BRAIN PRODUCTS
Solutions for neurophysiological research

BrainVision Recorder
User Manual

as of Software Version 1.20.0601

valid as of September 30, 2013*

BRAINVISION
professional RECORDER

* Valid until publication of a new version of the manual

Imprint

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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 the 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 the Recorder in combination with the actiCAP active electrode system.
- Chapter 8 contains information on using the amplifiers of the BrainAmp family, the QuickAmp, the V-Amp, the FirstAmp, the actiCHamp and the NI 6071e A/D converter board from National Instruments and on using the "Simulated Amplifier" option.
- Chapter 9 contains information on how you can control the Recorder via other programs by means of OLE automation.
- Chapter 10 explains how you can use the BrainVision Video Recorder to record not only EEG but also video data.
- Chapter 11 describes how you can transfer data from the 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 the manual

The manual uses the following typographical conventions:

italic	Italic text is used to identify menus, menu commands, dialog boxes, options, the names of files and folders and the labels on the devices. Italic font is also used to highlight portions of running text.
underscore	Underscored text indicates a cross-reference or a web address.
`monospaced`	A monospaced font is used to indicate text or characters to be entered at the keyboard, such as source code and programming examples.
●	The blue dot indicates the end of a chapter.

The manual also uses the following symbols to help you find your way around:

The *Personal Injury* symbol indicates that incorrect use of the software may result in a health hazard to the test subject, the user and/or a third-party. Incorrect use means non-adherence to the guidelines set out in the current User Manual.

The *Damage to property* symbol indicates that the incorrect use of the software may bring about a risk of damage to property.

The *Stop* symbol indicates that you should not carry out a particular action.

The *Note* symbol draws your attention to important information relating to the current topic.

The *Cross-reference* symbol indicates a reference to a related chapter, section or document.

The *Tip* symbol draws your attention to recommendations on how to use our products.

The *New* symbol indicates that the User Manual has been changed or that new material has been added at this point.

Revision history

Page	Status	Subject
24	modified	Intended use
24	modified	Corrrect use
25	new	Combination with other products

Reporting errors and support

You can search for updates of this manual on our Web site under http://www.brainproducts.com/downloads.php?kid=5&tab=2.

If you require technical support or if you discover a mistake in the manual, the software or during operation, please contact:

Brain Products GmbH
Zeppelinstraße 7
D-82205 Gilching
Tel. +49 8105 73384 – 0
Fax: +49 8105 73384 – 505
Web site: http://www.brainproducts.com
Email: techsup@brainproducts.com

On request, the technical support team will also send you a form to assist in clarifying faults and problems.

The Recorder and its functions

The 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 the Recorder allows you to work with an unlimited number of channels.

The fact that OLE automation has been implemented allows you to control the 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 bio-feedback 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 the Recorder or calculated with the BrainVision Analyzer.

The 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 the 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.

The 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.

If you are using an amplifier of the BrainAmp family, the value range that can be displayed for the impedances of the ground electrode and the reference electrode is 0 through 100 kOhm.

In the same way as with the Analyzer, you can select individual channels or multiple channels when viewing data (monitoring) in the 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 BrainVision 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 BrainVision Recorder for diagnosis, therapy, monitoring of vital physiological processes (such as cardiovascular functions etc.) or other medical purposes is expressly forbidden.

BrainVision Recorder is intended to be used for recording neuro-/electrophysiological signals (e.g. 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 GmbH provides no guarantee and accepts no liability for the results obtained with BrainVision Recorder.

Correct use

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

BrainVision Recorder is not permitted to be used by

- unqualified persons (e.g. laymen),
- persons who cannot read (e.g. due to visual impairment) or understand (e.g. due to a lack of language skills) the Operating Instructions.

BrainVision 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.

Personal injury

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 BrainVision 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 (i.e. to perform post market surveillance, for example) until the end of their service life.

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

The user should however be aware that if a former BrainVision 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 BrainVision Recorder version are effective only from then on.

Use together with other products and components

BrainVision 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 (e.g. regarding its MR compatibility) are fulfilled for the specific combination and purpose of application (i.e. 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.

Chapter 1 Installation

Under normal conditions, the Recorder does not cause any conflicts with other programs that are already installed. Brain Products GmbH, however, only guarantees that programs will interact without problems if the programs concerned have been tested for compatibility. This applies to the BrainVision Analyzer, BrainVision RecView and actiCAP ControlSoftware and to the Microsoft operating systems Windows® XP, Windows® Vista, Windows® 7, and Windows® 8 provided that no modifications to the configuration of the operating system as delivered have been undertaken (including official service packs and updates).

1.1 General requirements

You can only install the Recorder if you are logged in to your system as an administrator.

The system has the following hardware and software requirements:

System requirements

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 32-bit and 64-bit
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, Windows® 8 (32-bit): min. 1 GB Windows® 8 (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.

Please note that certain hardware components are not supported by some operating systems. The following table provides an overview of the compatibility between the hardware and the Windows® operating systems.

Table 1-1. Table of compatibilities

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 32-bit Windows® 8 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 Windows® 8 32-bit
actiCHamp	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit Windows® 8 32-bit Windows® 8 64-bit
FirstAmp/V-Amp	Windows® XP SP3 32-bit Windows® Vista 32-bit Windows® 7 32-bit Windows® 7 64-bit Windows® 8 32-bit Windows® 8 64-bit
NI 6071e A/D converter board (National Instruments)	Windows® XP SP3 32-bit Windows® Vista 32-bit

System requirements for the actiCHamp amplifier

Special system requirements apply when the actiCHamp amplifier is used:

Operating system	Windows® 7, 32-bit or 64-bit Windows® 8, 32-bit or 64-bit Windows performance index › 5.0
Processor	Intel® Core™ 2 Quad processor, 2.4 GHz or compatible
Graphics adapter	1280 x 1024 pixel resolution and at least 512 MB internal memory
RAM	4 GB of RAM

1.2 Installing the Recorder under Windows® XP

Proceed as follows to install the Recorder under Windows® XP:

1. Start Windows® XP.
2. Insert the supplied BrainVision program DVD into your CD-ROM drive.
3. If your computer is set up to autostart a CD-ROM, the menu that guides you through the installation will appear after a short time. If your computer is not set up to autostart CD-ROMs, you will have to run the installation file manually. Proceed as follows:
   a. From the taskbar, choose *Start › Run*.
   b. Click the *Browse...* button.
   c. In the *Browse* dialog box, select your CD-ROM drive and double-click the *Autorun.exe* file to open it.
4. Follow the instructions displayed. The installation process that follows is described in Section 1.3, step 5 up to step 12 as of page 31.

Installing updates from DVD or from the Brain Products web site

After you have completed installation of the Recorder, you should install all software updates that may be available. For details, refer to Section 1.5 on page 39.

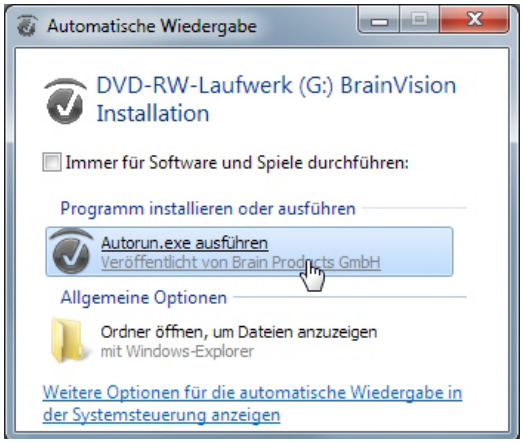
1.3 Installing the Recorder under Windows® Vista/Windows® 7

Proceed as follows to install the Recorder under Windows® Vista/Windows® 7:

1. Start Windows® Vista/Windows® 7.
2. Insert the supplied BrainVision program DVD into your CD-ROM drive.
3. If your computer is set up to autostart a CD-ROM, then the *AutoPlay* dialog box opens automatically after a short period. Click *Autorun.exe* (see Figure 1-1).

Skip step 4 and proceed directly to step 5 on page 31 of these installation instructions.

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



4. If your computer is not set up to autostart CD-ROMs, you will have to run the installation file manually. Proceed as follows:
   - **a** Click the *Start* button on the taskbar and then choose *All Programs* › *Accessories* › *Run* (see Figure 1-2).
   - **b** In the *Run* dialog box, click *Browse...* and select the CD-ROM drive.
   - **c** Double-click the file *Autorun.exe* to open it.
   - **d** Click *OK* in the *Run* dialog box (see Figure 1-3).

Figure 1-2. Executing the Autorun file manually under Windows® 7 (A)

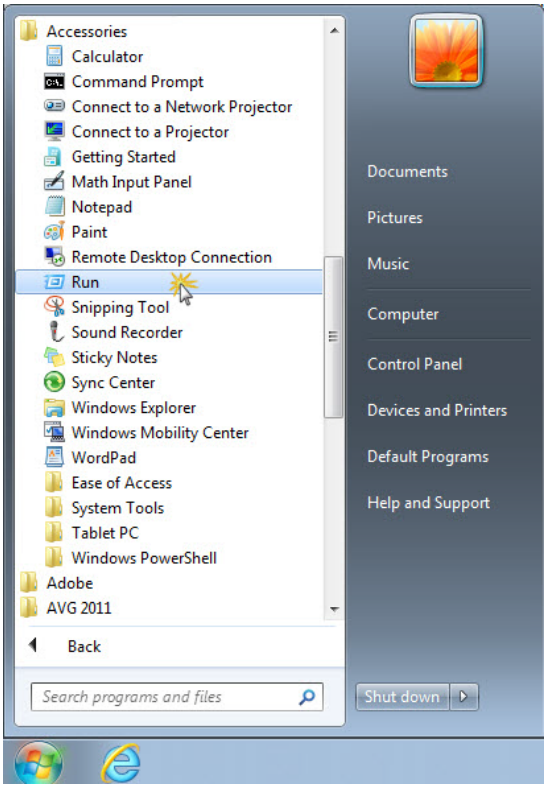
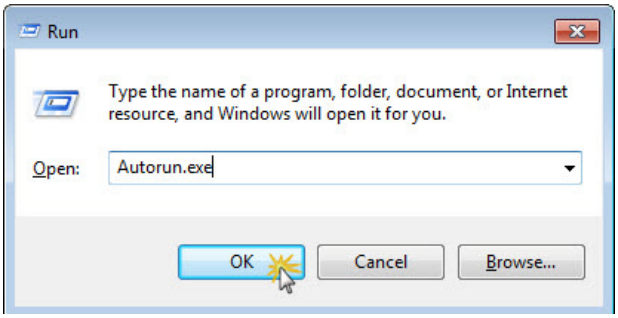
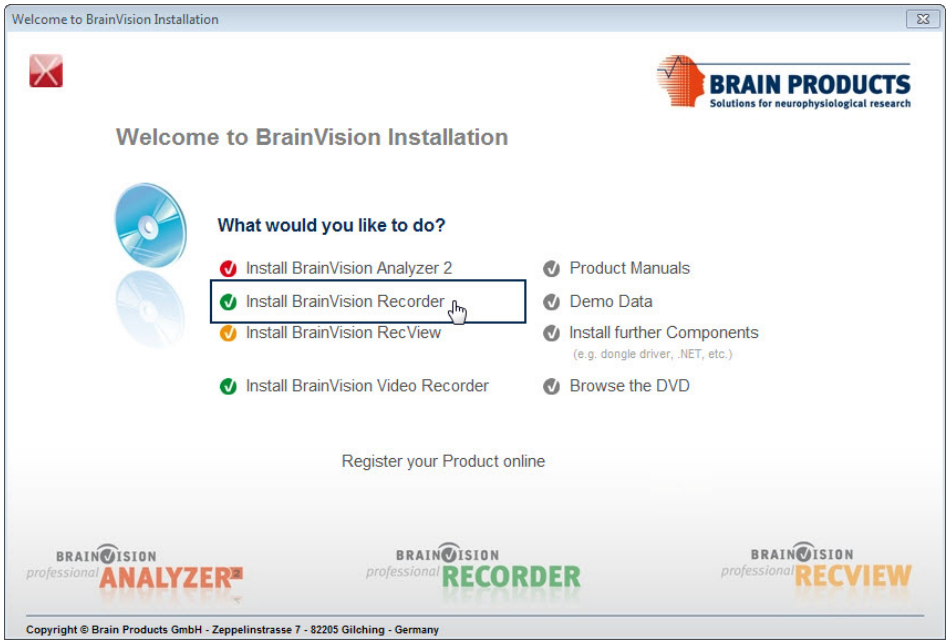


Figure 1-3. Executing the Autorun file manually under Windows® 7 (B)



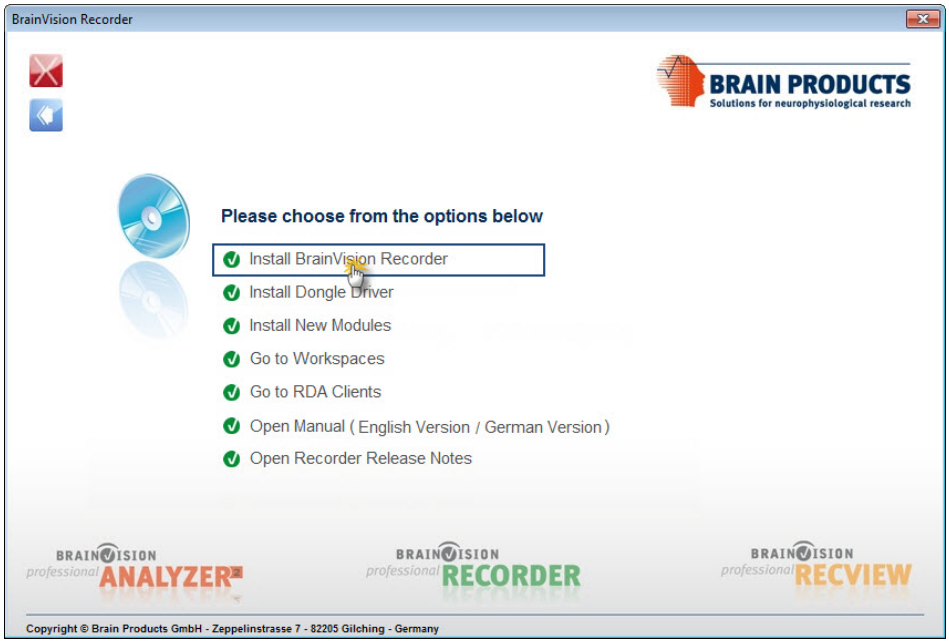
5 When the installation file is run, the *Welcome to BrainVision Installation* dialog box is displayed. Click *Install BrainVision Recorder* (see Figure 1-4).

Figure 1-4. Selecting the software to be installed (A)



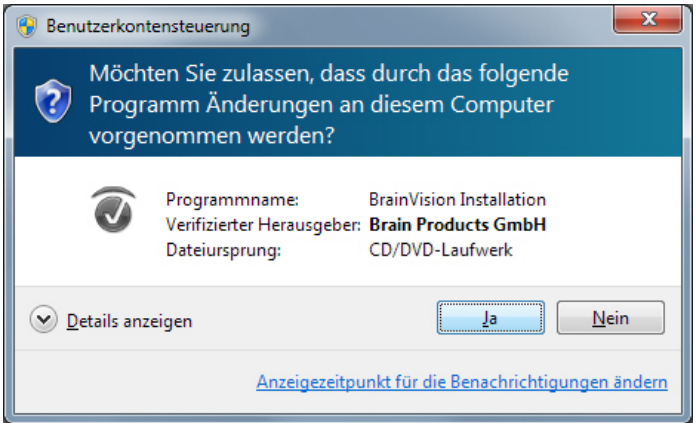
6 The second page of the dialog box is opened. Here also, click *Install BrainVision Recorder* (see Figure 1-5).

Figure 1-5. Selecting the software to be installed (B)



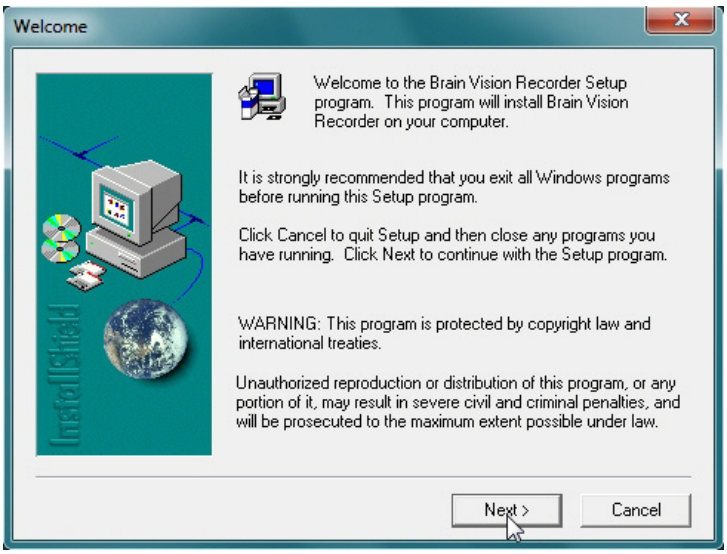
7 The system asks whether you want to authorize installation of the Recorder. Click *Yes* (see Figure 1-6).

Figure 1-6. Query before installation of the Recorder



8 The Setup Wizard opens. Click *Next* (see Figure 1-7).

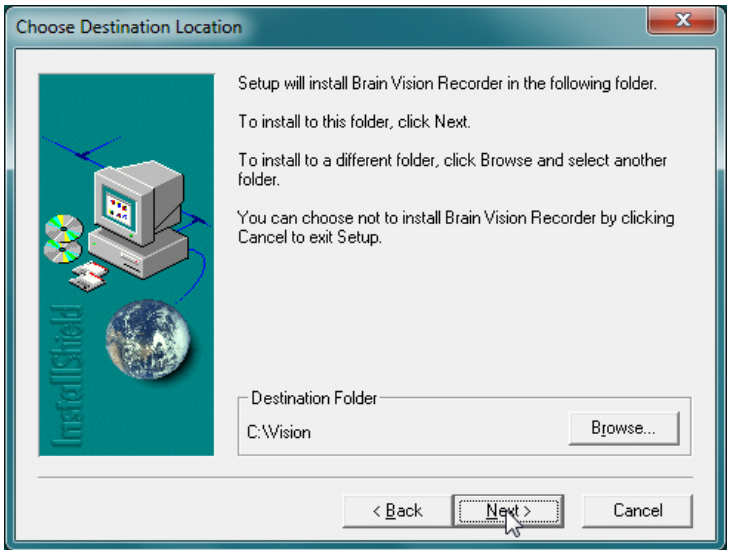
Figure 1-7. Setup Wizard



9 You specify the Recorder installation folder during the course of installation (see Figure 1-8).

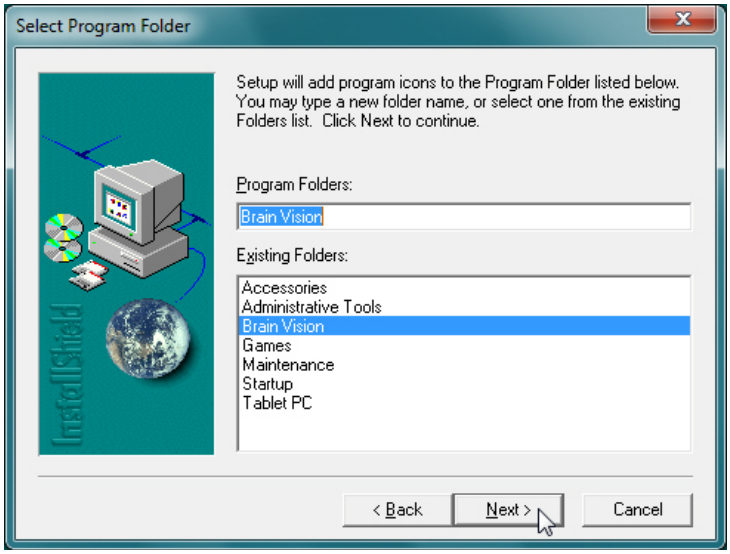
We recommend that you install the Recorder in the default folder proposed: *C:\Vision*. If you wish to use a different folder, ensure that it is not write-protected.

Figure 1-8. Selecting the installation folder



10 Then choose the name of the folder for all the program entries in the Windows® start menu (see Figure 1-9).

Figure 1-9. Selecting the name of the program folder



11 If you are prompted to do so during the process, it is essential to agree to the installation of the driver software by clicking the option "Install this driver software anyway" in the *Windows Security* dialog box (see Figure 1-10).

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

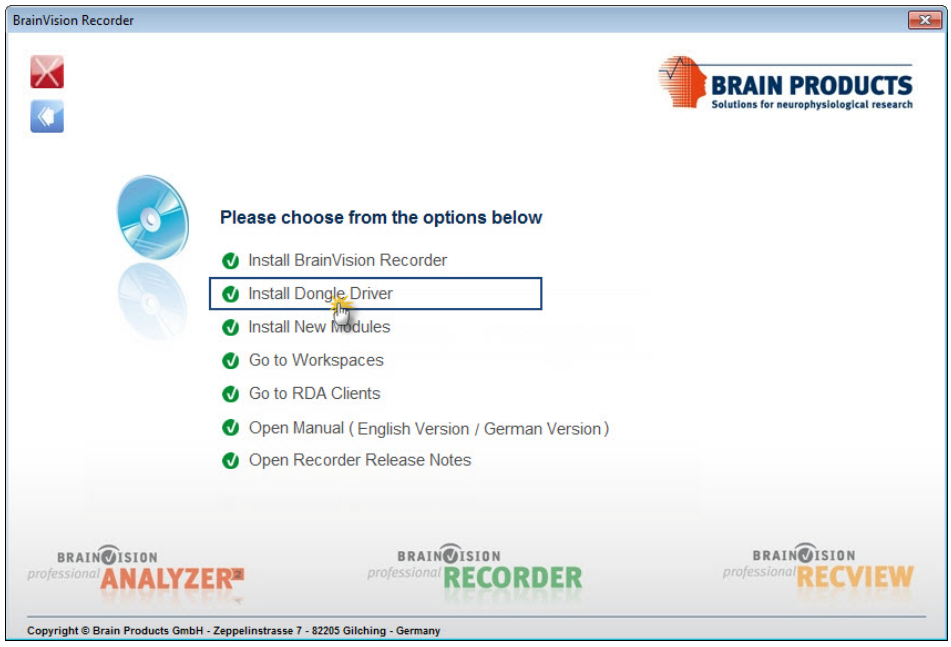
Figure 1-10. Accepting installation of the driver software

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

13 Install the dongle driver: Open the Recorder installation page again and click *Install Dongle Driver*.

Installation of the dongle driver

Figure 1-11. Installation of the dongle driver



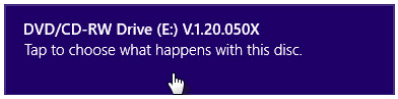
Installing updates from DVD or from the Brain Products web site

After you have completed installation of the Recorder, you should install all software updates that may be available. For details, refer to Section 1.5 on page 39.

1.4 Installing Recorder under Windows® 8

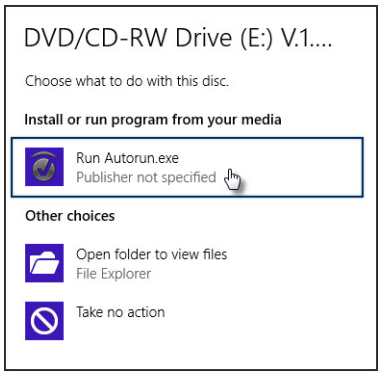
Proceed as follows to install the Recorder under Windows® 8:

1. Start Windows® 8.
2. Click the desktop tile.
3. Insert the supplied BrainVision program DVD into your CD-ROM drive.
4. If the DVD starts automatically then the dialog box containing the action to be performed appears. Click in the dialog box.



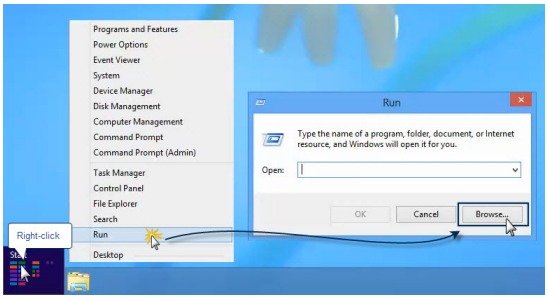
5. A second dialog box is now opened. Click "Run Autorun.exe" (see Figure 1-12). In this case, continue at step 7.

Figure 1-12. "AutoPlay" dialog box under Windows® 8

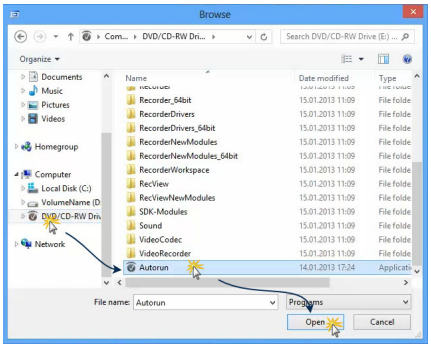


6. If the program DVD does not start automatically, proceed as follows:

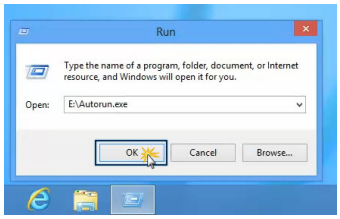
   ▷ Move the mouse pointer down and to the left to show *Start*. Right-click.
   Click *Run* in the context menu.
   In the *Run* dialog box, click [Browse...].



▷ Select the DVD drive, click *Autorun.exe* and then choose [Open].

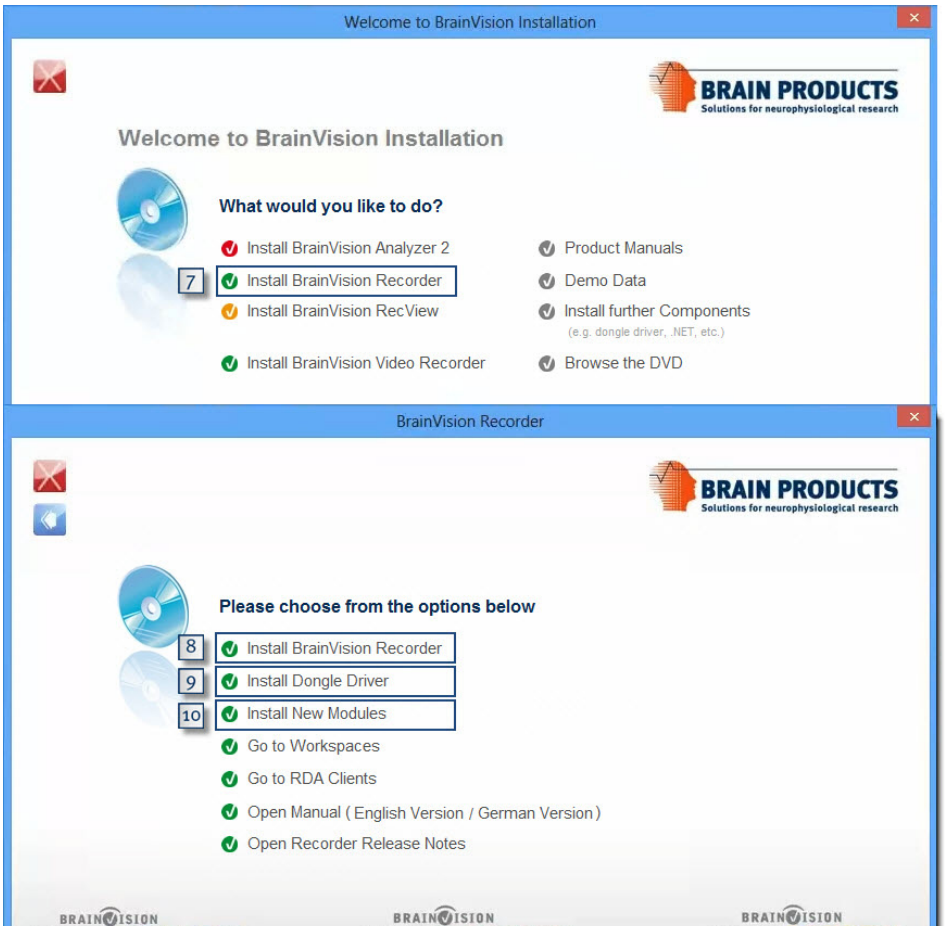


▷ In the *Run* dialog box, click [OK].



7 Open the installation screen for the Recorder.

Figure 1-13. Selecting the components for installation



8 Install BrainVision Recorder: Click "Install BrainVision Recorder" and follow the installation steps. These are similar to the steps described for Windows® 7. Confirm the dialog boxes that are then displayed as described for Windows® 7.

Dongle driver for Windows® 8

9 Install the dongle driver: Open the Recorder installation page again and click *Install Dongle Driver*.

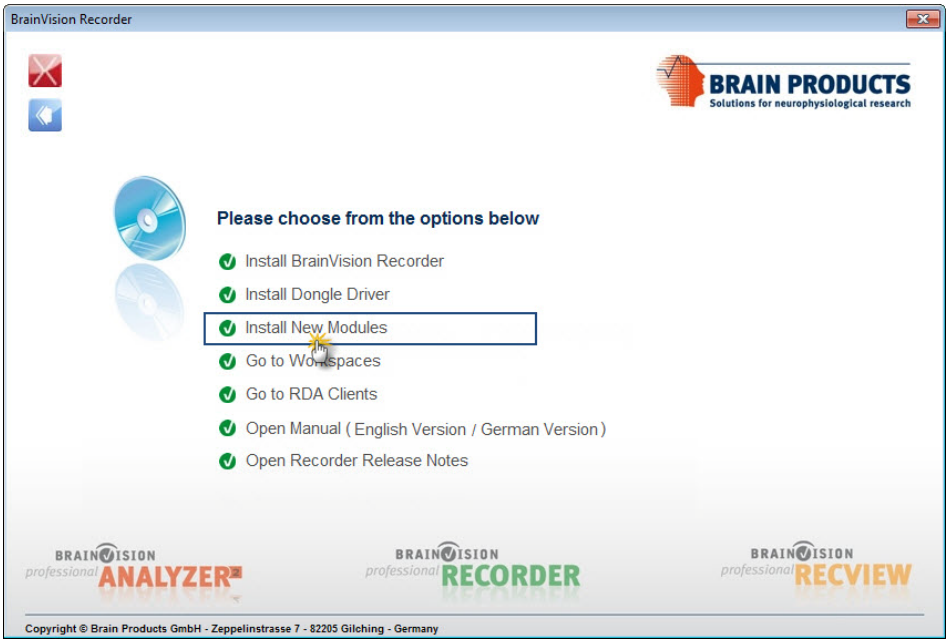
Updating the software

10  For information on updating the software, see Section 1.5 on page 39.

1.5 Software updates

After you have completed installation of the Recorder, you should install all additional software updates that may be available. For the Recorder, you will find these on the BrainVision program DVD under *Install New Modules* (see Figure 1-14). Alternatively, you can download the latest updates to the Recorder from the Brain Products Web site under this link: http://www.brainproducts.com/downloads.php?kid=2&tab=2.

Figure 1-14. Installing software updates from the BrainVision program DVD

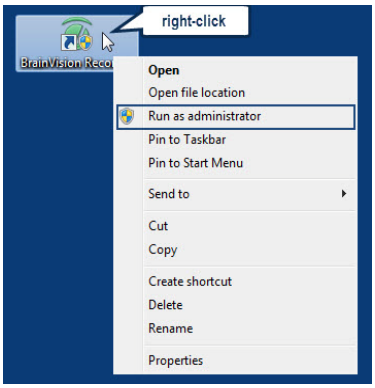


1.6 Dongle information

Damage to property

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

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



Note that you must select an amplifier the first time you start the program. This can only be done in Administrator mode.

Therefore, start the Recorder by right-clicking the Recorder icon that is located on the desktop after the software has been installed successfully and choose *Run as administrator*. Alternatively, you can specify that the Recorder is automatically always to be started in Administrator mode.

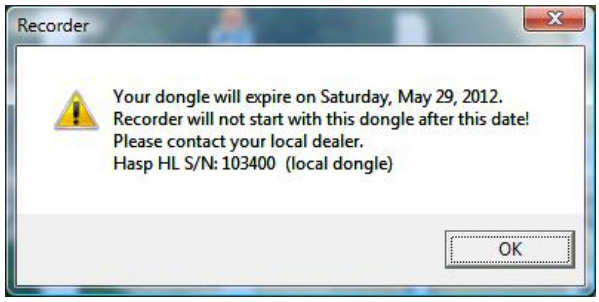
You will find detailed information on this option as well as on starting the program for the first time and selecting an amplifier in Section 3.1 as of page 53.

If you are still using a Hardlock, LPT or HASP HL dongle, please contact the Brain Products Sales department or your dealer to replace your dongle with a SafeNet SRM dongle. To show information about your dongle, choose *Help › About BrainVision Recorder...* from the menu to open the *About BrainVision Recorder* dialog box. This dialog box contains the following information: internal serial number of the dongle, the expiry date of the dongle and the sub-licenses bound to the dongle (see Figure 1-15).

Figure 1-15. Dongle information

If the validity of your dongle is nearing expiry, e.g. there are less than 30 days left, a warning message is issued when you start the Recorder (see Figure 1-16).

Figure 1-16. Warning before a dongle expires



Note that the expiry date is only shown for HASP HL and SafeNet SRM dongles, but not for Hardlock or LPT dongles.

Chapter 2 Configuring the Windows® operating system for recording data

To ensure error-free acquisition of data, you should make the following settings on your operating system *for the period during which data is being recorded*. (You can reactivate any services and functions that have been deactivated without difficulty once you have finished recording data.)

- Deactivate sleep mode.
- Deactivate the Windows Update function.
- Deactivate the Windows Defender function.
- Deactivate automatic 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 the Windows® 7 operating system. 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.

Please also note that, depending on the settings on your computer, the layout of the Control Panel startup dialog box and the other dialog boxes can also differ from the representation shown in this manual.

Figure 2-1. Windows® 7, Control Panel

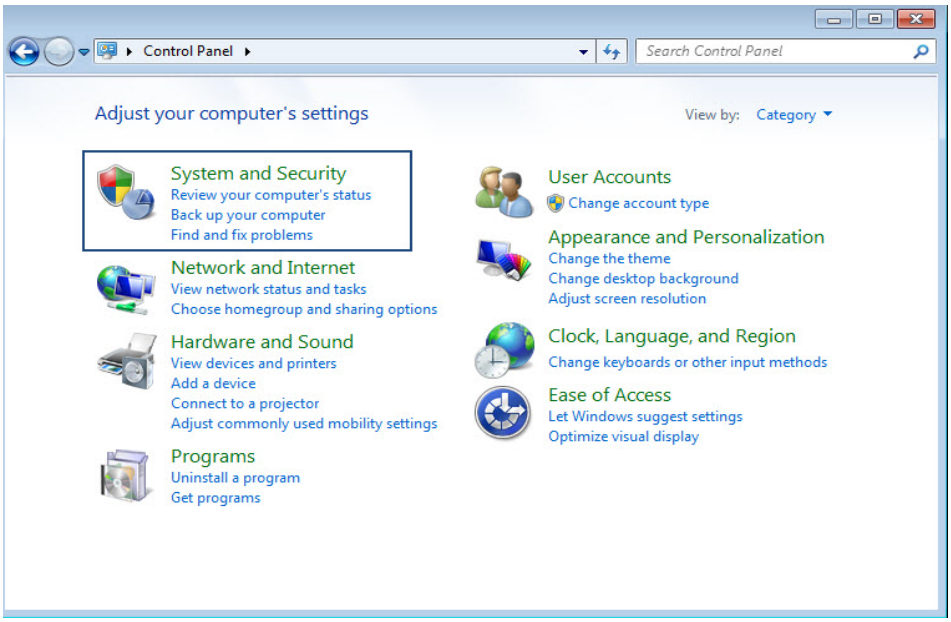
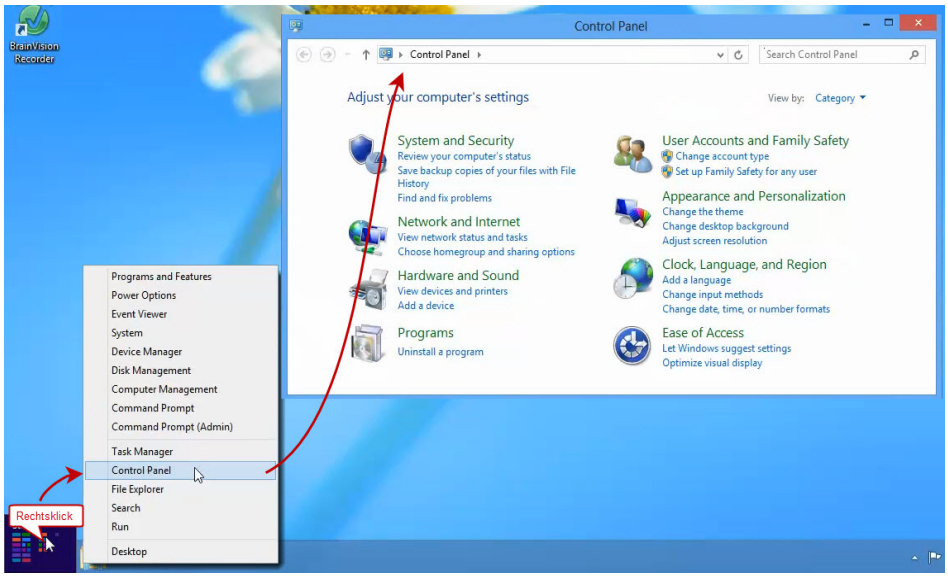


Figure 2-2. Windows® 8, Control Panel



Deactivating sleep mode

Proceed as follows to deactivate sleep mode:

1 Under *System and Security*, choose *Power Options* (see Figure 2-3).

2 Click *Change when the computer sleeps* in the dialog box that appears (see Figure 2-4).

3 Specify that the computer is never put to sleep and save this setting (see Figure 2-5).

Figure 2-3. Deactivating sleep mode (A)

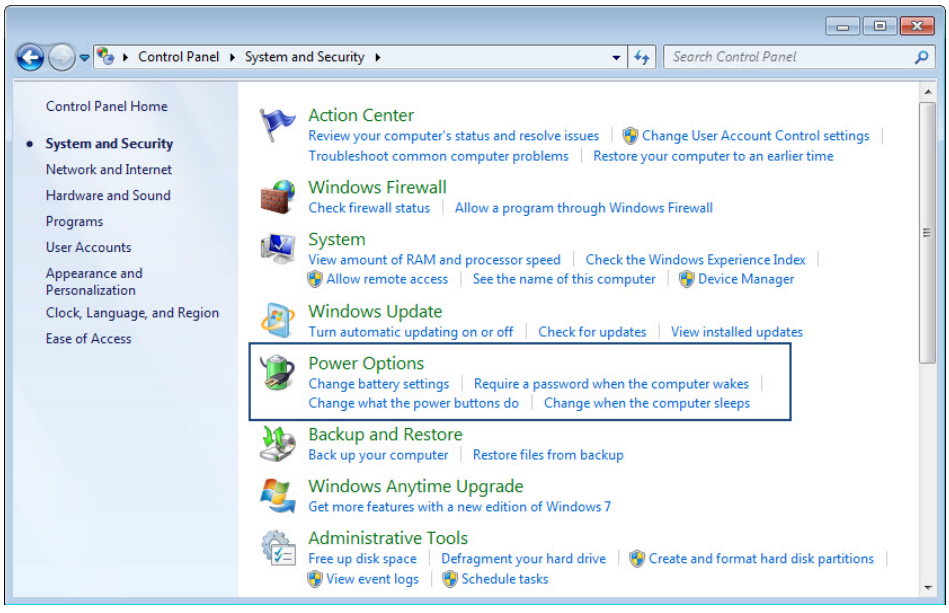


Figure 2-4. Deactivating sleep mode (B)

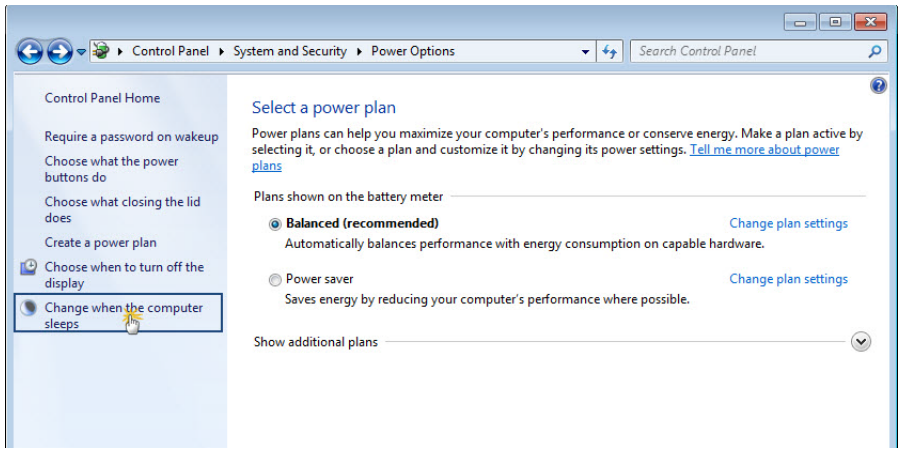
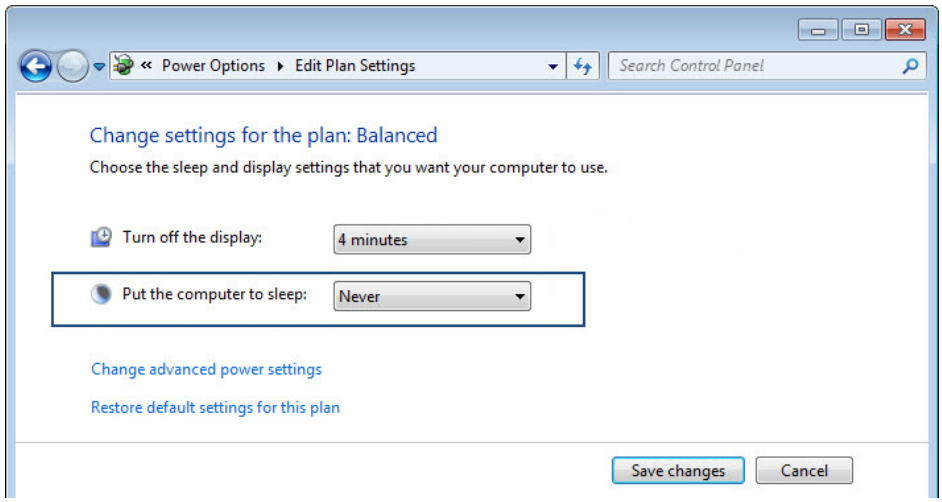


Figure 2-5. Deactivating sleep mode (C)



Deactivating automatic updates

Proceed as follows to deactivate automatic updates:

1. Under *System and Security*, choose *Windows Update* (see Figure 2-6).
2. Click *Change settings* in the dialog box that appears (see Figure 2-7).
3. Under *Important updates*, choose *Never check for updates* and save this setting (see Figure 2-8).

