



BRAIN PRODUCTS

Manual

BrainVision Recorder 2

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1. About this manual

This manual describes BrainVision Recorder 2 (hereafter referred to as Recorder).

This manual is a component of the product and its accessories supplied by Brain Products GmbH. It must be precisely adhered to in order to ensure that the product is used as intended and operated correctly and to guarantee the concomitant safety of participants, users, and third parties. Ensure that this manual is always available to users.

1.1 Target group

This manual is intended for users in the psychological and neurophysiological research area who are experienced in performing physiological data acquisition.

Users must know how to work safely and reliably with all the products in a given setup, such as EEG caps, amplifiers, accessories, sensors, and recording software.

1.2 Conventions in this manual

Typographical conventions

Bold	indicates items on the user interface such as menus, menu commands, dialog boxes, buttons, options, or checkboxes.
<i>Italic</i>	indicates file locations and folders and is used to highlight portions of running text.
<u>Underscore</u>	indicates cross-references or web addresses.
Monospaced	indicates code examples and text or characters to be entered at the keyboard.

Symbols



Note

Draws your attention to important information relating to the current topic and to recommendations on how to use the product(s).

1.3 Revision history

Section	Subject
Manual	Formal updates
Hardware license (HL)	Dongle information updated
Regulatory Information (German) – Regulatorische Informationen (Deutsch)	Regulatory information in German updated
Installing Recorder, Creating a workspace, Status bar	TurboLink added

1.4 Reporting errors and getting support

Please report without delay any error you find in this manual, any fault on the products, or any malfunction that you observe when using this product.

To do so, please contact your [local distributor](#), who will also assist you in general questions about the product, or our Technical Support team (techsup@brainproducts.com).

2. About Recorder

Recorder is a recording software for neurophysiological and electrophysiological signals that supports Brain Products EEG amplifiers.

Within Recorder, workspaces allow you to save settings for your data recordings, such as amplifier parameters, cap configurations, electrode positions, file locations, and triggers and annotations. You can set up multiple workspaces with different settings and switch between them, so that you work with one workspace at a time.

Working with Recorder follows a workflow that includes loading a workspace, checking the impedances, monitoring the signals, and recording the data. This manual guides you through this workflow.

2.1 Product identification

Product designation	BrainVision Recorder 2
Manufacturer	Brain Products GmbH Zeppelinstraße 7 82205 Gilching Germany Phone: +49 (0) 8105 733 84 - 0 Fax: +49 (0) 8105 733 84 - 505 Email: office@brainproducts.com Website: https://www.brainproducts.com Brain Products GmbH is registered as a manufacturer of electrical and/or electronic equipment with the stiftung elektro-altgeräte register, Nordostpark 72, 90411 Nürnberg, Germany, under the registration number DE89975135.
Warranty	The terms of warranty can be found on our website at: https://www.brainproducts.com/legal/brain-products-warranty-conditions/

2.2 Combinations with other products and components

Recorder is permitted by Brain Products GmbH to be combined with the following product families:

Product	Manufacturer
actiCHamp family	Brain Products GmbH
TurboLink	Distributed by Brain Products GmbH

Beside this general statement about permitted product combinations, the user must check if all stipulations of each product are fulfilled for the specific combination and purpose of application (intended use and correct use). The user must also check the system requirements (see [Installation](#)).

3. Safety

Read the following safety information carefully. It will help prevent personal injury and damage to property. It is assumed that you have the required specialist knowledge in handling the product and accessories. Brain Products GmbH shall not be liable in the event of any failure to observe the manual and, in particular, the safety information.

3.1 Intended use

Recorder is intended to be used for recording human neurophysiological and electrophysiological signals such as EEG and ExG (EMG, ECG, EOG, EDA, etc.) and signals from approved sensors.

Recorder is not a medical device. Use of Recorder for diagnosis, therapy, monitoring of vital physiological processes, or other medical purposes is expressly forbidden.

3.2 Correct use

Users

Recorder is permitted to be used by users in the psychological and neurophysiological research area who are experienced in performing physiological data acquisition.

Users must know how to work safely and reliably with all the products in a given setup, such as EEG caps, amplifiers, accessories, sensors, and recording software.

Recorder is not permitted to be used by the following users:

- ▶ Unqualified persons (for example, laypersons).
- ▶ Persons who cannot read the manual (for example, due to visual impairment) or cannot understand it (for example, due to a lack of language skills).

Environments

Recorder is permitted to be used in the following environments:

- ▶ Research institutes and other non-medical environments.
- ▶ Hospitals, clinics and other medical environments, provided that the product is not used for medical purposes.

4. Installation

Under normal conditions, Recorder does not cause any conflicts with other programs that are already installed. In particular, Brain Products GmbH guarantees compatibility with the following programs: BrainVision Analyzer, BrainVision RecView, actiCAP ControlSoftware, and with the Microsoft operating systems provided that no modifications to the configuration of the operating systems as delivered have been undertaken (including official service packs and updates).

4.1 Recommended system requirements

We recommend that the computer fulfills the following hardware and software requirements:

Hardware and software	Recommended requirements
Operating system	Windows® 11
Processor	≥ 2.5 GHz, 2 or more cores on an x64-bit compatible processor
RAM	≥ 8 GB
Graphics adapter / card	Compatible with DirectX 12 or later with WDDM 2.0 driver
Free disk space	› 16 GB free disk space Additional storage requirements depend on the extent of the data to be recorded.
Monitor	Full HD (1080p) or higher

The computer must comply with either IEC 62368-1, EN 62368-1, IEC 60601-1, EN 60601-1, or equivalent safety standards.

4.2 Preparing your computer

Before you install or use Recorder, ensure that the performance of your system is not impaired by background processes or other real-time applications that run with higher priority.

To prepare your computer:

1. Uninstall software that you do not need (for example, promotional software)
2. Stop services that run in the background, for example:
 - ▶ system services
 - ▶ indexing services
 - ▶ scanning services (anti-virus)
 - ▶ updating services (Java, web browser, anti-virus, office software, bloatware)

3. Run critical near real-time applications on a separate computer, for example:

- ▶ NIRS acquisition
- ▶ eye tracking acquisition
- ▶ simulation software
- ▶ voice, video, audio processing
- ▶ flash applications
- ▶ time tracker

4. Change the settings of Windows processes, for example:

- ▶ screen saver
- ▶ defragmentation
- ▶ Windows update
- ▶ power management

For more information on changing the settings of Windows processes, refer to [Troubleshooting](#).

**Note**

While recording, do not use the recording computer to browse the Internet or to playback multimedia files.

4.3 Installing Recorder

Prerequisites:

- ▶ The computer fulfills the system requirements (for more information, refer to [Recommended system requirements](#)).
- ▶ The computer is prepared (for more information, refer to [Preparing your computer](#)).
- ▶ You have administrator rights.

**Note**

Throughout the installation, some pop-up windows may open behind other windows. Ensure to check your task bar or minimize the windows that are already open.

To obtain the Recorder installation folder:

- ▶ Either insert the Application Suite (USB) into a USB port on your computer and navigate to the Application Suite (USB) folder › *Software* › *Recorder2*.
- ▶ Or download the Recorder installation folder from our [website](#). You need to be logged in to the website to start the download.

To install Recorder:

1. In the installation folder, double-click *BrainVisionRecorder2_Installer.exe*.
2. In the **BrainVision Recorder 2 Setup** window, agree to the license terms and conditions.
3. Click **Install**.
4. You may get a pop-up window asking you whether you want to make changes to your device. Confirm your choice.
5. In the **Allow Brainvision Recorder 2 to set Windows Defender Firewall rules** window, select whether you want to accept setting Windows Firewall rules for Remote Data Access (RDA), Lab Streaming Layer (LSL), and TurboLink.

**Note**

The RDA, LSL, and TurboLink options can also be selected later on, but activating them will require administrator rights.

6. If you are satisfied with your choices, click **Accept**.

Once the process is complete, you get a message. You can then close the window and start using Recorder.

4.4 Updating Recorder

Updating Recorder from the website

New versions and updates of Recorder can be downloaded from our website: <https://www.brainproducts.com>. To access the download area, you need to log in.

Updating Recorder from the Application Suite (USB)

New versions or updates may also be available on the Application Suite (USB). You can install these updates directly from the USB.

4.5 Uninstalling Recorder

To uninstall Recorder:

1. Navigate to  Start > Settings > Apps > Installed Apps.
2. Scroll to the BrainVision Recorder 2 entry.
3. Click the three dots to the right.
4. In the small pop-up window, select **Uninstall** and confirm your choice.
5. You may get a pop-up window asking you whether you want to make changes to your device. Confirm again.
6. In the **BrainVision Recorder 2 Setup** window, click **Uninstall**.

Once the process is complete, you get a message. You can then close the window.

5. Licenses

This chapter explains the different license options and how to select a license.

5.1 Hardware license (HL)

Your license dongle contains your license for Recorder. If you have received a new Recorder license dongle, your dongle may be time limited on arrival. In this case, you will receive an email with instructions on how to update the license to make it perpetual. Follow the instructions in the email.

5.1.1 Identifying your dongle

Your license dongle has an external dongle label and a key ID.

- ▶ The external dongle label is an ID that is printed on your license dongle (for Recorder, for example "UR12345" or "URA12345"). It identifies the software for which the license dongle is valid.
- ▶ The key ID is a ten-digit number that is printed on your license dongle or that you can access in the software as described in [Selecting a license](#).

5.1.2 Dongle information

Dongle battery

The dongle battery is a non-rechargeable manganese dioxide lithium battery (LiMnO₂) that is contained in the dongle.

REACH SVHC notification

In accordance with Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) as defined in article 57 Brain Products herewith notifies that the products listed below contain a concentration of a substance of very high concern (SVHC) above 0.1 % weight.

Coin battery in the dongles:

Substance	CAS No.
1,2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME)	110-71-4

Disposal



Do not dispose of products, accessories, cables, and batteries with the household waste. Dispose of them in accordance with national regulations, for example in Germany via the collection boxes in stores or at municipal collection points.

Batteries that are not permanently integrated into electronic devices and can be safely removed must be removed and disposed of separately prior to disposal of the device.

Note

In this case, batteries are permanently integrated and must be disposed of with the dongle.

For example, in the EU and EFTA, the Regulation Concerning Batteries and Waste Batteries (Battery Regulation) (EU) 2023/1542 as well as the Directive on Waste Electrical and Electronic Equipment (WEEE) 2012/19/EU apply.

On request, Brain Products will take back your old devices, provided that they are original Brain Products parts.

Data protection

We would like to point out to all end users that you are responsible for deleting personal data on the products to be disposed of.

Risks associated with handling lithium batteries

Note

To check whether your product contains lithium batteries, refer to [Dongle battery](#).

Lithium batteries are safe when handled properly.

If handled improperly, lithium batteries can cause fires.

- ▶ Avoid mechanical damage (for example, from impacts or dropping), thermal effects (for example, from strong sunlight), and short circuits.
- ▶ Observe the rules described in the manual regarding charging, use, storage, and transport to avoid damage and to extend battery life.
- ▶ Do not use defective, damaged, deformed, swollen, or leaking batteries.

Registration numbers

Brain Products GmbH is registered as a manufacturer of electrical and/or electronic equipment with the stiftung elektro-altgeräte register, Nordostpark 72, 90411 Nürnberg under the WEEE registration number DE89975135.

Brain Products GmbH is registered as a manufacturer of batteries with the stiftung elektroaltgeräte register, Nordostpark 72, 90411 Nürnberg under the following battery registration numbers:

DE28818587 (portable batteries)

DE28818587 (industrial batteries)

For this information in German, refer to [Regulatory Information \(German\) – Regulatorische Informationen \(Deutsch\)](#).

5.2 Software license (SL)

Some Recorder licenses (for example, Demo licenses) are distributed as software licenses (SL). For these SL, you receive an activation key via email. With this activation key, you can activate the SL via the license customer portal. For more information, refer to the email.

5.3 Selecting a license

Prerequisites:

- ▶ Recorder is installed on the recording computer.
- ▶ The license dongle is connected to the recording computer or an SL is activated as described in the email that you received along with your product key.

