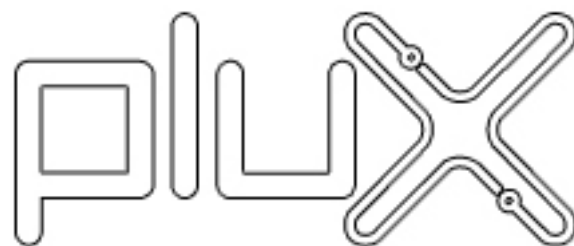




opensignals

(r)evolution

USER MANUAL



WIRELESS BIOSIGNALS S.A.



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1 - 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 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 *BITalino*.

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

It is available for Windows and Mac.

It is extendable with plug-ins that are provided with the device or can be purchased separately. It is even possible to create your own plug-ins with specific functions and instruments (this API will be published soon) and share them and your projects with the *BITalino* and BiosignalsPlux communities.

For more information visit: www.bitalino.com and www.plux.info



2 – How To Get Open Signals (r)evolution

You can download *OpenSignals (r)evolution* from the BITalino or BiosignalsPlux websites.

To download *Open Signals (r)evolution* visit the *BITalino* homepage and choose the version that supports your operating system (Windows/Mac), by clicking on the OS' logo.

Download at:

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

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

If your system is not supported by *Open Signals (r)evolution* yet, you may fill out the OpenSignals Request.

Therefore you have to fill in your Name (*NameBIT*), your e-Mail address (*MailBIT*), choose the not supported operating system and fill out the captcha.


The Request will be sent by clicking on the *SUBMIT* button.

OpenSignals Request

NameBIT

MailBIT

OS Mac Linux



Please Enter The Following

Help us prevent SPAM!

Fig. 1. OpenSignals Request



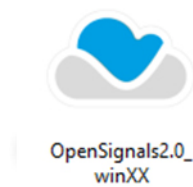
3 – Installation Guide

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

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

3.1 – Open Signals (r)evolution Installation

3.1.1 – Windows



Please select the Windows 32 or 64 bit installer, depending on the operating system you have installed on your computer.

Double click the *OpenSignals2.0-win(bit).exe* file and follow the standard installer steps. *Open Signals (r)evolution* will appear in your installed Program Files and on your desktop.

3.1.2 – Mac OSX



Double click on the *OpenSignals2.0_OSX.pkg* to start the installation. Follow the instructions of the installer, choose which users are allowed to use OS2, the installation path and confirm the installation.

Open Signals (r)evolution will appear on your Launchpad after a successful installation.

3.2 – Plug-Ins Information

Open Signals (r)evolution contains a list of plug-ins which are installed with the *Open Signal* software. These plug-ins are either included in your *BiosignalsPlux* kit or can be bought additionally to any of your *Plux* device(s).

In both cases these plug-ins have to be activated by *Plux* to be ready to use. Therefore an internet connection is only needed for the activation process, as the plug-ins are already installed with the *open signals* software and it is not needed to download them.

For more information about *Open Signals* plug-ins check Chapter 7 – Plug-Ins.



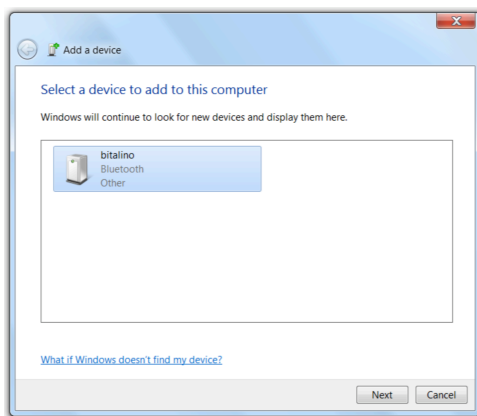
3.3 – Connecting Bluetooth Devices

Use the Bluetooth device manager provided by the operating system to create a Bluetooth connection between your PLUX device and your computer.

When connecting the device, you first need to enable Bluetooth on your computer or need to plugin an additional Bluetooth dongle to your USB port, if Bluetooth is not built in or reliable for your computer. BiosignalsPlux users receive this dongle as part of the package. BITalino users can purchase a trialed & tested Bluetooth dongle known to use with BITalino, at the BITalino web store.

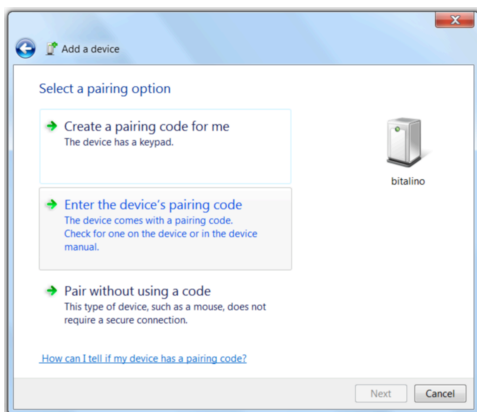
Note: There may be differences to the pictures in this manual as the device manager's interfaces can vary, depending from the operating system's version.

3.3.1 – Windows

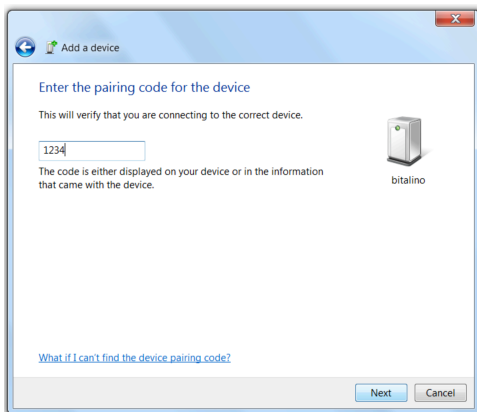


Press the Windows-key on your keyboard, go to System Preferences and start the Bluetooth device manager.

The manager will search for Bluetooth devices and add the *BITalino* when found. Click *Next* to continue.



To connect the device click on *Enter the device's pairing code [...]* and the window will proceed.



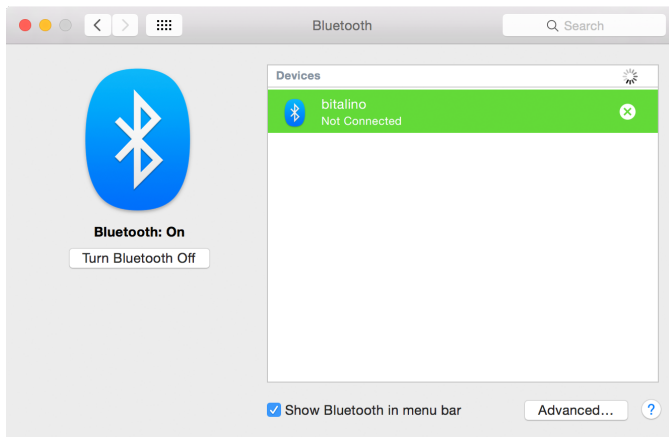
For BITalino, enter the pairing code *1234* and the connection between your *BITalino* and your computer will be build.


For BiosignalsPlux and MotionPlux, enter the pairing code *123*.

Fig. 2 Windows BT device manager

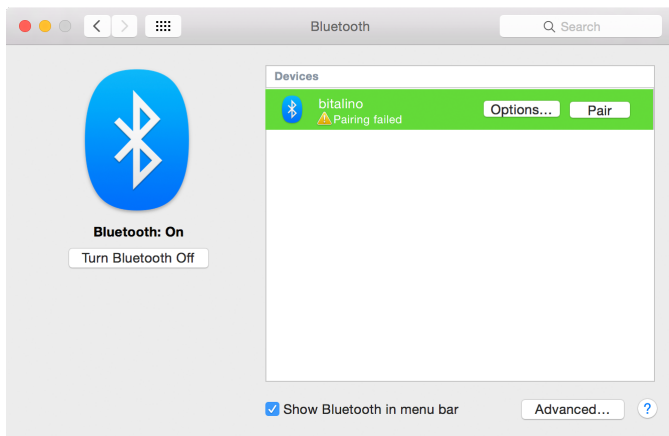


3.3.2 – Mac OSX



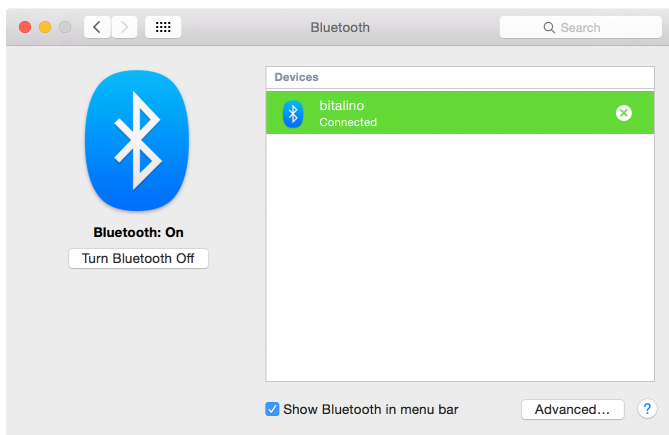
Click the  symbol on the upper left of your Screen, go to *System Preferences...* and start the Bluetooth device manager.

The device manager will search for devices and show you the *BITalino* when found.



Try to pair the *BITalino* with your Mac by clicking on *Pair* and an error message will be shown.

Click on *Options...* 1234 and the connection between your *BITalino* and your computer will be build, or 123 for your BiosignalsPlux and MotionPlux device



The device will be indicated as *Connected* and marked green, if the connection was successful.