Figure 2-6. Deactivating automatic updates (A)

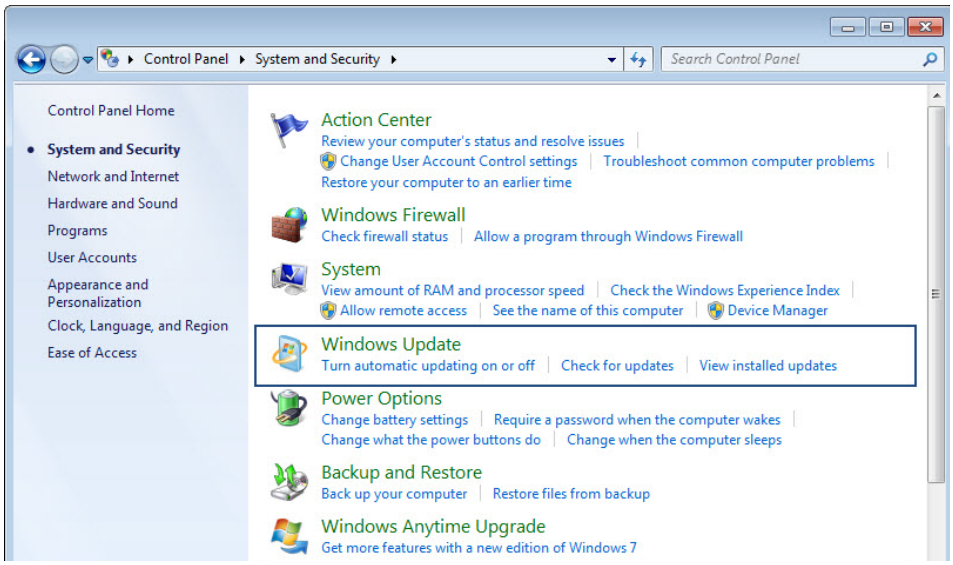


Figure 2-7. Deactivating automatic updates (B)

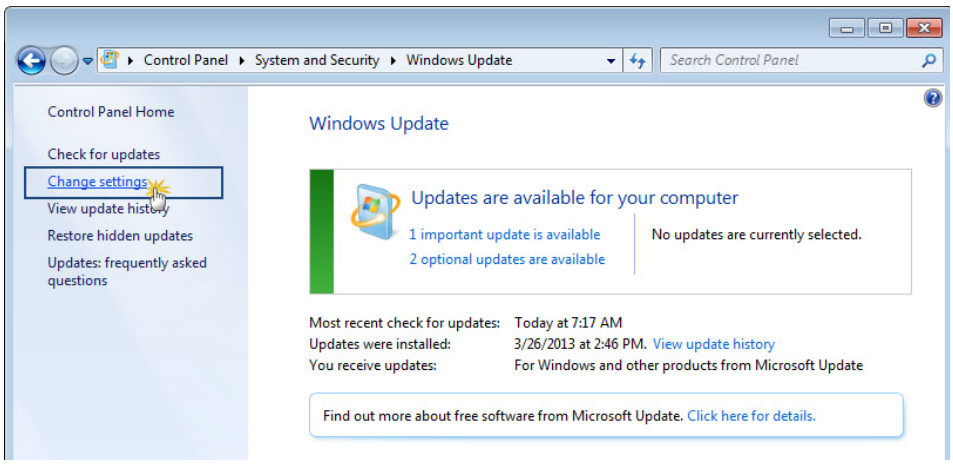
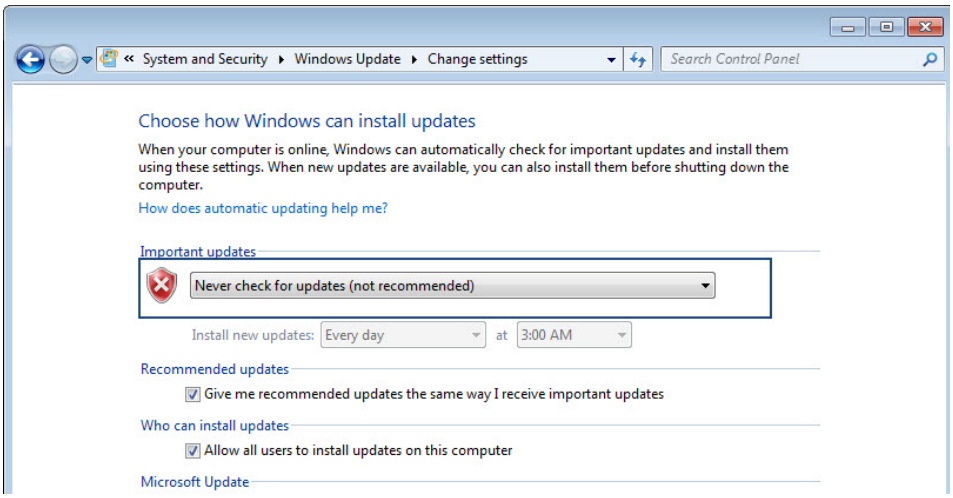


Figure 2-8. Deactivating automatic updates (C)



Deactivating Windows Defender

Proceed as follows to deactivate the Windows Defender function (for Windows 8®, see Figure 2-13):

1. In the *Control Panel*, search for the *Windows Defender* service (see Figure 2-9) and select it.
2. In the *Windows Defender* dialog box that appears, click *Tools* (see Figure 2-10).
3. In the dialog box that opens, click *Options* (see Figure 2-11).
4. To deactivate *Windows Defender* across the entire system, choose the *Administrator* option. Then uncheck the *Use this program* box (see Figure 2-12).

Figure 2-9. Deactivating Windows Defender (A)

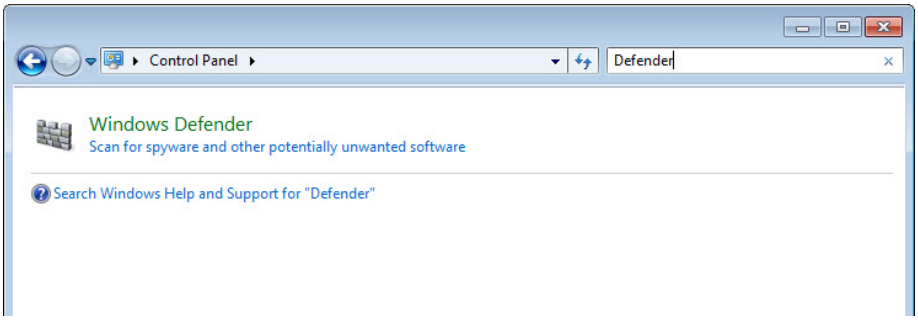


Figure 2-10. Deactivating Windows Defender (B)

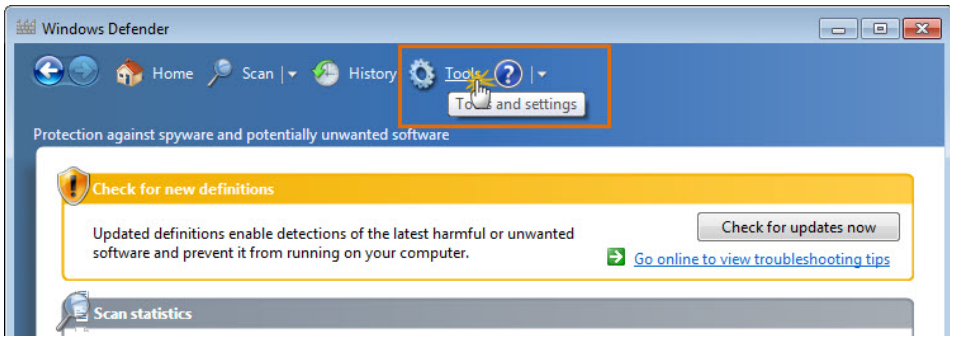


Figure 2-11. Deactivating Windows Defender (C)

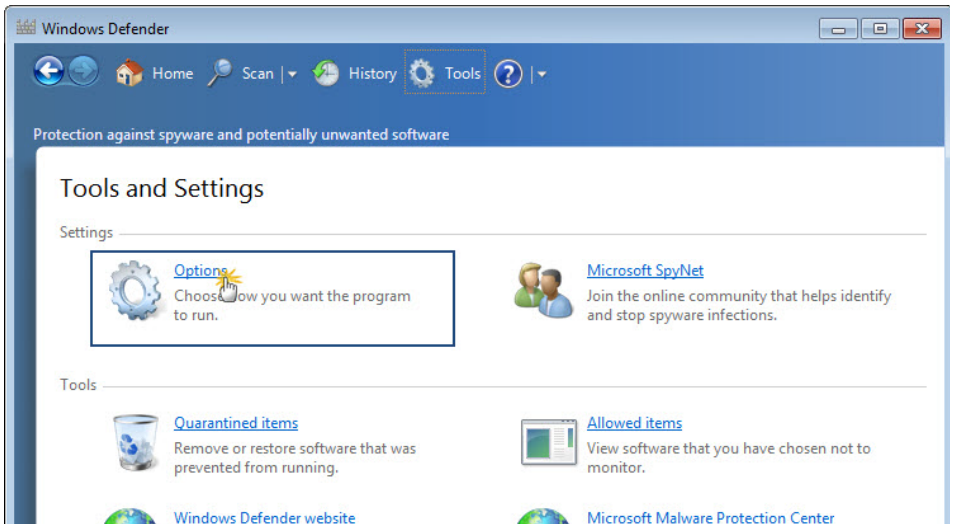


Figure 2-12. Deactivating Windows Defender (D)

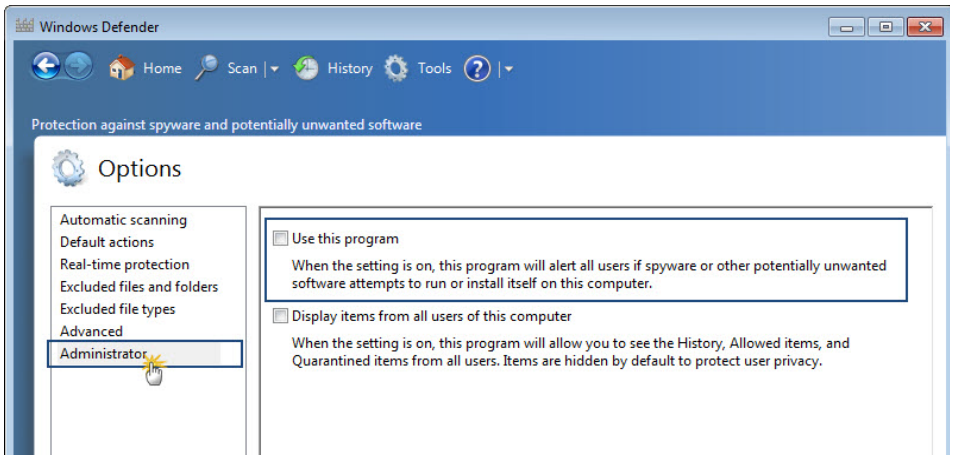
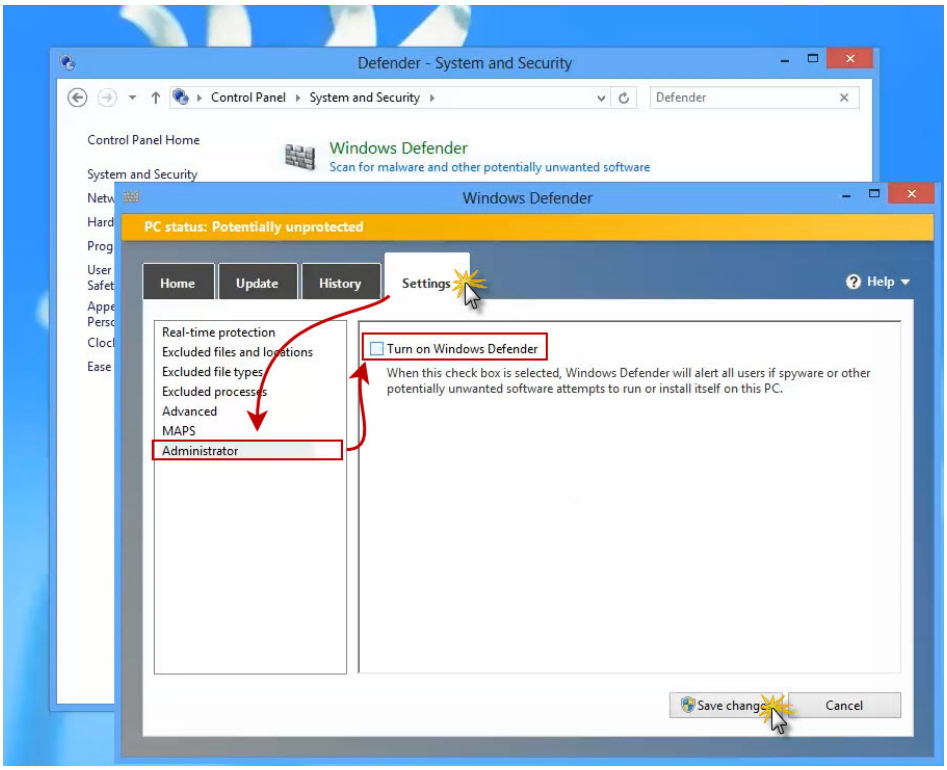


Figure 2-13. Deactivating Windows Defender under Windows 8®



Deactivating automatic defragmentation

You access the defragmentation options directly from the *Start* button. Proceed as follows to deactivate automatic defragmentation (for Windows 8®, see Figure 2-17):

1. Click *Start* and choose *All Programs › Accessories › System Tools › Disk Defragmenter* (see Figure 2-14).
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, uncheck the *Run on a schedule* box (see Figure 2-16).

Figure 2-14. Deactivating automatic defragmentation (A)

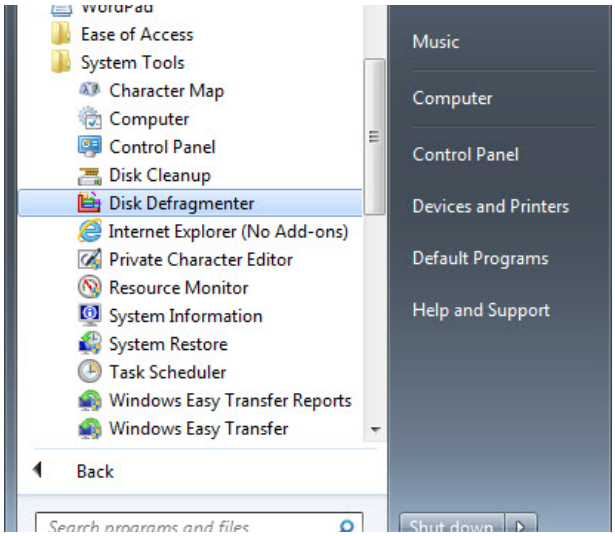


Figure 2-15. Deactivating automatic defragmentation (B)

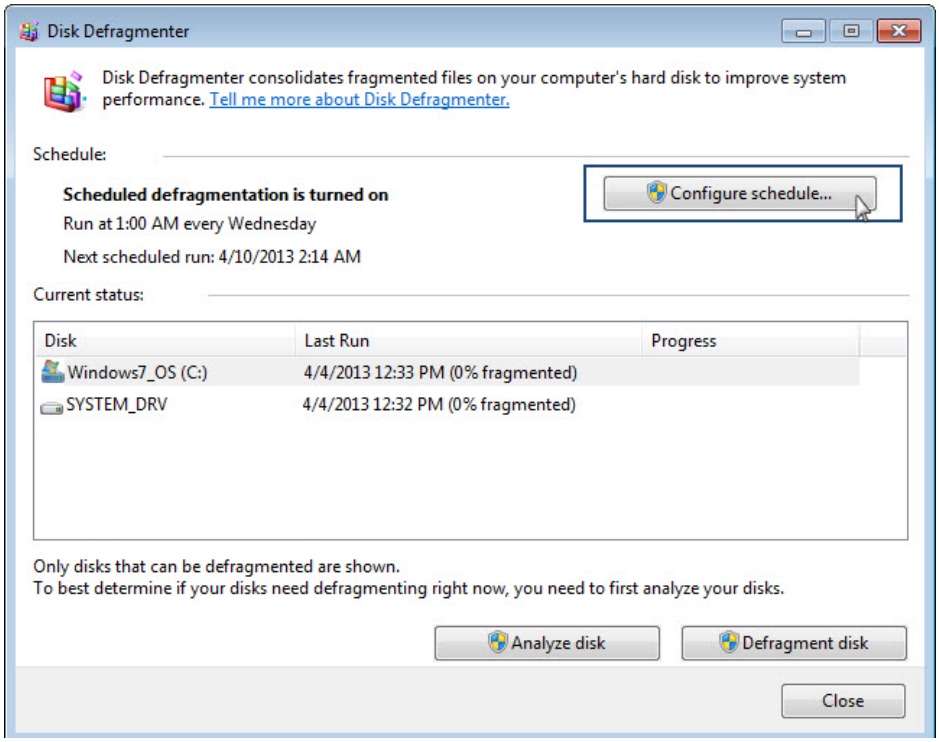


Figure 2-16. Deactivating automatic defragmentation (B)

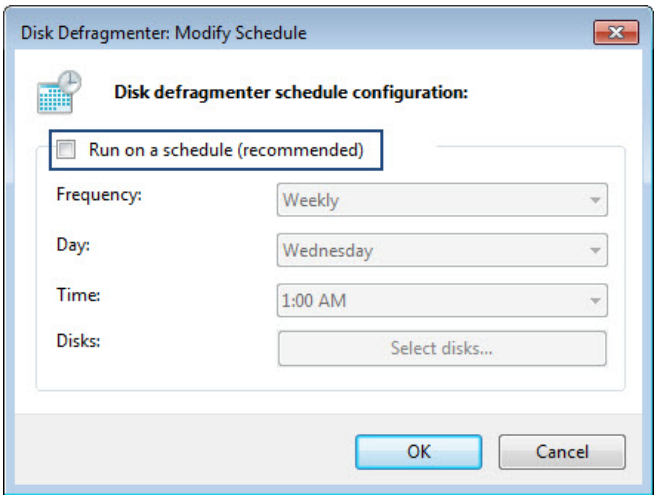
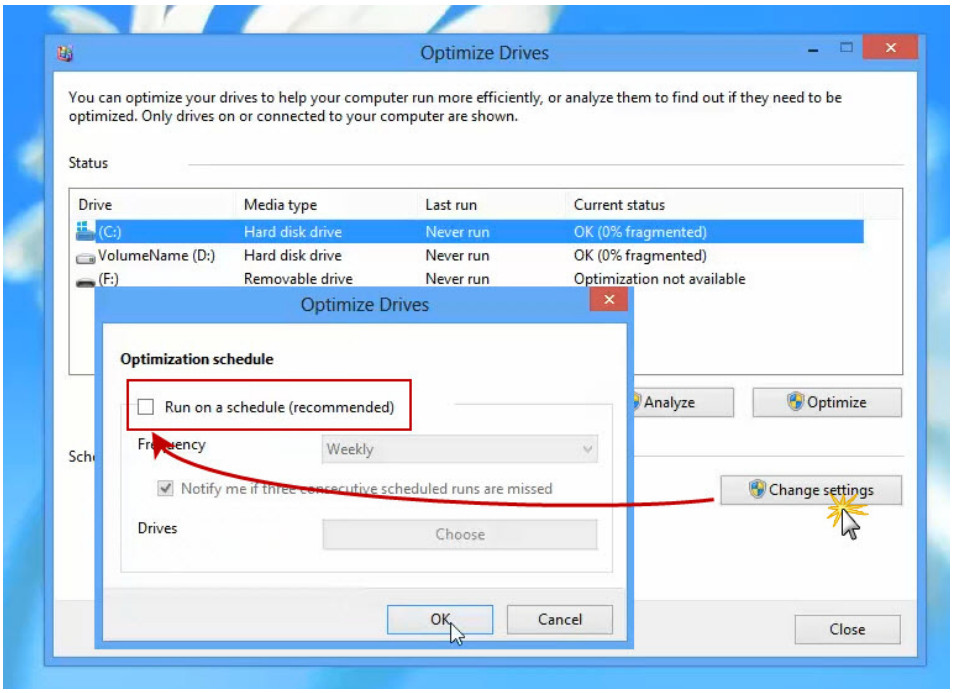


Figure 2-17. Deactivating automatic defragmentation under Windows 8®



Chapter 3 Getting started and handling the program

3.1 Starting the program for the first time and selecting an amplifier

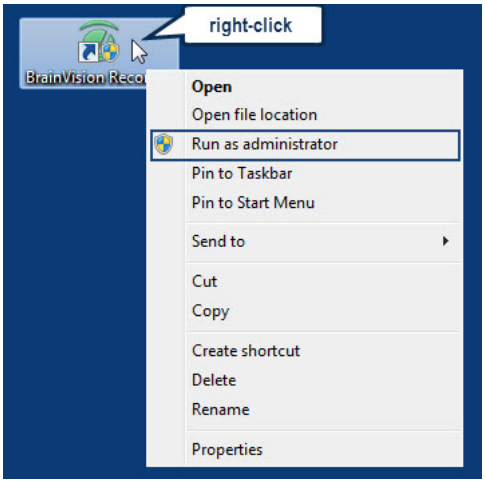
Connect the supplied USB dongle to one of the USB ports of your computer before you start the Recorder.

Amplifier can only be selected in 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 the Recorder in Administrator mode:

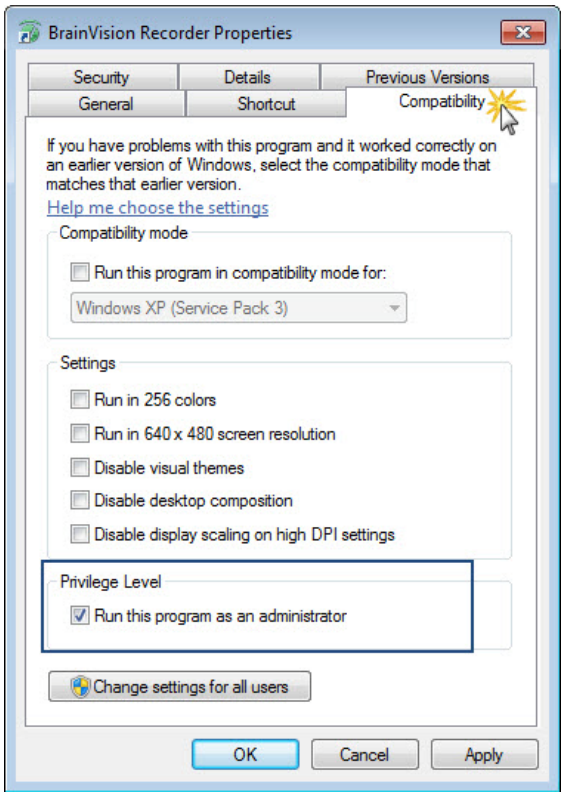
- You can start the Recorder by right-clicking the Recorder desktop icon and choosing *Run as administrator* from the context menu (see Figure 3-1). (When you run the Recorder as an administrator, the system prompts you to confirm that you wish to do so. Respond to the prompt by clicking *Yes*.)

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



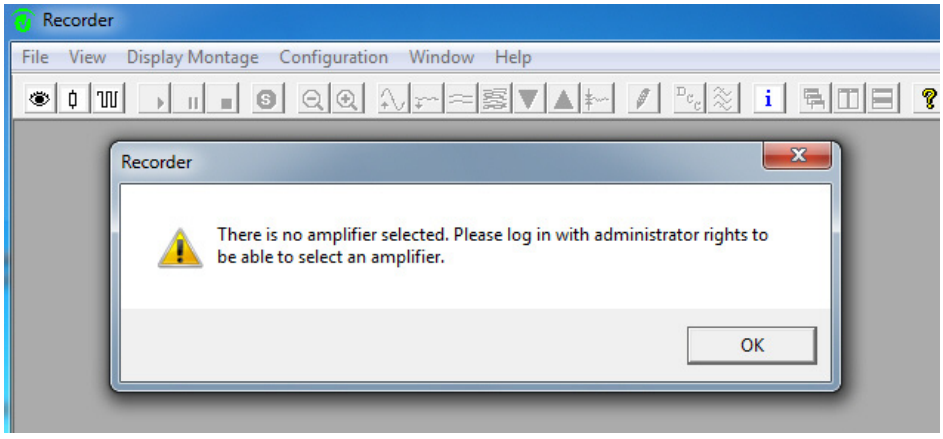
- If you always want to start the Recorder as administrator, right-click the Recorder desktop icon, choose *Properties* from the context menu and then open the *Compatibility* tab in the dialog box that appears. Under *Privilege Level*, check the *Run this program as an administrator* box (see Figure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

Figure 3-2. Always running the Recorder as administrator



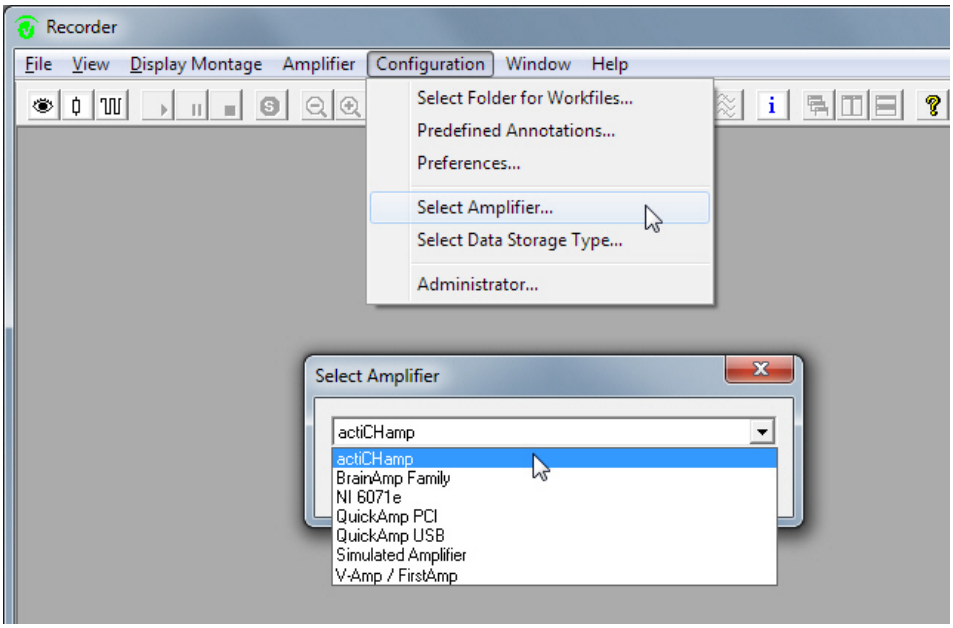
If you start the Recorder for the first time as a normal user rather than as an administrator, the following message is displayed (see Figure 3-3):

Figure 3-3. Message indicating that the Recorder must be run as administrator to select an amplifier



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



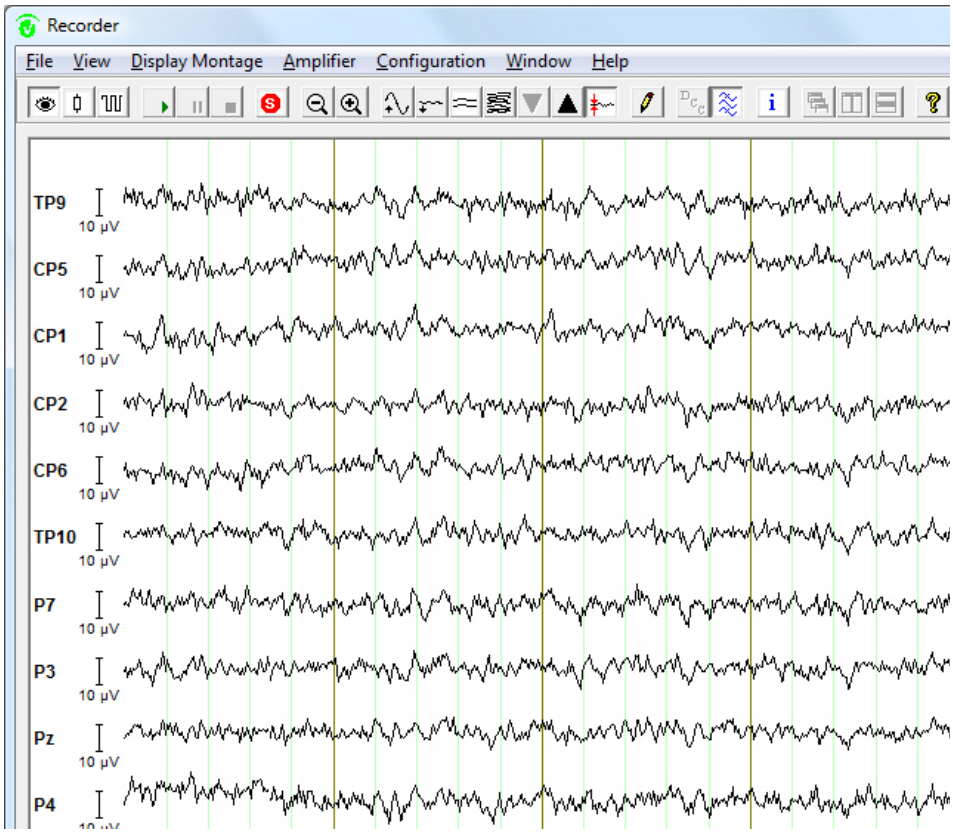
3.2 Data view (monitoring)

The 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 the Recorder toolbar, click the *Monitor* button. If no errors are encountered, EEG curves appear in the Recorder window running from left to right (see Figure 3-5).

To close monitoring mode, click the *Stop Monitoring* button in the toolbar. The 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. The Recorder in monitoring mode

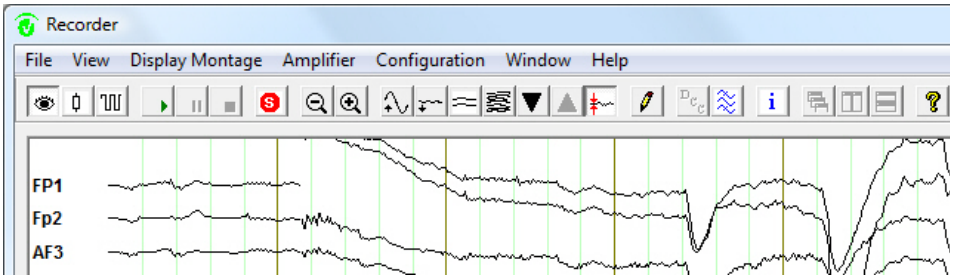


If the message "The setup does not match the amplifier's capabilities!" appears, the current amplifier settings are not compatible with the amplifier you have selected. To eliminate this problem, follow the instructions for setting up a workspace in Chapter 4 as of page 63.

3.3 The user interface

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

Figure 3-6. Menu bar and portion of the toolbar



Menu bar

The individual menus have the following functions:

File is used to set up and edit a workspace.

View is used to show and hide the status bar.

Display Montage is used to 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 as of page 161). Note also that the various items in the *Amplifier* menu depend on the selected amplifier.

Configuration is used to make default settings for the locations used to archive and store the work files and the data, to configure user rights and user settings and to select the amplifier used.

Window is used to configure the data windows.

Help is used to display program information and the installed components and to open this User Manual.

Toolbar

You can make a number of settings in the toolbar which is located below the menu bar. For example, you can define the time interval to be displayed and the number of channels that are displayed simultaneously. The labels for the elements in the toolbar are displayed when you position the mouse pointer over each element. A tool tip appears after a few moments. (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.

You will find detailed information on the form and size of the test signal in Chapter 8.

If this is permitted by the amplifier connected, you can click *Test Signal* to display the test signal. You can save the test signal in the current EEG file.

Start/Resume Recording starts recording or resumes it after a pause. A dialog box opens in which you can enter a comment. This comment is saved in the EEG file. A file name is proposed which you can either accept or change.

Pause Recording pauses the recording. While the 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-(–)›).

Decrease Interval decreases the time interval displayed (alternatively use the keyboard shortcut ‹Ctrl-(+)›).

You can assign different scaling factors to each channel, e.g. the ECG channels. For details, refer to Section 5.2 as of page 85.

Scale Up increases the scale (alternatively use the keyboard shortcut ‹Ctrl + arrow up›).

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 as of page 100).

Increase Channels increases the number of channels displayed.

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.

Next Group switches to the next channel group.

Previous Group switches to the previous channel group.

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 on page 97.

DC Correction activates or deactivates DC offset correction for the DC amplifier (alternatively use the keyboard shortcut ‹Ctrl-D›). DC offset correction acts directly on the data. This button only appears in the toolbar if you are using a BrainAmp DC, BrainAmp MR plus or BrainAmp ExG.

You will find information on performing a DC offset correction in Section 6.2.3 as of page 99.

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 4.5 on page 78). 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 the 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 as of page 63.

Cascade Windows cascades all the open segmentation and averaging windows one after another.

Tile Windows arranges the windows next to each other.

Tile Windows arranges the windows one above the other.

The three functions only arrange the segmentation and averaging windows. If you are not performing any segmentation/averaging, the icons are disabled.

About contains version information and information on the connected dongle.

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

Status bar

SAVING The first section shows the current status of the program (or the operating mode). We distinguish between the following operating modes: *monitoring*, *impedance check*, *test signal*, *saving*, *pause*.

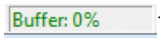
Average1 The second section shows the type of montage used.

For further information on montages, refer to Section 6.4 as of page 109.

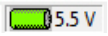
BrainAmp_0005.eeg The third section shows the name of the currently open EEG file.

Elapsed Time: 00:00:25 The fourth section shows the elapsed recording time of the currently open EEG file.

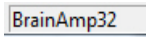
Free Space: 722:04:03 The fifth section shows the amount of free hard disk space in hours. This information is only available when an EEG file is open.



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

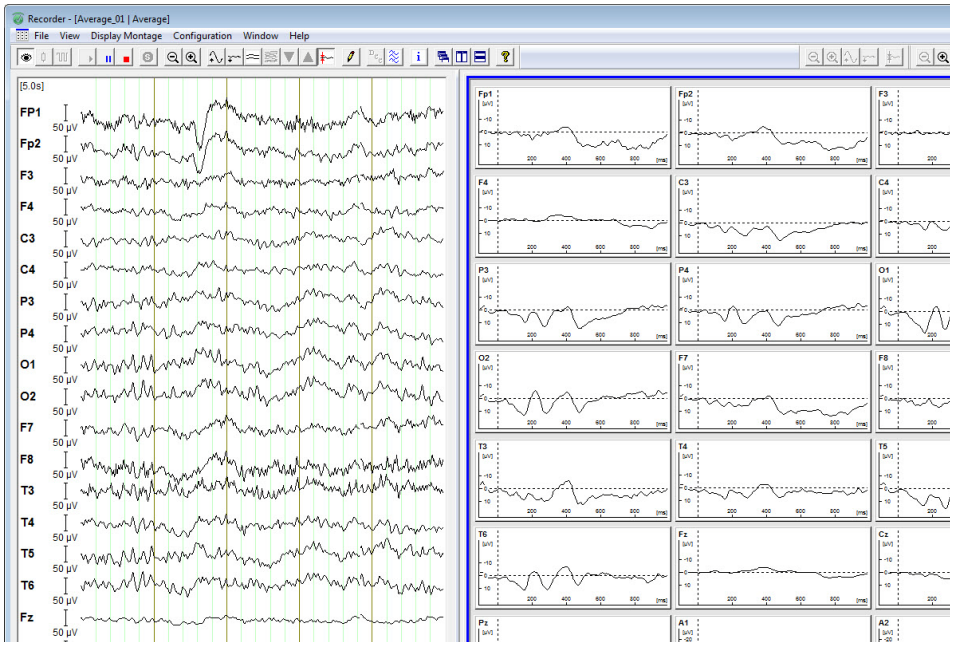
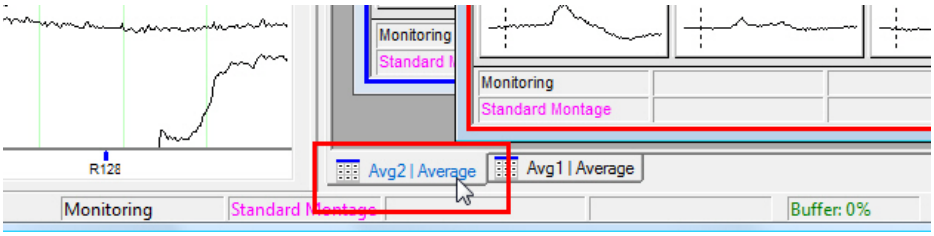


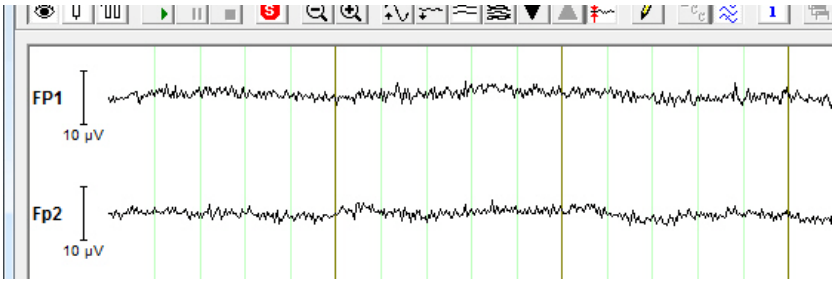
Figure 3-8. Tab for switching between segmentation and averaging groups



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.

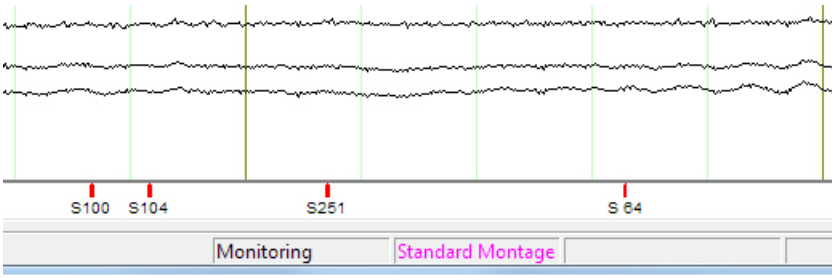
At the end of the channel list there is a scaling bar that helps you to assess the signal size. If a small number of channels are displayed and there is enough space, a scaling bar is shown in front of every channel (see Figure 3-9).

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

4.1 Workspaces in the Recorder

Many user-defined settings are administered in the Recorder. These include, for example, the storage location of EEG files and the amplifier parameters. These settings are saved in a central configuration file known as the workspace. Only one workspace is open in the Recorder 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 present in the Recorder. This allows you, for example, to define channel names and the sampling rate to be used during recording.

Recorder storage behavior

Alongside the settings you make in the wizard, the workspace also stores all the specifications you make in the *Configuration* (except for the specifications under *Select folder for Workfiles*... and *Select Amplifier*...) and *Amplifier* menus. For detailed information, refer to Chapter 5 as of page 83 and Chapter 8 as of page 139. Your impedance measurement settings are also saved in the workspace (see also Section 6.1 as of page 91 and Section 7.4 as of page 133).

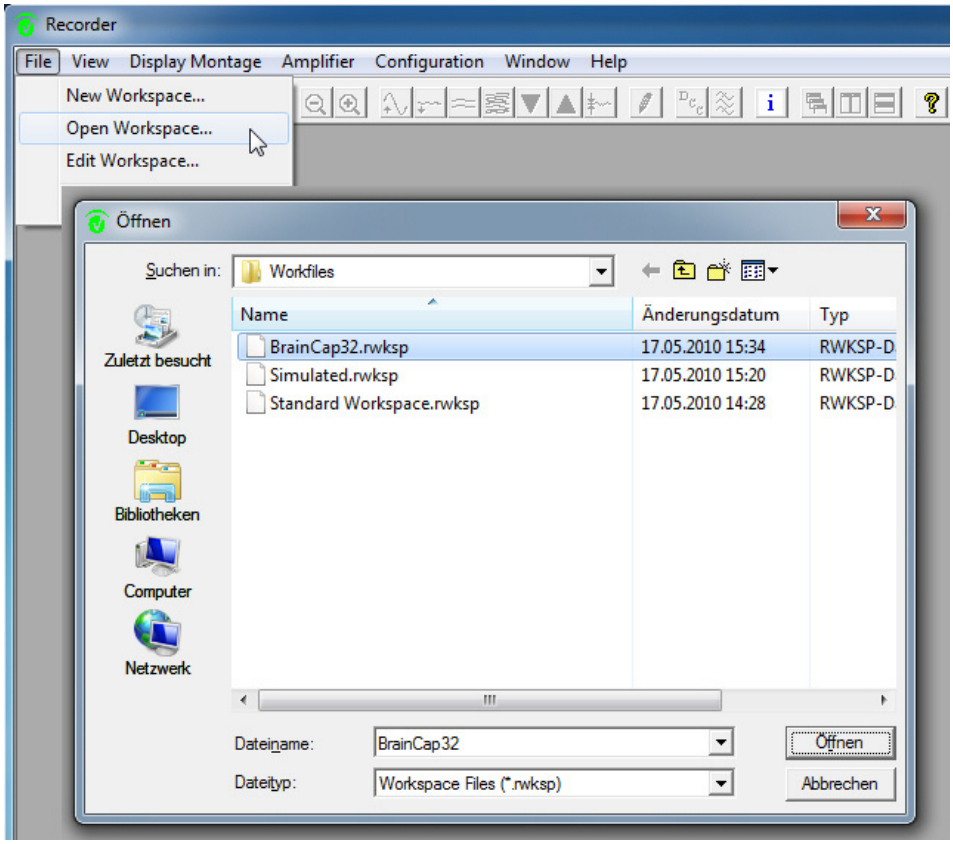
When you set up a new workspace or edit an existing workspace, all this information is automatically taken over from the last workspace that was opened. As a result, you may need to adapt these settings for use in the current workspace.

Workspaces that were created using an earlier version of the program (Recorder 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 version 1.20 or higher then the corresponding parameters are taken over from the last workspace to be opened on your computer into the current workspace.

4.2 File and folder settings

The first time the Recorder is started, it creates a default workspace. You can also create a new workspace by choosing *File › New Workspace…*. You load an existing workspace by choosing *File › Open Workspace…* (see Figure 4-1).