To select a hardware license:

1. Start Recorder.
2. To access information about your licenses and add-on licenses, go to **Workspace > About BrainVision Recorder 2**.

To select a different license, click **Select License**.

To open a PDF document of your license agreement, click **License Agreement**.

6. User interface

This chapter provides an overview of the user interface as well as the program settings that you can apply for Recorder as a whole. You will find more information on how the user interface adapts throughout the workflow in the chapters [Impedance check](#) and [Monitoring](#).

6.1 User interface on the start screen

When you open Recorder, you see the following start screen:

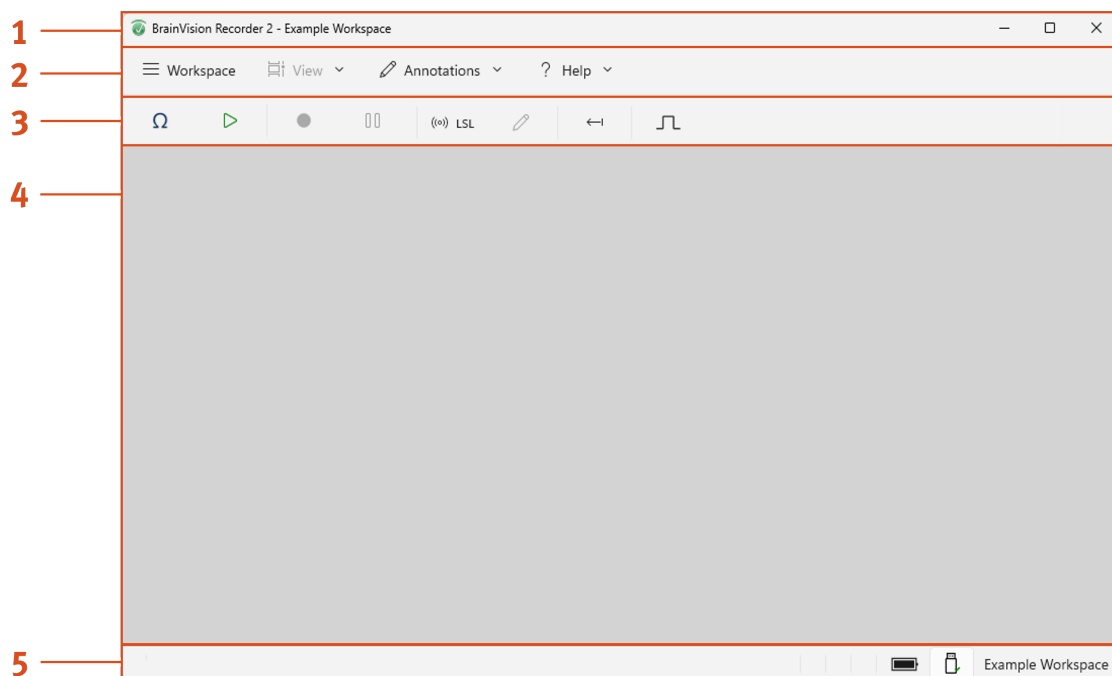


Figure 1: User interface on the start screen.

Pos.	Name	Description
1	Title bar	Displays the name of the software and the name of the workspace that is currently loaded. It also includes the standard Minimize, Maximize, and Close buttons.
2	Menu bar	Displays the most important menu tabs. For more information, refer to Menu bar .
3	Global tool bar	Guides you through the Recorder workflow by allowing you to start the impedance check, monitoring, and recording, and displays additional important tools. For more information, refer to Global tool bar .
4	View area	The view area is empty on the start screen. Once you do an impedance check, start monitoring, or test the signal, the view area displays the signals and an additional local tool bar appears to the right.
5	Status bar	Displays information about the workspace and the connected amplifier. For more information, refer to Status bar .

6.1.1 Menu bar

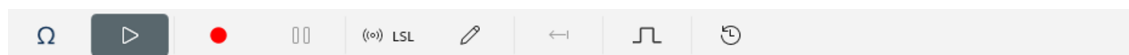
Icon	Name	Description
	Workspace	Opens the workspace menu and program settings.
	View	Allows you to adapt the view for the individual channels by setting channel colors, channel scalings, display time intervals, and display filters. In addition, you can optimize the display via montages.
	Annotations	Allows you to set keys with associated annotations. This function will modify the workspace settings and you will be asked whether you want to update these settings in the current workspace file.
	Help	Includes a PDF version of this manual as well as log files.

6.1.2 Global tool bar

In the global tool bar, some icons are always displayed:



During monitoring and recording, an additional icon is displayed:

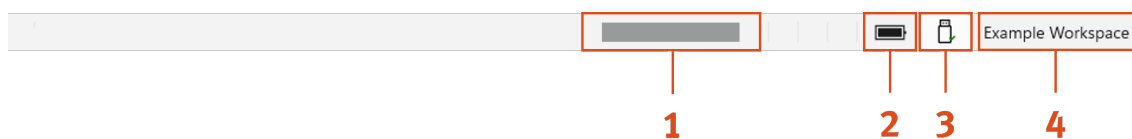


Icon	Name	Description
	Start/Stop Impedance check	Starts and stops the impedance check.
	Start/Stop Monitoring	Starts and stops monitoring.
	Start/Stop Recording	Starts and stops recording.
	Pause/Resume Recording	Pauses and resumes recording.
 LSL	Enable/Disable Lab Streaming Layer	Enables and disables the Lab Streaming Layer (LSL).
	Enter and send annotation	Allows you to enter annotations during monitoring and recording and add them to the data. At the time that you click this button, a marker is set with the placeholder name '???'. Then, you can enter and confirm a marker description.
	Import electrode positions	Allows you to import individual electrode positions in the BVCT format as measured with CapTrak. This function is available on the start screen and during the impedance check.

Icon	Name	Description
	Start/Stop Test signal	Starts and stops the test signal mode.
	Set display time and refresh views	Allows you to set a new time interval and refreshes the signals in the view area.

6.1.3 Status bar

In the status bar, some information is always displayed:



During recording, additional information is displayed:



Pos.	Name	Description
1	Mode	Displays the current mode: none, Impedance check, Monitoring, Recording, or Test Signal.
2	 Battery	Displays the battery charge level. If you double-click the icon, the Windows explorer with the log files opens.
3	 Connected amplifier	Displays the type and serial number of the connected amplifier. If you click the icon, a window opens that displays the serial numbers of the amplifier modules. It also displays available amplifiers and allows you to search for other amplifiers. If you use TurboLink, the window also displays the connection information. To open the TurboLink Monitor, click  TurboLink Monitor online control panel.
4	Workspace	Displays the name of the current workspace. If you click the icon, a window opens that displays the workspace properties.
5	Recording name	Displays the name of the current recording. If you double-click the icon, the Windows explorer with the recording files opens.
6	Free disk space	Displays the free disk space that is still available for recording.
7	Recording time	Displays the time span that has already been recorded for the current recording.

6.2 User interface on the workspace screen

In the menu bar,  **Workspace** opens the workspace screen. The workspace screen displays the recently opened workspaces and offers three menus ([Figure 2](#)).

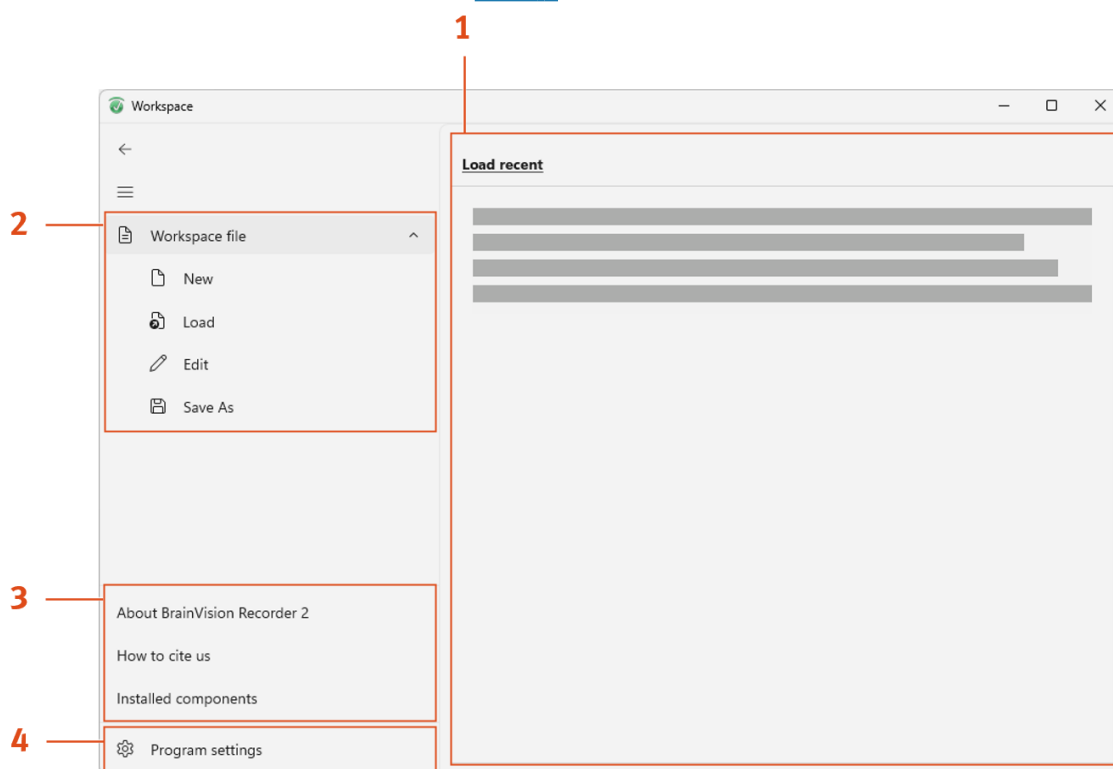


Figure 2: Overview of the user interface on the workspace screen.

Pos.	Name	Description
1	Load recent	Displays the file locations of the recently loaded workspace. To load one of the workspaces, click it.
2	Workspace menu	Allows you to create, load, edit, and save workspaces. For more information, refer to Workspace menu .
3	About menu	Contains information about Recorder including license information. For more information, refer to About menu .
4	Program settings menu	Allows you to make settings for Recorder as a whole. For more information, refer to Program settings menu .

6.2.1 Workspace menu

The workspace menu allows you to create, load, edit, and save a workspace.

Icon	Name	Description
	New	Opens the workspace editor and allows you to create a new workspace.
	Load	Opens the file explorer and allows you to load a workspace that already exists.
	Edit	Opens the workspace editor and allows you to edit the current workspace.
	Save As	Opens the file explorer and allows you to save the current workspace.

6.2.2 About menu

Name	Description
About BrainVision Recorder 2	Displays information about the version, copyright and licenses of the installed Recorder. It also allows you to choose whether you want Recorder to show a warning if a time limited license is expiring, and it contains a link that opens a PDF of the License Agreement.
How to cite us	Explains how to cite Brain Products hardware and software as an in-text reference or in the reference section of a publication.
Installed components	Displays information about the installed components in text format.

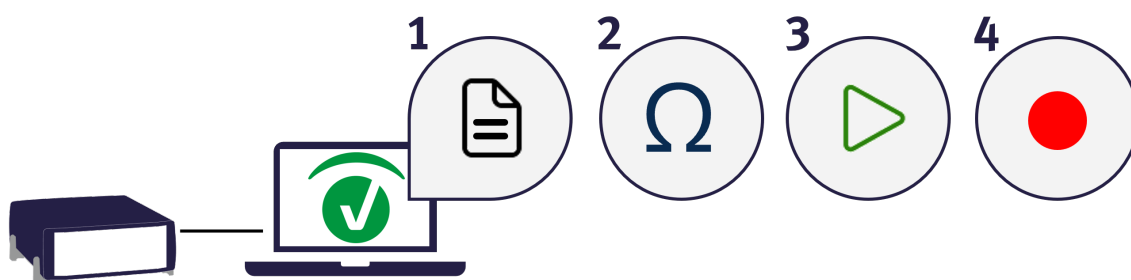
6.2.3 Program settings menu

Program settings are settings that you can apply for Recorder as a whole and that are independent from the workspace.

