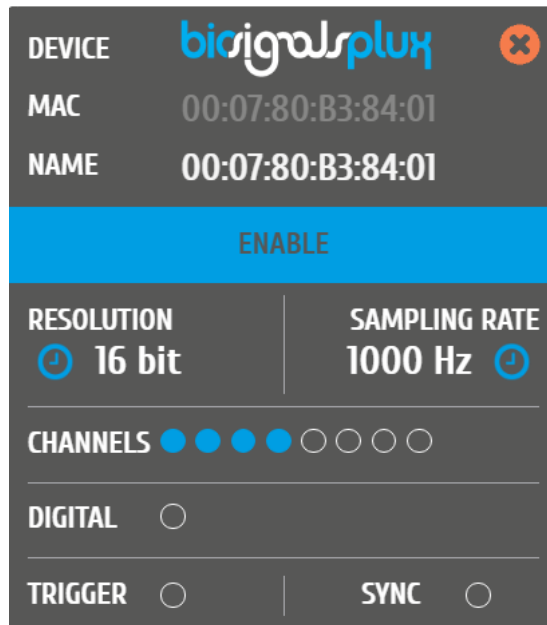


Figure 37: Extended device panel.

2.2.4.2 Device Name

To modify the device name, hover over the *NAME* field in the device panel and replace the MAC address of your device which is displayed as the default name of your device. Note, that the new name will only take effect inside *OpenSignals (r)evolution* but will not change the device's Bluetooth name in your operating system.

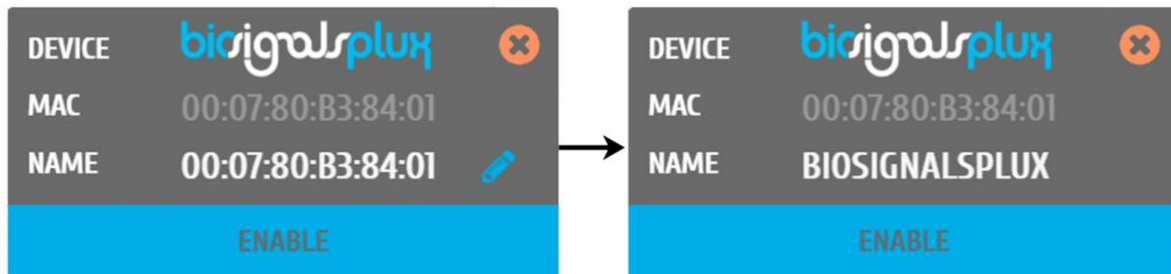


Figure 38: Changing device name.

2.2.4.3 Enable

Click on *ENABLE* to activate or deactivate your device for your next signal acquisition. If the *ENABLE* field is displayed blue, the device is activated for acquisition. If the *ENABLE* field is displayed gray, the device is deactivated for acquisition (also see 2.2.3 *Device States* for more information).

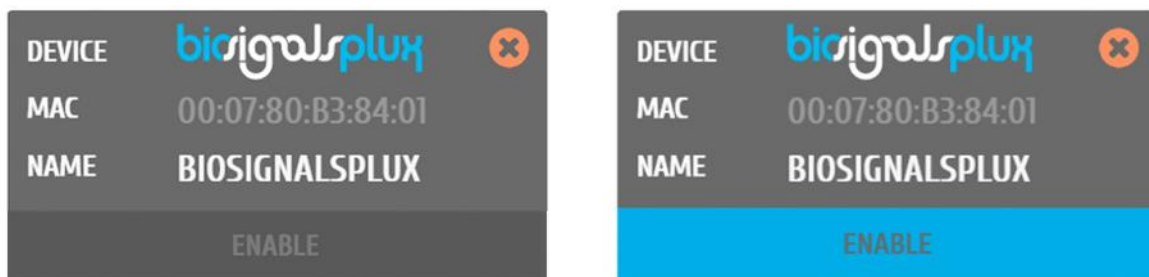


Figure 39: Left: deactivated biosignalsplx; right: activated biosignalsplx.

2.2.4.4 Sampling Resolution

The sampling resolution sets the number of bits per sample for each channel. Click on the device panel to see all the available configuration options of your device (if not done before) and hover over the *RESOLUTION* field so see the available sampling resolutions for your device (see Figure 40; here: 8-bit and 16-bit).

For more detailed information about the available sampling resolution options of your device check the 5 *Advanced Device Configuration* section of your device.

Note, higher resolutions and sampling rates lead to higher quality signal acquisitions but are linked to higher power consumption of system resources and higher probability of Bluetooth transmissions issues, which may lead to signal delays in the live acquisition mode. We recommend the usage of a PLUX proven Bluetooth dongle to prevent Bluetooth connection related acquisition issues or to reduce the sampling resolution (or sampling rate) to prevent such issues whenever it is possible.

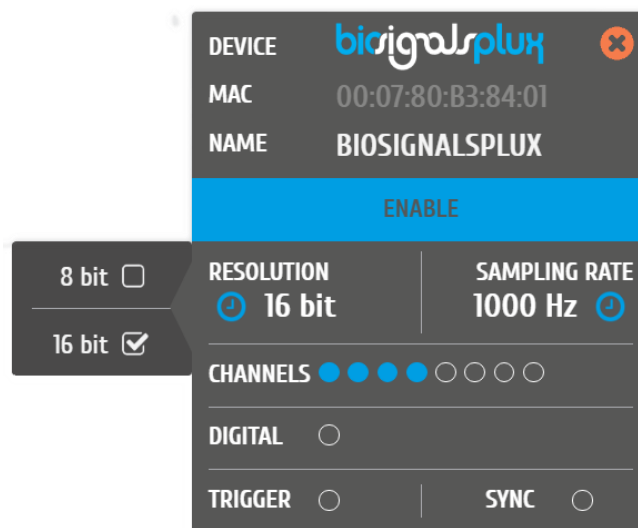


Figure 40: Available sampling resolutions.

2.2.4.5 Sampling Rate

The sampling rate sets the number of samples that are acquired per second per each channel, i.e. a sampling rate of 1000Hz will acquire 1000 samples per second per channel. Click on the device panel to see all the available configuration options of your device (if not done before) and hover over the *SAMPLING RATE* field so see the available sampling resolutions for your device (see Figure 41; here: 100, 200, 300, ... 1000Hz).

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz. However, note that high sampling *RATE* for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

For more detailed information about the available sampling rate options of your device check the *5 Advanced Device Configuration* section of your device.

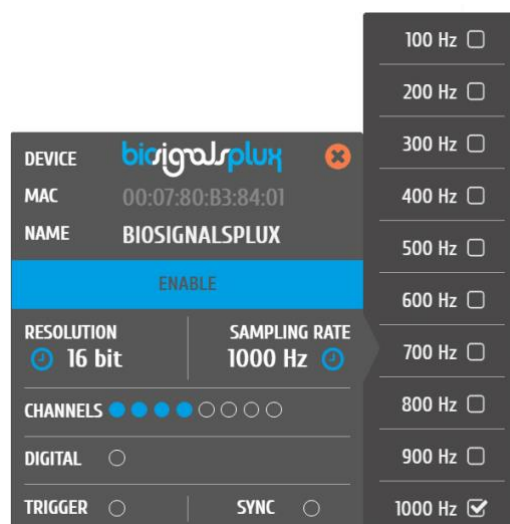


Figure 41: Available sampling rates.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

2.2.4.6 Channel Configuration

The channel configuration allows you to activate and deactivate channels for your signal acquisition session and to configure which sensors are connected to the single channels of your device.

Hover over the *CHANNELS* field to open the list of available channels. Activate or deactivate channels by clicking on the circles which are placed on the *CHANNELS* field or next to each single channel. Active channels are marked by blue circles, while inactive channels are marked by empty circles (e.g. in Figure 42 channels 1-4 are active, while channels 5-8 are not).

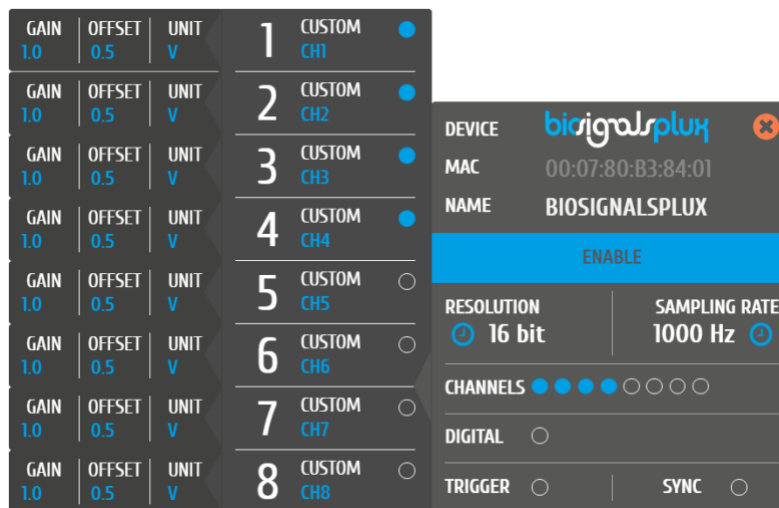


Figure 42: Channel configuration.

To select a pre-set sensor configuration for a channel, hover over the channel that you want to configure and click on the arrow next to the channel. Select the sensor type that fits to the sensor that is connected to your channel (see Figure 43).

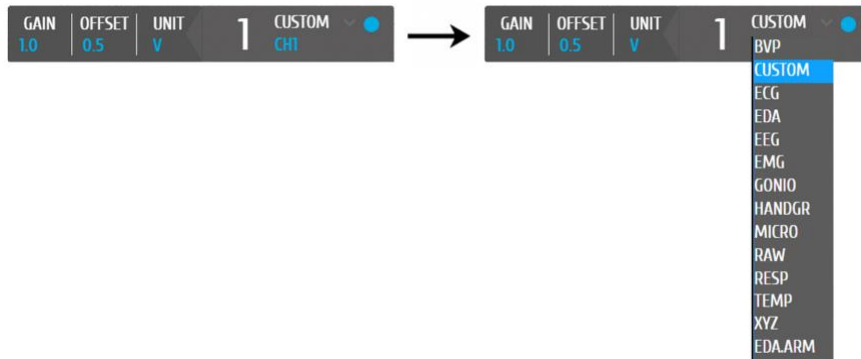


Figure 43: Channel type selection.

A possible channel configuration can be similar to the configuration displayed in Figure 44 with an 8-channel *biosignalsplux* device.

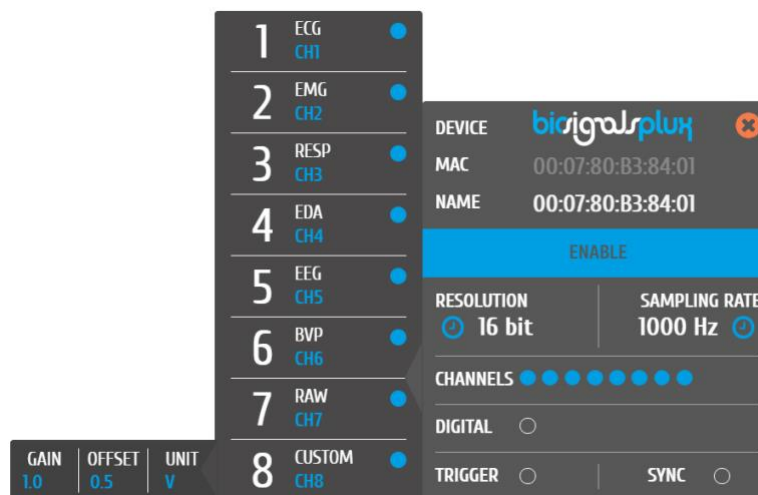


Figure 44: Possible channel configuration.

This configuration will convert the digital data, which is received from the device into the signals' original physical units. Choosing a sensor specific channel type will display the signal in its physical units in the real-time acquisition mode and in the visualization mode, however, the files storing the acquisition signals will only store the digital values (raw data). The visualization in physical units will be restored when reloading *OpenSignals (r)evolution* files.

NOTE

Some devices allow you to connect different sensor combinations and have to be configured according to your individual set up (e.g. *biosignalsplux*). Other devices have built-in sensors which are already pre-connected to the internal device channels. These devices have to be set up correctly according to the internal channel connections for the signals to be displayed correctly during acquisitions.

For more detailed information about the correct channel connections of your device check the *5 Advanced Device Configuration*

OpenSignals (r)evolution allows you to manually change the label of your channel, which can be useful when using multiple sensors of the same type, for example when using several EMG sensors applied on several muscles of the same muscle group. The channel label will be displayed during the real-time acquisition mode and can be helpful distinguishing the different channels.

Hover over the channel label that is located below the channel type field until a blue pen symbol appears. Click on it and enter the new channel label to change the channel label of the selected channel (see Figure 45).



Figure 45: Changing channel label.

2.2.4.7 Digital Output

Some accessories and components can be connected to the digital I/O port of the devices and controlled within the *OpenSignals (r)evolution* software. Such components are for example the *biosignalsplux* LED or the buzzer on the *BITalino (r)evolution* board.

Digital outputs are deactivated by default. Click on the circles on the *DIGITAL* field of the device panel to activate the digital output and to turn on components or accessories that are connected to the digital outputs at the start of the signal acquisition. Active digital outputs are marked by blue circles, while inactive outputs are marked by empty circles. The outputs can be turned off and on again as needed during the real-time acquisition mode.

Note, that *biosignalsplux* does only have a single digital output port to control any accessory that is connected to this port, while *BITalino (r)evolution* devices have two digital outputs pins with the first being connected to the on-board LED and the second being connected to the buzzer. However, additional digital ports can be available when using the [multi-sync splitter](#) for *biosignalsplux* devices.

Please check section [3.1.2.3 Digital Inputs & Outputs](#) to learn how to control the digital outputs (and inputs) during the real-time acquisition mode.

2.2.4.8 Trigger Options

Trigger accessories allow you to manually start acquisitions using the *biosignalsplux* [pushbutton](#), the [footswitch](#) or the *BITalino (r)evolution* [pushbutton](#) instead of automatically starting acquisitions when entering the real-time acquisition mode. *OpenSignals (r)evolution*'s trigger option is deactivated by default.

To use this feature, make sure your trigger accessory is connected to your device² and activate the trigger option in the *TRIGGER* field of the device panel (see Figure 46).

² biosignalsplux accessories have to be connected to the digital port of your device.

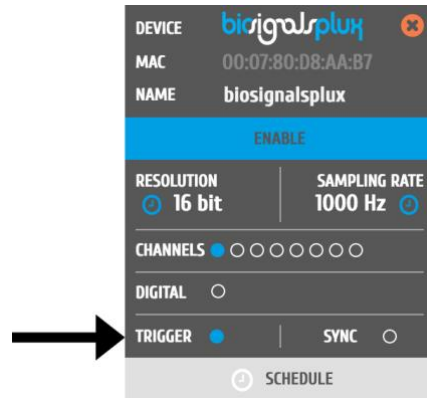


Figure 46: Trigger configuration.

If the acquisition start is set to wait for a manual trigger, the circle will be marked blue. Otherwise, the circle will remain empty. Open the real-time acquisition mode and press your trigger whenever you are ready to start your acquisition.

2.2.4.9 Synchronizing Devices

8-Channel *biosignalsplx* devices offer the possibility of synchronized acquisitions by connecting up to 3 *biosignalsplx* hubs using the synchronization kit. Activating the *SYNC* function will synchronize the acquisition between all devices and prevent signal drifts within different devices.

Please check section 3.4 *Synchronization* for more information on how to use this feature.

2.2.4.10 Removing Devices

To remove devices from the *OpenSignals (r)evolution* device manager, click on the 'x' inside the orange circle (top right corner of the device panel) to remove the device from the device manager.

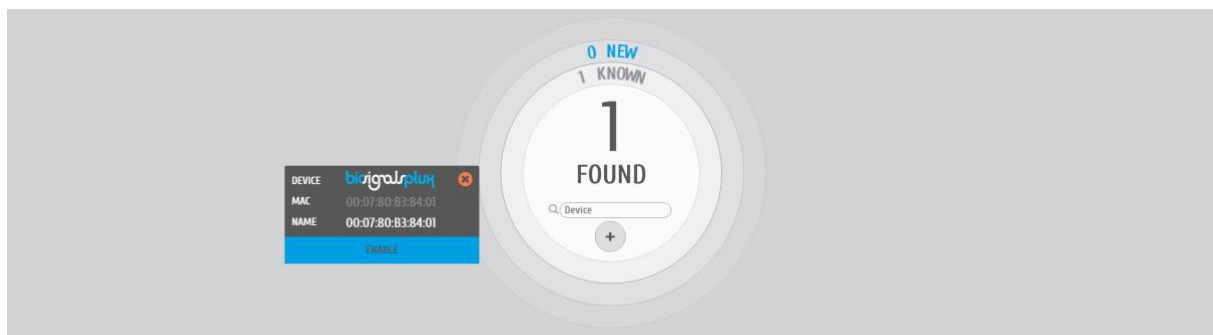



Figure 47: Remove device by clicking on the 'x' in the orange circle.

2.3 General Acquisition Settings

 save location, file prefix, file format and auto-save options

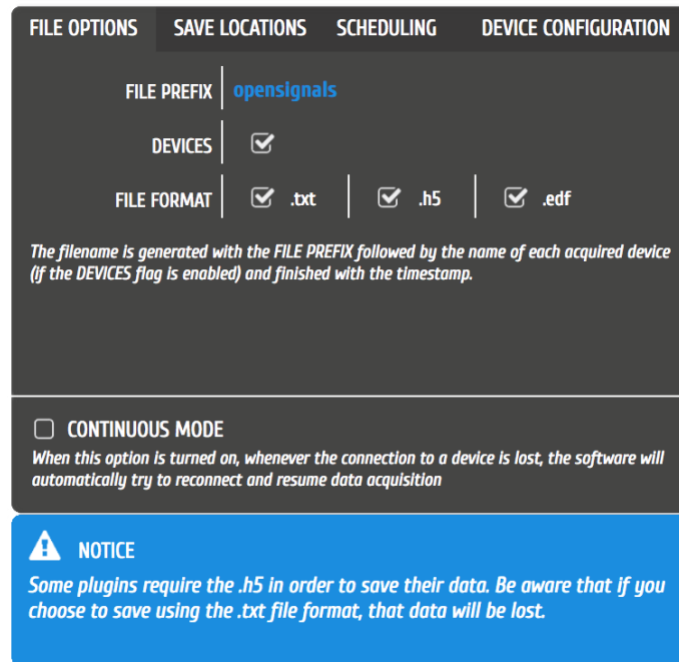


Figure 48: File options settings window.

2.3.1 Continuous Mode

The continuous mode will allow you a continuous acquisition until the acquisition is manually stopped. Activating this mode will continue your acquisition even if your device has lost connection to your computer and reconnect when the device is available and within a reachable distance. The Signal acquisition will then be restarted.

If this function is deactivated, the acquisition will be stopped after a communication break up.

2.3.2 File Prefix

The file prefix is a user-defined text that will be added to the acquisition's file name. An additional timestamp is automatically set after this prefix (example here: *opensignals__devicenames_YYYY-MM-DD_hh-mm-ss.format_extension*).

2.3.3 Devices

When this option is selected, the name of the device being used will be automatically added to the acquisition's file name. This is useful for example when recording data from multiple devices simultaneously, to easily distinguish the files generated by each device.

If you have not changed the name of your device (see 2.2.4.2 *Device Name*), the default device's MAC address will be used instead.

2.3.4 File Formats & Specifications

OpenSignals (r)evolution allows you to save the acquired sensor data into .TXT, .H5 or .EDF files. TXT files can be used to export signal data to 3rd party software. When opening TXT files,

OpenSignals (r)evolution will convert your file into an H5 file as this file is more suitable to store additional metadata which is created when using *OpenSignals (r)evolution*.

The European Data Format (EDF) is a simple and flexible format for exchange and storage of multichannel biological and physical signals. Visit <https://www.edfplus.info/> for more information.

NOTE

The TXT files do only contain the raw signal data from all sensors and digital I/O which were used during the acquisition. These files do not contain any processed data or results from *OpenSignals (r)evolution* add-ons (see 4 Add-Ons). If you need to export the results of these add-ons, please follow the instructions in section 4.3 Add-on Reports).

2.3.5 Save Locations

Sets the path where the acquired data and files will be saved.

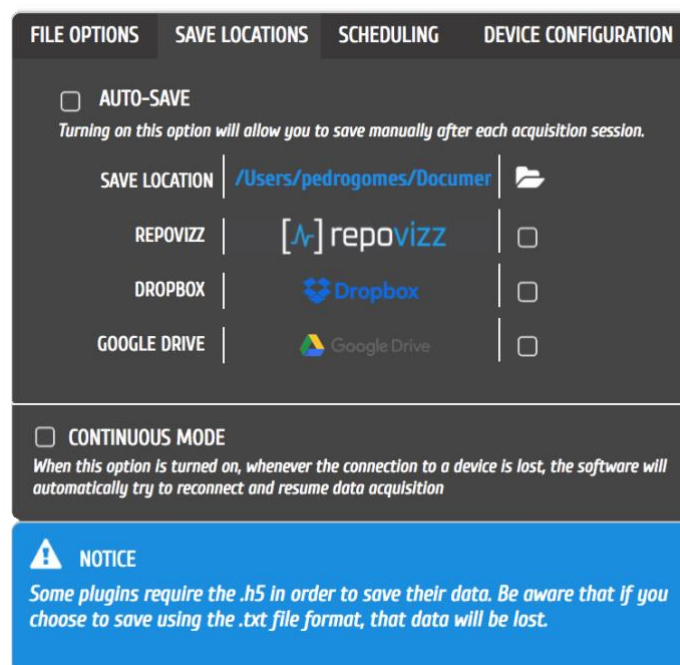


Figure 49: File options settings window.

2.3.5.1 Local

To store files on your computer, click on the folder icon at *SAVE LOCATION* and select a path where you want to store your acquisition files. *OpenSignals (r)evolution* files will then be stored into the selected path.

2.3.5.2 RepoVizz

RepoVizz is an integrated online system capable of structural formatting and remote storage, browsing, exchange, annotation, and visualization of synchronous multi-modal, time-aligned data. This online platform allows you to store your *OpenSignals (r)evolution* files online and to easily share them if needed.

To use RepoVizz, activate RepoVizz in the *SAVE LOCATIONS* window (see *Figure 49*) and log in into your RepoVizz account using your username and the API key which has been generated for your account during the registration process (see *Figure 50*).

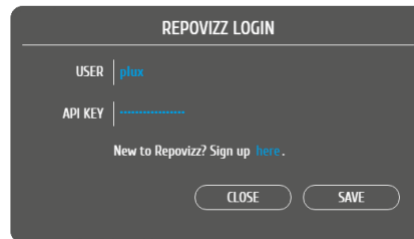


Figure 50: RepoVizz login window.

If you do not have a RepoVizz account yet, select *Sign up here* in the login window to access the RepoVizz homepage or follow this link:

<https://repovizz.upf.edu/repo/Home>

Note, that selecting RepoVizz as save location will not have any influence on other selected save locations (local, Dropbox or Google Drive).

2.3.5.3 Dropbox

To use Dropbox, activate Dropbox in the *SAVE LOCATIONS* window (see *Figure 49*). A new browser window will be opened in which you can log in into your Dropbox account (see *Figure 51*).

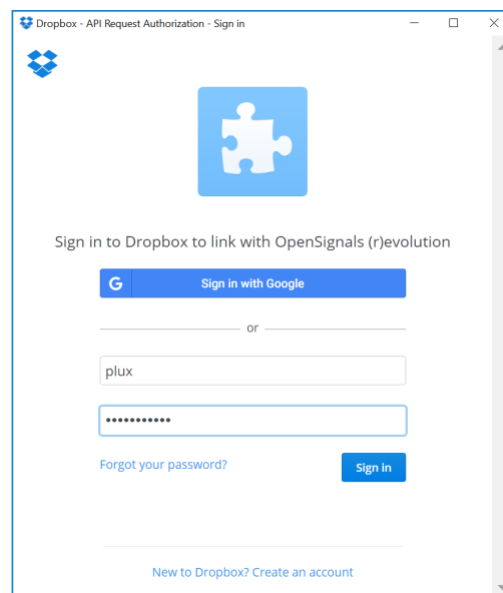


Figure 51: Dropbox login window.

Enter your Dropbox account information into the required fields and click on *Sign In* to proceed. Dropbox will require your confirmation to allow *OpenSignals (r)evolution* to access your Dropbox. Click on *Allow* to proceed. Your files can now be stored into your Dropbox account.

If you do not have a Dropbox account yet, click on *New to Dropbox? Create an account* in the login window or access the Dropbox sign up page using the following link and follow the instructions on the Dropbox website:

<https://www.dropbox.com/>

Note, that using Dropbox as save location will not have any influence on other selected save locations (local, RepoVizz or Google Drive).

2.3.5.4 Google Drive

To use Google Drive, activate Google Drive in the *SAVE LOCATIONS* window (see *Figure 49*). A new browser window will be opened in which you can log in into your Google Drive account (see *Figure 52*).

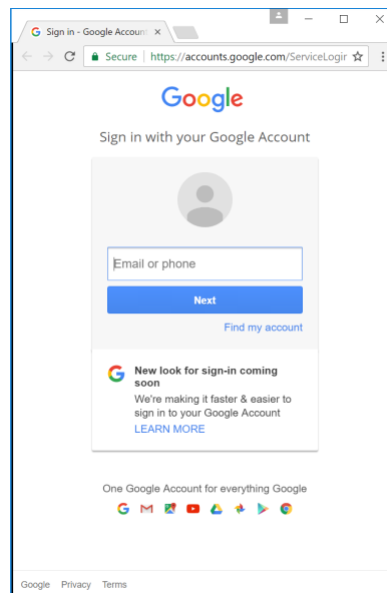


Figure 52: Google Drive login window.

Enter your Google Drive account information into the required fields and click on *Next* to proceed, enter your account's password and click on *Sign In*. Your files can now be stored into your Dropbox account.

If you do not have a Google Drive account yet, sign up using the following link and follow the instructions on the Google Drive website:

<https://accounts.google.com/SignUp>

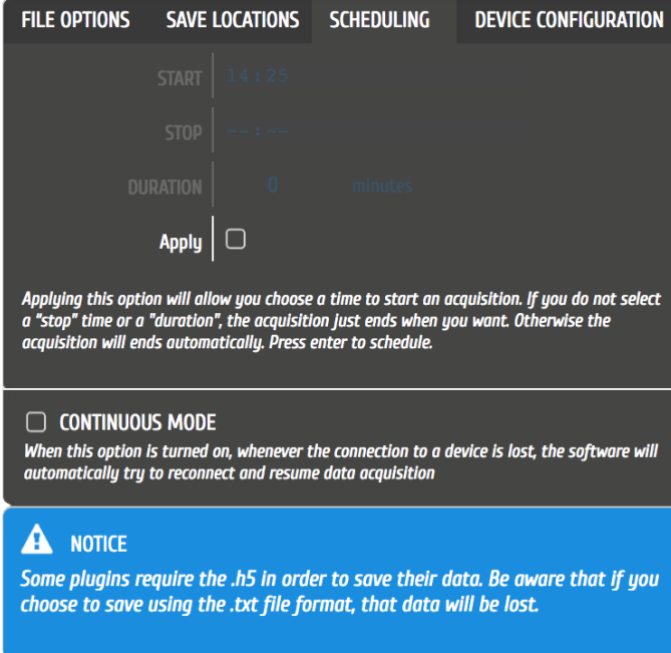
Note, that using Google Drive as save location will not have any influence on other selected save locations (local, RepoVizz or Dropbox).

2.3.6 Auto-save Options

When this option is enabled, *OpenSignals (r)evolution* will automatically save every acquisition session in a new file according to the configured file prefix, format, and other configurations mentioned in the last sections.

Auto-save is activated by default. Uncheck the box if you prefer to manually save your acquisitions after each recording session.

2.3.7 Online Scheduling



FILE OPTIONS	SAVE LOCATIONS	SCHEDULING	DEVICE CONFIGURATION
START	14 : 25		
STOP	-- : --		
DURATION	0	minutes	
Apply	<input type="checkbox"/>		

Applying this option will allow you choose a time to start an acquisition. If you do not select a "stop" time or a "duration", the acquisition just ends when you want. Otherwise the acquisition will ends automatically. Press enter to schedule.

