BRAIN PRODUCTS
Solutions for neurophysiological research

BrainVision Recorder

User Manual

Software version 1.21.0402

www.brainproducts.com

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About this document

This user manual describes the recording software *BrainVision Recorder*. This document forms an integral part of the product. Follow the instructions in this document in order to use the software correctly and as intended.

Target group of this document

This user manual is intended for users in the psychological and neurophysiological research area as well as physicians and medical experts.

Structure of this document

This document is divided into the following chapters:

- **Chapters 1 to 3**: Installation procedure and a high-level overview of Recorder for beginners.
- **Chapter 4**: Program modes (Administrator and Standard) and Program preferences.
- **Chapter 5**: General workspace settings and ways for creating a workspace.
- **Chapter 6**: Amplifier-specific settings in a workspace for all amplifiers.
- **Chapter 7**: Settings for your recording, for example Montages etc.
- **Chapter 8**: Information about the impedance measurement for active and passive electrodes.
- **Chapter 9**: Settings when using the actiCAP ControlBox with active electrodes.
- **Chapter 10**: Options when viewing the data.
- **Chapter 11**: Using Video Recorder.
- **Chapter 12**: OLE automation.
- **Chapter 13**: RDA settings.

Conventions in this document

Typographical conventions

Bold	indicates items on the user interface (menus, buttons, switches, connectors, options) and is used for emphases in the text
Italic	indicates titles of dialog boxes/tabs, file locations and is used to indicate product names
Underscore	indicates cross-references and web addresses
`Monospaced`	indicates text or characters to be entered at the keyboard

Symbols

Caution: This symbol indicates that incorrect use of the product(s) may result in a **personal injury** to the test subject, the user and/or a third-party. Failure to observe the information in this document constitutes incorrect use.

Notice: This symbol indicates that the incorrect use of the product(s) may bring about a risk of **damage to property**. Failure to observe the information in this document constitutes incorrect use.

Note or **Tip**: This symbol draws your attention to important information relating to the current topic and to recommendations on how to use the product(s).

Cross-reference: This symbol indicates a reference to a related chapter, section or document.

New: This symbol indicates changes or new content at this point.

Revision history

Page . . Status. . . . . .Subject

14 . . . . modified . . . . Application Suite is now available on USB instead of DVD, the procedure has been updated accordingly

79 . . . . modified . . . . LiveAmp 8/16/32 was previously listed as LiveAmp

80 . . . . modified . . . . Search for last connected LiveAmp option added

112 . . . new . . . . . Screenshot updated to reflect changes made to Averging and Baseline Cor-

rection

118 . . . new . . . . . Section has been updated to reflect changes made to Averaging and Baseline Correction

175 . . . modified . . . . Format of the EEG files section has been updated.

Reporting errors and support

We would ask you to report without delay any error you find in this document, any fault on the products or any malfunction that you observe when using this product. To do so, please contact your local dealer, who will also assist you in general questions about the product.

About Recorder

BrainVision Recorder is a powerful and flexible recording program. Its particular strengths lie in the following features:

- The program is structured in such a way that it is possible to use different amplifiers.
- The number of channels is restricted only by the amplifier that is being used. In itself, the internal structure of *Recorder* allows you to work with an unlimited number of channels.
- The fact that OLE automation has been implemented allows you to control *Recorder* remotely and monitor its internal status using other programs.
- The Remote Data Access (RDA) method allows you to acquire and record the digital signals with their own programs while the data is being displayed. This method can be used across different computers. Possible applications for RDA include biofeedback and signal quality analysis.
- Separate software filters that can be freely set on the level of single channels are available to you for displaying and storing continuous, segmented and averaged data.
- You can significantly reduce the space required to store your files using segmentation based on event markers.
- The optional video function allows you to record video data synchronously with your EEG data.
- The optional averaging function on the basis of event markers allows evoked potentials to be displayed during recording.
- The static overlay function allows you to compare current averaged data with, for instance, a prototypical curve that you have recorded previously with *Recorder* or calculated with *Analyzer*.

Recorder has an interface to the actiCAP ControlSoftware (as of version 1.2.1.0) to allow impedance measurement of active electrodes. If you control the actiCAP ControlSoftware using Recorder, you can automatically save the impedance values in the header file of the EEG data set, which obviates the need to save them in a separate file.

Recorder allows you to store amplifier-specific parameters (in the Amplifier menu), general configuration settings (in the Configuration menu) and the parameters used for impedance measurement in the workspace and load them automatically with the workspace.

In the same way as with *Analyzer*, you can select individual channels or multiple channels when viewing data (monitoring) in *Recorder* and display these separately.

The virtual amplifier function allows you to create and edit workspaces for your *BrainAmp* amplifier without the need to connect it to your computer.

Product identification

Product designation:	**BrainVision Recorder**
Manufacturer:	Brain Products GmbH Zeppelinstraße 7 D-82205 Gilching (Munich) Phone: +49 8105 73384 - 0 Fax: +49 8105 73384 - 33 Web site: http://www.brainproducts.com Email: techsup@brainproducts.com

Use together with other products and components

Recorder is permitted by Brain Products to be combined with the following amplifiers and software:

Product	Manufacturer
BrainAmp family (BrainAmp Standard, BrainAmp DC, BrainAmp MR, BrainAmp MR plus, BrainAmp ExG, BrainAmp ExG MR)	Brain Products GmbH
actiCHamp	Brain Products GmbH
FirstAmp	Brain Products GmbH
V-Amp	Brain Products GmbH
LiveAmp	Brain Products GmbH
MOVE	Brain Products GmbH
actiCAP ControlSoftware	Brain Products GmbH
RecView	Brain Products GmbH

Beside this general statement about permitted product combinations, the user must check, if all stipulations of each product (for example regarding its MR compatibility) are fulfilled for the specific combination and purpose of application (intended use and correct use).

Recorder may be used in combination with specific medical devices, , only if this combination is approved by the manufacturer of the medical device.

Intended use

As of September 30th, 2013 and software version 1.20.0601 *Recorder* is not a medical device anymore and can only be used in the context of non-medical applications in order to carry out fundamental or applied research on the basis of neurophysiological methodology and data.

Use of *Recorder* for diagnosis, therapy, monitoring of vital physiological processes (such as cardiovascular functions etc.) or other medical purposes is expressly forbidden.

Recorder is intended to be used for recording neuro-/electrophysiological signals (for example EEG, EMG, ECG, EOG) and/or signals from other approved sensors.

The user is solely liable for any risks if this software is not used in accordance with the correct use. Brain Products provides no guarantee and accepts no liability for the results obtained with *Recorder*.

Correct use

Recorder is permitted to be used by users in the psychological and neurophysiological research area as well as physicians and medical experts.

Recorder is not permitted to be used by

- unqualified persons (for example laymen),
- persons who cannot read (due to visual impairment, for example) or understand (due to a lack of language skills, for example) the user manual.

Recorder can be used to view and filter neuro-/electrophysiological signals from healthy and sick adults, children and animals.

Irrespective of any liability on our part, the specialist staff must observe the relevant national stipulations for operators and other relevant national legislation.

If you record EEG/ExG[1] signals in an MR scanner, the recording computer must always be positioned and used outside the scanner room.

All versions of *Recorder* that have been released into the market as medical products do remain medical products. Brain Products will continue to treat them as medical products until the end of their service life (for example by performing post market surveillance).

The user should be aware that if a former *Recorder* version that was a medical product is replaced by a newer version that is not a medical product anymore, the terms and conditions of the new *Recorder* version are effective only from then on.

1. EEG, EOG, ECG, EMG, EDA, etc.

1 Installing Recorder

Under normal conditions, Recorder does not cause any conflicts with other programs that are already installed. Brain Products, only guarantees that programs will interact without problems if the programs concerned have been tested for compatibility. This applies to BrainVision Analyzer, BrainVision RecView and actiCAP ControlSoftware and to the Microsoft operating systems provided that no modifications to the configuration of the operating system as delivered have been undertaken (including official service packs and updates).

To install Recorder you must be logged on as system administrator.

1.1 System requirements

The computer should fulfill the following minimum hardware and software requirements:

Operating System	Windows® 7 32-bit and 64-bit Windows® 8 64-bit Windows® 8.1 64-bit Windows® 10 64-bit
Processor	Intel Pentium III processor 1 GHz or higher
Graphics adapter	Min. resolution 1,024 x 768 pixels and 32,768 colors
RAM	Windows® 7: min. 1 GB Windows® 8 / 8.1: min. 2 GB Windows® 10: min. 4 GB
Free disk space	Min. 2 GB free hard-disk space Additional storage requirements depend on the extent of the data to be processed.
Monitor	Min. 17" A 21" monitor is recommended for more than 32 channels.

1.2 Preparing your computer

Before installing or using Recorder make sure that the performance of your system is not impaired by background processes or other real-time applications which run with higher priority.

Do the following:

- Uninstall software that you don't need (for example, promotional software).
- 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)
- Run critical real-time applications on a separate computer, for example:
  - NIRS acquisition
  - eye tracker acquisition
  - stimulation software
  - voice, video, audio processing
  - flash applications
  - time tracker
- Change the settings of Windows® processes (see also: Troubleshooting), for example:
  - screen saver
  - defragmentation
  - Windows® update
  - power management

Note

Do not use the recording computer to browse the Internet or playback multimedia files.

1.3 Install Recorder

Note

Install Recorder on a stand-alone computer. **No stimulation, NIRS, eye-tracking or similar software must run on this computer.**

1 Insert the *Application Suite* USB into a USB drive.

Open Windows Explorer or My Computer and browse to the location of the Application Suite USB. (Browse to the Application Suite USB folder.)

2 Double click to open the folder.

3 Double click **Autorun.exe**.

The Welcome screen opens.

4 Click **Install BrainVision Recorder & Video Recorder**.

The BrainVision Recorder screen opens.

5 Click **Install BrainVision Recorder**.

Follow the installation routine and use the default settings.

6 Now install all Recorder updates that may be available.

➔ By default, the installation directory of Recorder is `C:\Vision`.

Browse to the Application Suite USB folder

1 On your keyboard, press the Windows key + R key.

2 In the Run dialog, click on **Browse...**

3 Select the USB port and double-click the *Autorun.exe*.

4 In the Run dialog, click on **OK**.

➔ The Welcome screen of the Application Suite opens.

1.4 Update Recorder

New versions and updates of Recorder can be downloaded from the web site: http://www.brain-products.com/. You need to login in to access the download area.

Small updates might be available on the Application Suite USB. You can install these directly from the USB, if applicable.

1 Open the Welcome screen of Application Suite USB.
2 Click **Install BrainVision Recorder & Video Recorder**.
The BrainVision *Recorder* screen opens.
3 Click on **Install New Modules** to install minor updates.
The button is only available, if there are new modules.

1.5 Check the license information

After installing Recorder, ensure that the license information is correct.

Pre-requisites:

- licence dongle connected to computer

1 Start Recorder
When you start Recorder for the first time, start in Administrator mode. (For details refer to Program preferences.
2 Choose **Help › About BrainVision Recorder...**

➔ The About dialog opens.

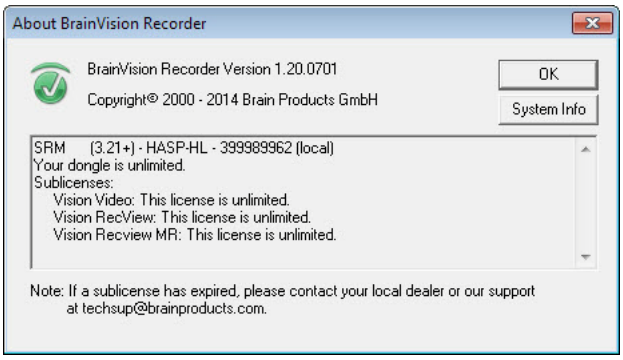


Figure 1-1. Dongle information

The About dialog contains the following information:

- dongle information and internal serial number of the dongle
- expiry date of the dongle and
- add-on licenses[1] bound to the dongle

If your dongle is due to expire, for example less than 30 days are left, a warning appears when you start Recorder. Contact your local dealer for a renewal.

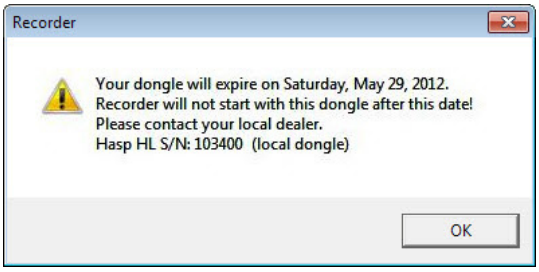


Figure 1-2. Warning before a dongle expires

Notes

- For Hardlock and LPT dongles no expiry date is shown.
- If you are using a Hardlock, LPT or HASP HL dongle, please contact your local dealer or Brain Products sales to replace your dongle with a latest dongle technology.
- For more information about the dongles, refer to Appendix B.

1. Depending on you dongle technology the add-on licenses may be called sublicenses.

2 Basic procedures

When you start a project from scratch you basically follow the steps below:

1 Connect the amplifier

First connect the amplifier to your computer and switch the amplifier on (if applicable).

2 Start Recorder

3 Select the amplifier in Recorder

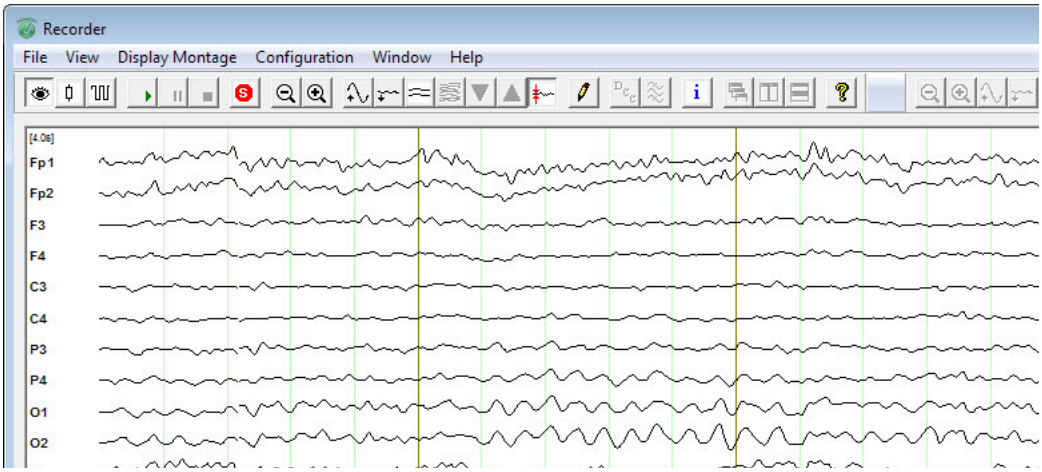
Click on **Configuration › Select Amplifier...** and select your amplifier from the drop-down list. You must start Recorder in administrator mode.

4 Create or open a workspace

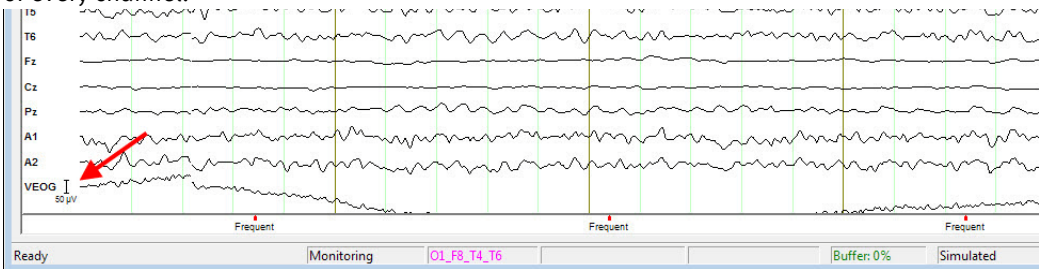
A workspace saves all amplifier-specific settings and some basic project settings, for example filters, segmentation and averaging.

5 Start monitoring

To check if the amplifier is working properly click on the button **Start Monitoring** . If no errors are encountered, EEG curves appear in Recorder window running from left to right.



At the end of the channel list there is a scaling bar that helps you to assess the signal size. If a small number of channels is displayed and there is enough space, a scaling bar is shown in front of every channel.



6 Measure the impedances

When all channels show a signal, measure the impedances. This is an important step in your project.

7 Record the data

From the impedance check you can switch directly to recording the data.

3 Your first steps in Recorder

Read this chapter if you are using Recorder for the first time.

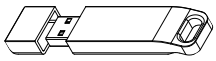
For your first steps you don't need an amplifier. Recorder has a simulated amplifier with which you can try out the basic functions. You can use the simulated amplifier whenever you want to try out functions or see the impact of settings.

3.1 Start Recorder for the first time

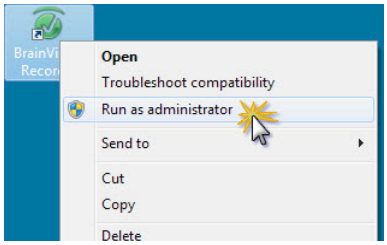
When you start *Recorder* for the first time, you must select an amplifier.

Prepare:

- license dongle

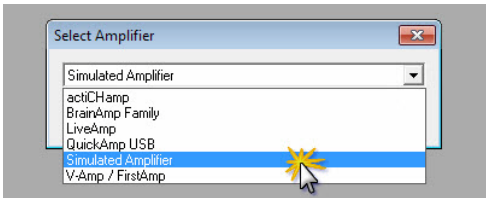


1 Connect the supplied license dongle to a USB port of the computer.



2 Start Recorder in administrator mode.
   ▷ Right-click on the Recorder icon and choose **Run as administrator**.
   ▷ Confirm the subsequent dialog.

3 In Recorder, click on **Configuration › Select Amplifier...**



4 Select your amplifier[a] from the drop down list and click on **OK**.

a. Depending on your system, not all amplifiers, as illustrated above, will be displayed

3.2 Simulate an EEG monitoring

Recorder has a simulated amplifier. You can use it to make yourself familiar with the basic functions of Recorder.

Pre-requisites

- Simulated amplifier selected

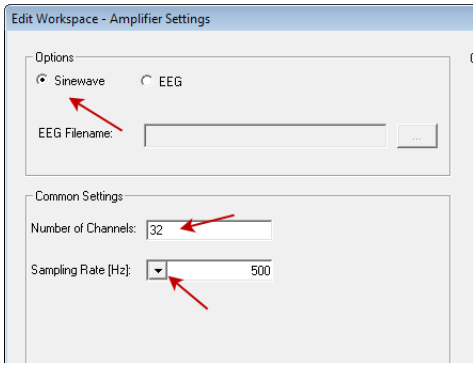
1 Choose **File › New Workspace...** from the menu bar.

The workspace wizard opens.

2 Click on **Next** in the first dialog page.

3 In the amplifier settings choose:

- ▷ Sinewave
- ▷ Number of Channels: 32
- ▷ Sampling Rate [Hz]: 500

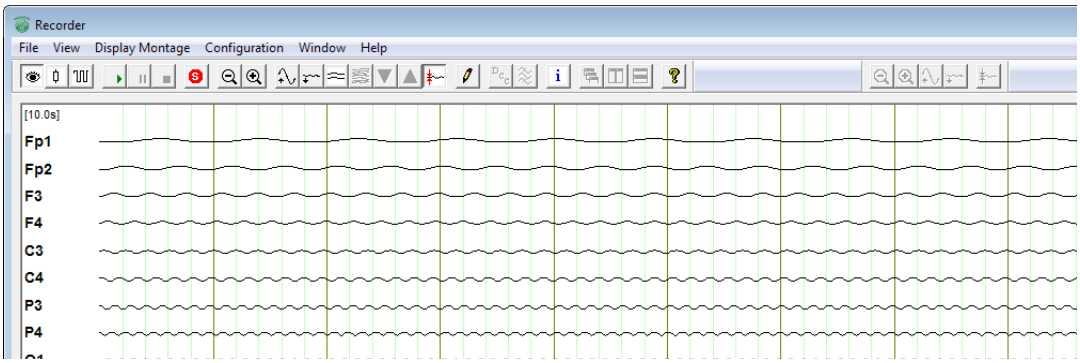


4 Click on **Next** (three times) and then on **Finish**.

5 Now click on the button **Start Monitoring** .

➔ The data is displayed but not saved. Each channel has another sine wave.

➔ To stop the monitoring mode click on the button **Stop Monitoring** .



3.3 Understanding the toolbar

Try out the common functions in the toolbar.

Changing the data display

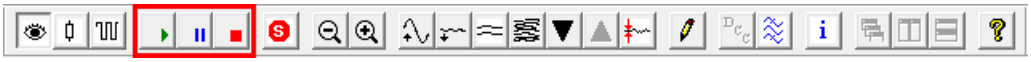
You can change the way the data is displayed by using the toolbar buttons:

	Increase the display interval (zoom out).
	Decrease the display interval (zoom in).
	Increase the scaling factor.
	Decrease the scaling factor.
	Decrease the number channels that are displayed on one screen.
	Increase the number of channels that are displayed on one screen.
	Switch to the next group of channels.
	Switch to the previous group of channels. **Note**: The Next Group and Previous Group buttons are only available, if you decrease the number of displayed channels or if you have more than 64 channels.
	Baseline Correction in Display activates or deactivates baseline correction. When activated, only the baseline of the display is changed, and not the actual data.

 For advanced view options, refer to Chapter 10.

3.4 Record the EEG data

You must save EEG data to analyze them later in Analyzer, for example.



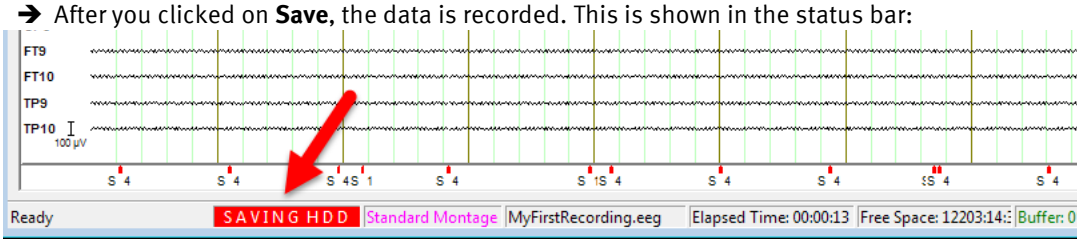
Pre-requisites

- Data monitoring is running

1 Click on the button **Record** .
The Save As dialog opens.

2 Put in a filename and optionally a comment.
The comment will be stored in the header file (*.VHDR).

➔ After you clicked on **Save**, the data is recorded. This is shown in the status bar:



Recording options

	Pause the recording. To continue, click on the button **Record** . A new segment marker will be set.
	You can stop recording with the button **Stop Recording** . When you click on button **Record** you can append the data to the previous EEG file. In this case, a new segment marker will be set.

3.5 Insert an annotation

In your project you might want to insert a note text to remember what a test subject did at a certain point; for example, *moving*.

Pre-requisites

- Monitoring or recording started

1 Increase the display interval to a maximum. Click the button **Increase Interval** until it is disabled.

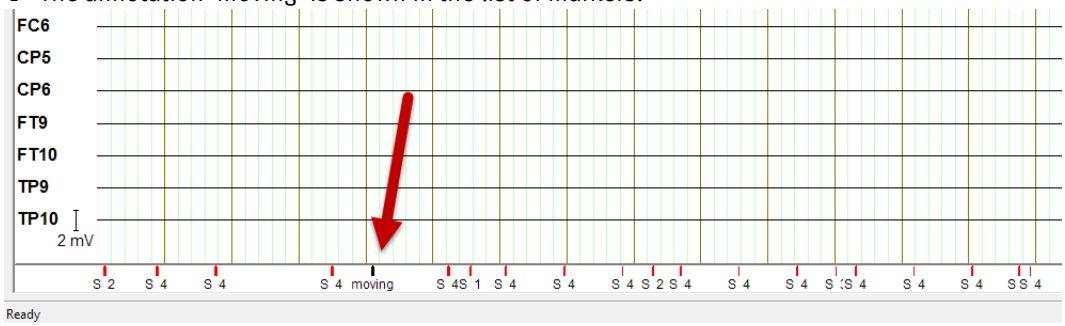
This gives you more time to see where the annotation is inserted. Once you know how it works you don't need to increase the display interval.

2 Click the button **Annotation**.

The Annotation dialog opens.

3 Put in a short, meaningful description, for example 'moving', and click **OK** or press Enter.

➔ The annotation 'moving' is shown in the list of markers.



Note: Annotations are inserted with a black marker. The red markers come from the amplifier.

3.6 Close Recorder

Recorder can't be closed during recording or data monitoring. You must first stop the data stream from the amplifier. Do the following:

1 While a recording is progress, click on the button **Stop Recording**  .

2 Then click on the button **Stop Monitoring**  .

This button is only active if a mode is running (data monitoring, test signal or impedance check).

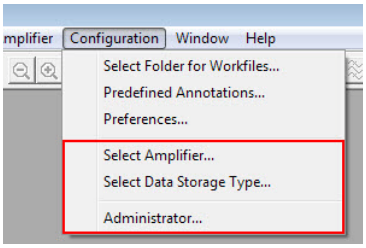
➔ You can now close Recorder.

4 Program preferences

4.1 Starting Recorder

You can start Recorder in administrator mode or in standard mode.

The administrator mode is mainly used for the basic program configuration. In the administrator mode you can change basic settings in the menu **Configuration**.



Limits in standard and administrator mode

	Standard	Administrator
Select amplifier	No	Yes
Select the data storage type	No	Yes
Change user rights	No	Yes

4.1.1 Start in standard mode

To start Recorder in standard mode, do the following:

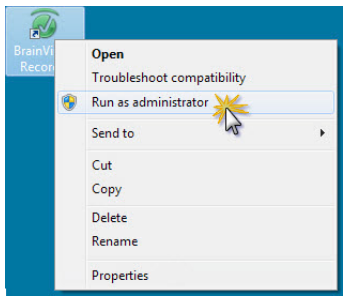
1 Double-click on the Recorder icon. 

➔ Recorder starts in standard mode with limited functionality.

4.1.2 Start in administrator mode

To start Recorder in administrator mode, do the following:

1 Right-click on the Recorder icon and choose **Run as administrator**.

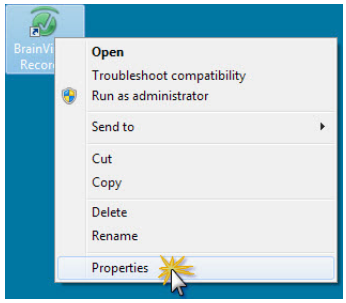


➔ Recorder starts this time in administrator mode.

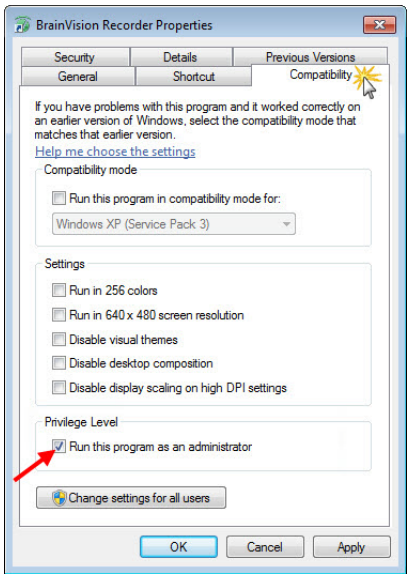
4.1.3 Set administrator mode as default

If you generally want to start Recorder as administrator, do the following:

1 Right-click on the Recorder icon and choose **Properties**.



2 Then, click on the **Compatibility** tab and choose **Run this program as an administrator**.



➔ Recorder will always start in administrator mode. You can undo this setting any time.

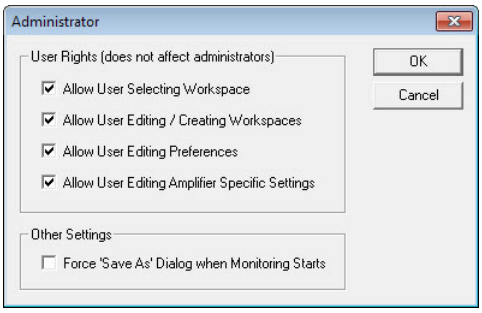
4.2 Setting user rights

As administrator you can limit the program functions for other users.

1 Start Recorder in administrator mode.

2 Click on **Configuration › Administrator**.

➔ The Administrator dialog opens.



Allow User Selecting Workspace	When deselected users cannot change the workspace. Editing or creating a workspace will still be possible.
Allow User Editing/Creating Workspaces	When deselected, users cannot edit or create a workspace. Opening another workspace will still be possible. **Tip**: Deselect the first and second option, if users must not change workspace settings.
Allow User Editing Preferences	This allows users to make changes to the global program configuration (**Configuration › Preferences...**). For details refer to Set global program preferences.
Allow User Editing Amplifier Specific Settings	When deselected, the options in the menu **Amplifier** are not available (for example, digital port settings). **Tip**: Deselct if the user must not change any settings related to triggers, for example
Force 'Save As' Dialog when Monitoring Starts	With this option, the ‘Save As’ dialog opens ever time the users clicks on the monitoring button.

4.3 Set global program preferences

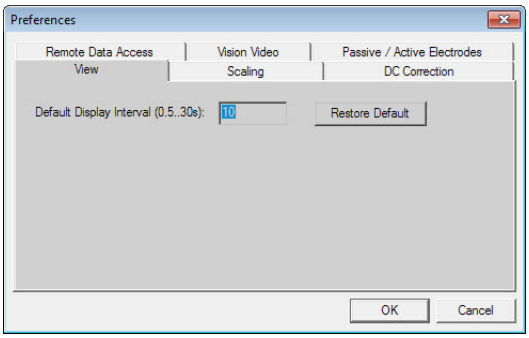
You can configure global program settings for all users.

1 Start Recorder in administrator mode or as standard user with the corresponding rights.

2 Click on **Configuration › Preferences...**

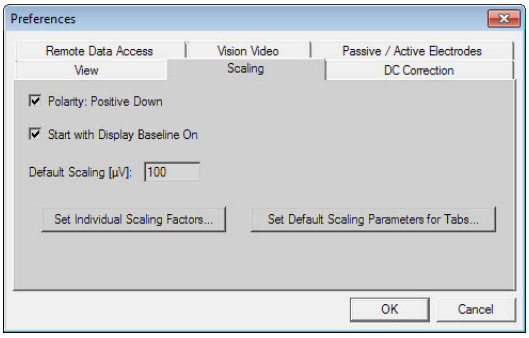
➔ The **Preferences** dialog opens.

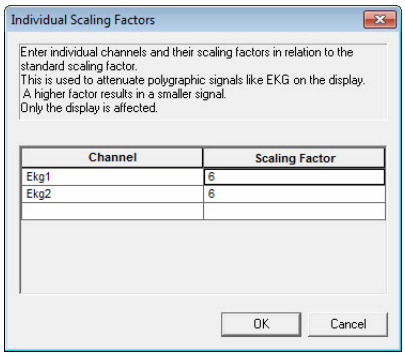
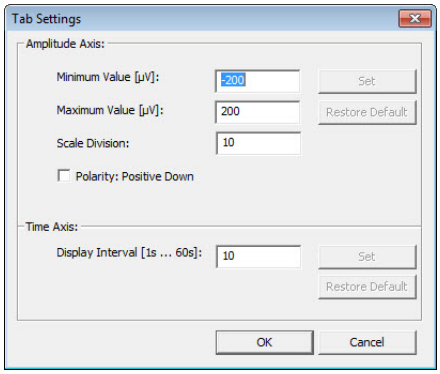
View tab



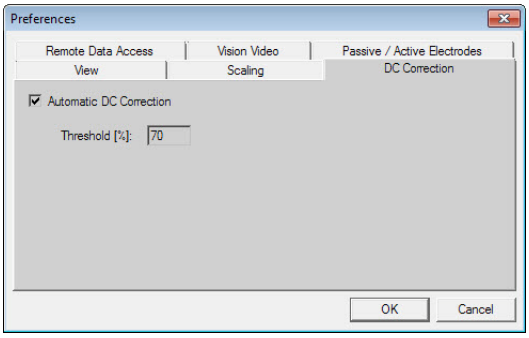
Default Display Interval	specifies the time interval shown on the computer screen by default.
Restore Default	allows you to reset any value that has been changed to the initial value.

Scaling settings tab



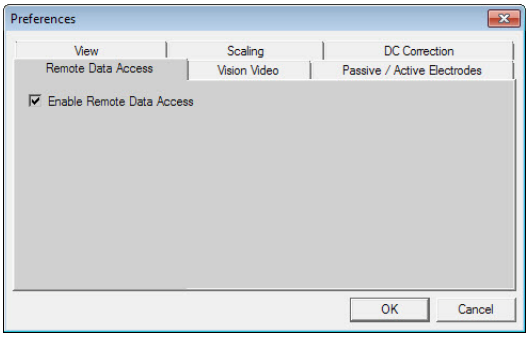
Polarity: Positive Down	defines the polarity of the displayed signal. If you select this box, the axis for positive signals points downwards.
Start with Display Baseline On	activates the button **Baseline Correction** is active by default.
Default Scaling [µV]	text box contains the scaling value to be used when monitoring starts.
Set Individual Scaling Factors... 	specify the channel for which you want to change the display scaling. Enter the channel names and a scaling factor. integer (e.g. 1, 2) = reduce scaling fractional number (e.g. 0.1) = increase scaling. The scaling only affects the display of the data; it does not affect the data itself. It makes sense to display the ECG channels with reduced scaling, since otherwise they encroach significantly on the curves of the EEG channels.
Set Default Scaling Parameters for Tabs... 	specifies the scaling of the amplitude and time axes for the scientific view. The setting applies to all the tabs in the scientific view.

DC Correction tab



Automatic DC Correction	Choose to activate automatic DC offset correction. You can specify the threshold (in percent) for the DC offset correction in the text box **Threshold [%]**. For further information on DC correction, refer to Toolbar.

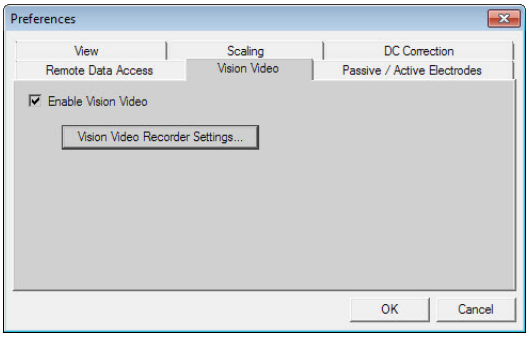
Remote Data Access tab



Enable Remote Data Access	to enable the RDA server. For further information on using the RDA server, refer to Chapter 13.

Vision Video tab

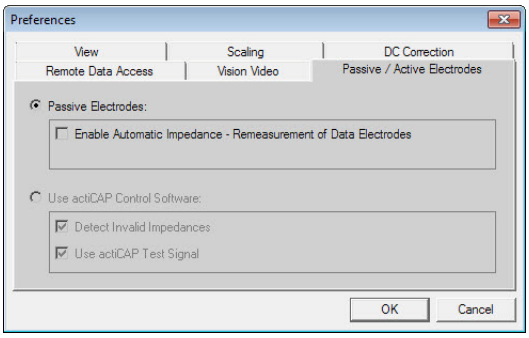
This tab is only available, If you have installed Video Recorder and if you purchased the corresponding add-on license.



Enable Vision Video	Choose to enable Vision Video. For using Vision Video refer to Chapter 11. Information about add-on licenses refer to Appendix B.

Passive/Active Electrodes tab

For BrainAmp, V-Amp and QuickAmp you must specify whether you are using passive electrodes or the actiCAP ControlBox with active electrodes.



Passive Electrodes	Choose if you are using passive electrodes. **Enable Automatic Impedance-Remeasurement of Data Electrodes:** Impedance measurement of the data electrodes (not reference and ground) is repeated, if the measured values were invalid. Invalid impedances are detected, if the measurement has not yet started or if the values are outside the measurement range. If the impedances are still invalid after the subsequent measurement, a message is shown where you can allow (**Yes**) or disallow (**No**) invalid impedances. When you click on **No**, you must improve the impedances before you can continue.
Use actiCAP Control Software	Choose if you use the actiCAP ControlBox with active electrodes. When selected, Recorder interfaces with the actiCAP ControlSoftware.
	Detect Invalid Impedances A message is shown where you can allow too high impedances.
	Use actiCAP Test Signal When selected, the button **Test Signal** in the toolbar is disabled, and you use the button **Test** on the actiCAP ControlBox

5 Workspace

Workspaces save user defined settings, such as file locations, amplifier parameters, cap configuration, electrode positions etcetera. You work with only one workspace at any one time. You can, , set up multiple workspaces with different settings, and switch between these as you wish. This provides you with an easy way to access recording parameters that you use frequently.

Whenever you set up or edit a workspace, you are assisted by a **wizard** that allows you, for example, to define channel names and the sampling rate for the recording.

Alongside these settings you make in the wizard, the workspace also stores all the settings you make in the **Amplifier** and **Configuration** menus. Also the impedance measurement settings are stored with the workspace (see Chapter 8).

When you create or edit a workspace the parameter settings are automatically taken from the last workspace that was opened. As a result, you may need to adapt these settings for use in the current workspace.

5.1 The workspace at a glance

Workspaces are created with the help of the workspace wizard. It consists of four dialog pages:

- Data File Settings
- Amplifier Settings
- Software Filters
- Averaging / Segmentation

Pre-requisites

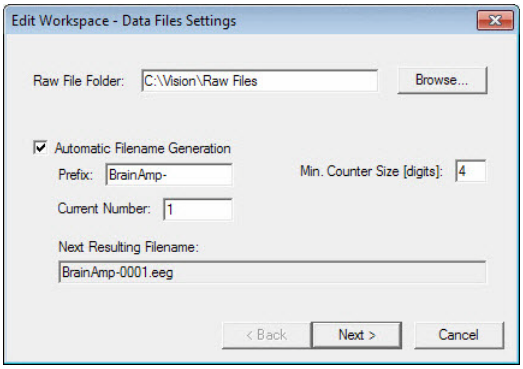
- An amplifier is selected
- The amplifier is connected to the recording computer

Click on **File › New Workspace...** or **File › Edit Workspace...**

➔ The workspace wizard opens.

Workspace wizard 1: Data File Settings

On the first dialog page, you set all file related options.



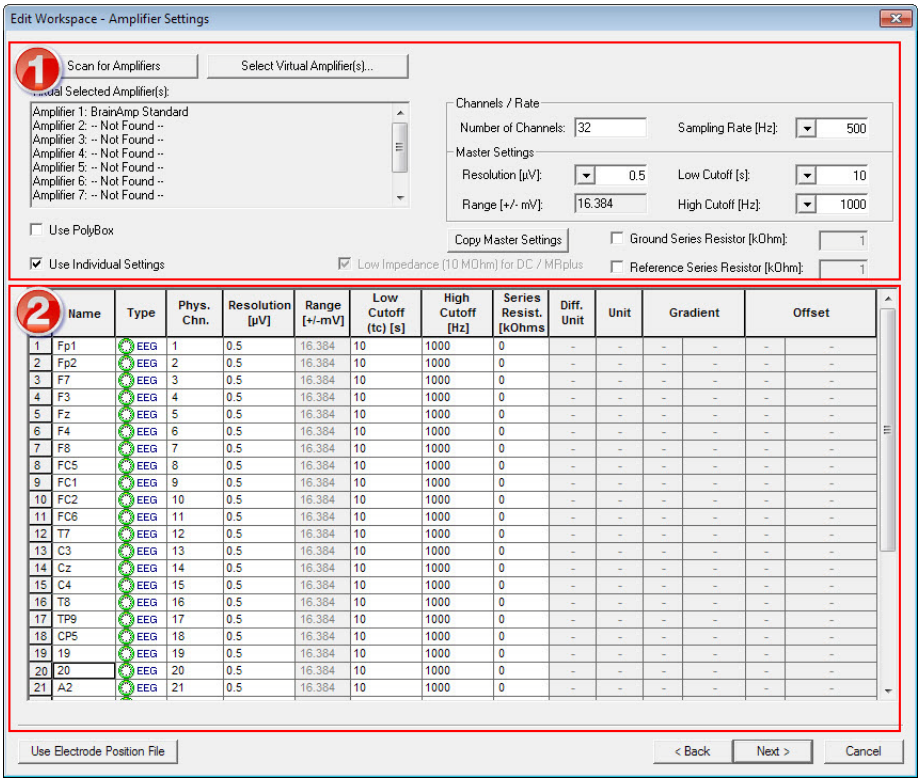
Raw File Folder	specifies the destination directory for the EEG data. By default this is 'C:\Vision\Raw Files'.
Automatic Filename Generation	generates automatic file names consisting of a *Prefix* and *Counter*. The prefix does not change. The counter is incremented each time you save data. You can specify the length of the counter by entering a number between 4 and 10
Current Number	specifies the start number of the counter.
Next Resulting Filename	shows the name that results from the entries you have made. In the example above the first data set is saved as 'BrainAmp_0001.eeg'. The second data set would, thus, be 'BrainAmp_0002.eeg'.

