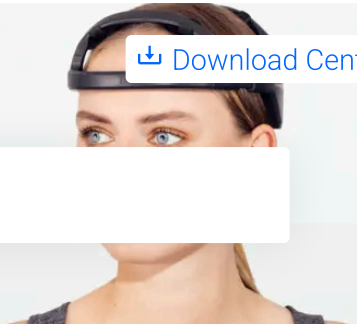


Cleaning and Storage Biosignal devices

Proper procedure for cleaning, maintaining and storing your Biosignal device (Ring, Versatile Bio)

Cleaning and Disinfection

Ring (Running time: 1 minute. Drying time: 2 minutes).

1. Apply the Clinell wipe to the entire housing of the device. The device should remain wet for 1 minute counting the application time. **Do not apply excessive pressure with the wipe, as this may release liquid that could damage the device internally. Do not insert the**
wipe into the charging hole or sd slot.

2. Spread the Clinell wipe over the GSR and BVP sensors, always spreading the wipe slightly with the sensors face down to ensure that no liquid leaks inside the device.

Versatile Bio (Run time: 5 minutes. Drying time: 1 minute).

To disinfect the sensors (GSR, Temperature, ExG...) use a Clinell wipe.

1. Apply the wipe to the sensor head. Surfaces must remain wet for 1 minute counting the application time. This application should be done lightly, always spreading the wipe with the sensors upside down to ensure that no liquid leaks inside the device.
2. Apply the Clinell wipe to the cables, running from the sensor to the connector (do not apply to the inside of the connector, as this could damage the electronics).

To disinfect the effort band sensor:

1. For the blue fastening strap, immerse in 2% diluted Bomix. Be careful not to immerse the sensor itself, only the fabric band.

To disinfect the amplifier:

1. Apply the Clinell wipe to the entire housing of the device. Do not apply excessive pressure with the wipe, this may release liquid which could damage the device internally.
   Do not insert the wipe into the connector, charging hole, sd slot or phot/dig slot.

Storage

Keep the **Ring** on its original packaging when not in use.

If the device will not be used for an extended period, we recommend discharging the battery to 40-50% capacity. Storing the device for more than a week at 100% charge could cause permanent capacity loss.

Recommended battery storage temperature range:
-10ºC to 35ºC (14ºF to 95ºF) for up to 1 month
-10ºC to 30ºC (14ºF to 86ºF) for up to 6 months

Keep the **Versatile Bio** and every sensor on its original packaging when not in use.

If the device will not be used for an extended period, we recommend discharging the battery to 40-50% capacity. Storing the device for more than a week at 100% charge could cause permanent capacity loss.

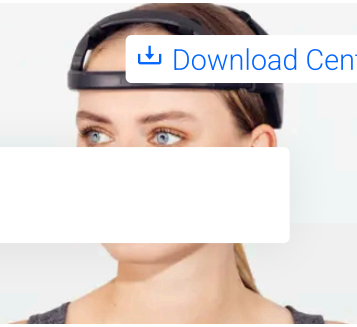
Recommended battery storage temperature range:
-10ºC to 35ºC (14ºF to 95ºF) for up to 1 month
-10ºC to 30ºC (14ºF to 86ºF) for up to 6 months

Safety data sheets

- Clinell wipes

- Bomix plus

For further information, please write to support@bitbrain.com



Versatile Bio - Master I/O List

A list of all inputs and Outputs for the Versatile Bio - Biosignal Amplifier

Amplifier connectors:

1. **ExG -** (9 X 3.5 mm inputs, plus 3.5 mm ground)

   a. Electrocardiogram (ECG)

   b. Electromyogram (EMG)

   c. Electrooculogram (EOG)

2. **Digital Input** (1 X 2.5 mm)

   a. Response button box

   b. Pedal

   c. Jack-to-jack cable

3. **Digital Output** (1 X 2.5 mm)

    a. Parallel cable

    b. Jack-to-jack cable

4. **Digital AUX** (2 X 2.5 mm)

    a. Inertial Measurement Unit (IMU)

    b. IMU Multiplexer

    c. Global Positioning System (GPS)

5. **Analog AUX** (8 X 2.5 mm)

    a. Photodiode

    b. Respiratory effort band

c. Respiratory air flow

d. Electrodermal Activity Sensor (EDA / GSR)

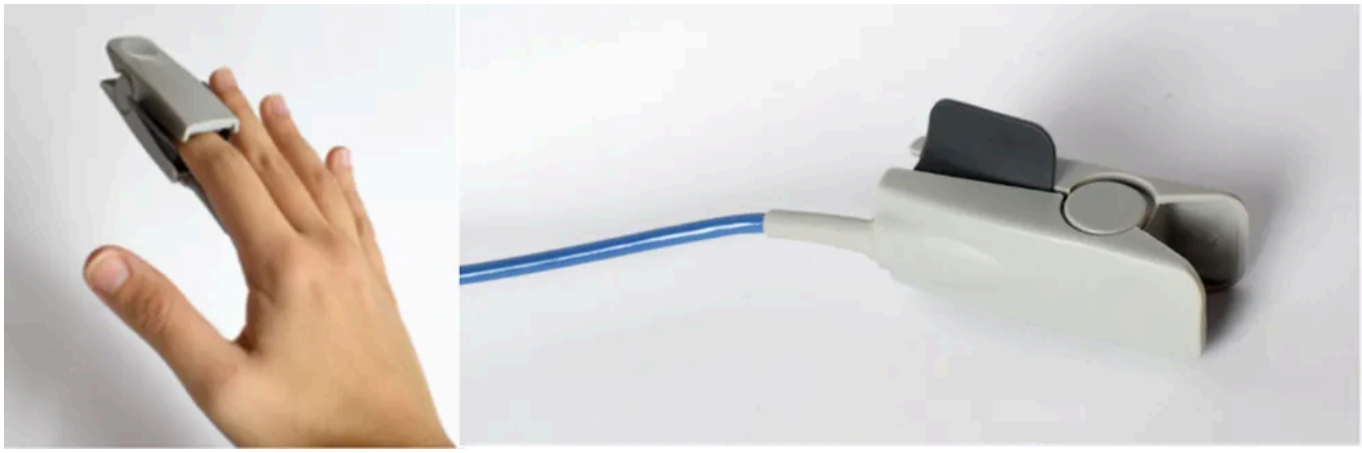
e. Temperature

f. Pulse (BVP)

g. Audio / Snoring Sensor

Versatile Bio Sensor Guide: Blood Volume Pulse (BVP)

Understanding the BVP sensor on the Versatile Bio



What it measures:

BVP is a method of detecting **heart beats** by measuring the volume of blood passing the sensor in either red or infrared light. From BVP, you can calculate **heart rate** and **heart rate variability (HRV)**.

Research Applications:

Psychology, neuroscience, human factors, user experience, market research, physiology, biomechanics, sports, kinesiology, etc.

How to use:

The BVP sensor consists of a small clip that is attached to the end of a finger (but not the thumb). This clip contains an **infrared light** and a **LED** that shines a light into the skin, then a sensor measures the intensity of the reflected light , corresponding to **blood volume**.
If a signal is not visible after placing the sensor, **try repositioning**. There are two possible wavelengths (red corresponging to the use of LED light and near-IR corresponging to the use of infrared light) which can be toggled for better results. Keep the hand still for proper recording.

> Note: BVP sensors are not designed for long-term use in a single location. Plan to change the location of the sensor every 2-4 hours to maintain normal circulation at the

> sample site.

The BVP sensor is **not designed** for participants that **weigh less** than **35 kg (77 lbs)**. For smaller participants the finger sensor may not fit properly, causing unreliable pulse detection.

> Note that fingernail polish and artificial nails may interfere with data collection.

See the detailed instructions that came with the device for more info.

How to clean:

The BVP sensor **includes** elaborate **cleaning instructions**. Please see these directions first.

To clean and disinfect the sensor, do the following:

- **Disconnect** the sensor from the Versatile Bio.
- Use Clinell Universal Wipes.
- Let it **dry before using**.
- **Autoclave** is **not recommended**.
- Do **not immerse** the device in **any liquid**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

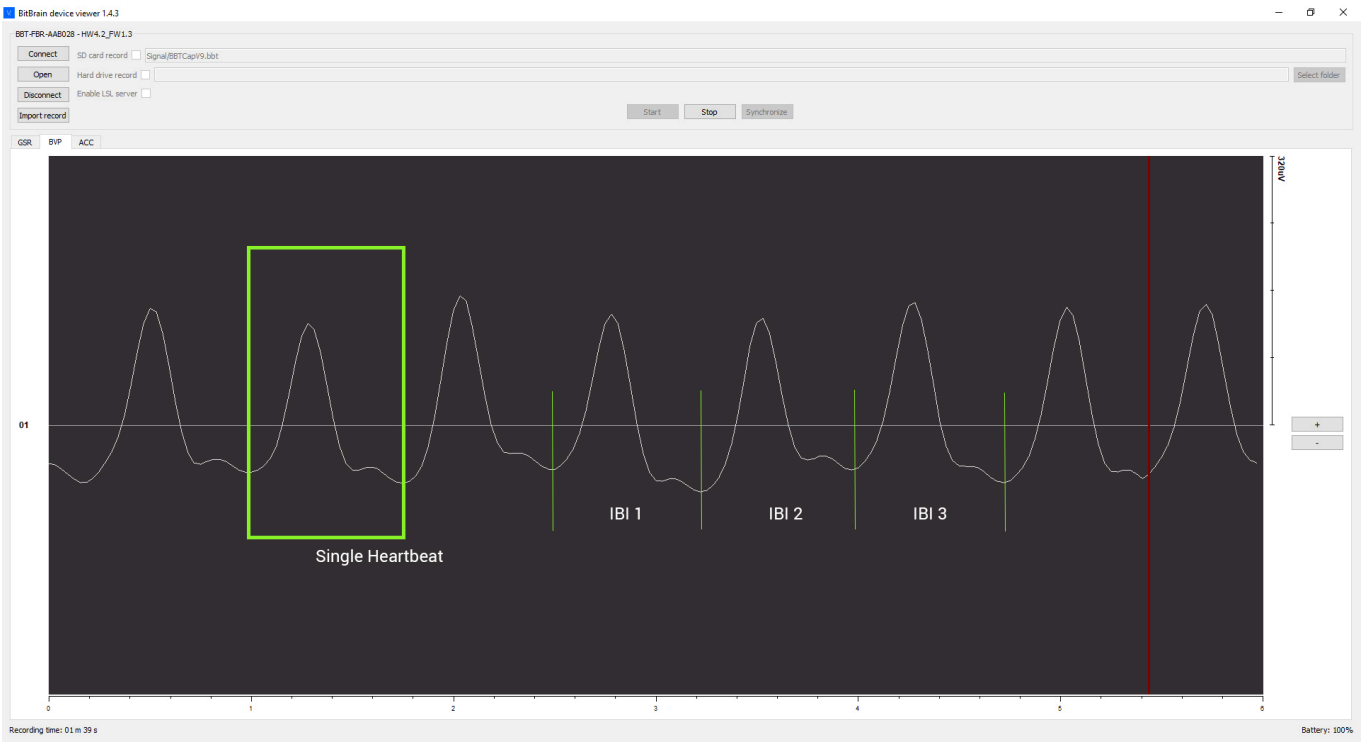
Under "Other Filter" click "enabled"
Set filter type to "Bandpass"
Set High (Hz) to 10 Hz
Set Low (Hz) to 0.5 Hz

Type is "Butterworth"
Order set to 4

Data file:

The BVP is reported in **µV** and will show a **deflection and peak** with every **heartbeat**.

Interbeat Interval (IBI) is the time interval between each heartbeat. Heart rate variability (HRV) is a calculation of the changes in the IBI between consecutive heartbeats.



For more information:

Shaffer, F., & Ginsberg, J. P. (2017). An Overview of Heart Rate Variability Metrics and Norms. *Frontiers in Public Health*, *5*. doi: 10.3389/fpubh.2017.00258

Felix, Jens, Wolf, & Martin. (2012, November 21). An Efficient Algorithm for Automatic Peak Detection in Noisy Periodic and Quasi-Periodic Signals. Retrieved from https://www.mdpi.com/1999-4893/5/4/588/htm

Janković D., Stojanović R. (2017) Flexible system for HRV analysis using PPG signal. In: Badnjevic A. (eds) CMBEBIH 2017. *IFMBE Proceedings*, vol 62. Springer, Singapore

Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio sensor guide: Duplexer

Using the duplexer on the Versatile Bio system

The Duplexer accessory allows synchronisation between a Versatile BIO and two Bitbrain devices with Dig input.

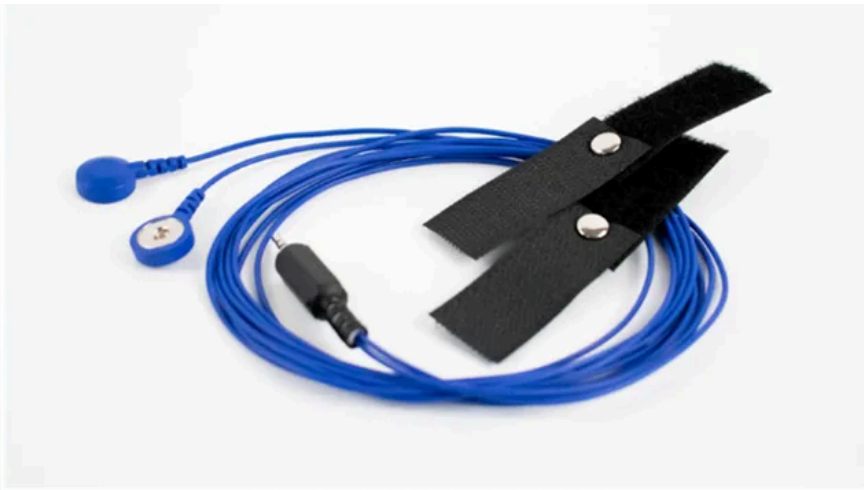
How to use:

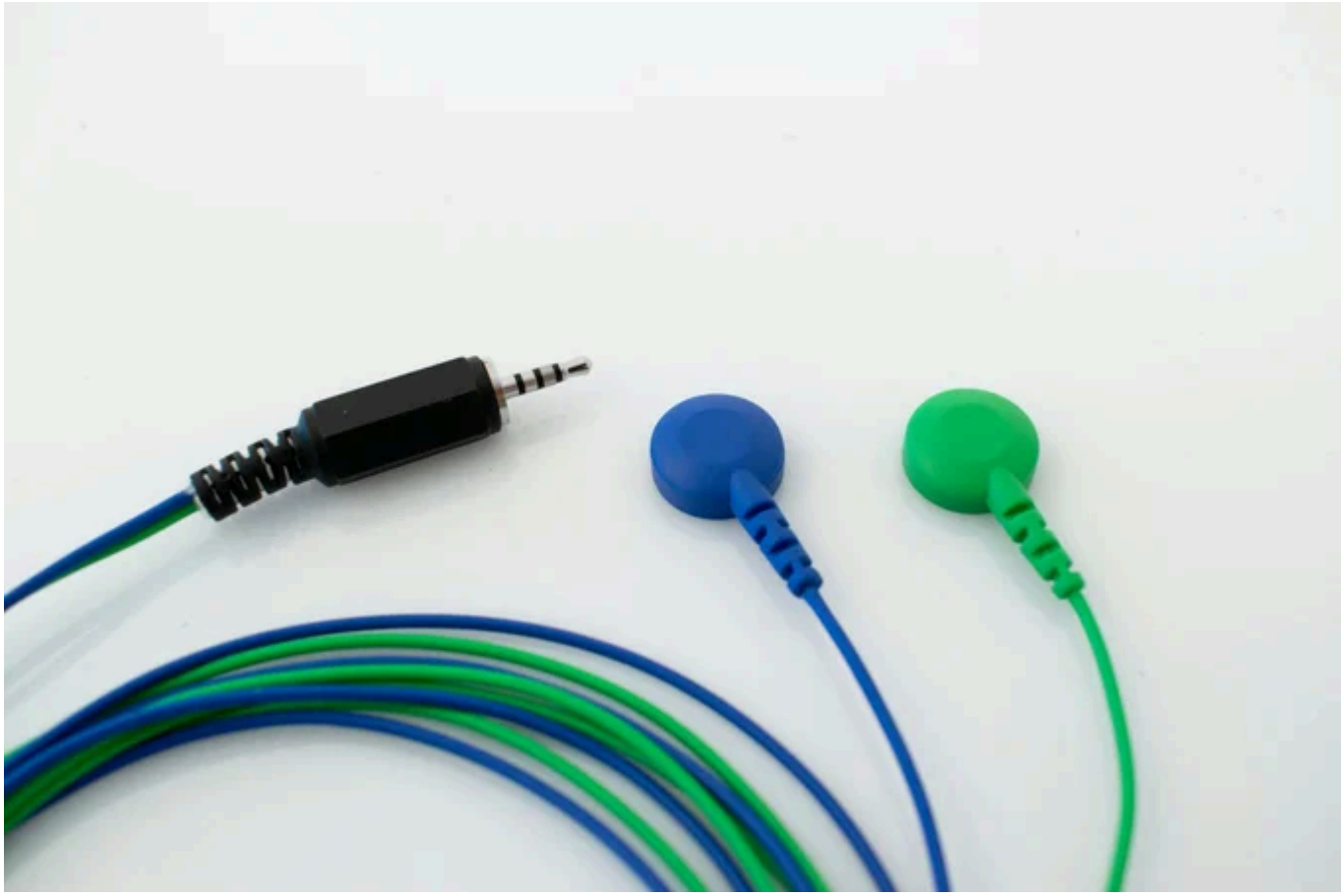
For connection, the jack is connected to the D out output of the Versatile BIO device. A TTL Trigger BBT cable is then connected to each jack input and then to the Dig input of the Bitbrain equipment being used.

Digital Auxiliary Input

Versatile Bio Sensor Guide: Electrodermal Activity Sensor (EDA / GSR)

Understanding the EDA / GSR sensor on the Versatile Bio





What it measures:

The **electrodermal activity / galvanic skin response** sensor measures the **admittance** (inverse of resistance) **across the skin**, which changes with **perspiration.**

Research Applications:

Psychology, neuroscience, human factors, user experience, market research, etc.

How to use:

There are **two sensors**, each one is usually attached via Velcro strap to the middle and ring-fingers of the **non-dominant hand. After the connection with the amplifier has to be made properly.**

> Resistance measured will change with different sensor locations, we recommend positioning the sensors in the same place on all participants within a study.

How to clean:

- Clean the wiring, body and sensor ends with Clinell Universal Wipes.
- **Avoid** getting the **connectors wet**.
- Allow the senors and all wiring to **dry completely before use**.
- **Autoclave** is **not recommended**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Bandpass"
Set High (Hz) to 10
Set Low (Hz) to 0.2
Type is "Butterworth"
Order set to 4

Data file:

Data for the EDA sensor is reported as analog voltage in μV (V analog in the formula below). To calculate GSR resistance in ohms (R_{GSR}), use the following formula, where (V analog) is the μV value reported by the Versatile Bio on the channel the EDA sensor is set up on:

$$R_{GSR}(\Omega) = \frac{6.49e6}{\frac{3.3}{(V\ analog)} - 1}$$

To calculate GSR admittance in siemens (Y_{GSR}), use the output from the previous formula in the following formula:

$$Y_{GSR}(siemens) = {}^{1}/_{R_{GSR}}$$

In MS excel, the conversion formula would look like this (analog µV values in column A, enter formula between [ ] marks into B1 and C1):

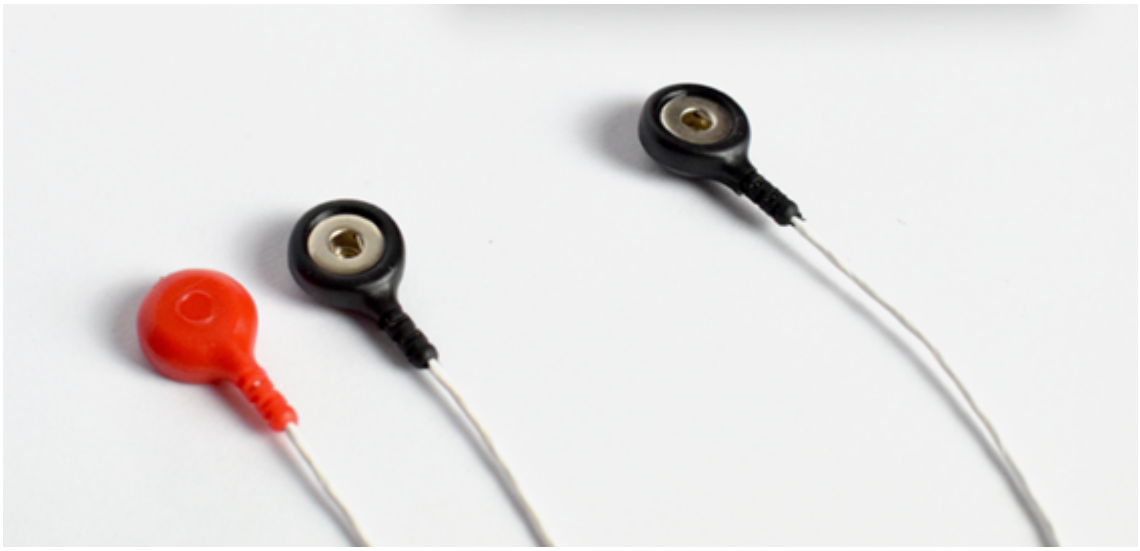
A1 = Recorded (analog V) value
B1 = [=6490000/((3.3/G3)-1)]
C1 = [=1/B1]

B1 = GSR Resistance in ohms
C1 = GSR admittance in siemens

> Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: ExG

Understanding the ExG (EMG, ECG, EOG) sensor on the Versatile Bio



What it measures:

The **ExG** sensors are used to measure **electrical activity** between a **pair of sensors** (differential).

They are typically used for one of these measurements:

EMG: Electromyogram, a way of measuring the electrical activity produced by skeletal muscles during contraction.

ECG: Electrocardiogram (also called "EKG"), a measure of the electrical activity of the heart vs time.

EOG: Electrooculogram, a measure of potential between the front and back of the eyeball as a way of determining relative orientation of the eye.

Research Applications:

Sports, rehabilitation, kinesiology, psychology, biomechanics, neuromarketing, human factors, etc.

How to use:

Connect the sensors to the participant using **standard adhesive disposable electrodes** like the Aqua-Tac (pictured here).

Electrode locations depend on the application (EMG, EOG, ECG). ExG electrodes are bipolar, requiring one electrode positioned on either side of the area to be measured. Consult standard practices for the electrode positions for ECG, EMG, EOG, etc.

Connect as many electrode channels as required via the labeled 2.5 mm ExG connectors on the Versatile Bio amplifier.

> Note: All ExG setups require a ground electrode, connected to the GND input.

> Initial placement:
>
> 1. Set to GND.
>   Can be placed anywhere.
> 2. Place ExG bipolar sensors.
>   Must be placed along the length of the muscle.

How to clean:

Clinell Universal Wipes can be used to clean the ExG leads and electrodes.

- **Dissconect** the **sensor** from the Versatile Bio.
- The **adhesive electrodes** themselves are **disposable**.

- Avoid getting the connectors wet.
- Allow the sensors and all wiring to dry completely before use.
- Autoclave is not recommended.

Connector on Versatile Bio:

ExG

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Bandpass"

For ECG and EOG detection:
Set Low (Hz) to 0.5 Hz
Set High (Hz) to 30 Hz

For EMG detection:
Set Low (Hz) to 1 Hz
Set High (Hz) to 100 Hz

Type is "Butterworth"
Order set to 4

Data file:

Output: ExG data output is reported in µV
Data Range: ±420 mV
Data Noise: <4 µVRMS (0.5-30Hz)
Output Type: Bipolar analog

Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: External TTL

Using the external TTL on the Versatile Bio system

The accessory TTL Trigger EXT allows the synchronization between an amplifier of a Bitbrain device with Dig input and a equipment external to Bitbrain.