CONTINUOUS MODE
When this option is turned on, whenever the connection to a device is lost, the software will automatically try to reconnect and resume data acquisition

NOTICE
Some plugins require the .h5 in order to save their data. Be aware that if you choose to save using the .txt file format, that data will be lost.

Figure 53: Online scheduling.

This scheduling feature allows to schedule the start and end-time or duration of an acquisition. To configure, set up your device in the device manager as described in section 2.2 *Device Manager*, the *Apply* checkbox and set up the preferred times for your acquisition.

If no end-time or duration is set for a scheduled acquisition, the acquisition can be stopped manually.

For instructions on how to schedule offline acquisitions with biosignalsplux devices with internal memory, please check section 3.3 *Data Logging*.

2.3.8 Replicate Device Configuration

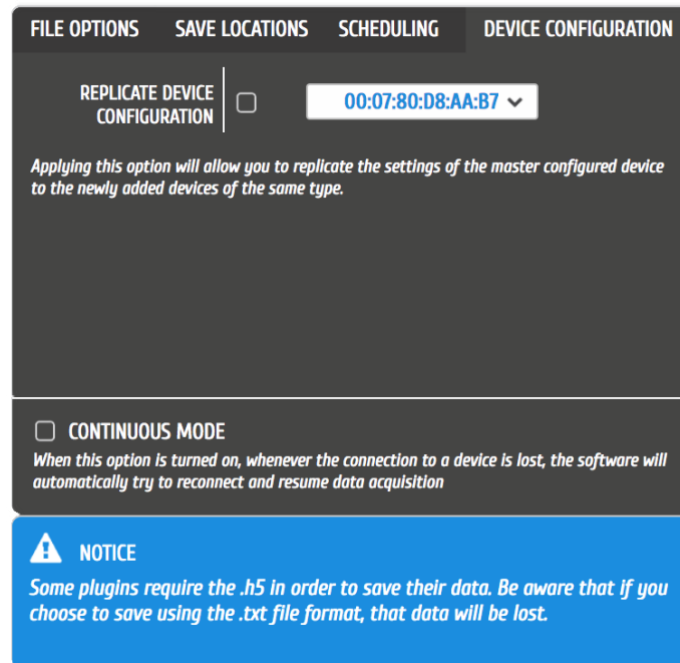


Figure 54: Replicate device configuration.

This feature allows to select a master device which configuration will be used as the new standard configuration of newly added devices.

To use this feature, set up your master device in the device manager as described in section 2.2 *Device Manager*. When done, return to the *DEVICE CONFIGURATION* seen in Figure 54 and select the master device by selecting its MAC-address in the dropdown menu and check the checkbox next to *REPLICATE DEVICE CONFIGURATION* to set it as the master device. Every new device will then inherit the configuration of the selected master devices (channel configuration, sampling rate & resolution).

3 Recording & Visualizing Signals

OpenSignals (r)evolution has a live signal acquisition mode which enables real-time signal acquisition using PLUX devices and a signal visualization mode which allows you to visualize acquired signal acquisition sessions.

Both modes share common functions, which can be accessed via the symbols displayed on the following pages. We recommend going through these explanations to take advantages of all *OpenSignals (r)evolution* features.

3.1 Signal Acquisition Mode

NOTE

We recommend configuring your device before entering the signal acquisition mode by following the instructions described in *2.2.4 Device Configuration* as modifications in device configurations cannot be done afterwards.

Recording signals with *OpenSignals (r)evolution* is made in signal acquisition mode (see Figure 55) which can be accessed in the main interface by clicking on the red button.

- Enter signal acquisition mode to record signals.

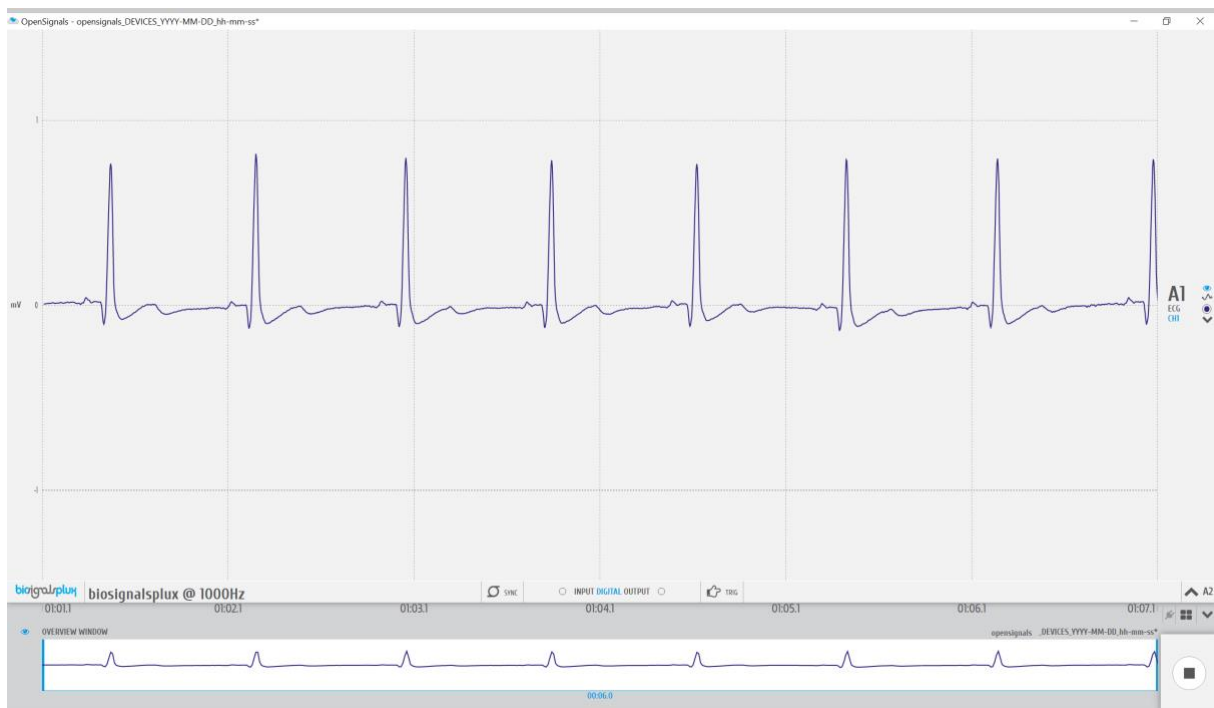


Figure 55: Signal acquisition mode.

When entered the signal acquisition mode, *OpenSignals (r)evolution* will automatically connect to your device to configure and start the signal acquisition. If your devices is

configured to start by a manual trigger, for example using a [trigger button](#) or a [foot switch](#), the recording will only start when the manual trigger has been set.

OpenSignals (r)evolution will automatically issue warning notifications if any error occurs during connection and/or configuration attempts with your device(s). If any of these errors occur, please check if your problem can be solved with the information given in [7 Troubleshooting](#) or contact our support if the problems cannot be solved (see [9.3 Contact & Support](#)).

The visualization mode consists of 3 different interface sections which allow you to control the visualization of the selected files and signals:

- Signal acquisition (1 in Figure 70; see [3.1.1 Signal Acquisition](#))
- Information bar (2 in Figure 70; see [3.1.2 Information Bar](#))
- Control bar (3 in Figure 70; see [3.1.3 Control Bar](#))

Please read the instructions on the following pages to take advantage of all the available feature of *OpenSignals (r)evolution*.

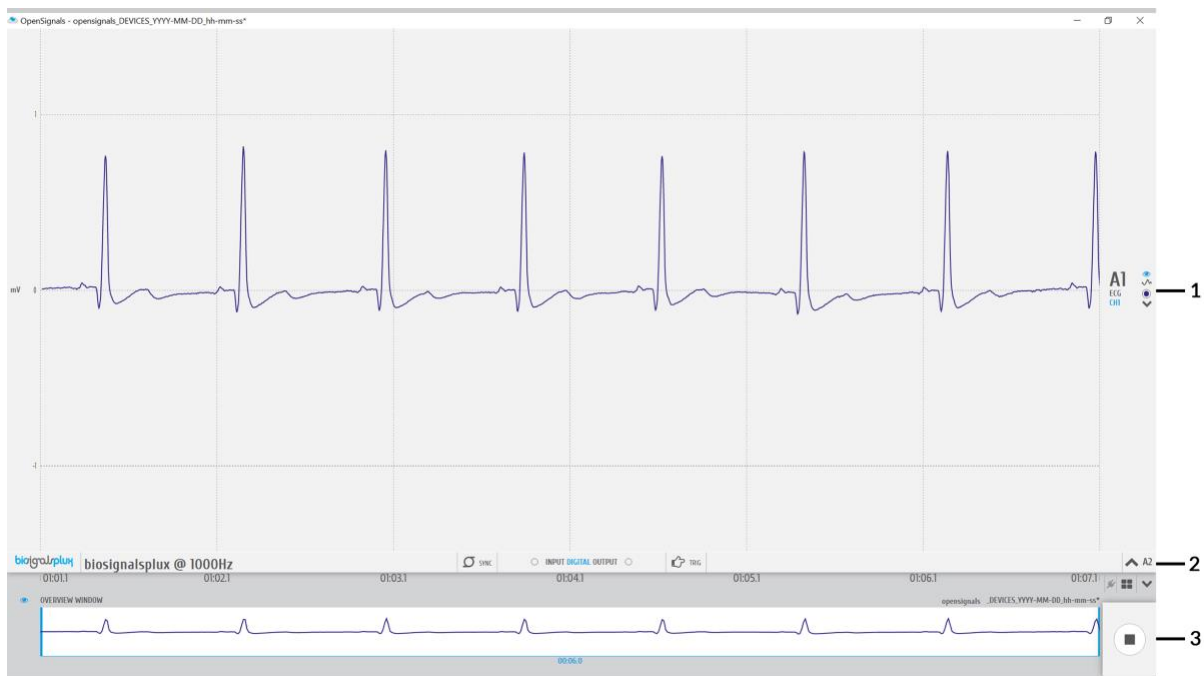


Figure 56: Sections of the visualization mode.

3.1.1 Signal Acquisition

The acquired signals are visualized in the signal acquisition window, which the signals of all acquiring channels (see Figure 73).

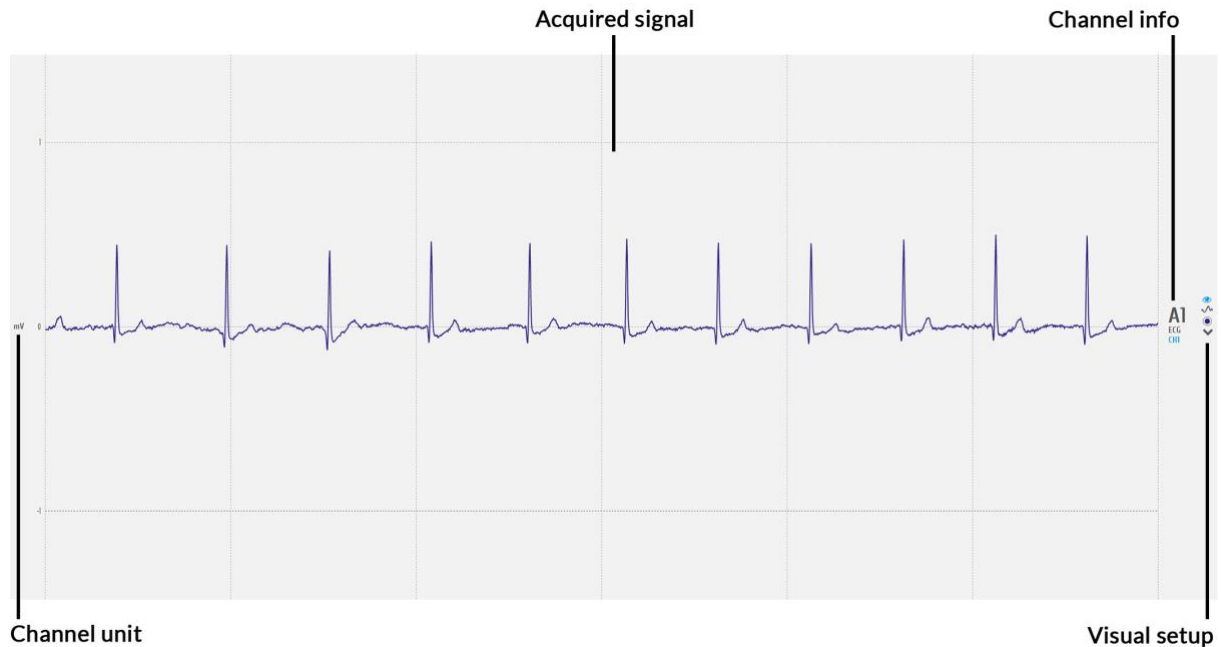


Figure 57: Visualization of the acquired signal(s).

In this window, there are several fields of information and configuration that lets you make some modifications on the displayed signals.

3.1.1.1 Channel info

The channel info provides information of the displayed channel (see Figure 57; here: channel 1 of a biosignalsplux device; A1), the type of channel which has been configured before the acquisition was made (here: ECG) and the label set for this channel and sensor during the acquisition (here: CH1)

Changes of these indications have to be made when configuring your device before starting an acquisition. Please review and follow the instruction in section 2.2.4.6 *Channel Configuration* for more information on channel types, number, and labelling.

3.1.1.2 Channel unit

The channel unit displays the original physical unit of the acquired signal, if a selection of channel type has been made during the configuration process of your device. The channel unit varies from the type of sensor and selected sensor type (here: ECG signal displayed in mV). If no selection has been made, the default unit to be displayed is Volt (V).

Changes of these indications have to be made when configuring your device before starting an acquisition. Please review and follow the instruction in section 2.2.4.6 *Channel Configuration* for more information on channel types, number, and labelling.

3.1.1.3 Visual Setup

The visual setup allows you to modify the visualization of your signal(s) (e.g. signal color) and to hide single channels, if their visualization is not required.

Additional functions to modify the visual setup of each channel can be accessed when hovering over each available channel (see Figure 58).

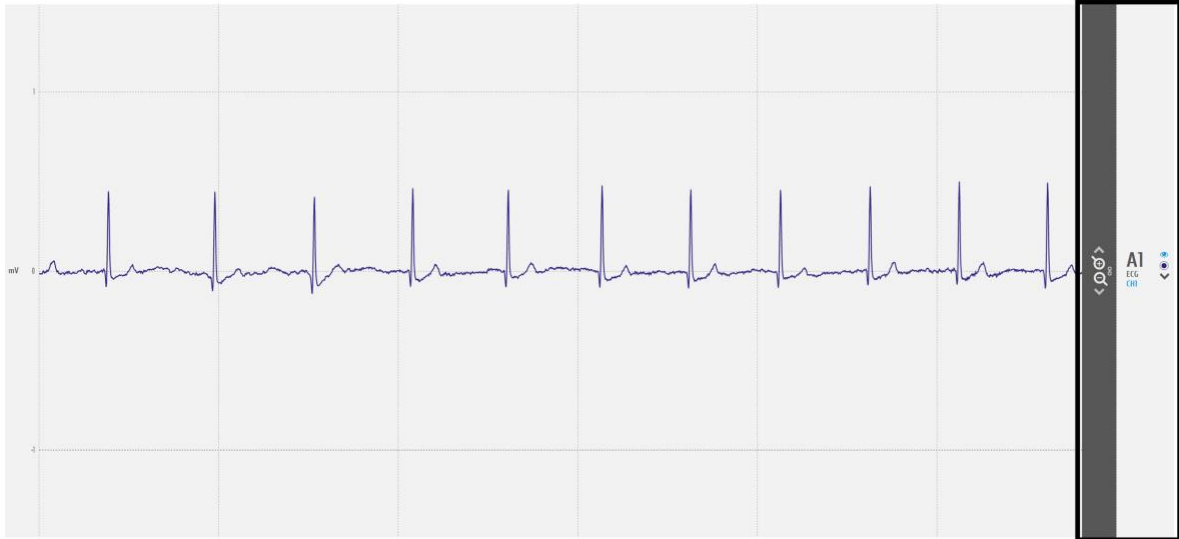


Figure 58: Visual setup options (black box).



Display channel in the overview window

Hides or displays the selected channel in the overview window at the bottom of the visualization mode (see 3.2.4.5 *Overview Window* for more information).



Signal smoothing

This visualization option mode allows one to change the plotting of the chart from the raw data to a sampling frequency weighted sub-sampled interpolation, which smooths the chart, showing only the general shape. This option is saved into the device configurations to a new property called *smoothChannels*, which defines, for each channel, whether to smooth or not the chart.



Signal color

Changes the color of the visualized signal. Click on this symbol to see all the available colors.



Hide channel

Click on this symbol to hide a single channel from the visualization mode. This feature is useful when the visualization of specific channels is not required at the moment. The hidden channel can be displayed again by selecting it in the information bar (see 3.1.2 *Information Bar*).



Move baseline up

Moves the baseline of the selected channel up (incl. signal).



Move baseline down

Moves the baseline of the selected channel down (incl. signal).



Zoom in

Zooms into the selected channel.



Zoom out

Zooms out of the selected channel.



Link channels

Links channels of the same type to each other and adjusts the same visual setup to all linked channels (e.g. scale, offset).

3.1.2 Information Bar

In the information bar, information about the acquiring device is displayed (device logo, name or mac address, sampling rate) as well as all the hidden channels (channels which are acquiring signals but are not visualized during this acquisition). Additional information is given about the synchronization status (see 3.4 *Synchronization*) and the trigger status (see 2.2.4.8 *Trigger Options*).

The information bar does also provide options to control both digital input and outputs and, depending on the device being used, an adjustable output to control the analog output of a device (*BITalino* only).

When using *biosignalsplux* devices, the state of the digital inputs and outputs are displaced at the center of the information bar (see Figure 59).

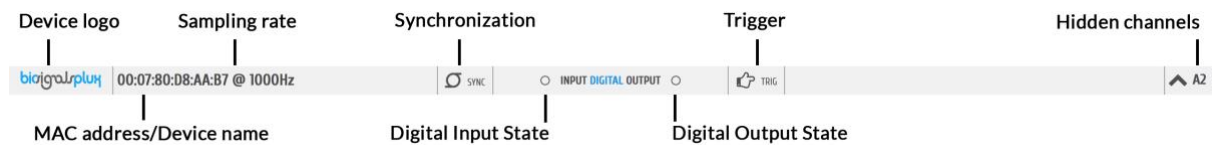


Figure 59: Information bar when using *biosignalsplux* devices.

When using *BITalino* devices, additional control functions are displayed to control both digital outputs and digital inputs of the device as well as adjusting the analog output using pulse width modulation (see Figure 60).

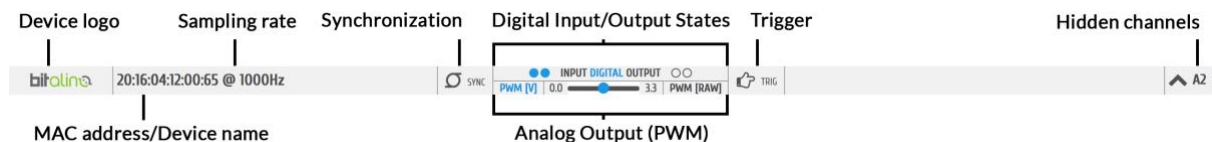


Figure 60: Information bar when using *BITalino* devices.

For more information on digital input and output control see section 3.1.2.3 *Digital Inputs & Outputs*. For more information on analog output control see 3.1.2.4 *Analog Output*.

3.1.2.1 General Controls

When using multiple devices during an acquisition, the synchronization function should be activated to ensure that all devices are synchronized during the acquisition (see 3.4 *Synchronization*). In the information bar it can be seen if the synchronization function is active or not.



Synchronization function

Indicates if *OpenSignals* is using the synchronization function to synchronize the acquisition of the multiple devices being used (function is active when symbol is blue; function is inactive when symbol is gray).

Hidden channels (see Figure 59; here: A2, channel 2) can be displayed in the acquisition window again by clicking on the arrow next to a hidden channel.

Show channel

Activates selected channel to be displayed in the visualization window.

3.1.2.2 Trigger

Accessories such as the [pushbutton](#) or the [foot switch](#) can be used to trigger the start of an acquisition. Triggered acquisitions have to be configured in the device manager before starting the acquisition. Make sure you have the trigger function activated during the configuration process of your device as described in [3.1.2.2 Trigger](#).

In the information bar it can be seen if the synchronization function is active or not.



Figure 61: Trigger state.

Triggered acquisition

Indicates if the current acquisition is configured to start by a trigger input (function is active when symbol is blue; function is inactive when symbol is gray).

3.1.2.3 Digital Inputs & Outputs

Accessories such as the [pushbutton](#) or the [foot switch](#) can be used as digital markers to mark special events during an acquisition.

In the information bar, it is possible to see the current input state of such devices. If the acquiring device is receiving a digital input (e.g. handheld switch is pressed), the circle next to **INPUT DIGITAL** turn blue. Otherwise, it will remain empty (see Figure 62).

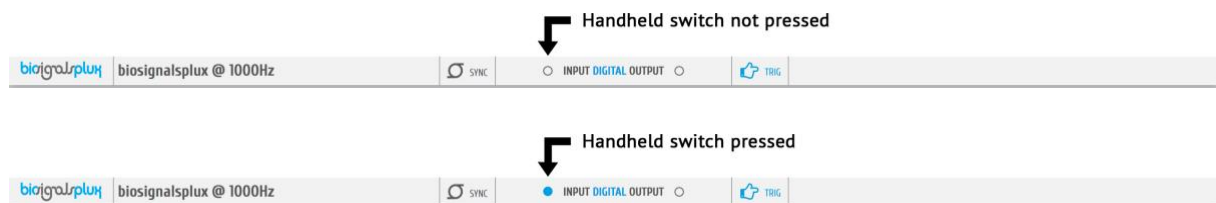


Figure 62: Digital input states (input device being used: handheld switch).

Accessories such as [LEDs](#) can be used as visual markers, for example, to synchronize PLUX devices with 3rd party hardware if needed. To control the output state of the LED during the acquisition, click on the circle next to **DIGITAL OUTPUT** in the information bar. If the acquiring device is receiving a digital input (e.g. handheld switch is pressed), the circle next to **INPUT DIGITAL** turn blue. Otherwise, it will remain empty (see Figure 62).

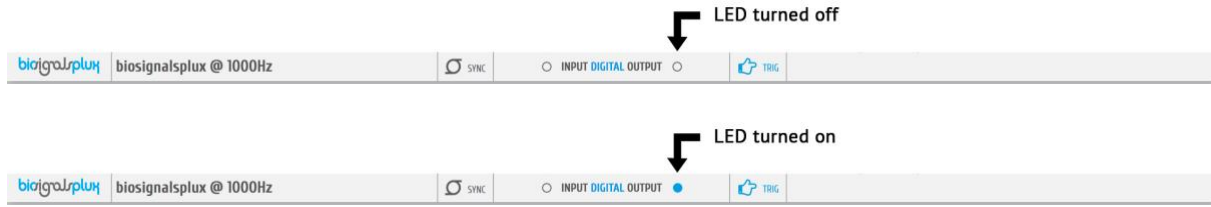


Figure 63: Digital output states for LED.

NOTE

BITalino devices allow you to control two digital outputs and two digital inputs. On *BITalino (r)evolution* boards the input and output indications are the following (referring to the circles in the information bar):

- Left digital input: button state
- Right digital input: -
- Left digital output: LED
- Right digital output: buzzer

This configuration can vary when using *BITalino Freestyle* or *BITalino Plugged* devices, as the your configuration of these devices may not be identical to the *BITalino Board*.

3.1.2.4 Analog Output

BITalino devices allow you to control an analog output to control additional hardware or 3rd party hardware (e.g. custom sensors). To control the analog output, click and drag the blue button to the preferred analog output (see Figure 64).



Figure 64: Adjusting analog output.

3.1.3 Control Bar

The following features and options can be accessed in the control bar:

- Time axis (x-axis; 1 in Figure 65)
- Access *OpenSignals* add-ons (2 in Figure 65)
- Multi-channel visualization modes (3 in Figure 65)
- Hide/Unhide all channels (4 in Figure 65)
- Overview window (x-axis adjustments; 5 in Figure 65)
- Return to *OpenSignals*' main interface (6 in Figure 65)

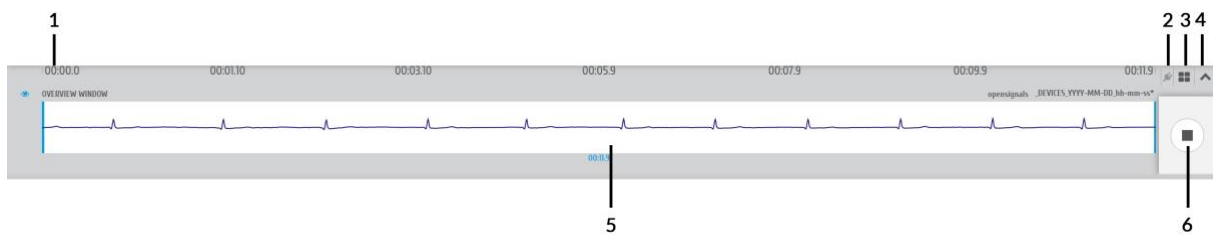


Figure 65: Control bar.

All features are explained on the following pages in more detail (except file information and access to open file dialog; see section 3.2.1 *Open OpenSignals Files*).

3.1.3.1 Time Axis

The x-axis provides the time information and scaling for the acquired signals. These values are not changeable. However, the time span which is displayed can be adjusted by scaling the x-axis in the overview window.

3.1.3.2 Access *OpenSignals* Add-ons

OpenSignals (r)evolution can be extended by signal-processing add-ons to extract meaningful information from specific signal and sensor types. All available add-ons can be accessed by using the following symbol in the control bar to open the add-ons menu (see section 4 *Add-Ons* for more information).



Add-ons

Displays all available offline add-ons for post-processing purposes.

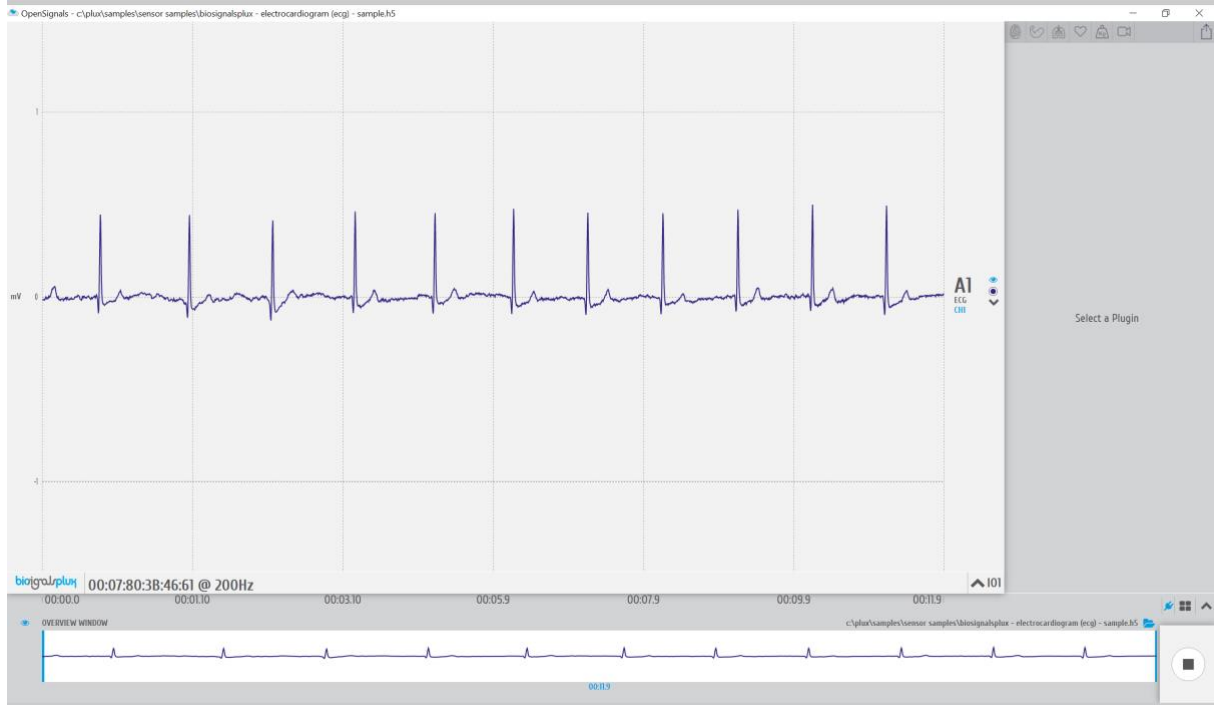


Figure 66: Add-ons menu.