➔ Click on **Next** to open the dialog *Amplifier Settings*.

Workspace wizard 2: Amplifier Settings

The second dialog page contains amplifier-specific parameters (1) and the channel table (2).

Each amplifier family has its specific settings. For more details about the workspace for your amplifier refer to Amplifier-specific settings.

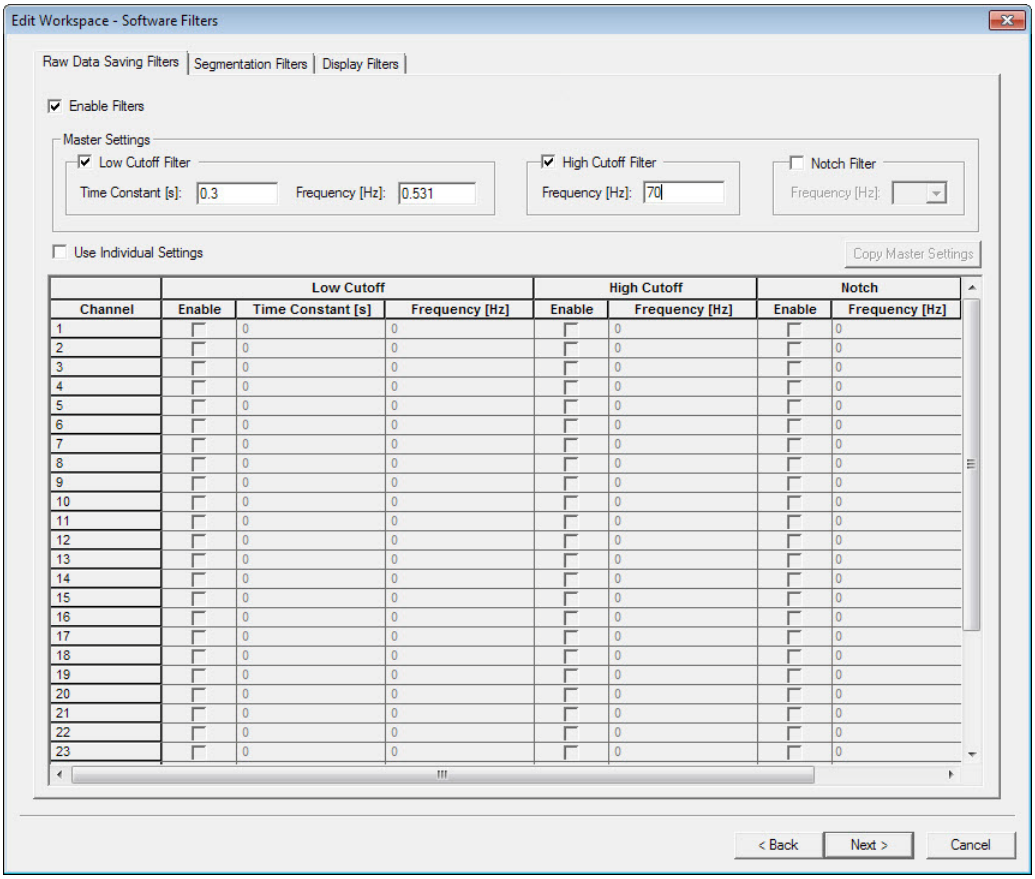


Scan for Amplifiers	before you can setup a workspace, you must scan for an amplifier. This connects the amplifier to Recorder. The detected amplifier(s) are shown in the *Scanned Amplifier(s)* list.
Number of channels	specify the number of channels (including data, ground, reference and auxiliary channels, if applicable).
Sampling rate	choose a sampling rate from the drop down list. Depending on your amplifier, a higher sampling rate can limit the number of channels.
Use Electrode Position File	Please refer to Using electrode position files.

➔ Click on **Next** to open the dialog *Software Filters*.

Workspace wizard 3: Filter settings

The third page contains the filter settings.



Three filter methods are available:

- **Raw Data Saving Filters**

  Filters are directly applied to the raw data. Use of this filter is not recommended, because this changes the raw data. When using BrainVision Analyzer you can apply filters to the raw data.

- **Segmentation Filters**

  When you specify segmentation (subsequent tab of the workspace wizard) you can also set filters for the segmented data.

- **Display Filters**

  This filter only has an effect on the display on your screen. When you set the filter, you can switch it on and off during the data display of the data by clicking on the button **Display Filter** .

Enable Filters	You can also deactivate the paths completely by deselecting the box for each path Because the filters are software filters, you can enter any values. Nevertheless, you should take care not to set any frequencies with a value equal to or greater than half the selected sampling rate.
Low Cutoff Filter High Cutoff Filter	The slope for the low-cutoff filter and the high-cutoff filter is 12 dB/ octave. 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.
Notch filter	This filters the noise of the mains line. You can choose between 50 Hz and 60 Hz. Depending on your region, the mains noise is either 50 Hz (for example, Germany) or 60 Hz (for example, USA).
Use Individual Settings	You can apply this setting to the channels as a group or to individual channels by selecting or deselecting the box.
Copy master settings	Copies the settings from above into the channel table. This button is only active, when you select the check box Use Individual Settings.

➔ Click on **Next** to open the dialog Segmentation / Averaging

Workspace wizard 4: Segmentation / Averaging

The Segmentation / Averaging dialog allows you to make optional settings for segmentation and averaging. You will find a detailed description of the configuration options for segmentation and averaging in Section 7.2.

Workspace wizard 5: Saving

When you click on Finish, the Save As dialog opens allowing you to save the workspace file.

Give the file a meaningful name and click **Save**.

5.2 Create a workspace from scratch

Pre-requisites

- An amplifier is selected
- The amplifier is connected to the recording computer

1 Click on **File › New Workspace...** or **File › Edit Workspace...**
The workspace wizard opens.

2 Configure the data file settings (first dialog page) and click on **Next**.

3 In the Amplifier Settings dialog, click on **Scan for Amplifiers**.
The connected amplifier will be displayed in the field underneath the button.

4 Configure the settings according to your needs (also: Filters and Segmentation/Averaging).

5 When finished click on **Finish** to save the workspace.
The Save As dialog opens allowing you to save the workspace file.

➔ By default the workspace is stored in *C:\Vision\Workfiles* .

5.3 Using electrode position files

Electrode names, electrode topographies and physical channels are assigned in a workspace. Newly created workspaces do not yet contain these specifications and they therefore have to be imported. To assist in the import function, there is a special electrode position file (EPF) created by the cap manufacturer. Alongside the names and positions of the electrodes (phi, theta, radius values), this also contains the physical channels.

An EPF can be used equally well for both for proportional (10-20 system incl. extensions) and spherical caps (equidistant) and gives users the opportunity to adapt the electrode position data (for example the physical channel). The EPF is written in XML format and is saved as a BVEF file. This can be opened and edited in a text editor. The file has the following structure (see also the Analyzer Manual):

```
<?xml version="1.0"?>
<Electrodes>
<Electrode>                  //opening tag
        <Name>Fp1</Name>     //Electrode name (here: 10-20 system)
        <Phi>-72</Phi>       //Phi value
        <Theta>-90</Theta>   //Theta value
        <Radius>1</Radius>   //Radius value
        <Number>1</Number>   //Physical channel
<Electrode>                  //closing tag
<Electrode>
        <Name>Fp2</Name>
        <Phi>72</Phi>
        <Theta>90</Theta>
        <Radius>1</Radius>
        <Number>2</Number>
</Electrode>
...
</Electrodes>
```

Figure 5-1. Example electrode position file

When the electrode position file has been read into *Recorder*, the data is written to the header file which acts as the interface between *Recorder* and *Analyzer*. This means that the same information is available in both *Recorder* and *Analyzer*.

5.3.1 Create a workspace using an electrode position file

You can either load the complete electrode position file, which covers the channel table and electrode topography or only load the electrode topography for the electrodes that are already present in the channel table.

- ▶ Load complete file: Steps 1 - 7
- ▶ Load electrode topography: Skip step 6

Pre-requisites:

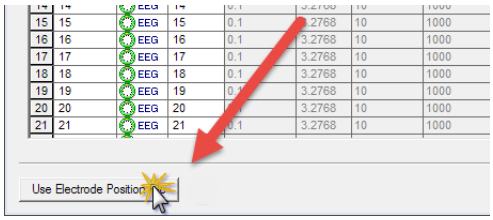
- An amplifier is selected
- The amplifier is connected to the recording computer

1 Click on **File › New Workspace...** or

The workspace wizard opens.

2 Go to the Amplifier Settings dialog (second dialog page).

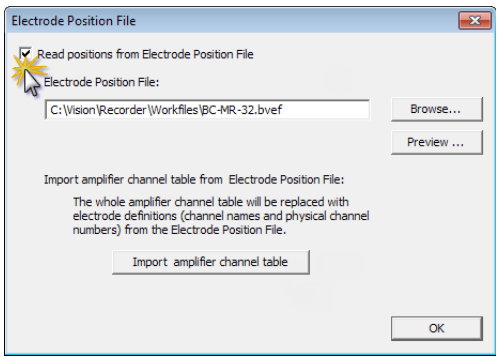
3 Click on **Use Electrode Position File**.



4 Select the check box **Read positions from Electrode Position File.**

5 Click on **Browse** and locate the electrode position file (*.BVEF).

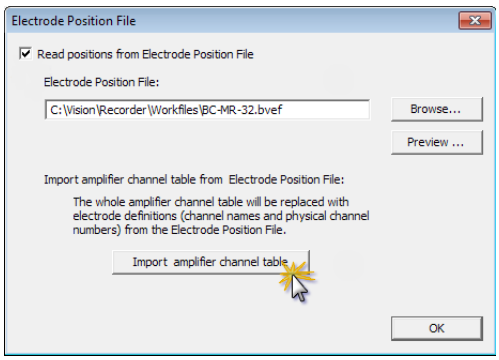
If you want to check the file, click on **Preview...**



6 Click on **Import amplifier channel table**.

Recorder takes over the assignment of channel names and physical channels.

NOTE: Don't click this button if you edit an existing workspace and want to keep the channel assignment.



7 Click on **OK** to load the electrode positions (topographies).

➔ The electrode positions and the channel table (if applicable), are loaded into Recorder. The information is written into the header file.

➔ You can check the result in the impedance measurement window.

Possible errors sources

- More channels in electrode position file than in the workspace:

  The exceeding channels are not imported. Change the number of channels in your workspace.

- Less channels in electrode position file than in the workspace

  The remaining channels stay unoccupied. You can remove the unoccupied channels from workspace, if necessary.

- You don't import the channel table and the electrode position file does not contain data for some electrodes in the workspace:

  The missing electrodes are set to zero. In the impedance measurement, these electrodes are displayed at the edge.

- Any changes to electrode positions during the impedance measurement are not written to the original electrode position file.

Electrode positions when using actiCAP Control Software

If you use active electrodes with the *actiCAP Control Software* as interface then the positions that are read in are not displayed in the topography during the impedance measurement. The values are nevertheless written to the header file.

5.3.2 Remove the electrode position file from the workspace

If you have already imported an electrode position file in the project then *Recorder* loads this file again when you open an existing workspace or create a new one.

You can stop the import as follows:

1 Click on **Use Electrode Position File**.

2 Deselect the check box **Read positions from Electrode Position File**.

3 Click **OK**.

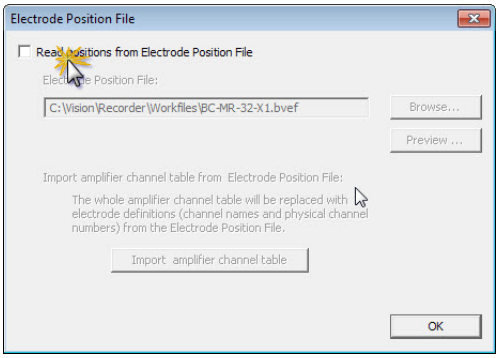


Figure 5-2. Stop the use of an electrode position file

5.4 Open a standard workspace

The first time you start *Recorder* it creates a default workspace. You can find standard workspaces on the *Application Suite* USB. Workspaces have the file extension *.RWKSP.

1 To open a workspace click on the menu **File › Open Workspace...**

2 Locate and open the workspace.

The default location for workspaces is *C:\Vision\Workfiles*.

Note

Workspaces of *Recorder* 1.10 or earlier contain only the parameters that were entered using the wizard but not the settings from the **Configuration** and **Amplifier** menus. If you open such workspaces then the corresponding parameters are taken over from the last opened workspace.

5.5 Display information of your workspace

You can view the parameters of the current workspace at any time – even during recording – by clicking the button **Show Workspace Info** i in the toolbar.

6 Amplifier-specific settings

Compatibility of Windows® and amplifiers

Some amplifiers are not supported by all Windows® operating systems. The following table provides an overview of the compatibility:

Amplifier	**Windows® 7** (SP3, 32-bit)	**Windows® 7** (64-bit)	**Windows® 8** (64-bit)	**Windows® 8.1** (64-bit)	**Windows® 10** (64-bit)
BrainAmp USB	●	●	●	●	●
actiCHamp	●	●	●	●	●
V-Amp / FirstAmp	●	●	●	●	●
LiveAmp	●	●	●	●	●

6.1 Simulated amplifier

The Simulated Amplifier function allows you to:

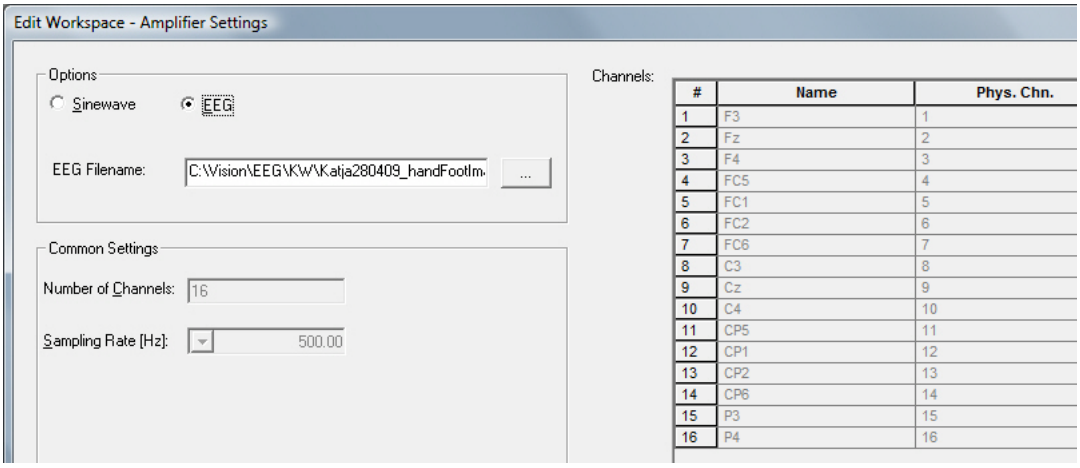
- use the Recorder without having an amplifier connected.
- display an EEG that has already been recorded.

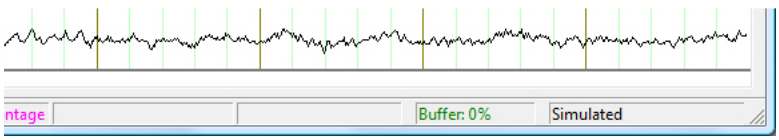
It simulates the activity of up to 256 channels.

6.1.1 Simulated workspace at a glance

When you select the simulated amplifier, a ‘simulated’ workspace is created. The parameters for this workspace are taken from the most recent workspace based on a real amplifier. You can edit the workspace for the simulated amplifier without overwriting the original workspace based on a real amplifier.

If you select a real amplifier after the simulated amplifier, the most recent associated workspace is loaded without changes (rather than the simulated workspace).



Sinewave	Sinewaves will be displayed for all channels.
EEG	Click the Browse button ... to open a saved EEG data set. If you then switch the Recorder to monitoring mode, the EEG data set is displayed. The EEG data is displayed in the same way as with a real amplifier. The EEG data set is repeated in a loop. 

Number of Channels	You can select up to 256 channels.
Sampling Rate [Hz]	Select a sampling rate.

Note

The menu bar does not contain the **Amplifier** item if you are using the Simulated Amplifier function.

Don’t modify the file properties of the simulated workspace.

6.2 BrainAmp amplifiers

6.2.1 BrainAmp workspace at a glance

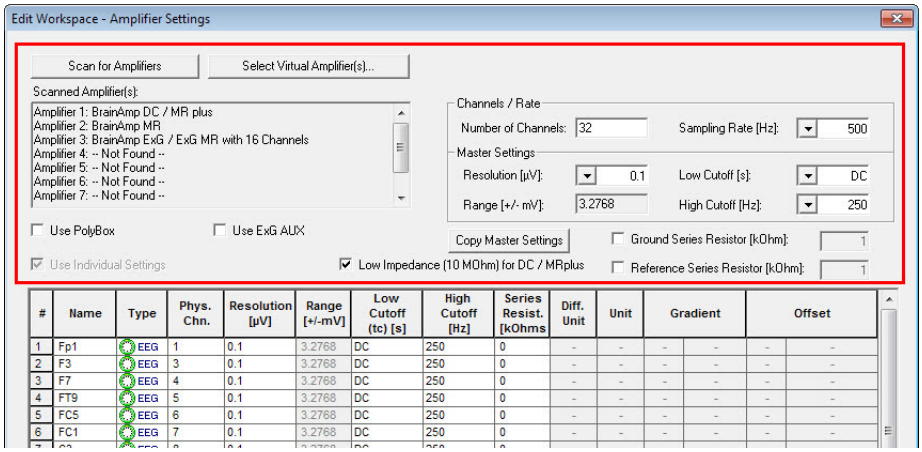
To access the workspace you must first create or edit a workspace.

1 Choose **File › New Workspace...** from the menu.

2 If you have connected an amplifier click on **Scan for Amplifiers**...
If you don't have an amplifier or **Select Virtual Amplifier(s)...** and select an amplifier.

3 The workspace wizard opens. Skip the first dialog page.

➔ On the Amplifier Settings dialog page, the settings for your amplifier are in the upper section.

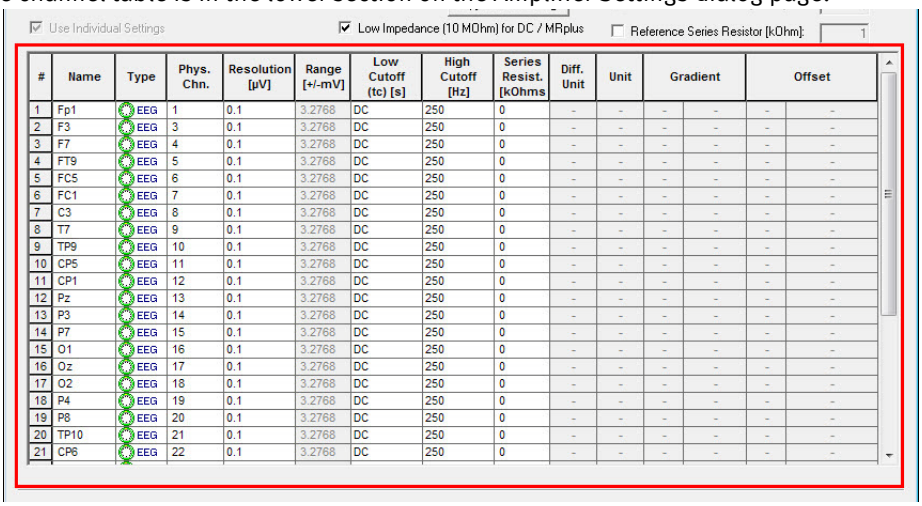


Number of Channels	Enter the number of channels.
Sampling Rate [Hz]	Choose the sampling rate from the drop-down list.
Resolution [µV]	Choose an amplitude resolution from the drop-down list.
Range [+/- mV]	The mV range shows the range across which the amplifier sends data to Recorder.
Low Cutoff [s] High Cutoff [Hz]	Specify the low and high-cutoff filters for the hardware.
Use PolyBox	If you are using a PolyBox select this check box to enable it. Refer to Use PolyBox.
Use ExG AUX	If you are using the AUX Box select this check box to enable it. Refer to Use ExG AUX.

Use Individual Settings	This allows you to make the relevant settings separately for each channel in a table.
Low Impedance (10 MOhm) for DC/ MRplus	Allows you to switch the input impedance of more than 10 GOhm to 10 MOhm if you are using a BrainAmp DC or BrainAmp MR plus in conjunction with a BrainAmp Standard or BrainAmp MR. This sets the input impedance of all amplifiers to a common value (10 MOhm).
Copy Master Settings	The *Copy Master Settings* button allows you to copy the parameters you have entered into the channel table so that you only have to edit those channels for which the settings are different.
Ground Series Resistor [kOhm] Reference Series Resistor [kOhm]	To specify the values for the protective resistors fitted in the electrode cables of the ground electrode and reference electrode, select the **Ground Series Resistor [kOhm]** and/or **Reference Series Resistor [kOhm]** box and assign the relevant values in the associated text boxes. **Note:** These details are only required for *B*rainAmp MR amplifiers or if you are using an electrode cap for acquisition that is fitted with resistors in the electrodes (for example, BrainCap MR or bipolar electrodes used in MR scanners). The resistance values for these protective resistors are stored in the workspace and are subtracted from the measured impedances during impedance measurement, so that only the impedance between the skin and the electrodes is shown in the **Impedance Check View** and saved in the header file.

Editing the channel table

➔ The channel table is in the lower section on the Amplifier Settings dialog page.



#	Name	Type	Phys. Chn.	Resolution [µV]	Range [+/-mV]	Low Cutoff (tc) [s]	High Cutoff [Hz]	Series Resist. [kOhms	Diff. Unit	Unit	Gradient		Offset	
1	Fp1	EEG	1	0.1	3.2768	DC	250	0	-	-	-	-	-	-
2	F3	EEG	3	0.1	3.2768	DC	250	0	-	-	-	-	-	-
3	F7	EEG	4	0.1	3.2768	DC	250	0	-	-	-	-	-	-
4	FT9	EEG	5	0.1	3.2768	DC	250	0	-	-	-	-	-	-
5	FC5	EEG	6	0.1	3.2768	DC	250	0	-	-	-	-	-	-
6	FC1	EEG	7	0.1	3.2768	DC	250	0	-	-	-	-	-	-
7	C3	EEG	8	0.1	3.2768	DC	250	0	-	-	-	-	-	-
8	T7	EEG	9	0.1	3.2768	DC	250	0	-	-	-	-	-	-
9	TP9	EEG	10	0.1	3.2768	DC	250	0	-	-	-	-	-	-
10	CP5	EEG	11	0.1	3.2768	DC	250	0	-	-	-	-	-	-
11	CP1	EEG	12	0.1	3.2768	DC	250	0	-	-	-	-	-	-
12	Pz	EEG	13	0.1	3.2768	DC	250	0	-	-	-	-	-	-
13	P3	EEG	14	0.1	3.2768	DC	250	0	-	-	-	-	-	-
14	P7	EEG	15	0.1	3.2768	DC	250	0	-	-	-	-	-	-
15	O1	EEG	16	0.1	3.2768	DC	250	0	-	-	-	-	-	-
16	Oz	EEG	17	0.1	3.2768	DC	250	0	-	-	-	-	-	-
17	O2	EEG	18	0.1	3.2768	DC	250	0	-	-	-	-	-	-
18	P4	EEG	19	0.1	3.2768	DC	250	0	-	-	-	-	-	-
19	P8	EEG	20	0.1	3.2768	DC	250	0	-	-	-	-	-	-
20	TP10	EEG	21	0.1	3.2768	DC	250	0	-	-	-	-	-	-
21	CP6	EEG	22	0.1	3.2768	DC	250	0	-	-	-	-	-	-

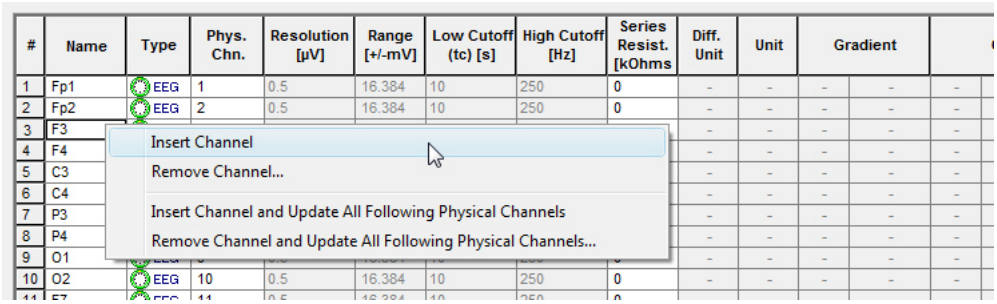
Name	You can change the name of the ‘logical channel’ by double-clicking. If you enter the same name twice, an error message is shown when you want to proceed to the next workspace page.
Type	Indicates the channel type (EEG, REF, BIP or AUX). The channel type is automatically assigned.
Phys. Chn.	Each channel name must have one physical channel. You can assign physical channels to the logical channels in the first column.
Resolution [µV]	Enter the signal resolution. (You must first select the check box **Use Individual Settings**.)
Range [+/- mV]	Indicates the range across which the amplifier sends data to Recorder.
Low Cutoff [s]	Enter a value for the low-cutoff filter. (You must first select the check box **Use Individual Settings**.)
High Cutoff [Hz]	Enter a value for the high-cutoff filter. (You must first select the check box **Use Individual Settings**.)
Series Resist. [KOhms]	Enter the resistance of the protective resistors installed in the electrode cables. **Note:** These details are only required for *B*rainAmp MR amplifiers or if you are using an electrode cap for acquisition that is fitted with resistors in the electrodes (for example, BrainCap MR or bipolar electrodes used in MR scanners). The resistance values for these protective resistors are stored in the workspace and are subtracted from the measured impedances during impedance measurement, so that only the impedance between the skin and the electrodes is shown in the **Impedance Check View** and saved in the header file.

Diff. Unit Unit Gradient Offset	These are settings for auxiliary channels. For details refer to Use ExG AUX or Use PolyBox.

Add and remove channels

Click with the right mouse button in the channel table, where you want to insert or remove a channel.

➔ A context menu opens.



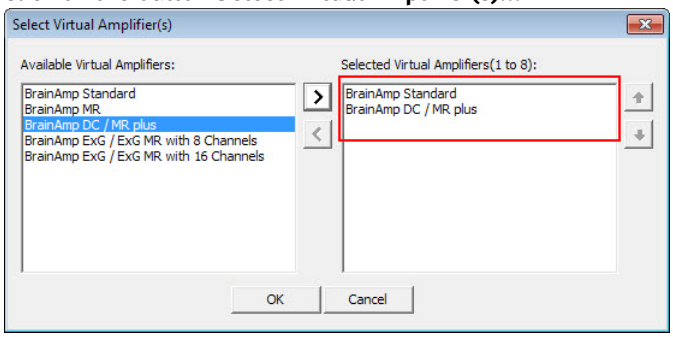
Insert Channel	Inserts a channel above the selected row.
Remove Channel...	Removes the channel. You must confirm this action. If the table contains only one channel, this command is not available.
Insert / Remove Channel and Update All Following Physical Channels	Choose this option, to update the names and numbers of the subsequent channels. The physical channel index of the subsequent channels is incremented or decremented automatically. The focus is set to the empty channel name and the remaining cells are filled with default values. The channel type is filled in automatically on the basis of the physical channel index.

6.2.2 Using virtual amplifiers

The option virtual amplifier allows you to setup your workspace without connecting an amplifier. You can choose any amplifier of the BrainAmp family and try out different amplifier combinations within the BrainAmp family.

You can't monitor data. The option virtual amplifier is only used to setup your workspace.

1 Click on the button **Select Virtual Amplifier(s)...**

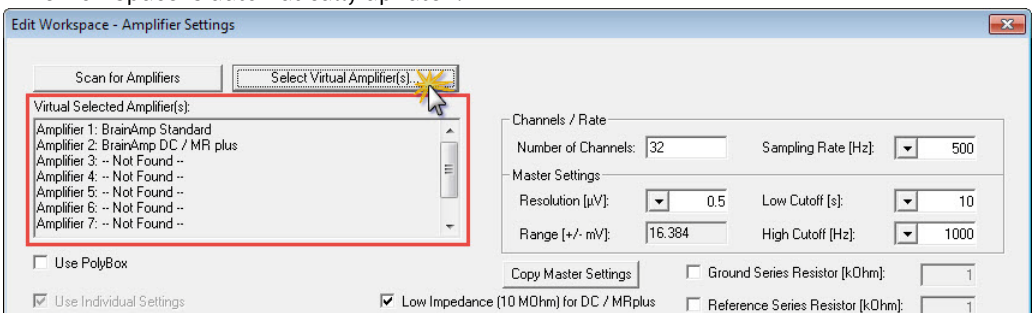


2 In the dialog select an amplifier from the list on the left and click on the arrow button ›.
To remove an amplifier select the amplifier from the list on the right and click the on ‹.

3 Set the order of the amplifiers with the up ↑ and down ↓ buttons.
Note: BrainAmp ExG amplifiers must be the last amplifier in the list.

4 Click **OK**.

➔ The workspace is automatically updated.



6.2.3 Using a BrainAmp ExG

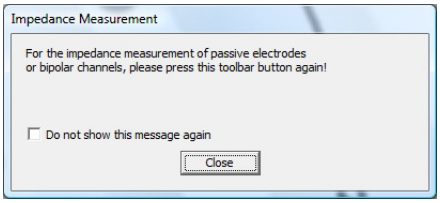
The BrainAmp ExG only works with passive electrodes.

You can combine a BrainAmp with active electrodes and a BrainAmp ExG with passive electrodes.

If you are using more than one amplifier (a BrainAmp MR together with the BrainAmp ExG MR, for example), you must connect the amplifiers in such a way that the BrainAmp ExG MR is displayed as the last amplifier in the list. Otherwise, a warning message is shown.

Measuring impedances

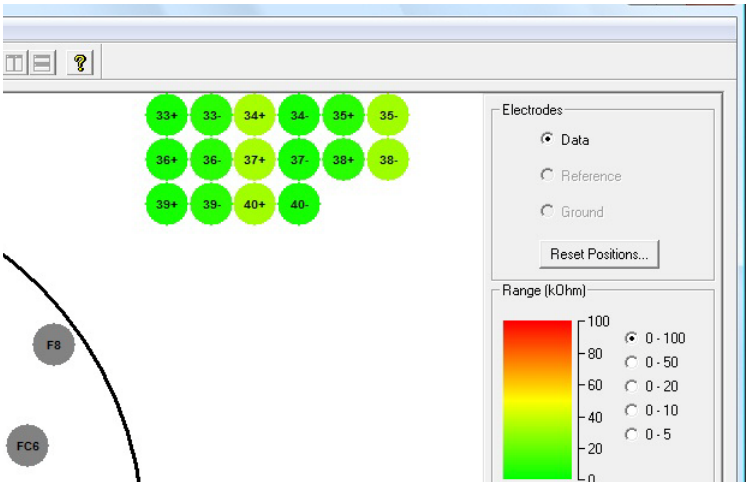
If you are using a BrainAmp ExG (passive electrodes) in addition to a BrainAmp (active electrodes) and you click the **button Impedance Check** in the toolbar, the following message is shown:



The active electrodes (BrainAmp) are always measured first, followed by the passive electrodes of the BrainAmp ExG in a second pass.

- Click the button **Impedance Check** in the toolbar again after the active electrodes have been measured in order to continue measuring the passive electrodes.
- If measurement of the passive electrodes has been completed and you click on the button **Impedance Check** again, the active electrodes are measured again.

The active electrodes which have already been measured are shown in gray on the second pass. The passive electrodes that are now to be measured are shown on the top right edge of the screen and color-coded.

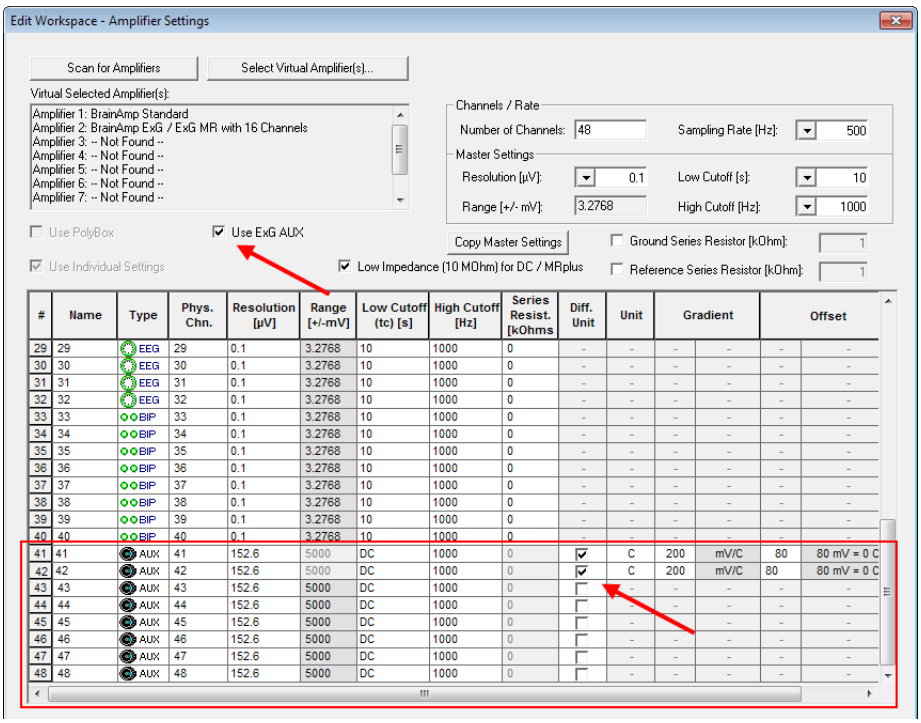


6.2.4 Use ExG AUX

The ExG AUX Box allows you to connect single electrodes and polygraph sensors (such as the GSR-MR module) to the BrainAmp ExG and the BrainAmp ExG MR in order to record bipolar signals.

In the workspace click on **Use ExG AUX**.

➔ AUX channels will be automatically added to the end of the channel table (see Note below).



Diff. Unit	If you select **Diff. Unit**, you can use a different unit such as 'C' for Celsius.
Unit	Enter the required unit in the Unit column.
Gradient	Enter the gradient in mV/unit. Example: For the unit C use mV/C. This will describe the voltage difference in mV at a temperature change of one degree Celsius. The value can also be negative.
Offset	Defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

Note: If installation has been carried out correctly, the AUX channels are always the last eight physical channels. If you are using a BrainAmp ExG or BrainAmp ExG MR, these are physical channels 9 through 16. If you are using a BrainAmp and a BrainAmp ExG, these are the physical channels 41 through 48. If you are using two BrainAmps and a BrainAmp ExG, these are the channels 73 through 80, etc. If you are only using two BrainAmp ExGs, these are the channels 9 through 16 and 25 through 32, etc.

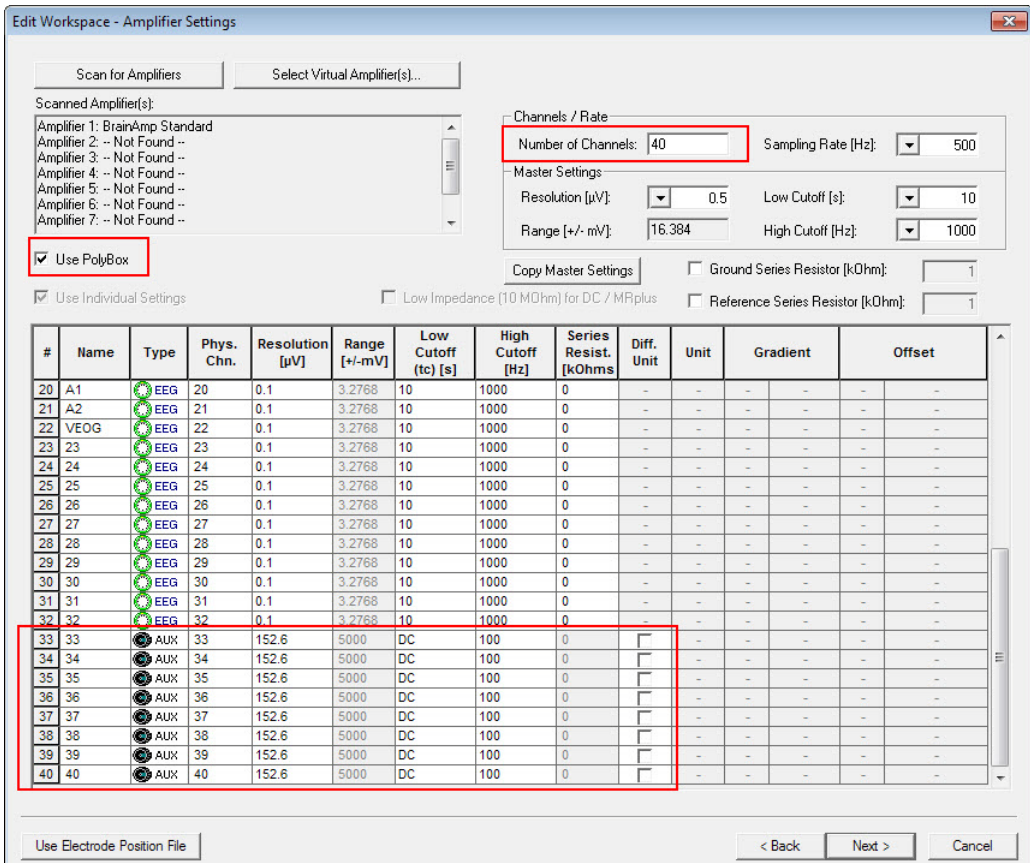
6.2.5 Use PolyBox

When used in conjunction with the BUA64 and one or two BrainAmp amplifiers, the PolyBox permits the additional, simultaneous recording of up to eight polygraph signals captured by sensors for the display of status changes.

1 If you are using a PolyBox select the check box **Use PolyBox**.

2 In **Number of Channels** you can add up to eight channels.

➔ The corresponding number of AUX channels is added at the end of the channel table.



Diff. Unit	If you select **Diff. Unit**, you can use a different unit such as 'C' for Celsius.
Unit	Enter the required unit in the Unit column.
Gradient	Enter the gradient in mV/unit. Example: For the unit C use mV/C. This will describe the voltage difference in mV at a temperature change of one degree Celsius. The value can also be negative.