Name	Description
Default directories	You can change the default directories for workspace files, recording files, and electrode position files. The log files are always stored in the <i>Logs</i> folder.

7. The Recorder workflow

Working with Recorder follows the workflow illustrated below.



1 [Workspace editor](#)

2 [Impedance check](#)

3 [Monitoring](#)

4 [Recording](#)

8. Workspace editor

When you create or edit a workspace, the workspace editor guides you through the settings.

The workspace editor consists of the steps visible in [Figure 3](#) and the table below. Some of these steps include multiple tabs in which you can make settings.

To move between the steps and the tabs, click the tabs directly or use the **← Back** and **→ Next** buttons.

To cancel your settings and close the workspace editor at any step, click **✕ Cancel**.

When you have completed the workspace editor, click **✓ Finish**.

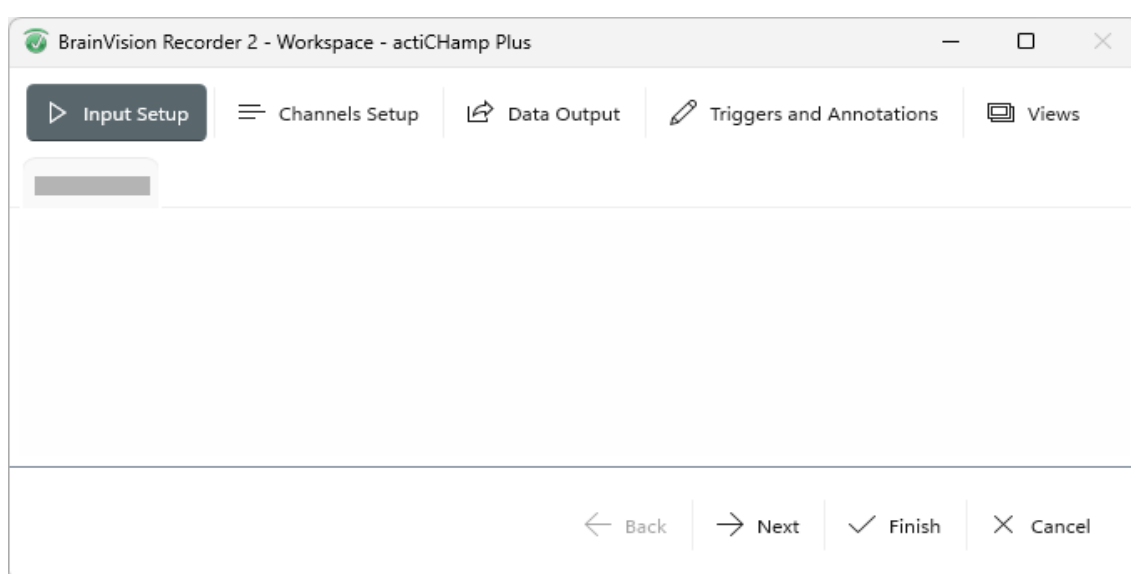


Figure 3: User interface of the workspace editor

Icon	Name	Description
▶	Input Setup	Allows you to set up the connected amplifier and enter its data such as channels, electrode types, and sampling rate.
≡	Channels Setup	Allows you to set up the channels, including the names and types of channels and sensors, as well as the electrode positions.
↗	Data Output	Allows you to set up the file locations and file names for storing the recordings, as well as a data output stream.
✎	Triggers and Annotations	Allows you to set up triggers and to assign annotations to shortcuts.
🖼️	Views	Allows you to adapt the view of the signals, including display filters, channel colors, and scaling and interval settings.

8.1 Creating a workspace

To create a new workspace:

1. Navigate to  **Workspace** > **Workspace file** and click  **New**.
2. Select the amplifier model that is connected to the recording computer.
If no connected amplifier is found or if the connected amplifier does not match the model that you select, you get a note that the virtual amplifier will be used to set up the workspace.

The workspace editor opens and guides you through the settings. They are explained in detail in the following sub-chapters.

8.1.1 Input Setup

If an amplifier is found, **Amplifier data** is automatically filled in. Ensure that the data is correct and compare the serial number to the one on your amplifier.

- ▶ If your amplifier has not been found automatically, click  **Search for amplifiers**.
- ▶ If you want to use the virtual amplifier to set up the workspace instead, check **Use virtual amplifier**.
- ▶ To change the amplifier data manually, use the drop-down menus for **Number of modules**, **Electrodes**, **Battery**, and **Sampling rate**.
- ▶ If you use an EP-PreAmp, check the checkbox **Use SplitterBox for EP-PreAmp(s)**. Use the drop-down menu **EP-PreAmp SplitterBox** to select the channels module to which the EP-PreAmp SplitterBox is connected.

Connection via TurboLink

Via TurboLink, you can stream EEG data from the actiCHamp (Plus) via the User Datagram Protocol (UDP).

To set up a connection via TurboLink:

1. Complete the setup according to the setup poster. The setup poster is available as a printed copy in the package, on our [website](#), or on the Application Suite (USB).
2. Check **Connection via TurboLink**.

The IP Address is displayed to the right of the checkbox. There is no need to change the default IP address.

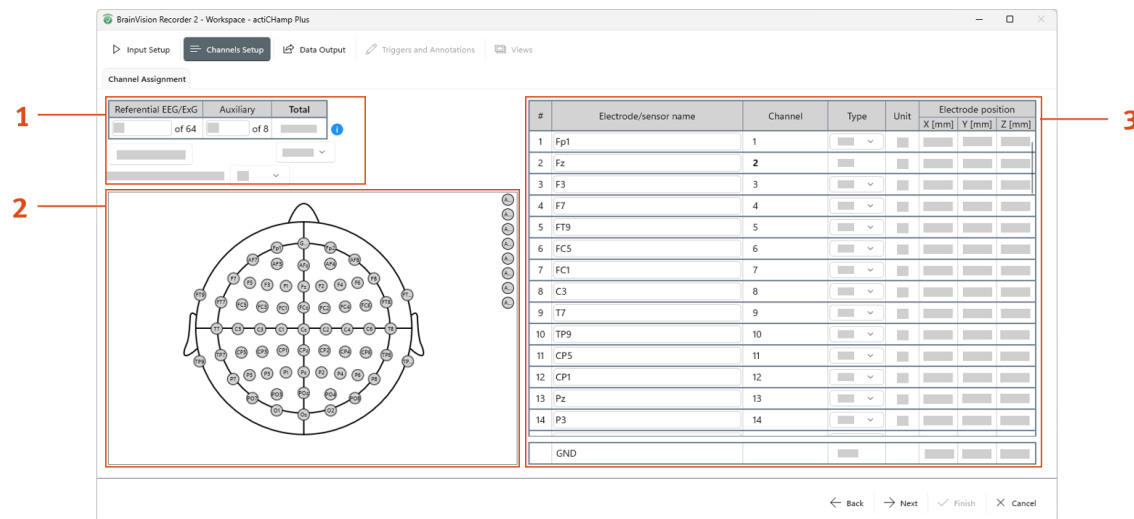


Note

A workspace for actiCHamp (Plus) with TurboLink is not compatible with actiCHamp (Plus) setups without TurboLink and vice versa.

8.1.2 Channels Setup

The following elements on the user interface allow you to set up your channels:



Pos.	Name	Description
1	Channel selection	Displays the numbers of referential EEG/ExG and auxiliary channels and allows you to change the numbers manually. ▶ To load previously defined channel settings from an electrode position file (*.BVEF) or from a different workspace file, click Load channels. ▶ To change the Electrode coordinates, use the drop-down menu. You can use MNI Realistic 10-05, Easycap 10-05, or the coordinates from a BVEF if you have loaded one. ▶ To set a Software reference, use the drop-down menu. It is recommended to set a software reference.
2	2D head	If electrode coordinates are loaded, the channels are mapped onto the 2D head. All channels without coordinates are listed next to the 2D head. ▶ To highlight the corresponding channel in the channel table, hover over the channel on the 2D head. ▶ To jump to the location of the corresponding channel in the channel table, click the channel on the 2D head.

Pos.	Name	Description
3	Channel table	Displays the EEG/ExG and AUX channels in detail. The order of channels in the table determines the order in which they are displayed during monitoring and recording. The table allows you to change the channel details: ▶ To change a name manually, enter it in the column Electrode/sensor name. ▶ To change the channel type, go to the column Type and use the drop-down menu. For more information on the available channel types, refer to Channel types. ▶ To choose the correct sensor for an auxiliary channel, go to the column Channel, click  and use the drop-down menu to select the sensor. ▶ To change the order of channels, drag-and-drop individual channels up and down the table.

Channel types

The following channel types are available:

GND	Ground (GND) stems from the GND electrode, which is connected to the ground circuit of the amplifier.
REF	Reference (REF) is used as a "baseline" for all referential EEG/ExG channels. This means that the signal displayed at the EEG/ExG channels is the difference in potential to the REF. With the actiCHamp (Plus), you can choose none or a REF from the Software reference drop-down menu. It is recommended to set a software reference.
EEG/ExG	You can choose between electroencephalography (EEG), electrooculography (EOG), electrocardiography (ECG), and electromyography (EMG) channels. With the actiCHamp (Plus), these channels can be either: ▶ Referential: channel is measured against REF. ▶ Bipolar: channel in which two electrodes are measured against each other. Bipolar EEG/ExG channels require a connection via the BIP2AUX or EP-PreAmp.
MISC	Channels for which you have not chosen a specific sensor display the channel type miscellaneous (MISC).
ACC	The acceleration channel (ACC) stems from the Acceleration (MR) Sensor. You can choose between 1D Acceleration, which measures one-dimensional acceleration as one channel, or 3D Acceleration, which measures acceleration in the X-, Y-, and Z-dimension as three separate channels.
FORCE	The force channel (FORCE) stems from the Force Sensor, which can be used for a variety of pressure- and force-related measurements.
GSR	The galvanic skin response channel (GSR) stems from the GSR (MR) sensor, which measures skin resistance.
PHOTO	The photo channel (PHOTO) stems from the Photo Sensor, which measures changes in light.

PPG	The plethysmography channel (PPG) stems from the Blood Pulse Sensor, which measures the blood pulse.
RESP	The respiration channel (RESP) stems from the Respiration Belt, which measures thoracic or abdominal respiratory movements.

8.1.3 Data Output

In this step, there are two tabs: **Data Storage** allows you to set up the file locations and file names for storing the recordings on your computer, while **Data Output Stream** allows you to set up a stream of the data in the network.

Data Storage

By default, recordings are stored in the *Recordings* folder and you need to specify a name for every new recording.

- ▶ To set a different file location for the recorded data, click **Browse**.
- ▶ If you want the file name to be generated automatically, check the checkbox **Automatic filename generation**. An automatic file name always consists of a prefix and a counter. The prefix does not change, while the counter is incremented each time you save data.

Enter a **Prefix**, specify the size of the counter in **Min. counter size [digits]**, and enter the starting number of the counter in **Current number**.

Next resulting filename shows you a preview of your settings.

Data Output Stream

To use **Remote Data Access (RDA)** or the **Lab Streaming Layer (LSL)** for your data output stream, check the respective checkbox.

Remote Data Access (RDA)

Recorder can pass EEG data to other programs on the local computer and to computer in a network via TCP/IP. This is referred to as Remote Data Access (RDA).

For more information on RDA, refer to [Remote Data Access \(RDA\)](#).

Lab Streaming Layer (LSL)

Recorder utilizes the Lab Streaming Layer (LSL) protocol to stream EEG data acquired from the connected amplifier and markers based on incoming events (triggers or annotations). Thereby, two kinds of streams are created:

- ▶ A single data stream
This regular stream (as it provides samples in regular intervals corresponding to the set sampling rate) includes multi-channel EEG signals and all other channels (ExG, sensors, etc.) as set up in the workspace, accompanied by precise timestamps to ensure synchronization across modalities. The data stream is structured with metadata such as channel labels, sampling rate, and device information, enabling integration with downstream analysis tools and near real-time applications.