3.1.3.3 Multi-channel Visualization Modes

OpenSignals (r)evolution offers two different channel visualization modes (see Figure 78). The first (default) mode displays all the channels stacked vertically in order of the channel number (see Figure 78, left visualization mode). The second type splits the visualization mode vertically in half, displaying half of the channels on the left side of the visualization window and the other half on the right side (see Figure 78, right visualization mode). This mode can be useful when visualizing multiple channels at the same time (e.g. using an 8-channel biosignalsplux).

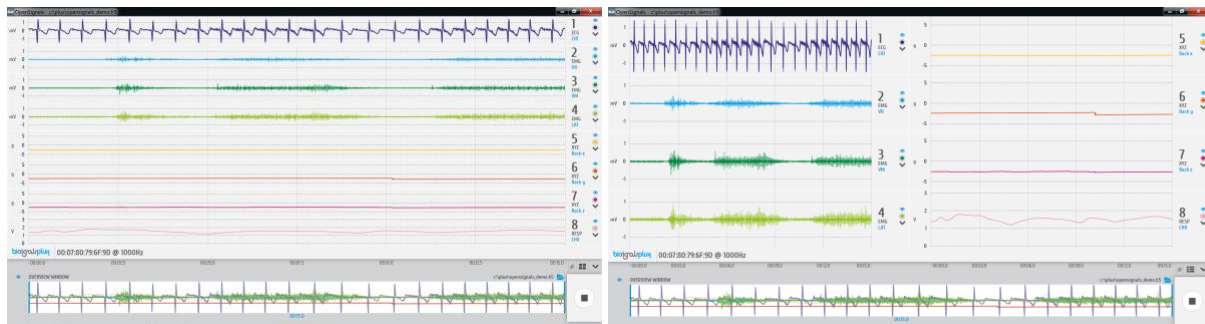


Figure 67: Channel visualization modes.



Multi-channel visualization modes

Switch between available multi-channel visualization modes.

3.1.3.4 Hide and Unhide Hidden Channels

By default, *OpenSignals (r)evolution* will display all the available channels and signals that are stored in a loaded *OpenSignals* file. As a permanent visualization of all available channels is

not always required, it is possible to hide the visualization of selected channels as described in section 3.1.1.3 *Visual Setup*.

All channels can be hidden or unhidden at once by clicking on the following symbols:



Unhide all channels

Unhides all hidden channels, resulting in a visualization of all available channels and signals.



Hide all channels

Hides all channels.

3.1.3.5 Overview Window

The overview window gathers and displays all available signals in the bottom frame of the signal visualization mode. This window serves to change the displayed time interval of the signals in the signal visualization window (adjustment of the x-axis).

To change the displayed time interval, click on the blue vertical bars in the overview window and move them to the start or ending point of your preferred time interval. Only the time interval which lies within the white frame in the overview window will be displayed in the visualization window (here: from 6 sec interval to 3 sec interval).

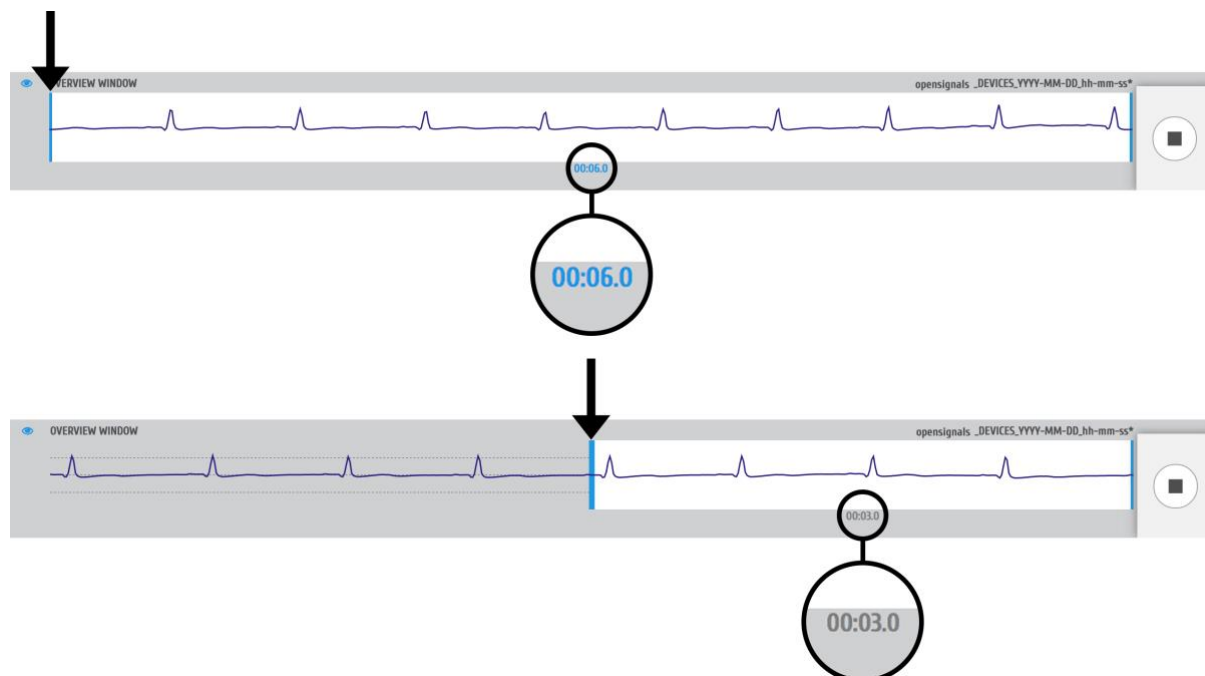


Figure 68: Changing the visualized time interval in the overview window.

Note, that the signals will be displayed in the overview window in the color which has been selected for the signals/channels in the visualization window.

If not needed, the overview window can be hidden by clicking on the following symbol placed to the left of the overview window. When hidden, the overview window can be displayed by clicking on this symbol again.



Hide/Show overview window

Hides the overview window when it is displayed and displays the overview window when it is hidden.

3.1.3.6 Return to the Main Interface

The signal acquisition mode can be stopped and exit at any time by clicking on the square symbol at the bottom right of the signal visualization mode. Exiting this mode will result in returning to the main screen.



Stop signal recording and exit signal acquisition mode

Stops signal recording and exits signal acquisition mode (returns to main screen).

3.2 Signal Visualization Mode

OpenSignals (r)evolution allows you open files containing the previous signal acquisitions and/or to use *OpenSignals* add-ons to post-process your data (see 4 *Add-Ons*). To enter the signal visualization mode, click on the following symbol, which you can find in the main screen of *OpenSignals (r)evolution* (see Figure 27).

▶ enter signal visualization mode to review and/or post-process your data



Figure 69: Signal visualization mode.

The visualization mode consists of 3 different interface sections which allow you to control the visualization of the selected files and signals:

- Signal visualization (1 in Figure 70; see section 3.2.2 *Signal Visualization*)
- Information bar (2 in Figure 70; see section 3.2.3 *Information Bar*).
- Control bar (3 in Figure 70; see section 3.2.4 *Control Bar*)

Please read the instructions on the following pages to take advantage of all the available features, including the instructions on how to select and open *OpenSignals* compatible files.

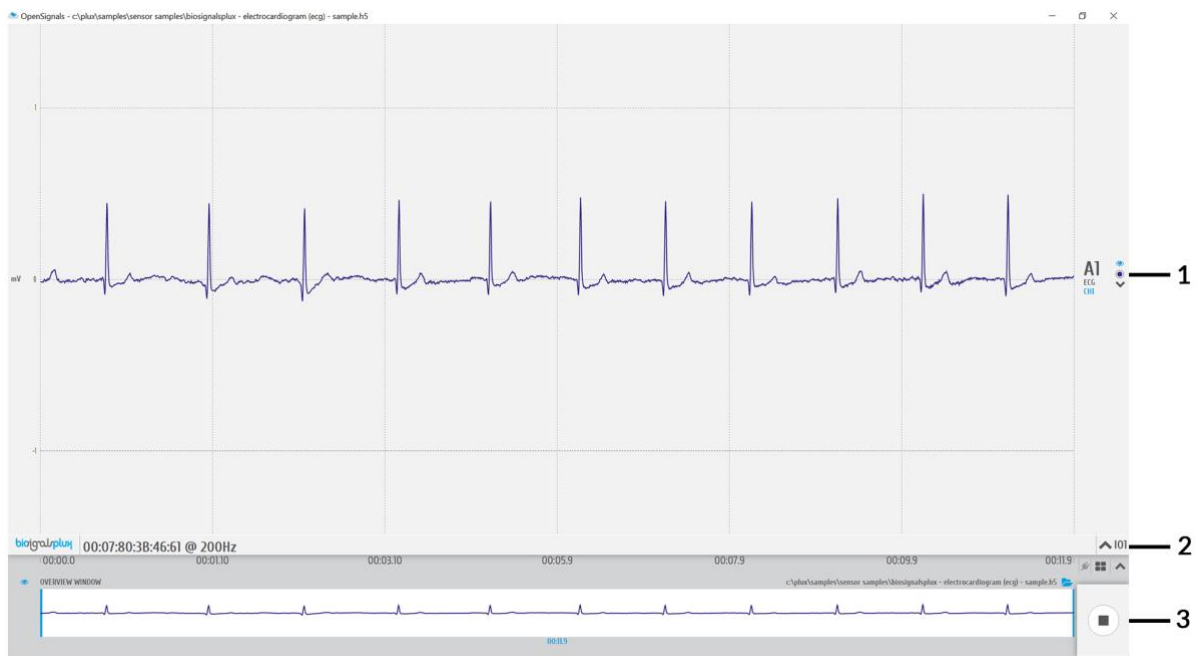

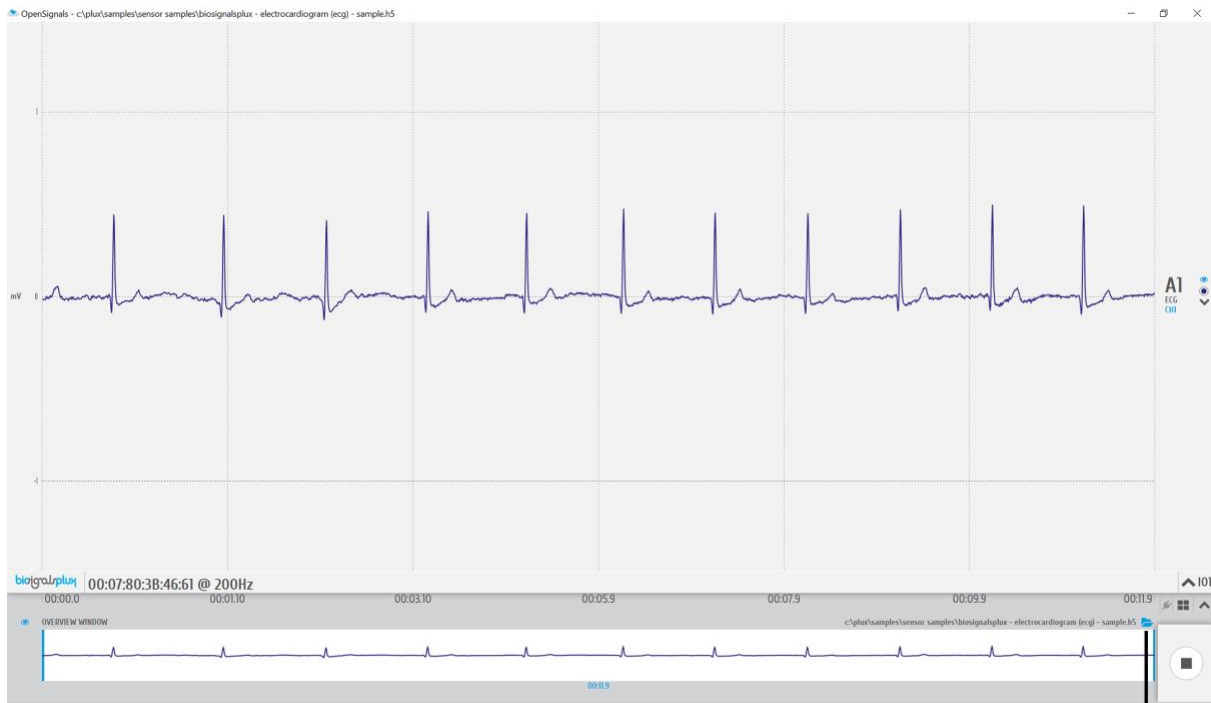


Figure 70: Sections of the visualization mode.

3.2.1 Open OpenSignals Files

To visualize your previous acquisitions, it is needed to select and open the file which contains acquired signals. For this, click on the folder symbol inside the signal visualization mode, to open the open file dialog which allows you to navigate through your folders on your computer and to select and open your preferred *OpenSignals* files (see Figure 71).

 navigate and select *OpenSignals* file



Select and open a file

Figure 71: Open the open file dialog.

At the top of the open file dialog, all the available save locations and platforms are displayed, which are connected to your *OpenSignals* (as described in 2.3.5 *Save Locations*). Click on the save location you have your files stored and wait for it to load the list of available files.

To navigate through the folder structures of your save location, click on a folder which is listed in the open file dialog to enter the folder or click on the first folder in the list (named “..”) to return to the previous folder. To select and open a file, click on your preferred file and confirm your selection by clicking on the *OK* button to open the selected file.

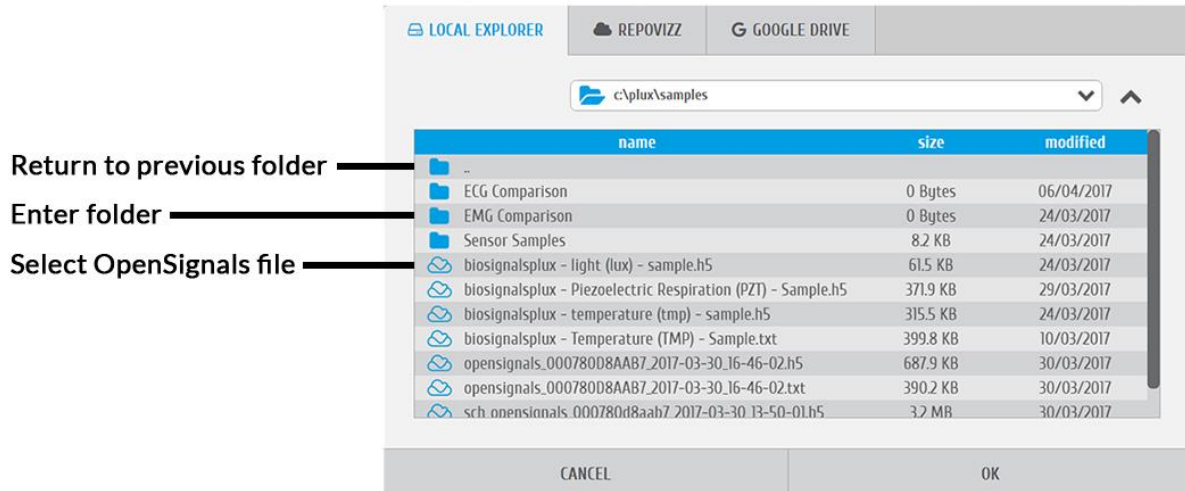


Figure 72: Open file dialog.

NOTE

Besides *OpenSignals (r)evolution* there are other 3rd party applications available which have been tested to work with PLUX devices and selected by our staff. *OpenSignals (r)evolution* can open, import, and visualize data acquired with these applications.

You can find all the available 3rd party applications on the following pages:

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

<http://bitalino.com/index.php/en/software>

3.2.2 Signal Visualization

The signal is visualized in a signal window, which displays all the channels which were acquired during a recording session (see Figure 73).

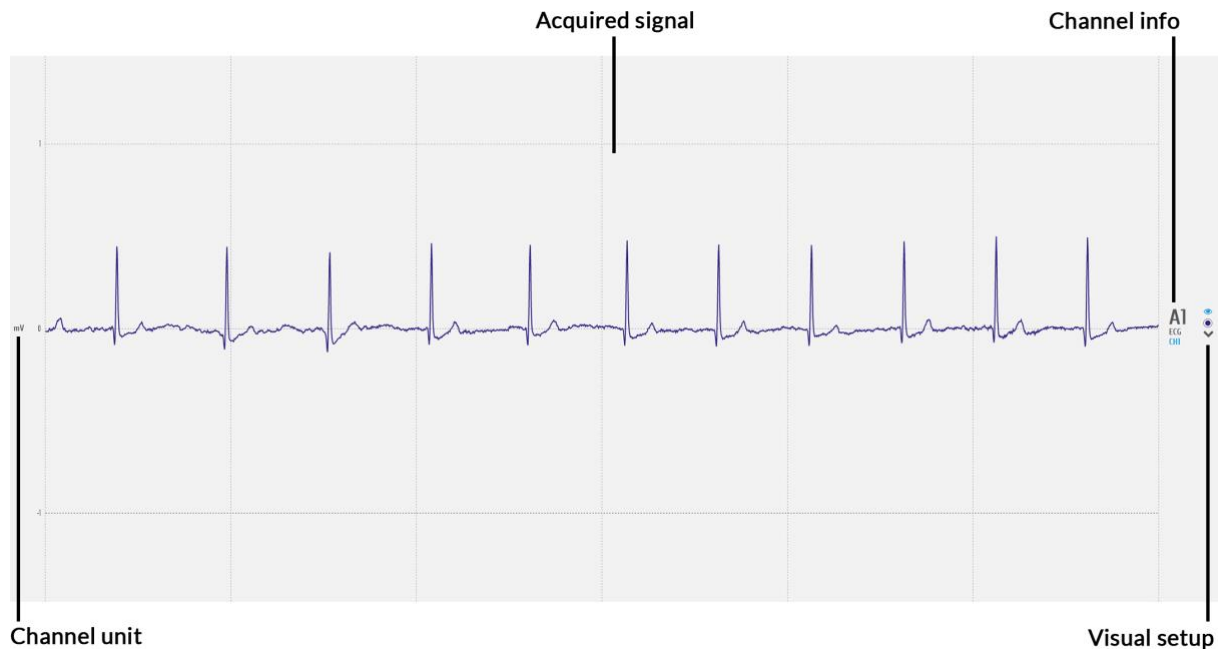


Figure 73: Signal visualization

In this window, there are several fields of information and configuration that let's you make some modifications on the displayed signals.

3.2.2.1 Channel info

The channel info provides information of the displayed channel (here: channel 1 of a biosignalsplux device; A1), the type of channel which has been configured before the acquisition was made (here: ECG) and the label set for this channel and sensor during the acquisition (here: CH1).

Changes of these indications have to be made when configuring your device before starting an acquisition. Please review and follow the instruction in section 2.2.4.6 *Channel Configuration* for more information on channel types, number, and labelling.

3.2.2.2 Channel unit

The channel unit displays the original physical unit of the acquired signal, if a selection of channel type has been made during the configuration process of your device. The channel unit varies from the type of sensor and selected sensor type (here: ECG signal displayed in mV). If no selection has been made, the default unit to be displayed is Volt (V).

Changes of these indications have to be made when configuring your device before starting an acquisition. Please review and follow the instruction in section 2.2.4.6 *Channel Configuration* for more information on channel types, number, and labelling.

3.2.2.3 Visual Setup

The visual setup allows you to modify the visualization of your signal (e.g. signal color) and to hide single channels, if their visualization is not required.

Additional functions to modify the visual setup of each channel can be accessed when hovering over each available channel (see

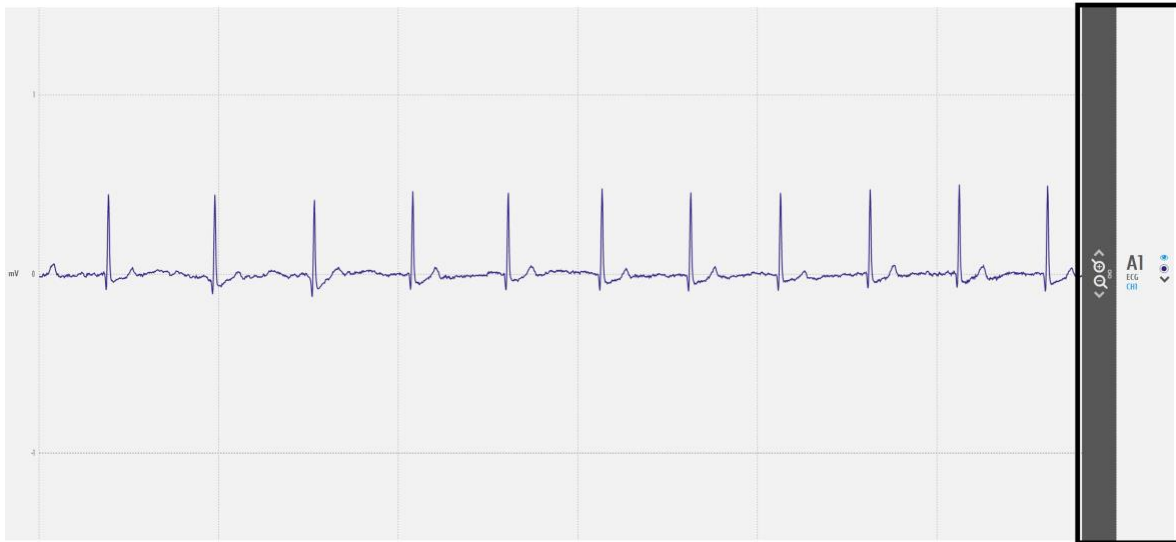


Figure 74: Visual setup options (black box).



Display channel in the overview window

Hides or displays the selected channel in the overview window at the bottom of the visualization mode (see 3.2.4.5 *Overview Window* for more information).



Signal color

Changes the color of the visualized signal. Click on this symbol to see all the available colors.



Hide channel

Click on this symbol to hide a single channel from the visualization mode. This feature is useful when the visualization of specific channels is not required at the moment. The hidden channel can be displayed again by selecting it in the information bar (see 3.2.2.3 *Visual Setup*).



Move baseline up

Moves the baseline of the selected channel up (incl. signal).



Move baseline down

Moves the baseline of the selected channel down (incl. signal).



Zoom in

Zooms into the selected channel.



Zoom out

Zooms out of the selected channel.



Link channels

Links channels of the same type to each other and adjusts the same visual setup to all linked channels (e.g. scale, offset).

3.2.3 Information Bar

In the information bar, information about the device which has been used for the selected acquisition is displayed (e.g. device logo, name or mac address, sampling rate) and all the hidden channels (signals which have been used during this acquisition but are not visualized at the moment).



Figure 75: Information bar.

Hidden channels (see Figure 75; here IO1 (digital input/output)) can be displayed in the visualization window again by clicking on the arrow next to a hidden channel.



Show channel

Activates selected channel to be displayed in the visualization window.

3.2.4 Control Bar

The following features and options can be accessed in the control bar:

- Time axis (x-axis; 1 in Figure 76)
- File information and access to open file dialog (2 in Figure 76)
- Access *OpenSignals* add-ons (3 in Figure 76)
- Multi-channel visualization modes (4 in Figure 76)
- Unhide hidden channels (5 in Figure 76)
- Overview window (x-axis adjustments; 6 in Figure 76)
- Return to *OpenSignals*' main interface

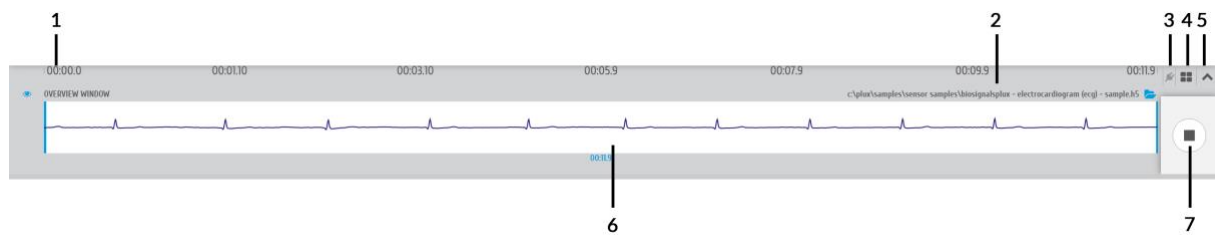


Figure 76: Control bar.

All needed features are explained on the following pages in more detail (except file information and access to open file dialog; see section 3.2.1 *Open OpenSignals Files*).

3.2.4.1 Time Axis

The x-axis provides the time information for the acquired signals. These values are not changeable. However, the time span which is displayed can be adjusted by scaling the x-axis in the overview window.

3.2.4.2 Access *OpenSignals* Add-ons

OpenSignals (r)evolution can be extended by signal-processing add-ons to extract meaningful information from specific signal and sensor types. All available add-ons can be accessed by using the following symbol in the control bar to open up the add-ons menu (see section 4 *Add-Ons* for more information and).



Add-ons

Displays all available offline add-ons for post-processing purposes.

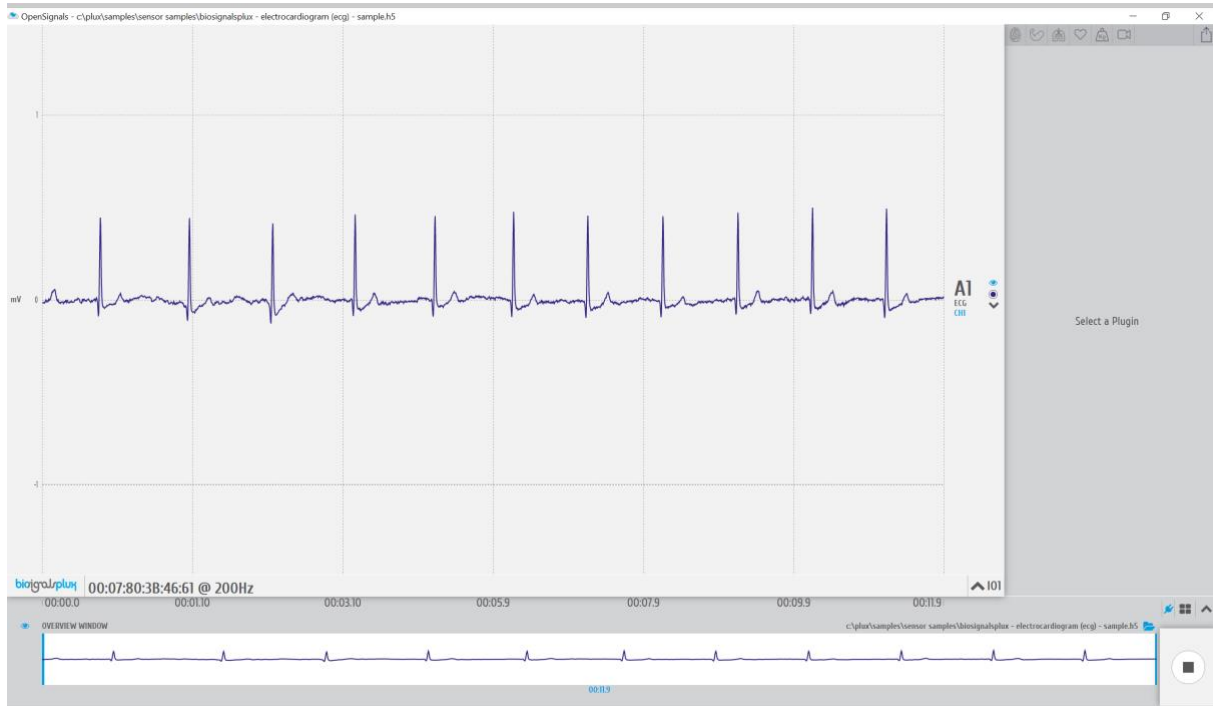


Figure 77: Add-ons menu.