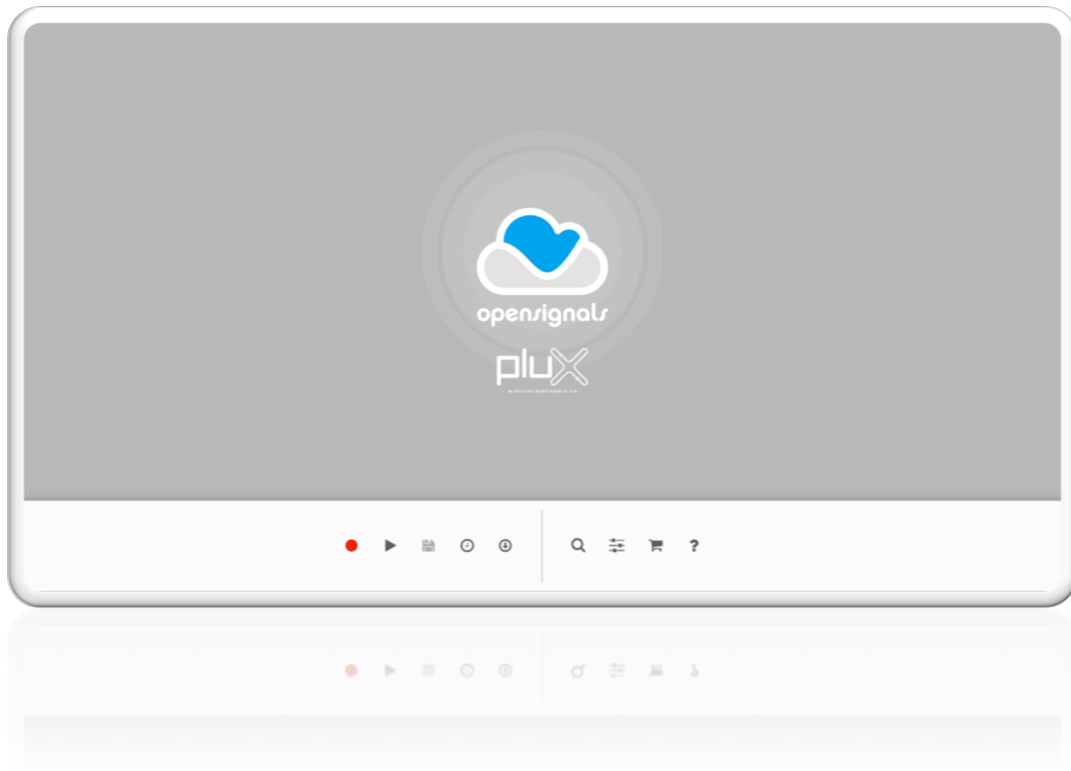
Fig. 3 MacOSX BT device manager












4 - Getting started with Open Signals (r)evolution

After installing *Open Signals (r)evolution*, Google Chrome and successfully connecting a BITalino device to the computer *Open Signals (r)evolution* is ready to use!

4.1 - Open Signals Main Interface



The main interface allows the access to all *Open Signals (r)evolution* menus and interfaces through the following buttons:

-  Starts the signal acquisition of selected channels
-  Visualizes recorded acquisitions
-  Manually saves the acquired signal(s) (when the Auto-Save option is disabled in settings)
-  Scheduling offline acquisitions for BiosignalsPlux* devices
-  Download PDF report of the acquired offline data
-  Device manager for device configurations
-  Acquisition settings
-  BITalino online store (accessories and components)
-  Open Signals (r)evolution Help

*BiosignalsPlux Professional devices only



Active or non-active options are differentiated through colours:

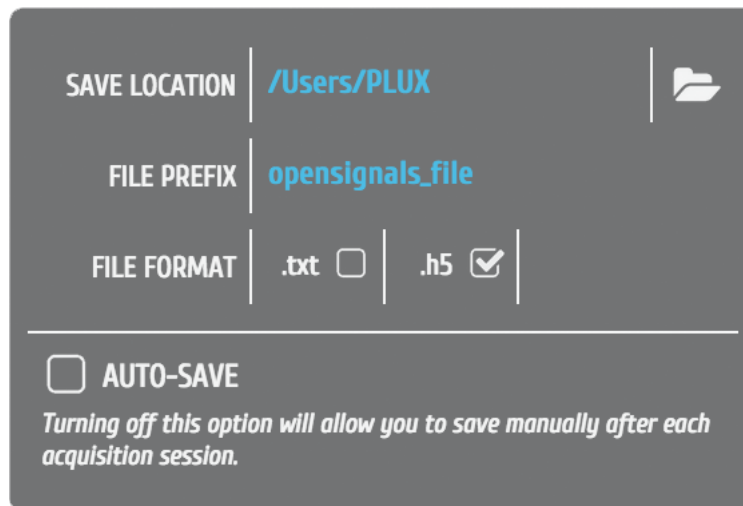
 Active

 Not active

General settings and device related settings should be configured before acquiring signals. The settings are divided in two different interfaces.

4.2 – Acquisition Settings

 Acquisition settings: save location, file name, format, auto-save



The screenshot shows a settings window with a dark grey background. It contains the following fields and options:

- SAVE LOCATION:** /Users/PLUX (with a folder icon on the right)
- FILE PREFIX:** opensignals_file
- FILE FORMAT:** .txt | .h5
- AUTO-SAVE:** AUTO-SAVE

Below the AUTO-SAVE option, there is a note: *Turning off this option will allow you to save manually after each acquisition session.*

Fig. 4 Settings window

SAVE LOCATION indicates the path in which the acquired signals will be saved.

FILE PREFIX will save all the acquired signals as the prefixes' value and add a timestamp to its name (Example: *opensignals_file_YYYY-MM-DD_hh-mm-ss.format_extension*).

FILE FORMAT saves the acquisitions into .txt-files or .h5-files. h5-files contains metadata which are used for signal visualization. txt-files don't have these metadata and are used to import the recorded data to third-party applications.

NOTE: *Saving recorded data to .txt-format needs you to manually save the acquisitions BEFORE visualising them, if the auto-save option is turned off. Open Signals (r)evolution will automatically save the acquisition to .h5-format by starting the visualization.*

AUTO-SAVE option automatically saves every recording session after ending them.



4.3 – Device Manager

Q Device Manager: select device(s), channels, channel labels, trigger, sample rate, resolution

Open the device manager to search and configure your device(s) over Bluetooth. *Open Signals (r)evolution* will search and show an overview of new or known devices, as seen below.



Fig. 5 Open Signals device overview

ENABLE will set the selected device as acquisition device.

To refresh the device list, click on the *Devices* button. Open Signals will then scan its surroundings again and list all found devices.

4.4 – Setting Up Devices

The device header extends when clicking on it and shows several device related settings such as channel status, channel labels, sampling rate, resolution, trigger and synchronisation settings.

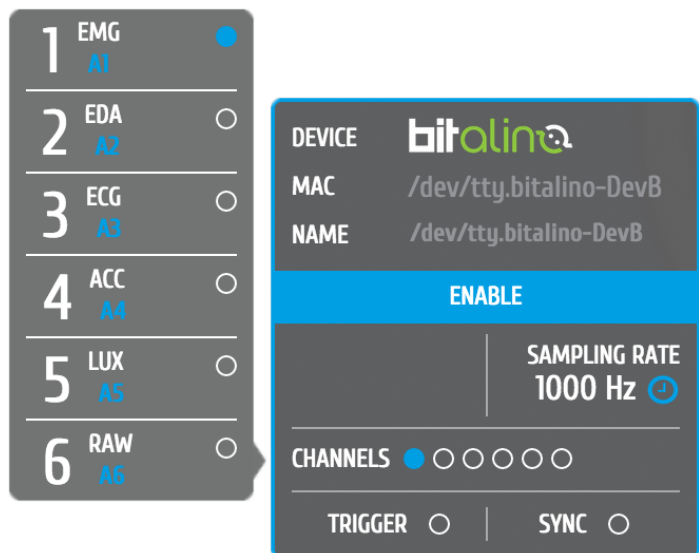


Fig. 6 BITalino extended header



4.4.1 – Resolution, Sampling Rate, Trigger and Synchronisation

RESOLUTION sets the minimal (digital) step between each acquired value.

SAMPLING RATE sets the amount of recorded samples per second.

Sensor	Minimum f [Hz]
EMG (electromyography)	1000
EDA (electro dermal activity)	10
ECG (electrocardiography)	100
ACC (accelerometer)	100
LUX (photodiode)	10



10 Hz

100 Hz

1000 Hz

SYNC offers the option for BiosignalsPlus users of using more than one device at the same time and synchronising all the devices with each other to prevent time offsets. (For more information go to Chapter 6 – Multi-Device Acquisition)

4.4.2 – Channel Settings

A – Channel number

B – Channel Type

C – Label change

D – Channel State

To get a better and correct visualization of the channels, choose the right channel types of each channel. The type will not only name a channel scale the visualization axis.

Data acquisition from a given channel can be enabled / disabled by clicking on them (Channel State; empty circle = offline, blue circle = online).

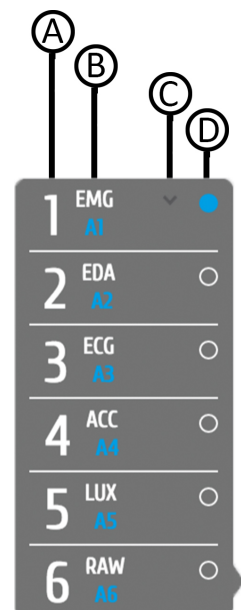


Fig. 7 Channel Settings



4.5 - Recording Signals

After setting up the device go to the main interface and click on the red recording button to start the acquisition.