► Marker streams

These irregular streams (as they only provide markers in case of incoming events) provide marker/timestamp pairs that are synchronized with the data streams and can be used for adding contextual information.

The streams can be found and accessed via any LSL tool that can read and/or display time series LSL data of the type "EEG" and/or can interpret markers. Brain Products offers the BrainVision LSL Viewer to find and view both kinds of LSL streams in your local network.

For more information on LSL, refer to [Lab Streaming Layer \(LSL\)](#).

8.1.4 Triggers and Annotations

In this step, there are two tabs: **Digital Port Settings** allows you to set up your trigger input and output as well as synchronization options for recording events synchronously with the EEG data via the digital port.

Annotation Assignment allows you to set up annotations that you can add to the data via keyboard short-cuts.

Digital Port Settings

Digital Port Settings allows you to set up your [Trigger Input](#), [Trigger Output](#), and [Sync In/Out](#). By default, no triggers are set up. To return to the default at any time, click **Reset**.

Trigger Input

To set up the Trigger Input:

1. Enable the Trigger In bits that you want to use.

To enable all Trigger In bits, check **Enabled** in the header of the table. To enable individual Trigger In bits, check the individual checkboxes.

2. To set the types of the Trigger In bits, go to the column **Type** and use the drop-down menus.

The types that are available by default are **Stimulus** and **Response**. To add a type, click **+ Add a new type** and type in a name.

Note

The name of each type needs a unique first letter. That means, for example, that you cannot give your new type a name that starts with 'S' or 'R', as they are already taken by Stimulus and Response.

Note

Trigger bits of the same type are interpreted as a group. This is, if bits 0-3 are of the type **Stimulus**, the resulting trigger codes are based on a 4-bit logic and generate values between 0 and 15. A group of 8 bits will result in trigger codes from 0 to 255.

3. To set colors for the Trigger In bits, go to the column **Color (R,G,B)** and use the drop-down menus.

The default color for Stimulus is red (255,0,0) and the default color for Response is blue (0,0,255). You can change it to one of the **Basic colors** or define a **Custom Color** by clicking on **Select**.

4. To set trigger conditions for the Trigger In bits, go to the column **Trigger condition** and use the drop-down menus.

The default trigger condition is **rising**. You can change it to **falling**, **falling & return** or **rising & return**.



Note

Rising: Marker is set when TTL signal changes from logical 0 to logical 1.

Falling: Marker is set when TTL signal changes from logical 1 to logical 0.

Falling & return: Markers are set when TTL signal changes from logical 1 to logical 0 and when it changes back to logical 1.

Rising & return: Markers are set when TTL signal changes from logical 0 to logical 1 and when it changes back to logical 0.

5. By default, the first letter of the type of the Trigger In bit is used in the marker description. For example, the marker description for a Stimulus is prefixed with 'S'. To disable this setting, un-check the checkbox **Use first letter as prefix in marker description**. The resulting marker will contain the trigger value only.
6. Decide whether you want to use debouncing. Debouncing means that a repetition of a marker of the same type and same description is ignored for a time period of 5 to 50 ms.

To enable debouncing, check the checkbox **Enable debouncing in milliseconds (5 ... 50 ms)**. The default value for the time period is 50 ms. To change it, enter a new value in the field next to the checkbox.

Trigger Output

To enable the trigger output, check the checkbox **Forward from 'Trigger In'**. This means that the trigger input is directly forwarded to the trigger output port. The forwarded triggers are not affected by the Digital Port Settings of Trigger In, but are forwarded exactly as they arrive at the amplifier.

Sync In/Out

1. To enable the **Sync-Out mode**, check the checkbox.
2. Choose the **Sync frequency**. In the drop-down menu, you can select the sync frequencies 0.1 Hz, 1 Hz, 5 Hz, 10 Hz, or 25 Hz.

Annotation Assignment

Annotations are markers with text that you can add to the data during monitoring and recording. You can add an annotation with freely definable text at any time during monitoring or recording. As a shortcut, you can assign the keys 1 to 0 on your keyboard with associated annotations and save them in your workspace.

To assign annotations, go to the text field **Associated annotation** next to the respective key and enter a text.

8.1.5 Views

Views allow you to make settings for the view of the signals and save these settings in the workspace. These settings only impact the display, not the raw data.

You can adapt the view at any time during monitoring and recording.

In this step, there are three tabs: **Display Filters**, **Channel Colors**, and **Scaling and Interval**.

Display Filters

For each channel, you can set a low cutoff filter, a high cutoff filter, and a notch filter.

Low cutoff filter	Reduces the amplitude of low-frequency digitized signals.
High cutoff filter	Reduces the amplitude of high-frequency digitized signals.
Notch filter	Filters the noise of the mains line. Depending on your area, you can choose between 50 Hz (for example, Germany) and 60 Hz (for example, USA).

By default, no display filters are applied, but you can make settings for each channel. The table **Individual channel settings** summarizes the settings.

1. In **Select channel type**, select whether you want to make settings for **ALL** channel types or only for specific ones.
2. To set display filters for all channels of the selected channel type, go to **General channel settings** and enter frequency values for **Low cutoff frequency** and/or **High cutoff frequency**. To apply a notch filter to filter out line noise, use the drop-down menu **Notch frequency** and select 50 or 60 Hz depending on your area.

The General channel settings are applied to all channels of the selected channel type. The table **Individual channel settings** summarizes your settings.

3. To make settings for individual channels, go to the table **Individual channel settings** and check the checkbox **Individual settings**.

In the column **Filter frequency (Hz)**, enter frequency values for **Low cutoff**, **High cutoff**, and **Notch**.



Note

During monitoring and recording, there is a button that you can toggle to enable and disable the display filters at any time.

Channel Colors

By default, all channels in the view area are displayed in black (0,0,0), but you can set a different color for each channel. The table **Individual channel settings** summarizes the settings.

1. In **Select channel type**, select whether you want to make settings for **ALL** channel types or only for specific ones.
2. To set a color for all channels of the selected channel type, go to **General channel settings** and use the drop-down menu.
3. To make settings for individual channels, go to the table **Individual channel settings** and check the checkbox **Individual settings**. Go to the column **Color (R,G,B)** and use the drop-down menu.

Scaling and Interval

By default, scaling and interval settings are already made for the different channel types to improve their visibility in the view area, but you can change the settings according to your needs. The table **Individual channel settings** summarizes the settings.

1. In **Select channel type**, select whether you want to make settings for **ALL** channel types or only for specific ones.
2. To make settings for all channels of the selected channel type, go to **General channel settings**, enter a scaling value in the text field **Scaling range**, and select a unit from the drop-down menu.



Note

Because of the different units for the channel types, you can only enter a scaling range for the channel types separately.

In **General channel settings**, use the **Vertical axis** drop-down menu to select either **Positive up** or **Negative up**.

3. To make settings for individual channels, go to the table **Individual channel settings** and check the checkbox **Individual settings**.

In the column **Scaling range**, enter a scaling value in the text field **Scaling range** and select a unit from the drop-down menu.

In the column **Vertical axis**, use the drop-down menu to select either **Positive up** or **Negative up**.

4. By default, vertical alignment is enabled and the time interval that is shown in the view area is 10 seconds. To change these settings, go to **Display settings**.

To disable vertical alignment, un-check the checkbox **Enable vertical alignment**.

To change the time interval, enter a value in the **Time interval** text field or use the arrows to increase and decrease the value.

When you have completed the workspace editor, click  **Finish**. In the file explorer, navigate to the folder in which you want to save the workspace. The default folder is **Workfiles**.

8.2 Loading a workspace

To load a recently opened workspace, navigate to  **Workspace** › **Open recent** and click the workspace in the list.

To load any saved workspace:

1. Navigate to  **Workspace** › **Workspace file** and click  **Load**.
2. In the file explorer, double-click the workspace. Alternatively, select the workspace and click **Load**.

8.3 Editing a workspace

To edit a workspace:

1. In the Title Bar, ensure that the workspace that you want to edit is loaded.
If you want to edit a different workspace, open it as described in [Loading a workspace](#).
2. Navigate to  **Workspace** › **Workspace file** and click  **Edit**.
3. In the workspace editor, navigate to the step in which you want to edit the settings.
For more information on the settings, refer to [Workspace editor](#) and to [Creating a workspace](#).

8.4 Saving a workspace

To save a workspace:

1. In the Title Bar, ensure that the workspace that you want to save is loaded.
If you want to save a different workspace, open it as described in [Loading a workspace](#).
2. Navigate to  **Workspace** › **Workspace file** and click  **Save As**.
3. In the file explorer, navigate to the folder in which you want to save the workspace. The default folder is *Workfiles*.
4. To save the workspace, enter a file name and click **Save**.
To replace an existing workspace with the one that you want to save, double-click the existing workspace. Alternatively, select the existing workspace and click **Save**.

9. Impedance check

The impedance check allows you to view the impedances for all channels.

First, prepare all electrodes as described in the respective manuals. Then, use the impedance check in Recorder to view the impedances and minimize them channel by channel.



Note

During the impedance check, you cannot close Recorder. This ensures that no data or settings are lost accidentally.

9.1 Starting and stopping impedance check

Starting impedance check

Prerequisites:

- ▶ A workspace is loaded.
- ▶ An amplifier is connected and switched on.
- ▶ All electrodes are prepared.

1. To start the impedance check, go to the global tool bar and click  **Start/Stop Impedance check**.
The view area displays a 2D head with the electrodes.
2. Follow the instructions in the manual of your cap to minimize impedances.

Stopping impedance check

To stop the impedance check, go to the global tool bar and click  **Start/Stop Impedance check**.
The impedance view closes.

9.2 User interface during impedance check

During the impedance check, the view area displays a 2D head with the channels and a local tool bar (Figure 4).

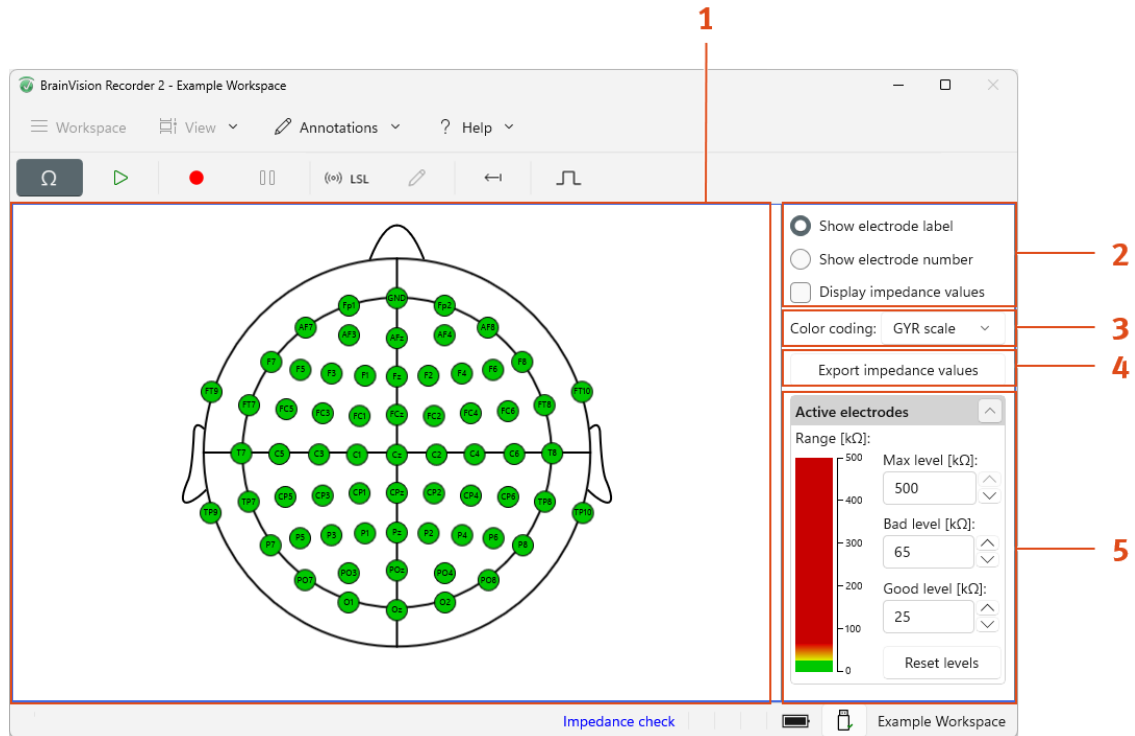


Figure 4: User interface during the impedance check (actiChamp Plus with active electrodes)

Pos.	Name	Description
1	View area	Displays a 2D head with the electrodes.
2	View options	Allows you to adapt how the electrodes are displayed in the view area. For more information, refer to Adapting the electrode view .
3	Color coding	Allows you to change the color coding of the electrodes. For more information, refer to Adapting the color coding .
4	Export	Allows you to export the impedance values in the BrainVision Recorder 2 Impedances format (*.bvri). For more information, refer to Exporting impedance values .
5	Impedance levels	Displays the levels for bad and good impedances and allows you to adapt these levels. For more information, refer to Setting impedance levels .

