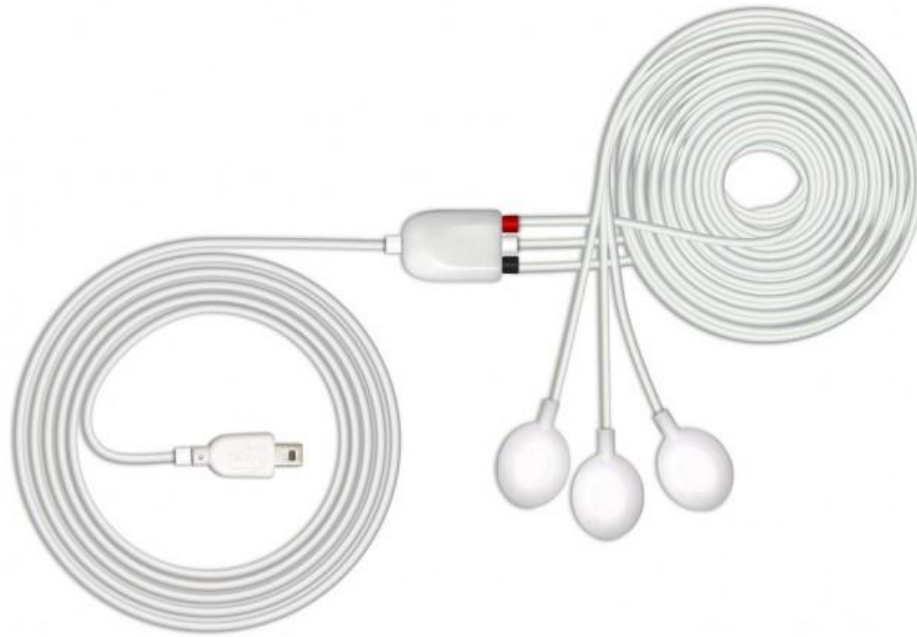# biosignalsplux

biosignal acquisition tool-kit for advanced research applications

Electrogastrography (EGG) Sensor User Manual

ATTENTION
Please read this datasheet before
using your biosignalsplux sensor

The information contained in this document 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 and products referenced at any time without notice.

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Please check your systems and sensors after receiving and before using it the first time to confirm if it contains all the ordered sensors, accessories and other components. Contact our support via e-mail at support@plux.info if there are any variations from your original order.

For regulatory information, please see the Regulatory Disclaimer at the end of this document.

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1. General Information

1.1. General Description

The **biosignalsplux Electrogastrography (EGG)** sensor has been designed for user-friendly recording of the electrical activity of the stomach. Multiple sensors can be used simultaneously in a cost-effective and straightforward way to assess bowel motility and overall gastric activity, for instance.

The bipolar configuration, with two measurement electrodes, detects the electrical potentials in the specific stomach region of choice, with respect to a reference electrode (placed in an area of low bioelectrical activity). The resulting signal is the amplified difference between these two leads, eliminating the common unwanted signals. Its convenient form-factor enables a discrete application in the typical **EGG** locations.
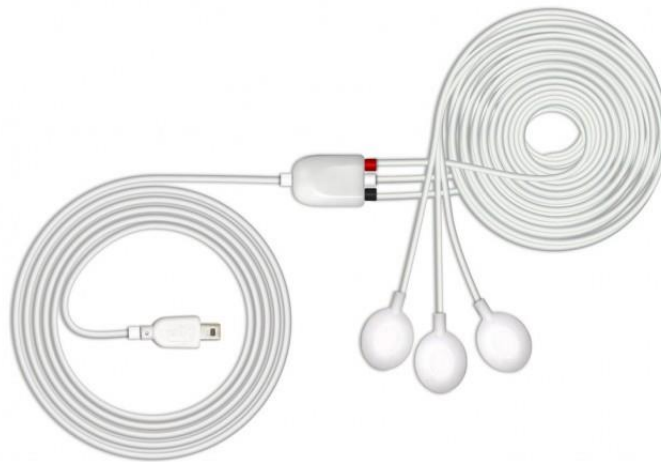
Figure 1: biosignalsplux Electrogastrography (EGG) sensor (standard version)

1.2. Typical Unfiltered Sensor Output

Figure 2 shows a typical unfiltered **EGG** sensor output acquired in a stationary state and with basal gastric activity. The raw digital sensor values received from the **biosignalsplux** device ranged between 0 and 2^n-1 (**n=sampling resolution**) were converted into the original unit of measurement of this sensor (mV) using the transfer function found in section **Transfer Function (Conversion Formula)**.