- Starts the acquisition

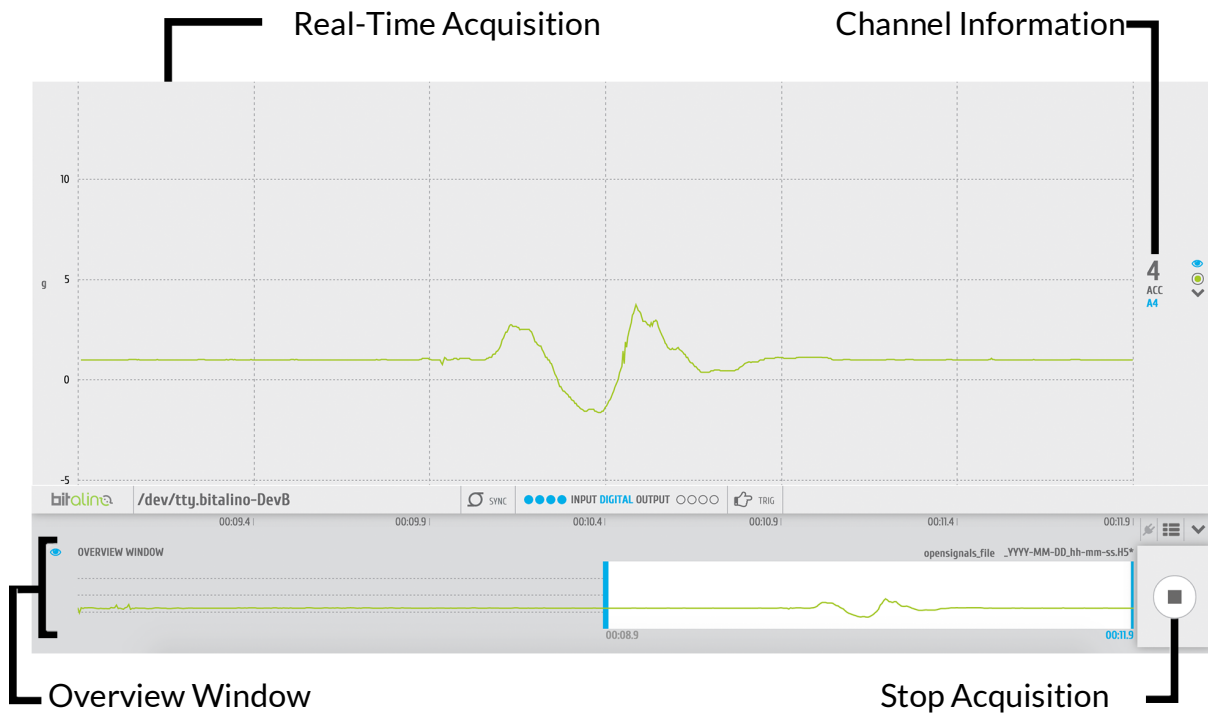
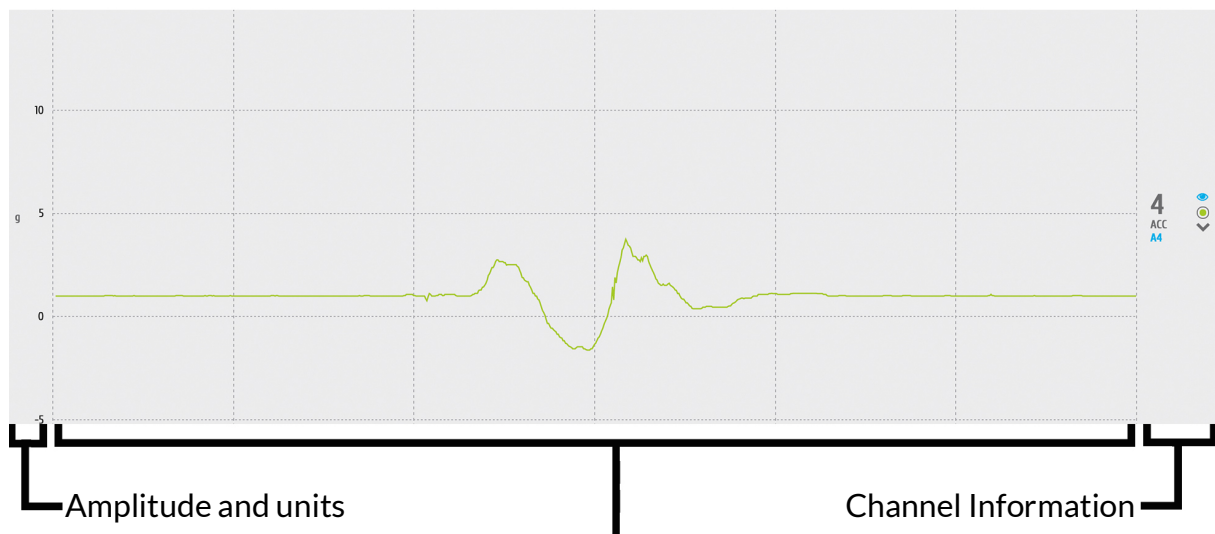


Fig. 8 Real-Time acquisition window

4.5.1 - Real-Time Acquisition



Data stream sent from the device in real-time

Fig. 9 Acquisition window

Real-Time visualization shows signals sampled from the device in Real-Time. This part of the interface is divided in three parts: Amplitude and units, the signal itself and channel information.



Amplitude and units are automatically scaled and assigned, when the channel type for this acquisition is set in the device manager (*here: ACC*).

Channel information contains the channel values, such as type and channel number, set in the device manager. The signal seen above was acquired using the accelerometer (ACC) on channel 4, digital input A4.

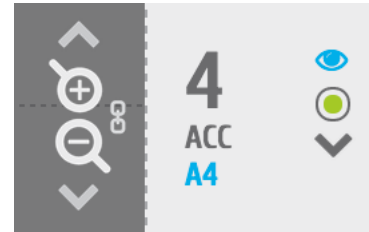










Fig. 10 Channel information

Two arrows (up/down) and two magnifying glasses (+/-) appear next to the channel information on the Real-Time visualization when scrolling over it with the mouse cursor.

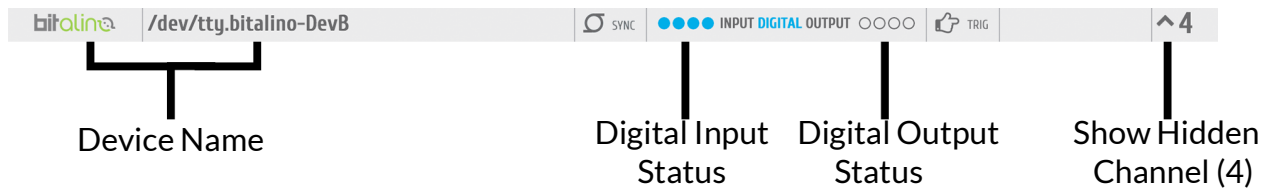
The chain will tether all channels of the same type. When the scaling of one of the connected channels is changed, the scaling of all the other connected channels will be changed too.

Symbol explanations:

-  Zoom in (ordinate)
-  Zoom out (ordinate)
-  Moves the zero line up
-  Moves the zero line down
-  Connects visualization format for channels of same type
-  Show/Hide signal in overview window
-  Sets signal colour (here in green)
-  Hides channel

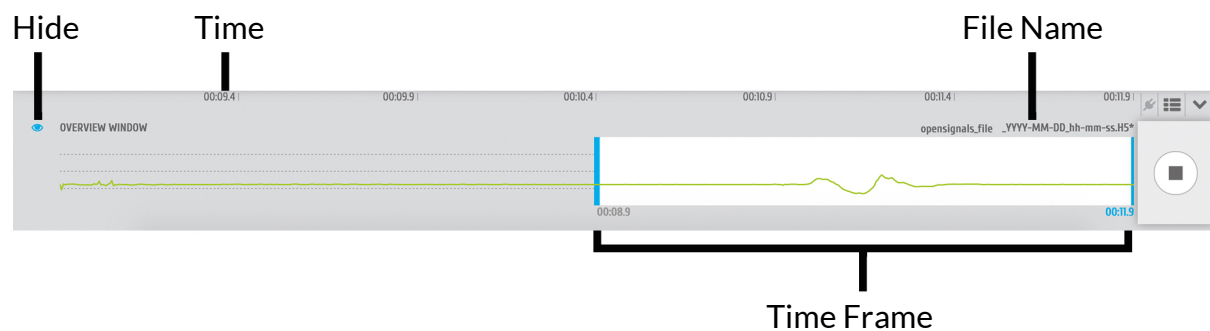


4.5.2 – Information Bar



The information-bar shows which device is being used, if it is synchronised with other devices, its input and output channel statuses and if it's a triggered acquisition. Hidden channels can be opened again by clicking on the up-arrow next to the channel number.

4.5.3 – Overview Window



The overview window manages the time axis and gives additional information about the file name. The time frame is changeable to adapt to the users signal. Its interval can be extended or reduced by moving one of the two blue borders. Changing the time frame's interval will also change the time line formatting in the Real-Time acquisition window.

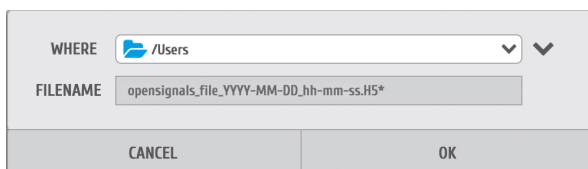
Symbol explanations:

- Stops the acquisition
- Shows a list of usable plug-ins
- Changes the order of acquiring channels
- Hides all channels
- Hides all channels in the overview window

4.5.4 – Saving Manually

If you're using *Open Signals (r)evolution* without the auto-save option you have to save your acquisitions manually. Go to *Open Signals'* main interface and click on the saving button.

Open saving-file window



The saving dialogue will pop up. Click on the down-arrow next to the *WHERE* field to get a better overview of the files and folders in the chosen file path.

Choose the file path and accept saving your signal by clicking on *OK*.



4.6 – Visualise Signals

To visualise recorded signals go to the main interface and active the *play* button.