3.2.4.3 Multi-channel Visualization Modes

OpenSignals (r)evolution offers two different channel visualization modes (see Figure 78). The first (default) mode displays all the channels stacked vertically in order of the channel number (see Figure 78, left visualization mode). The second type splits the visualization mode vertically in half, displaying half of the channels on the left side of the visualization window and the other half on the right side (see Figure 78, right visualization mode). This mode can be useful when visualizing multiple channels at the same time (e.g. using a 8-channel biosignalsplex).

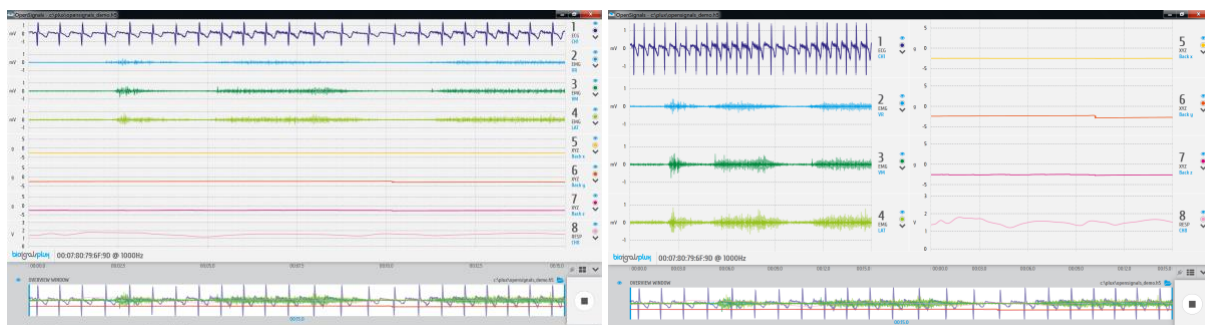


Figure 78: Channel visualization modes.



Multi-channel visualization modes

Switch between available multi-channel visualization modes.

3.2.4.4 Unhide Hidden Channels

By default, *OpenSignals (r)evolution* will display all the available channels and signals that are stored in a loaded *OpenSignals* file. As a permanent visualization of all available channels is

not always required, it is possible to hide the visualization of selected channels as described in section 3.2.2.3 *Visual Setup*.

All channels can be hidden or unhidden at once by clicking on the following symbols:



Unhide all channels

Unhides all hidden channels, resulting in a visualization of all available channels and signals.



Hide all channels

Hides all channels.

3.2.4.5 Overview Window

The overview window gathers and displays all available signals in the bottom frame of the signal visualization mode. This window serves to change the displayed time interval of the signals in the signal visualization window (adjustment of the x-axis).

To change the displayed time interval, click on the left blue vertical bar in the overview window and drag them until your preferred time interval is displayed below the white frame in the overview window.

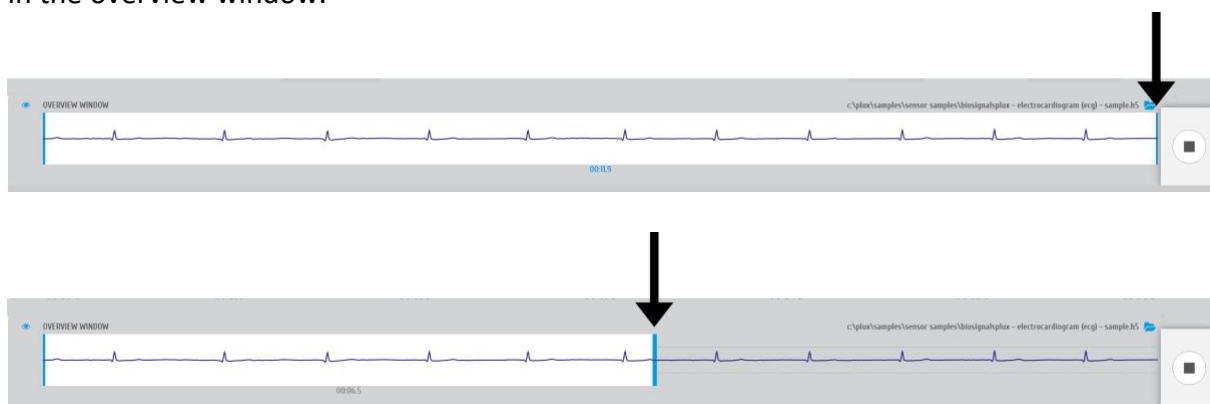


Figure 79: Changing the visualized time interval in the overview window.

Note, that the signals will be displayed in the overview window in the color which has been selected for the signals/channels in the visualization window.

If not needed, the overview window can be hidden by clicking on the following symbol placed to the left of the overview window. When hidden, the overview window can be displayed by clicking on this symbol again.



Hide/Show overview window

Hides the overview window when it is displayed and displays the overview window when it is hidden.

3.2.4.6 Return to the Main Interface

The signal visualization mode can be exit at any time by clicking on the square symbol at the bottom right of the signal visualization mode. Exiting this mode will result in returning to the main screen.



Exit signal visualization mode

Exits signal visualization mode and return to the main screen.

3.2.5 Visualization of Digital Input and Output Signals

Digital inputs and outputs from your devices can be controlled during signal acquisition by following the instructions in 3.1.2.3 *Digital Inputs & Outputs*. The digital input and output signals are visualized with all the other acquired signals in the signal visualization mode, with each digital input and output being displayed in an individual channel (see Figure 80).

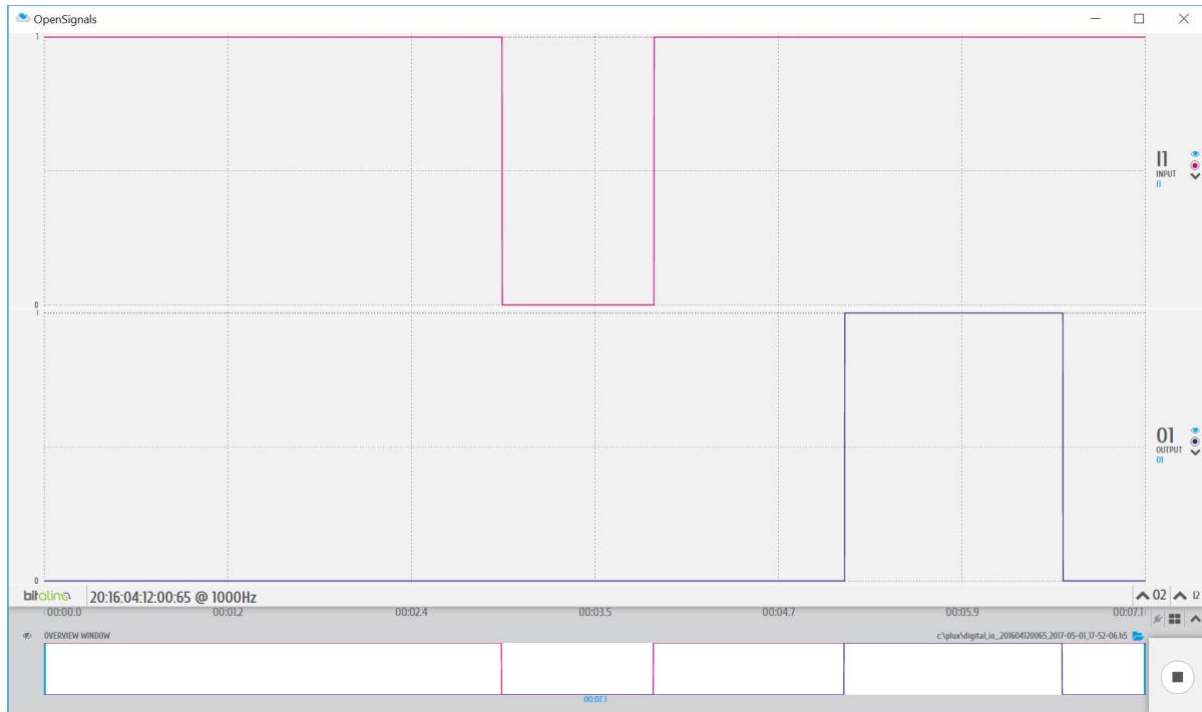


Figure 80: Visualization of digital input (I1) and output (O1) signals.

3.3 Data Logging

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

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

- biosignalsplux Professional
- biosignalsplux Force
- MotionBAN
- RespiBAN Professional

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

Devices with internal memory are displayed with an additional *SCHEDULE* button at the end of their device panels (see Figure 81). These devices are compatible with all data logging features.

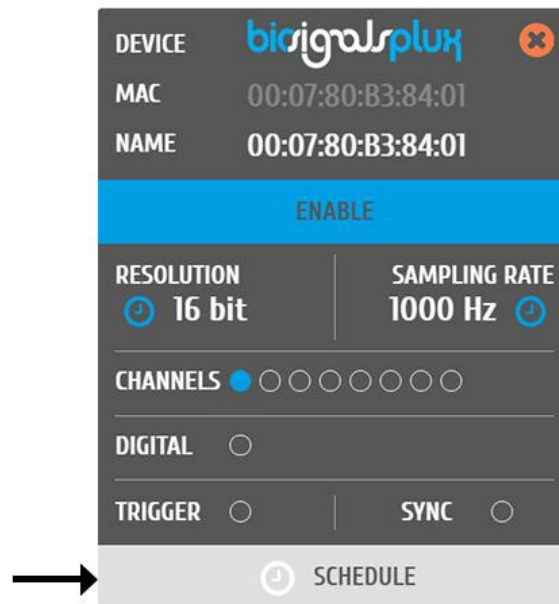


Figure 81: Data logging feature for devices with internal memory.

3.3.1 Scheduling Offline Acquisitions

NOTE

Before scheduling offline acquisitions, we recommend to set up the device and channels first. To do so, configure your device to fit your set up and channel configuration according to the instructions in section 2.2.4 *Device Configuration* 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 81).

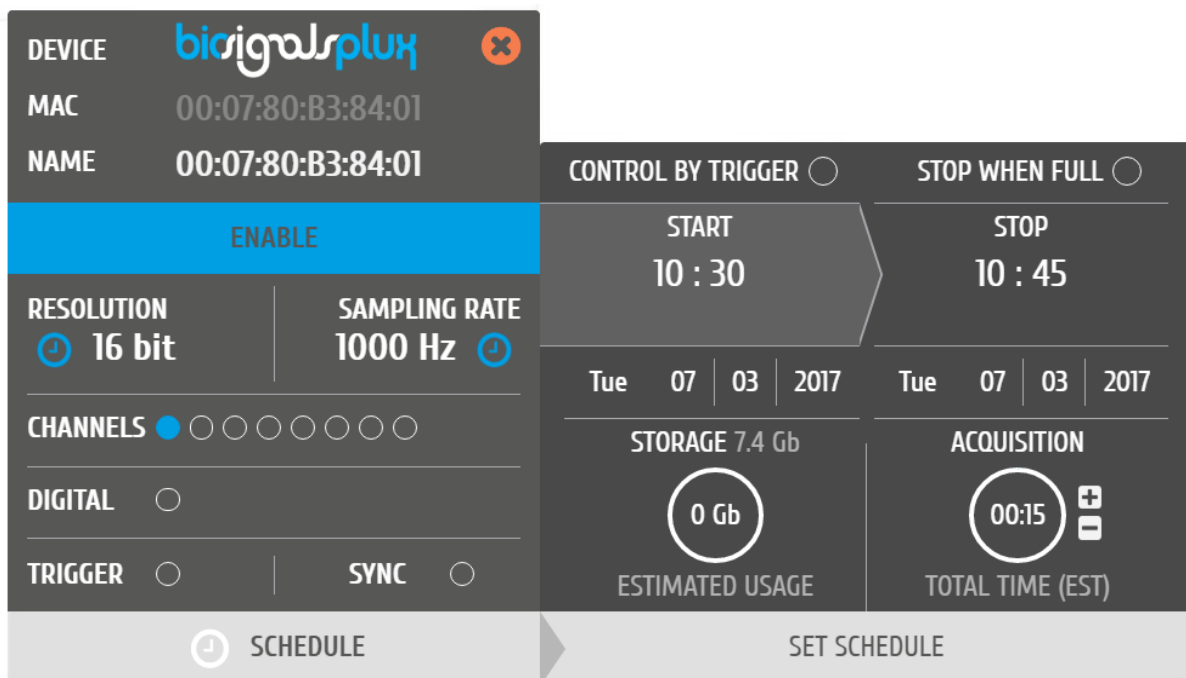


Figure 82: Scheduling panel.

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

NOTE

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

NOTE

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

NOTE:

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

To check if your device is acquiring data, check the LED information of your device as listed in chapter 5 *Advanced Device Configuration*.

3.3.1.1 Control by Trigger

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

3.3.1.2 Stop When Full

The *STOP WHEN FULL* option will stop your offline acquisition when the internal memory of your device has ran out of available memory. This function can both used with trigger-based or timer-based initiated offline acquisitions. If a fix time has been selected for the start of the acquisition, the estimated end of the acquisition will be calculated based on the available free memory and will be displayed in the *STOP* field of the scheduling panel (see Figure 83).

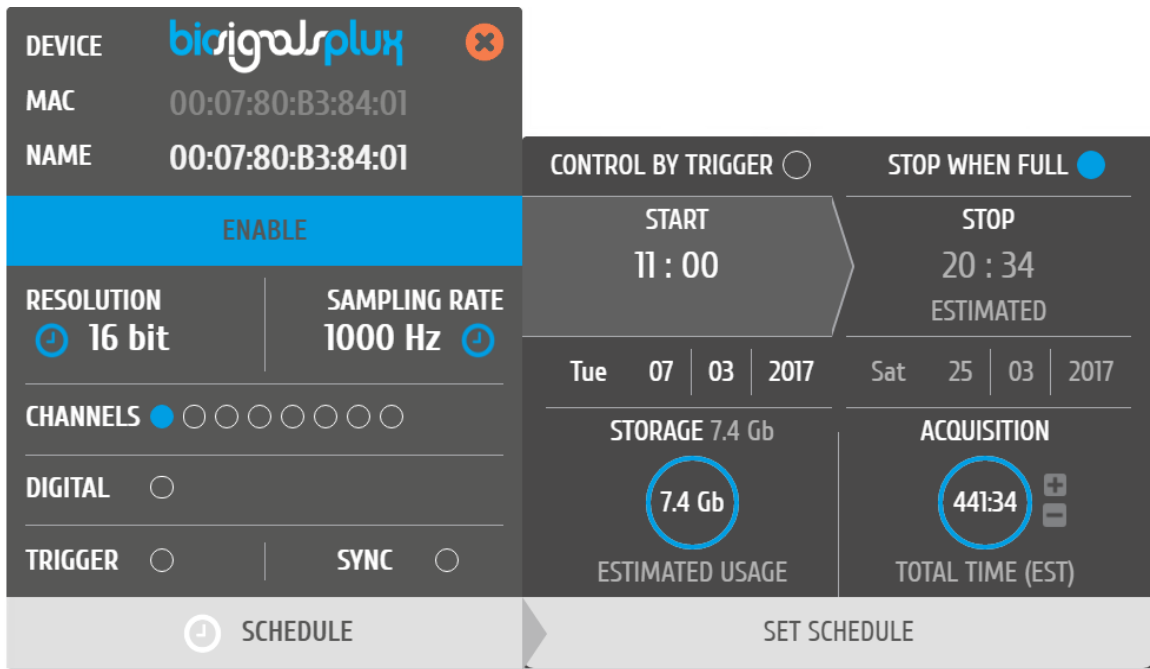


Figure 83: Scheduling panel displaying the estimated end of the acquisition.

3.3.1.3 Scheduling Start & End Times

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

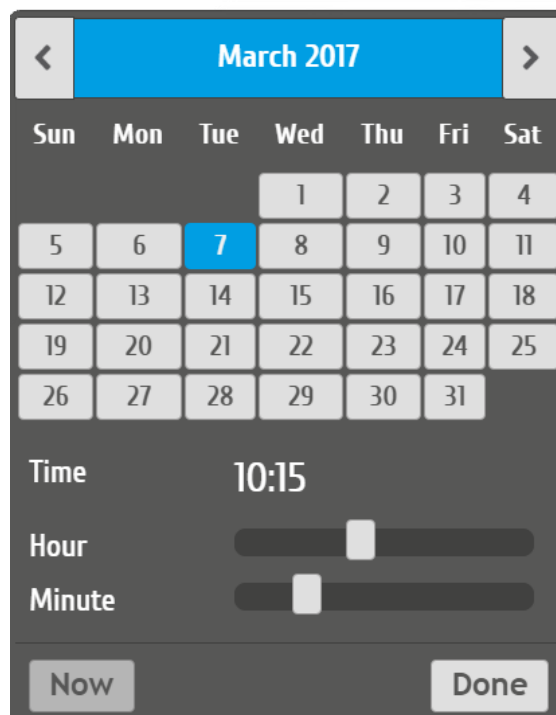


Figure 84: Time schedule for start and end points for offline acquisitions.

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.

3.3.1.4 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 83; here: Tuesday 19:00h).

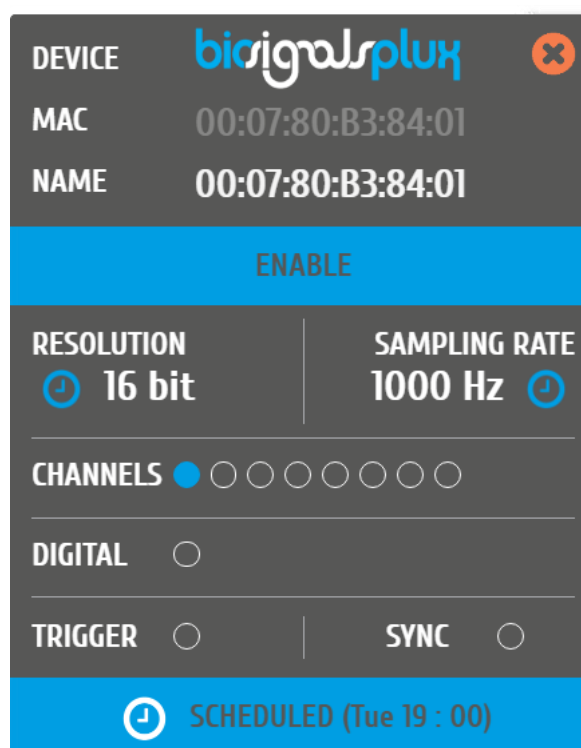


Figure 85: Device panel with a scheduled acquisition.

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.

3.3.2 Downloading Offline Acquired Data

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

- ④ 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.

3.3.2.1 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 85) 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.

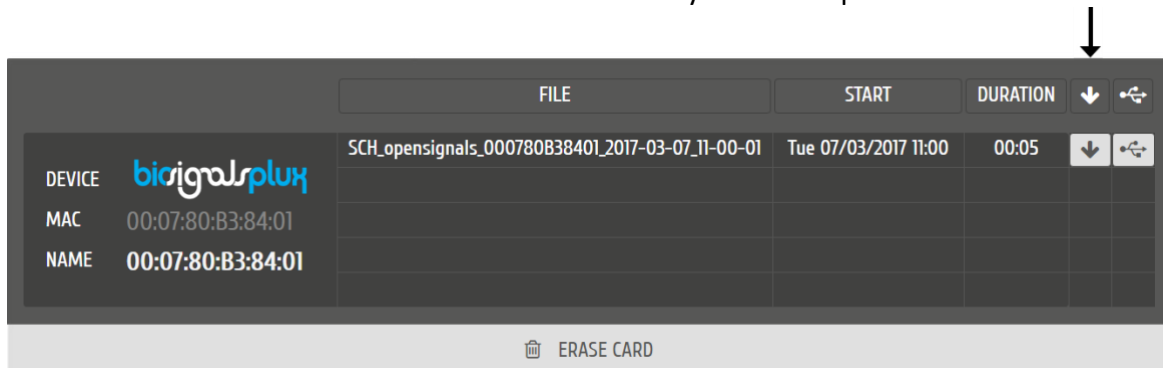


Figure 86: Downloading offline acquired data via Bluetooth.

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.

3.3.2.2 Download via Fast USB Data Transfer Cable

NOTE

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

biosignalsplux USB Adapter & fast USB data transfer cable:

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

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

Each offline acquisition creates its own file where the acquired data is stored. In the download panel, the files are listed with their file name (*FILE*) their start time (*START*) and their entire duration (*DURATION*). Click on the indicated USB symbol in a file’s row to download the selected file (see Figure 86) 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.

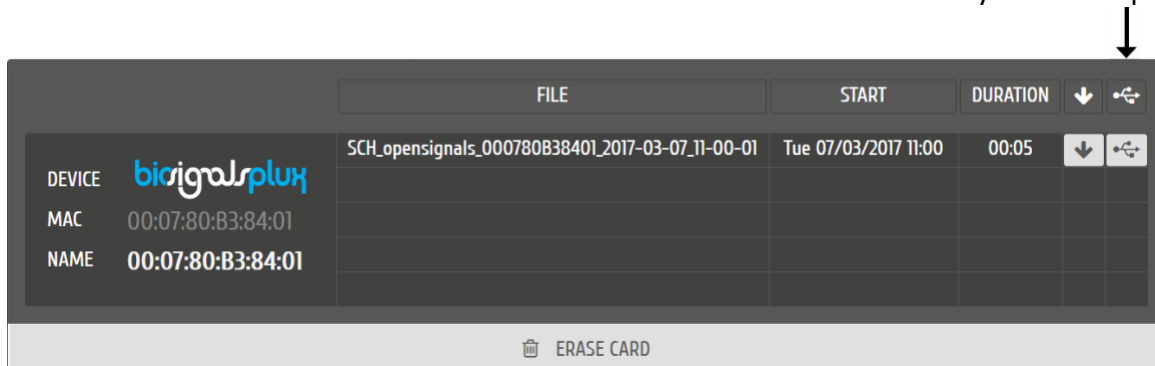


Figure 87: Downloading offline acquired data via USB.

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.

3.3.3 Deleting Offline Acquired Data

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

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.

3.4 Synchronization

One of *OpenSignals (r)evolution's* features is the possibility of synchronized multi-device data acquisitions. This feature allows to tether up to 3 8-channel biosignalsplux devices with each other using the biosignalsplux [sync-cables](#) and the [multi-sync splitter cable](#) to acquire signals from all devices simultaneously in a synchronized acquisition, preventing signal drifts between the single devices (time based differences) which could occur in non-synchronized long-time acquisitions.

NOTE

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

NOTE

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

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

3.4.1 Connecting Devices

NOTE

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

Connect the sync-cable to the digital ports of your devices. The digital port is the last input on the right side of the biosignalsplux device as marked in Figure 88. When connected, you devices should be connected as displayed in Figure 89.



Figure 88: Digital port of the 8-channel biosignalsplux.



Figure 89: biosignalsplux devices connected with a sync-cable.

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

3.4.2 Device Configurations in OpenSignals (r)evolution

Configure all your devices as needed by following the instructions in 2.2.4 *Device Configuration*. When done, enable all devices which will be used during the acquisition by clicking on the *ENABLE* field of each device, click on their device panels and activate the sync-function (*SYNC*; circle must be blue) if it is not activated. When done, your device panel should look similar to the one seen in Figure 90.

NOTE

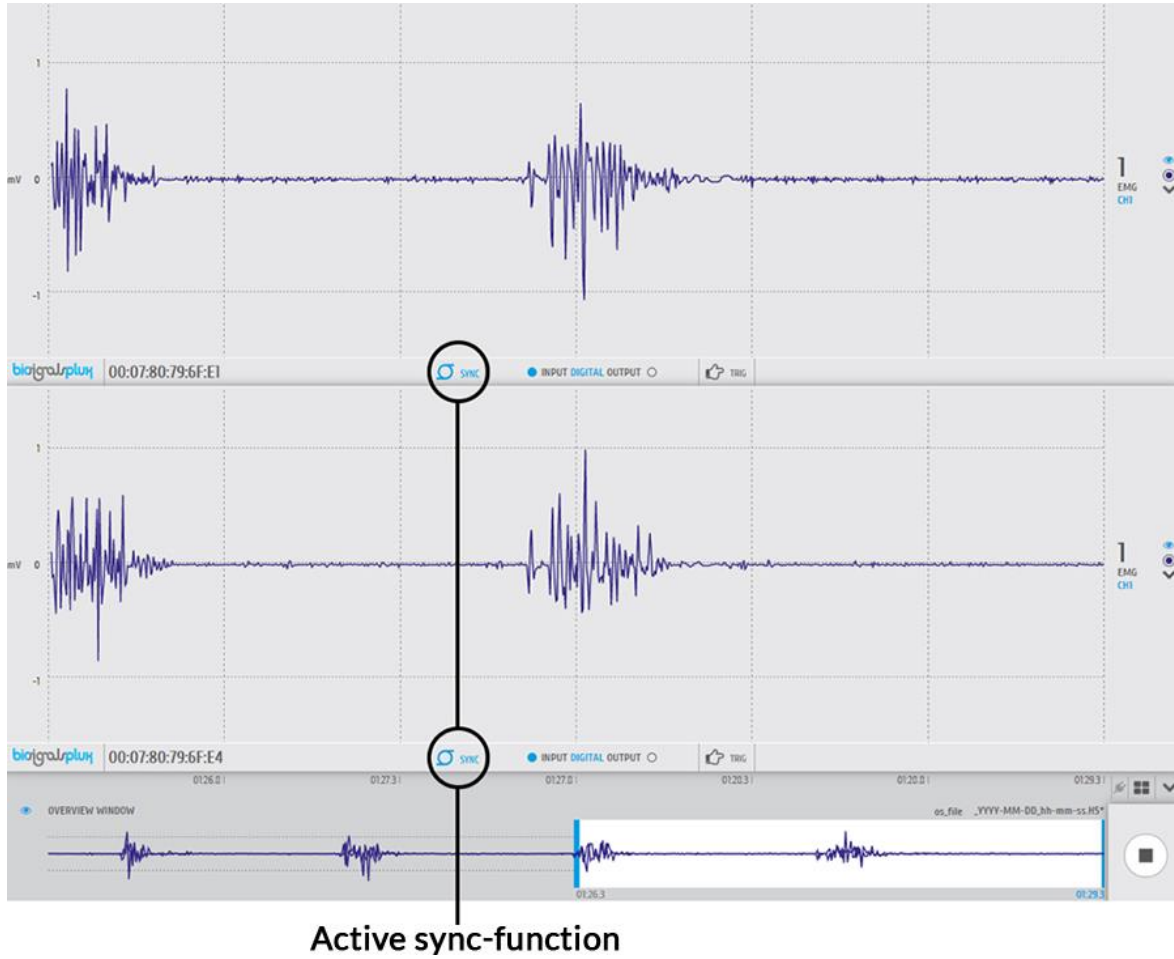
Variations in resolution, sampling rate, active channels, and/or trigger function of your configuration compared to the one displayed in Figure 90 will not influence your synchronized acquisition.



Figure 90: Activated sync-function.

When acquiring from several devices with a correctly set up synchronized acquisition, the sync-function symbol should be displayed in blue in the signal acquisition mode (see Figure 91).

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



Active sync-function

Figure 91: Synchronized acquisition with active sync-function.

3.5 Accessories

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

NOTE

biosignalsplux Accessories need to be connected to the 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).

3.5.1 Trigger

NOTE

See also 2.2.4.8 Trigger Options and 3.1.2.2 Trigger. For data logging acquisition see also 3.3.1.1 Control by Trigger.

3.5.1.1 Handheld Switch

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



Figure 92: Handheld switch.

How to connect your handheld switch to your biosignalsplux

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

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

Input devices, such as the handheld switch, do not require to be configured in *OpenSignals (r)evolution* if their intended use is to mark specific actions during an acquisition. In this case, their input state can be seen in *OpenSignals'* signal acquisition mode in the information bar located right below the acquired signals (see Figure 93; 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 93).





Figure 93: 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 94).

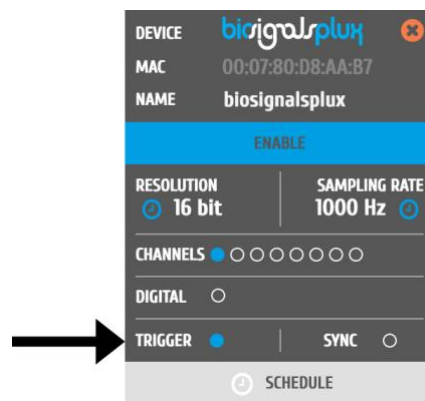


Figure 94: Trigger configuration.