Figure 2: Typical unfiltered EGG output (with subject at rest and presenting basal gastric activity)

1.3. Sensor Specifications

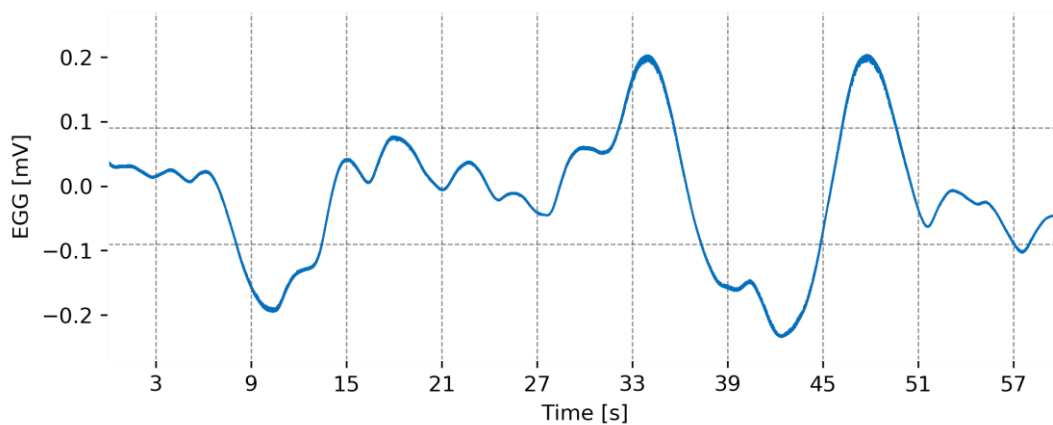|			
> Gain[1]:	6114	**> Range:**	±0.25mV (@ VCC=3.0V)
> Bandwidth:	0.01591-0.1591 Hz	**> Consumption:**	≈ 3mA
> Input Impedance:	> 100 GOhm	**> CMRR:**	100 dB
> Input Voltage Range:	1.8 - 5.5 V		

1.4. Features

> Single-channel sensor

> Bipolar differential measurement

> High signal-to-noise ratio

> Medical-grade raw data output

> Unobtrusive & lightweight sensor

> Pre-conditioned analog output

> Ready-to-use form factor

1.5. Applications

> Bowel motility anaalysis

> Life sciences studies

> Gastric contractions detection

> Biomedical device prototyping

1.6. Transfer Function (Conversion Formula)

The analog sensor signals acquired with **biosignalsplux** devices are converted into digital values ranged between 0 and 2^n-1 (**n=sampling resolution**, usually 8-bit or 16-bit) and streamed in the raw digital format.

In most applications, the original physical unit of the acquired **EGG** signal is preferred or required. The raw digital sensor samples can be converted back into millivolt (mV) using the following formulas:

$$EGG(V) = \frac{\left(\frac{ADC}{2^n - 1} - \frac{1}{2}\right) \times VCC}{G_{EGG}} \tag{1}$$

$$EGG(mV) = EGG(V) \times 1000 \tag{2}$$

Valid sensor range: [-0.25mV, 0.25mV]

with:
$EGG(V)$	**EGG** signal in V
$EGG(mV)$	**EGG** signal in mV
ADC	Value samples from the sensor/channel (digital value)
n	Sampling resolution (**default:** 16-bit resolution (n=16), although 12-bit and 8-bit may also be found)
VCC	Operating voltage (3V when used with **biosignalsplux**)
G_{EGG}	Sensor gain (6114)

1.7. Electrode Connections & Sleeve Color Meanings

Sleeve Color	Red	Black	White
Electrode Cable	+	-	reference

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[1] This sensor has a high amplification gain, reason for which it is particularly sensitive to noise resulting electromagnetic and motion sources. For optimal performance, it is therefore recommended that data acquisition is done in an appropriate environment and with the subject in stationary position. Power supplies, lighting and other common household elements are prone to introduce parasite signals. Measurement in dynamic conditions is prone to be affected by motion artifacts.

See section **2.1 Electrode Placement/Sensor Placement** for more information on where to place the electrodes and to connect electrodes cables for **EGG** acquisitions.

1.8. Physical Characteristics

> W1 x L1 x H1:	1.6cm x 2.2cm x 0.5cm	**> W2 x L2 x H2:**	1.4cm x 1.7cm x 0.5cm
> W3:	1.1 ± 0.1cm	**> L3:**	0.6 ± 0.1cm
> A1:	105.0 ± 0.5cm	**> A2:**	28.0 ± 0.1cm
> A3:	8.0 ± 0.1cm	**> D:**	0.4 ± 0.1cm
> S:	0.3 ± 0.1cm		