▶ Starts signal visualization

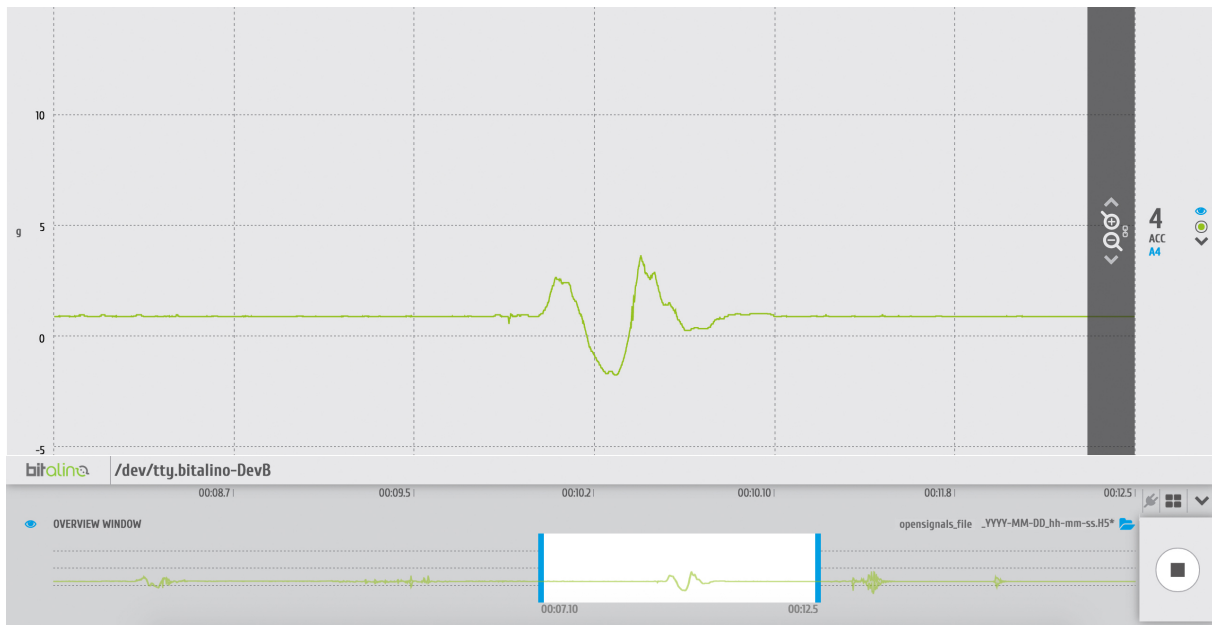


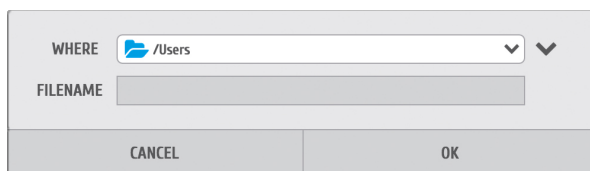
Fig. 11 Visualization window

The visualization window and the already known Real-Time acquisition window are very similar. Therefore the options from before are also available here.

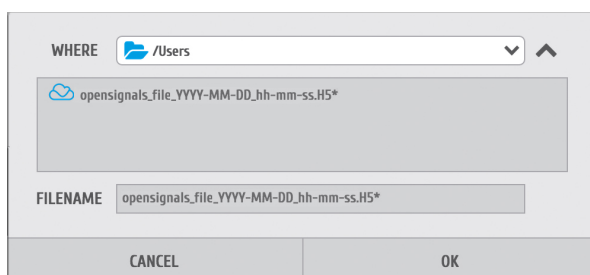
Differences can be found when looking at the overview window. The whole acquisition is now shown in this window. The time frame is also changeable and was set to show the same signal segment as in the examples before.

4.6.1 – Open Acquired Signals

📁 Starts open-file window



The *Open File* dialogue will pop up. Click on the down-arrow next to the *WHERE* field to get a better overview of the files and folders in the chosen file path.



Click on an *Open Signals* .h5 file and load it to the visualization module by accepting with *OK*.



4.6.2 – Multi-Channel Visualization

An acquisition can also consist of several channels. The visualization of such acquisitions looks like this example (EMG, ACC and LUX):

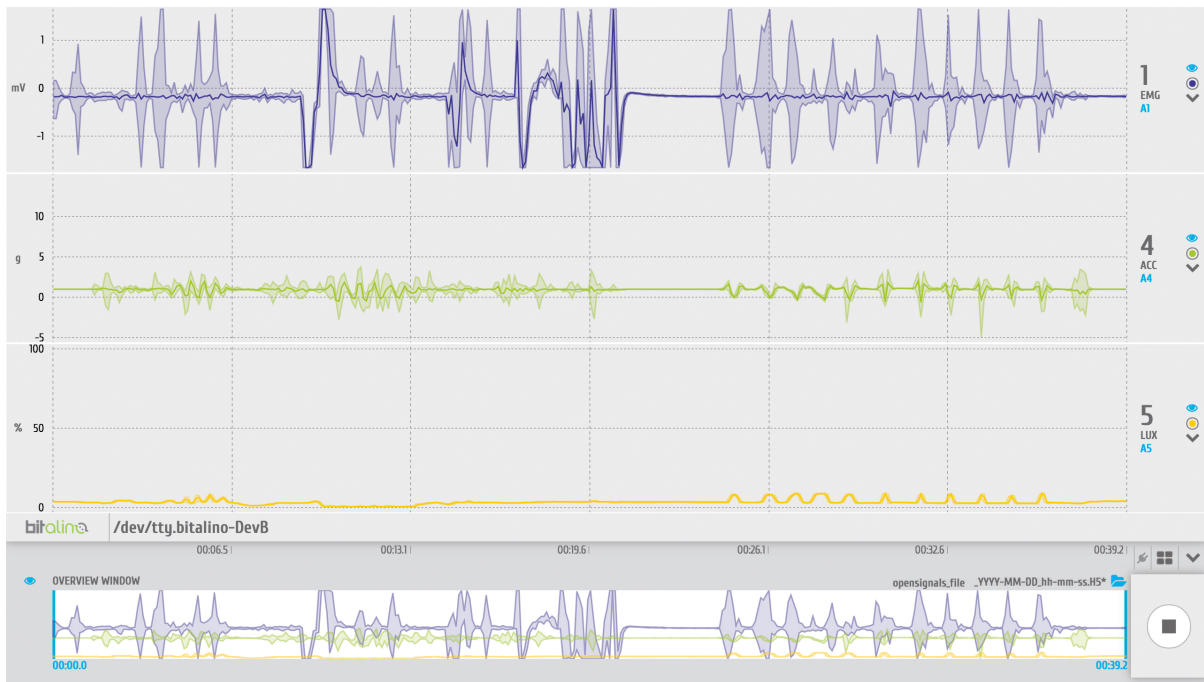


Fig. 12 Visualization of three channels (full time range)

The visualization extends the visualised time interval (Overview Window) over the whole acquisition. Each channel is shown in 2 different colours, the dark one shows the arithmetic mean of each signal and the light one shows a rough visualization of the real acquisition.

Shortening the visualising time interval will show the correct visualization of each channel, but maintain the rough visualization in the overview window.

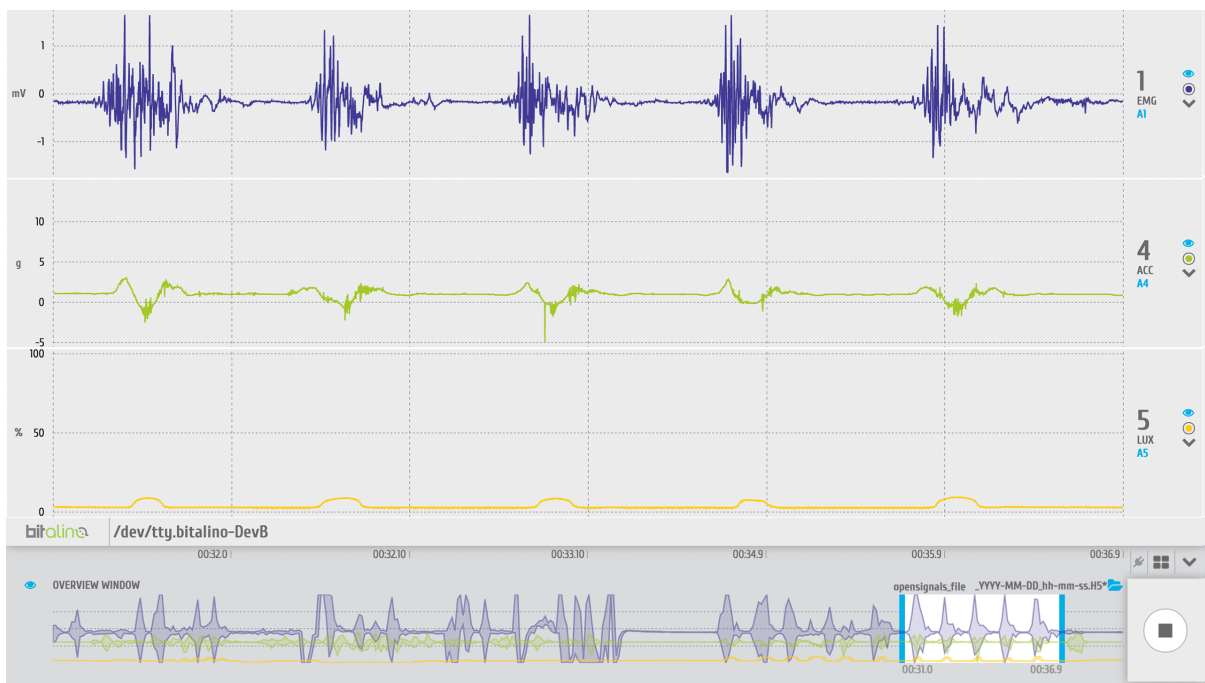


Fig. 13 Visualization of three channels (time interval)



4.7 – Scheduling

4.8 – Downloading PDF Report

4.9 – Synchronisation Kit

ADAPT, SYNC, LED and SWITCH are all components of the synchronisation kit provided as an option to BiosignalsPlux users. To connect these components to your BiosignalsPlux plug the micro USB connector of your equipment to the digital port (left/right arrow) of your device.