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 95).



Figure 95: 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

3.5.1.2 Foot Switch

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



Figure 96: Foot switch.

How to connect your foot switch to your biosignalsplux

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

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 97).

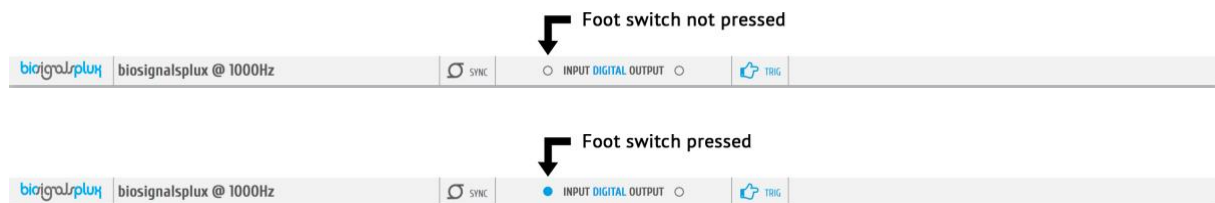


Figure 97: Digital input states.

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 98).

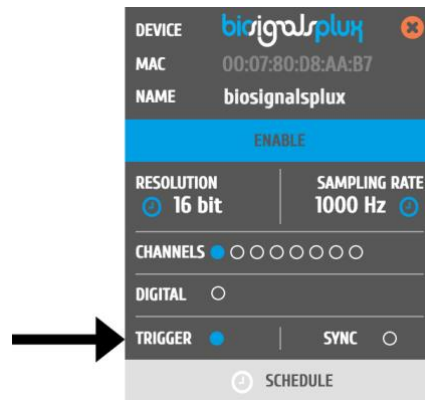


Figure 98: Trigger configuration.

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 99).



Figure 99: Trigger state.

3.5.2 Light-Emitting Diode (LED)

Note

See also 2.2.4.7 *Digital Output* and 3.1.2.3 *Digital Inputs & Outputs*.

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

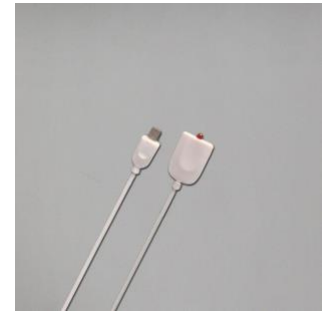


Figure 100: LED.

How to connect your accessory to your biosignalsplux

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

How to control your LED in OpenSignals (r)evolution

Output devices, such as the LED, do not require to be configured in *OpenSignals (r)evolution*. However, it is possible to select their initial state which can later be changed in the information bar of *OpenSignals'* real-time acquisition mode which is located right below the acquired signals (see Figure 102; 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 101).

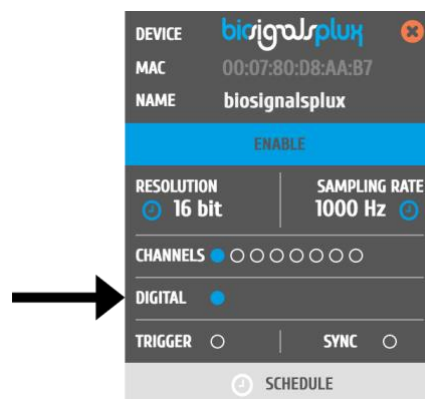


Figure 101: Initial state of the digital output (here: on).

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 102).

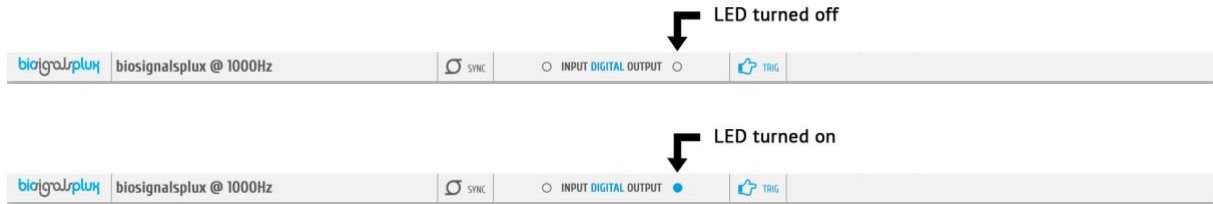


Figure 102: Digital output states for LED.

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.

For more information see section *4.12 Video Synchronization*.

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](http://biosignalsplux.com/datasheets/LED_Actuator_Datasheet.pdf)

3.5.3 Digital Synchronization Cable

Note

See also 3.4 *Synchronization*.

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



Figure 103: Sync cable & kit.

How to connect your accessory to your biosignalsplux

The digital synchronization cable needs to be connected to the digital ports of the devices that are being used for the multi-device acquisition (see 3.4 *Synchronization*).

How to configure synchronized acquisitions in OpenSignals (r)evolution

Open the *OpenSignals (r)evolution* device manager and select one of the devices you want to use for the multi-device acquisition. In the device's panel, click on the circle next to *SYNC* to turn on (blue circle) or off (empty circle) the synchronization function to synchronize the acquisition of your devices (see Figure 104). 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.

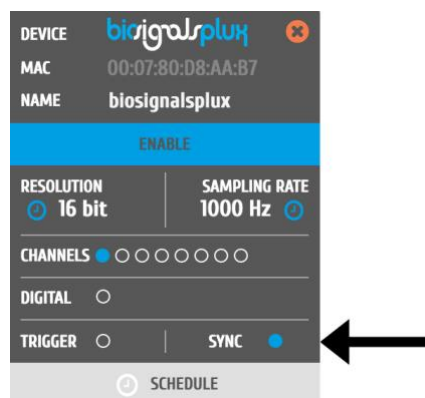


Figure 104: Activate synchronization feature.

3.5.4 Multi Sync Splitter

Note

See also 3.4 *Synchronization*.

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



Figure 105: Multi sync splitter.

How to connect your accessory to your biosignalsplux

The multi sync splitter needs to be connected to the digital port of one of the devices that are being used for the multi-device acquisition (see 3.4 *Synchronization*). When done, link the other device(s) with the multi sync splitter by connecting digital synchronization cable(s) (see 3.5.3 *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 106). 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.

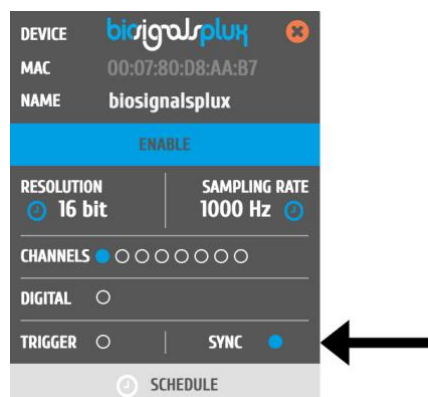


Figure 106: Activate synchronization feature.

4 Add-Ons

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

Real-time Add-on:

Add-ons process signals during real-time signal acquisitions. These add-ons are available in the real-time visualization mode. At the time being, the following add-ons of this type are available:



Event Emulation



Signal Statistics



Oximetry



Muscle Load



Export analysis reports

Post-processing Add-on:

Add-ons process signals after a finalized acquisition session. These add-ons are available in the signal visualization mode. At the time being, the following add-ons of this type are available:



Electrodermal Activity Events (EDA)



Electromyography Analysis (EMG)



Heart Rate Variability (HRV)



Respiration Analysis (PZT & RIP)



Video Synchronization



Muscle Load



Export analysis reports

Add-ons are not part of the free *OpenSignals(r)evolution software* and are either already included in some [biosignalsplux kits](#) and [wearables](#) or need to be purchased separately, with the *Event Emulation* and the *Signal Statistics* add-ons being exceptions as they come free with *OpenSignals (r)evolution*. However, it is possible to test add-ons on time limited signals before purchasing them.

4.1 Add-on Purchase & Activation

Purchasable add-ons can be bought in the *biosignalsplux* and *BITalino* webstore which can be accessed via the following links:

biosignalsplux

<https://store.plux.info/23-software-add-ons>

BITalino:

<https://store.plux.info/22-software-add-ons>

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

NOTE

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

NOTE

Add-ons are linked to your PLUX device. Therefore, it is possible to use them on any computer your device is connected to. For this, connect your device to the computer you would like to use and configure it in *OpenSignals* according to the instructions in section *2.2.4 Device Configuration*.

Add-ons which are included in kits are already activated by default and ready-to-use when you receive them; if this is not the case please contact our team (see *9.3 Contact & Support*).

4.2 Listing & Using Add-ons

Normally, all add-ons are activated and listed by default after a successful purchase. However, if your add-on is not listed in the signal visualization mode you have to activate the add-on the help interface (see Figure 107 and section *1.6.4 Activating & Deactivating Add-ons*).



Enable add-ons in the help interface.



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

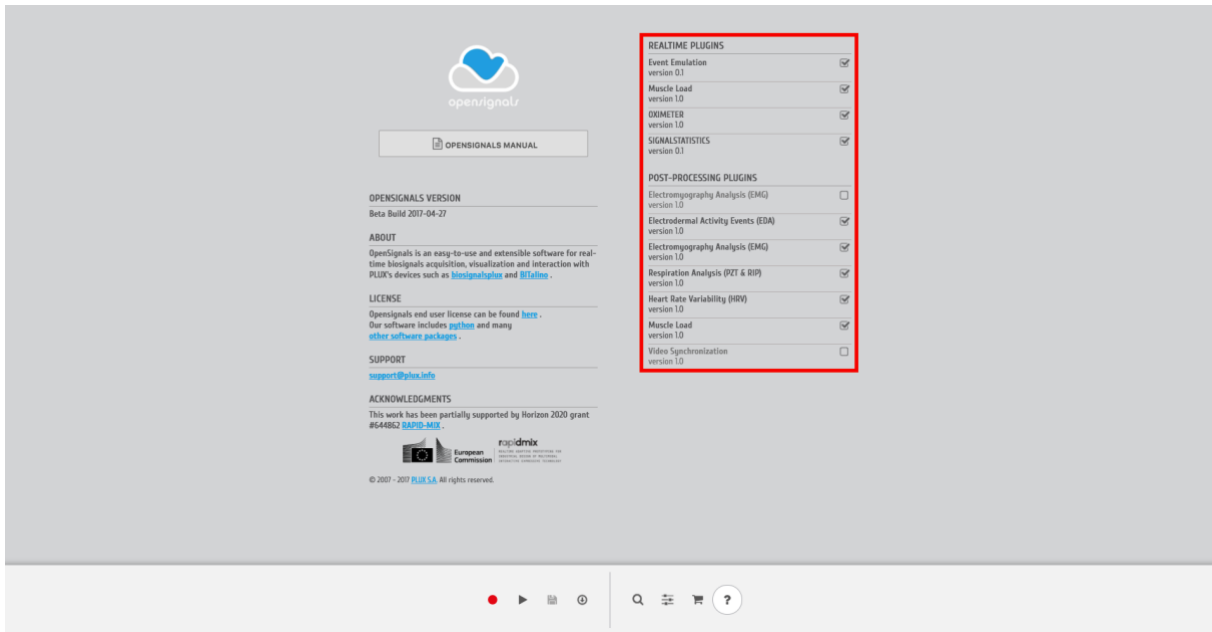


Figure 107: Activate add-ons in the help interface

Activated add-ons can then be selected in the respective modes. Real-time add-ons can be used in the signal acquisition mode (see 3.1 *Signal Acquisition Mode*), while visualization add-ons can be used in the signal visualization mode (see 3.2 *Signal Visualization Mode*). Click on the add-on of your choice to start using it the add-on.

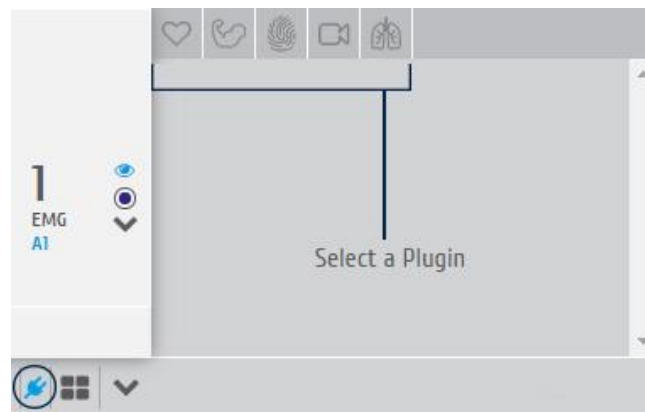


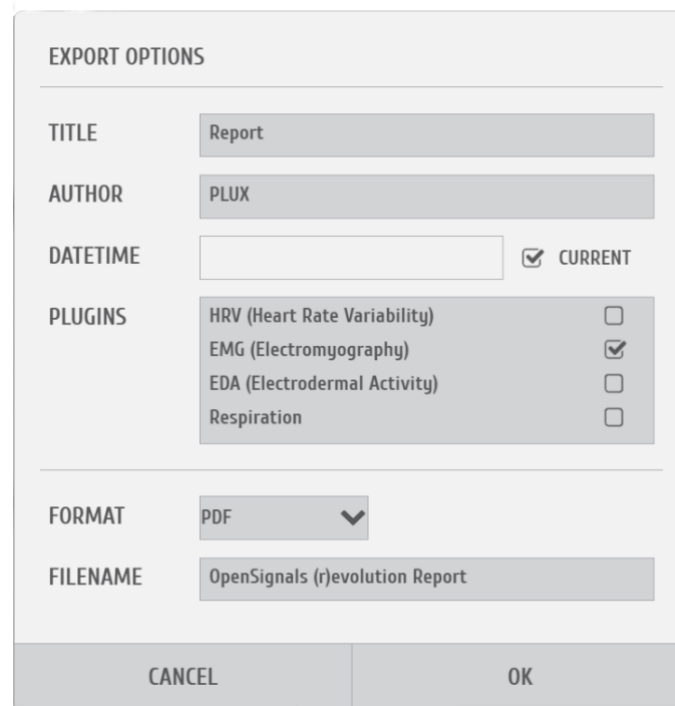
Figure 108: Add-on selection in the visualization mode.

4.3 Add-on Reports



Export generated add-on results into PDF or CSV file.

The results generated by OpenSignals (r)evolution add-ons can be exported to a PDF or a CSV file containing all the generated data. While PDF files are useful to display all the acquired signal processing results including diagrams, CSV files allow you to export all your files into a readable format which can then be imported into 3rd party software.



The screenshot shows a dialog box titled "EXPORT OPTIONS". It has several input fields and a list of plugins. The "TITLE" field contains "Report", "AUTHOR" contains "PLUX", and "FORMAT" is set to "PDF". The "PLUGINS" section lists HRV (Heart Rate Variability), EMG (Electromyography), EDA (Electrodermal Activity), and Respiration, with checkboxes next to each. The "EMG" checkbox is checked. The "CURRENT" checkbox is also checked. The "FILENAME" field contains "OpenSignals (r)evolution Report". At the bottom, there are "CANCEL" and "OK" buttons.

Figure 109: PDF report window.

FILE PROPERTIES

Insert the title & author information of the current acquisition and processing session into the *TITLE* and *AUTHOR* fields. This information will be displayed on the first page of the PDF file.

The first page will also contain general information about the selected OpenSignals file, information about the devices used during the acquisition and information about the acquisition configuration containing the sampling rate, sampling resolution and active channels.

ADD-ONS

Select the add-ons for which the generated results should be exported into the PDF/CSV file. Make sure you have used the selected add-ons before for processing your signals, otherwise the generated PDF/CSV files will list no information about the selected and non-used plugins.

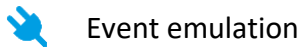
FORMAT

The export function offers the export of files into PDF or CSV file. The PDF file will contain all the add-on generated results and diagrams as well as general information about the acquisition settings (e.g., *OpenSignals (r)evolution* version, date time, duration, used devices, etc.). The CSV file will only contain the generated data without the diagrams and all the general information. In this case, the CSV contains headers which are placed within curved parenthesis ({...}) providing general information and about processed file/signal and about the extracted values. These values are always listed right below a given header ({...}).

FILENAME & PATH

Select the preferred filename of the new file. The file can be found in your Google Chrome's pre-set download folder after the successful export.

4.4 Event Emulation



Event emulation

DESCRIPTION

The event emulation add-on allows you to apply specific conditions which trigger different actions of your device and/or computer based on amplitude values of the signals which are being acquired in real-time. The conditions create rules for when a specific action is triggered as for exemplifying triggering digital outputs to control LEDs whenever a sensor signal has surpassed or fallen below set thresholds.

This add-on is a real-time add-on. It is only available in the signal acquisition mode (see 3.1 *Signal Acquisition Mode*).

This add-on is included in *OpenSignals (r)evolution* and does not have to be purchased additionally.

4.4.1 Hardware Configuration

This add-on works with every kind of signal being acquired with PLUX devices. It is not restricted to any specific sensor.

4.4.2 Add-on Configuration

Figure 110: Event emulation add-on.

DEVICES & CHANNELS - CONDITIONS

It is possible to set several conditions and to apply them on several devices and signals during an acquisition session. To configure which conditions should be applied on which signal, select the one of the devices you are using and to which a condition should apply by selecting the MAC-address of the device in the dropdown menu under *DEVICE*. When done, select the channel of the signal you want to apply the condition.

THRESHOLD

The threshold allows you to set your condition by defining threshold values which trigger or do not trigger any actions. For this, it is needed to insert a value to at least one of the two available fields. The available configuration possibilities are listed in Table 1.

THRESHOLD VALUE FIELDS		Action triggered when...
LOW (unit)	HIGH (unit)	
Value	-	... signal values fall below the given value in LOW (unit).
-	Value	... signal values surpass the given value in HIGH (unit).
Lower Value	Higher Value	... signal values lie between the lower and the higher value.
Higher Value	Lower Value	... signal values fall below the given higher value in LOW (unit) and surpass the lower value in HIGH (unit).

Table 1: Threshold definitions to trigger actions.

To remove specific frequencies which could influence the signal, your conditions and therefore falsely trigger selected output actions (e.g. 50Hz noise), it is possible to enter specific frequency values into the *REJECTION BAND* field. The indicated frequency will then be ignored for all condition related processing steps.

For cases in which it is not needed to trigger any output action at every time during which the signals meet the configured conditions, it is possible to set an alert interval which will mute the output actions for a specified time after an output has been triggered. For instance, if after a triggered output action every following output action of the same condition can be ignored within the next 5 seconds, it is possible to specify this behavior by inserting this time into the *ALERT INTERVAL (S)* field.

OUTPUT & ACTIONS

The output allows you to configure the action which should be performed whenever the selected signal meets your defined condition. It is possible to choose between a keyboard event, mouse event or digital output.

The keyboard event allows you to select one of the available keyboard actions (e.g. emulation of space bar pressed) or to set a specific key of your choice which should be emulated (virtually pressed). To set a specific key, select *Keyboard Key* in the dropdown menu under *OUTPUT* and enter the key of your preference into the *KEY* field.

The mouse event allows you to select one of the available mouse actions (e.g. emulation of left button pressed). To set a specific mouse action, select one of the available options below *Mouse Event* in the dropdown menu under *OUTPUT*.

The digital output options allows you to turn on any of the available digital outputs of your PLUX devices (e.g. turning on a LED when the defined condition is met). For this, select the digital output which should be used for this condition.

If you want to trigger several outputs with the same condition, it is needed to add a new condition with the same configuration but a different output action.

CONDITION MANAGEMENT

If you have finished configuring your condition, click on *APPLY* to apply the condition. If you need to add new conditions or to remove an existing condition, click on *ADD CONDITION* to add a new condition to your signals or on *REMOVE CONDITION* to remove existing conditions. Note, that removed conditions cannot be restored.

4.5 Signal Statistics



Signal statistics extracts statistical time based information from all active channels.

DESCRIPTION

This add-on extracts time-based features from all active acquiring channels in real-time. It provides useful information such as the minimum and maximum values of each channel as also the mean, median, root mean square values and the residual sum of squares.

This add-on is a real-time add-on. It is only available in the signal acquisition mode (see 3.1 *Signal Acquisition Mode*).

4.5.1 Hardware Configuration

This add-on works with every kind of signal being acquired with PLUX devices. It is not restricted to specific sensors.

4.5.2 Add-on Configuration


	Min	Max	Mean	Median	↑↓	RMS	RSS
1	-0.10	0.10	0.01	0.01	0.04	0.20	0.04
2	502.00	521.00	510.89	511.00	2.45	19.00	510.89
3	3.00	5.00	3.63	4.00	0.51	2.00	3.67

Figure 111: Signal statistics add-on.

This add-on does not require any configuration. It will automatically provide statistical information as soon as it has been selected in the signal acquisition mode for all actively acquiring channels in a table. The respective channel number is displayed in the first column of the table (here: 1,2,3).

This add-on provides the minimum and maximum values of each channel as also the mean, median, root mean square values and the residual sum of squares.

4.6 Oximeter

 Computes and displays the oxygen saturation and beats per minutes.

DESCRIPTION

This add-on uses SpO2 sensor data from the *biosignalsplux* SpO2 sensor to estimate the saturation level in the blood with +/- 2% accuracy compared to a medical sensor. Additionally, this add-on analyses all the acquired sensor data and provides BPM values in real-time.

This add-on is a real-time add-on. It is only available in the signal acquisition mode (see 3.1 *Signal Acquisition Mode*).

This add-on is not included in *OpenSignals (r)evolution* and must be purchased additionally.

4.6.1 Hardware Configuration

The oximeter add-on processes sensor data acquired with one of the following sensors:

biosignalsplux SpO2 sensor:

<https://store.plux.info/professional-sensors/391-spo2.html>

biosignalsplux SpO2 sensor with finger clip:

<https://store.plux.info/professional-sensors/382-spo2.html>

Firmware requirements

The SpO2 sensor requires a specific *biosignalsplux* firmware version (v.3.4) to work. Please follow the instructions in chapter to learn how to check the current firmware version of your device and to upgrade or downgrade the firmware to version 3.4. if another version is currently being used on your device.

You can download the correct firmware here (v.3.4 for SpO2 & fNIRS):

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

After checking and, if required, downgrading or upgrading your device's firmware, remove your device from the *OpenSignals (r)evolution* device manager and your computer's Bluetooth list and reconnect your device inside *OpenSignals (r)evolution*. If the firmware change has been successfully, your device should now be displayed with an orange *biosignalsplux* in your device manager (see Figure 112).

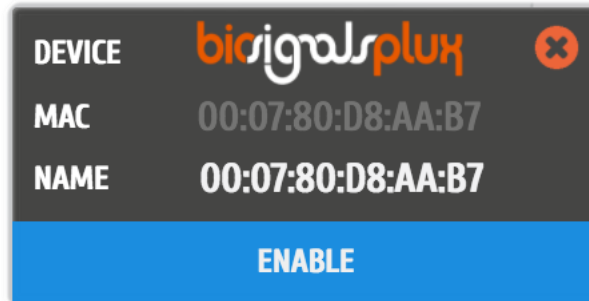


Figure 112: biosignalsplux device panel with firmware 3.4.

How to connect your sensor to your biosignalsplux

The SpO2 sensor has 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

4.6.2 Add-on Configuration

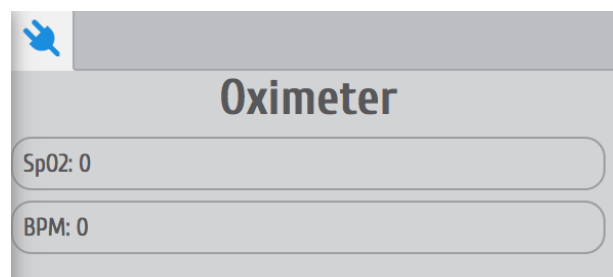


Figure 113: Oximeter add-on.

This add-on does not require any configuration. It will automatically provide the estimated oxygen saturation level in the *SpO2* field and the calculated BPM in the *BPM* field in real-time based on sensor data of the SpO2 sensor.

4.7 Muscle Load



Online and offline muscular load analysis add-on for ergonomic applications

DESCRIPTION

This add-on evaluates the muscular load that the muscles are subjected during a normal work day in real-time and after signal acquisition sessions. It measures the static, median and high intensity levels and displays the amplitude probability density function which helps detecting whether the worker is working within ranges that are safe or risky.

This add-on works both offline and online. It is available in the signal visualization mode (see *3.2 Signal Visualization Mode*) and in the signal acquisition mode (see *3.1 Signal Acquisition Mode*).

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

4.7.1 Hardware Configuration

The Muscle Load add-on processes EMG sensor data acquired with one of the following sensors:

biosignalsplux EMG Sensor:

<https://store.plux.info/sensors/283-electromyography-emg-820201201.html>

biosignalsplux MuscleBAN:

<https://store.plux.info/biosignalsplux-wearables/372-muscleban.html>

BITalino EMG Sensor:

<https://store.plux.info/bitalino-sensors/8-electromyography-emg-sensor.html>

The channel(s) you have one of these sensors connected to have to be configured properly before starting the acquisition. To do so, follow the device configuration instruction as described in *2.2.4 Device Configuration*. During the configuration process make sure to select the channel your EMG sensor is connected to and to set the channel configuration to *EMG* (see *2.2.4.6 Channel Configuration*).

4.7.2 Add-on Configuration

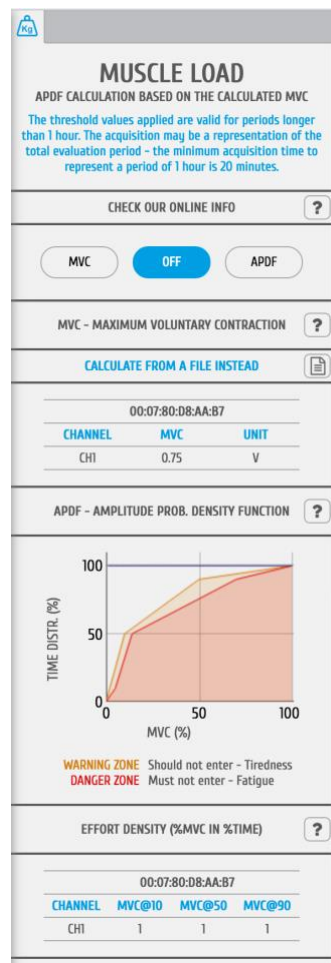


Figure 114: Muscle Load add-on.

DEVICES & CHANNELS

The Muscle Load add-on processes all available and active channels.

Active channels are all channels which have not been hidden and are therefore visualized in the signal visualization mode (see 3.2 *Signal Visualization Mode*, 3.2.4.4 *Unhide Hidden Channels* and 3.2.2.3 *Visual Setup*).

Make sure you have followed the instructions on 4.9.1 *Hardware Configuration* for the add-on to be able to recognize your EMG channels.

MVC – MAXIMUM VOLUNTARY CONTRACTION

At the beginning of each acquisition it is needed calibrate the add-on in order for it to provide reliable data. To do so, click on the *MVC* button (maximum voluntary contraction) and let the subject contract the muscle which is being monitored to its maximum. Make sure the muscle can be contract without any restrictions for the calibration to be done properly. This contraction will provide the value of the maximum possible contraction of the muscle. This value will be the reference point for the signal acquisition and processing. Each channel's MVC value are listed in the table below *MVC – MAXIMUM VOLUNTARY CONTRACTION*.

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

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

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



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

APDF – AMPLITUDE PROBABILITY DENSITY FUNCTION

After this acquiring the MVC, click on the *APDF* button to start the amplitude probability density function. This function calculates the cumulative percentage histogram of the enveloped data in terms (%) of the MVC and displays if the muscle load that the muscle(s) are subjected during the current task (represented by the blue lines in the graph) are causing muscle tiredness (see *WARNING ZONE* area in Figure 114) or muscle fatigue (see *DANGER ZONE* area in in Figure 114). Low to no muscle load will shift the blue line to the top left corner of the graph, will increasing muscle load and muscle load over duration will shift the graph into the warning and danger zones.

