Visualizer on Desktop v2.3.2

User Manual

For more info, follow / contact us at:

- **mindrove.com**
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- **facebook.com/mindrove**
- **github.com/MindRove**
- **the MindRove YouTube channel**

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1 Contents

2 Safety concerns

CAUTION: The MindRove devices are NOT designed for medical purposes or use in patient health care environments.
CAUTION: MindRove devices are NOT designed for use in flammable or explosive environments.
CAUTION: The battery of devices are not replaceable and any attempt of replacement may result in injury. Please do not try to replace and/or disconnect the battery.

WARNING: Do NOT use a MindRove device when the device is being charged by your PC or charger.
WARNING: Do not try to charge the MindRove device with anything else but the USB charger shipped with the device. This USB cable must be connected by the USB port of a certified laptop/PC or certified mini-USB charger.
WARNING: Risk of explosion or personal injury if the inner components of a MindRove device are exposed to fire, heat (above 45 °C) or liquid.
WARNING: Do NOT try to open the casing.

3 MindRove devices

minimal set-up time | portability | semi-dry electrodes

raw EEG | WiFi direct connection | free GUI & SDK

3.1 arc

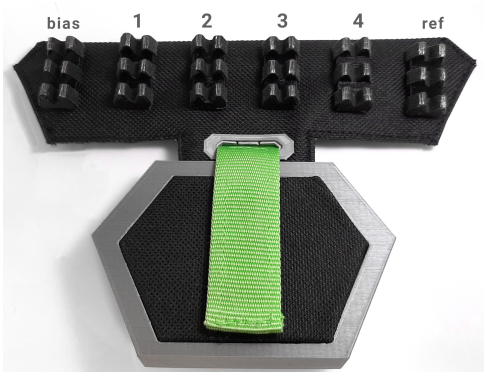
Standalone EEG headset with 1 minute set-up time.

- EEG electrodes: **6+2 (bias, ref) channels**
- EEG electrodes locations: **C5, C3, C1, C2, C4, C6**
- Reference electrode: **behind right ear**
- Bias electrode: **behind left ear**

3.2 strip

Transforms any headphone into a brain sensing device.

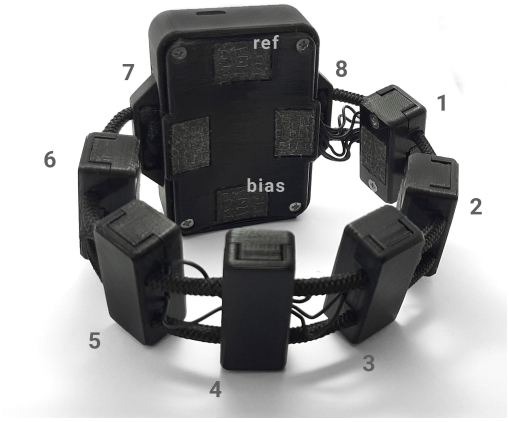
- EEG electrodes: **4+2 (bias, ref) channels**
- EEG electrodes locations: **C3, C1, C2, C4** (when attached to headphones)



3.3 armband

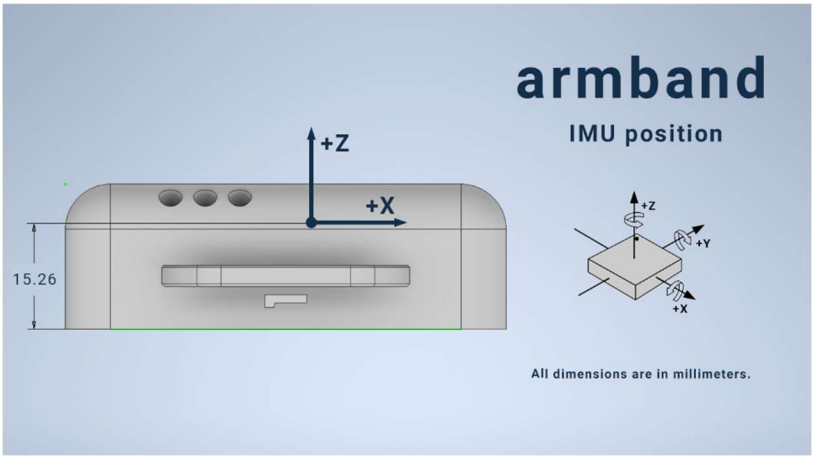
EMG-based armband for detecting muscle movements.