Note: Components of the synchronisation kit require a digital port. As only the 8 channels BiosignalsPlux has a digital port it is the only device that is compatible with the components below.



4.9.1 – Sync

The SYNC cable allows you to connect up to three BiosignalsPlux devices, to synchronise their acquisition and to prevent signal drifts caused by the difference between each device’s internal clocks.

More information about the Sync set-up and the SYNC function in Open Signals is available in Chapter 6 – Multi-Device Acquisition

4.9.2 – Trigger/Switch

The trigger/switch is useful to manually introduce markings in the acquisition signals or to activate the acquisition by manually pressing the switch button and using it as a trigger.

Trigger: The trigger function can be enabled in the device manager by clicking on *TRIGGER* in the device’s extended header (circle will turn blue). The trigger function state can also be seen in the information bar in the acquisition window.



Fig. 14 Trigger function in the Information Bar

4.9.3 – LED light

The external LED light can be used to give additional visual information besides the signal itself. This can be used for example for testing reaction times of test persons.

The LED light can be activated by sending a signal to the digital output of your BiosignalsPlux device via Open Signals. To do so, click on the empty circle next to *DIGITAL OUTPUT* in the information bar. The information about when the LED was activated will be added to the acquisition.



Fig. 15 Digital Output in the Information Bar



4.9.4 – Adapt

Adapt has the purpose of enabling the connection of several components at the same time. Therefore connect the single micro USB male end to the hub and the components to one of the female connectors of the adapt cable. The configuration of the component maintains the same as using only one component at a time.

4.10 – Open Signals Help Interface

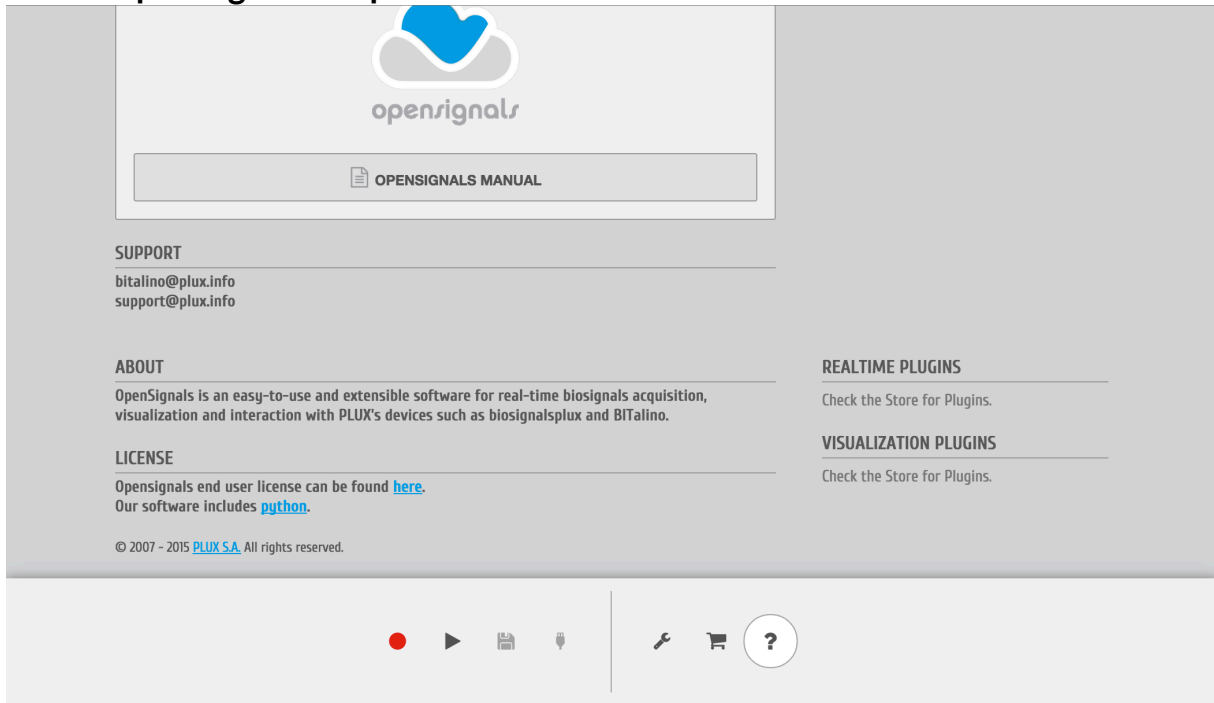


Fig. 16 Help Interface

The help interface offers a great amount of information and documents for the use of open signals.

? Opens the help interface

The *Open Signals (r)evolution User Manual* can be downloaded by clicking on the *OPENSIGNALS MANUAL* field, right below the OS logo.

Don't hesitate to contact us if you're struggling with any kind of problems that cannot be solved with the information in this manual. Write an e-mail to one of the addresses shown in the *Support* section. To be able to offer you the best service please add as much information as possible about the problem that occurred and, if possible, about the configuration and device you where using. Add screenshots of the problem if it can be seen in the interface or a copy of the terminal/console text.

The "Open Signals Terms of Use" are available in the *License* section if it's needed to reread them.

This section can also bring you to the Python.org homepage, where you can get more information about the Python programming language, in which Open Signals was written.



You can see the list of your available plugins and de/select them in the *Realtime Plugins* and *Visualization Plugins* section, as needed. Please check Chapter 7 – Plug-Ins for further information.

Want more information about Open Signals, Plux devices and Plux in general?
Then click on PLUX S.A. in the *License* section and you will be directed to the Plux homepage!



5 – Advanced Device Configuration and Information

Open Signals (r)evolution is compatible with all PLUX devices. It is recommended to use the following, specific configurations of each device to obtain the best acquisition results.

Note: BiosignalsPlux / MotionPlux Open Signals (r)evolution connection is not available for Mac OSX yet (Windows only).

5.1 – BITalino

Note: This BITalino configuration does work for the board, freestyle and plugged kit, but consider adapting the channel configuration to your setup as the channel configuration is pre-set for the board kit, but not for the other kits due to user depended setups.

CHANNEL TYPES

EMG	Electromyography
EDA	Electrodermal Activity
ECG	Electrocardiography
ACC	Accelerometer
LUX	Photodiode
RAW	Non-scaled signal visualization

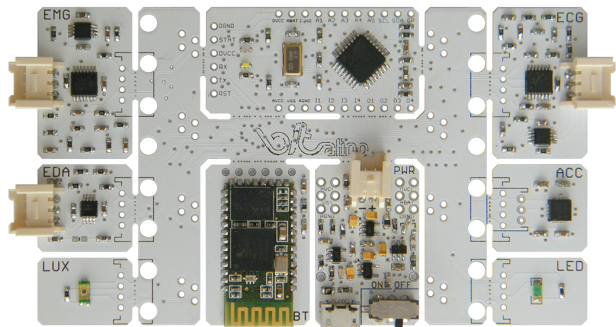


Fig. 17 BITalino Board

CHANNEL CONFIGURATION

BITalino's standard channel configuration:

- 1 EMG
- 2 EDA
- 3 ECG
- 4 ACC
- 5 LUX
- 6 Free for other (third party) components

The channel configuration is to be set up as seen on the image or above. Channel numbers are also listed in BITalino's manual or on the backside of each sensor (A[number]).

The 6st analogue input is free for adding other components (BITalino or third party components), such as trigger buttons or other accelerometer axis (only z-axis is connected to the MCU).

(For information about how to set the channel types check 4.4.2 – Channel Settings)

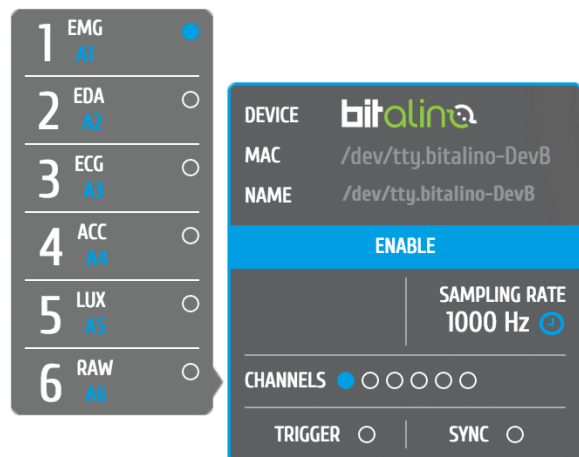


Fig. 18 BITalino extended Open Signals header



RESOLUTION

The resolution is pre-set to 10-bit for the first 4 channels and 6-bit for the last two and is not changeable, as the BITalino does not support other resolutions.

SAMPLING RATE

It's recommended to use a sampling rate of 1000Hz. Use at least 100Hz if the first configuration causes too much signal delay, otherwise you will get unusable results for EMG and ECG acquisitions.

LED STATES

<i>White LED</i>	Low frequency blinking on stand-by mode
<i>White LED</i>	High frequency blinking when acquiring
<i>Red LED (MCU)</i>	Battery is running low
<i>Red LED (Power Unit)</i>	BITalino is turned off; Battery's charging

<http://bitalino.com/index.php/learn/documentation>



5.3 – BiosignalsPlux

CHANNEL TYPES:

ECG	Electrocardiography*
EMG	Electromyography*
HANDGR	Handgrip (Force Measurement)*
RESP	Respiration*
RAW	Non-scaled signal visualization
XYZ	Accelerometer
CUSTOM	User-scaled visualization
GONIO	Goniometer*
EDA	Electrodermal Activity*
BVP	Blood Volume Pressure*
EEG	Electroencephalography*



Fig. 19 8 channel BiosignalsPlux hub

*These channel types have pre-set signal visualization scales

CHANNEL CONFIGURATION

BiosignalsPlux has no fix channel configuration. Every single channel is compatible with all BiosignalsPlux-Sensors and the user decides how to set up the device and channel type configuration.