> Available sleeve colors: White, Black, Blue, Green, Red, Yellow, Gray, and Brown
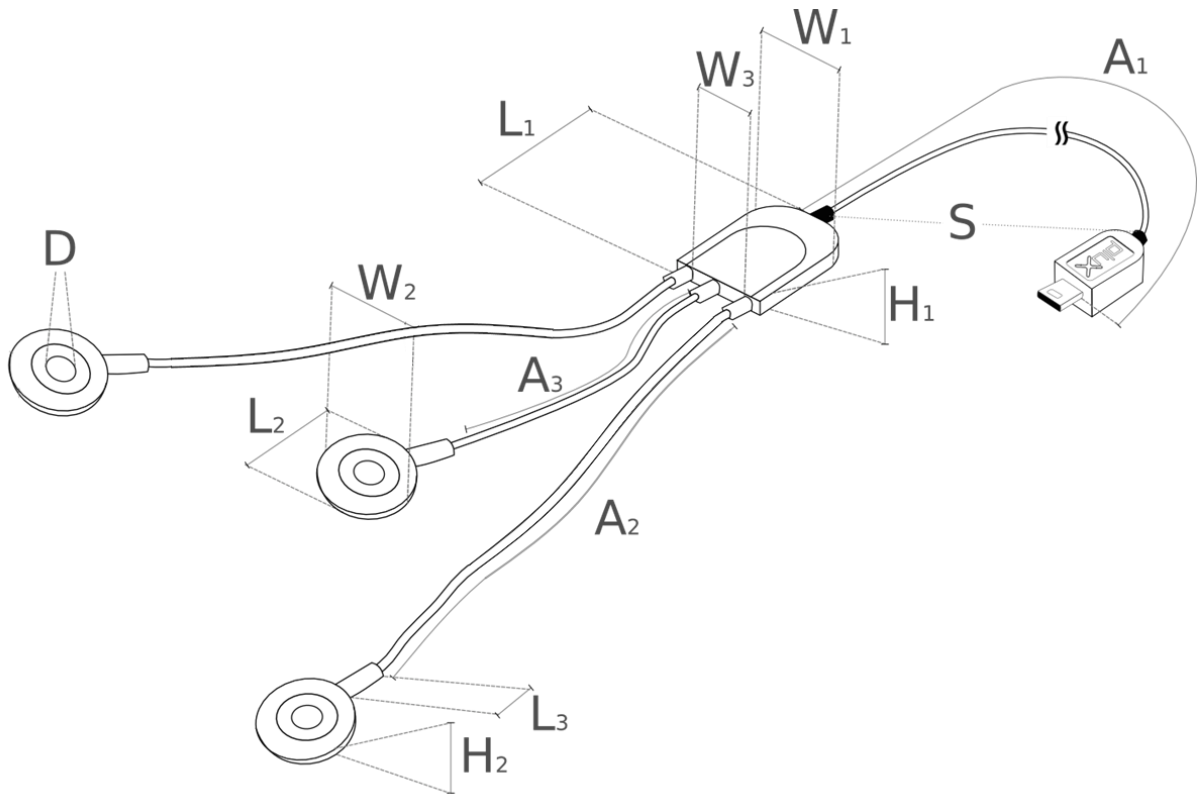

Figure 3: Physical characteristics of the standard EGG sensor.

2. Application Notes

2.1. Electrode Placement/Sensor Placement

In order to guarantee a proper evaluation of gastric motility and gastric slow-wave propagation, a multi-sensor configuration is advisable as the one proposed by Chen et al. [1], which was used on studies from other authors, namely G. Riezzo et al. [2], D. Komorowski et al. [3] and H. P. Simonian et al. [4].