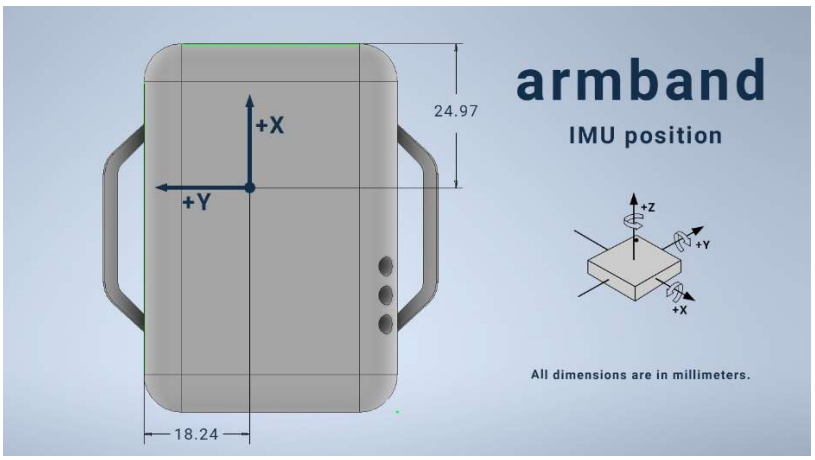
- Recommended device location: **on forearm**
- EMG electrodes: **8 + 2 (bias, ref) channels**
- EMG electrode locations: **equidistant**



IMU position

The inertial measurement unit (IMU) with the gyroscope and accelerometer is positioned in the device as shown below.





4 System requirements

Operation system: Windows 10

Architecture: 64-bit

.NET version: .NET Framework 4.8

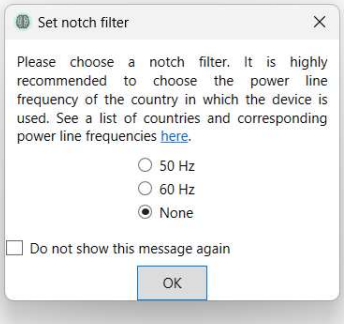
Other: Visual C++ Redistributable 2015–2022

5 Starting the application

The MindRove Desktop App can be run by clicking on Visualizer.exe within folder MindRove Desktop App. Prior to this, your PC is needed to be connected to the MindRove Headset (to do so, look for "MindRove_headset" in the list of wireless networks, connect to it and upon request enter password "#mindrove"). It is recommended to use the WiFi dongle provided (so that you can continue using the internal WiFi of your machine for internet access) and choose the option "Connect automatically".

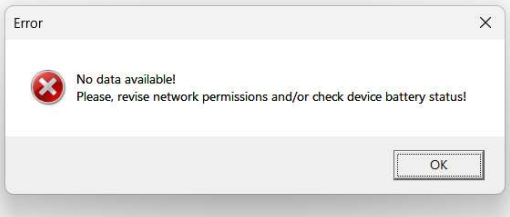
Upon the first start-up, Windows asks about communication permissions of the app. Please allow communication on both private and public networks:

The app also prompts the user to choose a notch filter that can be 50 or 60 Hz according to the line frequency that is applied in the given country. If the user does not want to set the filter (choosing *None*), they can do it later using the appropriate Config feature (for further details, refer to 6.4 Config).



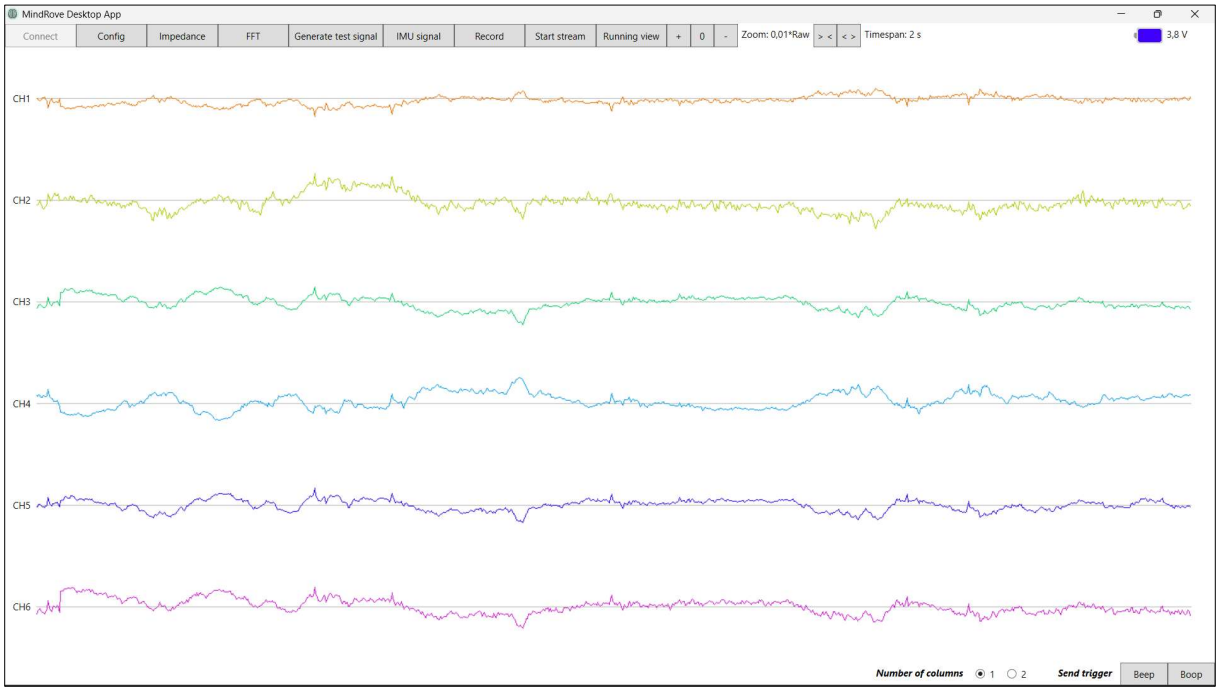
By checking the *Do not show this message again* checkbox, the user can prevent the dialog from showing up later.