How to use:

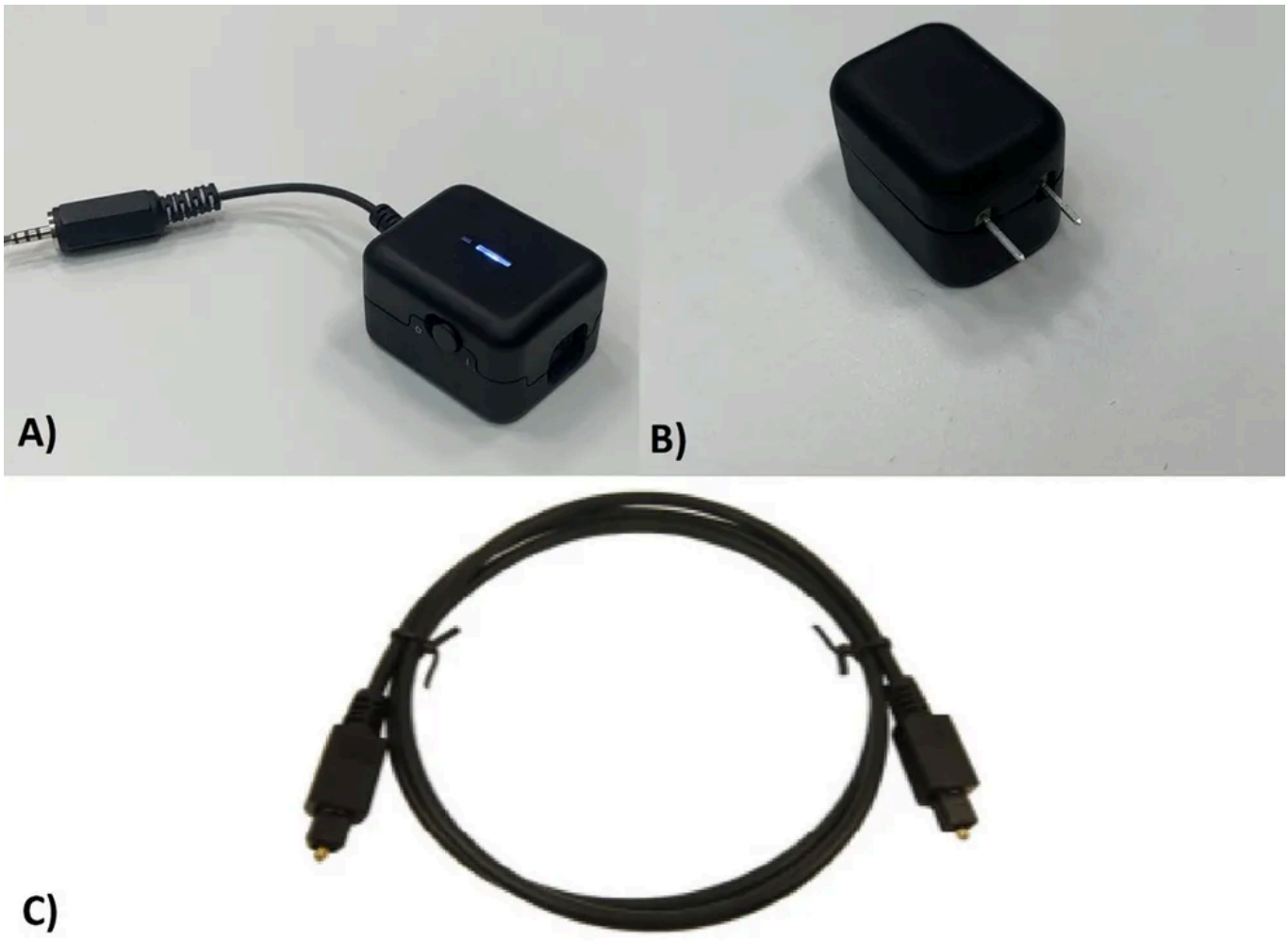
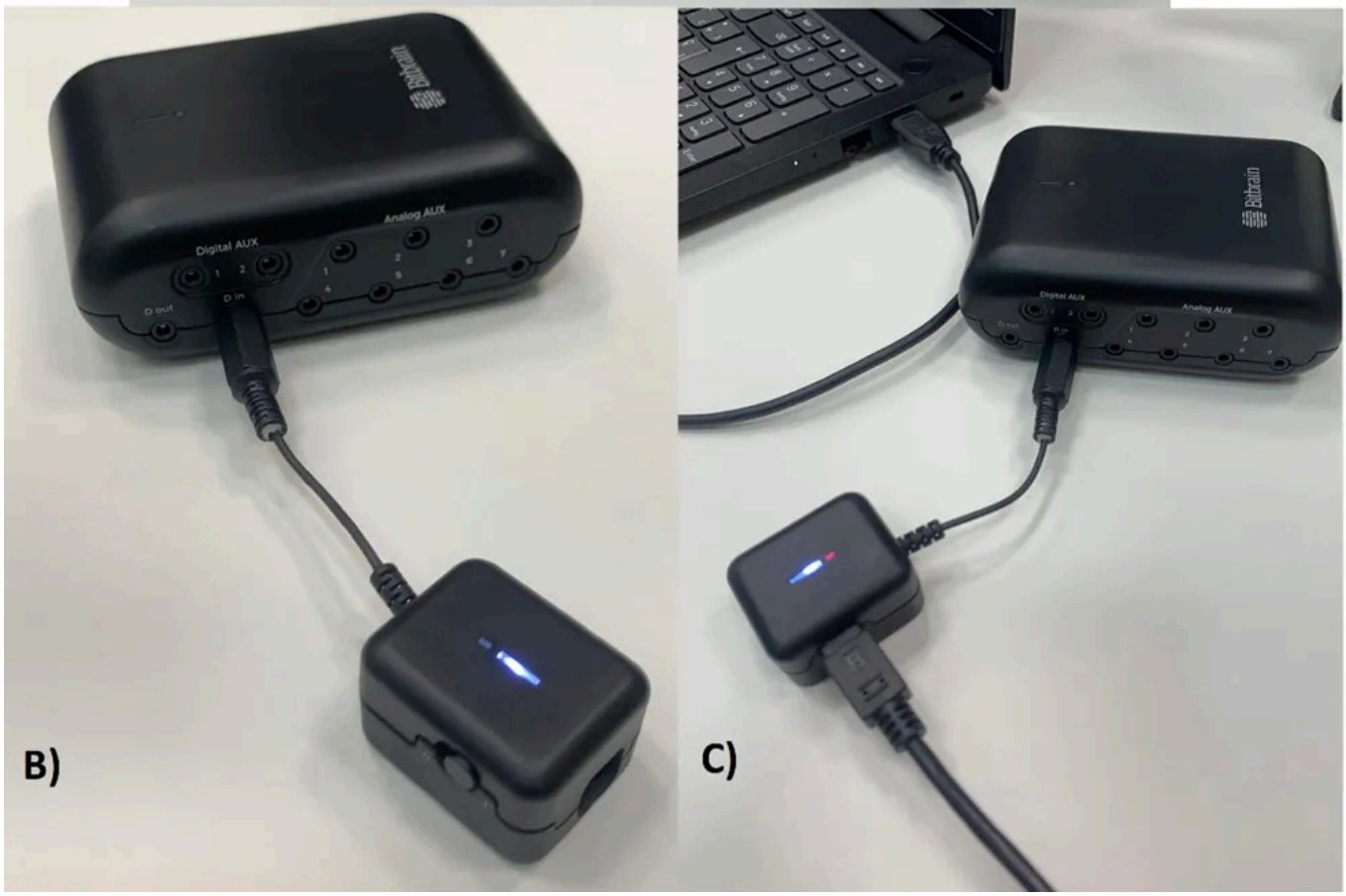


Figure 1: A) Receiver. B) Transmitter. C) Fiber optic cable

The connection is made as follows (for this example a Versatile BIO is used:)

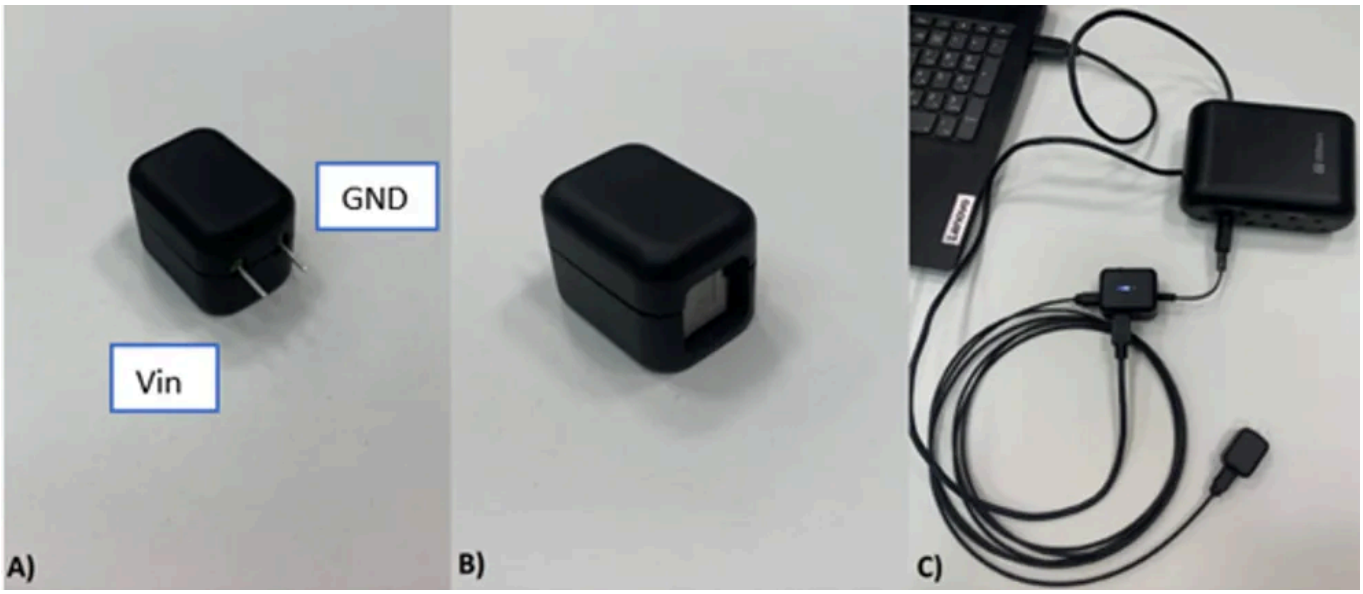
Receiver:

1. Plug in the receiver's jack in the Din input of the Versatile BIO amplifier.
2. Turn on the receiver with the switch. If the light is white then it is charged, if the light is red you need to charge it. It is not possible to use the receiver while it is charging.
3. Connect the receiver to the power (USB port of the computer or USB outputs with the same power supply).



Transmiter:

1. Connect the fiber optic cable to the transmitter.
2. The flat side of the casing must rest on the table, as shown in Figure 3-A) to connect Vin and GND of the external digital signal you want to use.



Connector on Versatile Bio:

Digital Input

Versatile Bio Sensor Guide: IMU

Understanding the inertial measurement unit sensor on the Versatile Bio

What it measures:

The **inertial measurement unit (IMU)** measures the **linear** and **angular** acceleration and **orientation relative to the earth's magnetic field**. The IMU combines a **gyroscope**, **accelerometer** and **magnetometer** (compass), each operating in 3 axes of space for measurement of **9 degrees of freedom**.
The sensor measures the movement and position of whatever it is attached to. Up to 13 different IMU sensors can be connected to the Versatile Bio via the optional multiplexer upgrade.

Research Applications:

Biomechanics, Kinesiology, sports, professional performance, etc. IMU can also be used as a method of artifact removal and error correction when using other sensors (GSR, EEG, EMG, etc).

How to use:

The IMU sensor is placed on the **part of the participant to be tracked** (i.e. the head, hand, etc).

> The magnetometer can be adversely effected by competing magnetic fields or EMF interference.

Connector on Versatile Bio:

Digital Auxiliary Input

Visualization filters:

A data visualization filter is **not necessary for IMU**. You may have to **reduce** the data **scale** until you see a signal.

Data file:

The IMU system reports the following:

- Channel 1: X Axis, Linear Acceleration
- Channel 2: Y Axis, Linear Acceleration
- Channel 3: Z Axis, Linear Acceleration
- Channel 4: X Axis, Angular Acceleration
- Channel 5: Y Axis, Angular Acceleration
- Channel 6: Z Axis, Angular Acceleration
- Channel 7: X Axis, Magnetic Orientation
- Channel 8: Y Axis, Magnetic Orientation
- Channel 9: -Z Axis, Magnetic Orientation

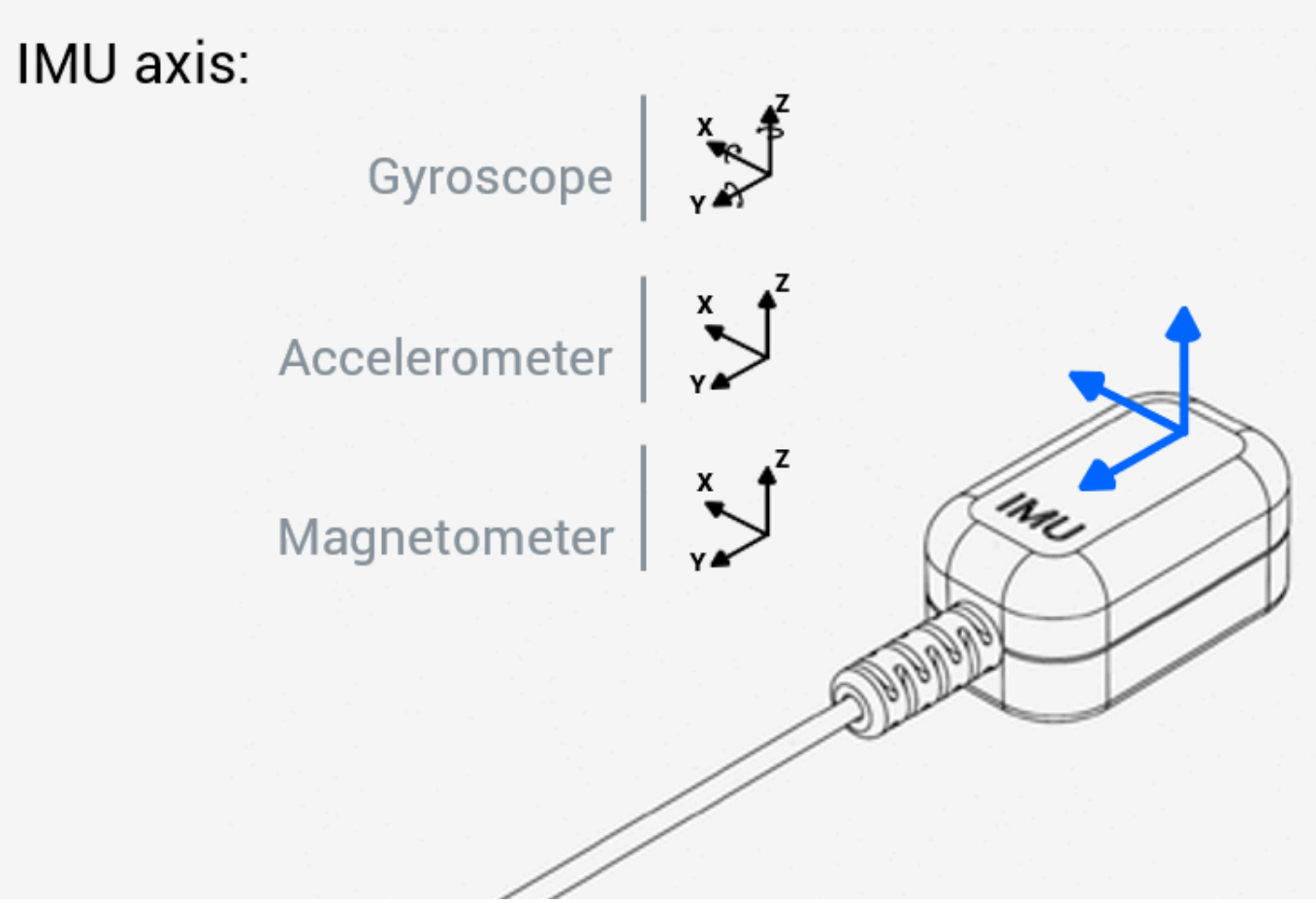
Scales and Sensitivities of the individual sensors in the IMU:

	Sensor	Scale	Sensitivity
Linear Acceleration	Accelerometer	±8g	0.24 mg
Angular Acceleration	Gyroscope	±1000 °/s	0.03 °/s
Orientation	Magnetometer	±4200 µT	0.6 µT

Data Conversion:

(VALUE) = recorded value in data file

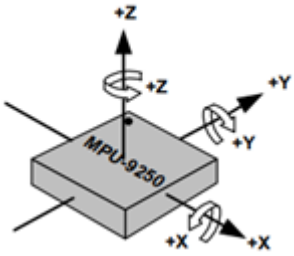
	Sensor	Conversion
Linear Acceleration (X, Y, Z)	Accelerometer	Acc in G = (VALUE) / 4096
Angular Acceleration (X, Y, Z)	Gyroscope	Acc in deg/second = (VALUE) / 32.8
Orientation (X, Y, Z)	Magnetometer	Mag in µT = (VALUE) * 0.6



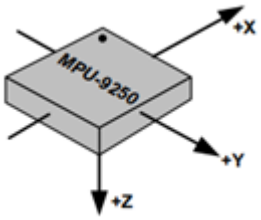
Sensor Axis orientation

- X, Y and Z are coaxial for the accelerometer and gyroscope
- Z orientation is *reversed* for the magnetometer

- Diagram for axis orientation for accelerometer and gyroscope:



- Diagram for axis orientation for magnetometer:



Digital Multiplexer

This is an optional add-on that allows the connection of up to 8 IMU sensors per digital AUX input channel, for a total of 13 possible IMU sensors via two multiplexers. See Versatile Bio Sensor Guide: IMU Multiplexer for more details.

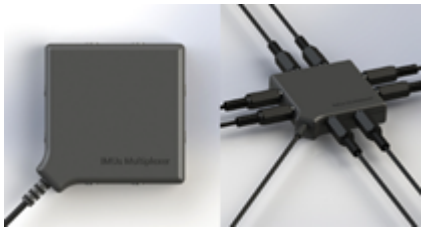
Versatile Bio Sensor Guide: IMU Multiplexer

Using the multiplexer for multiple IMU sensors on the Versatile Bio system

The multiplexer is used to attach up to **8 IMU units** to a single AUX input channel on the Versatile BIO. You can use **up to two multiplexer**s for a total of 13 IMU units.

How to use:

Each **IMU unit** must be **connected** to the multiplexer **sequentially**, starting at channel 1. You can attach a total of 8 IMU units to a multiplexer,. Each IMU have to be sequentially connected starting from number 1.



The multiplexer is attached to the Digital AUX channel on the Versatile Bio. A total of two multiplexers can be attached to the Versatile Bio with up to 8 sensors.

Connector on Versatile Bio:

Digital Auxiliary Input

> For more information on the IMU sensor, see the entry Versatile Bio Sensor Guide: IMU

Versatile Bio Sensor Guide: Photodiode

Understanding the photodiode, or light sensor, on the Versatile Bio

What it measures:

A **photodiode measures light** and translates it to a voltage signal that is recorded by the Versatile Bio.

Research Applications:

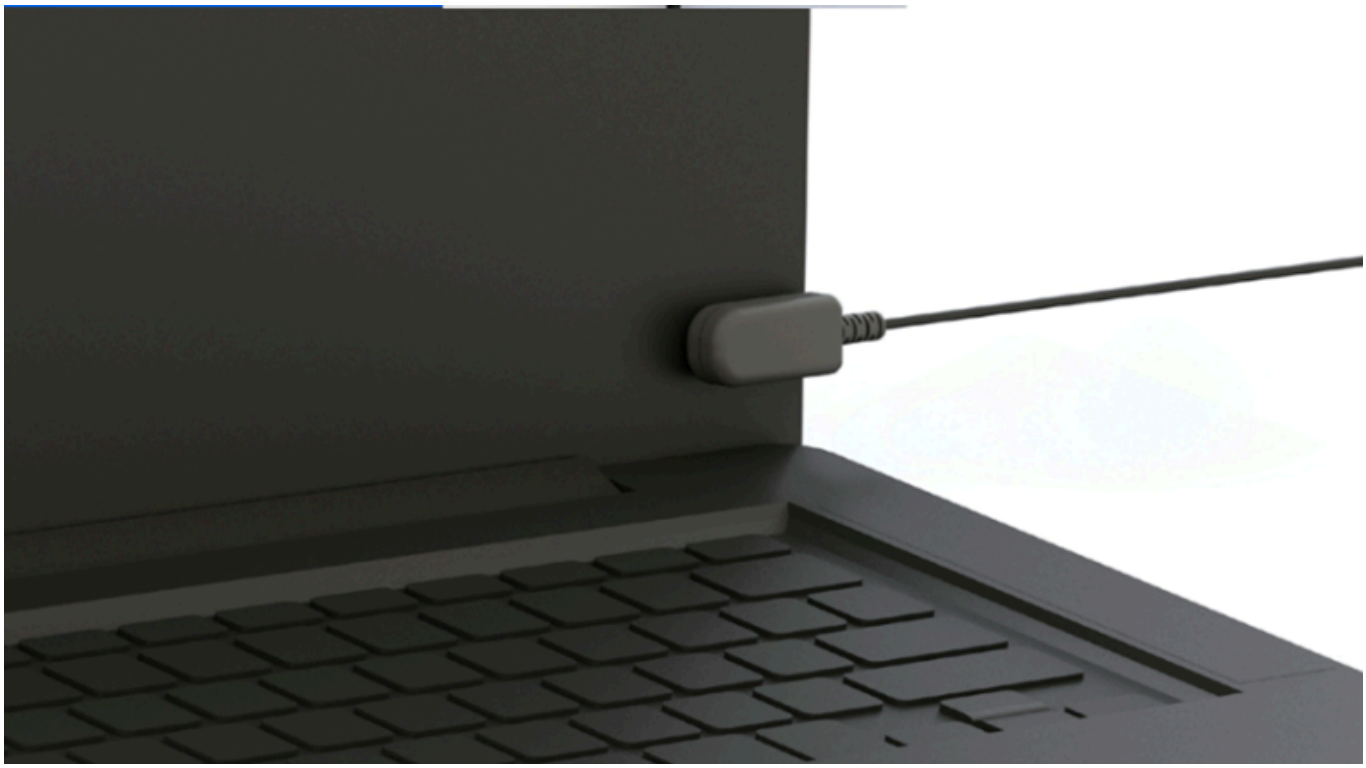
The most common use of a photodiode is as a method of **extremely accurate synchronization with visual stimuli**, especially when presented on a computer screen.

For example, a photodiode can be connected to the corner of a computer monitor. Alternating visual stimuli events can use a small box at that part of the screen, triggering the photodiode. This would create a marker in the Versatile Bio data corresponding to the change in the stimulus and allow the time synchronization of all other data recorded by the platform. Different intensity of light can be used on the box to denote different trials or parts of a test.

A photodiode can also be used to measure ambient light. This is useful in sleep studies, for example, where it may be useful to know if the lights were on or when sunlight entered the room.

How to use:

The photodiode sensor is **placed wherever the light must be measured** (i.e. directly on a computer screen).



Connector on Versatile Bio:

Analog input

Visualization filters:

The photodiode may pick up the refresh flickering of a computer monitor or florescent lights. To avoid this in the sensor visualization, consider setting a low-pass filter up to 30-40 Hz.

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Low-pass"
Set High (Hz) to 30-40 Hz
Type is "Butterworth"
Order set to 2

Data file:

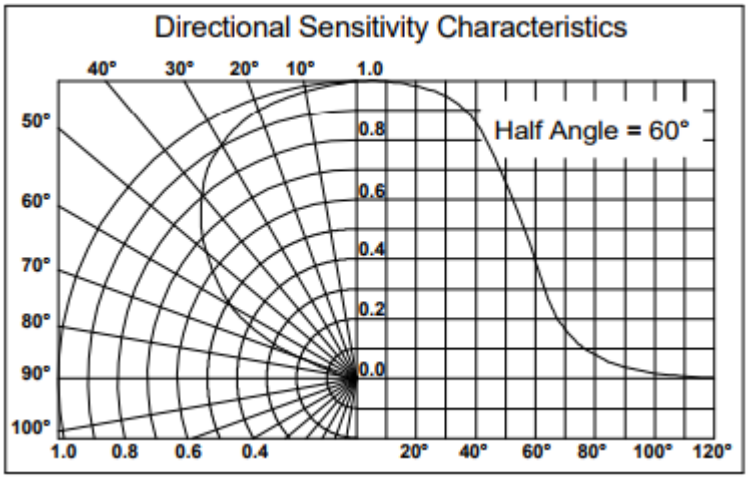
The output voltage roughly corresponds to light intensity recorded by the photodiode sensor.

Wavelength and Temperature Sensitivity

Operational temperature	-20ºC - +85ºC
Switch time	4µs - 6µs
Sense spectran range	400-700nm (peack 500 nm)
Acceptance angle	±60deg

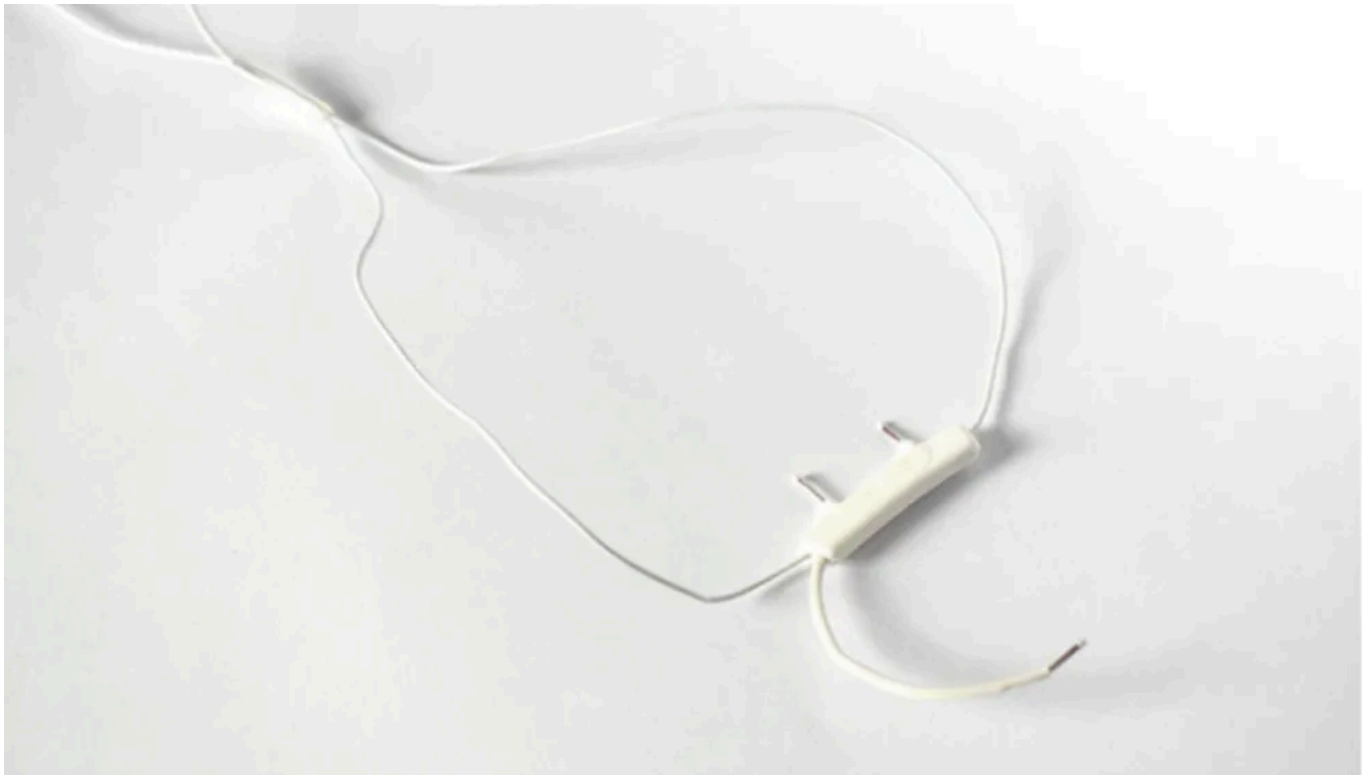
Directional Sensitivity

The photodiode sensitivity depends on direction, and it will not see a signal as well that is too peripheral. The following graph details sensitivity at increasing directional angle to the sensor:



Versatile Bio Sensor Guide: Respiratory airflow

Understanding the respiratory airflow sensor on the Versatile Bio



What it measures:

The **airflow sensor (MAF)** measures **temperature changes in breathed air** in order to measure inhaled and exhaled breaths.

Research Applications:

Sports, rehabilitation, kinesiology, psychology, biomechanics, etc.

How to use:

The sensor has to be placed on the **upper lip**, between the **nostrils and the mouth.** This can be used on **adult** and **pediatric participants**.

How to clean:

To clean and disinfect the **sensor**, do the following:

- **Disconnect** the sensor from the Versatile Bio.
- Use Clinell Universal Wipes.
- Let it **dry before using**.
- **Autoclave** is **not recommended**.
- Do **not immerse** the device in **any liquid**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Bandpass"
Set High (Hz) to 10 Hz
Set Low (Hz) to 0.1 Hz
Type is "Butterworth"
Order set to 4

Data file:

Output: µV
Output Bandwidth: 0.16 Hz - 15 Hz

Output data is reported in **microvolts** and is relative to the temperature recorded during inhalation and exhalation. **Inhaling** will cause a voltage **decrease**, while **exhaling** will cause a voltage **increase**.

Absolute voltage amplitude and signal strength can vary considerably based on sensor placement, airflow, posture, ambient temperature, CPAP pressure, etc.

> Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: Respiratory Effort Band

Understanding the respiratory effort band sensor on the Versatile Bio

What it measures:

The **respiratory stress band** detects a **participant breathing** via an elastic band worn around the chest.