The proposed configuration (Figure 4) can be achieved through the following guidelines:
"…*a main electrode (electrode 3) located 2 cm above the mid-point between the xiphoid process and the umbilicus. Two more electrodes (electrodes 2 and 1) were located on an upper 45-degree angle, with an additional electrode (electrode 4) located 4 cm to the right of the central electrode. The common reference electrode (CM) was placed at the cross point of two lines, one horizontal-connecting electrode 1 and the other vertical-connecting electrode 3. The ground electrode was placed on the left costal margin…*" [2]
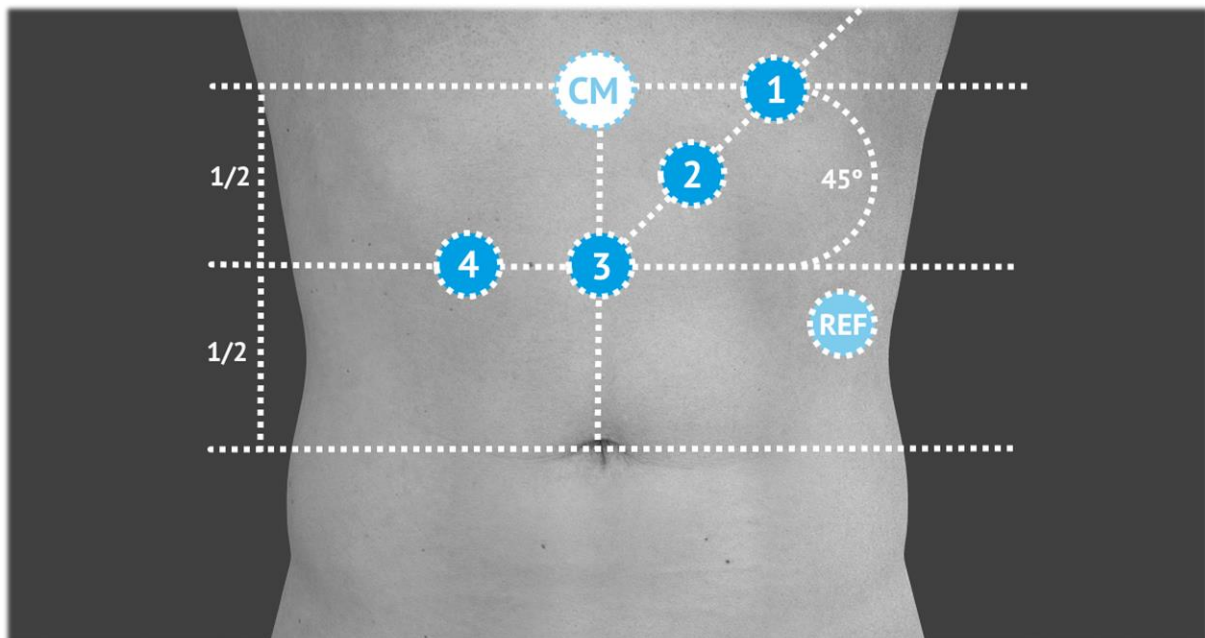

Figure 4: Recommended EGG electrode placement [2] (image based on the graphical resource available at [17]).

However, a simpler configuration is also reasonable using only 1 **EGG** sensor, as proposed by Riezzo et al. [2]:

> Placement of the first **EGG** exploratory electrode[2] in the standard position number 3 and the second on position 2 (Figure 4), which can be found with two reference points ("2 cm above the mid-point between the xiphoid process and the umbilicus (electrode 2) and on an upper 45 degree angle 5 cm away"[2]);

> Reference electrode should be placed on the left costal margin.

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[2] Using an Ag/AgCl disposable electrode or Ten20 conductive paste + dry electrodes

Bibliographic References

[1]   J. D. Z. Chen, X. Zou, X. Lin, S. Ouyang, and J. Liang, "Detection of gastric slow wave propagation from the cutaneous electrogastrogram," *Am. J. Physiol. - Gastrointest. Liver Physiol.*, vol. 277, no. 2, pp. G424–G430, 1999.

[2]   G. Riezzo, F. Russo, and F. Indrio, "Electrogastrography in adults and children: The strength, pitfalls, and clinical significance of the cutaneous recording of the gastric electrical activity," *Biomed Res. Int.*, vol. 2013, 2013.

[3]   D. Komorowski, S. Pietraszek, E. Tkacz, and I. Provaznik, "The extraction of the new components from electrogastrogram (EGG), using both adaptive filtering and electrocardiographic (ECG) derived respiration signal," *Biomed. Eng. Online*, vol. 14, no. 60, 2015.

[4]   H. P. Simonian *et al.*, "Multichannel Electrogastrography (EGG) in Normal Subjects: A Multicenter Study," *Dig. Dis. Sci.*, vol. 49, no. 4, pp. 594–601, 2004.

3. Using the Electrogastrography (EGG) Sensor with biosignalsplux & OpenSignals

3.1. Connecting the sensor to biosignalsplux Systems

3.1.1. biosignalsplux 4-Channel Hubs

The **biosignalsplux EGG** sensor is compatible with all 4 analog input channels of the 4-channel **biosignalsplux** hub, but incompatible with the reference/ground port. Connect the sensor to an analog input to use it with this device.
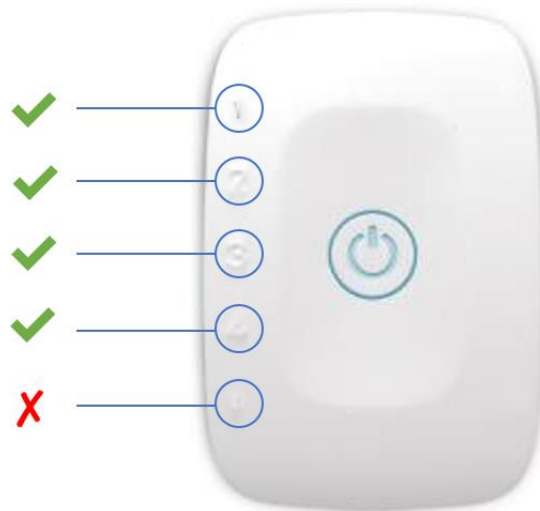

Figure 5: EGG compatible biosignalsplux channels (green checkmarks).