EFFORT DENSITY (%MVC IN %TIME)

This function displays the cumulated effort in terms (%) of the MVC at 10, 50 and at 90% of the time (blue lines on chart) and displays all values of all devices and sensors in a table.

4.8 Electromyography (EMG) Analysis



Electromyography Analysis

DESCRIPTION

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

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode (see 3.2 *Signal Visualization Mode*).

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

4.8.1 Hardware Configuration

The EMG analysis add-on processes sensor data acquired with one of the following sensors:

biosignalsplux EMG Sensor:

<https://store.plux.info/sensors/283-electromyography-emg-820201201.html>

biosignalsplux MuscleBAN:

<https://store.plux.info/biosignalsplux-wearables/372-muscleban.html>

BITalino EMG Sensor:

<https://store.plux.info/bitalino-sensors/8-electromyography-emg-sensor.html>

The channel(s) you have one of these sensors connected to have to be configured properly before starting the acquisition. To do so, follow the device configuration instruction as described in 2.2.4 *Device Configuration*. During the configuration process make sure to select the channel your EMG sensor is connected to and to set the channel configuration to *EMG* (see 2.2.4.6 *Channel Configuration*).

4.8.2 Add-on Configuration



Figure 115: EMG add-on.

DEVICES & CHANNELS

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

Additionally, it can be selected whether the channels units should be set to microvolt or millivolt in the *UNIT* dropdown menu.

ASSIGN DIGITAL TRIGGER

The processing interval selects the time interval of the EMG data that is to be processed. It can be changed by manually inputting the start and end point of the acquisition session into the time fields in the configuration window or by changing the size of the visualization interval in the overview window.

ASSIGN DIGITAL TRIGGER

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

The *FIND ACTIVATIONS FROM DIGITAL ON TO DIGITAL OFF* option will find all activations within the time frames where digital inputs have been received, for example, during the time frame a pushbutton has been being pressed (see also *3.5.1 Trigger*).

The *FIND ACTIVATIONS FROM DIGITAL ON TO ... SEC* will find all activations within the specified duration after the first digital inputs received, for example, beginning at the moment a pushbutton has been pressed (see also *3.5.1 Trigger*).

ADVANCED OPTIONS - Filters

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

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

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

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

ADVANCED OPTIONS – Process X Channel

This option allows you to apply the statistical algorithms of this add-on to a selected channel X within the same time intervals of another channel without any activation dependency of channel X. The add-on will search for activations on a selected EMG channel (click on the channel to select) and analyze the selected channel X at the same time intervals where activations have been found in the selected EMG channel even if there are no activations or activation triggering activities within these time intervals in channel X (e.g. muscle is relaxed in during this interval).

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

MCV – MAXIMUM VOLUNTARY CONTRACTION

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

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

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



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

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

MUSCLE ACTIVATION RESULTS

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

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

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

4.9 Electrodermal Activity (EDA) Events



Computes overall statistics and basic spectral analysis from EDA sensor data

DESCRIPTION

Electrodermal responses are characterized as phasic changes in the skin conductance, and associated with the sympathetic nervous system activation. This plugin has been designed to compute overall statistics, basic spectral analysis, and extract typical event-related phasic features from Electrodermal Activity (EDA) sensor data.

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode (see 3.2 *Signal Visualization Mode*).

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

4.9.1 Hardware Configuration

The EDA analysis add-on processes sensor data acquired with one of the following sensors:

biosignalsplux EDA Sensor:

<https://store.plux.info/sensors/280-electrodermal-activity-eda.html>

BITalino EDA Sensor:

<https://store.plux.info/bitalino-sensors/11-electrodermal-activity-eda-sensor.html>

The channel(s) you have one of these sensors connected to have to be configured properly before starting the acquisition. To do so, follow the device configuration instruction as described in 2.2.4 Device Configuration. During the configuration process make sure to select the channel your EDA sensor is connected to and to set the channel configuration to *EDA* (see 2.2.4.6 *Channel Configuration*).

4.9.2 Add-on Configuration

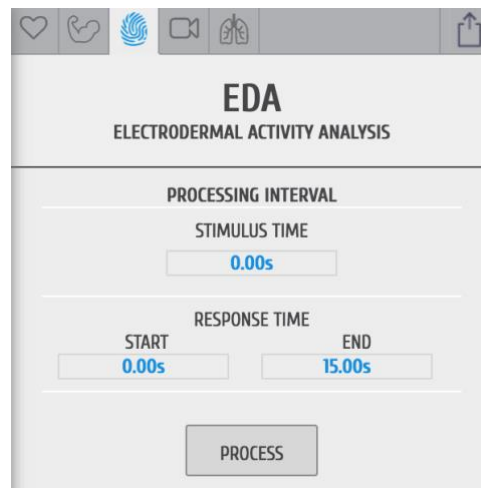


Figure 116: EDA analysis add-on configuration.

DEVICES & CHANNELS

The EDA analysis add-on processes all available and active EDA channels. Active channels are all channels which have not been hidden and are therefore visualized in the signal visualization mode (see 3.2 *Signal Visualization Mode*, 3.2.4.4 *Unhide Hidden Channels* and 3.2.2.3 *Visual Setup*).

Make sure you have followed the instructions on 4.9.1 *Hardware Configuration* for the add-on to be able to recognize your EDA channels.

STIMULUS TIME

Input the time at which the test person has experienced any external stimulus during your experiment. The input time in this field will mark the stimulus in the acquired signal.

RESPONSE TIME

The response time interval will set the time span of the EDA signal data to be processed after the external stimulus. This add-on will therefore process all the data that falls within the response time interval after the set stimulus time.

4.10 Heart Rate Variability (HRV) Analysis



HRV analysis add-on

DESCRIPTION

Heart Rate Variability (HRV) 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 Electrocardiography (ECG) or Blood Volume Pulse (BVP) sensor data. All the algorithms were implemented according to the "*Standards of Measurement, Physiological Interpretation, and Clinical Use*" devised by the joint European Society of Cardiology and North American Society of Pacing Electrophysiology task force.

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode (see 3.2 *Signal Visualization Mode*).

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

4.10.1 Hardware Configuration

The EMG analysis add-on processes sensor data acquired with one of the following sensors:

biosignalsplux ECG Sensor:

<https://store.plux.info/sensors/277-electrocardiogram-ecg.html>

biosignalsplux BVP Sensor:

<https://store.plux.info/sensors/271-blood-volume-pulse-bvp.html>

BITalino ECG Sensor:

<https://store.plux.info/bitalino-sensors/10-electrocardiography-ecg-sensor.html>

We recommend to configure the channel(s) you have one of these sensors connected to have properly before starting the acquisition. To do so, follow the device configuration instruction as described in 2.2.4 *Device Configuration*. During the configuration process make sure to select the channel your ECG sensor is connected to and to set the channel configuration to *ECG* or, if using the BVP sensor, set the channel to configuration to *BVP* respectively (see 2.2.4.6 *Channel Configuration*).

4.10.2 Add-on Configuration

The screenshot shows the HRV analysis configuration interface. At the top, there is a navigation bar with icons for home, share, settings, heart, weight, video, and upload. Below this, the title 'HRV HEART RATE VARIABILITY ANALYSIS' is displayed. The configuration fields are as follows:

DEVICE	CHANNEL
00:07:80:79:6F:9D	1

PROCESSING INTERVAL

START (S)	END (S)
0.00	5.04

FILTER RR [NOISE BY VALUE]

RR MIN. (S)	RR MÁX. (S)
0.4	2

FILTER RR [NOISE BY WINDOW]

# RR INT. BEFORE AND AFTER	% WINDOW AVG. ACCEPTANCE
20	20

PROCESS

Figure 117: HRV analysis add-on.

DEVICE & CHANNEL

Select the MAC address of the device that was used for the signal acquisition. If only one device has been used for signal acquisition, the MAC address of the used device will automatically be selected (several MAC addresses will be displayed if several devices were used during the acquisition session). When done, select the channel of the ECG signal that is to be processed.

PROCESSING INTERVAL

The processing interval selects the time interval of ECG data that is to be processed. It can be changed by manually writing the start and end of the acquisition session into the time fields in the configuration window or by changing the size of the visualization interval in the overview window.

FILTER RR [NOISE BY VALUE]

This RR filter improves the R-peak detection by analyzing the R-peaks within a set time interval, by detecting the minimum R-peak value and the maximum R-peak value. This filter can be useful when analyzing ECG signals which have been acquired under heavy movement, where muscle activity can cause variations in R-peak heights.

For this, enter the time of both the start and ending point of the preferred interval into the *RR. MIN (S)* and *RR. MAX (S)* fields. Note, that short intervals may not provide enough data to

conduct a deep analysis. In this case, *OpenSignals (r)evolution* will issue a warning (“*Not enough NN Peaks for deeper analysis.*”; not enough beat-to-beat intervals found).

FILTER RR [NOISE BY WINDOW]

This RR filter improves the R-peak detection and signal processing by analyzing the noise within a set number of RR-intervals before and after each detected R-peak.

4.11 Respiration Analysis (PZT & RIP)



Respiration analysis add-on

DESCRIPTION

Respiratory data provide useful information about the breathing dynamics. Designed to work with Respiration (PZT) and Respiration (RIP) sensor data, this plugin is a convenient way to determine respiratory rate and other useful temporal and statistical parameters associated with the respiratory cycles.

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode (see 3.2 *Signal Visualization Mode*).

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

4.11.1 Hardware Configuration

The Respiration analysis add-on processes sensor data acquired with one of the following sensors:

biosignalsplux RIP Sensor:

<https://store.plux.info/sensors/317-respiration-rip.html>

biosignalsplux PZT Sensor:

<https://store.plux.info/sensors/316-respiration-pzt.html>

RespiBAN Explorer:

<https://store.plux.info/biosignalsplux-wearables/312-respiban-explorer.html>

RespiBAN Researcher:

<https://store.plux.info/biosignalsplux-wearables/314-respiban-researcher.html>

RespiBAN Professional:

<https://store.plux.info/biosignalsplux-wearables/313-respiban-professional.html>

BITalino PZT Sensor:

<https://store.plux.info/bitalino-sensors/40-respiration-pzt-sensor.html>

We recommend to configure the channel(s) you have one of these sensors connected to have properly before starting the acquisition. To do so, follow the device configuration instruction as described in 2.2.4 *Device Configuration*. During the configuration process make sure to select the channel your ECG sensor is connected to and to set the channel configuration to *ECG* or, if using the BVP sensor, set the channel to configuration to *BVP* respectively (see 2.2.4.6 *Channel Configuration*).

4.11.2 Add-on Configuration

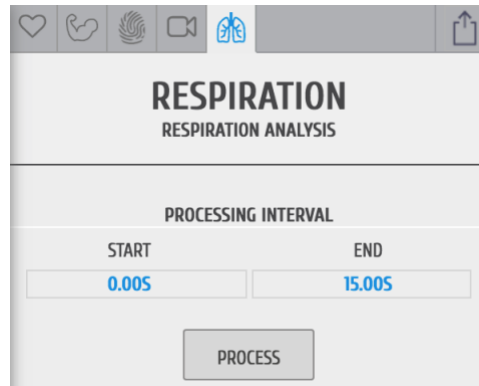


Figure 118: Respiration analysis add-on.

DEVICES & CHANNELS

The respiration analysis add-on will process all available signals.

PROCESSING INTERVAL

The processing interval selects the time interval of respiration data that is to be processed. It can be changed by manually writing the start and end point of the acquisition session into the time fields in the configuration window or by changing the size of the visualization interval in the overview window.

4.12 Video Synchronization

Video synchronization add-on

DESCRIPTION

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

This is an offline add-on for post processing purposes. It is only available in the signal visualization mode (see 3.2 *Signal Visualization Mode*).

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

4.12.1 Hardware Configuration

The add-on does not specifically require any actuators or accessories, however, the use of one of the following is recommended to facilitate the synchronization of your signal and video recordings using light sources and light sensors.

LIGHT SENSORS

When using light sensors to record external light signals coming from other devices, it is recommended to configure the channel your sensor is connected to a suitable channel type (see 2.2.4.6 *Channel Configuration* and 5 *Advanced Device Configuration* of your device).

biosignalsplux light sensor:

<https://store.plux.info/bitalino-sensors/16-light-lux-sensor.html>

BITalino light sensor:

<https://store.plux.info/bitalino-sensors/16-light-lux-sensor.html>

LEDs

When using LEDs to emit light signals to synchronize the device of your setup, connect the LED to your device and follow to instruction in section 3.1.2.3 *Digital Inputs & Outputs* on how to control your LED during the acquisition.

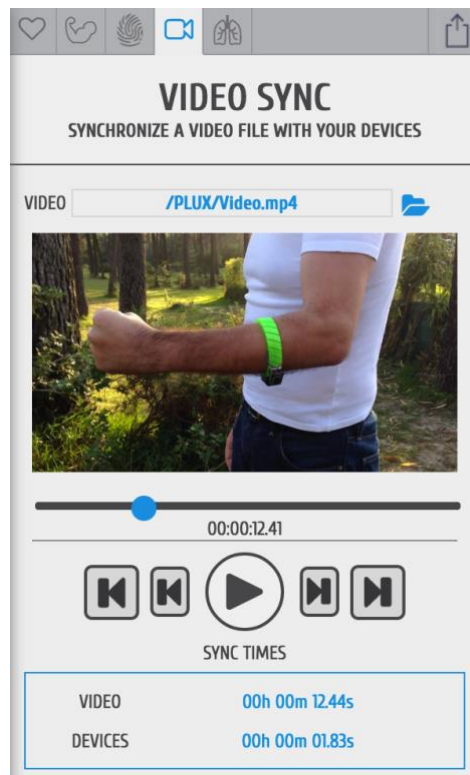
biosignalsplux LED:

<https://store.plux.info/actuators/295-led.html>

BITalino LED:

<https://store.plux.info/bitalino-actuators/19-light-emitting-diode-led.html>

4.12.2 Add-on Configuration



DEVICES & CHANNELS

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

VIDEO PATH

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

SYNC TIMES

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

Video: Locked synchronization point in the video timeline

Devices: Locked synchronization point in the acquired signals



Locked synchronization point

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



Current position

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

5 Advanced Device Configuration

OpenSignals (r)evolution is compatible with all PLUX devices. It is recommended to review the following device specific configuration to obtain the best acquisition results.

This section provides you more information for the correct configuration of your PLUX device in OpenSignals to allow optimal signal acquisition quality. General and basic information on how to setup your device in *OpenSignals (r)evolution* (e.g. de/activating channels) is described in *2.2.4 Device Configuration*.

5.1 BITalino

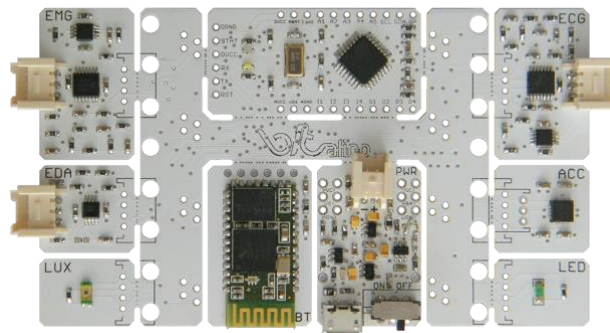


Figure 119: BITalino Board

NOTE

The following *BITalino* configuration is described for the *BITalino Board* kit. Keep in mind that, the channel configurations might be different if you're using a *BITalino Freestyle* or *Plugged* kit and that you may need to adjust them to your current setup.

CHANNEL CONFIGURATION

The following channel configuration is the standard configuration for *BITalino Boards* (see Table 2). Keep in mind, that this configuration might not apply to *BITalino Freestyle* or *Plugged* devices. The configuration of these devices has to be adjusted to your current device setup.

CHANNEL	SENSOR	CHANNEL TYPE
A1	Electromyography	EMG
A2	Electrocardiography	ECG
A3	Electrodermal activity	EDA
A4	Accelerometer	ACC
A5	Light sensor	LUX
A6	Battery level	-
I1	-	-
I2	-	-
O1	LED	-
O2	-	-

Table 2: Standard *BITalino Board* configuration.

All the available channel types for *BITalino* are listed in Table 3.

TYPE	SENSOR
RAW	Compatible with every sensor
ACC	Accelerometer
ECG	Electrocardiography
EDA	Electrodermal Activity
EMG	Electromyography
LUX	Light
CUSTOM	Customizable channel configuration

Table 3: BITalino channel types.

LED STATES

When using *BITalino (r)evolution*, the onboard led provides visual information about the current device status (see Table 7).

LED	BEHAVIOR	DEVICE STATUS
White LED	Fading	Idle
White LED	Blinking	Acquiring signals
Red LED (MCU)	On	Low battery/Channel A6 is not connected (<i>BITalino Freestyle</i> and <i>BITalino Plugged</i>)
Red LED (PWR Block)	On	Charging battery (<i>BITalino (r)evolution</i> needs to be turned off)

Table 4: BITalino LED behavior.

Keep in mind that the red LED on the MCU board might be permanently turned on when using a *BITalino Freestyle* or *Plugged* devices as the channel A6 is not connected by default on this devices.

RESOLUTION

The resolution is pre-set for *BITalino* devices. When 5 or 6 channels are actively acquiring signals, channels 1,2,3, and 4 are acquiring with 10-bit resolution while channels 5 and 6 are acquiring with 6-bit resolution.

When 4 or less channels are actively acquiring signals, all active channels are acquiring with 10-bit resolution including channels 5 and 6.

Digital inputs and outputs are acquiring with 1-bit resolution.

SAMPLING RATE

BITalino supports sampling rates of 1, 10, 100 and 1000Hz. However, in *OpenSignals (r)evolution* only 10, 100 and 1000Hz can be selected.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DATASHEETS

BITalino Board:

http://bitalino.com/datasheets/BITalino_Board_Datasheet.pdf

BITalino Freestyle:

http://bitalino.com/datasheets/BITalino_Freestyle_Datasheet.pdf

BITalino Plugged:

http://bitalino.com/datasheets/BITalino_Plugged_Datasheet.pdf

HeartBIT:

http://bitalino.com/datasheets/HeartBIT_Datasheet.pdf

5.2 BITalino (r)evolution BT (Bluetooth)

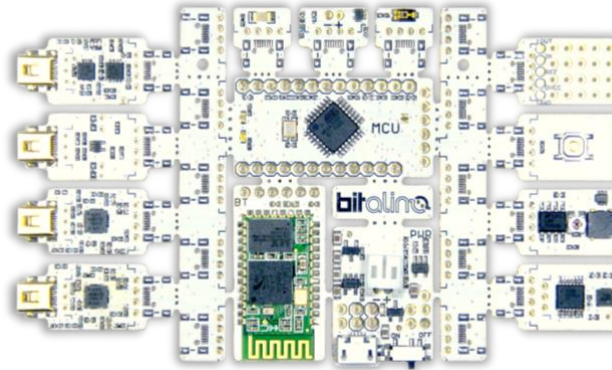


Figure 120: BITalino (r)evolution Board BT

NOTE

The following *BITalino (r)evolution* configuration is described for the *BITalino (r)evolution Board BT* kit. Keep in mind that, the channel configurations might be different if you're using a *BITalino (r)evolution Freestyle BT* or *Plugged BT* kit and that you may need to adjust them to your current setup.

CHANNEL CONFIGURATION

The following channel configuration is the standard configuration for *BITalino (r)evolution Boards* (see Table 5). Please keep in mind, that this configuration might not apply to *BITalino (r)evolution Freestyle* or *Plugged* devices. The configuration of these devices has to be adjusted to your current device setup.

CHANNEL	SENSOR	CHANNEL TYPE
A1	Electromyography	EMG
A2	Electrocardiography	ECG
A3	Electrodermal Activity	EDA
A4	Electroencephalography	EEG
A5	Accelerometer	ACC
A6	Light Sensor	LUX
I1	Button	-
I2	-	-
O1	LED	-
O2	Buzzer	-

Table 5: Standard *BITalino (r)evolution Board BT* configuration.

All the available channel types for *BITalino (r)evolution* are listed in Table 6.

TYPE	SENSOR
RAW	Compatible with every sensor
ACC	Accelerometer
ECG	Electrocardiography
EDA	Electrodermal Activity
EEG	Electroencephalography
EMG	Electromyography
LUX	Light
TEMP	Temperature
CUSTOM	Customizable channel configuration

Table 6: BITalino (r)evolution channel types.

LED STATES

When using *BITalino (r)evolution*, the onboard led provides visual information about the current device status (see Table 7).

LED	BEHAVIOR	DEVICE STATUS
White LED	Fading	Idle
White LED	Blinking	Acquiring signals
Red LED (MCU)	On	Low battery
Red LED (PWR Block)	On	Charging battery (<i>BITalino (r)evolution</i> needs to be turned off)

Table 7: BITalino (r)evolution LED behavior.

RESOLUTION

The resolution is pre-set for *BITalino (r)evolution* devices. When 5 or 6 channels are actively acquiring signals, channels 1,2,3, and 4 are acquiring with 10-bit resolution while channels 5 and 6 are acquiring with 6-bit resolution.

When 4 or less channels are actively acquiring signals, all active channels are acquiring with 10-bit resolution including channels 5 and 6.

Digital inputs and outputs are acquiring with 1-bit resolution.

SAMPLING RATE

BITalino supports sampling rates of 1, 10, 100 and 1000Hz. However, in *OpenSignals (r)evolution* only 10, 100 and 1000Hz can be selected.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DATASHEETS

BITalino (r)evolution Board:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Board_Kit_Datasheet.pdf

BITalino (r)evolution Freestyle:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Freestyle_Kit_Datasheet.pdf

BITalino (r)evolution Plugged:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Plugged_Kit_Datasheet.pdf

5.3 BITalino (r)evolution BLE (Bluetooth Low Energy)

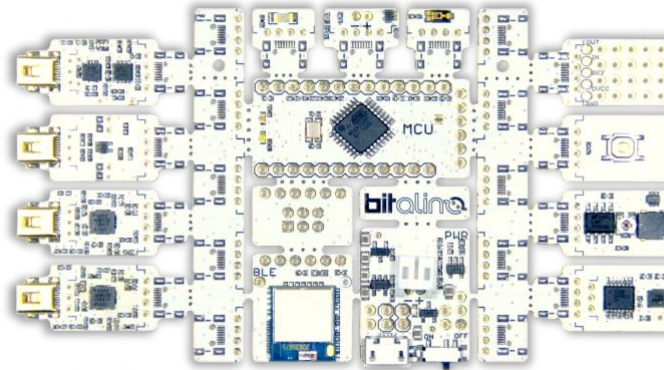


Figure 121: BITalino (r)evolution Board BLE

NOTE

The following *BITalino (r)evolution* configuration is described for the *BITalino (r)evolution Board BLE* kit. Keep in mind that, the channel configurations might be different if you're using a *BITalino (r)evolution Freestyle BLE* or *Plugged BLE* kit and that you may need to adjust them to your current setup.

NOTE

The *BITalino (r)evolution BLE* (Bluetooth Low Energy) devices are currently not supported on Mac OS and Linux systems.

CHANNEL CONFIGURATION

The following channel configuration is the standard configuration for *BITalino (r)evolution Boards* (see Table 8). Please keep in mind, that this configuration might not apply to *BITalino (r)evolution Freestyle* or *Plugged* devices. The configuration of these devices has to be adjusted to your current device setup.

CHANNEL	SENSOR	CHANNEL TYPE
A1	Electromyography	EMG
A2	Electrocardiography	ECG
A3	Electrodermal Activity	EDA
A4	Electroencephalography	EEG
A5	Accelerometer	ACC
A6	Light Sensor	LUX
I1	Button	-
I2	-	-
O1	LED	-
O2	Buzzer	-

Table 8: Standard BITalino (r)evolution Board BT configuration.

All the available channel types for BITalino (r)evolution are listed in Table 9.

TYPE	SENSOR
RAW	Compatible with every sensor
ACC	Accelerometer
ECG	Electrocardiography
EDA	Electrodermal Activity
EEG	Electroencephalography
EMG	Electromyography
LUX	Light
TEMP	Temperature
CUSTOM	Customizable channel configuration

Table 9: BITalino (r)evolution channel types.

LED STATES

When using BITalino (r)evolution, the onboard led provides visual information about the current device status (see Table 10).

LED	BEHAVIOR	DEVICE STATUS
White LED	Fading	Idle
White LED	Blinking	Acquiring signals
Red LED (MCU)	On	Low battery
Red LED (PWR Block)	On	Charging battery (BITalino (r)evolution needs to be turned off)

Table 10: BITalino (r)evolution LED behavior.

RESOLUTION

The resolution is pre-set for BITalino (r)evolution devices. When 5 or 6 channels are actively acquiring signals, channels 1,2,3, and 4 are acquiring with 10-bit resolution while channels 5 and 6 are acquiring with 6-bit resolution.

When 4 or less channels are actively acquiring signals, all active channels are acquiring with 10-bit resolution including channels 5 and 6.

Digital inputs and outputs are acquiring with 1-bit resolution.

SAMPLING RATE

BITalino supports sampling rates of 1, 10, 100 and 1000Hz. However, in *OpenSignals (r)evolution* only 10, 100 and 1000Hz can be selected.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth Low Energy dongle](#) to prevent Bluetooth connection related acquisition issues.

Due to limitations associated with the current Bluetooth Low Energy capabilities, please keep in mind the following aspects when using a BITalino (r)evolution BLE device for data acquisition:

- Only a single channel can be acquired at the maximum sampling rate (1000Hz)
- To acquire data from all channels simultaneously a sampling rate of 100Hz or lower needs to be selected
- BITalino (r)evolution BLE devices currently are only supported on Windows
- A Bluegiga BLED112 BLE dongle is required ([BLE dongle](#))

DATASHEETS

BITalino (r)evolution Board:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Board_Kit_Datasheet.pdf

BITalino (r)evolution Freestyle:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Freestyle_Kit_Datasheet.pdf

BITalino (r)evolution Plugged:

http://bitalino.com/datasheets/REVOLUTION_BITalino_Plugged_Kit_Datasheet.pdf

5.4 biosignalsplux



Figure 122: 4 channel (left) and 8 channel biosignalsplux HUBs.

CHANNEL CONFIGURATION

biosignalsplux devices have no specific channel configuration by default. The channel configuration has to be done according to your setup. All available channel types are listed in Table 11.

TYPE	SENSOR	SENSOR PAGE
RAW	Raw signal; compatible with every sensor;	-
BVP	Blood Volume Pressure (Link)	Link
ECG	Electrocardiography	Link
EDA EDA.ARM	Electrodermal Activity	Link
EEG	Electroencephalography (Link)	Link
EMG	Electromyography	Link
	Vaginal EMG	Link
GONIO	Goniometer (Link)	Link
HANDGR	Load Cell (Link)	Link
RESP	Respiration	Link
SpO2.ARM SpO2.HEAD	SpO2 Sensor (without finger clip)	Link
SpO2.FING	SpO2 Sensor (without finger clip)	Link
	SpO2 Sensor (with finger clip)	Link
TEMP	Temperature	Link
XYZ	Accelerometer	Link
Custom	Customizable channel configuration (e.g., Light & Force sensor)	-

Table 11: *biosignalsplux* channel types.

The *CUSTOM* channel type has no pre-set channel configuration allowing you to manually select the gain, offset and unit of the selected channel. This channel configuration can be helpful when using 3rd party or custom sensors.

RESOLUTION

biosignalsplux devices support 8-bit, 12-bit (in some models) and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

INTERNAL MEMORY

biosignalsplux hubs with internal memory can be used for offline acquisitions which do not require an active Bluetooth connection during data acquisition. For detailed instructions on how to use the internal memory of your device, please check section 3.3 *Data Logging*.

DOCUMENTATION

Datasheets and user manuals for your *biosignalsplux* device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.5 biosignals Force



Figure 123: biosignalsplux Force

NOTE

The *biosignalsplux Force* is a force platform with real-time streaming and data logging capabilities which uses a 4-channel *biosignalsplux* device. It is recommended to also check the following sections to take full advantage of all the force platform features:

- Data logging (see [3.3 Data Logging](#))
- Force platform add-on
- *biosignalsplux* configuration (see [5.4 biosignalsplux](#))

CHANNEL CONFIGURATION

The available channel types for the *biosignalsplux* device being used with the force platform are listed in Table 11 on page 134. For the force platform, no specific channel configuration is required for which reason the *CUSTOM* channel type may be used for the sensors being used.