Research Applications:

Sports, rehabilitation, kinesiology, psychology, biomechanics, neuromarketing, etc.

How to use:

The sensor band is placed **around the participant's chest** and under the arms and **tightened enough to be snug**.

> We recommend taping the cables to the participant's body in order to avoid movement artifacts.

How to clean:

To clean and disinfect the **sensor**, do the following:

- **Disconnect** the sensor from the Versatile Bio.
- Use Clinell Universal Wipes.
- Let it **dry before using**.
- **Autoclave** is **not recommended**.
- Do **not immerse** the device in **any liquid**.

The **Velcro** can be washed with **household detergent**, then **air dried**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Bandpass"
Set High (Hz) to 5 Hz
Set Low (Hz) to 0.1 Hz
Type is "Butterworth"
Order set to 4

Data file:

Sensitivity: 2-30 µV/mm
Output Bandwidth: 0.5 Hz to 12 Hz
Maximum signal amplitude 400 mV

Output data is reported in **microvolts** and is relative to the **expansion** and **contraction** of the **band** during inhalation and exhalation.

Absolute voltage amplitude and signal strength can vary based on sensor placement and size of the participant.

> Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: Snore sensor

Understanding the snore sensor on the Versatile Bio

What it measures:

The **snore sensor** measures sound **changes in participants throat.**

Research Applications:

Sports, rehabilitation, kinesiology, psychology, biomechanics, etc.

How to use:

The sensor has to be placed on the **neck of the participant, close to the trachea.**

How to clean:

To clean and disinfect the **sensor**, do the following:

- **Disconnect** the sensor from the Versatile Bio.
- Use Clinell Universal Wipes.
- Let it **dry before using**.
- **Autoclave** is **not recommended**.
- Do **not immerse** the device in **any liquid**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

Right-click on wave view in Bitbrain Device Viewer to view data-visualization filter settings.

Under "Notch-Filter" we recommend setting this to the preset matching your country's AC frequency (presets exist for USA/Japan at 60 Hz, and Europe at 50 Hz).

Under "Other Filter" click "enabled"
Set filter type to "Bandpass"
Set High (Hz) to 60 Hz
Set Low (Hz) to 0.1 Hz
Type is "Butterworth"
Order set to 4

Data file:

Output: µV
Output Bandwidth: 0.16 Hz - 15 Hz

Output data is reported in **microvolts** and is relative to the temperature recorded during inhalation and exhalation. **Inhaling** will cause a voltage **decrease**, while **exhaling** will cause a voltage **increase**.

Absolute voltage amplitude and signal strength can vary considerably based on sensor placement, airflow, posture, ambient temperature, CPAP pressure, etc.

> Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: Temperature

Understanding the temperature sensor on the Versatile Bio

What it measures:

The **temperature sensor (TEMP)** measures **temperature changes** at the site of the probe as voltage changes.

Research Applications:

Physiology, sports, kinesiology, biomechanics, etc.

How to use:

The **probe** should be placed where temperature should be measured. It can be **attached to the body** with appropriate **medical tape** or adhesive. After that the connection between the sensor and the amplifier has to be set.

> As with any temperature sensor, direct sunlight can alter the recorded temperature drastically.

How to clean:

To clean and disinfect the sensor, do the following:

- **Disconnect** the sensor from the Versatile Bio.
- Use Clinell Universal Wipes.
- Let it **dry before using**.
- **Autoclave** is **not recommended**.
- Do **not immerse** the device in **any liquid**.

Connector on Versatile Bio:

Analog AUX

Visualization filters:

A data visualization filter is **not necessary** for the temperature sensor. For live data viewing, you will have to reduce the data scale for the analog channel until the signal is visible.

Data file:

Sensor Range: -50 degrees C to 105 degrees C in air, -55 degrees C to 70 degrees C in fluid
Dissipation Factor (in air): 3 mW / degree C
Thermal time constant (in air): 75 seconds

Data is reported as **analog voltage in µV**, listed as (analog V) in the formula below. To convert to **temperature in C**, use the following:

$$R_{NTC} = \frac{56\,e3}{\frac{3.3}{analog\,V} - 1}$$

$$T(K) = \frac{1}{\frac{1}{25 + 273.15} + \frac{\ln\left(\frac{R_{NTC}}{10e3}\right)}{3435}}$$

$$T(°C) = T(K) - 273.15$$

In MS excel, the conversion formula would look like this (analog V values in µV as recorded by the temperature probe in column A, enter formula between [ ] marks into B, C and D):

A1 = Recorded (analog V) value
B1 = [=56000/((3.3/A1)-1)]
C1 = [=1/(0.003354+(LN(B1/10000)/3435))]
D1 = [=C1-273.15]

C1 = Temperature in degrees K
D1 = Temperature in degrees C

> Click on this link for a video showing the setup of the Versatile Bio.

Versatile Bio Sensor Guide: TTL trigger cable

Using the Bitbrain TTL on the Versatile Bio system

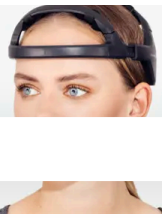
The TTL Trigger BBT accessory allows synchronisation between a Versatile BIO amplifier and Bitbrain equipment with Dig input.

How to use:

To make the connection, connect one end of the cable to the D out input of the Versatile BIO amplifier and the other end to the Dig input of the Bitbrain device being used.

Connector on Versatile Bio:

Digital Input



Export format differences

Main differences between the "CSV - Full", "CSV - Lite" and EDF export formats

CSV:

CSV is an interoperable file format for storing tabular data in plain text. One file is provided for every device signal. Supported for all Bitbrain devices. We provide two output formats with varying levels of detail (Lite and Full).

EDF:

EDF is a standardized file format designed for storing biological signals. One file is provided for every device. Supported for Bitbrain devices containing EEG signals. We refer to “EDF” through the software and this document for simplicity, note however that we specifically provide the EDF+ format.

Main differences:

- Resolution and filtering: EDF represents the signal values in 2 bytes (16 bits), which does not allow to store the EEG and PPG signals as the full range of the amplifier ADC is 24 bits. Thus, EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) when exported to EDF format. CSV formats (CSV-Lite, CSV-Full) export the full-band signals.
- Lost samples adjust: Some signal samples might be lost due to the wireless nature of the communication. In EDF and CSV-Full, the exported signals are expanded with nan values in case of lost samples. In CSV-Lite, additional information is provided such a sequence number (counter) to detect these cases.

- Multi-device adjust: In simultaneous multi-device recordings, the devices might start the recording with a slight difference (even when they are commanded at the same time). In EDF and CSV-Full, we provide a common t0 for all signals, and expand the signals with initial nan values so that the initial sample corresponds to the same time point. In CSV Lite, we simply provide the initial timestamp (t0) for each device signals, which might be different.

output data formats properties	EDF	CSV-Full	CSV-Lite
Supported devices	EEG devices (Ring or Versatile Bio not supported)	All	All
Full-band	No, EEG and PPG are high prefiltered (0.1 Hz)	Yes	Yes
Lost samples adjust	Yes	Yes	No
Multi-device adjust	Yes	Yes	No
Supported in SennsLite	Yes	Yes	Yes
Supported in SennsLab	No	Yes	Yes

EDF Format:

An EDF file for every recorded device is provided, thus containing all its signals that operate at different sampling rates.

> Example:
> *eeg_AF7, eeg_A1, eeg_Fp2, eeg_AF8, eeg_A2, mask_eeg, imu_1, imu_2, imu_3, imu_4, imu_5, imu_6, imu_7, imu_8, imu_9, mask_imu, spo_1, spo_2, spo_3, mask_spo*

Channel	Description

<signal_id><i> * In case of EEG signals, we provide the position: <signal_id><loc>	Values of signal and channel i (from 1 to N). EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) and clipped to (-3000, 3000) uV.
mask_<signal_id>	Mask of boolean values (0 or 1) for each signal that indicates whether samples were lost and should be interpreted as missing values (nan). Note we include a mask channel because nan values cannot be represented in EDF format. A sample j was lost in signal eeg when mask_eeg[j] is 1.

Header of the EDF file:

The header of the EDF file fills the following fields:

- Start date and start time (note these fields provide a resolution of seconds; for a higher time resolution access the UTC timestamps provided in the JSON file – metadata).
- Patient code
- Equipment (device type)

CSV Format:

We provide a CSV file for every recorded signal.
The first line contains a header with the name of the columns.

> Examples:
> *CSV-Full: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2*
> *CSV-Lite: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2, sequenceNumber, timestampReception, timestamp*

The CSV file contains the following columns:

Column	Full/Lite	Description

ch<i> * In case of EEG signals, the position is added: ch<i>-<loc>	Full/Lite	Values of channel i (from 1 to N).
sequenceNumber	Lite	Sequence number (counter) is incremented by 1 every block.
timestampReception	Lite	Reception timestamp (high res., us) per block, might be null if lost online.
timestamp	Lite	Corrected timestamp (high res., us), using the t0 computation.

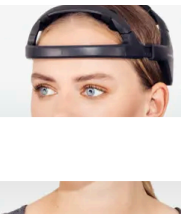
Events:

The events registered with SennsLite during the recording are exported to CSV files.
We provide a CSV file for every event type.
The first line contains a header with the name of the columns.

> Examples:
> *timestamp, value1*

The CSV file contains the following columns:

Column	Description
timestamp	Timestamp (high res., us) when the event occurred.
value<i>	Value/s of the event. Note that one event might have several values. For instance, one event type “quality” is provided for every device that provides the signal quality of every channel.



SennsLab Installation requirements

Technical requirements of SennsLab

Technical requirements for installing SennsLab:

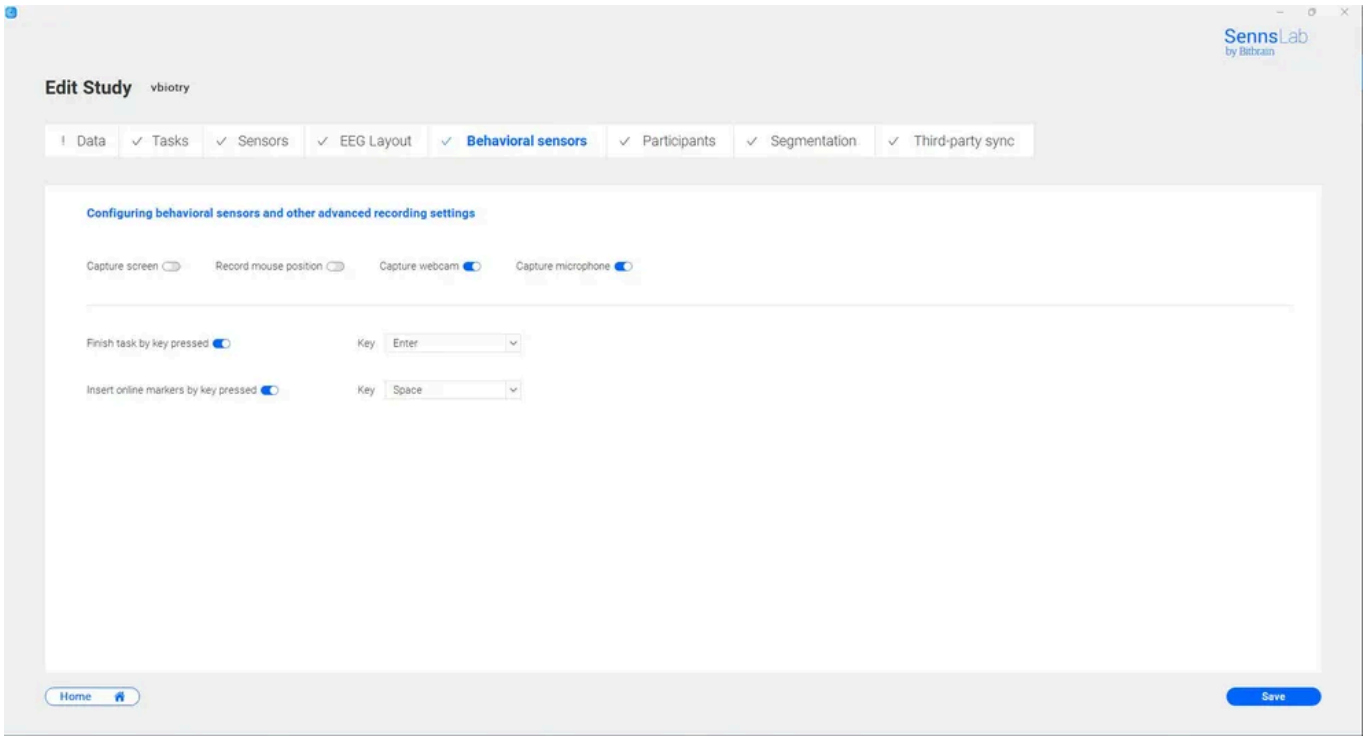
- Windows 7 64-bit operating system or later
- User with administrator rights.
- Bluetooth 4.0 or higher adapter (if Bluetooth is the device you are using).
- i5 6th generation processor or higher.
- 8Gb RAM or higher.
- Hard disk with available space of 1Gb or higher.
- Graphics card with 2Gb of memory. Nvidia GeForce GTX 1050 recommended. (Neccessary for screen capture only).
- Wi-Fi adapter available to connect to Tobii Pro Glasses (if used).

> To download the Software please visit our Download center.

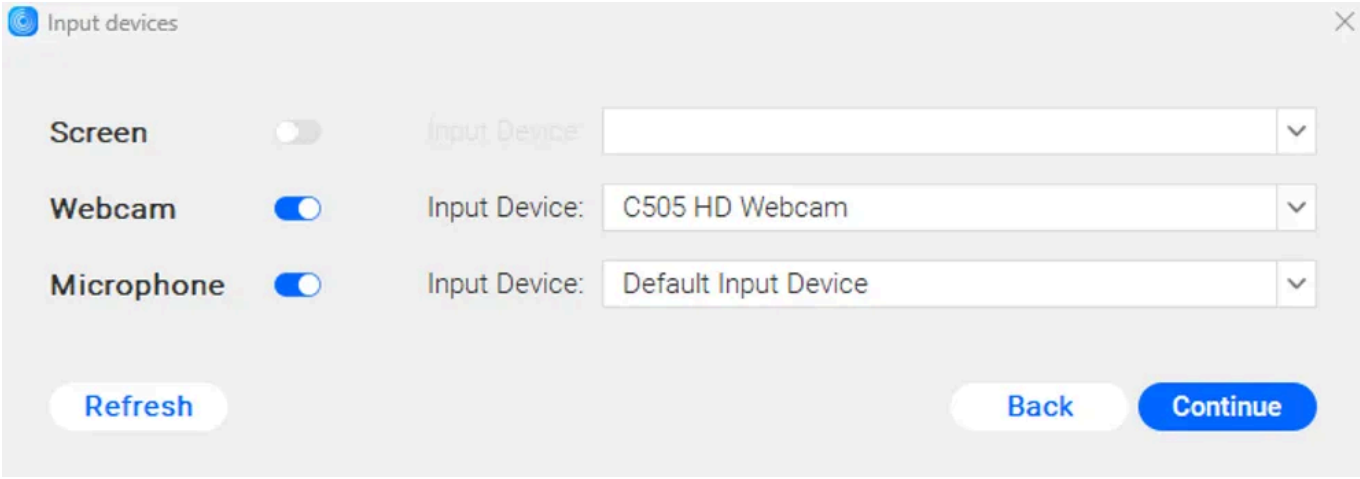
SennsLab: How can I record participant audio and video?

Using a microphone and webcam in SennsLab

This is in the "**Design**" section of SennsLab. In the "**Study Edit**" screen, click on the "**Behavior**" tab. Select "**Capture Microphone**".



Before launching the study a **pop up** will come out.



You can choose the **microphone** or **webcam** from the **drop down menu**.

This are the tested **Webcams** in SennsLab:

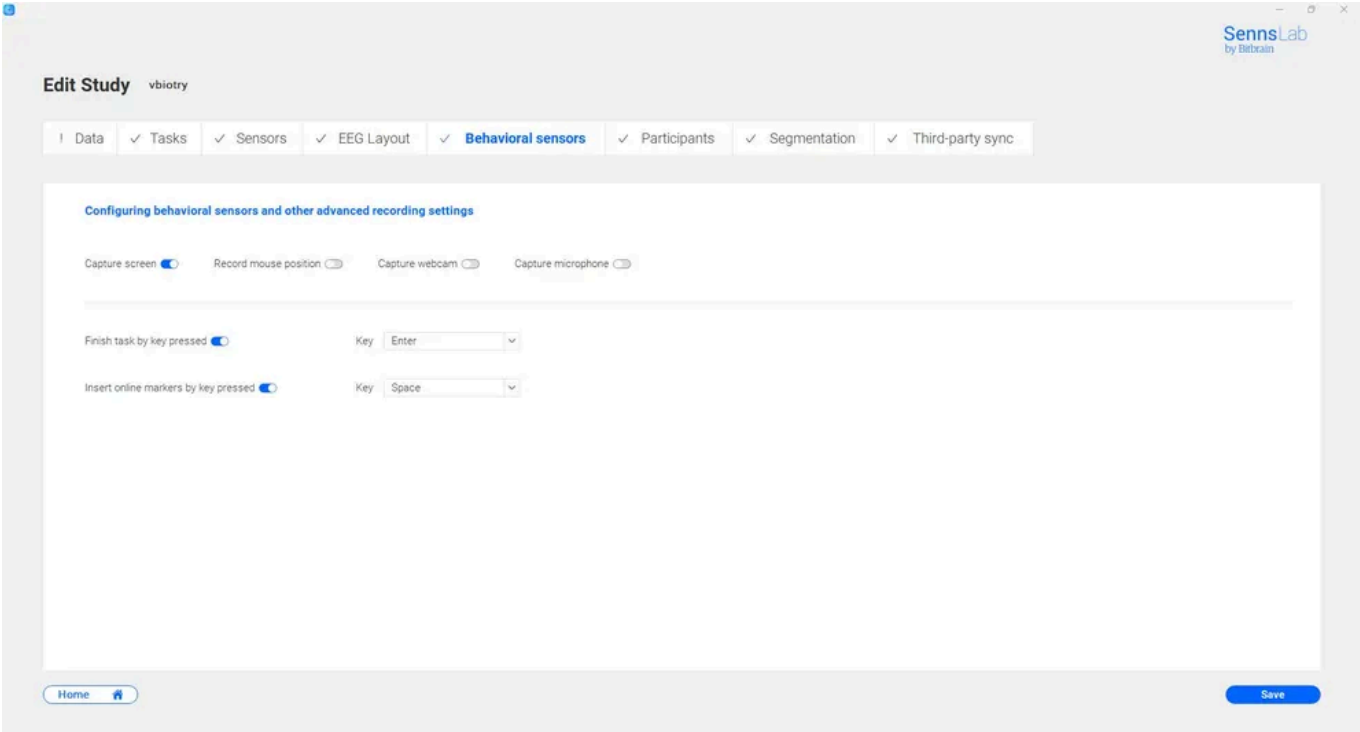
- Logitech Webcam BCC950
- Logitech Webcam C505
- Logitech Webcam C930e

> Remember to run a trial study to verify that the Audio and Video Recording is operating properly.

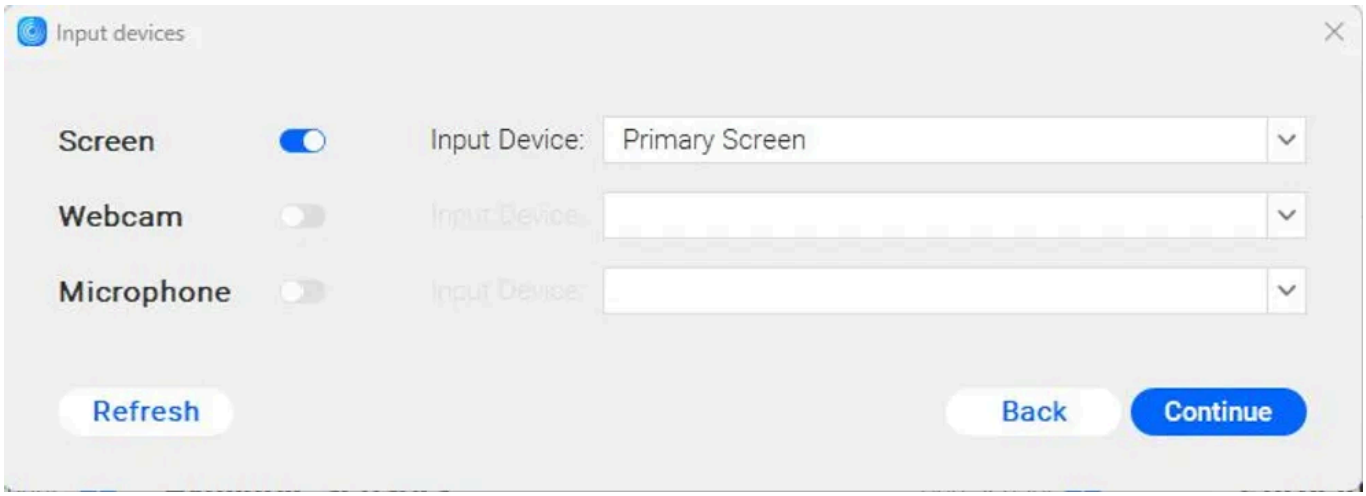
SennsLab: How can I set up screen recording?

SennsLab Screen Recording

This is in the "**Design**" section of SennsLab. In the "**Study Edit**" screen, click on the "**Behavior**" tab. Select "**Capture Screen**" .



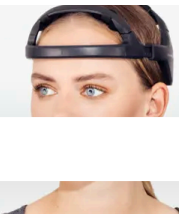
Before launching the study a **pop up** will come out.



If you have more than one screen attached (for example, a laptop and external monitor), choose the **screen** to be recorded from the **drop down menu**. The screens included are defined in Windows display management.

> Remember to run a trial study to verify that the Screen Recording is operating properly

> Please note that for this feature a graphics card with 2Gb of memory is needed.
> Nvidia GeForce GTX 1050 is recommended.



SennsLab: What video or image files are supported as stimuli?

Using video and images in SennsLab

Accepted **image** formats are: * .jpg, * .jpeg, * .png and * .bmp.

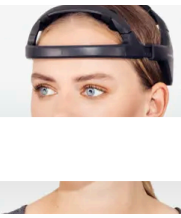
- Note that image resolution will be scaled to the monitor size, and may appear pixelated if the starting resolution is insufficient.

Accepted **video** formats are: * .avi, * .mpeg, * .mpg, * .wmv, and * .mp4.

- Note that the stimulus computer must be capable of playing the codec used to create the videos. If you have trouble playing a particular video in SennsLab, try converting to * .avi format.

> When SennsLab presents images, they will be resized to fit the size and resolution of the presentation screen, while still maintaining the aspect ratio. If an image is too small for the monitor size, it could appear pixelated. Consider pre-formating your images into the proper resolution before using them.

> A specific image (name) can be included only once in a study.



SennsLab: Why do my images look pixelated during a study?

Image size and resolution in SennsLab

SennsLab will **automatically reformat** your **images** to fit the resolution and **size** of your presentation **screen** as much as possible **without changing the aspect ratio**. If your images are of an inadequate resolution for the stimulus monitor you are using, they will appear **pixelated** and of reduced quality when blown up during the **test**.

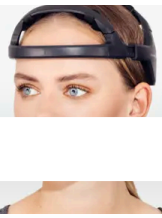
For example, if you have an image created at 640 X 480 resolution, but your monitor is running in HD (1920 X 1080), the smaller image will be displayed at the higher resolution at a significant loss of quality - similar to zooming in too far on a digital photograph. An image that is already at 1024 X 768 resolution does not have to be expanded nearly as much and will look much more natural.

To **avoid** this problem, format your images in the **proper resolution** before adding them to SennsLab. Generate materials at a **higher resolution**.

If you want an image to appear in its **native resolution**, add a **border** so the total image size is correct for your monitor.

For example, the 640 X 480 image can still be displayed without enlarging if it is embedded in a 1920 X 1080 resolution file.

> You can always verify that the images will display correctly by running a trial study.



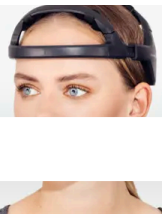
SennsLab: Why does my study not appear on the "launch study" list?

Creating a new study in SennsLab

Only **studies** that are **completely designed** appear in the "**studies in progress**" list. If your study is missing, most likely some **parts** of the study are still **undefined**.

Click on "**manage studies**" in SennsLab and find your study in the list. Click on your study.

Any tab that lists an "**X**" or "**!**" next to the **tab title** means that that part is **not defined** so still requires input before the study is complete. If you hover your mouse over these tabs, a **pop-up dialog box** will indicate what is **missing** in that category.



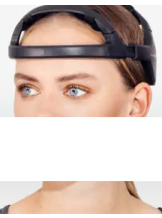
SennsLite Installation requirements

Technical requirements of SennsLite

Technical requirements for installing SennsLite:

- Windows 10 64-bit or later Operating System.
- User with administrator rights.
- Bluetooth 5.0 or higher adapter.
- Bluetooth Low Energy adapter.
- 6th generation or higher i5 processor.
- RAM memory of 8Gb or higher.
- Hard disk with available space of 1Gb or more.

> To download the software please visit our Download Center.



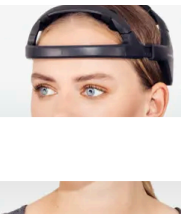
SennsMetrics Installation requirements

Technical requirements of SennsMetrics

Technical requirements for installing SennsMetrics:

- Operating system: Windows 7 64-bit or later (Windows 10 recommended).
- Processor: Intel Core i5 or higher
- RAM: 8GB or higher
- Hard disk: 1GB available or higher.
- Monitor at least 24", screen resolution 1920x1080 recommended.
- User with administrator rights.

To download the Software please visit our Download center.



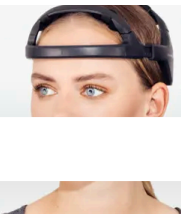
Tools for data analysis

Additional links to analyse EEG data

Here are some useful links related to widely used tools in research for the analysis of various biosignals:

- EEGLAB: https://eeglab.org/tutorials/
- FieldTrip: https://www.fieldtriptoolbox.org/getting_started/
- MNE - Python: https://mne.tools/dev/auto_tutorials/index.html
- ERPLAB: https://github.com/ucdavis/erplab/wiki
- Brainstorm: https://neuroimage.usc.edu/brainstorm/Tutorials

These links include brief getting started guides, as well as basic preprocessing (filters, artifacts, preprocessing) and more advanced techniques (ERPs, source analysis, etc.). They also cover the practical aspects of installation and function references.



Definition of Analysis Metrics in SennsMetrics

Bitbrain's cloud-based analysis platform will generate different metrics based on the template and hardware used.