3.1.2. biosignalsplux 8-Channel Hubs

The **biosignalsplux EGG** sensor is compatible with all 8 analog input channels of the 8-channel **biosignalsplux** hub, but incompatible with the reference/ground and digital I/O ports. Connect the sensor to an analog input to use it with this device.
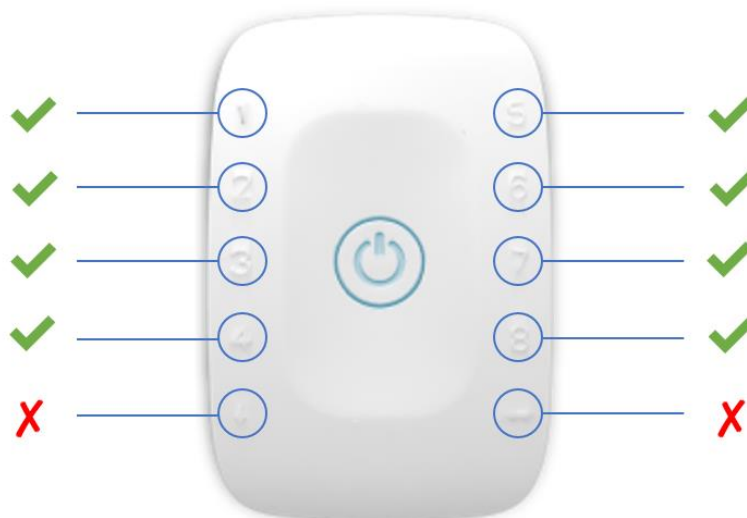

Figure 6: EGG compatible biosignalsplux channels (green checkmarks).

3.1.3. biosignalsplux Solo & Single-Channel openBAN Devices

The **biosignalsplux EGG** sensor is compatible with the analog input channel of the **biosignalsplux Solo** (openBAN) device. Connect the sensor to the analog input channel to use it with this device.

Figure 7: Connect the EGG to the analog input channel of the biosignalsplux Solo (openBAN).

3.2. Configuring the Sensor in OpenSignals

3.2.1. OpenSignals (r)evolution (Windows, macOS, Linux)

Open the **OpenSignals (r)evolution** device manager to access and configure your **biosignalsplux** device.

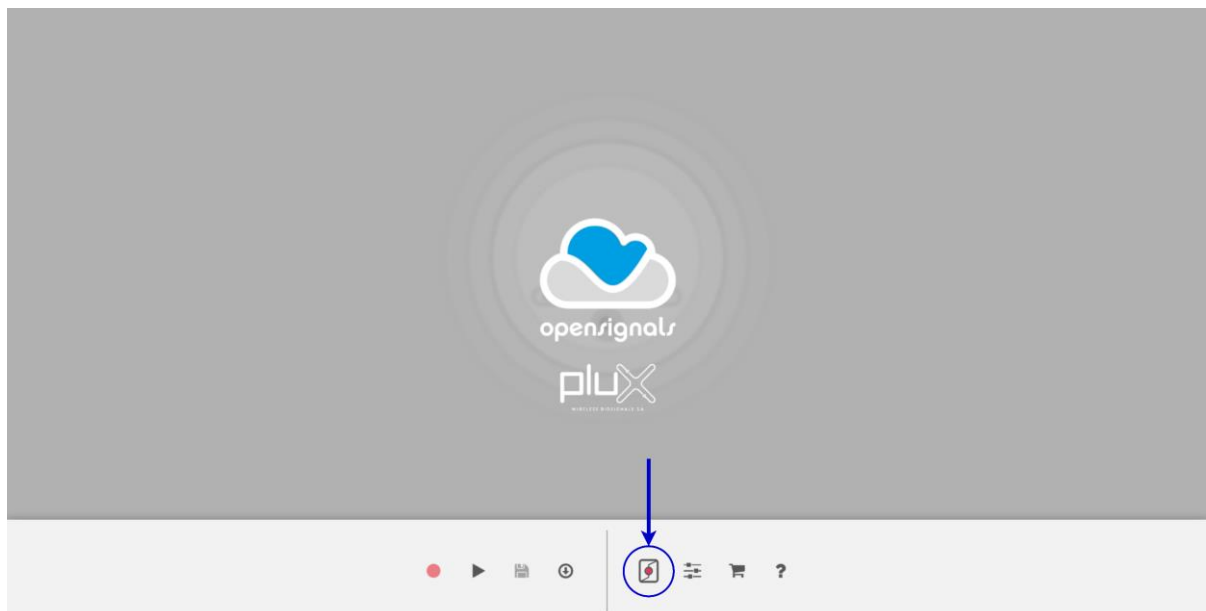
Figure 8: Access the OpenSignals (r)evolution device manager.