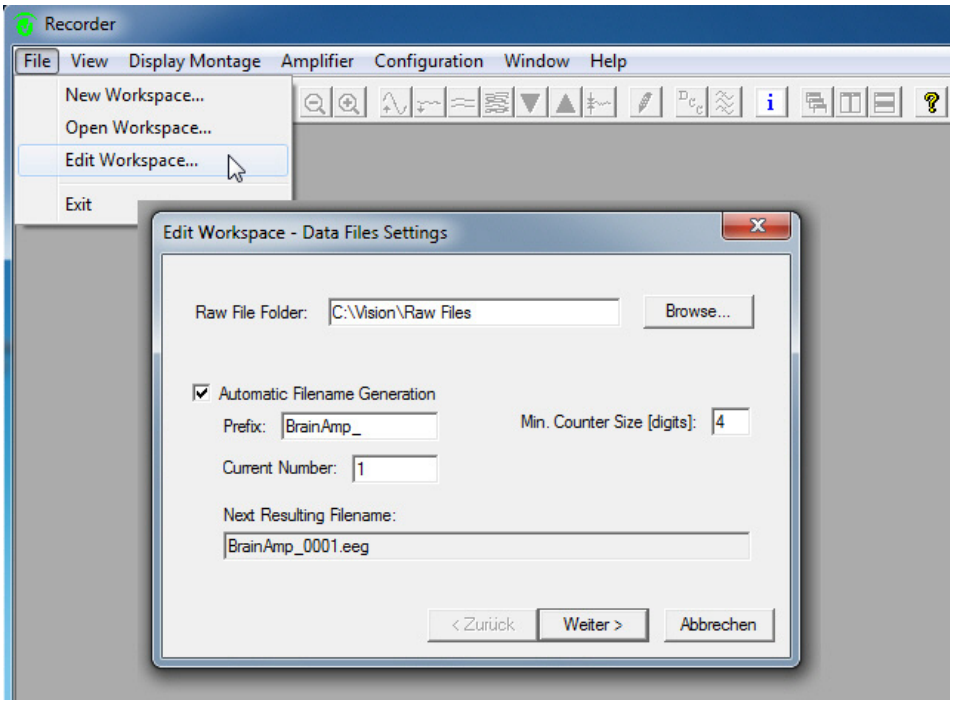
Figure 4-1. Opening an existing workspace



The following description also applies if you choose *File › New Workspace…*.

If you wish to modify a workspace, choose *File › Edit Workspace…*. The *Edit Workspace – Data Files Settings* dialog box appears (see Figure 4-2).

Figure 4-2. Editing a workspace, page 1, "Data File Settings"



The *Recorder-Workspace* folder on the BrainVision program DVD contains standard workspaces for the EEG caps actiCAP, BrainCap, BrainCap MR and EasyCap.

The *Raw File Folder* text box is used to specify where the raw EEG data is stored. You can select the folder by clicking the *Browse...* button.

If you check *Automatic Filename Generation*, the name of the raw data set is generated automatically on the basis of a *Prefix*, to which a sequential number (*Current Number*) is appended. The name of the data set for the first recording could therefore be "BrainAmp_0001.eeg", in which case the name of the second data set would be "BrainAmp_0002.eeg".

The *Min. Counter Size [digits]* box specifies the minimum number of digits that appear in the name of the data set. You can enter a number between 4 and 10.

The *Next Resulting Filename* text box shows the name that results from the entries you have made.

Click the *Next* button to proceed to the *Edit Workspace – Amplifier Settings* page.

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

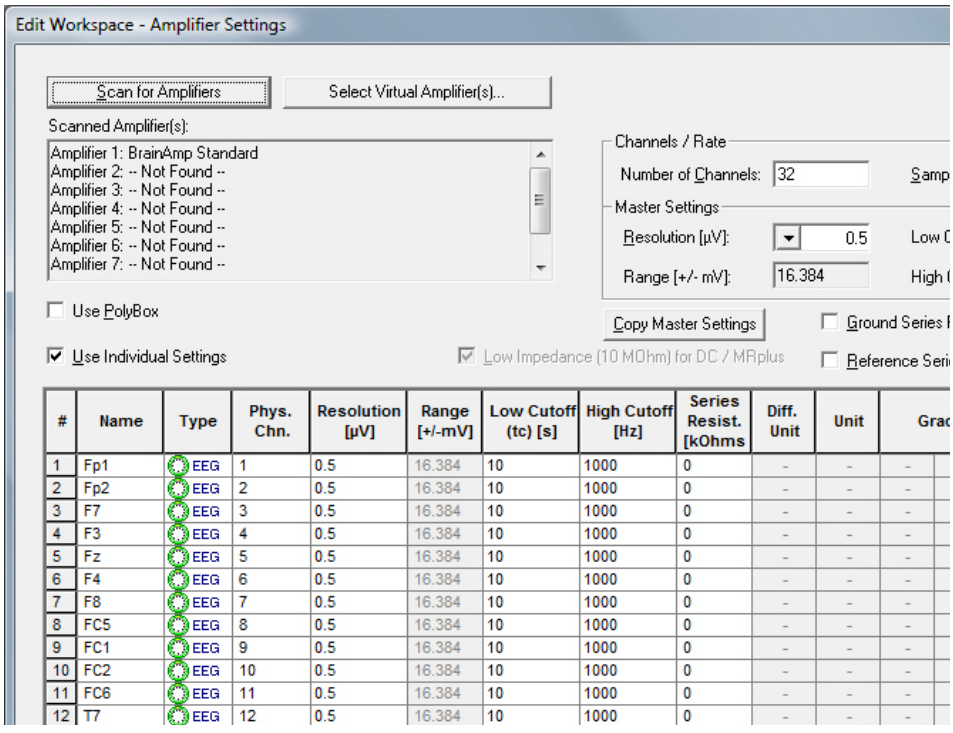
For further information on the individual amplifiers and their accessories, refer to Chapter 8 as of page 139.

4.3 Amplifier-specific settings using the BrainAmp as an example

Note that 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.

To be able to make settings, you must first open the *Amplifier Settings* dialog box (see Figure 4-3).

Figure 4-3. Editing a workspace, page 2, "Amplifier Settings" for amplifiers of the BrainAmp family



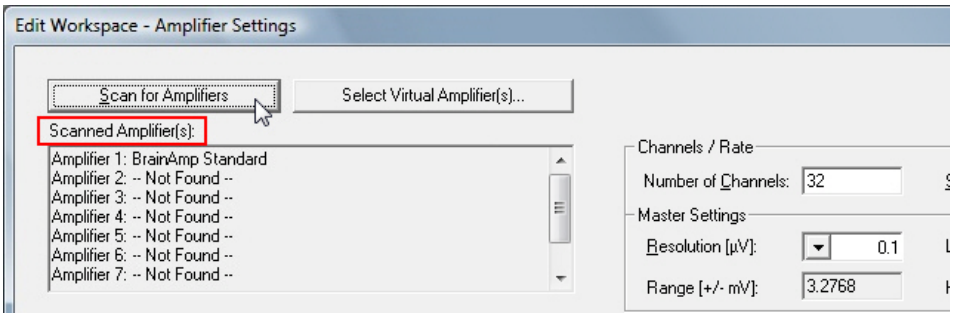
Selecting an amplifier

The *Scan for Amplifiers* and *Select Virtual Amplifier(s)...* buttons offer you two options for selecting amplifiers, editing their parameters and configuring their workspace. Before you can select amplifiers using *Scan for Amplifiers*, you must connect the amplifiers to your computer. The *Select Virtual Amplifier(s)...* function allows you to select virtual amplifiers and configure and edit workspaces without the amplifiers being connected to your computer.

Click *Scan for Amplifiers*. This lists the amplifiers connected to your computer under *Scanned Amplifier(s)* (see Figure 4-4).

Section 8.1.7 on page 149 explains how to check what BrainAmp amplifiers are connected to your computer.

Figure 4-4. List of connected amplifiers



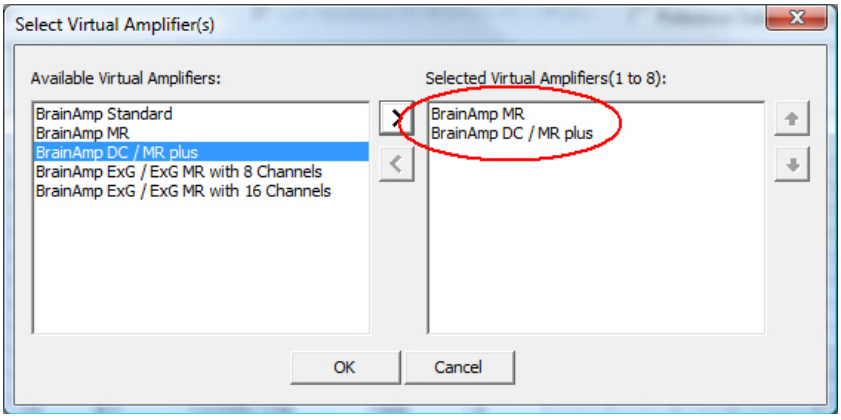
Click *Select Virtual Amplifier(s)...* to select a virtual amplifier from the BrainAmp family offline, i.e. without any amplifiers actually being connected. The *Select Virtual Amplifier(s)...* dialog box appears (see Figure 4-5). The *Available Virtual Amplifiers* text box contains all the currently available amplifiers in the BrainAmp family. The *Selected Virtual Amplifiers (1 to 8)* text box contains the selected amplifiers. You can add up to eight virtual amplifiers to this box.

Note that the function for selecting virtual amplifiers is only available for amplifiers of the BrainAmp family.

Select the entries in the left-hand box and click the > button to select one or more amplifiers or double-click on the name of the required amplifier. Click < to cancel your selection.

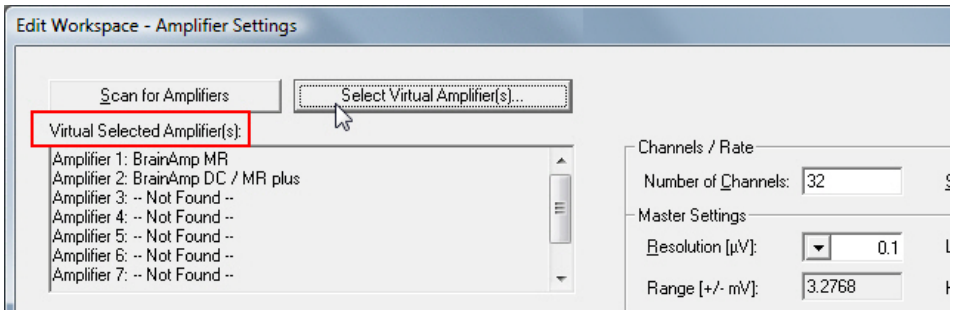
Use the ↑ and ↓ buttons to move a selected amplifier up or down in the list.

Figure 4-5. Selecting virtual amplifiers (BrainAmp)



Click *OK*. The workspace is then automatically updated (see Figure 4-6).

Figure 4-6. Listing the selected virtual amplifiers (BrainAmp)



Editing a workspace

After you have selected an amplifier in a workspace, you can edit the workspace (see Figure 4-3):

Note that the parameters and the permitted ranges depend on the amplifier you have selected.

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

Choose the amplitude resolution from the *Resolution [µV]* text box. The value in the *Range [+/- mV]* text box specifies the range across which the amplifier sends data to the Recorder.

Specify the low and high-cutoff filters in the *Low Cutoff [s]* and *High Cutoff [Hz]* text boxes.

The *Low Impedance (10 MOhm) for DC/MRplus* check box 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).

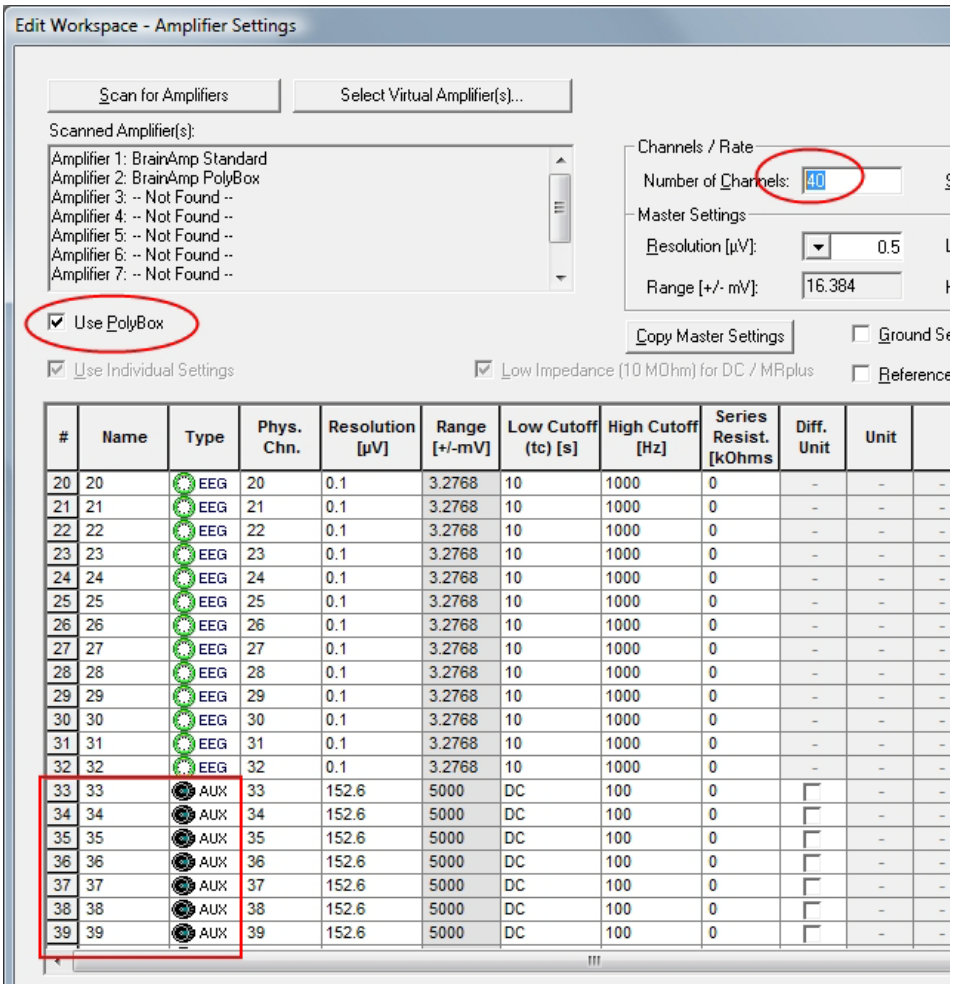
If your amplifier permits individual settings to be made for each channel, you can check the *Use Individual Settings* box. This allows you to make the relevant settings separately for each channel in a table. The *Copy Master Settings* button allows you to copy the parameters you have entered into the channel table so that you only have to edit those channels for which the settings are different.

When used in conjunction with the USB2 Adapter 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.

If a PolyBox is connected, it is enabled by checking *Use PolyBox*. 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 4-7).

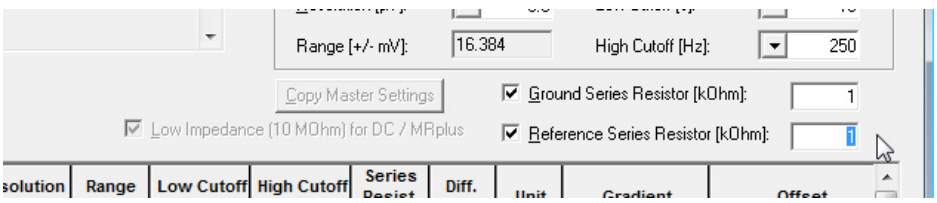
Please note that simultaneous use of the PolyBox and the ExG AUX Box is not supported. You are not able to configure the settings of the PolyBox if you are using a virtual amplifier.

Figure 4-7. Selecting the PolyBox and adjusting the number of channels



To specify the values for the protective resistors fitted in the electrode cables of the ground electrode and reference electrode, check the *Ground Series Resistor [kOhm]* and/or *Reference Series Resistor [kOhm]* box and assign the relevant values in the associated text boxes (see Figure 4-8).

Figure 4-8. Protective resistors for the ground electrode and reference electrode



Inserting and removing channels

Note that the functions for inserting and removing channels are only available for amplifiers of the BrainAmp family.

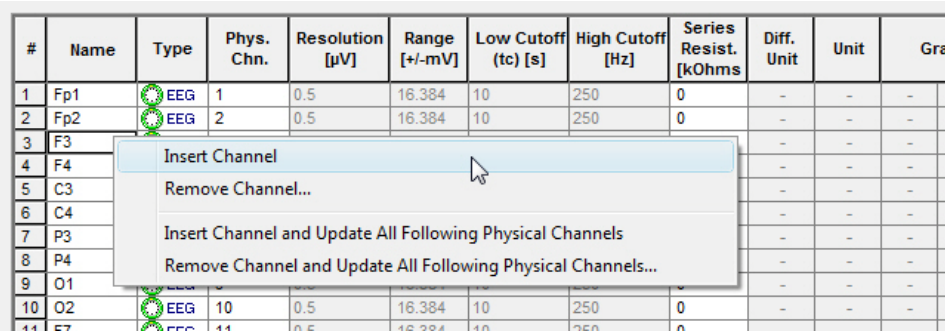
If you wish to insert a channel in the channel table or remove a channel from the channel table, right-click in the relevant row. This opens a menu (see Figure 4-9).

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 4-9. Inserting and removing channels for amplifiers of the BrainAmp family



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:

Enter the channel name in the *Name* column. If you enter the same name twice, an error message appears when you click *Next* at the bottom of the dialog box. This considerably facilitates reconfiguration of the workspace. *Note that this function is not available for QuickAmp PCI, NI 6071e A/D converter board and Simulated Amplifier.*

Enter the channel type (EEG, BIP, AUX) in the *Type* column.

The *Phys. Chn.* column allows you to assign physical channels to the logical channels in the first column provided that your amplifier permits this.

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.

Enter the signal resolution in the *Resolution [µV]* column.

The *Range [+/- mV]* column contains the range across which the amplifier sends data to the Recorder.

Enter the low-cutoff filter in the *Low Cutoff (tc) [s]* column.

Enter the high-cutoff filter in the *High Cutoff [Hz]* column.

In the *Series Resist. [KOhms]* column, enter the resistance of the protective resistors installed in the electrode cables. 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 (e.g. EEG caps such as the 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.

4.4 Electrode positions

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 (e.g. modify 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):

Figure 4-10. Example electrode position file

```
<?xml version="1.0"?>
<Electrodes>
<Electrode>//opening tag
<Name>Fp1</Name>//Electrode name (here: int. 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>
```

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

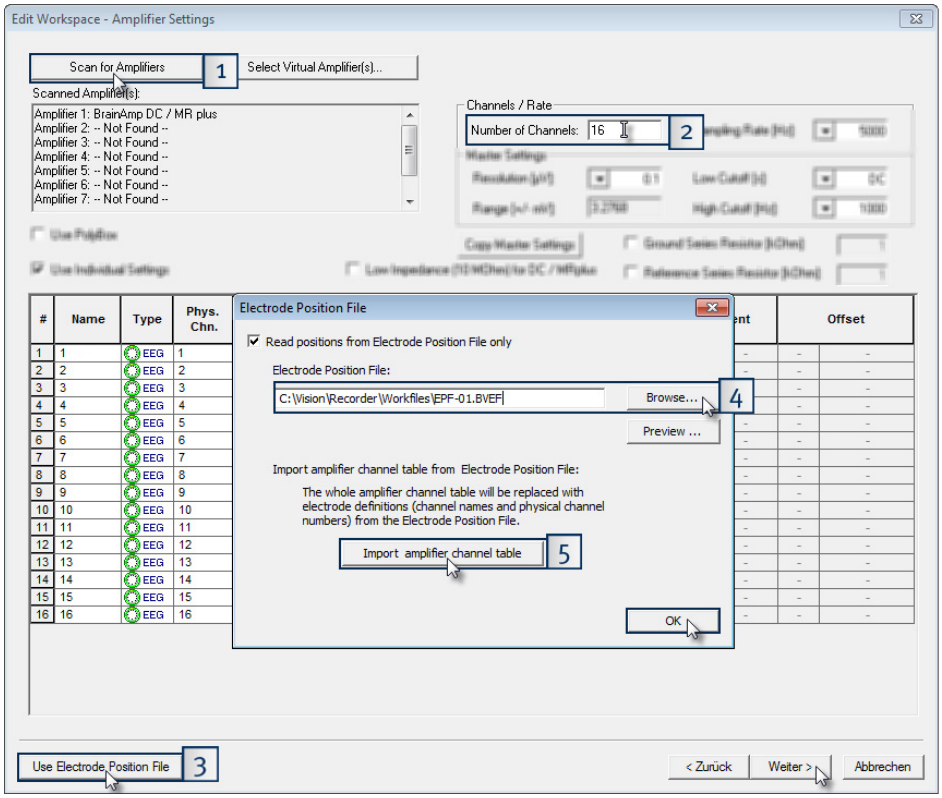
You can use the import function to create a new workspace or modify an existing workspace.

1. EPF: Electrode position file

4.4.1 Creating a workspace from the 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 4-11. Creating a workspace from an electrode position file



1 First, scan for the amplifier.

2 Specify the number of channels used.

3 Click [Use Electrode Position File].

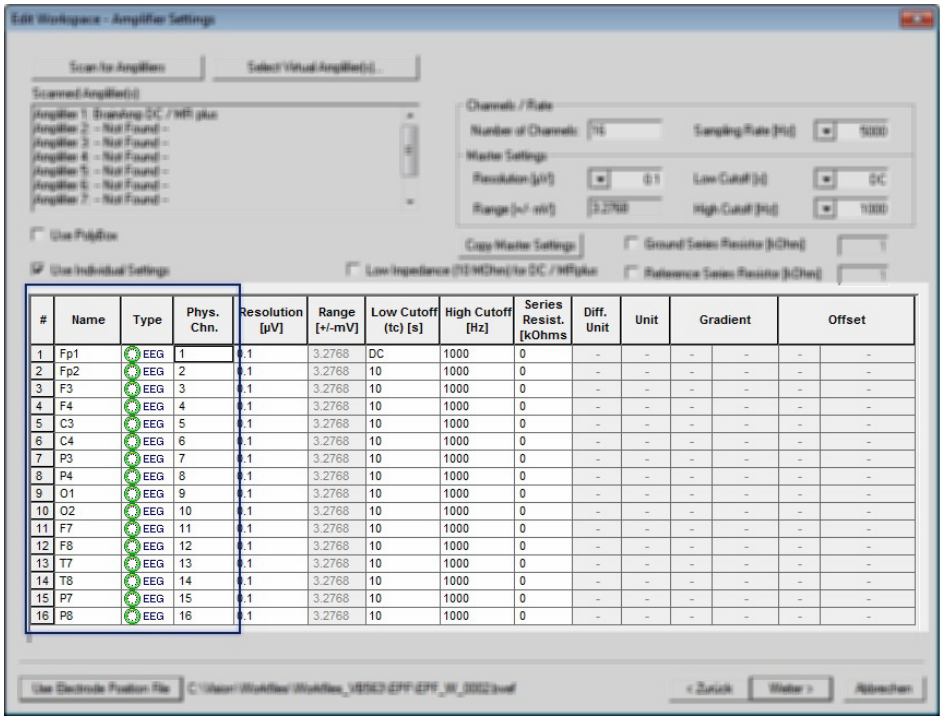
If you are not sure how many channels the electrode position file contains, you can click on [Preview...] in the *Electrode Position File* dialog box. Check the number of channels that are specified in the file and then adapt the number of channels in the workspace if necessary.

4 Load the electrode position file (BVEF format) in the *Electrode Position File* dialog box.

5 Now click [Import amplifier channel table] in the dialog box.

The data from the electrode position file is loaded into the channel table (see Figure 4-12). This causes the Recorder to take over the channel name and physical channel assignments together with the topography.

Figure 4-12. Read-in electrode position file



#	Name	Type	Phys. Chn.	Resolution [µV]	Range [+/-mV]	Low Cutoff (tc) [s]	High Cutoff [Hz]	Series Resist. [kOhms	Diff. Unit	Unit	Gradient		Offset	
1	Fp1	EEG	1	0.1	3.2768	DC	1000	0	-	-	-	-	-	-
2	Fp2	EEG	2	0.1	3.2768	10	1000	0	-	-	-	-	-	-
3	F3	EEG	3	0.1	3.2768	10	1000	0	-	-	-	-	-	-
4	F4	EEG	4	0.1	3.2768	10	1000	0	-	-	-	-	-	-
5	C3	EEG	5	0.1	3.2768	10	1000	0	-	-	-	-	-	-
6	C4	EEG	6	0.1	3.2768	10	1000	0	-	-	-	-	-	-
7	P3	EEG	7	0.1	3.2768	10	1000	0	-	-	-	-	-	-
8	P4	EEG	8	0.1	3.2768	10	1000	0	-	-	-	-	-	-
9	O1	EEG	9	0.1	3.2768	10	1000	0	-	-	-	-	-	-
10	O2	EEG	10	0.1	3.2768	10	1000	0	-	-	-	-	-	-
11	F7	EEG	11	0.1	3.2768	10	1000	0	-	-	-	-	-	-
12	F8	EEG	12	0.1	3.2768	10	1000	0	-	-	-	-	-	-
13	T7	EEG	13	0.1	3.2768	10	1000	0	-	-	-	-	-	-
14	T8	EEG	14	0.1	3.2768	10	1000	0	-	-	-	-	-	-
15	P7	EEG	15	0.1	3.2768	10	1000	0	-	-	-	-	-	-
16	P8	EEG	16	0.1	3.2768	10	1000	0	-	-	-	-	-	-

Note the number of channels. The following applies to the example depicted here:

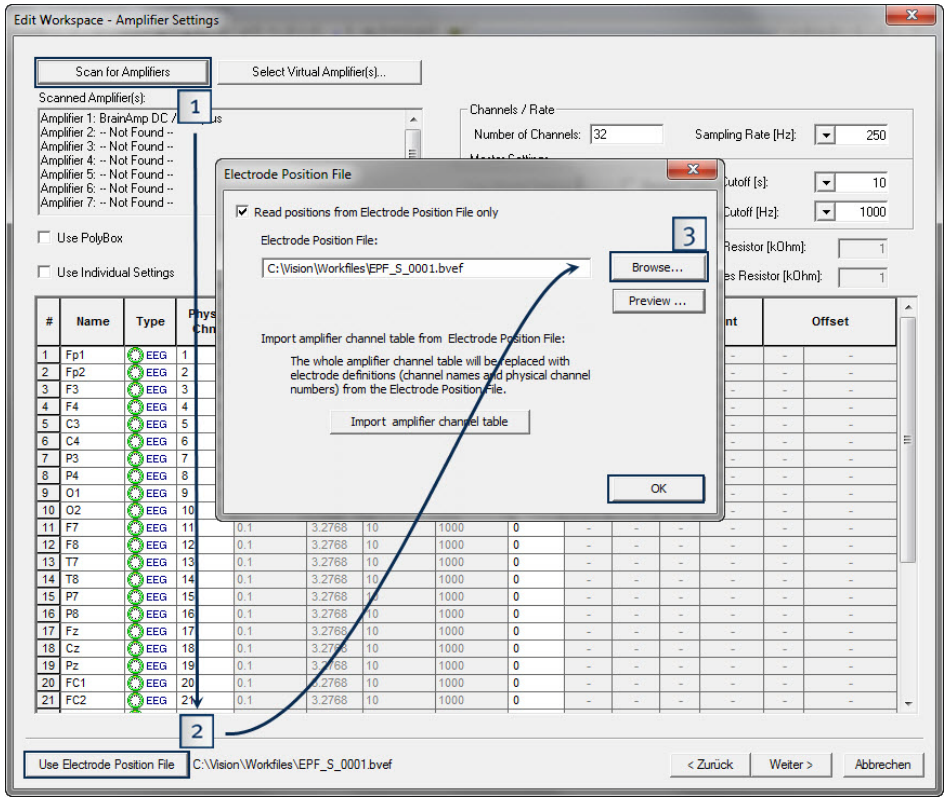
- ▷ If you import more electrode positions than are specified in the amplifier then only the first 16 are imported and an information message is issued.
- ▷ If you import fewer channels (e.g. 14) then the remaining channels are unoccupied. If necessary, you can correct the number of channels if you do not require unoccupied channels for your project.

4.4.2 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. Because, in this case, a workspace already exists and the channel names it contains are already assigned to physical channels, only the new topography has to be read from the EPF. This operation does not modify the physical channels. The import operation only reads in the positions of electrodes that are also present in the channel table.

To import the electrode positions from a file, first open a workspace and then proceed as follows:

Figure 4-13. Importing an electrode position file



1 Open a workspace and search for the amplifier.

First of all, click [Scan for Amplifiers] in order to register the amplifier in the Recorder and display the channels in the channel table.

2 Click [Use Electrode Position File] to use an electrode position file. This opens the *Electrode Position File* dialog box.

3 Upload the file.

Click [Browse] and select the required BVEF file. The path of the selected file is now displayed in the text box.

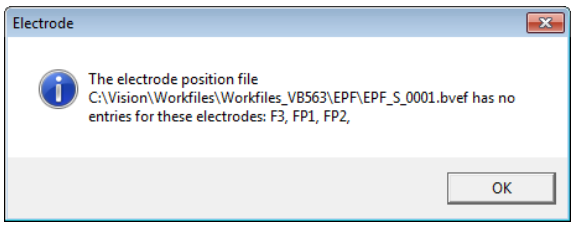
You can check the selected file with [Preview. . .].

When you have finished, click [OK] and then click [OK] again to confirm any message that is issued regarding missing position data. If the file contains no corresponding data for electrodes that are specified in the workspace then these electrodes are set to zero (see

Missing position data

Figure 4-14). These electrodes are then displayed at the edge during impedance measurement!

Figure 4-14. Example information message



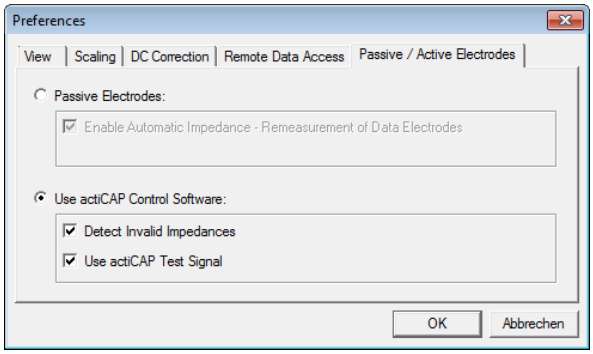
Notes

- 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 as of page 91). If there is no data corresponding to certain electrodes that are present then these electrodes appear at the edge during the impedance measurement.

actiCAP ControlBox + EPF

- If you use active electrodes with the interface to the control software then the positions that are read in are not displayed in the topography during the impedance measurement.

Figure 4-15. Settings when using the actiCAP control software



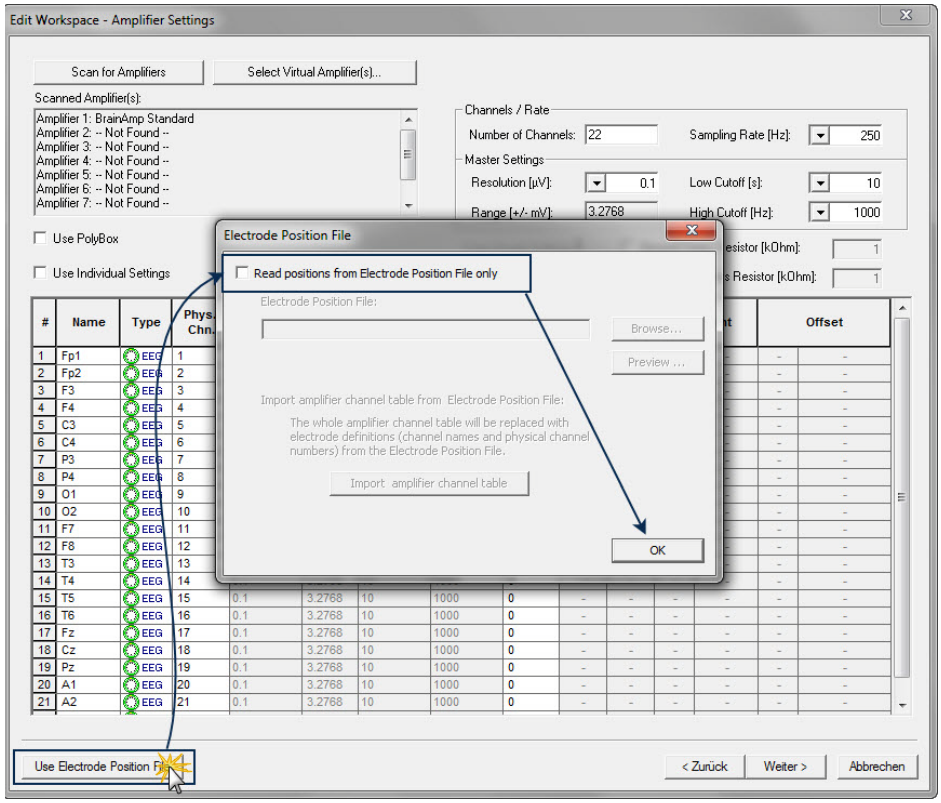
The values are nevertheless still written to the header file.

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

4.4.3 Terminating the import

If you have already imported an electrode position file in the project then the 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.

Figure 4-16. Preventing the use of an electrode position file



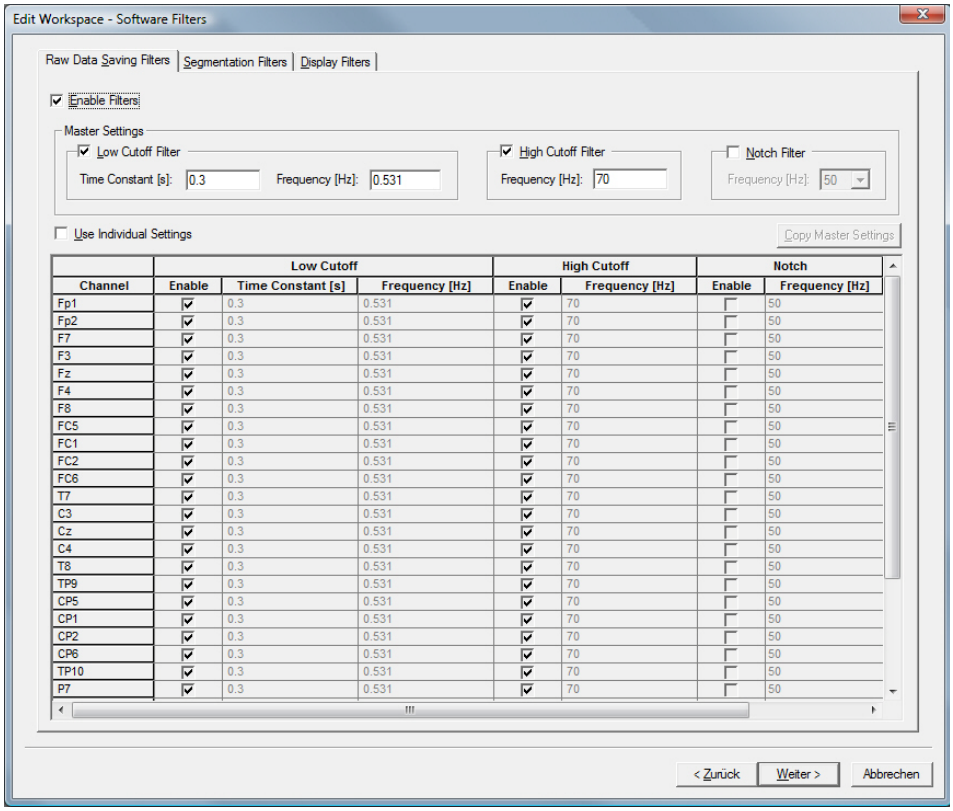
- Click [Use Electrode Position File], clear the *Read positions from the Electrode Position File only* check box and click [OK].

4.5 Filter settings

You can set the filter parameters for the individual software filter paths on the *Edit Workspace – Software Filters* page (see Figure 4-17). 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 4-17. Configuring the software filters



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

4.6 Segmentation and averaging

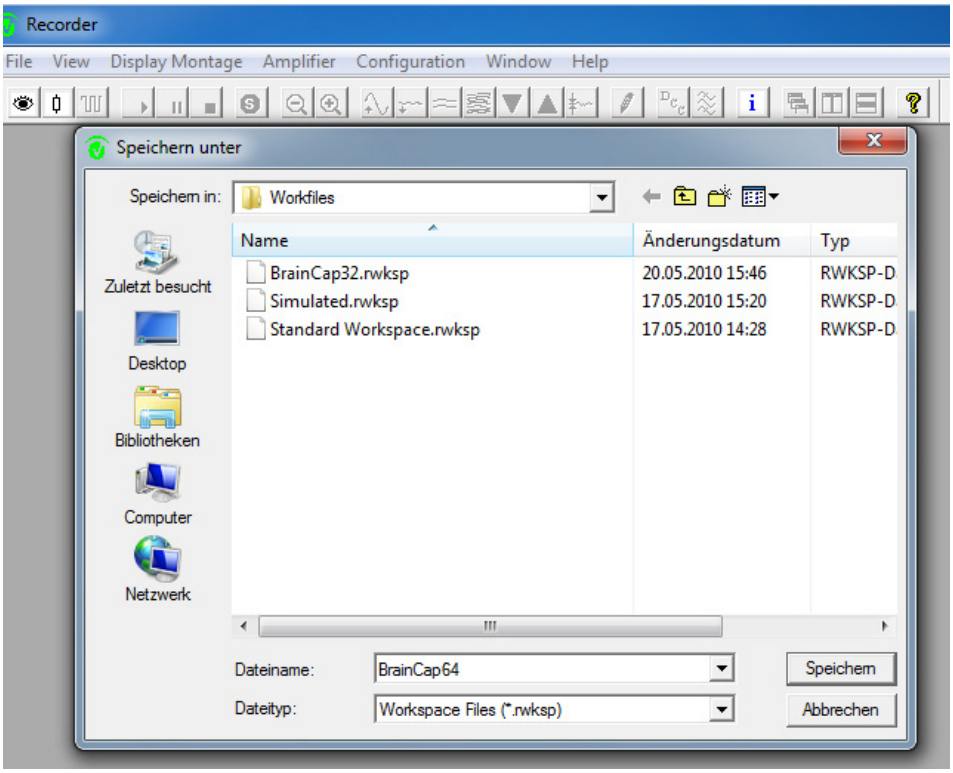
The *Edit Workspace – Segmentation/Averaging* dialog page allows you to make optional settings for segmentation and averaging. You will find a detailed description of the configuration options for segmentation and averaging in Section 6.5 as of page 114.

When you have finished making your settings, a dialog box opens allowing you to save the workspace file (see Figure 4-18 on page 81). Give the file a meaningful name and press the ‹Enter› key or click *Save*.

4.7 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 4-18). 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 is issued "???.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 4-18. 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.

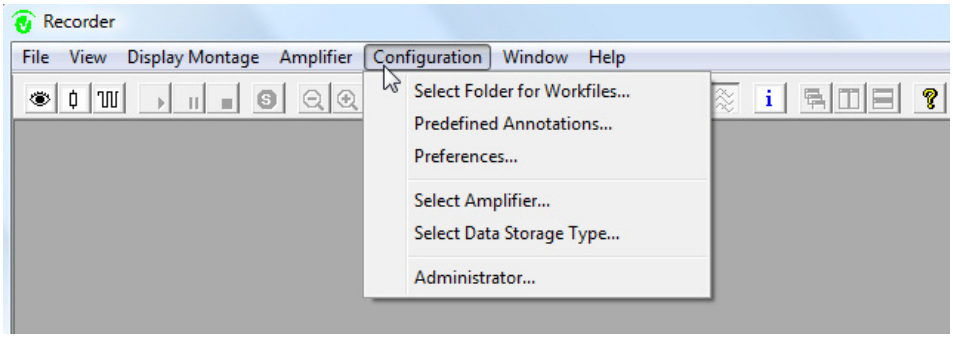
You will find a description of the basic functions of the Recorder in Chapter 6 as of page 91. Amplifier-specific properties such as test signal values and digital port settings are described in Chapter 8 as of page 139.

Chapter 5 Program configuration

5.1 Configuring the user privileges

Whether or not you have full or restricted access to the functions of the Recorder depends on whether you have administrator privileges or not. If you have administrator privileges, all the entries in the *Configuration* menu are available (see Figure 5-1).

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



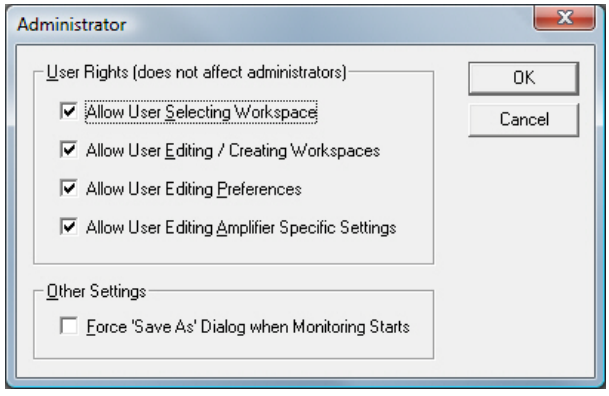
The following functions are only available to users with administrator privileges:

Choose *Select Amplifier...* from the menu to select the amplifier that is to be used.

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

Administrator... opens the *Administrator* dialog box (see Figure 5-2). Here you can further restrict access rights for normal users.

Figure 5-2. "Administrator" dialog box



You can make the following settings:

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.

You will find detailed information on configuring the user settings in Section 5.2 as of page 85.

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

By checking or unchecking the *Allow User Editing Amplifier Specific Settings* box, you can enable or disable all the items in the *Amplifier* menu.

If you check 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.

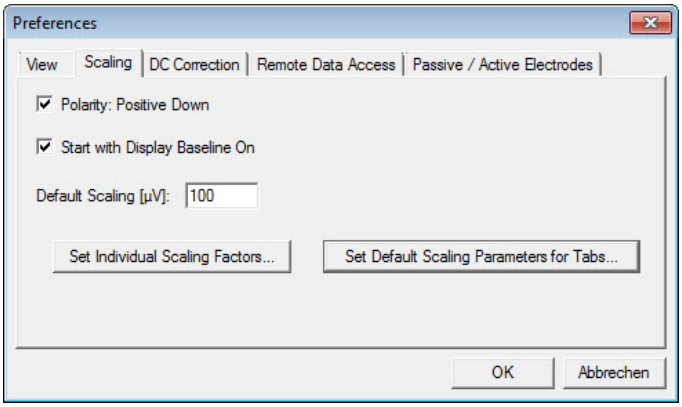
5.2 Configuring the user settings

If you have administrator permissions, or if the administrator has not restricted your user permissions (see Section 5.1), you can configure a number of different user settings.

To do this, stop monitoring mode by clicking *Stop Monitoring* and choose *Configuration › Preferences*... from the menu. The dialog box that opens contains the following tabs: *Scaling*, *DC Correction*, *Remote Data Access*, *Passive/Active Electrodes*, *View* and, if you have a video license, *Vision Video*.

Figure 5-3. Setting the scaling

Scaling settings

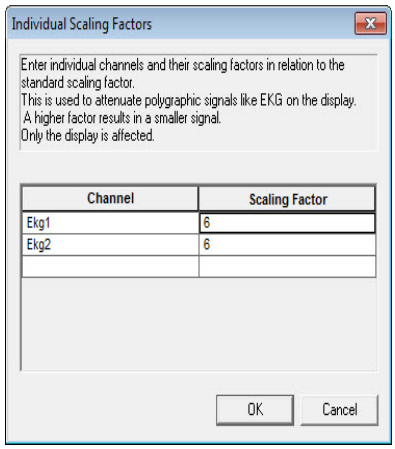


The *Scaling* tab contains the following functions:

- *Polarity: Positive Down* defines the polarity of the displayed signal. If you check 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 (see Figure 5-4). The attenuation only affects the display of the data; it does not affect the data itself.

