



biosignal acquisition tool-kit for advanced research applications

Temperature (TMP) Sensor User Manual



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#### ATTENTION

Please read this datasheet before  
using your biosignalsplux sensor

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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](mailto: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 **biosignalsplus Temperature (TMP)** sensor is specifically developed for biosignal research applications where it can be used to measure corporal or ambient temperatures. The sensor produces an accurate analog output signal with short response times to temperature alterations.

The medical-grade PVC insulation of the Temperature sensor allows a safe use of this sensor even when in direct skin contact. Additionally, the small form-factor of the sensor and small diameter of the sensing element (~2mm) enable possibilities of local and accurate temperature measurements within a 0°C and 50°C temperature range.



Figure 1: biosignalsplus TMP sensor

### 1.2. Typical Unfiltered Sensor Output

Figure 2 shows a typical unfiltered **TMP** sensor output. The raw digital sensor values received from the **biosignalsplus** device ranged between 0 and  $2^n - 1$  ( $n = \text{sampling resolution}$ ) were converted into the original unit of measurement of this sensor (°C) using the transfer function found in section **Transfer Function (Conversion Formula)**.

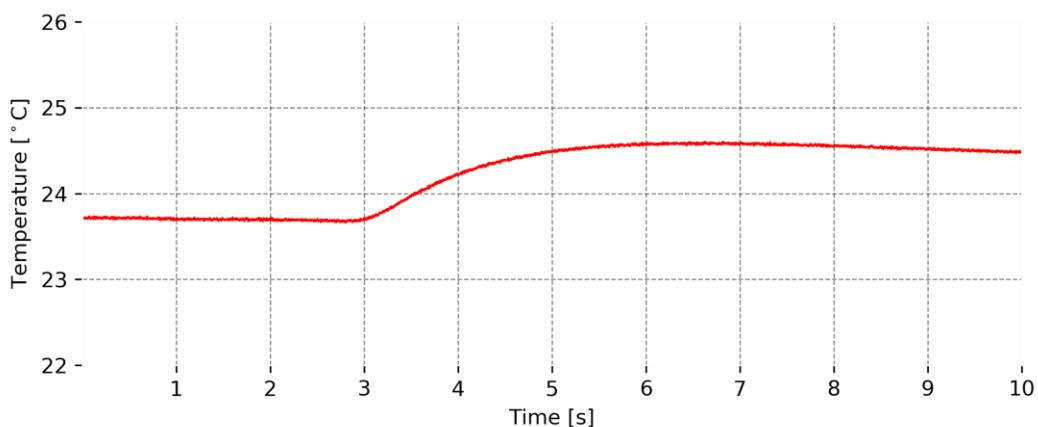


Figure 2: Typical unfiltered sensor output.

### 1.3. Sensor Specifications

> Range:	0°C –50°C	> Response Time (Air):	15 ± 1 seconds
> Type:	NTC thermistor	> Element Diameter:	1.90 ± 0.01 mm

### 1.4. Features

- > Medical-grade PVC insulation
- > Short response times
- > 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

- > Life sciences studies
- > Human-Computer Interaction
- > Physiology Studies
- > Biomedical research
- > Robotics & Cibernetics
- > Psychophysiology

### 1.6. Transfer Function (Conversion Formula)

The analog sensor signals acquired with **biosignalsplus** 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 **TMP** signal is preferred or required. The raw digital sensor samples can be converted back into Celsius degrees (°C) using the following formulas:

$$NTC(V) = \frac{ADC \cdot VCC}{2^n} \quad (1)$$

$$NTC(mV) = NTC(V) \times 1000 \quad (2)$$

$$NTC(\Omega) = \frac{1 \times 10^4 \cdot NTC(V)}{VCC - NTC(V)} \quad (3)$$

$$TMP(K) = \frac{1}{a_0 + a_1 \cdot \ln(NTC(\Omega)) + a_2 \cdot [\ln(NTC(\Omega))]^3} \quad (4)$$

$$TMP(^{\circ}C) = TMP(K) - 273.15 \quad (5)$$

**Valid sensor range:** [0°C, 50°C]

with:	$NTC(V)$	NTC output in Volt (V)
	$NTC(mV)$	NTC output in millivolt (mV)
	$NTC(\Omega)$	NTC output in Ohm ( $\Omega$ )
	$TMP(K)$	Temperature value in Kelvin (K)
	$TMP(^{\circ}C)$	Temperature value in degrees Celsius (°C)
	$ADC$	Value samples from the sensor/channel (digital value)
$n$		Sampling resolution ( <b>default:</b> 16-bit resolution ( $n=16$ ), although 12-bit and 8-bit may also be found)