Activation

Hardware Required: **Ring**

Tests Supported: Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: Basal level of physiological **activation** produced by a **stimulus or situation**. Emotional activation may be due to a **positive** or **negative emotional response**. Activation is expressed in percentages based on a baseline defined during the **calibration stimuli**. Values less than **0** are associated with a state of **relaxation or calm**. Values **higher** than **0** are associations with a state of **excitement**. A value of **-100%** refers to the **maximum relaxation response** observed during calibration. A value of **100%** refers to the **maximum response** seen in response to the calibration media. A value of **more than 100%** is possible if the calculated **reaction exceeds** that measured during the **calibration**.

Impact

Hardware Required: **Ring**

Tests Supported: Passive Image Template*, Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: Emotional **impact** measures the **number** and **intensity of point changes** in the emotional state produced by a stimulus, external event, or in the performance of a task. In other

words, **Impact identifies** something that is striking or produces **excitement** or **stress**. **Impact** is expressed as a **percentage**. A value of **0% means no impact**. **100%** equals the **value measured** in response to the **calibration media**. A value of **more than 100%** is possible if the calculated **reaction exceeds** that measured during the **calibration**.

**Impact is calculated as a binary response in the Passive Image Template. This information is meant to be useful in the aggregate (averaged over multiple participants).*

Valence

Hardware Required: **Diadem EEG**

Tests Supported: Passive Image Template*, Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: Measures the **degree of attraction experienced** in response to **stimuli** or a **situation**, from a **positive / pleasant** reaction to a **negative / unpleasant** reaction. Valence is expressed as a **percentage**. A value of **100% positive** or **negative** equals the value measured in response to the **calibration media**. A valence level exceeding **100%** (positive or negative) is possible if the calculated **reaction exceeds** that measured during the **calibration**.

**Valence is calculated somewhat differently in the Passive Image Template and requires some self-reporting for accurate calculation.*

Memorization

Hardware Required: **Diadem EEG**

Tests Supported: Passive Image Template, Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: This indicator **measures** the **intensity of cognitive processes** related to the formation of future **memories** during the presentation of stimuli or during an experience. Captures the **degree** of **storage**, encoding, and retention in **memory**. Memorization is expressed as a **percentage**. A value of **0%** indicates that the **chance** that the stimulus will be **remembered** is **low**. A value close to **100%** indicates a **high possibility** that the stimulus will be **retained** in the **participant`s memory.**

Workload

Hardware Required: **Diadem EEG**

Tests Supported: Passive Image Template, Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: **Workload** measures the **neurological focus**, or concentration of a participant when presented with stimuli or during experiences. In other words, it represents the use of **cognitive resources** to carry out a task or visualize a stimulus. Workload is expressed in **percentages**. Values close to **0%** indicate that the participant is **very distracted**, while a value close to **100%** indicates that they are very **attentive** to the stimulus.

Engagement

Hardware Required: **Diadem EEG**

Tests Supported: Passive Image Template, Active Image Template, Passive AV Template, Active AV Template, Free Task Template, AV Recording Template, Focus Group Template, Survey Template.

Definition: This is a measurement of the degree of **involvement** or **connection** between the **participant** and the **stimulus** or **task**. This is a more complex indicator than attention, as a participant can be **attentive** to a task even if the information presented is **not of interest**. Engagement is expressed as a **percentage**. A value close to **0%** indicates **no connection** or **link** to the **stimuli**. A value close to **100%** indicates **high engagement** with the **stimuli** or **task**.

Useful Links relating to SennsLab and SennsMetrics:

- References for SennsMetrics Data Calculations
- List of SennsLab Experiment Templates
- Understanding Experiment Structure in SennsLab
- Understanding SennsLab Emotional-Cognitive Calibration

References for SennsMetrics Data Calculations

References for the different metrics calculated in SennsMetrics Analysis software

The following are references for the emotional and cognitive states estimation analysis in SennsMetrics:

Arousal and Impact

[1] Boucsein, W. (2012). Electrodermal Activity. PhD Proposal (Vol. 1).
[2] Benedek, M., & Kaernbach, C. (2010). Decomposition of skin conductance data by means of nonnegative deconvolution. Psychophysiology, 47(4), 647–58.
[3] Benedek, M., & Kaernbach, C. (2010). A continuous measure of phasic electrodermal activity. Journal of Neuroscience Methods, 190(1), 80–91.
[4] Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. Biological Psychology, 84(3), 394–421.
[5] Golland, Y., Keissar, K., & Levit-Binnun, N. (2014). Studying the dynamics of autonomic activity during emotional experience. Psychophysiology, 51(11), 1101–1111

Valence

[1] Harmon-Jones, E., Gable, P. A., & Peterson, C. K. (2010). The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. Biological Psychology, 84(3), 451–462
[2] Allen, J. J. B., Coan, J. A., & Nazarian, M. (2004). Issues and assumptions on the road from raw signals to metrics of frontal EEG asymmetry in emotion. Biological Psychology, 67, 183–218.

[3] Davidson, R. J. (1992). Anterior Cerebral Asymmetry and the Nature of Emotion. Brain and Cognition, 20, 125–151.

Engagement

[1] Pope, A. T., Bogart, E. H., & Bartolome, D. S. (1995). Biocybernetic system evaluates indices of operator engagement in automated task. Biological Psychology, 40(1–2), 187–195.
[2] Mikulka, P. J., Scerbo, M. W., & Freeman, F. G. (2002). Effects of a biocybernetic system on vigilance performance. Human Factors, 44(4), 654–664.
[3] Freeman, F. G., Mikulka, P. J., Prinzel, L. J., & Scerbo, M. W. (1999). Evaluation of an adaptive automation system using three EEG indices with a visual tracking task. Biological Psychology, 50(1),61–76.
[4] Stikic, M., Berka, C., Levendowski, D. J., Rubio, R. F., Tan, V., Korszen, S., … Wurzel, D. (2014). Modeling temporal sequences of cognitive state changes based on a combination of EEG-engagement, EEG-workload, and heart rate metrics. Frontiers in Neuroscience, 8(342), 1–14.

Workload

[1] Gevins, A., Smith, M. E., Leong, H., McEvoy, L., Whitfield, S., Du, R., & Rush, G. (1998). Monitoring working memory load during computer-based tasks with EEG pattern recognition methods. Human Factors, 40(1), 79–91.
[2] Klimesch, W. (1999). EEG alpha and theta oscillations reflect cognitive and memory performance: A review and analysis. Brain Research Reviews, 29(2–3), 169–195. http://doi.org/10.1016/S0165-0173(98)00056-3
[3] Stikic, M., Berka, C., Levendowski, D. J., Rubio, R. F., Tan, V., Korszen, S., … Wurzel, D. (2014). Modeling temporal sequences of cognitive state changes based on a combination of EEG-engagement, EEG-workload, and heart rate metrics. Frontiers in Neuroscience, 8(342), 1–14.
[4] Brouwer, A.-M., Hogervorst, M. A., van Erp, J. B. F., Heffelaar, T., Zimmerman, P. H., & Oostenveld, R. (2012). Estimating workload using EEG spectral power and ERPs in the n-back task. Journal of Neural Engineering, 9(April 2016), 1–14

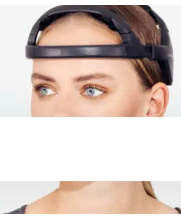
Memory

[1] Klimesch, W., Doppelmayr, M., Schimke, H., & Ripper, B. (1997). Theta synchronization and alpha descynchronization in a memory task. Psychophysiology. Retrieved from FC
[2] Sederberg, P. B., Kahana, M. J., Howard, M. W., Donner, E. J., & Madsen, J. R. (2003). Theta and Gamma Oscillations during Encoding Predict Subsequent Recall. The Journal of Neuroscience,

23(34)
[3] Klimesch, W., Doppelmayr, M., Russegger, H., & Pachinger, T. (1996). Theta Band Power in the Human Scalp EEG and the Encoding of New Information. NeuroReport, 7, 1235–1240.
[4] Long, N. M., Burke, J. F., & Kahana, M. J. (2014). Subsequent memory effect in intracranial and scalp EEG. NeuroImage, 84, 488–494.

Useful Links relating to SennsLab and SennsMetrics:

- Definition of Analysis Metrics in SennsMetrics
- List of SennsLab Experiment Templates
- Understanding Experiment Structure in SennsLab
- Understanding SennsLab Emotional-Cognitive Calibration



SennsLab: Emotional-Cognitive Calibration

Understanding the calibration for emotional and cognitive analysis in SennsLab Experiments

The **emotional** and **cognitive** analysis functions within SennsLab and SennsMetrics must be **calibrated** for **each participant**. The type of calibration **varies** depending on the test **template**. This is a description of the calibration that will be carried out in the software.

Passive Image Template

The participant will view **12 default images** that are generated by SennsLab directly. These images were selected from the IAPS database and **based** on **previous** research **studies** conducted by **Bitbrain**.

Sequence:

1. **Fixation Cross** - This will appear before each image. Instruct the participant to stare at it.
2. **Calibration Image** - The participant should view the image naturally, with minimal movements.
3. **Rest** - The word "rest" will appear on the screen and the participant can relax and wait for the next fixation cross.

Example built-in calibration image

Passive Audiovisual Template

The participant will view **5 videos** that are generated by SennsLab directly. These videos were selected based on **previous** research **studies** conducted by **Bitbrain**.

Sequence:

1. **Fixation Cross** - This will appear before each image. Instruct the participant to stare at it.
2. **Calibration Video** - The participant should view the video naturally, with minimal movements.
3. **Rest** - The word "rest" will appear on the screen and the participant can relax and wait for the next fixation cross.

Other Standard Templates
(Active Image Template, Active Audiovisual Template, Free Task Template)

In these templates, there are **no built-in images** or **videos** for **calibration**. Instead, the participant is introduced to a **cognitive task** before the main test blocks are displayed.
There are two parts of this:

1. **Cognitive Task Familiarization** (20 seconds): The participant learns to perform the calibration task

2. **Cognitive Task Calibration** (1 minute): The participant performs the calibration task

This is a **cognitive task** that induces mild **controlled stress** in the participant. The participant will have to **count backwards by 7**, out loud, starting with a number generated automatically by SennsLab.

How to proceed with this stage of the study:
When the task starts, the participant will see a number. Instruct the participant to start subtracting 7 from this number and press ENTER to start the countdown. The countdown timer will appear on the participant's screen, while the list of correct numbers appears on the test evaluator's screen.

It is important that you **do not provide feedback during this process**. If the participant makes a mistake, let them continue.

Once the task is complete, the word "**Rest**" will appear, and the participant can **relax**.

SennsLab: Guide to the Active Audiovisual Template

The Active Audiovisual Template in SennsLab

The **active audiovisual template** is used to present **video files**, where the participant is expected to provide feedback or interaction.
This template is most often used to simulate the experience of a **point-of-sale** or store **shelf environment**.

The active audiovisual template is a Standard template.

To set up an active audiovisual test:

1. **Enter Familiarization Tasks:** This is a set of videos used to familiarize the participant with the context of the task. You can define between 0-3 of these. Familiarization tasks are *not* analyzed. Note that, unlike in the Passive Audiovisual Test, SennsLab will not add familiarization videos automatically. The order can be randomized by checking the "randomize" checkbox.
2. **Enter Assessment Tasks:** This is a set of 1-15 videos for full analysis. The order can be randomized by checking the "randomize" checkbox.
3. **Create Intervals of Interest (IOI):** An Interval of Interest is an optional design tool that allows you to define a segment of a video for statistical comparison with other segments within the video, or similar segments in other target videos. IOI work somewhat like areas of interest (AOI), except that they are defined by time rather than area and are used over dynamic stimuli like videos.
   For more information about creating IOI, see Guide to Intervals of Interest.
4. **Set Up Behavioral Sensors**
   Active image experiments often require some degree of user interaction (clicking on a

product, answering questions, etc.). Click on the Behavioral Sensors tab to activate mouse position tracking, webcam video recording, or a microphone for audio recording.

Important Considerations:

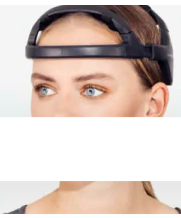
Some important considerations when using the active audiovisual template:

- When there are **1 or 2 stimuli events**, the total test duration allowed is **150 minutes** (two and a half hours).
- When there are **3 or more stimuli events**, the maximum **total test** time allowed is limited to **35 minutes**.
- Acceptable video formats are: * .avi, * .mpeg, * .mpg, * .wmv and * .mp4. The video must be **playable** on the **computer** you are using for **stimulus presentation** (and this could depend on the codec used to create the video). If there is an **error** when importing a specific video, we recommend **converting** to *** .avi** format **before importing**.

Other Resources:

For an explanation of the general test sequence and execution, see Understanding Experiment Structure in SennsLab

For more information about the built-in calibration in this experiment template, see SennsLab Emotional-Cognitive Calibration



SennsLab: Guide to the Active Image Template

The Active Image Template in SennsLab

The **active image template** is used to present images to participants in a **fixed** or **variable** amount of **time**, when they are expected to provide a response or **active interaction**.
This template is mostly **used** for the **viewing images** of: static web pages, apps, products on a shelf, product displays, etc.

The active image template is a Standard template.

To set up an active image test:

1. Enter Familiarization Tasks:
   This is a set of images used to familiarize the participant with the context of the task. You can define between 0-3 of these. Familiarization tasks are *not* analyzed.
   Note that, unlike in the Passive Image Template, SennsLab will not add familiarization tasks automatically. The order can be randomized by checking the "randomization" button in each familiarization task.

2. Enter Assessment Tasks:
   Between 1-15 assessment tasks can be added for full evaluation. The order can be randomized by checking the "randomization" button in each task.

3. Configure Task Duration:
   Both Familiarization and Assessment tasks require a task duration.
   Fixed: This is a pre-defined stimulus presentation time, between 15 seconds and 1 hour. The task will automatically end when the time limit is reached.
   Variable: This means the stimulus presentation will be ended in the test itself by the test

moderator. Each task marked "variable" is open-ended.

4. Define Areas of Interest (AOI):
   An AOI is a specific region of the image that is defined to allow for statistical comparison between different parts of the picture (or between similar AOI in multiple pictures).
   For more information on defining AOI, see the knowledge base entry "Guide to Areas of Interest". Defining AOI is optional and can also be done in analysis.

5. Set Up Behavioral Sensors
   Active image experiments often require some degree of user interaction (clicking on a product, answering questions, etc.). Click on the Behavioral Sensors tab to activate mouse position tracking, webcam video recording, or a microphone for audio recording.

Important Considerations:

Some important considerations when using the active image template:

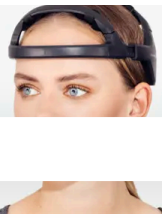
- SennsLab will **resize images** to fit the **presentation screen** size and resolution (without changing the aspect ratio). If you use images that are **too small** for the screen size, these could appear **pixelated**. Consider formatting your images in advance to the correct resolution.
- Acceptable image formats are: * .jpg, * .jpeg, * .png, * .bmp

---

Other Resources:

For an explanation of the general test sequence and execution, see Understanding Experiment Structure in SennsLab

For more information about the built-in calibration in this experiment template, see SennsLab Emotional-Cognitive Calibration



SennsLab: Guide to the Audiovisual Recording Template

The Audiovisual Recording Template in SennsLab

The **audiovisual recording template** is used to **record** an **interview** with a participant while evaluating their **emotional response**.

The audiovisual recording template is an In Lab template.

This template is a **variable-time recording task**. There are **no configurable parameters**.

Use the behavioral sensors tab to configure audio or webcam recording of the participant.

SennsLab: Guide to the Custom Study Template

The Custom Study Template in SennsLab

The **custom template** is used to create a completely **personalized experiment** with **images**, video or **screen recording**. No calibration or familiarization tasks are included in custom experiments.

> Note: Custom Template experiments produce raw data only. There is no automatic analysis of emotion or cognition data in these experiments.

The custom study template is designed for users who are interesting in applying their **own analysis** to **EEG** and physiological data.

The custom study template is a custom template.

To setup a custom study:

1. Enter Tasks:
   This is a set of images, videos, or open sessions presented to the participant. Click on the "Add" button to create a task. The task can be named via the "Name:" field under task description.

2. Choose Task Type and Upload:
   Choose "Free", "Image" or "Video" as the task type. Use the button to upload the appropriate stimulus file (for image or video).

3. Configure Task Duration and Behavior:
   If "Variable" is selected, the task will end when the test moderator advances the experiment. Otherwise, enter a duration for the task time, between 1 second and 1 hour.

4. Choose Randomization Behavior:
   If **Randomize** is checked, that particular stimulus event will be presented in random order. Otherwise, tasks will appear in the order they are listed on the left side of the screen. Use the  button to change the order of tasks.

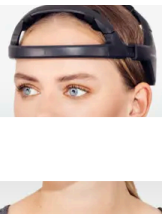
5. Choose Task Behavior
   Select "show all tasks as a single sequence" to display the entire experiment (with fixed timing) continuously once started. Otherwise, the experiment will pause at the end of each task and the test moderator will have to manually start each.

Important Considerations:

Some important considerations when using the custom template:

- SennsLab will **resize images** to fit the presentation screen **size** and **resolution** (without changing the aspect ratio). If you use images that are **too small** for the screen size, these could appear **pixelated**. Consider formatting your images in advance to the correct resolution.
- Acceptable image formats are: * .jpg, * .jpeg, * .png, * .bmp
- Acceptable video formats are: * .avi, * .mpeg, * .mpg, * .wmv, and * .mp4
- The stimulus computer must be capable of **playing** the **codec** used to create the videos. If you have trouble playing a particular video in SennsLab, try **converting** to *** .avi** format.

Bitbrain Help Center



Search for answers

SennsLab: Guide to the Focus Group Template

The Focus Group Template in SennsLab

The **focus group** template is used to record the **emotional response** of multiple participants in a **group interview**.

The focus group template is an In Lab template.

To set up a focus group experiment:

1. **Defining Tasks:** A task in the focus group template consists of a labeled section of time in order for the test moderator to start a discussion or ask questions on a particular topic. There is no predefined stimuli in the focus group template, tasks are provided only for organization and analysis purposes.
2. **Enter Familiarization Tasks:** This is a set of 0-3 tasks used to familiarize the participants with the context of the test. Familiarization tasks are *not* analyzed and SennsLab will not add familiarization tasks automatically.
3. **Enter Assessment Tasks:** This is a set of 1-15 defined tasks for full analysis.
4. **Set Timing**: Both familiarization and assessment tasks can be either fixed (a set time defined minimum 15 seconds and maximum 60 minutes) or variable (the task is manually ended by the test moderator).
5. **Set randomization preferences**
   If "randomize" is selected, the tasks will be presented in random order. If not, tasks will be presented in the order they are listed in the task lists. To change this order, use the  buttons.

> Note: Multiple sensors must be set up in the Sensors Tab, with Group Use selected.

SennsLab: Guide to the Free Task Template

The Free Task Template in SennsLab

The **free task** template is used to **evaluate** open **tasks** with **fixed** or **variable time** limits and user interaction. This template allows for more **flexibility** in study **design**.

The free task template is a Standard template.

To set up a free task experiment:

1. Create and define tasks:
   Under the "Tasks" tab, define tasks by clicking on the Add button.

   Familiarization tasks - You can optionally define up to 3 tasks with the purpose of familiarizing the participant with the context of the study. The collected data is not analyzed and there are no default familiarization tasks.

   Assessment Tasks - Define 1-15 tasks for full analysis. These are the defined tasks for your experiment.

2. Set task duration: fixed or variable
   Fixed time requires a duration value for the task (between 15 seconds and 1 hour). Variable means the task will be completed during the experiment.

3. Set randomization preferences
   If "randomize" is selected, the tasks will be presented in random order. If not, tasks will be presented in the order they are listed on the left. To change this order, use the button 

Important Considerations:

Some important considerations when using the free task template:

- If the duration of the tasks is **fixed**, the **minimum** time per task is **15 seconds**, and the maximum is 1 hour.
- Since the calibration for free tasks is non-specific, this template may show more **variability** in the **results** compared to the more predictable **fixed templates**. Free task template should only be used when **flexibility** is **required**.

Other Resources:

For an explanation of the general test sequence and execution, see Understanding Experiment Structure in SennsLab

For more information about the built-in calibration in this experiment template, see SennsLab Emotional-Cognitive Calibration

SennsLab: Guide to the Passive Audiovisual Template

The Passive Audiovisual Template in SennsLab

The **Passive Audiovisual template** is used to present **video files**, where the participant is not asked for any type of interaction. This template is most often used to **evaluate commercials**, **trailers**, **corporate videos**, **movies**, **TV shows**, etc.

The passive audiovisual template is a Standard template.

To set up a passive audiovisual test:

1. **In the "Materials" tab, choose the number of stimuli to be included in each class:**

   Familiarization: You can optionally add 1 video in order to accustom the participant to the context of the task. The familiarization video is *not* analyzed. SennsLab will automatically add 1 video for calibration purposes in all cases.

   Target Stimuli: These are your actual target video files that will be fully analyzed. Add 1-10 videos.

   Competition Stimuli: These are optional video files from competitors to your target stimuli, fully analyzed to allow comparison. Add 0-15 videos.

   Category Stimuli: These are additional "noise" video files within the same product type. They are primarily added to disguise which videos are the intended targets of the study. 0-40 videos can be added. *These are not analyzed.*

2. Load the images into the viewer

   On the right side of the screen, under each specific category, click on the ✎ icon to add video files. You can also preview with the 🔍 icon, and delete with the ✖ icon.

   To add multiple video files at once, use the "add several" button in the upper-right.

3. Set randomization preferences

   Video files can be presented in randomized order by checking "Randomized". This is intended to break up any unintentional emotional biases from one video to the next. If you prefer to maintain precise control of video order, choose "Sequence". Click the ✎ button to create a customized order.

Important Considerations:

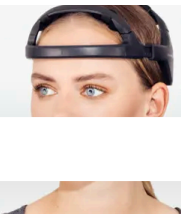
Some important considerations when using the passive audiovisual template:

- When there are **1 or 2 stimuli events**, the total test duration allowed is **150 minutes** (two and a half hours).
- When there are **3 or more stimuli events**, the maximum total test time allowed is limited to **35 minutes.**
- Acceptable video formats are: * .avi, * .mpeg, * .mpg, * .wmv and * .mp4. The video must be **playable** on the computer you are using for **stimulus presentation** (and this could depend on the codec used to create the video). If there is an error when importing a specific video, we recommend **converting** to * .avi format **before importing**.

Other Resources:

For an explanation of the general test sequence and execution, see Understanding Experiment Structure in SennsLab

For more information about the built-in calibration in this experiment template, see SennsLab Emotional-Cognitive Calibration



SennsLab: Guide to the Passive Image Template

The Passive Image Template in SennsLab

The **passive image template** is used to present images to participants in a **fixed** amount of **time**, when they are not expected to provide a response. This template is mostly used for the **passive presentation of advertisements**, **logos**, **banners**, etc.

The passive image template is a Standard template.

To set up a passive image test:

1. In the "Materials" tab, choose the number of stimuli to be included in each class:

   Familiarization: This is a set of images presented to adapt the participant to the test context and the actual stimuli images that will appear. *These images are not analyzed.* By default, SennsLab will add 4 nonspecific images for calibration purposes. You can optionally add 0-4 additional specific images.

   Target Stimuli: These are your actual target images that will be fully analyzed. Add 1-20 images.

   Competing Stimuli: These are optional images from competitors to your target stimuli, fully analyzed to allow comparison. Add 0-15 images.

   Category Stimuli: These are additional "noise" images within the same product type. They are primarily added to disguise which images are the intended targets of the study. 0-60

images can be added. *These images are not analyzed.*

2. Load the images into the viewer
   On the right side of the screen, under each specific category, click on the icon to add images. You can also preview with the icon, and delete with the icon. To add more than one image at a time, select "add several".

3. Set randomization rules

   Images can be presented in randomized order. This is intended to break up any unintentional attention or emotional biases from one image to the next. This is particularly useful if you are using an eye tracking system, as the most salient aspect of the previous image may bias the first-looked at object on the next.

   If you prefer to maintain precise control of image order, choose "Sequence". Click the button to create an image order.

Important Considerations:

Some important considerations when using the passive image template:

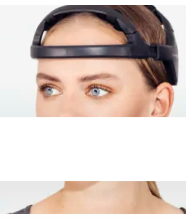
- **SennsLab** will **resize images** to fit the presentation screen size and **resolution** (without changing the aspect ratio). If you use images that are **too small** for the screen size, these could appear **pixelated**. Consider formatting your images in advance to the correct resolution.
- A specific image can **not** be **included** in more than one **stimuli** class in the same study (familiarization, evaluation, competitors and category). This is determined by **file name**.
- Acceptable image formats are: * .jpg, * .jpeg, * .png, * .bmp
- The **duration** of the study is defined by the **number** of **images** in each stimuli class.

Other Resources:

For an explanation of the general test sequence and execution, see Understanding Experiment

Structure in SennsLab

For more information about the built-in calibration in this experiment template, see SennsLab Emotional-Cognitive Calibration

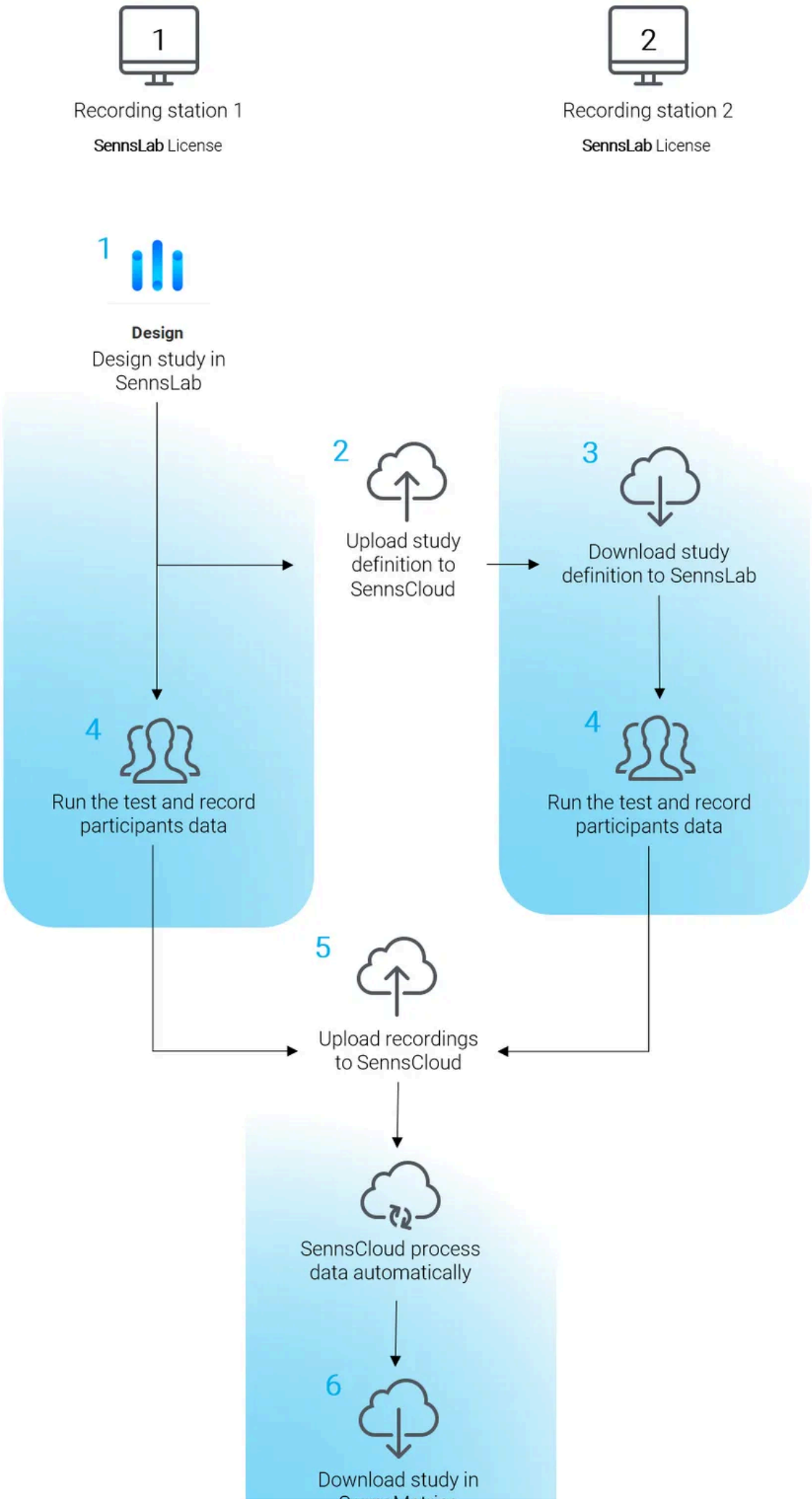


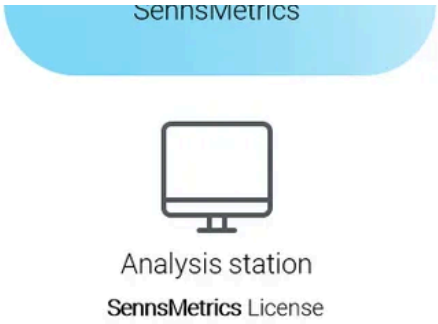
SennsLab: How to run a study with two recording stations.