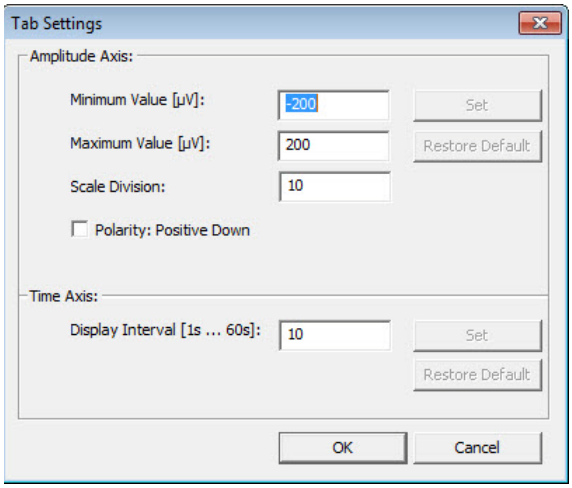
It makes sense to display the ECG channels attenuated, since otherwise they encroach significantly on the curves of the EEG channels.

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 page 106).

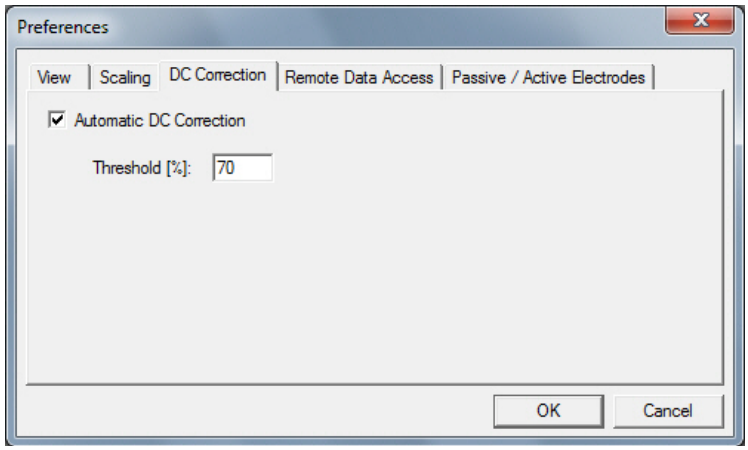
Figure 5-5. Entering the scaling of the axes for the scientific view



Activating automatic DC offset correction

Check 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.

Figure 5-6. Setting automatic DC offset correction

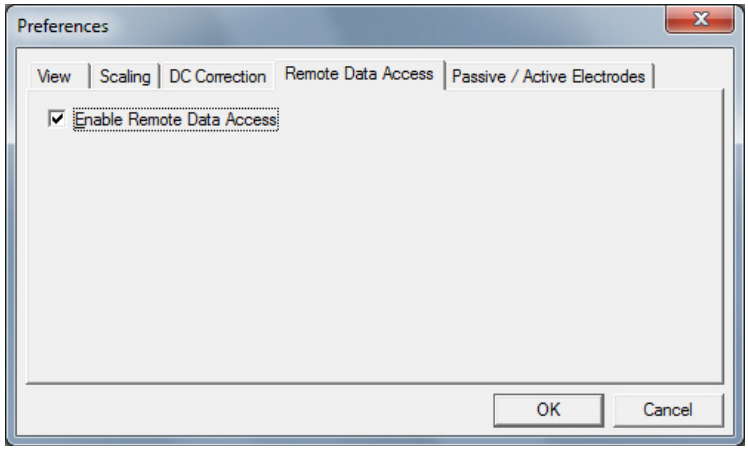


For further information on DC correction, refer to Section 6.2.3 as of page 99.

Check the *Enable Remote Data Access* box to enable the RDA server.

Activating the RDA server

Figure 5-7. Activating the RDA server

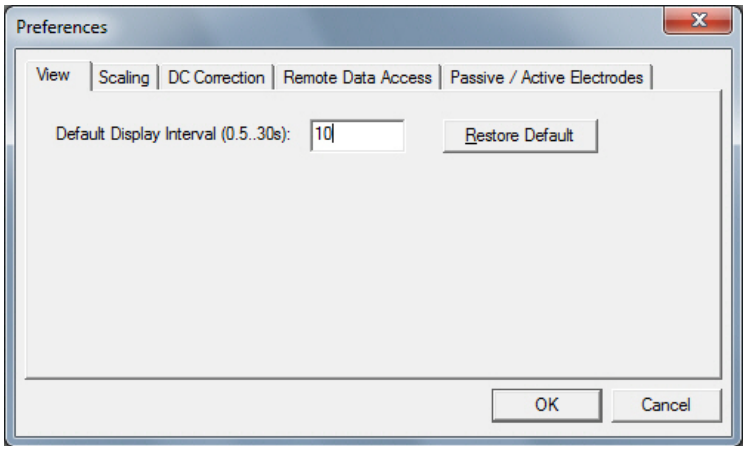


For further information on using the RDA server, refer to Chapter 11 as of page 197.

Data view on the screen

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.

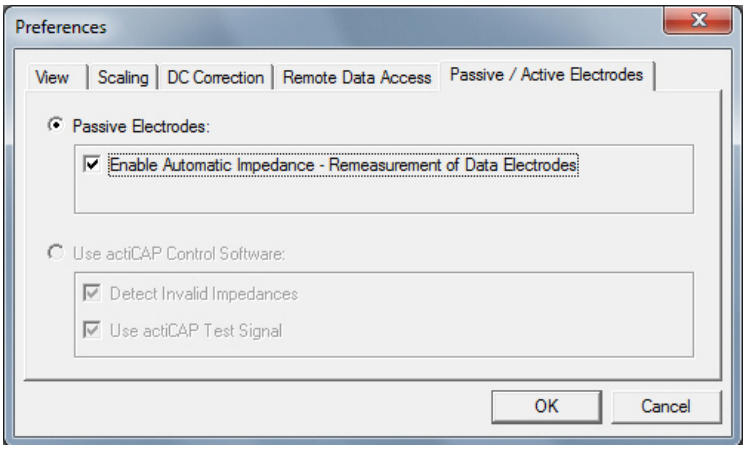
Figure 5-8. Configuration of the time interval to be displayed



Passive or 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

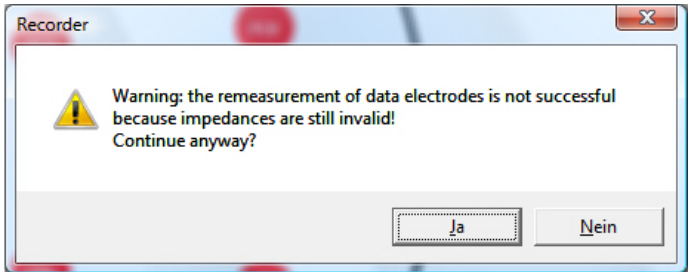


Choose the *Passive Electrodes* option for passive electrodes. Checking the *Enable Automatic Impedance-Remeasurement of Data Electrodes* box allows you to subsequently repeat measurement of the impedances of the EEG electrodes (i.e. all electrodes with the exception of the reference electrode or the ground electrode) if the measured values are not within the valid range. (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) (see 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)



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.

You will find further information on the test signal for active electrodes in Section 7.5 as of page 136.

If you check the *Detect Invalid Impedances* box, you will receive a message, similar to that issued for the function *Enable Automatic Impedance-Remeasurement of Data Electrodes* for passive electrodes (see Figure 5-10) where you can allow invalid impedances to be included in the recording or disallow them.

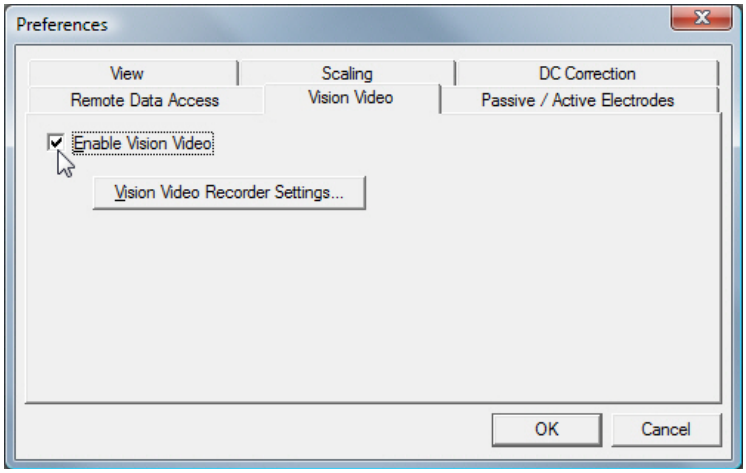
You can also use the actiCAP test signal by checking the *Use actiCAP Test Signal* box. (The box is checked by default.) This automatically controls the actiCAP ControlSoftware without the need for you to call it separately.

If you choose the *Use actiCAP Test Signal* option, the *Test Signal* button in the Recorder toolbar is disabled. Always 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 as of page 189. You will find information on purchasing and installing the video license in Appendix D as of page 211.

Chapter 6 Basic functions

You will find detailed information on using the Recorder in combination with active electrodes in Chapter 7 as of page 127.

6.1 Impedance measurement

Always prepare all channels before acquiring data and only then switch the Recorder to impedance mode to check the impedances of the channels. If a channel is open (for instance because an electrode is incorrectly prepared or damaged), this also impacts on the channel immediately following. This means that even if the following channel actually has a lower impedance, a higher impedance value will be shown 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.

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

A top view of a representation of a head appears (see Figure 6-1). A number of controls are located to the right of the Impedance Check View (see Figure 6-2). 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

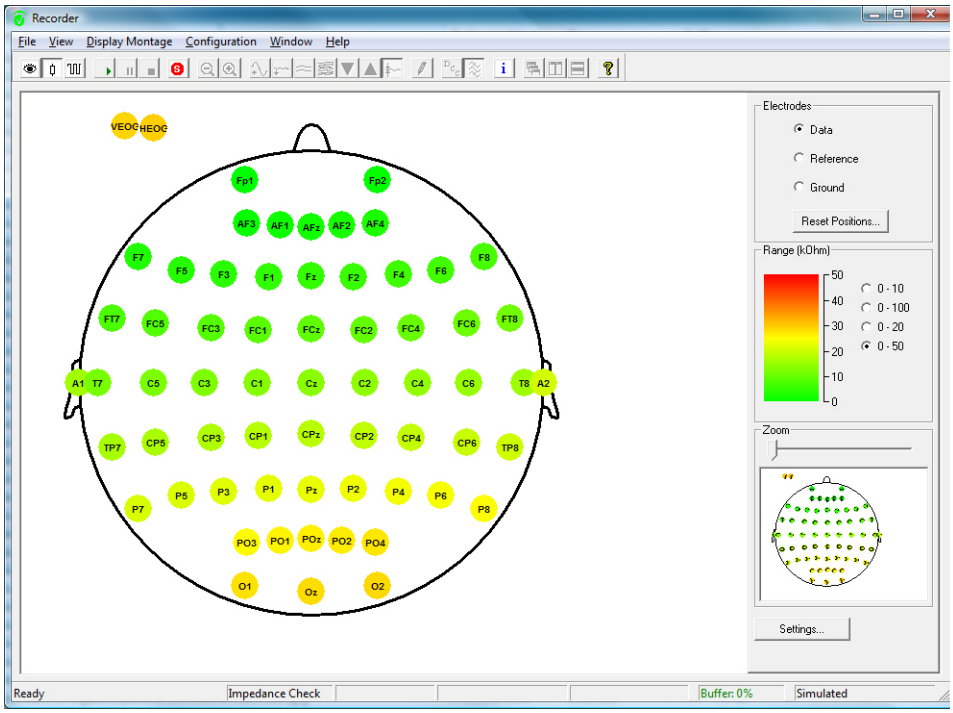
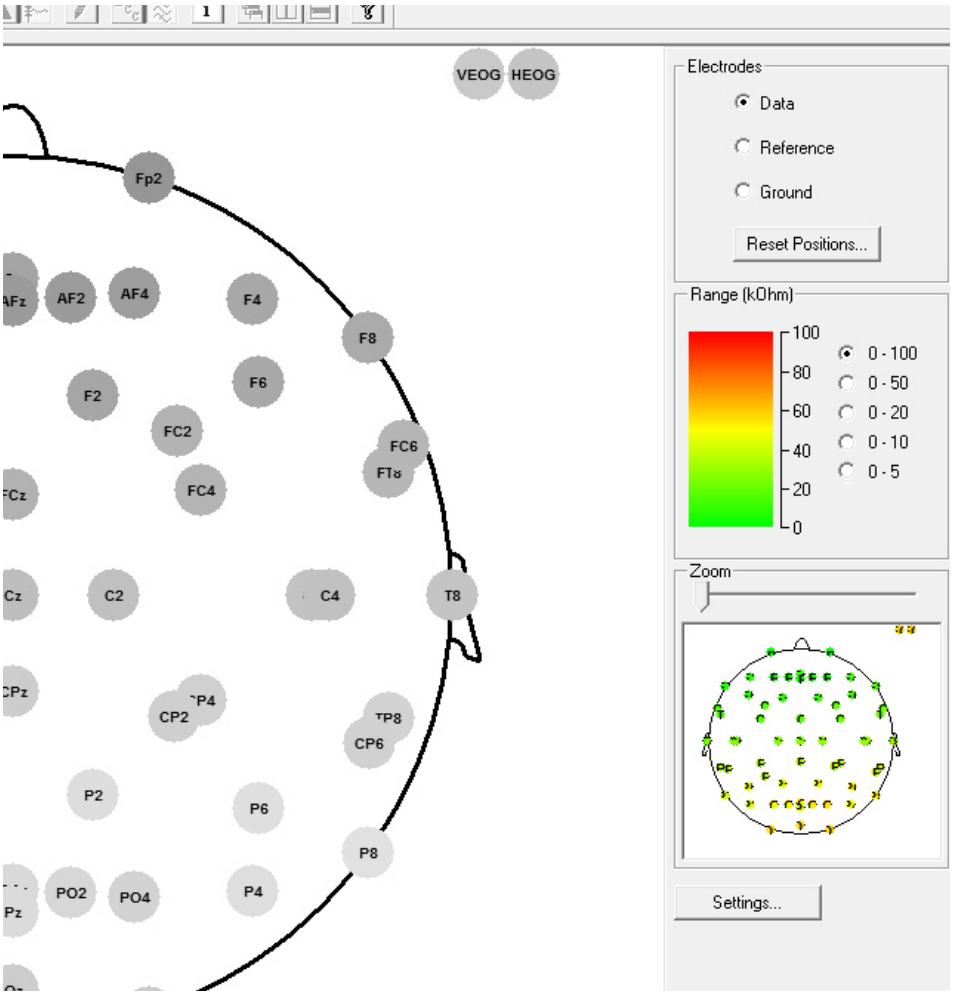


Figure 6-2. Impedance Check controls, details

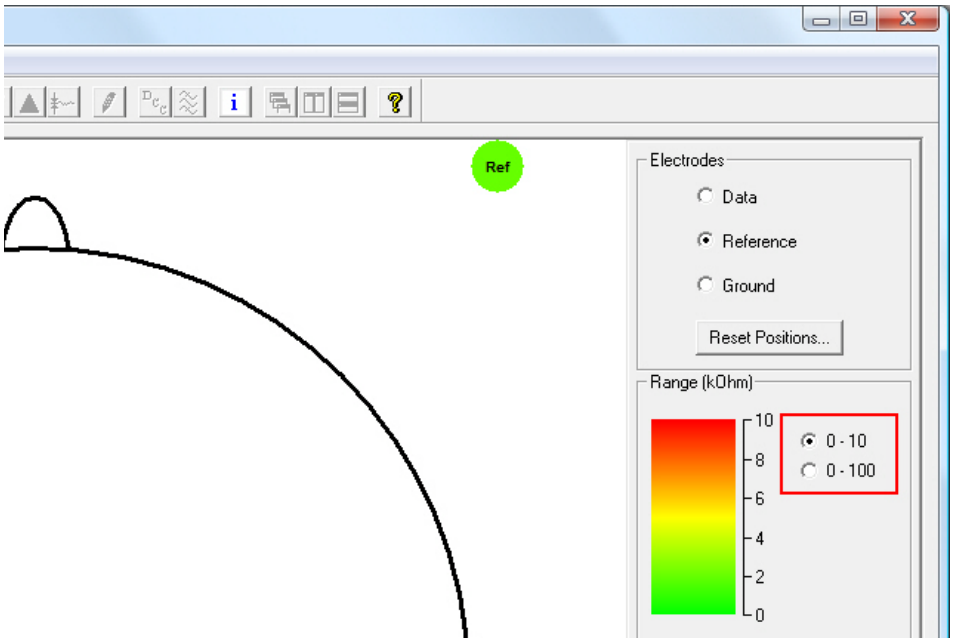


To change the position of the electrodes, left-click on an electrode, hold the mouse button down and move the electrode with the mouse. The *Electrodes* group box allows you to select different electrode groups for which data is to be determined. The groups and their names depend on the amplifier you are using. Click the *Reset Positions* button 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 box. The impedances of the electrodes are color-coded in accordance with the swatch.

As of Version 1.20 of the Recorder, two measurement ranges are available to you by default for the reference electrode and the ground electrode: from 0 through 10 kOhm and from 0 through 100 kOhm (see Figure 6-3).

Figure 6-3. Impedance value scale for the ground electrode 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 box (see Figure 6-4). Here you can define your own measurement ranges, the colors used, the color steps and an optional background bitmap.

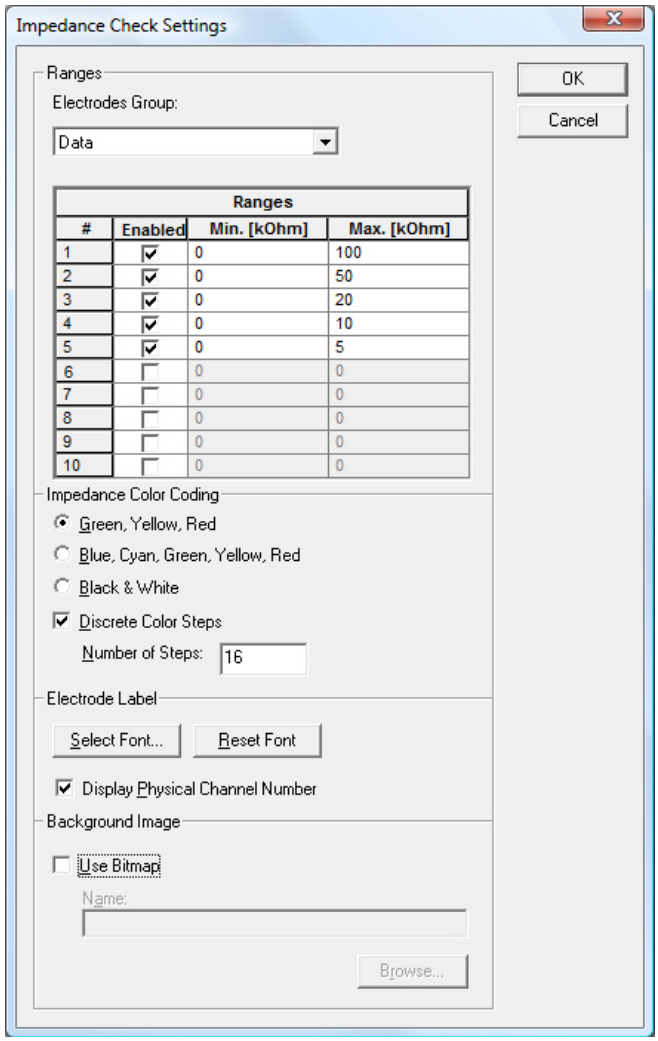
For each electrode group, you can select up to ten measurement ranges in the *Ranges* group box.

The *Impedance Color Coding* group box 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 6-4. Defining the measuring ranges and colors

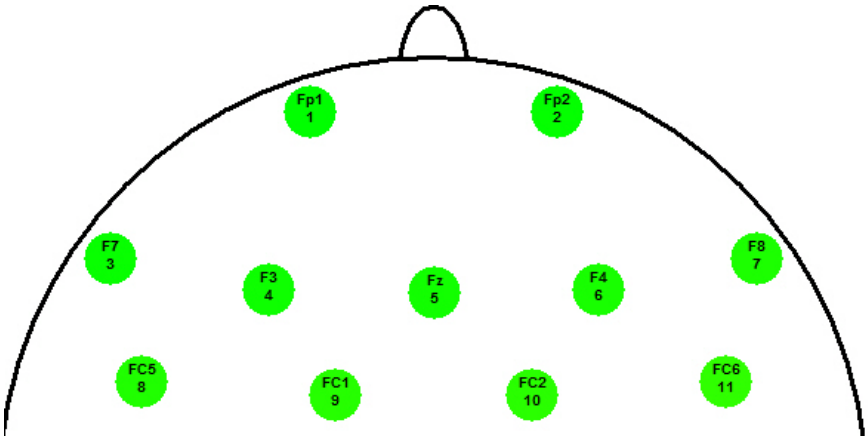


Click the *Select Font...* button to open a dialog box in which you can select the font used. The selected font is saved in the current workspace. Click *Reset Font* to reset the settings you have made to the default settings. Note that the font size is not automatically adjusted in zoom mode.

If you check the *Display Physical Channel Number* box, the numbers of the physical channels are also displayed in addition to the position (see Figure 6-5). 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 6-5. 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, check the *Use Bitmap* box. 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.

If the bitmap file you have selected does not exist or if it has an invalid format, the standard background is used automatically.

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.

You will find information on impedance measurement for BrainAmp amplifiers in Section 8.1.2 as of page 140. You will find information on impedance measurement for active electrodes in Section 7.4 as of page 133.

6.2 Viewing and recording data

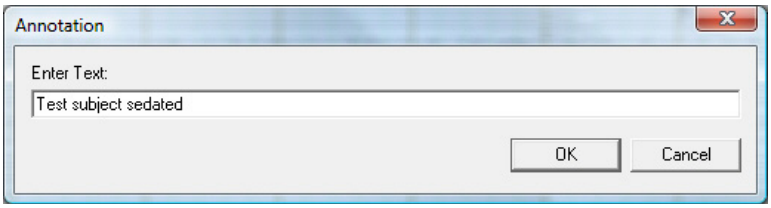
6.2.1 Entering comments

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 (see Figure 6-6). This then replaces the question marks.

Figure 6-6. Entering freely-definable text



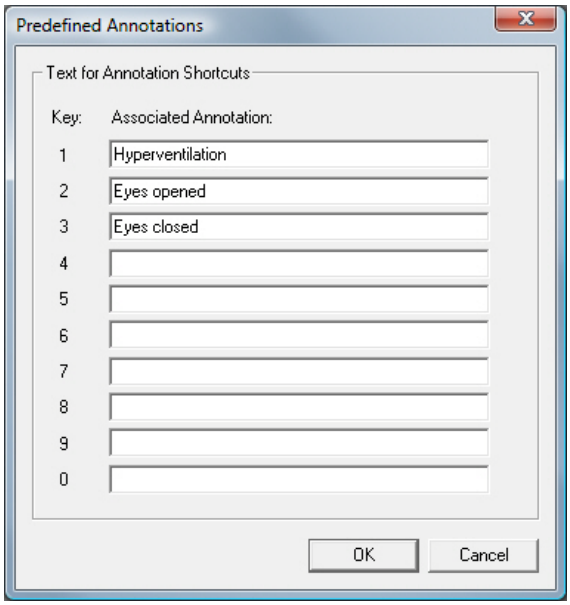
Predefined text

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 (see Figure 6-7). 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. If this is the case, speak to your system administrator. You will find information on user privileges in Section 5.1 as of page 83.

Figure 6-7. Entering predefined text

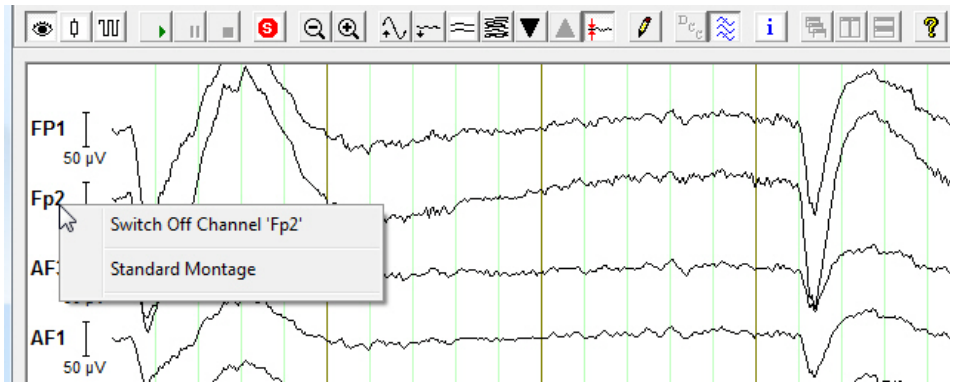


6.2.2 Blocking channels

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 ‹channel name›* from this menu (see Figure 6-8). 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 ‹channel name›* from the menu.

Figure 6-8. Blocking the selected channel



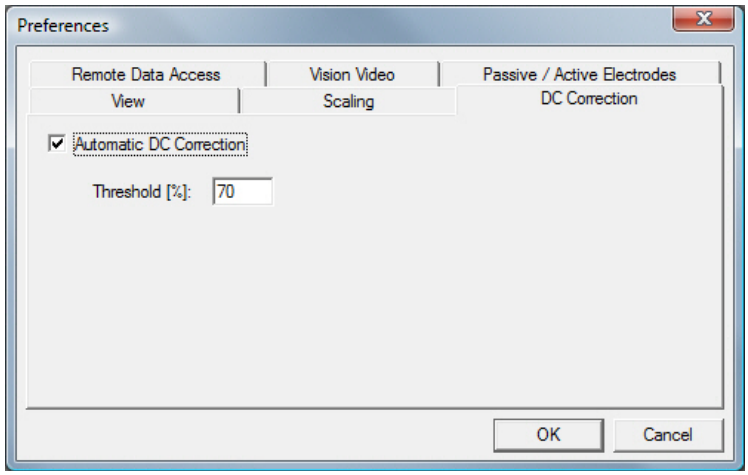
6.2.3 Performing DC offset correction

If you have a DC-coupled amplifier, then you can carry out DC offset correction with the Recorder. To do this, click the *DC Correction* button in the toolbar (or press the keyboard shortcut ‹Ctrl-D›). The 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 the 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, check the *Automatic DC Correction* box on the *DC Correction* tab and enter the required value for the threshold (see Figure 6-9).

Figure 6-9. Activating automatic DC offset correction for DC amplifiers



6.3 Selecting a channel

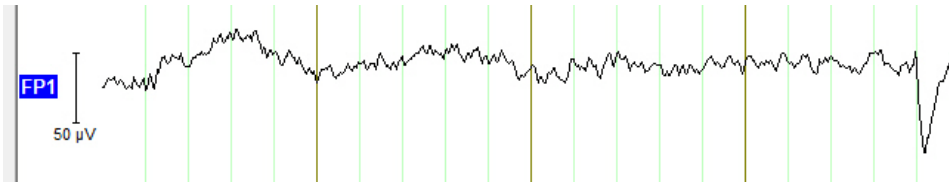
To select a channel, simply click the channel name. A selected channel is highlighted in blue (see Figure 6-10). If you click a channel again, the channel is deselected. You can select one or more channels of the EEG and then zoom the display into these channels, for instance.

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 6-10. Highlighting of the selected channel

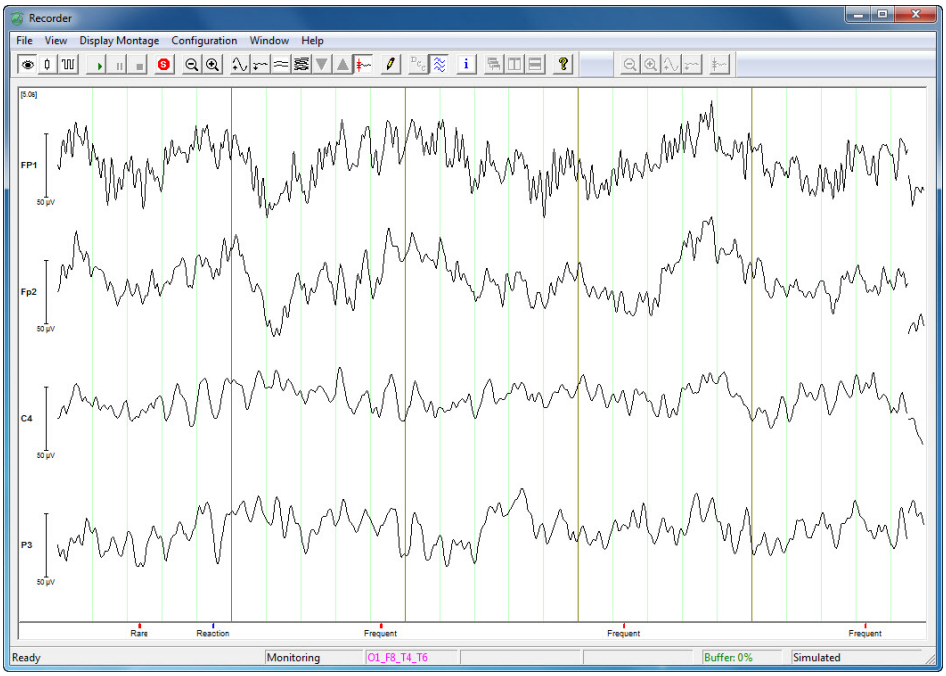


To display multiple channels separately, click once on each required channel name in sequence. Then double-click the last of the required channels (see Figure 6-11). If you double-click a channel name again, the display returns to how it was before.

Figure 6-11. Selecting multiple channels

The selection shown in Figure 6-11 results in the following channel display:

Figure 6-12. Displaying selected channels



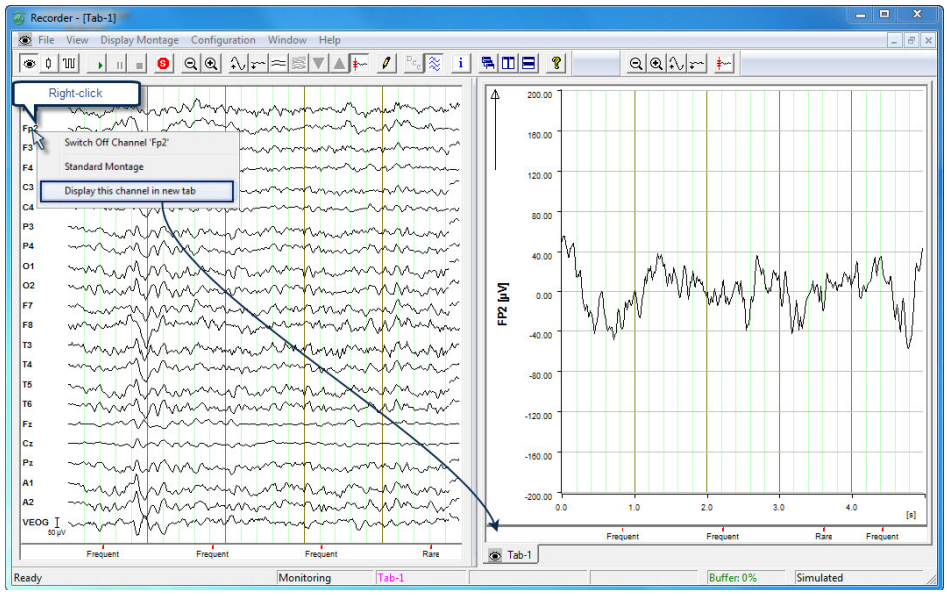
6.3.2 Scientific view

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 6-13).

6.3.2.1 Opening the view

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

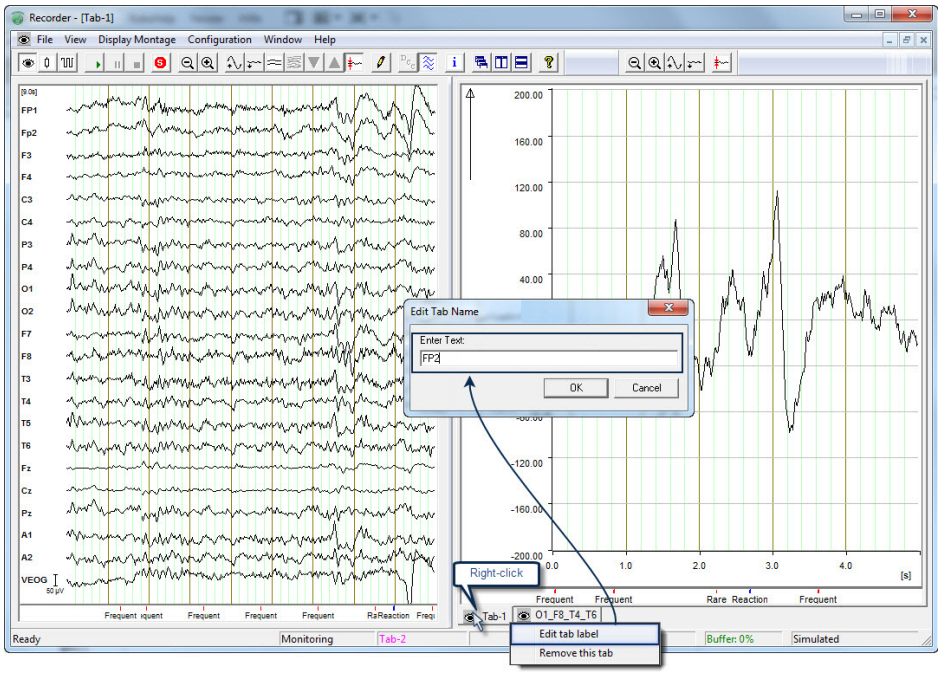
Figure 6-13. Opening the scientific view



1 Select and open the channel.

   Right-click the required channel name (e.g. 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 6-14. Renaming the tab in the scientific view



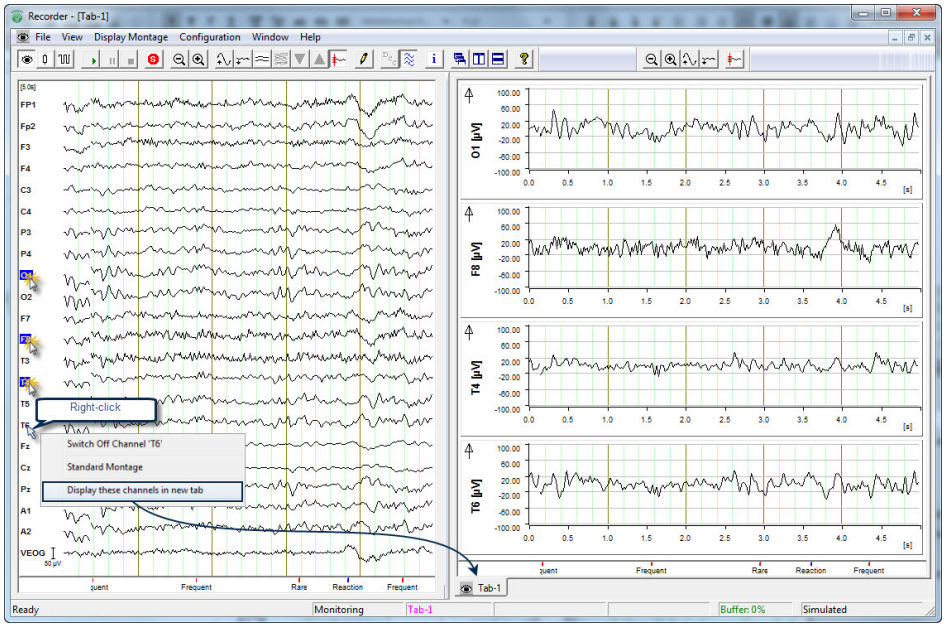
2 Rename the tab

The tabs are given the names *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 box 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* (see Figure 6-15).

Figure 6-15. Displaying multiple channels in the scientific view



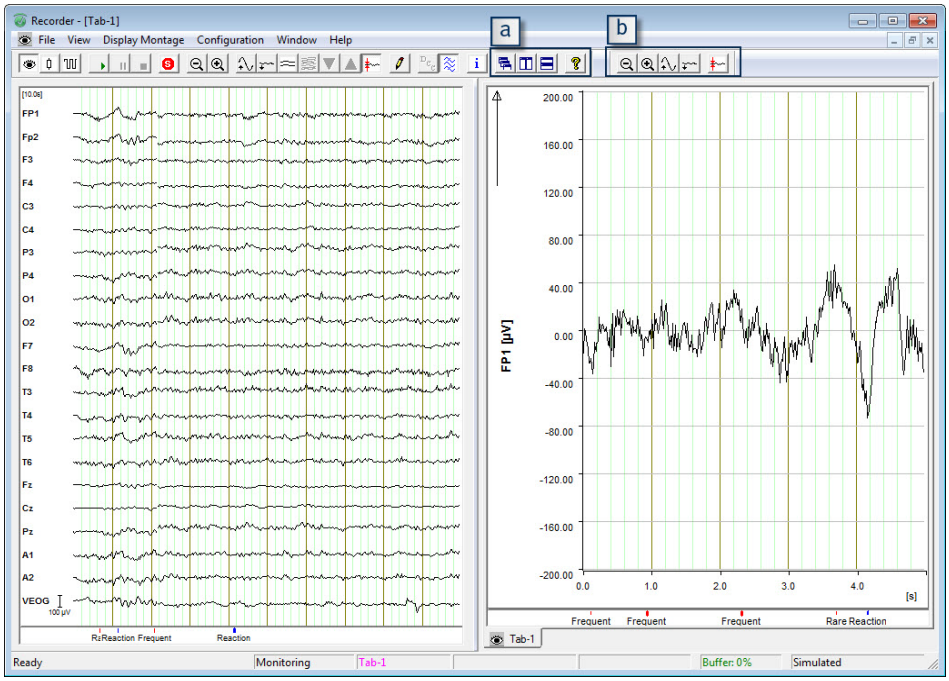
In the scientific view, the channels are displayed in a coordinate system with time and amplitude axes. You can adjust the scaling of the axes.

6.3.2.2 *Defining the scaling for the axes*

The following scaling controls are displayed above the tabs (see (b) in Figure 6-16):

- *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›).

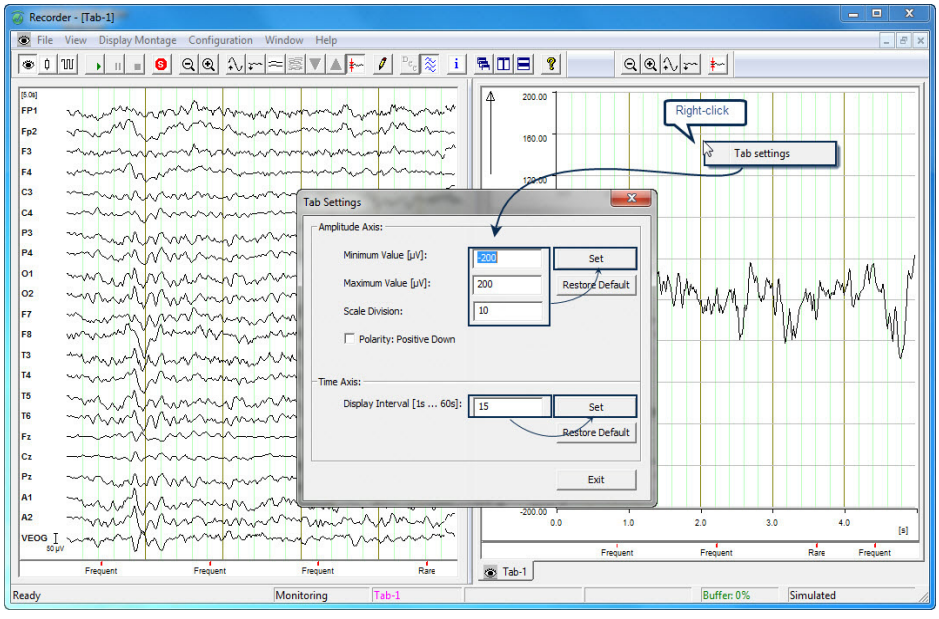
Figure 6-16. Controls in the scientific view



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 6-17. Defining the scaling of the axes for the current view



1 Right-click in the tab and open *Tab Settings*.

2 Adjust the parameters.

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

3 Click [Set] to define the settings.

If the input is invalid, a comment is issued indicating the permitted values.

Defining global scalings for axes

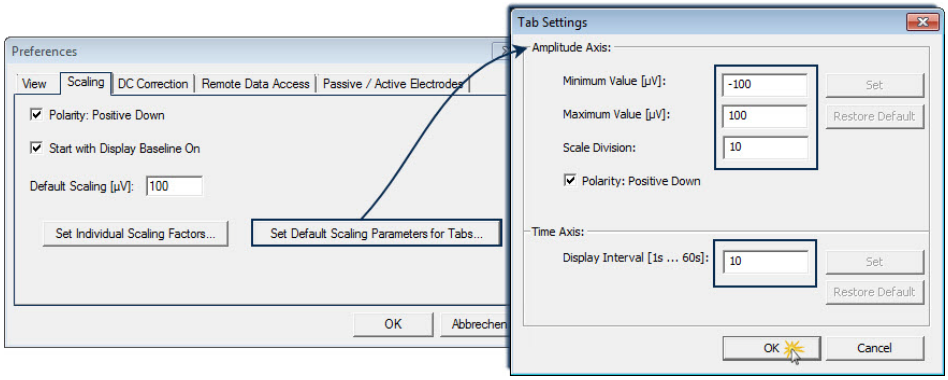
Alongside individual settings for the tabs, it is also possible to make a global setting that defines the default display in the scientific view.

Proceed as follows to adjust the scaling of the axes globally in *the scientific view*:

1 You can only make this setting if none of the modes (monitoring, impedance, test) is active. First of all, terminate these modes (with).

2 In the menu bar, click *Configuration › Preferences* and proceed as indicated in the figure:

Figure 6-18. Defining global scalings for axes



3 Select [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.

In the scientific view, channels are now displayed using the coordinate system that you have defined here. However, the parameters for existing tabs are not modified, i.e. the global parameters defined here only apply to new tabs.

