BRAIN PRODUCTS
Solutions for neurophysiological research

BrainVision Recorder

User Manual

Software version 1.20.0801

www.brainproducts.com

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BrainVision Recorder | User Manual
Software version 1.20.0801
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About this manual

This user manual describes version 1.20 of the *BrainVision Recorder*. It is part of the software product. It is essential to follow the instructions in the manual in order to use the software correctly and as intended.

The structure of the manual

The user manual has 11 chapters:

- Chapter 1 contains a description of the individual installation steps.
- Chapter 2 contains instructions on how to configure your operating system for trouble-free data recording.
- Chapter 3 describes the structure and operation of *Recorder*.
- In Chapter 4 you will learn how to set up a workspace.
- Chapter 5 provides information on configuring the user-specific settings.
- Chapter 6 describes the basic functions of the software such as impedance measurement, the recording and display of data, the use of montages etc.
- Chapter 7 describes how to use *Recorder* with the *actiCAP* active electrode system.
- Chapter 8 contains information on using the *BrainAmp* amplifiers, *QuickAmp*, *V-Amp*, *FirstAmp*, *actiCHamp*, the *NI 6071e A/D* converter board and the "Simulated Amplifier" option.
- Chapter 9 describes how to control *Recorder* via other programs by means of OLE automation.
- Chapter 10 explains how to use *Video Recorder* to record video data.
- Chapter 11 describes how you can transfer data from *Recorder* to other computers by means of "Remote Data Access".

Who is the manual intended for?

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

Conventions used 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 **health hazard** 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**.

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
124	new	SyncBox: Hint for selecting the scanner frequency
145	new	Recommended trigger length for actiCHamp

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.

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 with the following hardware[a]:	actiCHamp BrainAmp Standard BrainAmp DC BrainAmp MR BrainAmp MR plus BrainAmp ExG BrainAmp ExG MR QuickAmp PCI/USB MOVE FirstAmp V-Amp NI 6071e A/D converter board

a. Note also the restrictions on use for the individual hardware components under Windows® Vista and/or Windows® 7 on page 20 (“System requirements”).

Preface

The Recorder and its functions

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.

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 however 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.

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
QuickAmp PCI/USB	Twente Medical Systems International B.V. (TMSi)
FirstAmp	Brain Products GmbH
V-Amp	Brain Products GmbH
MOVE	Brain Products GmbH
NI 6071e A/D converter board	National Instruments
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, however, only if this combination is approved by the manufacturer of the medical device.

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Chapter 1 Installation

Under normal conditions, *Recorder* does not cause any conflicts with other programs that are already installed. Brain Products, however, 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 Microsoft operating systems *Windows® XP*, *Windows® Vista*, *Windows® 7*, *Windows® 8* and *Window® 8.1* 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 General requirements

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

Processor	Intel Pentium III processor 1 GHz or higher
Graphics adapter	min. resolution 1024 x 768 pixels and 32,768 colors
RAM	Windows® XP: min. 512 MB Windows® Vista, Windows® 7: min. 1 GB Windows® 8, Windows® 8.1 (64-bit): min. 2 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.
Operating System	Windows® XP 32-bit Service Pack 3 Windows® Vista 32-bit Service Pack 1 Windows® 7 32-bit and 64-bit Windows® 8 64-bit Windows® 8.1 64-bit

Please note that certain Windows® operating systems do not support all amplifiers and/or hardware components. The following table provides an overview of the hardware compatibility for Windows® operating systems

Hardware component	Supported by
BrainAmp PCI	Windows® XP SP3 32-bit
BrainAmp USB	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit Windows® 8 64-bit Windows® 8.1 64-bit
QuickAmp PCI	Windows® XP SP3 32-bit
QuickAmp USB	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit
actiCHamp	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit Windows® 8 64-bit Windows® 8.1 64-bit
FirstAmp/V-Amp	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit Windows® 8 64-bit Windows® 8.1 64-bit
NI 6071e A/D converter board (National Instruments)	Windows® XP SP3 32-bit Windows® Vista 32-bit

Table 1-1. Table of compatibilities

Hardware requirements when using actiCHamp:

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

Windows experience index	› 5.0
Processor	Intel® Core™ 2 Quad processor, 2.4 GHz or compatible
Graphics adapter	1280 x 1024 pixel resolution and at min. 512 MB internal memory
RAM	4 GB of RAM

1.2 Installing Recorder on Windows® XP

The installer includes the drivers for the dongle and amplifiers.

Proceed as follows to install *Recorder* on *Windows® XP*:

1 Insert the *Application Suite* DVD into the DVD drive.

If the installation main page does not open automatically, do the following:

a From the taskbar, choose **Start › Run**.

b Click the **Browse...** button.

c In the *Browse* dialog, select your DVD drive and double-click the *Autorun.exe*.

d Click on **OK** in the *Run* dialog.

2 The installation process that follows is described in Section 1.3, steps 3 through 10.

Notes

After you have completed installation of *Recorder*, you should install all software updates that may be available. For details, refer to Section 1.5.

1.3 Installing Recorder on Windows® Vista and Windows® 7

The installer includes the drivers for the dongle and amplifiers.

Proceed as follows to install *Recorder* on *Windows® Vista/Windows® 7*:

1 Insert the *Application Suite* DVD into the DVD drive.

2 In the *AutoPlay* dialog click on **Autorun.exe**.

Figure 1-1. "AutoPlay" dialog box under Windows® 7

If the *AutoPlay* dialog does not open automatically, do the following:

a From the taskbar, choose **Start** › **All Programs** › **Accessories** › **Run**.

b Click the **Browse...** button.

c Select the file *Autorun.exe* and click on **Open**.

d In the *Browse* dialog, select your DVD drive and double-click the *Autorun.exe*.

e Click on **OK** in the *Run* dialog.

3 On the installation main page click **Install BrainVision Recorder & Video Recorder**.

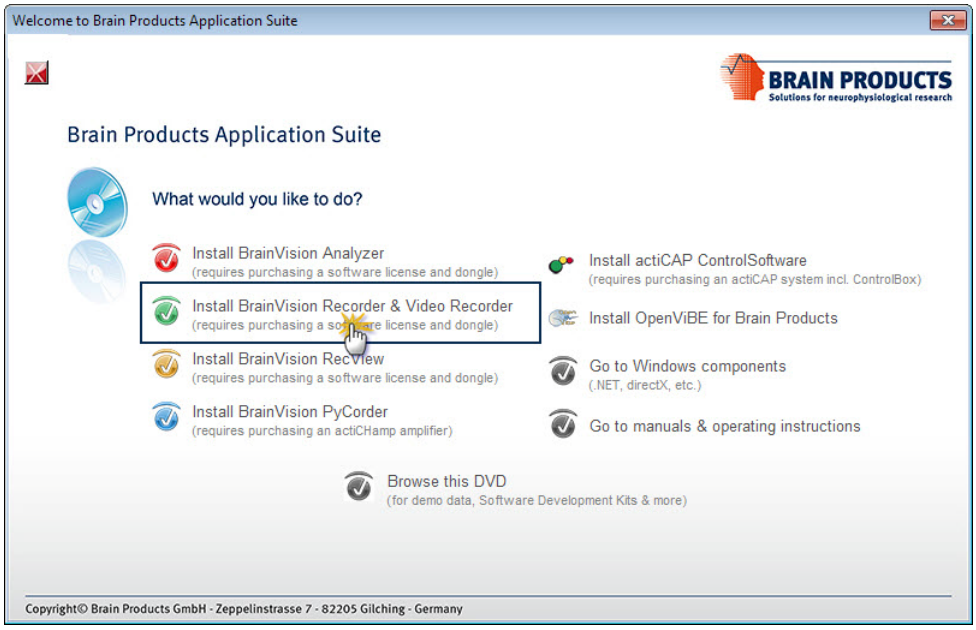


Figure 1-2. Installation main page

4 On the *Recorder* installation page click on **Install BrainVision Recorder**.

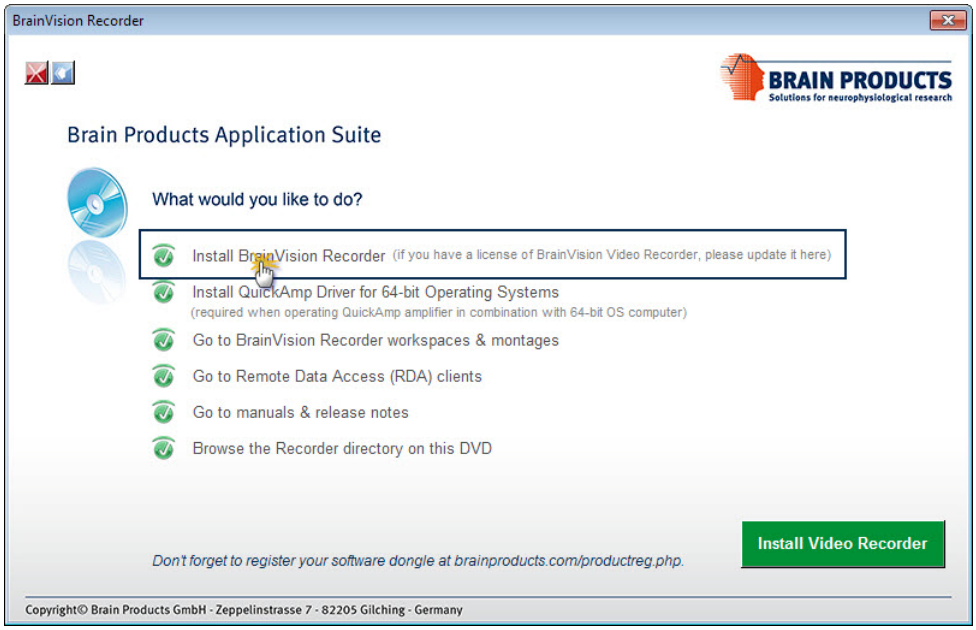


Figure 1-3. Recorder installation page

5 In the *User Account Control* dialog click on **Yes** to authorize installation.

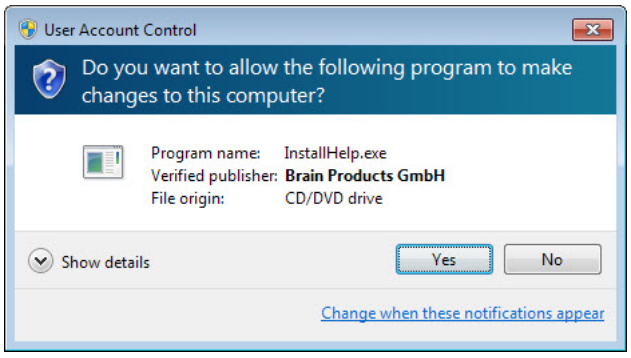


Figure 1-4. User Account Control

6 The *Setup Wizard* opens. Click **Next**.

Figure 1-5. Installation Wizard

7 You specify the *Recorder* installation directory during the course of installation.

We recommend that you install *Recorder* in the default directory proposed: *C:\Vision*. If you wish to use a different directory, ensure that it is not write-protected.

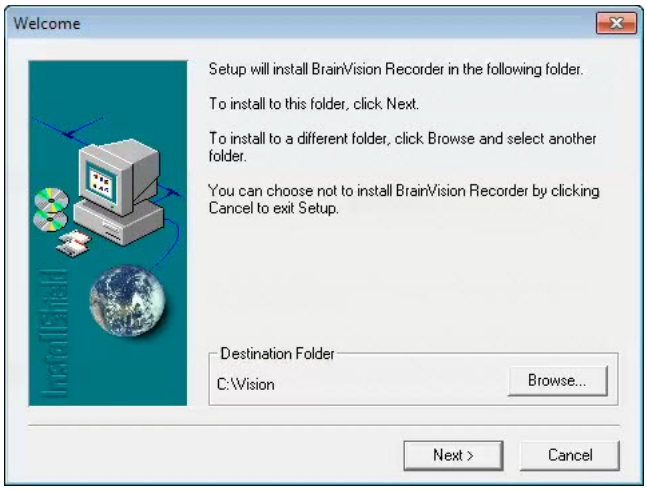


Figure 1-6. Selecting the installation directory

8 Then select directory name for the Brain Vision programs in the *Windows*® start menu.

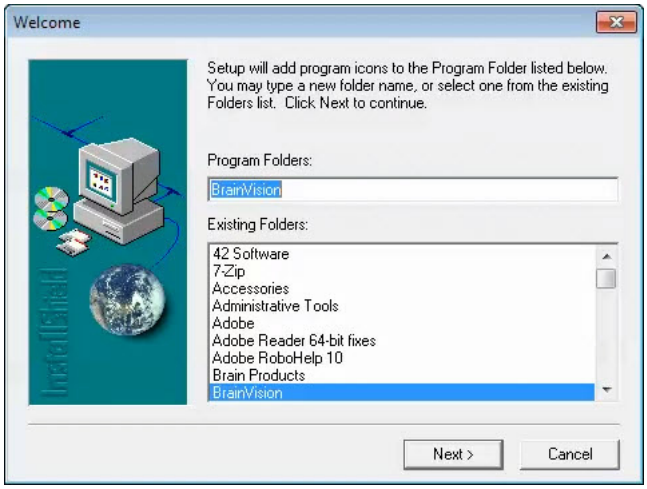


Figure 1-7. Selecting the name of the program folder

9 Agree to the installation of the driver software by clicking the option **Install this driver software anyway** in the *Windows Security* dialog box.

The confirmation prompt may appear several times, as drivers must be installed for all the supported hardware components.

10 Follow the installation instructions which are now displayed until installation is completed.

Notes

After you have completed installation of *Recorder*, you should install all software updates that may be available. For details, refer to Section 1.5.

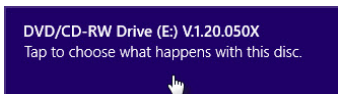
1.4 Windows® 8 and Windows® 8.1

NEW *The installer includes the drivers for the dongle and amplifiers.*

Proceed as follows to install the Recorder under Windows® 8 and 8.1:

1 *Application Suite* DVD into your DVD drive.

2 If the DVD starts automatically then the dialog box containing the action to be performed appears. Click in the dialog box.



3 A second dialog box is now opened. Click **Run Autorun.exe**. In this case, you can skip the next step.

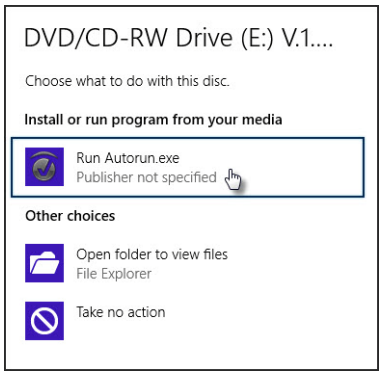


Figure 1-8. "AutoPlay" dialog box under Windows® 8

4 If the DVD does not start automatically, proceed as follows:

▷ Open the *Run* dialog[1] and click on **Browse...**

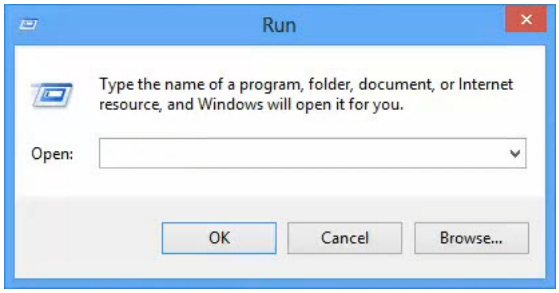


Figure 1-9. Run dialog in Windows® 8

1. The easiest way to open the Run dialog is to perform a search for "run".

▷ Select the DVD drive, click on *Autorun.exe* file and then on **Open**.

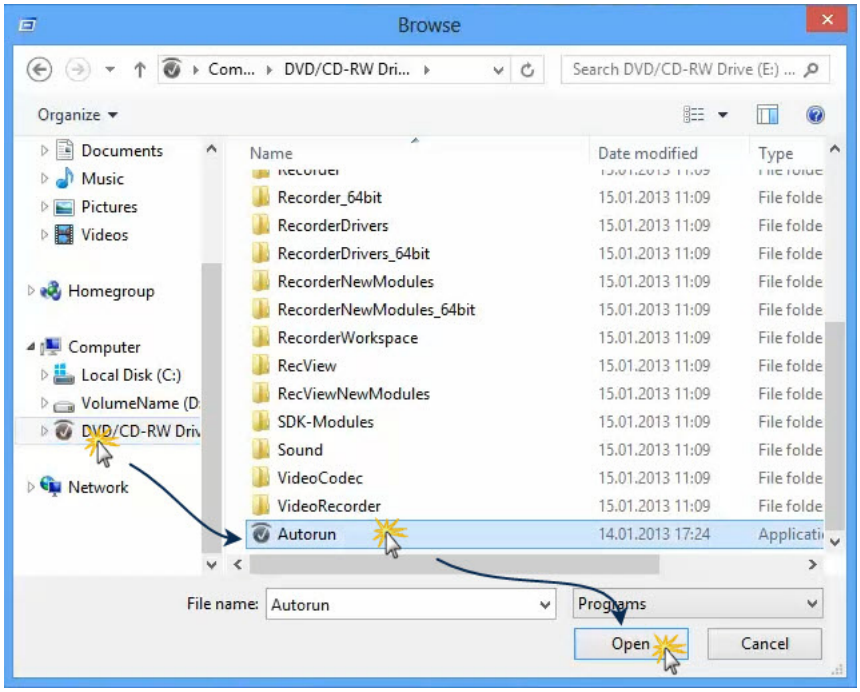


Figure 1-10. Locating "Autorun"

▷ In the *Run* dialog box, click **OK**, to open the installation menu.

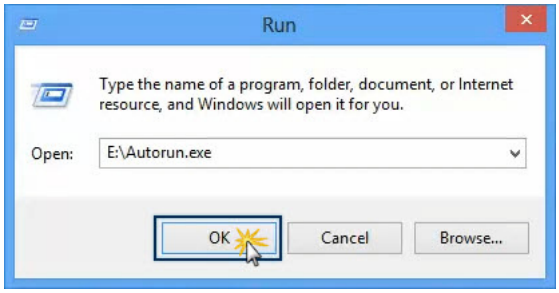


Figure 1-11. Execute the Autorun

5 Follow the procedure for Windows® 7 as of step 3 on page 23.

Notes

After you have completed installation of *Recorder*, you should install all software updates that may be available. For details, refer to Section 1.5.

1.5 Software updates

After you have completed installation of *Recorder*, you should install all additional software updates that may be available. Some new libraries may be available on the *Application Suite* DVD on the *Recorder* installation page. Click on **Install New Modules** to install minor updates.

Note

The **Install New Modules** item is only available if there are new modules that need to be installed.

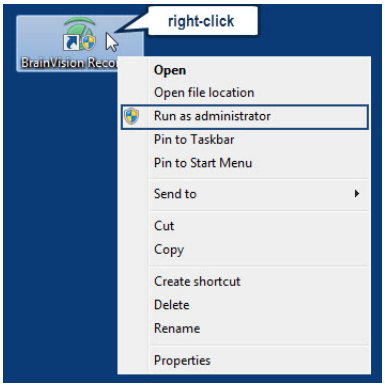
Alternatively, you can check the download section on the Brain Products website for the latest updates: http://www.brainproducts.com/.

1.6 License information

Connect the supplied dongle to one of the USB ports of your computer before you start *Recorder*.

Start *Recorder* in administrator mode:

- Right-click the *Recorder* shortcut on the desktop.
- Choose **Run as administrator**.



Tip:

To always run *Recorder* in administrator mode, you can make the settings under **Properties**.

For further details, please refer to Section 3.1.

To show information about your dongle, choose **Help › About BrainVision Recorder...** from the menu bar. The *About* dialog box contains the following information: internal serial number of the dongle, the expiry date of the dongle and the sublicenses bound to the dongle.

Figure 1-12. Dongle information

If the validity of your dongle is nearing expiry, for example if less than 30 days are left, a warning appears when you start *Recorder*.

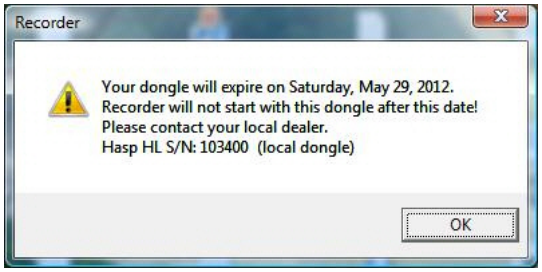


Figure 1-13. Warning before a dongle expires

Note

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.

Notice

Never connect stimulation devices to the parallel port of the computer on which Recorder is running! Otherwise damage may be caused by the stimulation device when Recorder is started!

Chapter 2 Configuring Windows®

To ensure uninterrupted acquisition of data, you should make the following settings on your operating system:

- deactivate sleep mode;
- deactivate Windows® Update;
- deactivate Windows® Defender;
- deactivate defragmentation.

Open the *Control Panel* and choose **System and Security** (see Figure 2-1). All further settings are made from here.

The following description refers to Windows® 7. The configuration procedure under other Windows® operating systems may differ from this. Refer to your Microsoft user documentation for information on configuring your operating system.

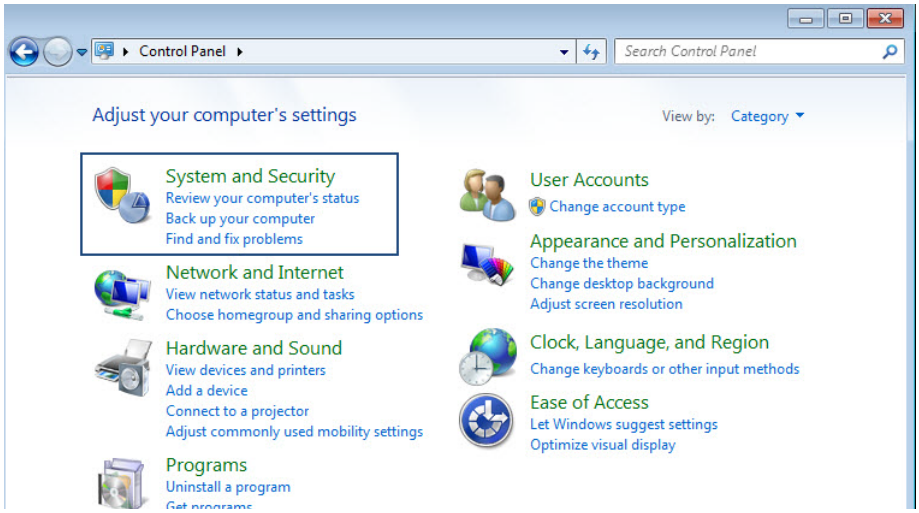


Figure 2-1. Windows® 7, Control Panel

Notes

You can reactivate any services and functions that have been deactivated after recording data.

Depending on the settings on your computer, the layout of the dialog boxes can differ from the depicted figures in this manual.

2.1 Deactivating sleep mode

Proceed as follows to deactivate the sleep mode:

1 Under *System and Security*, choose **Power Options** (Figure 2-2).

2 Click **Change when the computer sleeps** in the dialog box that appears (Figure 2-3).

3 Specify that the computer is never put to sleep and save this setting (Figure 2-4).

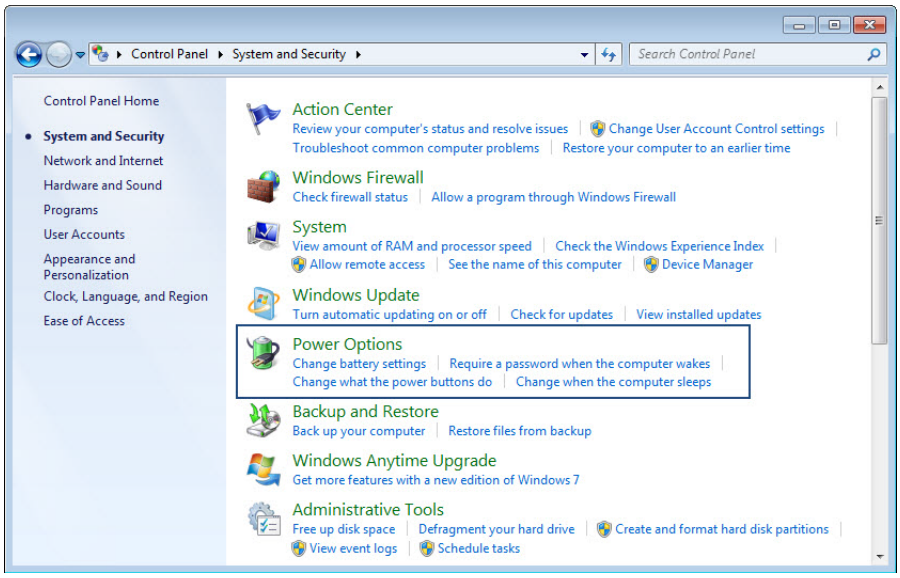


Figure 2-2. Deactivating sleep mode (A)

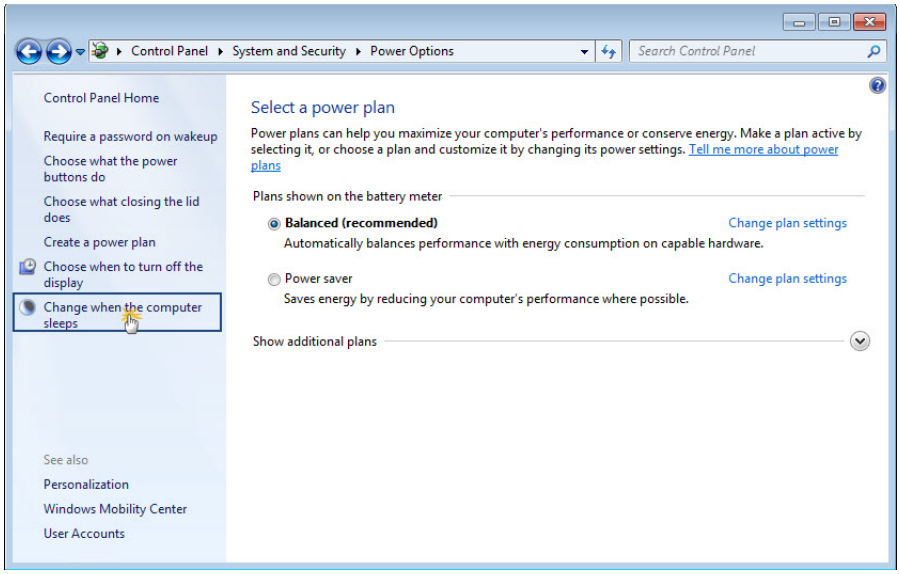


Figure 2-3. Deactivating sleep mode (B)

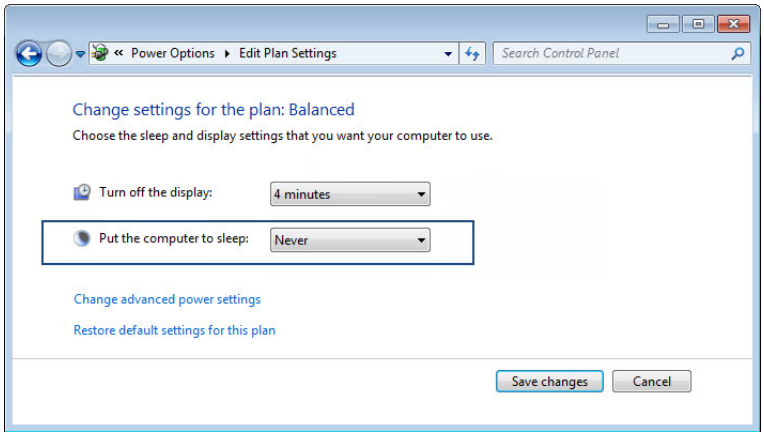


Figure 2-4. Deactivating sleep mode (C)

2.2 Deactivating automatic updates

Proceed as follows to deactivate automatic updates:

1 Under *System and Security*, choose **Windows Update** (Figure 2-5).

2 Click **Change settings** in the dialog box that appears (Figure 2-6).

3 Under *Important updates*, choose **Never check for updates** and save this setting (Figure 2-7).

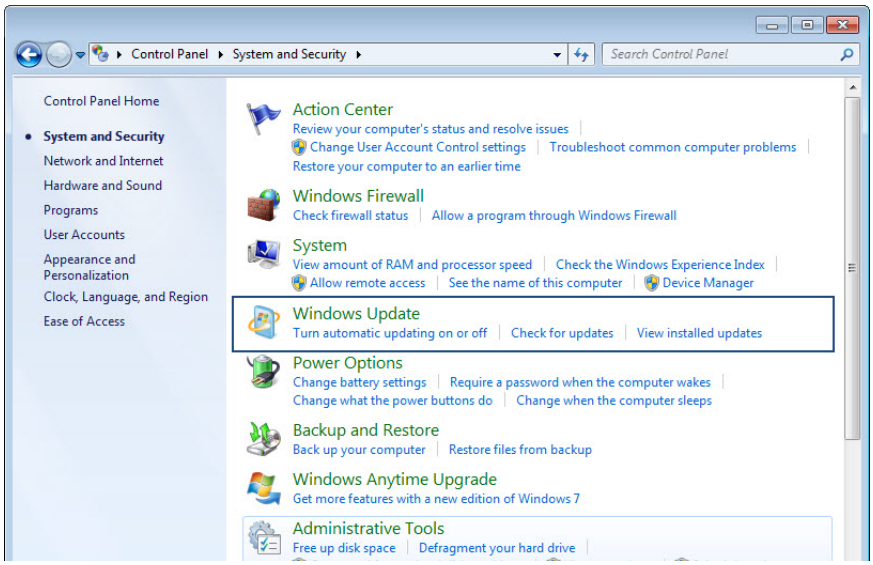


Figure 2-5. Deactivating automatic updates (A)

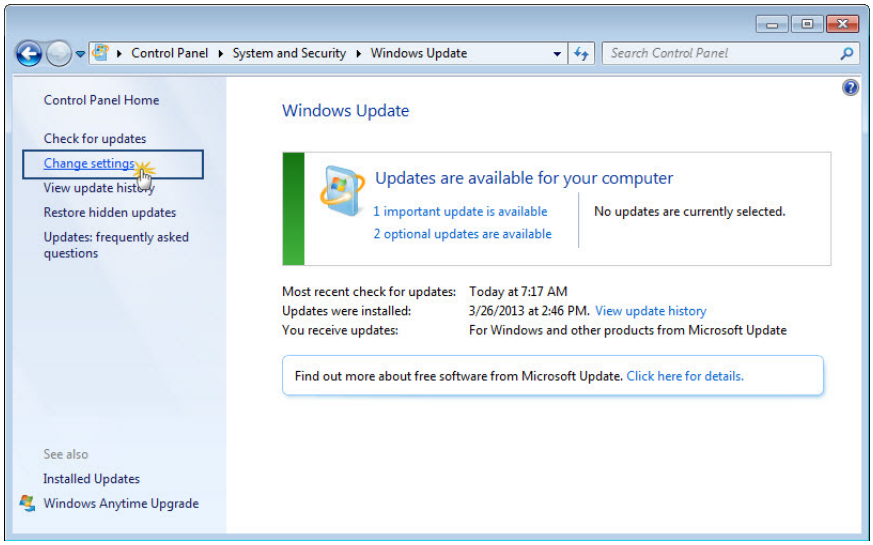


Figure 2-6. Deactivating automatic updates (B)

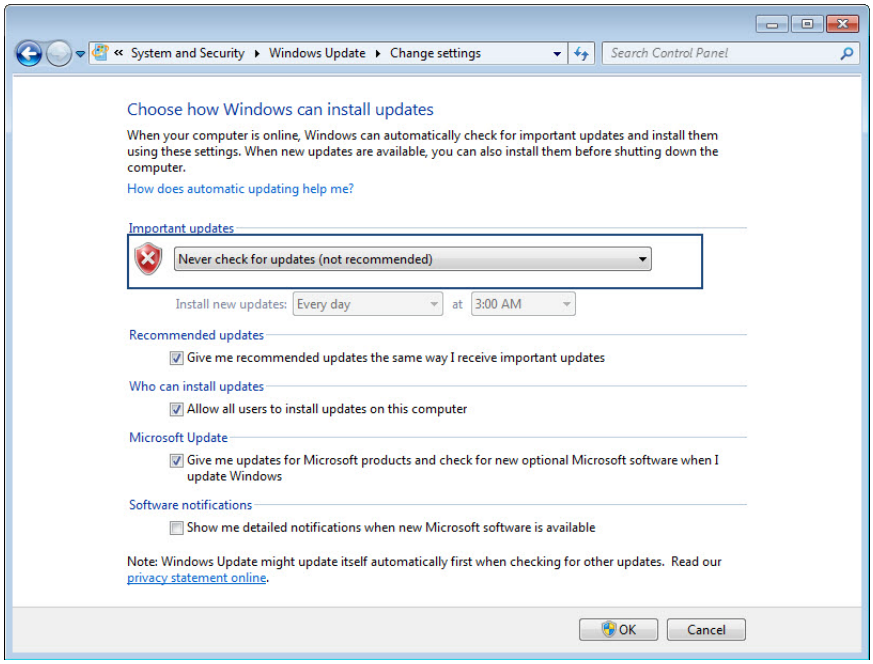


Figure 2-7. Deactivating automatic updates (C)

2.3 Deactivating Windows Defender

Proceed as follows to deactivate the Windows® Defender:

1 In the *Control Panel* select **Windows Defender** (Figure 2-8), for example by searching.

2 In the *Windows Defender* dialog box click on **Tools** (Figure 2-9).

3 In the dialog box that opens, click **Options** (Figure 2-10).

4 To deactivate **Windows Defender** across the entire system, choose the **Administrator** option. Then deselect the **Use this program** box (Figure 2-11).

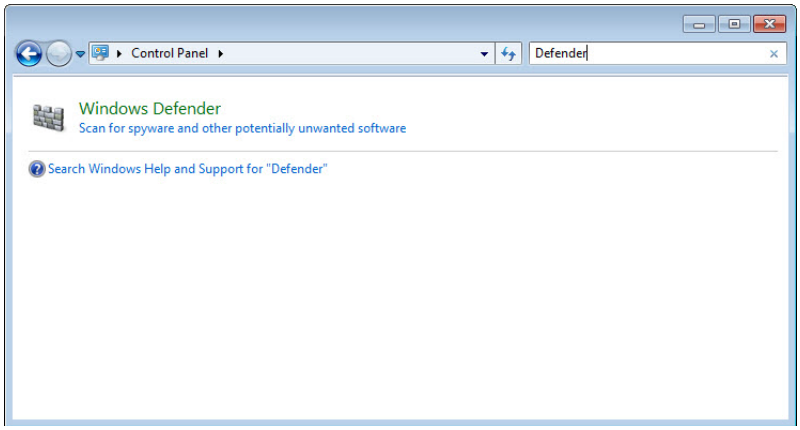


Figure 2-8. Selecting Windows® Defender

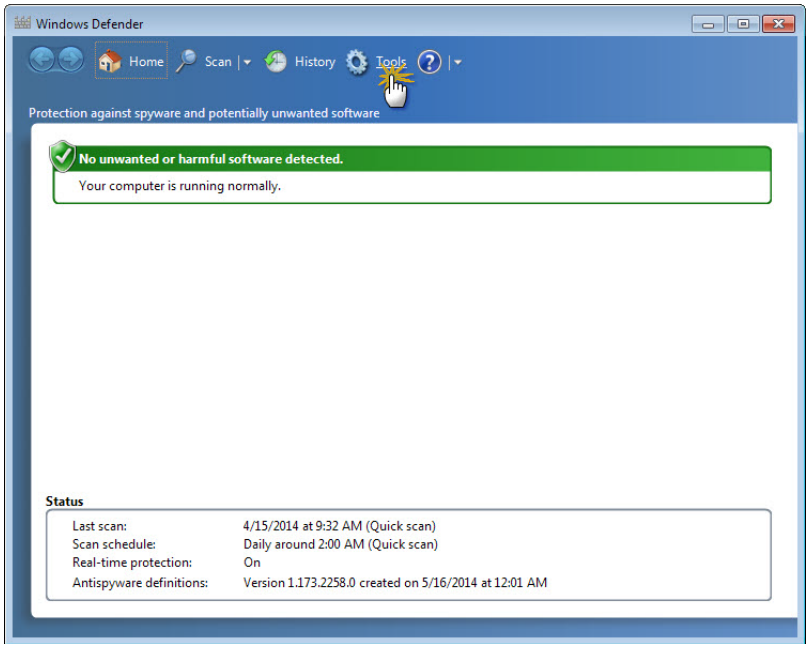


Figure 2-9. Deactivating Windows Defender (B)

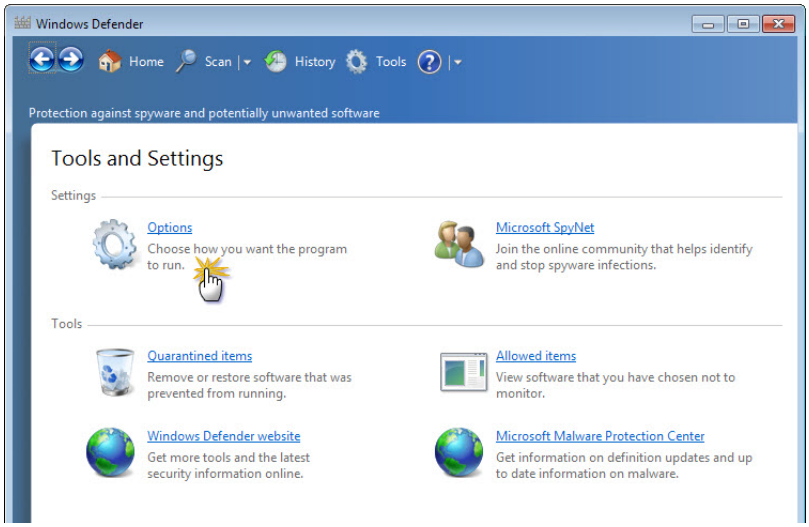


Figure 2-10. Deactivating Windows Defender (C)

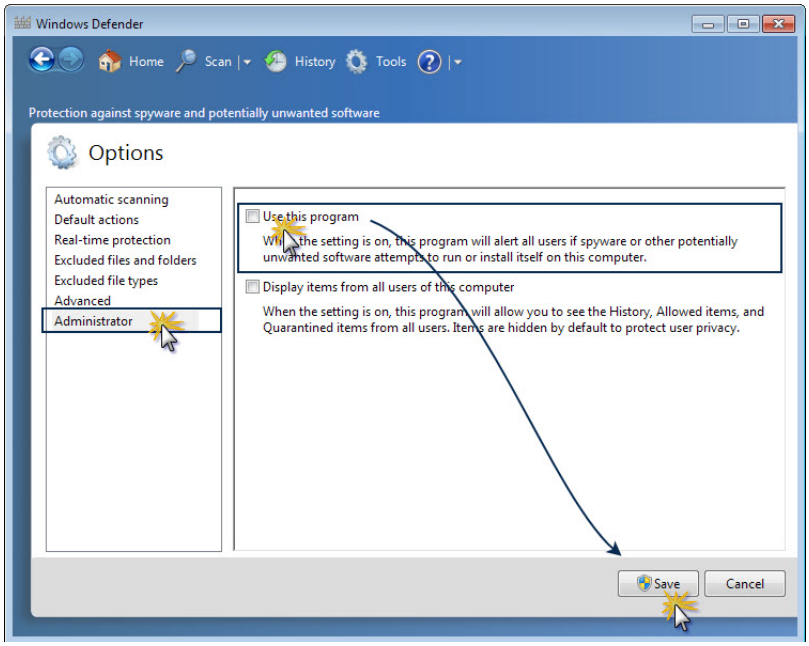


Figure 2-11. Deactivating Windows Defender (D)

2.4 Deactivating automatic defragmentation

You access the defragmentation options directly from the *Start* button. Proceed as follows to deactivate automatic defragmentation:

1 Click *Start* and choose **All Programs › Accessories › System Tools › Disk Defragmenter** (see Figure 2-12).

2 In the *Disk Defragmenter* dialog box that appears, click **Configure schedule** (see Figure 2-13).

3 In the *Disk Defragmenter: Modify Schedule* dialog box that opens, deselect the ***Run on a schedule*** box (see Figure 2-14).