9.3 Adapting the view in impedance check

During the impedance check, you can adapt the 2D head with the electrodes by using the tools in the local tool bar and by interacting directly with the view. Adapting the view during impedance check does not change your settings in the workspace. Once you stop impedance check, the default view is restored.

9.3.1 Zooming in and out

To zoom in and out of the view, press `ctrl` on your keyboard and scroll your mouse wheel at the same time.

9.3.2 Adapting the electrode position

If the electrodes are named according to the 10-10 or 10-20 system or if electrode positions are loaded, the electrodes are shown in their respective location on the head. If not, they are grouped next to the head.

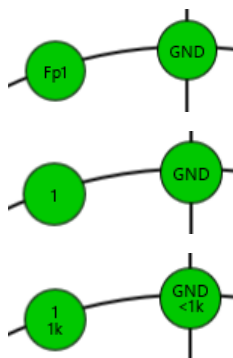
To change the position of the electrodes manually, drag-and-drop them.

To set their initial positions again, click **Set initial positions**, which appears in the top left corner.

9.3.3 Adapting the electrode view

You can display the electrodes on the 2D head either with the label that indicates the position on the head or with the number that indicates the channel.

In both cases, the impedance value is shown when you hover your mouse pointer over an electrode. Additionally, you can display the impedance value in the electrode view permanently.



To show the electrode label, go to the local tool bar and select **Show electrode label**.

To show the electrode number, go to the local tool bar and select **Show electrode number**.

To additionally display the impedance values, go to the local tool bar and select **Display impedance values**.

9.3.4 Adapting the color coding

The impedances are color-coded with a color scale that ranges from a minimum impedance to a maximum impedance. To ensure that you can clearly see and differentiate the impedances, you can adapt the color coding:

1. In the local tool bar, open the **Color coding** drop-down menu.
2. To use a green, yellow and red scale, select **GYR scale**.
To use a black and white scale, select **BW scale**.

9.3.5 Exporting impedance values

To export the impedance values as a file in the format *.bvri:

1. In the local tool bar, click **Export impedance values**.
2. In the file explorer, navigate to the folder in which you want to save the impedance values.
3. Enter a **File name**.
4. To save the impedance values and go back to the impedance check, click **Save**. To cancel and go back to the impedance check, click **Cancel**.



Note

You can save the results of several impedance measurements (for example, before and after an experiment) into the same file by choosing the same file again. If the channel number and labels match, the data will be stored in addition to the previous measurement results.

9.3.6 Setting impedance levels

In the local tool bar, you can set the impedance levels manually. The default values depend on whether you use active or passive electrodes.

Level	Default values for active electrodes	Default values for passive electrodes
Max level [kΩ]	500	100
Bad level [kΩ]	65	50
Good level [kΩ]	25	10

To adapt these levels, enter a value in the respective text field or use the arrows next to it to increase and decrease the values.

To reset the levels to the default values, click **Reset levels**.

10. Monitoring

Monitoring allows you to view signals without recording and saving them.

**Note**

During monitoring, you cannot close Recorder. This ensures that no data or settings are lost accidentally. Stop monitoring before you close Recorder.

10.1 Starting and stopping monitoring

Starting monitoring

Prerequisites:

- ▶ A workspace is loaded.
- ▶ An amplifier is connected and switched on.

To start monitoring, go to the global tool bar and click  **Start/Stop Monitoring**.

In the view area, the monitoring view is displayed. For more information, refer to [User interface during monitoring](#).

Stopping monitoring

To stop monitoring, go to the global tool bar and click  **Start/Stop Monitoring**.

The monitoring view closes.

10.2 User interface during monitoring

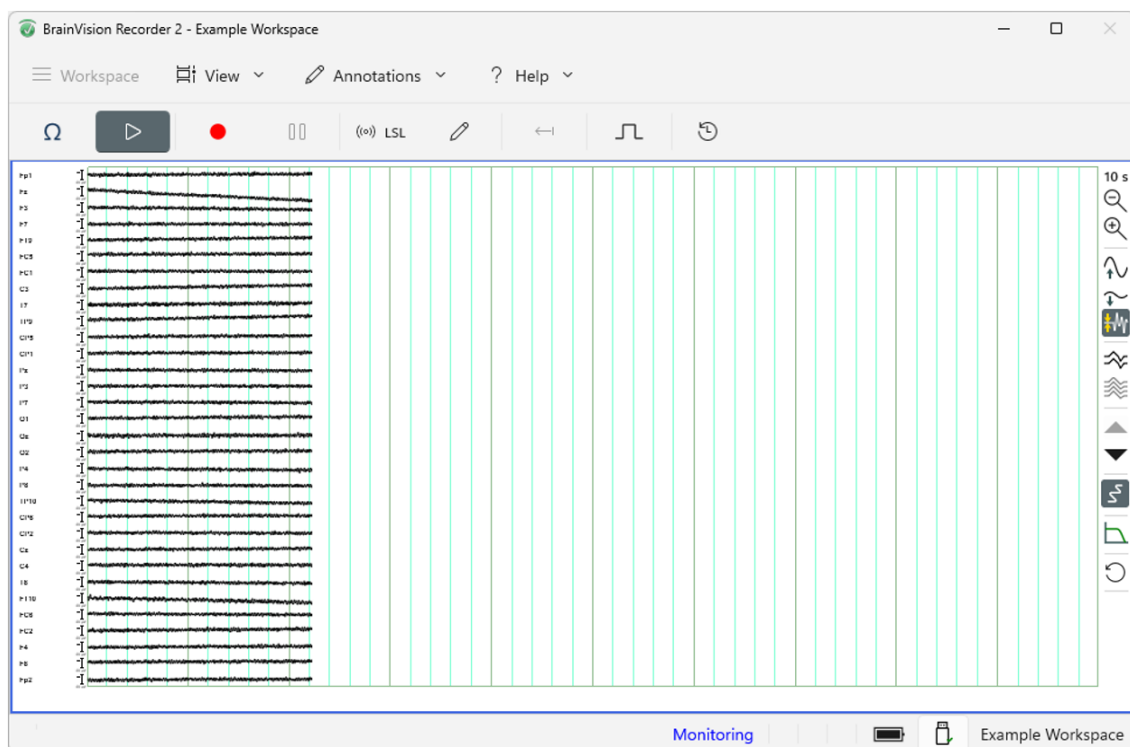


Figure 5: User interface during monitoring (actiChamp Plus with active electrodes).

During monitoring, the signals from the amplifier channels are displayed in the view area (see [Figure 5](#)).

The channel names are displayed on the left, together with a small scaling bar that helps you to assess the signal size.

To adapt the view of the signals, the following tools are available in the local tool bar:

Icon	Name	Description
	Increase time interval	Increases the time interval (in seconds) that is displayed in the view area.
	Decrease time interval	Decreases the time interval (in seconds) that is displayed in the view area.
	Scale up	Increases the scale for all channels.
	Scale down	Decreases the scale for all channels.
	Enable / disable vertical alignment	Enables and disables vertical alignment, which aligns the baseline for all signals in the display so that all signals are visible.
	Show less channels	Decreases the number of channels that are displayed in the view area.
	Show more channels	Increases the number of channels that are displayed in the view area.

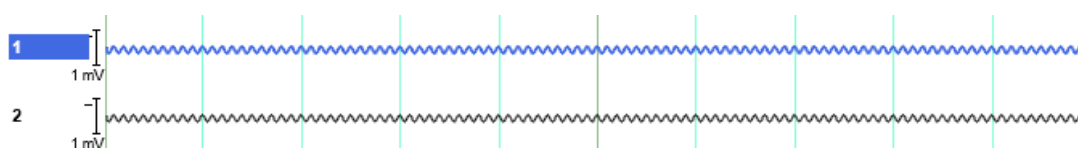
Icon	Name	Description
▲	Show previous channel group	Switches to the previous channel group.
▼	Show next channel group	Switches to the next channel group.
⚡	Enable / disable anti-aliasing	Enables and disables the anti-aliasing filter. This filter is enabled by default to enhance the view of the signals.
🔄	Refresh views	Refreshes the view of the signals in the view area.
📏	Enable/disable display filters	Enables and disables the display filters. You can toggle this button during monitoring and recording.

10.3 Selecting and deselecting channels

To highlight channels or to apply tools to them, you can select one or multiple channels.

1. To select one or more channels, click their channel names.

The selected channels are shown in blue.

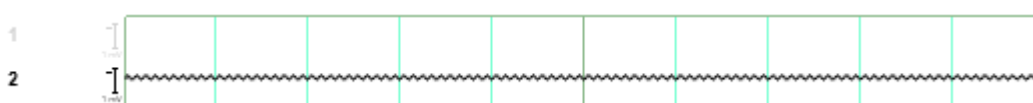


2. To deselect one or more channels, click their channel names again.

10.4 Hiding channels

1. To hide one or more channels, right-click their channel names and click **Hide**.

The selected channels are grayed out and no signal is drawn.



2. To show hidden channels, right-click their name and click **Show**.

10.5 Adapting the view

During monitoring, you can adapt the view of the signals in various ways:

- ▶ By using the local tool bar.
- ▶ By right-clicking individual channel names.
- ▶ By using the  **View** menu in the menu bar. This function will modify the workspace settings and you will be asked whether you want to update these settings in the current workspace file.

10.5.1 Setting display filters

For each channel, you can set a low cutoff and a high cutoff filter.

- | | |
|--------------------|--|
| Low cutoff filter | Filter that reduces the amplitude of low-frequency digitized signals. |
| High cutoff filter | Filter that reduces the amplitude of high-frequency digitized signals. |

To set display filters:

1. In the menu bar, click **View > Display filter**.
Alternatively, right-click an individual channel name and select **Set display filters**.
2. In the **Set display filters** dialog, enter filter frequency values for **Low cutoff** and **High cutoff** for individual channels.
3. To apply the display filters and go back to the monitoring, click **Apply**.
To cancel and go back to the monitoring, click **Cancel**.

10.5.2 Enabling and disabling display filters

If you have set display filters, you can enable and disable them during monitoring. This function applies to display filters that are set in the workspace and to display filters that are set during monitoring.

Prerequisites:

- ▶ Display filters are set.
For more information on setting display filters in the workspace, refer to [Display Filters](#). For more information on setting display filters during monitoring, refer to [Setting display filters](#).

To enable and disable display filters, go to the local tool bar and click  **Enable / disable display filters**.

10.5.3 Setting channel colors

By default, all channels in the view area are displayed in black (0,0,0). For each channel, you can set a pre-defined basic color or a custom color.

To set channel colors:

1. In the menu bar, click  **View > Channel colors**.
Alternatively, right-click an individual channel name and select **Set color**.
2. In the **Set channel colors** dialog, use the **Color (R,G,B)** drop-down menu to select a color for the individual channel.
3. To apply the channel colors and go back to the monitoring, click **Apply**.
To cancel and go back to the monitoring, click **Cancel**.

10.5.4 Scaling

You can scale the signals up or down, either for all channels or for individual channels.