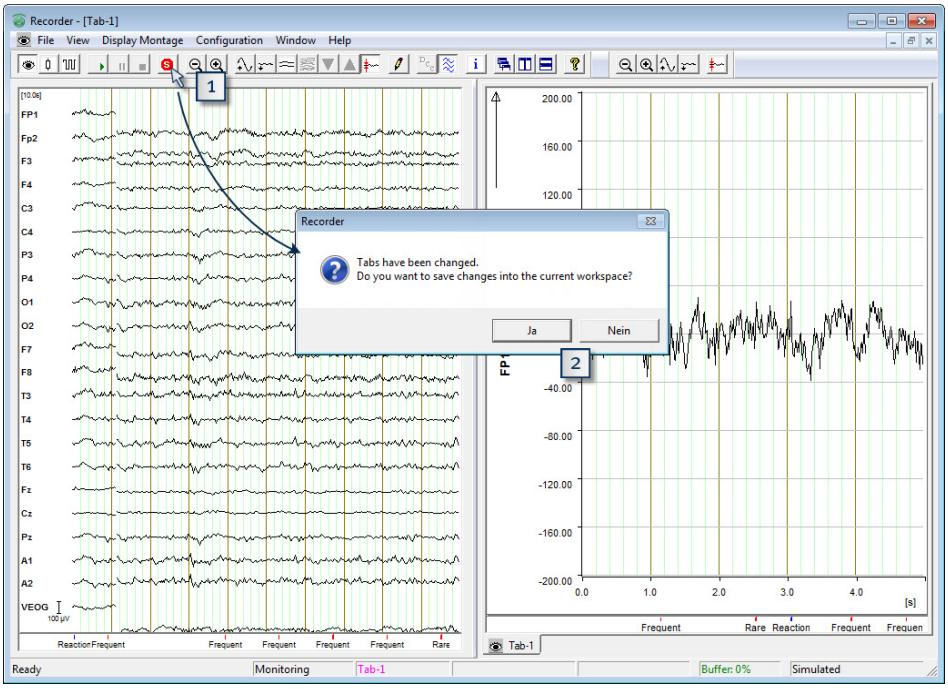
The [Set] and [Restore Default] buttons are grayed because they are only required for individual axis scaling (page 105).

6.3.2.3 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). The Recorder then asks whether you want to save the settings (2) (Figure 6-19).

Figure 6-19. Saving the tab layout



6.3.2.4 Closing tabs

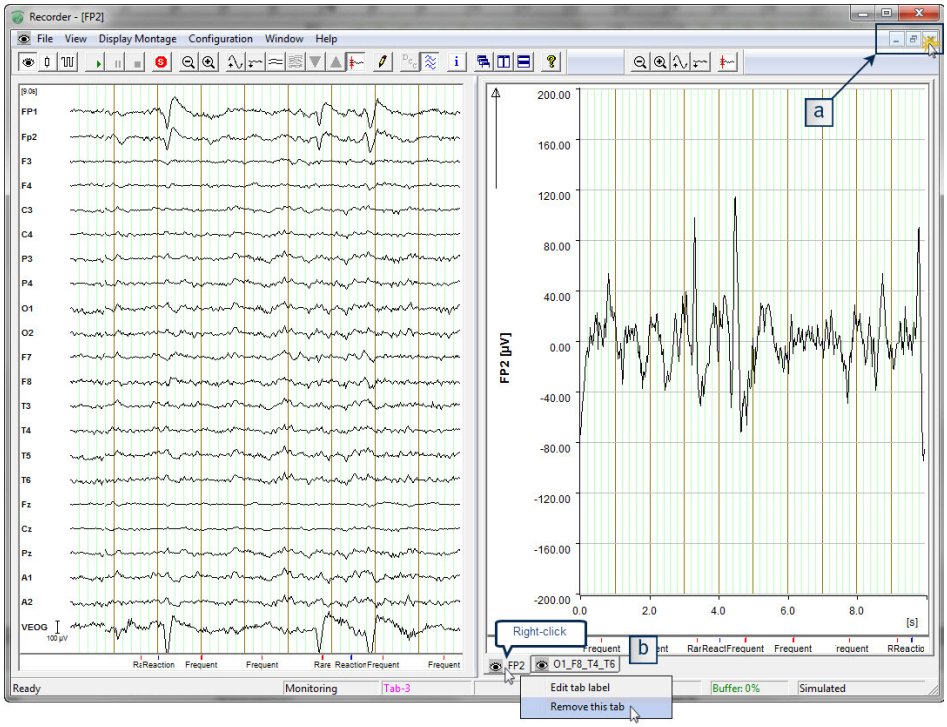
Proceed as follows to close the tabs in the scientific view:

a Click [X].

b Right-click the **active** tab › *Remove this tab*

Caution: The tab must be active! If you apply "Remove this tab" to an inactive tab then the currently active tab is closed!

Figure 6-20. 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.

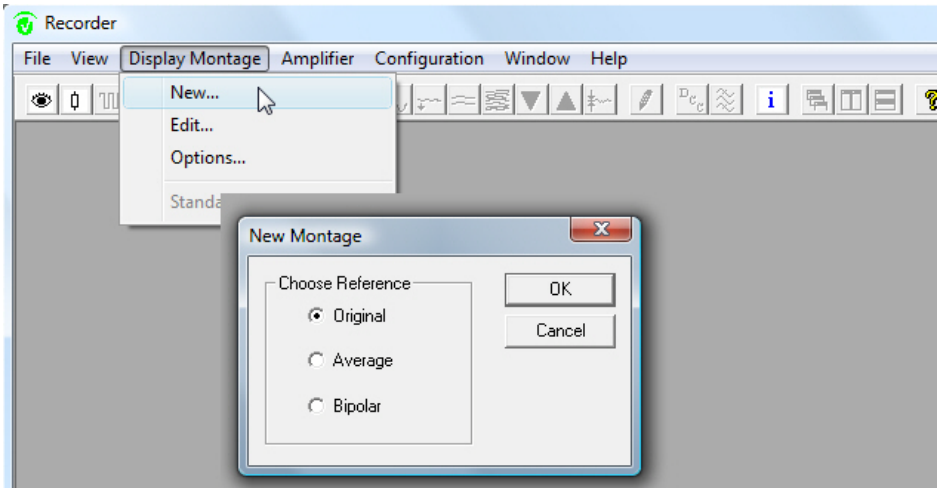
Montages allow you to optimize the display of data by, for example, grouping together frontal electrodes in one montage and occipital electrodes in another. When one of these montages is selected, only those channels that have been assigned to it are displayed. The sequence of channels can also be changed 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.

Creating a montage

To create a new montage, choose *Display Montage › New...* from the menu. The *New Montage* dialog box opens (see Figure 6-21). This dialog box is used for determining the type of reference to be used in the new montage.

Figure 6-21. 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.
- *Average*. The average reference is calculated, i.e. the average of all selected channels is used as the reference.
- *Bipolar*. The differences between different channels are calculated for a bipolar connection.

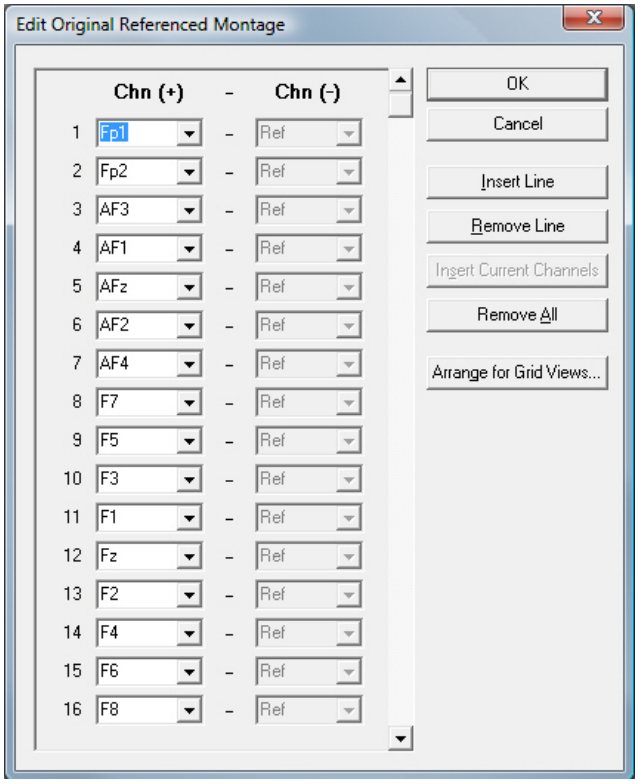
To begin with, we recommend that you take the easiest reference type – the original reference.

Editing montages

Click *OK* when you have selected a reference type. This opens the Edit dialog box (see Figure 6-22). 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 6-22. 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.

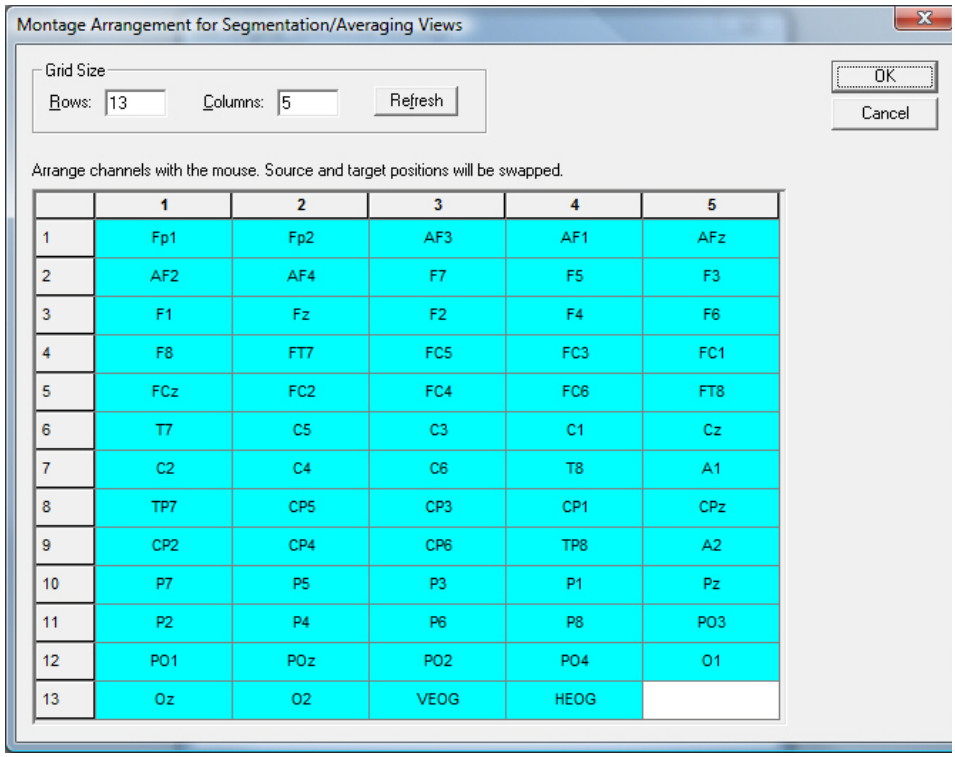
- *Remove All* removes the entire contents of a montage. You are prompted to confirm whether you wish this to be done. This button is enabled as soon as you have completed an entry.
- *Arrange for Grid Views*... opens a dialog box in which you can arrange the channels for grid views. Grid views are used 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.

Arranging the montages in the grid view

In the grid view used for representing segmented/averaged data, the channels are arranged in a grid (see Figure 6-23). 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 6-23. Creating a grid view



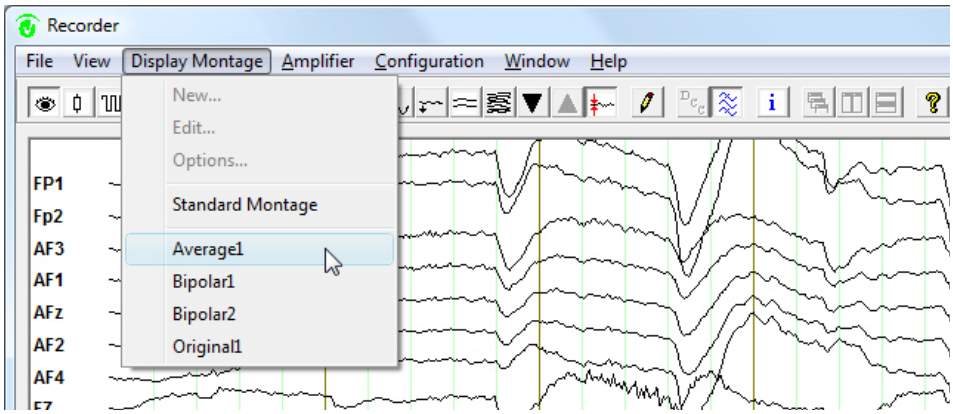
	1	2	3	4	5
1	Fp1	Fp2	AF3	AF1	AFz
2	AF2	AF4	F7	F5	F3
3	F1	Fz	F2	F4	F6
4	F8	FT7	FC5	FC3	FC1
5	FCz	FC2	FC4	FC6	FT8
6	T7	C5	C3	C1	Cz
7	C2	C4	C6	T8	A1
8	TP7	CP5	CP3	CP1	CPz
9	CP2	CP4	CP6	TP8	A2
10	P7	P5	P3	P1	Pz
11	P2	P4	P6	P8	PO3
12	PO1	POz	PO2	PO4	O1
13	Oz	O2	VEOG	HEOG	

Calling montages that have been created

To call a newly created montage, switch the Recorder to monitoring mode. Open the *Display Montage* menu. This menu has now been extended to include the name of your new montage

(see Figure 6-24). 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 6-24. 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.

Modifying a montage

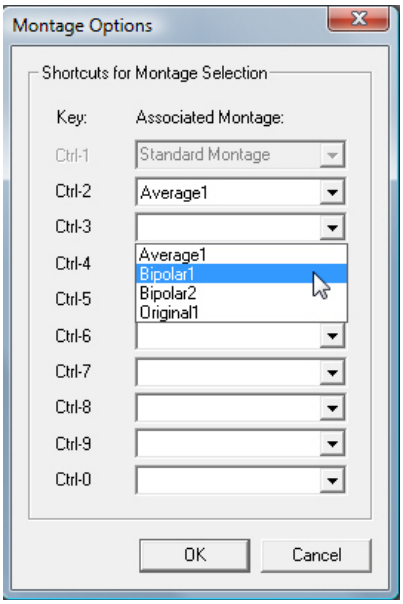
If you wish to modify an existing montage, select it with *Display Montage › Edit...* and then edit it. Please note that you cannot change the reference type of an existing montage.

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.

Switching between montages

You can assign specific keyboard shortcuts to montages to allow you to switch between them quickly (see Figure 6-25). 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 6-25. Assigning keyboard shortcuts to montages



If you have defined one or more segmentation or averaging groups (see also Section 6.5 as of page 114), 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

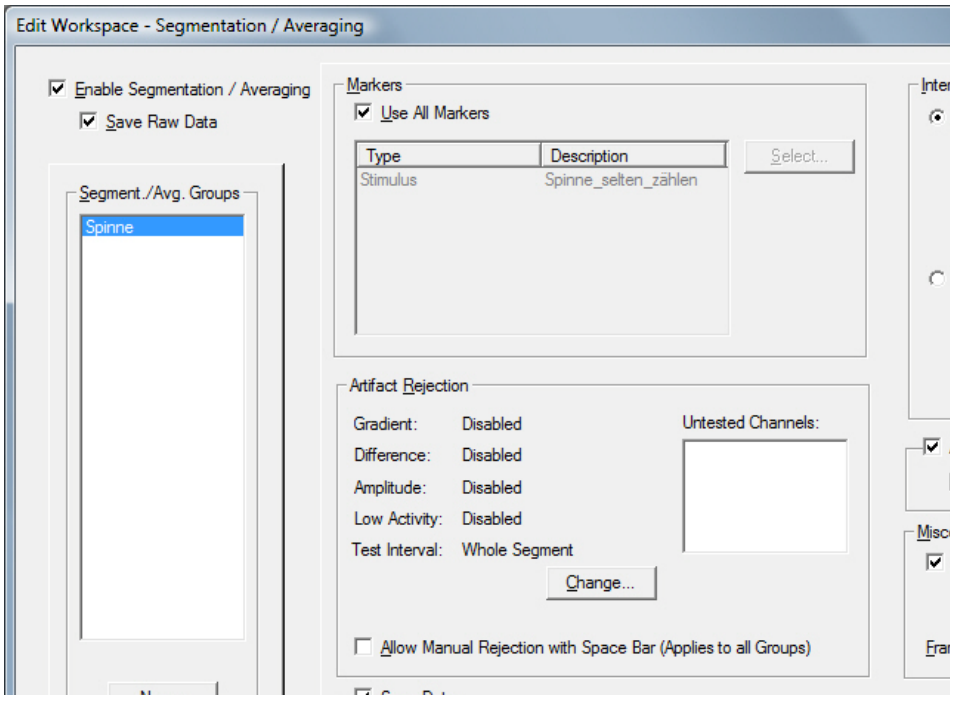
The Recorder can segment or average your data based on time markers such as stimulus markers or reaction markers. Segmentation is always a preliminary step in averaging. Both procedures will therefore be presented together in this section. You can save the segmented or averaged data in parallel with 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 6-26. Entering the segmentation/averaging parameters



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.

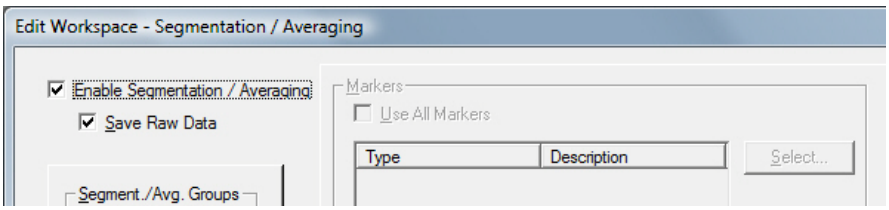
The *Edit Workspace – Segmentation/Averaging* dialog box is divided into two functional blocks. The left-hand block is used to select, create, rename and delete groups. The right-hand block is used to display the parameters of the selected group.

You will find detailed information on pages one through three of the *Edit Workspace* dialog box in Chapter 4 as of page 63.

Activating segmentation/ averaging and the saving of raw data

To begin with, activate the segmentation/averaging option by checking 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 (see Figure 6-27).

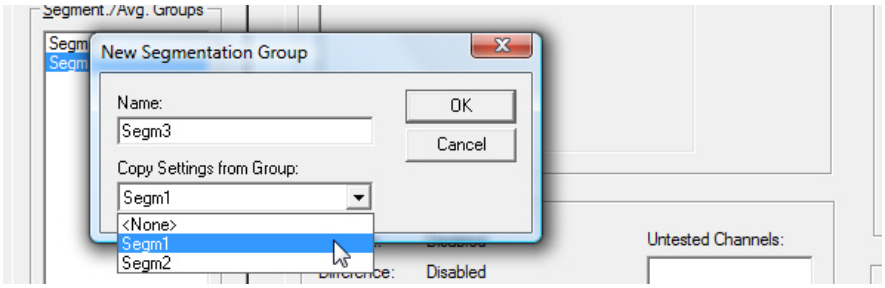
Figure 6-27. Activation of segmentation/averaging and saving of the raw data



Defining segmentation/ averaging groups

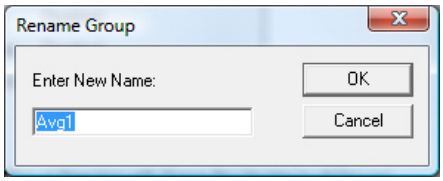
The *Segment./Avg. Groups* group box contains a list that allows you to select a group for editing. Click *New...* to create a new group. This opens the *New Segmentation Group* dialog box (see Figure 6-28). Enter the name of the group. You can optionally copy the settings from an existing group under *Copy Settings from Group*.

Figure 6-28. Creating a new segmentation/averaging group



Rename... is used to rename the current group (see Figure 6-29). *Remove...* is used to delete the current group.

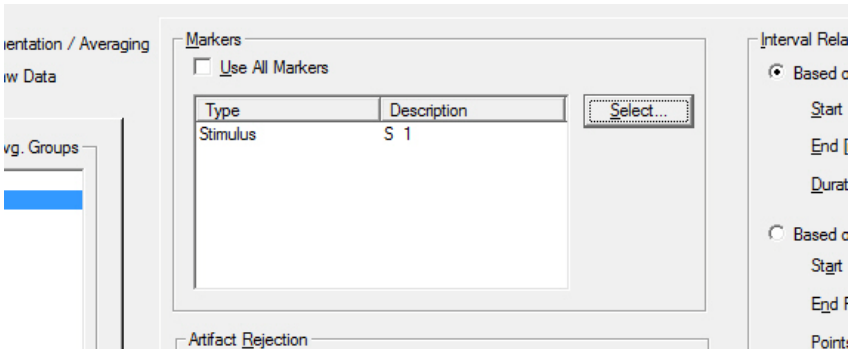
Figure 6-29. Renaming a segmentation/averaging group



Selecting the markers to be used

The *Markers* group box allows you to select the markers that describe the relevant segments for the current group (see Figure 6-30).

Figure 6-30. Selecting the markers to be used

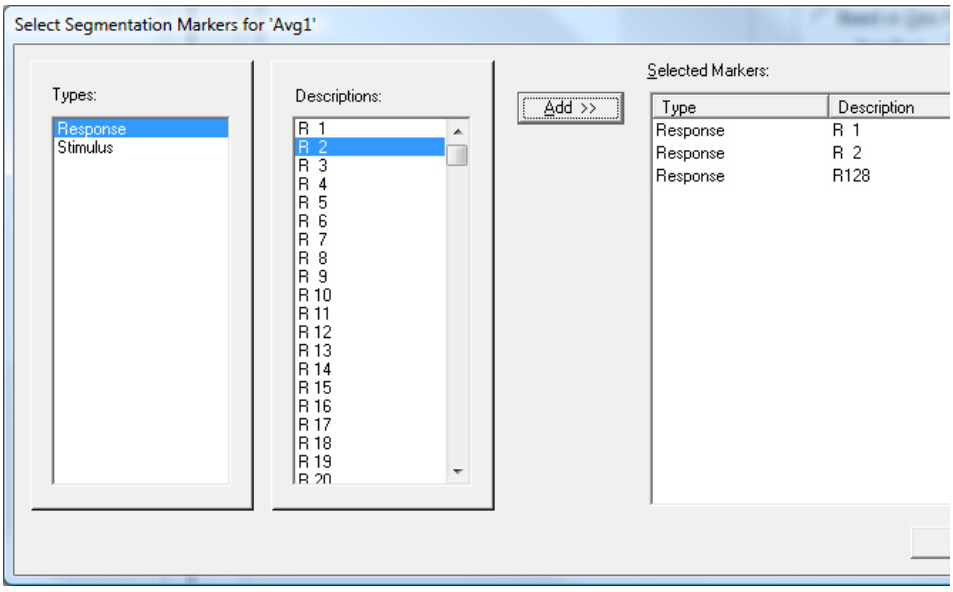


If you check the *Use All Markers* box, all the markers sent by the amplifier are used during segmentation/averaging. Otherwise, those markers are used that are listed with their type and description.

If you wish to modify the marker list, click *Select...*. The *Select Segmentation Markers* dialog box opens in which you can select various markers (see Figure 6-31). 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 6-31. Marker selection dialog box

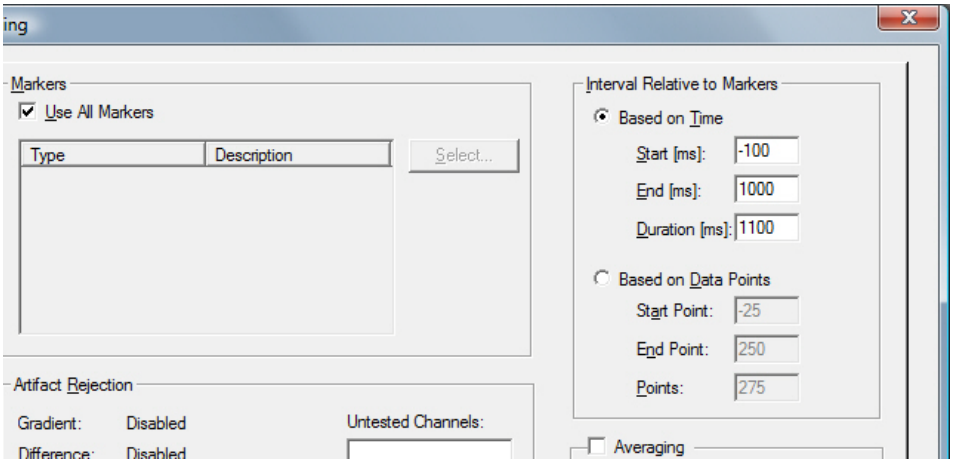


The *Interval Relative to Markers* group box (see Figure 6-32) allows you to set the relative positions of the segment interval in one of two ways: *Based on Time* or *Based on Data Points*.

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

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

Figure 6-32. Defining the interval length on the basis of markers or data points

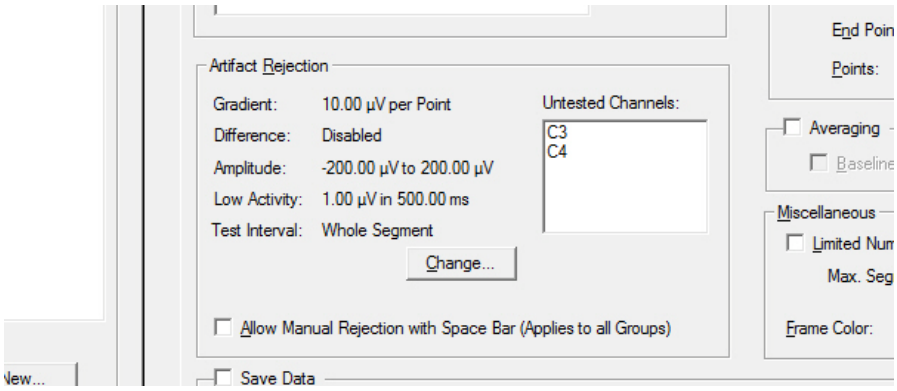


Rejecting segments containing artifacts

The *Artifact Rejection* group box (see Figure 6-33) allows you to examine the individual segments that you want to include in segmentation/averaging for various artifacts, or to carry

out a quality check. All segments that are detected as having artifacts are excluded from segmentation/averaging.

Figure 6-33. Excluding segments containing artifacts



You can also reject artifacts manually. If you check 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.

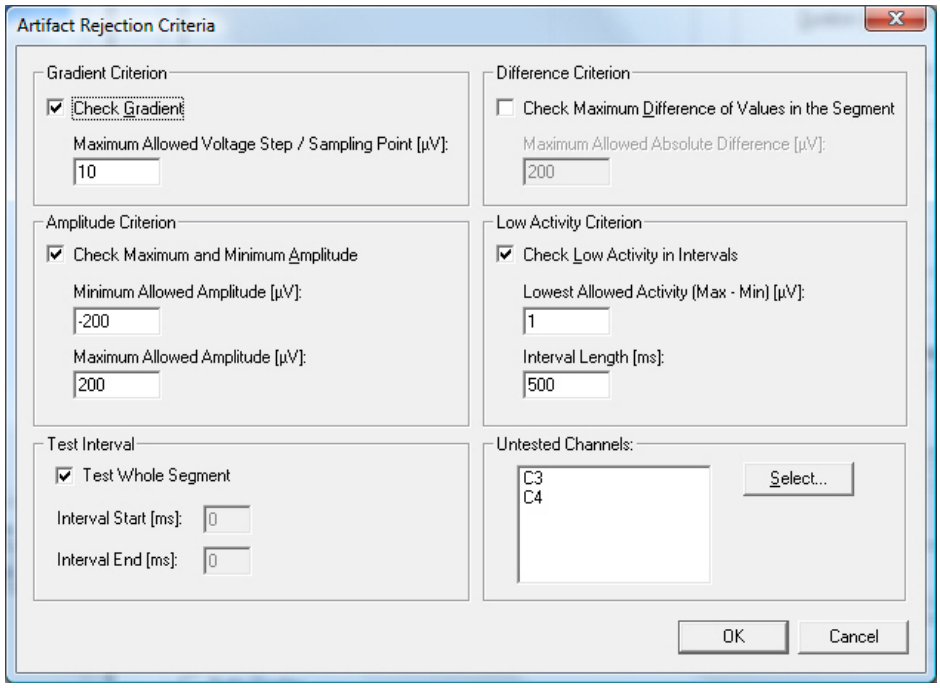
If you have defined several segmentation/averaging groups, the rejection refers to the segment of the group with the active window. The segments of the remaining groups which form an intersection with respect to time with the rejected segment are also rejected. However, only the most recently accepted 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 (see Figure 6-34).

Figure 6-34. Defining criteria for identifying artifacts



Check the relevant box to use each of the criteria:

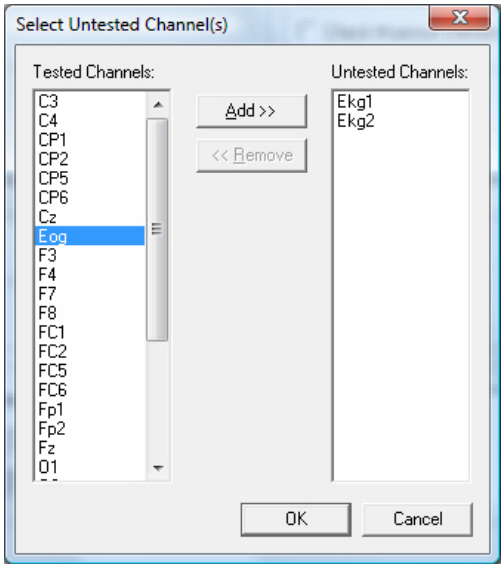
- *Gradient Criterion*. When the gradient criterion is applied, the absolute difference between two neighboring sampling points must not exceed a specific value. Enter the maximum permitted difference in voltage between two data points in the *Maximal Allowed Voltage Step/Sampling Point [µV]* text box.
- *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 check 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.

It is particularly advisable to exclude ECG channels from artifact identification. Note that in the 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 (see Figure 6-35).

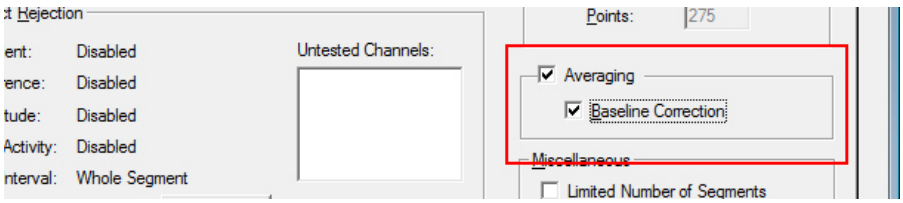
Figure 6-35. Excluding selected channels from artifact identification



Averaging and baseline correction

The *Averaging* group box (see Figure 6-36) 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 6-36. Activating averaging and baseline correction



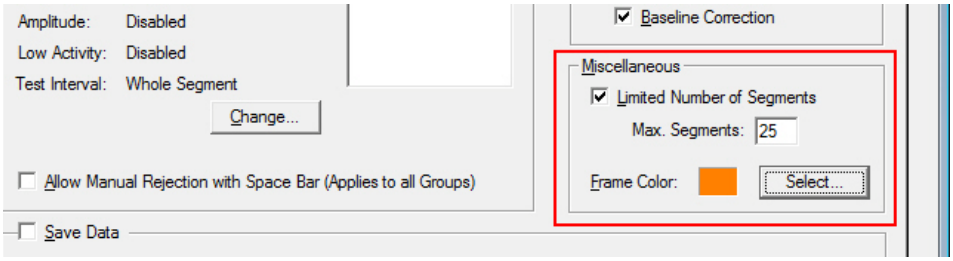
Other settings

The *Miscellaneous* group box (see Figure 6-37) 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.

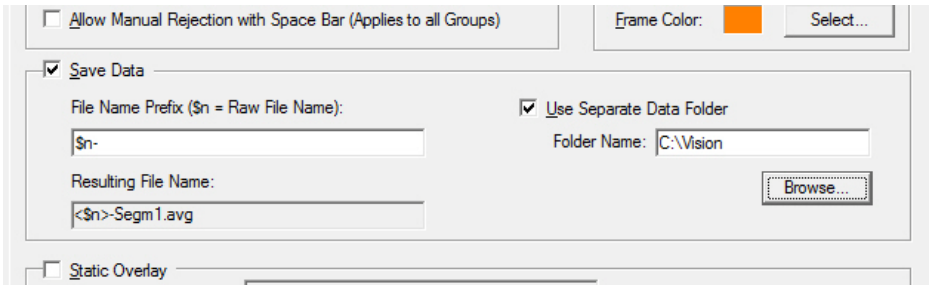
Figure 6-37. Other settings



Save options

The *Save Data* group box (see Figure 6-38) contains the save options.

Figure 6-38. Options for saving segmentation/averaging



If you check the *Save Data* box, the data is saved when you click *Start/Resume Recording* .

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*.

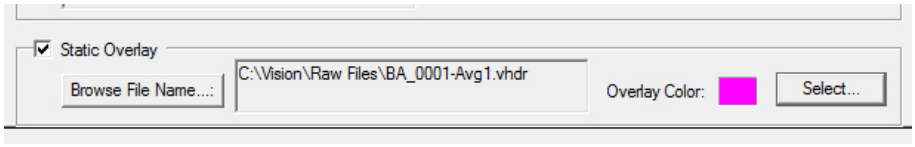
If you do not check the *Use Separate Data Folder* box, the previously defined raw data folder is used. Otherwise, you can click *Browse...* to select a separate folder for the group under *Folder Name*.

Using a static overlay

Check the *Static Overlay* box to apply a static overlay to the data (see Figure 6-39).

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

Figure 6-39. 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 will be issued. In our example, the segmentation intervals in the static overlay and the workspace do not match (see Figure 6-40).

Figure 6-40. Static overlay: Sample error message when the segmentation intervals in the overlay and the workspace do not match

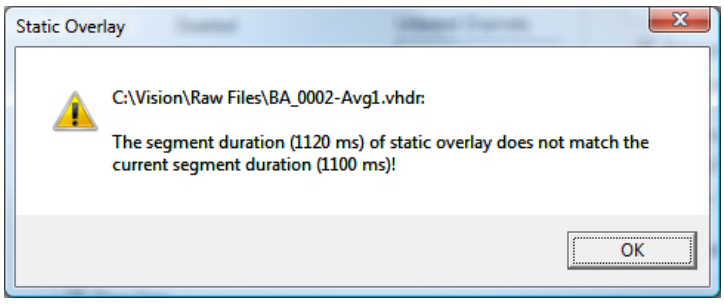
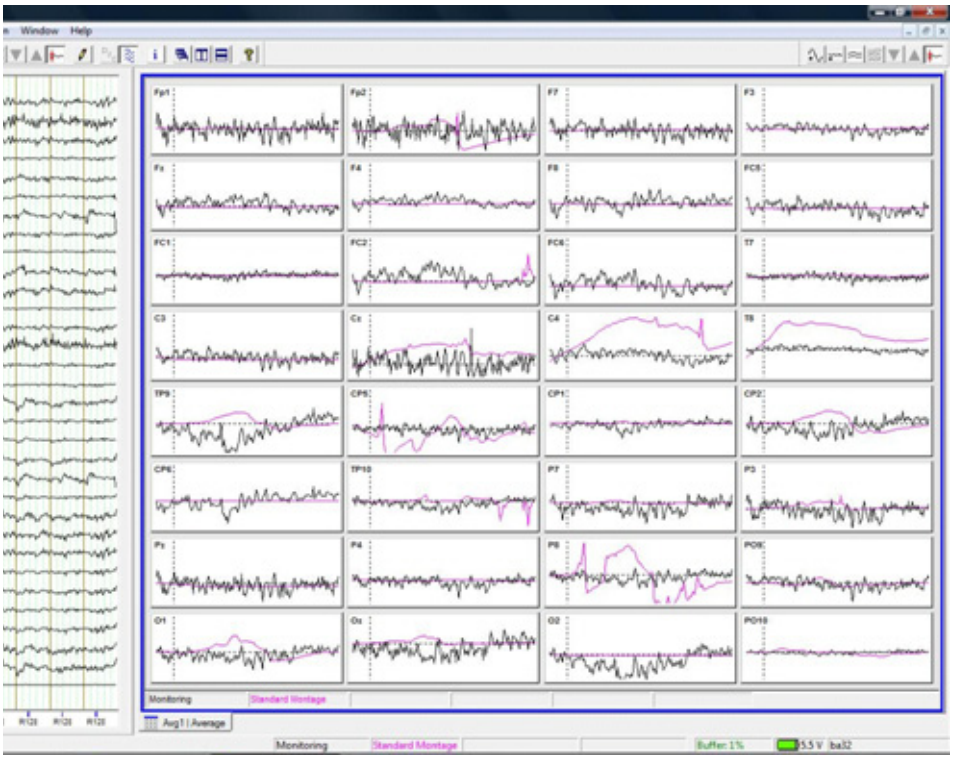


Figure 6-41. Static overlay: data view



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

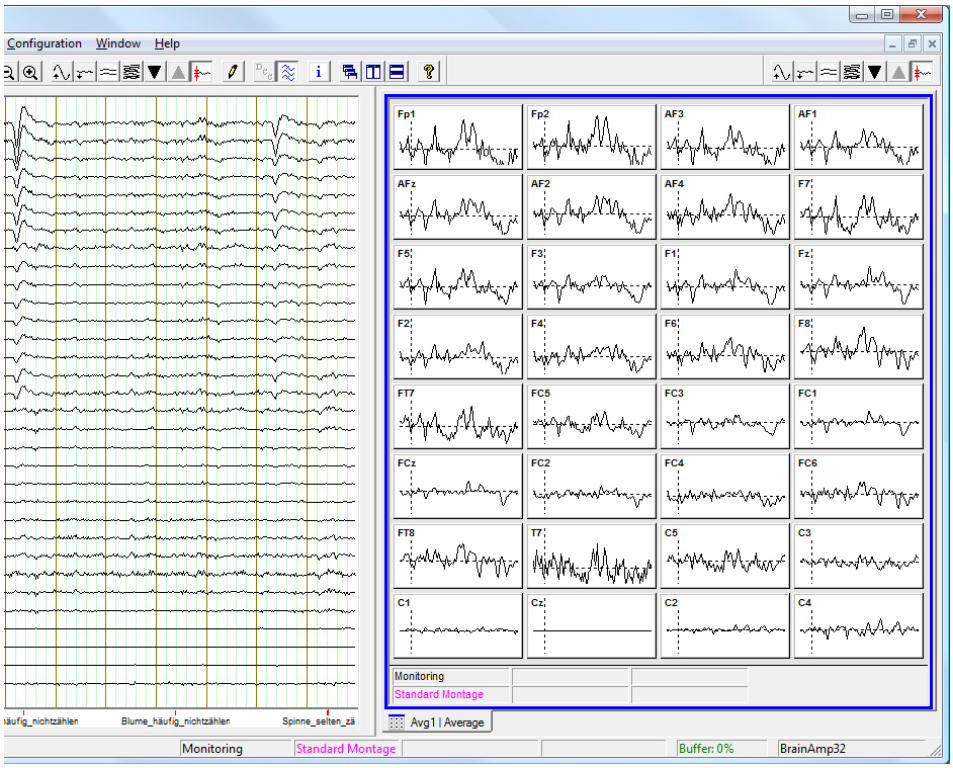
6.5.2 Viewing and recording segmented/averaged data

Start the 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 (see Figure 6-42). 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 6-42. Monitoring window (left) and view of segmentation/averaging groups (right)

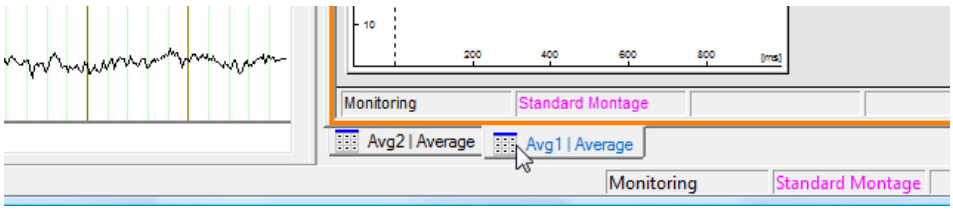


If you have activated manual artifact rejection (see page 118 in Section 6.5.1) when you set the parameters, you can now use the space bar during recording to subsequently reject segments which have not automatically been identified as having artifacts.

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 (see Figure 6-43).

Figure 6-43. 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 as of page 109.

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:

You will find detailed information on changing the scaling, the number of channels and channel groups displayed in Section 3.3 as of page 57.

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.

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.

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.

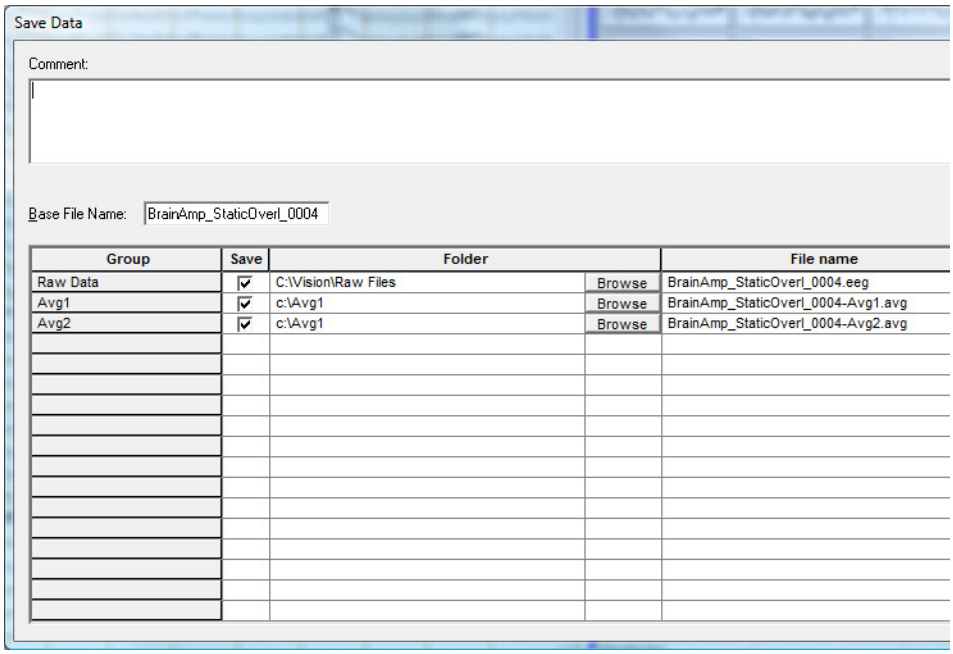
To start recording data, click *Start/Resume Recording* in the toolbar. The *Save Data* dialog box opens (see Figure 6-44). This allows you to overwrite the parameters originally specified for the raw data and for every group.

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

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).

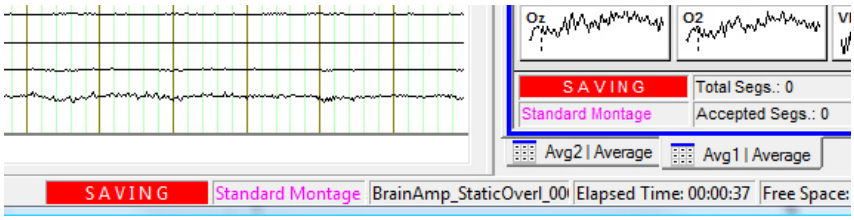
The *Base File Name* text box is used to enter a base name for the raw file. You can also use the $n placeholder. Wherever this placeholder occurs, it is replaced by the name of the raw file. Then click *Save*. The Recorder switches to save mode (see Figure 6-45).

Figure 6-44. "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* (see Figure 6-45). Note that this refers to the capacity that would be available if only the relevant group were stored.