RESOLUTION

biosignalsplux devices support 8-bit, 12-bit (in some models) and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

INTERNAL MEMORY

biosignalsplux hubs with internal memory can be used for offline acquisitions which do not require an active Bluetooth connection during data acquisition. For detailed instructions on how to use the internal memory of your device, please check section *3.3 Data Logging*.

DOCUMENTATION

Datasheets and user manuals for your *biosignalsplux* device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.6 OpenBAN



Figure 124: OpenBAN

NOTE

OpenBAN is a single channel acquisition device which can be used with any *biosignalsplus* sensor except the SpO2 sensor. Also, this device is not compatible with any of the accessory devices which require a digital port, as this device does not have a digital port.

CHANNEL CONFIGURATION

OpenBAN devices have no specific channel configuration by default. The channel configuration has to be done according to your setup. All available channel types are listed in Table 12.

TYPE	SENSOR	SENSOR PAGE
RAW	Raw signal; compatible with every sensor;	-
BVP	Blood Volume Pressure (Link)	Link
ECG	Electrocardiography	Link
EDA EDA.ARM	Electrodermal Activity	Link
EEG	Electroencephalography (Link)	Link
EMG	Electromyography	Link
	Vaginal EMG	Link
GONIO	Goniometer (Link)	Link
HANDGR	Load Cell (Link)	Link
MICRO	-	-
RESP	Respiration	Link
TEMP	Temperature	Link
XYZ	Accelerometer	Link
Custom	Customizable channel configuration (e.g., Light & Force sensor)	-

Table 12: OpenBAN channel types.

The *CUSTOM* channel type has no pre-set channel configuration allowing you to manually select the gain, offset and unit of the channel. This channel configuration can be helpful when using 3rd party or custom sensors.

RESOLUTION

OpenBAN supports 8-bit and 12-bit resolutions.

SAMPLING RATE

The sampling rate can be set to 100Hz, 200Hz, 300Hz, ..., 1000Hz.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.7 OpenBAN (2017)



Figure 125: OpenBAN

NOTE

OpenBAN is a single channel acquisition device which can be used with any *biosignalsplux* sensor except the SpO2 sensor.

Also, this device is not compatible with any of the accessory devices which require a digital port, as this device does not have a digital port.

NOTE

The usage of some sensors is limited or not possible due to the limited number of inputs of this device, as some sensors require several channels to work properly (e.g., external accelerometer, goniometer).

CHANNEL CONFIGURATION

OpenBAN devices have a specific channel configuration with the exception of channel 2, which is the channel *biosignalsplux* are connected to. Therefore, only the configuration of channel 2 has to be adjusted to the connected sensor.

Additionally, the *OpenBAN* comes with an integrated and pre-connected microphone, triaxial accelerometer, and triaxial magnetometer.

The channel configuration must be done according the internal setup of the *OpenBAN* and your additional sensor; see Table 13.

CHANNEL	SENSOR	CHANNEL TYPE
1	Microphone	MICRO

2	biosignalsplux sensor	[DEPENDS ON CONNECTED SENSOR]
3	Accelerometer – X-Axis	ACC_X
4	Accelerometer – Y-Axis	ACC_Y
5	Accelerometer – Z-Axis	ACC_Z
6	Magnetometer – X-Axis	MAG_X
7	Magnetometer – Y-Axis	MAG_Y
8	Magnetometer – Z-Axis	MAG_Z

Table 13: Channel configuration of the OpenBAN (2017).

The available channel types for channel 2 are listed in Table 14.

TYPE	SENSOR	SENSOR PAGE
RAW	Raw signal; compatible with every sensor;	-
BVP	Blood Volume Pressure (Link)	Link
ECG	Electrocardiography	Link
EDA EDA.ARM	Electrodermal Activity	Link
EEG	Electroencephalography (Link)	Link
EMG	Electromyography	Link
	Vaginal EMG	Link
GONIO	Goniometer (Link)	Link
HANDGR	Load Cell (Link)	Link
MICRO	-	-
RESP	Respiration	Link
TEMP	Temperature	Link
XYZ	Accelerometer	Link
Custom	Customizable channel configuration (e.g., Light & Force sensor)	-

Table 14: OpenBAN (2017) channel types.

The *CUSTOM* channel type has no pre-set channel configuration allowing you to manually select the gain, offset and unit of the channel. This channel configuration can be helpful when using 3rd party or custom sensors.

NOTE

This sensor has a virtual reference; there is no need to connect an additional reference electrode.

RESOLUTION

OpenBAN supports 8-bit and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.8 MuscleBAN



Figure 126: MuscleBAN.

NOTE

MuscleBAN devices are closed devices with prewired, internal analog ports. Other *biosignalsplux* sensors cannot be connected to this device.

CHANNEL CONFIGURATION

MuscleBAN devices have a specific channel configuration by default. The configuration inside *OpenSignals (r)evolution* should be done as displayed in Table 15.

CHANNEL	SENSOR	CHANNEL TYPE
1	Electromyography	EMG
2	Accelerometer (x-axis)	XYZ
3	Accelerometer (y-axis)	
4	Accelerometer (z-axis)	
5	Magnetometer (x-axis)	
6	Magnetometer (y-axis)	
7	Magnetometer (z-axis)	

Table 15: MuscleBAN channel configuration.

RESOLUTION

MuscleBAN devices support 8-bit and 16-bit resolutions.

SAMPLING RATE

The sampling rate can be set to 100Hz, 200Hz, 300Hz, ..., 1000Hz. However, note this devices streams all samples in envelopes to your computer with a streaming rate of up to 50Hz.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth Low Energy dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.9 MotionBAN



Figure 127 : MotionBAN

NOTE

MotionBAN devices are closed devices with prewired, internal analog ports. Other *biosignalsflux* sensors cannot be connected to this device.

CHANNEL CONFIGURATION

MotionBAN devices have a specific channel configuration by default. The configuration inside *OpenSignals (r)evolution* should be done as displayed in Table 16.

CHANNEL	SENSOR	CHANNEL TYPE
1	Accelerometer (x-axis)	XYZ
2	Accelerometer (y-axis)	
3	Accelerometer (z-axis)	
4	Magnetometer (x-axis)	
5	Magnetometer (y-axis)	
6	Magnetometer (z-axis)	

Table 16: *MotionBAN* channel configuration.

RESOLUTION

MotionBAN supports 8-bit and 16-bit resolutions.

SAMPLING RATE

The sampling rate can be set to 100Hz, 200Hz, 300Hz, ..., 800Hz.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

INTERNAL MEMORY

MotionBAN devices have an internal memory which can be used for offline acquisitions without the need of an active Bluetooth connection during data acquisition. For detailed instructions on how to use the internal memory of your device, please check section 3.3 *Data Logging*.

DOCUMENTATION

Datasheets and user manuals for your devices can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.10 CardioBAN



Figure 128: CardioBAN

NOTE

CardioBAN devices are closed devices with prewired, internal analog ports. Other *biosignalsplex* sensors cannot be connected to this device.

CHANNEL CONFIGURATION

CardioBAN devices have a specific channel configuration by default. The configuration inside *OpenSignals (r)evolution* should be done as displayed in Table 17.

CHANNEL	SENSOR	CHANNEL TYPE
1	Electrocardiography	ECG
2	Accelerometer (x-axis)	XYZ
3	Accelerometer (y-axis)	
4	Accelerometer (z-axis)	

Table 17: CardioBAN channel configuration.

RESOLUTION

CardioBAN supports 8-bit and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplex* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.11 RespiBAN Explorer



Figure 129: RespiBAN Explorer

NOTE

RespiBAN Explorer devices are closed devices with prewired, internal analog ports. Other *biosignalsplux* sensors cannot be connected to this device.

CHANNEL CONFIGURATION

RespiBAN Explorer devices have a specific channel configuration by default. The configuration inside *OpenSignals (r)evolution*.

CHANNEL	SENSOR	CHANNEL TYPE
1	Respiration	RESP
2	Accelerometer (x-axis)	XYZ
3	Accelerometer (y-axis)	
4	Accelerometer (z-axis)	

Table 18: RespiBAN Explorer channel configuration.

RESOLUTION

RespiBAN Explorer supports 8-bit and 16-bit resolutions.

SAMPLING RATE

The sampling rate can be set to 100Hz, 200Hz, 300Hz, ..., 1000Hz.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.12 RespiBAN Researcher



Figure 130: RespiBAN Researcher

NOTE

RespiBAN Researcher devices are closed devices with prewired, internal analog ports. Other *biosignalsplux* sensors cannot be connected to this device.

CHANNEL CONFIGURATION

RespiBAN Researcher devices have a specific channel configuration by default. The configuration inside *OpenSignals (r)evolution* should be done as displayed in

CHANNEL	SENSOR	CHANNEL TYPE
1	Respiration (inductive)	RESP
2	Accelerometer (x-axis)	XYZ
3	Accelerometer (y-axis)	
4	Accelerometer (z-axis)	

Table 19: *RespiBAN Researcher* channel configuration.

RESOLUTION

RespiBAN Researcher supports 8-bit and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.13 RespiBAN Professional



Figure 131: RespiBAN Professional

CHANNEL CONFIGURATION

RespiBAN Professional devices have 4 prewired channels which are connected to the onboard sensors and 4 generic channels which can be used to connect *biosignalsplux* sensors to this device.

The configuration for the first 4 channels have to be done according to the configuration of the prewired sensors while the last 4 have to be done according to your sensor specific setup (see Table 20).

CHANNEL	SENSOR	CHANNEL TYPE
1	Respiration (inductive)	RESP
2	Accelerometer (x-axis)	XYZ
3	Accelerometer (y-axis)	
4	Accelerometer (z-axis)	
5	Generic	Sensor specific selection needed.
6		
7		
8		

Table 20: RespiBAN Professional channel configuration.

RESOLUTION

RespiBAN Researcher supports 8-bit and 16-bit resolutions.

SAMPLING RATE

If using *OpenSignals (r)evolution* versions from December 2017 (and newer) and *biosignalsplux* devices with firmware version 3.5, it is even possible to select higher sampling rates of up to 4000Hz.

However, note that high sampling rate for all channels are only supported for sampling rates of up to 3000Hz, while 4000Hz is limited to a maximum of 3 channels only.

NOTE

Higher resolutions & sampling rates lead to higher quality signal acquisitions but are linked to higher consumption of system resources & higher probability of Bluetooth transmissions issues which may lead to signal delays in the real-time acquisition mode.

We recommend the usage of a PLUX proven [Bluetooth dongle](#) to prevent Bluetooth connection related acquisition issues.

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

<http://biosignalsplux.com/index.php/en/learn/documentation>

5.14 Compatible Sensors

OpenSignals (r)evolution is compatible with all *biosignalsplux* & *BITalino* sensors. See below the links to access more information about these sensors and all sensor datasheets.

5.14.1 biosignalsplux

Accelerometer (ACC):

<http://biosignalsplux.com/en/acc-accelerometer>

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

Blood Volume Pressure (BVP):

<http://biosignalsplux.com/en/bvp-blood-volume-pulse>

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

Electrocardiogram (ECG):

<http://biosignalsplux.com/en/ecg-electrocardiogram>

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

Electrodermal Activity (EDA):

<http://biosignalsplux.com/en/eda-electrodermal-activity>

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

Electroencephalography (EEG):

<http://biosignalsplux.com/en/eeg-electroencephalography>

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

Electromyography (EMG):

<http://biosignalsplux.com/en/emg-electromyography>

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

Force (FSR):

<http://biosignalsplux.com/index.php/fsr-force>

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

Goniometer (GON):

<http://biosignalsplux.com/en/ang-goniometer>

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

Light (LUX):

<http://biosignalsplux.com/en/lux-light>

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

Load Cell:

<http://biosignalsplux.com/en/load-cell>

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

Respiration (RIP):

<http://biosignalsplux.com/en/rsp-respiration>

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

Respiration (PZT – Piezoelectric):

<http://biosignalsplux.com/en/pzt-respiration>

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

RFID:

<http://biosignalsplux.com/en/rfid-sensor>

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

Temperature (TMP):

<http://biosignalsplux.com/en/tmp-temperature>

Vaginal EMG:

<http://biosignalsplux.com/en/vaginal-probe>

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

SpO2 Sensor:

<http://biosignalsplux.com/en/spo2-sensor>

http://biosignalsplux.com/datasheets/SpO2_Sensor_Datasheet.pdf

5.14.2 BITalino

Accelerometer (ACC):

<https://store.plux.info/bitalino-sensors/14-accelerometer-acc-sensor.html>

http://bitalino.com/datasheets/REVOLUTION_ACC_Sensor_Datasheet.pdf

Electrocardiography (ECG):

<https://store.plux.info/bitalino-sensors/10-electrocardiography-ecg-sensor-111111111111.html>

http://bitalino.com/datasheets/REVOLUTION_ECG_Sensor_Datasheet.pdf

Electrodermal Activity (EDA):

<https://store.plux.info/bitalino-sensors/11-electrodermal-activity-eda-sensor.html>

http://bitalino.com/datasheets/REVOLUTION_EDA_Sensor_Datasheet.pdf

Electroencephalography (EEG):

<https://store.plux.info/bitalino-sensors/12-electroencephalography-eeeg-sensor.html>

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

Electromyography (EMG):

<https://store.plux.info/bitalino-sensors/8-electromyography-emg-sensor.html>

http://bitalino.com/datasheets/REVOLUTION_EMG_Sensor_Datasheet.pdf

Flexi Force:

<https://store.plux.info/bitalino-sensors/381-flexiforce-fsr-sensor.html>

Light (LUX):

<https://store.plux.info/bitalino-sensors/16-light-lux-sensor.html>

http://bitalino.com/datasheets/REVOLUTION_LUX_Sensor_Datasheet.pdf

Pulse Sensor:

<https://store.plux.info/bitalino-sensors/42-pulsesensor.html>

Respiration (PZT – Piezoelectric):

<https://store.plux.info/bitalino-sensors/40-respiration-pzt-sensor.html>

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

Temperature (TMP):

<https://store.plux.info/bitalino-sensors/379-temperature-ntc-sensor.html>

http://bitalino.com/datasheets/TMP_Sensor_Datasheet.pdf

5.15 3rd-party Sensors

OpenSignals (r)evolution and PLUX devices allow the usage and acquisition of data from 3rd party sensors, using the respective accessories (see below). These accessories allow you to connect analog or digital third party sensors to your PLUX devices which comply with the **specified and compatible electric values of the PLUX device**.

Please read the following sections and review the sensor's and/or device's datasheet **before** connecting any device to your PLUX device or sensor.

5.15.1 I/O Breakout Cable

WARRANTY WARNING

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

DISCLAIMER

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

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

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



SPECIFICATIONS

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

DOCUMENTATION

Datasheets and user manuals for your device can be found on the following website:

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

Check the table below and the breakout cable datasheet (see annexes) for detailed information about the pinout configuration for the analog ports (standard sensor channels)

and digital ports (8-channel *biosignalsplux* devices only) **BEFORE CONNECTING YOUR SENSOR TO YOUR DEVICE** to avoid damaging your PLUX device.

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

Table 21: Pinout configuration for analog & digital ports.

5.15.2 Sensor Breakout PCB

WARRANTY WARNING

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

DISCLAIMER

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

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

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

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



DOCUMENTATION & SPECIFICATIONS

Please read the datasheet of your sensors to confirm the electrical values and compatibility of your sensor.

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

ANALOG SENSOR	
V-	GND
GND	1.5V (to sensor)

DIGITAL SENSOR	
V-	GND
GND	Sensor output

V+	3V (to sensor)
IN	Sensor output

V+	3V (to sensor)
IN	1.5V (to sensor)

Table 22: Pinout configuration for analog & digital ports.

6 Software & APIs

6.1 OpenSignals (r)evolution

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

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

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

biosignalsplux:

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

BITalino:

<http://bitalino.com/index.php/en/software>

6.2 OpenSignals Mobile

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

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

6.3 APIs

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

biosignalsplux APIs:

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

BITalino APIs:

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

7 Troubleshooting

7.1 Windows Bluetooth Stack Troubleshooting

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

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

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

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

NOTE

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

NOTE

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

NOTE

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

7.1.1 Windows 7 & Windows 8

Step 1: Removing already paired devices from your operating system

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

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

In the *Device and Printers* window, PLUX devices can be found in the *Unspecified* section. Right-click on the device you want to remove and select *Remove device* (see *Figure 132*)

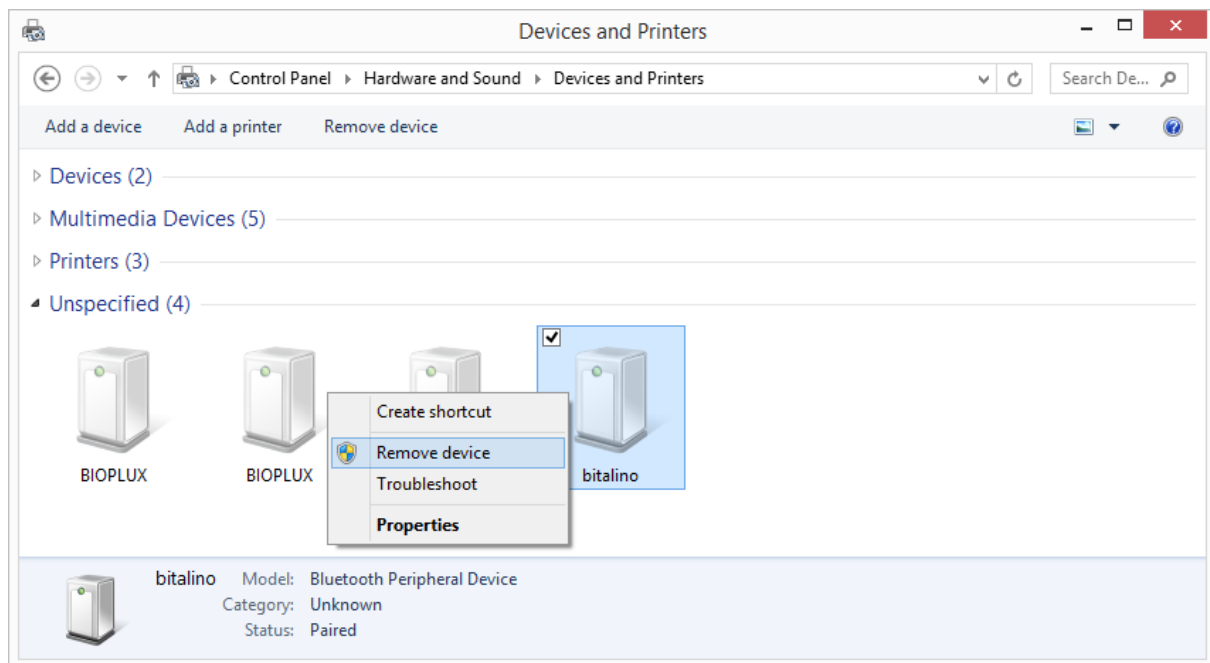


Figure 132: Windows 7 "Devices and Printers" window.

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

Step 2: Installing PLUX-proven Bluetooth dongle

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

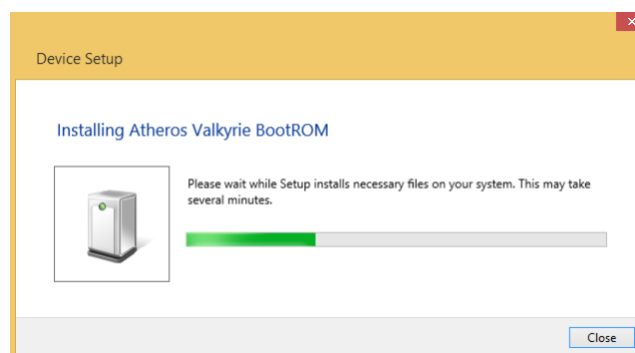


Figure 133: Wait for Windows to install your Bluetooth dongle.

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

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

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

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

In the device manager, the Bluetooth dongle should be listed as *Generic Bluetooth Adapter* (see *Figure 134*). If your machine already has an internal Bluetooth Adapter and you have just plugged in the PLUX-proven Bluetooth Dongle, keep in mind that the last one will be automatically disabled by Windows. This is why one of your Bluetooth adapters under Bluetooth in the device manager shows a yellow warning icon (⚠) stating: *Code 10 - This device cannot start*.

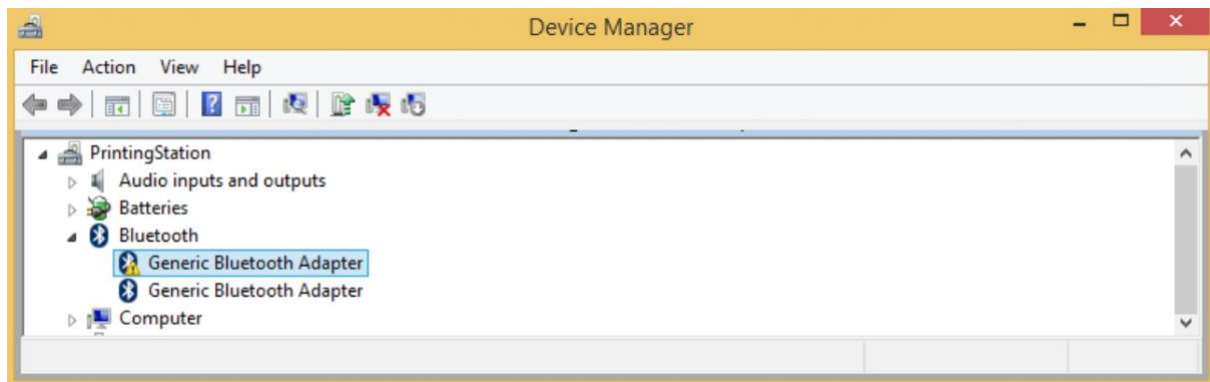


Figure 134: Bluetooth dongle listed in the device manager.

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

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

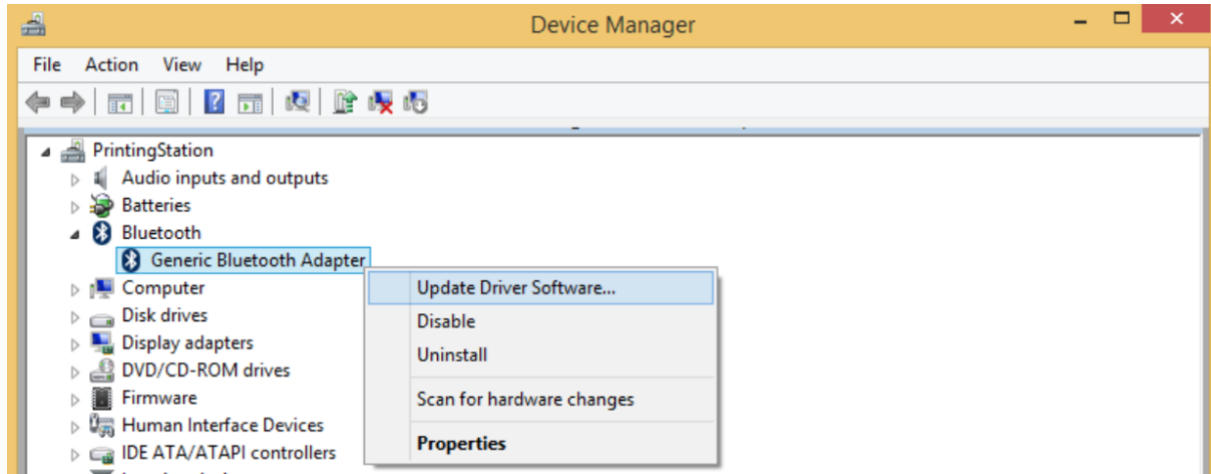


Figure 135: First step to update the driver of the Bluetooth dongle.

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

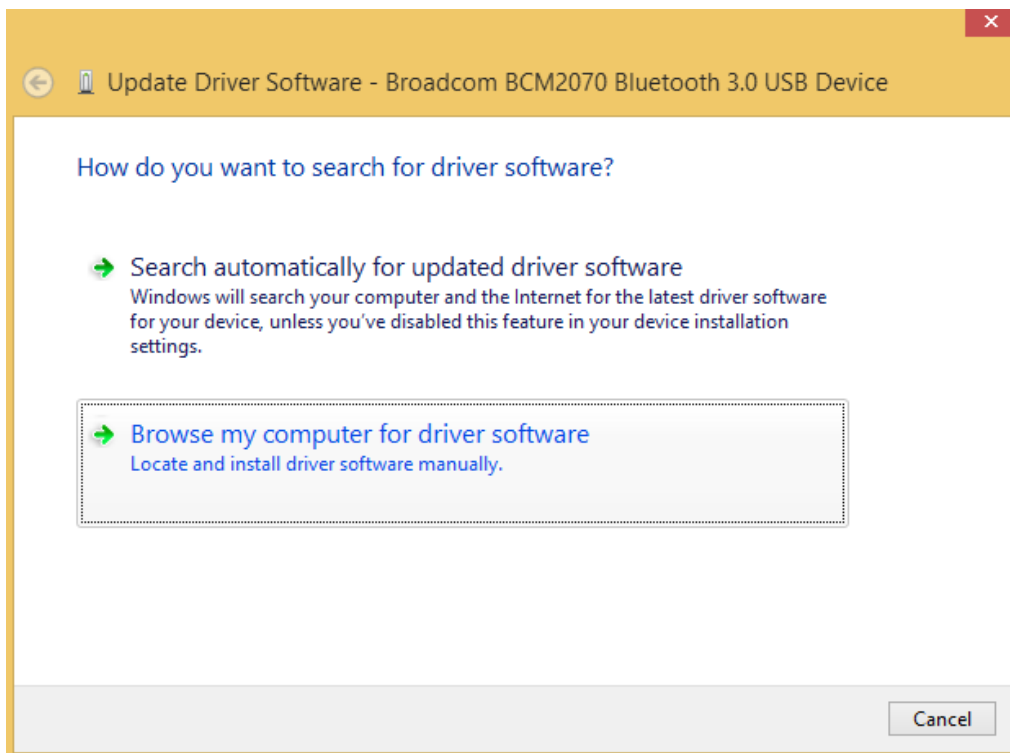


Figure 136: Browse for driver software.

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

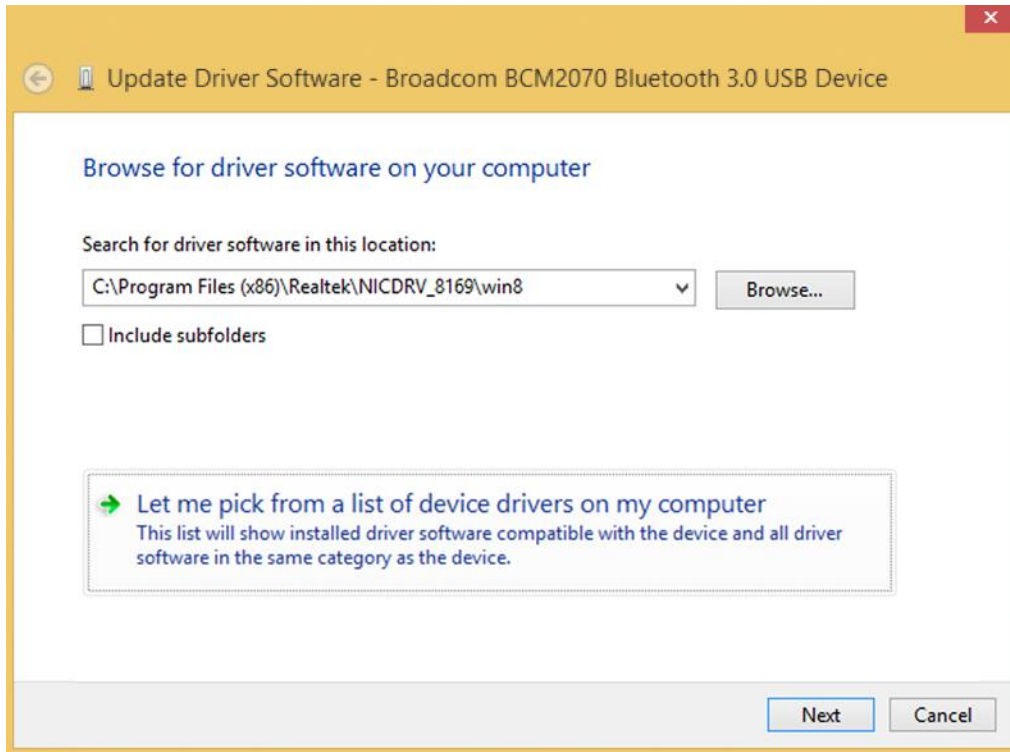


Figure 137: Pick driver from list of device drivers on the computer.