Scaling all channels

To scale up all channels, go to the local tool bar and click  **Scale up** until you reach the desired scaling.

To scale down all channels, go to the local tool bar and click  **Scale down** until you reach the desired scaling.

Scaling individual channels

To scale individual channels:

1. In the menu bar, click  **View > Scaling**.
Alternatively, right-click an individual channel name and select **Set scaling**.
2. In the **Set channel scalings** dialog, enter a value and a unit for the **Scaling range**.
3. To apply the scaling and go back to the monitoring, click **Apply**. To cancel and go back to the monitoring, click **Cancel**.

10.5.5 Setting the time interval

By default, the time interval that is displayed in the view area is 10 s. You can increase it to show a longer time interval or decrease it to show a shorter time interval.

The current time interval is displayed at the top of the local tool bar.

Setting the time interval in the local tool bar

To increase the time interval, click  **Increase time interval** until you reach the desired time interval.

To decrease the time interval, click  **Decrease time interval** until you reach the desired time interval.

Setting the time interval in the menu bar

1. Click  **View > Time interval**.
2. In the **Set display time** dialog, enter the the exact value or use the arrows to increase and decrease the value.
3. To apply the time interval and go back to the monitoring, click **Apply**. To cancel and go back to the monitoring, click **Cancel**.

10.5.6 Enabling and disabling vertical alignment

By default, vertical alignment is enabled. Vertical alignment corrects the baseline in the display so that all signals are visible. Vertical alignment does not impact the raw data.

To enable and disable vertical alignment, click  **Enable/Disable vertical alignment**.

10.5.7 Showing less or more channels

You can show less or more channels in the view area. The minimum number of channels is 1, the maximum number is 32.

To show less channels, go to the local tool bar and click  **Show less channels** until you reach the desired number of channels.

To show more channels, go to the local tool bar and click  **Show more channels** until you reach the desired number of channels.

10.5.8 Flipping through channel groups

If the view area does not display all channels, you can flip through them in channel groups.

To flip through the channel groups, got to the local tool bar and click  **Show previous channel group** and  **Show next channel group** until you reach the desired channel group.

10.5.9 Refreshing views

The view area displays the signals from left to right. When the signals reach the right side of the view area, they start again on the left side and overwrite the previous signals.

You can refresh the view to clear all previous signals from the view area and display the signals starting from the left again.

Refreshing views

To refresh a specific view, go to the local tool bar and click  **Refresh views**.

Setting a time interval and refreshing views

To set a time interval and refresh all open views at the same time:

1. In the global tool bar, click  **Set time interval and refresh views**.
2. In the **Set display time** dialog, enter the the exact value or use the arrows to increase and decrease the value.
3. To apply the time interval, refresh the view and go back to the monitoring, click **Apply**. To cancel and go back to the monitoring, click **Cancel**.

10.6 Using quick views

Quick views allow you to view one or more channels in a separate quick view in addition to the general view area. When a quick view is already open, any additional one is opened in a new tab.

Similar to the view area, the quick view has a local tool bar that allows you to set the time interval, scale up and down, and enable / disable vertical alignment. These tools are applied only on the respective quick view. Additionally, the tools that refresh the view in the general view area also refresh it in the quick view (for more information, refer to [Refreshing views](#)).

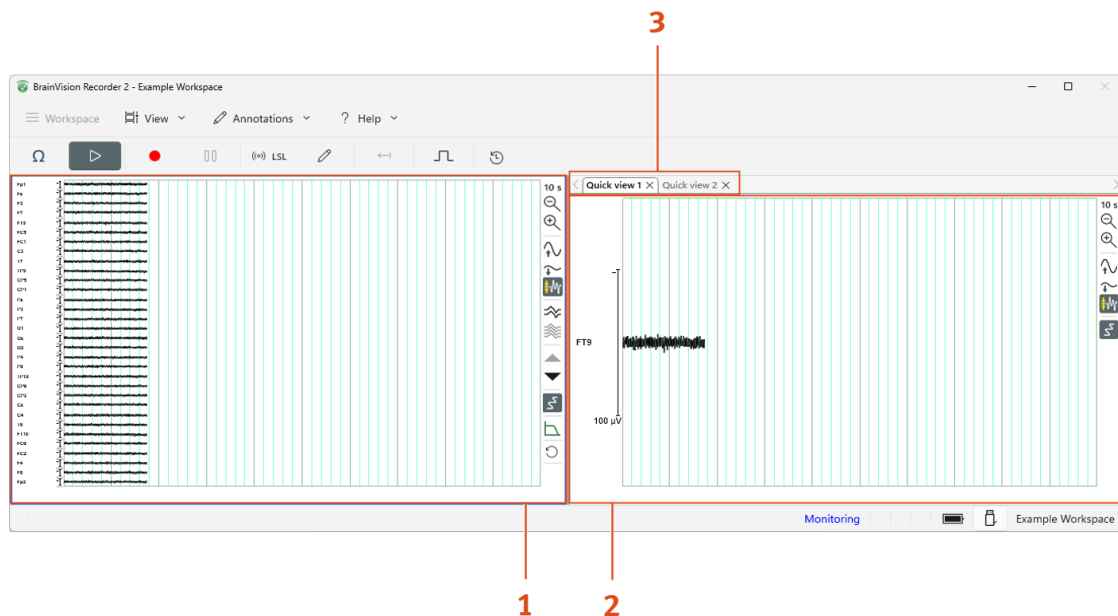


Figure 6: User interface during monitoring with a quick view (with virtual amplifier).

Pos.	Name	Description
1	View area	Remains open and displays all channels, including the one that is open in the Quick view.
2	Quick view	Displays the channels that you have selected for the quick view.
3	Quick view tabs	Displays any additional quick views that you open.

10.6.1 Opening a quick view

Prerequisites:

- ▶ Monitoring is running.
- ▶ [Optional] One or more channels are selected.

To open a quick view, right-click on the channel name and click **Quick view**.

The quick view opens.

10.6.2 Displaying a quick view in a separate window

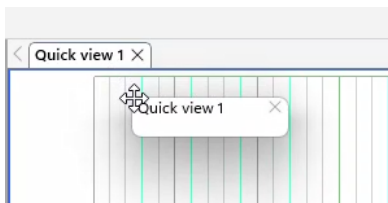
You can display a quick view in a separate window instead of the main window.

Prerequisites:

- ▶ A quick view is open.

To open a quick view in a separate window, drag-and-drop the quick view tab.

The quick view disappears from the main window and is displayed in a separate window.



To dock the quick view, go to the title bar of the quick view window and click  **Dock view to main window**.

The quick view is displayed in the main window.

10.6.3 Closing a quick view

To close a quick view that is open in the main window, go to its quick view tab and click  **Close view**.

To close a quick view that is open in a separate window, close the window.

10.7 Using montages

Montages allow you to use a different reference than the one specified in the workspace and see the result in a separate view area.

Montages are for visualization purposes and do not alter the raw data.

10.7.1 Creating a montage

Prerequisites:

- ▶ Monitoring is running.
- ▶ The required electrodes exist and the corresponding channel names are defined in the workspace.

To create a new montage:

1. In the menu bar, click  **View > Montages**. The montage options are displayed in a drop-down menu.
2. Select one of the following montage options:

Average earlobes uses the average of the two earlobe electrodes as the reference. (Required electrodes: A1 and A2)

Average mastoids uses the average of the two mastoid electrodes as the reference. (Required electrodes: M1 and M2)

Average TP9/TP10 uses the average of the TP9 and TP10 electrodes that are located over the left and right mastoid regions as the reference. (Required electrodes: TP9 and TP10)

Common average uses the average of all the electrodes as the reference.

Once you have selected a montage option, the montage opens to the right of the main window. You can open multiple montages at once.

10.7.2 Displaying a montage in a separate window

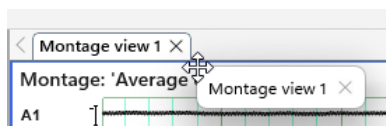
You can display a montage in a separate window instead of the main window.

Prerequisites:

- ▶ A montage view is open.

To open a montage in a separate window, drag-and-drop the montage tab.

The montage disappears from the main window and is displayed in a separate window.



To dock the montage, go to the title bar of the montage window and click  **Dock view to main window**.

The montage is displayed in the main window.

10.7.3 Closing a montage

To close a montage that is open in the main window, go to its montage tab and click  **Close view**.

To close a montage that is open in a separate window, close the window.

10.8 Adding annotations

Annotations are markers with text that you can add to the data during monitoring and recording.

To add an annotation with freely definable text at any time during monitoring and recording:

1. In the global tool bar, click  **Enter and send annotation**.
At the time that you click this button, a marker is set with the placeholder name '???'. Then, you can enter and confirm a marker description.
2. In the pop-up window Annotation, enter a name and click **Send now**.
To cancel the annotation, click **Close**.

For frequently used annotations, we recommend defining a shortcut. To assign the keys 1 to 0 on your keyboard with associated annotations:

1. In the menu bar, click  **Annotations > Annotation Assignment**.
2. In the window **Set annotations**, enter a name in the text field next to the key that you want to use.
3. To set the annotation, click **Apply**.
In the pop-up window, decide whether you want to save the shortcut in the workspace file. If you do not save the shortcut, it will only be available until you stop the current monitoring.

To define the shortcut directly in the workspace, refer to [Annotation Assignment](#).

10.9 Enabling and disabling LSL

Pre-requisites:

- LSL is selected as the output.

To enable and disable LSL at any time during monitoring and recording, go to the global tool bar and click

 **Enable / Disable LSL**.

11. Recording

Recording saves the signals as EEG files in the BrainVision Recording Format (BVRF). These EEG files can be analyzed further, for example in BrainVision Analyzer. For more information, refer to [Format of the EEG files](#).



Note

During recording, you cannot close Recorder. This ensures that no data or settings are lost accidentally. Stop recording and monitoring before you close Recorder.

11.1 Starting and stopping recording

Starting recording

Prerequisites:

- Impedance check or monitoring is running.

To start recording:

1. Go to the global tool bar and click  **Start/Stop Recording**.
2. In the file explorer, navigate to the folder in which you want to save the data. The default folder is *Recordings*.
3. To save the data, enter a file name and click **Save**.
The data recording starts.

Stopping recording

To stop recording, go to the global tool bar and click  **Start/Stop Recording**.

11.2 Pausing and resuming recording

You can pause and resume recording at any time. During this time, monitoring is still running, but the data is not saved.

1. To pause recording, go to the global tool bar and click  **Pause/Resume Recording**.
2. To resume recording, go to the global tool bar and click  **Pause/Resume Recording**.

11.3 User interface during recording

Once you start recording, the view area displays the signals from left to right. The status bar displays information on the recording as described in [Status bar](#).