Figure 6-45. Recorder in save mode



Chapter 7 Special functions when using active electrodes

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.

Damage to property

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.

7.1.1 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 that it is not possible to use a single BrainAmp ExG in combination with active electrodes. The BrainAmp ExG is only used with passive electrodes.

7.1.2 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).

7.1.3 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 SplitterBox 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.

- In contrast, if you connect the active electrodes (SplitterBox with up to 18 active electrodes) to the V-Amp via the multi-way plug then you do not need the actiCAP ControlBox/actiCAP ControlSoftware for impedance measurement. Instead, you can use the ImpBox.  For more detailed information on using the ImpBox for impedance measurements, please refer to the V-Amp Operating Instructions.

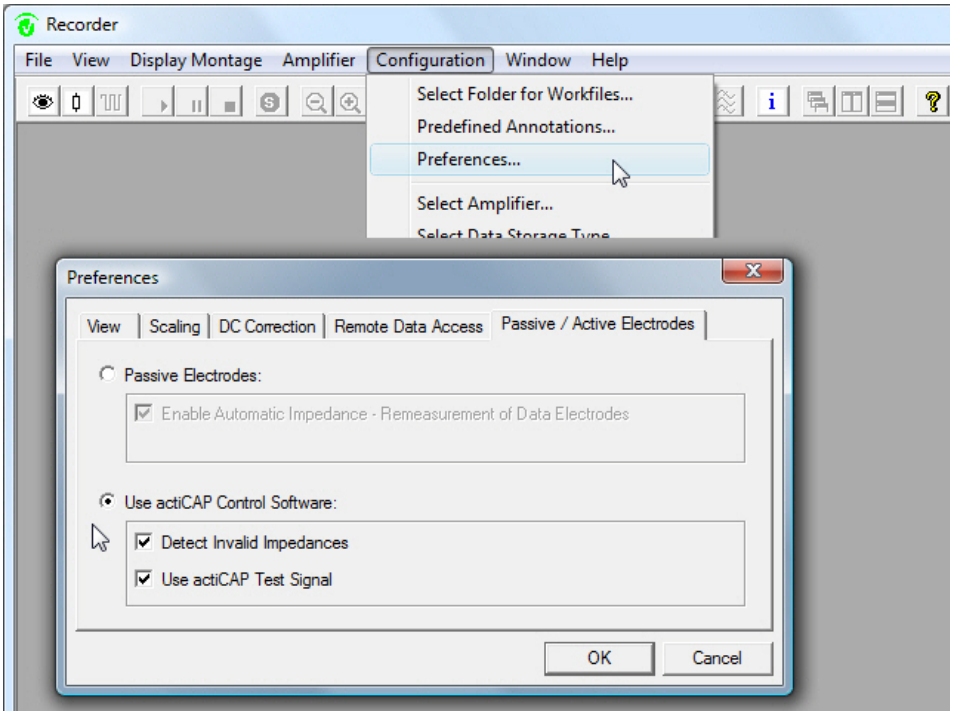
7.1.4 actiCHamp

The actiCHamp can be used with active electrodes without the need for any additional accessories.  You will find detailed information on the actiCHamp in the corresponding Operating Instructions as well as in Section 8.6 as of page 167 of the current manual.

7.2 Configuring the Recorder

Choose *Configuration › Preferences...* from the menu to open the *Preferences* dialog box and choose *Use actiCAP Control Software* on the *Passive/Active Electrodes* tab (see Figure 7-1).

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



7.3 Interaction between the Recorder and the actiCAP ControlBox

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

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

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

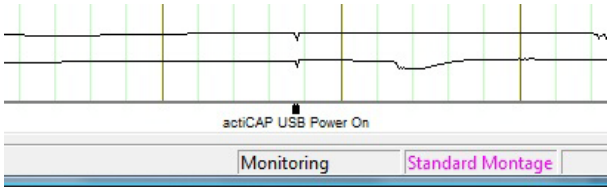
Please note here that the Recorder only recognizes the ControlBox if it is connected to the computer via USB. There must be a USB connection if markers are to be written. If you use the ControlBox with rechargeable batteries then the marker "no USB Connection to actiCAP" is written when you start recording.

Meaning of the various markers

The following markers can be written:

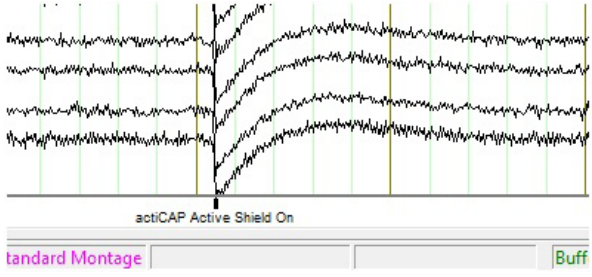
- When you press the *Power* button of the actiCAP ControlBox, the "actiCAP USB Power On" marker is set (see Figure 7-2). This marker indicates that the actiCAP ControlBox is in acquisition mode and is sending data to the Recorder.

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



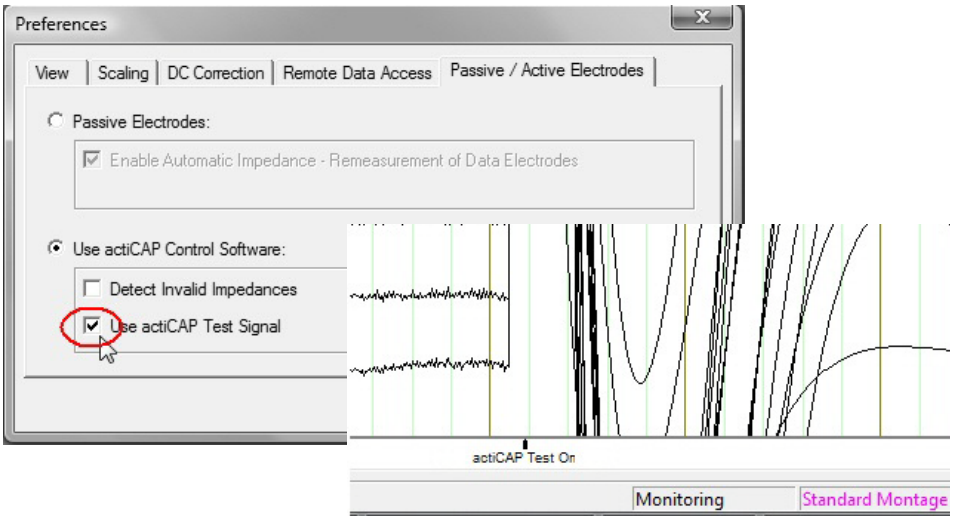
- When you switch to the *Active Shield* actiCAP mode, a marker is set showing the time in the data set that the *Active Shield* mode was activated (see Figure 7-3). When you exit the *Active Shield* actiCAP mode by pressing the *Active Shield* button on the actiCAP ControlBox again, the "actiCAP Active Shield Off" marker is written.

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



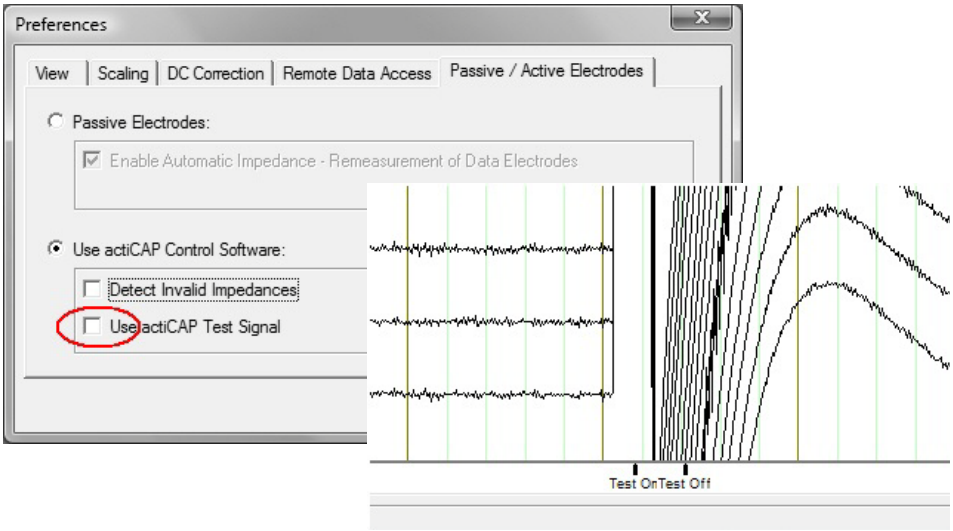
- If you have checked the *Use actiCAP Test Signal* box in the *Preferences* dialog box, the "actiCAP Test On" marker is set when you press the *Test* button on the actiCAP ControlBox (see Figure 7-4).

Figure 7-4. "actiCAP Test On" marker



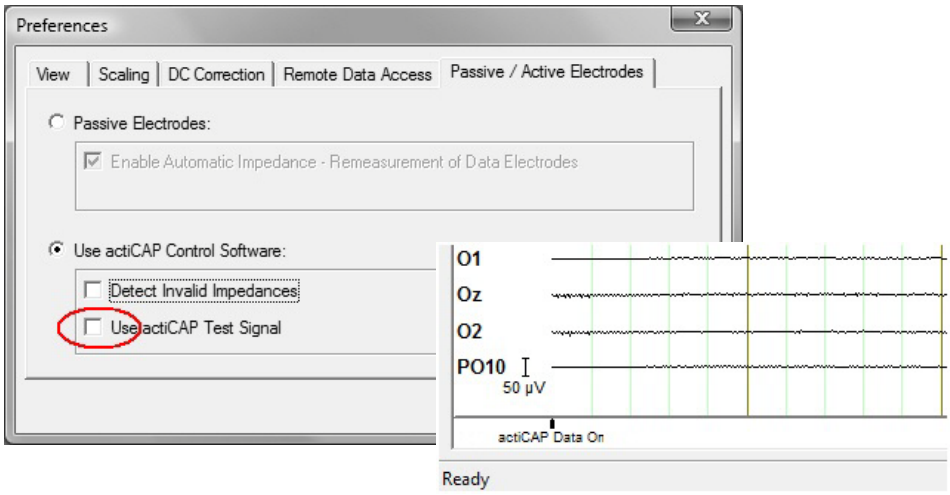
- If you do not check the *Use actiCAP Test Signal* box and the Recorder is in monitoring mode or test signal mode, and you then press the *Test* button on the actiCAP ControlBox, the actiCAP ControlBox briefly switches to test mode, and then the Recorder automatically switches it back to acquisition mode. Two markers are written in quick succession: "Test On" and "Test Off" (see Figure 7-5).

Figure 7-5. "Test On" and "Test Off" markers



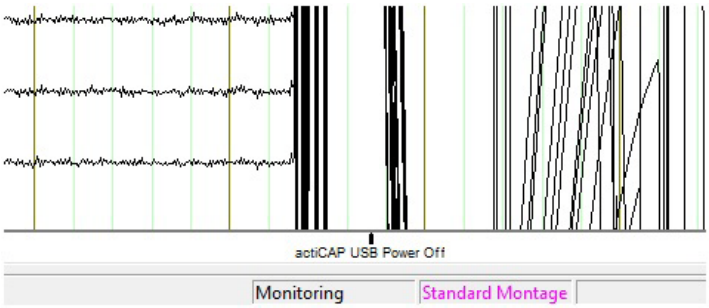
- If you start test signal mode in the Recorder, and you have not checked the *Use actiCAP Test Signal* box in the *Preferences* dialog box (i.e. if you are using the amplifier's test signal), the "actiCAP Data On" marker is set (see Figure 7-6).

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 (see Figure 7-7).

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

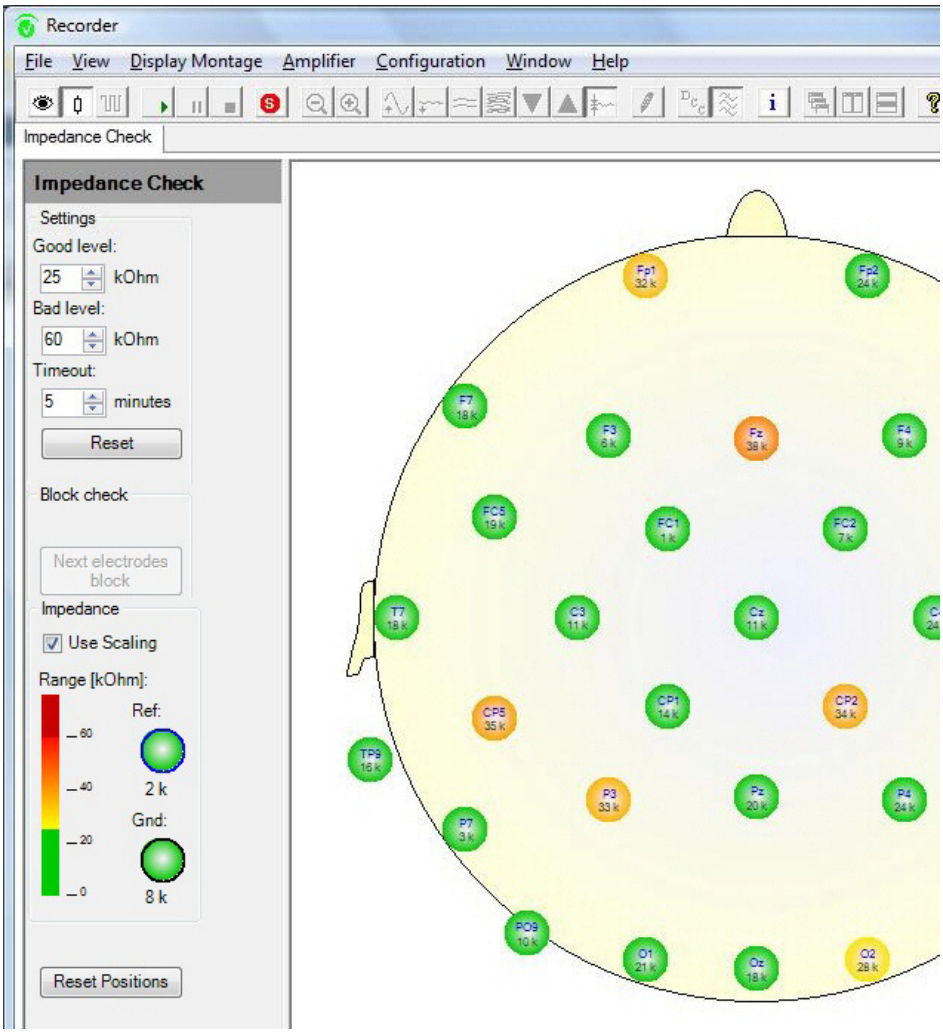


7.4 Impedance measurement of active electrodes

The Impedance Check View for active electrodes is virtually the same as the view for passive electrodes (see Section 6.1 on page 91).

When you click *Impedance Check* in the toolbar, a top view of a representation of a head appears (see 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 (kOhm)* and *Bad level (kOhm)* in the *Settings* group box, the color scale in the *Impedance* group box 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 reset the *Good level*, *Bad level* and *Timeout* settings to the factory values 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 box. 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 check 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.

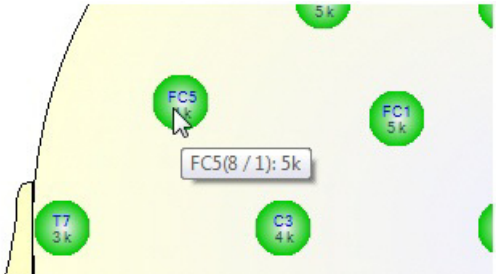
If you click the *Reset Positions* button, you return the electrodes to their initial positions if you had previously made any changes.

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, i.e. membership of the corresponding electrode of the associated actiCAP electrode branch
- Impedance value of the electrode

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

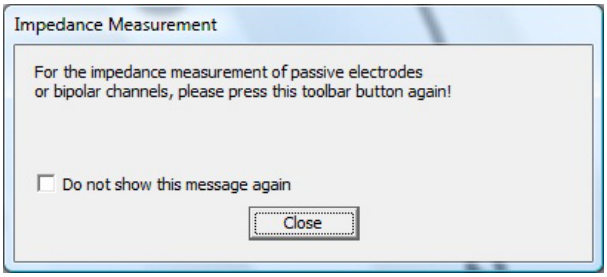
Figure 7-9. Tool tip for an active electrode



Using a BrainAmp ExG

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

Figure 7-10. Message issued when measuring active and passive electrodes with an additional BrainAmp ExG



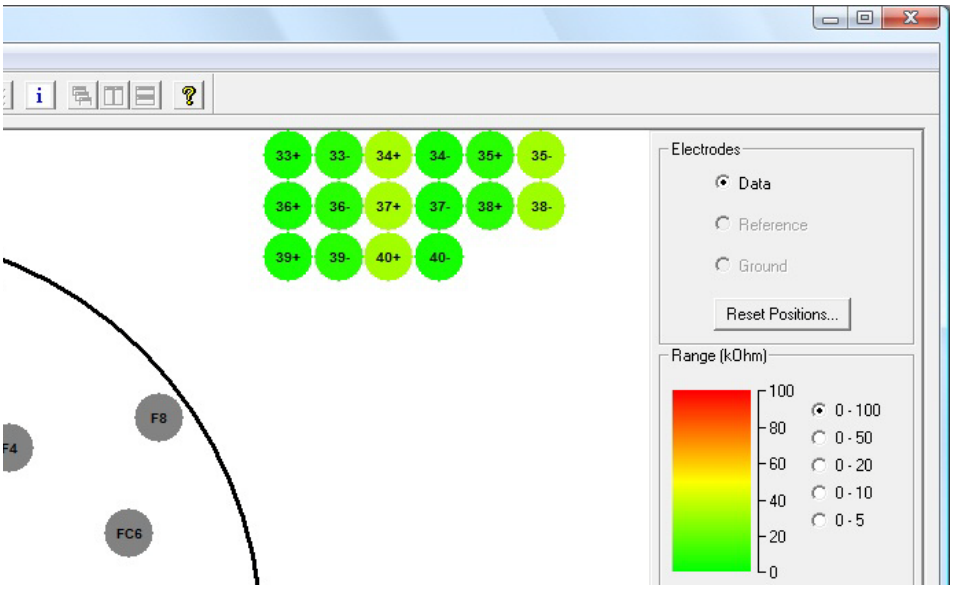
The active electrodes (BrainAmp) are always measured first, followed by the passive electrodes of the BrainAmp ExG in a second pass. Click *Impedance Check* again after the active electrodes have been measured in order to continue measuring the passive electrodes.

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 (see 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.

If measurement of the passive electrodes has been completed and you click the button again, the active electrodes are measured again.

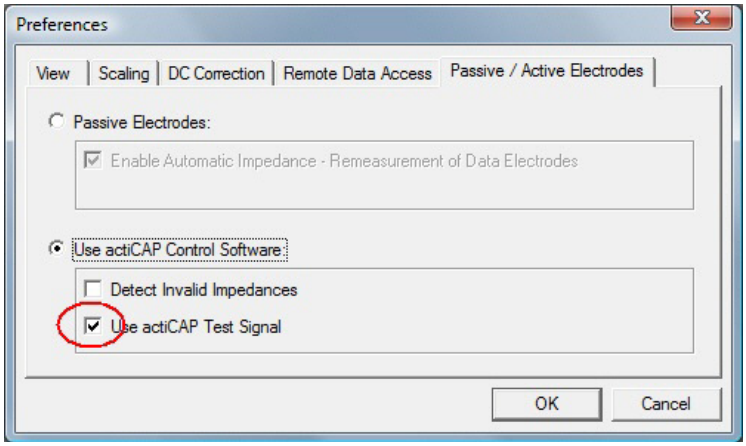
Figure 7-11. Measurement of the passive electrodes in a second pass when using a BrainAmp ExG



7.5 Test signal for the actiCAP active electrode system

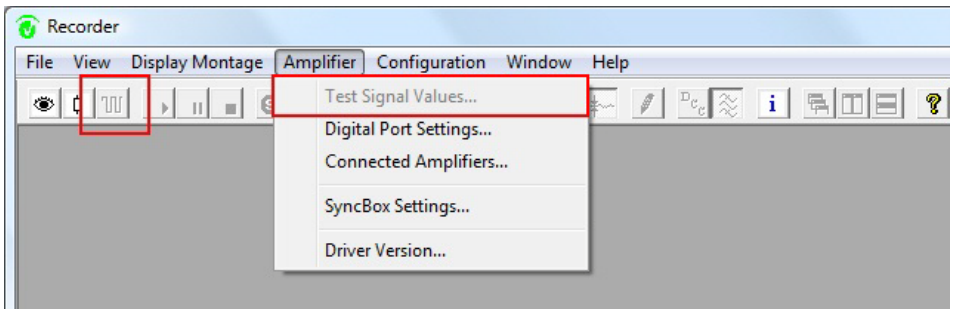
If you want to check that the active electrodes are working properly, check the *Use actiCAP Test Signal* box in the *Passive/Active Electrodes* tab of the *Preferences* dialog box (see Figure 7-12). Otherwise, the test signal is supplied by the amplifier when you run a function test.

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



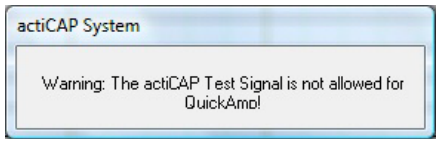
☞ If you are using the test signal of the actiCAP active electrode system, the *Test Signal* button in the toolbar of the Recorder and the menu item *Amplifier › Test Signal Values...* are disabled (see Figure 7-13).

Figure 7-13. Disabled functions in the Recorder 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 checked under *Preferences › Passive/Active Electrodes* (see Figure 7-14).

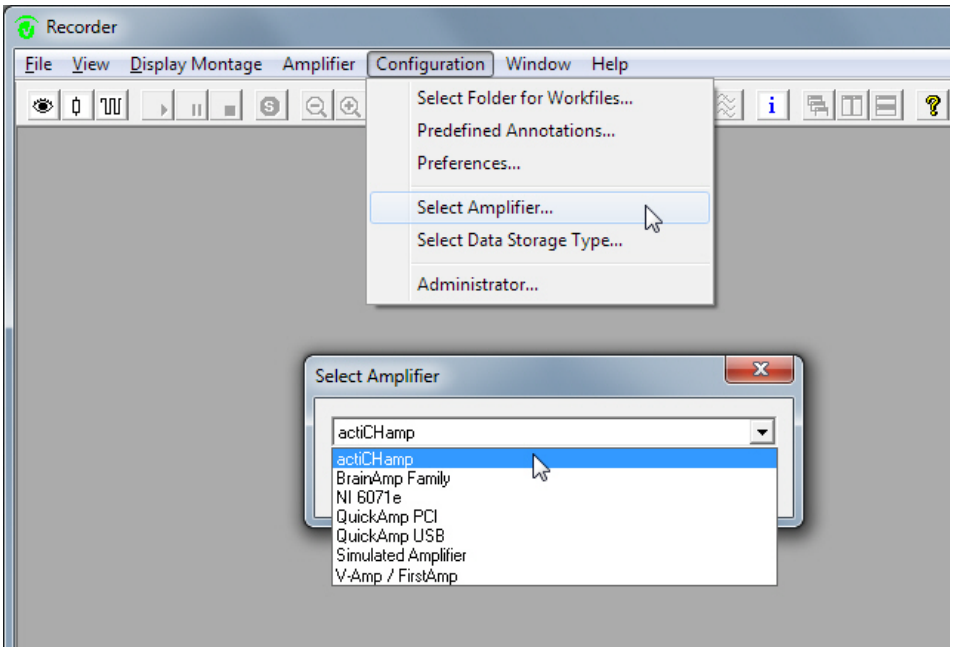
Figure 7-14. The actiCAP test signal is not supported for the QuickAmp



Chapter 8 Amplifier-specific properties

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

Figure 8-1. Selecting an amplifier



Note also the restrictions on use for the individual hardware components under Windows® Vista and/or Windows® 7 in Chapter 1 on page 27 ("System requirements").

Note also the restrictions on use for BrainAmp amplifiers under Windows® Vista and/or Windows® 7 in Chapter 1 on page 27 ("System requirements").

8.1 Amplifiers of the BrainAmp family

8.1.1 Creating and editing a workspace for the BrainAmp

Choose *File › New Workspace*... from the Recorder menu. You will find a detailed description of the configuration options for BrainAmp workspaces in Chapter 4 as of page 63.

8.1.2 Impedance measurement

You will find information on impedance measurement for passive electrodes in Section 6.1 as of page 91 and on impedance measurement for active electrodes in Section 7.4 as of page 133.

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:

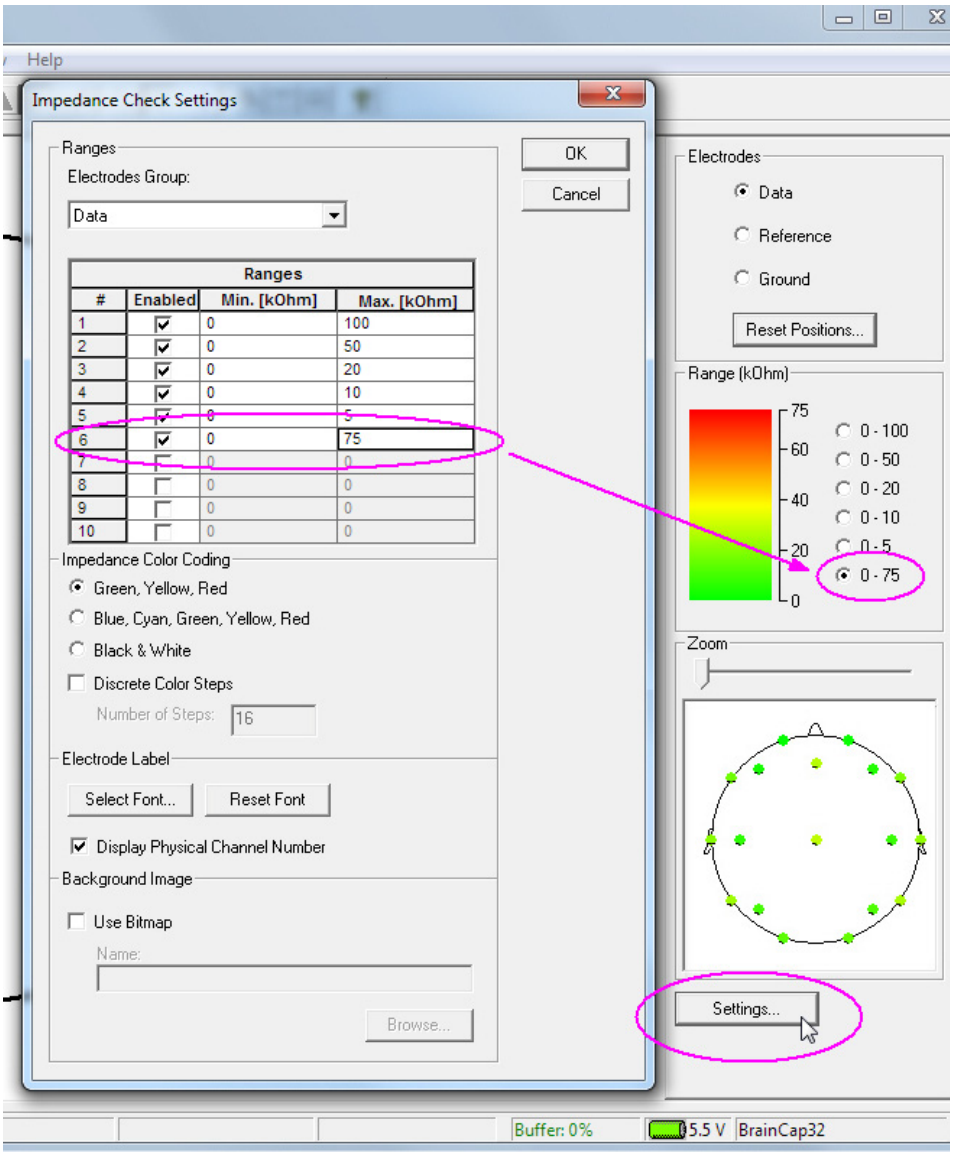
1. Prepare the electrodes and attach them to the test subject.
2. Measure the EEG electrodes. You can choose from five measuring ranges: 100, 50, 20, 10 and 5 kOhm.

   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*... (see 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 the BrainAmp



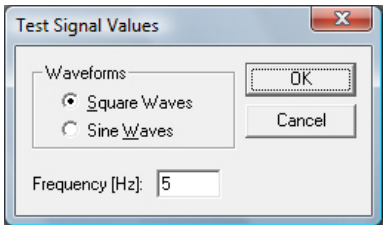
8.1.3 Using the test signal for the BrainAmp

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 (see Figure 8-3).

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



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

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

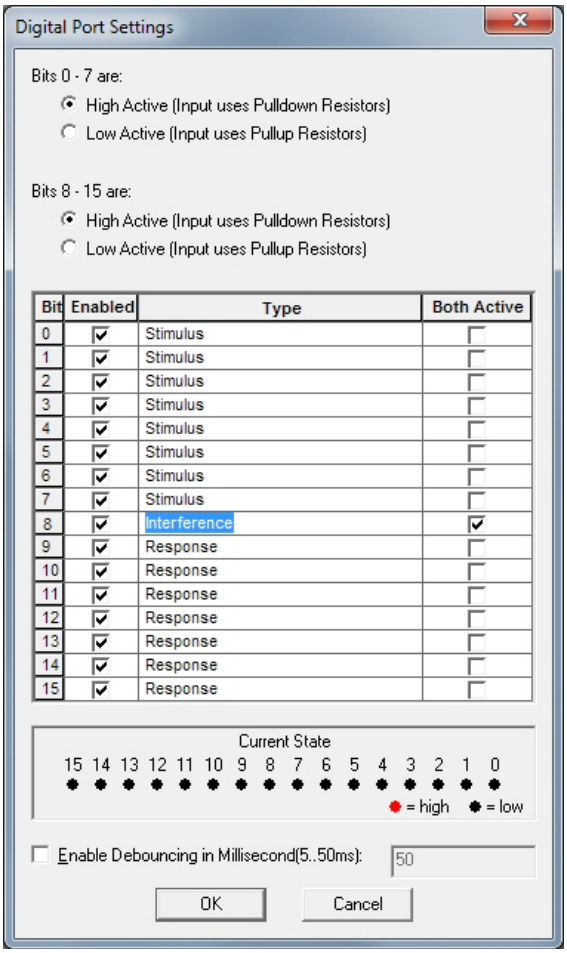
The amplifier's PCI adapter card or USB2 Adapter incorporates a 26-pin HD D-sub socket for recording events synchronous with the EEG such as stimuli or test subject responses. The socket contains 16 1-bit digital inputs that can be programmed separately from each other. The designations D00 through D15 relate to the bit number, with the first bit being designated with 0.

Personal injury

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

Figure 8-4. Configuring the digital port for the 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, pulldown (high-active) or pullup (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 checking 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 (i.e. this name may only occur once) so that the corresponding bit line can be precisely identified.

Both pulldown and pullup resistances (i.e. high-active and low-active signals) 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.

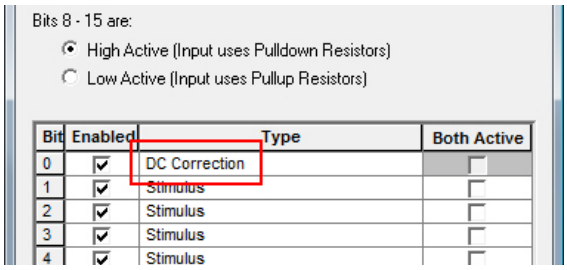
In the *Enabled* column of the table (see Figure 8-4), you can specify whether the associated bit is to be evaluated or not. In the *Type* column, you can specify what time marker type each bit represents. It is also possible to assign the same type to several different bits.

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 (see 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, i.e. 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 check 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 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 1000 Hz, the minimum length of the trigger signal is 1 ms and that at 500 Hz the minimum length is 2 ms, etc.

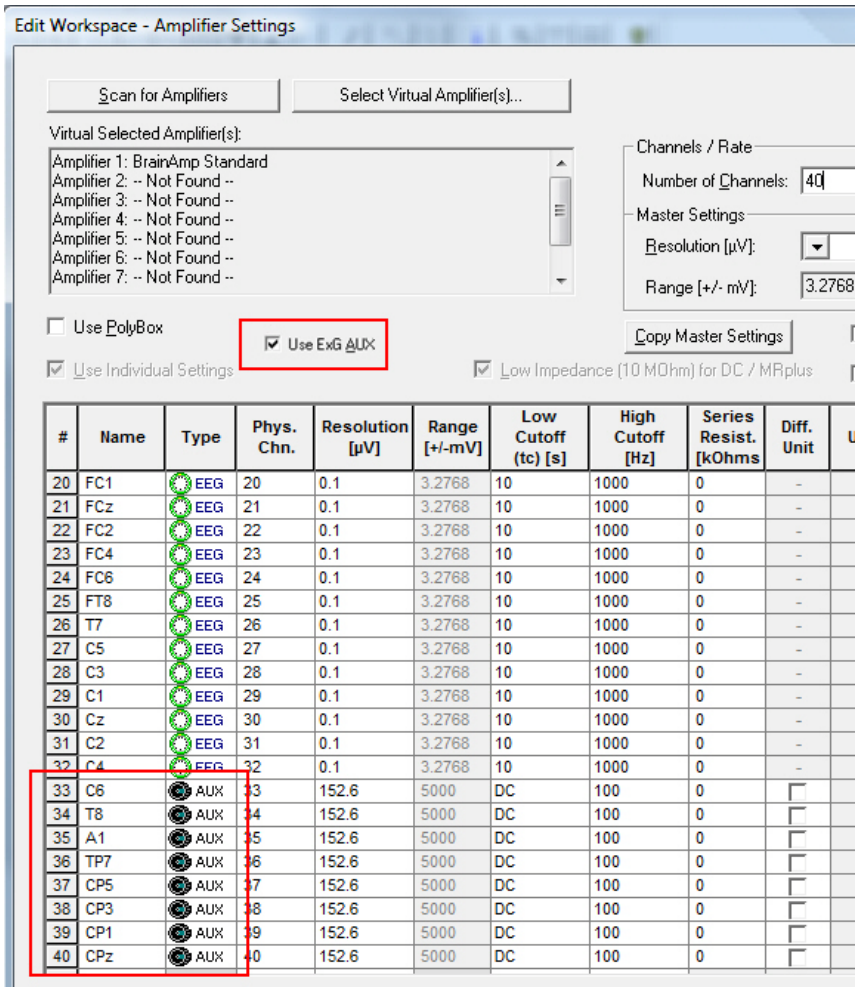
8.1.5 ExG AUX Box

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 check the *Use ExG AUX* box (see 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 (see Figure 8-7):

If you check 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.

Figure 8-7. Additional settings for AUX channels

#	Name	Type	Phys. Chn.	Diff. Unit	Unit	Gradient		Offset	
10		EEG	10	-	-	-	-	-	-
11	T7	EEG	11	-	-	-	-	-	-
12	T8	EEG	12	-	-	-	-	-	-
13	P7	EEG	13	-	-	-	-	-	-
14	P8	EEG	14	-	-	-	-	-	-
15	Fz	EEG	31	-	-	-	-	-	-
16	Cz	EEG	32	-	-	-	-	-	-
17	Pz	AUX	33	☑	C	200	mV/C	80	80 mV = 0 C
18	FC1	AUX	34	☑	C	200	mV/C	80	80 mV = 0 C
19	FC2	AUX	35	☑	C	200	mV/C	80	80 mV = 0 C
20	CP1	AUX	36	☐	-	-	-	-	-

Setting up a GSR-MR channel

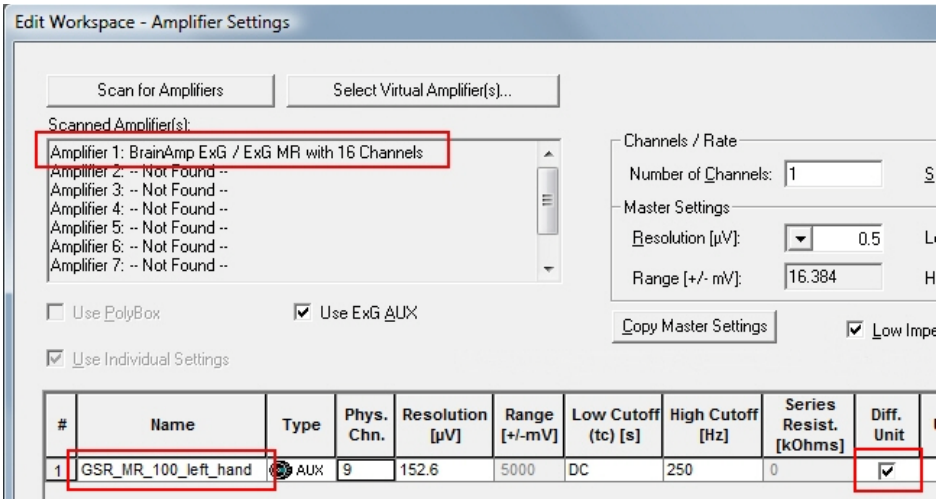
If you are using the GSR-MR module with the ExG AUX Box, you can set up a GSR-MR channel in the workspace. The input signals for the GSR-MR module must be corrected due to the resistors fitted in the electrodes. Proceed as follows to load the corrected values (see Figure 8-8):

1. In the table, check 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. The Recorder now automatically loads the correction values.

You will find detailed information on using the GSR-MR module in the relevant Operating Instructions.

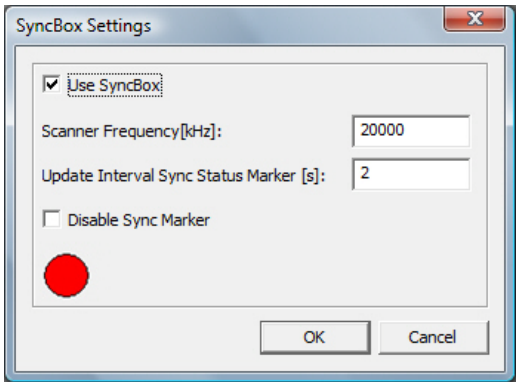
Figure 8-8. Setting up a GSR-MR channel



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 (see Figure 8-9).

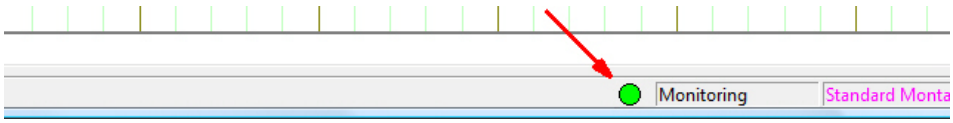
Figure 8-9. SyncBox settings



If you check the *Use SyncBox* box in the *SyncBox Settings* dialog box, the SyncBox icon appears in the status bar in both monitoring mode and save mode in the Recorder (see 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 in the status bar indicates utilization and status of the 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 20000 in Figure 8-9 represents a 20 MHz input signal at the SyncBox.

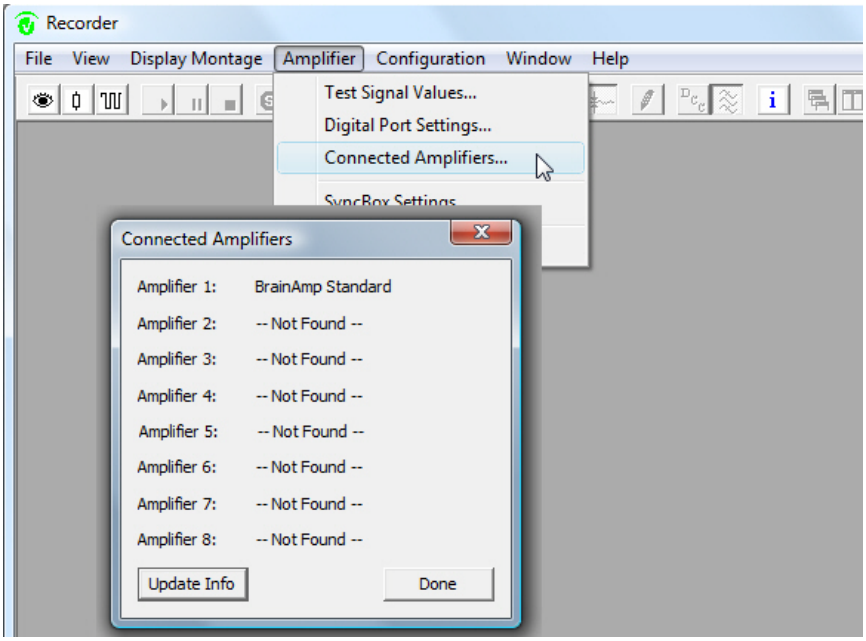
Check or uncheck the *Disable Sync Marker* box to specify whether or not synchronization markers are to be written during synchronization. If you use this function, markers are written to the data stream every few seconds indicating the synchronization status, i.e. "in sync" or "out of sync". Only check 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 (see Figure 8-11).

Figure 8-11. List of connected BrainAmp amplifiers



Note also the restrictions on use for QuickAmp amplifiers under Windows® Vista and/or Windows® 7 in Chapter 1 on page 27 ("System requirements").

8.2 QuickAmp PCI and QuickAmp USB

As of Version 1.10 of the Recorder, two types of QuickAmp are distinguished: QuickAmp PCI and QuickAmp USB. The QuickAmp PCI is used in combination with a 22-bit QuickAmp amplifier and a PCI card. The driver version for the QuickAmp PCI is V.5.0.3.2 and can be found in the file *\RecorderDrivers\QuickAmp PCI.zip* on the BrainVision program DVD. The QuickAmp USB is used in combination with a 24-bit/22-bit QuickAmp amplifier (40/72/136 channel system) and USB. The correct driver version is V.6.0.0.76 and can be found in the *\RecorderDrivers\QuickAmp USB* folder on the BrainVision program DVD.