$VCC$	Operating voltage (3V)
$a_0$	$1,12764514 \times 10^{-3}$
$a_1$	$2,34282709 \times 10^{-4}$
$a_2$	$8,77303013 \times 10^{-8}$

Note that for the temperature calculation, ADC should be considered as:

$$ADC = \begin{cases} 17361, & \text{if } ADC < 17361 \\ 50161, & \text{if } ADC > 50161 \\ ADC, & \text{otherwise} \end{cases}$$

## 1.7. Physical Characteristics

- |                            |   |       |                                   |
|----------------------------|---|-------|-----------------------------------|
| > W1 x L1 x H:             | 1.6cm x 2.2cm x 0.5cm                                   | > W2: | $1.0 \pm 0.1\text{cm}$            |
| > W3:                      | $1.90 \pm 0.01\text{mm}$                                | > L2: | $8.25\text{mm} \pm 0.01\text{mm}$ |
| > A1:                      | $105.0 \pm 0.5\text{cm}$                                | > A2: | $90.0 \pm 0.5\text{cm}$           |
| > S:                       | $0.3 \pm 0.1\text{cm}$                                  |       |                                   |
| > Available sleeve colors: | White, Black, Blue, Green, Red, Yellow, Gray, and Brown |       |                                   |

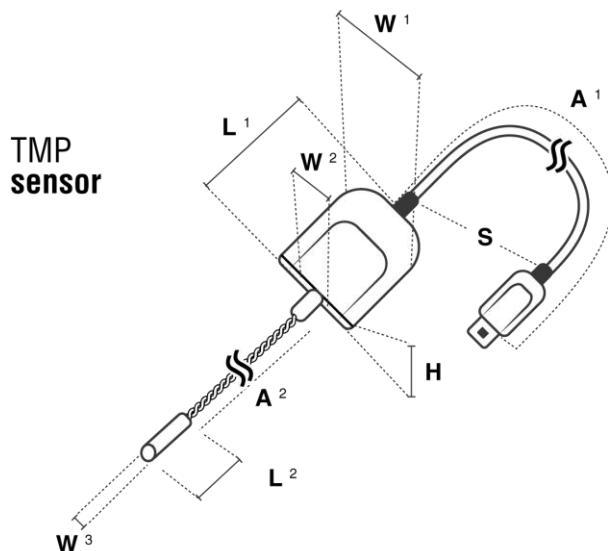


Figure 3: Physical characteristics of the standard TMP sensor.

## 2. Using the Temperature (TMP) Sensor with biosignalsplus & OpenSignals

### 2.1. Connecting the sensor to biosignalsplus Systems

#### 2.1.1. biosignalsplus 4-Channel Hubs

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



Figure 4: TMP compatible biosignalsplus channels (green checkmarks).

#### 2.1.2. biosignalsplus 8-Channel Hubs

The **biosignalsplus TMP** sensor is compatible with all 8 analog input channels of the 8-channel **biosignalsplus** 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.