Offset	Defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

Notes

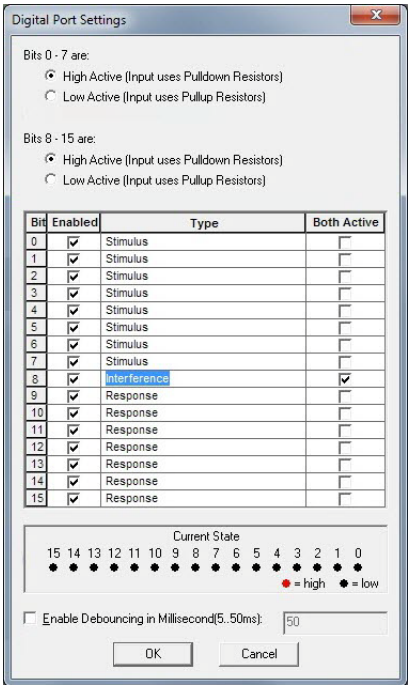
- Simultaneous use of the PolyBox and the ExG AUX Box is not supported.
- The PolyBox is not available if you are using a virtual amplifier.

6.2.6 Configuring the digital port

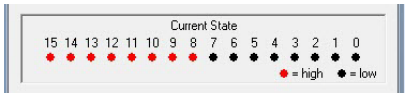
The BrainAmp USB adapter (BUA) has a Trigger input (26-pin socket) for recording events synchronous with the EEG such as stimuli or test subject responses. The socket contains sixteen 1-bit digital inputs that can be programmed separately from each other. The designations D00 through D15 relate to the bit number, with the first bit being designated with 0.

To change the settings of the digital port click on **Amplifier › Digital Port Settings...**

➔ The Digital Port Settings dialog opens.



High Active	In the recording a marker is set on the rising edge and in the hardware a pull-down resistor with 4.9 kOhm is activated. This resistor is switched to ground.

Low Active	In the recording a marker is set on the falling edge and in the hardware pull-up resistor with 4.9 kOhm is activated. This resistor is switched to the 5 Volt power supply.
	You can set **High Active** or **Low Active** for each group (bit 0-7 and 8-15). This setting specifies when a marker is recorded. It also specifies the default configuration of the hardware:
Bit overview table	**Enabled** Select to enable the bit and deselect to disable the bit.
	Type Specify the name for each bit. You can assign the same type to several bits. *Recorder* and *Analyzer* use color coding for 'Stimulus' and 'Response' types. Thus it is recommended to choose 'Stimulus' and 'Response' for stimulus and response inputs respectively.
	Both active Select **Both Active** to record the length (or duration) of the generated trigger. This option is only available for one bit line at any time. When you use this option, you must choose a *unique* name for the marker type to be able to identify the corresponding bit line. Both pull-down (high-active signal) and pull-up (low-active signal) resistances are taken into account on the generation of the trigger signal. Two markers, which indicate the start and end of the trigger signal, are written for each of these. For example, one marker may be written at the time at which a transmission error between the MOVE receiver and transmitter is detected and another marker at the time when data transmission between transmitter and receiver functions correctly again. Note that this function is not available for the 'DC Correction' marker type.
Current state	Check your setup with the help of this field. The black and red bullets indicate the state of your trigger sources. Activate a trigger to check if the state of the bullet changes and that a marker will be set. If the bullet does not change, then adapt the **Low Active** and **High Active** settings. 
Enable Debouncing in Millisecond (5..50 ms)	If you select this option, repetition of a marker of the same type and same description is ignored for a period of 5 to 50 ms.

Notes

Trigger signals must be present at least for the extent of a sampling point. This means, for instance, that at a sampling rate of 1,000 Hz, the minimum length of the trigger signal is 1 ms and that at 500 Hz the minimum length is 2 ms, etc.

The digital port of the BrainAmp USB Adapter is designed only to receive triggers. Do not connect the adapter to the trigger input of stimulation devices.

Note for using the TriggerBox

To use all of the 16 bits of the *TriggerBox* and *TriggerBox Extension* together with BrainAmp, take note of the following.

If you connect a high-active source to the bits 8-15:

- set the used bits to **High Active**, and
- disable the unused bits of the group 8-15.

If you connect a low-active trigger source to the bits 8-15, then select **Low Active**.

6.2.7 Show connected amplifiers

Choose **Amplifier › Connected Amplifiers...** from the menu

The Connected Amplifiers dialog opens. It lists all amplifiers that are currently connected to your computer and are ready for operation.

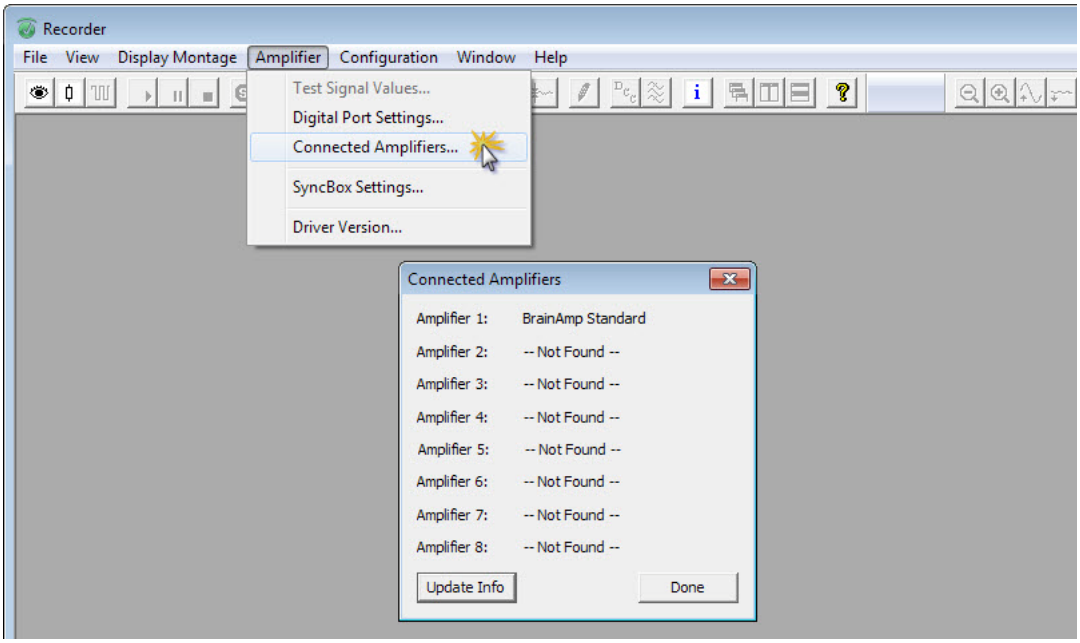


Figure 6-1. List of connected BrainAmp amplifiers

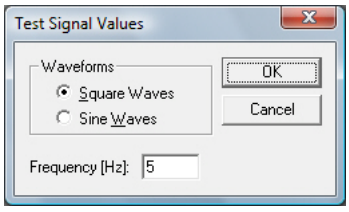
6.2.8 Using the test signal

To display and record a test signal, attach the supplied signal tester to the BrainAmp amplifier via the electrode input socket.

In the toolbar, click the button **Test Signal** .

➔ A signal with an amplitude of 50 μV_{pp} (square) or 100 μV_{pp} (sine) is shown.

You can change the signal shape (square or sine) by choosing **Amplifier › Test Signal Values...**



The **Frequency [Hz]** text box allows you to specify the frequency of the signal in a range 1 Hz through 50 Hz.

6.2.9 Measuring the impedances

Note

If a channel is open (for example an electrode is incorrectly prepared or damaged), it will impact the subsequent channel. This means that although the subsequent channel actually has a lower impedance, a higher impedance value will be displayed for it. You can only rectify the situation by correcting the bad value caused by the open channel. This is done by preparing the relevant electrode correctly or replacing the damaged electrode.

With the *BrainAmp*, we distinguish between three groups of electrodes that are measured separately: EEG electrodes, the reference electrode and the ground electrode. The electrode groups are not entirely independent of each other.

Proceed as follows to measure impedances:

1 Prepare the electrodes.

2 Measure the EEG electrodes.

Start with the largest range. If all electrodes are in a high-impedance state, check that the reference and ground electrodes are connected firmly.

3 If the EEG electrodes show impedances that are roughly correct, measure the reference electrode.

4 Finally measure the ground electrode.

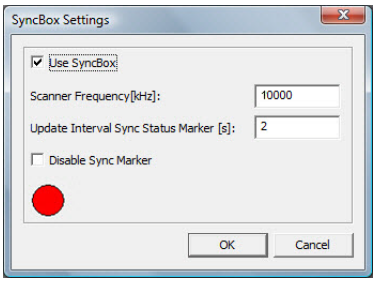
You will find information on impedance measurement in Chapter 8.

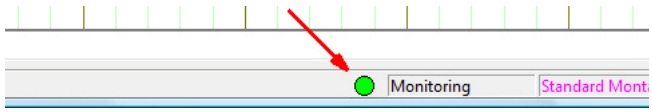
6.2.10 Using the SyncBox

The SyncBox is mainly used in MR environment with BrainAmp MR, BrainAmp ExG MR and BrainAmp MR plus. It synchronizes the sampling rate of the amplifier with the clock rate of the MR scanner to ensure the stability of EEG recording during MR acquisition.

Choose **Amplifier › SyncBox Settings...**

➔ The SyncBox Settings dialog opens.



Use SyncBox	When selected the SyncBox icon appears in the status bar in both monitoring mode and save mode. A change to the synchronization status is indicated by markers and stored in save mode. The markers indicate the synchronization status by 'in sync' or 'of sync'. ▶ Green: synchronization is on ▶ Red: synchronization is off 
Scanner Frequency [kHz]	The specified frequency must divisible by 5 kHz (for example 10,000 kHz). This is the frequency of the signal on the gradient board of the MR system that the SyncBox Scanner Interface is connected to. Note that this value is specified in kilohertz (kHz). So, if you put in 10,000 the input signal at the SyncBox is 10 MHz
Disable Sync Marker	When selected no synchronization markers are written during synchronization.
Update Interval Sync Status Marker [s]	Specify the frequency with which the markers are written.

6.2.11 DC-offset correction

DC offset correction is available for the DC-coupled amplifiers BrainAmp DC, BrainAmp MR plus, BrainAmp ExG and BrainAmp ExG MR.

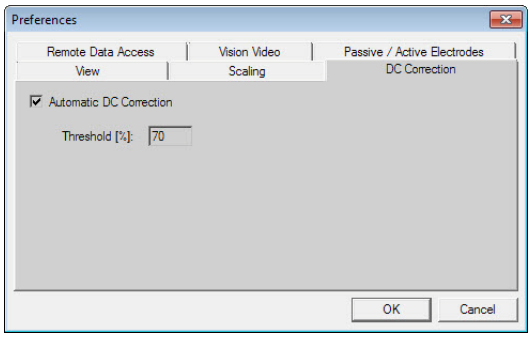
The DC offset correction is based on the average of the EEG signals. If this average is equal to 0, there is no DC offset. If analysis is negatively affected by too high a DC offset, it may be necessary to activate DC offset correction.

DC offset correction directly impacts the data. We therefore recommend that you try to avoid DC offset correction in important sections of the EEG.

Automatic DC offset correction

You can configure Recorder to perform automatic DC offset correction as soon as a channel value exceeds a critical threshold.

1 Click on **Configuration › Preferences...**
The Preferences dialog opens.
2 Open the tab DC Correction.
3 Select the check box Automatic DC Correction and enter a threshold value in percent.
4 Click on the button **DC Correction** to activate the DC offset correction.
Recorder sets a corresponding marker to flag the DC offset correction in the data.



➔ The channel names are shown on the far left of the window. The percentages for each channel only appear if a DC amplifier is connected in DC recording mode. In this event, the values correspond to the DC offset of the signal. An offset of 100% corresponds to saturation at the positive end of the recording level range. An offset of -100% corresponds to saturation at the negative end of the recording level range.

Trigger-controlled DC offset correction

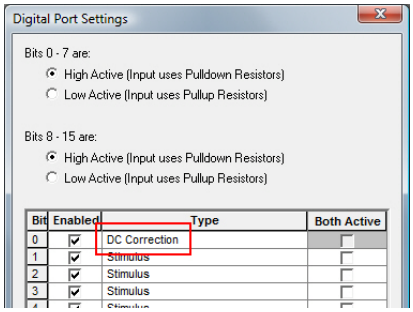
You can use the marker type 'DC Correction' for carrying out a DC measurement.

1 Click on **Amplifier › Digital Port Settings...**

The Digital Port Settings dialog opens.

2 Choose a marker and type in 'DC Correction'. You can define this at any bit position.

Note that Both Active is not available for the 'DC Correction' marker.



➔ DC offset correction is automatically performed when this trigger is received. If several markers of the type 'DC Correction' are set simultaneously, correction is only performed once. This applies to both USB and PCI ports.

The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Example

Bit 8 through bit 15 are of the type 'Response'. If bits 11 and 13 are set, this results in a marker of the type 'Response' with the description 'R 40'. Bit 11 has a value of 8 and bit 13 a value of 32. The total is 40. The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, by assigning a separate marker type to every bit. Alternatively, you can assign a separate type to every bit in the table.

6.3 actiCHamp amplifier

For actiCHamp amplifiers your computer must fulfill the following system requirements:

- **Windows experience index:** min. 5.0
- **Processor:** Intel® Core™ 2 Quad processor, 2.4 GHz or higher
- **Graphics adapter:** 1280 x 1024 pixel resolution, min. 512 MB memory
- **RAM:** 4 GB

6.3.1 actiCHamp workspace at a glance

To access the workspace you must first create or edit a workspace.

Pre-requisites:

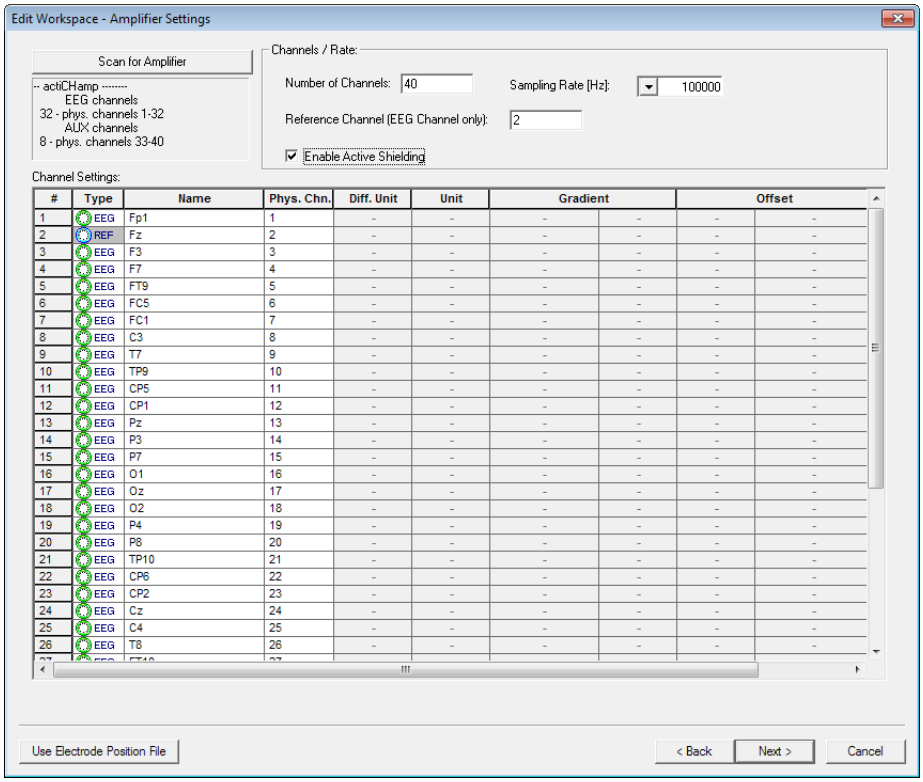
- actiCHamp connected to the computer

1 Choose **File › New Workspace...** from the menu.

2 Click on **Scan for Amplifiers**. The connected amplifier and available number of channels is shown.

3 The workspace wizard opens. Skip the first dialog page.

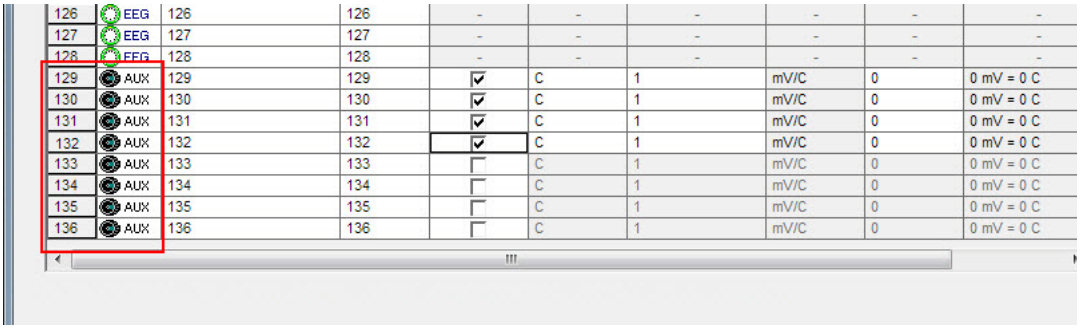
➔ On the Amplifier Settings dialog page, the settings for your amplifier are in the upper section.



Number of Channels	Enter the number of channels.
Reference Channel	Enter the physical channel number of the reference channel. You can use any EEG channel as the reference channel; by default, the program uses the second channel. The channel selected as the reference channel is grayed in the display.
Sampling Rate [Hz]	Choose the sampling rate from the drop-down list. The minimum sampling rate is 100 Hz. The maximum sampling rate depends on the number of channels used. ▶ 32 EEG + 8 AUX: 100 kHz ▶ 64 EEG + 8 AUX: 50 kHz ▶ 160 EEG + 8 AUX: 25 kHz
Enable Active Shielding	Active shielding mode is used to reduce environmental influences such as noise, electrical interference or cable movement, that would otherwise have an effect on the electrodes. When the check box is selected the active shielding information window will display. ▶ Select **OK** to enable active shielding or ▶ select **Cancel** to close the window and leave active shielding unchecked.

6.3.2 Configuring the AUX inputs

If you wish to use external sensors to measure temperature, skin conductivity etc. you can carry out the appropriate adaptations at this point. The AUX channels are always the last eight channels in the channel table.



Diff. Unit	If you select **Diff. Unit**, you can use a different unit such as 'C' for Celsius.
Unit	Enter the required unit in the Unit column.
Gradient	Enter the gradient in mV/unit. Example: For the unit C use mV/C. This will describe the voltage difference in mV at a temperature change of one degree Celsius. The value can also be negative.
Offset	Defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

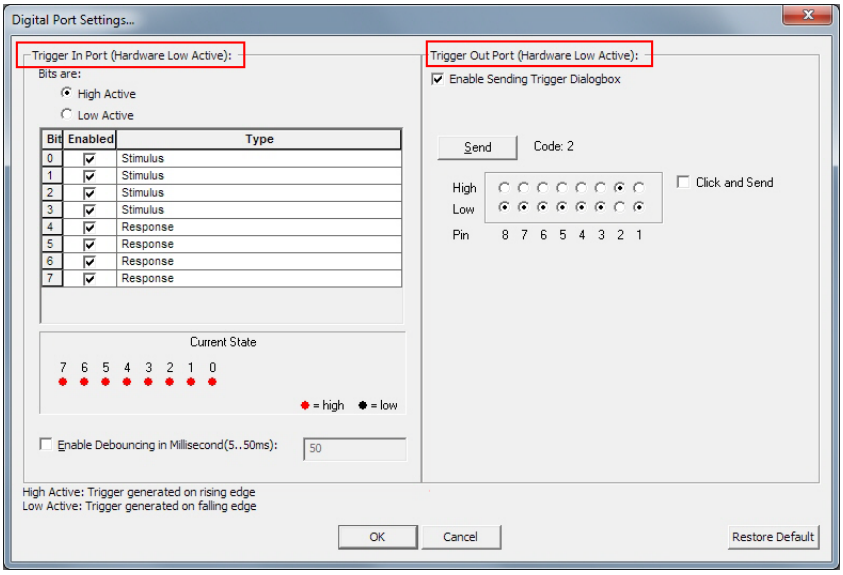
6.3.3 Configuring the digital port

actiCHamp has trigger connectors on the rear labeled Trigger In and Trigger Out. The trigger connections have eight trigger lines and therefore eight bits each.

To change the settings of the digital port click on **Amplifier › Digital Port Settings...**

➔ The Digital Port Settings dialog opens.

You encode inbound triggers in the left section and the outbound triggers in the right section of this dialog.



Set up the trigger input

Use the inbound triggers for recording events that are synchronous with the EEG such as stimuli or test subject responses.

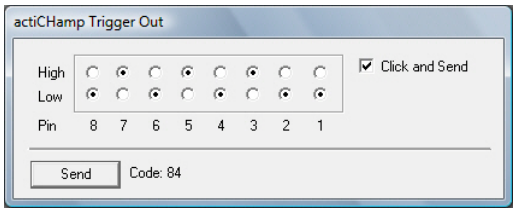
High Active / Low Active	You can choose whether the signals are interpreted as high-active (5 V = active) or low-active (0 V = active). ▶ **High Active**: trigger is generated on a rising edge: ▶ **Low Active**: trigger is generated on a falling edge.
Enabled	select to enable the bit
Type	specify what time marker type each bit represents (for example Stimulus, Response). You can assign the same name to several different bits.
Current State	view the current status of the bit lines (active or inactive).
Enable Debouncing in Millisecond (5..50 ms)	Repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.
Restore Default	To reset changed settings to their initial configuration, click **Restore Default** in the lower part of the dialog box.

Set up the trigger output

To change the settings of the digital port click on **Amplifier › Digital Port Settings...**

➔ The Digital Port Settings dialog opens. You encode outbound triggers in the right-hand section of this dialog.

Enable Sending Trigger Dialogbox	Select to send triggers from the trigger port
Send	Click the button to encode and send the trigger to the output.
Click and Send	Select this check box, to send triggers manually during recording. When selected the trigger that is encoded here is sent directly to the trigger output when you select (bits 1 to 8) **High** or **Low**. If you do not use this function then you can only send triggers to the trigger output by clicking the **Send** button.



Minimum trigger length

Please take note of the recommended minimum length of the trigger signal for various sampling rates in the table below. Shorter signal lengths can result in faulty markers.

Sampling rate	Minimum length of trigger signal
100 Hz	20 ms
200 Hz	10 ms
250 Hz	8 ms
500 Hz	4 ms
1000 Hz	2 ms
2500 Hz	0.8 ms
5000 Hz	0.4 ms
10000 Hz	0.2 ms
25000 Hz	0.08 ms
50000 Hz	0.04 ms

Sampling rate	Minimum length of trigger signal
100000 Hz	0.02 ms

Initial configuration of the digital port

To reset the digital port settings to their initial configuration, click **Restore Default** in the lower part of the dialog box. The default settings are listed in the table below:

Parameters	Default setting
Bits are	High Active
Enabled	All boxes are selected.
Type	Bit 0 through 3: Stimulus, 4 through 7: Response
Enable Debouncing in Millisecond	Not selected
Enable Sending Trigger Dialogbox	Not selected
Bits (Pins) Low	All bits are selected
Bits (Pins) High	No bits are selected
Click and Send	Not selected

Note

The trigger input and output are designed only for TTL signals (0 to +5 V, maximum 10 mA).

For the pinout of the digital port please refer to the actiCHamp operating instructions.

6.3.4 Measuring the impedances

actiCHamp works with active electrodes for which you don't need the actiCAP ControlBox.

Pre-requisites

- workspace configured and amplifier connected
- electrodes connected and prepared

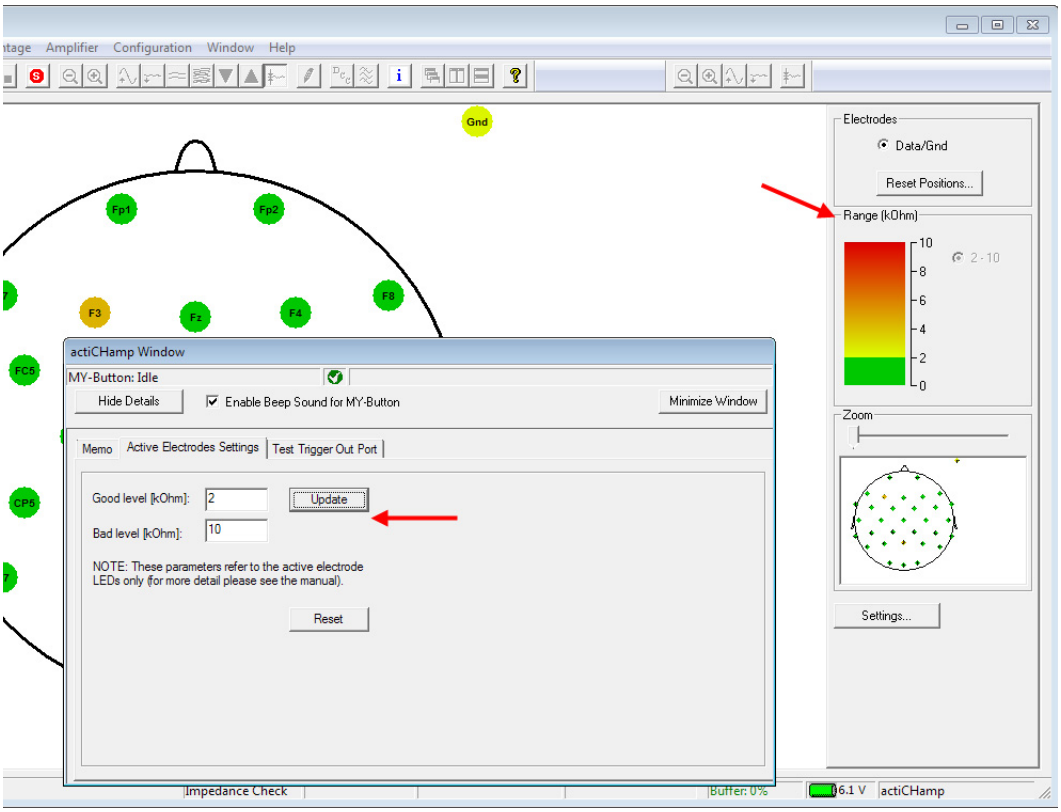
1 Click on the button **Impedance Check**  .

2 The Impedance Check View and the actiCHamp window open.

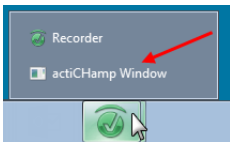
3 Set the threshold levels for the impedance in the actiCHamp window and click on Update.

➔ The values will be updated in the Impedance Check View. At the same time the LEDs in the electrode may change as well as the electrodes in the Impedance Check View.

➔ To restore the default values click on the button **Reset**.



Note: If the actiCHamp window does not open, it might be minimized. Look in the task bar.



6.3.5 The actiCHamp window

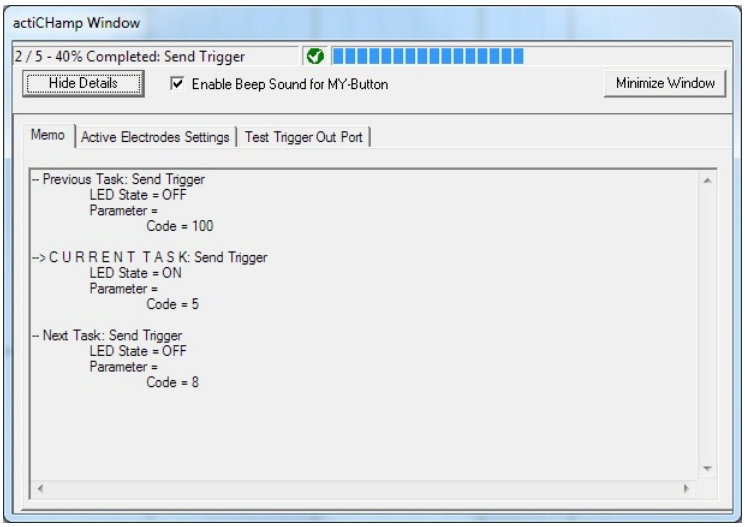
The actiCHamp window is displayed in all operating modes.

The button **Hide/Show Details** allows you to hide or expand the window. If you want to minimize the window to the task bar, click **Minimize Window**.

The upper part of the window displays the function currently being executed as a result of pressing the **MY-Button**. If you select the **Enable Beep Sound for MY-Button** box, then either a short beep (move on to the next function) or long beep (move back to the previous function) sounds when you press the **MY-Button**.

Memo tab

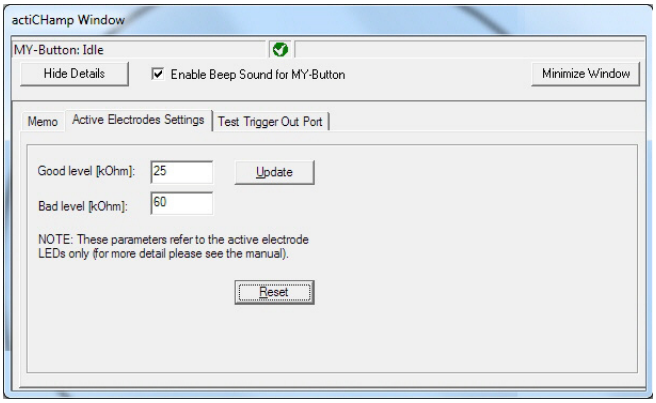
On the *Memo* tab, you can see the functions you have assigned to the **MY-Button**. At the most, the previous, current and next steps in a function sequence are displayed.



Active Electrodes Settings tab

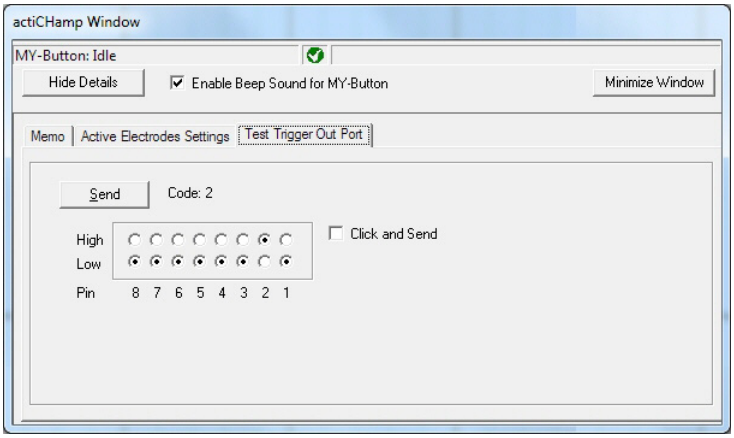
On the Active Electrodes Settings tab, you can modify the range of values for the LEDs of the active electrodes. The functions available on this tab can be accessed as soon as you switch the Recorder to impedance mode.

To modify the display, enter the required values in the **Good level kOhm** and **Bad level kOhm** text boxes: The LEDs indicate impedance values below the ‘Good level’ in green, values between the ‘Good level’ and ‘Bad level’ in yellow and values above the ‘Bad level’ in red. Click **Update** to apply the modified values. You can use **Reset** to restore the values from the initial configuration.



Test Trigger Out Port tab

The Test Trigger Out Port tab allows you to send triggers to the actiCHamp's trigger output. This function is only used to check that the trigger output is working properly.



6.3.6 Show information about your actiCHamp

Driver versions

To call driver version information, choose **Amplifier › Version Information...** from the menu.

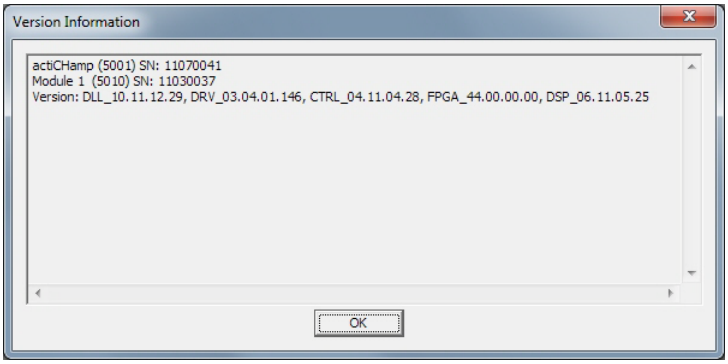


Figure 6-2. Driver versions

Connected amplifiers

Choose **Amplifier › Connected Amplifiers...** from the menu to determine which actiCHamp amplifiers are currently connected to your computer and are ready for operation.

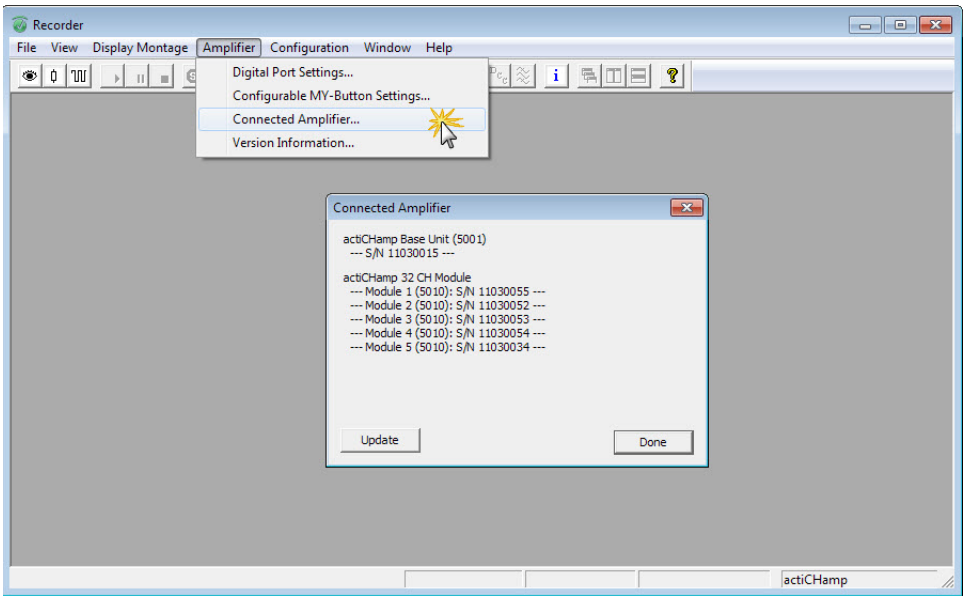
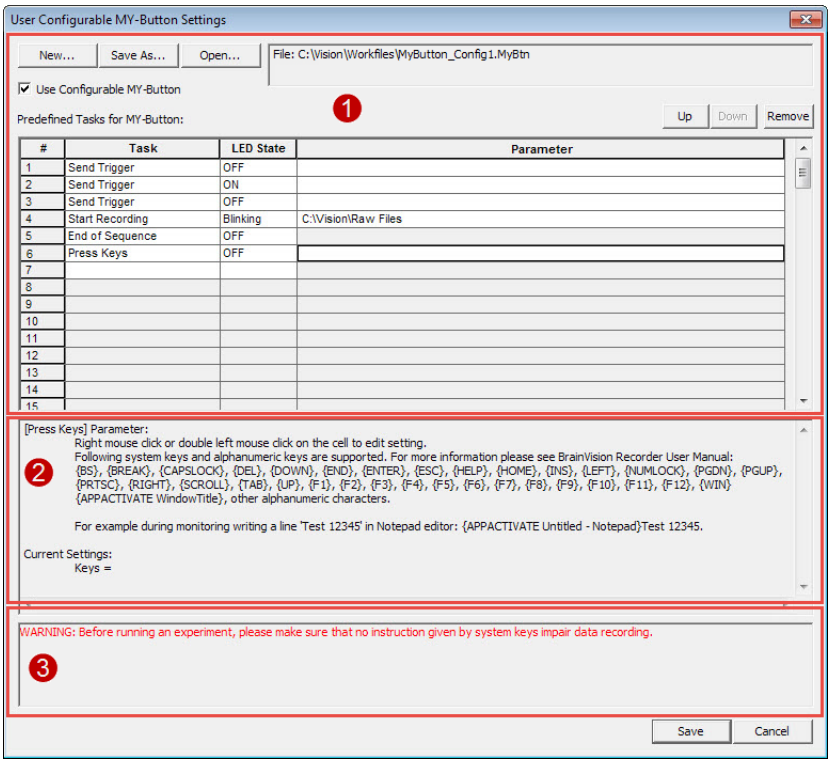


Figure 6-3. List of connected BrainAmp amplifiers

6.3.7 MY-Button

On the front of the actiCHamp, there is a control button labeled MY-Button to which you can assign your own individual functions. The MY-Button provides you with many different ways of configuring functions for a wide range of tasks. However, its use requires the user to display a high level of personal responsibility and safety awareness.

These functions are stored in a separate configuration file (extension: .MyBtn) in the Workfiles folder and will be called again in the predefined sequence.



1	Settings for the MY-Button.
2	Information about the selected task and parameter.
3	Important hints for the selected task.

Configure the MY-Button

To configure the MY-Button do the following:

1 Choose **Amplifier › Configurable MY-Button Settings...**

The MY-Button Settings dialog opens

2 Select the check box **Use Configurable MY-Button**.

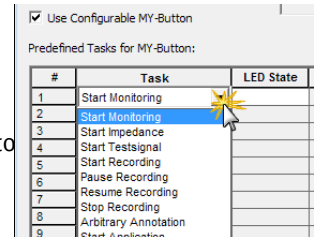
3 Click on the button **New...** to create a predefined tasks.

If you want to edit an existing set of tasks, click on the button **Open...** or just edit the displayed task table.

4 Choose a task.

Click in the task field and choose a task from the drop-down list.

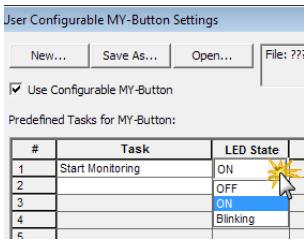
Note: For some tasks you must specify parameters (please refer to Specify Parameters for the Tasks).



5 Choose a LED state.

This defines the LED state of the MY-Button.

Click in the task field and choose a task from the drop-down list.



6 To change the order of the tasks select a task click on the buttons **Up** or **Down**.

7 To remove a task select the task in the list and click on the button **Remove**.

8 When finished click on the button **Save As...**

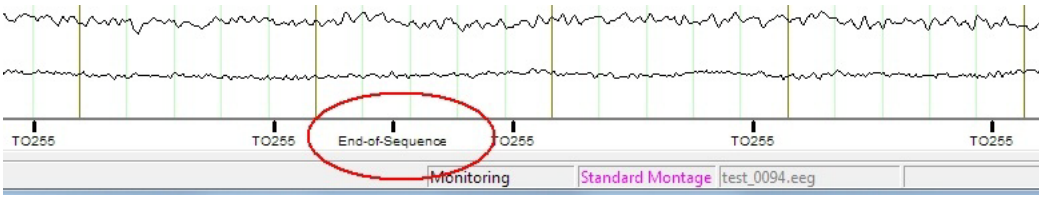
➔ When you press the MY-Button on the actiCHamp, all the functions in the sequence are executed.

Execute the predefined tasks

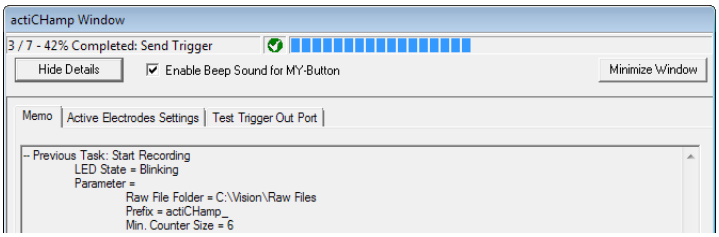
Do the following, to execute the predefined tasks:

- Press the MY-Button on actiCHamp briefly once to call a function. The next time you press the button, the next task is called.

➔ A marker is inserted and recorded when you call a task.



➔ You can see the state of the sequence in the actiCHamp window.