(For information about how to set the channel types check [4.4.2 – Channel Settings](#))

As most of the channels have pre-set signal visualization scales, only *CUSTOM*, *XYZ* and *RAW* offer the possibility to modify *GAIN*, *OFFSET* and *UNIT* values.

RESOLUTION

BiosignalsPlux has changeable resolution values of 8bit and 12bit.

12bit values leads to a more accurate and precise resulting signal. On the other hand it needs more resources from your computer, which may cause delay in the signal acquisitions if your computer does not support the recommended requirements.

SAMPLING RATE

The sampling rate can be set between 100Hz and 1000Hz (by 100Hz steps).

The higher the sampling rate is, the more precise are the resulting signals, as there exists a greater amount of samples, but just as the resolution it consumes more of your systems resources and can cause delay in the Real-Time visualization.

LED STATES (for single-device and multi-device acquisition)

Main Rules:

1 blink	Device is idle
2 blinks	Device is acquiring
Green Blink	Bluetooth on
Red Blink	Low Battery
Green	Charging
Orange blink	Internal acquisition



Detailed Information:

<i>none</i>	Power down (RTC is running)
<i>1 Green Blink</i>	Idle; Bluetooth on
<i>2 Green Blinks</i>	Real-time acquisition; Bluetooth on
<i>1 Red Blink</i>	Idle; Low battery; Bluetooth on
<i>2 Red Blinks</i>	Real-time acquisition; Low battery; Bluetooth on
<i>1 Black Blink in the Background</i>	Idle; Charging; Bluetooth on
<i>2 Black Blinks in the Background</i>	Real-time acquisition; Charging; Bluetooth on
<i>1 Orange Blink</i>	Waiting for external trigger to start internal acquisition; Bluetooth off
<i>1 Orange Blink alternating with 1 Red Blink</i>	Waiting for external trigger to start internal acquisition; Low battery; Bluetooth off
<i>2 Orange Blinks</i>	Internal acquisition; Bluetooth off
<i>Orange - Red Blinks</i>	Internal acquisition; Charging; Bluetooth off
<i>2 Orange blinks in green Background</i>	Internal acquisition; Charging; Bluetooth off
<i>Orange - Green Blinks</i>	Internal acquisition; Bluetooth on
<i>Green - Red blinks</i>	Internal acquisition; Low Battery; Bluetooth on
<i>Orange - Black blinks in green background</i>	Internal acquisition; Charging; Bluetooth on

BUTTON BEHAVIOUR

<i>Device state before button press:</i>	<i>Device state after button press:</i>
Power Down	Idle
Idle or real-time acquisition	Power down
Internal acquisition (Bluetooth on)	Intern acquisition (Bluetooth off)
Internal acquisition (Bluetooth off)	Internal Acquisition (Bluetooth on)



5.2.1 BiosignalsPlux Explorer Channels – 4 Channel Device

BiosignalsPlux Explorer offers 4 input channels for sensors and a ground connection. The user can set up these 4 channels, as it is needed.

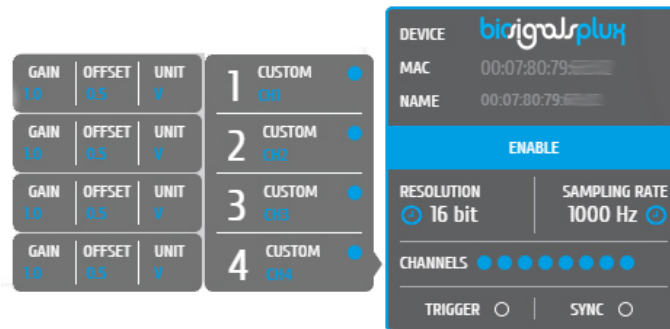


Fig. 20 4 channel BiosignalsPlux extended Open Signals header

5.2.2 BiosignalsPlux Researcher/Professional Channels – 8 Channel Device

BiosignalsPlux Researcher/ Professional offers 8 input channels for sensors, a ground connection and a digital port for synchronisation with other devices via USB connection, using the SYNC-function (see Chapter 6 – Multi-Device Acquisition). The user can set up these 8 input channels, as it is needed.

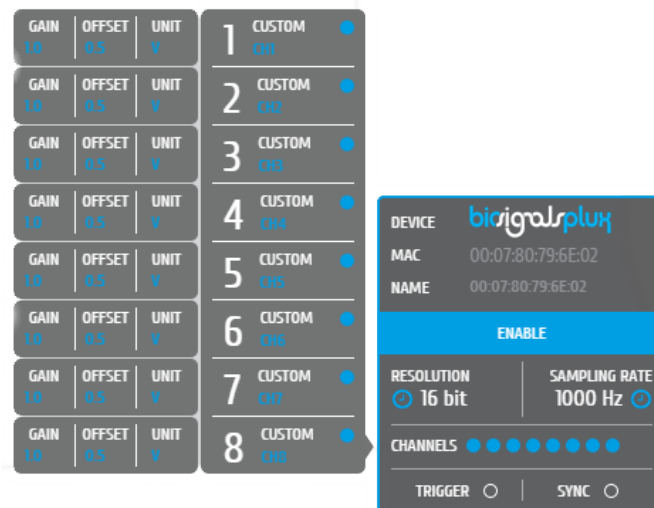


Fig. 21 8 channel BiosignalsPlux extended Open Signals header

<http://www.biosignalsplux.com>



5.3 – MotionPlux

(Open Signals (r)evolution and BiosignalsPlux connection is not supported on Mac OSX yet)

CHANNEL TYPES:

ACC	Accelerometer
MAG	Magnetometer
RAW	Non-scaled signal visualization
CUSTOM	User scaled signal visualization

CHANNEL CONFIGURATION

MotionPlux' standard configuration:

- 1 Accelerometer (X-Axis)
- 2 Accelerometer (Y-Axis)
- 3 Accelerometer (Z-Axis)
- 4 Magnetometer (X-Axis)
- 5 Magnetometer (Y-Axis)
- 6 Magnetometer (Z-Axis)



Fig. 22 MotionPlux

The channel configuration is to be set up as seen on the image or above. Channel numbers are also listed in MotionPlux' data sheet.

The first three channels, 1-3, belong to the accelerometer and each of these 3 channels receives the signals for one specific axis.

The last three channels, 3-6, belong to the magnetometer and each of these 3 channels receives the signals for one specific axis.

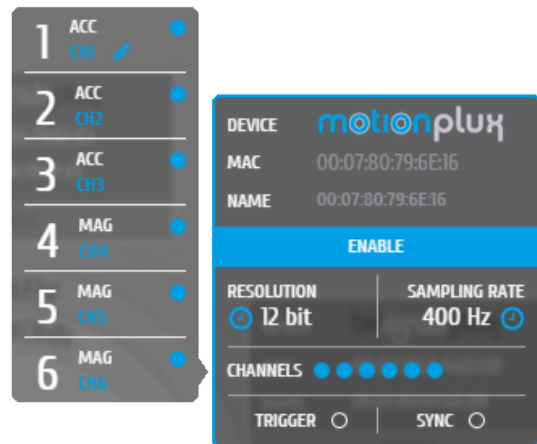


Fig. 23 MotionPlux extended Open Signals header

(For information about how to set the channel types check 4.4.2 – Channel Settings)

RESOLUTION

MotionPlux has changeable resolution values of 8bit and 12bit. 12bit values leads to a more accurate and precise resulting signal. On the other hand it needs more resources from your computer, which may cause delay in the signal acquisitions if your computer does not support the recommended requirements.

SAMPLING RATE

The sampling rate can be set to 50Hz, 100Hz, 200Hz or 400Hz.

The higher the sampling rate is, the more precise are the resulting signals, as there exists a greater amount of samples, but just as the resolution it consumes more of your systems resources and can cause delay in the Real-Time visualization.



LED STATES

<i>Blinks 1/sec</i>	Stand-By
<i>Blinks 2/sec</i>	Acquiring
<i>Blinks Green</i>	High battery level
<i>Blinks Red</i>	Low battery level
<i>Constantly Green</i>	Charging

5.4 – Force Platform

(*Open Signals (r)evolution* and *BiosignalsPlux* connection is not supported on Mac OSX yet)

[COMING SOON]

5.5 – Advanced Goniometer

(*Open Signals (r)evolution* and *BiosignalsPlux* connection is not supported on Mac OSX yet)

[COMING SOON]



6 – Multi-Device Acquisition (SYNC)

One of *Open Signals (r)evolution's* newest features is the possibility of multi-device acquisitions. This feature enables to connect 2 or 3 of PLUX' BiosignalsPlux Researcher/Professional devices to each other via a sync cable and to acquire data from both devices at the same time.

Longer acquisitions without this SYNC-function would cause signal drifts, due to that each BiosignalsPlux HUB have a different internal clocks. The acquired signals would therefore be visualized with a time shift, which is not accurate, and in longer acquisitions can appear seconds apart.

The SYNC-function solves this problem through sample selection and manages the receiving signals differently, as in non-synchronised signal acquisitions. (For more information see 6.3 – Open Signals (r)evolution Synchronisation)

6.1 – Connecting Devices

Therefore connect the BiosignalsPlux Pro hubs with a BiosignalsPlux micro USB cable, as shown in the picture below.

