BITalino (r)evolution ~~Lab~~ Home Guide

EXPERIMENTAL GUIDES TO MEET & LEARN YOUR BIOSIGNALS

ATTENTION

The present document includes experimental protocols to be shared with customers who have PLUX products.

This document should not be distributed through alternative routes unless the customer chose to acquire our biosignals acquisition systems.

The information contained in this manual has been carefully checked and were made every effort to ensure its quality. PLUX reserves the right to make changes and improvements to this manual, especially during the initial phases of the creation of this document.

PLUX – Wireless Biosignals, S.A.
Av. 5 de Outubro, n. 70 – 2.
1050-059 Lisbon, Portugal
BITalino@plux.info
http://BITalino.com/

© 2020 PLUX

Table of Contents

HOME-GUIDE #0

EXPLORE THE HARDWARE & SOFTWARE

Getting started with BITalino (r)evolution and OpenSignals (r)evolution

1. GOALS

After this lesson you will be able to set-up your BITalino (r)evolution and acquire different physiological data with deeper comprehension on both the hardware and software.

In this Home-Guide you will explore the BITalino (r)evolution hardware and OpenSignals (r)evolution software. The main goals for this lesson are:

- Perform a set of experiments using a real-world biomedical data acquisition system.
- Understand the basic blocks of a data acquisition system.
- Get familiar with biosignals acquisition procedures.
- Handling recorded data on a computing environment.
- Review typical setup procedures.
- Observe multiple signal sources in real-time.

2. INTRODUCTION

Complementary information can be found at bitalino.com

Biosignals correspond to measurements of biological events happening in living beings and can be both electrical [e.g., Electrocardiography (ECG) & Electroencephalography (EEG)] and non-electrical signals [e.g., mechanical signals (e.g., the mechanomyogram or MMG), acoustic signals (e.g., phonetic, and non-phonetic utterances, breathing), chemical signals (e.g., pH, oxygenation) and optical signals (e.g., movements)].

The electrical, chemical, and mechanical activity that occurs during biological events often produces signals that can be measured and analyzed using the appropriate tools. Biosignals contain useful information that can be used to understand the underlying physiological mechanisms of a specific biological event. For this reason, the monitoring of biosignals is critical for medical diagnosis and treatment.[1]

Biosignals can be acquired through different devices, namely electronic devices, with the implementation of electronic circuits that range from simple to advanced, depending on the application. Biosignals comprise important data that must be properly analyzed to extract valuable information. To have measurable and readable data, basic methods, such as signal amplification, filtering, digitalization, processing, and storage are commonly applied.

In addition to these common procedures, sophisticated digital processing methods are quite common and can significantly improve the quality of the acquired data. These include signal averaging, wavelet analysis, and artificial intelligence techniques.[1]

[1] *Monty Escabí PhD, in Introduction to Biomedical Engineering (Third Edition), 2012*

3. MATERIALS

OpenSingals (r)evolution software is available on: https://bitalino.com/en/software

- OpenSignals (r)evolution software
- 1 x BITalino (r)evolution Assembled Core BT
- 1 x Assembled Accelerometer (ACC)
- 1 x Assembled Electromyography (EMG) Sensor
- 1-lead electrode cable (e.g., usually placed in an arm bone to be used as an internal reference)
- 3 x Gelled Self-adhesive Disposable Ag/AgCl*electrodes
- 1 x Bluetooth dongle

(a) (b) (c) (d) (e) (f) (g)

Figure 1: BITalino (r)evolution Assembled Core BT - Front View (a) and Back View (b); Assembled Electromyography (EMG) Sensor (c); 1-Lead Electrode Cable (d); Accelerometer (ACC); (e) Gelled Self-adhesive Disposable Ag/AgCl electrodes (f) and Bluetooth dongle (g).

**for each experiment you must use 2 gelled electrodes for the EMG sensor and another one to the one-lead cable that will serve as reference. Each time you want to repeat your experiment, or each time you see the electrodes are not in a good condition it is recommended to change them for new ones. Also make sure that you clean the skin area with alcohol before adjusting the electrodes to remove skin particles and improve the skin conductivity.*

4. RELATED DOCUMENTATION

BITalino (r)evolution Quick Start Guide

BITalino Assembled Core BT Datasheet

Assembled Electromyography (EMG) datasheet

Electromyography (EMG) Sensor User Manual

Assembled Accelerometer (ACC) datasheet

5. PROTOCOL

For additional information review the quick start guide which is available here: http://bitalino.com/downloads/quickstart-guide-1.0.0.10-print.pdf and the documentation available on the previous section "RELATED DOCUMENTATION"

5.1. Device Set-up

Connect your BITalino (r)evolution Core BT by following the steps:

1. Turn on the device (see
2. Figure 2); a white LED should start fading.
3. Insert the Bluetooth dongle into your computer USB port and open the Bluetooth device manager.
4. Search for your BITalino device.
5. Locate the device named BITalino-XX-XX, where XX-XX are the last four hexadecimal digits on the sequence XX:XX:XX:XX:XX:XX labelled on the back of BITalino's case.
6. Pair your device with the computer using the PIN code 1234.

Figure 2: BITalino (r)evolution Assembled Core BT: Power button location on the right side of the device.

5.2. Testing your set-up

1 Download OpenSignals (r)evolution software, which is available on the BITalino website http://www.bitalino.com/en/software [Note: you can choose the version that supports your operating system (Windows/Mac OS/Linux), by clicking on its logo].

2 Access the DEVICE MANAGER screen on the OpenSignals (r)evolution software (Figure 3, left).

3 Click on your device (see Figure 3, right; the mac address on the computer should correspond to the mac address of your BITalino device) and confirm that it is enabled for data acquisition (Figure 4, left); ENABLE button highlighted in blue, as shown in (Figure 4, left).

4 Available options in the OpenSignals Device manager will po up (Figure 4, right).

5 Select the analog channel where you want to connect your sensor (Figure 5, left) and select the name, respectively (i.e., Channel A1 and EMG sensor) (Figure 5, right). You also can edit the label A1 by clicking on top of it.

6 Depending on your preference, you can select the number of acquiring channels, by selecting the circle on the CHANNELS menu, respectively. The circle will turn blue meaning the channel will be acquiring.

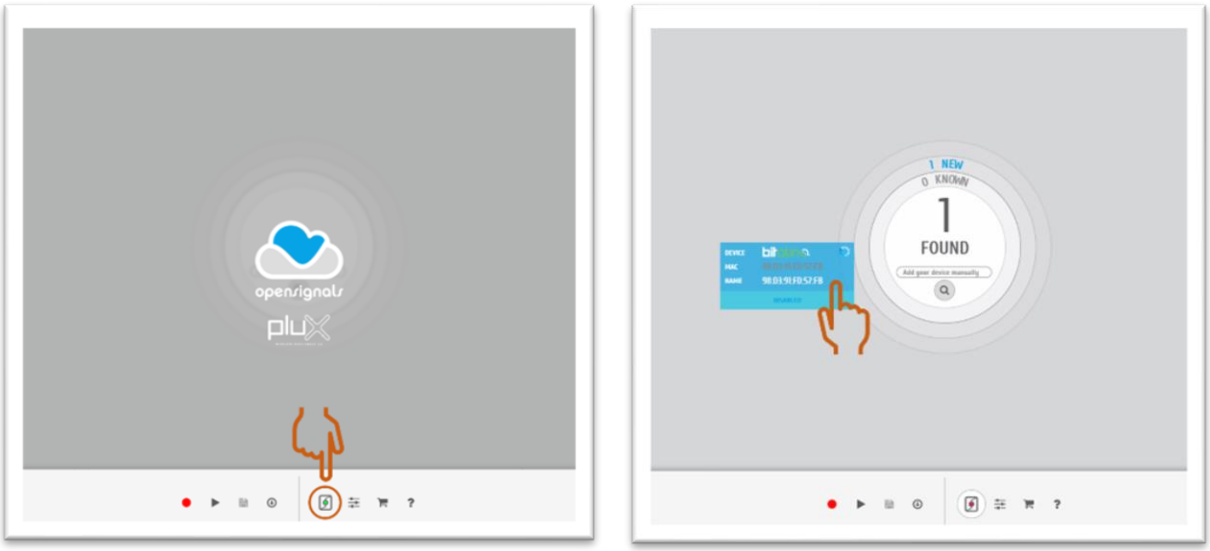

Figure 3: Sequence of steps to perform an acquisition session in the first use: Access the device manager (left) and enable the device for acquisition (right).

Figure 4: Available options in the OpenSignals Device manager: The enabled device (left) and the available options (right).

Figure 5: Activation of channels and selecting the signal types: Active channel with a blue dot (left) and the drop-down list to select the signal type (right).

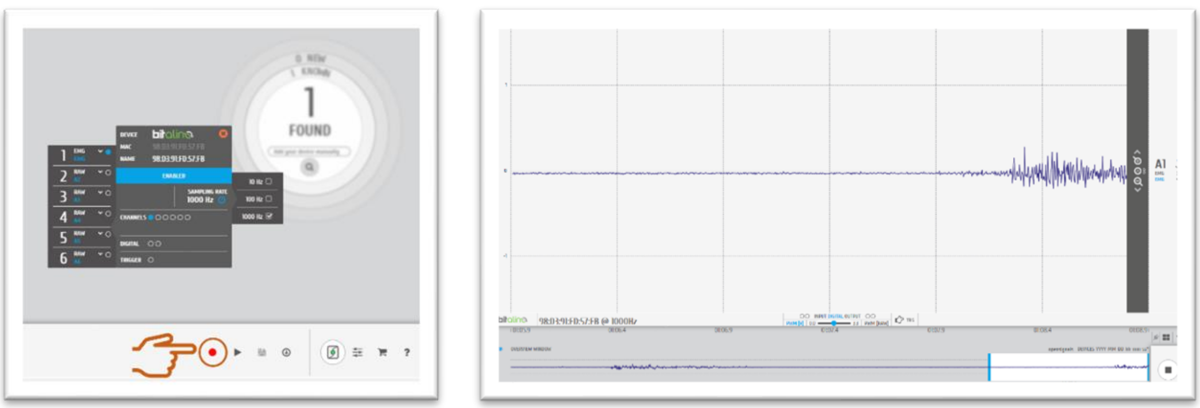

Figure 6: Signal Acquisition (Example of EMG signal): Start the signal acquisition (left) and view the signal in real-time (right).

> *For additional information review the user manual for OpenSignals (r)evolution (v.2019) which is available here: https://www.downloads.plux.info/OpenSignals/OpenSignals-Manual.pdf*

5.3. Basic Biomechanics with Accelerometry (ACC)

5.3.1. ACC Basics

Living cells, tissues and organs produce and are subjected to forces or displacement (e.g., when we walk, breathe, etc.), which usually have measurable mechanical manifestations. For this experiment you will use BITalino (r)evolution Assembled Core BT (Figure 1 a) and the Accelerometer (ACC) (Figure 7) sensor to observe a simple biomechanical process. Although the sensor is capable of triaxial sensing, by default only one axis is connected. The referential is oriented as identified in Figure 7.

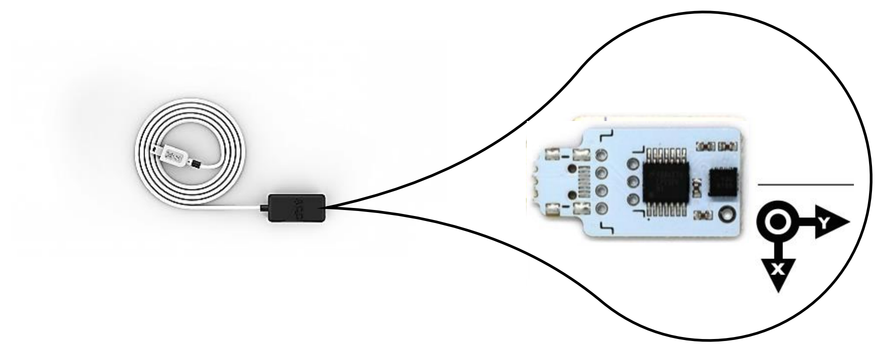

Figure 7: XY referential of the Accelerometer (ACC) sensor.

5.3.2. ACC Set-up

1 Connect the ACC sensor to any of the available analog channels. On the back of the BITalino (r)evolution Assembled Core (Figure 1 b) you will find the enclosure labelled as AX (X=1, ..., 6) where X corresponds to the channel number Be sure to select the analog channel you chose on OpenSignals (check Section 2 regarding the OpenSingals set-up).

2 Start recording data on OpenSignals (r)evolution.

3 Firmly hold the sensor on your hand and make slow vertical movements with the sensor. Check the signal on the software while doing so.

4 Perform repetitions of the following exercise:

   a. Hold on your arm (with the sensor on your hand) parallel to the sagittal plane.

   b. Lift the arm at a 90º angle parallel to the frontal plane (at the end of each repetition your arm should be parallel to the transverse plan and perpendicular to the sagittal plane).

   c. Try to do a slow movement in the first repetition and increase the speed in such way that the last repetition corresponds to fastest you can lift your arm.

5 Stop the recording and save your data (Figure 8).

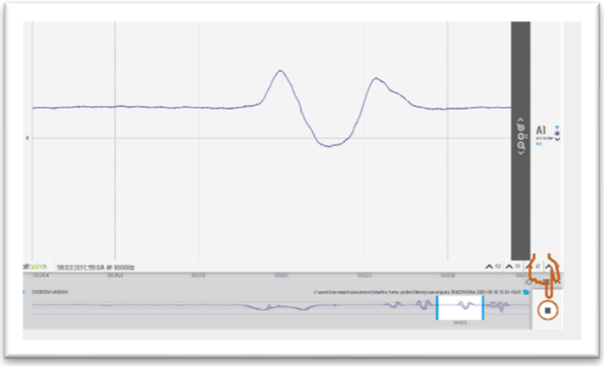

Figure 8: Signal Acquisition (Example of ACC signal): Stop the signal acquisition (left) and examine the stored signal after acquisition (right).

IMPORTANT NOTES:

- ✓ Experimental procedures and parameters are easy to remember in the day one executes them but tend to be forgotten over time. As such, make sure that you choose an understandable file name and add comprehensive metadata such as a description and eventually keywords that may be representative of the contents you have stored on that file. These will be useful in the future to help you or others using your recordings, to recall important details about the experiment (e.g. the exercise performed, number of repetitions, etc.). OpenSignals (r)evolution already stores several setup-related details for you, which are detailed at: http://bitalino.com/datasheets/OpenSignals_File_Formats.pdf

- ✓ You can review your recorded data directly on OpenSignals (r)evolution through the PLAYBACK option as shown in Figure 8, right. Refer to the user manual for additional information about this option.

- ✓ Learn more about the accelerometer specifications and working principle on the data sheet available at: http://www.analog.com/media/en/technical-documentation/data-sheets/ADXL335.pdf

5.4. Live Muscles with Electromyography (EMG)

5.4.1. EMG Basics

Whenever a given muscle is mobilized (voluntarily or involuntarily), its muscle fibers are stimulated with electrochemical activation impulses (aka action potentials), creating voltage imbalances within the muscle cells that cause them to contract. Although of low amplitude, this process can be measured with suitable instrumentation due to the constructive effect of numerous cells being stimulated simultaneously. For this experiment you will use the BITalino (r)evolution Assembled Core, Electromyography (EMG) sensor and 1-Lead Electrode Cable as shown in Figure 1 (a), (c) and (d), respectively.