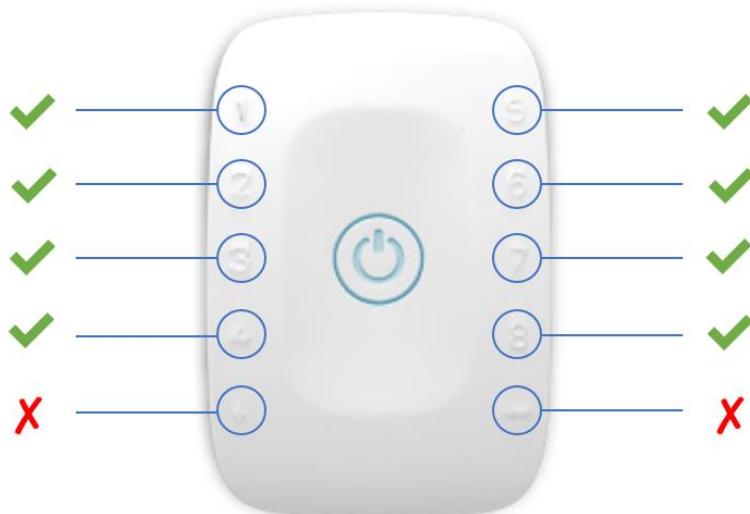


Figure 5: TMP compatible biosignalsplus channels (green checkmarks).

### 2.1.3. biosignalsplus Solo & Single-Channel openBAN Devices

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



Figure 6: Connect the TMP to the analog input channel of the biosignalsplus Solo (openBAN).

## 2.2. Configuring the Sensor in OpenSignals

### 2.2.1. OpenSignals (r)evolution (Windows, macOS, Linux)

**Note**

Download OpenSignals (r)evolution here: <https://biosignalsplus.com/index.php/software>

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

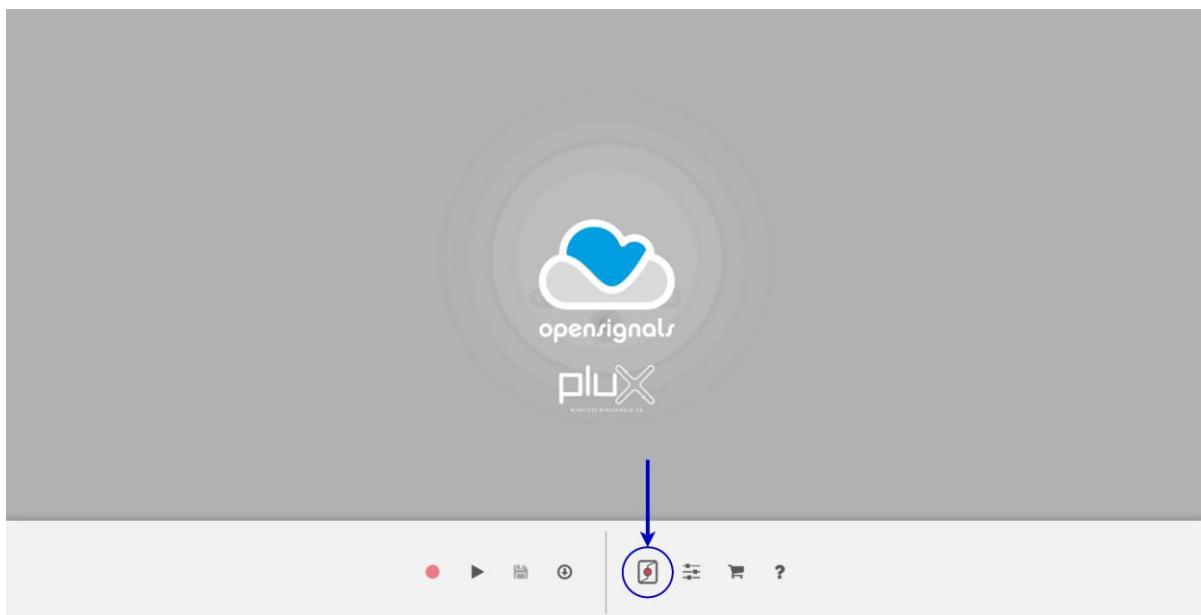


Figure 7: Access the OpenSignals (r)evolution device manager.

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 8: Enabling the device for acquisition.

Click on the **biosignalsplus** logo to access the available settings. Select the channel your sensor is connected to and select the **TEMP** from the dropdown menu highlighted in the next screenshot.