Requirements and pipeline to record participants with two stations.

To run a study in two different stations and Usenns Solution (SennsLab + SennsCloud + SennsMetrics), the following materials would be required:

- 2 SennsLab licenses.
- 1 SennsMetrics license.
- 2 Setups to run the study.
- Same Hardware devices in each station.


1
Recording station 1
SennsLab License
2
Recording station 2
SennsLab License
1
Design
Design study in SennsLab
2
Upload study definition to SennsCloud
3
Download study definition to SennsLab
4
Run the test and record participants data
4
Run the test and record participants data
5
Upload recordings to SennsCloud
SennsCloud process data automatically
6
Download study in

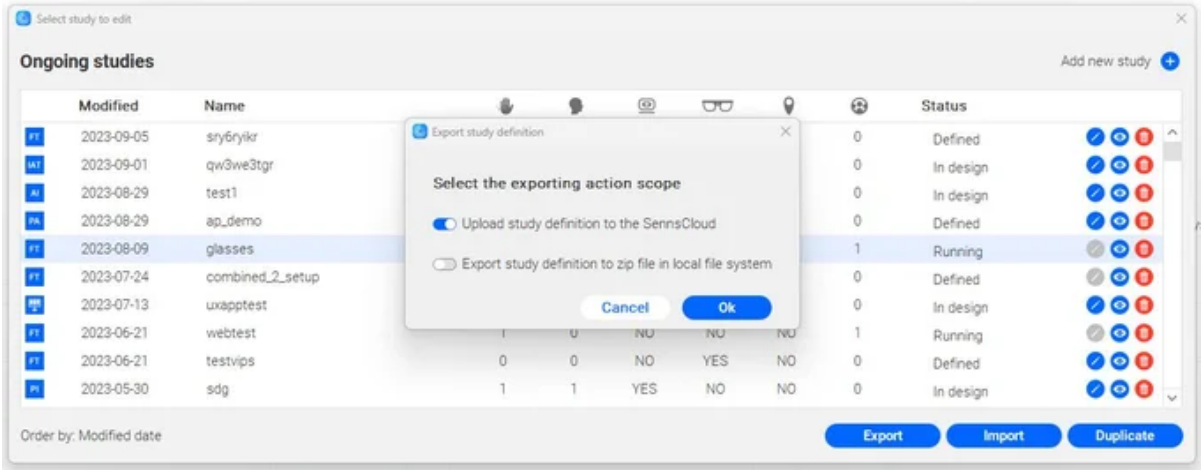


The workflow that must be followed in this kind of studies with two stations, are the following:

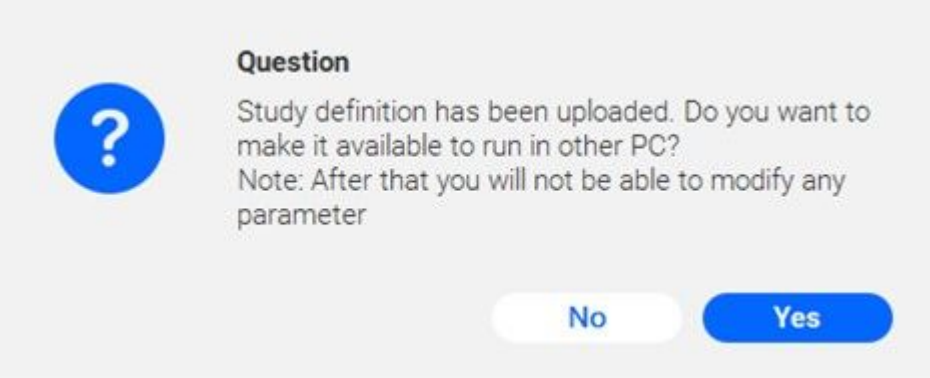
1. Create the study definition in SennsLab (recording station 1): Follow the proper study template to design a study in SennsLab.

> Note: Make sure your design is ready and you will not need to make any more changes before moving on to the next step.

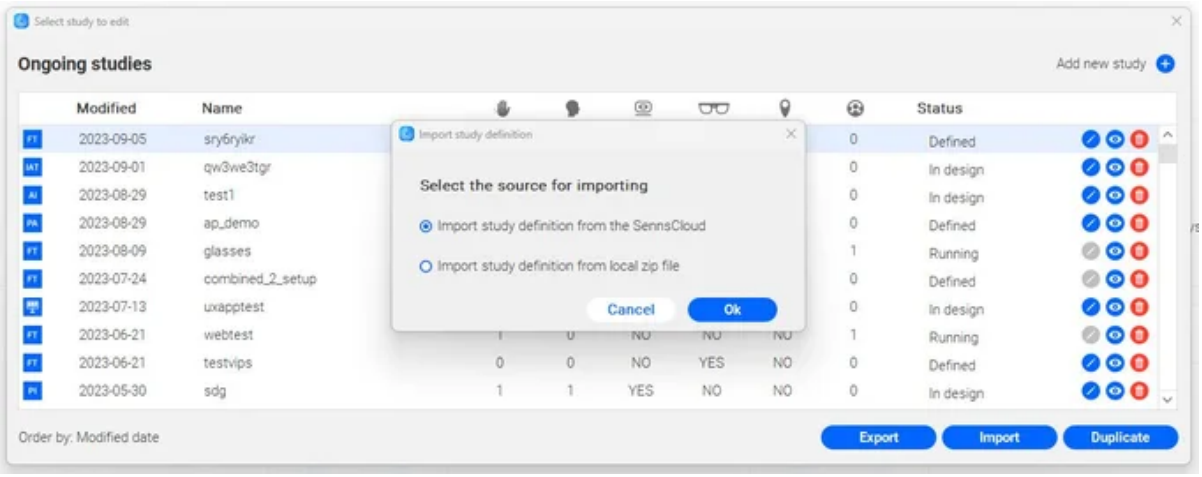
2. Upload the study definition to SennsCloud:
    - This action can be done in “Manage studies” tab, by pressing export button and select the option “Upload study definition to the SennsCloud”



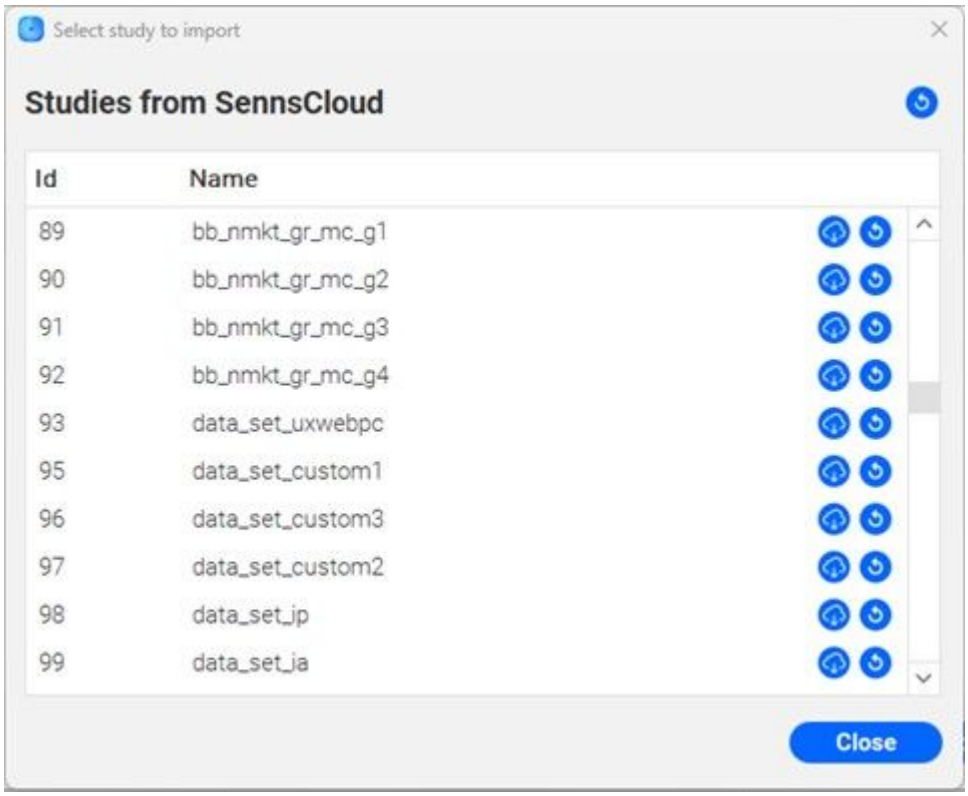
    - This pop up will appear, as the study must be made available to run in other PC, “Yes” button must be selected.



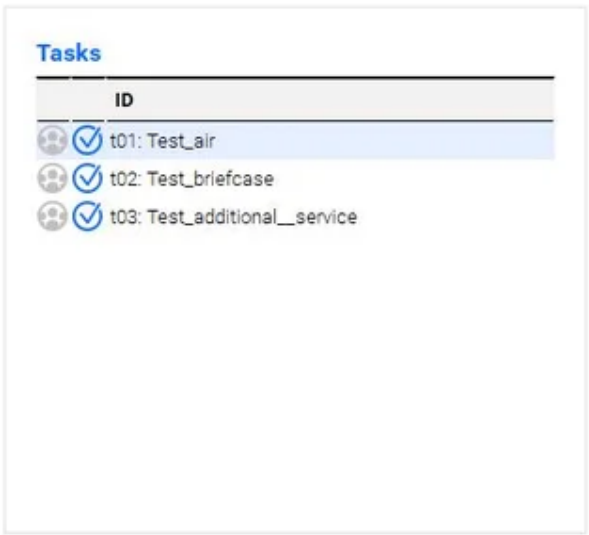
3. Download the study definition in SennsLab (recording station 2):
    - This action can be done in “Manage studies” tab, by pressing import button and select the option “Import study definition from the SennsCloud”

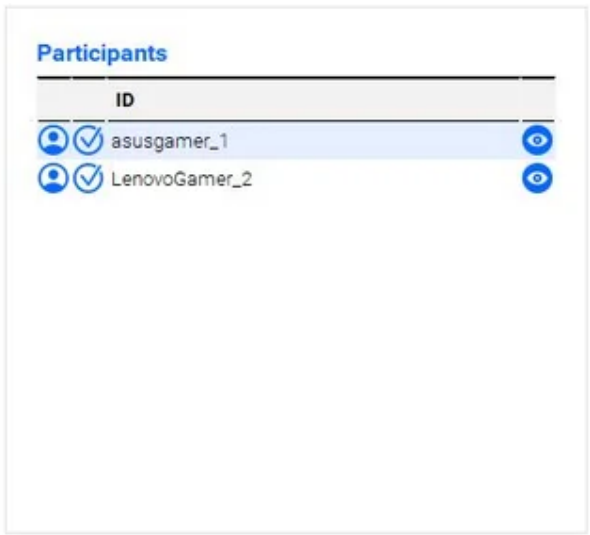


    - Then select the study from this window.

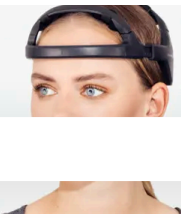


4. Run the test and data acquisition in both stations seamlessly.
5. Upload the participants recording to SennsCloud: in SennsCloud the study data will be decoded in a single study.
6. Download the study results locally in SennsMetrics: Studies can be downloaded from SennsCloud to SennsMetrics in the hard drive of the PC with an activated SennsMetrics license.
   Downloaded results would show the station name given by the researcher as “station-name_ID” in ID field of participants tab.





Remember to be connected to ethernet when uploading or downloading data from SennsCloud.



SennsLab: List of Experiment Templates

This is a list of all defined templates in SennsLab, with links to each template guide.

Standard Templates:

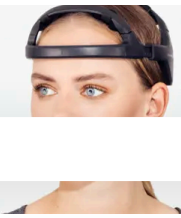
- Passive Image Template
- Active Image Template
- Passive Audiovisual Template
- Active Audiovisual Template
- Free Task Template

In Lab Templates

- Audiovisual Recording Template
- Focus Group Template

Custom Study Templates

- Custom Study Template



SennsLab: Understanding the Experiment Structure

Guide to SennsLab experiment structure for different templates and devices

The **possible blocks** that make up experiment protocols include:

- Familiarization (F)
  - This is a block of stimuli chosen to familiarize the participant with the content of the test and the overall test protocol. Familiarization blocks are not analyzed and no data is collected. In some templates, familiarization content is automatically added by SennsLab - in addition to any you add yourself.

- Washout 1 (W1)
  - The participants are instructed to close their eyes and enter a resting state. The washout block is meant to de-couple the emotional response from one block to the next and to establish a null baseline for EEG and biosensing data. This is a break where the participant clears their emotional response. W1 is positioned between the familiarization tasks and the rest of the study.

- Washout 2 (W2)
  - The second washout block is the same as the first, except it is positioned between the calibration and the actual test block.

- Eyes open (OA)
  - The participant is instructed to enter a rest state with eyes open, used to establish a baseline measurement in EEG and biosensing.

- Calibration (C)
    - This block displays built-in stimuli to the participant as a method of determining the range of physiological responses for the individual, and normalizing across all participants. This is required for all biosensing and EEG tests. It is not to be confused with eye tracking calibration, which is done during test setup. Images and videos in this step are built into SennsLab and can not be changed.

> For more information about EEG and biosensing calibration in SennsLab, see the entry:
>
> SennsLab Emotional-Cognitive Calibration

- Test (T)
    - This is the actual stimuli for evaluation and analysis

- Test survey (ST)
    - This is a survey to have the participant evaluate the test images displayed as "Negative", "Neutral" and "Positive" in order to calibrate the valence calculation.

- Calibration survey (TC)
    - This is a survey to have the participant evaluate the calibration images displayed as "Negative", "Neutral" and "Positive" in order to calibrate the valence calculation.

The **sequence** and total number of test **blocks** depends on the **template** and the devices used. Here are some possible experiment layouts:

1. **Solo Eye Tracker**
   F - T
2. **Ring - Biosensing**
   F - W1 - C - W2 - T
3. **Diadem - Dry EEG**
   F - W1 - OA - C - W2 - T - ST* - TC*

   **Passive Image Template Only*

Useful Links relating to SennsLab and SennsMetrics:

- Definition of Analysis Metrics in SennsMetrics
- References for Analysis Metrics in SennsMetrics
- List of SennsLab Experiment Templates
- Understanding Experiment Structure in SennsLab
- Understanding SennsLab Emotional-Cognitive Calibration

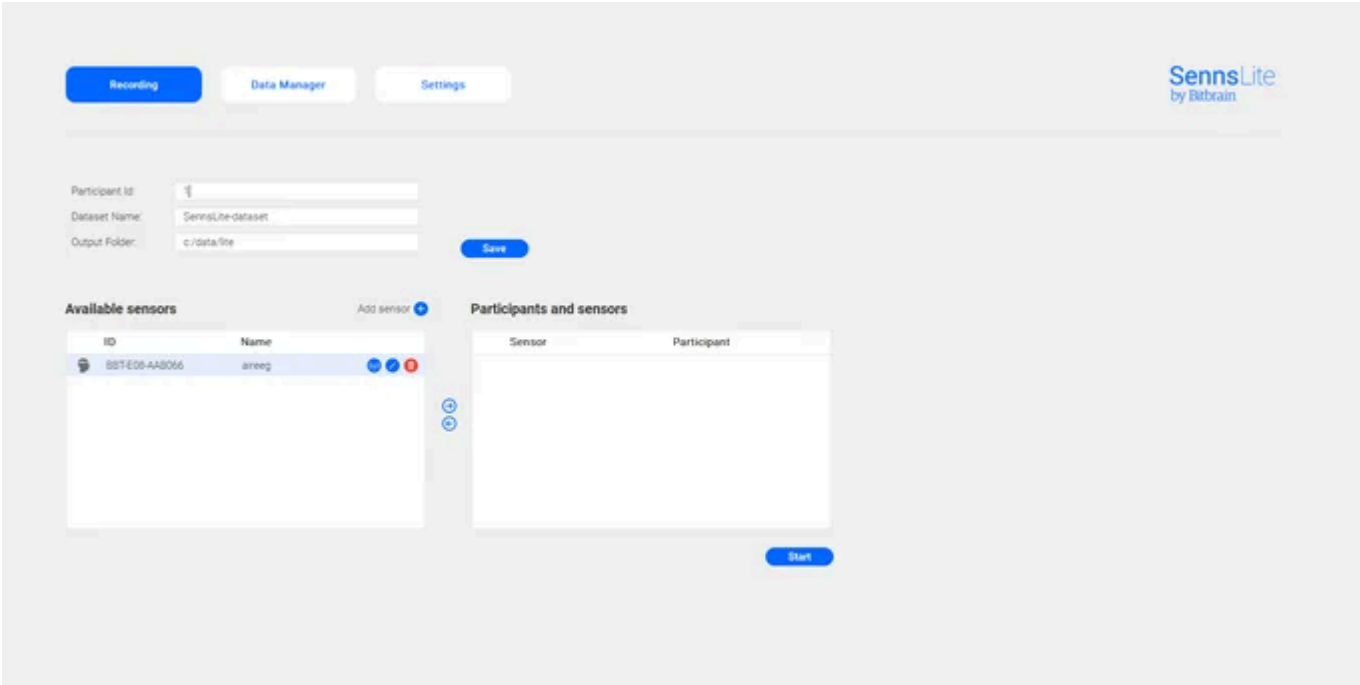
SennsLite: Understanding the data structure

Definition of the SennsLite data structure

When starting a recording with SennsLite it is necessary to fill in the following fields that will allow the user to identify the recorded data.

- Participant ID: Numerical ID. (only numbers are allowed)
- Dataset ID: Name of the dataset that will be recorded.
- Output folder: Path of the folder where to store the data.

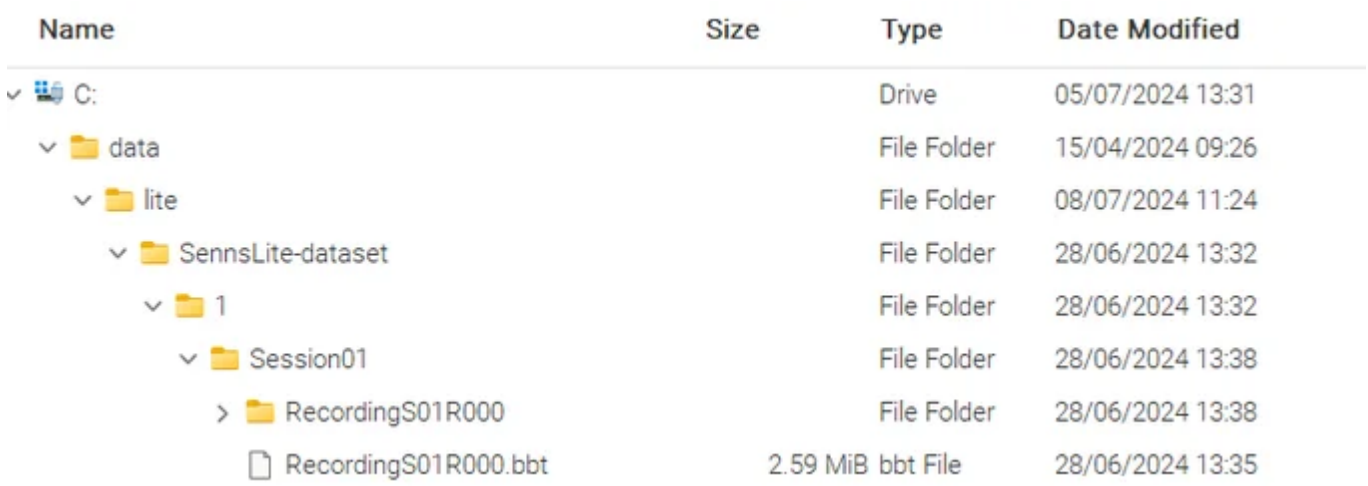
Save button allows to persist “Participant ID”, ”Dataset ID” and “Output folder” settings.



These three configuration parameters are mandatory and determine the output folder where the data is stored.

After the recording, the information is structured as follows:

- The output folder defined by the user
- Folder with the dataset ID
- Folder with the participant ID
- Folder with the session number



Note that the session number is not defined by the user, but is an internal number that is automatically increased every time a recording is started using the same configuration of the three parameters (output folder, participant, dataset).

USER MANUAL

SennsLite user manual

Version 1.2.1

March 2025

Bitbrain

CONTENT

1. Introduction

SennsLite is a research application for data collection with several sensor modalities seamlessly synchronized.

This software allows the user to record data from a single or multiple Bitbrain devices and sensor modalities simultaneously, synchronize the sensors and export the output to an interoperable format so that the researchers can perform their own analysis.

This document includes installation guides, operation modes (recording mode, data manager mode, settings) and a description of the exported data. Finally, annexes are included for specific information and guidelines for contacting Bitbrain technical support.

1.1 CONNECTIVITY

Most of the Bitbrain devices (Air, Diadem, Hero, Versatile EEG, Versatile Bio) transfer data to the recording station using a Bluetooth connection. The Ikon device uses Bluetooth Low Energy (BLE).

Note that Bluetooth connectivity does not guarantee that all the data packages are received. Due to this reason, our devices include an internal SD card to store the data.

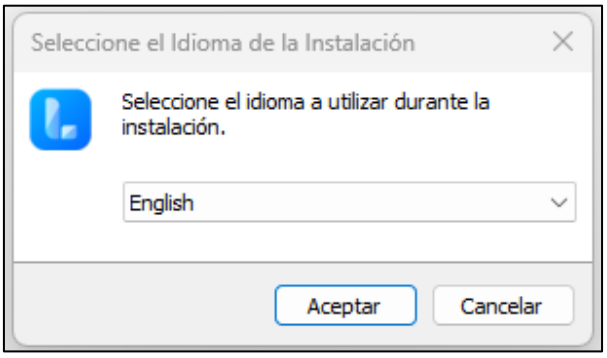
1.2 SOFTWARE VERSIONS

Note: Currently SennsLite is available for Windows OS.

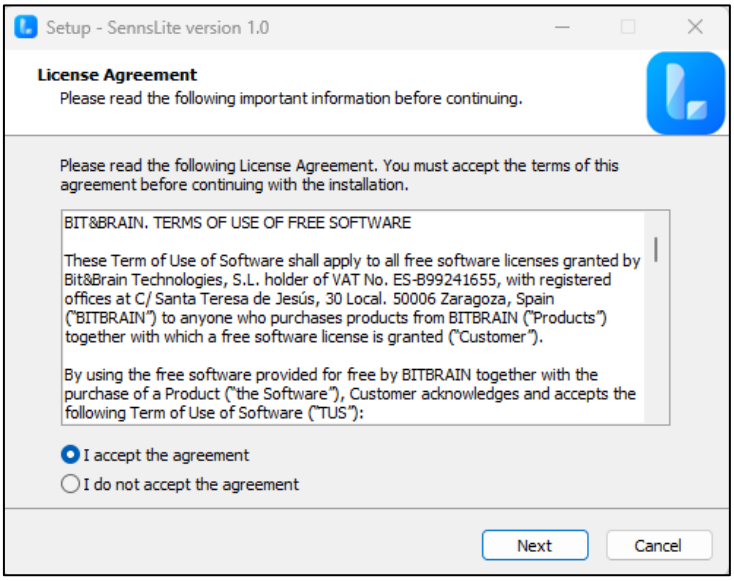
2. Installation

Use the installer provided by Bitbrain to setup the software in the selected computer. These are the steps to follow for a successful installation.

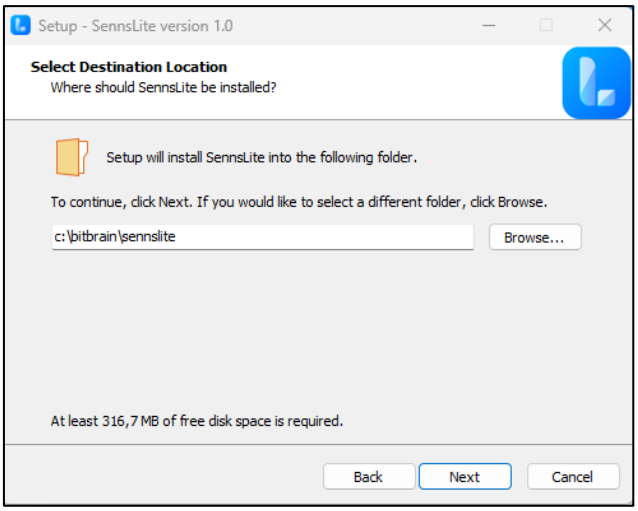
1. Select the language to use during the installation



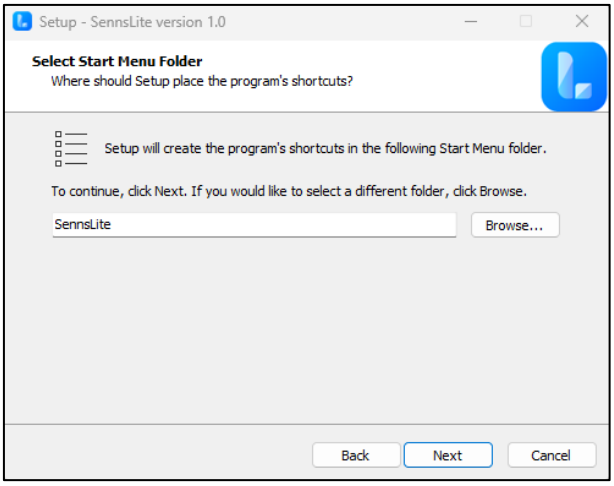
2. Accept the license agreement



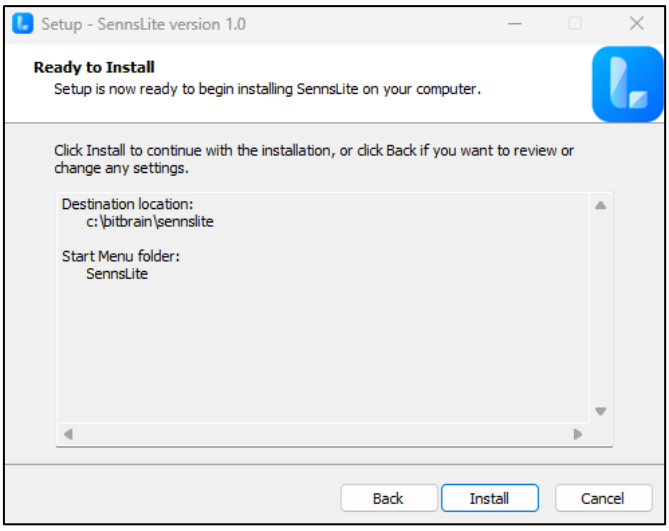
3. Select where to install SennsLite



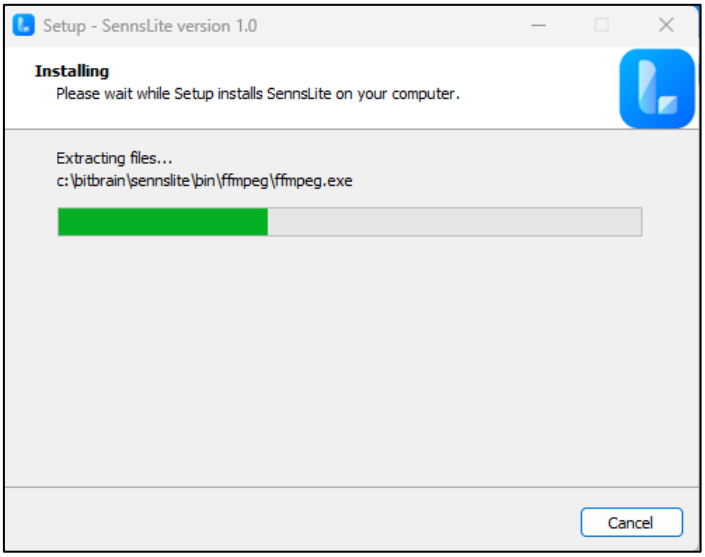
4. Select where to place the programs shortcuts.



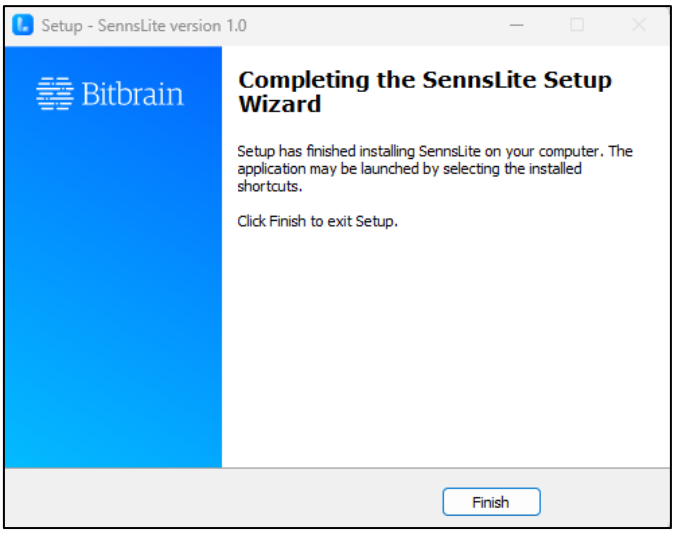
5. Confirm the previous settings to proceed with the installation of the software.



6. After clicking install, the installation process takes place.



7. The installation is finished, and the software can be use

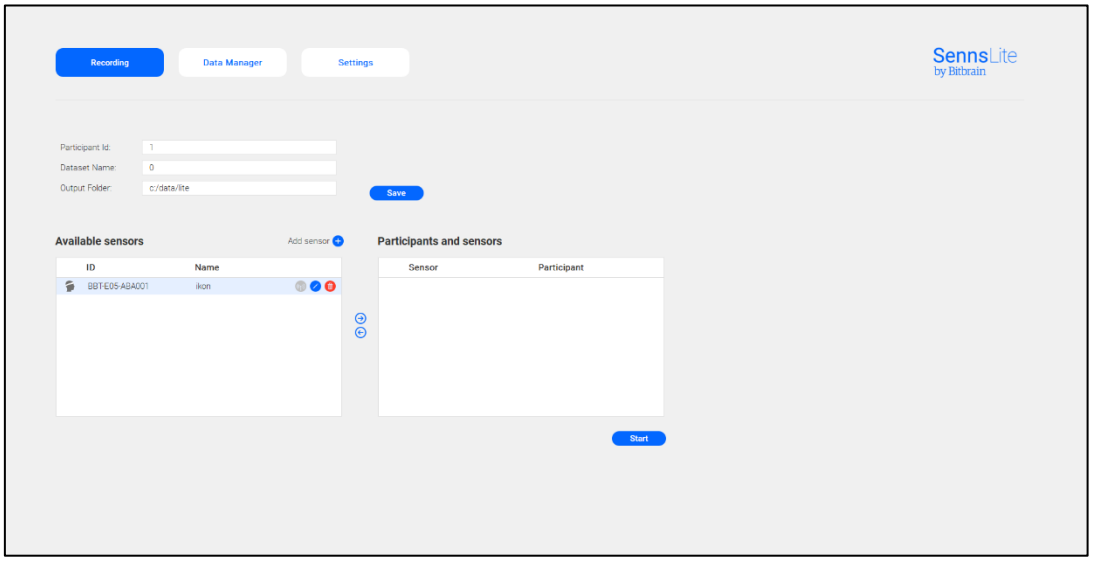


3. Software modes

The software has **three main modes** of operation:

- Recording: allows to record biosignals from Bitbrain devices.
- Data manager: allows to export the recorded data seamlessly synchronized so that can be analyzed by the researchers. In addition to this, allows to import the SD card data (if enabled) and visualize the data.
- Settings: allows to configure some settings (export settings, user marker)

In the initial screen there are three main buttons (top left corner) to switch between them.



Main window of SennsLite software.
Main buttons in the initial screen to switch between the three modes.

4. Recording mode

In order to perform a recording, 3 steps must be performed:

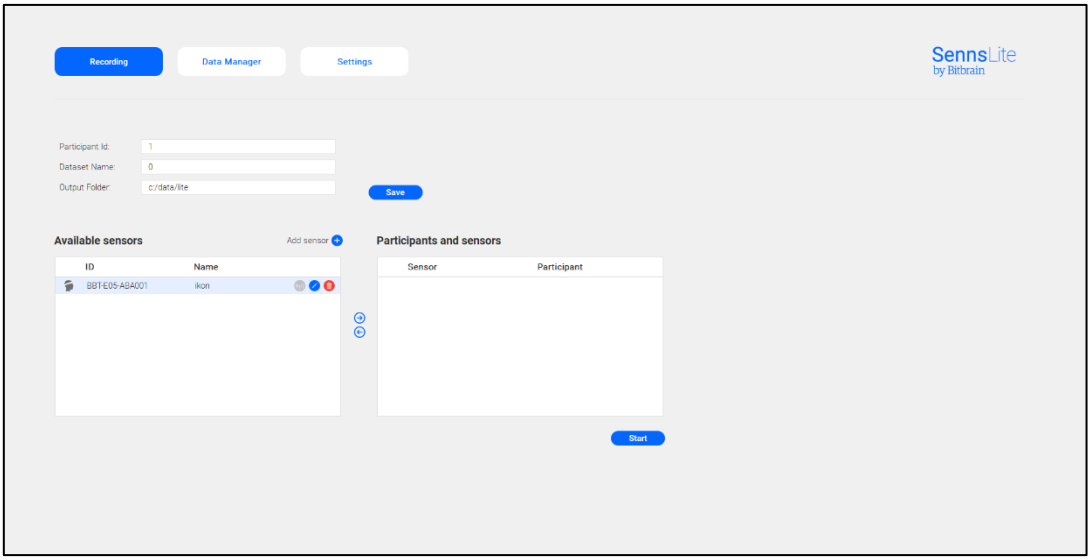
1. Configuration: configure the participant-dataset ID, and output folder; the devices to record from, and settings of each device (i.e., serial number, signal types, ability to record in the SD card).
2. Data quality checking: check the data quality indexes before starting the actual recording so that we can improve (if needed) the EEG device placement. Currently, data indexes are provided the EEG signals and for the ring device.
3. Actual recording: perform the actual recording to save the data to disk.

4.1 CONFIGURATION

In the upper left part of the screen, there are three text boxes:

- Participant ID: Numerical ID (only numbers are allowed)
- Dataset ID: Name of the dataset that will be recorded
- Output folder: Path of the folder where to store the data

Save button allows to persist “Participant ID”,”Dataset ID” and “Output folder” settings.



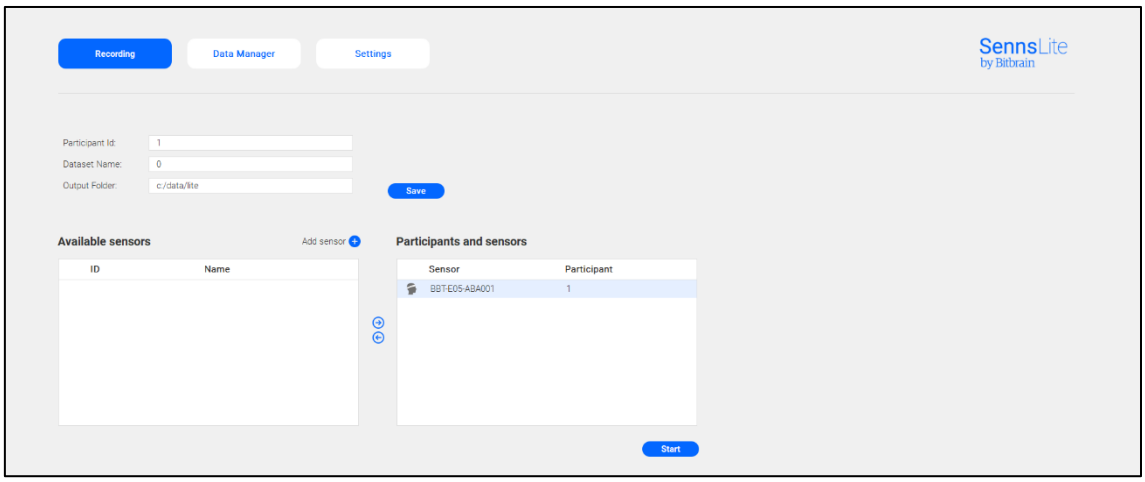
Recording mode.

These three configuration parameters are mandatory and determine the output folder where the data is stored (see Data manager - section 5).

Then you can select the device form the sensor list and transfer it to “Participants and sensors” list with the arrows buttons and click on “Start” button. The first time the software is used, or after acquiring a new device, it should be first added using the “Add sensor” button (4.1.1).

Using the buttons in the “Available sensors” list, the following actions can be done:

- Pairing of the Bluetooth device: this step is mandatory (only once in a computer) for the standard Bluetooth devices; **it is not needed in Ikon as it uses a BLE connection and there this button appears disabled**.
- Edit the device settings.
- Remove the device from the list.

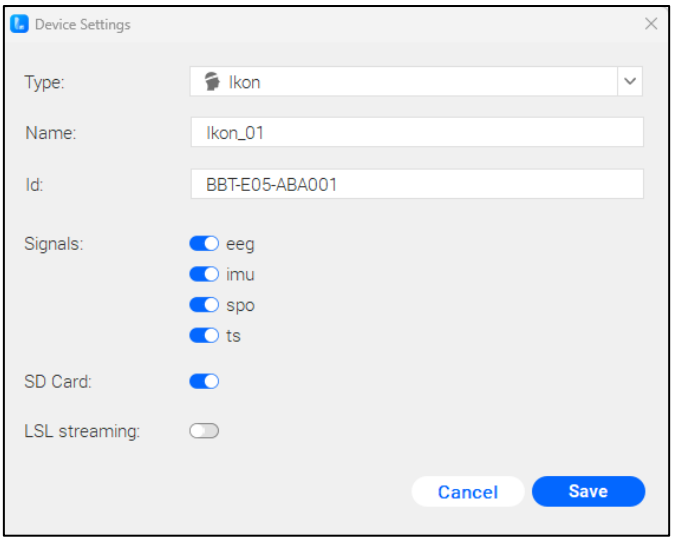


Device selected from the sensors list.

4.1.1 Adding a new device

By “Add sensor option”, a connection display is open to guide the user in the connection configuration.

- Type: Select the type of the sensor from a dropdown menu.
- Name: Set a name to identify this device.
- Id: Type the serial number of the device.
- Signals: Select the signals to be recorded with the device.
  Selected signals are the only ones that would be recorded with the device and would not be possible to take back the non-selected signals when recording or exporting data.
- Sd Card: Enable the recording in the SD card of the device.

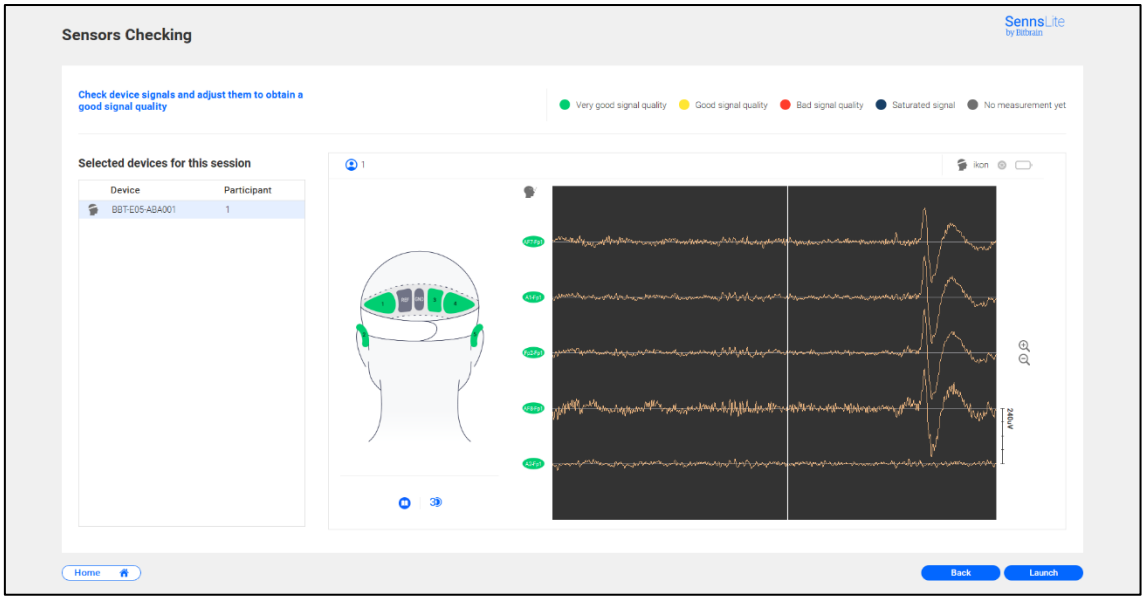


Sensor configuration tab.

Once the sensor has been set click on “Save” button to continue.

4.2 DATA QUALITY CHECKING

After pressing the “start” button in the configuration interface, the quality of the registered signal must be verified through the indicators for each type of sensor.



Data quality checking window.

The left part of the window shows a list of devices. By selecting each one, the signal viewer displays the streaming data. Right-button click over the signal viewer allows to configure the filter settings (4.2.1).

In this screen, the signal quality indicators are displayed using a colour legend (displayed in the upper part of the screen) for each sensor. These quality indicators are displayed over its position and in the left side of the signal viewer as well.

In case of the EEG or Ring signal, the quality indicators take the following levels:

- Dark grey level means that is not recording yet
- Orange is a saturated signal.
- Red level is bad signal quality.
- Yellow is for fair quality level.
- Green is for optimal status.

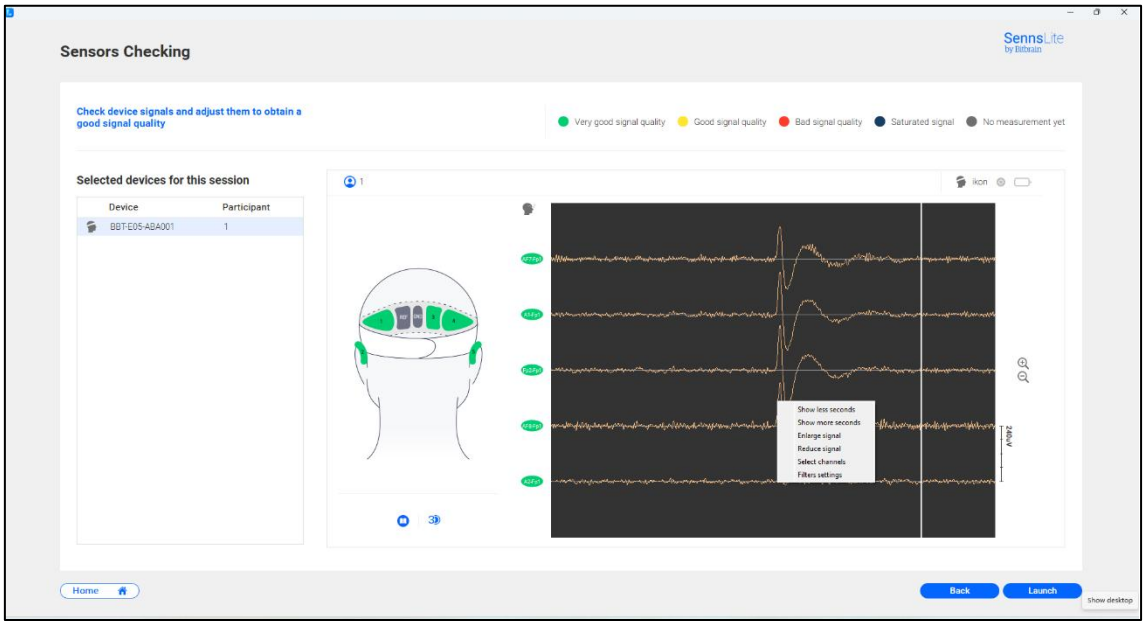
These quality indicators have a circle around it, which denotes how close the current level is from an adjacent one (i.e., transitions between green-yellow, and yellow-red states). This way the progress in the signal quality can be tracked.

Once the signal is checked and an optimal status is achieved, click on “Launch” button to start the data acquisition.

4.2.1 Filter settings

Besides the zoom buttons on the right, there are more visualization options available by right clicking on the plot, including channel selection, x-y rescale and signal filtering.

These parameters **do not change the recording process, only the visualization. All the signals are registered unfiltered.**

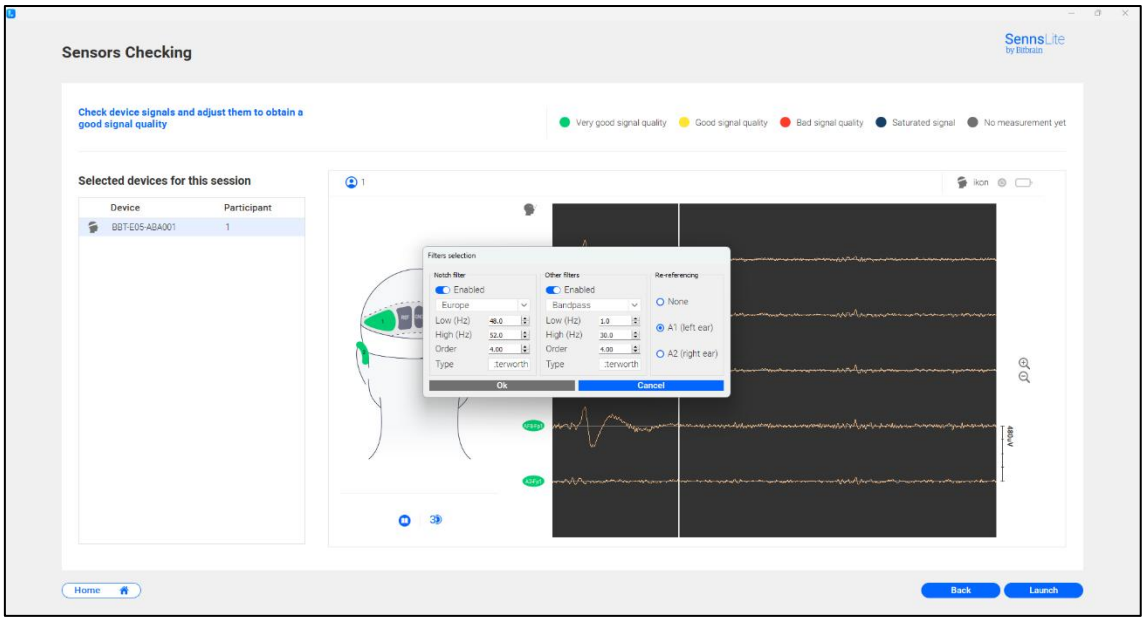


Visualization settings.

With the filter settings the user can add some visualization filter to the signal.

- Notch filter
- Pass filter: Highpass, lowpass, or bandpass filter
- Re-referencing **(just for the Ikon device)**: The Ikon device has the reference in the forefront (FP1 position, see Annex 8 for further information). With this option, the re-referencing can be disabled, or set to A1 or A2 sensors.

By default, the re-referencing for the EEG signal in the Ikon device is set to A1 (note again this does not change the recording process, only the visualization).

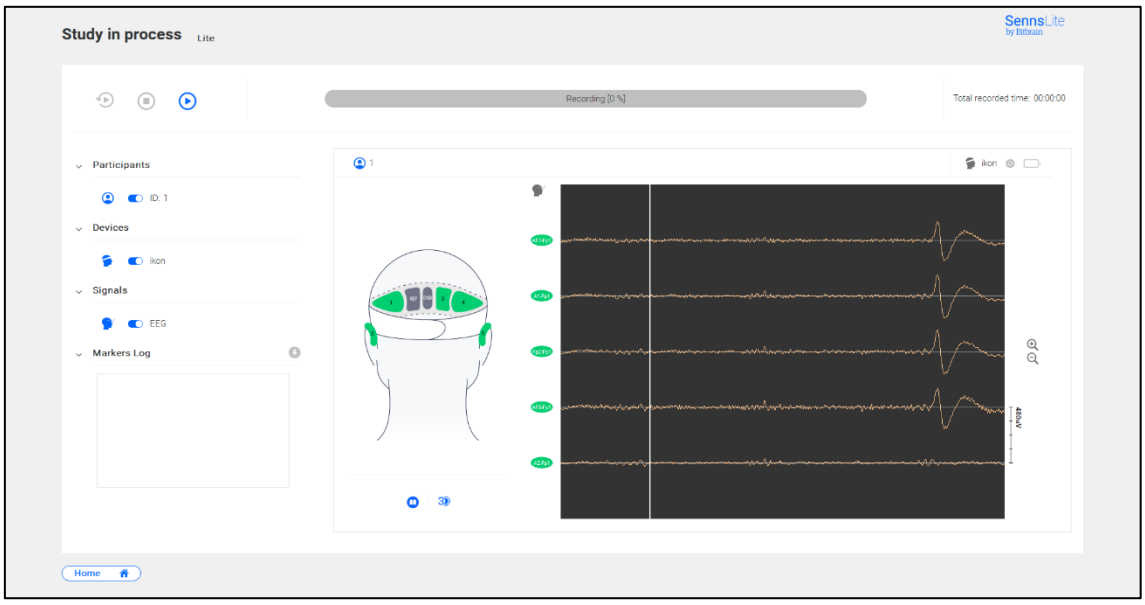


Recommended filter settings tab.

The default visualization settings for each signal type are defined in Section 0.

4.3 ACTUAL RECORDING

Once the user clicks on “Launch” button, the data acquisition window comes up.

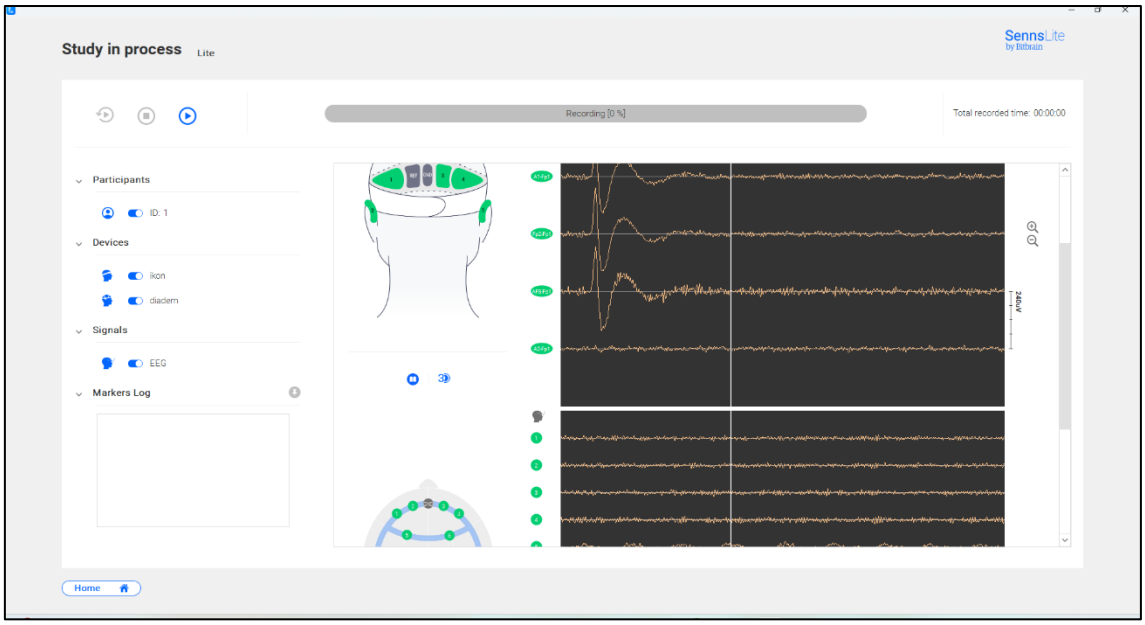


Recording window for Ikon device recording session.

In the upper left corner of the window “Start”, “Stop” and “Re-start” buttons are displayed and can be used to control the start and end of the recording:

- To start the data acquisition process, click on “Start” button and carry out all the tasks defined on the experimental design.
- Click on “Stop” button to stop the recording process.
- Once every task has been finished, click on “Home” button to get back to the main screen.
- After this, remove the devices from the participant and switch them off.