5.4.2. EMG Set-up

To initiate your experiment you need to connect the sensor to the board and then to identify the channel to which the sensor is connected and make sure that it is selected for acquisition on the software; on the back of the BITalino (r)evolution Assembled Core (Figure 1 b) you will find the enclosure labelled as AX (X=1, ..., 6) where X corresponds to the channel number. Afterwards you can do the following procedure:

1. Connect the Assembled Electromyography (EMG) Sensor to one of the analog channels available; also connect the 1-lead electrode cable to any of the other analog channels.
2. Place the Gelled Electrodes on the snaps of the EMG sensor and 1-lead electrode cable.
3. Place the Assembled EMG alongside the muscular fibers of a muscle of your choice (check the example depicted on Figure 9 and Figure 10. Note, that the electrodes must be placed on the muscle belly and with about 2cm distance to each other.[2]
4. Place the 1-lead electrode cable in an area of low muscular activity, namely a bone Figure 9 and Figure 10).
5. Start recording data on OpenSignals (r)evolution (if needed, check Section 2 to recall how this is done).
6. Repeat a cycle of CONTRACTION-RELEASE-REST five times, maintaining the contraction for two seconds and resting for two seconds; try to start with a low intensity contraction and gradually increase the level in each repetition, in such way that the last corresponds to your maximum voluntary contraction ability.
7. Stop the recording and save your data (if needed, refer to Section 3 to recall how this is done).

[2] *Criswell, Eleanor. Cram's introduction to surface electromyography. Jones & Bartlett Publishers, 2010*

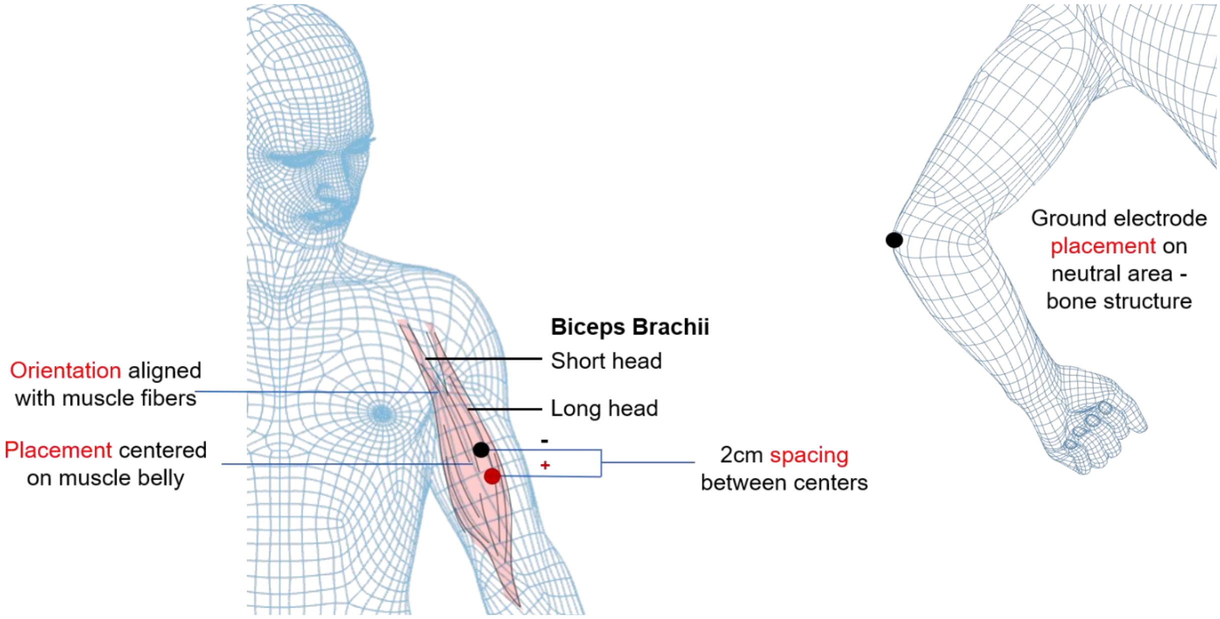

Figure 9: Electrode position: measuring electrodes in black (-) and red (+) on the muscle belly of biceps brachii (left) and reference electrode on the elbow (right).