- To jump back a task and run it again, press and hold the MY-Button for at least one second (› 1 s).
- When you reach the end of the task list (e.g. marked as ‘End of Sequence’), the sequence does not start from the beginning.

Specify Parameters for the Tasks

For some Tasks you must specify Parameters. Do the following:

1 Double-click in the Parameter column.

A dialog box is shown.

2 Enter your settings and click on OK.

Task	Parameters
Start Monitoring	--
Start Impedance	--
Start Testsignal	--
Start Recording	Specify the name and storage location of the file.
Pause Recording	--
Resume Recording	--
Stop Recording	--
Arbitrary Annotation	Enter a text of your choice. Don't use special characters like **$%-@/|;,:.** ➔ The text will be displayed and recorded as a marker.
Start Application	You can select an application via the Windows® Explorer. **Notes**: The real-time performance of Recorder may be impaired if you run an application. This may result in a loss of data. If you use stimulation software, you must not connect stimulation devices to the parallel port of the computer on which Recorder is running.
Press Keys	Define a keyboard shortcut. For available shortcuts refer to Keyboard shortcuts for MY-Button (actiCHamp). **Note**: Before including any given keyboard shortcut in your experiment, make sure that this does not impair your experimental paradigm or the recording of the data.
Send Trigger	Enter a value in the range 0 to 255. ➔ The defined trigger will be sent to the trigger output.
End of Sequence	--

Keyboard shortcuts for MY-Button (actiCHamp)

You can use the following keyboard shortcuts for the MY-Button. The input values must be between curly brackets {}:

Input	Key
BACKSPACE, BS or BKSP	Backspace
BREAK	Break
CAPSLOCK	Caps Lock
DELETE or DEL	Del
DOWN	Down arrow
END	End
ENTER or ~	Enter
ESC	Esc
HELP	Help
HOME	Home
INS	Ins
LEFT	Left arrow
NUMLOCK	Num Lock
PGDN	Page down
PGUP	Page up
RIGHT	Right arrow
SCROLL	Scroll Lock
TAB	Tabulator
UP	Up arrow
F1 to F12	F1 to F12
ADD	Numeric keypad: Plus
SUBTRACT	Numeric keypad: Minus
MULTIPLY	Numeric keypad: Multiply
DIVIDE	Numeric keypad: Divide
PLUS	+
AT	@
CARET	^
TILDE	~
LEFTBRACE RIGHTBRACE	{ }
LEFTPAREN RIGHTPAREN	( )
WIN or @	Windows key

Input	Key
+	Shift
^	Ctrl
%	Alt
APPACTIVATE WindowTitle	Set focus to window by entering window title

Restrict user privileges for the MY-Button

As administrator set the user privileges, so that standard users cannot make changes to the MY-Button settings.

Pre-requisites

- Start Recorder in administrator mode

1 Click on **Configuration › Administrator...**

2 In the dialog, deselect the check box **Allow User Editing Amplifier Specific Settings.**

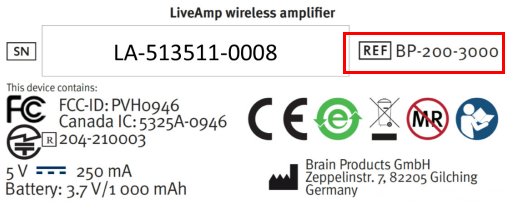
➔ If the **Use Configurable MY-Button** box is selected (MY-Button settings) the user can use the predefined task sequence, but cannot modify or load another sequence.

➔ All other amplifier-specific settings will also be disabled for standard users.

6.4 LiveAmp amplifier

Refer to the LiveAmp Operating Instructions for detailed information on the LiveAmp amplifier.

LiveAmp is a wireless amplifier that allows you to record data to a memory card in LiveAmp, a computer or both. LiveAmp is available in three versions, 32 channel, 16 channel and 8 channel. Also available is the LiveAmp 64 which allows you to connect two LiveAmp 32's to record 64 channels.



You can identify which version of LiveAmp you have by referring to the reference number (REF) on the type plate at the bottom of your LiveAmp.

- BP-200-3000 - LiveAmp 32 Channel
- BP-200-3010 - LiveAmp 16 Channel
- BP-200-3020 - LiveAmp 8 Channel

Note:

- Ensure your LiveAmp amplifier is running the latest firmware. Refer to the *LiveAmp Operating Instructions* for details on how to update the firmware.
- If switching between LiveAmp 32 and LiveAmp 64 ensure the LiveAmp is restarted each time.
- Support for LiveAmp 8 channel and LiveAmp 16 channel is available in Recorder software version 1.21.0201 or later.
- Support for LiveAmp 64 is available in Recorder software version 1.21.0303 or later.

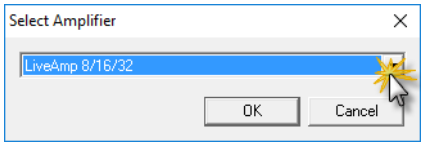
6.4.1 *Select your LiveAmp*

1 Turn on your LiveAmp/s by pressing and holding the power button for five seconds.

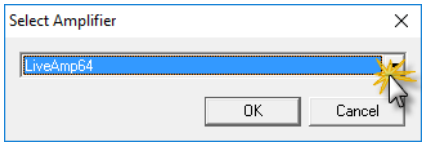
2 Refer to Section 4.1.2 Start in administrator mode.

3 Click **Configuration** › **Select Amplifier**, the Select Amplifier dialog is shown.

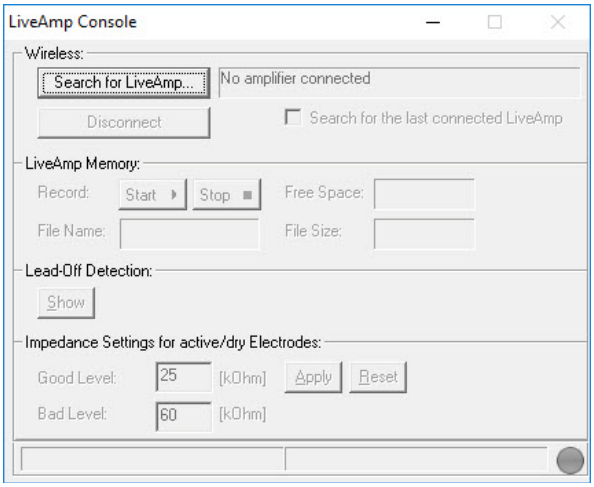
NEW 4 Select either **LiveAmp 8/16/32** or **LiveAmp64** and click **OK**.



or



The **LiveAmp Console** is shown.



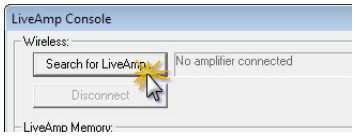
Search for amplifier	Click to search for all LiveAmps within reach. Select your LiveAmp and connect it with recorder.
Disconnect	Disconnects LiveAmp from Recorder.
NEW Search for the last connected LiveAmp	Select to search for the last connected LiveAmp only. No other LiveAmps will be included in the search. If no LiveAmp is found the search will be extended.
Record (Start / Stop)	Starts and stops the recording to the memory card. **Note**: By clicking on Start, a part of the memory card is prepared for the recording. Preparation takes several seconds and is indicated by a progress bar. During that time the memory card is not accessible.
File Name	Name of the EEG file that is stored on the memory card. The EEG file is automatically generated.
Free Space	Remaining free space on the memory card.
File Size	Size of the current EEG file.
Lead-Off Detection (Show)	Click on Show to check if an EEG lead has dropped off during the acquisition. This option is only available for **passive electrodes**.
Impedance Settings (Good Level/Bad Level)	For active and dry electrodes you can set the levels for the impedance measurement.
Reset	Click on **Reset** to restore the default values.
Status bar	The status bar shows if data is recorded to the LiveAmp memory and information about.
	The colors of the bullet show the quality of the wireless connection (green = good, amber = weak, red = bad).

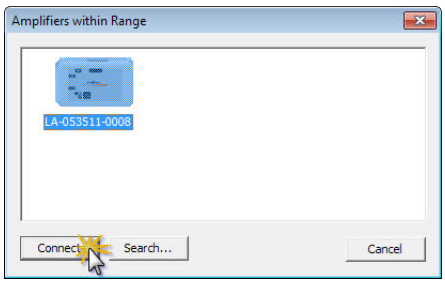
6.4.2 Connect LiveAmp 8, 16 or 32 with Recorder

To use LiveAmp you must connect LiveAmp with the recording computer through the wireless adapter.

Prerequisites:

- LiveAmp is selected in Recorder (LiveAmp Console is open)
- LiveAmp is switched on





1 In the *LiveAmp Console* click on **Search for LiveAmp...**

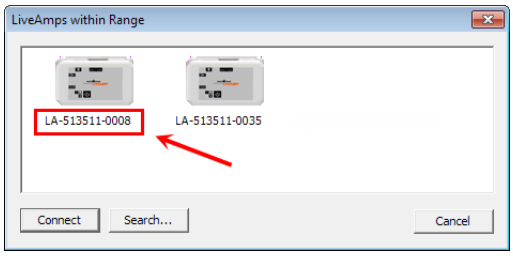
2 The **LiveAmps within Range** window opens.
If no LiveAmp was found, 'Simulation' is shown.

3 Choose a LiveAmp and then click on **Connect**.
Alternatively, double-click on the LiveAmp icon.

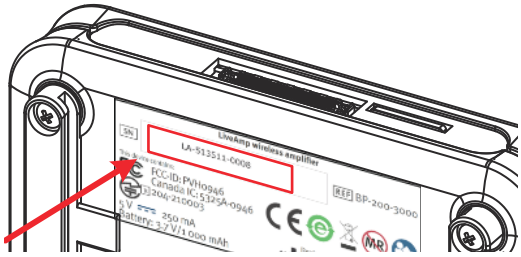
➔ The wireless LED (blue) on LiveAmp starts blinking. Your LiveAmp is now connected with the recording computer.

6.4.3 Identify your LiveAmp 8, 16 or 32

You identify the LiveAmps by their serial numbers. The serial number starts with 'LA-'.



The LiveAmps within Range window lists all LiveAmp amplifiers with their serial numbers that were detected during the scan.



You can find the serial number (SN) on the type plate at the bottom of your LiveAmp.

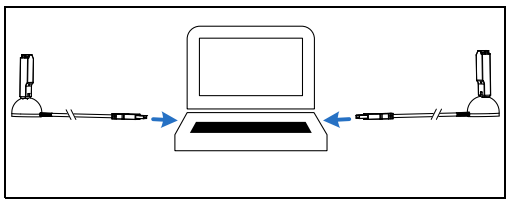
To read the serial number, you can disconnect the electrode connector without turning off LiveAmp.

6.4.4 Connect LiveAmp 64 with Recorder

To record data, LiveAmp 64 must be connected **wirelessly** with Recorder. Use the supplied wireless adapters to make the connection.

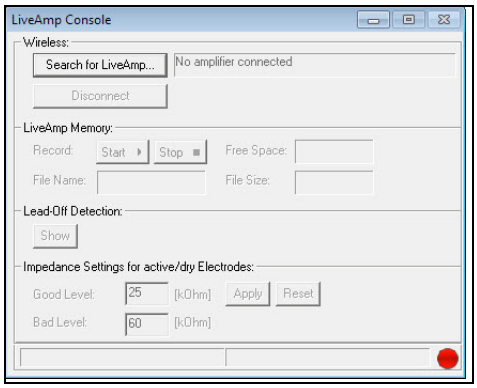
Prepare

- 2 x USB extension cable
- 2 x Wireless adapter
- LiveAmp 64 (with memory cards if required)
- Computer with Recorder 1.21.0303 or higher



1 Connect the wireless adapters with the USB extension cable to your computer.
To ensure reliable data transmission keep the wireless adapters at least 50cm apart.

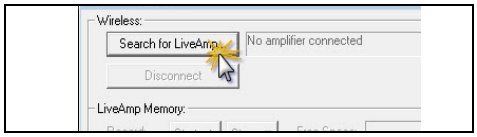
2 Position the wireless adapters within line-of-sight of LiveAmp.



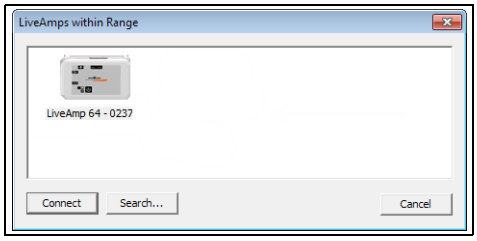
3 Start Recorder (in administrator mode) and choose LiveAmp64 from the menu **Configuration › Select amplifier...**

The LiveAmp Console opens.

4 Switch on each LiveAmp by pressing and holding the power button for five seconds.



5 In the LiveAmp Console click on **Search for LiveAmp...**

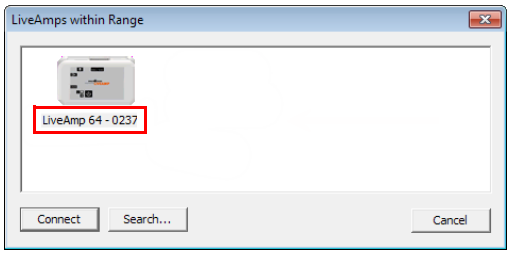


6 Select the LiveAmp 64 and click on **Connect**. (See also Identify your LiveAmp 64.)

➔ The blue LED of both the wireless adapter is ON and the wireless LED on both LiveAmps are blinking. LiveAmp is now connected with Recorder.

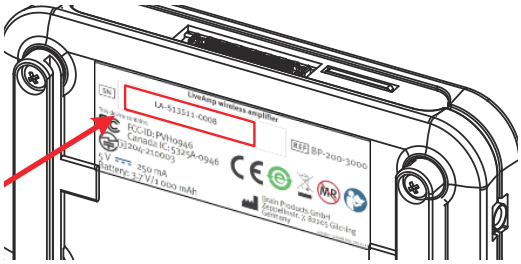
6.4.5 Identify your LiveAmp 64

You identify the LiveAmp 64 using the last four digits of master LiveAmp amplifier's serial number.



The LiveAmps within Range window lists any LiveAmp 64 amplifiers that were detected during the scan.

The LiveAmp 64 is listed with the last four digits of the master LiveAmp amplifier's serial number.



You can find the serial number on the type plate at the bottom of your master LiveAmp.

CH 1 - 32 = master LiveAmp
CH 33 - 64 = slave LiveAmp

To read the serial number turn off the LiveAmp amplifier and disconnect it from the adapter.

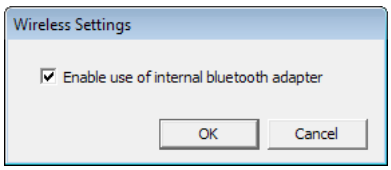
6.4.6 Use the internal wireless adapter

Note: We recommend you use the provided wireless adapters (UBT21) to ensure reliable data transmission. When using LiveAmp 64 one wireless adapter (UBT21) should remain connected.

By default, Recorder uses the wireless adapter UBT21. To use the internal adapter of your computer instead, do the following:

1 Start Recorder (no amplifier connected).

2 Click on **Amplifier** › **Wireless Settings...**



3 The Wireless Settings window opens.

4 Select the check box and click **OK**.

➔ You now use the internal adapter of your computer.

6.4.7 LiveAmp workspace at a glance

In the workspace you specify the number of channels, sampling rate, and other hardware-related settings.

Note: For the following procedure a LiveAmp 32 channel was used. Different settings will be available when using a LiveAmp 8 channel, LiveAmp 16 channel or LiveAmp 64.

- LiveAmp 8 can record up to 8 EEG channels and/or bipolar channels.
- LiveAmp 16 can record up to 16 EEG channels with a maximum of 8 bipolar channels.
- LiveAmp 32 can record either 32 referential EEG channels or 24 referential and 8 bipolar channels.
- LiveAmp 64 can record either 64 unipolar channels or 56 unipolar and 8 bipolar channels.
- ACC channels are always available.
- AUX channels are always available when a LiveAmp sensor & trigger extension is connected.

Pre-requisites

- LiveAmp is connected with Recorder (Connect LiveAmp 8, 16 or 32 with Recorder or Connect LiveAmp 64 with Recorder)
- The Workspace editor is open
- You clicked on **Scan for Amplifier**.

➔ In the workspace window, you can make the following settings:

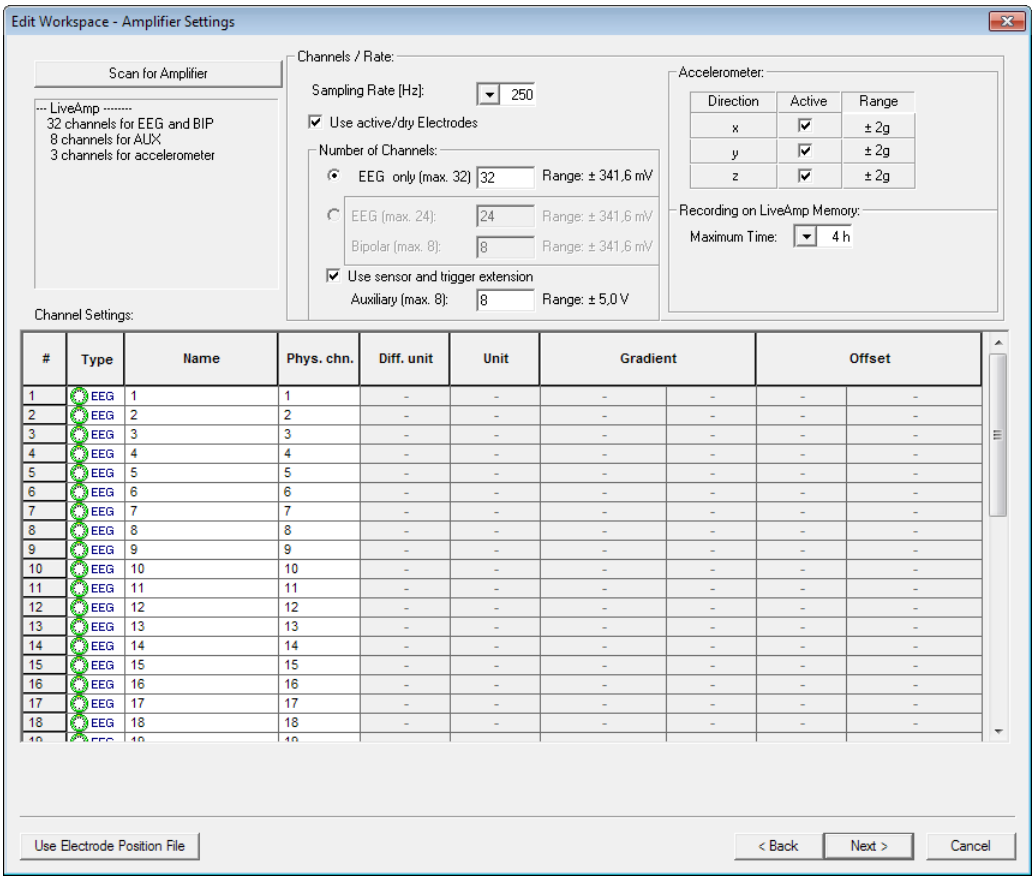


Figure 6-4. LiveAmp workspace

Sampling Rate [Hz]	Select between 250 Hz, 500 Hz and 1,000 Hz. **Note**: Maximum wireless bandwidth cannot always be guaranteed due to external interference.	
	Sampling Rate	**EEG/ExG channels**
	1000Hz	Up to 32 channels (this incl. AUX and acceleration)
	500Hz	32 channels or more (this incl. AUX and acceleration)

Use active/dry Electrodes	Select this option when you use active or dry electrodes.
Number of Channels	Select the type and specify the number of channels.
Use sensor and trigger extension	If you use sensors, choose this option. Specify the number of channels you are using (max. 8).
Accelerometer	LiveAmp has a built-in accelerometer with three axes (x, y, z). You can select and deselect each axis individually. The axes always occupy the last three channels and are not shown in the channel table. The unit of the accelerometer is 'g' (=gravitational constant).
Recording to LiveAmp Memory	If you record to the memory card of LiveAmp, select the maximum expected recording time. **Note:** This setting defines how much space is prepared on the *memory card*. If your recording exceeds this setting, another part of the memory card is automatically prepared. Preparation takes several seconds. **During this time no data can be written to the memory card.**
Channel Settings	*Type*: Indicates the channel type (EEG, REF, BIP or AUX). The channel type is automatically assigned based on the physical channel. For example: LiveAmp channels 1 to 24 are always referential. Channels 25 to 32 can be either referential or bipolar, they cannot be both.
	Name: Click to edit the name of the 'logical channel'. If you enter the same name twice, an error message is shown when you want to proceed to the next workspace page.
	Phys. Chn. : Each channel name must have one physical channel. You can assign physical channels to the logical channels in the first column. The physical channels do not have to be assigned in consecutive order.
Use Electrode Position	Please refer to Using electrode position files .

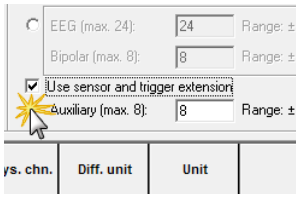
6.4.8 Using sensors

When you connect sensors to LiveAmp using the Sensor and trigger extension, you must select the Sensor and trigger extension in the workspace.

Always disconnect LiveAmp from Recorder before connecting or disconnecting the sensor and trigger extension.

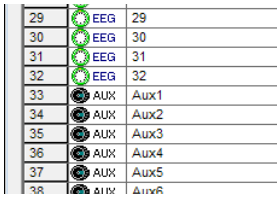
Pre-requisites

- LiveAmp is connected with Recorder
- Sensor and trigger extension is connected to LiveAmp
- Workspace editor is open



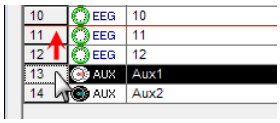
1 Select the check box Use sensor and trigger extension.

2 Specify the number of auxiliary channels, that you want to use (maximum eight).



3 The channel table is updated.

The auxiliary channels are the last eight physical channels.



➔ In the channel table, you can move a channel by drag-and-drop.

➔ You can now rename the auxiliary channels and set different units, gradients and offsets for the sensors.

Setting the units for sensors

Diff. Unit	Select **Diff. Unit** to you can use a different unit such as 'C' for Celsius.
Unit	Enter the required unit in the Unit column.
Gradient	Enter the gradient in mV/unit. Example: For the unit C use mV/C. This will describe the voltage difference in mV at a temperature change of one degree Celsius. The value can also be negative.
Offset	Defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

6.4.9 Configuring the digital port LiveAmp 8, 16 or 32

You can use up to nine trigger bits with LiveAmp 8, 16 and 32. For details refer to the LiveAmp Operating instructions, chapter 7.

Pre-requisites

- LiveAmp connected with Recorder (Connect LiveAmp 8, 16 or 32 with Recorder)

Optional accessories

- Trigger source connected to the trigger input of LiveAmp (1 bit)
- Sensor and trigger extension connected to the AUX input of LiveAmp (8 bit)

➔ Click on **Amplifier › Digital Port Settings...** to open the **Digital Port Settings...** dialog:

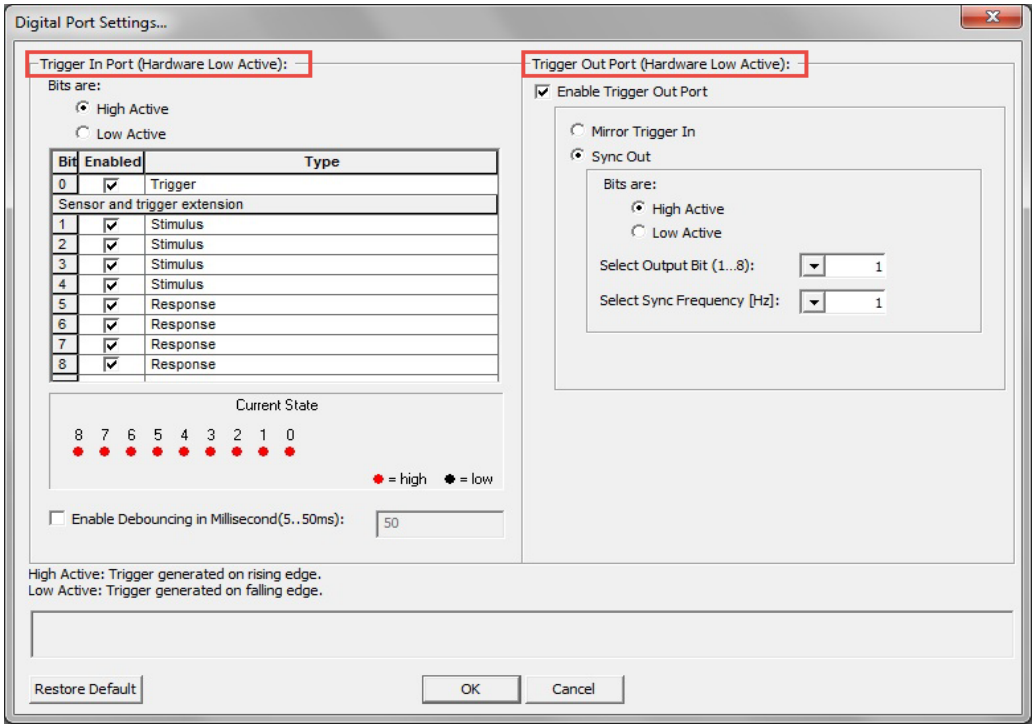


Figure 6-5. LiveAmp digital port settings

Trigger In Port

High Active / Low Active	▶ High Active: a marker is set on the rising edge. ▶ Low Active: a marker is set on the falling edge.
Type	You can change the name of the type. This name will display as marker in your recording.
Enable Debouncing in Millisecond (5..50 ms)	Select this option to ignore the repetition of a marker of the same type and same description for a period of 5 to 50 ms.

Trigger Out Port

Enable Trigger Out Port	Select to activate the Trigger Out connector on the Sensor and trigger extension.
Mirror Trigger In	Select this option, to make the triggers from the input available on the output connector (1:1).
Sync Out	Select to send a trigger at a predefined frequency. When a trigger is sent, a marker (SyncOut) is added to the EEG stream.
High Active / Low Active	Select High Active or Low Active as required; you should use a similar logic to the type of device being synchronized. ▶ High Active: a SyncOut marker is set on the rising edge. ▶ Low Active: a SyncOut marker is set on the falling edge.
Select Output (1...8)	Select the required output bit from 1 to 8.
Select Sync Frequency [Hz]	Select the required sync frequency from 0.1, 1, 5, 10 to 25 Hz.

Note: A trigger pulse may be generated, when you connect the trigger cable to LiveAmp.

Minimum trigger length

Please take note of the recommended minimum length of the trigger signal for various sampling rates in the table below. Shorter signal lengths can result in faulty markers.

Sampling rate	Minimum length of trigger signal
1000 Hz	2 ms
500 Hz	4 ms
250 Hz	8 ms

6.4.10 Configuring the digital port LiveAmp 64

You can use up to ten trigger bits with LiveAmp 64. For details refer to the LiveAmp Operating instructions, chapter 7.

Pre-requisites

- LiveAmp 64 or simulation connected with Recorder (Connect LiveAmp 64 with Recorder)

Optional accessories

- Sensor and trigger extension connected to the AUX input of either the master or slave LiveAmp
- Trigger source connected to the trigger input of either or both LiveAmp amplifiers

➔ Click on **Amplifier › Digital Port Settings...** to open the **Digital Port Settings...** dialog:

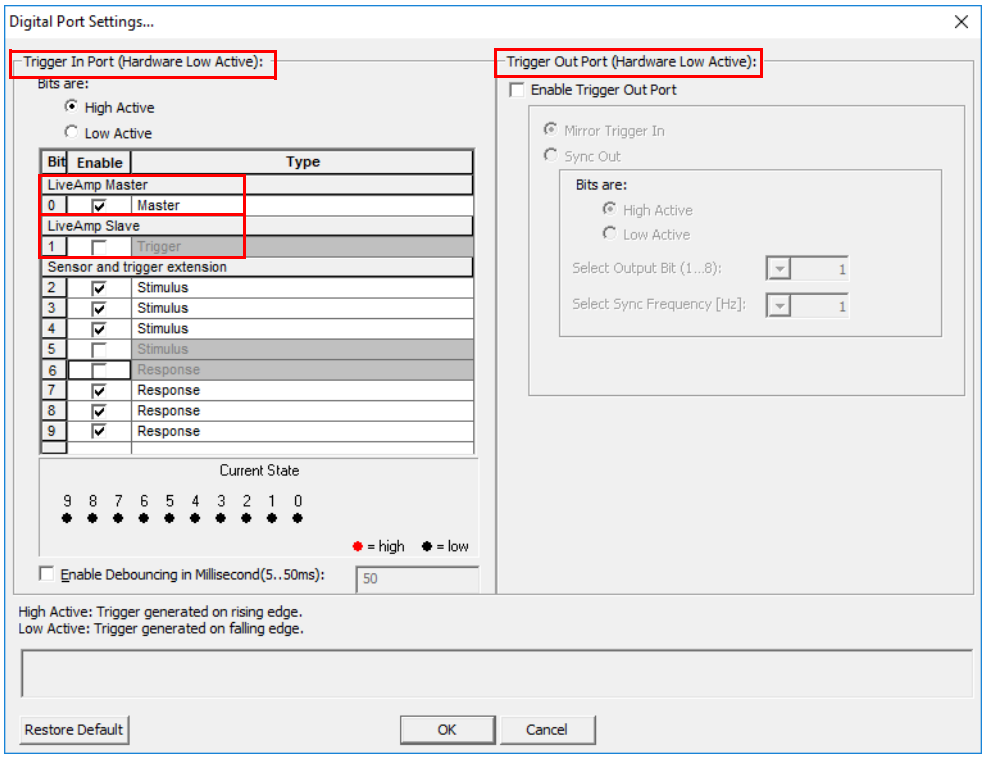


Figure 6-6. LiveAmp 64 digital port settings

Trigger In Port

High Active / Low Active	▶ High Active: a marker is set on the rising edge. ▶ Low Active: a marker is set on the falling edge.
LiveAmp Master	Select the Bit 0 check box to enable the master LiveAmp (CH 1 - 32) trigger
LiveAmp Slave	Select the Bit 1 check box to enable the slave LiveAmp (CH 33 - 64) trigger
Type	You can change the name of the type. This name will display as marker in your recording.
Enable Debouncing in Millisecond (5..50 ms)	Select this option to ignore the repetition of a marker of the same type and same description for a period of 5 to 50 ms.

Trigger Out Port

Enable Trigger Out Port	Select to activate the Trigger Out connector on the Sensor and trigger extension.
Mirror Trigger In	Select this option, to make the triggers from the input available on the output connector (1:1). - Only triggers from the sensor trigger box will be mirrored. - For LiveAmp 64 Trigger bit 2 is output to trigger bit 0 of trigger out port.
Sync Out	Select to send a trigger at a predefined frequency. When a trigger is sent, a marker (SyncOut) is added to the EEG stream.
High Active / Low Active	Select High Active or Low Active as required; you should use a similar logic to the type of device being synchronized. ▶ High Active: a SyncOut marker is set on the rising edge. ▶ Low Active: a SyncOut marker is set on the falling edge.
Select Output (1...8)	Select the required output bit from 1 to 8.
Select Sync Frequency [Hz]	Select the required sync frequency from 0.1, 1, 5, 10 to 25 Hz.

Note: A trigger pulse may be generated, when you connect the trigger cable to LiveAmp.

Minimum trigger length

Please take note of the recommended minimum length of the trigger signal for various sampling

rates in the table below. Shorter signal lengths can result in faulty markers.

Sampling rate	Minimum length of trigger signal
1000 Hz	2 ms
500 Hz	4 ms
250 Hz	8 ms

6.4.11 Measure the impedances

Observe the following guidance when measuring the impedances.

Prerequisites:

- LiveAmp is connected with Recorder (Connect LiveAmp 8, 16 or 32 with Recorder or Connect LiveAmp 64 with Recorder)

1 Prepare the cap and switch Recorder into the impedance mode.
2 Select the impedance threshold values.
   ▷ Active/dry electrodes: in the LiveAmp console.
   ▷ Passive electrodes: in the **Impedance** window.

   Initially, Recorder is set to the default values.
3 Minimize the impedances of the reference, ground and one data electrode.
4 Then minimize the impedances of all other electrodes.
5 To save the impedance values start recording the EEG signals ( ).

Example 1:Saving battery power

To save battery power, first prepare the electrode cap and then switch on LiveAmp.

6.4.12 Recording procedures with LiveAmp

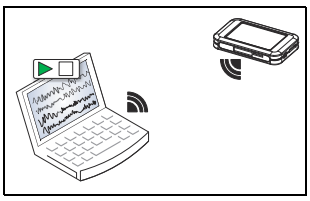
LiveAmp allows you to write data to different locations. Try out the procedures before you actually record real data.

General prerequisites:

- memory card inserted
- LiveAmp connected with Recorder
- workspace created

Record to computer

EEG data is written to the recording computer only. During the recording LiveAmp must stay in the range of the wireless connection. If you move LiveAmp out of the wireless range, samples will be lost.



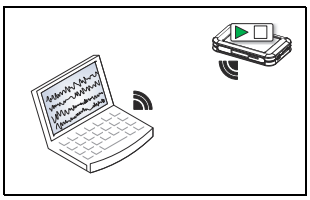
1 Click on **Monitor** .

2 Click on **Start Recording** .

➔ To stop recording, click on **Stop Recording** .

Record to LiveAmp

EEG data is displayed on the recording computer and written to the memory card of LiveAmp. If you move LiveAmp out of the wireless range, writing the data will continue, but no data will be displayed on the recording computer.



1 Click on **Monitor** .

2 In the LiveAmp console, click on **Start** Start .

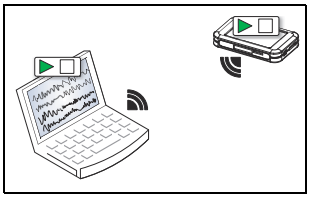
Data is recorded to the memory card, when the battery/recording LED blinks fast.

➔ To stop recording, click on **Stop** Stop in the LiveAmp console.

➔ After recording, the files of the memory card must be converted with the LiveAmp File Converter.

Record to computer and LiveAmp

EEG data is written to the computer and the memory card of LiveAmp. If you move LiveAmp out of the wireless range, writing data to LiveAmp will continue.



1 Click on the button **Monitor** .
2 In the Recorder main window, click on **Start Recording** .
3 In the LiveAmp console, click on **Start** Start .
Data is recorded to the memory card, when the battery/recording LED blinks fast.

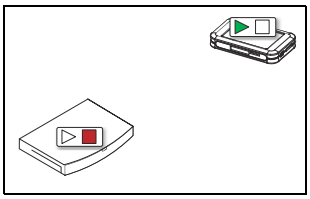
➔ To stop recording do the following:

a In the LiveAmp console, click on **Stop** Stop .
b In the main window, click on **Stop Recording** .

➔ After recording, the files of the memory card must be converted with the LiveAmp File Converter.

Record to LiveAmp as holter

EEG data is written to LiveAmp, while LiveAmp is disconnected from the recording computer. This is called the *holter* function of LiveAmp.



1 Click on **Monitor** .
2 In the LiveAmp console, click on **Start** Start .
Data is recorded to the memory card, when the battery/recording LED blinks fast.
3 In the main window, click on **Stop Monitoring** .
4 In the LiveAmp console, click on **Disconnect**.
The wireless LED on LiveAmp goes off after approximately 2 minutes.

➔ To stop recording do the following:

a Switch on the wireless module by pressing the I/O button on LiveAmp for one second.
b In the LiveAmp console, click on **Search for LiveAmp...** and connect to the LiveAmp.
c Then click on **Stop** Stop .

➔ After recording, the files of the memory card must be converted with the LiveAmp File Converter.

Notes

- The status bars in the main window and LiveAmp console show, if data is recorded.
- Recording Annotations, Video and pausing a recording only works for recording to the HDD, but not the memory card.

6.4.13 Convert the LiveAmp data

After the data acquisition, use the LiveAmp File Converter to convert the data from memory card.

LiveAmp 8, 16 and 32

LiveAmp 8, 16 and 32 saves the EEG data and the settings of the Recorder workspace on the memory card. These files have following names and extensions:

- Workspace: TEMP.WSP
- EEG, bipolar and trigger data: LA*000001*.DAT (the digit is automatically incremented)

LiveAmp 64

LiveAmp 64 saves the EEG data and the settings of the Recorder workspace on the memory card's of each LiveAmp 32. When using the LiveAmp 64 you will have to copy the files from the memory card of **both** LiveAmps to the same folder as both files are required for compilation by File Converter.

These files have following names and extensions:

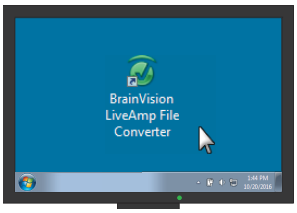
- Workspace: TEMP.WSP
- Master LiveAmp - EEG and trigger data: LA*000001*.DAM (the digit is automatically incremented)
- Slave LiveAmp - EEG, bipolar and trigger data: LA*000001*.DAS (the digit is automatically incremented)

Prepare

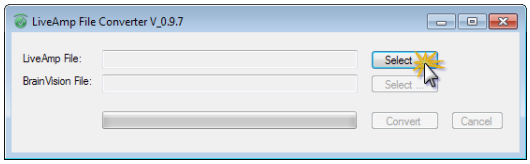
- Computer with BrainVision LiveAmp File Converter

- Memory card inserted into recording computer

- When using the LiveAmp 64 you will have to copy the files from the memory cards of **both** LiveAmps (.DAS and .MAS) to the same folder as both files are required for compilation by File Converter.
- The TEMP.WSP file does not have to be copied for any version of LiveAmp.

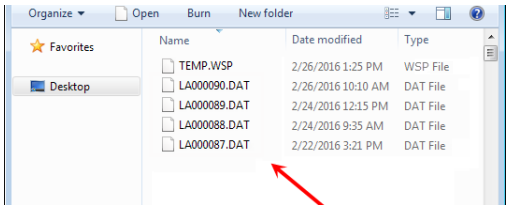


1 Open the LiveAmp File Converter.
Windows start button › All Programs › BrainVision › BrainVision LiveAmp File Converter.

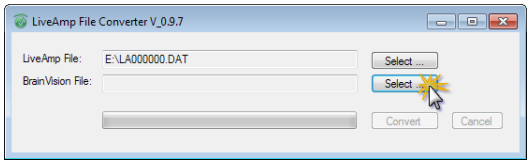


2 Load the EEG files.

In the line 'LiveAmp File', click on **Select** and locate the EEG data.
Search for the folder with your EEG data. When using LiveAmp 64 it is essential that files from both LiveAmps are copied to the same folder.

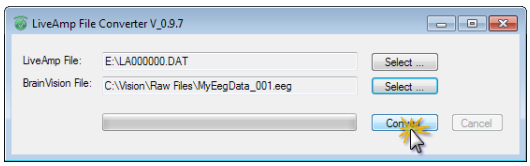


3 Select the ***.DAT** file if using LiveAmp 8, 16 or 32 or select the ***.DAM** file if using LiveAmp 64 and then **OK**.

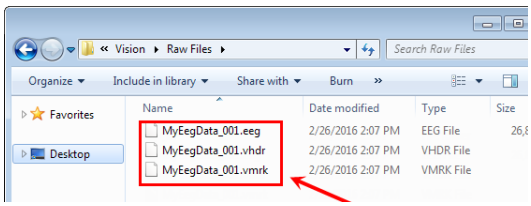


4 Specify the target file.

a In the line 'BrainVision File', click **Select**.
b Select the target folder.
c If required, rename the file and click **OK**.



5 Finally, click **Convert**.



6 Check the conversion.

Open the target folder and make sure that there is the EEG file (*.EEG), header file (*.VHDR) and marker file (*.VMRK).