Select the device you intend to use for acquisition by clicking on *ENABLE button on* the device panel in the **OpenSignals** device manager. The device is activated for acquisition if the *ENABLE* button is blue.
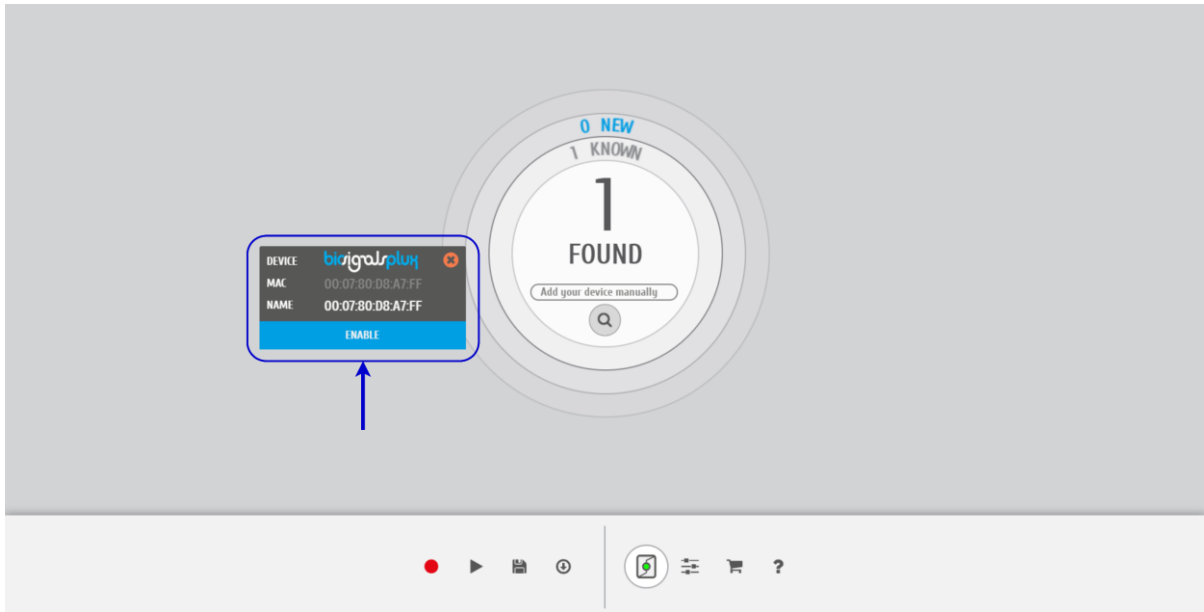
Figure 9: Enabling the device for acquisition.

Click on the **biosignalsplux** logo to access the available settings. Select the channel your sensor is connected to and select the *RAW* [3] from the dropdown menu highlighted in the next screenshot.
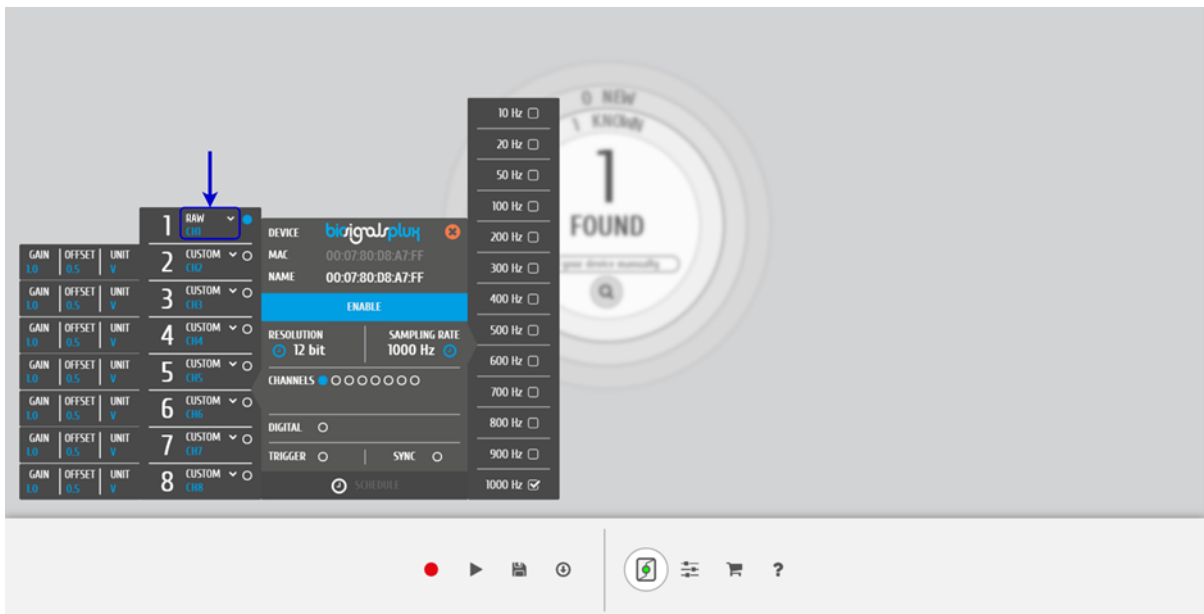
Figure 10: Set the channel type of the channel you have your EGG sensor connected to, to *RAW*.