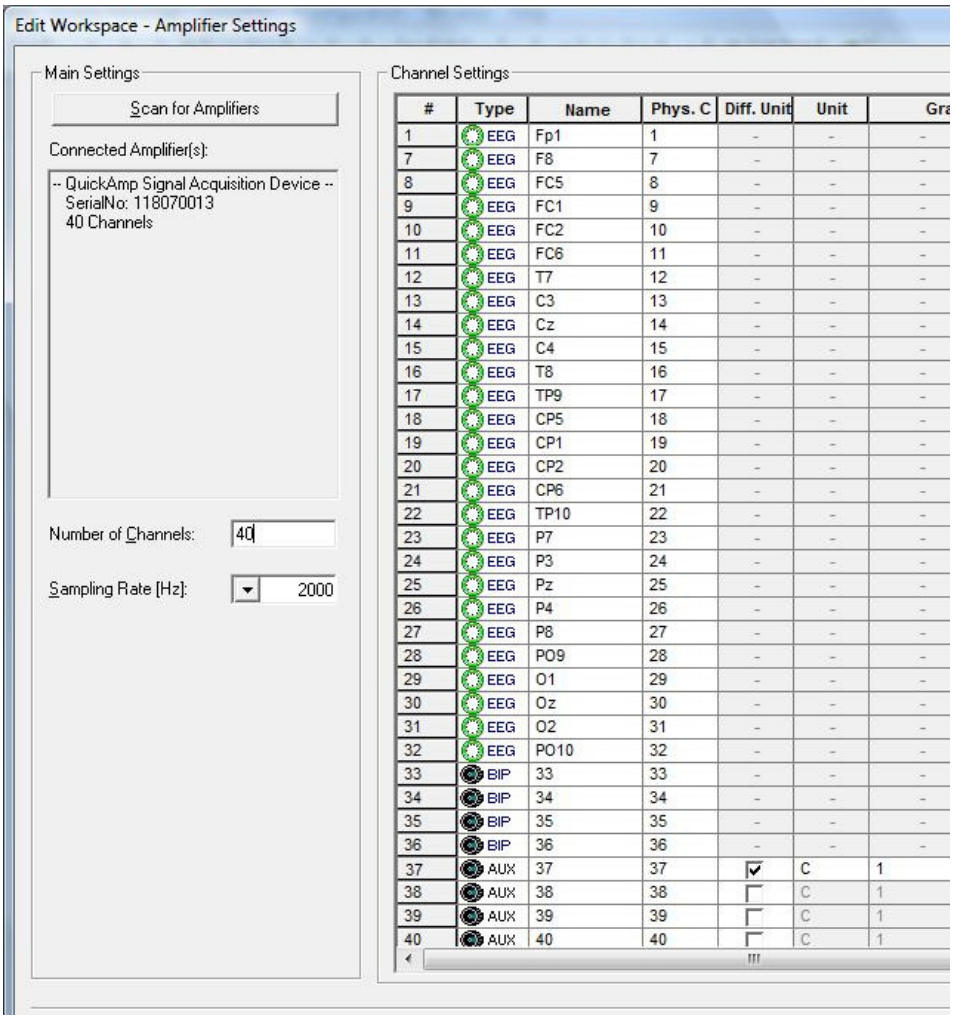
Note that only the QuickAmp USB supports non-Administrator mode (i.e. user mode).

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 (see Figure 8-12).

You will find a description of the settings for filters and segmentation/averaging in Section 4.5 and Section 4.6.

Figure 8-12. Editing a QuickAmp workspace



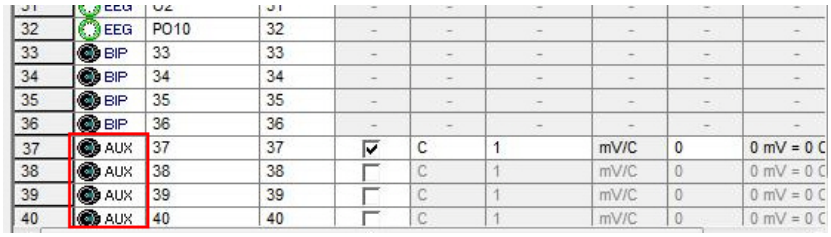
Click *Scan for Amplifiers*. The QuickAmp amplifiers connected to your computer are shown under *Connected Amplifier(s)*.

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 (see Figure 8-13), for a QuickAmp72 channels 69 through 72 and for a QuickAmp128 channels 125 through 128.

Figure 8-13. QuickAmp, AUX channels



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

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

If you check 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.

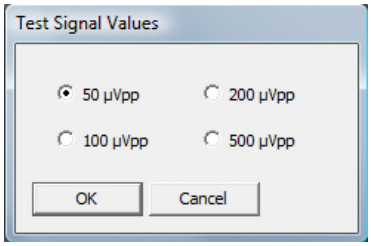
8.2.2 Using the test signal for the QuickAmp

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 that 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 (see Figure 8-14).

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

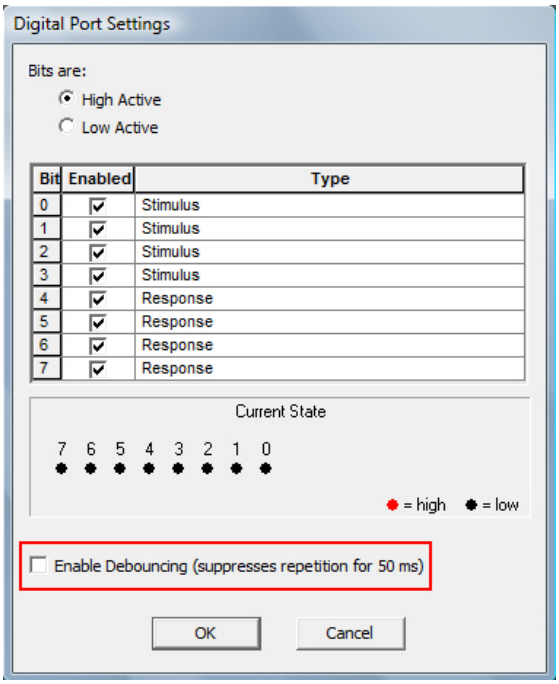


8.2.3 Configuring the digital port (marker port) for the QuickAmp

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.

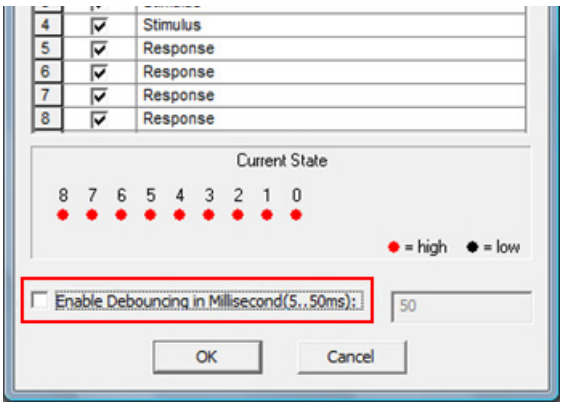
You make the settings for the digital port by choosing *Amplifier › Digital Port Settings...* from the menu.

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



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

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, i.e. 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 check 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 check 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 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 1000 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.

Using the BrainVision Recorder Professional Edition

If you are using a BrainVision Recorder Professional Edition, you must install the drivers and an additional Windows® service in addition to the Recorder. Proceed as follows:

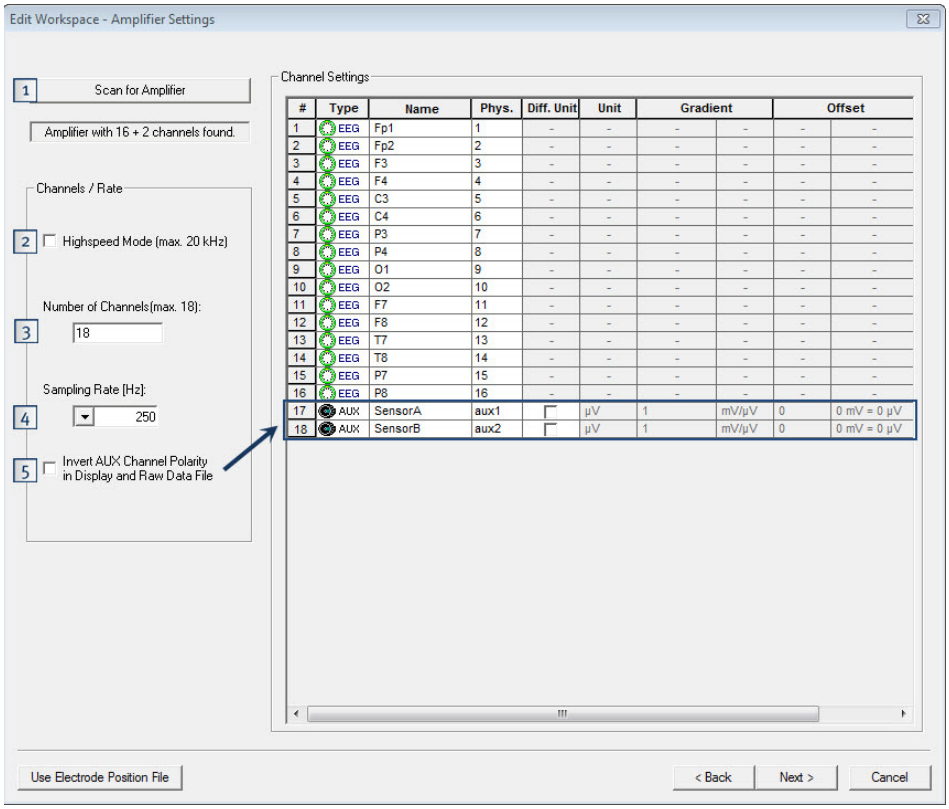
1. Make sure that no amplifier is connected during installation.
2. Insert the BrainVision program DVD into your CD-ROM drive.
3. Navigate to the folder *FirstAmp, V-Amp*.
4. Run the file with the name *FirstAmpACC-xxx.exe*.

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 (see Figure 8-17).

You will find a description of the settings for filters and segmentation/averaging in Section 4.5 and Section 4.6.

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 check 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 check 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.

Adjusting the sensors for the AUX inputs of the V-Amp/ FirstAmp

5 *Invert AUX Channel Polarity in Display and Raw Data File* allows you to invert the display of AUX channels (see 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 checked)

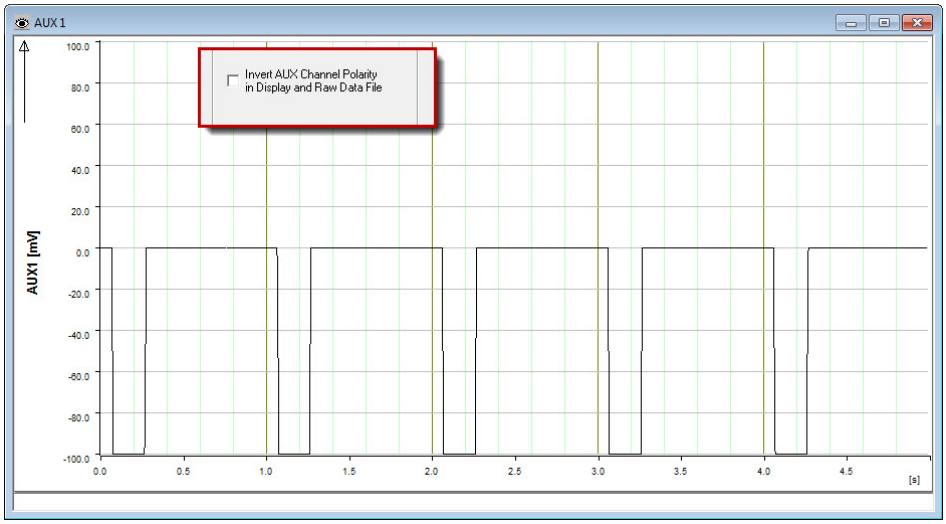
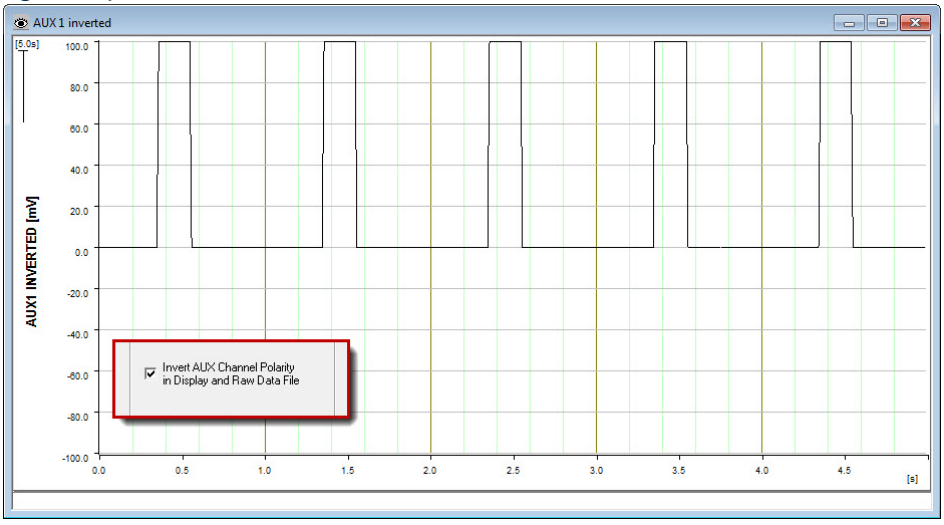
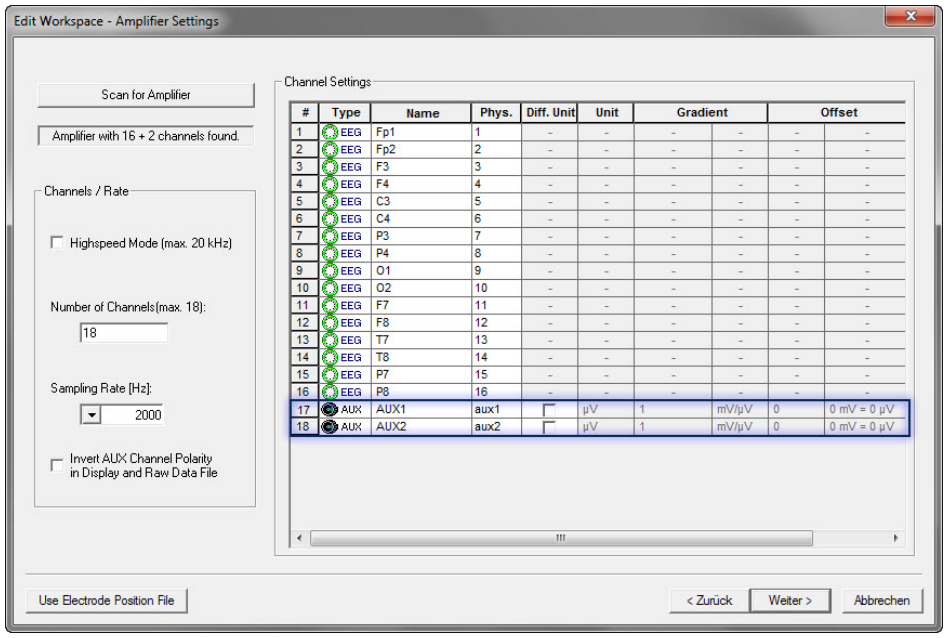


Figure 8-19. AUX 1 channel inverted (box checked)



You can also make the following settings (see Figure 8-20).

Figure 8-20. V-Amp, AUX channels



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

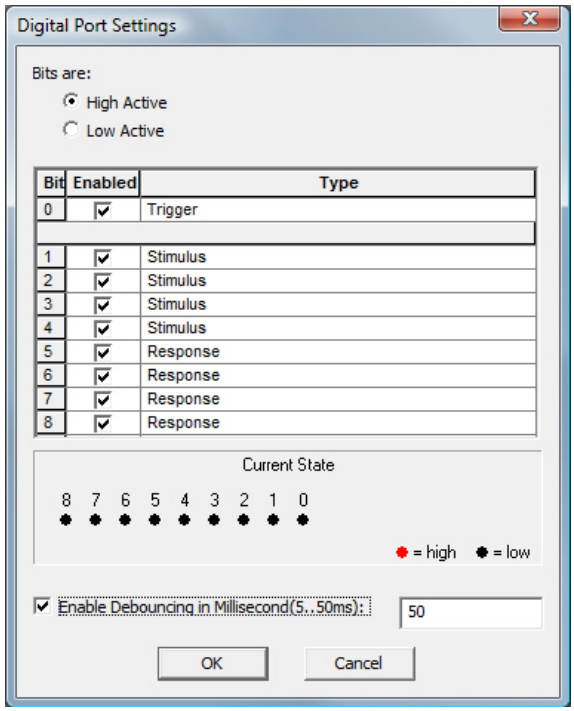
- If you check the box under *Diff. Unit*, you can use a different unit such as "C" for Celsius.
- Enter the required unit in the *Unit* column.
- Enter the gradient in mV/unit in the *Gradient* column – for the unit C, for example, use mV/C. In this example, you describe the voltage difference in mV 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 *Triggers1* port (jack) of the amplifier. All the remaining bits are located on the *Triggers2* 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 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, i.e. 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.

Table 8-1 contains the recommended minimum length of the trigger signal for various sampling rates. Shorter signal lengths can result in errored markers.

Table 8-1. Recommended minimum length for trigger signals

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

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

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

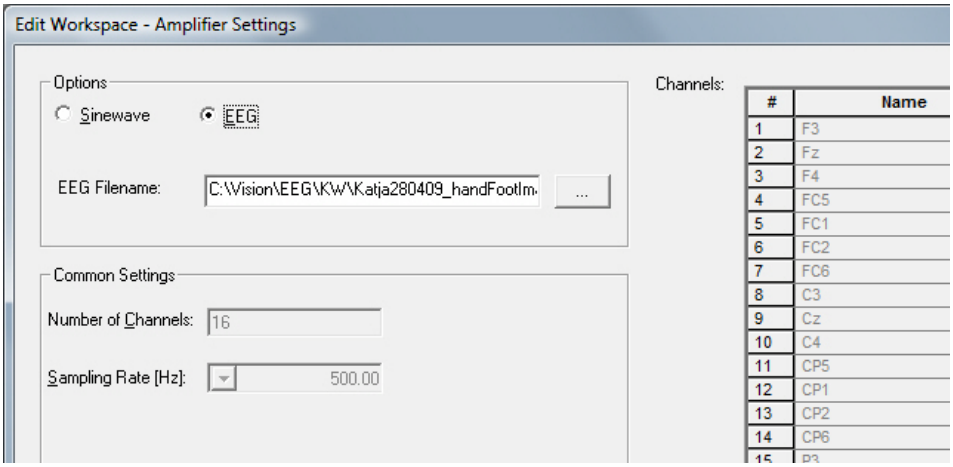
The Simulated Amplifier function allows you to use the Recorder without having an amplifier connected and to display an EEG that has already been recorded. It simulates the activity of up to 256 channels. The menu bar does not contain the *Amplifier* item if you are using the Simulated Amplifier function.

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 (see Figure 8-22).

You will find a description of the settings for filters and segmentation/averaging in Section 4.5 and Section 4.6.

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.

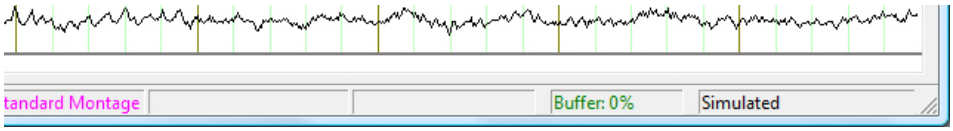
In the case of the *Sinewave* option, you can enter the number of channels in the *Number of Channels* text box and the sampling rate in the *Sampling Rate [Hz]* text box.

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.

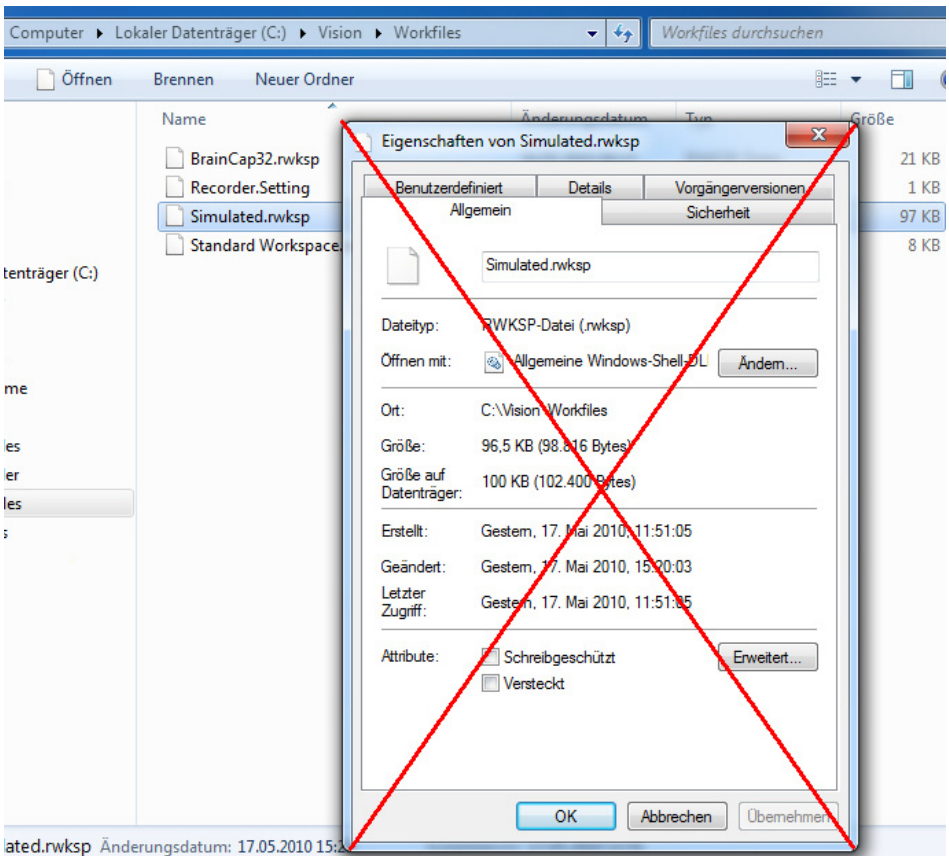
If you edit the simulated workspace, you can make changes without overwriting the original workspace based on a real amplifier. If you select a real amplifier after the *Simulated Amplifier*, the most recent associated workspace is loaded without changes (rather than the simulated workspace).

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



Do not under any circumstances change the file properties of the simulated workspace (right click on *File › Properties*) (see Figure 8-24).

Figure 8-24. Changes to the file properties of the simulated workspace are not permitted



8.5 National Instruments NI 6071e A/D converter board

Note also the restrictions on use for the A/D converter board under Windows® Vista and/or Windows® 7 in Chapter 1 on page 27 ("System requirements").

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. The Recorder treats the card just like an amplifier.

Personal injury

Note that 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.

Please refer to the documents "PCI E Series User Manual.pdf" and "SCB-100 100-Pin Connector Block Installation Guide.pdf" in the subfolder *NI6071e* of the BrainVision program DVD for further information about the A/D converter board.

8.5.1 Installing the A/D converter board

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 CD-ROM drive and follow the instructions in the setup program.

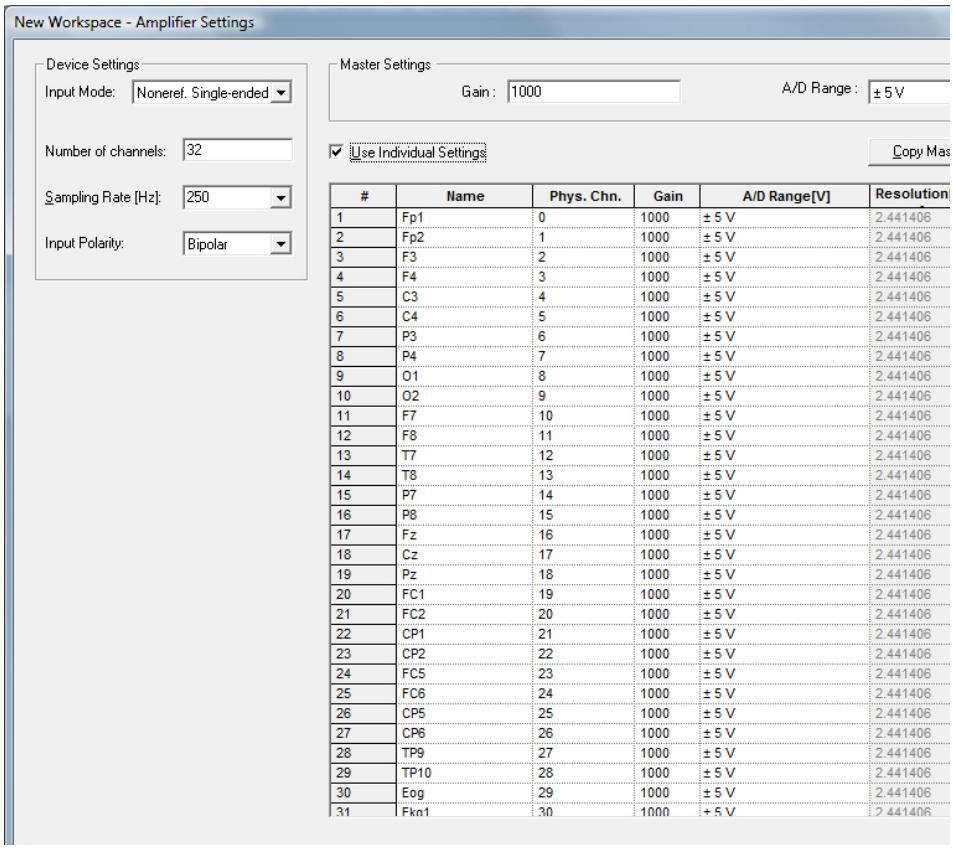
8.5.2 Editing the workspace for the A/D converter board

Choose *Configuration › Select Amplifier...* from the menu and select the entry *NI 6071e*. Choose *File › New Workspace...* from the menu. After you have made all the file-specific and folder-specific settings described in Section 4.2, open the *New Workspace – Amplifier Settings* page (see Figure 8-25).

You will find a description of the settings for filters and segmentation/averaging in Section 4.5 and Section 4.6.

Note that the names of 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



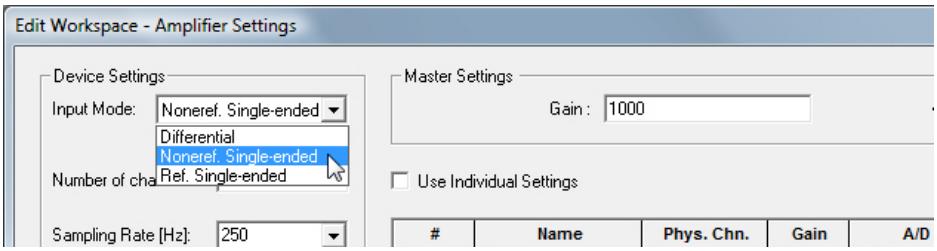
#	Name	Phys. Chn.	Gain	A/D Range[V]	Resolution
1	Fp1	0	1000	± 5 V	2.441406
2	Fp2	1	1000	± 5 V	2.441406
3	F3	2	1000	± 5 V	2.441406
4	F4	3	1000	± 5 V	2.441406
5	C3	4	1000	± 5 V	2.441406
6	C4	5	1000	± 5 V	2.441406
7	P3	6	1000	± 5 V	2.441406
8	P4	7	1000	± 5 V	2.441406
9	O1	8	1000	± 5 V	2.441406
10	O2	9	1000	± 5 V	2.441406
11	F7	10	1000	± 5 V	2.441406
12	F8	11	1000	± 5 V	2.441406
13	T7	12	1000	± 5 V	2.441406
14	T8	13	1000	± 5 V	2.441406
15	P7	14	1000	± 5 V	2.441406
16	P8	15	1000	± 5 V	2.441406
17	Fz	16	1000	± 5 V	2.441406
18	Cz	17	1000	± 5 V	2.441406
19	Pz	18	1000	± 5 V	2.441406
20	FC1	19	1000	± 5 V	2.441406
21	FC2	20	1000	± 5 V	2.441406
22	CP1	21	1000	± 5 V	2.441406
23	CP2	22	1000	± 5 V	2.441406
24	FC5	23	1000	± 5 V	2.441406
25	FC6	24	1000	± 5 V	2.441406
26	CP5	25	1000	± 5 V	2.441406
27	CP6	26	1000	± 5 V	2.441406
28	TP9	27	1000	± 5 V	2.441406
29	TP10	28	1000	± 5 V	2.441406
30	Eog	29	1000	± 5 V	2.441406
31	Ekg1	30	1000	± 5 V	2.441406

Please refer to chapter 4, pages 4-13 ff. of the file "PCI E Series User Manual.pdf" on the BrainVision program DVD for information about optimum wiring of the amplifier used.

In the *Device Settings* group box, you can set the *Input Mode*. This must match your chosen wiring configuration. You have three options here (see 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*, the *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 2048 Hz, with 32 channels, sampling can be performed at 1024 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, e.g. 1000, and then record a short data sequence. Measure the values in the Analyzer. You can now correct the gain by comparing the actual value with what it should be.

Example: Set the gain to 1000 and feed in a test voltage of 100 μV_{pp}. The voltage measured in the Analyzer is 120 μV_{pp}, 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.

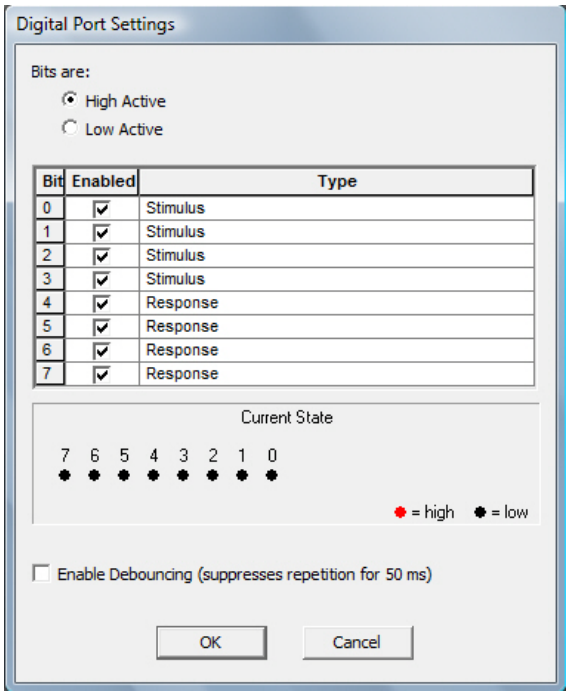
If you require individual settings for each channel, check the *Use Individual Settings* box.

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 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, i.e. 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 check 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 1000 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

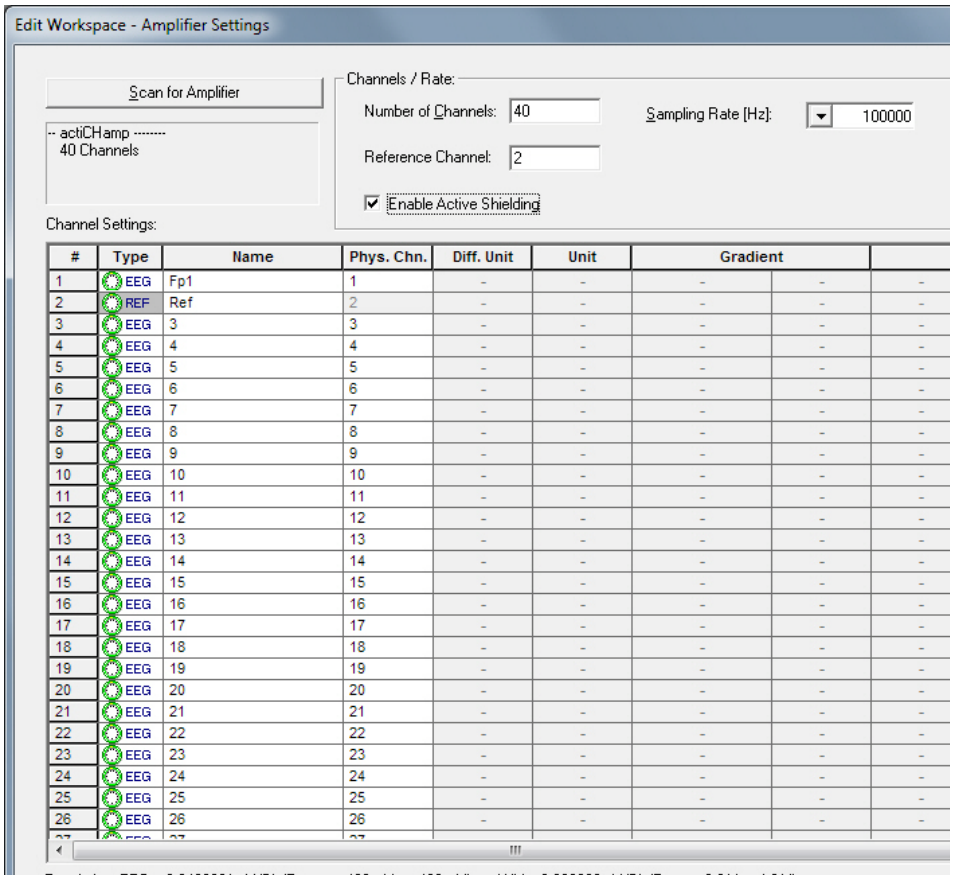
Please note the special system requirements applicable to the actiCHamp in Chapter 1 on page 28.

8.6.1 Creating and editing a workspace for the actiCHamp

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 (see Figure 8-28).

You will find a description of the settings for filters and segmentation/averaging in Section 4.5 and Section 4.6.

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.

Table 8-2. actiCHamp sampling rate

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

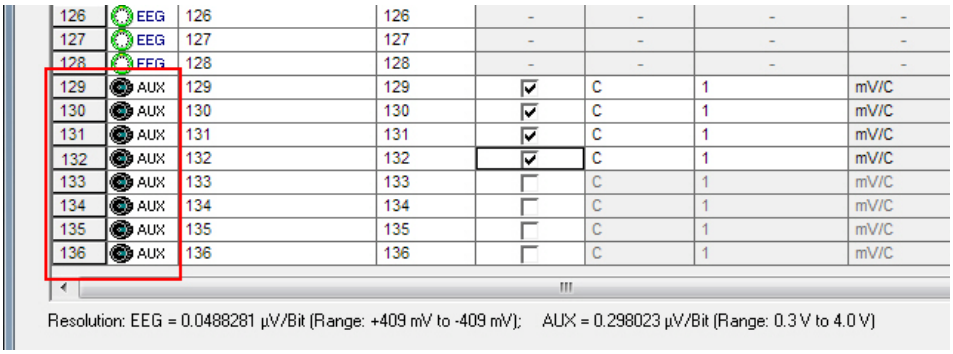
Active shielding mode is used to reduce environmental influences such as noise, electrical interference or cable movement, that would otherwise have an effect on the electrodes. If you want to use this mode, check the *Enable Active Shielding* box. The Recorder then automatically switches to active shielding mode when you start it.

Please note that 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 (see Figure 8-29).

Figure 8-29. actiCHamp, AUX channels



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

If you check 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.

Damage to property

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

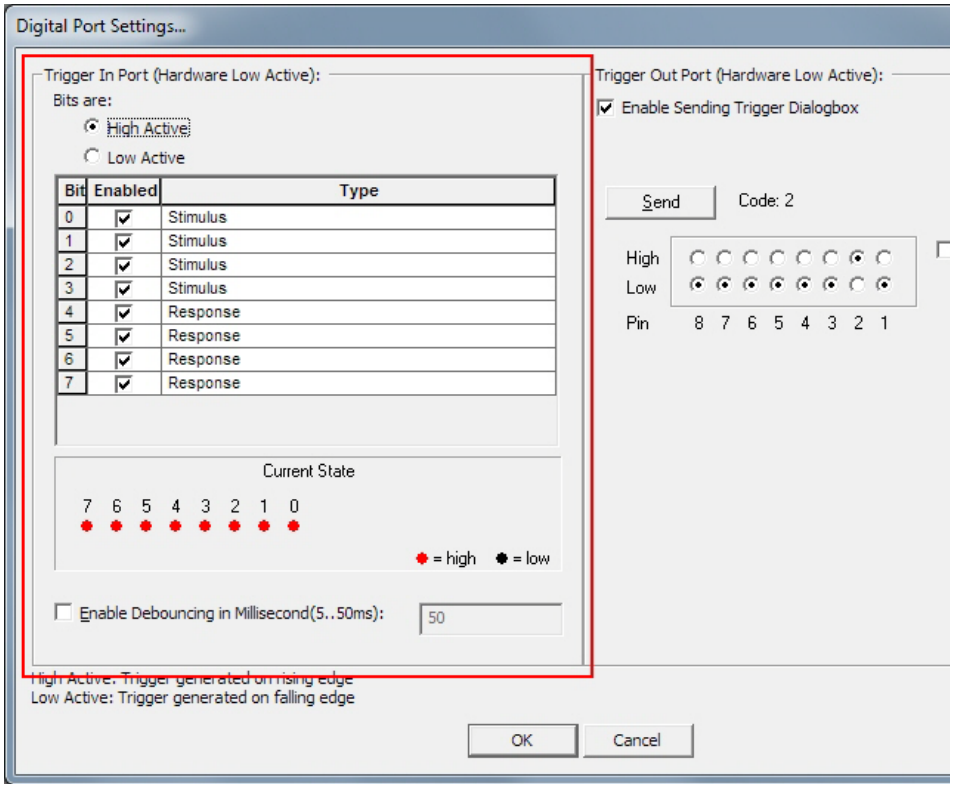
You will find the pinout of the digital port in the Operating Instructions for your actiCHamp amplifier.

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*) (see Figure 8-30).

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.

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 (e.g. Stimulus, Response). It is also possible to assign the same type to several different bits.

Under *Current State*, you can view the current status of the bit lines (active or inactive).

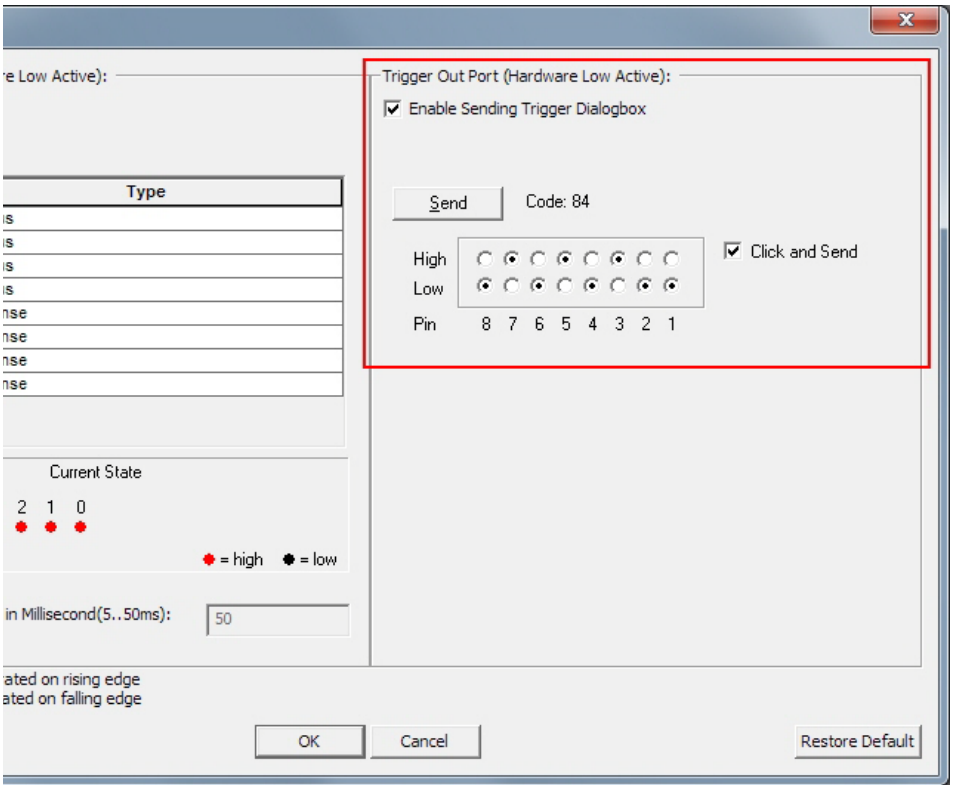
If you check the *Enable Debouncing in Millisecond (5..50 ms)* box, repetition of a marker of the same type and same description is ignored for a period of 5 through 50 ms.

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

Configuring the actiCHamp's trigger output

You can encode outbound triggers in the right-hand section of the dialog box (*Trigger Out Port*) (see Figure 8-31).

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

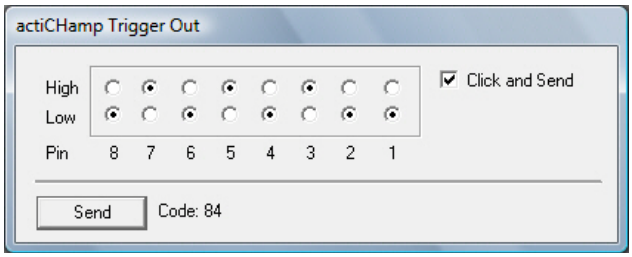


If you want to be able to send triggers from the trigger port, check the *Enable Sending Trigger Dialogbox* box.

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

You can also send triggers manually during recording (see Figure 8-32): If you check 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:

Table 8-3. actiCHamp, default settings for the digital port

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

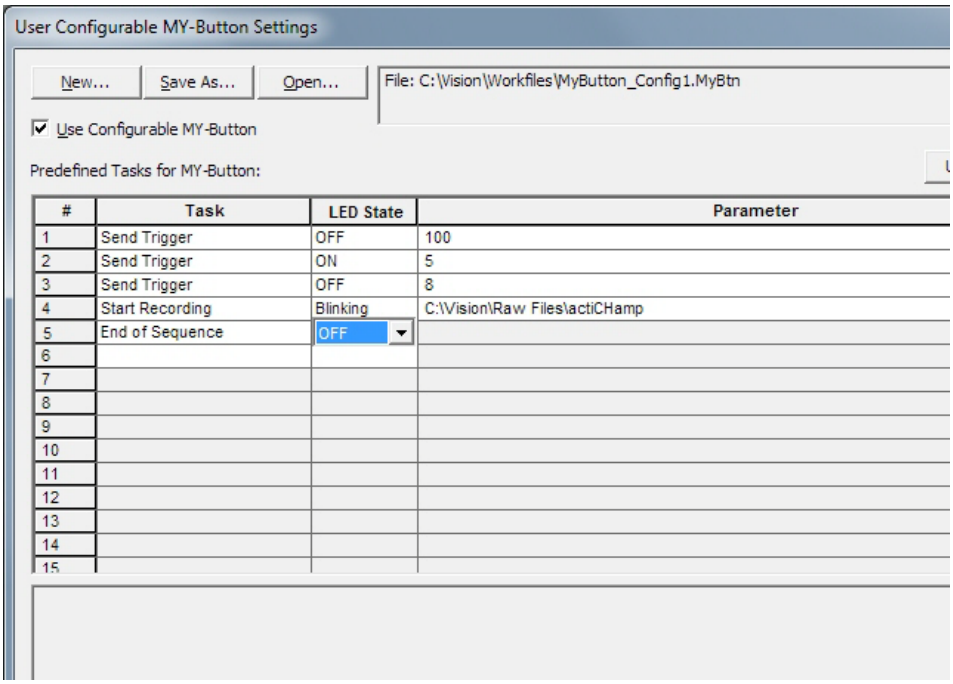
8.6.3 Configuring the MY-Button

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 (see Figure 8-33).

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 as of page 83):

- If the *Allow User Editing Amplifier Specific Settings* box is not checked then the administrator can prohibit all access to the *MY-Button* by leaving the *Use Configurable MY-Button* box unchecked (default setting).
- If the *Allow User Editing Amplifier Specific Settings* box (*Configuration › Administrator...* in the menu) is not checked and the *Use Configurable MY-Button* box (*Amplifier › Use Configurable MY-Button Settings...* in the menu) is checked 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 checked 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.