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

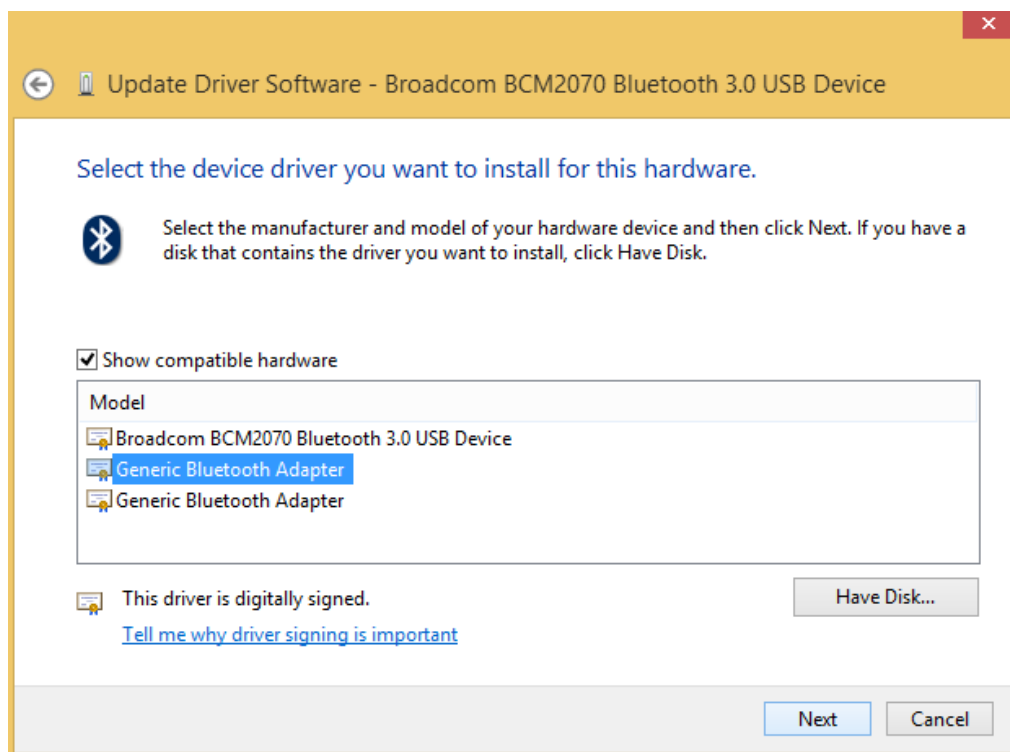


Figure 138: Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your device (see instructions in *1.5.1 Windows 7 or 1.5.2 Windows 8*) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

7.1.2 Windows 10

Step 1: Removing already paired devices from your operating system

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

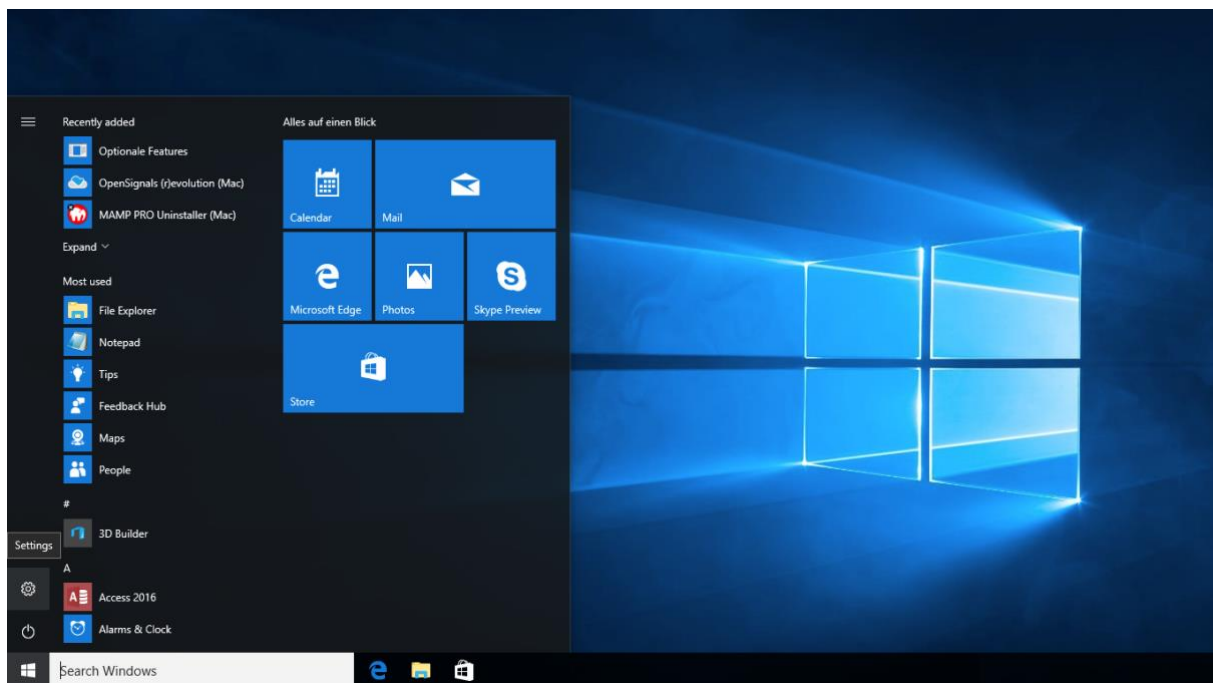


Figure 139: Access to the settings panel in Windows 10.

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

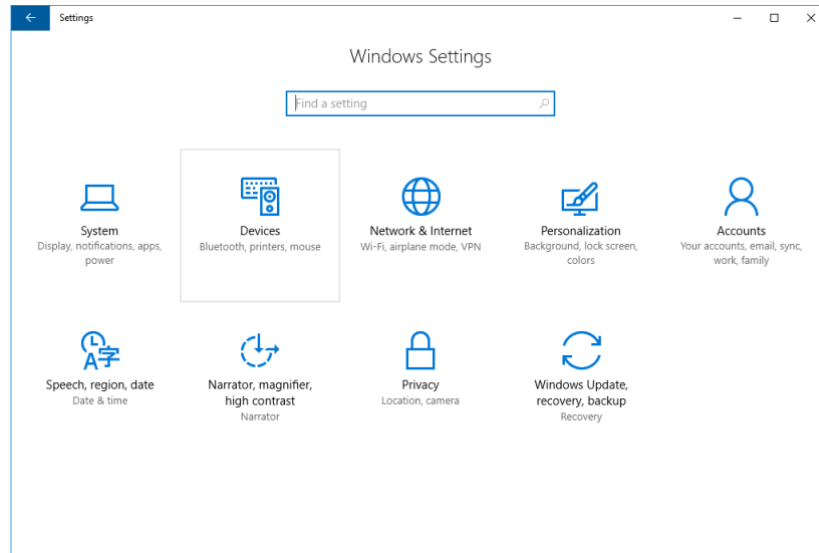


Figure 140: Windows 10 settings panel.

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

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

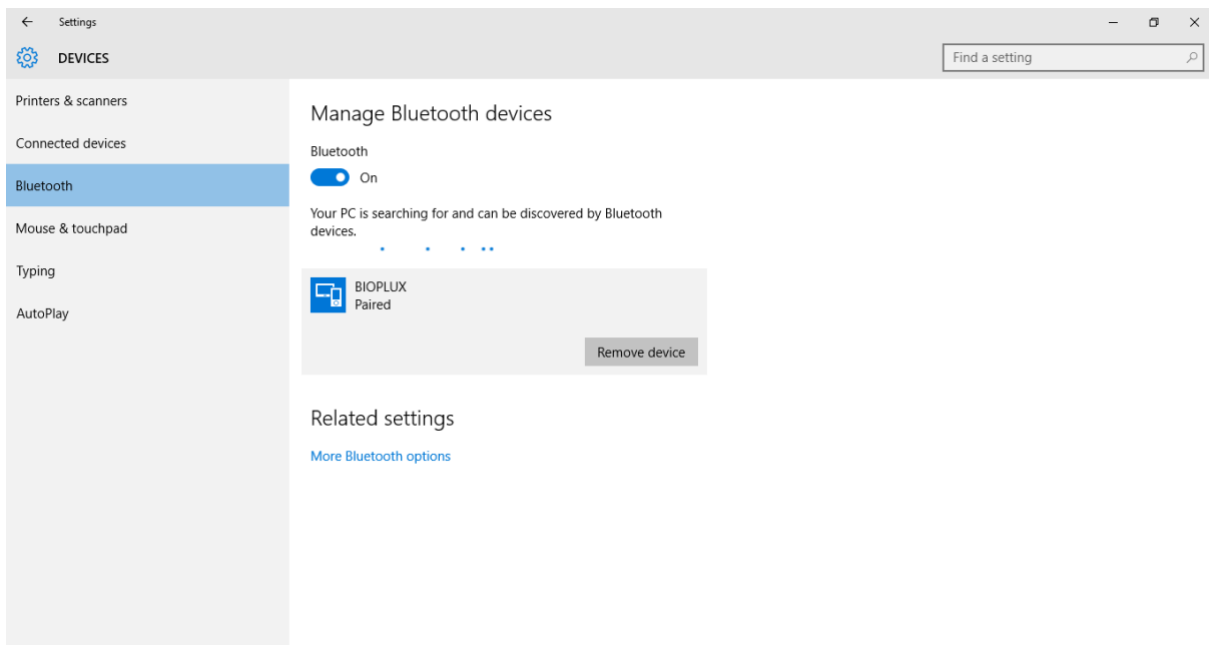


Figure 141: Windows 10 Bluetooth devices

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

Step 2: Installing PLUX-proven Bluetooth dongle

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

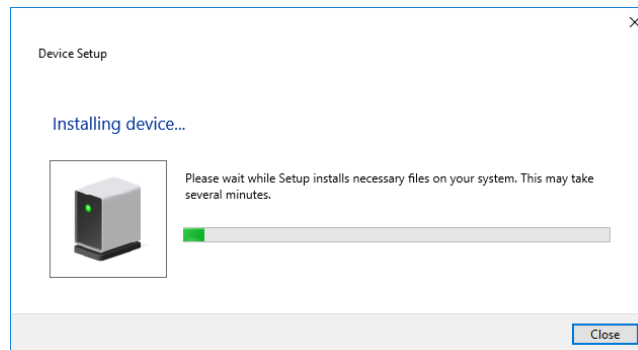


Figure 142: Wait for Windows to install your Bluetooth dongle.

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

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

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

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

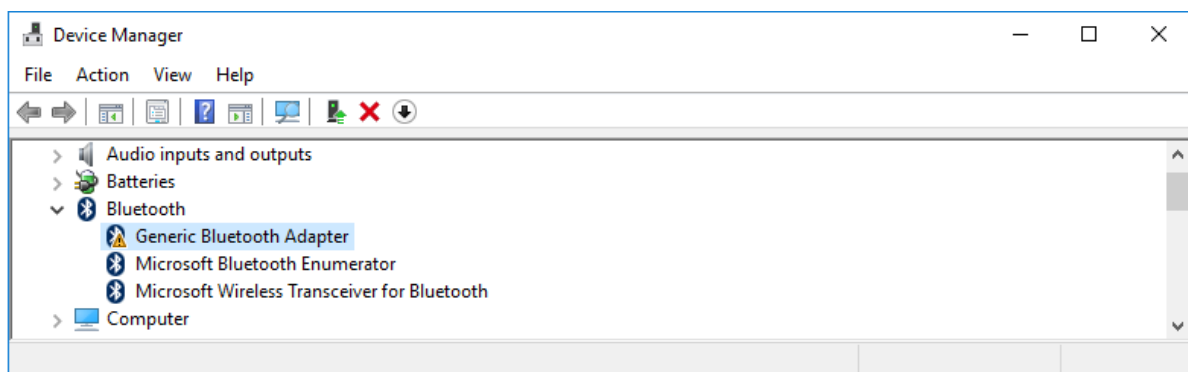


Figure 143: Bluetooth dongle listed in the device manager.

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

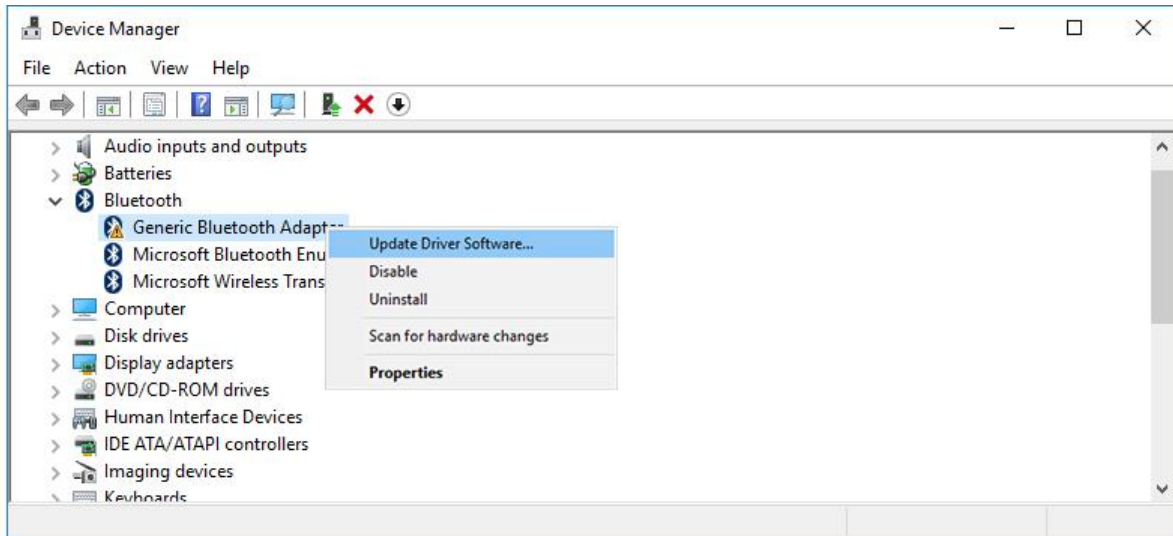


Figure 144: First step to update the driver of the Bluetooth dongle.

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

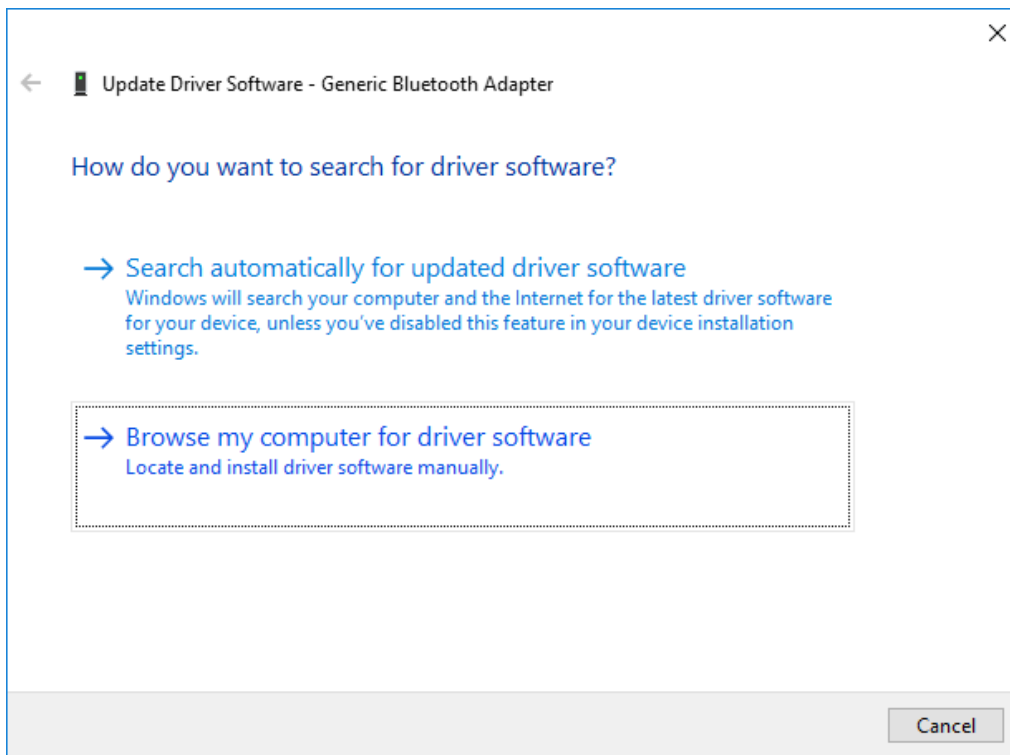


Figure 145: Browse for driver software.

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

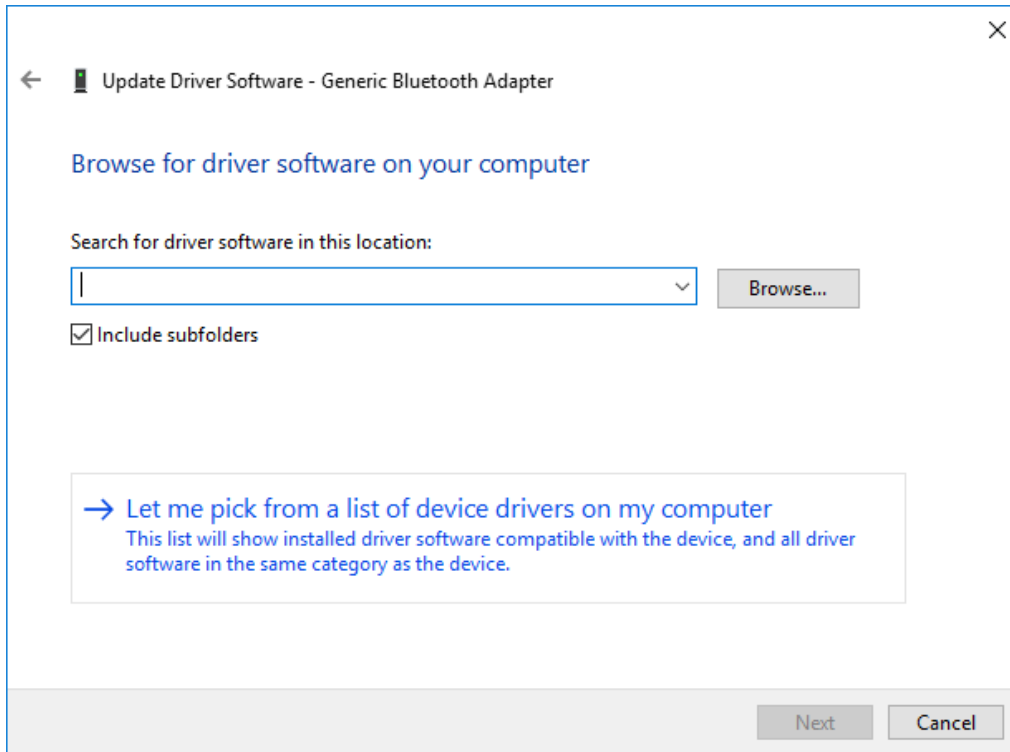


Figure 146: Pick driver from list of device drivers on the computer.

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

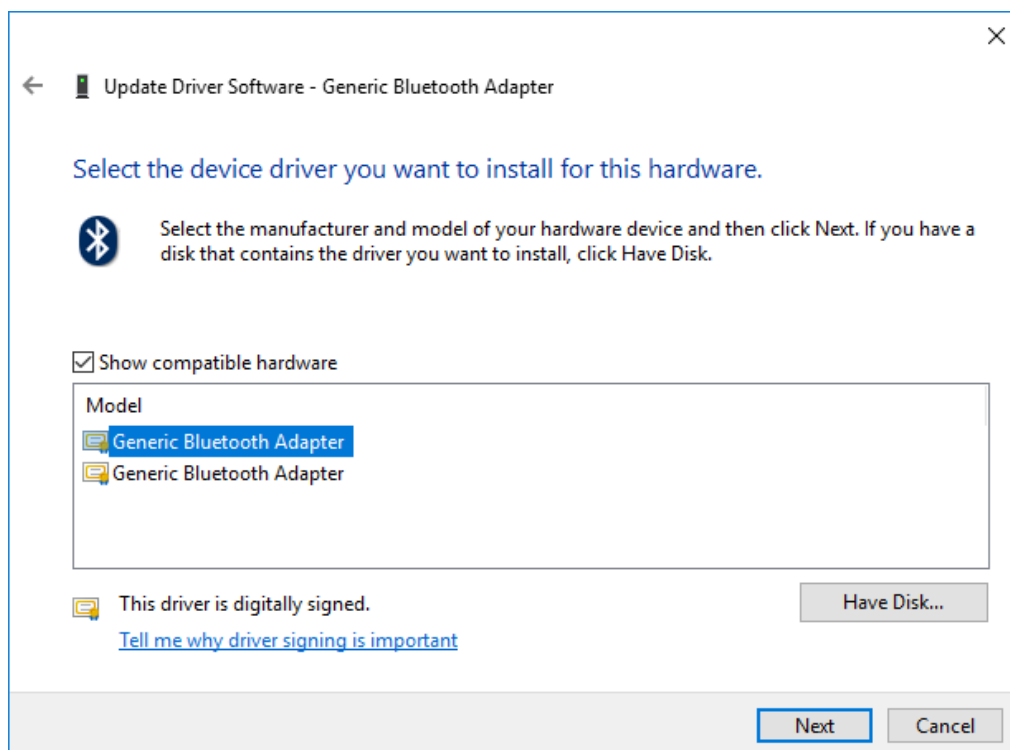


Figure 147: Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your *biosignalsplux* device (see *1.5 Connecting Bluetooth Devices*) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

7.2 Device Firmware & Update

biosignalsplux firmware updates are not done automatically. We recommend to frequently check if newer firmware versions are available and to upgrade or update the firmware on your device when newer versions are available to ensure full functionality and compatibility with all biosignalsplux sensors and accessories. Updating the biosignalsplux firmware lets you also take advantage of all the newest recording resolutions and offline scheduling features.

Newer versions of *OpenSignals (r)evolution* will also issue a notification if the firmware of your device is too old and not supported by your current version of *OpenSignals*.

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

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

NOTE

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

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

7.2.1 Checking Firmware Version

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

To do so, make sure that your device is charged and turned on (LED must blink green). If you haven't connected your device to your computer via Bluetooth before, connect your device following the instructions *1.5 Connecting Bluetooth Devices* before following the next steps.

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

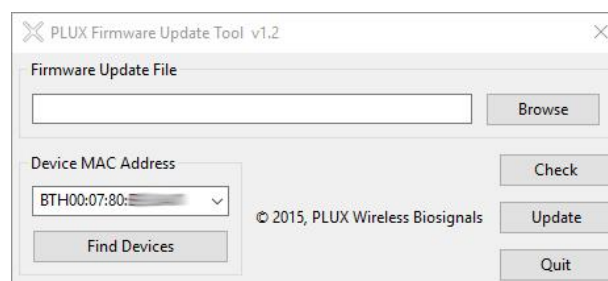


Figure 148: PLUX firmware update tool has found one biosignalsplux.

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

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

7.2.2 Updating or Upgrading Firmware

If your device is running on an older firmware³ it is recommended to update or upgrade the firmware for compatibility reasons with new features and to ensure that your device works properly with the newest version of the *OpenSignals (r)evolution* software.

To do so, make sure that your device is charged and turned on (LED must blink green). If you haven't connected your device to your computer via Bluetooth before, connect your device following the instructions *1.5 Connecting Bluetooth Devices* before following the next steps.

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

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

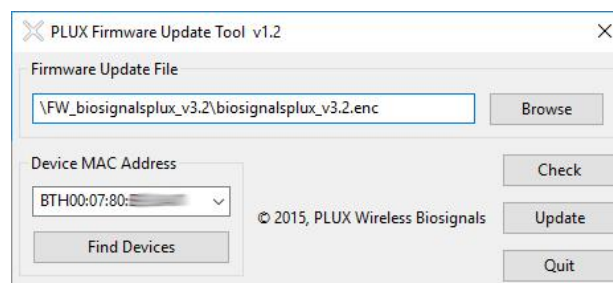


Figure 149: Firmware update tool is ready to update the firmware.

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

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

³ or if you need to upload another firmware to run with specific sensors (e.g. beta versions of new sensors)

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

7.3 Error List

The following table will help you resolve them. Do not hesitate to contact us if you have any other problems or questions. TID stands for Troubleshoot ID.

TID	Error:
1	No Bluetooth adapter found. Verify if an adapter is connected and turned on. - No Bluetooth adapter detected.
	Solution:
	If you have an internal Bluetooth Adapter or have the external Bluetooth Adapter Dongle plugged in your computer, the problem might be due to: - Driver or installation issue: Follow steps on section 3. Checking Bluetooth Adapter. - Using wrong drivers: To solve, follow instructions in 4. Changing to Microsoft Bluetooth Stack.
TID	Error:
2	The device could not be found. Verify that it is within range and turned on.
	Solution:
	Your Bluetooth Adapter is not being able to find the specified device. Either it's turned off, out of range or there's interference in the environment.
TID	Error:
3	The communication port does not exist or it is already being used.
	Solution:
	This exception usually means that the device to which you are trying to connect is already connected somewhere else. To solve, you can either shutdown the software that is connecting to the device or try turning off and on the device itself, since this action will close the connection.
	If you keep having this issue multiple times, it may be due to a problem with the Bluetooth Adapter when it comes to closing the connection to the device. Please try the instructions in 3. Checking Bluetooth Adapter or 4. Changing to Microsoft Bluetooth Stack.
	If the issue is still not solved, you have to manually force the disconnection of your software with the device after each interaction. To do so, follow the instruction in 6. Removing Paired Device.

TID	Error:
4	A socket operation was attempted to an unreachable network.

	- A socket operation encountered a dead
	Solution: This exception will present itself in your Windows language and when you are using a BITalino. The problem (and solution) is similar to TID 1.
TID	Error:
5	A connection attempt failed because the connected party did not respond after a period of time, or established connection failed because connected host has failed to respond.
	Solution: This exception will be presented to you in your native Windows language and if you're using a BITalino. The problem (and solution) is similar to TID 2.
TID	Error:
6	Only one usage of each socket address is normally permitted.
	Solution: This exception will be presented to you in your native Windows language and if you're using a BITalino. The problem (and solution) is similar to TID 3.

8 Safety Information

Please read the following safety instructions **before** using your devices system with *OpenSignals (r)evolution* to prevent any damages or issues with the user, test persons and/or devices being used in your acquisition setup and environments. Note, that violations of these instructions can lead to inferior signal quality and/or damages to the system and user.

All PLUX products and PLUX related *OpenSignals (r)evolution* products are hereinafter referred to as “device” and/or “devices”.

- ! The user should always keep the device and its accessories dry.
- ! The user must turn off the device and contact Technical Support if the device (system and/or accessories) reach uncomfortable temperatures.
- ! The user should not use the 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 device if experience any kind of discomfort or skin irritation.
- ! The user should not use the 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 device. Detection surfaces are single-user and disposable. Reusable electrodes should be reused by the same user. Do not use reusable electrodes on several users.
- ! The user must not place the device in the microwave.
- ! The user must not insert objects into the holes of the device.
- ! The user should not open the 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 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 device with caution and not expose the device or accessories to high accelerations and vibrations.
- ! The devices should not be used in patients with implanted electronic devices of any kind, including pace-makers, electronic infusion pumps, stimulators, defibrillators or similar.
- ! Do not apply electrodes over damaged or irritated skin.
- ! Do not use your device while charging its internal battery.

9 Regulatory & Legal Information

9.1 Disclaimer

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

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

9.2 Certification

OpenSignals (r)evolution and any PLUX device connected to this software do not have a medical device certification and are, therefore, not a medical device.

PLUX research products are intended for use in life science education and research applications with humans and not intended for diagnostics, cure, mitigation, treatment or prevention of disease.

9.3 Contact & Support

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

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