➔ The converted EEG files can now be used in Analyzer.

6.4.14 Use the simulation

If you do not have an amplifier, but want to prepare a workspace, for example, you can use the simulated amplifier.

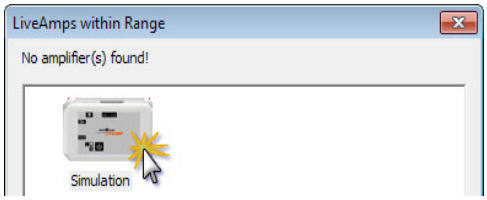
Prepare

- LiveAmp or LiveAmp 64 is selected in Recorder
- All LiveAmps switched off (no LiveAmp within range)

1 In the LiveAmp console, click on **Search for LiveAmps...**

2 Select the **Simulation** amplifier.

3 Create a workspace to your needs.



➔ You can use a workspace, created with the simulated amplifier, with a real LiveAmp amplifier.

6.4.15 Check the functionality of LiveAmp (test signal)

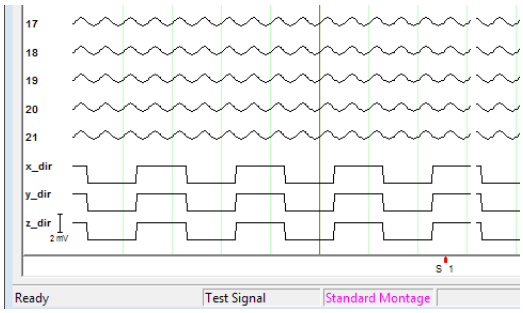
The test signal mode injects a sine wave signal in all EEG channels and a square signal in the acceleration channels. You can also test the transmission range of LiveAmp with the test signal mode.

Prerequisites

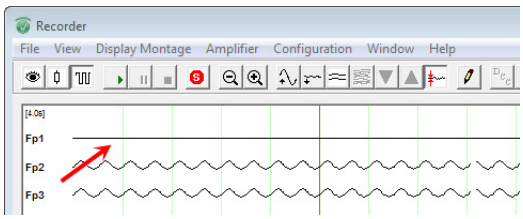
- LiveAmp connected with Recorder
- Workspace created
- No electrode cap connected

1 In the Recorder main window, click on the button **Test Signal**.

The test signal is injected in the EEG channels (sine wave) and in the acceleration channels (square wave). Additionally, a stimulation marker is set every three seconds.



➔ If a channel shows a flat line it is not working correctly. Contact your local dealer for remedy.



6.4.16 Show connected amplifier

When you need support, you can find helpful information in Recorder and the log files.

Version information

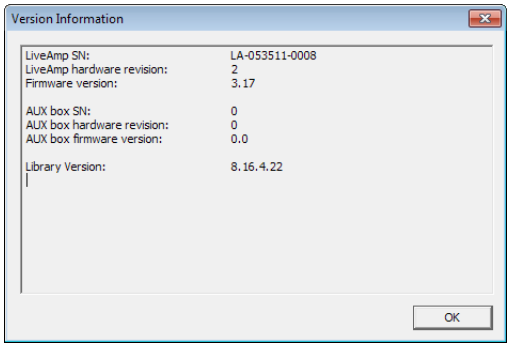
Pre-requisites

- LiveAmp connected with Recorder

1 In Recorder, click on **Amplifier › Version information...**

➔ The Version Information window shows for example the serial number (SN), Product revision and firmware version.

Provide these information to the support team or your local dealer.



Log information

The log files might be required by your dealer or the support team for troubleshooting. You can find log files for LiveAmp and general log files on your local drive. By default they are stored under: `C:\Vision\Recorder\Log`.

6.5 V-Amp and FirstAmp amplifiers

Both administrator mode and user mode are supported for the *V-Amp* and *FirstAmp*.

6.5.1 V-Amp workspace at a glance

Choose **File › New Workspace...** from the menu.

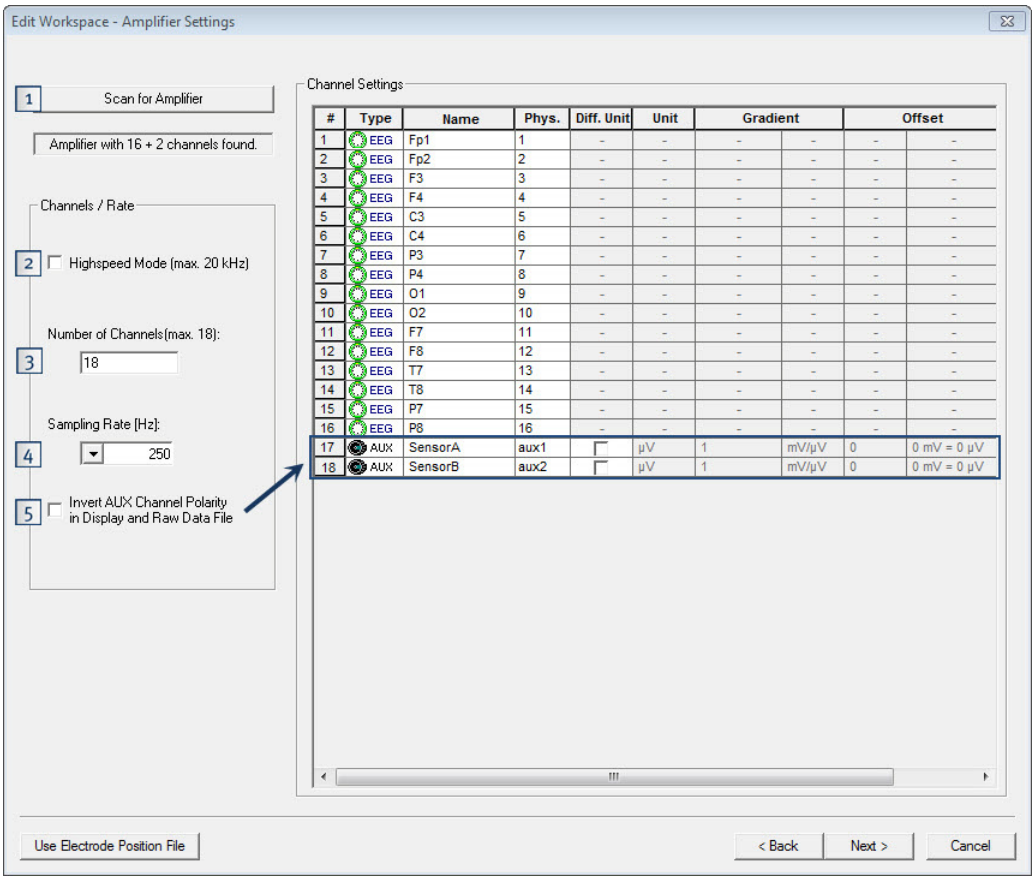


Figure 6-7. Editing a workspace for the V-Amp/FirstAmp

1 Click **Scan for Amplifier**. The amplifier connected to your computer is displayed.

2 If you select the **Highspeed Mode (max. 20 kHz)** box, you can select a value of 5, 10 or 20 kHz for the sampling rate. This option is only available for four channels. If you do not select the box, the maximum sampling rate is 2 kHz.

3 Enter the number of channels in the **Number of Channels** text box.

4 Choose the sampling rate in the **Sampling Rate [Hz]** text box.

5 **Invert AUX Channel Polarity in Display and Raw Data File** allows you to invert the display of AUX channels. The AUX inputs are used to connect external sensors to measure temperature, skin conductivity, etc.

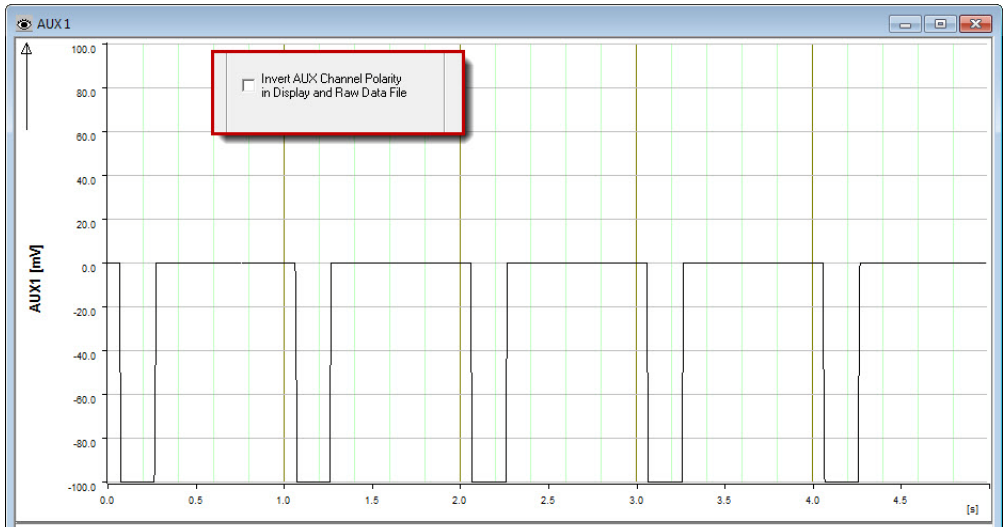


Figure 6-8. AUX 1 channel not inverted (box not selected)

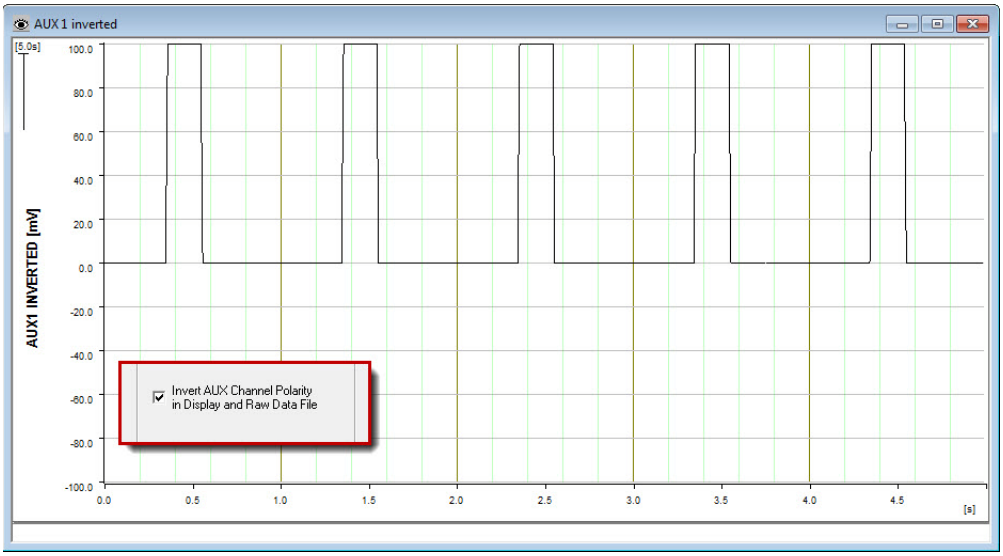


Figure 6-9. AUX 1 channel inverted (box selected)

You can also make the following settings:

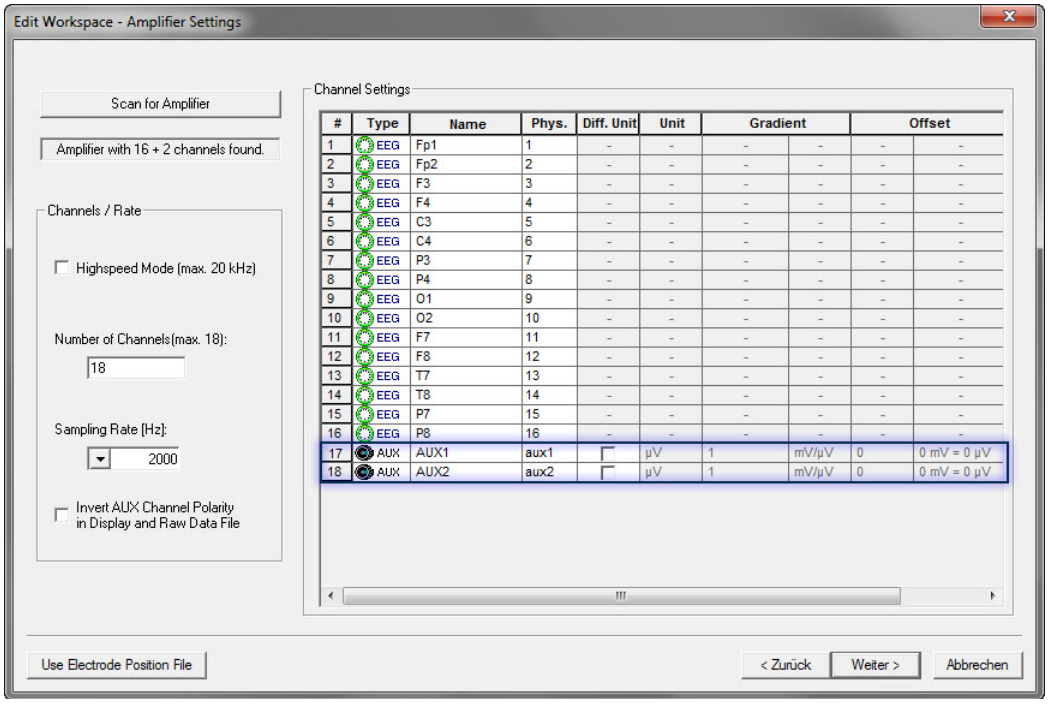


Figure 6-10. V-Amp, AUX channels

Additional data entry columns are available for the AUX channels in the channel table:

- If you select the box under **Diff. Unit**, you can use a different unit such as 'C' for Celsius.
- Enter the required unit in the **Unit** column.
- Enter the gradient in mV/unit in the **Gradient** column – for the unit C, for example, use mV/C. In this example, you describe the voltage difference in mV at a temperature change of one degree Celsius. This value can also be negative.
- The **Offset** defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

6.5.2 Configuring the digital port (marker port)

Use the trigger input connectors of the *V-Amp/FirstAmp* for recording events that are synchronous with the EEG such as stimuli or test subject responses. Nine digital bit inputs and hence nine bits are available. The first bit is numbered 0 and is located on the *Trigger 2* port (jack) of the amplifier. All the remaining bits are located on the *Trigger 1* port.

You make the settings for the digital port by choosing **Amplifier › Digital Port Settings...**

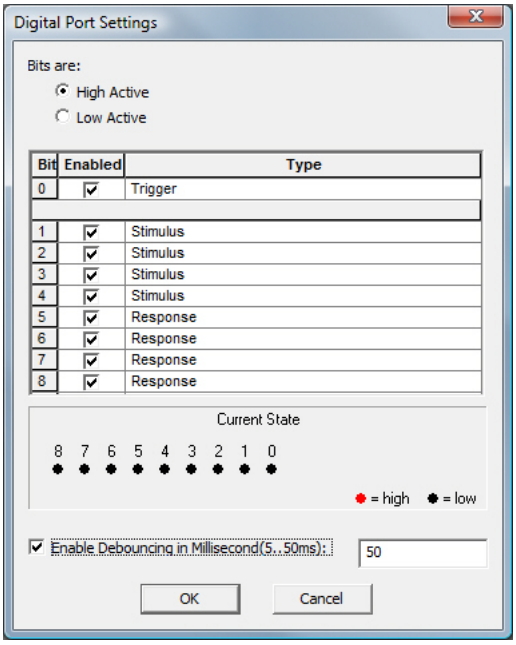


Figure 6-11. Configuring the digital port for the V-Amp/FirstAmp

You can choose whether the signals are interpreted as high-active (5 V = active) or low-active (0 V = active).

In the **Enabled** column of the table, you can specify whether the associated bit is to be evaluated or not. In the **Type** column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

In principle, you can freely select the name of the type. You should, however, note that *Recorder* and *Analyzer* use color coding for certain types. For this reason, it is advisable to choose 'Stimulus' and 'Response' for stimulus and response inputs respectively.

The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Example

Bit 4 through bit 7 are of the type 'Response'. If bits 5 and 7 are set, this results in a marker of the type 'Response' with the description 'R 10'. Bit 5 has a value of 2 and bit 7 a value of 8. The total is 10. The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, by assigning a separate marker to every bit. Alternatively, you can assign a separate type to every bit in the table.

Note that a suitable ratio between the length of the trigger signal and the sampling rate is required to ensure that the TTL trigger signals are recorded without errors. You make the appropriate settings when you set up the workspace.

Please take note of the recommended minimum length of the trigger signal for various sampling rates in the table below. Shorter signal lengths can result in errored markers.

Sampling rate	**Minimum length of trigger signal**
100 Hz	25.0 ms
250 Hz	10.0 ms
500 Hz	5.0 ms
1000 Hz	2.5 ms
2000 Hz	2.5 ms
5000 Hz	0.5 ms
10000 Hz	0.5 ms
20000 Hz	0.5 ms

You can view the current state of the digital port for test purposes in the *Current State* box.

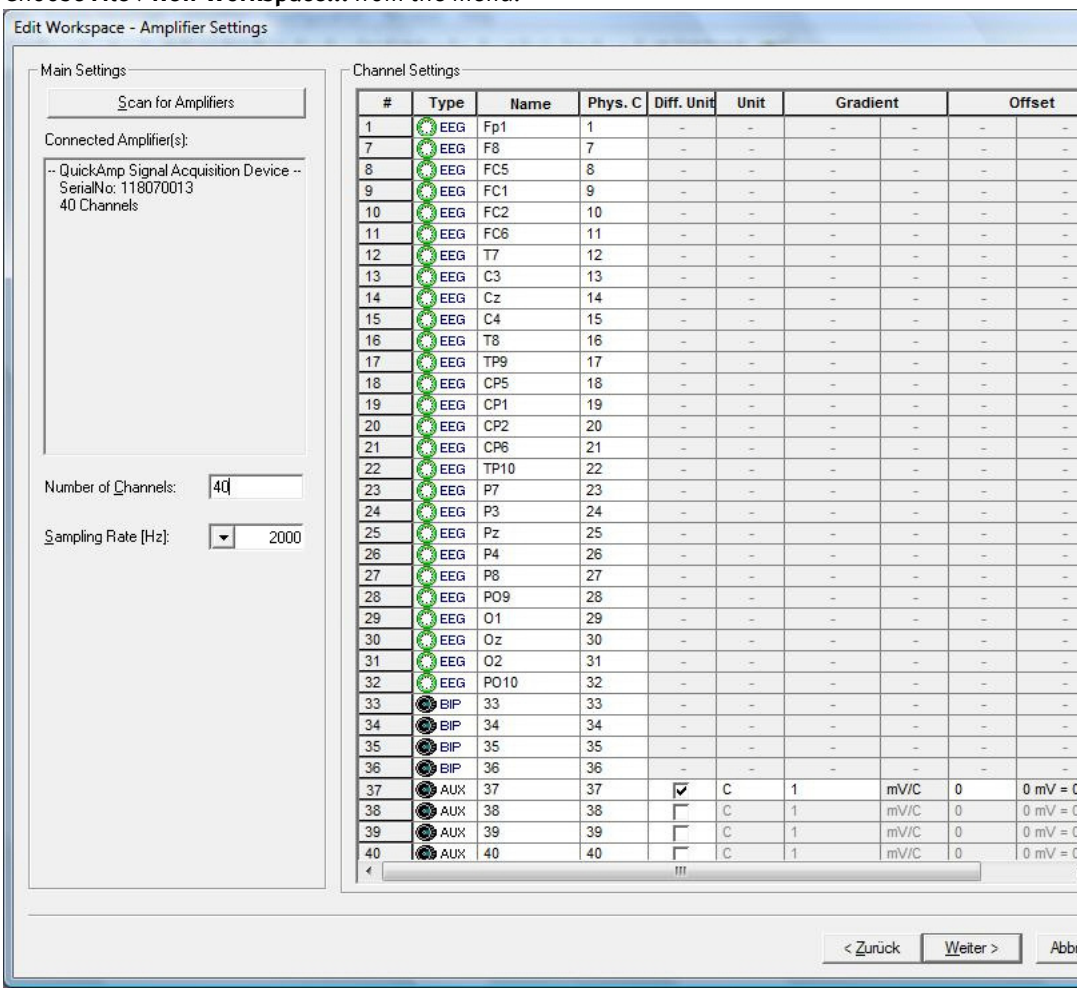
Another option available in the *Digital Port Settings* dialog box is debouncing. If you select the *Enable* **Debouncing in Millisecond (5..50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.

6.6 QuickAmp

If you use a QuickAmp amplifier with the Windows® 7 64-bit operating system you need to install the driver separately.

6.6.1 QuickAmp workspace at a glance

Choose **File › New Workspace...** from the menu.

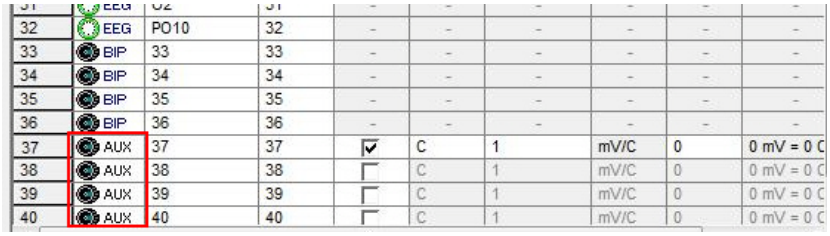


Click **Scan for Amplifiers**. The QuickAmp amplifiers connected to your computer are shown under *Connected Amplifier(s)*.

Enter the number of channels in the **Number of Channels** text box. Choose the sampling rate in the **Sampling Rate [Hz]** text box.

Adjusting the sensors for the AUX inputs

If you wish to use external sensors to measure temperature, skin conductivity etc. you can carry out the appropriate adaptations at this point. The AUX channels are always the last four channels of the amplifier. This means that for a QuickAmp40, you use the physical channels 37 through 40, for a QuickAmp72 channels 69 through 72 and for a QuickAmp128 channels 125 through 128.



32	EEG	PO10	32	-	-	-	-	-	-
33	BIP	33	33	-	-	-	-	-	-
34	BIP	34	34	-	-	-	-	-	-
35	BIP	35	35	-	-	-	-	-	-
36	BIP	36	36	-	-	-	-	-	-
37	AUX	37	37	☑	C	1	mV/C	0	0 mV = 0 C
38	AUX	38	38	☐	C	1	mV/C	0	0 mV = 0 C
39	AUX	39	39	☐	C	1	mV/C	0	0 mV = 0 C
40	AUX	40	40	☐	C	1	mV/C	0	0 mV = 0 C

Figure 6-12. QuickAmp, AUX channels

Additional data entry columns are available for the AUX channels in the channel table:

- If you select the box under **Diff. Unit**, you can use a different unit such as ‘C’ for Celsius.
- Enter the required unit in the **Unit** column.
- Enter the gradient in mV/unit in the **Gradient** column – for the unit C, for example, use mV/C. In this example, you describe the voltage difference in mV at a temperature change of one degree Celsius. This value can also be negative.
- The **Offset** defines the zero point. In our temperature example, this is the voltage in mV that the sensor returns at a temperature of 0 degrees Celsius.

6.6.2 Using the test signal

To display and record click on the *Test Signal* button. A square wave signal is generated and displayed.

To configure the test signal for the *QuickAmp*, choose **Amplifier › Test Signal Values...** from the menu.

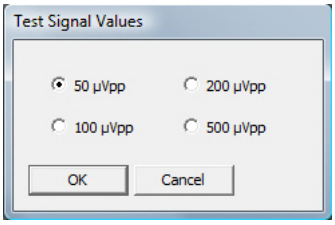


Figure 6-13. Selecting a test signal for the QuickAmp

Note

The test signal is not calibrated. It is only an approximate value.

6.6.3 Configuring the digital port

Use the digital ports DIO0 through DIO7 for recording events that are synchronous with the EEG such as stimuli or test subject responses. The designations DIO0 through DIO7 relate to the bit number, with the first bit being designated with 0.

You make the settings for the digital port by choosing **Amplifier › Digital Port Settings...** from the menu.

Note that the contents of the dialog box differ in respect of the debouncing parameters with the *QuickAmp PCI* and *QuickAmp USB*.

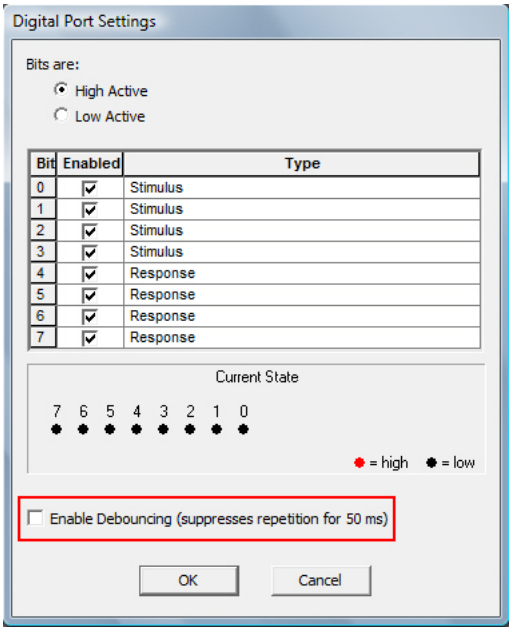


Figure 6-14. Configuring the digital port for the QuickAmp PCI

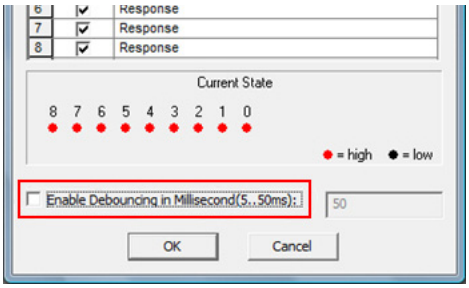


Figure 6-15. Configuring the digital port for the QuickAmp USB

You can choose whether the signals are interpreted as high-active (5 V = active) or low-active (0 V = active).

In the *Enabled* column of the table, you can specify whether the associated bit is to be evaluated or not. In the *Type* column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

In principle, you can freely select the name of the type. You should, however, note that the Recorder and Analyzer use color coding for certain types. For this reason, it is advisable to choose ‘Stimulus’ and ‘Response’ for stimulus and response inputs respectively.

The description of the markers is encoded automatically. The following procedure is used: The first occurrence of the type in the table is weighted with value 1, the second occurrence with value 2, the third with value 4 etc. For every data point, all set bits of a type are added together according to this pattern. The resultant number is combined with the initial letter of the type, resulting in the description.

Example

Bit 4 through bit 7 are of the type ‘Response’. If bits 5 and 7 are set, this results in a marker of the type ‘Response’ with the description ‘R 10’. Bit 5 has a value of 2 and bit 7 a value of 8. The total is 10. The consequence of this logic is that only markers of different types can be detected at any one time. If you want to record different responses simultaneously, you can do so by decoding the number values subsequently in the analysis, by assigning a separate marker to every bit. Alternatively, you can assign a separate type to every bit in the table.

You can view the current state of the digital port for test purposes in the **Current State** box.

Another option available in the *Digital Port Settings* dialog box is debouncing.

- *QuickAmp PCI*. If you select the **Enable Debouncing (suppresses repetition for 50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 50 ms.
- *QuickAmp USB*. If you select the **Enable Debouncing in Millisecond (5..50 ms)** box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.

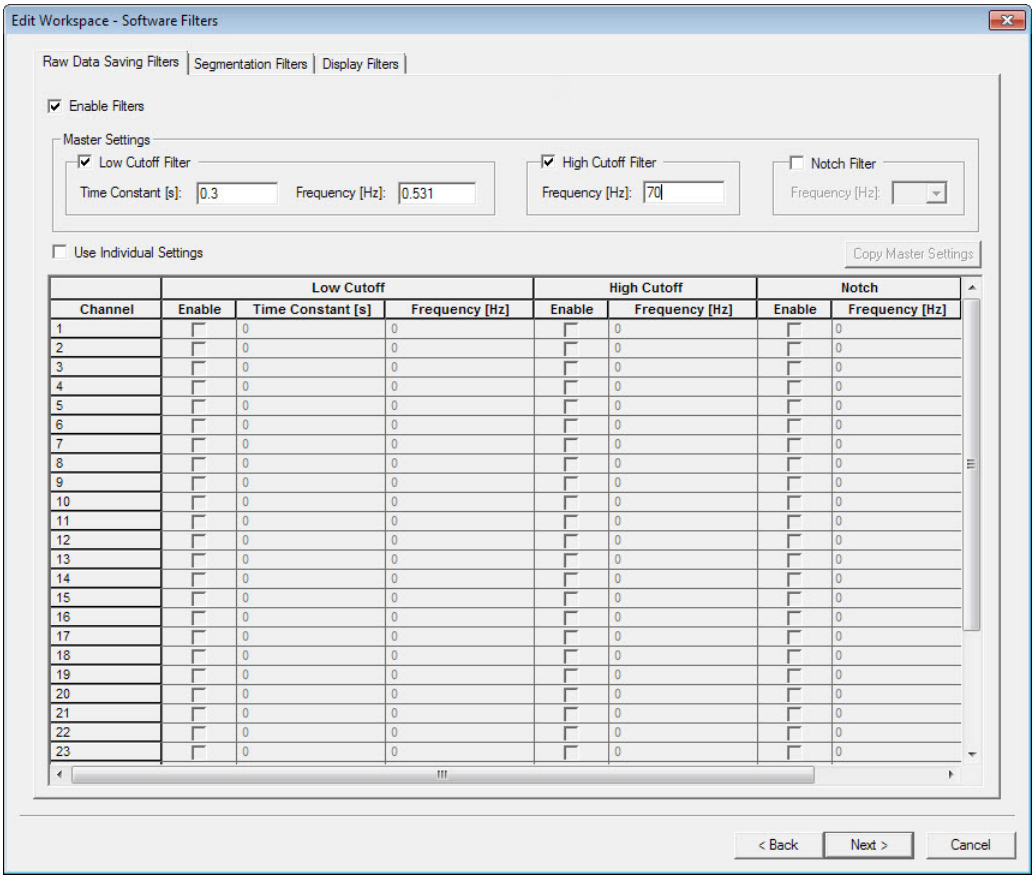
Note

Trigger signals must be present at least for the extent of a sampling point. This means, for instance, that at a sampling rate of 1,000 Hz, the minimum length of the trigger signal is 1 ms and that at 500 Hz the minimum length is 2 ms, etc.

7 General settings

7.1 Filters

➔ Click on **File › New Workspace...** or **File › Edit Workspace...** to open the workspace wizard. In the wizard click on **Next** until you reach the dialog Software Filters.



Three filter methods are available:

- **Raw Data Saving Filters**

  Filters are directly applied to the raw data. Use of this filter is not recommended, because this changes the raw data. When using BrainVision Analyzer you can apply filters to the raw data.

- **Segmentation Filters**

  When you specify segmentation (subsequent tab of the workspace wizard) you can also set filters for the segmented data.

- **Display Filters**

  This filter only has an effect on the display on your screen. When you set the filter, you can switch it on and off during the data display of the data by clicking on the button **Display Filter**  .

Enable Filters	You can also deactivate the paths completely by deselecting the box for each path Because the filters are software filters, you can enter any values. Nevertheless, you should take care not to set any frequencies with a value equal to or greater than half the selected sampling rate.
Low Cutoff Filter High Cutoff Filter	The slope for the low-cutoff filter and the high-cutoff filter is 12 dB/ octave. 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.
Notch filter	This filters the noise of the mains line. You can choose between 50 Hz and 60 Hz. Depending on your region, the mains noise is either 50 Hz (for example, Germany) or 60 Hz (for example, USA).
Use Individual Settings	You can apply this setting to the channels as a group or to individual channels by selecting or deselecting the box.
Copy master settings	Copies the settings from above into the channel table. This button is only active, when you select the check box Use Individual Settings.

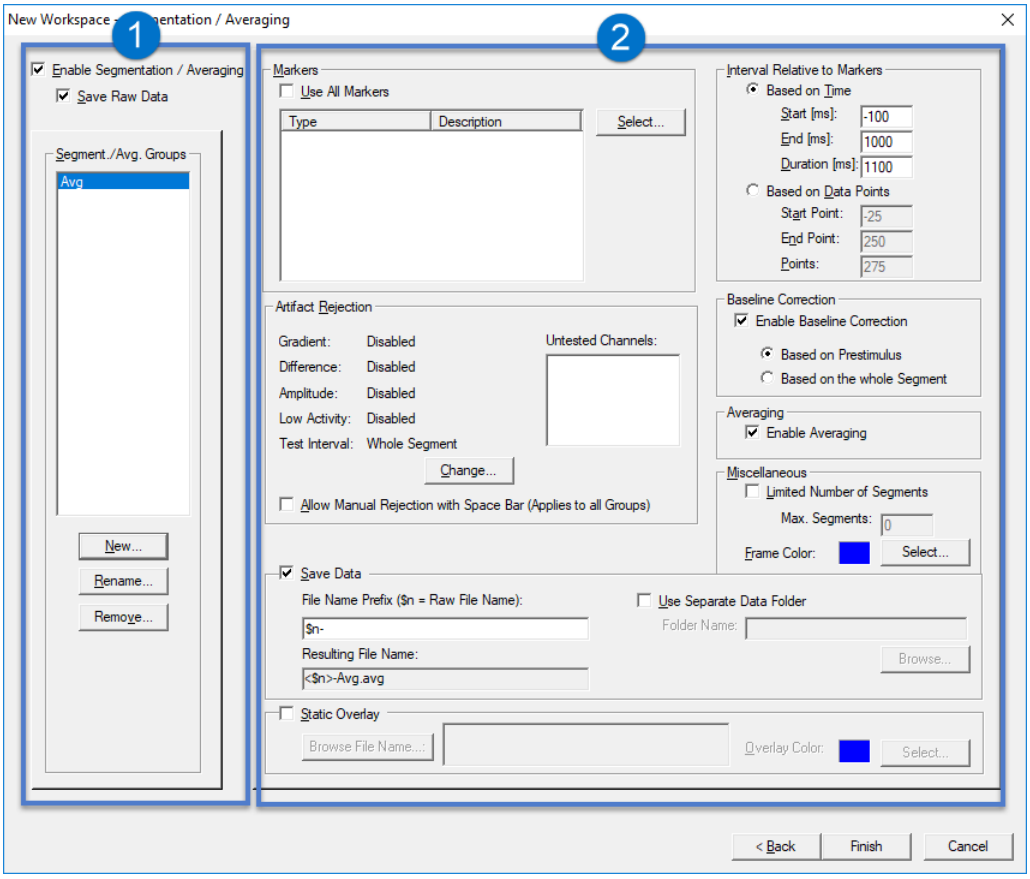
7.2 Segmentation and averaging

Recorder can segment or average your data based on time markers such as stimulus markers or reaction markers. Segmentation is always a preliminary step in averaging. Both procedures will therefore be presented together in this section. You can save the segmented or averaged data in parallel with the raw data. You can also use segmentation and averaging to ascertain whether a visible evoked potential is formed. In this case you do not store the segments or the average. It is also possible to save segmented data or the averaged data only, and to dispense with raw data.

Segmentation / Averaging dialog at a glance

➔ Click on **File › New Workspace...** or **File › Edit Workspace...** to open the workspace wizard. In the wizard click on **Next** until you reach the dialog Segmentation/Averaging.

NEW



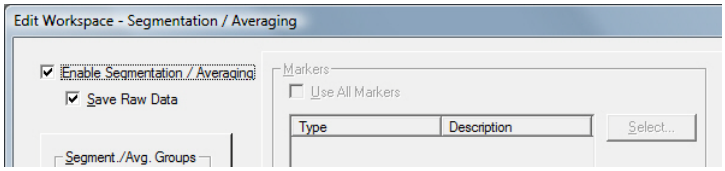
1	Enables segmentation/averaging and manage segmentation groups.
2	Specify the parameters for the corresponding group.

7.2.1 Setup segmentation / averaging

Enable segmentation/averaging

- Select the check box **Enable Segmentation / Averaging**.
- Choose **Save Raw Data** to save the raw data together with the segmented data.

  Note: This option is recommended, because it allows you to change the averaging parameters later.



➔ Next, create a segmentation group.

Create a segmentation/averaging group

A segmentation group contains the parameters for one or more markers. You can define up to 16 groups with different parameters. During recording each group will be displayed in a separate window and you can save separate files. Initially the *Segment./Avg. Groups* box is empty.

1. Click **New...** to create a new group.
2. Enter a meaningful name of the group and click on **OK**.

   The group name will be part of the file name.

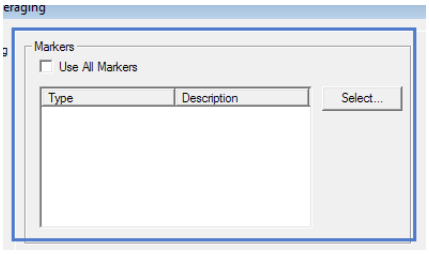
➔ Next, select the markers.

Select the segmentation/averaging markers

In the *Markers* group you select the markers that describe the relevant segments for the current group. The box is initially empty.

You can use all makers (click **Use All Markers)** or select individual markers.

1 To use individual markers, click **Select...**



2 In the Select Segmentation Markers dialog, do the following:
- ▷ choose a marker type from the list *Type* on the left.
- ▷ Select the marker(s) from the list *Descriptions*.
- ▷ Click on the **Add››** button.
- ▷ When finished click on **OK**.

➔ To remove a marker from this list, select the marker and click **Remove**.

➔ Next specify the interval (optional).

Note on the markers

The number of available markers is retrieved from the digital port settings (**Configuration › Digital Port settings...**).

In the digital port settings dialog you specify the trigger bits. Each bit has two states - on or off. Recorder combines all bits of the same type which results in 2^n markers. The state in which all bits are 'off' is ignored. Thus, if you select three stimulus bits in the digital port settings dialog there will be seven stimulus markers ($2^3 - 1 = 7$).

Specify the interval

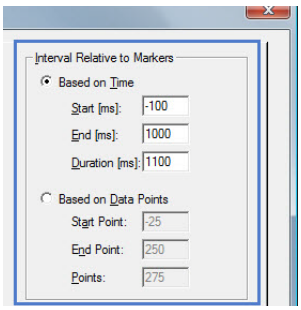
An Interval specifies the time before and after the occurrence of a marker.

You can set the relative positions of the segment interval based on time or based on data points.

1 Choose the desired method (**Based on Time** or **Based on Data Points**).

2 Specify the **Start** and **End** of the interval.

▷ Alternatively, you can specify the **Duration** of the interval, which will change the end of the interval.

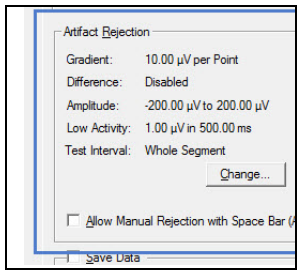


➔ Next set the artifact rejection.

Note

Do not specify a too large interval. Each interval only contains one marker by default. Subsequent markers are ignored. If the interval is too large a second marker could occur which is then ignored.

Reject segments with artifacts



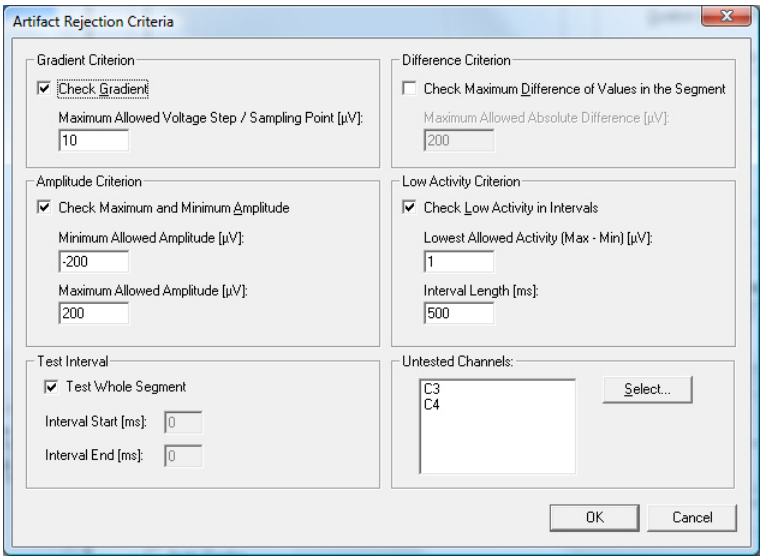
The *Artifact Rejection* group box allows you to examine the individual segments for various artifacts, or to carry out a quality select.

You can specify the artifact rejection criteria, so that the segments are rejected automatically, or you can reject artifacts manually.

When you choose the manual option **Allow Manual Rejection with Space Bar (Applies to all Groups)**, you can reject any segment by pressing the space bar, until the next segment is shown.

If you work with several segmentation/averaging groups, the rejection criteria are applied to the segments in the active window. The segments in the inactive windows that overlap the rejected segment are also rejected. However, only the most recently accepted segment in a group is checked.

➔ To set artifact rejection criteria, click **Change...** The *Artifact Rejection Criteria* dialog opens.



Gradient Criterion	Select and specify the maximum permitted difference in microvolt between two neighboring sampling points. If this value is exceeded, the segment is rejected.
Difference Criterion	Select and specify the maximum permitted difference in voltage between the lowest and highest value within the region to be tested.
Amplitude Criterion	Select and specify the minimum and maximum permitted amplitude in microvolt.

Low Activity Criterion	Selected to check if a minimum amount of activity has occurred within a defined time period. Enter the minimum activity in microvolt and the length of the interval within which the activity must not fall below the specified value. **Example**: If you specify a period of five milliseconds, the program checks whether there is no change of voltage of the selected magnitude over a period of five milliseconds within the test interval.
Test Whole Segment	Select to check the entire segment for artifacts. Alternatively, specify the length of the segment to be checked.
Untested Channels	Specify the channels that must not be tested. Click **Select...** and choose the channels that should be ignored during artifact checking.

Notes

- All segments that are detected as having artifacts are excluded from segmentation/averaging.
- It is particularly advisable to exclude ECG channels from artifact identification.
- In *Recorder*, unlike in the *Analyzer*, you must select the channels that are not to be tested.

NEW

Baseline Correction and Averaging

Baseline correction when enabled adjusts the baseline of the segment on prestimulus (**Based on Prestimulus** radio button) or on the whole segment (**Based on the whole Segment** radio button).

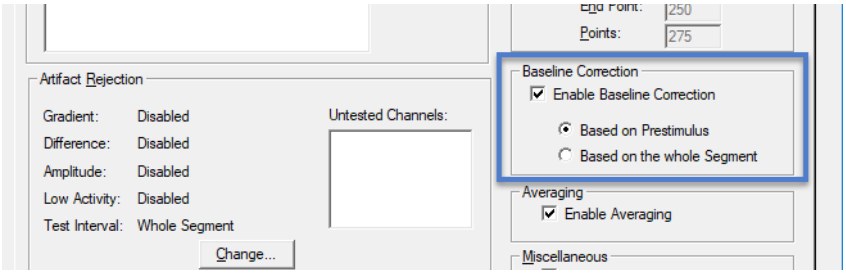


Figure 7-1. Enable Baseline Correction

Averaging allows you to specify whether the data is to be averaged (**Enable Averaging** check box selected) or not.

- If *Averaging* is enabled then *Baseline Correction* is applied to the averaged data.
- If *Averaging* is disabled then *Baseline Correction* is applied to the single segment.

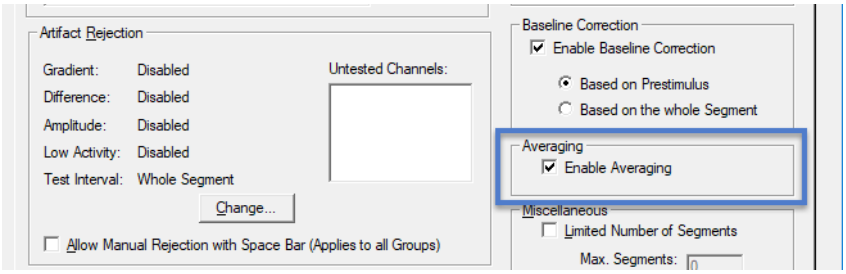
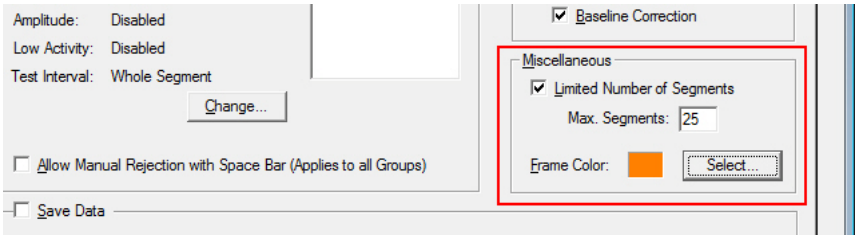


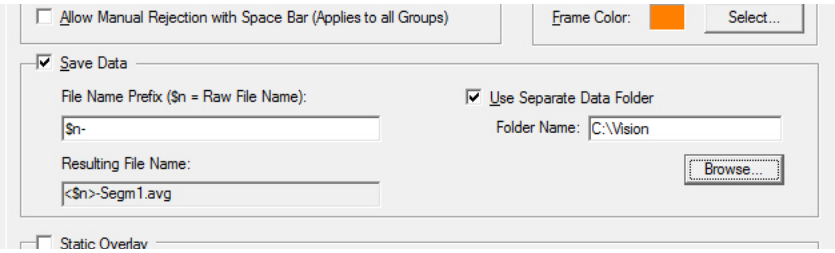
Figure 7-2. Enable Averaging

Other settings



Limited Number of Segments	allows you to limit the number of segments that you want to record during segmentation or include in averaging.
Frame Color	allows you to select a frame color for the group in order to identify the associated data window.

Saving options



Save Data	By selecting this option the data is saved when you click the button **Record** in the toolbar
File Name Prefix	Enter a file name in the text box. The group name and a file extension are added to the name that you enter here. Insert '$n' as a placeholder for the raw data file name.
Resulting File Name	The name that is formed is shown under .
Use Separate Data Folder	If you do not select the box, the previously defined raw data folder is used. Otherwise, select a folder for the group.

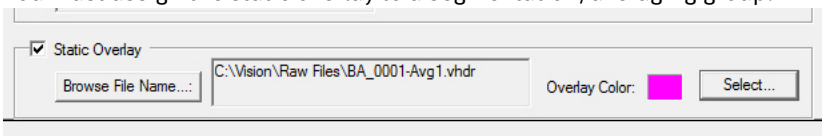
Using a static overlay

A static overlay is an average that has already been recorded with Recorder or that has been exported from Analyzer using the *Generic Data Export* component.

Note

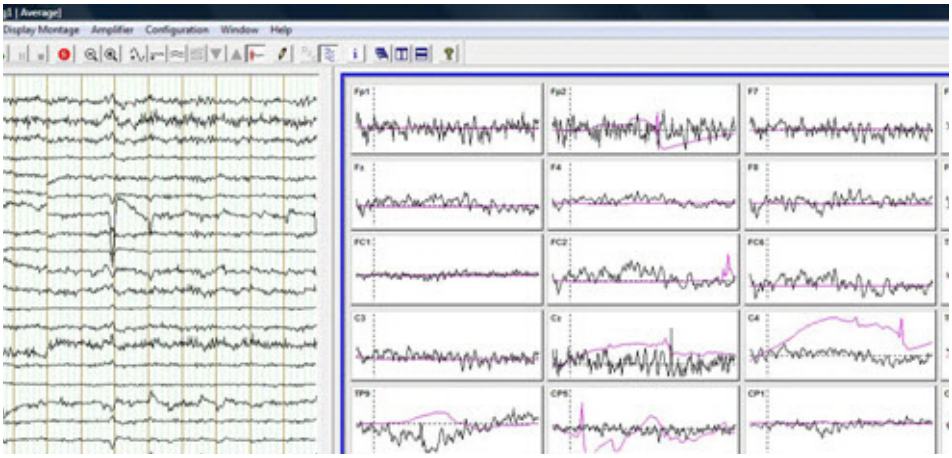
- The sampling rate and segmentation length (prestimulus and poststimulus intervals) must match the setting in the Recorder workspace.

1 Select the box **Static Overlay**.
You must assign the static overlay to a segmentation/averaging group.



2 Choose a saved overlay using **Browsing File Name...**

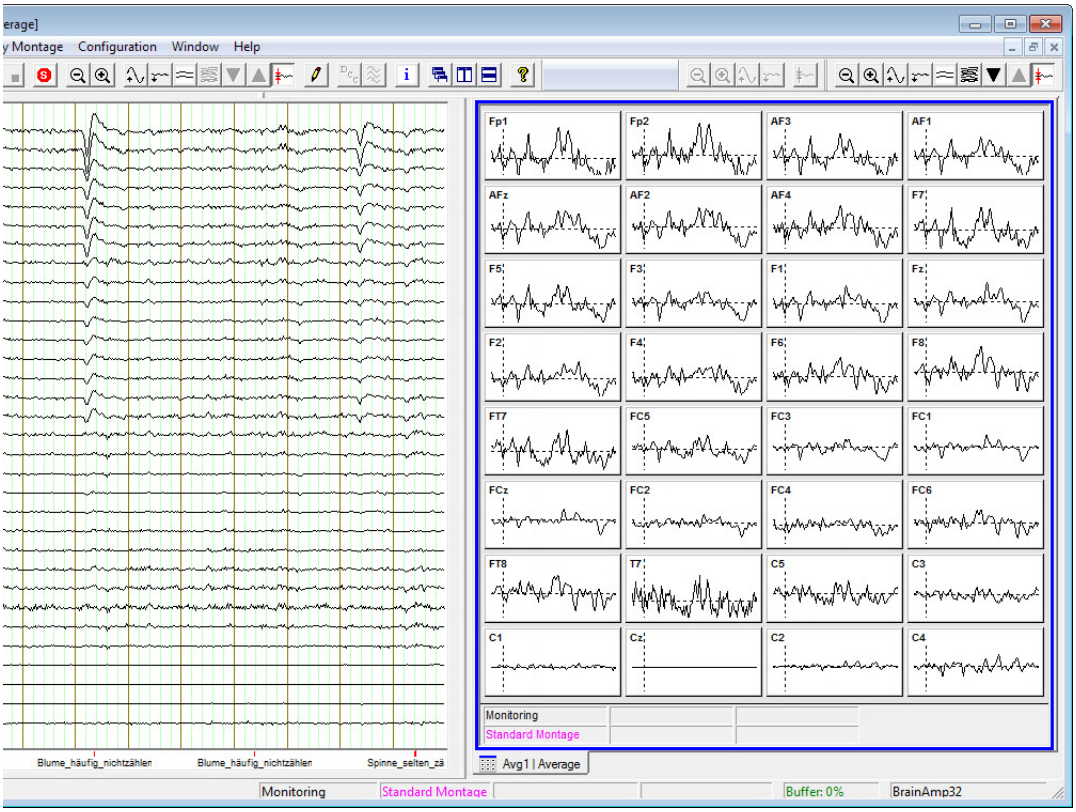
➔ Static overlay is applied to the data.



7.2.2 Viewing segmented/averaged data

Click the button **Monitor** .

➔ The monitoring window opens.



About the data display

The left-hand pane (monitoring window) contains the recorded raw EEG data or shows a dynamic display of the raw data. The right-hand pane contains the segmentation or averaging groups. Tabs allow you to switch between the individual groups. You can change the ratio between the monitoring window and the segmentation windows with the mouse.

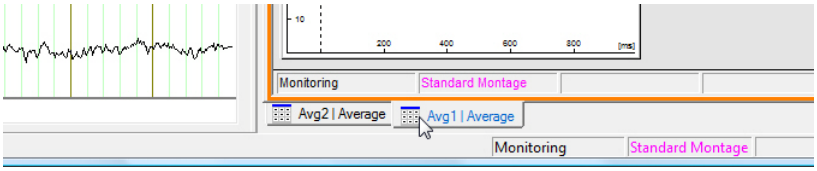


Figure 7-3. Switching between groups using tabs

You can do the following

- In the segmentation tab the curves are shown in red if the segment does not match the artifact criteria. This enables you to check the criteria easily prior to recording data.

- If you have specified the manual artifact rejection, you can now use the space bar during recording to subsequently reject segments which have not automatically been identified as having artifacts.
- There are tabs beneath the group windows. These enable you to quickly bring a group window into the foreground.
- Right-clicking in a data window and selecting a montage type from the context menu allows you to select a new montage for this window.
- You can arrange the group windows in different ways with the toolbar buttons below:

Cascade Windows cascades all the open windows one after another.

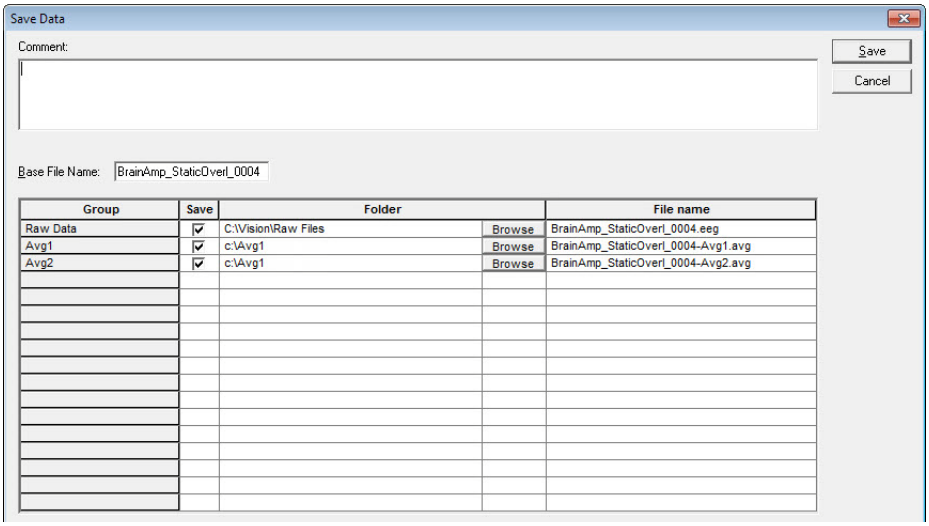
Tile Windows arranges the windows next to each other.

Tile Windows arranges the windows one above the other.

7.2.3 Recording segmented/averaged data

Click the button **Record** in the toolbar.

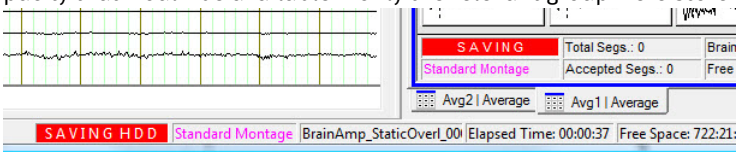
➔ The Save Data dialog opens. This allows you to check and change the parameters originally specified for the raw data and for every group.



Comment	Enter a comment. The comment is saved in the EEG file.
Base File Name	Enter a base name for the raw file. You can also use the $n placeholder. Wherever this placeholder occurs, it is replaced by the name of the raw file. Then click Save. Recorder switches to save mode.
File table	A file name is proposed which you can either accept or change. You can also specify whether the raw data and the various groups are to be saved (**Save** check box), what folder the data is to be saved in (**Browse** button), and the file name (**File name** column).

➔ After clicking on **Save**:

The sections of the status bar in the individual groups now show the number of segments (*Total Segs.*) and the number of accepted segments (Accepted Segs.) in addition to the group status and the current montage. In addition, the EEG file name is shown and the remaining storage space in hours, minutes and seconds is shown under *Free Space*. Note that this refers to the capacity that would be available if only the relevant group were stored.



7.3 Montages

Montages enable channels to be reconnected on a software basis or new voltage reference points to be assigned to the channels.

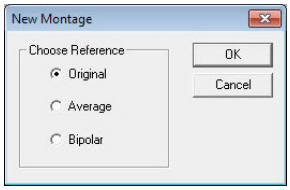
Montages allow you to optimize the display of data by, for example, grouping together frontal electrodes in one montage and occipital electrodes in another. When one of these montages is selected, only those channels that have been assigned to it are displayed. The sequence of channels can also be changed in a montage so that channels which were originally apart can be shown next to each other. A channel can also occur more than once in a montage.

Montages are used for visualization purposes only, i.e. the resulting data only exists temporarily and the original data is not changed.

7.3.1 Create a montage

1 To create a new montage, choose **Display Montage › New...** from the menu.

The *New Montage* dialog box opens.

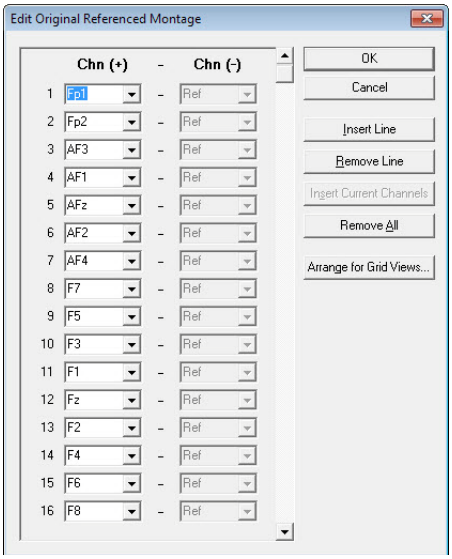


2 Select the type of reference to be used in the new montage.

- ▷ Original: No new reference is calculated. The original reference is only used to group channels or optimize the way they are presented. To begin with, we recommend that you choose this reference type.
- ▷ Average: The average reference is calculated by averaging all selected channels.
- ▷ Bipolar: The differences between different channels are calculated for a bipolar connection.

3 Click **OK** when you have selected a reference type.

This opens the *Edit* dialog box.



Chn (+) - Chn (-)	Chn (+) contains the channels and Chn (-) the reference channels. The column Chn (-) can only be modified if you have selected the Bipolar montage. Otherwise the column Chn (-) is filled in automatically. You can enter the channel names manually or select a channel from the drop-down list.
Insert Line	inserts a new line above the current line. This button is enabled as soon as you have entered text in the first box of the first channel.
Remove Line	removes the current line provided that it is not the last line.
Insert Current Channels	copies all the channels of the current setup into the montage in their original sequence. This allows you, for instance, to construct the montage you require much more quickly by removing and inserting individual channels. This button is enabled if the montage list is empty.
Remove All	removes the entire contents of a montage. You are prompted to confirm whether you wish this to be done. This button is enabled as soon as you have completed an entry.
Arrange for Grid Views...	opens a dialog box in which you can arrange the channels for grid views.

➔ After you have edited the montage, the system prompts you to enter a name under which you wish to save the montage. You can also enter a new name and thus derive a new montage from an existing one.

7.3.2 Arranging the montages in the grid view

Grid views are used when representing segmented or averaged data. In the grid view the channels are arranged in a grid. A preset pattern is used for the default montage. For other montages, you can use the **Arrange for Grid Views...** function to freely define the pattern. You can specify the desired number of rows and columns in the channel grid. Click the **Refresh** button to update the grid pattern that is shown. You can use the mouse to freely arrange the channels and the spaces between them.

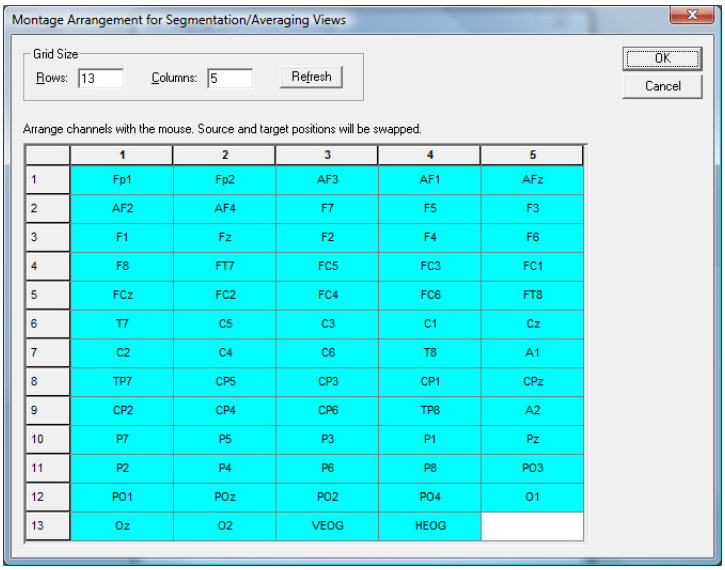


Figure 7-4. Creating a grid view

7.3.3 Calling a montage

To call a newly created montage, switch *Recorder* to monitoring mode. Open the **Display Montage** menu. This menu has now been extended to include the name of your new montage (Figure 7-4). Choose the new montage. The EEG is displayed using the montage. To display the default montage again, simply call it from the **Display Montage** menu.

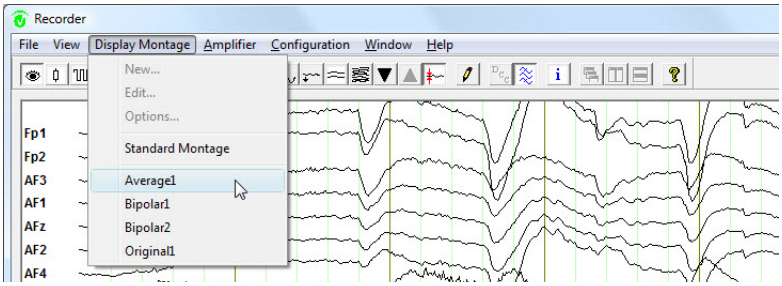
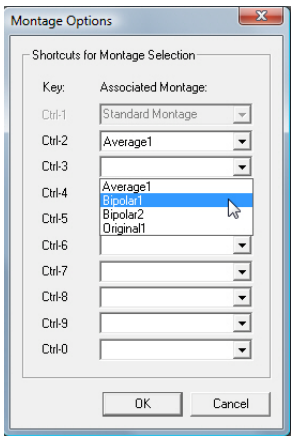


Figure 7-5. Calling a montage

If you have created a montage that does not contain any channels of the current setup, you cannot call this montage during monitoring.

7.3.4 Switching between montages

You can assign specific keyboard shortcuts to montages to allow you to switch between them quickly. Pressing these keyboard shortcuts activates the montages. You can choose **Display Montages › Options** to assign the keyboard shortcuts *Ctrl-2* to *Ctrl-0* to the existing montages as you wish. *Ctrl-1* is reserved for the default montage.



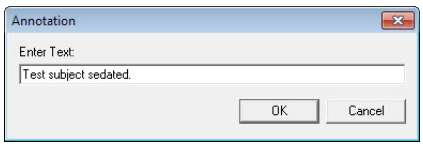
If you have defined one or more segmentation or averaging groups, you can use the keyboard shortcuts *Ctrl-Shift-1* through *Ctrl-Shift-0* to select the montage for the current group window in the same way. Alternatively, you can call a new montage by right-clicking in a data window.

7.4 Annotations

You have the option of adding comments to the recorded EEG. These are displayed as markers in the lower marker area during recording (marker type: 'Comment'). You can enter your comments as freely-definable text or as predefined text.

7.4.1 Enter free text

You enter freely-definable text by clicking the button **Annotation** in the toolbar. You can also use the keyboard shortcut *Ctrl-A*. The **Annotation** dialog box opens and a marker with three question marks is added to the marker area (below the EEG curves). Enter your text in the dialog box. This then replaces the question marks.



7.4.2 Define Annotations

You can specify annotations and insert these by pressing a key on your keyboard. This is a fast way of inserting annotations.

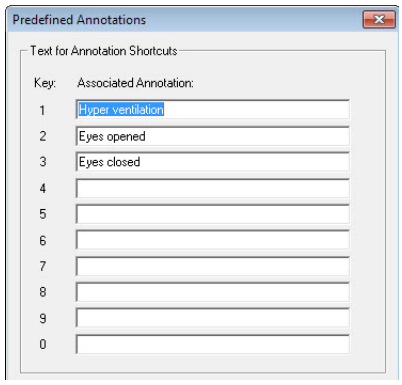
Pre-requisites:

- Administrator privileges or corresponding user rights

Close monitoring mode and choose **Configuration › Predefined Annotations...**

➔ The dialog *Predefined Annotations* opens.

You can enter up to ten predefined annotations. You insert these annotations in the EEG data stream by pressing the corresponding keys *1* to *0* on your keyboard.



8 Impedance measurement

Note: Always prepare all channels before acquiring data and only then switch Recorder to impedance mode to check the impedances of the channels.

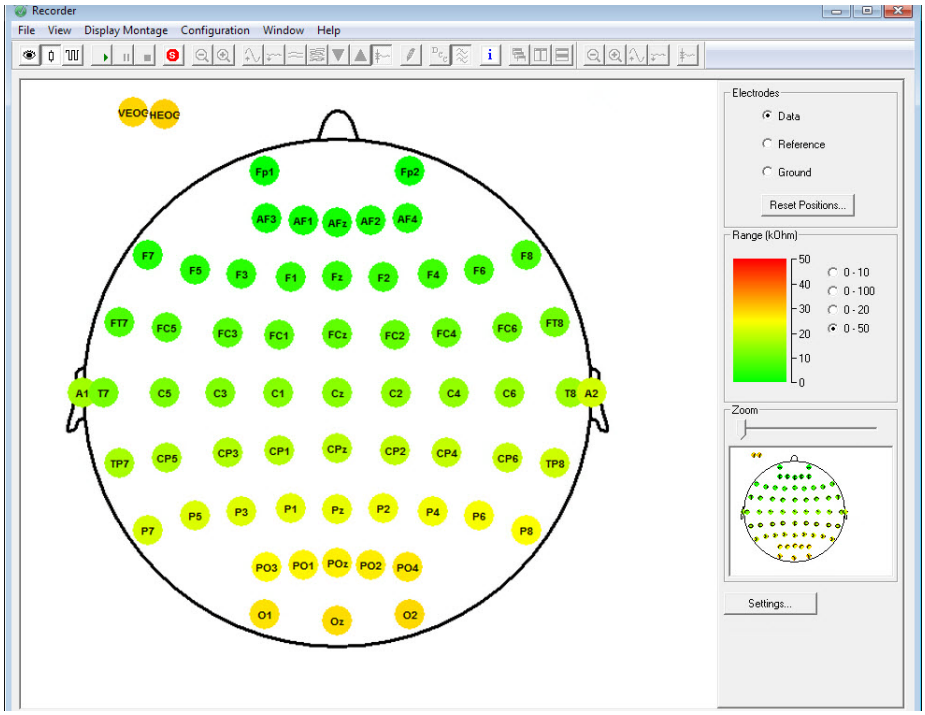
8.1 Using passive electrodes

Pre-requisites

- You have selected Passive Electrodes in **Configuration › Preferences...** (see 4.3 Set global program preferences).

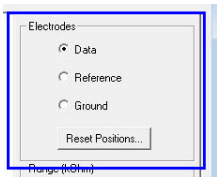
➔ Click the button **Impedance Check** in the toolbar.

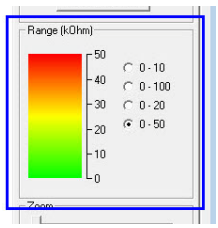
The Impedance Check View window opens.



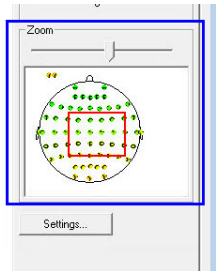
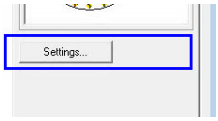
<table>
<tr><td>Impedance Check View</td><td>Schematic view of a head with the electrodes.

▶ Color of electrodes: indicates the impedance value. By hovering the mouse over an electrode, the value is shown.
 
▶ Position of electrodes:
▷ The electrodes are shown on their correct positions, if the electrodes are named according to the 10-10 or 10-20 system or if you have loaded an electrode position file (*.BVEF).
▷ The electrodes are shown in the top right corner, if the electrodes are not named our if you didn’t load an electrode position file.
▶ The impedance view can show up to 256 standard positions.

You can change the position of the electrodes with drag-and-drop (left-click on the electrode, hold the mouse button and move the electrode with the mouse). Click on Reset Positions... to reset the electrodes to their initial positions.</td></tr>
<tr><td rowspan="3">Settings panel</td><td>You can select an electrode group for the impedance view. The available groups depend on the amplifier you are using.
  </td></tr>
<tr><td>You can choose different impedance ranges (measurement ranges). The electrodes in the Impedance Check View indicate the impedance by the color , according to the selected range.

You can specify the measurement ranges by clicking on the button Settings (if available).
  </td></tr>
<tr><td>If you are using a large number of electrodes, you can use the slider control to select the region of the head to be shown.

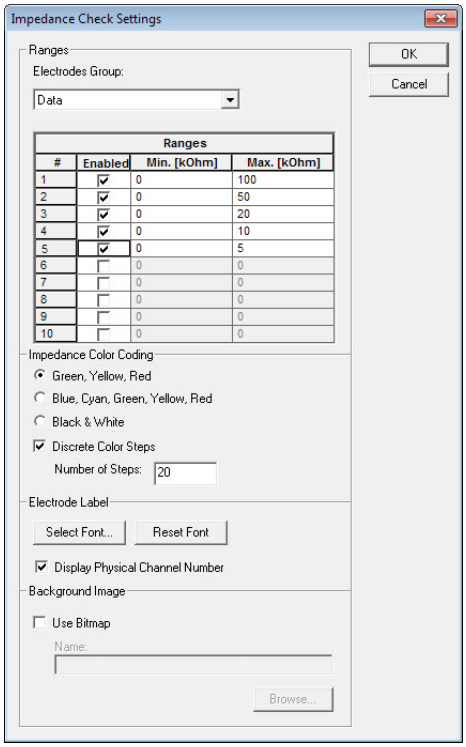
A red square shows the zoom region. You can move the square with the mouse.

Note: The font size is not automatically adjusted in zoom mode.
  </td></tr>
<tr><td>Settings button</td><td>You can set the preferences for the Impedance Check View by clicking on settings. (Refer to Set preferences for the impedance check view.)
  </td></tr>
</table>

8.1.1 Set preferences for the impedance check view

Click on the button **Settings** button

➔ The Impedance Check Settings dialog opens.



Ranges	For each electrode group, you can select up to ten measurement ranges.
Impedance Color Coding	You can choose a continuous gradient in which the impedances from minimum to maximum are shown. **Discrete Color Steps**: Instead of the gradient you can specify steps for showing the color-coded impedance values. Enter a value in the text box.
Electrode Label	You can edit the electrode label as it is shown in the Impedance Check View. You can change the font by clicking on the button **Select Font...** By selecting **Display Physical Channel Number** the numbers of the physical channels are shown in addition to the position. 

Background Image	You can replace the default background (representation of a head) by any bitmap image. To load the bitmap file, select the **Use Bitmap** box. If the bitmap file you have selected does not exist or if it has an invalid format, the standard background is used automatically. Note that you can move the electrode positions on the horizontal plane, because the default background uses an 'isotropic' representation. This means that any changes to the ratio between the height and width of the display window are ignored and the head remains round. In contrast to this, the bitmap always fills the entire window and the electrodes retain their relative positions on the bitmap.

8.2 Using active electrodes with the actiCAP ControlBox

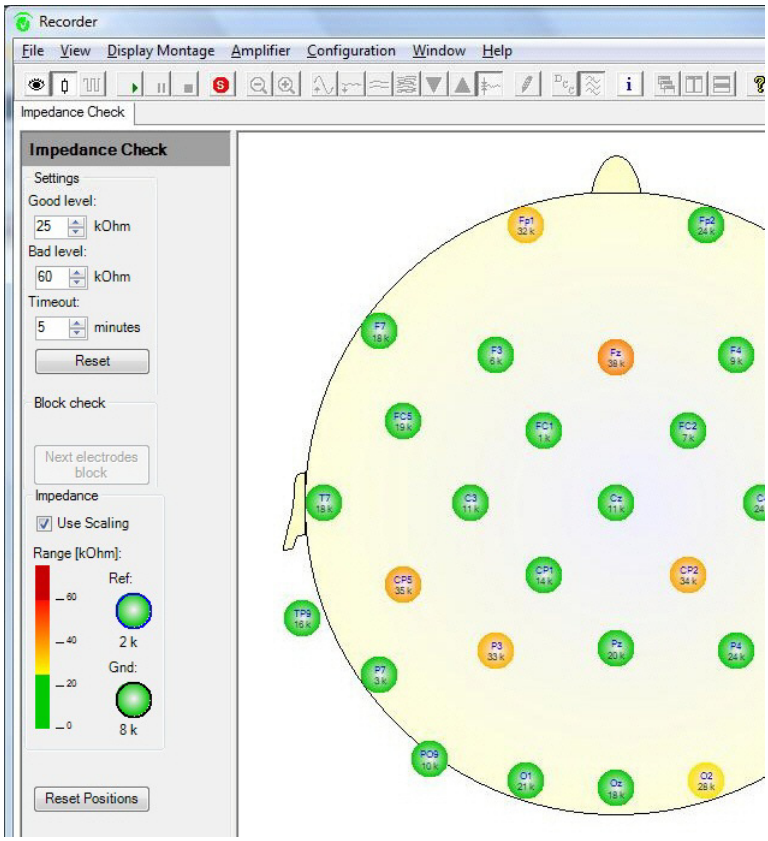
Note: This section refers to users of BrainAmp, V-Amp and QuickAmp.

Pre-requisites

- actiCAP Control Software is installed
- You have selected Use actiCAP Control Software in **Configuration › Preferences...** (see 4.3 Set global program preferences)
- Electrodes are connected and prepared

➔ Click the button **Impedance Check** in the toolbar.

The Impedance Check View opens.



Settings panel	**Good level**: Impedance values below this level are good. **Bad level**: Impedance values above this level are bad. Values between these 'threshold' levels are acceptable. **Timeout** specify the time during which impedance measurement is active (default: five minutes). After this period the actiCAP ControlBox automatically switches back to acquisition mode.
	Next electrodes block button is available, if you are using more than two *actiCAP* electrode branches or more than 64 electrodes. You measure the electrodes in blocks of 32 electrodes. To measure the impedances of the next electrode group click **Next electrodes block**.
	Use Scaling: A color scale is used to display the impedances. The color scale consists of three areas: The topmost area displays the bad level and the bottom area the good level. The middle area of the color scale represents the transition between good level and bad level. The reference electrode and the ground electrode are displayed separately. The color used to display these two electrodes is also based on the color scale.
Reset Positions...	You can change the position of the electrodes with drag-and-drop (left-click on the electrode, hold the mouse button and move the electrode with the mouse). Click on **Reset Positions...** to reset the electrodes to their initial positions.
Impedance Check View	Schematic view of a head with the electrodes. ▶ The color of the electrodes indicates the impedance value. By hovering the mouse over an electrode, the value is shown. ▶ If your electrodes are numbered according to the 10-10 or 10-20 system, they are shown on the correct position. ▶ If the electrodes are not numbered, they are shown at the top right of the window. ▶ The impedance view can show up to 256 standard positions.

8.3 Saving the impedance values

The impedances are saved together with your EEG data.

Pre-requisites

- Impedance measurement is ongoing
- Impedances are measured

Do one of the following to save the impedances:

▶ Start Recording immediately

▷ During impedance measurement click on the button **Record** .

This starts the EEG recording, for which a header file, EEG file and marker file is created. The impedance values are written into the header file (*.VHDR).

▶ Start Recording after a break

▷ During impedance measurement click on the button **Stop Monitoring** .

This stops the impedance measurement. You can now, for example, move the test subject into another room. , **don't close Recorder or change the workspace**.

▷ When the subject is in its final position click on the button **Record** .

This starts the EEG recording, for which a header file, EEG file and marker file is created. The impedance values are written into the header file (*.VHDR).

➔ If you have changed the positions of the electrodes, the program prompts you to save these changes. The electrode positions are assigned to the current workspace.

Note: If you close Recorder or edit the workspace the impedance values are lost.

9 Using actiCAP ControlBox

A special interface might be required to connect active electrodes to your amplifier. Below you will find a list of the required interfaces between the active electrodes and the amplifier.

Note: When your amplifier requires the actiCAP ControlBox (including the actiCAP ControlSoftware), you must change settings in Recorder.

Interface between amplifier and active electrodes

Amplifier	Interface
BrainAmp	actiCAP ControlBox and actiCAP ControlSoftware (1.2.1.0 or later)
QuickAmp USB	actiCAP ControlBox and actiCAP ControlSoftware (1.2.1.0 or later)
V-Amp without multi-way plug	actiCAP ControlBox and actiCAP ControlSoftware (1.2.1.0 or later)
V-Amp with multi-way plug	ImpBox for impedance measurement
actiCHamp	None
LiveAmp	None

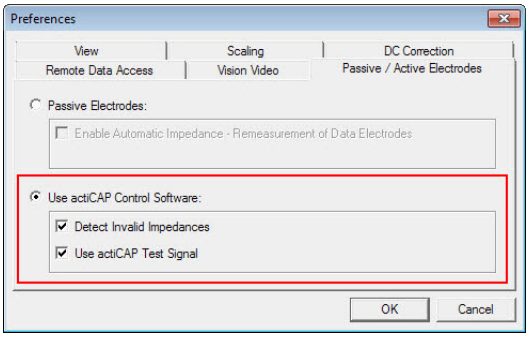
9.1 Select the active electrodes

For amplifiers that require the actiCAP ControlBox, you must change the general preferences in Recorder first.

1 Start Recorder in administrator mode or with the corresponding user rights.

2 Choose **Configuration › Preferences...**

➔ The Preferences dialog opens. Click on the tab Passive/Active Electrodes.



Use actiCAP Control Software	Select if you use active electrodes with the actiCAP ControlBox.
Detect Invalid Impedances	A message is shown where you can allow too high impedance values.
Use actiCAP Test Signal	When selected, the button **Test Signal** in the Recorder toolbar is disabled, and you use the Test button on the actiCAP ControlBox.

9.2 Use the actiCAP ControlBox

Note: If you are using a USB hub, do not use the actiCAP active electrode system and the amplifier on the same USB hub. Use a separate USB hub for the amplifier and the actiCAP.

Pre-requisites

- amplifier selected
- electrodes connected to actiCAP ControlBox
- actiCAP ControlBox connected to amplifier

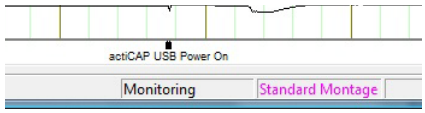
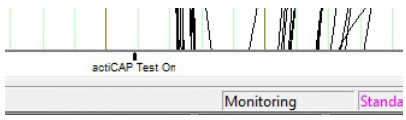
- Workspace created

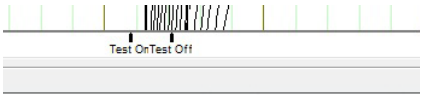
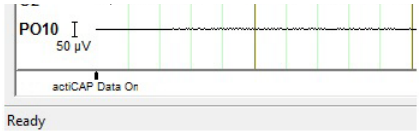
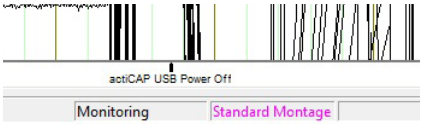
1 Connect the actiCAP ControlBox to a USB port of your computer.
2 Start Recorder in monitoring mode.
3 Press a button on the actiCAP ControlBox to switch the mode, for example Impedance.
Recorder also switches to the corresponding mode. Similarly, when you switch Recorder to a particular mode, the corresponding control button on the actiCAP ControlBox lights up.

➔ Markers are set in the EEG, for example in order to indicate changes of mode.

Understanding the markers

The following markers can be set:

no USB Connection to actiCAP	This marker is set, if you have selected Use actiCAP Control Software in the Preferences dialog, but use the actiCAP ControlBox with rechargeable batteries.
actiCAP USB Power On	When you press the button **Power** ⏻ of the actiCAP ControlBox. This marker indicates that the actiCAP ControlBox is in acquisition mode and is sending data to the Recorder. 
actiCAP Active Shield On actiCAP Active Shield Off	You can switch the active shielding mode on and off by pressing the button **Active Shield** ⏦ on the actiCAP ControlBox. The marker shows the time when the Active Shield mode was activated or deactivated. 
actiCAP Test On	If you have selected the **Use actiCAP Test Signal** box in the Preferences dialog, the marker is set when you press the button **Test** Λ on the actiCAP ControlBox. 

Test On Test Off	If you did not select **Use actiCAP Test Signal** and press the button **Test** on the actiCAP ControlBox while Recorder is in monitoring mode or test mode, the actiCAP ControlBox briefly switches to test mode. Recorder automatically switches it back to acquisition mode. The two markers are written in quick succession. 
actiCAP Data On	If you start the test signal mode in the *Recorder*, and you have not selected the **Use actiCAP Test Signal** box (which means you are using the amplifier's test signal), the 'actiCAP Data On' marker is set. 
actiCAP USB Power Off	When you press the button **Power** of the actiCAP ControlBox to switch it off, the 'actiCAP USB Power Off' marker is set. 

9.3 Testing the active electrodes

You can check if the active electrodes are working properly.

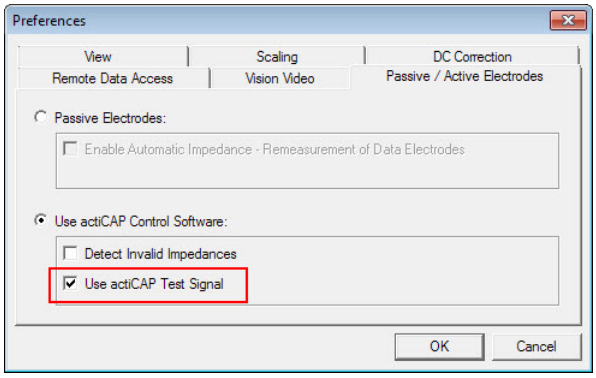
1 Click on **Configuration › Preferences...**

2 Open the tab Passive/Active Electrodes.

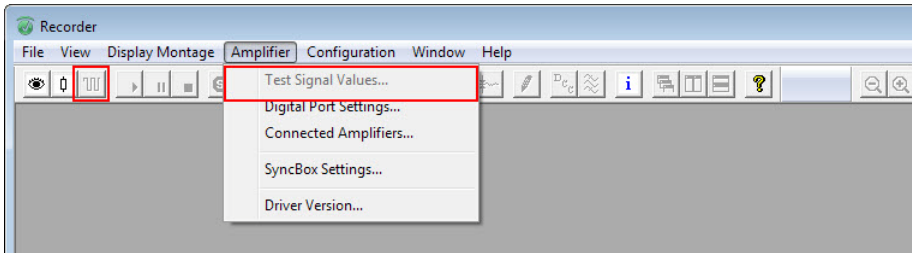
3 Select Use actiCAP ControlSoftware.

4 Select the check box Use actiCAP Test Signal.

Otherwise, the test signal is supplied by the amplifier when you run a function test.

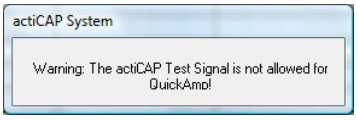


➔ If you are using the test signal of the actiCAP active electrode system, the button **Test Signal** in the toolbar of the Recorder and the menu item **Amplifier › Test Signal Values...** are disabled.



Note

If you are using a QuickAmp with the actiCAP active electrode system, you cannot obtain the actiCAP test signal.



10 View options

10.4 Switch off a channel

To block a channel and thus suppress the signal received, right-click the required channel name. This opens a context menu. Choose **Switch Off Channel ‹XXX›** from this menu. The channel is blocked and the channel name and EEG curve are highlighted in red.

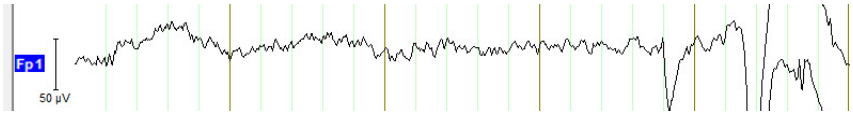
To reactivate the channel, repeat the process and choose **Switch On Channel ‹XXX›** from the menu.

10.5 Display a single channel

To select a channel, simply click the channel name. A selected channel is highlighted in blue. If you click a channel again, the channel is deselected. You can select one or more channels of the EEG and then zoom the display into these channels, for instance.

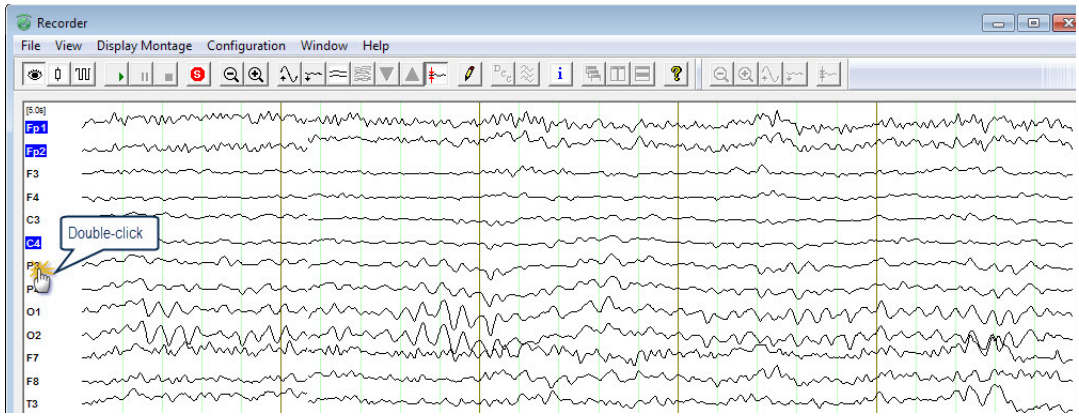
If you click the *Next Group* ▼ or *Previous Group* ▲ button to show different channels of the EEG, your selection is retained. If you click the *Decrease Channels* or *Increase Channels* button to change the number of channels shown, your selection is also retained.

By double-clicking a channel name you can display the corresponding channel separately.

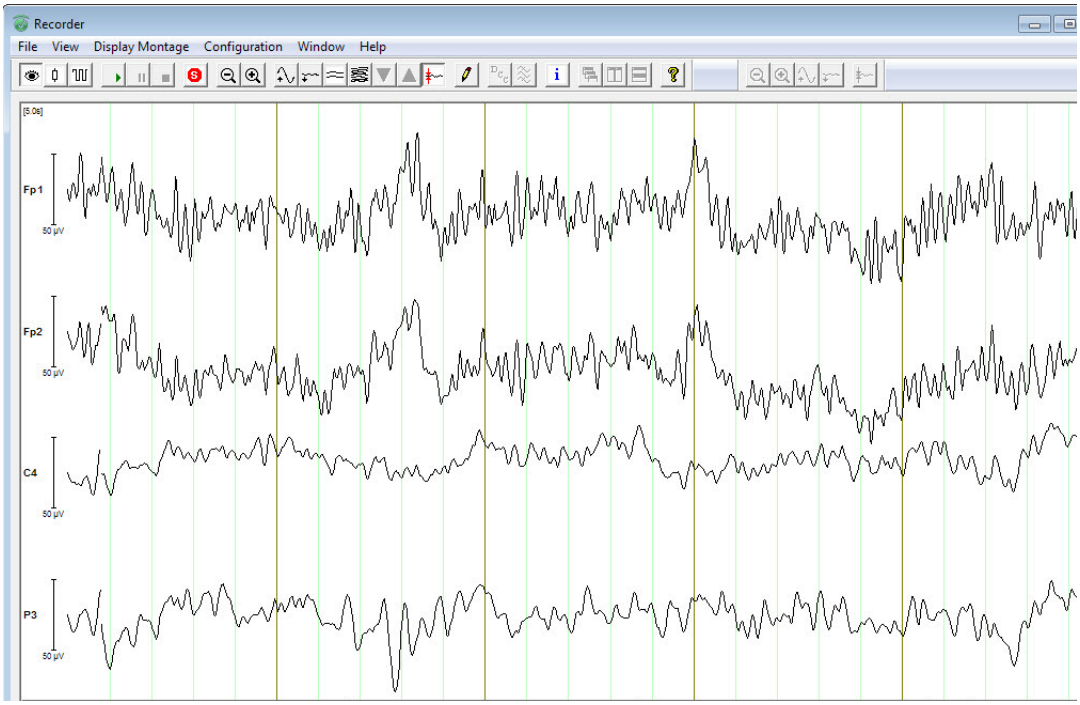


10.6 Display selected channels

To display multiple channels separately, click once on each required channel name in sequence. Then double-click the last of the required channels. If you double-click a channel name again, the display returns to how it was before.



The selection results in the following channel display:



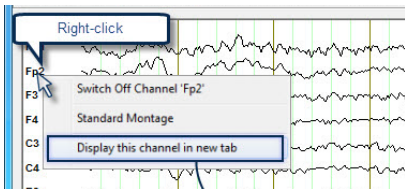
10.7 Display channels in scientific view

In the scientific view, the channels are displayed in a coordinate system with time and amplitude axes. The view is opened in a tab to the left of the main view.

To open the scientific view, switch to the standard montage in monitoring mode. Only in this mode are you able to specify the default settings for your project. Proceed as follows to open the scientific view:

1 Select and open the channel (not available during recording).

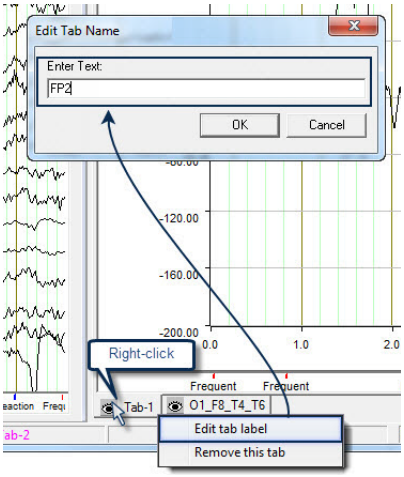
Right-click the required channel name (for example Fp2) and then choose **Display this channel in new tab** from the context menu. This opens a new tab at the right-hand edge of the Recorder window with the selected channel displayed.



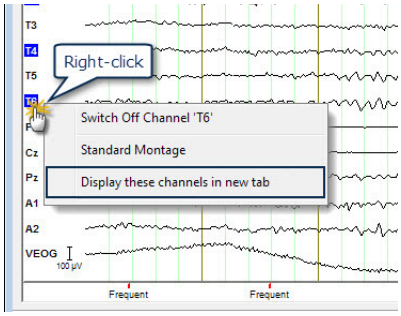
▶ You can rename the tab

Right-click on the tab label and choose **Edit tab label**.

Enter a name in the Edit Tab Name dialog and click **OK**.



▶ You can also display several different channels in a single tab. To do this, first left-click the individual channels. Then, right-click one of them and choose **Display these channels in new tab**.

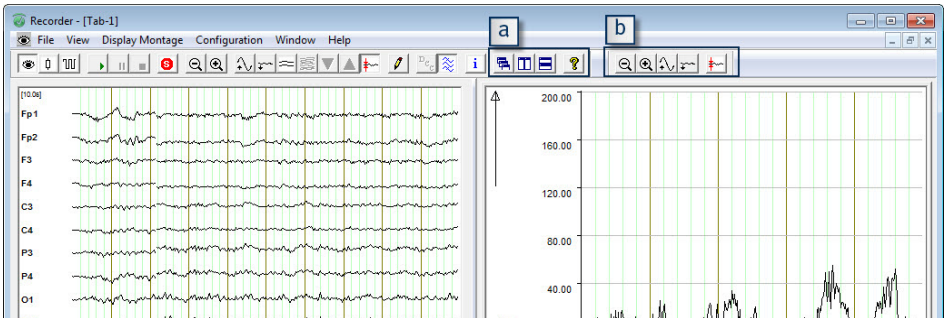


➔ You can adjust the scaling of the axes.

10.7.1 Change the scaling and display

You can change the scaling for the tabs as follows:

- Click on the buttons on the right to change the scaling, amplitudes and the layout of the tabs:

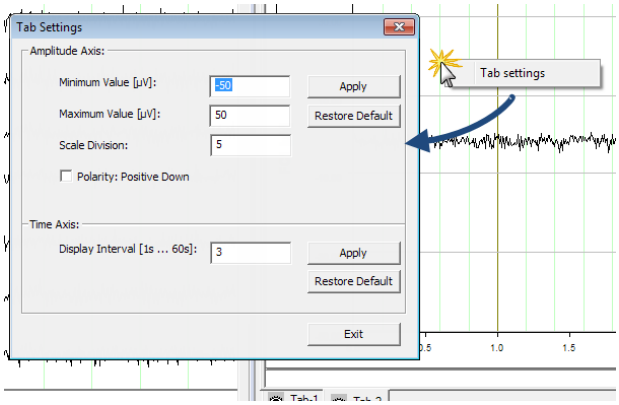


- If you want to scale the *active tab* more precisely, you can enter the values manually. To do this, proceed as follows:

  a Right-click and select Tab Settings. The Tab Settings dialog opens.

  b Change the settings of amplitude and time axes.

  c Click on **Apply** to apply the settings.



➔ If the input is invalid, a message with the permitted values appears.

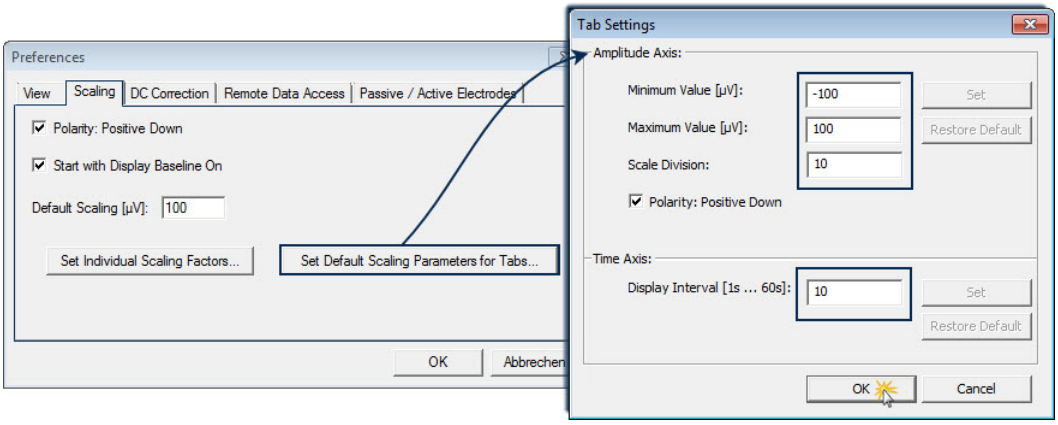
- Set the scaling preferences. Alongside individual settings for the tabs, you can set display preferences for the scientific view. Do the following:

1 Open the **Configuration › Preferences...**

2 Click on **Set Default Scaling Parameters for Tabs...** to define the scaling for the amplitude and time axes globally for the scientific view. The same values are then used for all the tabs.

  The **Set** and **Restore Default** buttons are inactive because they are only required for individual axis scaling.

➔ These settings only apply to new tabs. The settings for open tabs will not be modified.



10.7.2 Saving the view

You prepare your project in monitoring mode. This is where you can save the way channels are displayed in tabs and the settings for the time and amplitude axes.

To save the appearance of the display, you simply have to stop monitoring mode and, if necessary, the standard montage (1). *Recorder* then asks whether you want to save the settings (2).

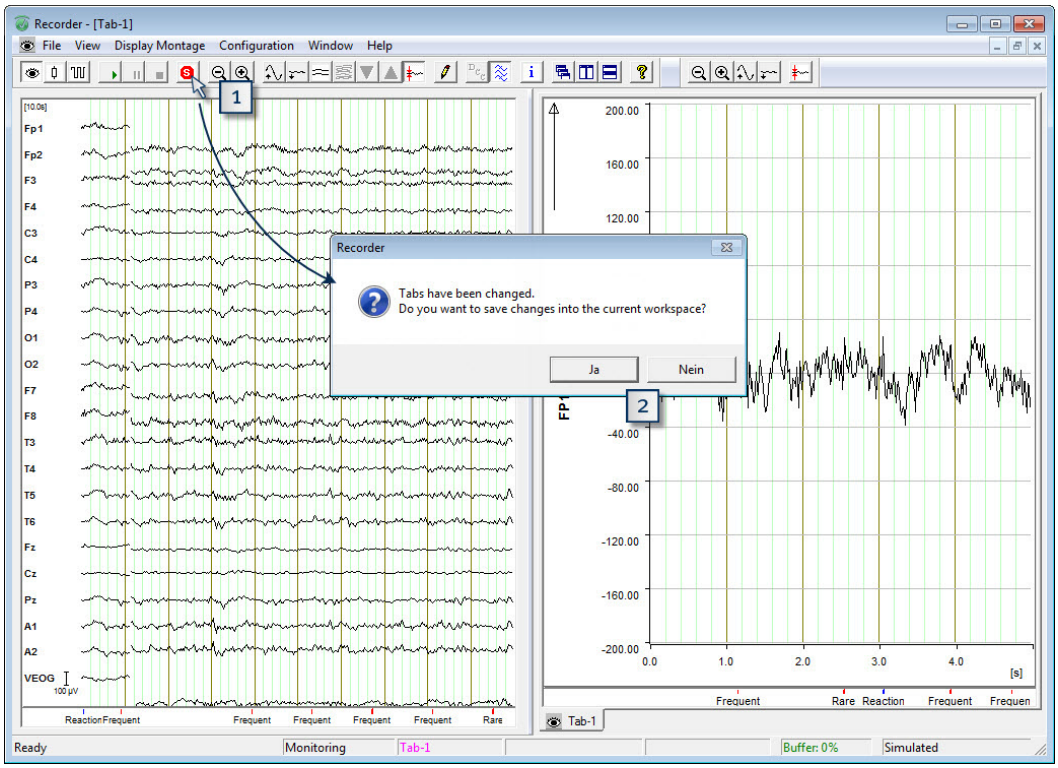


Figure 10-1. Saving the tab layout

10.7.3 Closing tabs

Proceed as follows to close the tabs in the scientific view:

a Click on **X** in the menu bar.

b Right-click on the tab and select **Remove this tab**.

Note

If you click on **Remove this tab** *of an inactive tab then the active tab is closed!*

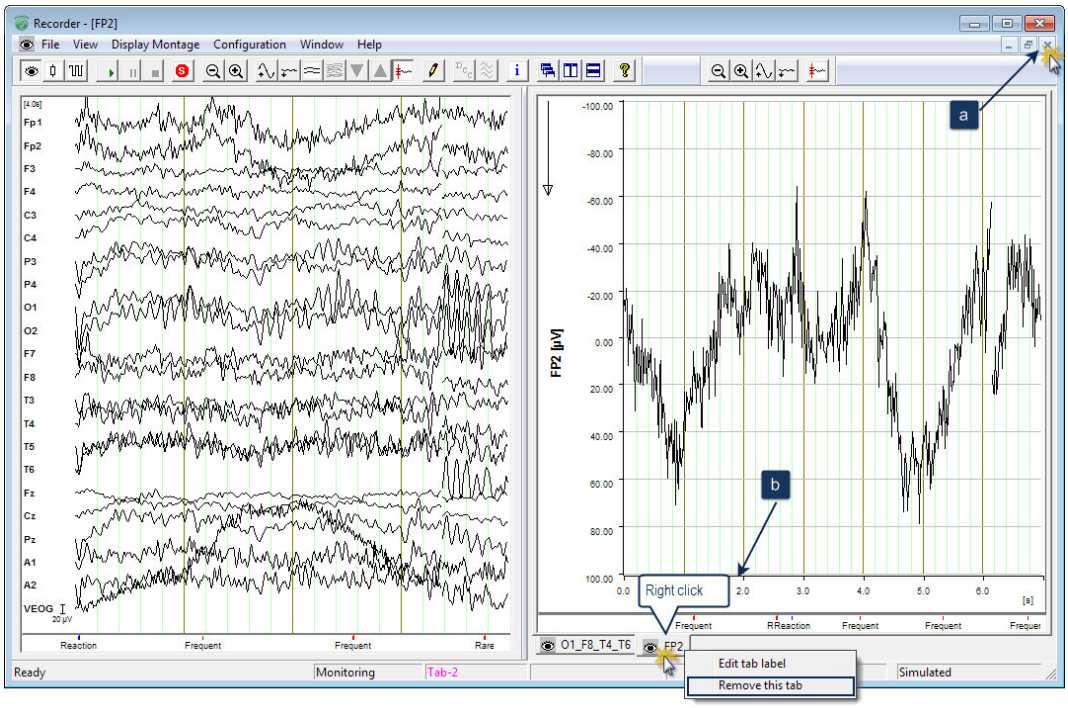


Figure 10-2. Closing tabs

11 Video Recorder

The BrainVision Video Recorder allows you to record video data concurrently with your EEG recording.

Video Recorder can only be used if you have already purchased a Video sublicense that you must install in addition to Recorder.

You will find details on installing sublicenses in Appendix B.

If you purchased sublicenses at the same time as you purchased Recorder, the sublicense file is included on a USB data carrier supplied with the software. Sublicenses that are purchased subsequently can be downloaded from the Brain Products website. You will find details on downloading sublicenses in Appendix B.

To check whether you have a USB dongle with Video option, choose **Help › About BrainVision Recorder...** from the Recorder menu. If you have a USB dongle with Video option, the line *Vision Video* appears under *Sublicenses*.

Figure 11-1. Dongle with sublicense for the Video Recorder

11.1 Installing the Video Recorder and codec

Pre-requisites

- computer with FireWire port

1 Insert the *Application Suite* USB (for details please refer to Chapter 1).

2 Click on **Install BrainVision Recorder & Video Recorder** in the welcome screen.

3 Click on the **Install Video Recorder** button in the bottom right corner.

4 On the following screen, click on **Install BrainVision Video Recorder** and follow the instructions of the installation wizard.

After installing *Video Recorder,* install the codec supplied. The codec is used to compress the video data.

5 Click on **Go to video codec**. This opens a folder containing the installation program for the video codec.

6 Run the program file '*LEADMCMPCodec.exe'* to start the installation and follow the instructions of the installation wizard.

Note: You will find the serial number in your product documentation.

7 To use the video codec in the *Video Recorder*, you must select the codec in the Recorder's program settings. These settings are described in Section 11.2.

In the video settings, select the entry for LEAD Video for Windows (VFW) Codec from the **Select Video Codec** drop-down list. Depending on your system configuration, this will be displayed as either 'LEAD MCMP/MJPEG Codec (2.0) (VFW)' or 'LEAD MCMP/MJPEG Codec (VFW)'. Any other LEAD codecs that may be present in the list are not suitable for the operation of the *Video Recorder*.

8 Connect the video camera to the computer and switch it on.

Note: Some video cameras with a video tape inserted switch over to standby mode after a set time. Since we store the data directly in the computer, no video tape is required.

11.2 Configuring the Video Recorder

To configure *Video Recorder*, open **Recorder** and choose **Configuration › Preferences...** With the installation of Video Recorder the tab Vision Video is added to the Preferences dialog. You enable synchronous video recording by selecting the **Enable Vision Video** box.

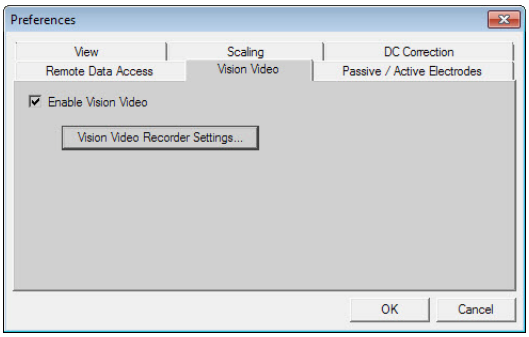


Figure 11-2. Video settings and codec selection

Video settings

Click the **Vision Video Recorder Settings...** button, for the following settings:

Select Video Device: choose the installed video camera from a drop-down list.

By clicking on **Select Video Device** you can change the camera properties.

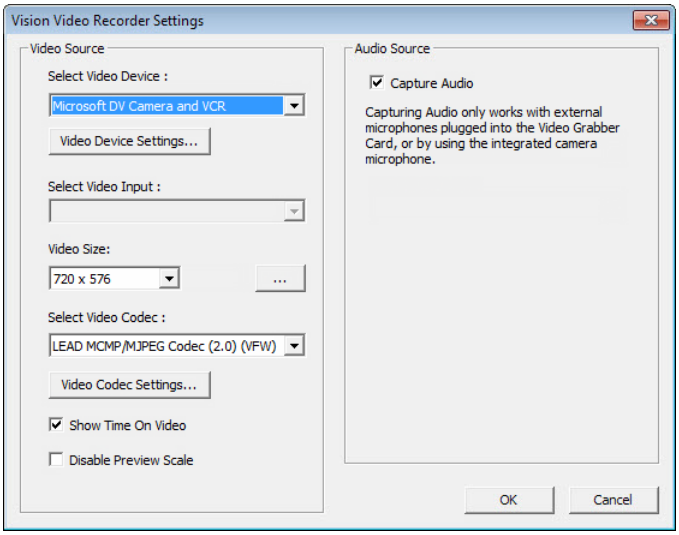


Figure 11-3. Video settings and codec selection

Video Size sets the resolution of the video data. The resolution depends on the video camera used. If you click the ... button, *Recorder* opens an interface to DirectX® (Figure 11-4) that allows you to configure the video format. (This button is not available if your camera does not support different resolutions.)

Note: Recorder only supports changes to the output size. None of the other parameters in the dialog box are currently supported.

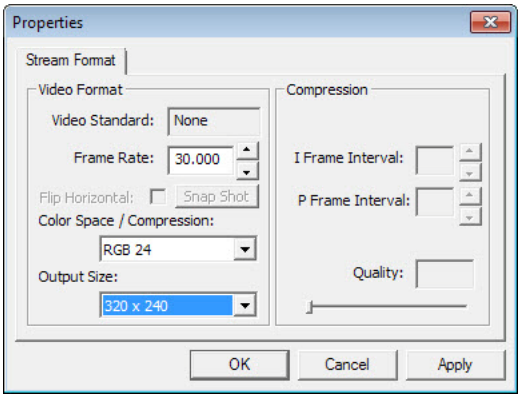


Figure 11-4. Configuring the video format

You can select a codec by clicking **Select Video Codec.**

Note: Most of codecs offered are not suitable for real time recording. You should therefore choose the supplied codec or one that you know meets the requirements.

Select the entry for LEAD Video for Windows (VFW) Codec from the **Select Video Codec** drop-down list in order to enable the supplied LEAD codec. Depending on your system configuration, this will be displayed as either 'LEAD MCMP/MJPEG Codec (2.0) (VFW)' or 'LEAD MCMP/MJPEG Codec (VFW)' in the list. Any other LEAD codecs that may be present in the list are not suitable for the operation of the Video Recorder. The procedure for installing the supplied LEAD codec is explained in Section 11.1.

The entry for the supplied LEAD codec in the **Select Video Codec** list is not updated by the LEAD Codec Installer if you are updating an older existing installation of the codec. If you have run the current LEAD Codec Installer then version 2.0 of the codec is active in your system even if the older codec designation is still displayed in the list. You can see that version 2.0 is active by selecting this codec and then clicking the **Video Codec Settings...** button to open the settings dialog box for the codec. Version number 2.0 is displayed in the title bar.

You can use **Video Codec Settings...** to set the optimum balance between image quality and video file size. Experiment with different settings by recording part of an EEG in conjunction with the Video

Recorder and looking at the resulting quality and file size. For debugging purposes, choose the codec *‹None›*. In this case the video data is not compressed.

You should, however, select this option for test purposes only.

Show Time On Video shows the date and time on the video. If you select the **Disable Preview Scale** box, you cannot change the size of the video window.

Audio settings

Select the **Capture Audio** box if you also wish to record audio information.

Select Audio Device is used to select the audio recording device.

If you have connected analog audio devices, **Select Audio Input** allows you to select between different input options (such as line-in, microphone, phone). However, we recommend that you use digital audio equipment.

11.3 Combined EEG/video recording

After you have selected a suitable codec, switch *Recorder* to monitoring mode. A video window opens in addition to the data display in *Recorder*. This shows the current video data.

Figure 11-5. Combined EEG/video recording

Note: If the video camera is not ready, the video window will show the message ‘Camera Not Connected!’. If the display is black, the most likely cause is an incompatible codec. In this case, select a different codec.

You can move and resize the video window.

Now record part of an EEG, for example 10 seconds. Make sure that the video image does not disappear. If you pan with the camera, this should also be visible after a short delay of less than a second. If not, the codec used is not suitable.

An offset of the displayed video data to the EEG data of less than a second is, however, normal. For a recording of eight hours you can expect an offset of maximum 0.5 seconds.

The video data is saved in the current raw data folder. The file with the extension *.videoconfig and the base name of the EEG file contains detailed information about the video (names of video files, time, length etc.). The actual video data is saved to a file with the extension *.VisionVideo. A new video file is created after every pause in recording. It is therefore possible for one EEG file to be associated with several video files.

You should always check the size of the video files generated. A value of 150 to 300 kilobytes per second is possible while maintaining good quality. If, however, your video files have a size of several megabytes per second, either a codec that is unsuitable for this task or no codec is selected.

12 Object Linking and Embedding (OLE) automation

Recorder can be controlled remotely by other programs using OLE automation methods.

The program ID (ProgID) for external access to *Recorder* is 'VisionRecorder.Application'. *Recorder* contains a registered type library that is stored in the *Recorder.exe*. The registry entry for the type library is *Vision Recorder x.x Type Library* where x.x stands for the current version.

Under Windows® XP, Windows® Vista and Windows® 7/8, Recorder can also be controlled, for example, via a Visual Basic (VB) script batch file, as shown below:

```
' TestRecorder
' Create recorder object
Set Rec = CreateObject("VisionRecorder.Application")
Rec.Acquisition.ViewData()
Rec.Acquisition.StartRecording
(Rec.CurrentWorkspace.RawFileFolder & "\TestData.eeg")
WScript.Sleep 5000 ' Analyzer Macro: use Wait 5
Rec.Acquisition.StopRecording()
Rec.Acquisition.StopViewing()
Rec.Quit
```

In this example, *Recorder* is started, data is displayed and an EEG file named *TestData.EEG* with a length of 5 seconds (5,000 milliseconds) is stored. If you are using *Analyzer*, you can also control *Recorder* by means of an Analyzer macro. The macro looks like this:

```
' TestRecorder
Sub Main
    ' Create recorder object
    Set Rec = CreateObject("VisionRecorder.Application")
    Rec.Acquisition.ViewData()
    Rec.Acquisition.StartRecording
    Rec.CurrentWorkspace.RawFileFolder & "\TestData.eeg")
    Wait 5
    Rec.Acquisition.StopRecording()
    Rec.Acquisition.StopViewing()
    Rec.Quit
End Sub
```

This chapter will not deal with programming in depth but will just outline the *Recorder's* object model.

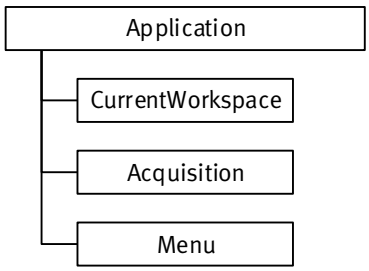


Figure 12-1. Object hierarchy of the Recorder

In the following sections the objects are described in Visual Basic notation.

12.1 Application

Description

The *Application* object represents the program as a whole. It is the default object, which means that the methods and properties of this object can be addressed directly, for example 'Version' corresponds to 'Application.Version'.

Methods

```
Sub Quit()
```

Terminates the program

Properties

```
Acquisition As Acquisition
```

Write-protected
The Acquisition object.

```
CurrentWorkspace As CurrentWorkspace
```

Write-protected
The current workspace.

```
Menu As Menu
```

Write-protected
The Menu object.

```
State As VisionRecorderState
```

Write-protected
The program status, see below for enumerator types.

```
SubLicenses As Licenses
```

Write-protected
Lists the registered sublicenses.

```
Version as double
```

Write-protected
Specifies the current program version.

```
DisableThreadBlockingMode as Bool
```

Disables thread-blocking call of the Recorder functions: ViewData, ViewImpedance, and others.

12.2 Acquisition

Description

This object controls recording.

Methods

Sub Continue()

This resumes interrupted recording.

`Sub DCCorrection()`

This performs a DC offset correction.

`Sub Pause()`

This interrupts recording.

`Sub StartRecording(FileName As String, [sComment As String]))`

This starts recording to 'FileName'.
An optional comment can be specified.

`Sub StopRecording()`

This stops recording.

`Sub StopViewing()`

This stops the viewing of data, test signals or impedance measurements.

`Sub ViewData()`

This displays data, or starts monitoring.

`Sub ViewTestSignal()`

This displays test signals.

`Sub ViewImpedance()`

This displays impedance measurements.

`Sub SelectMontage (Montage As String)`

This selects a montage that has already been defined.

`Sub SetMarker (Description As String, [MarkerType As String])`

This inserts a marker in the EEG. `Description` = Description of the marker.
`MarkerType` is optional. The default value is 'Comments', other types are 'Stimulus', 'Response', etc.

Properties

`GetAcquisitionState as Integer`

Write protected
Returns current state of the acquisition:
STOPPED = 0;
RUNNING = 1;
WARNING = 2;
ERROR = 3;

`GetLastAcquisitionError as String`

Write protected
Returns a message in case of error state in the Acquisition module.

12.3 CurrentWorkspace

Description

This object represents the current workspace.

Methods

```
Sub Load(FileName As String)
```

Loads the specified workspace file ‘FileName’.

Properties

```
FullName As String
```

Write-protected
Name of the workspace file including full path.

```
Name As String
```

Write-protected
Base name of the workspace file without folder and file name extension.

```
RawFileFolder
```

Write-protected
Folder for raw data.

12.4 License

Description

This object describes a license/sublicense (for example a video sublicense).

Methods

```
./.
```

Properties

```
ID As Long
```

Write-protected
Unique ID of the license.

```
Description As String
```

Write-protected
Description of the license.

12.5 Licenses

Description

This object comprises a list of ‘License’ objects.

Methods

```
./.
```

Properties

```
Count As Long
```

Write-protected
Number of licenses in the list.

```
Item(Index As Long) As License
```

Default element, write-protected
On specifying the index (1-...), returns a ‘License’ object.

12.6 Menu

Description

This object allows manipulation of the menu.

Methods

```
Sub DisableMenuItem(MenuItem As VisionRecorderMenuItem)
```

This disables a menu option; the option to be disabled is specified in ‘MenuItem’ (see ‘Enumerator types’).

```
Sub EnableMenuItem(MenuItem As VisionRecorderMenuItem)
```

This enables a menu option; the option to be enabled is specified in ‘MenuItem’ (see ‘Enumerator types’).

```
Sub Reset()
```

This resets all manipulated menu options.

12.7 Enumerator types

The following sections describe the various enumerator types.

12.7.1 VisionRecorderMenuItem

Constants for the various menu items that can be addressed with the ‘Menu’ object:

```
Enum VisionRecorderMenuItem
    vrMiMonitoring = 32777,
    vrMiImpedanceCheck = 32778,
    vrMiTestsignal = 32779,
    vrMiStartRecording = 32791,
    vrMiPauseRecording = 32792,
    vrMiStopRecording = 32793,
    vrMiStop = 32780,
End Enum
```

12.7.2 VisionRecorderState

Constants for the various states of the program:

```
Enum VisionRecorderState
    vrStateOff = 0                      ' Idle state
    vrStateMonitoring = 1               ' Viewing EEGs
    vrStateTestsignal = 2               ' Test signal
    vrStateImpedanceCheck = 3           ' Impedance measurement
    vrStateSaving = 4                   ' Saving data
    vrStateSavingTestsignal = 5         ' Saving test signals
    vrStatePause = 6                    ' Data saving paused
    vrStatePauseTestsignal = 7          ' Data saving paused
                                        ' displaying test signal
    vrStatePauseImpedanceCheck = 8      ' Data saving paused, ' display-
    ing impedance
End Enum
```

13 Remote Data Access (RDA)

While it is being displayed, the EEG data 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, the Recorder acts as the server, and the program receiving the data acts as a client. Up to ten clients can be logged in 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.

13.1 Example

RDAClient is a program that was developed with Microsoft Visual C++ Version 6.0 under Windows®. You can find the example project on the *Application Suite* USB in the *\Software\Recorder\RDA_Client* directory. RDAClient establishes the connection to the server, and then waits for data in a loop. When data arrives, it is stored in *BrainVision*-compatible EEG files. The name of the computer on which *Recorder* is running is passed to the program as an argument. If this argument is not specified, the local computer is examined.

There is a 16-bit and 32-bit version of the RDAClient. The 16-bit version works with amplifiers and A/D converters with an A/D range of a maximum of 16 bits. The 32-bit version covers an A/D range of up to 25 bits.

Before the RDA server can run, it must have been enabled in the Recorder. To do this, choose **Configuration › Preferences...**, select the *Remote Data Access* tab and select the **Enable Remote Data Access** box.

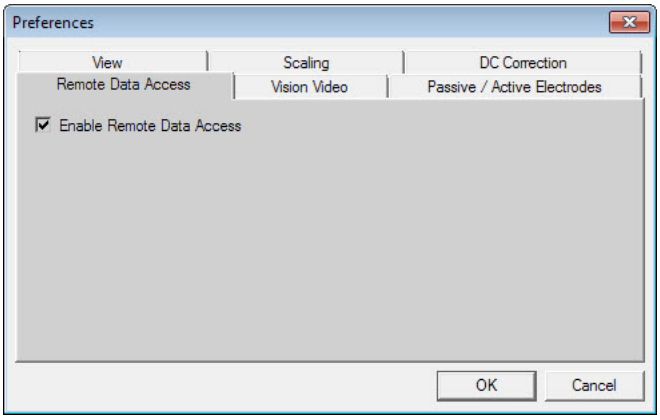


Figure 13-1. Enabling the RDA server

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 uses port number 80 by default. The *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. This is done using standard socket programming that we will not explain here. You will find an example of this in the file *RDAClient.cpp* or *RdaClient32.cpp* located in an zip-archive on the *Application Suite* USB (*Software**Recorder**RDA_Clients*). 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`. You can find the declaration of this header and all other structures and constants in the file *RecorderRDA.h* (*Application Suite* USB). 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
1	start of message (`RDA_MessageStart`)
2	data block (`RDA_MessageData`) for clients on port 51234
3	end of message (`RDA_MessageStop`)
4	data block (`RDA_MessageData32`) for clients on port 51244

The messages in detail:.

RDA_MessageStart (nType = 1)

This message is sent by the server (1) when it switches to monitoring mode and (2) after a client has logged in during monitoring.

In addition to the header, data is sent on the number of channels (`nChannels`), the sampling interval in µS (`dSamplingInterval`), the sensitivity of the channels in µV separately for each channel (`dResolutions`) and the channel names (`sChannelNames`). The size of the `dResolutions` field is flexible and depends on the value of `nChannels`. `sChannelNames` contains all channel names in one string. The individual channel names are null-terminated.

The `WriteHeaderFile(RDA_MessageStart* pMsg)` routine in the file *RDAClient.cpp* shows how the fields can be exploded.