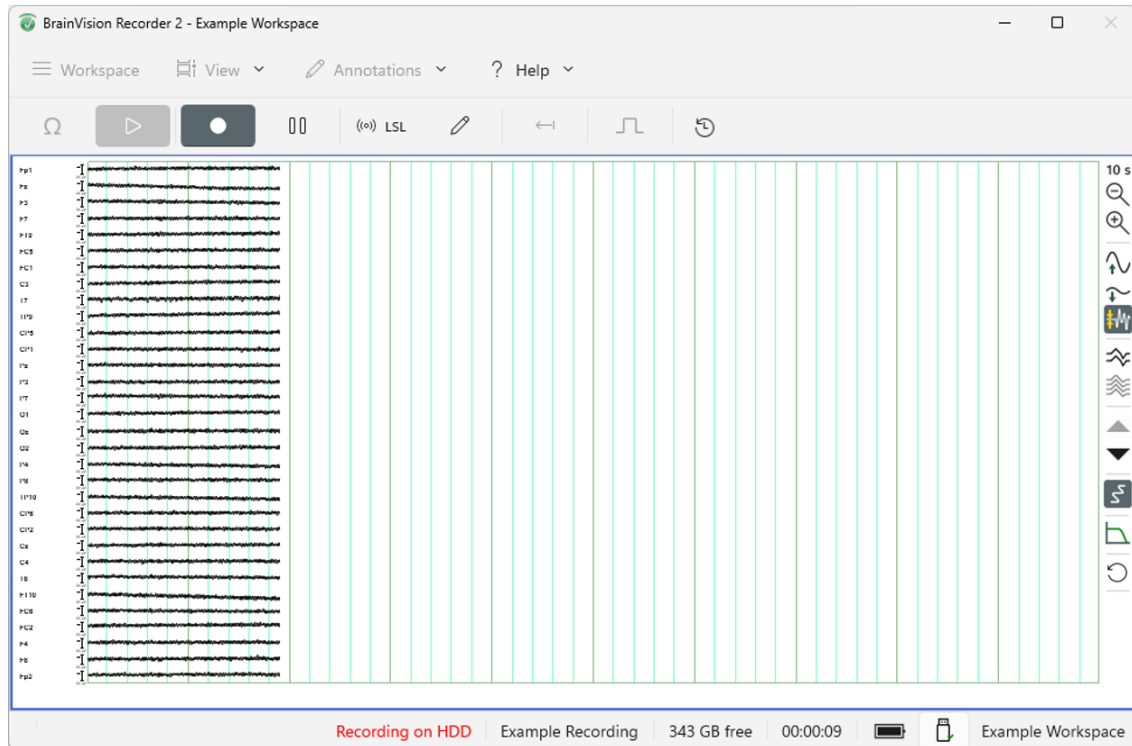


Figure 7: User interface during recording (actiCHamp Plus with active electrodes).

11.4 Available functions during recording

Similarly to monitoring, the following functions are available during recording:

- ▶ [Selecting and deselecting channels](#)
- ▶ [Hiding channels](#)
- ▶ [Adapting the view](#)

The  **View** menu is not available during recording, but you can use the local tool bar to adapt the view.

- ▶ [Using quick views](#)
- ▶ [Adding annotations](#)
- ▶ [Enabling and disabling LSL](#)

12. Test signal

You can use the internal test signal generator of the actiCHamp (Plus) to check the integrity of the signal pipeline. The test signal generator injects a signal in all channels simultaneously.

To start and stop the test signal mode of Recorder, click  **Start/Stop Test Signal**.

For more information on applying a test signal, refer to the actiCHamp (Plus) Manual.

13. Troubleshooting

13.1 TurboLink and connection issues

13.1.1 Connection with TurboLink does not work

Connection issues with TurboLink may be due to Windows Defender.

During [installation](#), make sure that you accept setting Windows Firewall rules for TurboLink. By doing so, the inbound/outbound rules for Windows Defender are set to allow connection between Recorder and TurboLink.

In some cases, for example when your Windows Defender is updated, Recorder and TurboLink can be blocked and the inbound/outbound rules may need to be reset.

Prerequisites:

- ▶ You have administrator rights.

To reset the inbound/outbound rules:

1. Close Recorder.
2. Download the BVR2Rules tool from our [website](#). To access the download area, you need to log in.
3. Extract the contents of the .zip file.
4. Run the BVR2Rules tool.
5. In the main dialog, click **Reset**.
The BVR2Rules tool resets the inbound/outbound rules.
6. Close the BVR2Rules tool.
7. Start Recorder.

13.1.2 The network usage speed is displayed as 10 Mb/s during connection with TurboLink

For the connection with TurboLink, a throughput of 1000 Mb/s is required. If your network hardware does not provide enough throughput, it is possible that the network hardware is throttling your speed. To correct this, we recommend enabling Wake-on-LAN.

Prerequisites:

- ▶ You have administrator rights.

To enable Wake-on-LAN:

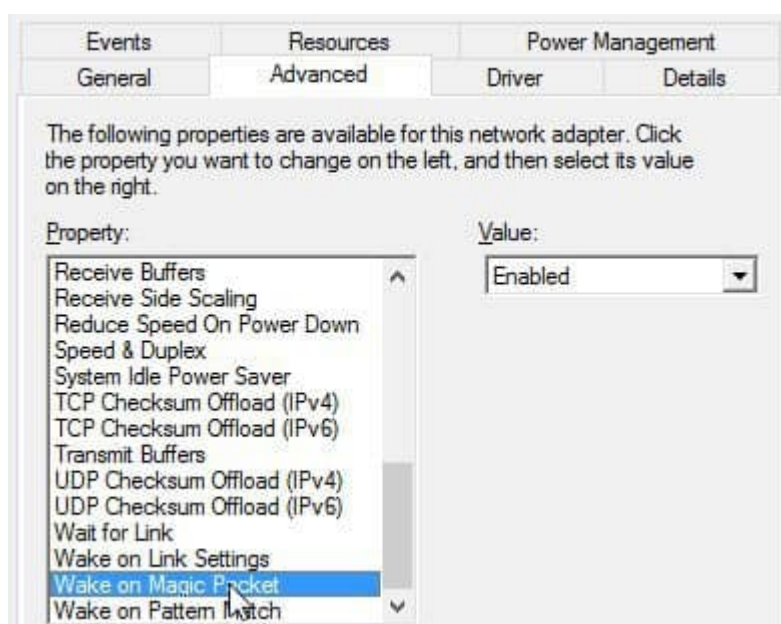
1. Press the  Windows key + x and select **Device Manager**.
2. In the Device Manager, expand **Network adapter** in the device tree.
3. Right-click your network adapter and click **Properties**.

4. In the network adapter window, go to the **Power Management** tab and enable all three options:



5. In the network adapter window, go to the **Advanced** tab, scroll through the **Property** list, and select **Wake on Magic Packet**.

Ensure that **Value** is set to **Enabled**.



6. Click **OK**.

13.1.3 Checking the speed of the network adapter

If you are unsure of the speed of your network adapter, you can check it as follows.

1. Disconnect any connected network cables. This ensures that the speed of the network adapter is displayed instead of the speed of the network connection.

2. Press the  Windows key + R.

The Run dialog opens.

3. In the command line, enter `powershell` and click **OK**.

The Windows PowerShell window opens.

4. Copy and paste the following text into the Windows PowerShell window:

```
param( [string]$computer = "." )
$instances = Get-WMIObject -Query "SELECT InstanceName,NdisLinkSpeed
    FROM MSNdis_LinkSpeed" -Namespace "root/WMI" -Computername $computer
foreach ( $item in $instances ) {
    Write-Host "Adapter : " $item.InstanceName
    $speed = ($item.NdisLinkSpeed -as [int])/10000
    Write-Host "Max. speed : " $speed "Mbps"
    Write-Host }
```

7. Press Enter.
8. In the list of available network adapters, look for the one that you want to use. If its **Max. speed** is 1000 Mbps, the network adapter meets the requirements.

13.2 Contacting Brain Products GmbH Technical Support

If you have technical issues with Recorder, you can contact Brain Products GmbH Technical Support at tech-sup@brainproducts.com. Please include the Recorder log files so that Technical Support can diagnose the issues.

To access the Recorder log files:

1. Navigate to the *Recorder* installation folder under *C:\Vision*.

Alternatively, if an amplifier is connected, go to the status bar and double-click the  icon.

2. In the *Recorder* folder, right-click the **Log** folder.
3. Select **Send to > Compressed (zipped folder)**.
4. Attach the .zip file to your email to Brain Products GmbH Technical Support.

Appendix A Format of the EEG files

Recorder records EEG files in the BrainVision Recording Format (BVRF). For information on BVRF, refer to the Support Resources Knowledge Base on our website: <https://www.brainproducts.com/support-resources/brainvision-recording-format/>.

Appendix B Electrode coordinate system

Electrode coordinates are required in the following cases:

- ▶ When analytical procedures make use of channel positions.
- ▶ When topographies are output in 2D or 3D.

[Figure 8](#) and [Figure 9](#) illustrate the coordinate system used by BrainVision Analyzer:

- ▶ The x-axis extends from channel T7 on the left side of the head (negative values) to channel T8 on the right side of the head (positive values).
- ▶ The y-axis runs from the back to the front of the head via channel Fpz (positive values).
- ▶ The z-axis runs from the bottom of the head toward the crown via channel Cz (positive values).

Electrode coordinates consist of three variables that specify a point on the surface of the head:

- ▶ r (radius) specifies the distance in millimeters between point P and the origin of the coordinate system.
 $r = 0$ signifies an invalid position, for example if the position of an electrode is unknown.

If realistic electrode coordinates are used, r can have a different value for each channel. If a spherical head model is used, r should have the same value for all channels. For instance, $r = 1$ in BrainVision Analyzer's standard coordinate system.

- ▶ ϕ (theta) specifies the angle between the x-axis and the projection of the line that connects point P and the origin of the coordinate system on the xy plane.
 $\phi > 0$ in the front right and back left quadrants.
 $\phi < 0$ in the back right and front left quadrants.
- ▶ θ (phi) specifies the angle between the z-axis and the line that connects point P and the origin of the coordinate system.
 $\theta > 0$ in the right hemisphere.
 $\theta < 0$ in the left hemisphere.

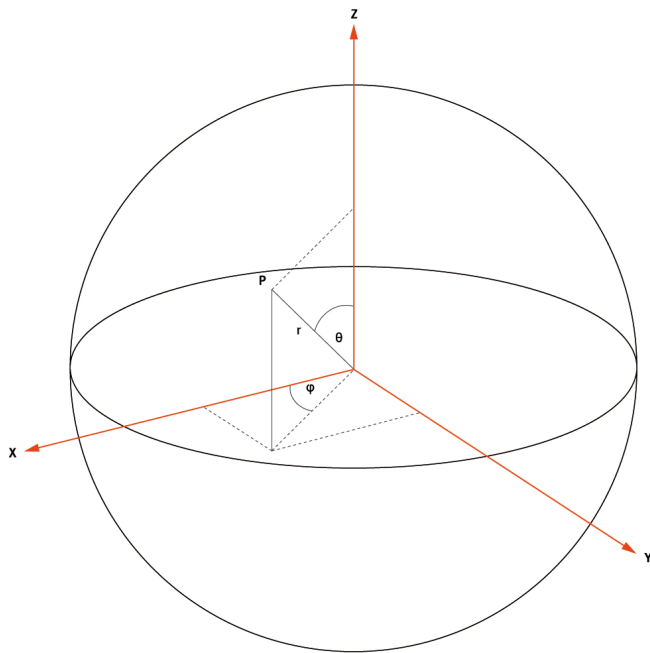


Figure 8: Coordinate system for electrodes (spherical head model)

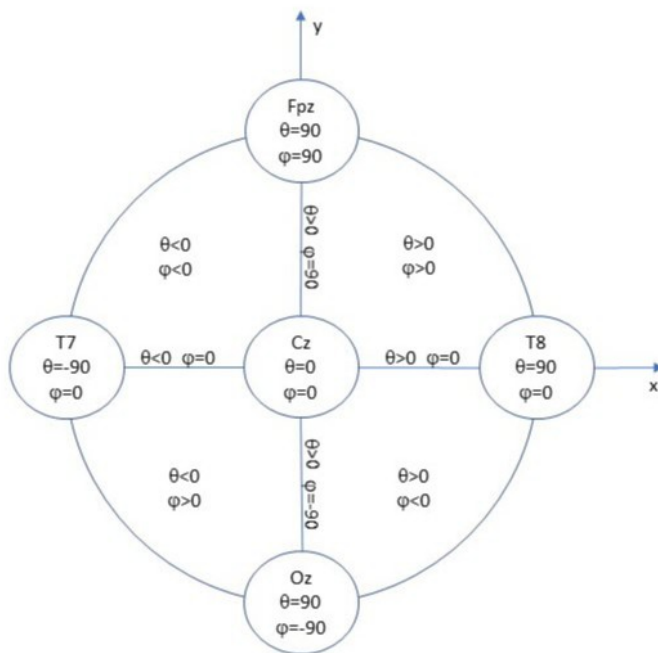


Figure 9: Sign conventions for angles

Appendix C Remote Data Access (RDA)

While the EEG data is being displayed, it can be passed to other programs on the local computer and to computers in a network via TCP/IP. This is referred to as Remote Data Access (RDA). In this process, Recorder acts as the server, and the program receiving the data acts as a client. Up to ten clients can be connected to the RDA server at the same time.