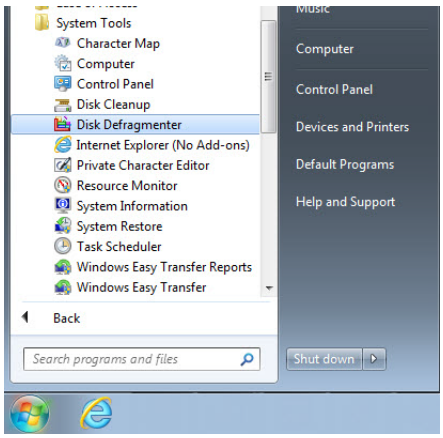


Figure 2-12. Deactivating automatic defragmentation (A)

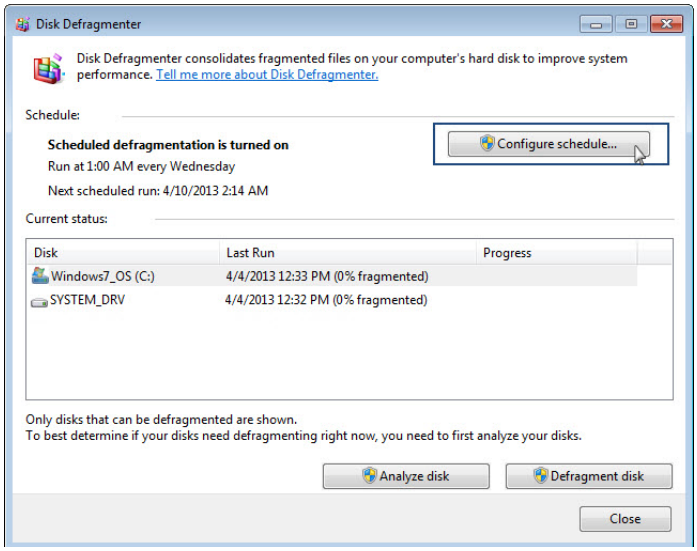


Figure 2-13. Deactivating automatic defragmentation (B)

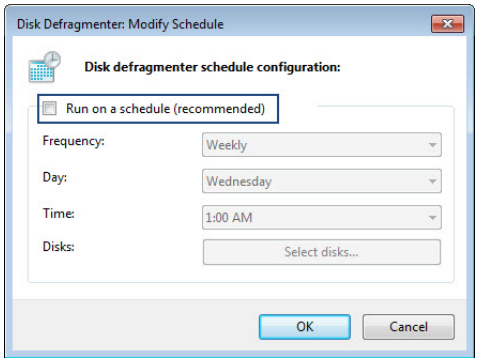


Figure 2-14. Deactivating automatic defragmentation (B)

Chapter 3 Getting started with Recorder

This chapter describes the structure and operation of *Recorder*.

3.1 Starting for the first time and selecting an amplifier

Connect the supplied USB dongle to one of the USB ports of your computer before you start *Recorder*.

Administrator mode: *You must select an amplifier the first time you start the program. This can only be done in administrator mode. There are a number of ways of starting Recorder in administrator mode:*

- You can start *Recorder* by right-clicking on the desktop short-cut and choosing **Run as administrator** from the context menu (see Figure 3-1). (When you run *Recorder* as an administrator, the system prompts you to confirm that you wish to do so. Respond to the prompt by clicking **Yes**.)

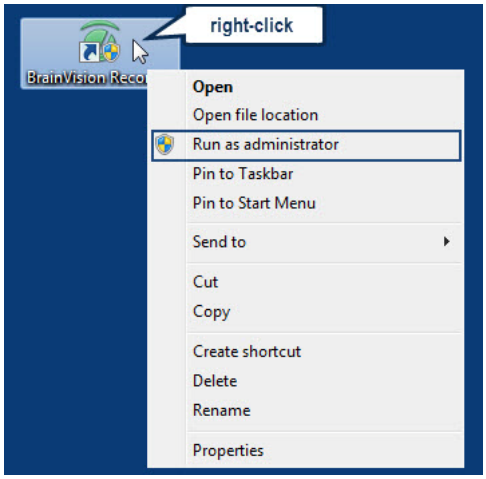


Figure 3-1. Starting Recorder in administrator mode (Windows® 7)

- If you always want to start *Recorder* as administrator, right-click the *Recorder* desktop short-cut, choose **Properties** from the context menu and then open the **Compatibility** tab in the dialog box that appears. Under **Privilege Level**, select the **Run this program as an administrator** box (see Figure 3-2).

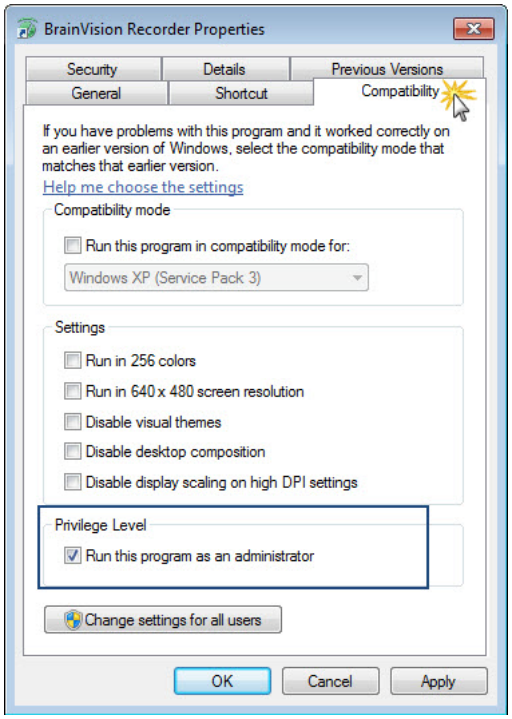


Figure 3-2. Always run Recorder as an administrator

If you start *Recorder* for the first time as a normal user rather than as an administrator, the following message is displayed (see Figure 3-3):

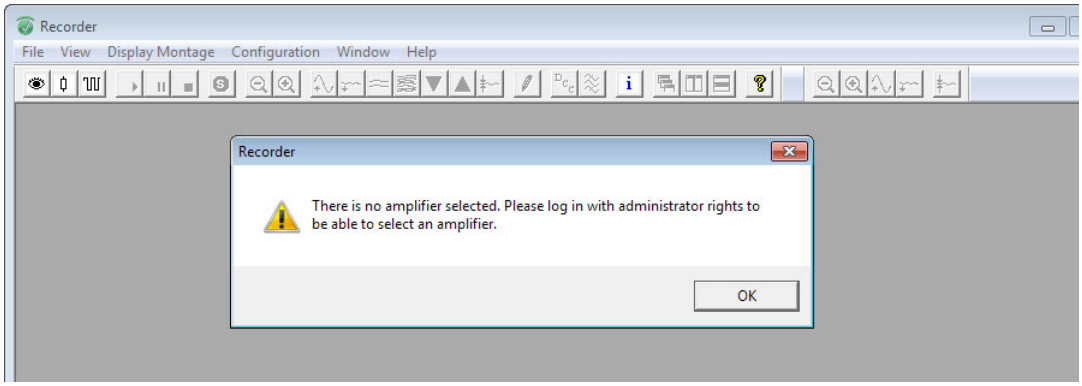


Figure 3-3. Notification message to run Recorder as administrator

To select an amplifier, open the *Select Amplifier* dialog box by choosing **Configuration › Select Amplifier...** from the menu (see Figure 3-4).

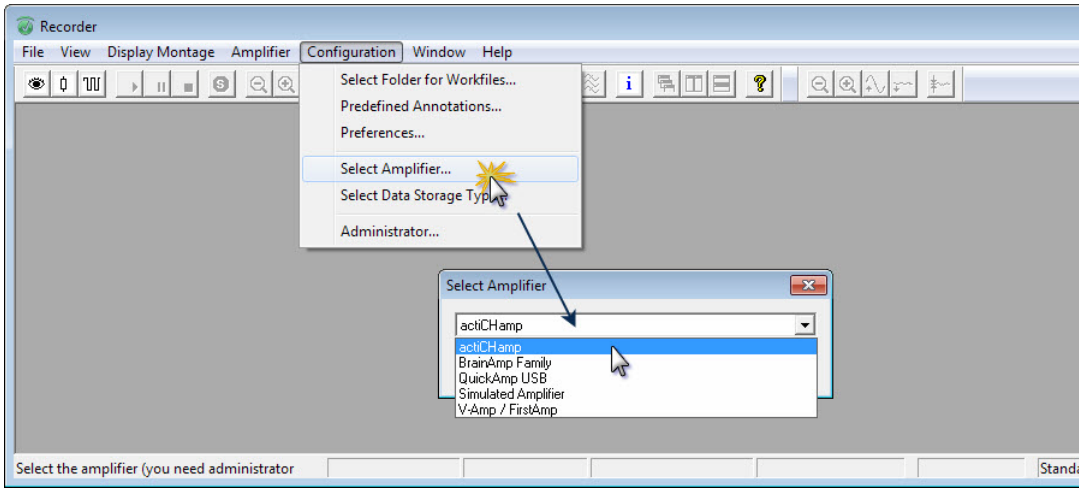


Figure 3-4. Selecting an amplifier

For further details about the administration mode and user rights please refer to Chapter 5.

3.2 Data view (monitoring)

Recorder makes default settings for your amplifier. To check that the amplifier is working properly, first make sure that the amplifier is connected to your computer correctly and is switched on. In *Recorder* toolbar, click on the *Monitor* button in the toolbar. If no errors are encountered, EEG curves appear in *Recorder* window running from left to right (see Figure 3-5).

To close monitoring mode, click the *Stop Monitoring* button in the toolbar. *Recorder* switches to idle mode.

We recommend that you configure your operating system as described in the instructions in Chapter 2 before starting to record data.

Figure 3-5. Monitoring mode

If the message “The setup does not match the amplifier's capabilities!” appears, the current amplifier settings are not compatible with the amplifier you have selected.

To eliminate this problem, follow the instructions for setting up a workspace in Chapter 4.

3.3 The user interface

The menu bar and the toolbar are located at the top of *Recorder* window (see Figure 3-6).

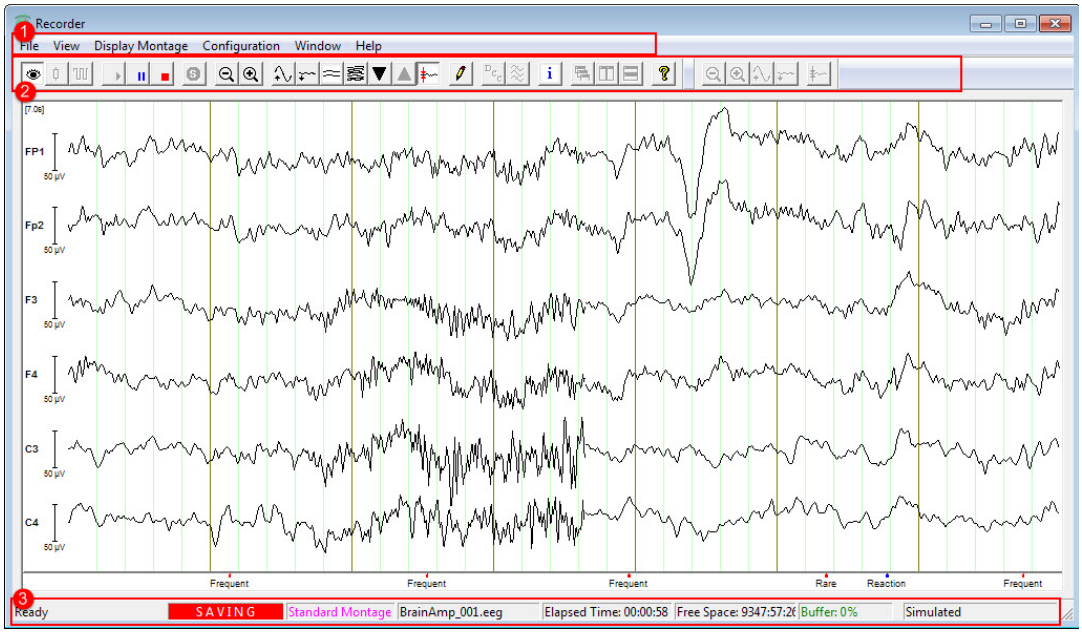


Figure 3-6. User interface: (1) menu bar, (2) toolbar, (3) status bar

Menu bar

The individual menus have the following functions:

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 Amplifier menu does not appear in the menu bar if you have selected the Simulated Amplifier under* **Configuration › Select Amplifier** *(for detailed information on this option, see Section 8.4). Note also that the available options depend on the selected amplifier.*
Configuration	▶ make 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	configure the data windows
Help	display program information and the installed components and to open this user manual

Toolbar

You can make a number of settings in the toolbar. For example, you can define the time interval to be displayed and the number of channels that are displayed simultaneously. 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.)

The toolbar contains the following 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.

For detailed information on the form and size of the test signal please refer to Chapter 8.

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. For details, refer to Section 5.2.

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 Section 6.3).

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 Section 6.2.1. You will find information on performing a DC offset correction in Section 6.2.3.

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.

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 Section 4.2.3). 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*.
For information on setting up a workspace, refer to Chapter 4.

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.

Status bar

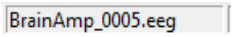
The status bar at the bottom of the window is made up of the following sections:

Program status (or operating mode). There are the following modes:

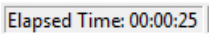
- monitoring
- impedance check
- test signal
- saving
- pause.

The second section shows the type of montage used.

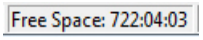
For further information on montages, refer to Section 6.4.



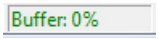
The third section shows the name of the currently open EEG file.



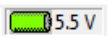
The fourth section shows the elapsed recording time of the currently open EEG file.



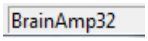
The fifth section shows the amount of free hard disk space in hours. This information is only available when an EEG file is open.



The sixth section shows the utilization of the internal cache as a percentage.



If you are using a BrainAmp or actiCHamp, the following section shows a battery symbol indicating the battery voltage. The charge level of the battery is indicated by a color (green, yellow, red). If the battery indicator shows yellow, you should replace the battery. If the indicator shows red then operation will be automatically terminated after a few minutes in order to prevent the battery from being 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.

Two-pane view

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 (see Figure 3-7). Tabs allow you to switch between the individual groups (see Figure 3-8).

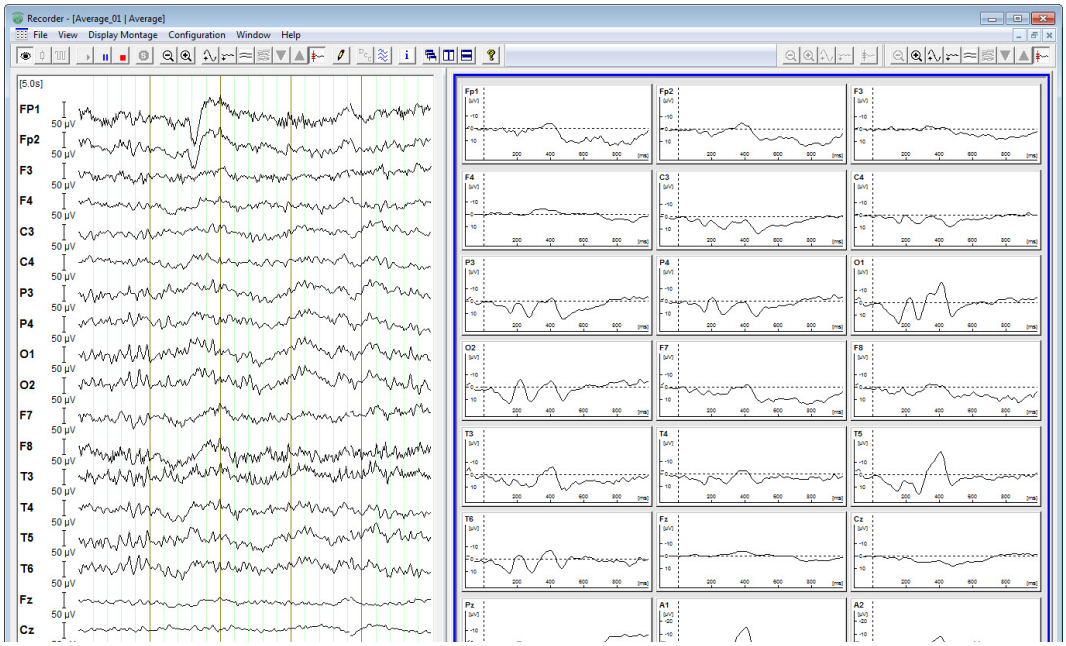


Figure 3-7. Interface with two-pane view

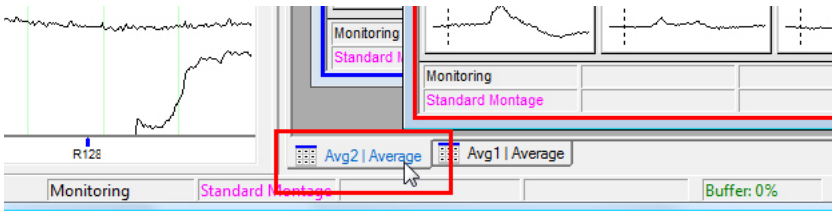


Figure 3-8. Tab for switching between segmentation and averaging groups

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.

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 are displayed and there is enough space, a scaling bar is shown in front of every channel (see Figure 3-9).

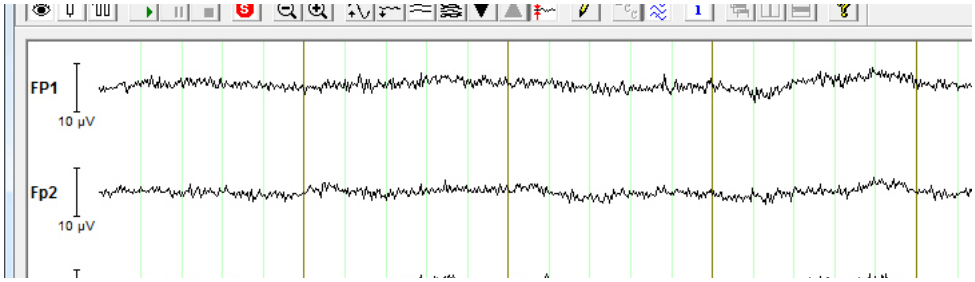


Figure 3-9. Channel names displayed with scaling bar

Markers contained in the data set are shown below the EEG curves, separated by a gray line (see Figure 3-10).

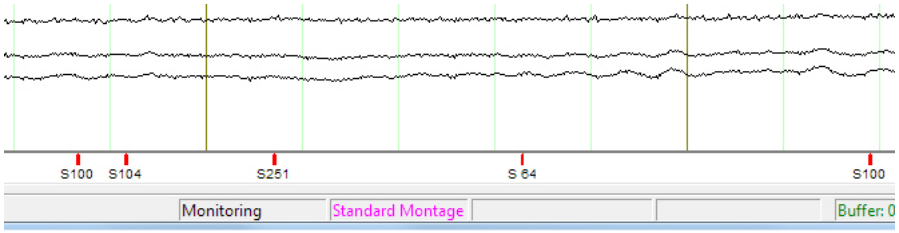


Figure 3-10. Markers displayed

Chapter 4 Setting up a workspace

This chapter describes the concept of a workspace an how to use workspaces.

4.1 Workspace overview

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, however, 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[1]. Also the impedance measurement settings are stored with the workspace (see Section 6.1 and Section 7.4).

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.

The first time you start *Recorder* it creates a default workspace. You can open, edit or create a new workspace from the **File** menu (see Figure 4-1). There are standard workspaces for some EEG caps on the *Application Suite* DVD.

1. The settings under *Select folder for Workfiles...* and *Select Amplifier...* are not stored. Please also refer to Chapter 5 and Chapter 8.

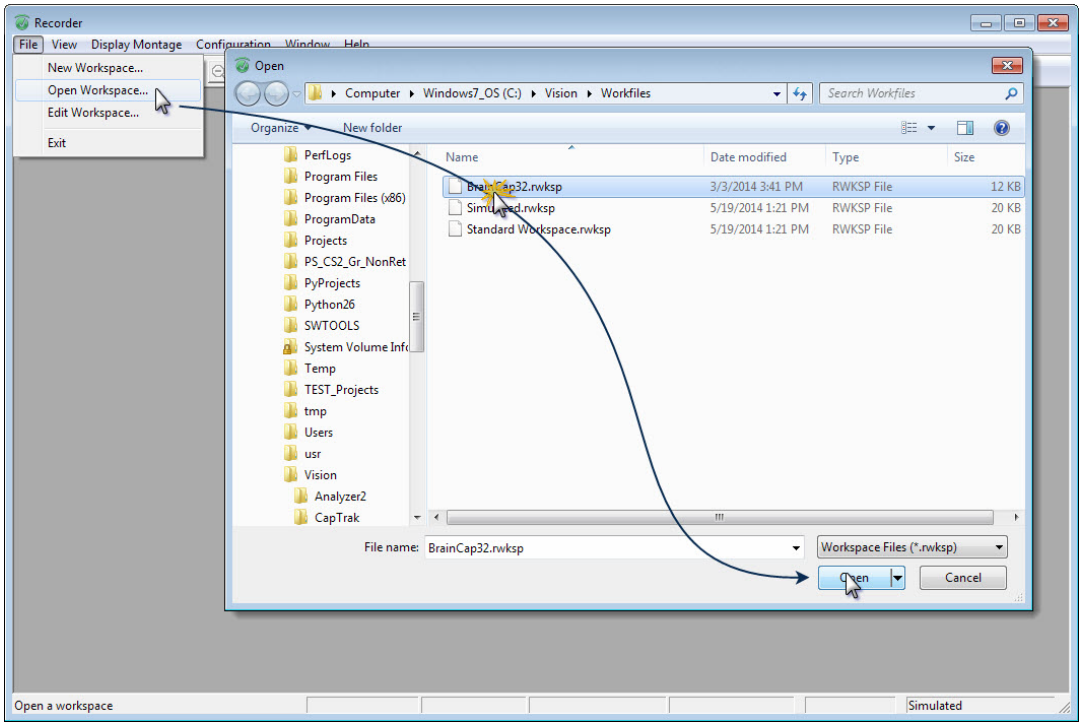


Figure 4-1. Opening an existing workspace

Note

Workspaces that were created in an earlier version of *Recorder* (version 1.10 or earlier) contain only the parameters that were entered using the wizard but not any settings made in the **Configuration** and **Amplifier** menus. If you open this type of workspace in *Recorder* 1.20 or higher then the corresponding parameters are taken over from the last opened workspace.

4.2 Workspace wizard

To open the workspace wizard go to **File › Edit Workspace...** or **File › New Workspace...**

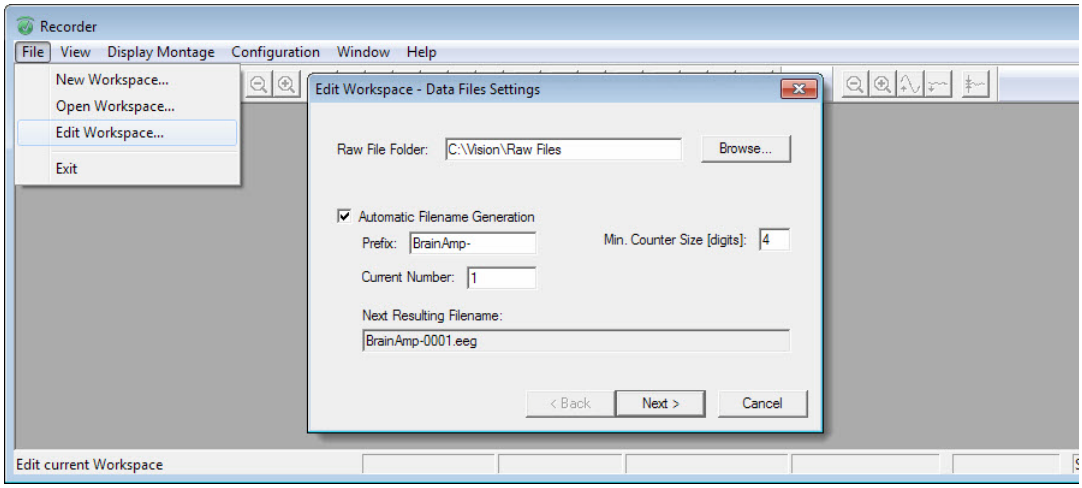


Figure 4-2. Editing a workspace

4.2.1 EEG data-file settings

In the first window of the wizard (*Data Files Settings)* you can make the following settings:

- **Raw File Folder**: specifies the destination directory for the EEG data.
- **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.
- The **Next Resulting Filename** box 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".

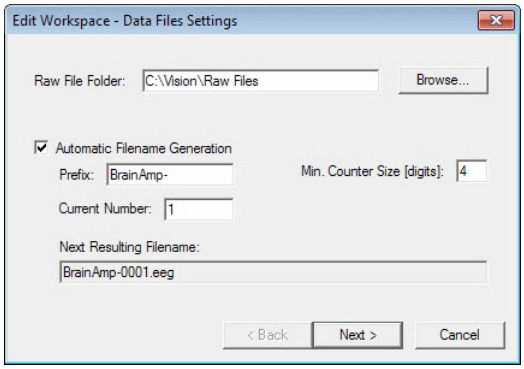


Figure 4-3. Editing a workspace, page 1, "Data File Settings"

Click on **Next** to proceed to the following window *Edit Workspace – Amplifier Settings*.

4.2.2 Amplifier-specific settings using the BrainAmp as an example

The second page contains amplifier-specific parameters. These are described below using the *BrainAmp* as an example.

Note

The following description refers to amplifiers of the *BrainAmp* family. The functions for selecting virtual amplifiers and for inserting and removing channels are only available for *BrainAmp* amplifiers.

You will find information on the settings you can make for the other amplifiers in the relevant sections of Chapter 8.

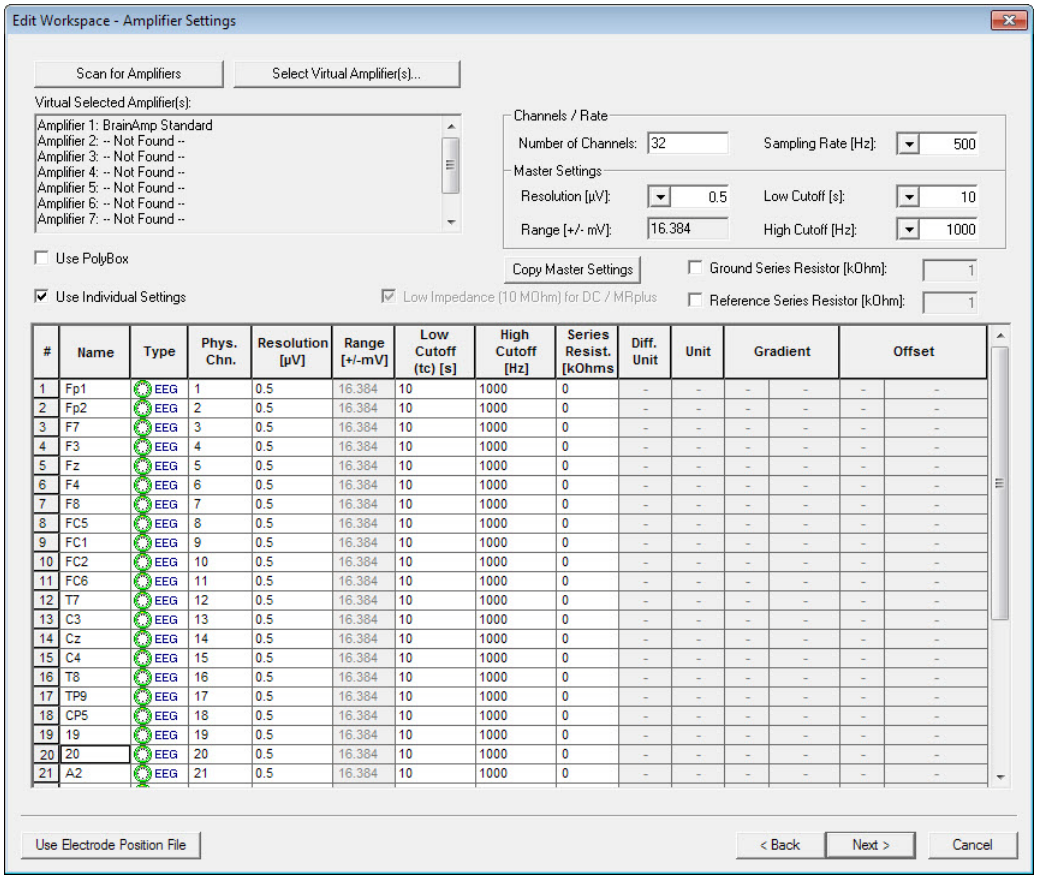


Figure 4-4. Editing a workspace, page 2, "Amplifier Settings" for BrainAmp amplifiers

Selecting an amplifier

The **Scan for Amplifiers** and **Select Virtual Amplifier(s)...** buttons offer you two options for selecting amplifiers, editing their parameters and configuring their workspace.

- **Scan for Amplifiers** only works, when you have connected an amplifier to your computer. Recorder can detect several amplifiers, that will be displayed in the *Scanned Amplifier(s)* list (see Figure 4-5).

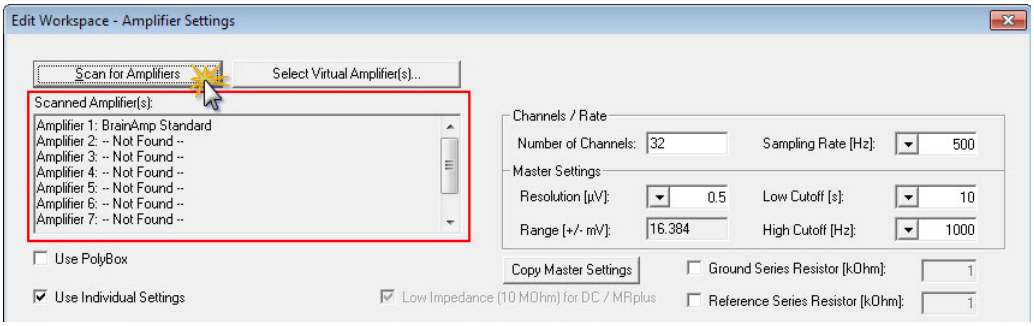


Figure 4-5. List of connected amplifiers

- **Select Virtual Amplifier(s)...** function allows you to select an amplifier of the *BrainAmp* family and configure and edit workspaces without an amplifier actually being connected to your computer.
  In the *Select Virtual Amplifier(s)* dialog (Figure 4-6) you can select amplifiers that you want to use for your virtual recording.
  Add amplifiers from the left list by double-clicking on the amplifier or clicking on ›. To remove an amplifier from the right list click on ‹ or double-click. Use the ↑ and ↓ buttons to set the order of the amplifiers.

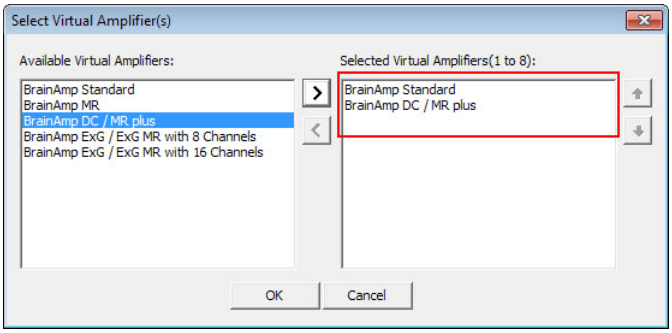


Figure 4-6. Selecting virtual amplifiers (BrainAmp)

Click **OK**. The workspace is then automatically updated.

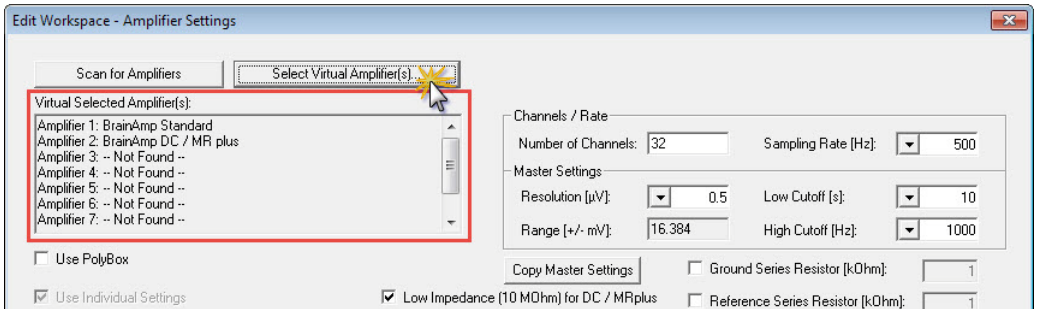


Figure 4-7. Listing the selected virtual amplifiers (BrainAmp)

Amplifier settings

After you have selected an amplifier in a workspace, you can make the amplifier-specific settings (compare Figure 4-4). The parameters and permitted ranges depend on the amplifier you have selected.

Following settings are available:

Number of Channels	Specify the number of channels.
Sampling Rate [Hz]	Choose the sampling rate from the drop-down list.
Resolution [µV]	Select an amplitude resolution from the drop-down list.
Range [+/- mV]	The mV range specifies the range across which the amplifier sends data to *Recorder*.
Low Cutoff [s] **High Cutoff [Hz]**	Specify the low and high-cutoff filters.
Low Impedance (10 MOhm) for DC/ MRplus	The checkbox *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).
Use Individual Settings	If your amplifier permits individual settings to be made for each channel, you can select the *Use Individual Settings* box. This allows you to make the relevant settings separately for each channel in a table.
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.

Use PolyBox

If a *PolyBox* is connected, it is enabled by selecting this box. If you attach the *PolyBox*, you can increase the number of channels in the **Number of Channels** text box by up to 8. The corresponding number of AUX channels is added at the end of the channel list (see Figure 4-8).
Notes:
a) Simultaneous use of the PolyBox and the ExG AUX Box is not supported. You are not able to configure the settings of the PolyBox if you are using a virtual amplifier.
b) When used in conjunction with the BUA64 and one or more BrainAmp amplifiers, the PolyBox permits the additional, simultaneous recording of up to eight polygraph signals captured by sensors for the display of status changes.

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 (see Figure 4-9).

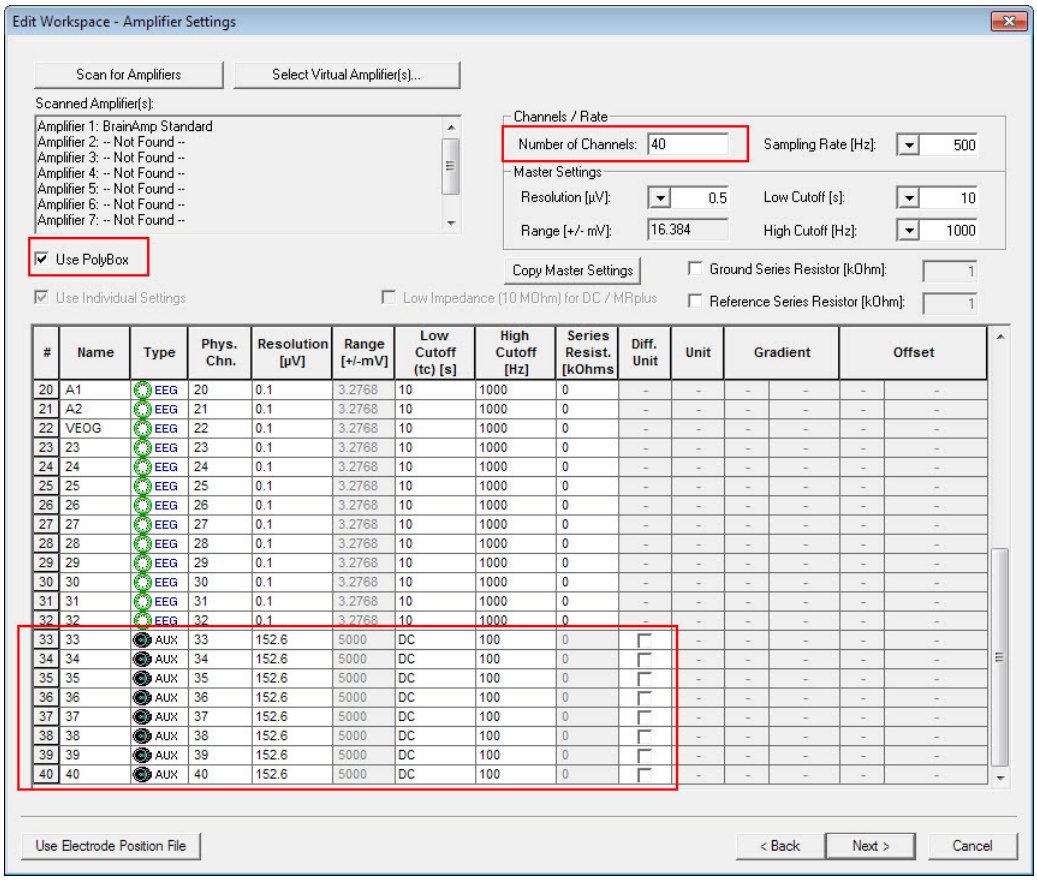


Figure 4-8. Selecting the PolyBox and adjusting the number of channels

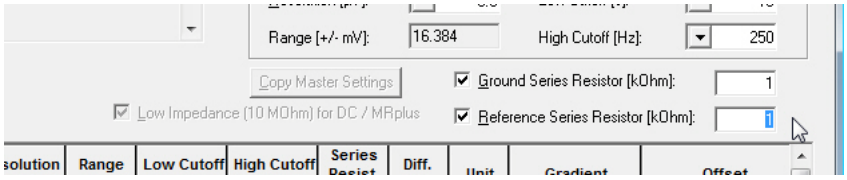


Figure 4-9. Protective resistors for the ground electrode and reference electrode

Adding and removing channels

If you wish to insert a channel in the channel table or remove a channel from the channel table, right-click in the relevant row. This opens a menu (see Figure 4-10).

Note

The functions for inserting and removing channels are only available for amplifiers of the *BrainAmp* family.

The first two entries of this menu allow you to insert or remove a channel without changing the names and numbers of the subsequent physical channels.

Click the **Insert Channel** command to insert a channel.

Remove Channel... removes the corresponding channel. When you choose this command, you are asked to confirm whether you really want to remove the channel. The command is not available if the table only contains one channel.

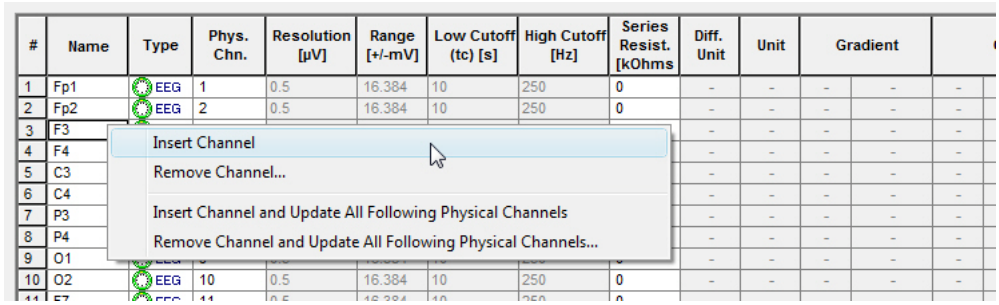


Figure 4-10. Inserting and removing channels for BrainAmp amplifiers

If you wish to update the names and numbers of the subsequent channels, choose **Insert/Remove Channel and Update All Following Physical Channels**. The physical channel index of the subsequent channels is incremented 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.

The channel table allows you to make the following settings:

Column	Setting
Name	Enter a channel name. **Notes** If you enter the same name twice, an error message appears when want to proceed to the next workspace page. This considerably facilitates reconfiguration of the workspace. The **Name** column is not available for *QuickAmp PCI*, *NI 6071e A/D* converter board and *Simulated Amplifier*.
Type	Specify the channel type (EEG, BIP, AUX).
Phys. Chn.	Assign physical channels to the logical channels in the first column provided that your amplifier permits this. **Note** Assignment of the channels in this way makes sense, for instance, if you are working with an electrode cap but only wish to work with selected electrodes of the cap.
Resolution [µV]	Enter the signal resolution.
Range [+/- mV]	This column contains the range across which the amplifier sends data to *Recorder*.
Low Cutoff [s]	Enter the low-cutoff filter.
High Cutoff [Hz]	Enter the high-cutoff filter.
Series Resist. [KOhms]	Enter the resistance of the protective resistors installed in the electrode cables. **Note** These details are only required for *BrainAmp 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.

Table 4-1. Settings in the channel table

4.2.3 Filter settings

You can set the filter parameters for the individual software filter paths on the *Edit Workspace – Software Filters* page (see Figure 4-11). Three separate filter paths are available:

- Filtering of the raw data to be saved (*Raw Data Saving Filters* tab)
- Filtering of all data used for segmentation/averaging (*Segmentation Filters* tab)

- Filtering of the displayed data (*Display Filters* tab)

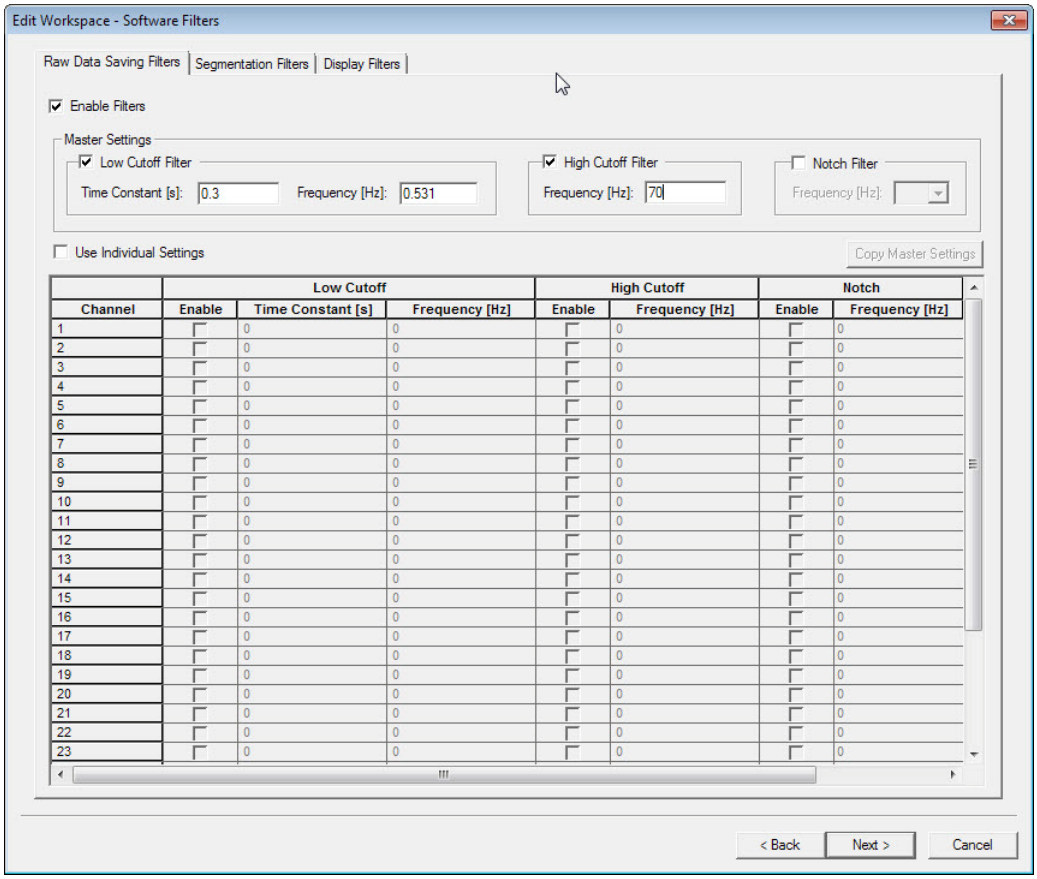


Figure 4-11. Configuring the software filters

You can apply this setting to the channels as a group or to individual channels by selecting or deselecting the **Use Individual Settings** box. You can also deactivate the paths completely by deselecting the **Enable Filters** 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.

The slope for the low-cutoff filter (**Low Cutoff Filter**) and the high-cutoff filter (**High Cutoff Filter**) is 12 dB/octave.

Click the **Next** button to proceed to the *Segmentation/Averaging* page.

4.2.4 Segmentation and averaging

The *Edit Workspace – Segmentation/Averaging* dialog page 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 6.5.

When you have finished making your settings, a dialog box opens allowing you to save the workspace file (see Figure 4-12). Give the file a meaningful name and press the Enter key or click **Save**.

4.2.5 Saving the workspace

For all amplifier families except the *Simulated Amplifier* you are prompted to save the edited workspace after you have finished editing (see Figure 4-12). By default, the workspace to be saved has the same name as the active workspace. If you do not change this name, the following warning appears:

"???.rwksp already exists. Do you want to replace it?".

You can change the name of the workspace or confirm that the workspace is to be replaced. If you choose to replace the workspace, the old workspace is overwritten.

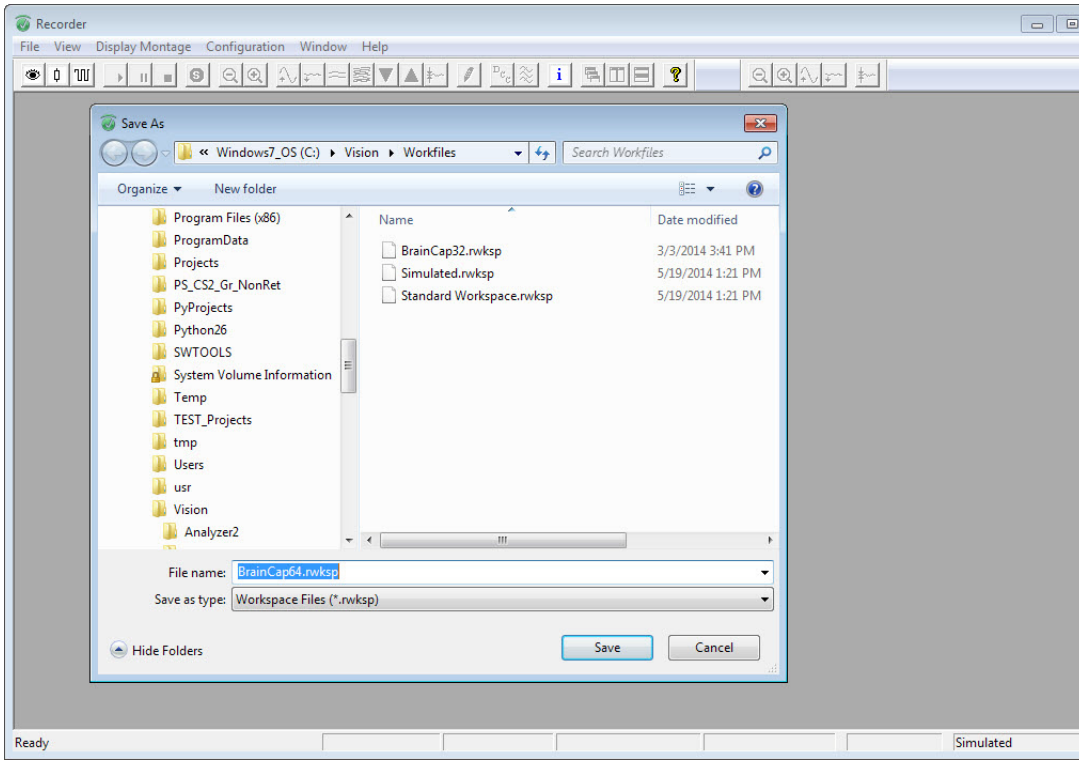


Figure 4-12. Saving the workspace

Choose **File › Edit Workspace...** from the menu to modify the workspace. You can view the parameters of the current workspace at any time – even during recording – by clicking the *Show Workspace Info* button in the toolbar.

You will find a description of the basic functions of *Recorder* in Chapter 6. Amplifier-specific properties such as test signal values and digital port settings are described in Chapter 8.

4.3 Electrode position file

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)[1] 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 4-13. 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*.

Note

You can use the import function to create a new workspace or modify an existing workspace.

1. EPF: Electrode position file

4.3.1 Creating a workspace from the Electrode Position File (EPF)

The creation of workspaces based on an EPF (electrode position file) is recommended if you want to set up your own workspace but this does not yet contain any electrode position data. Proceed as indicated below to read the electrode positions into an empty workspace.

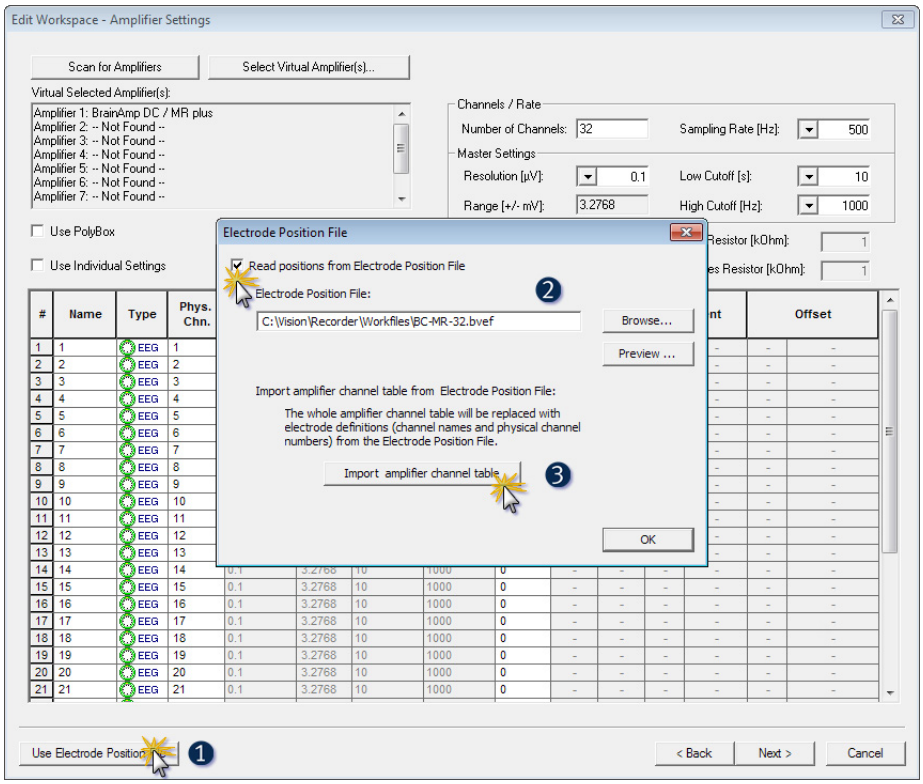


Figure 4-14. Creating a workspace from an electrode position file

Scan for the amplifier and specify the number of channels. Then do the following:

1 In the workspace, click on **Use Electrode Position File**.

2 In the *Electrode Position File* window do the following:

- ▷ Select the **Read positions form Electrode Position File** check box**.**
- ▷ Browse the electrode position file (BVEF format).

If you are not sure how many channels the electrode position file contains, you can click on **Preview...** If necessary adapt the number of channels in the workspace.

3 Click on **Import amplifier channel table** and then on **OK.**

The data from the electrode position file is loaded into the channel table (Figure 4-15). Thus, *Recorder* takes over the channel names and physical channel assignments together with the topographies.

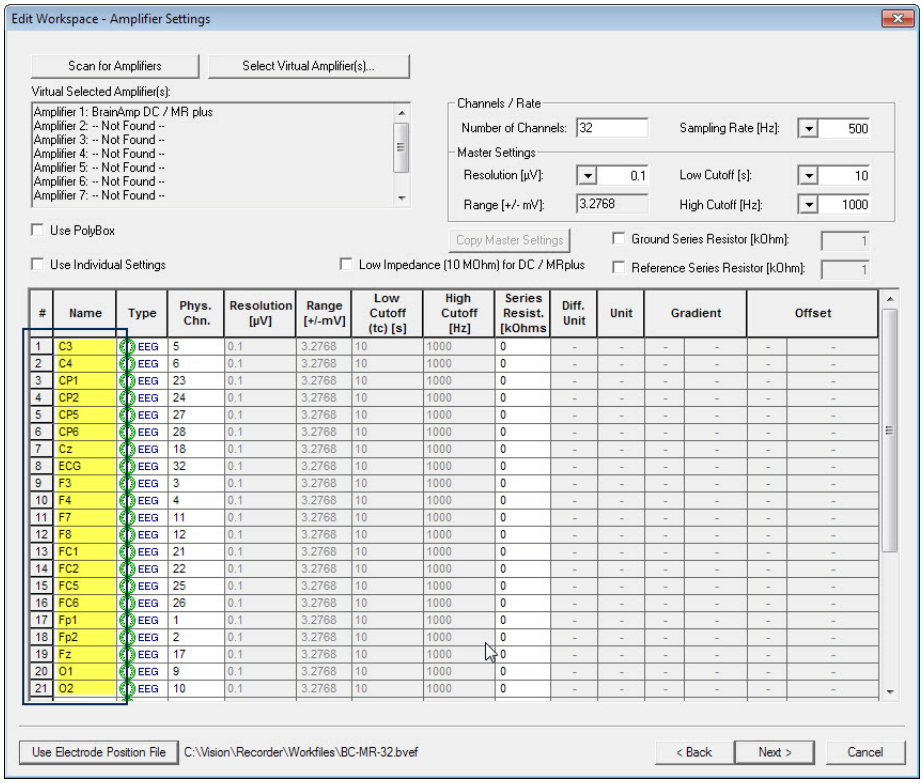


Figure 4-15. Read-in electrode position file

Note

Recorder imports the complete data set from the electrode position file. If you specify less channels than in the electrode position file, the exceeding channel data will be lost.

If specify more channels than in the electrode position file, the remaining channels will stay unoccupied. You can remove the unoccupied channels, if necessary.

4.3.2 Importing electrode positions

You can load new electrode position data into an existing workspace, for example if you want to combine another electrode cap with the same amplifier. Since the channel names of the existing workspace are already assigned to physical channels, you only have to load the new topography from the electrode position file. This operation does not modify the physical channels.

To import the electrode positions from a file, do the following:

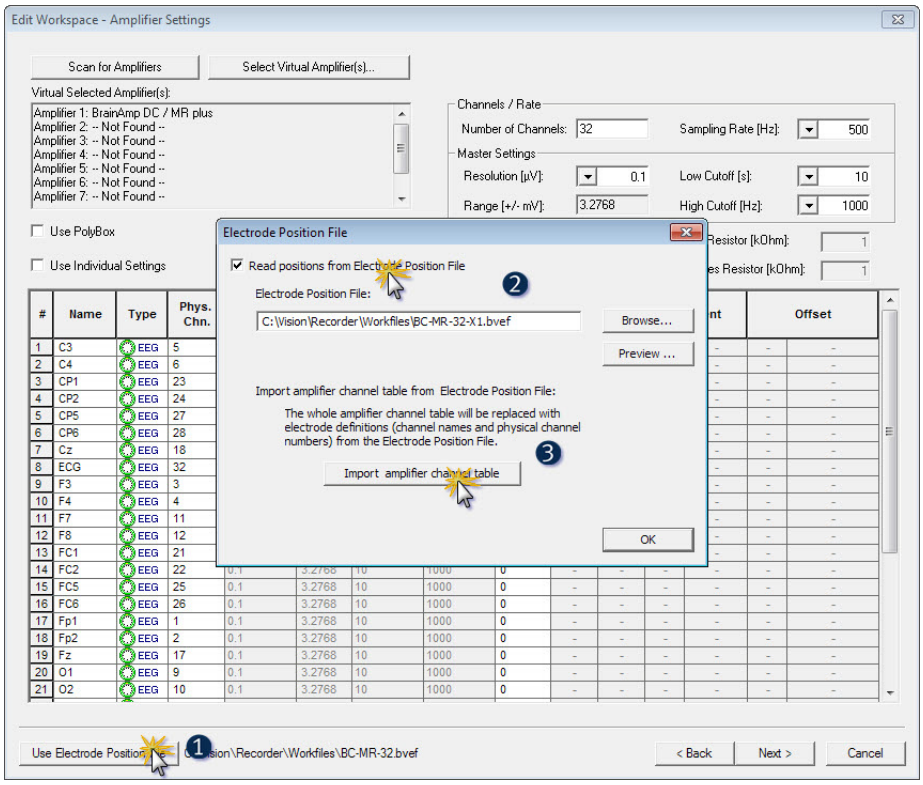


Figure 4-16. Importing an electrode position file

In an existing workspace, do the following:

1 Click on **Use Electrode Position File**. This opens the *Electrode Position File* dialog.

2 In the *Electrode Position File* window do the following:

- ▷ Select the **Read positions form Electrode Position File** check box**.**
- ▷ Browse the electrode position file (BVEF format).

  If you are not sure how many channels the electrode position file contains, you can click on **Preview...** If necessary adapt the number of channels in the workspace.

3 Click on **Import amplifier channel table** and then on **OK.**

  The data from the electrode position file is loaded into the channel table (Figure 4-15). Thus, *Recorder* takes over the channel names and physical channel assignments together with the topographies.

If the file contains no corresponding data for electrodes that are specified in the workspace, a message appears (Figure 4-17). The missing electrodes are set to zero and will be displayed at the edge during impedance measurement.

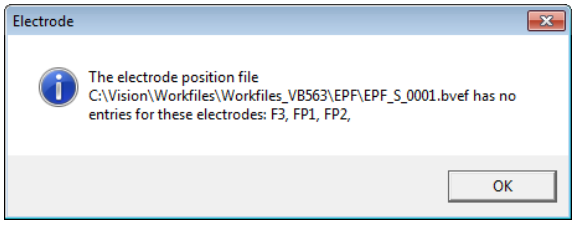


Figure 4-17. Example information message

Notes

- The electrodes are automatically assigned to physical channels.
- The imported electrode data is taken over into the channel table and is displayed in the correct topography for the impedance measurement (see Chapter 6.1). If there is no data corresponding to certain electrodes that are present then these electrodes appear at the edge during the impedance measurement.
- Any changes to electrode positions during the impedance measurement are not written to the original electrode position file.

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

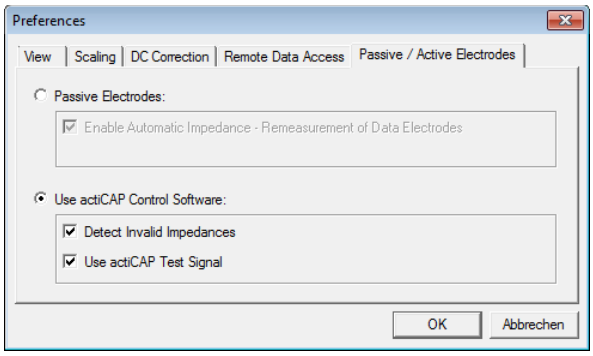


Figure 4-18. Settings when using the actiCAP control software

4.3.3 Terminating the import

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. If you do not want it to do this, proceed as described below.

Click on **Use Electrode Position File**, deselect the **Read positions from the Electrode Position File only** check box and click **OK**.

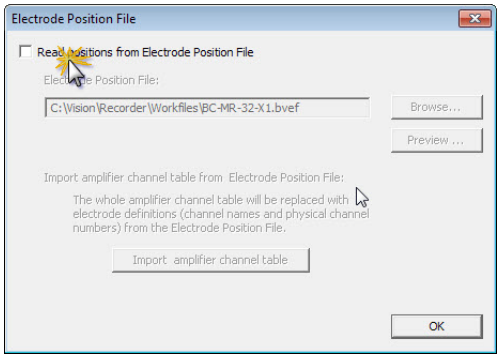


Figure 4-19. Preventing the use of an electrode position file

Chapter 5 Program configuration

This chapter provides information on configuring the user-specific settings.

Recorder can be started in administrator mode or standard user mode. Depending on the mode and granted rights, some functions might not be available. For details on how to start *Recorder* in the two modes, please refer to Chapter 3.

5.1 Administrator mode

When you start *Recorder* in administrator mode, all the entries in the **Configuration** menu are available.

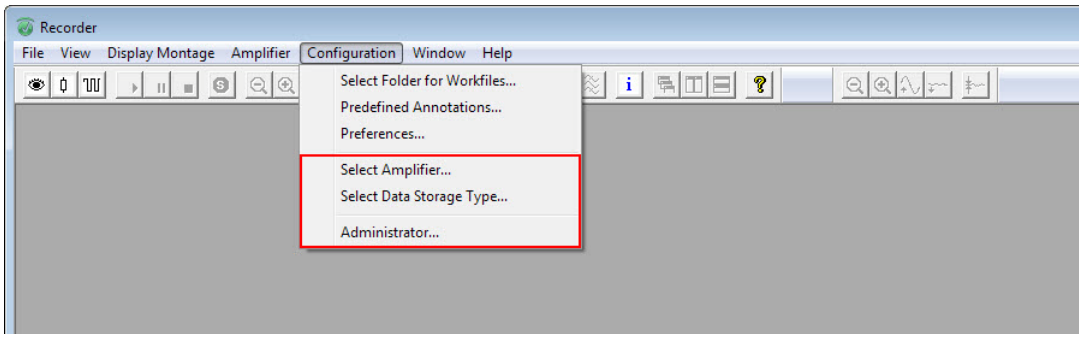


Figure 5-1. "Configuration" menu in Administrator mode

You can use the administrator mode to setup the rights for standard users. The following functions are only available to users with administrator privileges:

Select Amplifier... to change the amplifier.

Select Data Storage Type... contains the data format in which the data is to be stored.

Administrator... opens the *Administrator* dialog.

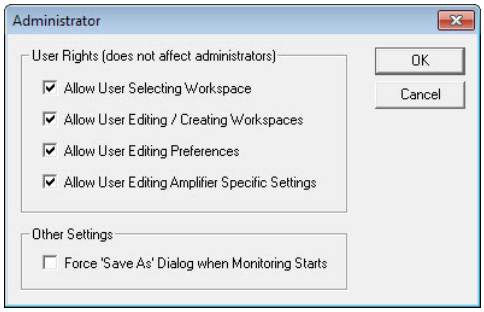


Figure 5-2. "Administrator" dialog box

In the **Administrator** dialog you can limit the following access rights (see also Section 5.2):

Allow User Selecting Workspace specifies whether normal users are permitted to select a workspace.

Allow User Editing/Creating Workspaces specifies whether normal users are permitted to edit existing workspaces and create new ones.

Allow User Editing Preferences specifies whether normal users are permitted to configure the user settings.

Allow User Editing Amplifier Specific Settings enables or disables the items in the **Amplifier** menu.

If you select the **Force 'Save As' Dialog when Monitoring Starts** box, the **Start/Resume Recording** button is implicitly activated every time the EEG view is called, thus causing the *Save* dialog box to open.

5.2 Configuring the user settings (Preferences)

If you have administrator or restricted user permissions, you can configure the following user settings in the **Configuration › Preferences...** dialog:

- *Scaling*
- *DC Correction*
- *Remote Data Access*
- *Passive/Active Electrodes*
- *View*
- *Vision Video*

Scaling settings

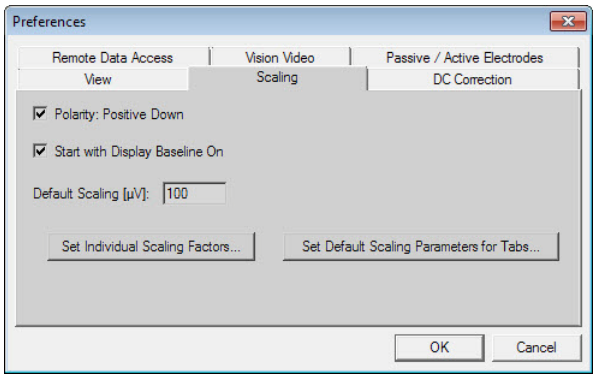


Figure 5-3. Setting the scaling

The *Scaling* tab contains the following functions:

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 baseline correction in the EEG view.

Default Scaling [µV] text box contains the scaling value to be used when monitoring starts.

Set Individual Scaling Factors... specifies channels that are to be displayed attenuated. In the table, enter the channel names and the associated scaling factors by which you want to reduce the scale of the signals (Figure 5-4). The attenuation only affects the display of the data; it does not affect the data itself.

It makes sense to display the ECG channels attenuated, since otherwise they encroach significantly on the curves of the EEG channels.

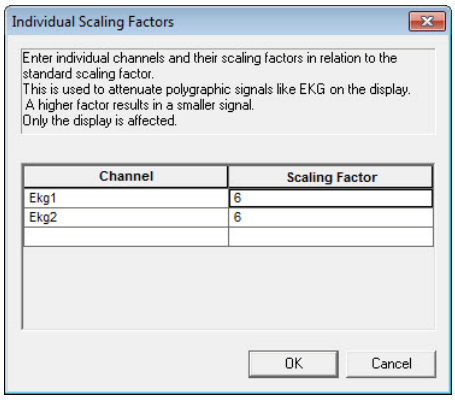


Figure 5-4. Entering scaling factors

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 (see Section 6.3.2).

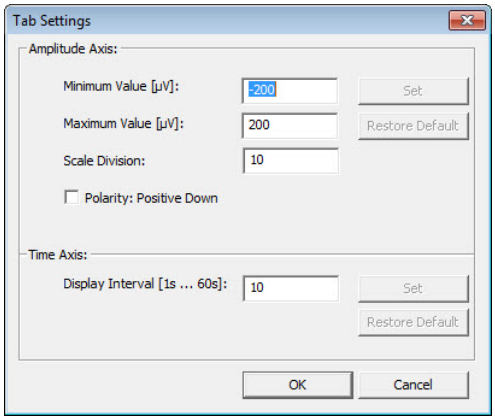


Figure 5-5. Entering the scaling of the axes for the scientific view

DC correction

Select the **Automatic DC Correction** box to activate automatic DC offset correction. The **Threshold [%]** text box is used to specify the threshold (as a percentage) at which DC offset correction is performed. For further information on DC correction, refer to Section 6.2.3.

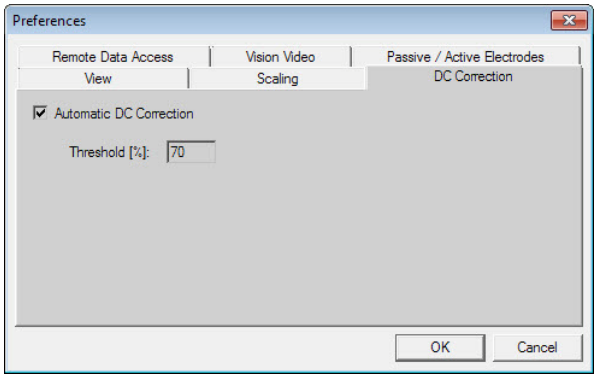


Figure 5-6. Setting automatic DC offset correction

Remote Data Access (RDA)

Select the **Enable Remote Data Access** box to enable the RDA server. For further information on using the RDA server, refer to Section 11.

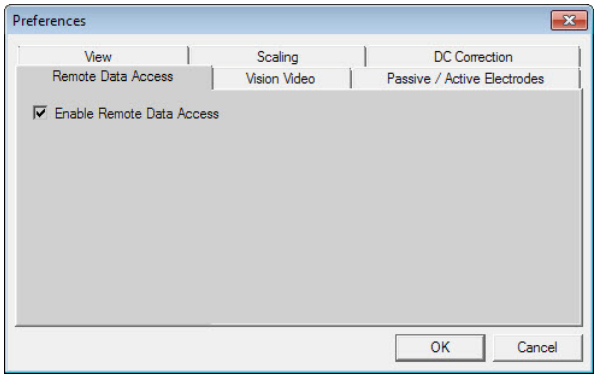


Figure 5-7. Activating the RDA server

View

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.

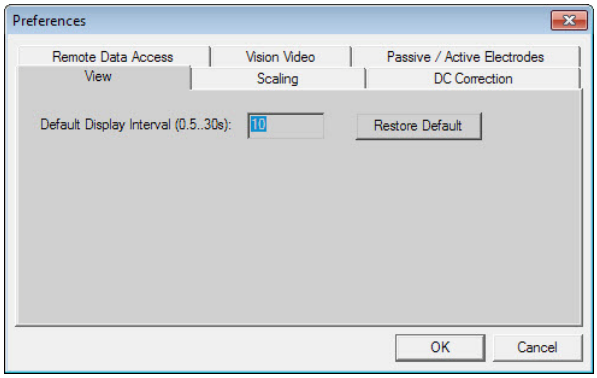


Figure 5-8. Configuration of the time interval to be displayed

Passive/Active Electrodes

The *Passive/Active Electrodes* tab allows you to specify whether you are using passive electrodes or the active electrodes of the *actiCAP* active electrode system.

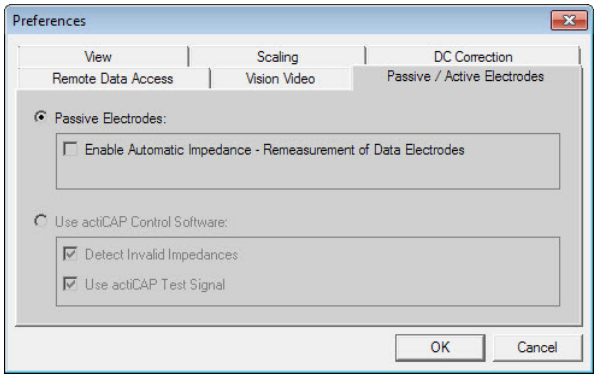


Figure 5-9. Settings for passive or active electrodes

Select **Passive Electrodes** when you are using passive electrodes. Selecting the **Enable Automatic Impedance-Remeasurement of Data Electrodes** box allows you to subsequently repeat measurement of the impedances of the EEG electrodes if the measured values are not within the valid range. This applies to all electrodes with the exception of the reference and ground electrode. Invalid impedances are present if the electrodes have not yet been measured or if the impedances are outside the measurement range.

If invalid impedances are still present after this subsequent measurement has been carried out, a warning is issued for each electrode group (EEG electrodes, reference electrode and ground electrode) (Figure 5-10). Recording is resumed if you click **Yes**.

If, for example, you are performing combined EEG-fMRI measurements, you can choose **No** to cancel recording and prevent high-resistance electrodes from being damaged or destroyed.

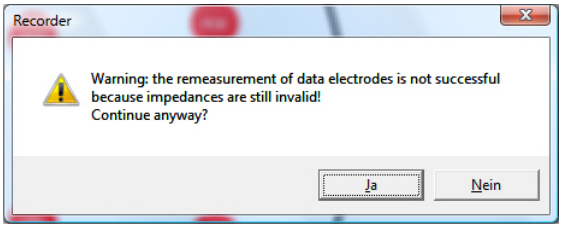


Figure 5-10. Warning in the event of invalid impedances (of EEG electrodes)

You will find further information on the test signal for active electrodes in Section 7.5.

If you are using the active electrodes of the *actiCAP* active electrode system, you can use the interface to the *actiCAP ControlSoftware* by selecting the **Use actiCAP Control Software** option.

If you select the **Detect Invalid Impedances** box, you will receive a message (Figure 5-10) where you can allow or disallow invalid impedances.

You can also use the *actiCAP* test signal by selecting the **Use actiCAP Test Signal** box (selected by default). This automatically controls the *actiCAP ControlSoftware* without the need for you to call it separately. If you choose this option, the **Test Signal** button in the *Recorder* toolbar is disabled. Use the **Test** button on the *actiCAP ControlBox*.

Video function

If you have purchased a video license and have installed the *Video Recorder* correctly, the additional tab *Vision Video* is available.

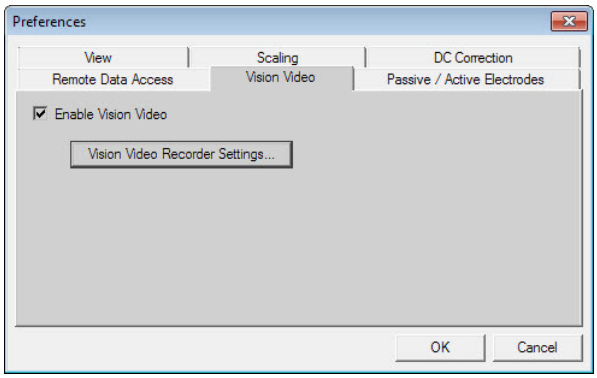


Figure 5-11. Activating the video function

For information on the functions available and how to use the *Vision Video* option, refer to Chapter 10. You will find information on purchasing and installing the video license in Appendix C.

Chapter 6 Basic functions

This chapter describes the basic functions of the software such as impedance measurement, the recording and display of data, the use of montages etcetera.

6.1 Impedance measurement

If your amplifier features built-in impedance measurement, you can carry out such measurements using *Recorder*. To do so, click the *Impedance Check* button in the toolbar.

A top view of a representation of a head appears (Figure 6-1). A number of controls are located to the right of the *Impedance Check View*. If your electrodes are numbered according to the 10-10 or 10-20 system, they are shown automatically on the head. It is possible to show up to 256 standard positions. If this is not the case, the electrodes are arranged at the top right of the window.

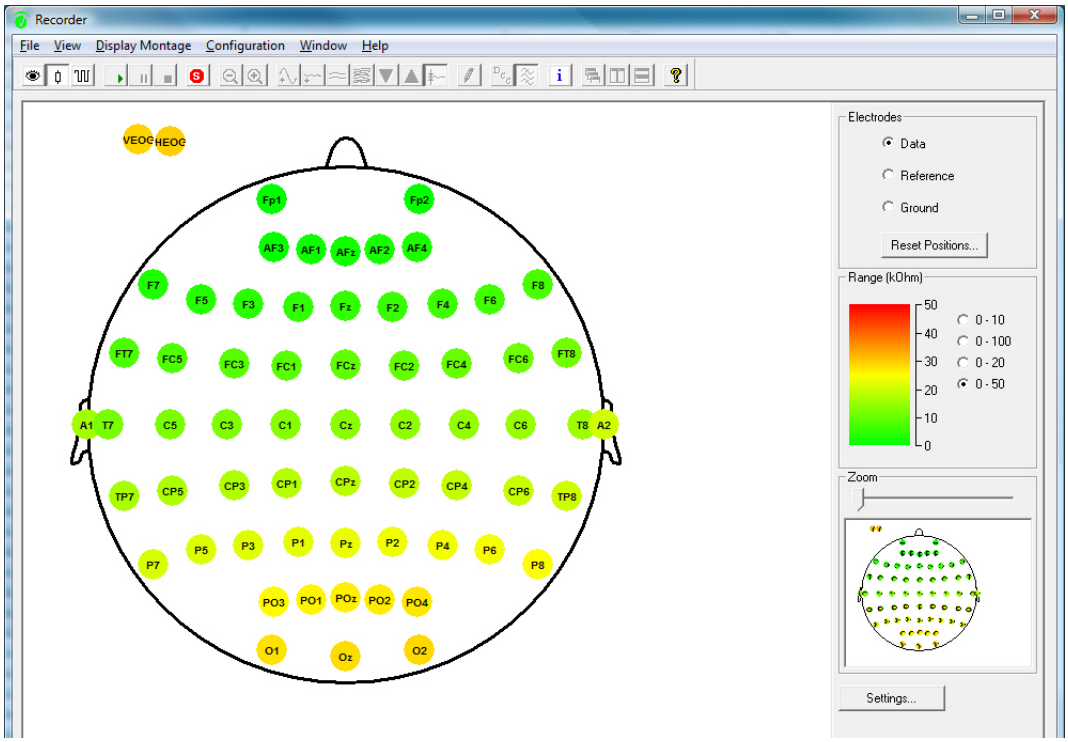


Figure 6-1. Impedance Check View

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). The *Electrodes* group allows you to select different electrode groups for which data is to be determined. The groups and their names depend on the amplifier you are using. Click on **Reset Positions...** to reset the electrodes to their initial positions.

Depending on the amplifier and the selected electrode group, you can configure different impedance ranges (measurement ranges) in the *Range (kOhm)* group. The impedances of the electrodes are color-coded in accordance with the swatch.

As of Version 1.20 of *Recorder*, two measurement ranges are available to you by default for the reference and ground electrode: from 0 through 10 kOhm and from 0 through 100 kOhm.

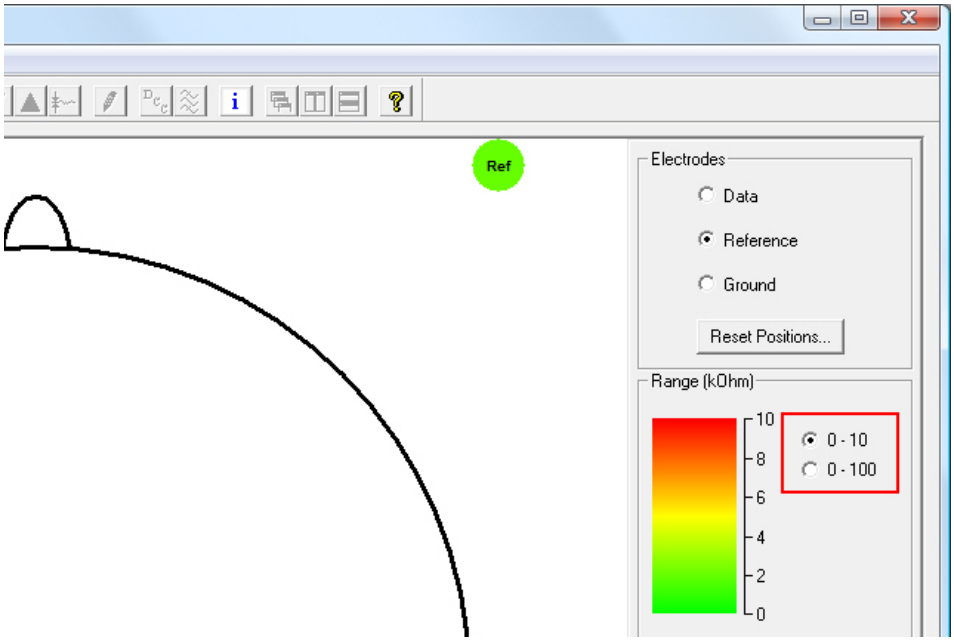


Figure 6-2. Impedance value scale for the ground and reference electrode

If you are using a large number of electrodes, you can use the slider control in the *Zoom* group box to select the region of the head to be shown. The red square in the electrode view below defines the region shown in the view. You can also move the rectangle using the mouse.

Clicking the **Settings** button opens the *Impedance Check Settings* dialog (Figure 6-3). Here you can define your own measurement ranges, the colors used, the color steps and an optional background bitmap.

For each electrode group, you can select up to ten measurement ranges in the *Ranges* group.

The *Impedance Color Coding* group allows you to define the color coding. You can choose a color gradient

- from green through yellow to red
- from blue through turquoise, green and yellow to red

- from black to white

Instead of a continuous color gradient between the minimum and maximum impedance value, you can change the colors in discrete steps. Do this by checking the **Discrete Color Steps** box. In addition, you can enter the number of color steps in the **Number of Steps** text box.

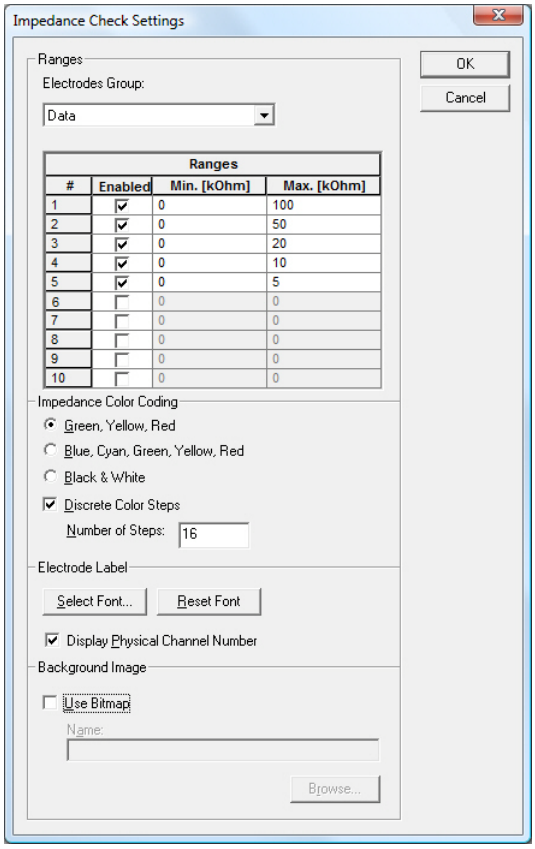


Figure 6-3. Defining the measuring ranges and colors

Click the **Select Font...** button to open a dialog box in which you can select the font used. The selected font is saved in the current workspace. Click **Reset Font** to reset the settings you have made to the default settings. Note that the font size is not automatically adjusted in zoom mode.

If you select the **Display Physical Channel Number** box, the numbers of the physical channels are also displayed in addition to the position (Figure 6-4). This setting is saved in the current workspace.

All families of amplifiers except for the *QuickAmp PCI* support display of the numbers of the physical channels.

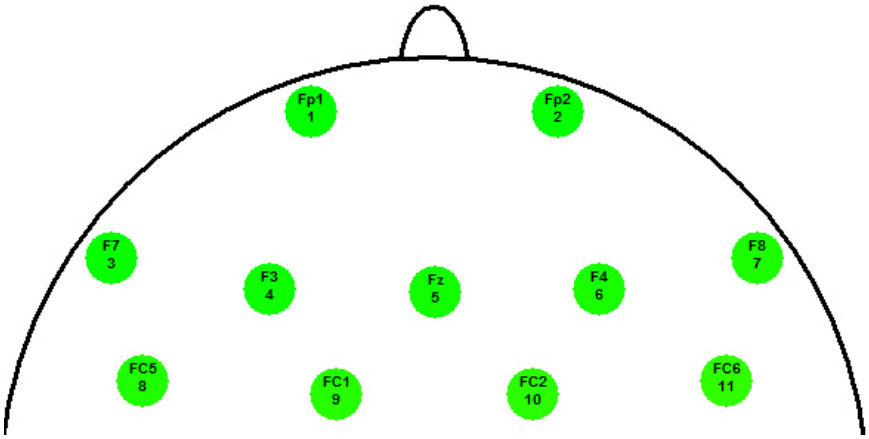


Figure 6-4. Displaying the position and numbers of the physical channels

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.

Click the *Stop Monitoring* button in the toolbar to stop impedance measurement. 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.

Notes

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

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.

You will find information on impedance measurement for BrainAmp amplifiers in Section 8.1.2. You will find information on impedance measurement for active electrodes in Section 7.4.

6.2 Viewing and recording data

6.2.1 Entering comments

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.

Freely-definable text

You enter freely-definable text by clicking the *Annotation* button 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.

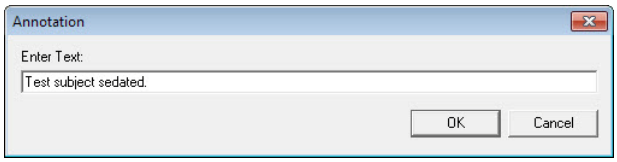


Figure 6-5. Entering freely-definable text

Predefined text

You are also able to predefine texts. To use this option, close monitoring mode and choose **Configuration › Predefined Annotations...**

This opens the *Predefined Annotations* dialog box. In this dialog box, you can enter up to ten predefined texts (Figure 6-6). The predefined texts are displayed in the lower marker area if you press the corresponding keys *1* through *0* in monitoring mode.

If the **Predefined Annotations...** menu command is not available, the probable reason is that you do not have administrator privileges. For further information on user privileges, please refer to Section 5.1.

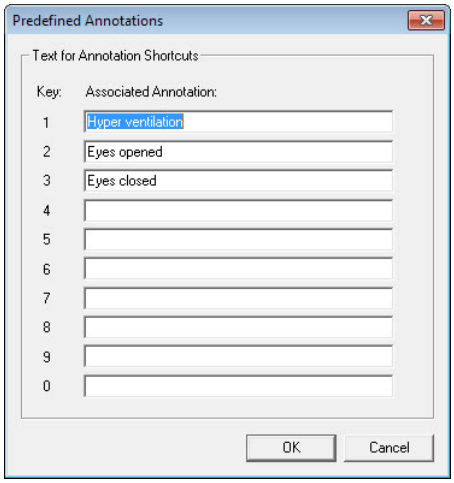


Figure 6-6. Entering predefined text

6.2.2 Blocking channels

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.

Figure 6-7. Blocking the selected channel

6.2.3 Performing DC offset correction

If you have a DC-coupled amplifier, then you can carry out DC offset correction with *Recorder*. To do this, click the *DC Correction* button in the toolbar (or press the keyboard shortcut *Ctrl-D*). *Recorder* sets a corresponding marker to flag the DC offset correction in the data.

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

You can also configure *Recorder* to perform automatic DC offset correction as soon as a channel value rises above or falls below a critical threshold. To do this, choose **Configuration › Preferences...** in the menu, select the **Automatic DC Correction** box on the *DC Correction* tab and enter the required value for the threshold.

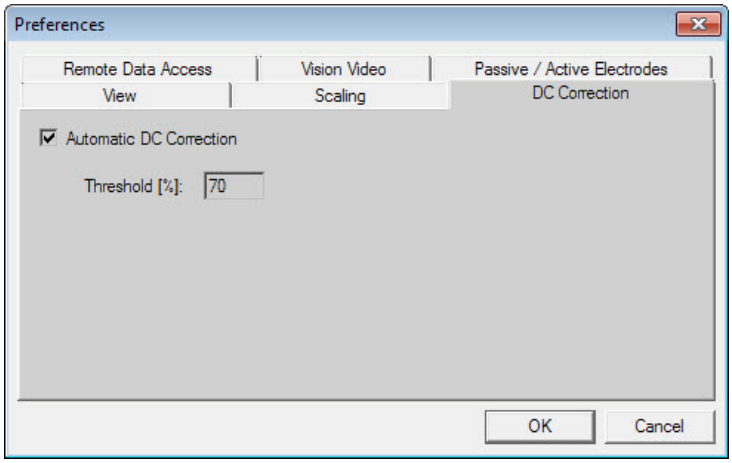


Figure 6-8. Activating automatic DC offset correction for DC amplifiers

6.3 Selecting a channel

To select a channel, simply click the channel name. A selected channel is highlighted in blue (Figure 6-9). 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.

6.3.1 Individual view

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

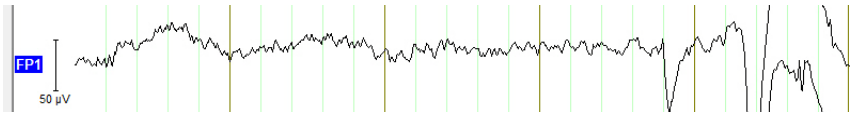


Figure 6-9. Highlighting of the selected channel

To display multiple channels separately, click once on each required channel name in sequence. Then double-click the last of the required channels (Figure 6-10). If you double-click a channel name again, the display returns to how it was before.

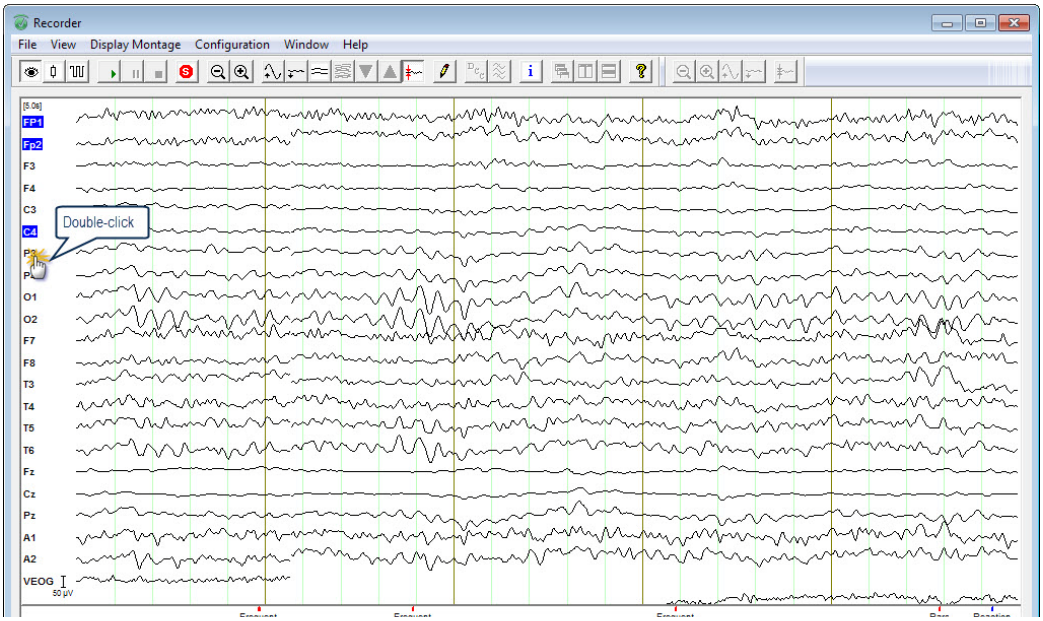


Figure 6-10. Selecting multiple channels

The selection shown in Figure 6-10 results in the following channel display:

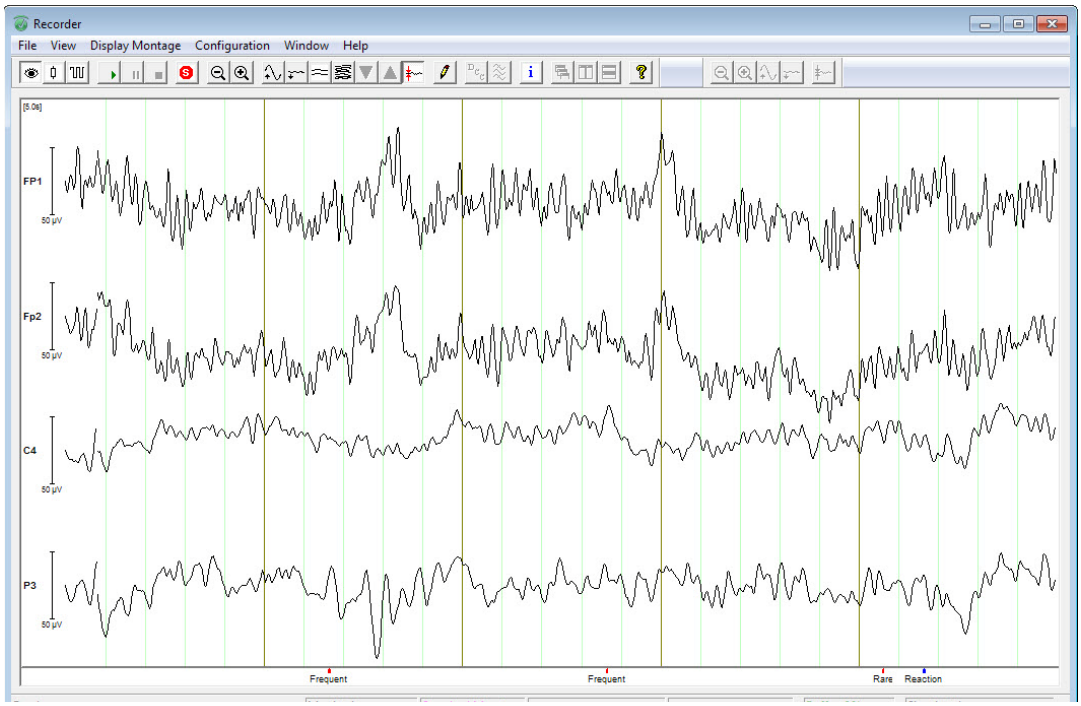


Figure 6-11. Displaying selected channels

6.3.2 Scientific view

You can depict channels in detail in a coordinate system with time and amplitude axes. The view is opened in a separate window to the left of the main view (Figure 6-12).

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:

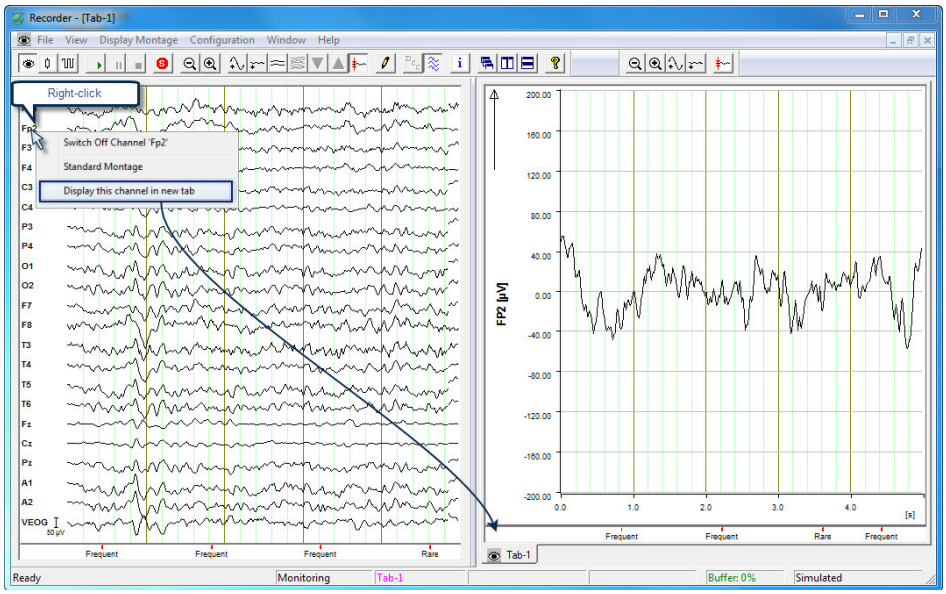


Figure 6-12. Opening the scientific view

1 Select and open the channel.

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 and displays the channel separately in it.

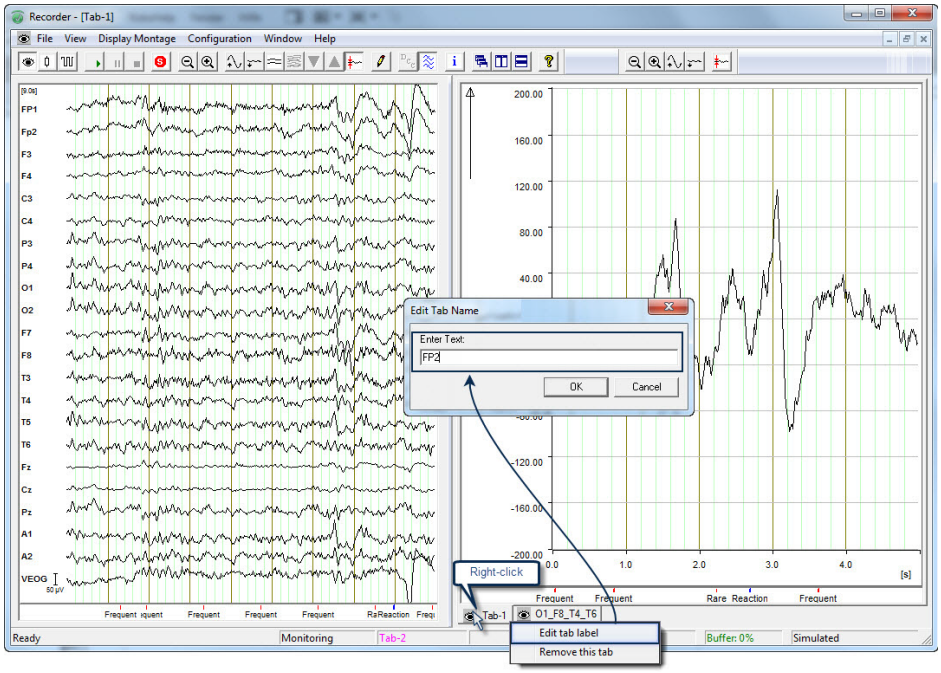


Figure 6-13. Renaming the tab in the scientific view

2 Rename the tab

By default the tabs are called *Tab 1*, *Tab 2*, etc. To change these names, right-click the tab and choose **Edit tab label**.

Enter the required 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**.

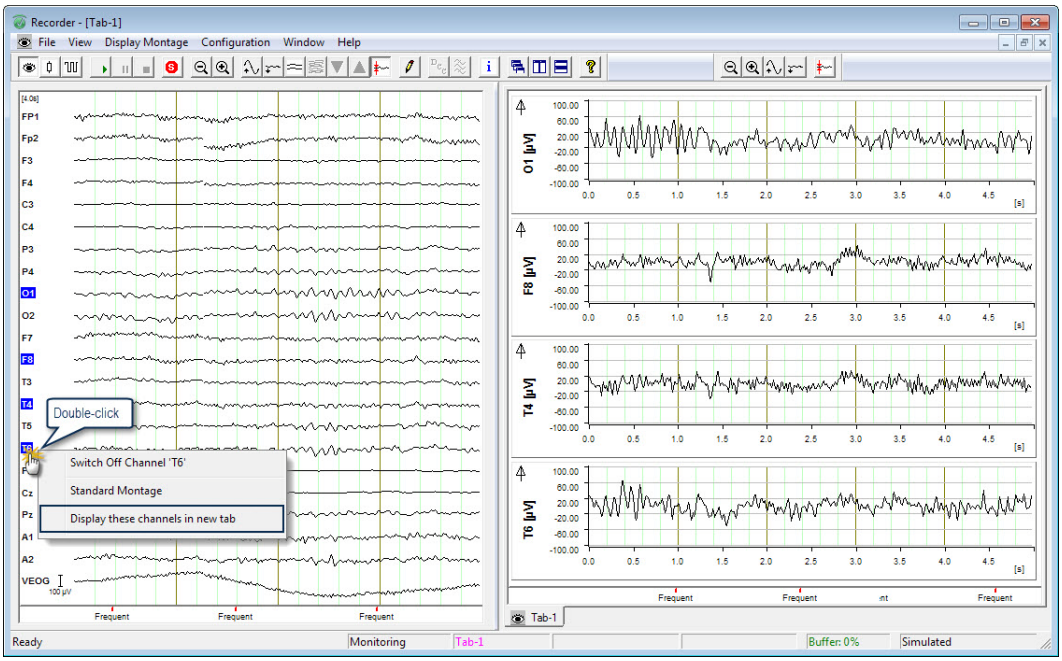


Figure 6-14. Displaying multiple channels in the scientific view

In the scientific view, the channels are displayed in a coordinate system with time and amplitude axes. You can adjust the scaling of the axes.

Defining the scaling for the axes

The following scaling controls are displayed above the tabs (see (b) in Figure 6-15):

Increase Interval increases the scaling of the time axis (x-axis) (alternatively *Alt + Shift + Num-*)

Decrease Interval decreases the scaling of the time axis (x-axis) (alternatively *Alt + Shift + Num+*)

Scale Down decreases the scaling of the amplitude axis (y-axis) (alternatively *Alt + Shift + down arrow*).

Scale Up increases the scaling of the amplitude axis (y-axis) (alternatively *Alt + Shift + up arrow*).

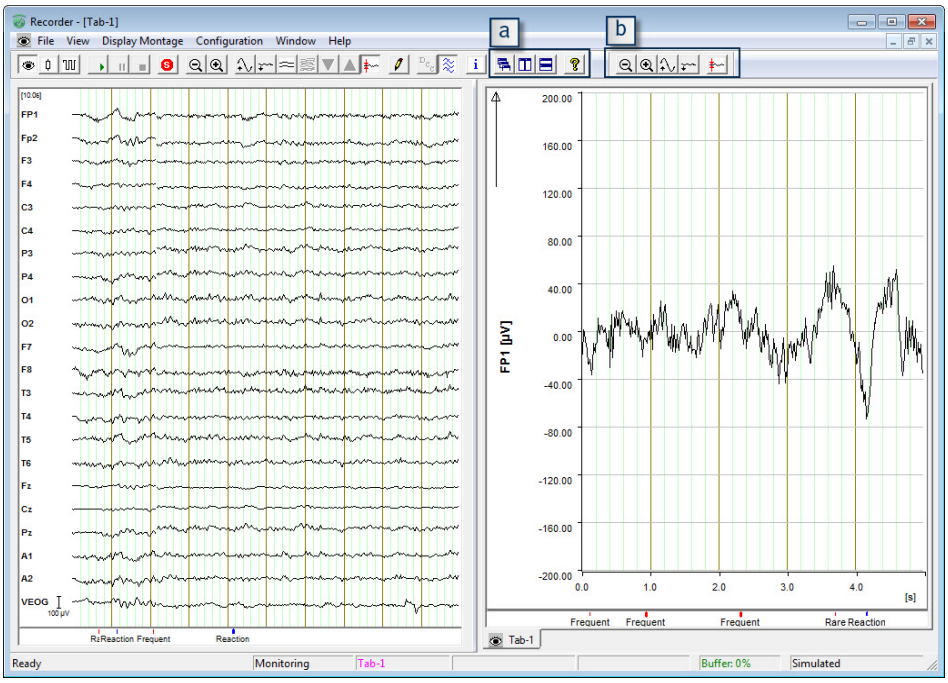


Figure 6-15. Controls in the scientific view

Defining individual scalings for axes

When this type of scaling is used, default values are applied to the x and y-axes. If you want to scale the *active tab* more precisely, you can enter the values manually. To do this, proceed as follows:

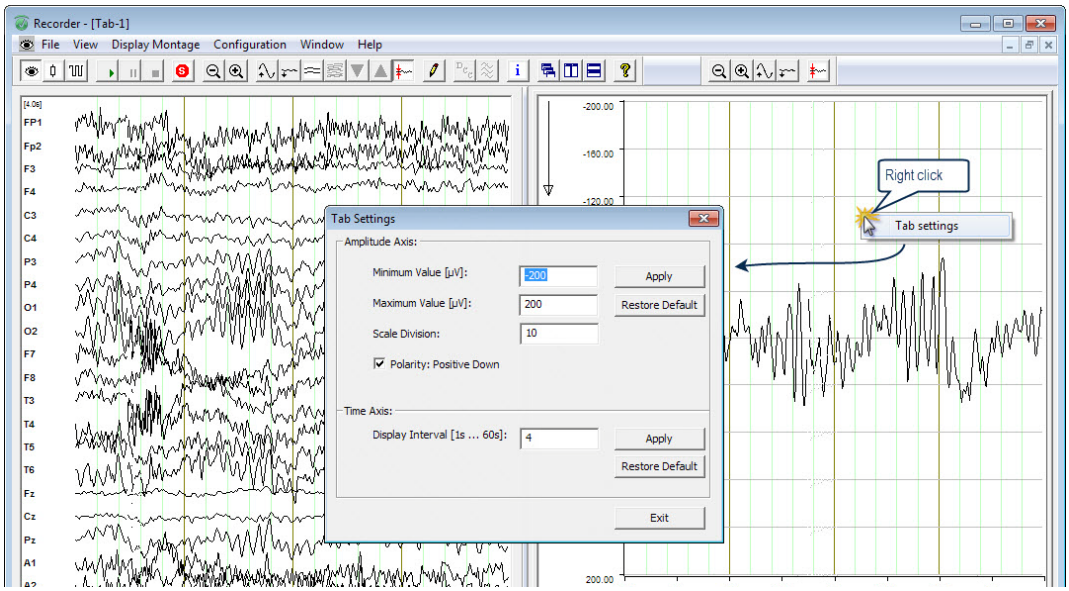


Figure 6-16. Defining the scaling of the axes for the current view

1 Right-click and select **Tab Settings**.

2 Adjust the parameters.

Adjust the scaling of the time and amplitude axes in the *Tab Settings* dialog box.

3 Click **Apply** to define the settings.

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

Defining global scalings for axes

Alongside individual settings for the tabs, you can set global display parameters 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.

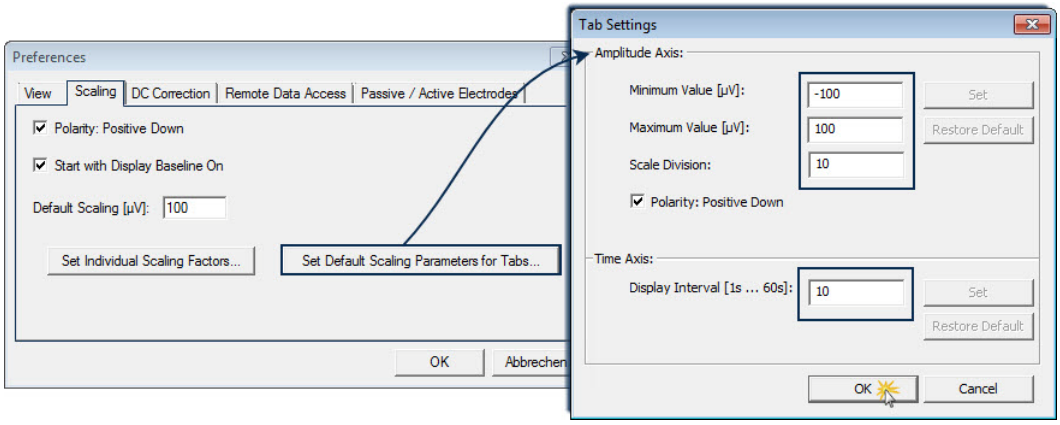


Figure 6-17. Defining global scalings for axes

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

The **Set** and **Restore Default** buttons are inactive because they are only required for individual axis scaling (page 85).

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).

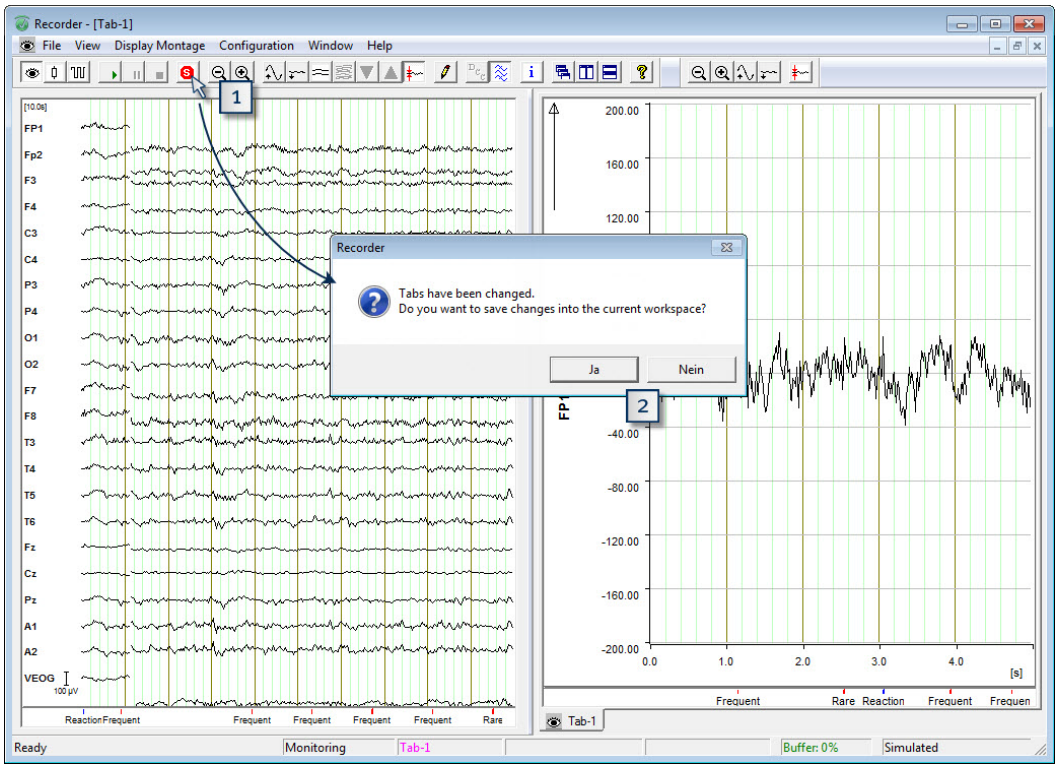


Figure 6-18. Saving the tab layout

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!

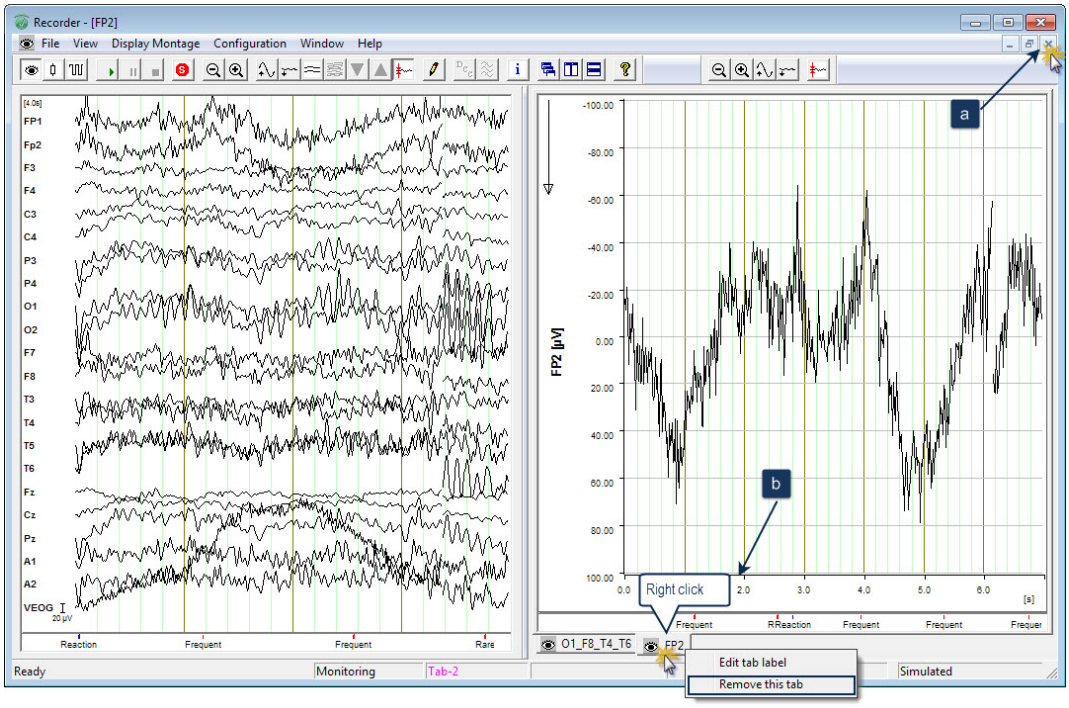


Figure 6-19. Closing tabs

6.4 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.

6.4.1 Creating a montage

To create a new montage, choose **Display Montage › New...** from the menu. The *New Montage* dialog box opens (Figure 6-20). This dialog box is used for determining the type of reference to be used in the new montage.

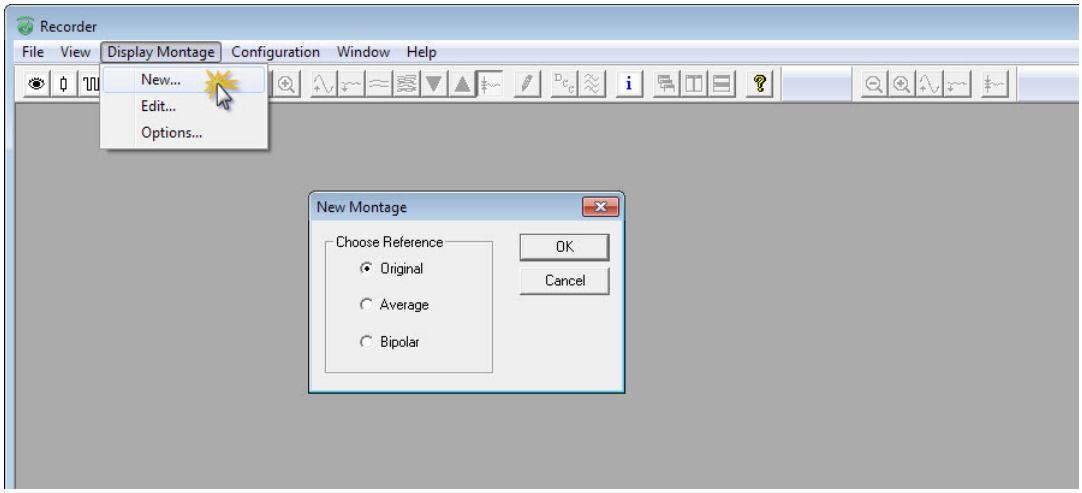


Figure 6-20. Creating a montage

You can choose between three reference types:

- *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 take 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.

6.4.2 Editing montages

Click **OK** when you have selected a reference type. This opens the *Edit* dialog box (Figure 6-21). The *Edit* dialog box is made up of two columns titled *Chn (+)* and *Chn (-)*. The columns contain the channels and their reference channels.

The second column cannot be referenced if you have selected any reference type other than Bipolar. If the montages are not bipolar, the program automatically fills the boxes for the reference channels with suitable names.

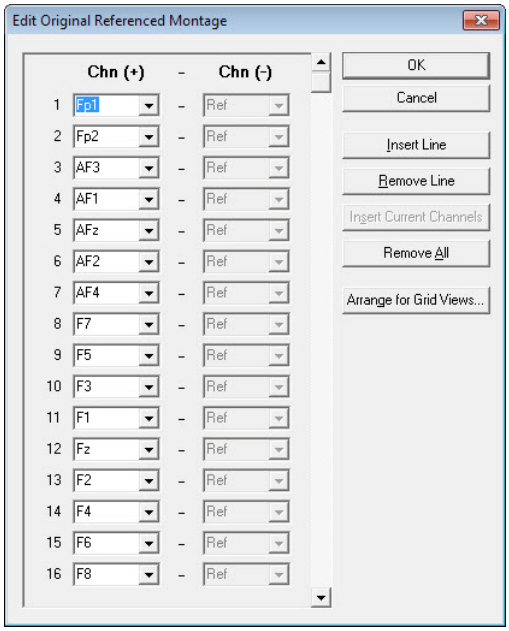


Figure 6-21. Editing montages

The dialog box incorporates the following functions:

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. Grid views are used when representing segmented or averaged data.

You can either enter the channel names manually or activate the drop-down list and select a channel name from the list. When you have filled in the first 16 channels, you can reach the remaining channels at the bottom of the list by using the scroll bar.

6.4.3 Arranging the montages in the grid view

In the grid view used for representing segmented/averaged data, the channels are arranged in a grid (Figure 6-22). 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.

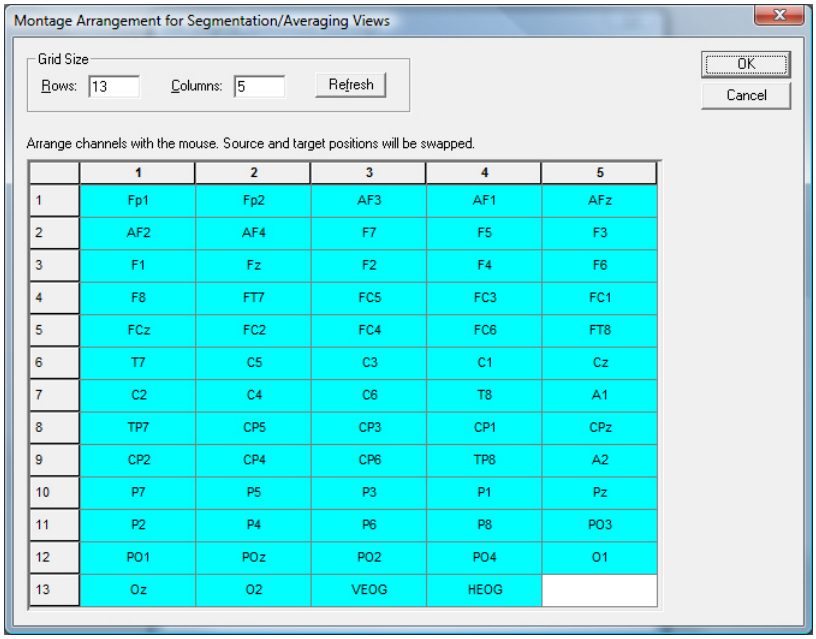


Figure 6-22. Creating a grid view

6.4.4 Calling montages that have been created

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 6-23). 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.

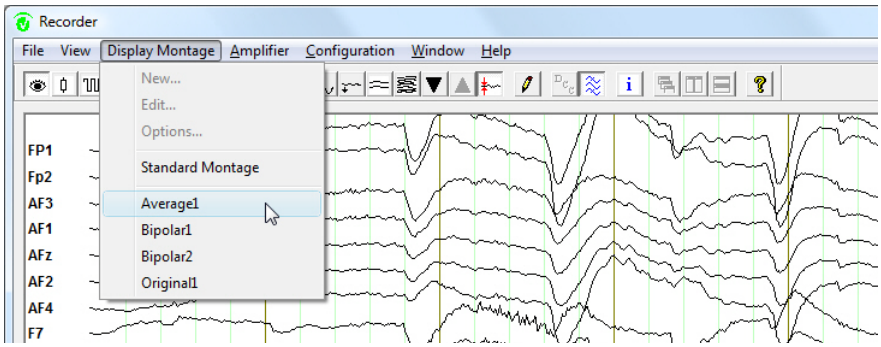


Figure 6-23. Calling a montage

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

6.4.5 Modifying a montage

If you wish to modify an existing montage, select it with **Display Montage › Edit...** and then edit it. Please note that you cannot change the reference type of an existing montage.

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.

6.4.6 Switching between montages

You can assign specific keyboard shortcuts to montages to allow you to switch between them quickly (Figure 6-24). 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.

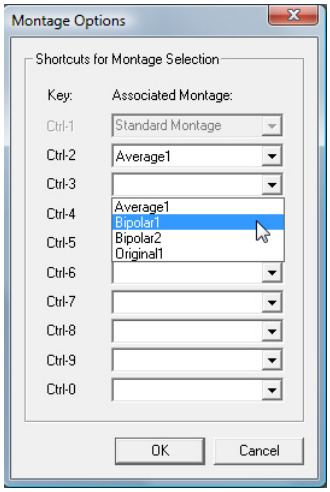


Figure 6-24. Assigning keyboard shortcuts to montages

If you have defined one or more segmentation or averaging groups (see also Section 6.5), 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.

6.5 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.

We advise you to save raw data if possible. Only if you do this do you have the opportunity of changing the averaging parameters later.

6.5.1 Entering parameters

The parameters for segmentation/averaging can be found under **File › New Workspace...** or **File › Edit Workspace...** on the fourth page of the dialog box in which you set up a workspace.

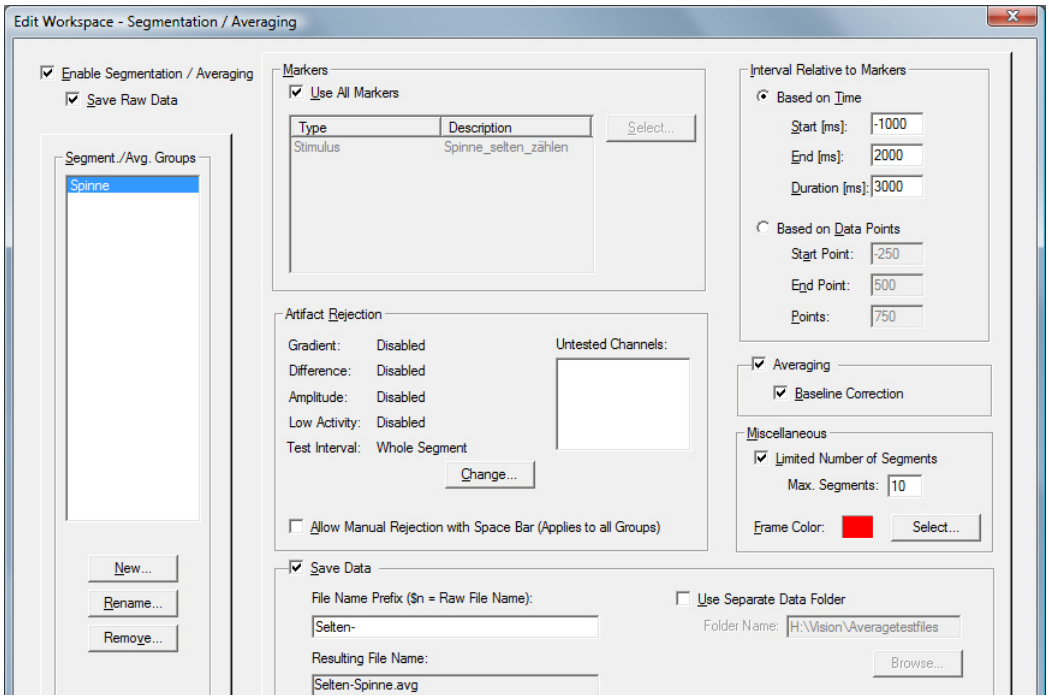


Figure 6-25. Entering the segmentation/averaging parameters

You will find detailed information on pages one through three of the Edit Workspace dialog box in Chapter 4.

On the **Edit Workspace – Segmentation/Averaging** page, you will see the terms “segmentation group” and “averaging group”. A segmentation group describes segmentation based on one or more markers.

You can define the averaging parameters for each group separately. The data for each group is displayed in a separate window and can optionally be stored in separate files. You can define a total of up to 16 groups.

The *Edit Workspace – Segmentation/Averaging* dialog box is divided into two functional blocks. The left-hand block is used to select, create, rename and delete groups. The right-hand block is used to display the parameters of the selected group.

Activating segmentation/averaging and the saving of raw data

To begin with, activate the segmentation/averaging option by selecting the *Enable Segmentation/Averaging* box. The **Save Raw Data** function allows you to define whether the raw data is to be stored in addition to the segmented/averaged data.

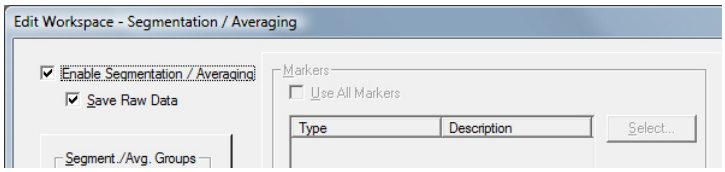


Figure 6-26. Activation of segmentation/averaging and saving of the raw data

Defining segmentation/averaging groups

The *Segment./Avg. Groups* box contains a list that allows you to select a group for editing. Click **New...** to create a new group. This opens the *New Segmentation Group* dialog (Figure 6-27). Enter the name of the group. You can optionally copy the settings from an existing group under **Copy Settings from Group**.

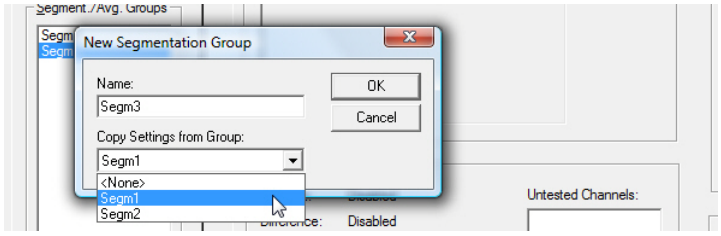


Figure 6-27. Creating a new segmentation/averaging group

Rename... is used to rename the current group (Figure 6-28). **Remove...** is used to delete the current group.

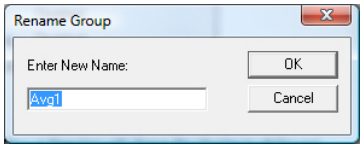


Figure 6-28. Renaming a segmentation/averaging group

Selecting the markers to be used

The *Markers* group allows you to select the markers that describe the relevant segments for the current group (Figure 6-29).

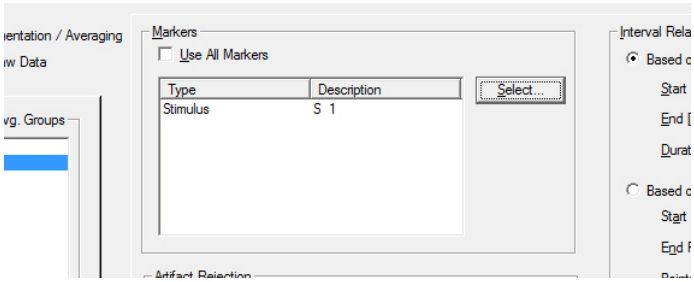


Figure 6-29. Selecting the markers to be used

If you select the **Use All Markers** box, all the markers sent by the amplifier are used during segmentation/averaging. Otherwise, those markers are used that are listed with their type and description.

If you wish to modify the marker list, click **Select...** The *Select Segmentation Markers* dialog box opens in which you can select various markers (Figure 6-30). To start with, choose the marker type from the left-hand drop-down list *Types*. Then select one or more markers from the middle list *Descriptions*.

Click **Add››** to add the markers to the *Selected Markers* list. To remove a marker from this list, select it and click **Remove**. Once you have completed selection of the markers, click **OK**.

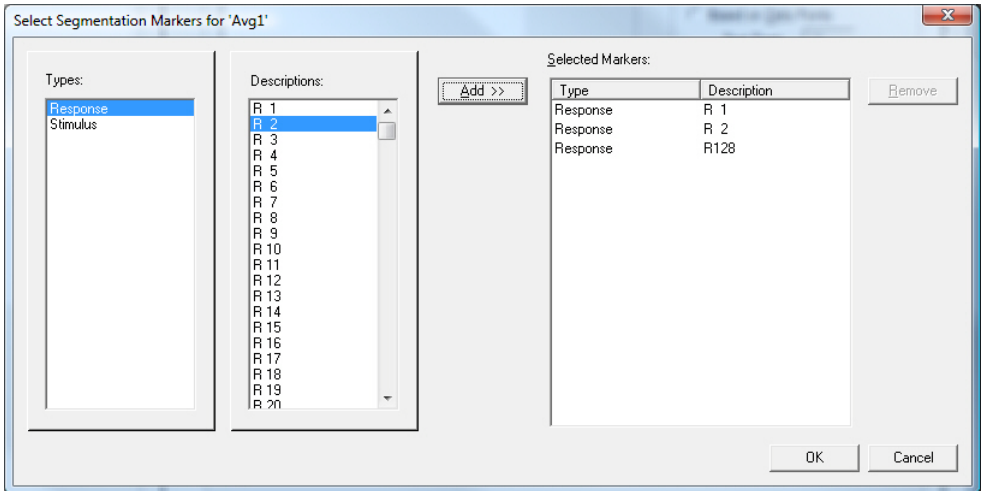


Figure 6-30. Marker selection dialog box

The *Interval Relative to Markers* group box (Figure 6-31) allows you to set the relative positions of the segment interval in one of two ways: **Based on Time** or **Based on Data Points**.

Note

Do not select too large an interval, as *Recorder* will not include overlapping segments in segmentation/averaging.

You can specify the **Start** and **End** of the interval or alternatively the duration of the interval instead of the end.

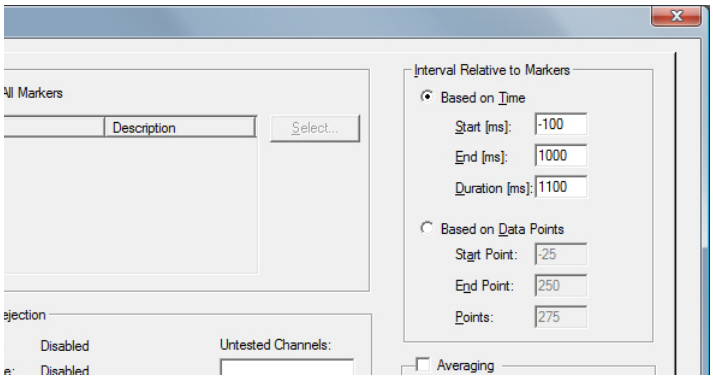


Figure 6-31. Defining the interval length on the basis of markers or data points

Rejecting segments containing artifacts

The *Artifact Rejection* group box (Figure 6-32) allows you to examine the individual segments that you want to include in segmentation/averaging for various artifacts, or to carry out a quality select. All segments that are detected as having artifacts are excluded from segmentation/averaging.

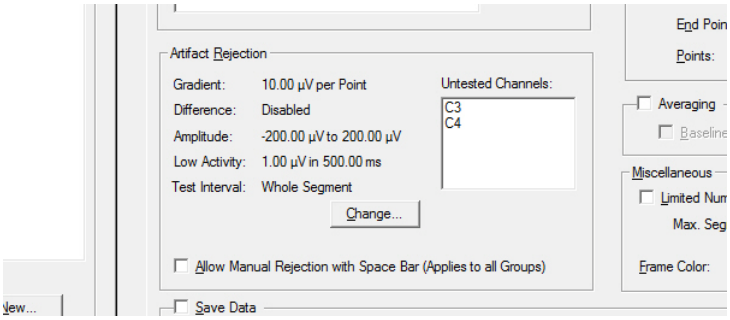


Figure 6-32. Excluding segments containing artifacts

You can also reject artifacts manually. If you select the **Allow Manual Rejection with Space Bar (Applies to all Groups)** box, you can subsequently reject any segment which has just been accepted during segmentation/averaging by pressing the space bar. This is possible until the next segment appears.

If you have defined several segmentation/averaging groups, the rejection refers to the segment of the group with the active window. The segments of the remaining groups which form an intersection with respect to time with the rejected segment are also rejected. However, only the most recently accepted segment in a group is checked.

The following criteria are used to check for artifacts: gradient, difference, amplitude and low activity.

All these criteria are checked at an interval that you have to define. You can also disable individual criteria, or all of them, in which case they are not used for artifact checking.

To change the settings for artifact checking, click **Change...** The *Artifact Rejection Criteria* dialog box opens.

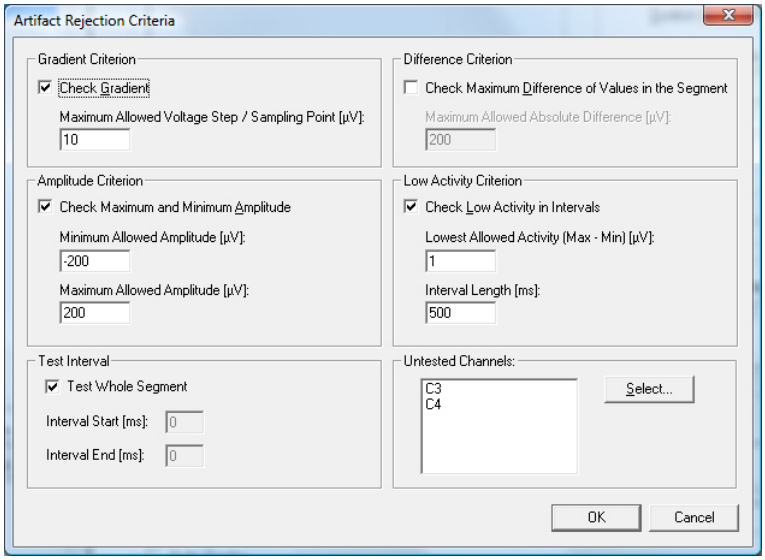


Figure 6-33. Defining criteria for identifying artifacts

Select the relevant box to use each of the criteria:

- *Gradient Criterion*. When the gradient criterion is applied, the absolute difference between two neighboring sampling points must not exceed a specific value. Enter the maximum permitted difference in voltage between two data points in the **Maximal Allowed Voltage Step/Sampling Point [µV]** text box.
- *Difference Criterion*. If the difference criterion is selected, the maximum difference between two values within a segment must not exceed a specified value. Enter the value of the maximum permitted difference in voltage between the lowest and highest value within the region to be tested in the **Maximum Allowed Absolute Difference [µV]** text box.
- *Amplitude Criterion*. When the amplitude criterion is applied, the amplitude must not violate specified maximum and minimum values. Enter the minimum permitted voltage in the **Minimal Allowed Amplitude [µV]** text box and the maximum permitted voltage in the **Maximal Allowed Amplitude [µV]** text box.
- *Low Activity Criterion*. If this criterion is specified, the system checks whether a minimum amount of activity has occurred within a defined time period. If, for example, you specify a period of 5 ms here, the program checks whether there is no change of voltage of the selected magnitude over a period of 5 ms within the test interval. Enter the minimum activity in the **Lowest Allowed Activity (Max-Min) [µV]** text box. Enter the length of the interval within which the activity must not fall below the specified amount in the **Interval Length** text box.

- If you select the **Test Whole Segment** box, the entire segment is checked for artifacts. Alternatively, you can specify the length of the segment to be checked using the **Interval Start [ms]** and **Interval End [ms]** text boxes.

Notes

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.

Under **Untested Channels**, you can choose **Select...** to select the channels that are to be ignored during artifact checking.

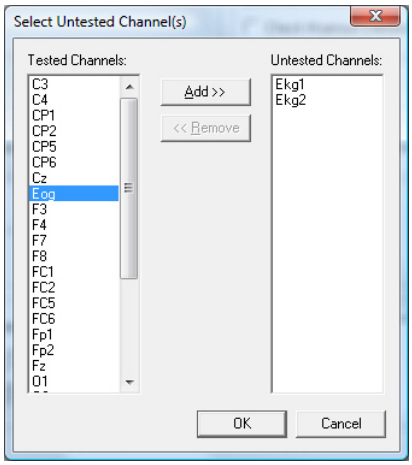


Figure 6-34. Excluding selected channels from artifact identification

Averaging and baseline correction

The *Averaging* group box (Figure 6-35) allows you to specify whether the data is to be averaged. You can perform a baseline correction in addition to averaging (**Baseline Correction** check box). Baseline correction adjusts the baseline of every segment. Correction is carried out immediately before averaging. The average voltage value of the prestimulus interval is defined as the new zero value. In other words, the average of the points in the prestimulus interval is ascertained, and this is subtracted from all points in the segment. This operation is performed for all channels.

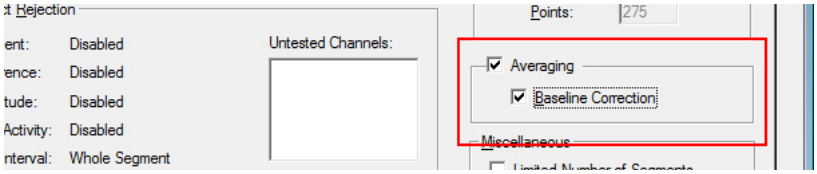


Figure 6-35. Activating averaging and baseline correction

Other settings

The *Miscellaneous* group box (Figure 6-36) contains two functions:

The **Limited Number of Segments** option allows you to limit the number of segments that you want to record during segmentation or include in averaging.

The **Frame Color** option allows you to select a frame color for the group in order to identify the associated data window.

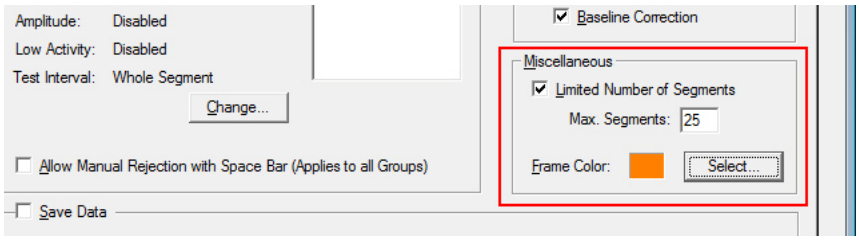


Figure 6-36. Other settings

Save options

The *Save Data* group box contains the save options.

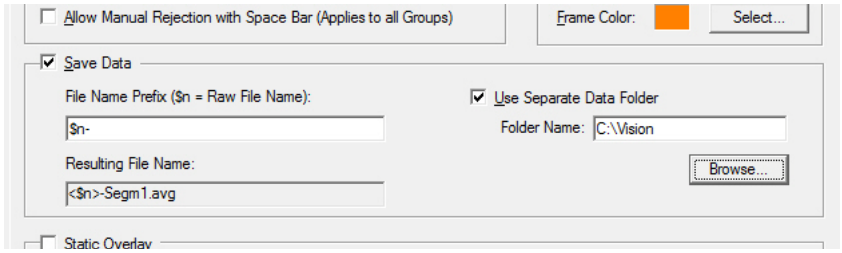


Figure 6-37. Options for saving segmentation/averaging

If you select the **Save Data** box, the data is saved when you click the *Start/Resume Recording* button in the toolbar.

Enter a file name in the **File Name Prefix** text box. You can also use the `$n` placeholder. Wherever this placeholder occurs, it is replaced by the name of the raw file. The group name and a file extension are added to the name that you enter here. The name that is formed is shown under **Resulting File Name**.

If you do not select the **Use Separate Data Folder** box, the previously defined raw data folder is used. Otherwise, you can click **Browse...** to select a separate folder for the group under **Folder Name**.

Using a static overlay

Select the **Static Overlay** box to apply a static overlay to the data (Figure 6-38).

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

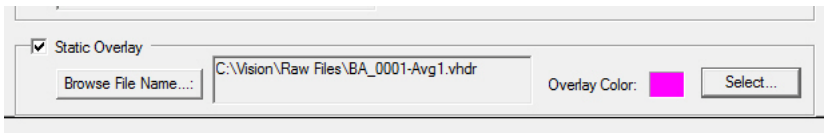


Figure 6-38. Using a static overlay

Select a saved overlay using ***Browsing File Name...***

You can specify the color of the static overlay using **Overlay Color › Select** (the default setting for this is blue).

You must assign the static overlay to a segmentation/averaging group. In doing so, you must ensure that the sampling rate, the segmentation interval and the prestimulus and poststimulus intervals of the static overlay correspond to the settings in the workspace. If you do not do so, an error message appears. In our example, the segmentation intervals in the static overlay and the workspace do not match.

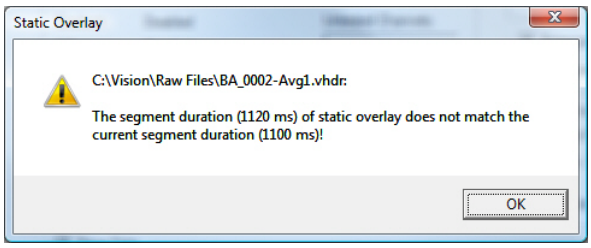


Figure 6-39. Exemplary message for Static Overlay errors

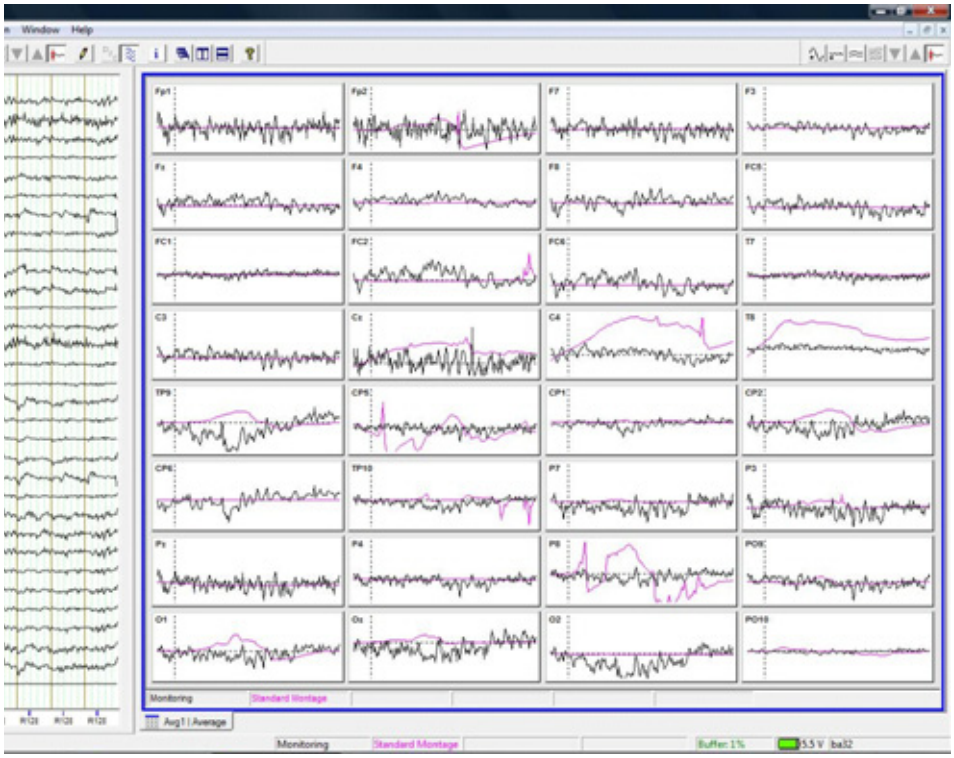


Figure 6-40. Static overlay: data view

Click **Finish** to complete the settings in the *Edit Workspace – Segmentation/Averaging* dialog box.

6.5.2 Viewing and recording segmented/averaged data

Start *Recorder* and click the *Monitor* button in the toolbar.

The *Recorder* interface is split into two parts. The monitoring window is displayed on the left. On the right-hand side, there is a separate data window for the segmentation or averaging groups (Figure 6-41). The data in this window is updated whenever a matching marker is found.

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.

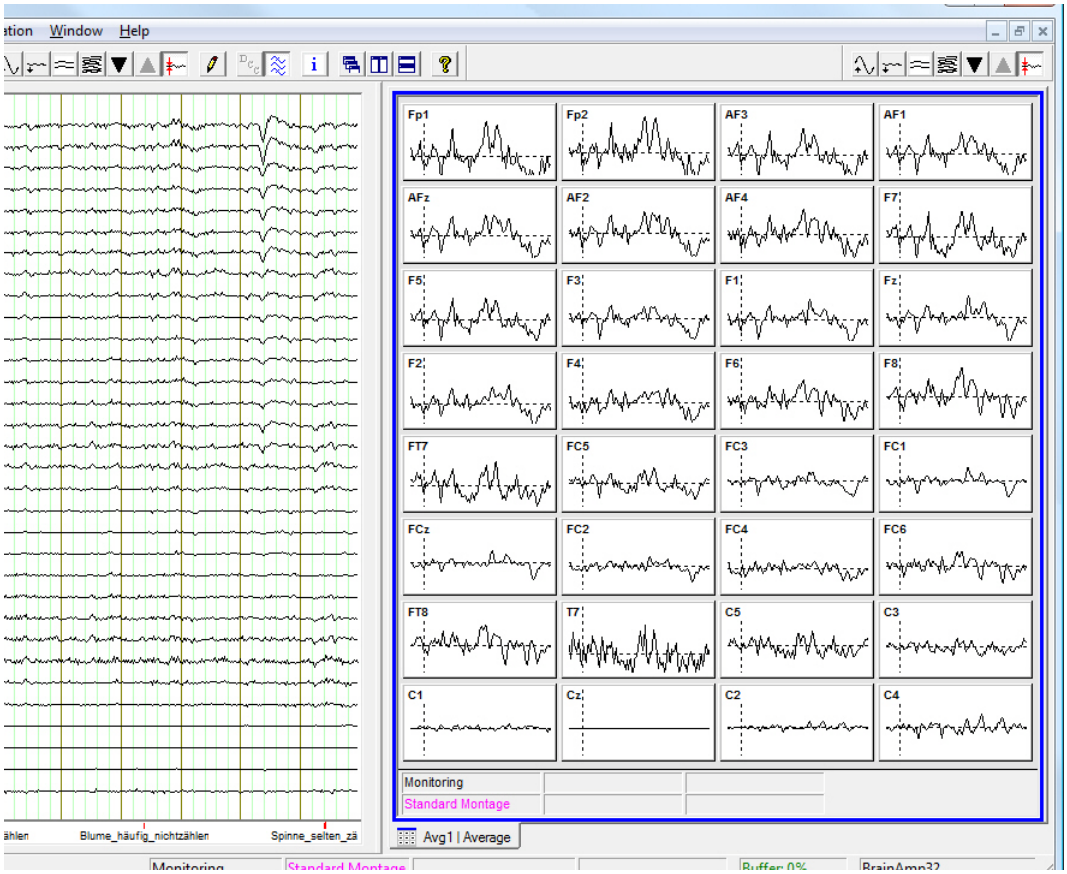


Figure 6-41. Monitoring window (left) and segmentation/averaging group view (right)

If you have activated manual artifact rejection (see page 97 in Section 6.5.1) when you set the parameters, you can now use the space bar during recording to subsequently reject segments which have not automatically been identified as having artifacts.

You can change the ratio between the monitoring window and the segmentation windows by dragging the split bar between them to the left or right with the mouse. However, there is a limit to prevent an area disappearing completely from the screen.

There are tabs beneath the group windows. These enable you to quickly bring a group window into the foreground.

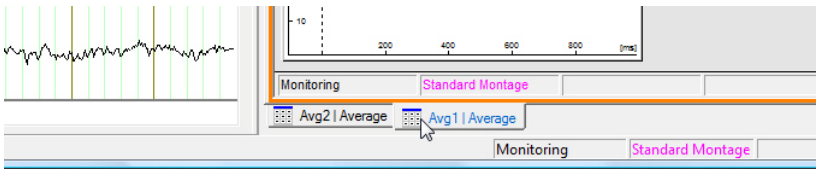


Figure 6-42. Switching between groups using tabs

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.

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 will find details on creating and using montages in Section 6.4.

You will find detailed information on changing the scaling, the number of channels and channel groups displayed in Section 3.3.

At the top right of the workspace there is a separate toolbar for the right-hand data window. The functions of this separate toolbar are the same as those of the main toolbar. However, note that you have to press the key combination *Ctrl-Shift* rather than *Ctrl* to use the keyboard shortcuts. The separate toolbar has the following buttons that always relate to the active group window:

- **Scale Up** increases the scale (alternatively use the keyboard shortcut ‹Ctrl-Shift+arrow up›).
- **Scale Down** decreases the scale (alternatively use the keyboard shortcut ‹Ctrl-Shift + arrow down›).
- **Decrease Channels** decreases the number of channels displayed.
- **Increase Channels** increases the number of channels displayed.
- **Next Group** switches to the next 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.
- **Previous Group** switches to the previous channel group.
- **Baseline Correction in Display** activates or deactivates baseline correction. Only the baseline of the display is changed, not the data itself.

We recommend that you configure your operating system as described in the instructions in Chapter 2 before starting to record data.

To start recording data, click the *Start/Resume Recording* button in the toolbar. The *Save Data* dialog box opens (Figure 6-43). This allows you to overwrite the parameters originally specified for the raw data and for every group.

The **Comment** text box allows you to enter a comment. This comment is saved in the EEG file. 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).

The **Base File Name** text box is used to 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 (Figure 6-44).

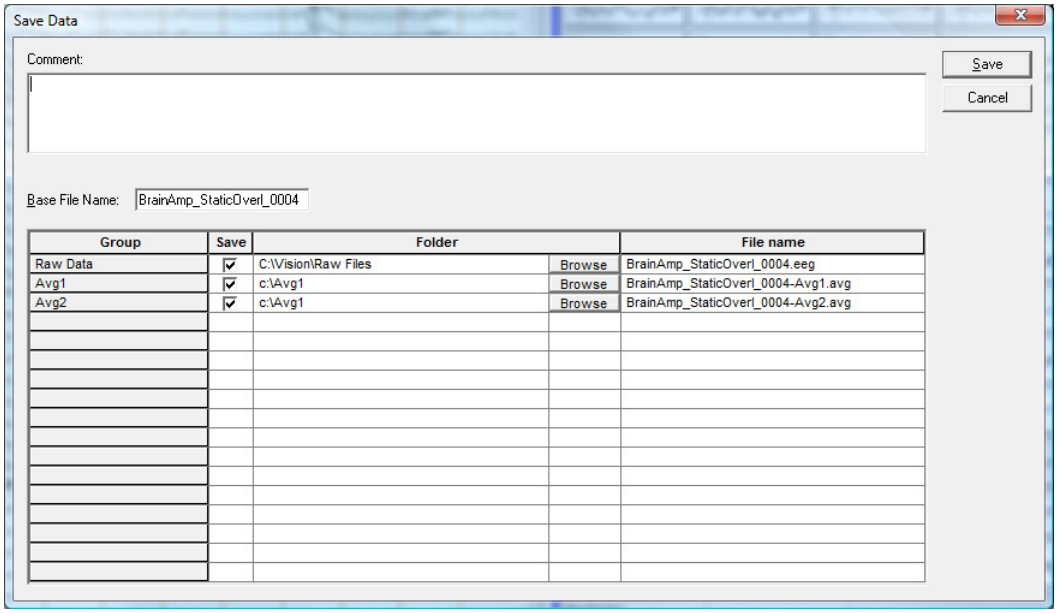


Figure 6-43. "Save Data" dialog box

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* (Figure 6-44). Note that this refers to the capacity that would be available if only the relevant group were stored.

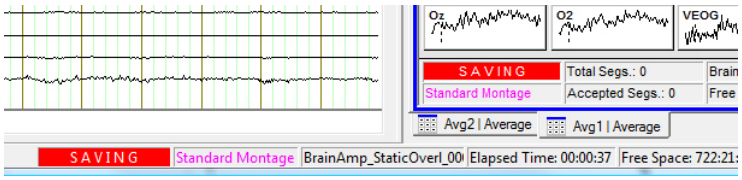


Figure 6-44. Recorder in save mode

Chapter 7 Special functions when using active electrodes

This chapter describes how to use *Recorder* with the *actiCAP* active electrode system.

Notice

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.

7.1 Accessories required for your amplifier system

If you want to use active electrodes then, depending on the type of amplifier you have, you may need additional hardware accessories such as the *actiCAP ControlBox* (including the *actiCAP ControlSoftware*) or the *ImpBox*.

Amplifier	Accessories
BrainAmp	If you use active electrodes in combination with a *BrainAmp* then you also need the *actiCAP ControlBox* (including the *actiCAP ControlSoftware* as of version 1.2.1.0). **Note** It is not possible to use a single *BrainAmp ExG* in combination with active electrodes. The *BrainAmp ExG* is only used with passive electrodes.
QuickAmp USB	If you use active electrodes in combination with a *QuickAmp USB* then you also need the *actiCAP ControlBox* (including the *actiCAP ControlSoftware* as of version 1.2.1.0).

Amplifier	Accessories
V-Amp	Depending on your *V-Amp*'s hardware configuration, you will also need either the *actiCAP ControlBox* (including the *actiCAP ControlSoftware*) or the *ImpBox*: - If you use a *V-Amp* that does not have a multi-way plug for the actiCAP splitter box then you will need the *actiCAP ControlBox* (including the *actiCAP ControlSoftware*) in order to connect the active electrodes to the *V-Amp* and perform the impedance measurement. - If you can connect the *actiCAP* to your *V-Amp* with the multi-way plug (splitter box with up to 18 active electrodes), you can use the *ImpBox*. For more detailed information on using the *ImpBox* for impedance measurements, please refer to the *V-Amp Operating Instructions*.
actiCHamp	The *actiCHamp* can be used with active electrodes without the need for any additional accessories. You will find detailed information on the *actiCHamp* in Section 8.6 or in the *actiCHamp Operating Instructions*.

7.2 Configuring Recorder

Choose **Configuration › Preferences...** from the menu to open the *Preferences* dialog box and open the *Use actiCAP Control Software* on the *Passive/Active Electrodes* tab.

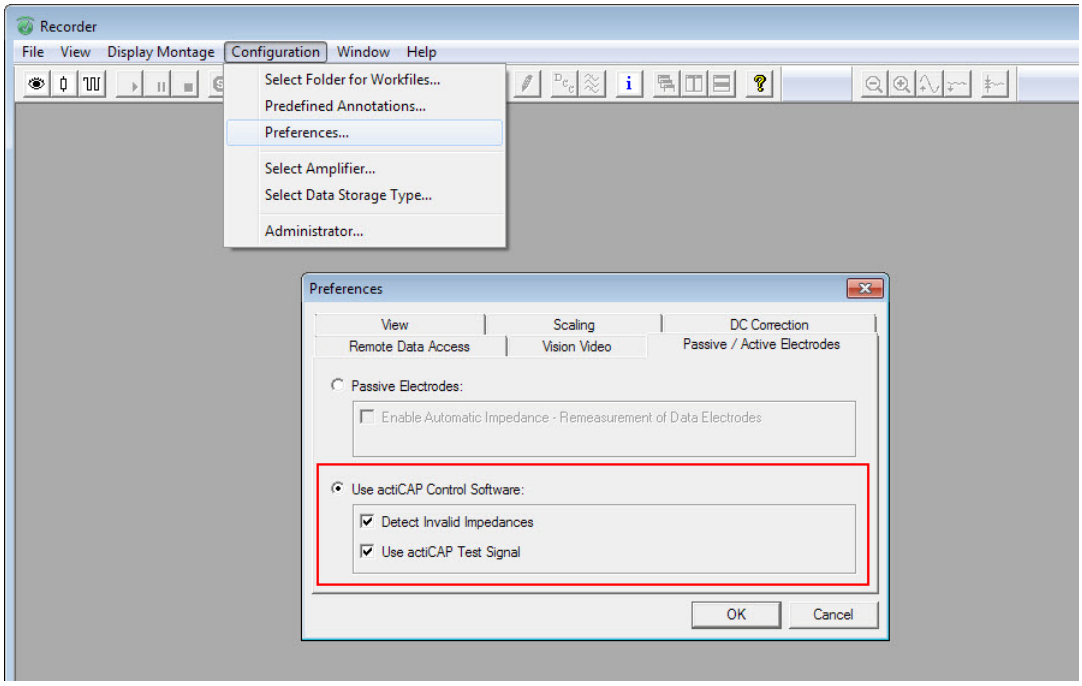


Figure 7-1. Configuring Recorder for using active electrodes (actiCAP)

7.3 Interaction between Recorder and the actiCAP ControlBox

Connect the *actiCAP ControlBox* to your computer. Start *Recorder* in monitoring mode. If you switch the *actiCAP ControlBox* to a particular mode, *Recorder* also switches to the corresponding mode. Similarly, the appropriate control button on the *actiCAP ControlBox* will light up when you switch *Recorder* to a particular mode.

In addition, markers are set in the EEG, for example in order to indicate changes of mode.

Note

Recorder only recognizes the *ControlBox* if it is connected to the computer via USB. There must be a USB connection if markers are to be written. If you use the *ControlBox* with rechargeable batteries then the marker "no USB Connection to actiCAP" is written when you start recording.

Meaning of the various markers

The following markers can be written:

- When you press the **Power** button of the *actiCAP ControlBox*, the "actiCAP USB Power On" marker is set. This marker indicates that the *actiCAP ControlBox* is in acquisition mode and is sending data to the *Recorder*.

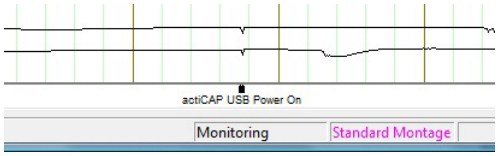


Figure 7-2. "actiCAP USB Power On" marker (switching on actiCAP ControlBox)

- By pressing the **Active Shield** button on the *actiCAP ControlBox* you switch to the *Active Shield* actiCAP mode. A marker is set showing the time in the data set that the *Active Shield* mode was activated. When you exit the *Active Shield* actiCAP mode by pressing the **Active Shield** button again, the "actiCAP Active Shield Off" marker is written.

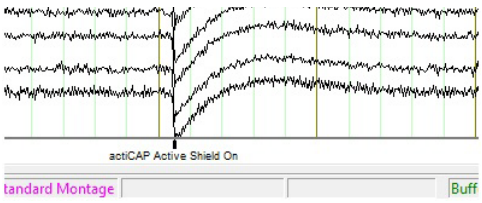


Figure 7-3. "actiCAP Active Shield On" marker

- If you have selected the **Use actiCAP Test Signal** box in the *Preferences* dialog box, the “actiCAP Test On” marker is set when you press the **Test** button on the *actiCAP ControlBox*.

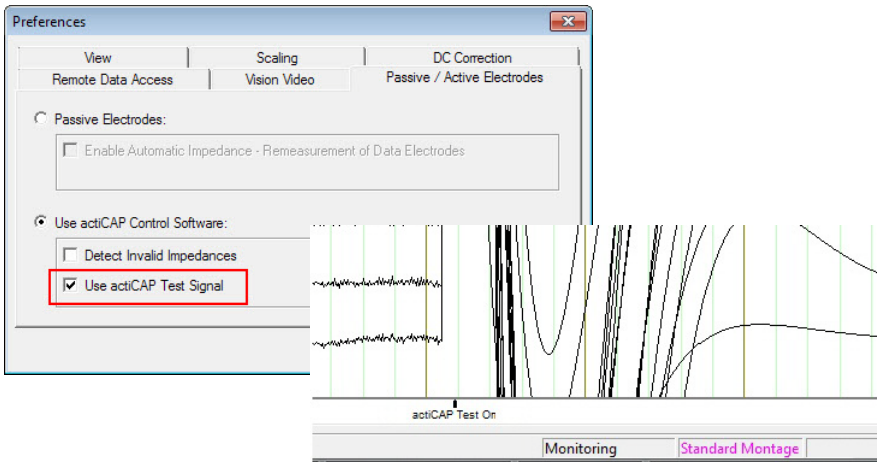


Figure 7-4. “actiCAP Test On” marker

- If you do not select the **Use actiCAP Test Signal** box and you press the **Test** button on the actiCAP ControlBox while *Recorder* is in monitoring mode or test signal mode, the *actiCAP ControlBox* briefly switches to test mode. *Recorder* automatically switches it back to acquisition mode. Two markers are written in quick succession: “Test On” and “Test Off”.

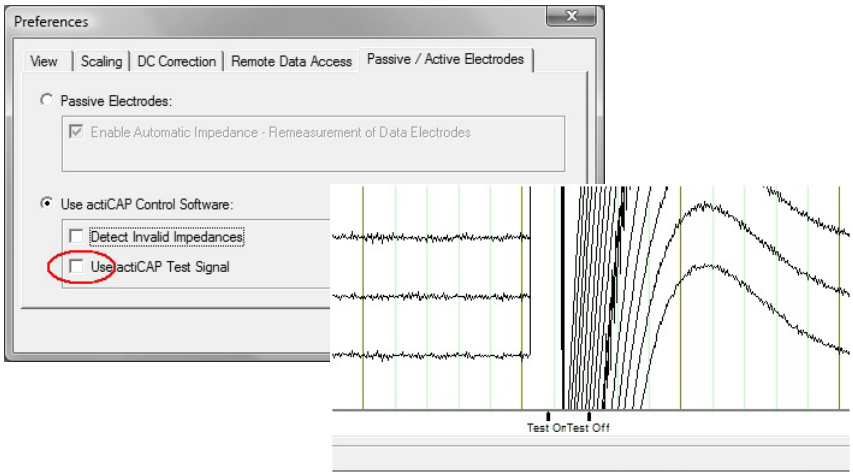


Figure 7-5. “Test On” and “Test Off” markers

- 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.

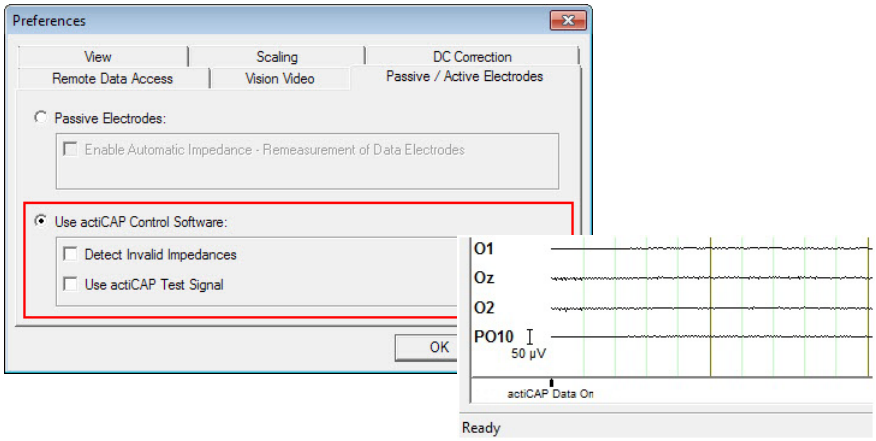


Figure 7-6. "actiCAP Data On" marker

- When you press the **Power** button of the *actiCAP ControlBox* to switch it off, the "actiCAP USB Power Off" marker is set.

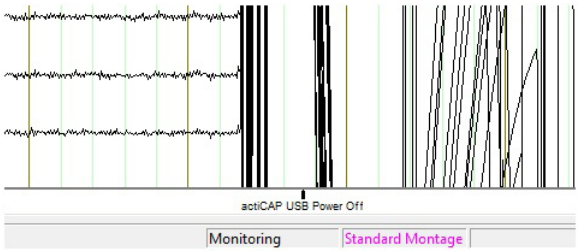


Figure 7-7. "actiCAP USB Power Off" marker (switching off actiCAP ControlBox)

You will find details on installing and using the *actiCAP ControlBox* in the *Operating Instructions* for the *actiCAP* active electrode system.

7.4 Impedance measurement of active electrodes

The *Impedance Check View* for active electrodes is virtually the same as the view for passive electrodes (compare Section 6.1). When you click the *Impedance Check* button in the toolbar, a top view of a representation of a head appears (Figure 7-8). The controls are located to the left of the view.

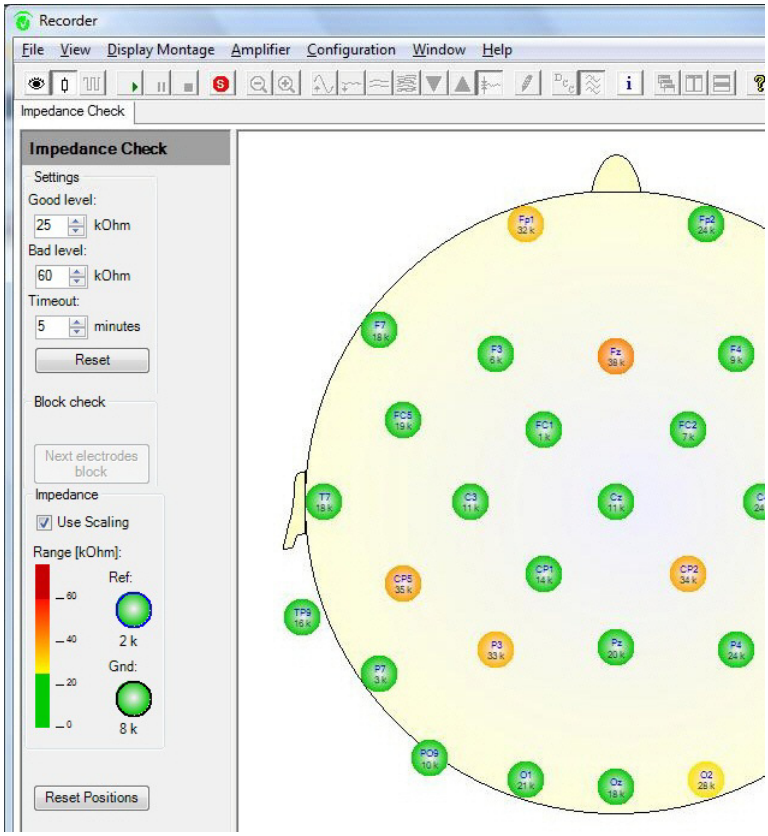


Figure 7-8. Impedance measurement of active electrodes, Impedance Check View

If you change the values for **Good level** and **Bad level** in the *Settings* group, the color scale in the *Impedance* group is automatically adjusted.

The **Timeout** value specifies the time in minutes during which impedance measurement is active. (The factory setting provides for an impedance measurement time of five minutes.) If this period is exceeded then the *actiCAP ControlBox* automatically switches back to acquisition mode. You can change the **Timeout** value as required.

You can revert any changes to the factory changes by clicking **Reset**.

If you are using more than two *actiCAP* electrode branches or more than 64 electrodes, then the **Next electrodes block** button becomes available in the *Block Check* group. 32 electrodes are measured at any one time. If you want to measure the impedances of the next electrode group (i.e. the next 32 electrodes), select **Next electrodes block**.

If you select the **Use Scaling** box, a color scale is used to display the impedances. The color scale is subdivided into 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.

If you click the **Reset Positions** button, you return the electrodes to their initial positions if you had previously made any changes.

When you move the mouse pointer over the electrodes you will see a tool tip containing the following information:

- Name of the electrode
- Physical channel name
- Electrode branch of the corresponding electrode
- Impedance value of the electrode

In our example (Figure 7-9), channel FC5 has the physical channel name 8, belongs to electrode branch 1 and has an impedance of 5 kOhm.

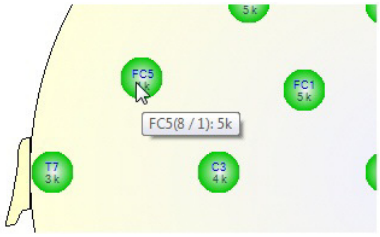


Figure 7-9. Tool tip for an active electrode

Using a BrainAmp ExG

If you are using a *BrainAmp ExG* in addition to a *BrainAmp* and you click the *Impedance Check* button in the toolbar, the following message appears:

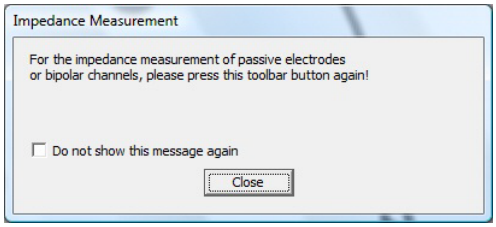


Figure 7-10. Notification for measuring active and passive electrodes

The active electrodes (*BrainAmp*) are always measured first, followed by the passive electrodes of the *BrainAmp ExG* in a second pass. Click the *Impedance Check* button 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 **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 (Figure 7-11).

You can view the impedance values of the active electrodes by moving the mouse pointer over the electrode. A tool tip appears.

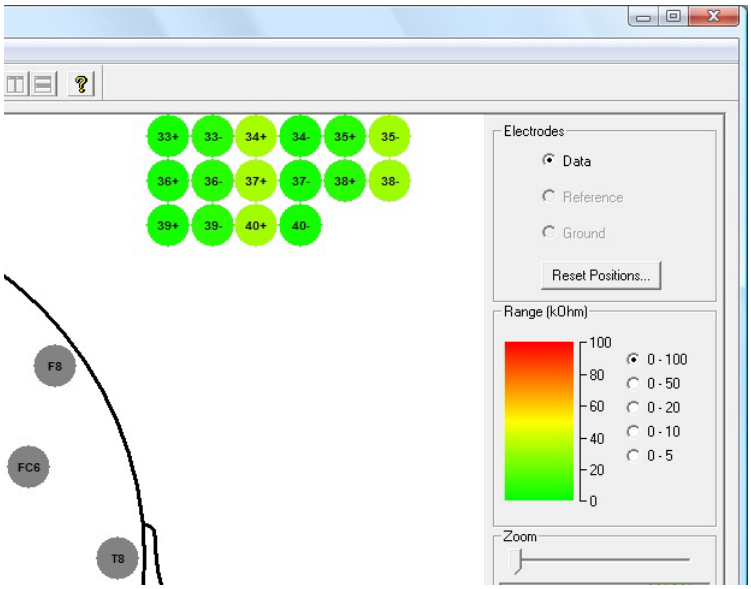


Figure 7-11. Measurement of passive electrodes in a second pass with BrainAmp ExG

7.5 Test signal for the actiCAP active electrode system

If you want to check that the active electrodes are working properly, select the **Use actiCAP Test Signal** box in the *Passive/Active Electrodes* tab of the *Preferences* dialog (Figure 7-12). Otherwise, the test signal is supplied by the amplifier when you run a function test.

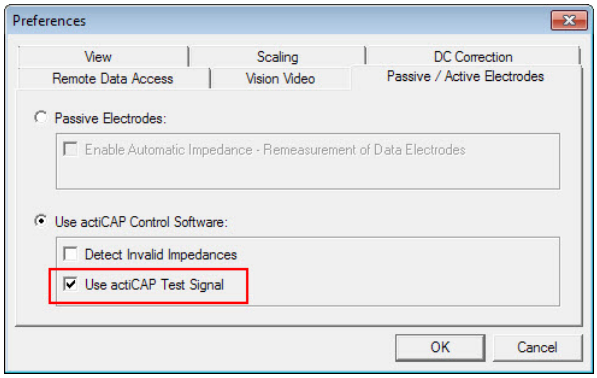


Figure 7-12. Using the test signal for the actiCAP active electrode system

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

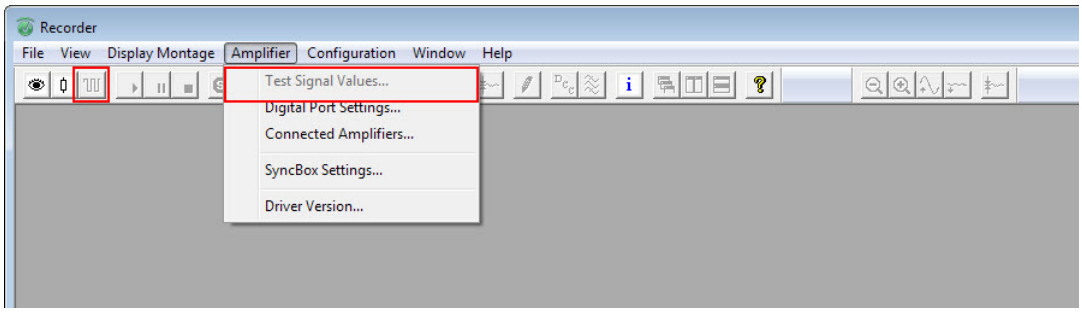


Figure 7-13. Disabled functions when using the actiCAP test signal

If you are using a *QuickAmp PCI* or *QuickAmp USB* in combination with the *actiCAP* active electrode system, it is not possible to obtain the *actiCAP* test signal. The Recorder draws your attention to this if the **Use actiCAP Test Signal** box is selected under **Preferences › Passive/Active Electrodes**.

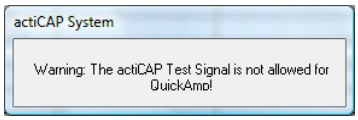


Figure 7-14. actiCAP test signal is not allowed for the QuickAmp

Chapter 8 Amplifier-specific properties

This chapter contains detailed information on using the amplifiers of the *BrainAmp* family, *QuickAmp*, *V-Amp, FirstAmp*, *actiCHamp* and *NI 6071e A/D* converter board from National Instruments and on using the *Simulated Amplifier* option.

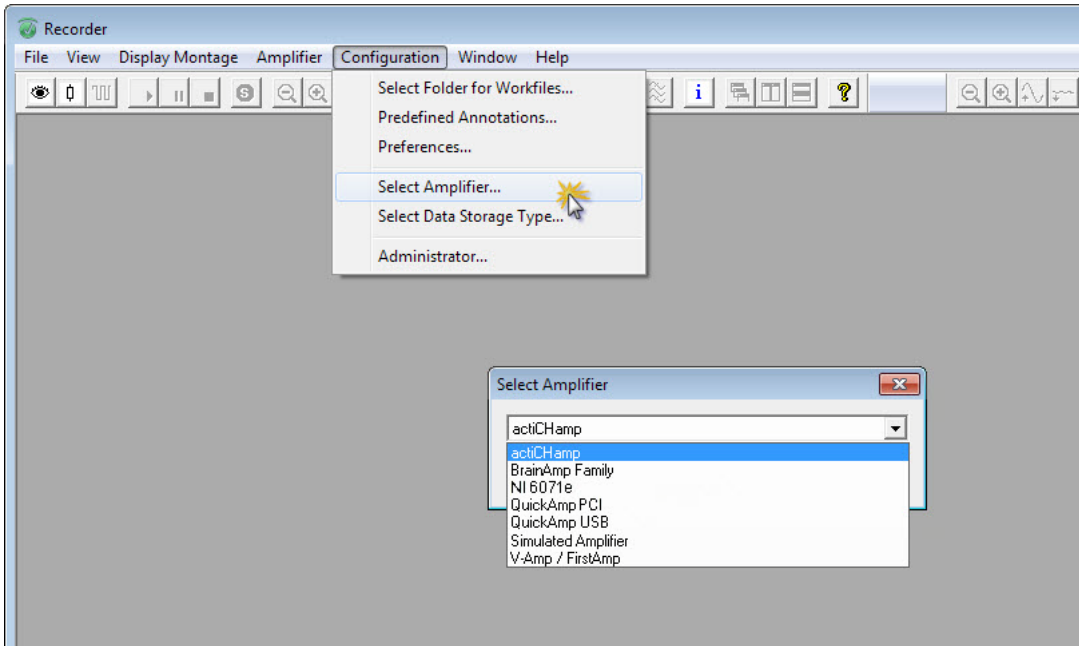


Figure 8-1. Selecting an amplifier[1]

Important note

Please observe the hardware compatibility with Windows® operating systems as described in Chapter 1.

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

8.1 Amplifiers of the BrainAmp family

8.1.1 Creating and editing a workspace for the BrainAmp

You can create or edit an existing workspace in the **File** menu.

For a detailed description of the configuration options for *BrainAmp* workspaces please refer to Chapter 4.

8.1.2 Impedance measurement

With the *BrainAmp*, we distinguish between three groups of electrodes that are measured separately: EEG electrodes (“Data”), 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 and attach them to the test subject.

2 Measure the EEG electrodes. You can choose from five measuring ranges: 100, 50, 20, 10 and 5 kOhm.

   Start with the largest range. If all electrodes are in a high-impedance state, check that the reference and ground electrodes are connected firmly. If you want to define other measuring ranges, you can do so by clicking **Settings...** (Figure 8-2).

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

   Note that the measurement range for the reference and ground electrodes is from 0 through 10 kOhm or from 0 through 100 kOhm.

4 Finally measure the ground electrode.

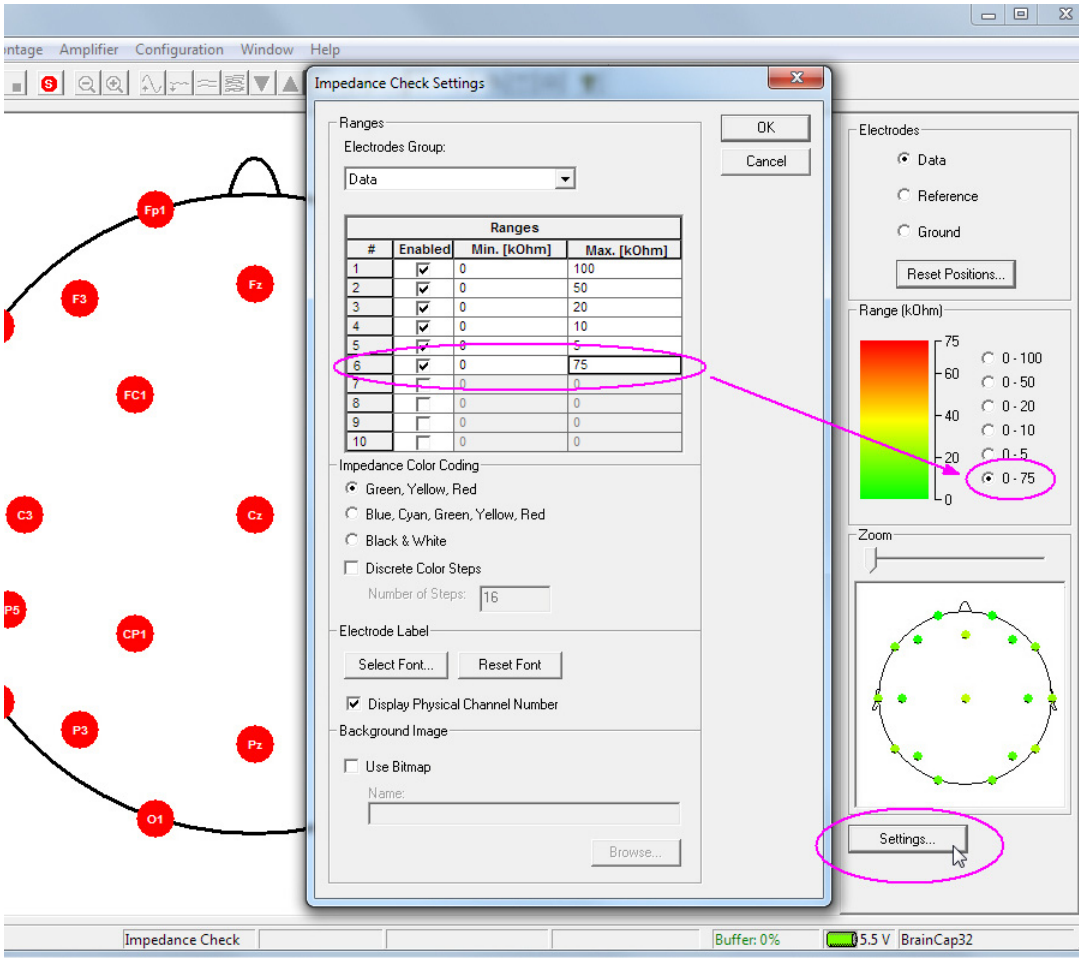


Figure 8-2. Adjusting the settings for impedance measurement with BrainAmp

You will find information on impedance measurement for passive electrodes in Section 6.1 and on impedance measurement for active electrodes in Section 7.4.

8.1.3 Using the test signal for the BrainAmp

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 *Test Signal* button. A signal with an amplitude of 50 μV_{pp} (square) or 100 μV_{pp} (sine) is shown. You can choose the signal shape (square or sine) by choosing **Amplifier › Test Signal Values...** from the menu. The **Frequency [Hz]** text box allows you to specify the frequency of the signal in a range 1 through 50 Hz.

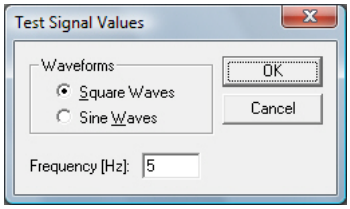


Figure 8-3. Selecting the shape and frequency of the test signal for BrainAmp

8.1.4 Configuring the digital port (marker port) for the BrainAmp

The amplifier's PCI adapter card or USB2 Adapter incorporates a 26-pin HD D-sub socket for recording events synchronous with the EEG such as stimuli or test subject responses. The socket contains 16 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.

Notice

Note that the BrainAmp's digital port is designed only to receive triggers. Never connect the USB2 Adapter or the PCI Adapter Card to the trigger input of stimulation devices using the trigger cable.

You will find the pinout of the digital port in the Operating Instructions for the *BrainAmp* (MR).

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

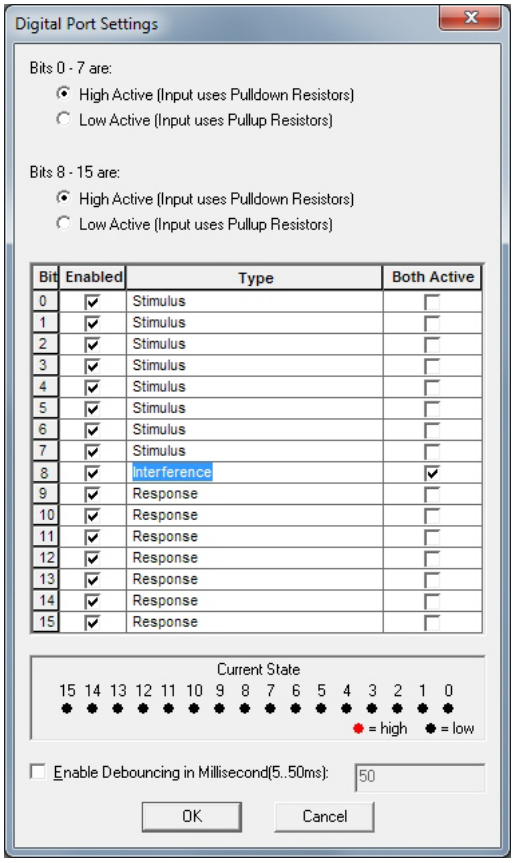


Figure 8-4. Configuring the digital port for BrainAmp

For each group of 8 bits (bit 0 through 7 and bit 8 through 15) you can define whether the trigger signals are interpreted as high-active (5 V = active) or low-active (0 V = active). In addition, pull-down (high-active) or pull-up (low-active) resistors with a value of 4.9 kOhm are switched to ground or 5 volts at each input.

You can also record the length (or duration) of the generated trigger by selecting the **Both Active** box for the required bit.

Note that only one bit line can be used for this at any time. In addition, you must choose a *unique* name for the marker type so that the corresponding bit line can be precisely identified.

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.

In the **Enabled** column of the table (Figure 8-4), 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.

Additional marker type for DC measurements

The marker type “DC Correction” is also available if you are carrying out a DC measurement (Figure 8-5). You can define this at any bit position (0 through 15) you choose.

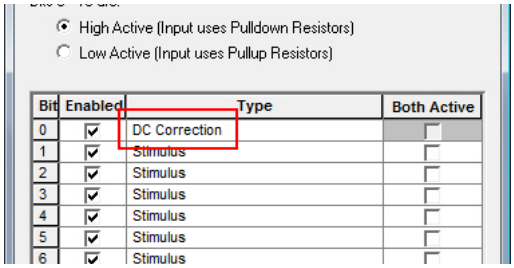


Figure 8-5. Additional marker type “DC Correction” during DC measurements

DC offset correction is automatically performed when this marker 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 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 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.

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.

8.1.5 ExG AUX Box

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

You must activate the *ExG AUX Box* in the workspace in order to be able to use sensors for measuring temperature, skin conductivity, etc. To do this, choose **File › Edit Workspace...** from the menu, open the page *Edit Workspace – Amplifier Settings*, and select the **Use ExG AUX** box (Figure 8-6).

If installation has been carried out correctly, the AUX channels are always the last eight physical channels (see lower highlighted section in Figure 8-6). 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.

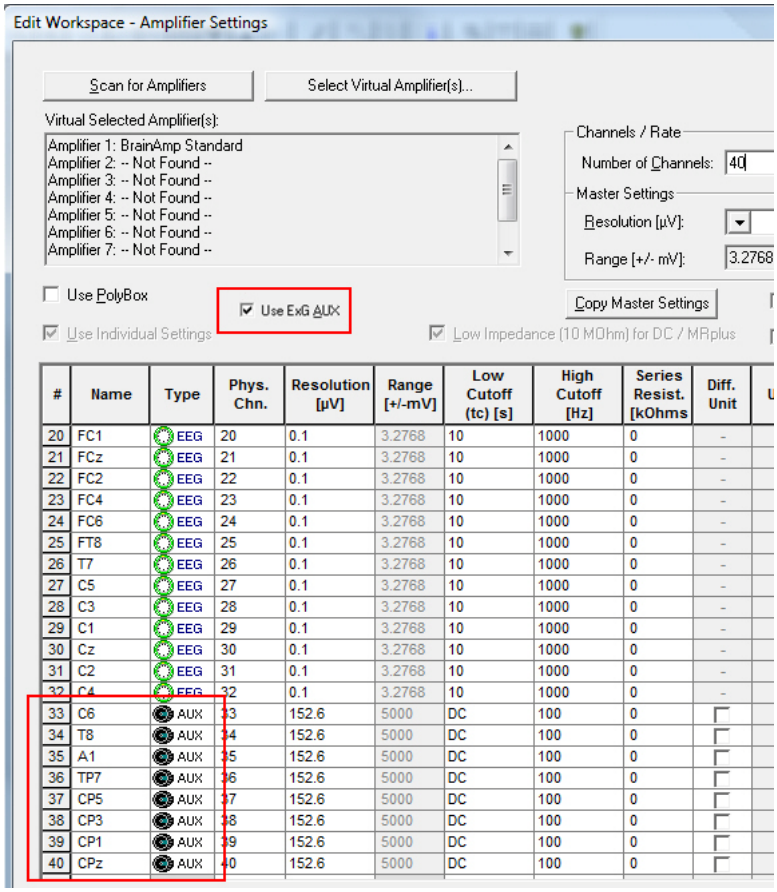


Figure 8-6. Using the ExG AUX Box and displaying the AUX channels

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

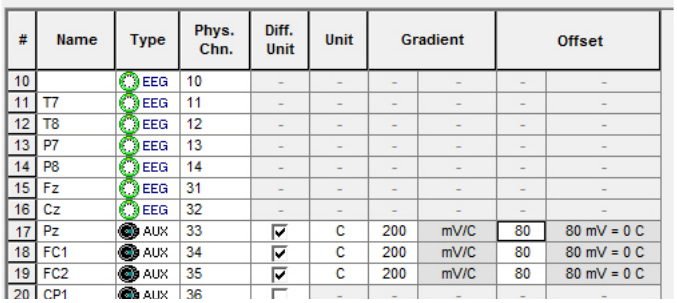


Figure 8-7. Additional settings for AUX channels

Column	Setting
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.

Table 8-1. AUX channel settings

Column	Setting
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.

Table 8-1. AUX channel settings

Setting up a GSR-MR channel

If you are using the *GSR-MR* module with the *ExG AUX Box*, you can set up a *GSR-MR* channel in the workspace. The input signals for the *GSR-MR* module must be corrected due to the resistors fitted in the electrodes. Proceed as follows to load the corrected values (Figure 8-8):

1 In the table, select the box in the **Diff. Unit** column.

2 Move the mouse pointer to the name of the corresponding channel and click once.

3 The selection arrow of the associated drop-down list appears in the cell. Choose the entry “GSR_MR_100_xx” from the list. You can modify the end of the channel name (“xx”).

Do not, however, change any of the other characters in the name of the GSR-MR channel!

4 *Recorder* now automatically loads the correction values.

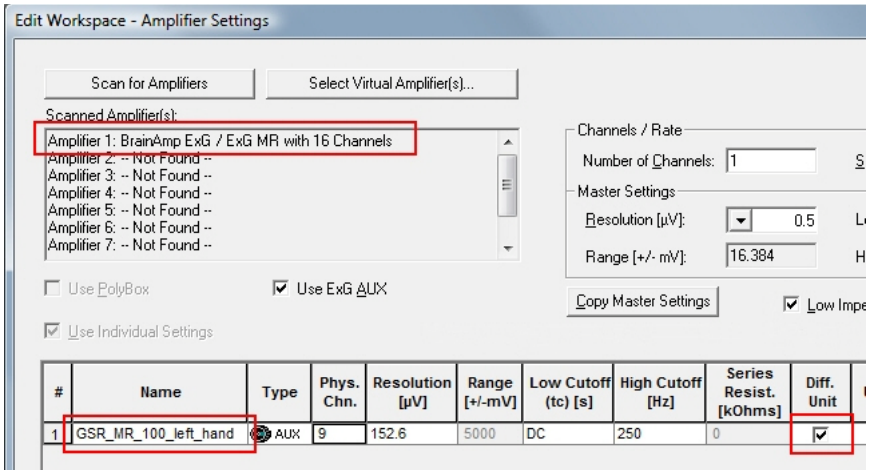


Figure 8-8. Setting up a GSR-MR channel

You will find detailed information on using the *GSR-MR* module in the relevant operating instructions.

8.1.6 SyncBox

The *SyncBox* is used to synchronize the sampling rate of the *BrainAmp (ExG) MR/BrainAmp MR plus* with the clock rate of the MR scanner in order to ensure the stability of EEG recording during MR acquisition. Choose **Amplifier › SyncBox Settings...** from the menu to access the *SyncBox* settings.

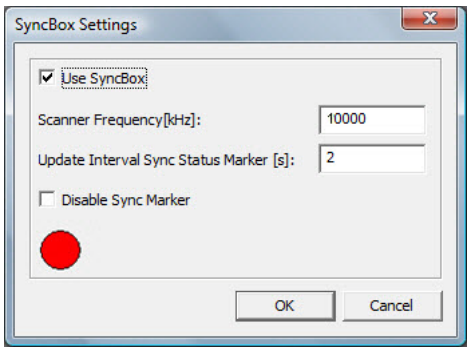


Figure 8-9. SyncBox settings

NEW

The **Scanner Frequency** should be a value that is divisible by 5 kHz, for example 10,000 kHz.

If you select the **Use SyncBox** box, the SyncBox icon appears in the status bar in both monitoring mode and save mode in the *Recorder* (Figure 8-10). A green icon indicates that synchronization is on and a red icon indicates that synchronization is off.

In addition, any change to the synchronization status is indicated by markers and stored in save mode.

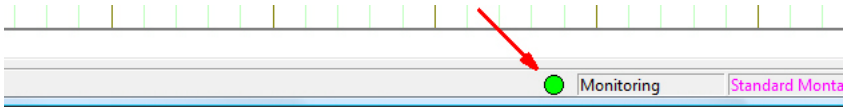


Figure 8-10. Icon indicating status of SyncBox

The **Scanner Frequency [kHz]** 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). This means that the value 20,000 in Figure 8-9 represents a 20 MHz input signal at the *SyncBox*.

Select or deselect the **Disable Sync Marker** box to specify whether or not synchronization markers are to be written during synchronization. If you use this function, markers are written to the data stream every few seconds indicating the synchronization status by “in sync” or “out of sync”. Only select this box if you do not want this to happen.

The **Update Interval Sync Status Marker [s]** text box allows you to specify the frequency with which these markers are written.

8.1.7 Displaying the connected BrainAmp amplifiers

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

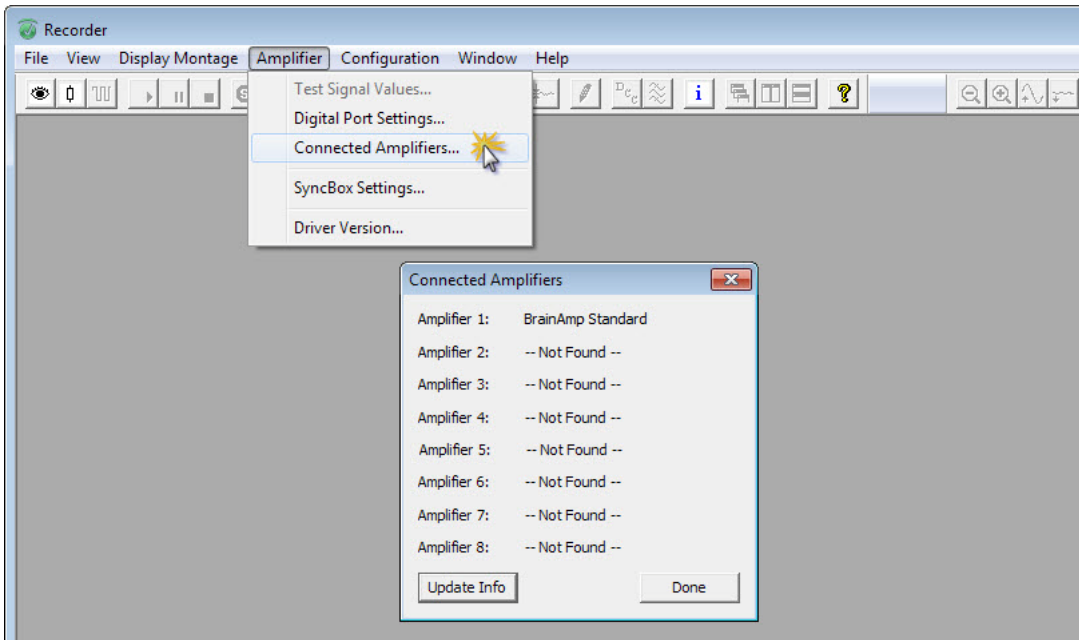


Figure 8-11. List of connected BrainAmp amplifiers

8.2 QuickAmp PCI and QuickAmp USB

If you wish to use a *QuickAmp USB* amplifier with a Windows® 64-bit operating system (except Windows® 8 64-bit) you need to install the driver separately.

8.2.1 Creating and editing a workspace for the QuickAmp

Choose **File › New Workspace...** from the menu. After you have made all the file-specific and folder-specific settings described in Section 4.2, open the *New Workspace – Amplifier Settings* page (Figure 8-12).

You will find a description of the settings for filters and segmentation/averaging in Section 4.2.3 and Section 4.2.4.

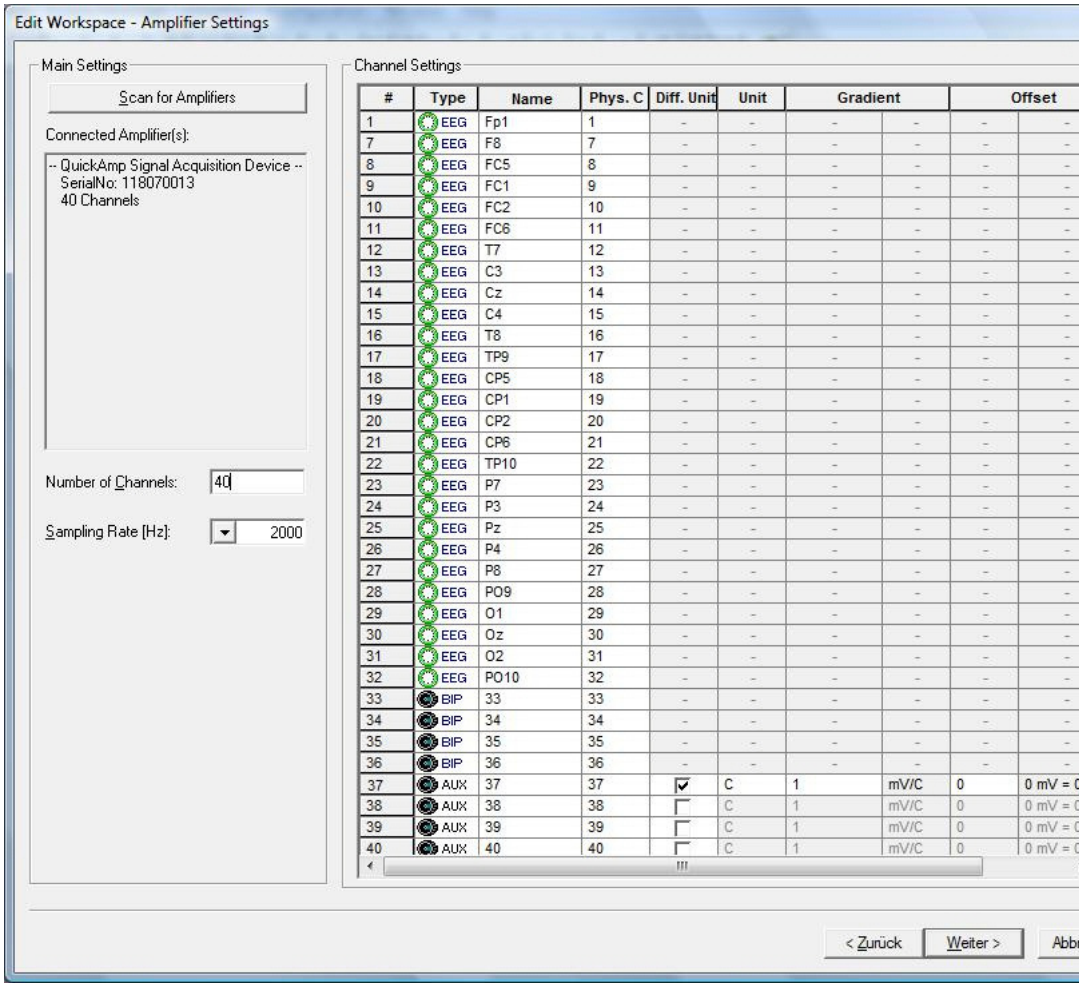


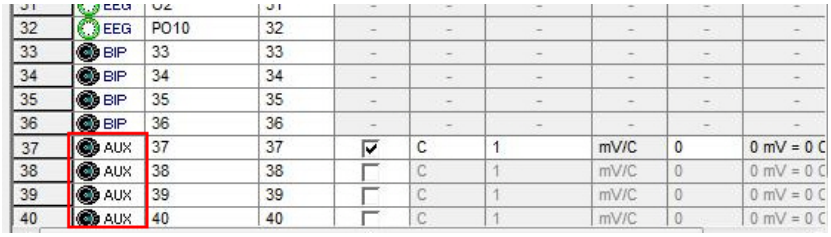
Figure 8-12. Editing a QuickAmp workspace

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 of the QuickAmp

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 (Figure 8-13), 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 8-13. 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.

8.2.2 Using the test signal for the QuickAmp

To display and record a test signal, attach the supplied signal tester to the *QuickAmp* via the electrode input socket. In the toolbar, click the *Test Signal* button. A square wave signal is generated and displayed.

Note

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

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

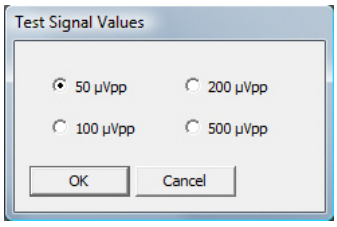


Figure 8-14. Configuring the test signal for the QuickAmp

8.2.3 Configuring the digital port (marker port) for the QuickAmp

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*.

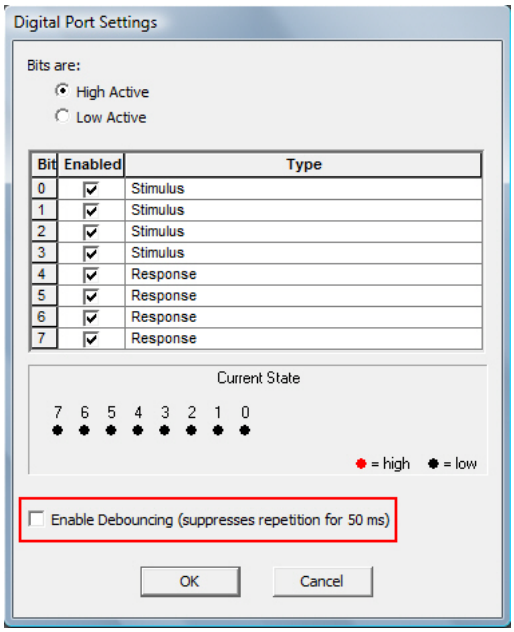


Figure 8-15. Configuring the digital port for the QuickAmp PCI

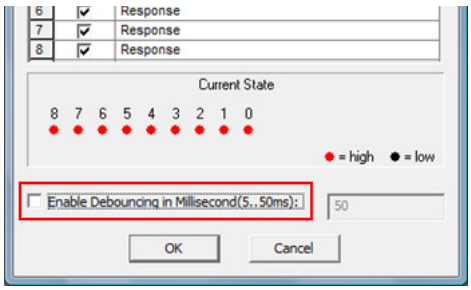


Figure 8-16. Configuring the digital port for the QuickAmp USB

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.

8.3 V-Amp and FirstAmp

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

8.3.1 Creating and editing a workspace for the V-Amp/FirstAmp

Choose **File › New Workspace...** from the menu. After you have made all the file-specific and folder-specific settings described in Section 4.2, open the *New Workspace – Amplifier Settings* page (Figure 8-17).

You will find a description of the settings for filters and segmentation/averaging in Section 4.2.3 and Section 4.2.4.

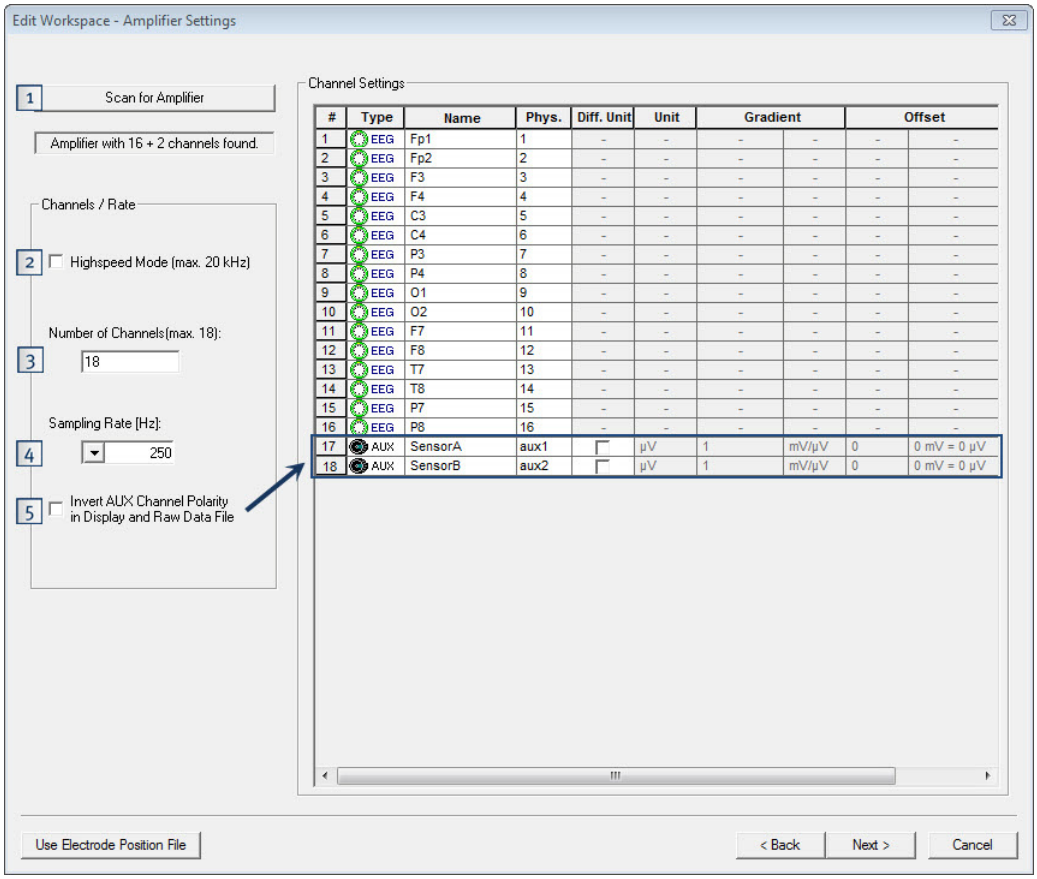


Figure 8-17. Editing a workspace for the V-Amp/FirstAmp

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 (Figure 8-18 and Figure 8-19). The AUX inputs are used to connect external sensors to measure temperature, skin conductivity, etc.

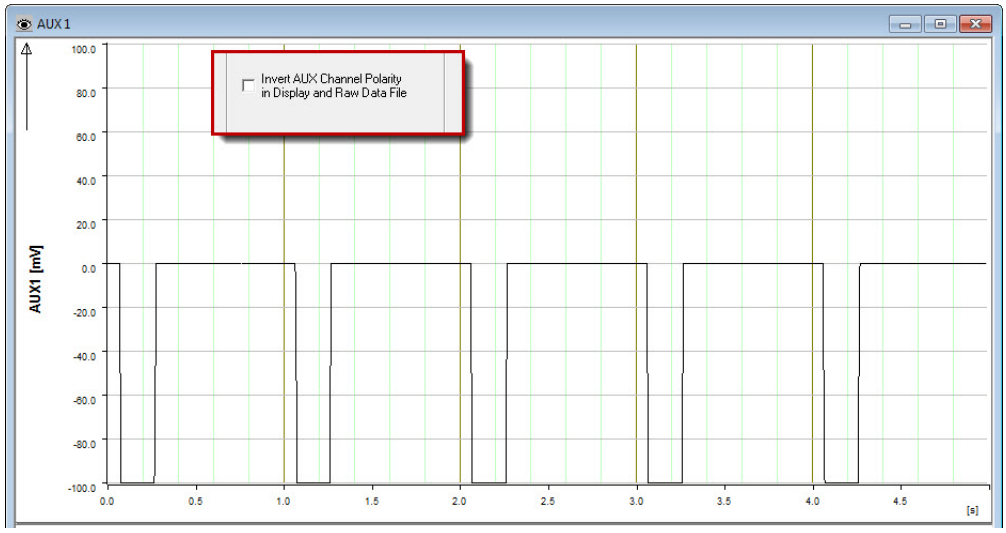


Figure 8-18. AUX 1 channel not inverted (box not selected)

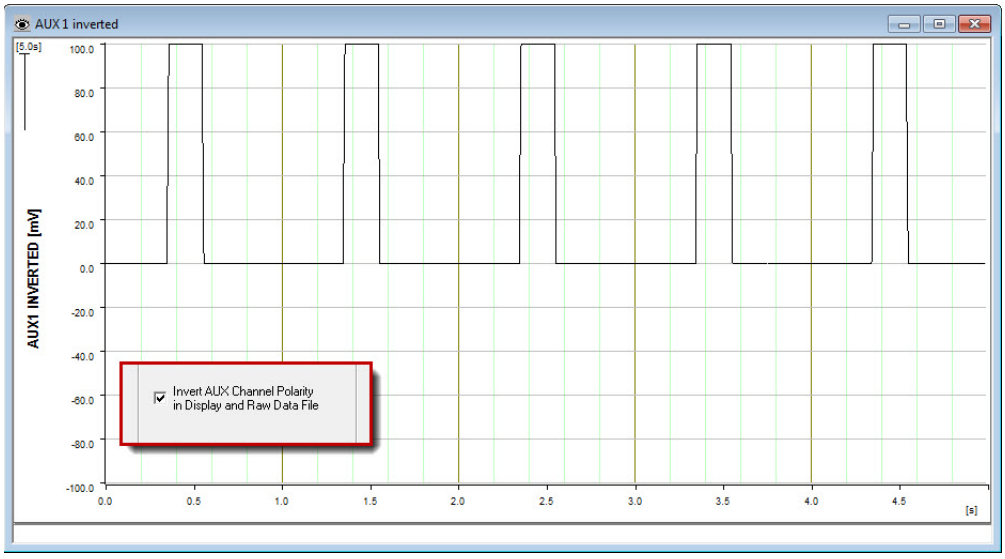


Figure 8-19. AUX 1 channel inverted (box selected)

You can also make the following settings:

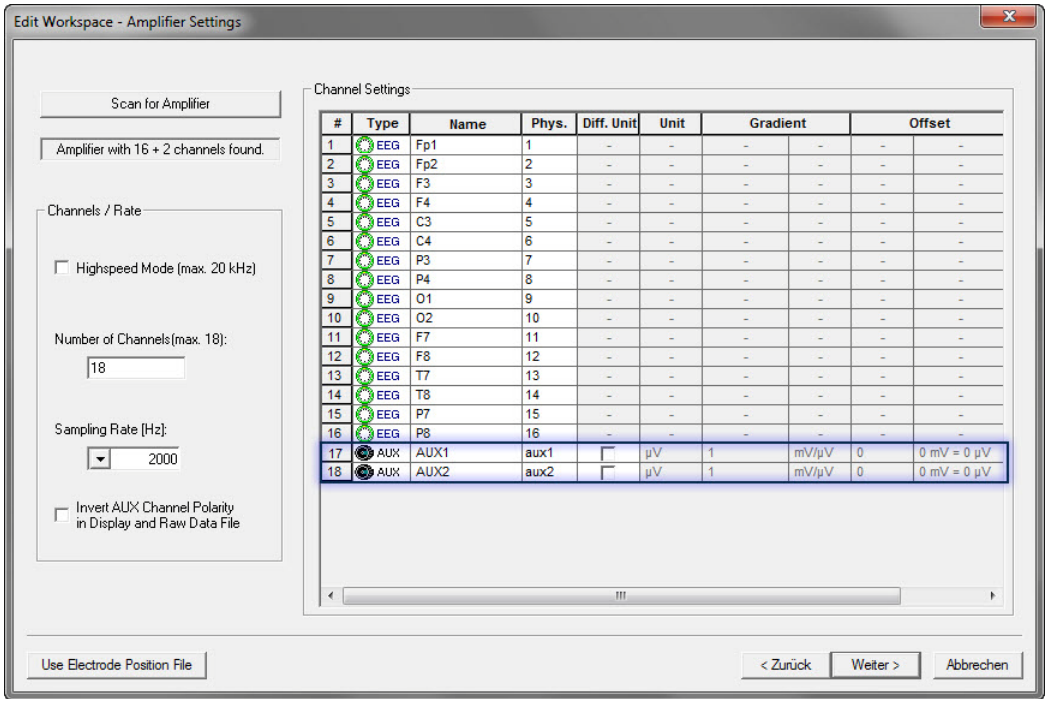


Figure 8-20. V-Amp, AUX channels

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.

8.3.2 Configuring the digital port (marker port) for the V-Amp/FirstAmp

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 1* port (jack) of the amplifier. All the remaining bits are located on the *Trigger 2* port.

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

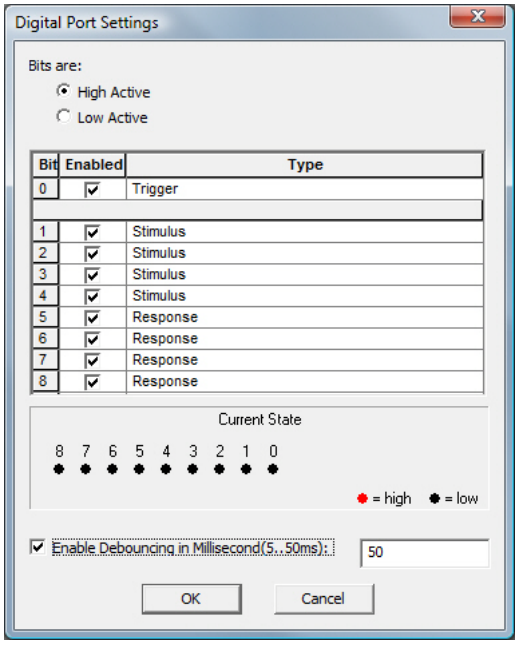


Figure 8-21. Configuring the digital port for the V-Amp/FirstAmp

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 Table 8-2. 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

Table 8-2. Recommended minimum length for trigger signals (V-Amp)

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.

8.4 Simulated Amplifier

The Simulated Amplifier function allows you to use the *Recorder* without having an amplifier connected and to display an EEG that has already been recorded. It simulates the activity of up to 256 channels. The menu bar does not contain the **Amplifier** item if you are using the Simulated Amplifier function.

Creating and editing a workspace

Choose **File › New Workspace...** from the menu. After you have made all the file-specific and folder-specific settings described in Section 4.2, open the *New Workspace – Amplifier Settings* page (Figure 8-22).

You will find a description of the settings for filters and segmentation/averaging in Section 4.2.3 and Section 4.2.4.

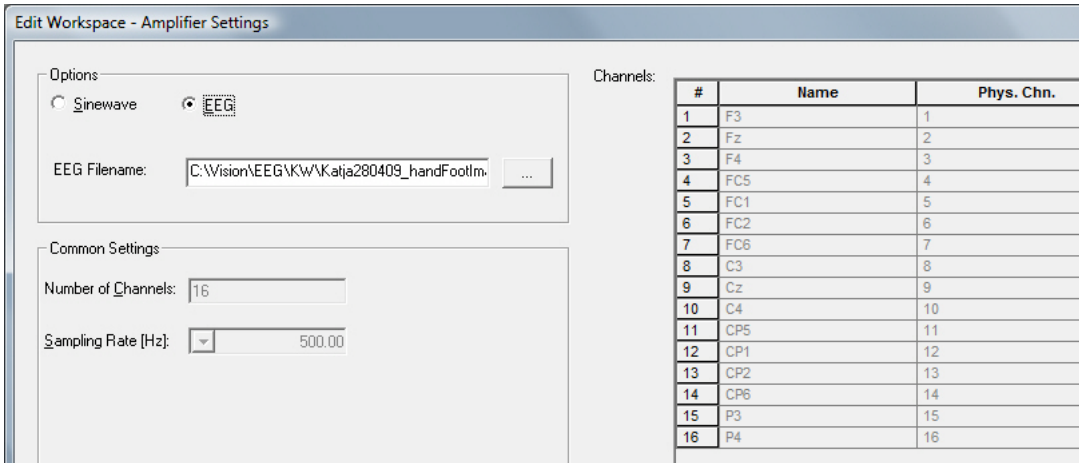


Figure 8-22. Editing a workspace for Simulated Amplifier

The **Sinewave** and **EEG** options are available:

- If you select the **Sinewave** option, sine waves are displayed in monitoring mode. The sine waves vary from channel to channel.
- If you select the **EEG** option and then click the ... button, a dialog box appears allowing you 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.

In the case of the **Sinewave** option, you can enter the number of channels in the **Number of Channels** text box and the sampling rate in the **Sampling Rate [Hz]** text box.

Simulated workspace

When you select the Simulated Amplifier, a separate workspace (the “simulated” workspace) is created and the parameters for this workspace are taken from the most recent workspace based on a real amplifier.

If you edit the simulated workspace, you can make changes 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).

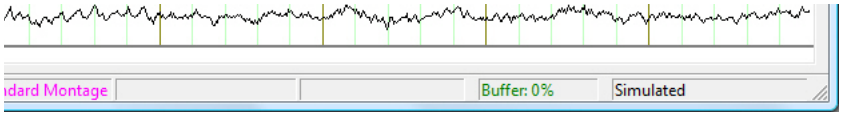


Figure 8-23. Display of the simulated amplifier workspace in the status bar

Do not under any circumstances modify the file properties of the simulated workspace (right click on the icon **Simulated.rwksp › File › Properties**).

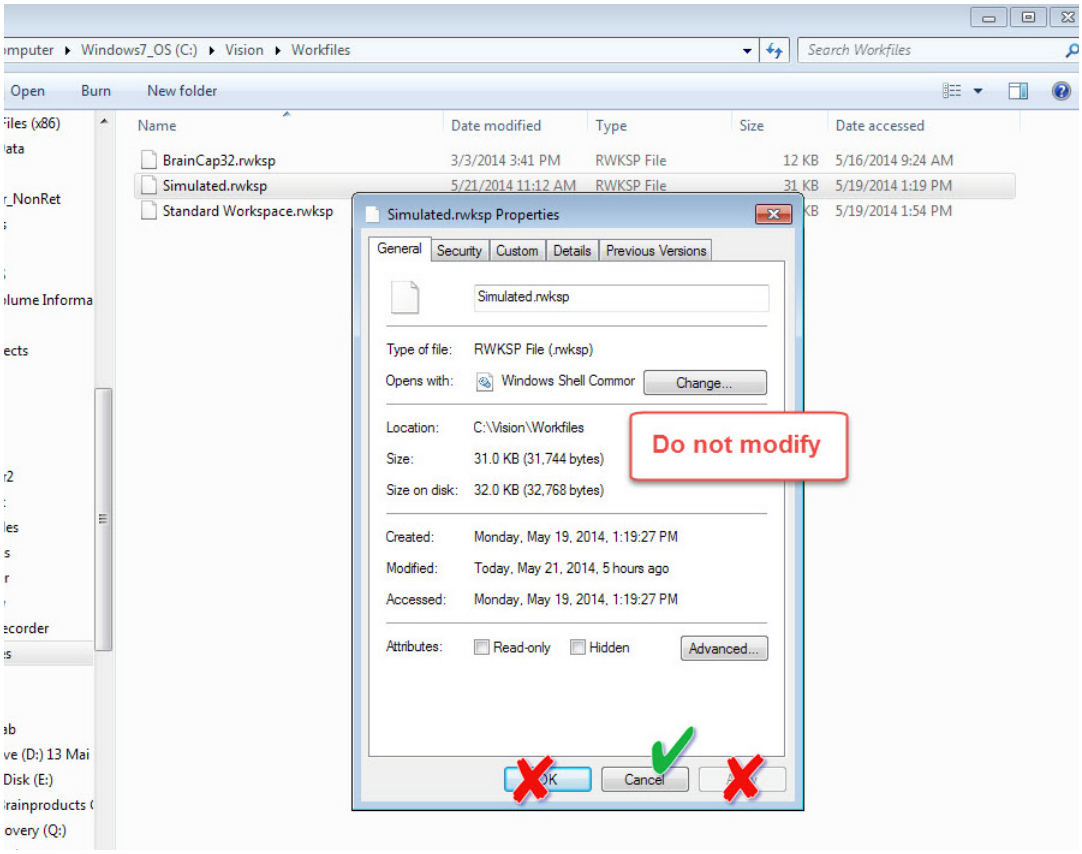


Figure 8-24. Properties of the simulated workspace file

8.5 National Instruments NI 6071e A/D converter board

You can also enable EEG analog amplifiers to be connected to the Recorder using the A/D converter board from National Instruments. The board converts the analog signals of the amplifier into digital signals. *Recorder* treats the card just like an amplifier.

Notes

- The A/D converter board does not provide any electrical isolation between the inputs and the computer. You must therefore ensure that the amplifier used guarantees the prescribed electrical patient isolation at the analog outputs.
- The A/D converter board is only supported by Windows® 32-bit systems. Please refer to Chapter 1 for further information.

8.5.1 Installing the A/D converter board

Note

Do NOT use the CD supplied by National Instruments to install the A/D converter board. The drivers on this CD are not compatible with the Recorder.

Use only the *BrainVision Program* DVD to install the A/D converter board, as you will only find the appropriate drivers here.

Carry out installation as follows:

1 Install the Recorder.
2 Shut down the computer.
3 Insert the A/D converter board in a free PCI slot in your computer.
4 Restart the computer.
5 The *New Hardware* wizard will prompt you for the driver for the new hardware.
6 Insert the *BrainVision program DVD* in the DVD drive and follow the instructions in the setup program.

8.5.2 Editing the workspace for the A/D converter board

Choose **Configuration › Select Amplifier...** from the menu and select the entry *NI 6071e*. Choose **File › New Workspace...** from the menu. Make the file and directory specific settings as described in

Section 4.2, open the workspace assistant and go to the page *New Workspace – Amplifier Settings* page (Figure 8-25).

For filter settings and segmentation/averaging please refer to Section 4.2.3 and Section 4.2.4.

Note that the parameter names reflect the terminology used by National Instruments and their meanings may differ from the terms used in neurophysiological research.

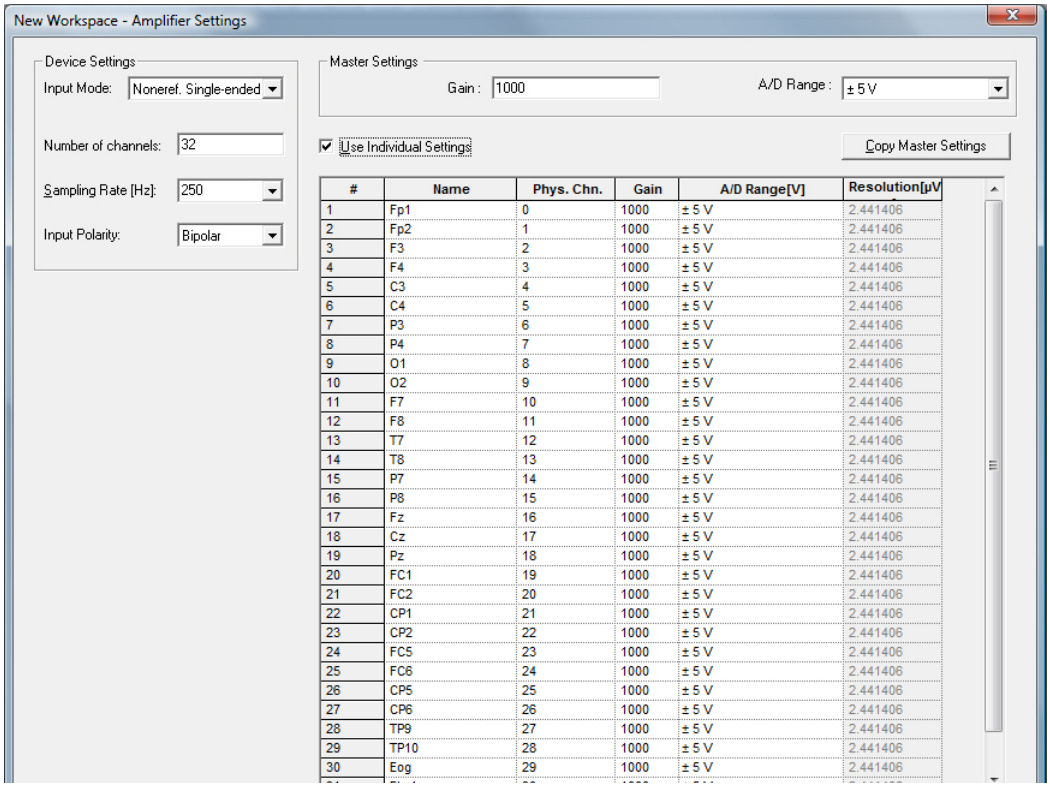


Figure 8-25. Editing a workspace for the A/D converter board

In the *Device Settings* group box, you can set the *Input Mode*. This must match your chosen wiring configuration. You have three options here (Figure 8-26):

- **Differential.** Every channel has its own reference. A total of 32 channels are available.
- **Noneref. Single-ended**. Unipolar without a connection to ground. The reference point for all channels is the “AISENSE” terminal.
- **Ref. Single-ended**. Unipolar with a connection to ground. The reference point for all channels is the “AIGND” terminal.

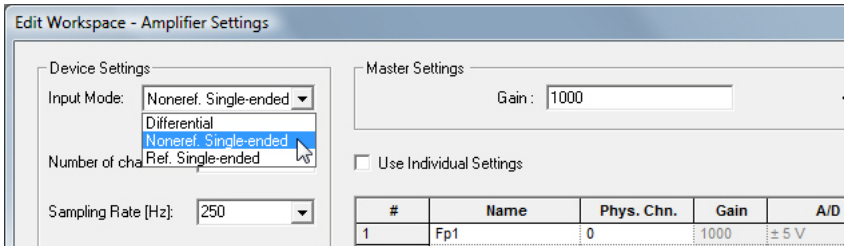


Figure 8-26. Selecting the input mode for the A/D converter board

You can also specify the **Number of Channels**, **Sampling Rate** and the **Input Polarity**. The maximum sampling rate depends on the number of channels. With up to 16 channels, you can perform sampling at 2,048 Hz, with 32 channels, sampling can be performed at 1,024 Hz and with 64 channels, the maximum value is 512 Hz. The input polarity indicates whether the amplifier supplies a symmetrical or asymmetrical output signal.

The **A/D Range** drop-down list allows you to specify the recording level range of your amplifier.

The **Gain** text box allows you to enter the gain of the amplifier. If you do not know the gain, you can determine it empirically. To do this you require a calibration signal which is fed into the amplifier. Choose a realistic gain, for example 1,000, and then record a short data sequence. Measure the values in A*nalyzer*. You can now correct the gain by comparing the actual value with what it should be.

Example: Set the gain to 1,000 and feed in a test voltage of 100 µVpp. The voltage measured in the Analyzer is 120 µVpp, for instance. Correct the gain: new value = old value * 120 µV / 100 µV = 1200. Now enter the new value and repeat the test. The value of the signal feed and the measured value should now match.

If you require individual settings for each channel, select the **Use Individual Settings** box.

8.5.3 Configuring the digital port (marker port) for the A/D converter board

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...**

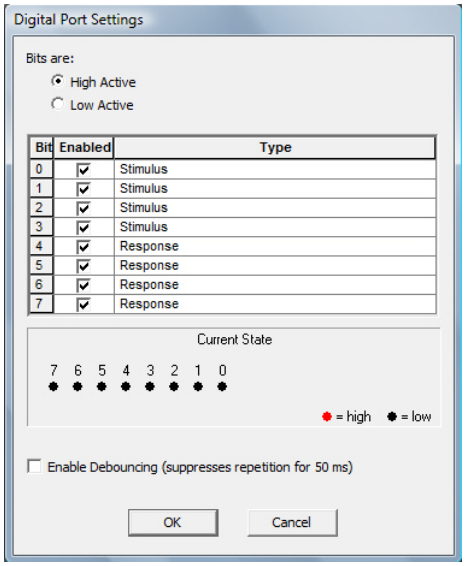


Figure 8-27. Configuring the digital port for the A/D converter board

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.

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 (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.

Note that 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.

8.6 actiCHamp

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

Windows experience index	› 5.0
Processor	Intel® Core™ 2 Quad processor, 2.4 GHz or compatible
Graphics adapter	1280 x 1024 pixel resolution and min. 512 MB internal memory
RAM	4 GB of RAM

8.6.1 Creating and editing a workspace for the actiCHamp

Choose **File › New Workspace...** from the menu. Make the file and directory specific settings as described in Section 4.2, open the workspace assistant and go to the page *New Workspace – Amplifier Settings* page (Figure 8-28).

For filter settings and segmentation/averaging please refer to Section 4.2.3 and Section 4.2.4.

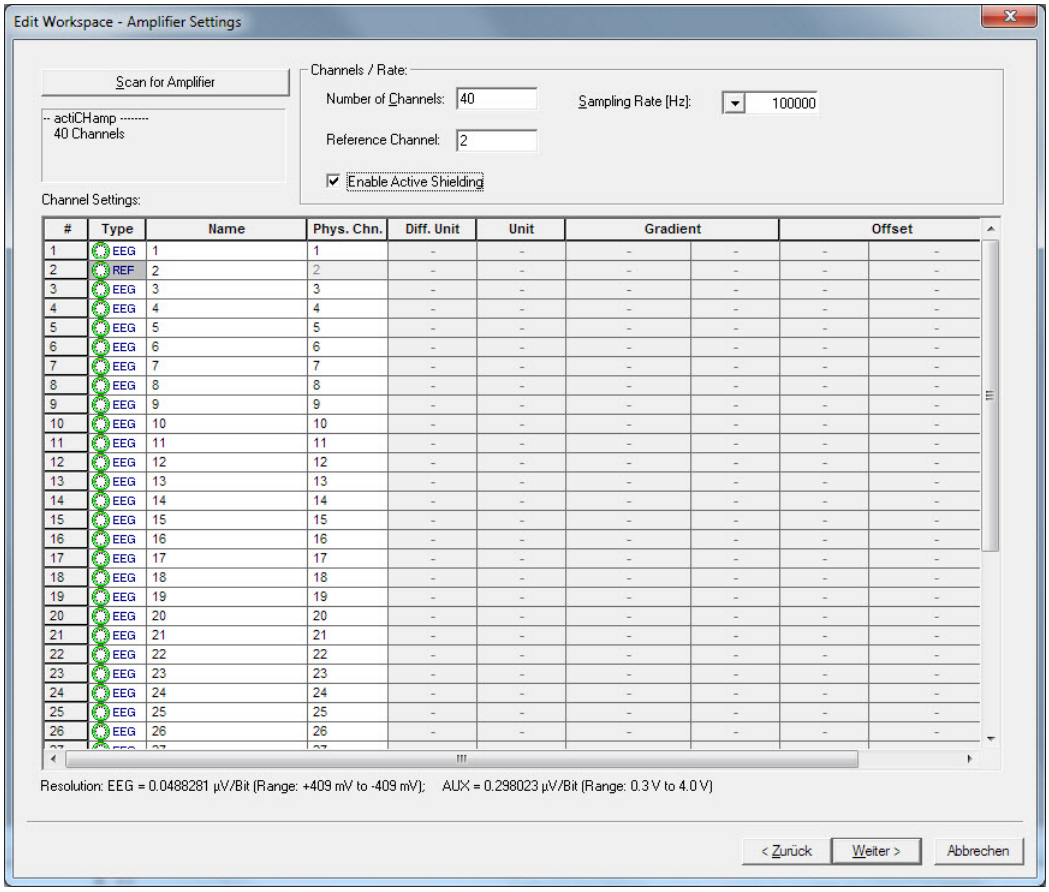


Figure 8-28. Editing a workspace for the actiCHamp

Click **Scan for Amplifier**. The *actiCHamp* amplifier connected to your computer is displayed in the dialog box.

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

Enter the physical channel number of the reference channel in the **Reference Channel** text box. 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.

Enter the sampling rate in the **Sampling Rate [Hz]** text box. The minimum sampling rate is 100 Hz. Please note that the maximum sampling rate depends on the number of channels used.

Number of channels	**Maximum sampling rate**
32 EEG channels + 8 AUX channels	100 kHz
64 EEG channels + 8 AUX channels	50 kHz
160 EEG channels + 8 AUX channels	25 kHz

Table 8-3. actiCHamp sampling rate

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. If you want to use this mode, select the **Enable Active Shielding** box. The Recorder then automatically switches to active shielding mode when you start it.

Note

The gain is set to 5 when active shielding mode is started.

Adjusting the sensors for the AUX inputs of the actiCHamp

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.

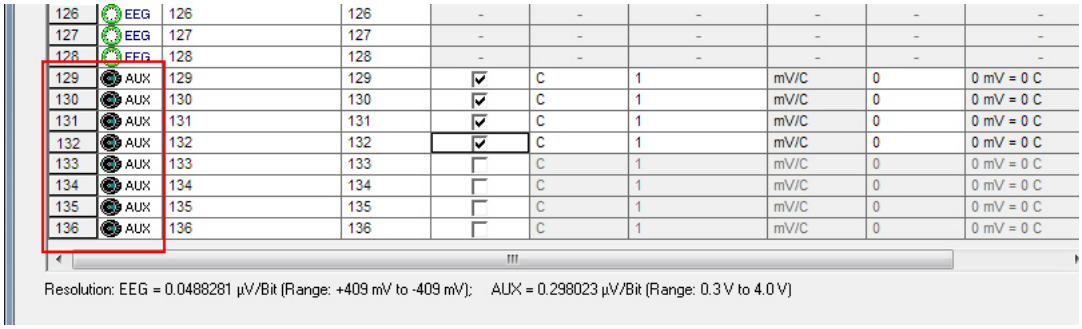


Figure 8-29. actiCHamp, AUX channels

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.

8.6.2 Configuring the digital port (marker port) for the actiCHamp

Use the trigger connectors on the rear of the actiCHamp (labeled *Trigger In* and *Trigger Out*) for recording events that are synchronous with the EEG such as stimuli or test subject responses. The trigger connections have eight trigger lines and therefore eight bits each.

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

You will find the pinout of the digital port in the operating instructions for your *actiCHamp* amplifier.

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

Configuring the actiCHamp's trigger input

You can encode inbound triggers in the left-hand section of the dialog box (*Trigger In Port*).

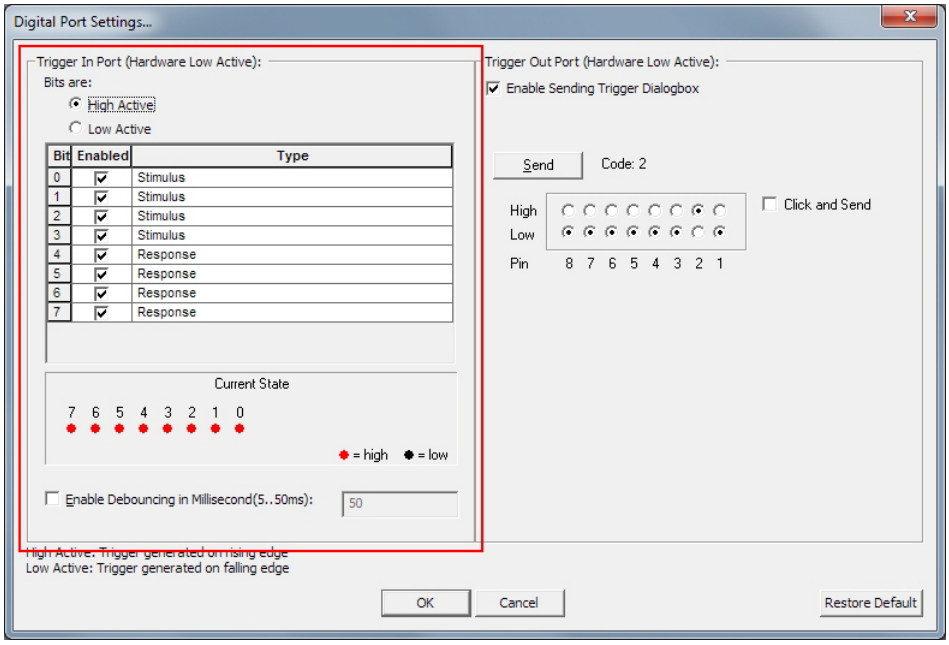


Figure 8-30. Configuration of the actiCHamp's trigger input

You can choose whether the signals are interpreted as high-active (5 V = active) or low-active (0 V = active). **High Active** means that the trigger is generated on a rising slope; **Low Active** means that it is generated on a falling slope.

Column	Setting
Enabled	specify whether the associated bit is to be evaluated

Table 8-4. actiCHamp, digital port settings

Column	Setting
Type	specify what time marker type each bit represents (for example Stimulus, Response). It is also possible to assign the same type to several different bits.
Current State	view the current status of the bit lines (active or inactive).

Table 8-4. actiCHamp, digital port settings

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.

To reset changed settings to their initial configuration, click **Restore Default** in the lower part of the dialog box.

NEW

Please take note of the recommended minimum length of the trigger signal for various sampling rates in Table 8-5. Shorter signal lengths can result in errored 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
100000 Hz	0.02 ms

Table 8-5. Recommended minimum length for trigger signals (actiCHamp)

Configuring the actiCHamp's trigger output

You can encode outbound triggers in the right-hand section of the dialog box (**Trigger Out Port**).

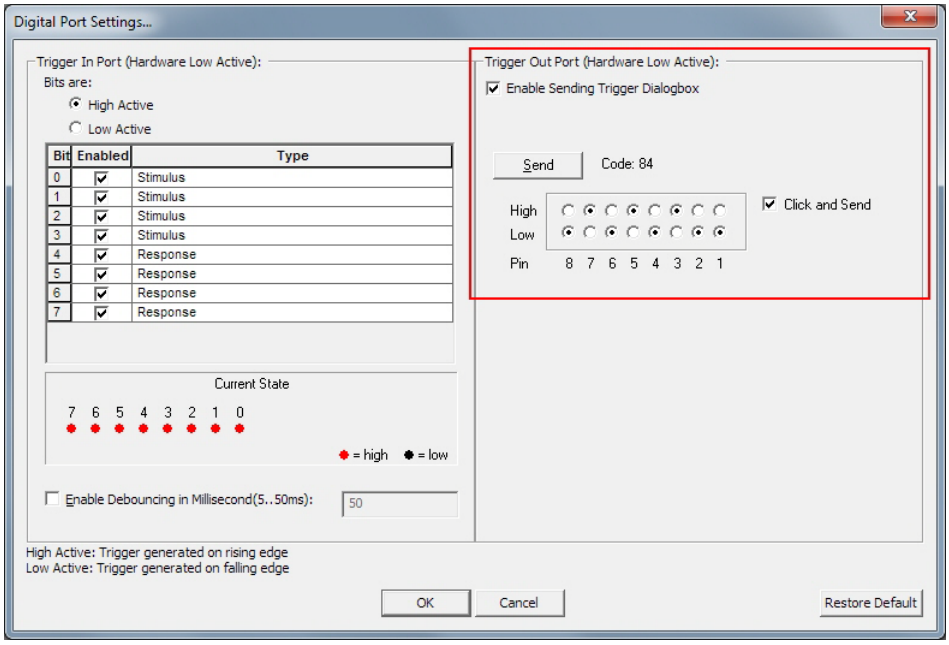


Figure 8-31. Configuration of the actiCHamp's trigger output

If you want to be able to send triggers from the trigger port, select the **Enable Sending Trigger Dialogbox** box.

When you click the **Send** button, the trigger encoded here is sent to the trigger output.

You can also send triggers manually during recording (Figure 8-32): If you select the **Click and Send** box, 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.

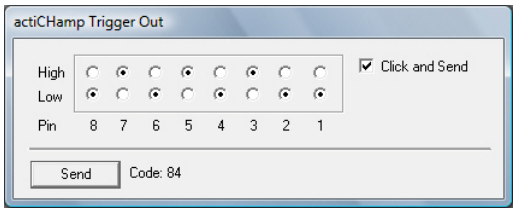


Figure 8-32. Sending triggers manually during operation

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

Table 8-6. actiCHamp, default digital port settings

8.6.3 Configuring the 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. These functions can be stored in a separate configuration file (extension: .MyBtn) in the Workfiles folder and then be called again in the predefined sequence.

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.

To make settings for the *MY-Button*, choose **Amplifier › Configurable MY-Button Settings...** from the menu.

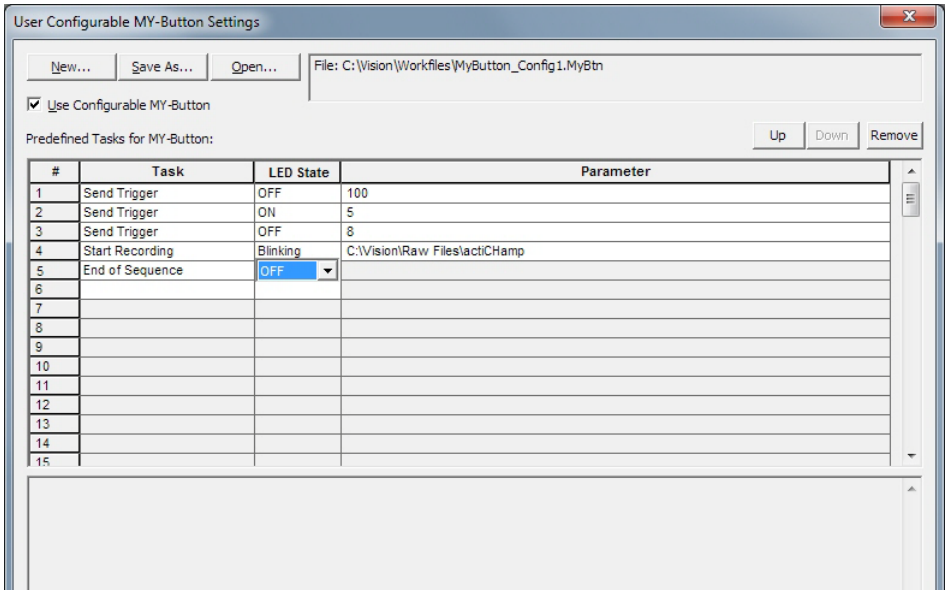


Figure 8-33. Configuring "MY-Button"

Restricting user privileges for the MY-Button

The administrator can restrict user privileges for the *MY-Button* function via the **Allow User Editing Amplifier Specific Settings** check box which is accessed by selecting **Configuration › Administrator...** from the menu (see also Section 5.1):

- If the **Allow User Editing Amplifier Specific Settings** box is not selected then the administrator can prohibit all access to the *MY-Button* by leaving the **Use Configurable MY-Button** box deselected (default setting).
- If the **Allow User Editing Amplifier Specific Settings** box (**Configuration › Administrator...** in the menu) is not selected and the *Use Configurable MY-Button* box (**Amplifier › Use Configurable MY-Button Settings...** in the menu) is selected then the user can use the predefined sequence of functions. However, in this case the user is not able to modify the sequence or load his or her own user-defined *MY-Button* configuration file.

If the **Allow User Editing Amplifier Specific Settings** box is selected then no restriction is placed on the way users configure and use the *MY-Button*.

Creating and using function sequences

To create a new function sequence, click **New...** in the dialog box. This also deletes any existing list of functions.

You can then choose **Save As...** to save the created sequence in a configuration file.

Open... then allows you to open the created configuration files. The configuration that is currently in use is displayed in the box next to the **Open...** button.

The **Up** and **Down** buttons allow you to change the sequence of the functions in the list. **Remove...** allows you to remove individual functions.

When you press the *MY-Button* on the actiCHamp, all the functions in the sequence are executed. There are two possibilities:

- Press briefly once to move on to the next function.
- Press and hold down the button (› 1 s) to go back to the previous function and run it again.

The functions that you have defined are displayed as markers and recorded.

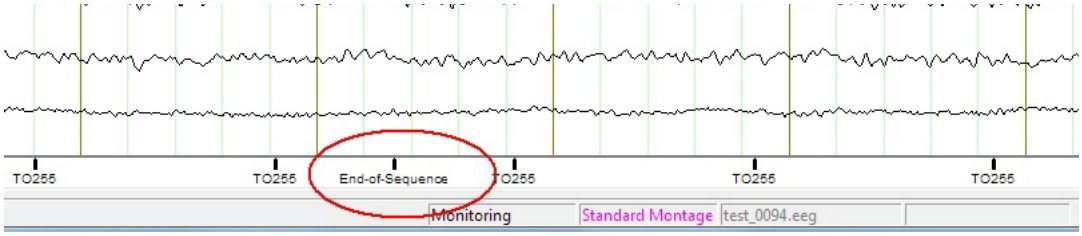


Figure 8-34. "MY-Button" functions as markers

You can select the individual functions available for assignment to the *MY-Button* from a drop-down list in the table under **Task** (Table 8-7).

In the **LED State** column, you can control how the LED on the *MY-Button* (On, Off, Flashing) is to respond to the execution of each function.

Function ("Task")	**Description**	**Settings ("Parameters")**
Start Monitoring	Switches into monitoring mode.	
Start Impedance	Switches into impedance mode.	
Start Testsignal	Switches into test signal mode.	
Start Recording	Starts data recording.	You must specify the name and storage location of the file manually (see also Figure 8-35).
Pause Recording	Interrupts recording.	
Resume Recording	Resumes recording.	
Stop Recording	Stops recording.	
Arbitrary Annotation	Displays a freely defined text as a marker and records this.	You can enter a text of your choice provided that you do not use special characters [$%-@/\\|;,:.].

Table 8-7. Selecting predefined functions for the "MY-Button"

Function (“Task”)	Description	Settings (“Parameters”)
Start Application	Starts an application.	You can select an application via the Windows® Explorer.
Press Keys	Executes a predefined key-board shortcut.	For the keyboard shortcuts that you can use here, see Appendix D as of page 188.
Send Trigger	Sends the trigger defined in the *Parameter* column to the trigger output.	You can enter values in the range 0 to 255.
End of Sequence	Ends the sequence.	

Table 8-7. Selecting predefined functions for the “MY-Button”

In the case of the functions **Start Recording, Arbitrary Annotation, Start Application, Press Keys** and **Send Trigger**, you can make additional settings in the **Parameter** column. To do this, double-click in the column and enter the settings in the dialog box that appears (Figure 8-35, example for the **Start Recording** function: You must enter storage information in the dialog box).

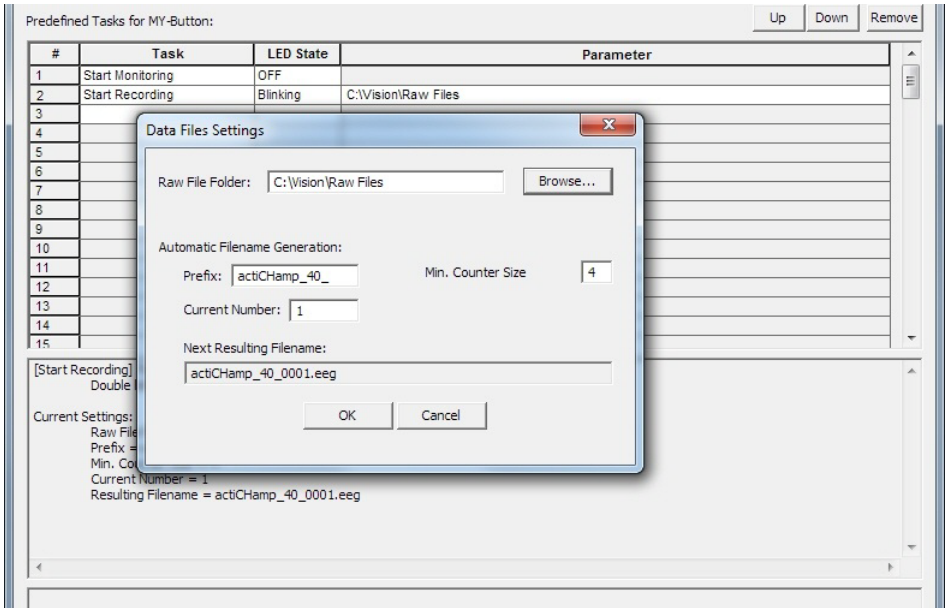


Figure 8-35. Settings for the “Start Recording” function

At this point, we would like to warn you explicitly about the use of the **Start Application** and **Press Keys** functions.

With regard to the **Start Application** function, please note: On the one hand, the real-time performance of *Recorder* may be impaired if you run an additional application on the computer on which recording is performed. This may result in a loss of data. On the other, under no circumstances should you connect stimulation devices to the parallel port of the computer on which *Recorder* is running.

With regard to the **Press Keys** function: Before including any given keyboard shortcut in your experiment, you should always make sure that this does not impair either your experimental paradigm or the recording of the data.

8.6.4 Information on driver versions

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

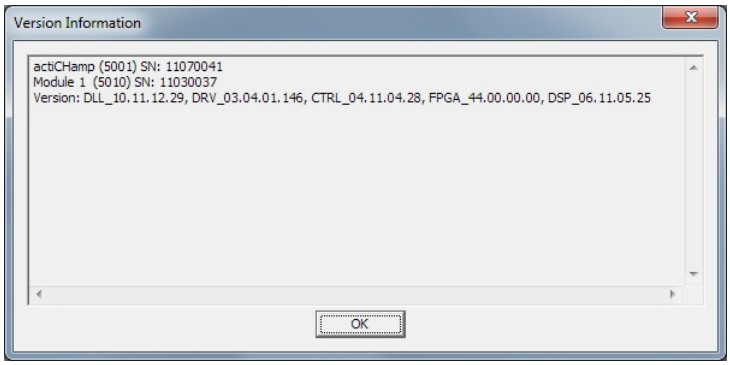


Figure 8-36. Driver versions

8.6.5 The actiCHamp window

The *actiCHamp* window is displayed in all operating modes.

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**.

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

On the *Memo* tab, you can see the functions you have assigned to the **MY-Button** (see also Section 8.6.3). At the most, the previous, current and next steps in a function sequence are displayed.

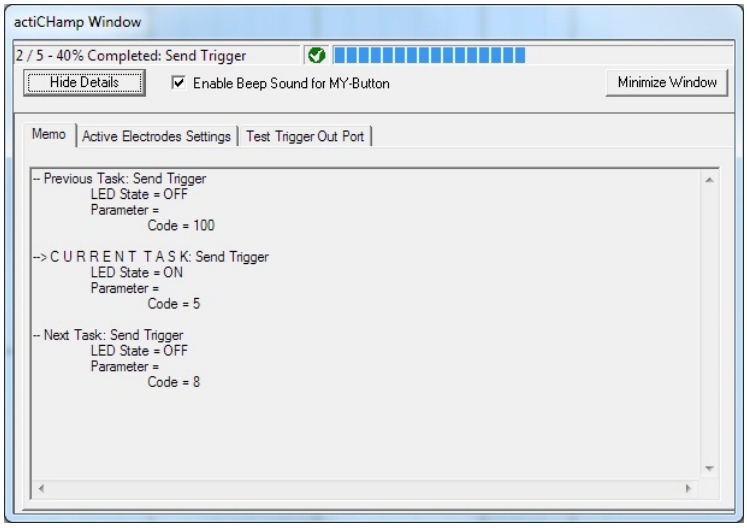


Figure 8-37. actiCHamp window, "MY-Button" functions

On the *Active Electrodes Settings* tab, you can modify the range of values for the LEDs of the active electrodes (Figure 8-38). The functions available on this tab can be accessed as soon as you switch the *Recorder* to impedance mode. You will find detailed information on impedance measurement for active electrodes in Section 7.4.

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.

Please note that this setting only controls the LEDs in the active electrodes. It does not affect the values in the *Impedance Check View*. You should take this into account during the visual check of the impedances.

When connecting the *actiCAP* electrodes to *actiCHamp*, make sure to align the connector correctly and to connect the electrode harnesses in the correct sequence: The bottommost slot in the amplifier is intended for the first branch (electrodes 1 through 32); the slot above this for the second branch (electrodes 33 to 64) etc. If you do not respect the correct sequence or incorrectly leave one or more slots free between the electrode branches then the *actiCHamp* will not recognize the electrode branches and it will not be possible to perform impedance measurement correctly.

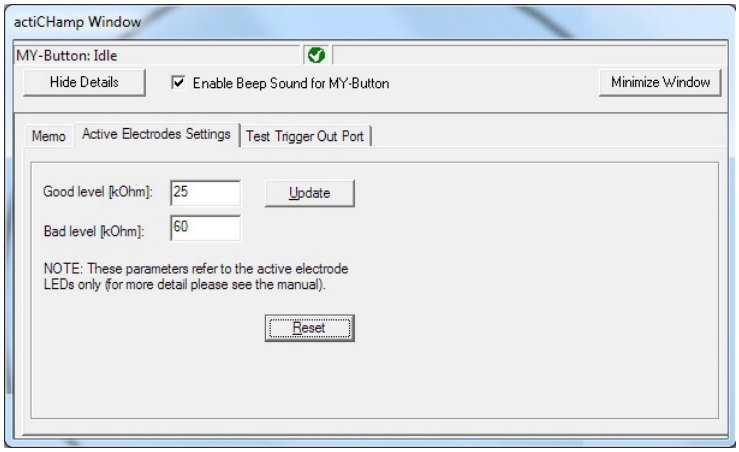


Figure 8-38. actiCHamp window, modifying value ranges for LEDs

The *Test Trigger Out Port* tab allows you to send triggers to the *actiCHamp's* trigger output (Figure 8-39). This function is only used to check that the trigger output is working properly. You will find detailed information on configuring the *actiCHamp's* trigger output in Section 8.6.2.

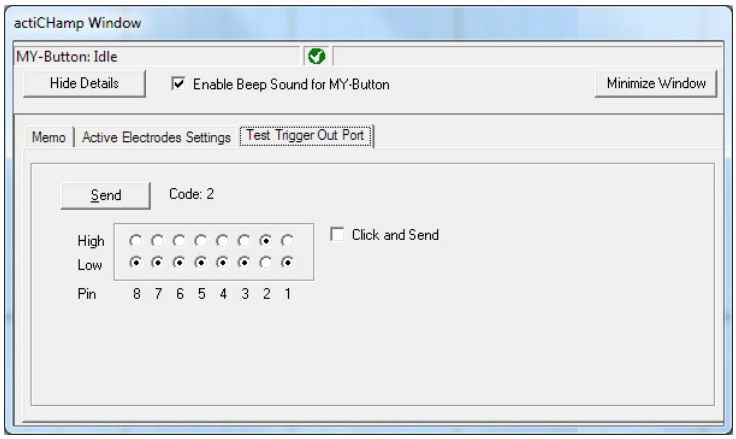


Figure 8-39. actiCHamp window, testing the trigger output

Chapter 9 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 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.

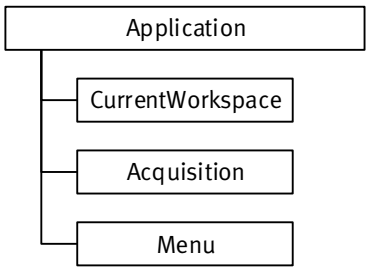


Figure 9-1. Object hierarchy of the Recorder

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

9.1 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.

9.2 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.

9.3 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.

9.4 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.

9.5 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.

9.6 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.

9.7 Enumerator types

The following sections describe the various enumerator types.

9.7.1 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
```

9.7.2 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
```

Chapter 10 BrainVision Video Recorder

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

10.1 Installing the Video Recorder and codec

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 C.

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 C.

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 10-1. Dongle with sublicense for the Video Recorder

Proceed as follows to install the Video Recorder and codec:

1 Insert the *Application Suite* DVD (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.

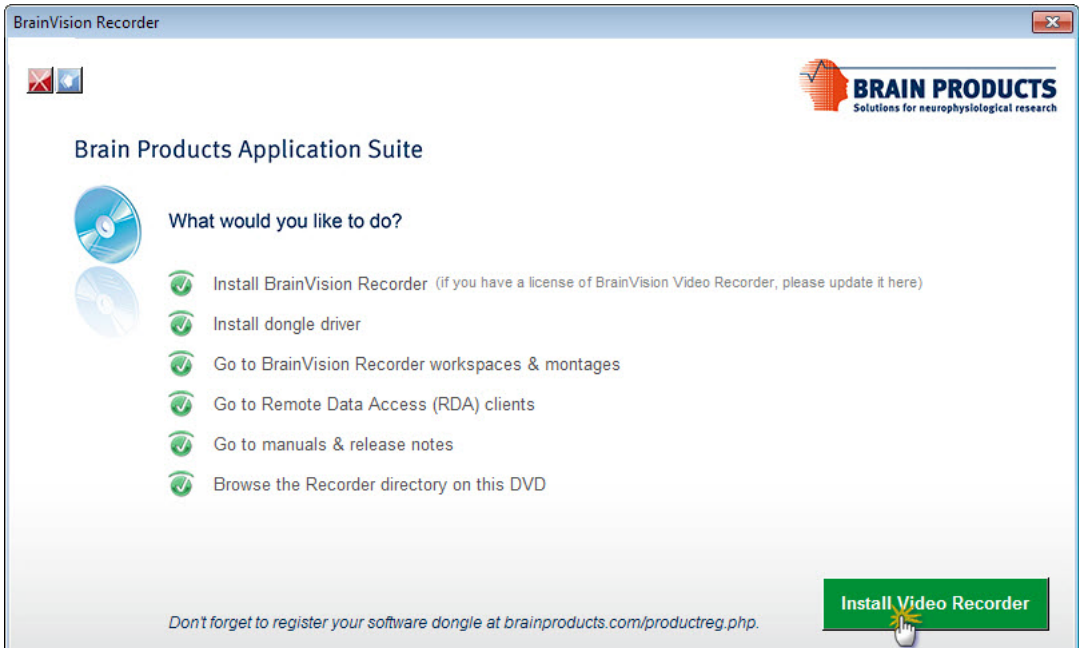


Figure 10-2. Installing the Video Recorder

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

5 After you have installed *Video Recorder*, you must install the codec supplied. The codec is used to compress the video data.

6 Go to the installation menu of *BrainVision Video Recorder* and click on **Go to video codec** (Figure 10-3). This opens a folder containing the installation program for the video codec.

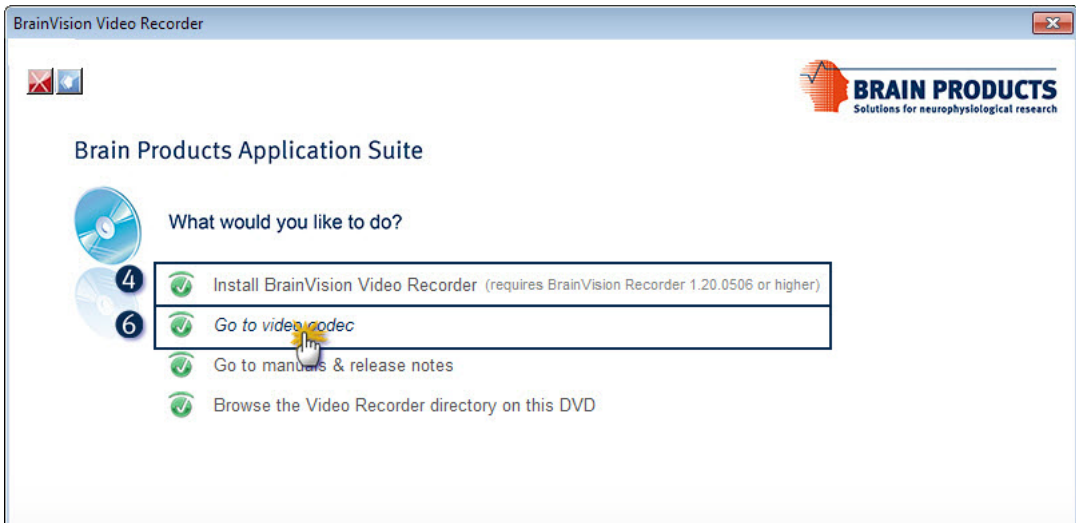


Figure 10-3. Installing the video codec

7 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.

8 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 10.2.

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*.

9 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.

10.2 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 (Figure 10-4). You enable synchronous video recording by selecting the **Enable Vision Video** box.

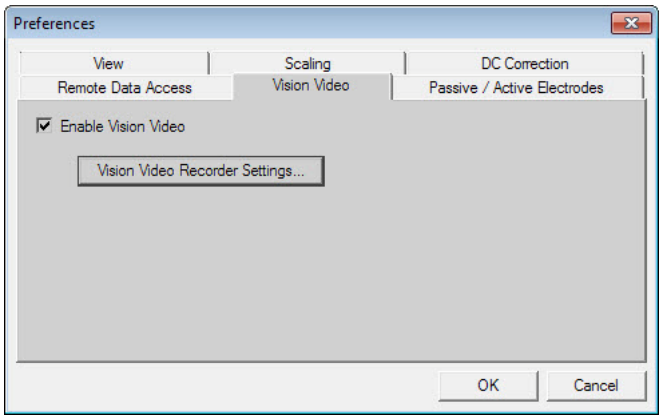


Figure 10-4. Video settings and codec selection

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. If you have connected analog video devices, you can select between different input options (such as *Video Tuner, SVideo, Composite*). However, we recommend that you use digital video equipment.

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

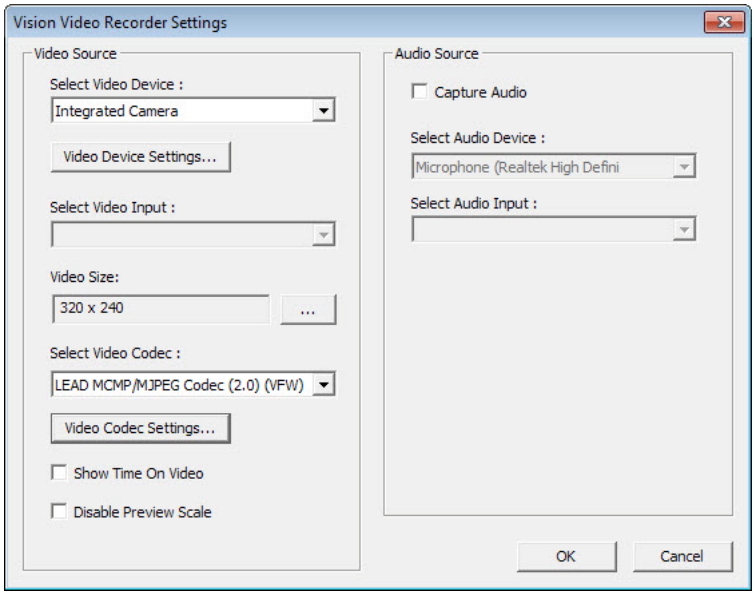


Figure 10-5. Video settings and codec selection

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 10-6) 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.

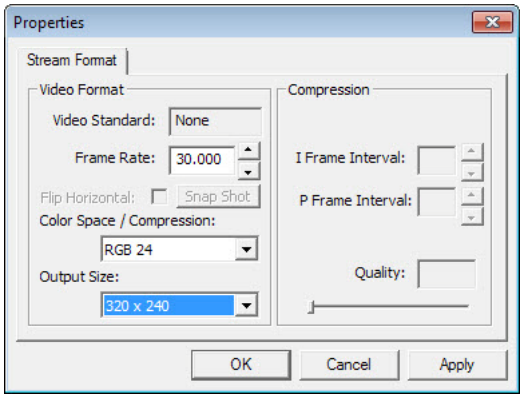


Figure 10-6. Configuring the video format

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 10.1.

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.

10.3 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.

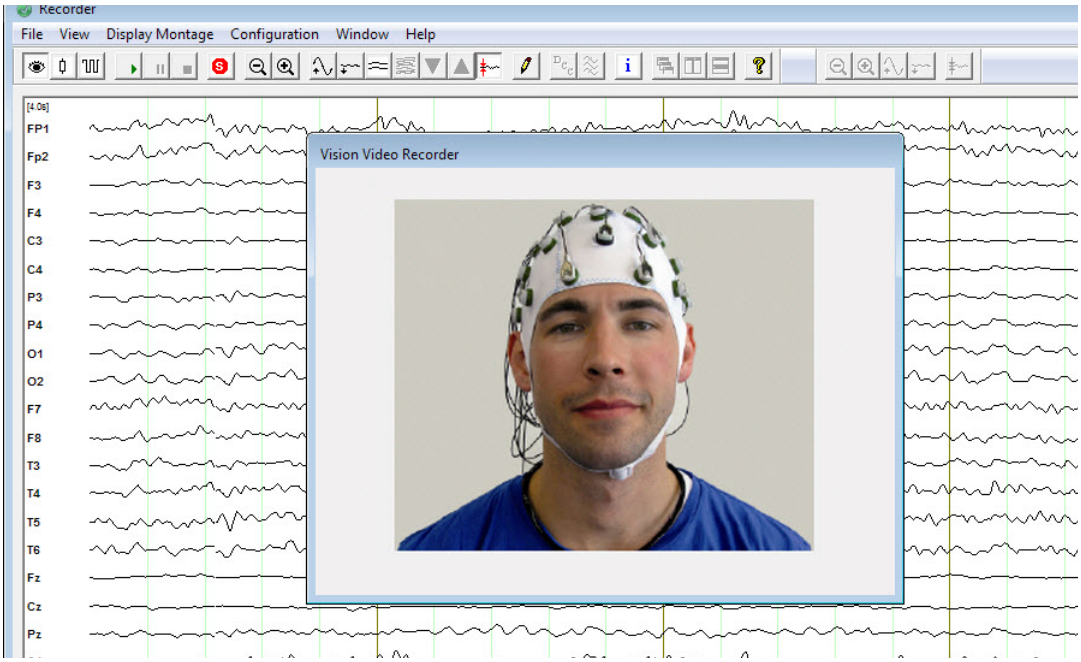


Figure 10-7. Combined EEG/video recording

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.

A constant delay of the displayed video data of less than a second is, however, normal. This does not result in any time difference between the video and the EEG when subsequently replayed in *Analyzer*.

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.

Chapter 11 Remote data access

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.

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* DVD 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.

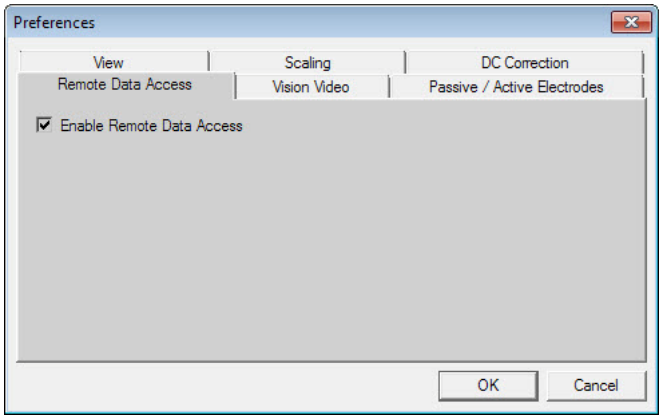


Figure 11-1. Activating the RDA server

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* DVD (*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* DVD). 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 DVD).
- `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* DVD) 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* DVD in the directory *\Software\Recorder\RDA_-Client*.

Appendix A EEG file format

The current version of the *Recorder* supports the BrainVision Data Exchange Format only. This format is described below.

An EEG consists of three files: the header file, the marker file and the actual data. The header file describes the EEG. This file is an ASCII file with the extension .vhdr. It will normally be given the same base name as the raw data EEG that is described in it. The header file is stored in the raw data folder of the workspace.

Header file

The format of the header file is based on the Windows® INI format. It consists of various named sections containing keywords/values. Here is an extract from a header file:

```
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 first line identifies the header file and is mandatory.

A semicolon at the beginning of a line identifies a free-text comment. This line is ignored. Blank lines are also ignored. A section is identified by a line with a heading enclosed in square brackets. The header extract above, for example, contains the *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 predefined value which is used by the Generic Data Reader if a keyword is not found.

The amplifier setup parameters are listed in the *Amplifier-Setup* section. (You will find a description of the individual parameters in Section 4.2.2.)

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

“Common Infos” section

This section contains general information on the EEG file.

Keyword	Meaning	Default value
`DataFile`	Name of the EEG file. If the name does not contain a path, it is assumed that the EEG file is in the same folder as the header file. The placeholder $b can be used in the file name. It is replaced by the base name of the header file when the file is read in. Example: If the name of the header file is *Test.vhdr*, the entry `DataFile=$b-EEG.dat` is interpreted as `DataFile=Test-EEG.dat`.	None, a value must be specified.
`MarkerFile`	Optional marker file. The marker file contains a list of markers assigned to the EEG. If no path is specified explicitly, the marker file is searched for in the folder containing the header file. The format of the marker file is explained on page 179. The placeholder $b can be used in the file name.	–
`DataFormat`	Data format: `BINARY`	

`DataOrientation`	Data orientation. Possible values:
	`VECTORIZED`
	The file begins with all the data points of the first channel, followed by all the data points of the second channel, and so on.
	`MULTIPLEXED`
	All the channels come one after the other for every data point. In other words, the data structure is multiplexed.
		`MULTIPLEXED`

`DataType`	Data type. Possible values:
	`TIMEDOMAIN`
	The data is in the time domain.
	`FREQUENCYDOMAIN`
	The data is in the frequency domain.
		`TIMEDOMAIN`

`NumberOfChannels`	Number of channels in the EEG file.	None, a value must be specified.
`SamplingInterval`	Sampling interval. The interval is specified in µs in the time domain and in hertz in the frequency domain.	None, a value must be specified.

Table A-1. “Common Infos” section of the EEG file

Keyword	Meaning	Default value
Averaged	This indicates whether the data set to be read in has been averaged. It is particularly relevant to the enabling and disabling of transforms on the Analyzer's *Transformations* menu. 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
AveragedSegments	Number of segments included in averaging. This value is only evaluated when "Averaged=YES" is set.	0
SegmentData-Points	If the data is segmented evenly, the number of data points per segment can be specified at this point.	0
SegmentationType	Segmentation type. Like Averaged, this variable is relevant to the enabling and disabling of transforms on the Analyzer's *Transformations* menu. 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. All segments have the same length. FIXTIME Segmentation was based on fixed times. All segments have the same length.	NOTSEG-MENTED
DataPoints	Number of data points in the EEG file. If no predefined value has been specified, the data is read in up to the end of the file. In the case of binary data, the TrailerSize parameter in the [Binary Infos] section can be set as an alternative.	0
Codepage	Codepage used in the header file. Possible values: UTF-8, ANSI	ANSI

Table A-1. "Common Infos" section of the EEG file

“ASCII Infos” section

This section is only relevant if ASCII is set for “DataFormat” in the “Common Infos” section.

Keyword	Meaning	Default value
`DecimalSymbol`	Decimal symbol used in the EEG file. This symbol can be either a point or a comma. In the header file, the decimal symbol is always a point.	Point (.)
`SkipLines`	Number of header lines to be skipped	
`SkipColumns`	Number of columns to be skipped at the beginning of a line.	

Table A-2. “ASCII Infos” section

“Channel Infos” section

Channel information. This section lists the individual channels and their properties.

Keyword	Meaning	Default value
`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,,1 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 1 µV. The resolution is the value by which the value of the data point is multiplied to convert it to µV or to the selected unit.	Point (.)

Table A-3. “Channel Infos” section

“Binary Infos” section

This section is only relevant if BINARY is set for “DataFormat” in the “Common Infos” section.

Keyword	Meaning	Default value

`BinaryFormat`	Binary format. Possible values:
	`IEEE_FLOAT_32`
	IEEE floating-point format, single precision, 4 bytes per value
	`INT_16`
	16-bit signed integer
	`UINT_16`
	16-bit unsigned integer
		`INT_16`

`ChannelOffset`	Channel offset at which the data starts. The offset is only relevant to vectorized data. `ChannelOffset` and `DataOffset` can be used simultaneously.	`0`
`DataOffset`	Size of the offset in the file at which the actual data starts.	`0`
`SegmentHeader-Size`	If the data is segmented evenly, the size of the segment header can be entered here in bytes.	`0`
`TrailerSize`	Size of the trailer of the EEG file in bytes. This parameter can be specified as an alternative to `DataPoints` in [Common Infos] in order to stop reading in the data before the end of the EEG file is reached.	`0`

`UseBigEndianOr-der`	This only applies to integer formats. It specifies whether big Endian order (most significant byte is stored first) is used (Macintosh, Sun).
	Possible values are:
	`YES`
	Yes, big Endian order is used.
	`NO`
	No, little Endian order is used (corresponds to the Intel specification).
		`NO`

Table A-4. “Binary Infos” section

Marker file

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

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

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

“Common Infos” section

This section contains general information on the marker file.

Keyword	Meaning	Default value
`DataFile`	Name of the EEG file. If the name does not contain a path, it is assumed that the EEG file is in the same folder as the marker file. This information is not evaluated by the Generic Data Reader.	–

Table A-5. “Common Infos” section

“Marker Infos” section

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

Keyword	Meaning	Default value

`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 channel 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.
	Specifying a date
	`19990311140312003012`
	means 11 March 1999, 14:03:12.003012
		–

Table A-6. “Marker Infos” section

Appendix B 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, $\varphi > 0$; for the back right and front left quadrants, $\varphi < 0$.

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, $\theta > 0$. In the left hemisphere, $\theta < 0$.

Figure B-1 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).

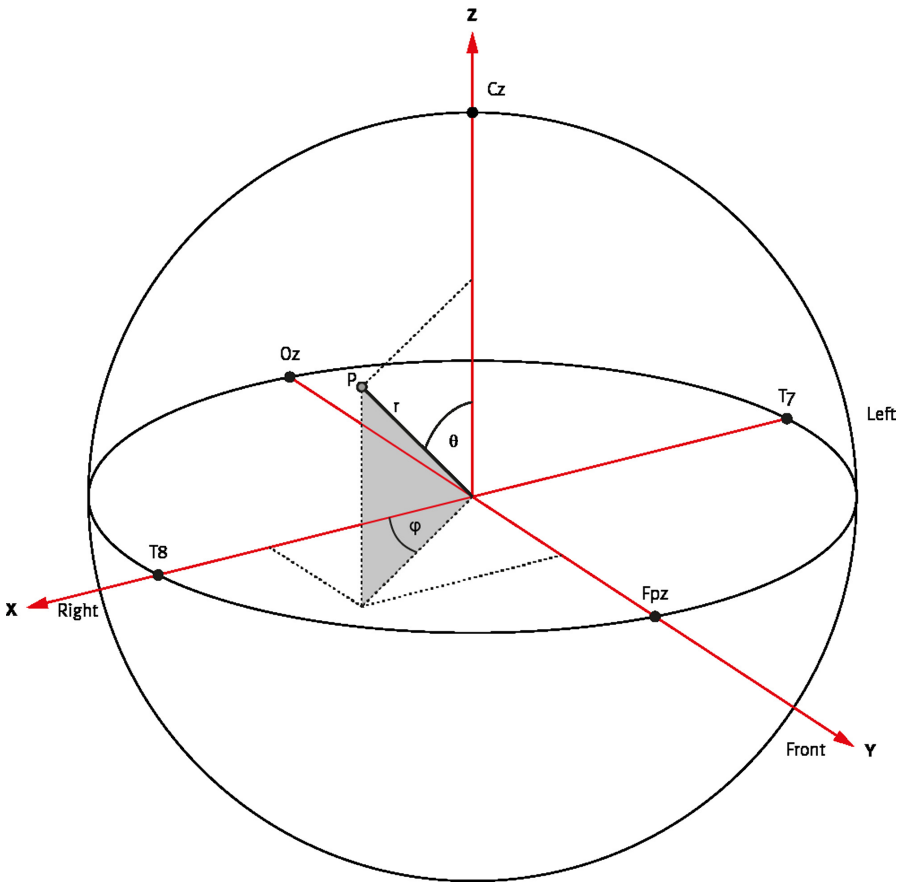


Figure B-1. Coordinate system for electrodes

Appendix C Installing sublicenses

Some optional components of *Recorder* will only run if you have previously purchased sublicenses. A sublicense is a file associated with your USB dongle. You can install sublicenses for several dongles in parallel without problems.

If you purchased add-on licenses 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.

This appendix describes how to download and install sublicenses that you purchase subsequently.

Downloading sublicense files

To activate the downloading of sublicenses, your USB dongle must first be registered. To do this, go to http://www.brainproducts.com and choose **Downloads & Support › Product Registration**.

To register your USB dongle, enter the external and internal serial ID of your dongle, your name, university and email address in the product registration form (Figure C-1). The external serial ID is printed on your dongle. You can find out the internal serial ID using the *Serial ID Check Program* available on the website. Further information is available at http://www.brainproducts.com/productreg.php. Once your registration has been processed, you will receive a confirmation mail.

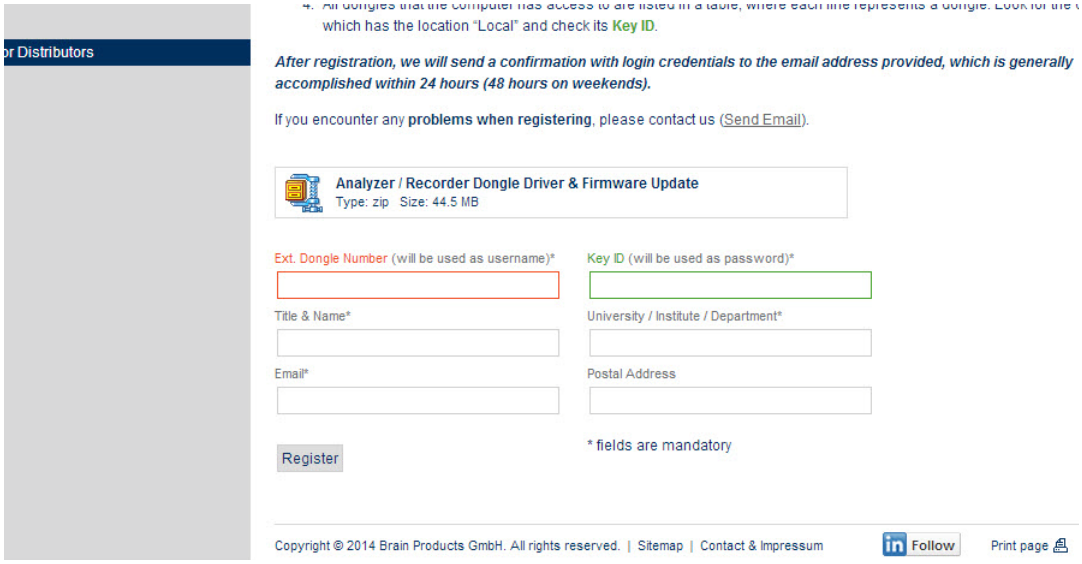


Figure C-1. Data entry form for product registration

After you have received the confirmation mail, you can log in to download your files by proceeding to the login page (Figure C-2). Use the login data you received by mail.

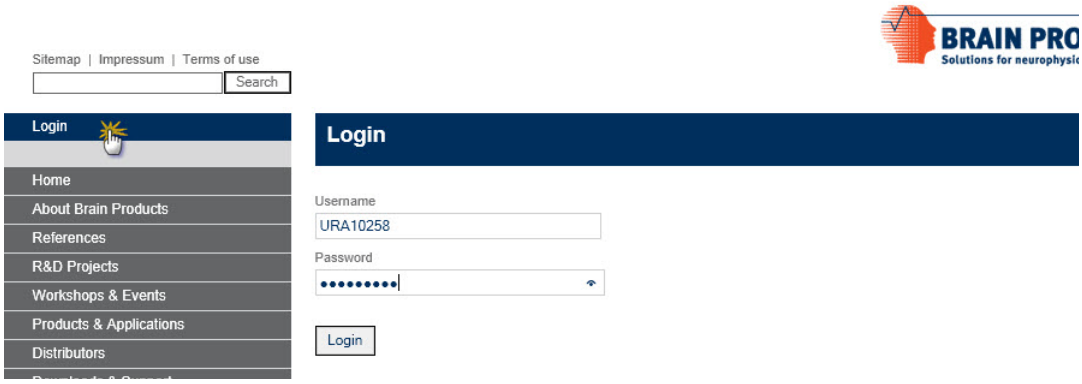


Figure C-2. Login form

Now you can select and download the sublicense file *License File for Analyzer 1 and/or Recorder* from the download area under **Downloads & Support › Downloads** (Figure C-3).

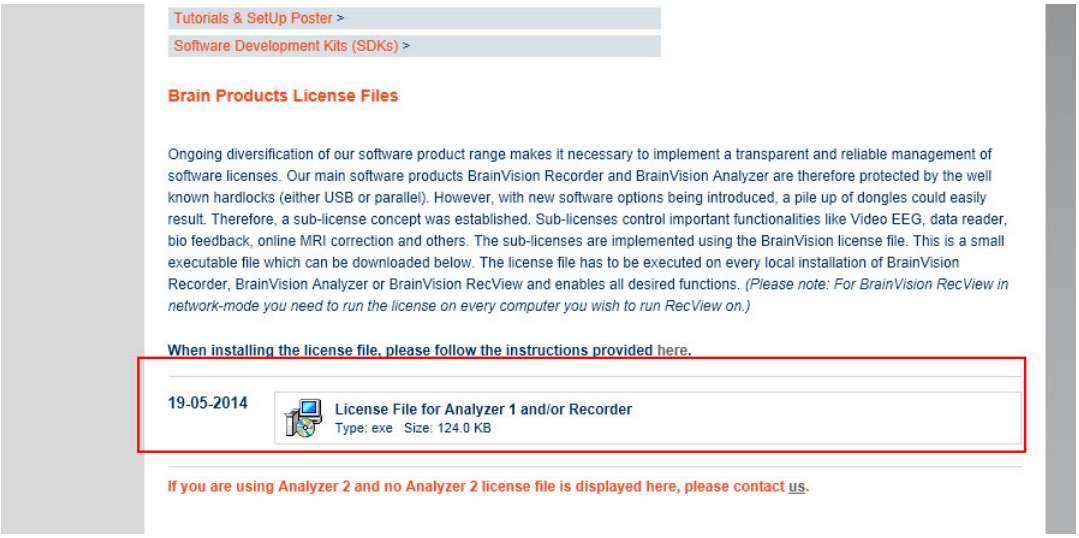


Figure C-3. Download area for sublicense files

Installing sublicense files

A sublicense file is an executable file whose name corresponds to the external serial number of the USB dongle. The file automatically installs the sublicense in the *Recorder* installation folder.

Start the executable file by double-clicking it and then click **Continue** to install the sublicense (Figure C-4). Then follow the instructions in the automatic installation routine.

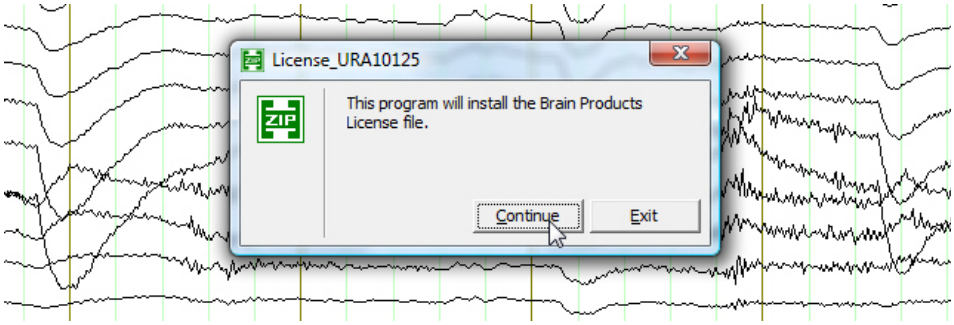


Figure C-4. Installing sublicenses

Installing a license under Windows® Vista or Windows® 7

If you are using Windows® Vista or Windows® 7, you should not double-click the license file, but instead run it as administrator to avoid installation problems. To do this, right-click the installation file and choose **Run as administrator** from the context menu.

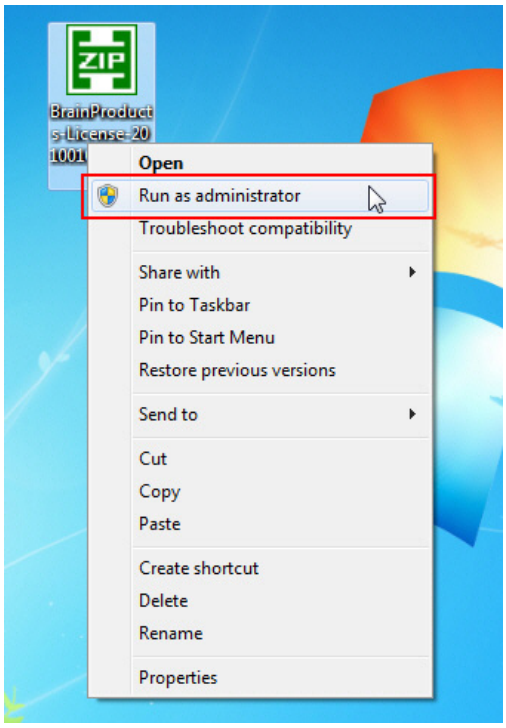


Figure C-5. Running the license file as administrator (Windows® Vista/7)

You can check what sublicenses are active by choosing **Help › About BrainVision Recorder...** from the menu (Figure C-6).

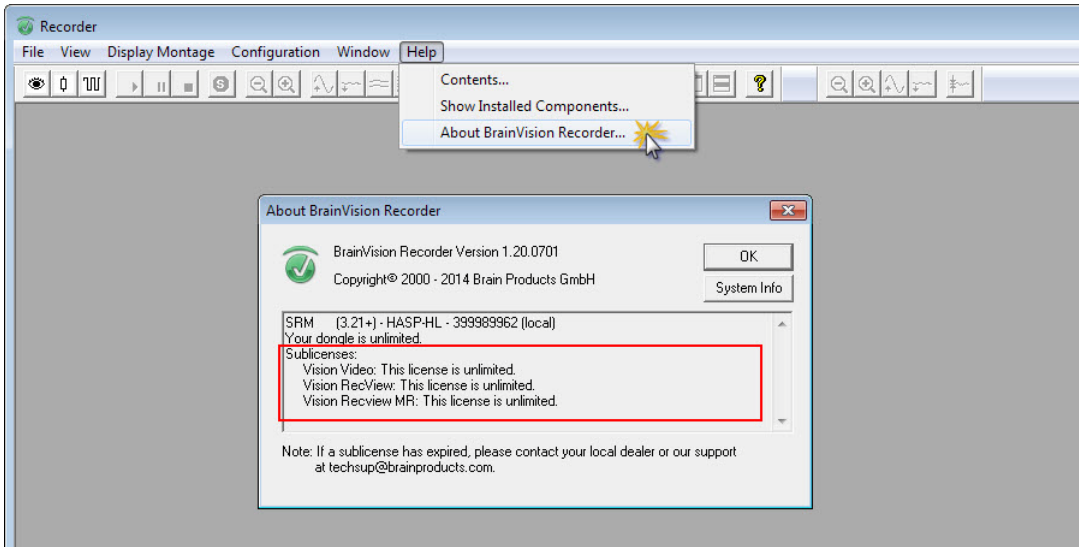


Figure C-6. Displaying sublicenses in the Recorder

The installed sublicense 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.

Note

Do not make any changes to this file, otherwise the sublicense will become invalid.

Appendix D Keyboard shortcuts for MY-Button (actiCHamp)

You can use the following keyboard shortcuts for the *MY-Button Press Keys* function:

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	@

Input	Key
CARET	^
TILDE	~
LEFTBRACE RIGHTBRACE	{}
LEFTPAREN RIGHTPAREN	()
WIN or @	Windows key
+	Shift
^	Ctrl
%	Alt
APPACTIVATE WindowTitle	Set focus to window by entering window title

List of abbreviations

A/D..... Analog/Digital
OLE..... Object Linking and Embedding
RDA ..... Remote Data Access
EEG..... Electroencephalogram
EMG..... Electromyogram
ECG ..... Electrocardiogram
EOG ..... Electrooculogram
PCI..... Peripheral Component Interconnect
LPT ..... Line printing terminal ("parallel port")
DC ..... Direct current
AUX ..... Auxiliary
BUA ..... BrainVision USB2 Adapter
MR..... Magnetic resonance
EPF ..... Electrode position file
fMRI..... Functional magnetic resonance imaging
GSR ..... Galvanic skin response
TTL..... Transistor-transistor logic
VB ..... Visual Basic
TCP/IP ..... Transmission Control Protocol/Internet Protocol

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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.

actiCHamp: Modular, extensible amplifier from Brain Products for the recording of up to 160 channels. It is used in combination with active actiCAP electrodes.

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.

Dongle: Pluggable copy protection device.

E

ExG AUX Box: Hardware accessory from Brain Products for the BrainAmp ExG or BrainAmp ExG MR that allows individual electrodes and/or polygraph sensors to be connected to the amplifier for the recording of bipolar signals.

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.

F

FirstAmp: Compact amplifier from Brain Products with eight channels and two AUX channels suitable in particular for study and training purposes.

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.

GSR-MR channel: Abbreviation for "galvanic skin response". Auxiliary channel for recording the electrical conductivity of the skin in an MR scanner using the GSR-MR module.

GSR-MR module: Sensor from Brain Products that can be used in MR scanners for recording and converting the electrical conductivity of the skin to a voltage that can be recorded by the amplifier. The GSR-MR module is used in conjunction with a BrainAmp ExG MR and the ExG AUX Box.

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

ImpBox: Optional hardware accessory for the V-Amp amplifier which is used to measure the impedances of active electrodes.

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.

Input signal: The signal connected to the EEG amplifier.

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.

Monitoring: Observation of the EEG signals on screen.

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.

Q

QuickAmp: Amplifier in which the average value across all channels is used as the average reference for the individual channels (common average reference).

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

V-Amp: Compact amplifier from Brain Products with eight or alternatively sixteen channels and two AUX channels that can, for instance, be used for BCI applications.

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.