If the machine does not connect to any MindRove devices, an error message shows up reminding the user to check connections. This error is most commonly due to the user not allowing communication over both public and private networks and insufficient battery charge (in this case, the green LED of the device can be lit but the connection is disrupted).



6 Overview

The app starts with the EEG View (this view is also used for displaying EMG signals of the armband). All the EEG channels are displayed on the screen using separate colours for each one, in the following order in case of an arc device. You can select the type of your device (arc, strip, armband) at the Config View (see at: 6.4 Config)



In the top of the window, the Menu Bar can be found. The menu provides access to the different app functions; these functions are described briefly in the following sections. Next to the Menu Bar, the current zoom values (software gain and window timespan) and on the far right, the battery state are displayed.

6.1 Connect

The connection is established upon start-up automatically. By default, the *Connect* button is disabled.

If the connection is lost, the app waits approximately 15 seconds then enables the manual option with the Connect button turning orange. During this few seconds, closing the application is not possible, either (it terminates after the waiting time).

***Note** that if option "Connect automatically" has not been chosen, you have to connect to the headset manually.*

6.2 One- and two-column view

Signal tracks can be displayed in either a one- or two-column layout by using the *Number of columns* feature at the bottom of the screen. In the one-column view, all the tracks will appear in a separate row while in the two-column view, the first half of the tracks will be shown in the left side of the screen and the second on the right, respectively.

6.3 Trigger signals

Send trigger signals to the device. These signals will be registered in the recorded files if the recording is on (see at: 0 The user can return to the display of EEG/EMG values by clicking the *EEG* button.

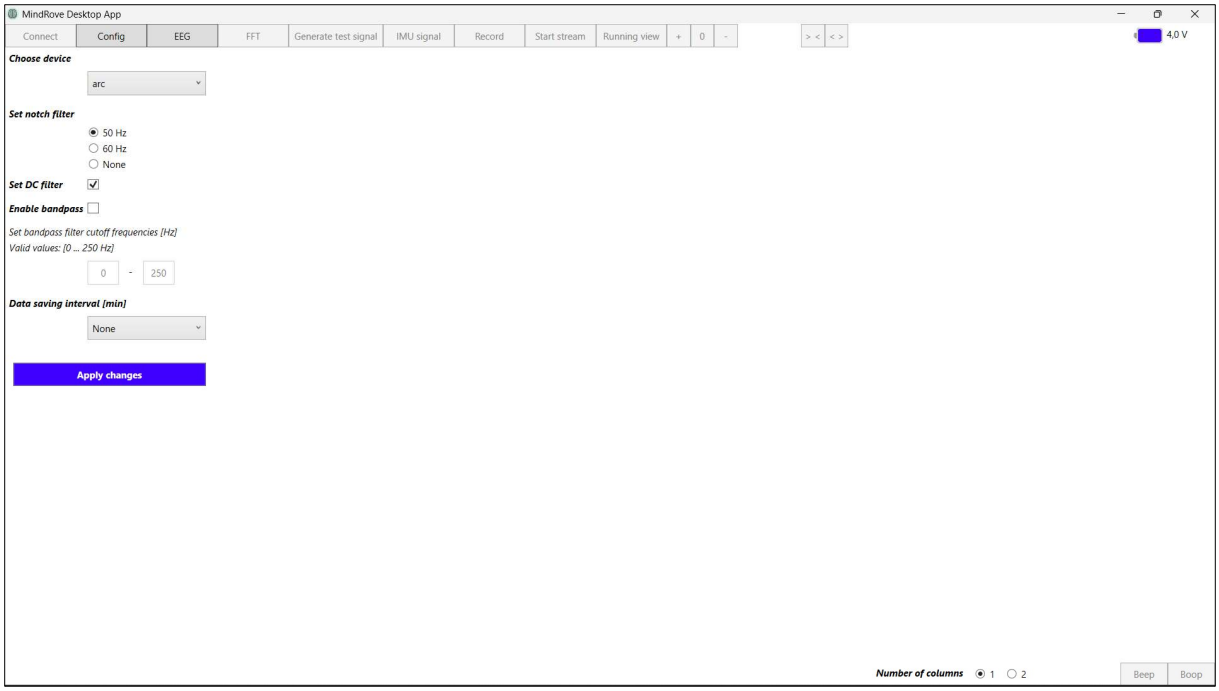
Record) and also in the LSL data stream (see at 6.10. Data streaming via Lab Streaming Layer (LSL))