Activate the channel for acquisition by clicking on the circle next to the channel type (must be blue). If not done before, follow the instruction available in section **2.1 Electrode Placement/Sensor Placement** to learn how to apply the sensors and **3.1 Connecting the sensor to biosignalsplux Systems** to learn how to connect your device to your **biosignalsplux** device.

Click on the record button in the **OpenSignals** main interface whenever you're ready for your acquisition.

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[3] Currently the EGG transfer function is not available in **OpenSignals (r)evolution**

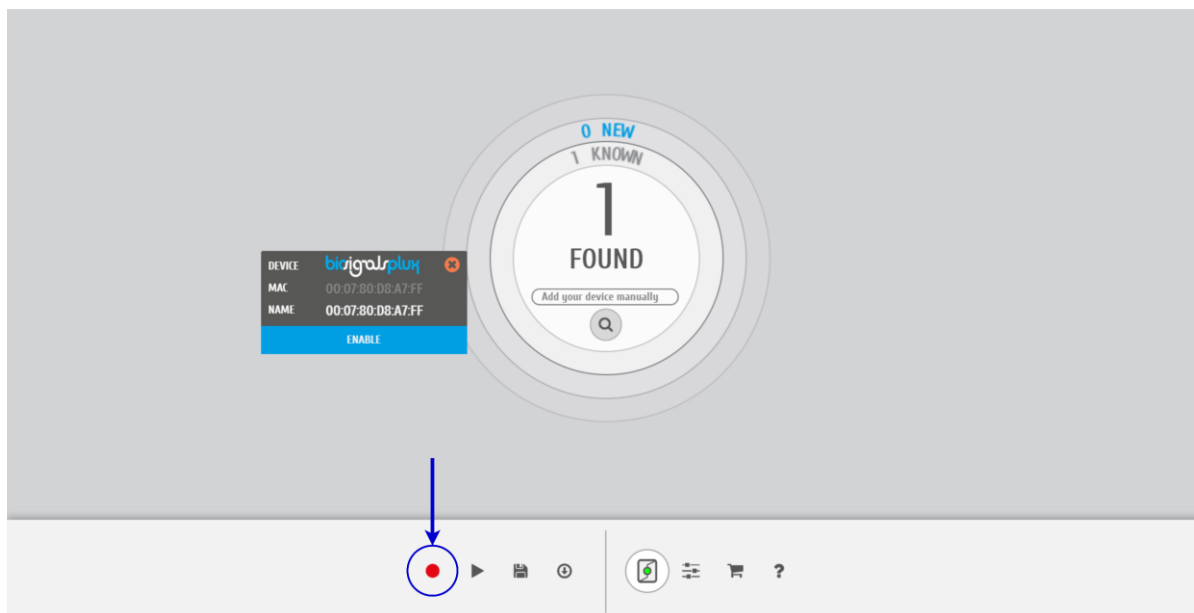Figure 11: Start the acquisition whenever you're ready.

4. Safety & Maintenance

4.1. Safety Instructions

Please read the following safety instructions **before** using your **biosignalsplux** system with the **EGG** sensor to prevent any damages or problems with the user, test persons and/or **biosignalsplux** devices. Violations of these instructions can lead to inferior signal quality and/or damages to the **biosignalsplux** system and user.

!   The user should always keep the device and its accessories dry.

!   The user must turn off the **biosignalsplux** device and contact Technical Support if the system or accessories reach uncomfortable temperatures.

!   The user should not use the **biosignalsplux** device in noisy environments (environments with microwaves and other similar equipment). Doing so will lead to noise increase in the acquired signals and Bluetooth connectivity issues.

!   The user must not use the device near the fire or in potentially explosive atmospheres, such as atmospheres with flammable gas.

!   The user should only use the detection surfaces or other approved accessories purchased from **PLUX** or by a **PLUX** agent.

!   The user should inspect the sensors on a regular basis to ensure that they remain in good working order.

!   The user should stop using the **biosignalsplux** device if experience any kind of discomfort or skin irritation.

!   Do not use the system on persons with allergies to silver.

!   The user should dispose detection surfaces after using the **biosignalsplux** device. Detection surfaces are single-user and disposable. Reusable electrodes should be reused by the same user. Do not use reusable electrodes on several users.

!   The user must not place the device in the microwave.

!   The user must not insert objects into the holes of the device.

!   The user should not open the **biosignalsplux** device or its accessories. The repair of the same should be only done by properly authorized **PLUX** personnel.

!   The user should make sure the cables do not obstruct the passage of people.

!   The user should use the sensor cables with extreme caution to avoid risk of strangulation.

!   The user should keep a safe distance between the **biosignalsplux** device and other devices to ensure their proper functioning.
!   The user should only send the device to repair to qualified **PLUX** personnel.

! The user should not immerse the sensors or the **biosignalsplux** device, nor clean with liquid or abrasives.

! The user should handle the **biosignalsplux** device with caution and not expose the device or accessories to high accelerations and vibrations.

! **biosignalsplux** devices should not be used in patients with implanted electronic devices of any kind, including pace-makers, electronic infusion pumps, stimulators, defibrillators or similar.

! Do not apply electrodes over damaged or irritated skin.

! Do not use your device while charging its internal battery.

4.2. Transportation and Storage

Please follow these recommendations to ensure safe transportation and storage of your **biosignalsplux** equipment and sensors to prevent any damaging of your system.

The **biosignalsplux** equipment and sensors should be stored in the original box in a dry place when those are not being used.

- **Relative humidity:** up to 95% with no condensation
- **Ambient temperature:** 10°C to 30°C
- **Atmospheric pressure** between 500hPa and 1060hPa

Whenever the equipment needs to be transported, it should be placed in the original box, since this was designed and tested to ensure the equipment and accessories are securely stored.

Take care while handling the transportation of the system and avoid dropping it, since the device is not shock-proof and should not be placed under stress or sudden acceleration.

4.3. Cleaning

Please follow these cleaning instructions to prevent any damage of the system or the user because of conducting cleaning methods that may cause any damage.

- The **biosignalsplux** and sensors should be visually checked before each use and cleaning process to ensure that no mechanical damage occurred.

- The **biosignalsplux** equipment and sensors (including the cables) should be cleaned with a slightly damp cloth or suitable absorbent paper, ensuring no liquid enters the equipment of sensors. Do not use detergent or any type of cleaning liquid as these may damage your equipment and/or sensor.

- Do not clean or re-use detection surfaces (electrodes). They are only suitable for single use, and should be disposed of after usage except indicated otherwise.

5. Ordering Guides, Regulatory & Legal Information

5.1. Ordering Guide

Please follow the following ordering guide when submitting orders of **EGG** sensors to orders@plux.info. If no specification is provided, the standard version of the sensor will be delivered.

EGG Sensor

SKU Reference	PLUX Code	UPC
SENSPRO-EGG	820201233	785614265150
Description		
Gastric activity specialized measurement sensor.		

Electrodes & Accessories

For a full list of available and compatible electrodes, please visit the biosignalsplux store.

5.2. Guarantee of Quality & Warranty

biosignalsplux sensors have three months quality guarantee from the date of purchase. **PLUX** guarantees that the system, sensors and accessories will be free from material or manufacturing defects for the mentioned time periods following date of purchase.

If **PLUX** receives notification of any such defects within the guarantee period, it will repair or substitute with the same unit/model, any products with proven defects at no cost to the client. During the repair period **PLUX** promises to provide a temporary replacement under the same specification. Repairs will be carried out at **PLUX**'s premises after the equipment has been received.

5.3. Warranty Voidance

Usage of the device that is not in accordance with the handling instructions indicated in the manual, or use with accessories other than those manufactured by **PLUX** will invalidate the warranty of your devices.

Be careful when connecting your **biosignalsplux** devices, sensors and/or accessories to any third party device including the usage of the 3rd party connection components that are available for **biosignalsplux** systems as **the usage of these components will void the electrical warranty of your biosignalsplux device and sensors and, if not indicated otherwise, the warranty of the 3rd party system you're connecting to the device**. Check the electrical specifications of both systems you want to connect to prevent any damage of the user(s) or the systems.

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

5.4. Contact & Support

Contact us if you are experiencing any problems that cannot be solved with the information given in the biosignalsplux documentation.

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.

5.5. Regulatory Disclaimer

biosignalsplux products are intended for use in life science education and research applications; they are not medical devices nor are they intended for medical diagnosis, cure, mitigation, treatment or prevention of disease. 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.