We bellow describe the remaining options in the interface.



SennsLite used with two EEG devices.

4.3.1 Registering events

The operator can press different keys (see Settings, section 6) to register events that will be stored for its latter interpretation. The events that are triggered are displayed in the online signal viewer as a vertical white line; and registered in the “Markers log”.

4.3.2 Graphical elements description

In the upper part there are the following options:

- In the upper centre part of the window there is a bar used to indicate that the task is being recorded.
- In the upper right corner, there is a timer that shows the total time recorded.

The left side provides a list with the following information.

- Participant´s ID
- Devices being recorded
- Selected signals being recorded
- Markers log: User makers will be logged in the "markers log" window. (For more information, see Settings, section 6)

The right side displays the signal viewer together with the following information:

- Device name
- SD card connection feedback
    - Recording in SD. The signal is being received and is being recorded to the microSD card correctly

    - Communication interrupted. The recording has started on the microSD card, but no signal is currently being received.
    - Writing error. An error has occurred, and data is not being written to the microSD card.

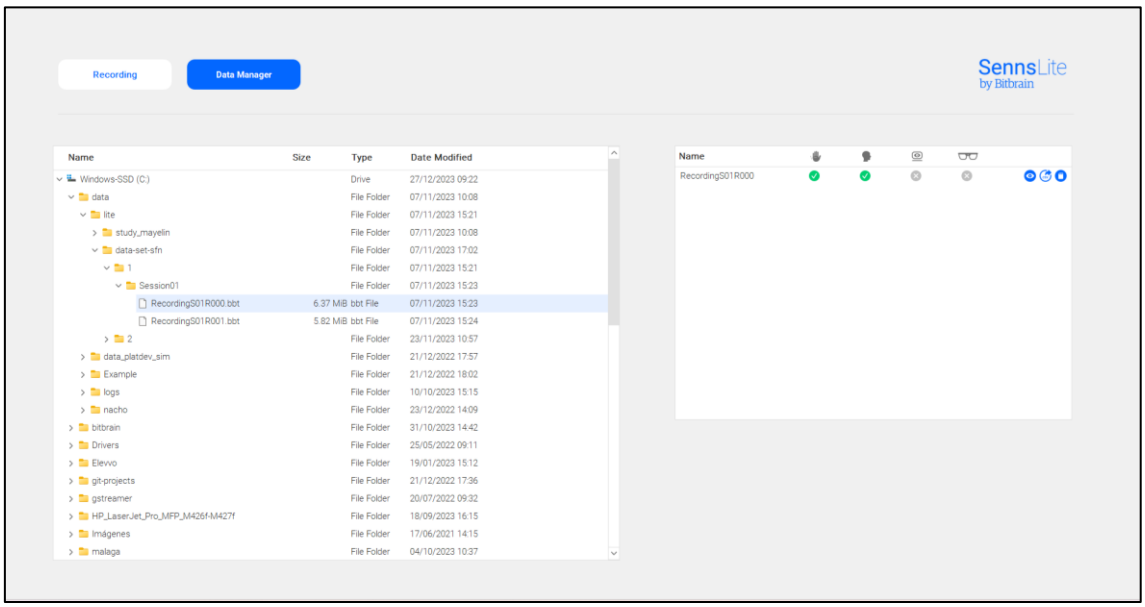
- Battery status: The icon shows 5 battery ranges depending on the charge level sent by the device:
    - 0-20%
    - 20-40%
    - 40-60%
    - 60-80%
    - 80-100%
- Sensors layout for EEG and Ring devices
- Hardware's user guide
- 3D brain layout (just for EEG devices)
- Sensor numbers or locations. Note that in case of the Ikon device, as it supports a re-referencing, the sensor locations in the EEG also represent the reference (e.g., FP1-A1).

The bar in the signal viewer moves from left to right, and represents the current time instant in every signal from every device.

5. Data manager mode

In this mode, you can manage the recorded data:

- Import the data of the SD card (if enabled in the recording).
- Visualize the data.
- Export the data to EDF or CSV..

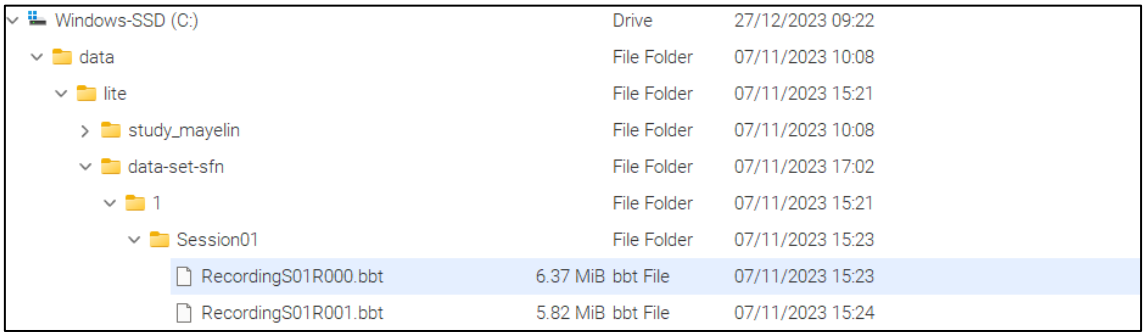


Data manager window.

In the left of the window, a file explorer tab is shown.

The recorded data with SennsLite follows a logical organization:

- The output folder defined by the user (e.g., C:/data/lite).
- Folder with the dataset ID (e.g., data-set-sfn)
- Folder with the participant ID (e.g., 1)
- Folder with the session number (e.g., 1)



Folder logical organization for a recording.

Note that the session number is not defined by the user, but is an internal number that is automatically increased every time a recording is started using the same configuration of the three parameters (output folder, participant, dataset).

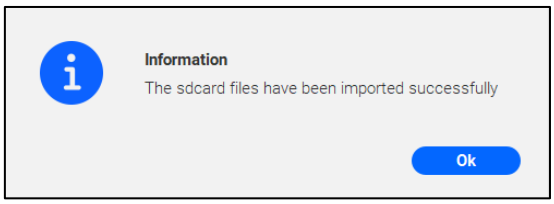
After selecting a recording session, the right side of the window displays the kind of sensor used in the recording (EEG, Biosignals), and options to Import the SD card , visualize the signal , and export the data in csv. files .

5.1 IMPORTING SD CARD FILES

For recordings performed in the SD card of the devices, those files can be imported into the computer.

Get the SD card from the device and plug it in the computer where SennsLite is installed. Once it is recognized by the computer, click on the button to import the SD card files. This process will take the data from the SD card.

If the import of the files is correctly done, a message like this will pop up.



Pop up message for the SD card importation.

5.1.1 Importing in Ikon device

For Ikon devices, the aforementioned process is slightly different. To import SD card files the following steps should be followed:

- Connect the amplifier through Bluetooth.
- Once it is done, click on import SD card to import files.

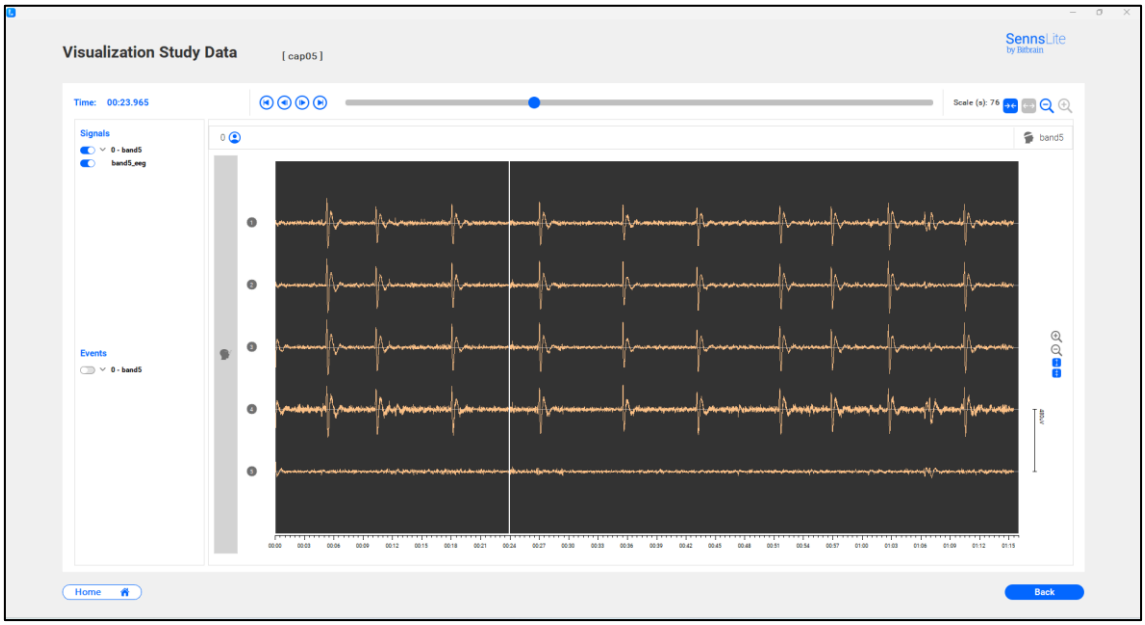
Once data has been imported, the data from the internal SD card will be deleted automatically.

5.2 VISUALIZATION WINDOW

The visualization window allows user to see the signal recorded. Filter settings configuration is the same as the one described in section 4.1.2.

- Upper left side of the screen, the timer that shows the exact time of the recording.
- Centre part, time bar that represents the total duration of the recording and can move through it to see different parts of the recording. This bar has also some icons on the left that also help the user to move through this bar.
- Upper right side, Scale that allows the user to see the whole recording.

In the left part of the screen a list of the sensor used, the signals recorded with that sensor and the events logged are shown there.



Visualization screen.

Please note the following shortcuts for an easier navigation:

- CTRL+Left/Right: Move forward or backward in the displayed data window

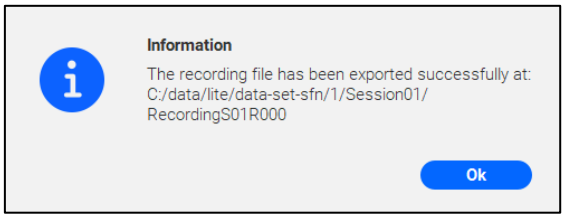
5.3 DATA EXPORT

In order to export the data, select the recording to export and click on the corresponding button to export in EDF or CSV format:

- EDF is a standardized file format designed for storing biological signals. One file is provided for every recording device. We currently support this format for Bitbrain devices containing EEG signals.
- CSV is an interoperable file format for storing tabular data in plain text. One file is provided for every device signal. All the Bitbrain devices are supported. We provide two output formats with varying levels of detail.

Section 7 provides a detailed information of the exported data.

Once the export process has been done successfully a pop-up message will come out displaying the output folder where the exported files were created.



Pop up message for the exportation of the recording files.

SD card importation

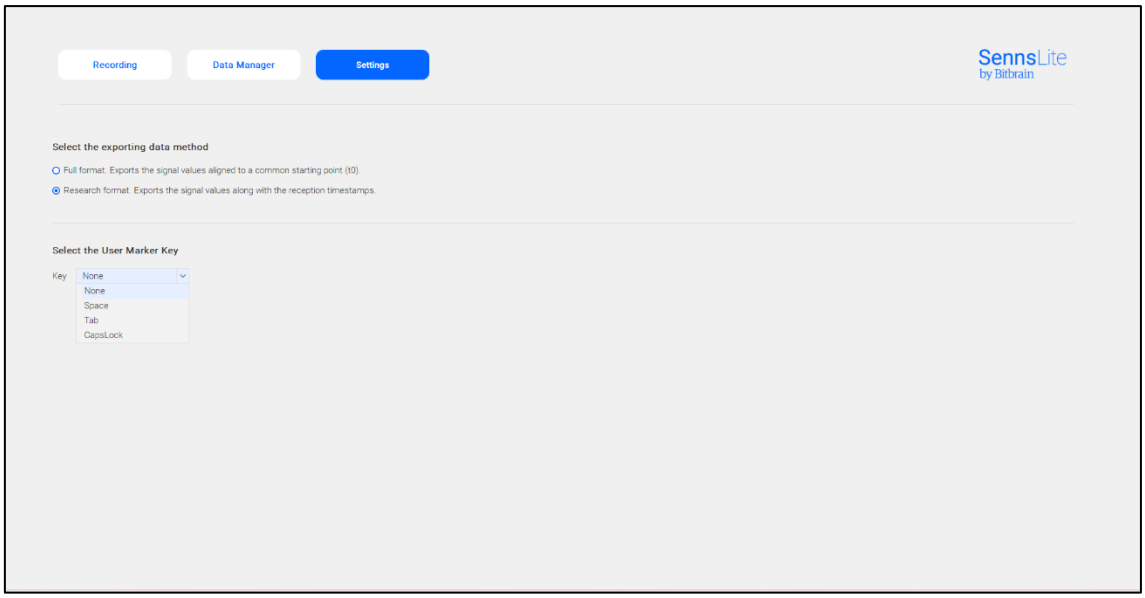
Before proceeding with the data export, SD card recordings (if enabled) should be imported. **If not, the exported data will only contain the data received during online operation with possible missing values due to the Bluetooth connectivity.**

It can be checked in the metadata of the exported data whether the output data integrated the contents of the SD card, specifically checking the fields *sd_sync_read* and *sd_data_read* are true (see section 7).

6. Settings

In this window some settings can be selected:

- Exporting data method: To select the kind of data exportation for the CSV (CSV-Lite, CSV-Full). The user is directed to section 7 for detailed information of the exported data.
- Key User Marker: To select the key to mark the user markers that can be introduce in the recording. Keys available are:
    - Space
    - Tab
    - CapsLock



7. Description of exported data format

SennsLite allows exporting the data in two formats:

- EDF is a standardized file format designed for storing biological signals. One file is provided for every device. Supported for Bitbrain devices containing EEG signals. We refer to "EDF" through the software and this document for simplicity, note however that we specifically provide the EDF+ format.
- CSV is an interoperable file format for storing tabular data in plain text. One file is provided for every device signal. Supported for all Bitbrain devices. We provide two output formats with varying levels of detail (Lite and Full).

These three output data formats (EDF, CSV-Lite, CSV-Full) differ in the following properties:

- Resolution and filtering: EDF represents the signal values in 2 bytes (16 bits), which does not allow to store the EEG and PPG signals as the full range of the amplifier ADC is 24 bits. Thus, EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) when exported to EDF format. CSV formats (CSV-Lite, CSV-Full) export the full-band signals.
- Lost samples adjust: Some signal samples might be lost due to the wireless nature of the communication. In EDF and CSV-Full, the exported signals are expanded with nan values in case of lost samples. In CSV-Lite, additional information is provided such a sequence number (counter) to detect these cases.
- Multi-device adjust: In simultaneous multi-device recordings, the devices might start the recording with a slight difference (even when they are commanded at the same time). In EDF and CSV-Full, we provide a common t0 for all signals, and expand the signals with initial nan values so that the initial sample corresponds to the same time point. In CSV-Lite, we simply provide the initial timestamp (t0) for each device signals, which might be different.

The following table summarizes this information:

	EDF	CSV-Full	CSV-Lite
Supported devices	EEG devices (Ring or Versatile Bio not supported)	All	All
Full-band	No, EEG and PPG are high prefiltered (0.1 Hz)	Yes	Yes
Lost samples adjust	Yes	Yes	No
Multi-device adjust	Yes	Yes	No

In the next subsections we describe:

- EDF format
- CSV format
- Events
- Metadata (JSON files)
- Signal properties for every sensor modality, and the events properties.
- Information on how the Bitbrain devices data transfer works and timestamps.

7.1 EDF FORMAT

We provide an EDF file for every recorded device, thus containing all its signals that operate at different sampling rates.

The EDF file is composed of a set of channels:

Example:
eeg_AF7, eeg_A1, eeg_Fp2, eeg_AF8, eeg_A2, mask_eeg, imu_1, imu_2, imu_3, imu_4, imu_5, imu_6, imu_7, imu_8, imu_9, mask_imu, spo_1, spo_2, spo_3, mask_spo

Channel	Description
<signal_id><i> * In case of EEG signals, we provide the position: <signal_id>_<loc>	Values of signal <signal_id> and channel i (from 1 to N). EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) and clipped to (-3000, 3000) uV.
mask_<signal_id>	Mask of boolean values (0 or 1) for each signal that indicates whether samples were lost and should be interpreted as missing values (nan). A sample *j* was lost in signal *eeg* when *mask_eeg[j]* is 1. Note we include a mask channel because nan values cannot be represented in EDF format.

Header of the EDF file

The header of the EDF file fills the following fields:

- Start date and start time (note these fields provide a resolution of seconds; for a higher time resolution access the UTC timestamps provided in the JSON file – metadata).
- Patient code

- Equipment (device type)

7.2 CSV FORMAT

We provide a CSV file for every recorded signal.

The first line contains a header with the name of the columns.

Examples:

CSV-Full: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2

CSV-Lite: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2, sequenceNumber, timestampReception, timestamp

The CSV file contains the following columns:

Column	Full/Lite	Description
ch<i> * In case of EEG signals, the position is added: ch<i>-<loc>	Full/Lite	Values of channel i (from 1 to N).
sequenceNumber	Lite	Sequence number (counter) is incremented by 1 every block.
timestampReception	Lite	Reception timestamp (high res., us) per block, might be null if lost online.
timestamp	Lite	Corrected timestamp (high res., us), using the t0 computation

7.3 EVENTS

The events registered with SennsLite during the recording are exported to CSV files.

We provide a CSV file for every event type.

The first line contains a header with the name of the columns.

Examples:

timestamp, value1

The CSV file contains the following columns:

Column	Description
timestamp	Timestamp (high res., us) when the event occurred.
value<i>	Value/s of the event.

	Note that one event might have several values. For instance, one event type “quality” is provided for every device that provides the signal quality of every channel.

7.4 METADATA (JSON FILES)

The metadata is provided in a file with a JSON data format with the following fields.

system
- version: version of the data exporter
- adjust: full, lite

status:
- ok: bool, indicates whether the data export worked fine
- t0: float, initial ts (high res., us) of the recording (full export only)
- tn: float, final ts (high res., us) of the recording (full export only)
- utc: object with fields:
  - enabled: bool, indicates whether UTC timestamp could be measured
  - stable: bool, indicates whether the UTC timestamps were stable
  - t0: float, initial ts (us) in UTC units (when stable = true)
  - tn: float, final ts (us) in UTC units (when stable = true)

signals: array object of:
- id: string, id
- num_channels: int, number of channels
- num_elements: int, samples per block
- sampling rate: int, nominal sampling rate
- other information:
  - signal loc: string list, list of EEG positions (only available for EEG)
  - subject name: id of the participant
  - device name: id of the device
  - device type: device type (Ikon, Ikon Sleep, Diadem, Hero, Air, Versatile EEG, Versatile Kids EEG, Versatile Bio, Ring)
  - signal type: signal type, see section 7.5
- status: status of the export procedure on this signal, object with fields:
  - enabled: bool, indicates whether the signal could be exported
  - error_flag: int, indicates the error (when enabled = false)
  - error_message: string, indicates the error (when enabled = false)
  - sd_sync_read: bool, indicates whether the SD card (sync file) was read
  - sd_data_read: bool, indicates whether the SD card (data file) was read
- internal: advanced metadata information, object with fields:
  - pad_ini: int, number of padding samples added to the beginning (full export only)
  - pad_end: int, number of padding samples added to the end (full export only)
  - t0: float, initial ts (us)
  - tn: float, initial ts (us)
  - utc: object (idem as utc object in status)

event: array object of:
- id: string, id
- num_channels: int, number of channels

- other information: device name, config

7.5 SIGNAL AND EVENTS PROPERTIES

This section contains the description of the signal and event properties. The signal properties are grouped into devices sharing sensor modalities:

- EEG systems and Versatile Bio
- Ring device

7.5.1 Signals of EEG systems and Versatile Bio

The signals are recorded without any filtering. All the signals are sampled at 256 Hz (8 samples per block) except for the IMU (32 Hz, 1 sample per block). In case of EEG, [1-30] Hz bandpass filter is applied to the EEG for visualization purposes only.

SIGNAL TYPE	DESCRIPTION	DEVICE TYPE
eeg	**EEG signal** Number of channels * Samples per block: 8 Sampling rate: 256 Hz Unit: uV Visualization filter: [1-30 Hz] *The number of channels [value n] depends on the device type.	Ikon (n=5) Ikon Sleep (n=2) Air (n=8) Diadem (n=12) Hero (n=10) Versatile EEG 8 (n=8) Versatile EEG 16 (n=16) Versatile EEG 32 (n=32)
imu	**Inertial measurement unit (IMU)** Number of channels: 9 - ch 1: accelerometer, x-axis (g) - ch 2: accelerometer, y-axis (g) - ch 3: accelerometer, z-axis (g) - ch 4: gyroscope, x-axis (deg/s) - ch 5: gyroscope, y-axis (deg/s) - ch 6: gyroscope, z-axis (deg/s) - ch 7: magnetometer, x-axis (uTeslas) - ch 8: magnetometer, y-axis (uTeslas) - ch 9: magnetometer, z-axis (uTeslas) Samples per block: 1 Sampling rate: 32 Hz	Ikon Ikon Sleep Air Diadem Hero Versatile EEG Versatile Bio
photodiode	**Photodiode input** Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Air Diadem Hero Versatile EEG Versatile Bio
din	**Digital input** Number of channels: 1* Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Diadem Versatile EEG Versatile Bio

	*The number of channels is 1, except for the Versatile 32 (n=3)	
dout	**Digital output** Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit This signal type generates TTL pulses that, when received in the DIN of another device, can be used to synchronize them at sample level.	Versatile Bio
analog	**Input to record analogic signals such as GSR, respiration, temperature, etc.** The Versatile Bio has 7 analogic inputs. Samples per block: 8 Sampling rate: 256 Hz	Versatile Bio
exg	**Input to record bipolar signals such as ECG, EMG, etc.** The number of inputs depends on the device type [value n]. Samples per block: 8 Sampling rate: 256 Hz	Versatile EEG 32 (n=2) Versatile Bio (n=9)
ppg	**PPG signal** Number of channels: 3 - ch 1: red light intensity - ch 2: infrared light intensity - ch 3: green light intensity Samples per block: 1 Sampling rate: 32Hz Unit: nA	Ikon Sleep
ts	**ts signal: internal timestamp of the device** Number of channels: 1 Samples per block: 1 Sampling rate: 32Hz Unit: us	Ikon Ikon Sleep

7.5.2 Signals of the Ring device

The signals are recorded without any filtering. The signals are sampled at 32 Hz (1 sample per block). [0.5-2] Hz and [0.5-4] Hz bandpass filters are applied to the GSR and BVP signals, respectively, for visualization purposes only.

SIGNAL TYPE	DESCRIPTION	DEVICE TYPE
gsr_bvp_acc	The Ring device provides the following signals: Number of channels: 5 - ch 1: galvanic skin response (GSR) (uS) - ch 2: blood volume pulse (BVP) (uV) - ch 3: accelerometer (ACC), x-axis (g) - ch 4: accelerometer (ACC), y-axis (g) - ch 5: accelerometer (ACC), z-axis (g) Samples per block: 1 Sampling rate: 32 Hz	Ring

7.5.3 Events

The table shows all possible events logged by SennsLite along with a description.

EVENT	DESCRIPTION
userMarker	Denotes the time instants in which the operator pressed a key. Every time a key is pressed the value of this marker is increased. - ch1: value
{deviceID}_quality	Signal quality values for a given device (specified by its ID), available for EEG devices and for the Ring device. A signal quality value is provided for every channel; thus, the number of channels matches the number of channels in the original data. - ch1: signal quality of channel 1 - … - chN: signal quality of channel N The signal quality values are: - value = 1, optimal quality - value = 2, fair quality - value = 3, bad quality - value = 4, saturated signal

7.6 UNDERSTANDING THE DATA TRANSFER AND SYNCHRONIZATION

Bitbrain devices iteratively register a “block of data” and transfer it to the recording software. This data transfer happens block by block at a fixed rate of 32 Hz (i.e., every 31.25 ms a “block of data” is recorded and transferred to the recording computer).

The data blocks contain multiple signals (for instance EEG, SPO, IMU) and a sequence number. This sequence number is a counter to detect missing blocks due to the wireless nature of the communication (either using standard Bluetooth or Bluetooth Low Energy in Ikon). At reception, the software captures a “reception timestamp”.

Based on all this information (sequence number, reception timestamps, and the fact that we impose a data transfer at a fixed rate), we can apply a series of algorithms to correct the jitter from the timestamps, estimate the initial time point of each signal (referred as to “t0” in this section), and synchronize the signals from multiple devices. The synchronized data is exported in CSV format along with metadata.

Finally, it is important to understand that data blocks contain, for each signal, a pre-defined number of samples. For instance, since the sampling rate of the EEG is 256 Hz, we capture 8 samples of EEG per block (and channel). In case of SPO and IMU signals they have a sampling rate of 32 Hz, thus 1 sample of data is transferred per block.

7.6.1 Timestamps

We capture two types of timestamps:

- High resolution timestamps (using QueryPerformanceCounter in Windows OS). These timestamps have a high resolution (<1us) and can be used for time-interval measurements.
- UTC timestamps (using GetSystemTimePreciseAsFileTime in Windows OS). These timestamps measure absolute time units and can be used to synchronize to external events.

Both types of timestamps are captured in microsecond units.

All the timestamps contained in the exported files (either signals or events) are high resolution timestamps. The metadata contains the initial time point estimates in both timestamps formats, so that a correspondence between them can be computed.

8. Annex: Ikon reference

The Ikon device has sensors in the forefront (Af7, Fp1, Fp2, Af8) and in upper part of the ears (A1, A2). The ground electrode is in Fpz, and the amplifier reference is in Fp1.

The design decision to have the amplifier reference in Fp1 allows to:

- Provide signal quality indexes in the ear's sensors. This is interesting as the ear's sensors are likely to be more difficult to place correctly than forefront sensors, thus helping in the correct placement of the device by non-experts.
- Set the reference to A1 or A2 in offline analysis depending on the researcher needs, or switch between them if the contact is loss in any of them. In summary, this potentially makes the technology more robust for real-word recordings. This point also applies to online processing scenarios, in which the reference can be dynamically switched.
- Have a linked-ears reference.

Important: while the EEG signal is re-referenced in the signal viewer in SennsLite for usability, it is stored unfiltered and with the amplifier reference (Fp1). Thus, researchers that load the exported data will commonly need to re-reference the signal to either A1 or A2 for its interpretation.

8.1 RE-REFERENCING

Recorded data can be expressed in the form:

(Af7-Fp1, A1-Fp1, Fp2-Fp1, Af8-Fp1, A2-Fp1)

Re-referencing implies to perform a mathematical operation to transform this to:

(Af7-A1, Fp1-A1, Fp2-A1, Af8-A1, A2-A1)

This Python code performs such an operation:

```
def _rereference_array(data: np.ndarray) -> np.ndarray:
    """
        Perform re-referencing of EEG data to A1 (ch index = 1).

        Parameters:
        - eeg_data: numpy array of shape (num_channels, num_samples)
          - locations: (Af7-Fp1, A1-Fp1, Fp2-Fp1, Af8-Fp1, A2-Fp1)

        Returns:
        - eeg_data_referenced: numpy array of shape (num_channels, num_samples)
          - locations: (Af7-A1, Fp1-A1, Fp2-A1, Af8-A1, A2-A1)
        """
    reference_ch = 1
    ch_ref = np.copy(data[reference_ch, :])
    for ch in range(data.shape[0]):
        if ch != reference_ch:
            data[ch, :] = data[ch, :] - ch_ref
        else:
            data[ch, :] = -data[ch, :]

    return data
```

9. LSL Connectivity

This software allows no further interaction with the data while acquiring but visualization (filtering only affects visualization). For those users that want to access the data while being acquired, we provide the LSL server option.

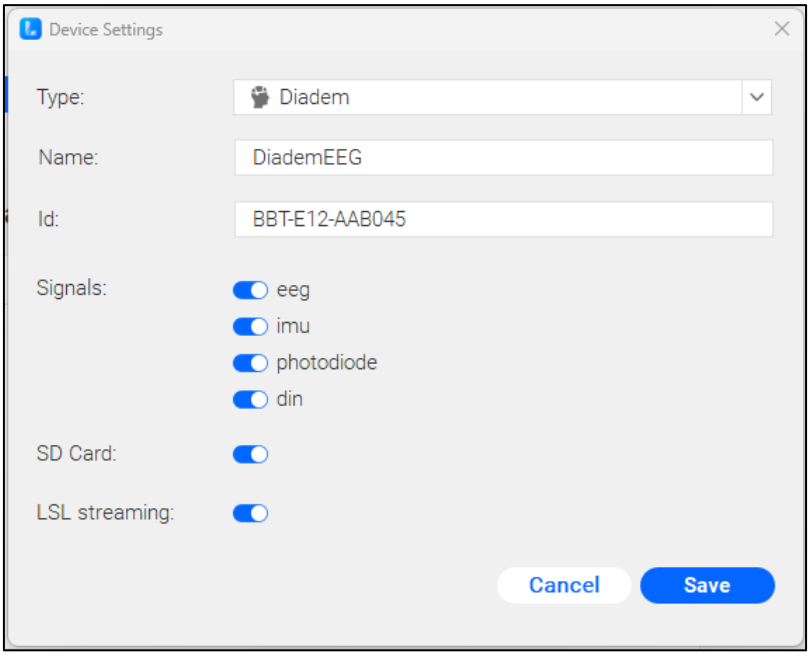
If this feature is enabled, an LSL server will be created when the acquisition starts. This server will publish one data stream per signal being acquired. Other applications in the same computer or over the network can connect to the server to subscribe to any of the stream and receive the data online to do any kind of external processing using this standard protocol.

To record properly with LSL protocol, some third part applications should be needed to perform this recording. The LabRecorder is the default recording program that comes with LSL. It allows to record all streams on the lab network (or a subset) into a single file. The LabRecorder application is shown in the following example.

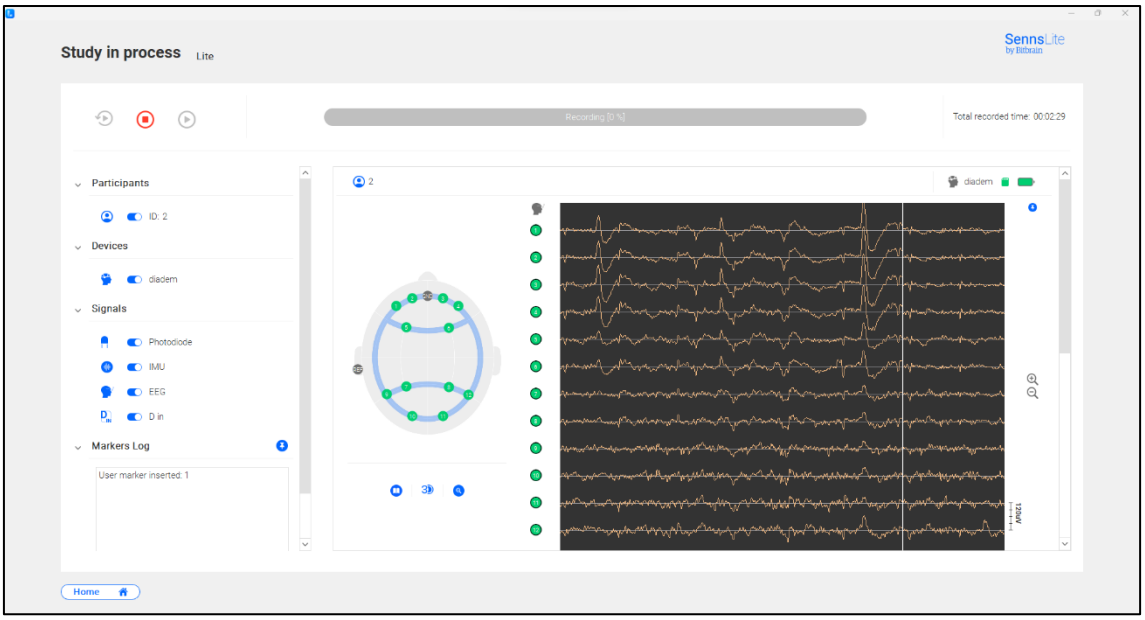
LabRecoder can be downloaded here: [GitHub - labstreaminglayer/App-LabRecorder: An application for streaming one or more LSL streams to disk in XDF file format.]

To perform the recording properly the following steps should be performed:

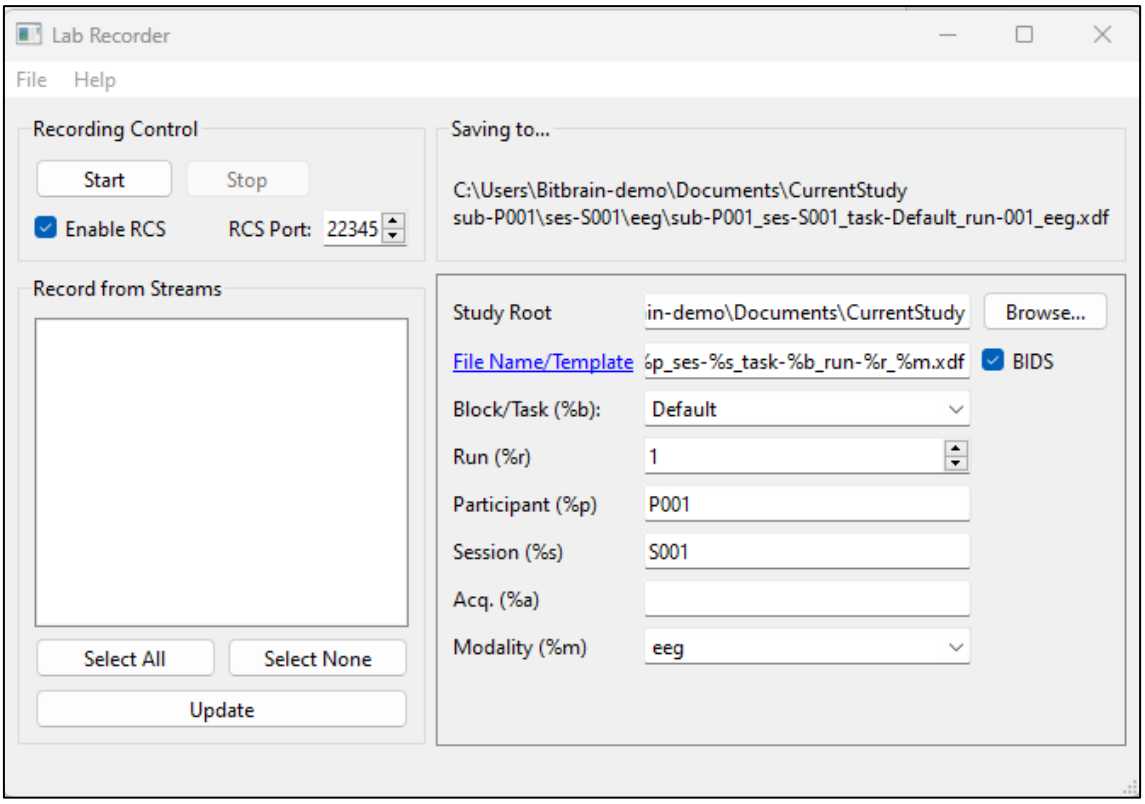
1. Configure the device in SennsLite, activating the LSL streaming switch.



2. Go through the configuration steps and throughout the quality check process. And get to the recording screen.



3. Start SennsLite recording.
4. Launch LabRecorder.



5. Update available signals and select the relevant ones for the data set.
6. Select the folder to record the data set.
7. Start LabRecorder recording.
8. Carry out the experimental design.

9. Stop LabRecorder recording.
10. Stop SennsLite recording.

After this recording process a .xdf file should have been created in the previously selected directory.

9.1 OUTPUT STREAMS

SIGNAL TYPE/OUTLET ID	LSL METADATA	DEVICE TYPE
eeg <device_name>_eeg	**EEG signal** Number of channels * Samples per block: 8 Sampling rate: 256Hz Unit: uV *The number of channels [value n] depends on the device type.	Ikon (n=5) Ikon Sleep (n=2) Air (n=8) Diadem (n=12) Hero (n=10) Versatile EEG 8 (n=8) Versatile EEG 16 (n=16) Versatile EEG 32 (n=32)
imu <device_name>_imu	**IMU signal** Number of channels: 9 - ch 1: accelerometer, x-axis (g) - ch 2: accelerometer, y-axis (g) - ch 3: accelerometer, z-axis (g) - ch 4: gyroscope, x-axis (deg/s) - ch 5: gyroscope, y-axis (deg/s) - ch 6: gyroscope, z-axis (deg/s) - ch 7: magnetometer, x-axis (uTeslas) - ch 8: magnetometer, y-axis (uTeslas) - ch 9: magnetometer, z-axis (uTeslas) Samples per block: 1 Sampling rate: 32 Hz	Ikon Ikon Sleep Air Diadem Hero Versatile EEG Versatile Bio
photodiode <device_name>_photodiode	**Photodiode input** Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Air Diadem Hero Versatile EEG Versatile Bio
din <device_name>_din	**Digital input** Number of channels: 1* Samples per block: 8 Sampling rate: 256 Hz Unit: bit *The number of channels is 1, except for the Versatile 32 (n=3)	Diadem Versatile EEG Versatile Bio
dout <device_name>_dout	**Digital output** Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Versatile Bio

analog <device_name>_analog	Input to record analogic signals such as GSR, respiration, temperature, etc. The Versatile Bio has 7 analogic inputs. Samples per block: 8 Sampling rate: 256 Hz	Versatile Bio
exg <device_name>_exg	Input to record bipolar signals such as ECG, EMG, etc. The number of inputs depends on the device type [value n]. Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Versatile EG 32 (n=2) Versatile Bio (n=9)
ppg <device_name>_ppg	ppg signal Number of channels: 3 - ch 1: red light intensity - ch 2: infrared light intensity - ch 3: green light intensity Samples per block: 1 Sampling rate: 32Hz Unit: nA	Ikon Sleep
ts <device_name>_ts	ts signal Number of channels: 1 Samples per block: 1 Sampling rate: 32Hz Unit: us	Ikon Ikon Sleep
gsr_bvp_acc <device_name>_signal	ring signal The Ring device provides the following signals: Number of channels: 5 - ch 1: galvanic skin response (GSR) (uS) - ch 2: blood volume pulse (BVP) (uV) - ch 3: accelerometer (ACC), x-axis (g) - ch 4: accelerometer (ACC), y-axis (g) - ch 5: accelerometer (ACC), z-axis (g) Samples per block: 1 Sampling rate: 32 Hz	Ring

A timestamp is assigned to every sample of every signal. These timestamps values are stored in seconds with a precision up to milliseconds. A smooth algorithm is performed over the transmitted timestamps (LSL) to reduce the inherent jitter in the Bluetooth transmission.

10. Contact

For any problem, question or comment please contact us at support@bitbrain.com

Bitbrain

www.bitbrain.com
info@bitbrain.com

Bitbrain

Bitbrain

Versatile Bio

Modelo: BIO

Guía de uso

V-BIO-00-200125-ES

Español

Esta es la guía de uso del dispositivo *Versatile Bio* de Bitbrain.

En ella encontrará toda la información necesaria para poner en funcionamiento su producto.

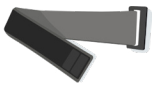
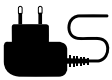
Bitbrain

Índice

Índice

¿Qué incluye?

El pack incluye todos los elementos necesarios para poner en funcionamiento el equipo de biosensores. Estos son:

Objeto	Nombre/descripción	Cantidad
	**Amplificador** • Funciona con batería interna.	1
	**Sensores (personalizable)** • Permiten monitorizar bioseñales (ExG, RESP, GSR, TEMP, etc.), movimiento (IMU, GPS) y eventos. • La cantidad y el tipo de biosensores incluidos dependen del pedido realizado.	
	**Tarjeta MicroSD 8Gb de clase 10 y Adaptador SD**	1
	**Banda elástica ajustable** • Permite colocar el amplificador en el brazo o en la cintura.	1
	**Cargador y adaptadores** • Carga la batería del amplificador.	1

Sensores

Versatile Bio cuenta con 20 entradas (hasta 35 canales), para registrar simultáneamente y de forma sincronizada con cualquiera de los siguientes sensores.

Entrada ExG

- EMG: Electromiograma
- ECG: Electrocardiograma
- EOG: Electrooculograma

Entradas digitales

- TTL trigger EXT: Recepción de pulsos para sicronización con otros dispositivos externos
- TTL trigger BBT: Recepción de pulsos para sicronización con otro Versatile Bio
- Pedal: Trigger de 1-bit
- Pulsador 1 botón: Trigger de 1-bit
- Pulsador 3 botónes: Trigger de 3-bit
- Pulsador 7 botónes: Trigger de 3-bit

Salida digital

- TTL trigger BBT: Emisón de pulsos para sicronización de un equipo EEG o con otro Versatile Bio

Entradas auxiliares analógicas

- RESP: Banda de esfuerzo respiratorio
- AFS: Sensor de flujo respiratorio
- BVP: Actividad cardiaca
- GSR: Sensor de respuesta galvánica de la piel
- SNORE: Sensor de ronquidos
- TEMP: Sensor de temperatura
- PHOTODIODE BIO: Detector de cambios de iluminación. *Trigger* óptico

Entradas auxiliares digitales

- IMU: Unidad de medición inercial
- IMUs Multiplexer: Permite la conexión de hasta 8 IMUs por entrada, 16 unidades en total
- GPS: Sistema de posicionamiento global

Información de seguridad

Lea detenidamente la información de seguridad, las condiciones de uso y las instrucciones antes de usar el dispositivo. El incumplimiento de las indicaciones detalladas en dichos documentos implicará la cancelación de la garantía del producto.

Uso y trato cuidadoso

- No manipule el dispositivo con las manos húmedas ya que podría provocar un cortocircuito.
- No use el dispositivo para otro fin distinto para el que ha sido diseñado.
- No golpee, lance, muerda, abra o queme el dispositivo.
- Evite caídas y golpes contra otros objetos.
- Guarde el dispositivo en un ambiente seco y que se encuentre alejado de temperaturas extremas.

Advertencias sobre el equipo

- NO use el dispositivo mientras se está cargando.
- NO abra el dispositivo. Comuníquese con support@bitbrain.com si su dispositivo no funciona correctamente.
- NO acerque este dispositivo a aparatos electrónicos ni a aparatos eléctricos de soporte vital.
- El manejo y la supervisión del equipo obligatoriamente serán realizados por un adulto cuando este sea utilizado para medir datos biométricos en niños.
- Si nota que el dispositivo despide olores o ruidos extraños o su temperatura es excesiva, déjelo en un lugar apartado y comuníquese con support@bitbrain.com.

Advertencias sobre la batería

- Desconecte el cable de carga una vez la batería del dispositivo se encuentre cargada, de lo contrario puede verse reducido el ciclo de vida de esta.
- Si se procede a almacenar el dispositivo durante largos períodos (más de una semana), es recomendable que la batería no se encuentre cargada al 100%. Esto puede degradar la batería, lo que conlleva una disminución de la autonomía del dispositivo.
- Guarde el dispositivo en un ambiente seco y que se encuentre entre 5ºC y 40ºC. La exposición prolongada a altas temperaturas puede afectar a la estabilidad de la batería.

Información de seguridad

Retirada del dispositivo

¡No arroje dispositivos eléctricos y electrónicos a la basura! Conforme a la Directriz Europea 2012/19/UE sobre aparatos eléctricos y electrónicos inservibles, deberán ser depositados en instalaciones de recogida adecuadas para ser sometidos a un reciclaje ecológico.

Antes del depósito de los aparatos en las instalaciones de recogida de estos, deberán extraerse las baterías y ser depositadas separadamente del resto de la electrónica, para su adecuada gestión.

Para proceder a retirar la batería se abrirá la carcasa del amplificador con ayuda de un destornillador Torx 6, y se despegará con cuidado la batería para luego depositar la electrónica del equipo y batería cada una por separado.

Conformidad y marcado CE

Este dispositivo es un equipo radioeléctrico y es considerado equipo de tecnología de la información.
El marcado CE indica el cumplimiento con los requisitos esenciales de la Directiva RED (2014/53/UE).

El módulo Bluetooth que incorpora cumple previamente dicha Directiva, y es utilizado de acuerdo a las instrucciones de su fabricante y teniendo en cuenta los requisitos que este especifica.

CE

Importante

Versatile BIO es un dispositivo diseñado por Bitbrain para medir datos biométricos destinados a investigación.

Condiciones de uso

- Lea detenidamente la información de seguridad del dispositivo y conserve el manual para consultas futuras.
- Lea detenidamente los “Términos y Condiciones Generales de venta y uso de los Productos de Bitbrain”, puede acceder al documento en https://downloads.bitbrain.com/documents/terms-and-conditions-eu

Descargo de responsabilidad

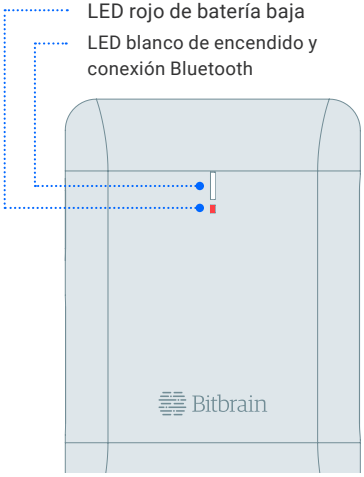
Los equipos Hardware incluidos en los Productos (EEG, biosensores, localización de interiores, eye tracking) no son dispositivos médicos, no han sido diseñados ni fabricados para prestar servicios sanitarios, ni se comercializan con fines de diagnóstico, cura, paliación, consejo médico ni prevención de la enfermedad, sino con fines de investigación.

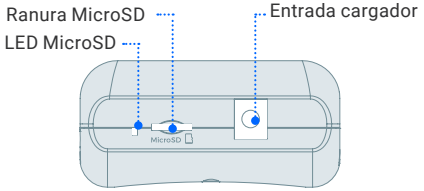
Lea nuestros “Términos y Condiciones Generales de venta y uso de los Productos de Bitbrain” antes de adquirir un equipo para su comprensión completa. Puede acceder al documento en https://downloads.bitbrain.com/documents/terms-and-conditions-eu

Bitbrain se reserva el derecho a revisar esta guía de uso y hacer los cambios en su contenido que estime adecuado en cualquier momento sin obligación de notificar a cualquier persona o entidad los cambios realizados. A pesar de todos los esfuerzos realizados para asegurar la precisión de la información aquí contenida, esta no debe ser interpretada como un compromiso por parte de Bitbrain. Para asegurarse de que dispone de la última versión visite el apartado de descargas de la página del producto en www.bitbrain.com.

Versatile Bio

Versatile Bio es un sistema versátil de adquisición de bioseñales en tiempo real optimizado para aplicaciones fuera de laboratorio que requieren una buena calidad de señal para el investigador. Puede grabar hasta 35 canales (20 entradas).



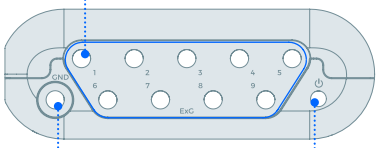


Estado LED MicroSD

Tarjeta MicroSD insertada

Sensores ExG

Entradas ExG:
Permiten conectar cualquier tipo de entrada analógica bipolar (EOG, EMG, ECG, etc.)

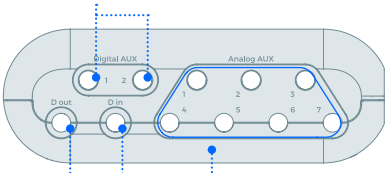


Toma a tierra:
Conectar siempre que se vaya a usar entrada ExG.

Botón de encendido

Sensores Auxiliares

Entradas digitales auxiliares:
Permiten conectar sensores como IMU, GPS...



Salida digital:
Permite sincronizar con otros dispositivos.

Entradas analógicas auxiliares

Entrada digital:
Permite conectar entradas digitales provenientes del ordenador o dispositivos como interruptores, pulsadores, etc.

Especificaciones técnicas

Tensión nominal	3.7V
Potencia nominal	1000mW
Autonomía	>8h
Tiempo de carga	≤3h
Frecuencia muestreo	256Hz
Tecnología inalámbrica	Bluetooth 2.1 + EDR
Respaldo de datos	Sí (tarjeta MicroSD extraíble)
Dimensiones aplificador	105x76x37mm
Peso	176g
Conexión de carga	Circular (Fuente de alimentación proporcionada)
Normativa	UNE EN 62368-1:2020, EN 55011

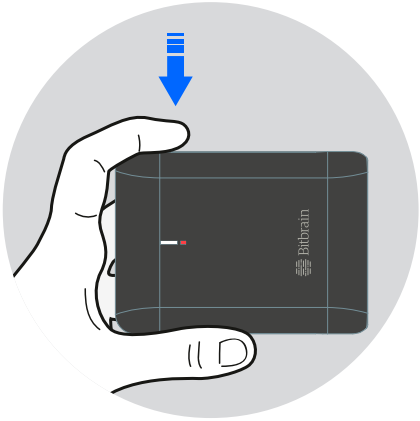
Preparación para el registro de datos

1

Encienda el amplificador presionando sobre el **botón de encendido**(⏻). El LED blanco de conexión inalámbrica parpadeará hasta que se establezca conexión con el *software*, momento en el que permanecerá fijo.

Cuando el dispositivo tenga batería baja, se encenderá el LED rojo de batería.

IMPORTANTE:
No se recomienda comenzar una grabación con batería baja, esto puede afectar a la calidad de la señal registrada. No utilizar el equipo mientras se esté cargando.



Preparación para el registro de datos

2

Este equipo realiza el envío de datos de forma inalámbrica mediante tecnología Bluetooth.

Los datos se pueden guardar en:

- **El ordenador al que esté emparejado el equipo.** Hay que tener en cuenta que, si el equipo pierde conectividad Bluetooth con el ordenador, estas desconexiones provocarán pérdidas de datos.
- **Tarjeta MicroSD.** En esta modalidad la señal continuará enviándose de forma inalámbrica, por lo que se podrá seguir visualizando y registrando en tiempo real en el ordenador mientras los datos se guardan en paralelo dentro de la tarjeta de memoria.

Emparejamiento

Asegúrese de que el ordenador posee adaptador Bluetooth de versión 2.1 o superior. Es necesario realizar un proceso de emparejamiento la primera vez que se usa el dispositivo. Este proceso puede realizarse desde la pantalla "Configuración > Dispositivos" de Windows.

El nombre del equipo corresponde con su número de serie (S/N), indicado en la etiqueta del dispositivo.

Respaldo de datos con MicroSD

1. Introduzca la tarjeta MicroSD entregada con el equipo dentro de la ranura indicada en el *display*.
2. Active la opción de respaldo de datos "SD card record" en el *software*.

Los archivos guardados se graban en formato .sdf. Para convertir los archivos a formato .csv utilice la función "Import record" del *software*.

IMPORTANTE:

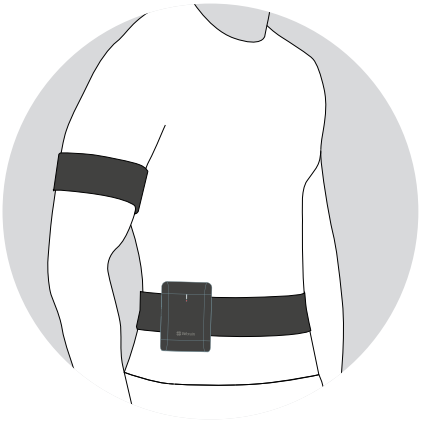
Se recomienda utilizar tarjetas MicroSD con una capacidad de 8Gb y clase 10 o superior. Utilizar otra tarjeta de memoria que no cumpla con estas especificaciones puede provocar pérdidas en la señal almacenada en ella.

Colocación del amplificador

1

Si se desea colocar el amplificador en el cuerpo:

1. Ajuste de la banda en brazo o cintura:
   - Utilice la banda corta o la intermedia, según la talla necesaria, para ajustarla al brazo.
   - Para la colocación en cintura utilice la banda más larga. Las bandas pequeñas se pueden utilizar como extensión para alargar la grande en caso de ser necesario.
2. Fije el amplificador a la banda mediante el Velcro.



Mantenimiento

Limpieza y desinfección del amplificador:

- Le recomendamos emplear un paño humedecido en agua o con una pequeña cantidad de alcohol para llevar a cabo la limpieza.

- Para llevar a cabo la desinfección del amplificador, se recomienda el uso de Clinell Universal Wipes:
  1. Utilice las toallitas de modo que toda la superficie del amplificador se mantenga húmeda durante 1 minuto. Deslice la toallita con suavidad sin presionar en exceso, se podría liberar líquido que podría dañar el dispositivo internamente.
  2. En la zona de las entradas, pase la toallita siempre con los agujeros boca-abajo para garantizar que no se filtra líquido en el interior del dispositivo.

Muy importante

- No emplee desinfectantes abrasivos o fuertes para limpiar el producto.
- Mire cuidadosamente las instrucciones de uso de la solución desinfectante. A la hora de elegir un producto, compruebe que se haya aprobado su efectividad y la compatibilidad con el material.

Conservación

- Procure guardar el producto en su embalaje original mientras no se esté utilizando.

- Si se procede a almacenar el dispositivo durante largos períodos (más de una semana), es recomendable que la batería no se encuentre cargada al 100%. Esto puede degradar la batería, lo que conlleva una disminución de la autonomía del dispositivo.

Bitbrain

Europa

Zaragoza, España
C. Sta Teresa de Jesús, 32, 50006
Zaragoza
+34 931 444 823

América

Nueva York, Estados Unidos
228 E 45th Street. Suite 9E
Nueva York, NY 10017

Más información en:

Email
info@bitbrain.com

Help Center
help.bitbrain.com