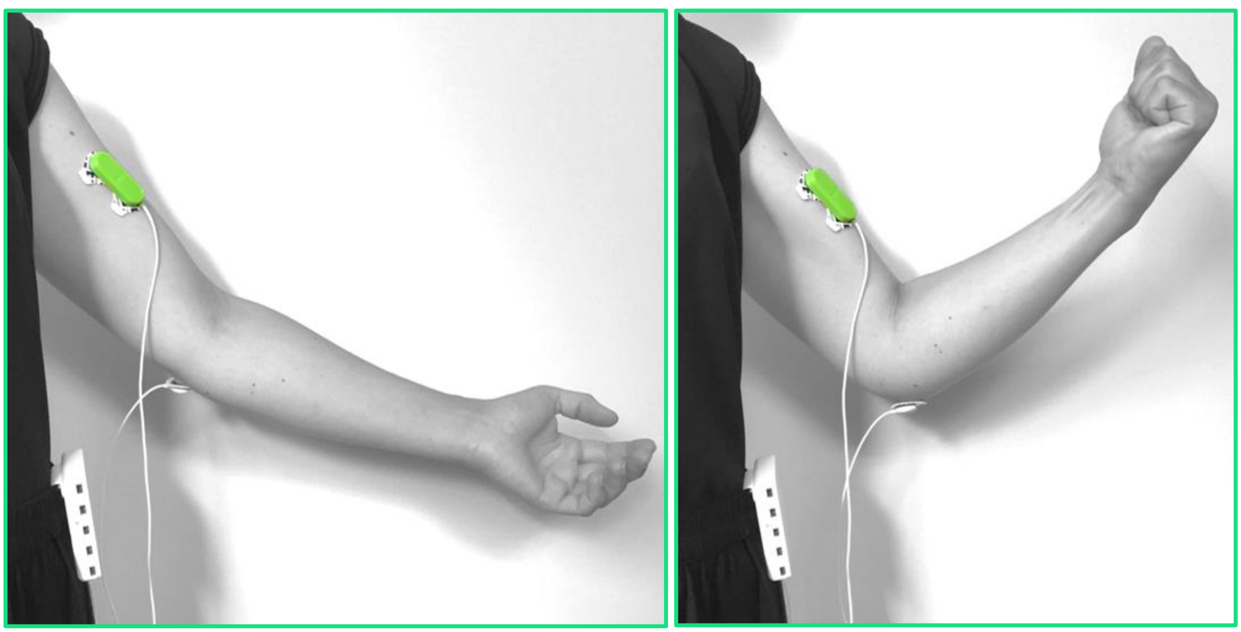

Figure 10: Example Electrode placement for the assembled EMG sensor on the muscle biceps with REF on a bone. Relaxing the muscle (left) and performing of muscular contraction when flexing the elbow and forearm in supination (right).

6. QUIZ

In this section you can find some questions for you to work on during your Lab Session and to explore the hardware and software

Q1. Draw a block diagram that shows the information flow and different stages between the body and the PC in a biosignal acquisition system.

Q2. Show a screenshot with Accelerometer (ACC) data for one of the repetitions executed in Section 3 of the Protocol. What do you interpret from this data?

Q3. As highlighted in the introductory segment of Section 3 of the protocol, only one axis is connected by default. Which axis is it? Explain how you reached your conclusion.

Q4. Show a screenshot of a relevant portion of Electromyography (EMG) data within the experiment proposed on Section 4. Does this signal correspond to what you expected? Why?

Q5. To the best of your knowledge, which noise sources can act during measurements made with bioelectrical sensors?