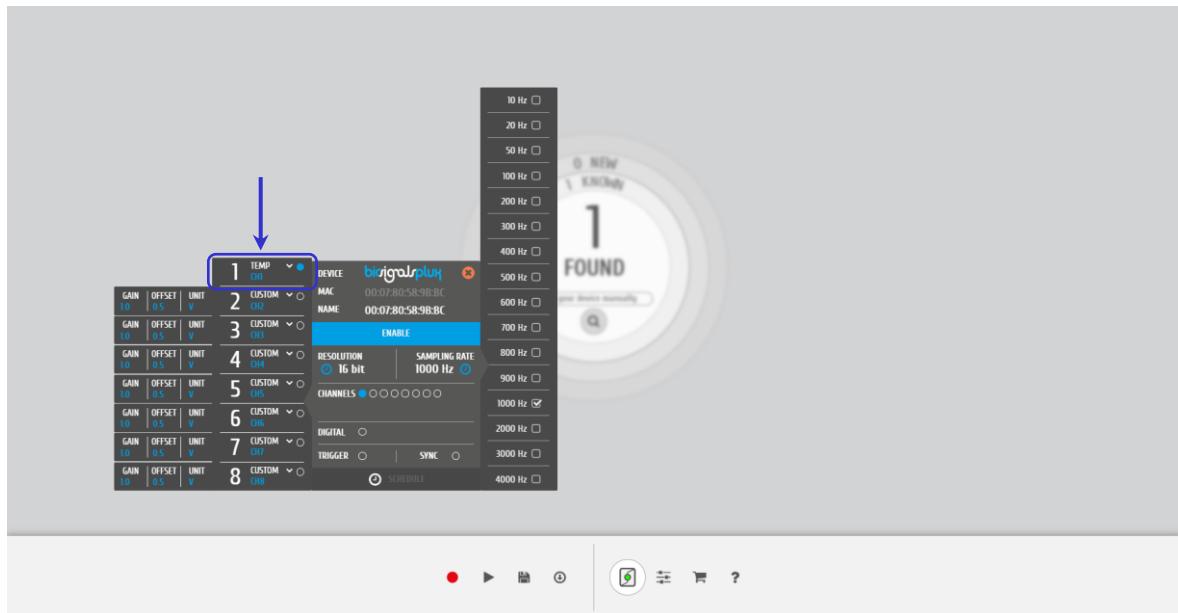


Figure 9: Set the channel type of the channel you have your TMP sensor connected to **TEMP**.

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 *Connecting the sensor to biosignalsplus Systems* to learn how to connect your sensor to your **biosignalsplus** device. Click on the record button in the **OpenSignals** main interface whenever you're ready for your acquisition.

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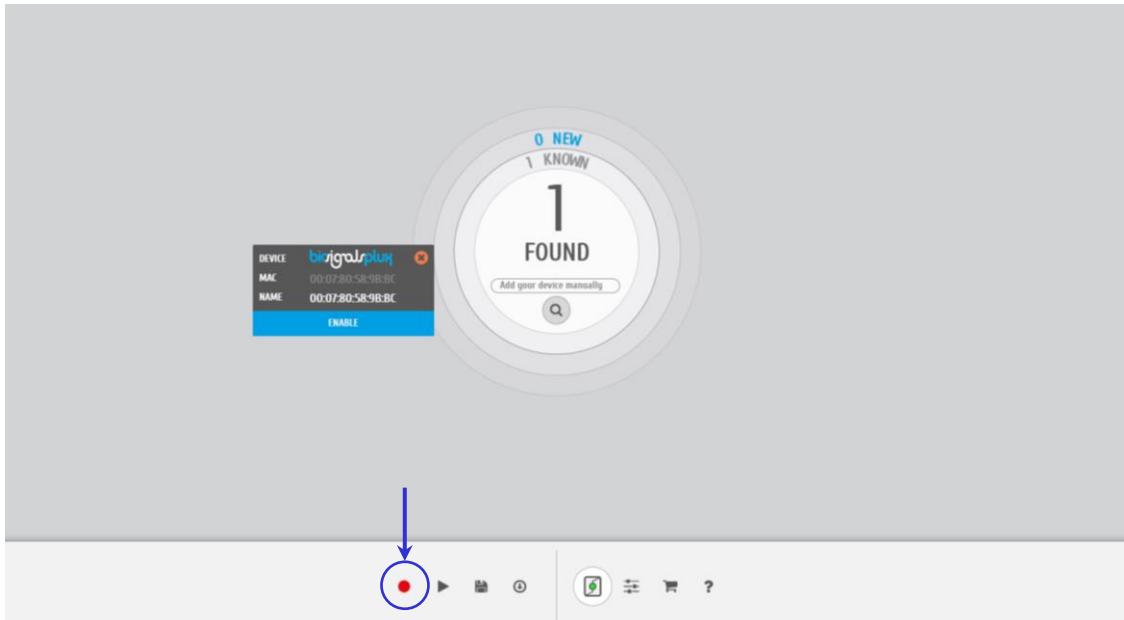