6.4 Config

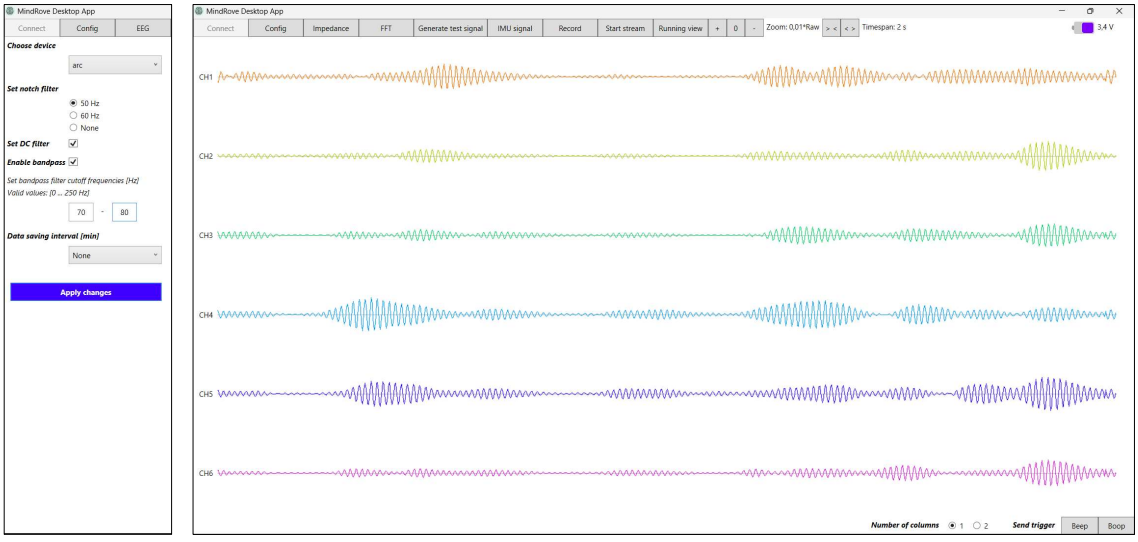
The Config View allows you to:

1. Choose the type of your device (arc, strip, armband, etc.)
2. Choose filters (DC, 50/60 Hz notch filter, bandpass filter)
3. Choose data saving interval (i.e. how frequently you want to save data to hard disk, None (all data is saved into one file, default selection)/1 min/ 5 min/10 min/15 min/30 min/45 min/60 min)

Changes will be applied only upon clicking the *Apply changes* button; after that, the app will return to displaying EEG data. The user can also exit from config mode by clicking the *EEG* button.



Bandpass filtering allows the user to display data restricted to a narrower frequency range, making some (e.g. electromyographic) activities more salient. The user can enable filtering by checking the *Enable bandpass* checkbox and by typing the desired upper and lower cutoff frequencies in the textboxes below *Set bandpass filter cutoff frequencies [Hz]*. Only integer values are accepted between 0 and 250 Hz. If the given values exceed this range, they will be substituted by the allowed minimum/maximum values.



If you need more complex software configuration for specific measurement paradigms and applications, please review the MindRove SDK at the following link:

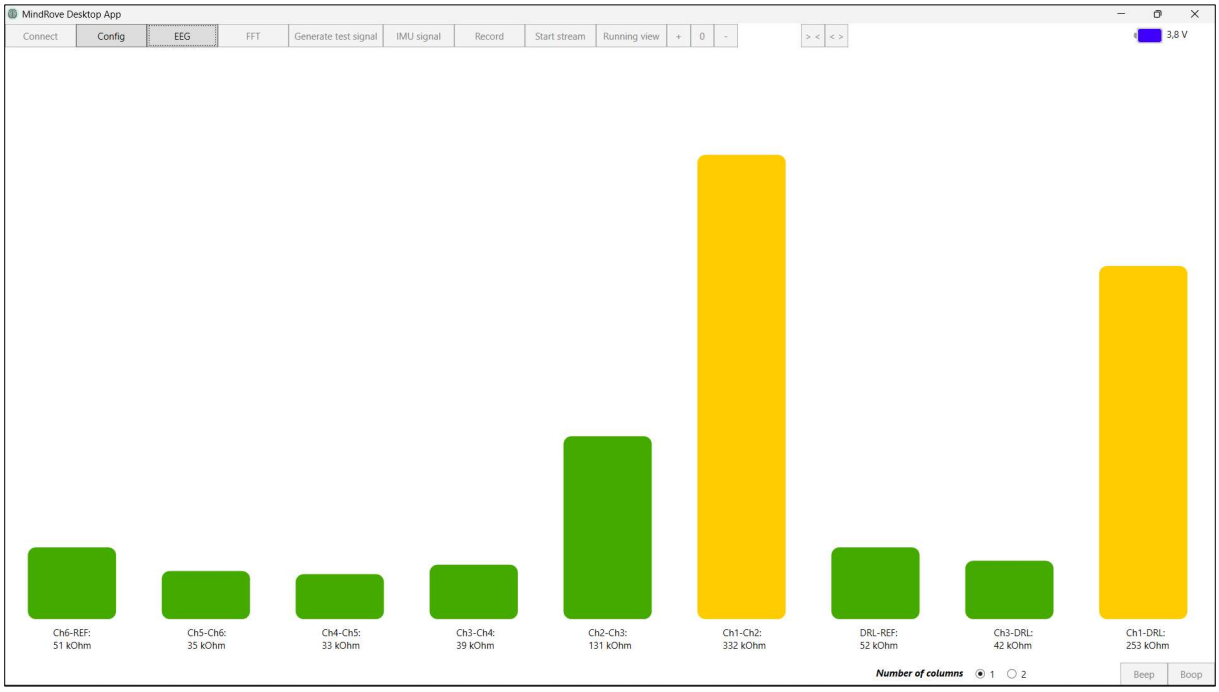
https://github.com/MindRove/SDK_Public

6.5 Impedance (only arc and strip)

The application starts displaying the EEG View showing the electrophysiological signals for each channel. This diagram has a timespan variable between 1 and 20 seconds (2

seconds by default). For details on adjusting the view, see sections 6.12 Zoom and 6.13 Timespan.

Upon clicking the *Impedance* button, a diagram showing the magnitudes of impedance measured between specific pairs of electrodes are displayed.



Accurate values are shown at the bottom of each bar (the chart graphically saturates at 400 kΩ). Impedances are colour coded as shown below.

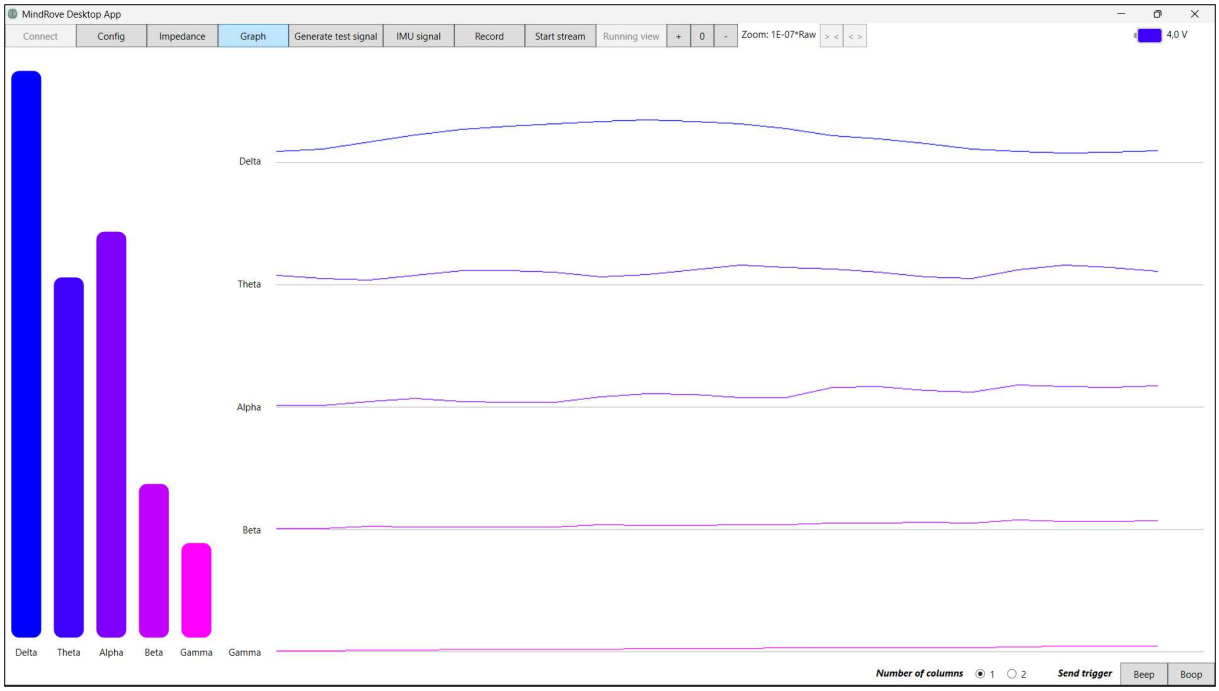
Impedance [kΩ]	Colour
Under 150	
150–400	
Above 400	

Upon clicking the *EEG* button, the app returns to EEG View.

Note *that this feature is incompatible with the armband.*

6.6 FFT

The FFT View displays signal intensities across frequency bands delta (< 4 Hz), theta (4–7 Hz), alpha (7–13 Hz), beta (13–30 Hz) and gamma (30–100 Hz). On the left side of the screen, the average intensities for the last second are shown (normed by the maximum band value), while on the right side a history diagram composed of values from the last 2 seconds is displayed. The magnitude of the displayed signals can be adjusted manually; for details, see section 6.12 Zoom.

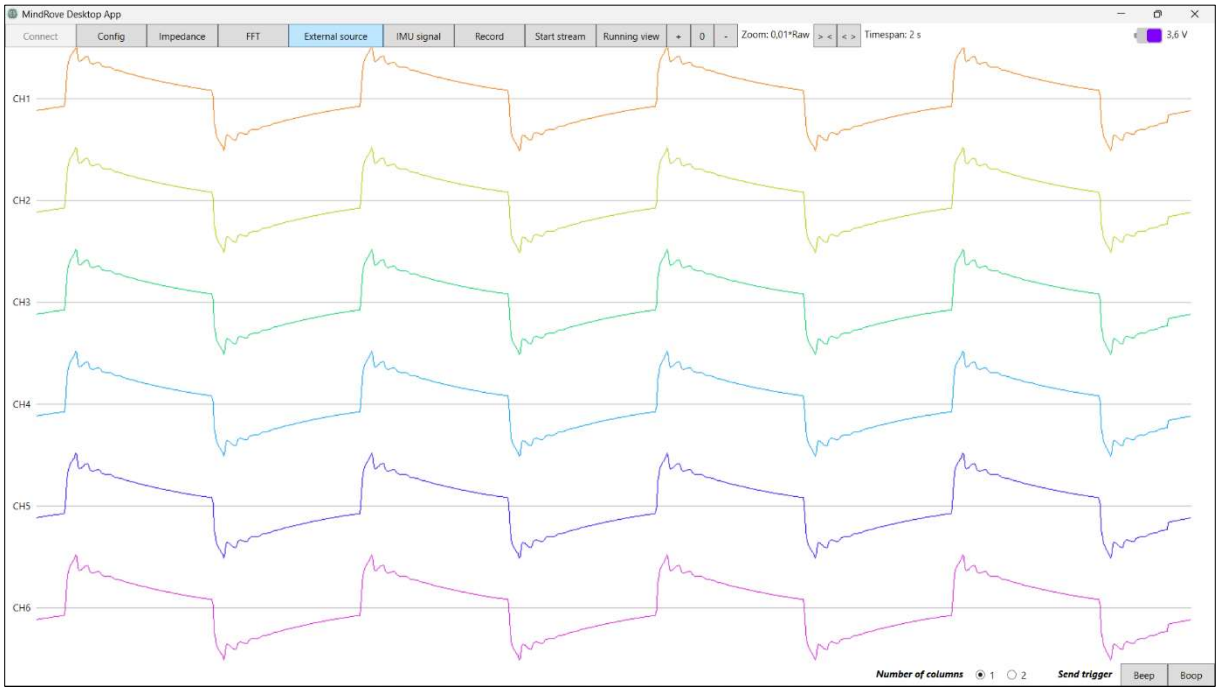


The user can return to the display of raw values by clicking the *Graph* button.

6.7 Generate test signal/External source

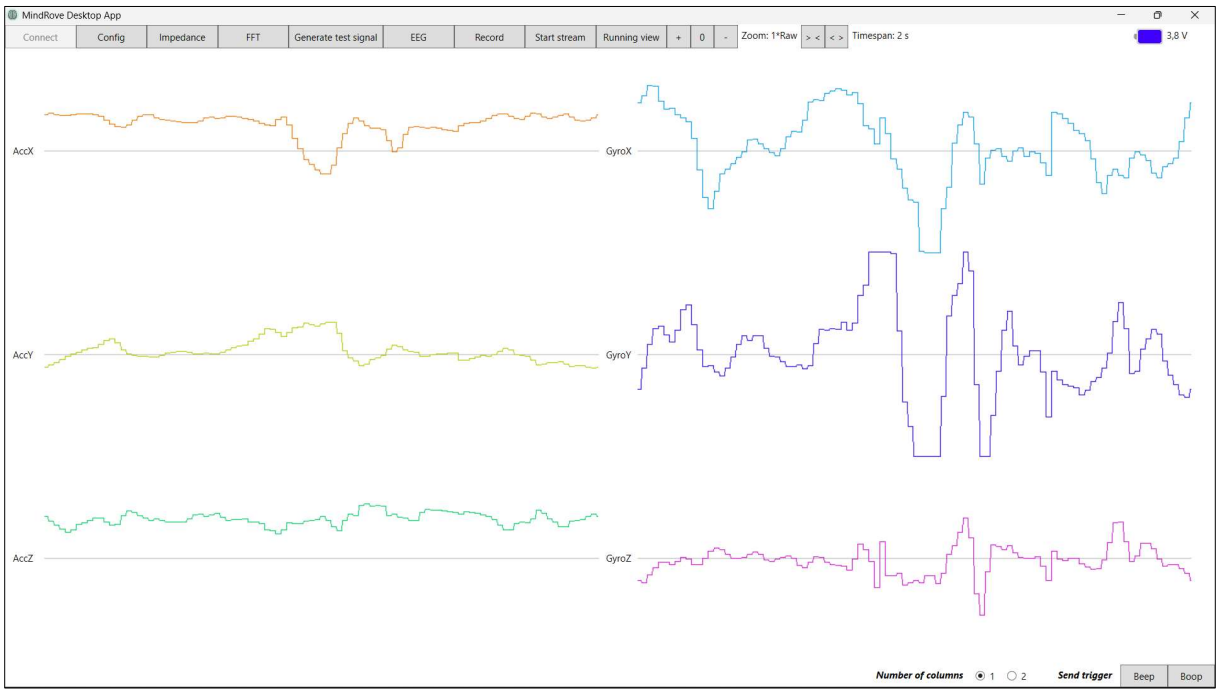
The headset is capable of generating signal internally (square wave, in the figure below its shape is distorted due to DC and 50 Hz notch filtering) for diagnostic purposes. This functionality can be accessed by clicking on the *Generate test signal* button.

Return to measurement mode is possible by clicking the *External source* button.



6.8 IMU signal

Signal tracks of the accelerometer and gyroscope can be displayed in a separate view by clicking the *IMU signal* button. Accelero and gyro signals are shown in the left and right column of the layout, respectively.



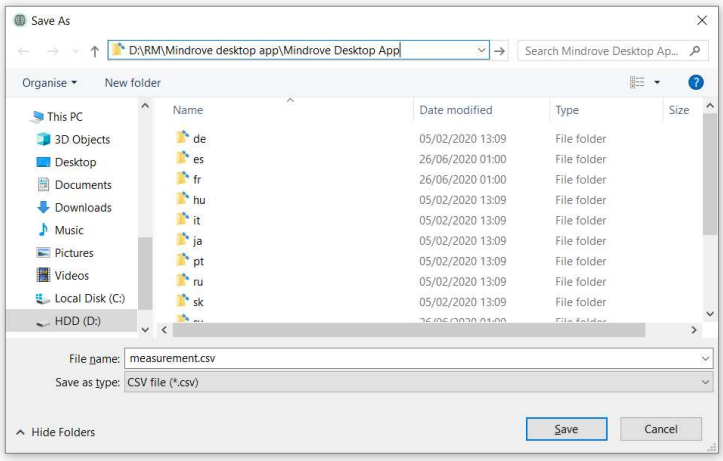
AccX/Y/Z corresponds to acceleration along the particular axes while GyroX/Y/Z measures angular velocities parallel to them, e.g., if an armband user raises or lowers their hand, the movement will induce the largest changes in the GyroY signal because the device is turned around axis Y (that is perpendicular to the longest side of the device—for further details, see IMU position in section 3.3 armband).

In contrast to EEG/EMG data, IMU tracks cannot be zoomed in (they are fit to view) but their timespan can be adjusted.

The user can return to the display of EEG/EMG values by clicking the *EEG* button.

6.9 Record

Signals measured by MindRove devices (and, if any type of filtering is enabled, processed by the Visualizer) can be saved in .csv files. Upon clicking on the *Record* button, a dialog window pops up enabling the user to save the measurement files anywhere on the PC.

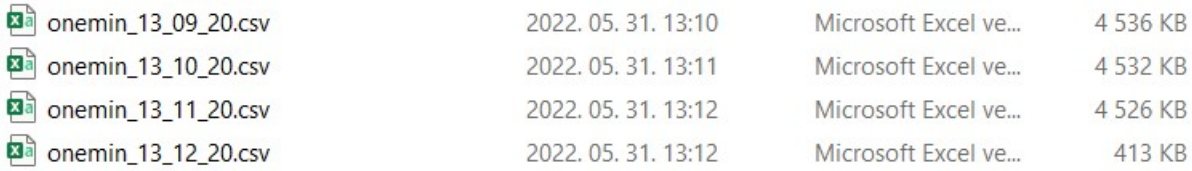


The name of the resulting data file will be the combination of a prefix given by the user and a timestamp corresponding to the start of the measurement as follows:

where example is the prefix and the recording started at 14:12:26 (hh:mm:ss, clock time of the computer the Visualizer runs thereon).

It is recommended to save data periodically by setting the recording data interval in the Config view. Available options are 1, 5, 10, 15, 30, 45 and 60 minutes. It is also possible to record all data into one file by setting the interval to None (default value).

If a value is set, a new recording starts in every *interval* minutes. The figure below illustrates the case of a three-minute recording where data were saved in each minute (i.e. the interval was set to 1 min; the fourth file remained a stub because the recording was stopped at the very start of the fourth minute):



Recording ends when the user clicks on the *Save* button. During recording, this button glows orange.

Measurement files store each variable in separate columns with their first row specifying the delimiters for Excel and the second row acting as a header.

CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	Vbat	Trigger	AccX	AccY	AccZ	GyX	GyY	GyZ	N	fs	Timestamp
-65,6921	459,4195	-585,643	-353,751	915,7878	174,7272	858,1953	-349,211	3258	0	16922	-225	70	-76	58	12	176483	500	09:57:27.565262
-160,418	584,6925	-648,25	-403,268	586,3956	186,0078	1820,513	-484,475	3258	0	16922	-225	70	-76	58	12	176484	500	09:57:27.565290
-42,267	728,26	-499,109	-289,39	1003,228	268,0894	-965,043	-215,196	3258	0	16922	-225	70	-76	58	12	176485	500	09:57:27.565307
-83,3489	-51,1748	-744,942	-425,927	-146,669	139,7966	3791,071	-878,668	3258	0	16922	-225	70	-76	58	12	176486	500	09:57:27.565326
272,5824	28,20202	-746,379	-24,7258	1048,724	-91,4722	3046,243	-1802,73	3258	0	16922	-225	70	-76	58	12	176487	500	09:57:27.565347
122,3556	1012,68	-419,009	278,8087	3176,403	44,82439	295,816	-1395,84	3258	0	16922	-225	70	-76	58	12	176488	500	09:57:27.565368
296,9714	757,7613	-62,5825	525,1559	912,1726	103,641	-3932,95	-791,839	3258	0	16916	-233	74	-98	39	7	176489	500	09:57:27.565390
174,6601	805,5778	-139,506	502,0781	824,4102	92,89105	-2504,68	-1066,89	3258	0	16916	-233	74	-98	39	7	176490	500	09:57:27.565414
222,1102	507,0562	-45,9886	547,5625	646,2612	72,65434	-3135,92	-939,057	3258	0	16916	-233	74	-98	39	7	176491	500	09:57:27.565438
87,47913	518,0609	-118,588	476,5525	428,1263	72,81959	-1226,84	-1158,5	3258	0	16916	-233	74	-98	39	7	176492	500	09:57:27.565466

Measurement values are listed below:

- **Ch1–Ch8:** voltage measured on each EEG channel [A/D converter counts]
- **Vbat:** battery voltage measured [mV]

- **Trigger:** trigger events; 0 — None, 1 — Beep trigger, 2 — Boop trigger
- **AccX, AccY, AccZ:** accelerometer data corresponding to the three axes [A/D converter counts]
- **GyX, GyY, GyZ:** gyroscope data corresponding to the three axes [A/D converter counts]
- **N:** packet identifier
- **fs:** sampling frequency [Hz]
- **Timestamp:** clock time of the computer the Visualizer runs thereon (measured at the time of writing the packet into file)

LSB values:

Measurement data (channels, IMU) are recorded as dimensionless numbers. If any type of filtering is enabled in the Config menu (see 6.4 Config for details), EEG/EMG signals are shaped by the filters, but their dimension is preserved. You have to multiply these data by the following LSBs if you want to get the real values (in microvolts in case of EEG/EMG). In case of DC filtering, DC offsets of EEG/EMG signals are eliminated. The offsets of the gyroscope and the accelerometer are not removed.

- **EEG/ EMG LSB:** 0.045 µV ***(gain: 12X)***
- **Gyroscope LSB:** 0.01526 dps
- **Accelerometer LSB:** $0.061035 \cdot 10^{-3}$ g

6.10 Data streaming via Lab Streaming Layer (LSL)

Signals measured by the MindRove headset can be streamed via **Lab Streaming Layer**. The stream is available under name "MindRoveStream".

Streaming can be initiated by clicking on the *Start stream* button and terminated by clicking on the *End stream* button.

Transmitted values are listed below:

- **Ch1–Ch8:** voltage measured on each EEG channel [A/D converter counts]
- **Trigger:** trigger events; 0 — None, 1 — Beep trigger, 2 — Boop trigger
- **AccX, AccY, AccZ:** accelerometer data corresponding to the three axes [A/D converter counts]
- **GyX, GyY, GyZ:** gyroscope data corresponding to the three axes [A/D converter counts]
- **N:** packet identifier

6.11 Running view/Fill screen

Measurement signals can be displayed in two ways:

- running from the left to the right in a static window, filling the screen; when the signal reaches the far right, new data are shifted in from the left, overwriting the content of the window (*Fill screen*, default option, depicted below)
- shifting from the right to the left continuously, giving the illusion of a moving screen (*Running view*)

Alternately, the user can switch between the two modes by pressing key R.

6.12 Zoom

The scale of the voltage diagrams (EEG and FFT View) can be adjusted manually either by clicking buttons +, *0* and − (+: zoom in, 0: default scale, −: zoom out) or by pressing the Shift buttons (left: zoom in, right: zoom out) on the keyboard.

The displayed amplitudes are increased or decreased by one order of magnitude. The scale factor is shown next to the Zoom buttons on the right with respect to the magnitude of the raw signal.

Zoom feature does not apply for IMU data (accelero and gyro signals are uniformly fit to view).

6.13 Timespan

The timescale of the EEG View can be adjusted manually either by clicking buttons > < and < > (> <: longer timespan, < >: shorter timespan) or by pressing the Ctrl buttons (left: longer timespan, right: shorter timespan) on the keyboard.

The timespan can be increased or decreased by one second. Its value is shown next to the Timespan buttons on the right.

6.14 Battery

Battery voltage is displayed in the right side of the menu bar, both in a graphic (battery icon) and a quantitative (exact voltage, measured in volts) way. Possible battery states are listed below.

Status	Voltage [V]	Icon
Full	3.7–4.25	
Satisfactory	3.3–3.7	
Almost empty	Under 3.3	
Charging	Above 4.25	

Thank you for choosing MindRove!

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- **the MindRove YouTube channel**