This chapter describes the interface that enables you to implement your own online analysis programs or bio-feedback methods. In principle, you can use different programming languages to do this. You can also develop and run a client program under Linux or other operating systems.

The RDA concept is visualized in [Figure 10](#).

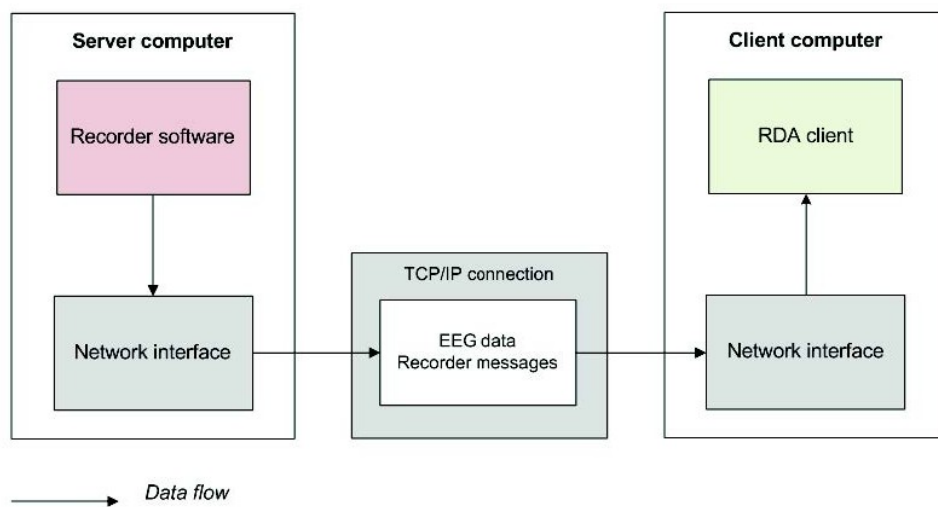


Figure 10: Overview of the interaction between the RDA server and the RDA client. The Server computer and the Client computer can be the same computer.

Examples

The data streamed from the RDA server can be received by many different clients that are written in different programming languages.

One example is RecView, which can directly connect to RDA for online processing of the signals.

However, RecView is just one example. Other viable options include using tools or languages such as MATLAB®, Python, C#, or C++. To give you some ideas, we provide corresponding examples as free downloads on our website (<https://brainproducts.com/downloads/recorder/#a22ce4537d47673db>).

More information on the specific RDA clients is provided next to the download links and/or as documentation within the code.

Using RDA

1. Download your RDA client of choice based on the programming or scripting language that you want to use and check its requirements where applicable.
2. Based on the examples, modify the code according to your needs.
3. Enable RDA in the workspace editor in the step **Data Output**, tab **Data Output Stream**. For more information, refer to [Data Output](#).
4. Activate monitoring or recording.
5. Connect the RDA client to the RDA server.

Additional information on RDA

One key term in programming involving TCP/IP is ‘socket’. A socket is the combination of a TCP/IP address and a port number. This combination describes a specific service on a computer. One well known, implicitly used service is, for example, the HTTP protocol on a Web server. This service uses port number 80 by default. Recorder's RDA server uses two port numbers:

- ▶ port 51234 for 16-bit data
- ▶ port 51244 for 32-bit data

The first task of the client program is to establish a connection to the server's RDA service using the port number. Then the client waits for data or messages to be sent from the server. The client itself never sends data to the server.

Every data block received contains a header of the type `RDA_MessageHeader` (based on the C++ example). You can find the declaration of this header and all other structures and constants in the file `RecorderRDA.h` after downloading and extracting the C++ example. The header consists of three parts:

- ▶ `guid` is a 128-bit constant for unique identification.
- ▶ `nSize` describes the total length of the block.
- ▶ `nType` describes the type of this message. Four message types are in use at present:

Message type	Meaning
2	data block (<code>RDA_MessageData</code>) for clients on port 51234 For more information, refer to RDA_MessageData (nType = 2) .
4	data block (<code>RDA_MessageData32</code>) for clients on port 51244 For more information, refer to RDA_MessageData32 (nType = 4) .
5	new state (<code>RDA_MessageNewState</code>) For more information, refer to RDA_MessageNewState (nType = 5) .
9	Recorder information (<code>RDA_MessageRecorderInfo</code>) For more information, refer to RDA_MessageRecorderInfo (nType = 9) .

RDA_MessageData (nType = 2)

This message is only received by clients that have logged in via port number 51234. This message is used to transfer 16-bit data. It consists of the following elements:

- ▶ `nBlock` specifies the current block number since the start of monitoring. The number can be used to identify whether a block has not been processed fast enough, thus causing a data overflow. An example of this is given in the file *RDAClient.cpp* (BrainVision program USB).
- ▶ `nPoints` specifies the number of data or sampling points in this block.
- ▶ `nMarkers` defines the number of markers in this data block.
- ▶ `nData[]` is the actual data in the form of 16-bit signed integers. The number of values is derived from `nPoints` and `RDA_MessageStart.nChannels`.
- ▶ `Markers` is a data field with markers of the `RDA_Marker` type. The individual elements of this field can have different lengths.

A marker of the `RDA_Marker` type consists of the following:

- ▶ `nSize` specifies the size of the marker in bytes.
- ▶ `nPosition` specifies the relative position in the data block in sampling points (0 -...).
- ▶ `nPoints` specifies the number of points covered by this marker (mostly 1).
- ▶ `nChannel` specifies the channel number to which this marker has been assigned (at present only -1 = all markers).
- ▶ `sTypeDesc` specifies the type and description of the marker as null-terminated text.

You will find examples of how to handle data and markers in *RDAClient.cpp* in the routines `WriteDataBlock(RDA_MessageData* pMsg)` and `WriteMarkers(RDA_MessageData* pMsg, ULONG nOffset, ULONG nExistingMarkers)`.

RDA_MessageData32 (nType = 4)

This message is only received by clients that have logged in via port number 51244. Its structure is identical to that of `RDA_MessageData` with the exception of the `fData[]` field, which replaces the `nData[]` field.

`fData[]` is the current data in the 32-bit IEEE floating point format. The number of values is derived from `nPoints` and `RDA_MessageStart.nChannels`.

**Note**

You will find detailed information on RDA clients in the examples (C#, C++, Python, MATLAB®) on the website.

RDA_MessageNewState (nType = 5)

This message notifies the RDA clients of the new state (start/stop of data acquisition mode; start/stop/-pause/resume recording; Recorder in idle state etc.) It consists of the following element:

nState:

nState:

```
enum eAcquisitionType
{
    eOff = 0, eMonitoring, eCalibration,
    eImpedanceCheck, eSaving, eSavingCalibration,
    ePause, ePauseCalibration,
    ePauseImpedance Check
};
```

RDA_MessageRecorderInfo (nType = 9)

This message notifies the RDA clients of the Recorder information. It consists of the following elements:

- ▶ dRecorderVersion: Recorder version.
- ▶ nChannels: Number of channels.
- ▶ dSamplingInterval: Sampling interval in microseconds.
- ▶ dResolutions[]: Array of channel resolutions. The size of the array is nChannels.
- ▶ sChannelNames: Channel names (in wide characters) delimited by '\0'. The size of the array is nChannels.
- ▶ sChannelUnits: Channel units (in wide characters) delimited by '\0'. The size of the array is nChannels.

Appendix D Lab Streaming Layer (LSL)

LSL is an open-source framework designed for the near real-time collection, synchronization, and transmission of time-series data, particularly in neuroscience, psychology, and biomedical research. It enables communication between devices and software applications that produce or consume data streams, such as EEG systems, eye trackers, motion sensors, and experiment control software.

Recorder offers the option to stream all data that is acquired into the local network using the LSL protocol. This option can be enabled in the global toolbar and a preset can be made during the workspace setup. If LSL streaming is activated, Recorder starts streaming data as soon as Monitoring or Recording is started. LSL is a TCP/IP network protocol and requires both sender and receiver of LSL to be connected to the same local network.

For more information, refer to our [Tips and tricks for using Lab Streaming Layer \(LSL\)](#).

Appendix E Regulatory Information (German) – Regulatorische Informationen (Deutsch)

In diesem Anhang sind auszugsweise die batterierelevanten Abschnitte sowie die Hinweise zur Entsorgung von Batterien und von Elektro- und Elektronik-Altgeräten auf Deutsch gesammelt.

5.1.2 Dongle-Information

Dongle-Batterie

Die Dongle-Batterie ist eine nicht-wiederaufladbare Lithium-Mangandioxid-Batterie (LiMnO₂), die in dem Dongle enthalten ist.

REACH SVHC Mitteilung

Gemäß der Verordnung (EG) No. 1907/2006 des Europäischen Parlaments und des Rates vom 18. Dezember 2006 zur Registrierung, Bewertung, Zulassung und Beschränkung chemischer Stoffe (REACH) gemäß Artikel 57 teilt Brain Products hiermit mit, dass die unten aufgeführten Produkte eine Konzentration eines besonders besorgniserregenden Stoffes (SVHC) von mehr als 0,1 Gewichtsprozent enthalten.

Knopfzelle in den Dongles:

Stoff	CAS Nr.
1,2-Dimethoxyethan; Ethylenglycoldimethylether	110-71-4

Entsorgung



**ELEKTROGERÄTE
RÜCKNAHME**

Die Produkte, Zubehör, Kabel und Batterien nicht über den Hausmüll entsorgen. Stets gemäß der nationalen Vorschriften entsorgen, in Deutschland beispielsweise über die Sammelboxen im Handel oder bei kommunalen Sammelstellen.

Batterien, die nicht fest in Elektrogeräte eingebaut sind und gefahrlos entnehmbar sind, müssen vor der Entsorgung des Elektrogeräts entnommen und separat entsorgt werden.

Note

In diesem Fall sind die Batterien fest eingebaut und müssen mit dem Dongle entsorgt werden.

In der EU und EFTA gelten beispielsweise die Verordnung (EU) 2023/1542 über Batterien und Altbatterien (Batterieverordnung) sowie die Richtlinie 2012/19/EU über Elektro- und Elektronik-Altgeräte (WEEE-Richtlinie).

Auf Anfrage nimmt Brain Products Ihre alten Geräte zurück, sofern es sich um Originalteile von Brain Products handelt.

Datenschutz

Wir möchten unsere Endnutzer darauf hinweisen, dass sie verantwortlich dafür sind, personenbezogene Daten auf den Geräten vor der Entsorgung zu löschen.

Risiken beim Umgang mit lithiumhaltigen Batterien**Anmerkung**

Um zu prüfen, ob Ihr Produkt lithiumhaltige Batterien enthält, siehe [Technical data](#).

Lithiumhaltige Batterien sind bei sachgemäßem Umgang sicher.

Bei unsachgemäßem Umgang können lithiumhaltige Batterien Brände verursachen.

- ▶ Vermeiden Sie mechanische Beschädigungen (zum Beispiel durch Stöße, Herunterfallen), thermische Einwirkungen (zum Beispiel starke Sonneneinstrahlung) sowie Kurzschlüsse.
- ▶ Berücksichtigen Sie die im Manual des Produktes beschriebenen Regeln bezüglich Laden, Verwendung, Lagerung und Transport, um Schäden zu vermeiden und die Lebenszeit der Batterien zu verlängern.
- ▶ Verwenden Sie keine defekten, beschädigten, verformten, aufgeblähten oder ausgelaufenen Batterien.

Registrierungsnummern

Brain Products GmbH ist als Hersteller von Elektro- und/oder Elektronikgeräten bei der stiftung elektro-altgeräte register, Nordostpark 72, 90411 Nürnberg unter der WEEE-Registrierungsnummer DE89975135 registriert.

Brain Products GmbH ist als Hersteller von Batterien bei der stiftung elektro-altgeräte register, Nordostpark 72, 90411 Nürnberg unter folgenden Batterie-Registrierungsnummern registriert:

DE28818587 (Gerätebatterien)

DE28818587 (Industriebatterien)