Figure 10: Start the acquisition whenever you're ready.

### 3. Scientific Publications Using the Temperature Sensor

The following scientific is only a small selection extracted from the list of available publications using [biosignalsplus](#). Please visit the following website to access the entire up-to-date list.

 biosignalsplus Publications

[List of Publications](#)

#### Publications

J. Pagán, J. L. Risco-Martín, J. M. Moya, J. L. Ayala, "[Modeling methodology for the accurate and prompt prediction of symptomatic events in chronic diseases.](#)", in *Journal of Biomedical Informatics*, no. 62, pp. 136-147, 2016

J. Heinisch, I. Hübener, K. David, "[The Impact of Physical Activities on the Physiological Response to Emotions](#)", in *Proc. of the 2nd International Workshop on emotion awareness for pervasive computing with mobile and wearable devices*, pp. 824-829, 2018

A. Kamenz, V. Bibaeva, A. Bernin, S. Ghose, K. von Luck, F. Vogt, L. Müller, "[Classification of Physiological Data in Affective Exergames](#)", in *Proc. of the IEEE Symposium Series on Computational Intelligence (SSCI)*, pp. 2076-2081, 2018

## 4. Safety & Maintenance

### 4.1. Safety Instructions

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

- ! The user should always keep the device and its accessories dry.
- ! The user must turn off the **biosignalsplus** device and contact Technical Support if the system or accessories reach uncomfortable temperatures.
- ! The user should not use the **biosignalsplus** 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 **biosignalsplus** 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 **biosignalsplus** 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 **biosignalsplus** 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 **biosignalsplus** 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 **biosignalsplus** device, nor clean with liquid or abrasives.
- ! The user should handle the **biosignalsplus** device with caution and not expose the device or accessories to high accelerations and vibrations.
- ! **biosignalsplus** 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 **biosignalsplus** equipment and sensors to prevent any damaging of your system.

The **biosignalsplus** 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 **biosignalsplus** and sensors should be visually checked before each use and cleaning process to ensure that no mechanical damage occurred.
- The **biosignalsplus** equipment and sensors (including the cables) should be cleaned with a slightly damp cloth or suitable absorbent paper, ensuring no liquid enters the equipment or 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 Temperature sensors to [orders@plux.info](mailto:orders@plux.info). If no specification is provided, the standard version of the sensor will be delivered.

#### Temperature Sensor

SKU Reference	PLUX Code	UPC
SENSPRO-TMP	820201207	641945959741
<b>Description</b>		
Temperature sensor for peripheral body temperature measurement with standard physical characteristics and random sleeve color.		

#### Electrodes & Accessories

For a full list of available and compatible electrodes, please visit the [biosignalsplus store](#).

### 5.2. Guarantee of Quality & Warranty

**biosignalsplus** 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 **biosignalsplus** devices, sensors and/or accessories to any third party device including the usage of the 3rd party connection components that are available for **biosignalsplus** systems as **the usage of these components will void the electrical warranty of your biosignalsplus 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 [biosignalsplus 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](mailto:support@plux.info).

## 5.5. Regulatory Disclaimer

**biosignalsplus 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.

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