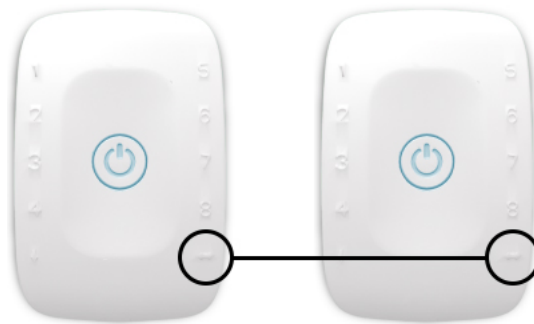


Fig. 24 Channels for sync cable connection

This device synchronisation is only available for 8-channel BiosignalsPlux Pro devices, as only these have the required digital output for this function.

Note: 3-device connections are also possible but most Bluetooth adapters do only provide stable connections for maximum two devices. Make sure your Bluetooth adapter is compatible with 3-device connections. Also you need a micro USB y-cable sync-cable

6.2 – Synchronisation Set Up

Configure your devices as explained in the chapters before (Note that all devices need to be configured with the same sampling rate. We also recommend using the same resolution to prevent signal differences caused by different resolution settings).

Click on one of your devices in the device manager and activate the SYNC function.



Fig. 25 Selection of sync-devices

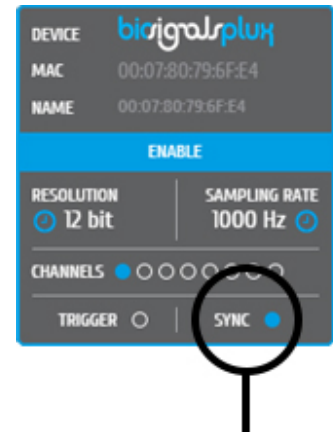


Activating this function in one device will activate it in all the other connected devices and lead to a synchronised signal acquisition.

You can now start the acquisition.

6.3 – Open Signals (r)evolution Synchronisation

The SYNC function will synchronise all the connected devices and prevent time delays between the online channels. *Open Signals* will for that compare the amount of received samples from each device in a certain, pre-set time frame and adjust the amount of samples.



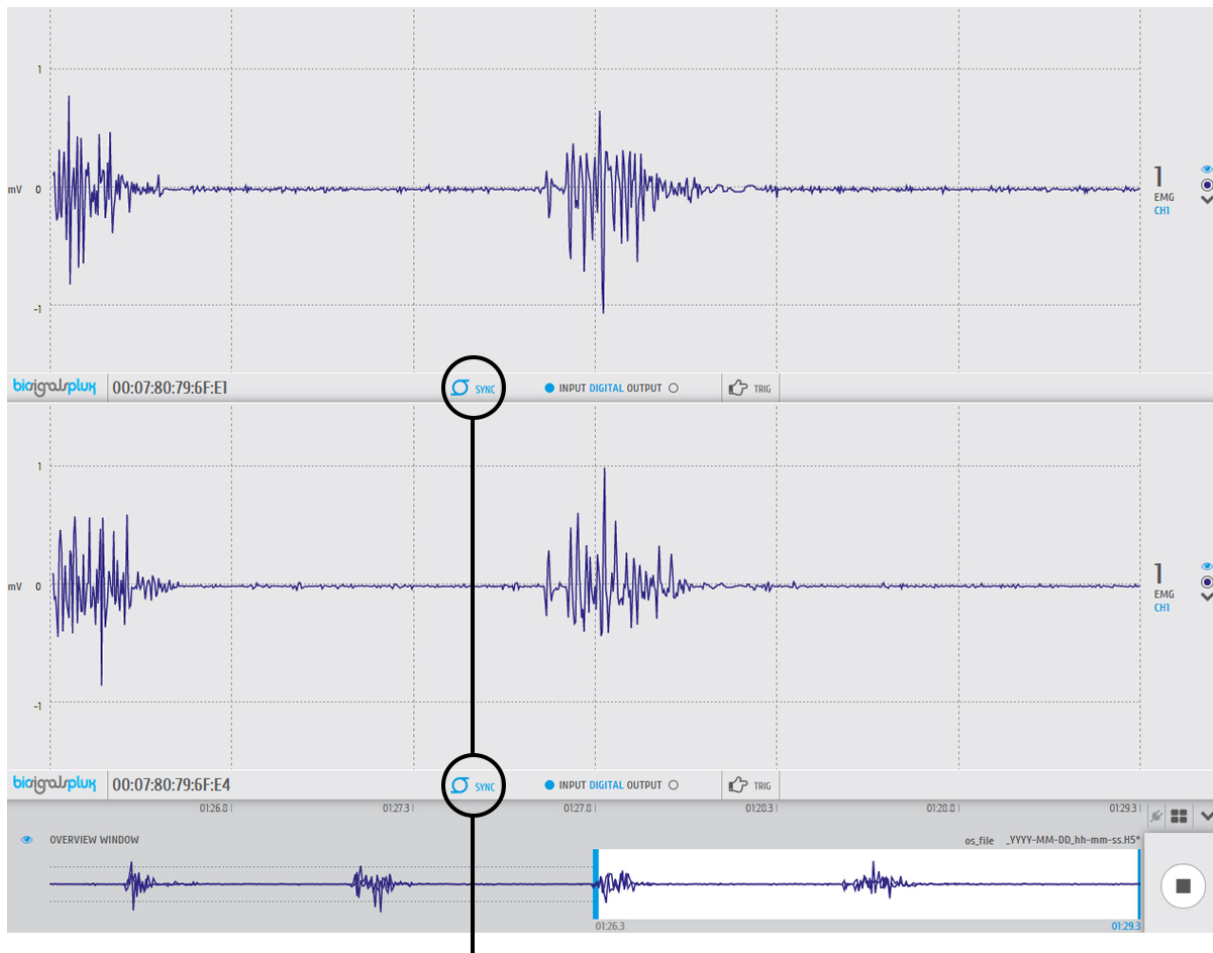
Activate Synchronisation

Example: Device A 5 samples in $\Delta T = 0.01$ sec
 Device B 4 samples in $\Delta T = 0.01$ sec

> *OpenSignals (r)evolution* will adjust the amount of samples by removing 1 sample from device A. This will lead to a synchronised signal, with the same amount of samples for each device during a determinate time interval.

6.4 – Synchronised Signal Acquisition

This is what a synchronised signal acquisition of two BiosignalsPlux devices looks like:



Activated SYNC Function

Fig. 26 Synchronised data acquisitions



On the first look, the only difference between a normal and the synchronised acquisition may be the activated sync-symbol on each device's information-bar. There is no other difference for the regular *Open Signals* user.

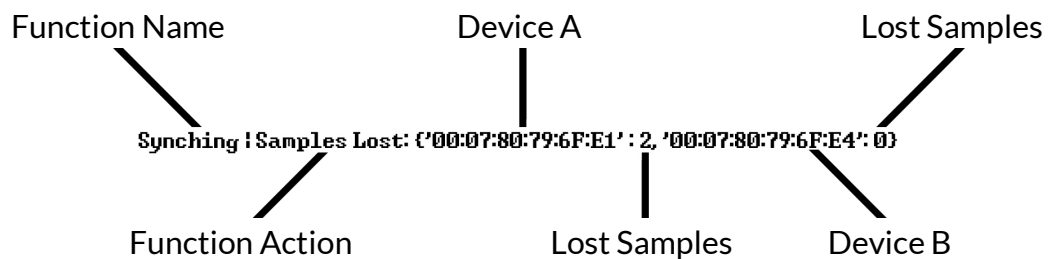
The real effect of this function can only be seen when starting *Open Signals (r)evolution* via the cmd.exe (Windows) or the mac terminal (Mac OSX).

```
C:\Windows\system32\cmd.exe
Synching | Samples Lost: <'00:07:80:79:6F:E1' : 2, '00:07:80:79:6F:E4' : 0>
Synching | Samples Lost: <'00:07:80:79:6F:E1' : 1, '00:07:80:79:6F:E4' : 0>
Synching | Samples Lost: <'00:07:80:79:6F:E1' : 3, '00:07:80:79:6F:E4' : 0>
Synching | Samples Lost: <'00:07:80:79:6F:E1' : 1, '00:07:80:79:6F:E4' : 0>
```

Fig. 27 Open Signals log shown in Windows' command program (CMD.exe)

The theory of the SYNC-function, explained in 6.3 - Open Signals (r)evolution Synchronisation, can be seen in action in this extract of the CMD-window that documented the acquisition of the signal above.

How to interpret each line:



SYNC compares the amount of samples of Device A and Device B. If the A's sample amount is greater than B's, it activates the Samples Lost action and removes 2 samples from Device A and 0 samples from device B. Both acquisitions contain the same amount of samples now.

This leads to two EMG signals, as seen above, from two devices but with the same amount of samples and no time delay.



7 – Plug-Ins

Open Signals (r)evolution is extendable via plug-ins. These plug-ins are already installed on your computer, through the *Open Signals* installation, and only need to be activated through Plux servers when bought, while other ones are free to download from the BITalino community (future project).

Note: The plug-in activation requires a stable internet connection, as OpenSignals has to communicate with the Plux servers. Plug-Ins will work without an internet connection after a successful activation.

7.1 – Plug-Ins List

See <http://www.biosignalsplux.com/index.php/order> for a list of currently available plugins (software add-ons).

Plug-In Online Store: [COMING SOON]

7.2 – How to get/activate Plug-Ins

If you purchased a BiosignalsPlux Professional device the *Video Sync*, the *Heart Rate Variability* and the *EMG Analysis* plug-ins are included in your purchase and therefore already available for your device(s).

If you purchased a BiosignalsPlux Researcher device the *Video Sync plug-in* is included in your purchase and therefore already available for your device(s).

Other Plux devices do not include plug-ins by purchase, but they can be bought additionally.