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* (*Application Suite* USB) in the routines `WriteDataBlock(RDA_MessageData* pMsg)` and `WriteMarkers(RDA_MessageData* pMsg, ULONG nOffset, ULONG nExistingMarkers)`.

RDA_MessageStop (nType = 3)

This message consists of the header only, and indicates the end of monitoring.

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`.

You will find detailed information on RDA clients in the examples (C++, Python, MATLAB®) on the *Application Suite* USB in the directory *\Software\Recorder\RDA_Client*.

Appendix A The Graphical User Interface (GUI)

The menu bar and the toolbar are located at the top of Recorder window.

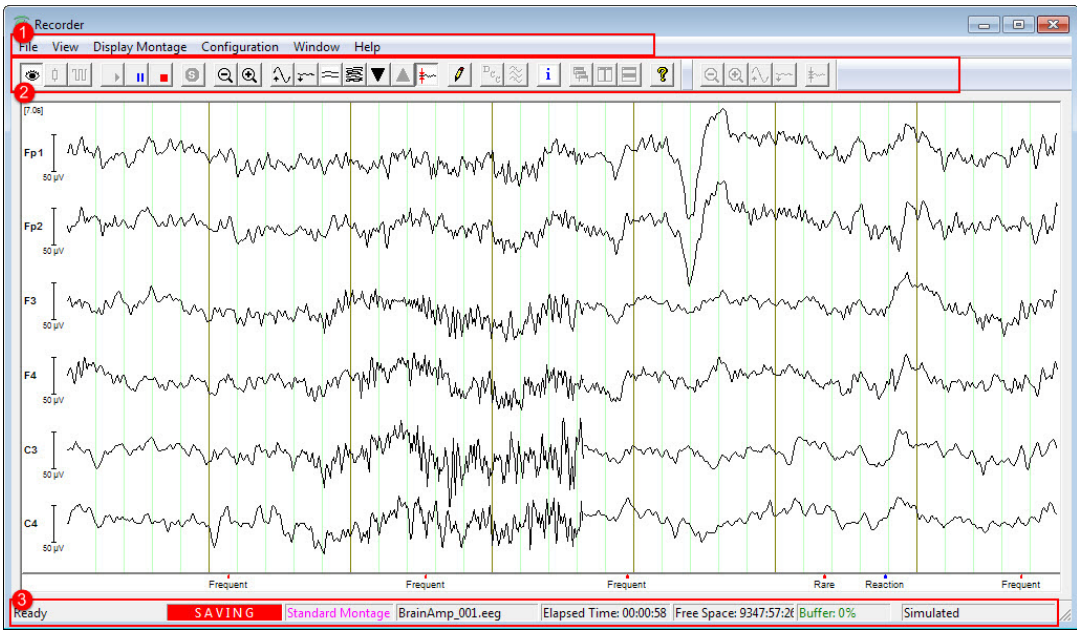


Figure 14-1. User interface: (1) menu bar, (2) toolbar, (3) status bar

1 Menu bar

File	open, edit or create a workspace
View	show and hide the status bar
Display Montage	display and edit the montages
Amplifier	contains amplifier-specific settings and settings for the test signal. The available options depend on your amplifier. The Amplifier menu does not show if you have selected the Simulated Amplifier. ➔ As administrator you can limit the access to the amplifier settings for standard users.
Configuration	▶ select the default settings for the locations used to archive and store the work files and the data ▶ configure user rights and user settings ▶ select the amplifier
Window	arrange the data windows
Help	open program information and the installed components and to open this user manual

2 Toolbar

You use the toolbar mainly to control the operating modes and display options of Recorder.

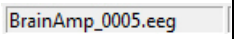
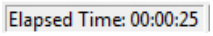
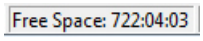
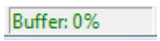
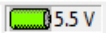
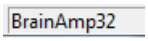
Note: When you position the mouse pointer over an element, a tool tip will appear. (The status bar at the bottom of the workspace contains additional brief information on the elements.)

	*Monitor* starts the data view (monitoring).
	*Impedance Check* starts impedance measurement.
	*Test Signal:* If the connected amplifier permits, you can click this button to display the test signal and save the test signal in the current EEG file.

	*Start/Resume Recording* starts recording or resumes it after a pause. A dialog box opens in which you can enter a comment. This comment is saved in the EEG file. A file name is proposed which you can either accept or change.
	*Pause Recording* pauses the recording. While *Recorder* is in pause mode, you can measure the impedance without closing the EEG file.
	*Stop Recording* stops the recording. You can continue recording by clicking the *Start/Resume Recording*  button.
	*Stop Monitoring* closes monitoring mode. Note that you can only close the program when you have explicitly stopped the recording and then closed monitoring mode by clicking the *Stop Monitoring* button.
	*Increase Interval* increases the time interval displayed (alternatively use the keyboard shortcut *Ctrl + Num(–)*).
	*Decrease Interval* decreases the time interval displayed (alternatively use the keyboard shortcut *Ctrl + Num(+)*).
	*Scale Up* increases the scale (alternatively use the keyboard shortcut *Ctrl + arrow up*). You can assign different scaling factors to each channel, for example the ECG channels.
	*Scale Down* decreases the scale (alternatively use the keyboard shortcut *Ctrl + arrow down*).
	*Decrease Channels* decreases the number of channels displayed. Alternatively, you can select individual channels to view them separately (see View options).
	*Increase Channels* increases the number of channels displayed.
	*Next Group* switches to the next channel group.
	*Previous Group* switches to the previous channel group.
	The *Next Group* and *Previous Group* functions are enabled if you have previously reduced the number of channels or if you are working with more than 64 channels, in which case it is not possible to show all channels together.
	*Baseline Correction in Display* activates or deactivates baseline correction. When activated, only the baseline of the representation is changed, and not the actual data.
	*Annotation* allows you to enter a free text (alternatively use the keyboard shortcut ‹Ctrl-A›). You will find information on entering comments in Annotations.

	*DC Correction* activates or deactivates DC offset correction for the DC amplifier (alternatively use the keyboard shortcut ‹Ctrl-D›). DC offset correction acts directly on the data. This button only appears in the toolbar if you are using a BrainAmp DC, BrainAmp MR plus or BrainAmp ExG. You will find information on DC offset correction in DC-offset correction.
	*Display Filter* activates or deactivates the filters. You can toggle this button during monitoring or recording. The preset value for this function can be found in the **New Workspace/ Edit Workspace** dialog box › **Software Filters** page › **Display Filters** tab › **Enable Filters** check box (see also Workspace wizard 3: Filter settings). This setting (filter on/off) is retained even if you pause and restart monitoring and recording. The workspace file is not changed. If you close *Recorder*, the old workspace with the setting made there is loaded when the program is restarted.
	*Show Workspace Info* shows the configuration of the current workspace. The information contains all the settings made when editing the workspace except for the settings made on the first page of the dialog box *Edit Workspace – Data Files Settings*.
	*Cascade Windows* cascades all the open segmentation and averaging windows one after another. The three functions only arrange the segmentation and averaging windows. If you are not performing any segmentation/averaging, the icons are disabled.
	*Tile Windows* arranges the windows next to each other.
	*Tile Windows* arranges the windows one above the other.
	*About* contains version information and information on the connected dongle.

3 Status bar

	Program status (or operating mode). There are the following modes: ▶ monitoring ▶ impedance check ▶ test signal ▶ saving ▶ pause.
	The second section shows the type of montage used. For further information on montages, refer to Montages.
	The third section shows the name of the currently open EEG file.
	The fourth section shows the elapsed recording time of the currently open EEG file.
	The fifth section shows the amount of free hard disk space in hours. This information is only available when an EEG file is open.
	The sixth section shows the utilization of the internal cache as a percentage.
	The seventh section shows a battery symbol indicating the battery voltage (for some amplifiers). The charge level of the battery is indicated by a color (green, yellow, red). ▶ Green: good battery charge ▶ Yellow: replace or recharge the battery. ▶ Red: operation will automatically stop after a few minutes, to prevent the battery from completely discharging and to ensure that no artifacts occur in the recorded data due to an insufficient power supply.
	The final section of the status bar contains the name of the current workspace.

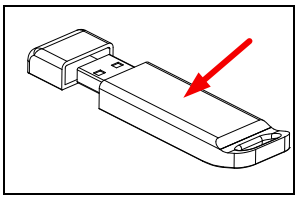
Appendix B Dongle information and licenses

1 Identify your dongle

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

Prepare

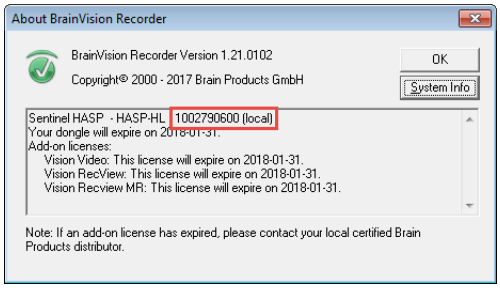
- License dongle
- Recorder



1 The **external dongle label** is an ID that is printed on your license dongle. Take note of this number.
   - ▷ Unnnnn: Analyzer local license
   - ▷ Nnnnnn: Analyzer network license
   - ▷ Rnnnnn or URnnnnn: Recorder professional license
   - ▷ URnnnnn: Recorder license for LiveAmp
   - ▷ URnnnnn: Recorder license for actiCHamp
   - ▷ URnnnnn: Recorder license for BrainAmp
   - ▷ VURnnnnn: Recorder license for V-Amp
   - ▷ URAnnn: Analyzer/Recorder license
   - ▷ VURAnnnnn: combined Analyzer/Recorder license for V-Amp
   - ▷ UCnnnnn: CapTrak license

2 Plug the dongle into the recording computer.

3 The **key ID** is a nine-digit number. To find it, open Recorder and click on **Help › About BrainVision Recorder...**



➔ You can register your product on http://www.brainproducts.com.

2 About the licenses

Some optional components of Recorder only run when you purchase an add-on license. Depending on your dongle generation an add-on license is installed on the recording computer and associated with your dongle or it is installed directly on the dongle. You can run both generations at the same time and you can install add-on licenses for different dongles on one computer.

When you purchase an add-on license together with Recorder, it will be installed on the license dongle. If you purchase an add-on license later, you can download it from the Brain Products website

3 Amplifier specific licenses

Amplifier specific licenses can be purchased for LiveAmp, actiCHamp, BrainAmp and V-Amp. An amplifier specific license can only be used with the type of amplifier for which it was purchased, for example a Recorder license for LiveAmp cannot be used with BrainAmp.

▷ To identify the license type select **Help › Show Installed components**...

A workspace created using an amplifier specific license can also be used with a Recorder professional license and vice versa.

4 Installing add-on licenses

You must install add-on licenses that are purchased later.

Pre-requisites

- Internet access

  alternatively: USB stick with license file (start with step 3)

- Administrator rights
- License dongle connected

1 Register your dongle.

   ▷ Open http://www.brainproducts.com and choose **Downloads & Support › Product Registration**.

   ▷ Follow the instructions on the screen.

2 Download the license file.

   ▷ Go to http://www.brainproducts.com and choose **Downloads & Support › Downloads**.

   ▷ To log in use the username and password from the confirmation mail.

   ▷ Select the *License File for Analyzer 1 and/or Recorder*.

3 Install the add-on license.

   ▷ Open the folder to which you have downloaded the file. Alternatively, open the USB stick.

   ▷ Double-click on the file and follow the installation routine.

4 Check if the add-on licenses were installed.

   ▷ Open Recorder and choose **Help › About BrainVision Recorder...**

➔ If the add-on licenses were not installed correctly, run the license file as administrator.

Note for administrators

The installed add-on license is stored in the directory C:\Windows\SysWOW64 or C:\Windows\System32 (architecture dependent) with the extension *.BPLCS. The file is in signed text format.

Don’t change this file, otherwise the add-on license will become invalid.

NEW Appendix C Format of the EEG files

The current version of the *Recorder* supports the BrainVision Data Exchange Core Format 1.0 only. This format is described in this appendix.

An EEG recording consists of three files: the header file, the marker file and the data file. All three files are stored in the raw file folder.

1 Header file

The header file...

- describes the EEG data file.
- is a text file with the extension .vhdr.
- has the same base name as the raw data EEG file.

Here is an extract from a header file as an example:

```
Brain Vision Data Exchange Header File Version 1.0
; Data created by the Vision Recorder

[Common Infos]
Codepage=UTF-8
DataFile=000007.eeg
MarkerFile=000007.vmrk
DataFormat=BINARY
; Data orientation: MULTIPLEXED=ch1,pt1, ch2,pt1 ...
DataOrientation=MULTIPLEXED
NumberOfChannels=48
; Sampling interval in microseconds
SamplingInterval=5000

[Binary Infos]
BinaryFormat=INT_16
```

```
[Channel Infos]
; Each entry: Ch<Channel number>=<Name>,<Reference channel name>,
; <Resolution in "Unit">,<Unit>, Future extensions..
; Fields are delimited by commas, some fields might be omitted (empty).
; Commas in channel names are coded as "\1".
Ch1=1,,0.1,µV
Ch2=2,,0.1,µV
...
Ch41=41,,0.1526,C
Ch42=42,,0.0763,mm
Ch43=43,,0.1526,mm
Ch44=44,,152.6,µV
...
[Comment]

A m p l i f i e r  S e t u p
============================
Number of channels: 48
Sampling Rate [Hz]: 200
Sampling Interval [µS]: 5000

Channels
--------
```

#	Name	Phys. Chn	Resolu-tion/Unit	Low Cut-off [s]	High Cut-off [Hz]	Notch [Hz]	Series Res. [kOhm]	Gradient	Offset
1	1	1	0.1 µV	DC	250	Off	0		
2	2	2	0.1 µV	DC	250	Off	0		
...									
41	41	41	0.1526 C	DC	250	Off	0	1 [mV/C]	0.02 [mV] = 0 [C]
42	42	42	0.0763 mm	DC	250	Off	0	2 [mV/mm]	0 [mV] = 0 [mm]
43	43	43	0.1526 mm	DC	250	Off	0	1 [mV/mm]	1 [mV] = 0 [mm]
44	44	44	152.6 µV	DC	250	Off	0		
...									

```
S o f t w a r e  F i l t e r s
==============================
#   Low Cutoff [s]      High Cutoff [Hz]    Notch [Hz]
1   0.0006366           Off                 Off
2   0.0006366           Off                 Off
...
41  0.0006366           Off                 Off
42  0.0006366           Off                 Off
```

```
43  0.0006366           Off                 Off
44  0.0006366           Off                 Off
...

Impedance [kOhm] at 12:10:43:
1:  Out of Range!
2:  Out of Range!
...
41: Out of Range!
42: Out of Range!
43: Out of Range!
44: Out of Range!
...
Ref: Out of Range!
Gnd: Out of Range!
```

The following first line identifies the header file, states its version and is mandatory.

```
Brain Vision Data Exchange Header File Version 1.0
```

Neither white spaces nor comments must be added before this line!

A semicolon at the beginning of a line identifies a free-text comment. This line is ignored. Blank lines are also ignored.

The format of the header file is similar to a Windows® INI file. It consists of various named sections containing keywords/values. A section is identified by a line with a heading enclosed in square brackets. The header extract above, for example, contains a *Common Infos* section. A header file can contain an unlimited number of sections.

The subsequent lines contain some keywords for this section and the values that have been assigned to them. A keyword can only occur once in a section. Its meaning depends on the section in which it occurs. There must not be a space before or after the equals sign. Most predefined keywords have a default value which is used by the Brain Products' Generic Data Reader if a keyword is not found.

The various predefined sections with keywords, their meanings and default values are listed below.

The amplifier setup parameters are listed in the *Amplifier-Setup* starting at Chapter 6.1.

'Common Infos' section of the header file

Keyword	Meaning	Default Value	Comment
`Codepage`	Character encoding defined by Codepage. Possible value: **UTF-8** Character encoding is done according to UTF-8.	**ANSI**	In fact, the encoding needs to be known before the file is read. The value ANSI is not available in the BrainVision Core File Format 1.0.
`DataFile`	Name of the EEG data file. It is assumed that the header file, the optional marker file and EEG data file are in the same folder. The placeholder $b can be used in the file name. It is replaced by the base name of the header file when the file is read in. Example If the name of the header file is Test.vhdr, the entry Data-File=$b-EEG.dat is interpreted as Data-File=Test-EEG.dat.	None	The keyword with value is mandatory.
`MarkerFile`	Name of optional marker file. If exists the marker file contains a list of markers assigned to the EEG. It is assumed that the marker file is in the same folder as the header file. For the format of the marker file refer to Marker file section below. The placeholder $b can be used in the file name (see example above).	None	
`DataFormat`	Data format. Possible value: **BINARY**	**ASCII**	**DataFormat=BINARY** is a mandatory entry. **BINARY** is the only possible value in the BrainVision Core file format.
`DataOrientation`	Data orientation. Possible value: **MULTIPLEXED** All the channels come one after the other for every data point. In other words, the data structure is multiplexed	**MULTIPLEXED**	**DataOrientation=MULTIPLEXED** is an optional entry, i.e. if missing the default value is assumed.
`DataType`	Data type. Possible value: **TIMEDOMAIN** The data is in the time domain.	**TIMEDOMAIN**	**DataType=TIMEDOMAIN** is an optional entry, i.e. if missing the default value is assumed.

Keyword	Meaning	Default Value	Comment
`NumberOf-Channels`	Number of channels in the EEG file.	None	Mandatory entry. Value is of type integer.
`SamplingIn-terval`	Sampling interval. The interval is specified in µs in the time domain.	None	Mandatory entry. Value is of type integer
`Averaged`	This indicates whether the data set to be read in has been averaged. Possible values are: **YES** Yes, the data set represents data that has been averaged. **NO** No, the data set represents data that has not been averaged.	**NO**	This is an optional entry, i.e. if missing the default value is assumed.
▶ Averaged Segements	This value is only evaluated if **AVERAGED=YES**. In this case the value states the number of segments included in the average.	**0**	The default value corresponds to the case **AVERAGED=NO**. Value is of type integer.
▶ SegmentData-Points	This value is only evaluated if **AVERAGED=YES**. In this case the value states the number of data points in each segment, i.e. each segment has the same length.	**0**	The default value corresponds to the case **AVERAGED=NO**. Value is of type integer.
▶ Segmentation-Type	Possible values are: **NOTSEGMENTED** The data set has not been segmented. **MARKERBASED** The data set has been segmented on the basis of one or more marker positions. This value is only evaluated if **AVERAGED=YES**.	**NOTSEGMENTED**	The default value corresponds to the case **AVERAGED=NO**.

'Channel Infos' section of the header file

Keyword	Meaning	Default Value	Comment
`Ch<x>` <x> stands for the channel number. In other words, the keyword for the first channel is Ch1, for the second channel Ch2, etc.	Individual properties for the channel are specified separated by commas: ‹channel name›,‹reference channel name›, ‹resolution in "unit"›[, ‹unit›] Example Ch1=Fp1,,0.1,µV The first channel has the channel name "Fp1". The common reference channel is taken as the reference channel because no entry has been made. The resolution is 0.1 µV. The resolution is the value by which the value of the data point is multiplied to convert it to the channel unit (i.e. µV or the selected unit).	‹channel number›, ,1.0,µV	▶ ‹channel name› is of type string ▶ ‹reference channel name› is of type string ▶ ‹resolution in "unit"› is of type float ▶ ‹unit› is of type string

'Binary Infos' section of the header file

This section contains general information on the EEG file.

Keyword	Meaning	Default Value	Comment
`BinaryFormat`	Binary format. Possible values: **IEEE_FLOAT_32** IEEE floating-point format, single precision, 4 bytes per value **INT_16** 16-bit signed integer	**INT_16**	**BINARYFORMAT=INT_16** is an optional entry, i.e. if missing the default value is assumed.

'Coordinates' section of the header file

Keyword	Meaning	Default Value	Comment
Ch<x> <x> stands for the channel number. In other words, the keyword for the first channel is Ch1, for the second channel Ch2, etc.	Coordinates of an individual channel in the form: ‹Radius›, ‹Theta›, ‹Phi› Example Ch1=1,-92,-72 The electrode coordinate system is described in Section D on page 184.	-	▶ ‹Radius› is of type float ▶ ‹Theta› is of type float ▶ ‹Phi› is of type float

'Comment' section of the header file

Keyword	Meaning	Default Value	Comment
-	Arbitrary content	-	▶ To be used for additional information only. ▶ Data readers cannot interpret this information unambiguously.

Lines starting with a ";" are interpreted as comments and are ignored, except the "Comment" section where ";" has no special meaning.

2 Marker file

The marker file is based on the same principle of sections and keywords as the header file. The following first line identifies the marker file, as follows:

```
Brain Vision Data Exchange Marker File Version 1.0
```

Neither white spaces nor comments must be added before this line!

The various predefined sections with keywords, their meanings and default values are listed below.

'Common Infos' section of the marker file

Keyword	Meaning	Default Value	Comment
`Codepage`	Character encoding defined by Codepage. Possible value: **UTF-8** Character encoding is done according to UTF-8.	**ANSI**	The encoding needs to be known before the file is read. The value **ANSI** is not available in the BrainVision Core File Format 1.0.
`DataFile`	Name of the EEG data file. It is assumed that the header file, marker file and EEG data file are in the same folder.	None	-

'Marker Infos' section of the marker file

Marker information. The individual markers and their properties are listed in this section.

Keyword	Meaning	Default Value	Comment
`Mk<x>` ‹x› stands for the marker number. In other words, the keyword for the first marker is Mk1, for the second marker Mk2, etc.	Individual properties for the marker are specified separated by commas: ‹type›, ‹description›, ‹position›, ‹points›, ‹channel number›[, ‹date›] *Example* Mk1=Time 0,,26,1,0 The first marker in this example has the type "Time 0", no description, its position is at data point 26, its length is 1 data point, and the channel number is 0, which means that this marker applies to all channels. The date is optional. It is only evaluated if the marker type is "New Segment". The date has the following format: 4 digits = year 2 digits = month 2 digits = day 2 digits = hour (24-hour system) 2 digits = minute 2 digits = second 6 digits = microsecond The result is a time resolution of a microsecond. *Example* 19990311140312003012 means 11 March 1999, 14:03:12.003012	None	▶ ‹description› is of type string ▶ ‹position› is of type unsigned integer ▶ ‹points› is of type unsigned integer ▶ ‹channel number› is of type integer ▶ ‹date› see column "meaning" ▶ In case of "New Segment" marker the date information is provided.

Appendix D Electrode coordinate system

Electrode coordinates are required whenever analytical procedures make use of channel positions or when topographies have to be output in 2D or 3D.

Spherical coordinates are used to specify a point on the surface of the head. A set of coordinates consists of the three variables r, θ and φ (radius, theta and phi).

The radius r specifies the distance (in millimeters) between point P and the origin of the coordinate system. The only exceptions are r = 0 and r = 1. r = 0 signifies an invalid position, for instance when the position of an electrode is not known. When realistic electrode coordinates are used, r can have a different value for each channel. In other cases, the value of r should be the same for all the channels if a spherical head model is used. For instance, in the *Analyzer's* standard coordinate system, r = 1.

φ specifies the angle between the x-axis and the projection of the line connecting the point P and the origin of the coordinate system on the xy plane. In the case of the front right and back left quadrants, φ › 0; for the back right and front left quadrants, φ ‹ 0.

θ is the angle between the z-axis and the line connecting the point P and the origin of the coordinate system. In the right hemisphere, θ › 0. In the left hemisphere, θ ‹ 0.

The figure below illustrates the coordinate system used by *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).

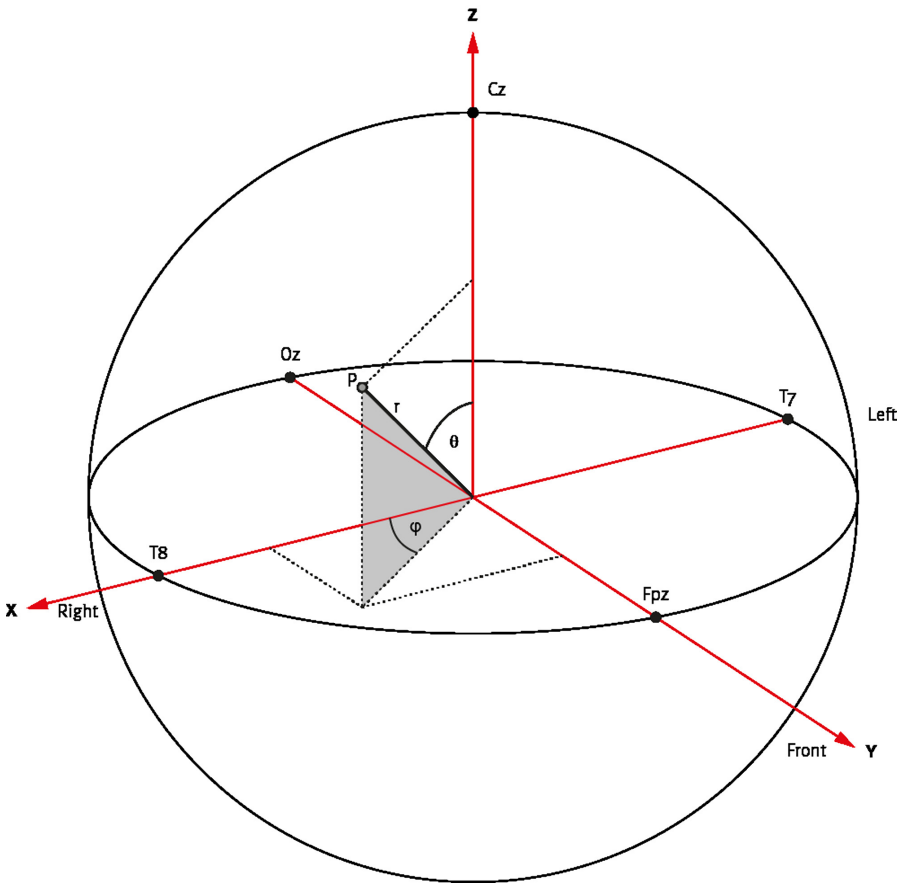


Figure D-1. Coordinate system for electrodes

Appendix E Troubleshooting

1 Where is my add-on license?

If your add-on license does not work, try the procedure below.

Prepare:

- License dongle

1 Identify your dongle.

2 Connect the dongle to the recording computer.

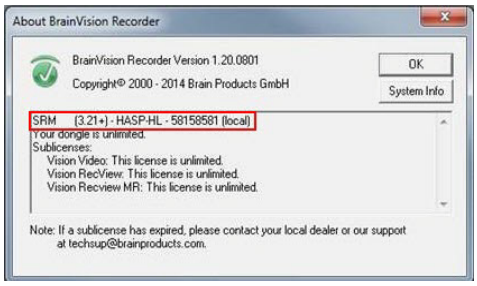
3 Start Recorder.

4 Click on **Help › About.**

5 Check the first line in the text field:

▶ **HASP-HL**: add-on information is installed on the computer and not on the dongle.

If you use the dongle on another or new computer install the add-on again.



▶ **SRM**: add-on information is installed on the dongle. You can use the dongle on any Recording computer without installing the add-on license anew.

2 Buffer overflow messages

Buffer overflow messages can be caused by insufficient resources of your computer. Software that runs in the background, like certain Windows® features, consume a lot of your system's resources. Switch the features off and stop programs that run in the background:

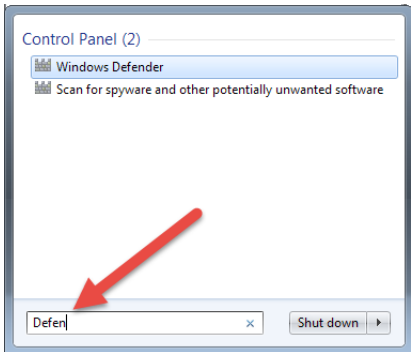
- Internet browser (for example, Microsoft Edge, Internet Explorer, Firefox, Chrome, Opera)
- sleep mode
- Windows® Update
- Windows® Defender
- Disk Defragmenter
- USB selective suspend setting

Finding the programs

To find a program use the **Search** function. This works across all Windows® platforms.

1 Type in the name of the program.

For example DEFENDER.



2 Click on the program you are looking for.

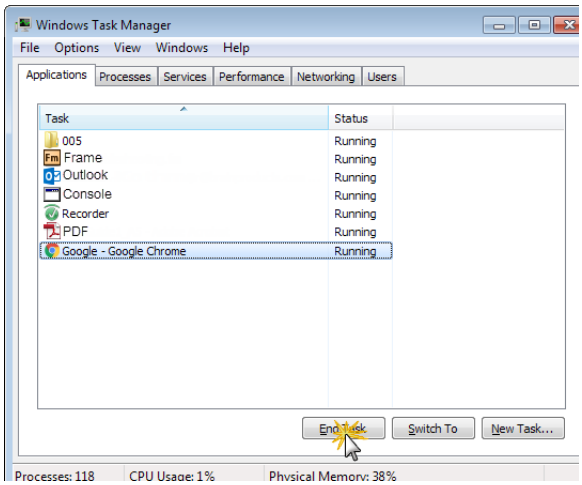
➔ This will open the dialog, for example Windows® Defender.

Close unused programs

1 Open the Windows Task Manager (search for TASK MANAGER).

2 End the programs (tasks) that you don't need during the recording.

➔ Make sure that all Internet browsers are closed during the recording.



Deactivate Windows® Defender

Windows® Defender can block certain programs on your computer.

1 Open the dialog **Windows Defender** (search for DEFENDER).
2 In the menu bar of the Windows Defender dialog click on **Tools**.
3 Then click on **Options**.
4 To deactivate **Windows Defender** across the entire system:
   ▷ choose the **Administrator** option,
   ▷ deselect the check box **Use this program**,
   ▷ click on **Save**.

Deactivate the sleep mode

When activated, your computer could go into the standby mode, in which all programs stop working. Therefore, deactivate the sleep mode.

1 Open the dialog **Change when the computer sleeps** (search for SLEEP MODE).
2 Specify that the computer is never put to sleep and save this setting.

Deactivate Windows® Update

Windows® Update can consume a lot of your system and network resources, causing your computer to slow down.

1 Open the dialog **Windows Update** (search for UPDATE).
2 Click **Change settings** in the side panel.
3 Under Important updates, choose **Never check for updates** and click on **OK**.

Deactivate the Disk Defragmenter

The Disk Defragmenter is a background process, that can consume your system resources.

1 Open the dialog **Disk Defragmenter** (search for DEFRAGMENTER).
2 Then click on the button **Configure schedule**.
3 In the Disk Defragmenter Modify Schedule dialog:
   ▷ deselect the check box **Run on a schedule**,
   ▷ click on **OK**.

Deactivate USB selective suspend setting

To save power, Windows® switches off the USB ports, when not in use. This also applies to the USB port, to which the license dongle is connected. If this port is switched off, Recorder may not function correctly anymore. This usually happens during long recordings (for example, over night).

1 Open the dialog **Power Options** (search for POWER OPTIONS).
2 Next to the selected power plan, click on **Change settings**.
3 Then click on **Change advanced power settings**.
4 Scroll to the USB settings
   ▷ and select **Disabled** from the drop-down list.
   ▷ Click on **OK** .

List of abbreviations

RDA . . . . . .Remote Data Access
EEG . . . . . .Electroencephalogram
EMG. . . . . .Electromyogram
ECG . . . . . .Electrocardiogram
EOG . . . . . .Electrooculogram
LPT. . . . . .Line printing terminal ("parallel port")
EPF . . . . . .Electrode position file
MR. . . . . .Magnetic resonance
MR. . . . . .Magnetic resonance
GSR . . . . . .Galvanic skin response
BUA . . . . . .BrainVision USB2 Adapter
AUX . . . . . .Auxiliary
TTL. . . . . .Transistor-transistor logic
TCP/IP . . . . . .Transmission Control Protocol/Internet Protocol
DC . . . . . .Direct current

Glossary

A

A/D conversion: Conversion of analog measurements into digital form so that they can be saved to hard disk and further processed using software.

actiCAP active electrode system: Electrode system (including control software) from Brain Products featuring active electrodes which is used for acquiring EEG signals and can be combined with all amplifiers available from Brain Products.

actiCAP ControlSoftware: Software from Brain Products that allows the actiCAP active electrode system to be controlled and configured. The actiCAP ControlSoftware can also be controlled from Recorder.

Active electrode: Electrode with integrated circuits (impedance converters) which makes it possible to perform recordings at high transition resistances.

Active Shielding: Recording mode that allows ambient noise, interference due to electrical effects and artifacts due to cable movement to be minimized.

Add-on license: Depending on the Recorder version licenses for additional modules are called 'sublicenses' or add-on licenses.

Amplitude: Maximum deflection of the EEG curve in µV measured from peak to trough.

Analyzer: Software from Brain Products for analyzing EEGs and other physiological signals and which is able to read and evaluate different file formats from various vendors.

Artifact: All potential shifts in the EEG recording that do not have their source in the cortex. Artifacts can be subdivided into those related to the test subject (physiological artifacts) and technical interference. Technical artifacts can be caused by faulty electrodes, defects in the apparatus or technical interference.

AUX channel: Abbreviation for "auxiliary channel". Supplementary channel for simultaneously recording polygraph signals such as breathing, ECG, eye movement, oxygen saturation, etc.

Average reference: Montage type in which the average of all the selected channels is used as the reference (see also *Montage*).

Average: Formation of arithmetic mean using segmentation (total value of the points divided by the number of segments). This is performed separately for each EEG channel.

Averaging group: Identifies an averaging operation defined in the Recorder workspace by specifying one or more markers (q.v.).

B

Baseline: An assumed horizontal line marking the vertical zero point in the EEG (voltage = 0).

Bipolar connection: Montage type in which the differences between two channels are calculated (see also *Montage*).

BrainAmp family: Amplifiers from Brain Products with 32 channels each (can be extended) that can be used in different fields (laboratory acquisition, combined EEG-fMRI measurements, EEG-TMS measurements, etc.).

Buffer: Memory area for internally buffering recording data.

C

Calibration: Method for checking the response of an EEG unit when a particular voltage difference is applied to the amplifier inputs.

D

DC offset: The average of the EEG signals. If this average is equal to 0, there is no DC offset. If analysis is negatively affected by too high a DC offset, it may be necessary to perform DC offset correction.

Digital port: Parallel interface over which data can be transferred between a computer and peripheral devices.

E

Export component: Module of the BrainVision Analyzer that can be used to export data sets to files so that they can be further processed using other programs.

G

Generic Data Reader: Reader component in Analyzer that reads data in the formats used by Brain Products.

Grid view: Representation of the EEG channels in a grid pattern.; Used for segmentation or montages, for instance.

H

Header file: File containing general information on the recording, such as the number and names of the channels, the electrode coordinates, the sampling rate, the number of data points, etc. Recorder writes different formats depending on the Recorder license. Possible extensions: .vhdr, .bhdr, .ahdr, .lhdr.

High-cutoff filter: Filter that reduces the amplitude of high-frequency digitized signals.

I

Impedance Check View: Display mode of Recorder, designed to assist the person running the experiment by allowing simple testing of the impedance values of the individual electrodes.

Impedance measurement: Recorder operating mode for measuring the resistance of the electrodes.

Impedance: Resistance between the electrode and the head skin.

Interval: A section of the EEG signal defined by its starting point and length or by its starting point and end point within the signal.

Isotropic representation: A representation of the positions of the electrodes on the head (top view) in which the head retains its round form because the horizontal and vertical directions are scaled to the same degree.

L

Low-cutoff filter: Filter that reduces the amplitude of low-frequency digitized signals.

M

Marker file: File listing all the markers present in the data set together with their position, type, description etc. Recorder writes different formats depending on the Recorder license. Possible extensions: .vmrk, .bmrk, .amrk, .lmrk.

Marker: Markers mark a point in time or a period within the EEG. A marker can be an item of stimulus information that is used to ascertain evoked potential, but it can also mark a new segment or indicate that a DC offset correction was carried out at a certain time. Markers are used for orientation during segmentation.

Montage: Reconnection of the channels in the software whereby new voltage references are assigned to the channels.

MOVE: Wireless transmission system from Brain Products consisting of a transmitter and a receiver which can be used for the wireless transmission of EEG data between the cap and the amplifier.

O

OLE automation: Method of controlling Recorder by means of external programs.

Original reference: Montage type in which no new reference is calculated, but which instead serves only to group channels in order to display them optimally (see also *Montage*).

Overlay: The result of overlaying EEG channels of the same name or data sets with the same sampling rate and the same duration with the aim of carrying out a direct visual comparison of the data.

P

Physical channel: Hardware-related assignment of a channel on the basis of its position in an EEG system.

Polarity: The polarity setting determines whether the axis for positive measurements points up or down on EEG curves.

PolyBox: Hardware accessory from Brain Products for BrainAmp amplifiers that allows up to eight polygraph signals acquired by sensors to be recorded concurrently with the EEG.

Polygraph recording: Simultaneous recording of different physiological signals such as EEG, breathing, ECG, eye movement, oxygen saturation, etc.

Potential: Frequently used as a synonym for "EEG wave".

Protective resistor: A resistor fitted in the electrode cables that restricts the power supply in the event of a fault.

R

Raw file: The EEG file obtained directly during recording without any modifications.

RDA (Remote Data Access): Remote access to Recorder or the transfer of data from Recorder to other programs located on the local computer or on computers in the network. In this process, Recorder acts as the server, and the program receiving the data acts as a client.

Resolution: Specifies the granularity with which the value range of the EEG signal is subdivided during digital acquisition. A higher resolution means finer granularity and more accurate acquisition of the original signal. Unit: µV.

S

Sampling rate: Number of data points measured per second when acquiring an EEG digitally.

Scaling: In the context of displaying the EEG signal, scaling is the assignment of an amplitude value in µV to an interval.

Segment: A section of the EEG resulting from segmentation (q.v.).

Segmentation group: Identifies a segmentation operation defined in the Recorder workspace by specifying one or more markers (q.v.).

Segmentation: Subdivision of the EEG into different segments (epochs). Segmentation can be based on a number of different criteria. On the one hand, segmentation is understood to be a preliminary stage in the analysis of evoked potentials. Epochs of the same length are generated relative to a reference marker (a stimulus, for example). This results in a data set consisting of a sequence of segments or epochs. On the other hand, segmentation is understood to be the preparation of separate processing steps for different sections of an EEG, for example for the analysis of different stages before and after medication.

Sublicense: File associated with the dongle and which can be used to enable optional functions.

SyncBox: Hardware accessory from Brain Products for the BrainAmp (ExG) MR/BrainAmp MR plus which makes it possible to synchronize the sampling rate of the amplifier with the clock rate of the scanner system.

T

Ten-ten system (10-10 system): One additional electrode is positioned between each of the electrodes of the 10-20 system (q.v.).

Ten-twenty system (10-20 system): Internationally recognized, standardized method for positioning electrodes on the head. The skull is measured from defined anatomical points. The distance between neighboring electrodes is either 10% or 20% of the measured distances.

Time marker: see *Marker*.

Trigger: Pulse generated by a device or software program and which initiates an operation. A presentation software package can, for example, generate a trigger each time an image appears. The trigger can be sent to the amplifier via the parallel port of the computer and recorded by Recorder as a marker simultaneously with the EEG. EEG activity (e.g. an EEG signal of sufficient amplitude or length) can also be used to generate a trigger pulse that starts a process (e.g. control of a program).

V

View: Method of representing the EEG, such as the grid view, the head view, and the mapping view. A view determines how the channels are arranged in the window, for example.

W

Workfile: A file containing information on workspaces (*.rwksp), montages (*.mont) and other user-defined settings.

Workspace: Configuration file containing user-defined recording parameters, amplifier settings and other information. File name extension: .rwksp.

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