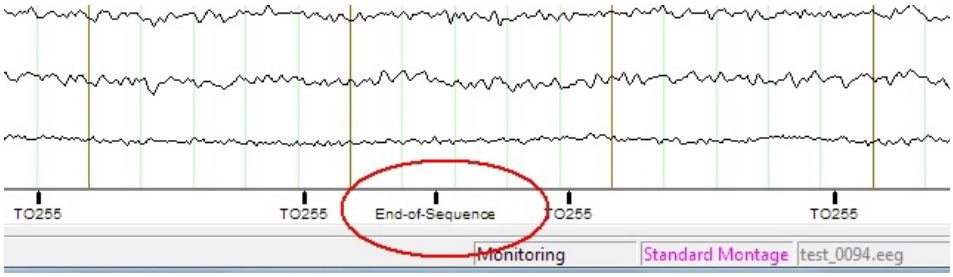
The *Up* and *Down* buttons allow you to change the sequence of the functions in the list. *Remove...* allows you to remove individual functions.

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 (see Figure 8-34).

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* (see Table 8-4).

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.

Table 8-4. Selecting predefined functions for the "MY-Button"

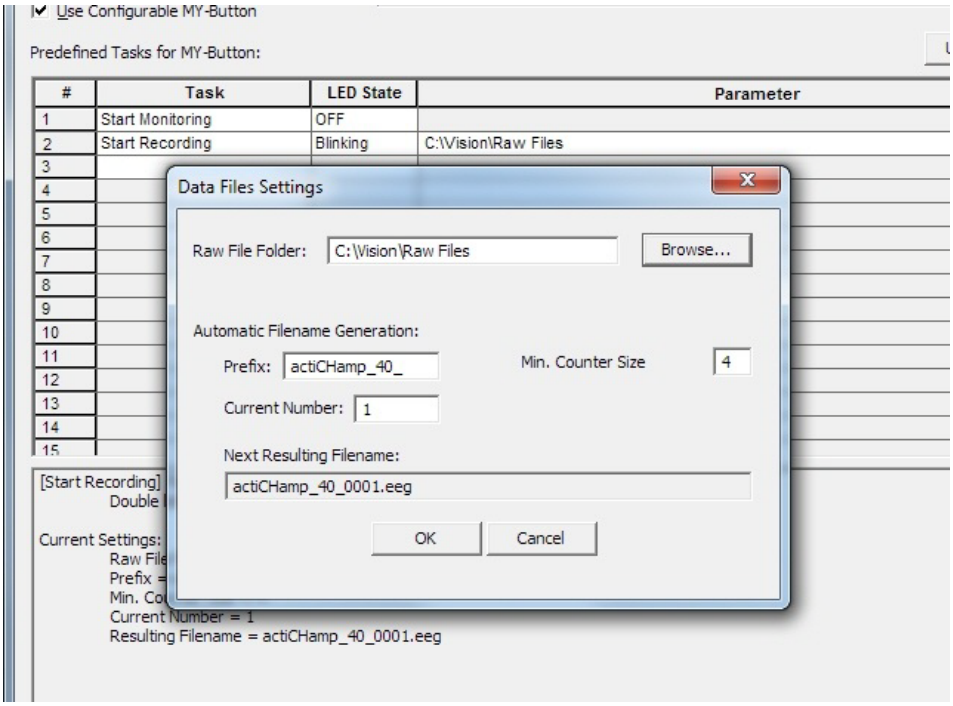
Function ("Task")	Description	Settings ("Parameters")
Start Monitoring	Switches the Recorder to monitoring mode.	
Start Impedance	Switches the Recorder to impedance mode.	
Start Testsignal	Switches the Recorder to test signal mode.	
Start Recording	Starts data recording.	You must specify the name and storage location of the file manually (see also Figure 8-35 on page 175).
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 8-4. 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 keyboard shortcut.	For the keyboard shortcuts that you can use here, see Appendix E as of page 215.
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.	

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 (see 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.

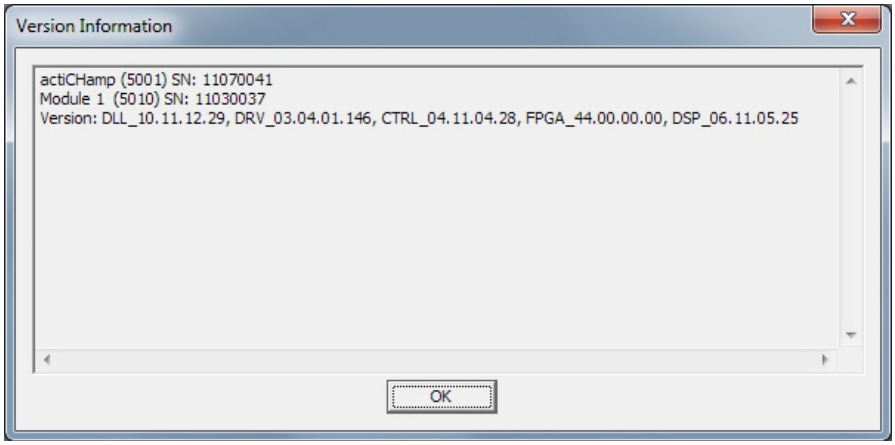
With regard to the *Start Application* function, please note: On the one hand, the real-time performance of the Recorder may be impaired if you run an additional application on the computer on which recording is performed. This may result in a loss of data. On the other, under no circumstances should you connect stimulation devices to the parallel port of the computer on which the 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 (see Figure 8-36).

Figure 8-36. Driver versions



8.6.5 The actiCHamp window

The actiCHamp window is displayed in all operating modes.

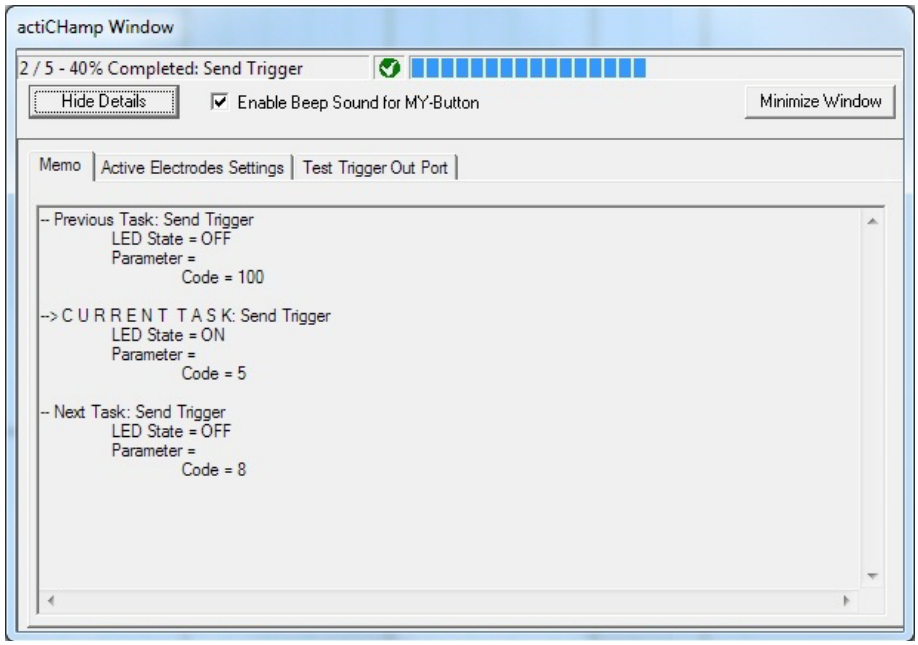
The upper part of the window displays the function currently being executed as a result of pressing the *MY-Button*.

If you check 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 as of page 172). At the most, the previous, current and next steps in a function sequence are displayed (see Figure 8-37).

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 (see 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 as of page 133.

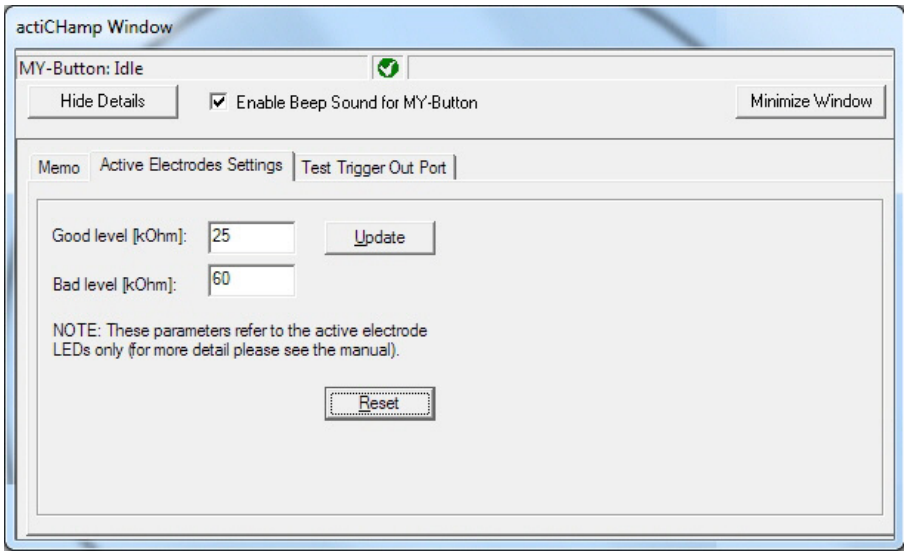
To modify the display, enter the required values in the *Good level kOhm* and *Bad level kOhm* text boxes: The LEDs indicate impedance values below the "Good level" in green, values between the "Good level" and "Bad level" in yellow and values above the "Bad level" in red. Click *Update* to apply the 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 inserting the actiCAP electrode branches into the actiCHamp, you should always make sure that they are inserted in the correct position and 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.

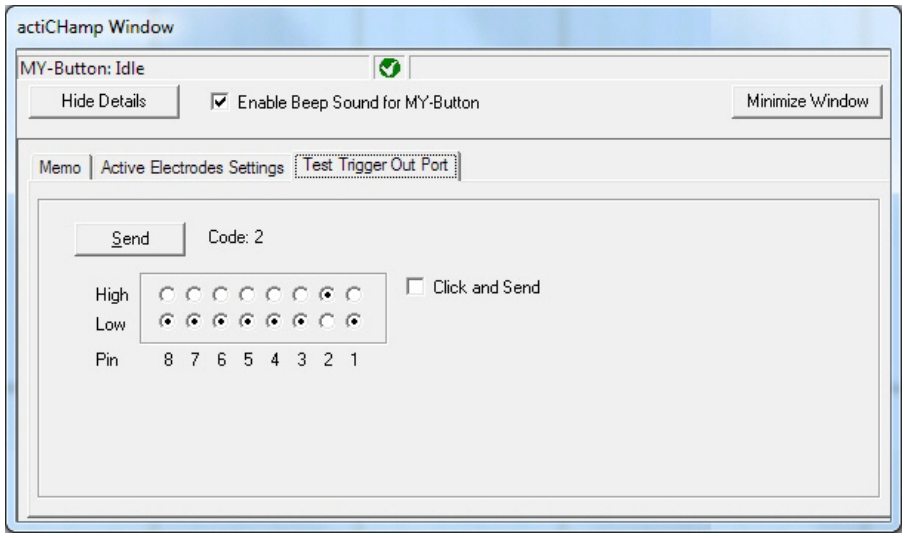
Figure 8-38. actiCHamp window, modifying value ranges for LEDs



The *Test Trigger Out Port* tab allows you to send triggers to the actiCHamp's trigger output (see 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 as of page 171.

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



Chapter 9 OLE automation

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

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

Under Windows® XP, Windows® Vista and Windows® 7, the 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
```

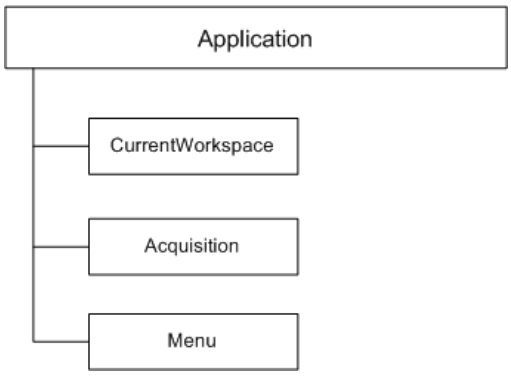
In this example, the Recorder is started, data is displayed and an EEG file named *TestData.EEG* with a length of 5 seconds (5000 milliseconds) is stored.

If you are using the Analyzer, you can also control the 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
```

In this chapter, we will not deal with programming in depth but will just outline the Recorder's object model (see Figure 9-1).

Figure 9-1. Object hierarchy of the Recorder



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

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, i.e. "Version" corresponds to "Application.Version", for example.

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 sub-licenses.

`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/sub-license (e.g. a video sub-license).

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 ' display-
                                   ing 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.

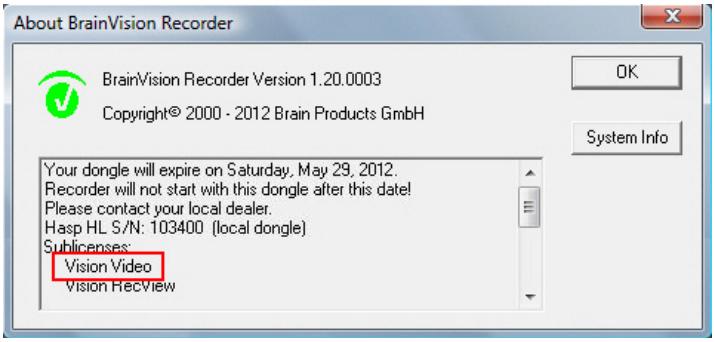
10.1 Installing the Video Recorder and codec

The Video Recorder can only be used if you have already purchased a Video sub-license that you must install in addition to the Recorder. You will find details on installing sub-licenses in Appendix D as of page 211.

If you purchased sub-licenses at the same time as you purchased the Recorder, the sub-license file is included on a USB data carrier supplied with the software. Sub-licenses that are purchased subsequently can be downloaded from the Brain Products Web site. You will find details on downloading sub-licenses in Appendix D as of page 211.

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* (see Figure 10-1).

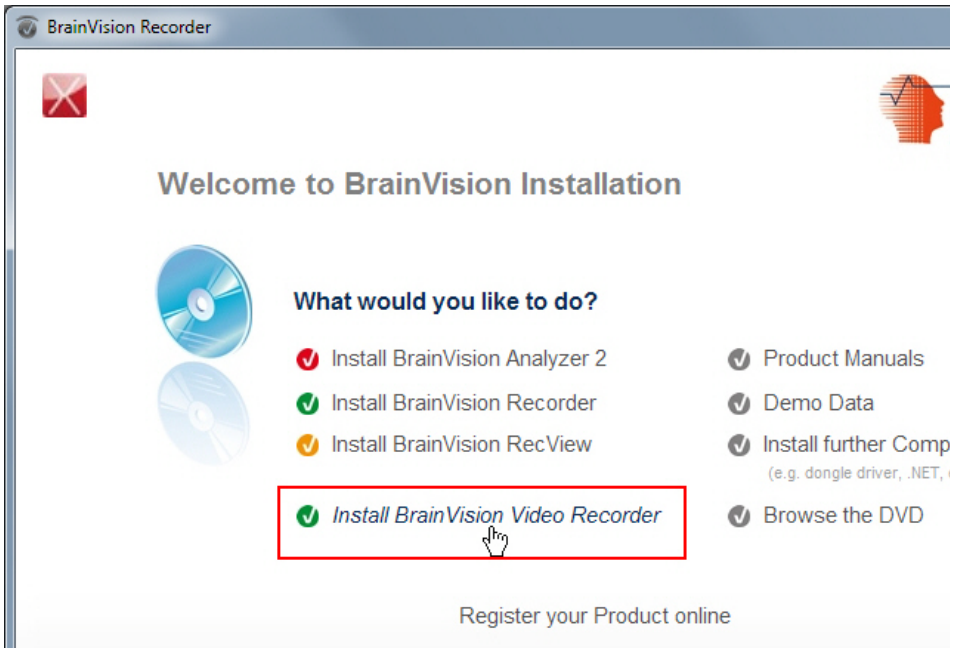
Figure 10-1. Dongle with sub-license for the Video Recorder



Proceed as follows to install the Video Recorder and codec:

1. Insert the BrainVision program DVD into your CD-ROM drive.
2. Run the file *Autorun.exe*.
3. Click *Install BrainVision Video Recorder* in the welcome screen (see Figure 10-2).

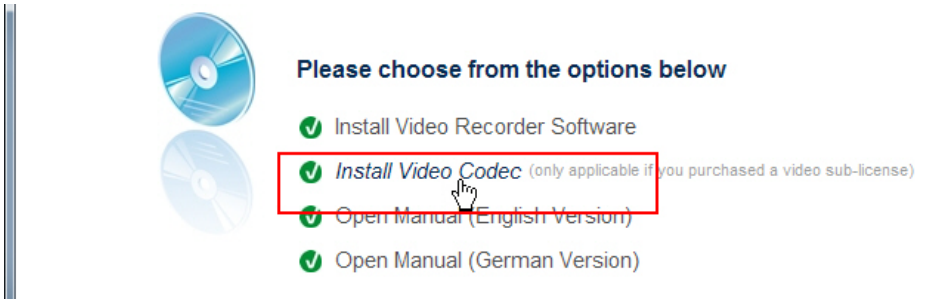
Figure 10-2. Installing the Video Recorder



4 On the second page, click *Install Video Recorder Software* and follow the instructions in the installation program.

5 Now install the codec supplied. The codec is used to compress the video data. On the second page of the dialog box displayed when you run the BrainVision program DVD, click *Install Video Codec* (see Figure 10-3). This opens a folder containing the installation program for the video codec.

Figure 10-3. Installing the video codec



6 Run the program file *LEADMCMPCodec.exe* to start the installation and follow the instructions output by the installation program. You will find the serial number required in order to perform the installation in your product documentation.

7 To use the video codec in the Video Recorder, you must select the codec in the Recorder's program settings. These settings are described in Section 10.2 as of page 192.

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)* in the list. Any other LEAD codecs that may be present in the list are not suitable for the operation of the Video Recorder.

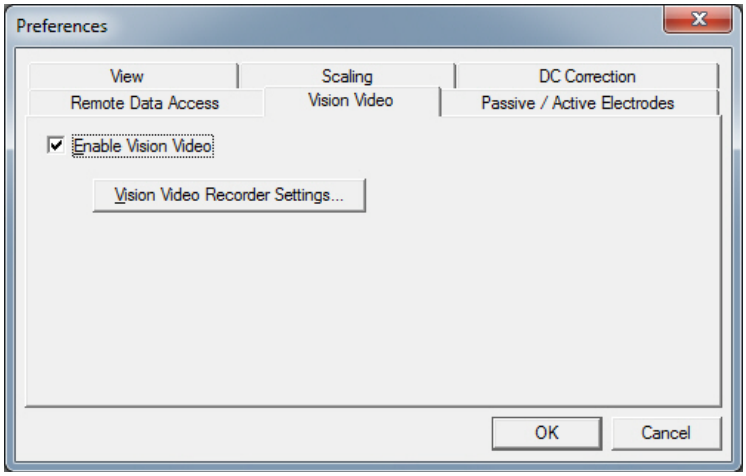
8 Connect the video camera to the computer and switch it on.

Note that 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 the Video Recorder, choose *Configuration › Preferences...* in the Recorder menu. If you have installed the Video Recorder correctly and you have a dongle with a Video license, the *Preferences* dialog box will contain an additional tab named *Vision Video* (see Figure 10-4). You enable synchronous video recording by checking the *Enable Vision Video* box.

Figure 10-4. Video settings and codec selection



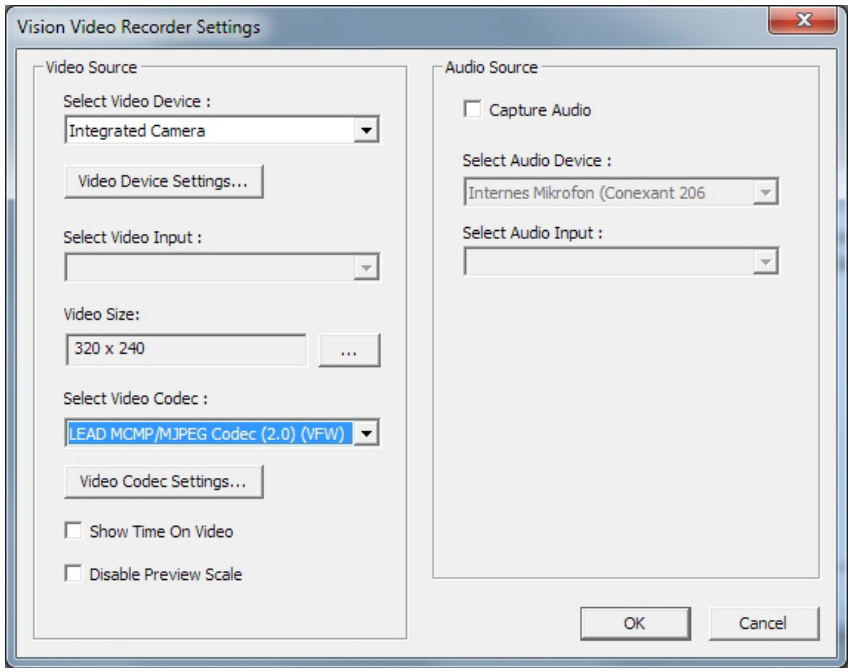
Video settings

Click the *Vision Video Recorder Settings...* button. You can make the following settings (see Figure 10-5):

Choose the installed video camera under *Select Video Device*. You can set the camera properties under *Video Device Settings*.

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

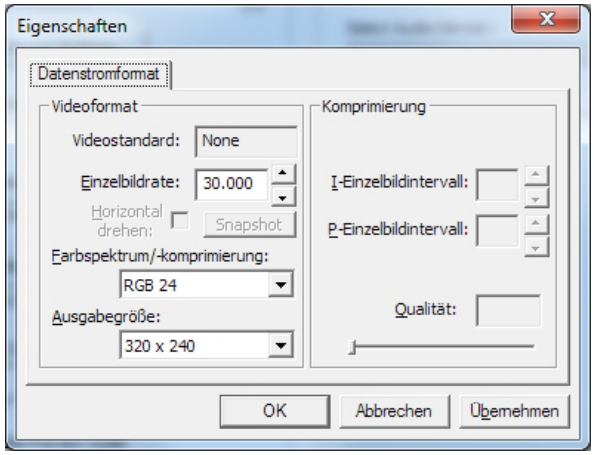
Figure 10-5. Video settings and codec selection



You can choose the resolution of the video data under *Video Size*. The resolution depends on the video camera used. If you click the ... button, the Recorder calls an interface to DirectX® (see 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 that the 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 that most of codecs offered are not suitable for realtime 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 as of page 189.

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 check the *Disable Preview Scale* box, you cannot change the size of the video window.

Audio options

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

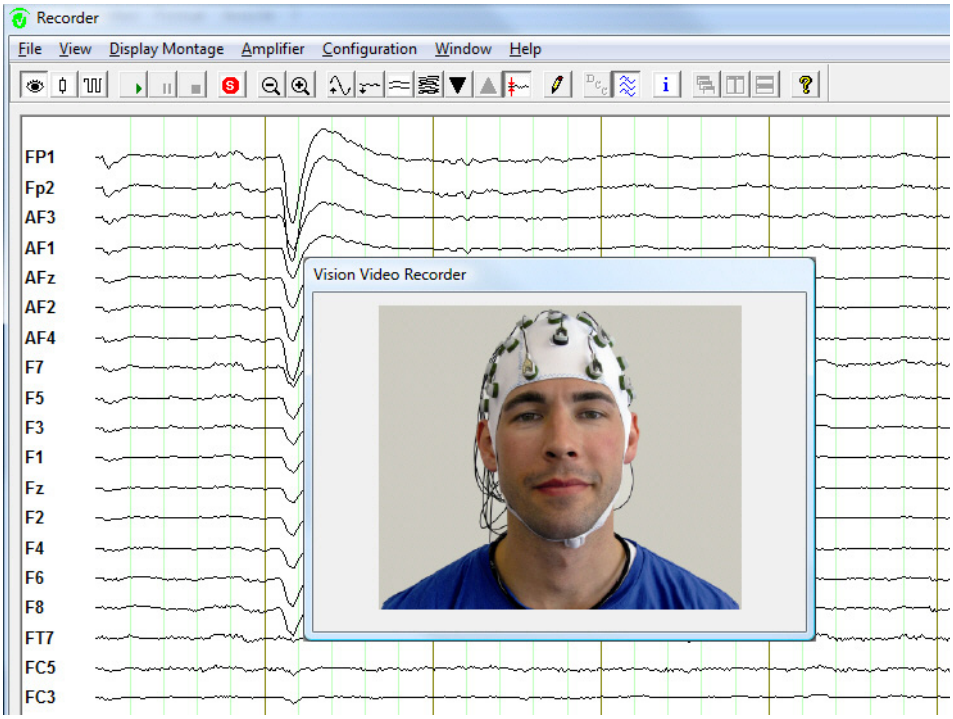
Select Audio Device is used to select the audio recording device.

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 the Recorder to monitoring mode. A video window opens in addition to the data display in the Recorder. This shows the current video data (see Figure 10-7).

Figure 10-7. Combined EEG/video recording



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 using the mouse.

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 the 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 kbytes 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.

Chapter 11 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.

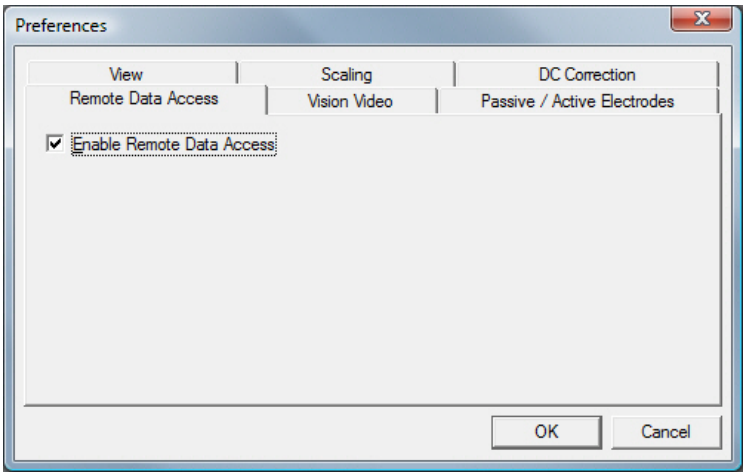
Example

RDAClient is a program that was developed with Microsoft Visual C++ Version 6.0 under Windows®. You can find the example project on the BrainVision program DVD in the *RDAClient* folder. 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 the Recorder is running is passed to the program as an argument. If this argument is not specified, the local computer is examined.

There are two versions of the RDAClient: a 16-bit version and a 32-bit version. 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 check the *Enable Remote Data Access* box (see Figure 11-1).

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: 51234 and 51244. The first port is used for 16-bit data, the second port 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 on the BrainVision program DVD. 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* (BrainVision program 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: 1 means the start of message (`RDA_MessageStart`), 2 means data block (`RDA_MessageData`) for clients of the 51234 socket, 3 means end of message (`RDA_MessageStop`), 4 means data block (`RDA_MessageData32`) for clients of the 51244 socket.

These different messages are described below.

`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* (BrainVision program 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 BrainVision program DVD in the folder *Recorder\RDAClient*.

Appendix A 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 27 ("System requirements").

Appendix B 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.

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	Resolution/ Unit	Low Cutoff [s]	High Cutoff [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 4.3 as of page 66.)

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

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

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 208. 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.

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

This section contains general information on the EEG file.		
Keyword	*Meaning*	*Default value*
`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.
`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`
`SegmentDataPoints`	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.
		`NOTSEGMENTED`

`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 B-2. "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 B-3. "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 B-4. "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`
`SegmentHeaderSize`	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`

`UseBigEndianOrder`	This only applies to integer formats. It specifies whether big endian order is used, i.e. whether the most significant byte is stored first (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`

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.

Table B-5. "Common Infos" section of the marker file

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 B-6. "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
	`19990311140312000000`
	means 11 March 1999, 14:03:12.003012
		–

Appendix C Electrode coordinate system

The electrode coordinate system used in the Recorder is explained below. This coordinate system is used wherever electrode positions are needed, e.g. in mapping.

The axis system is defined in such a way that the z-axis runs through the vertex. The x-axis points to the right, and the y-axis to the front.

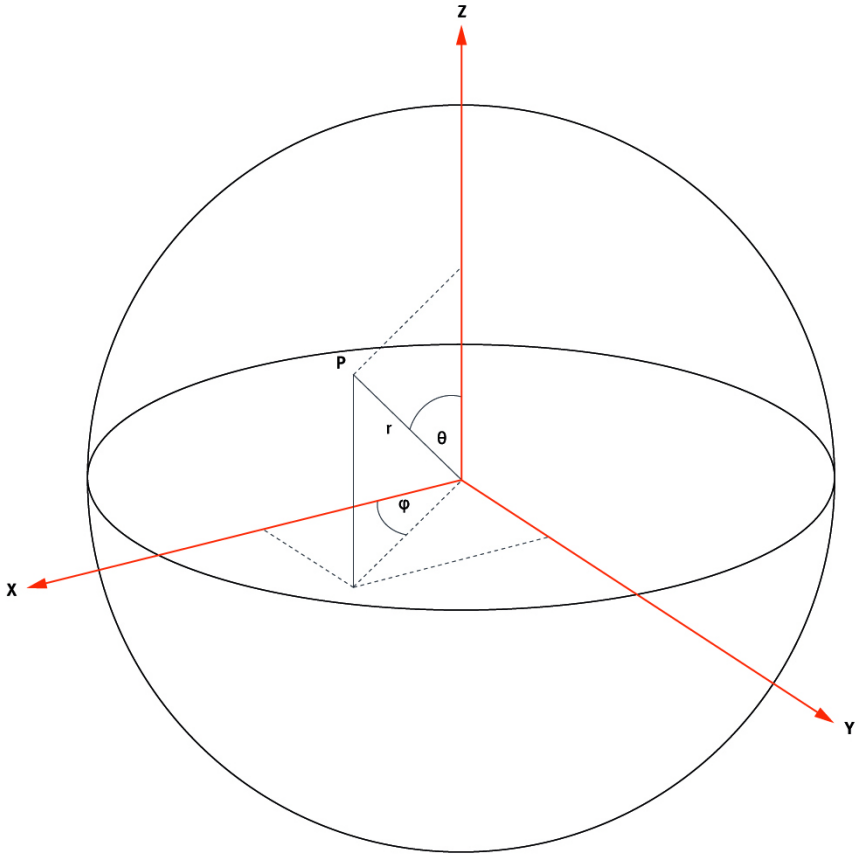
Spherical coordinates are used to specify a point on the head. A set of coordinates consists of the three variables r, θ and φ (radius, theta and phi).

The radius r specifies how far the point is away from the center of the coordinate system. It is stated in millimeters. 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, r = 1 means that a standard diameter has been chosen for the radius. This can be used when the surface of the head is approximated by the surface of a sphere.

φ specifies the angle between the x-axis and the projection of the line connecting the point and the coordinate origin on the xy plane. $\varphi > 0$ applies to the front right and rear left quarter of the sphere and $\varphi < 0$ to the front left and rear right.

θ is the angle between the z-axis and the line connecting the point and coordinate origin. In the left hemisphere, $\theta < 0$. In the right hemisphere, $\theta > 0$.

Figure C-1. Coordinate system for electrodes



Appendix D Installing sub-licenses

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

If you purchased sub-licenses at the same time as you purchased the Recorder, the sub-license file is included on a USB data carrier supplied with the software. Sub-licenses that are purchased subsequently can be downloaded from the Brain Products Web site.

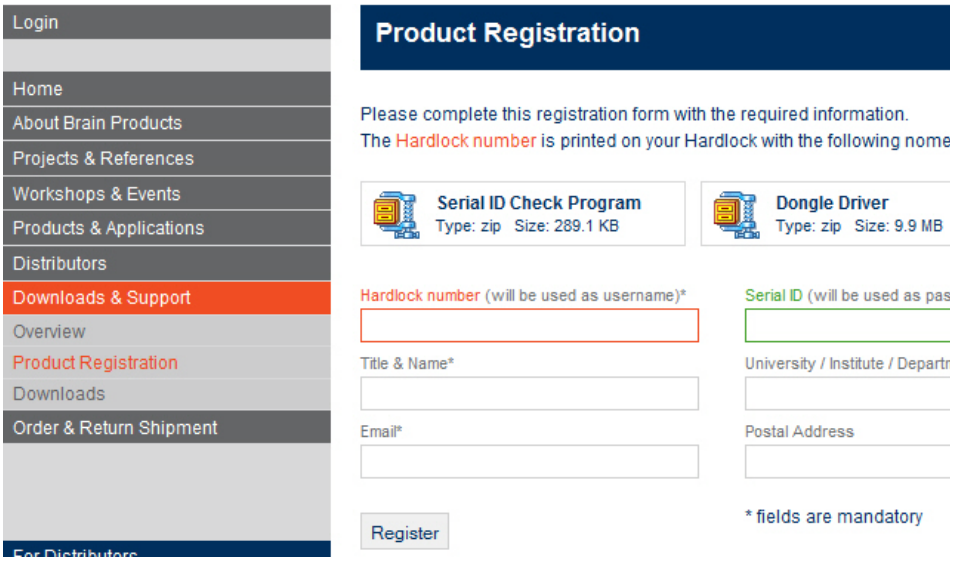
This appendix describes how to download and install sub-licenses that you purchase subsequently.

Downloading sub-license files

To activate the downloading of sub-licenses, your USB dongle must first be registered. To do this, choose *Downloads & Support › Product Registration* at http://www.brainproducts.com.

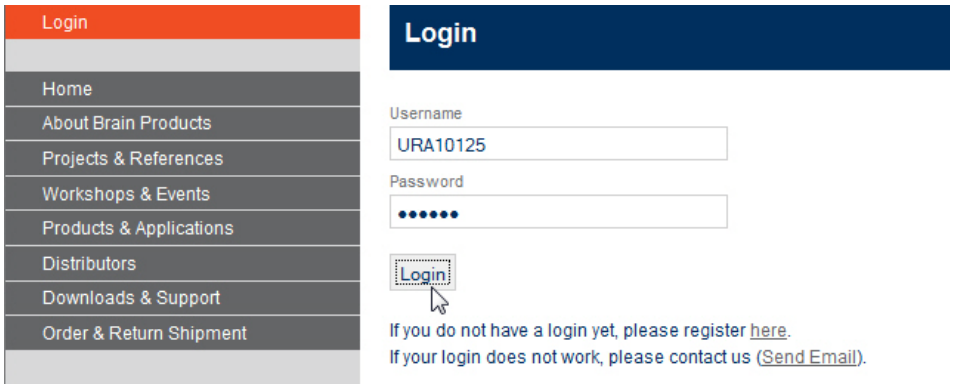
To register your USB dongle, enter the external and internal serial ID of your dongle, your name, university and email address in the product registration form (see Figure D-1). The external serial ID is printed on your dongle. You can find out the internal serial ID using the *Serial ID Check Program*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

Figure D-1. Data entry form for product registration



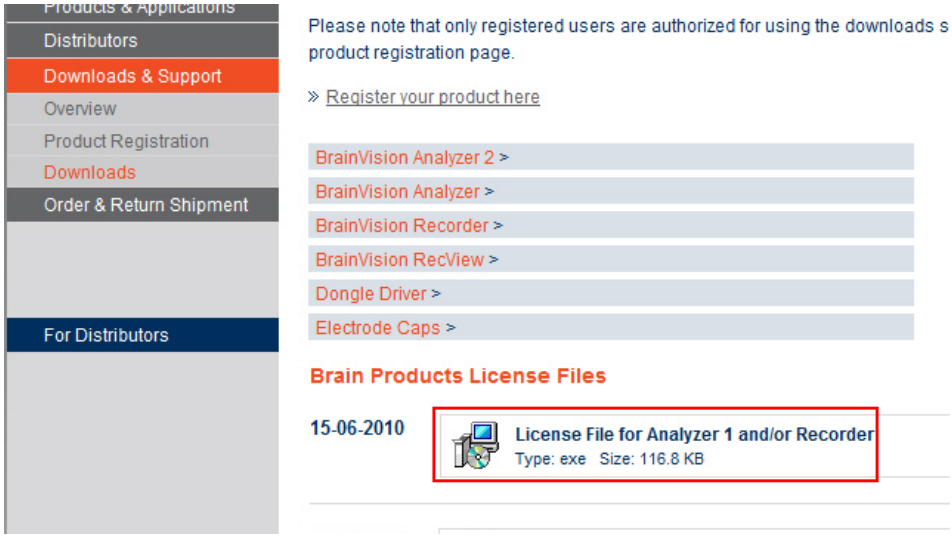
After you have received the confirmation mail, you can log in to download your files by proceeding to the Login page (see Figure D-2). Use the login data you received by mail.

Figure D-2. Login form



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

Figure D-3. Download area for sub-license files

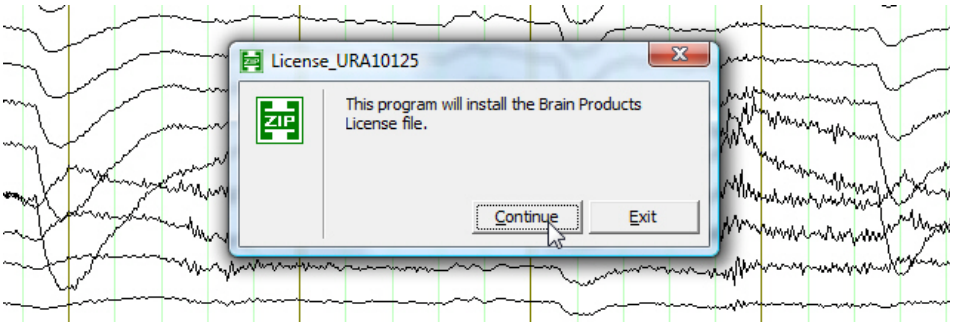


Installing sub-license files

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

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

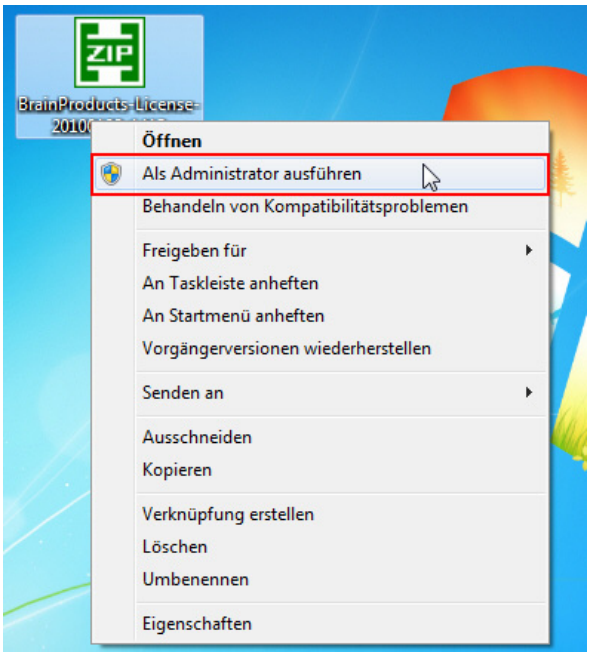
Figure D-4. Installing sub-licenses



Installing a license under Windows® Vista or Windows® 7

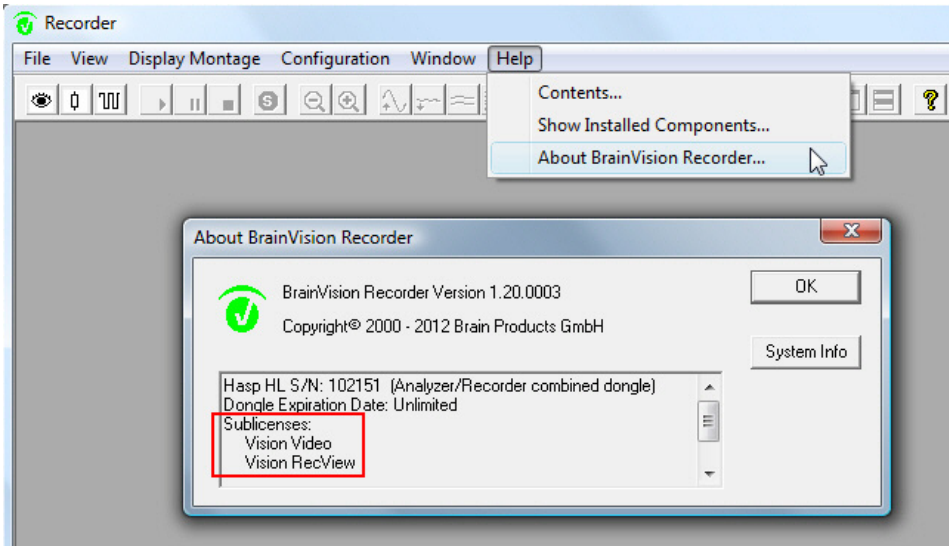
If you are using Windows® Vista or Windows® 7, you should not double-click the license file, but instead run it as administrator to avoid installation problems. To do this, right-click the installation file and choose *Run as administrator* from the context menu (see Figure D-5).

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



You can check what sub-licenses are active by choosing *Help › About BrainVision Recorder...* from the menu (see Figure D-6).

Figure D-6. Displaying sub-licenses in the Recorder



The installed sub-license is stored in the Recorder installation folder as a file with the extension .bplc. The file is in signed text format.

Do not make any changes to this file, otherwise the sub-license will become invalid.

Appendix E Keyboard shortcuts for MY-Button (actiCHamp)

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

Table E-1. Keyboard shortcuts for the "Press Keys" function

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

Table E-1. Keyboard shortcuts for the "Press Keys" function

Meaning	Entry
Shift	`+`
Ctrl	`^`
Alt	`%`
Set focus to window by entering window title	`APPACTIVATE WindowTitle`

List of abbreviations

A/D ..... Analog/Digital

AUX ..... Auxiliary

BUA ..... BrainVision USB2 Adapter

CE ..... Conformité européenne (European Conformity)

DC ..... Direct current

ECG ..... Electrocardiogram

EEC ..... European Economic Community

EMG ..... Electromyogram

EOG ..... Electrooculogram

EU ..... European Union

fMRI ..... Functional magnetic resonance imaging

GSR ..... Galvanic Skin Response

IEC ..... International Electrotechnical Commission

LPT ..... Line printing terminal ("parallel port")

MR ..... Magnetic resonance

OLE ..... Object Linking and Embedding

PCI ..... Peripheral Component Interconnect

RDA ..... Remote Data Access

TCP/IP ..... Transmission Control Protocol/Internet Protocol

TTL ..... Transistor-transistor logic

VB ..... Visual Basic

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 the 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.

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 the 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. The 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 the 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. The 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 the 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 the Recorder or the transfer of data from the Recorder to other programs located on the local computer or on computers in the network. In this process, the 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.

Sampling rate: see *DELETE THIS MARKER!!*.

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.

Sub-license: 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 the 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.

Subject Index

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