For purchasable plug-ins, you simply have to buy plug-ins in the BiosignalsPlux online store. Plug-ins are related to the MAC address of devices. Therefore you will be asked to introduce your device's MAC address during the purchase procedure. The next time you connect your device to *Open Signals*, after the purchase, your plug-in(s) will be activated for usage with your device(s) by Plux servers (*internet connection needed*).

7.3 – Using Plug-Ins

To use purchased plug-ins (re)start *Open Signals (r)evolution* and they will now be accessible in the visualization and/or the acquisition window through the plug-ins symbol, depending on which kind of plug-in you bought.



Shows a list of available plug-ins

There are two kinds of plug-ins:

Real-Time Plug-Ins:

Plug-Ins functions will work during real-time signal acquisitions. Therefore these plug-ins will be available in the real-time visualization (window).



Visualization Plug-Ins:

Plug-Ins post-acquisition functions will work when visualising already acquired signals. Therefore these Plug-Ins will be available in the visualization (window).

To select which plug-ins are to be displayed in the real-time/visualization go to the help interface (?-symbol in the main interface) and select or deselect plug-ins as needed.

To access plug-ins in the visualization windows, click on the plug-in symbol (circle) and a list activated plug-ins will be shown. Click on the plug-ins' symbol to select it.

All the needed information will then appear with the selected plug-in.

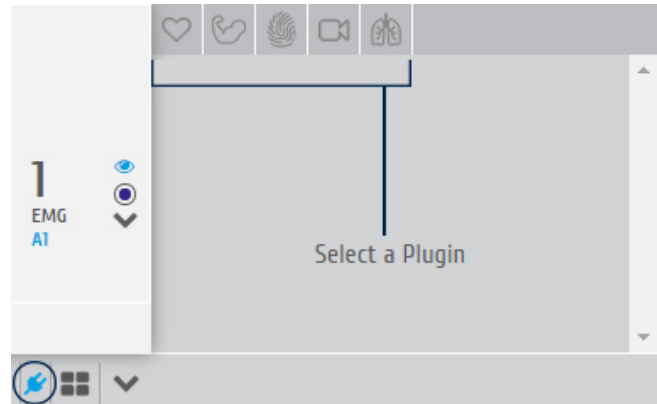


Fig. 28 Plug-In selection

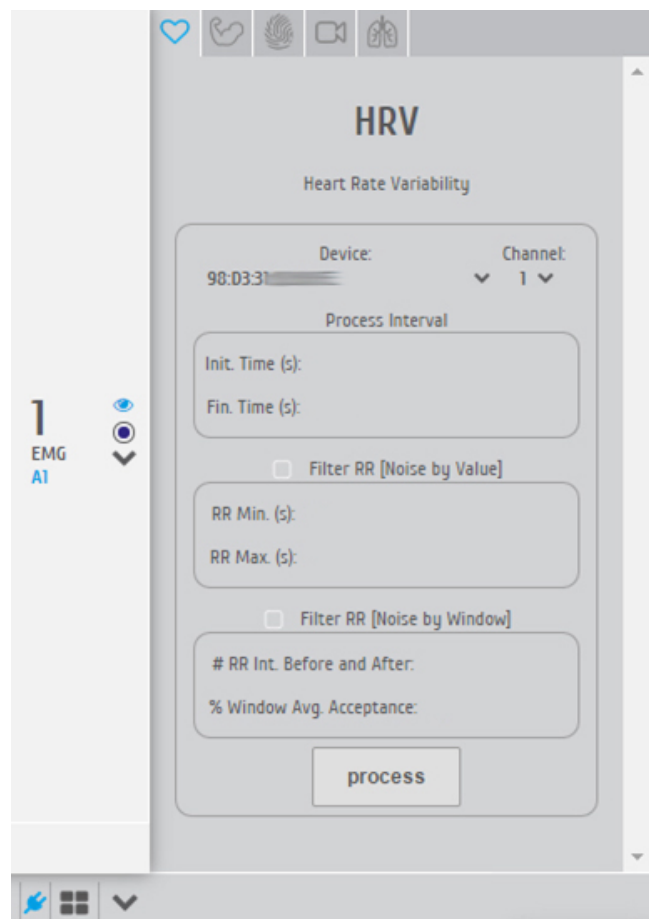


Fig. 29 Active Heart Rate Variability Plug-In



8 – Do It Yourself! - API

Open Signals (r)evolution is not the only way to acquire, visualise and analyse signals received by Plux devices. It is possible to connect the devices to third party application including your own applications and algorithms. The needed kit to start your own biosignal software is delivered by Plux for free!

What you need to do is to check your firmware, get the API and start working!

8.1 – Firmware Update

In order to get the most out of your new device, we strongly recommend that you check if your device is installed with the most recent firmware (latest version is **v3.1**). To check and update the device firmware, you can use the Plux Firmware Update Tool:

http://downloads.plux.info/FW_biosignalsplux_v3.1.zip

After extracting the files within the zip file to a temporary folder, run the Updater.exe application with a Bluetooth adapter connected and click the *Find Devices* button. After a few seconds, the MAC address of your device should appear in the dialog. Then click the *Check* button. You should update the device's firmware, if the returned firmware version is earlier than v3.1. To update the firmware, select the *.enc file from the package and click the Update button.

8.2 – PLUX API

The device functionality is available to applications through our standard API, the PLUX API. This API is currently available for Python 2.7 applications in Windows 7 or later (32-bit and 64-bit). In the near future, the API will be available for C++ applications as well, and also for Mac OS and Linux platforms.

In order to start working with the device through PLUX Python API, please follow these steps:

- Download the Python API package available at http://downloads.plux.info/PLUX_API_Python2.7_v1.1.zip
- Extract the files from the package to a working folder
- Open the readme.rtf file on the working folder and follow the instructions



9 – Troubleshooting

9.1 – Error List

[Coming Soon]

Error Number: 00000 Error description: [DESCRIPTION]

[SOLUTION]

9.2 – Bluetooth

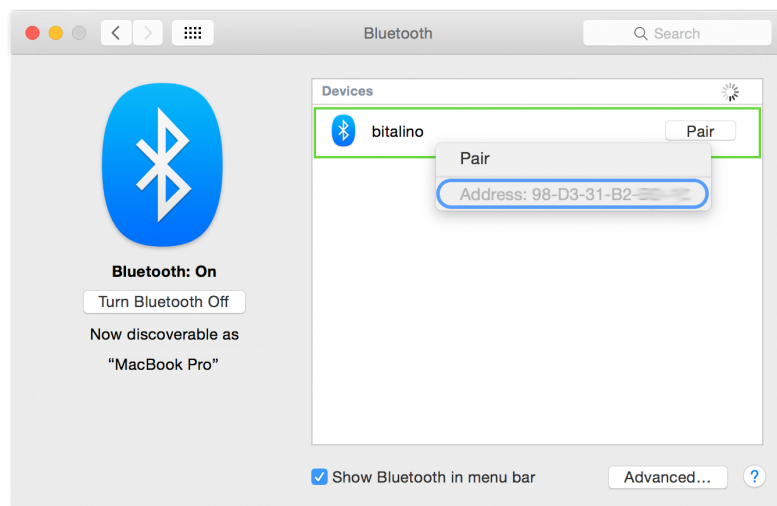
9.2.1 – Which one is my device?

Using several Plux devices at a time, for example using many Bitalinos in a classroom, may be confusing when trying to detect the right device for the right computer. Comparing the device's MAC address to the one shown on your computer will help finding the correct device.

How to show the MAC Address:

Mac OSX – Yosemite and newer

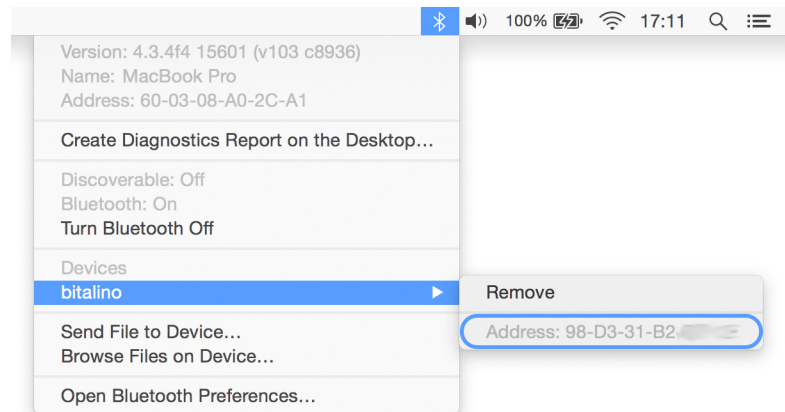
Open the Bluetooth device manager and search for available devices. Right-click on one of the devices to see its MAC address





Mac OSX – Mavericks and older

Hold the alt key on your keyboard and click on the Bluetooth symbol in the menu bar. A list of the connected devices will appear. Click on your device and check the MAC address on your device with the MAC address on your display.



Windows XP/Vista/7/8

Click the “Start” button and go to the “Control Panel”. Select the “Hardware” tab and open the device’s properties (right click > properties) and check the shown MAC address with your device’s MAC address.

Note: Unfortunately, it is not able to see the device’s MAC address before establishing a connection with it in Windows operating systems.

9.2.2 – Fixing Connection Issues

Simply rebuilding the connection between your PLUX device and your computer can solve most of the existing Bluetooth connection problems.

For this, delete your device from your operating systems device manager (Windows: left click > Remove device... ; Mac OSX: click on the circled ‘x’ on your device’s information) and connect it again as explained in Chapter 3.3 – Connecting Bluetooth Devices)



10 – Support

Please contact us if your problem is not listed in this manual, so that we can find a solution to it as fast as possible.

Send us an e-mail with precise information of what you were doing, which device was being used, what problem occurred, when it occurred and, if possible, screenshots of the problem.

E-Mail at: bitalino@plux.info
support@plux.info

Error:

Error description:

When did it occur?

Screenshots: