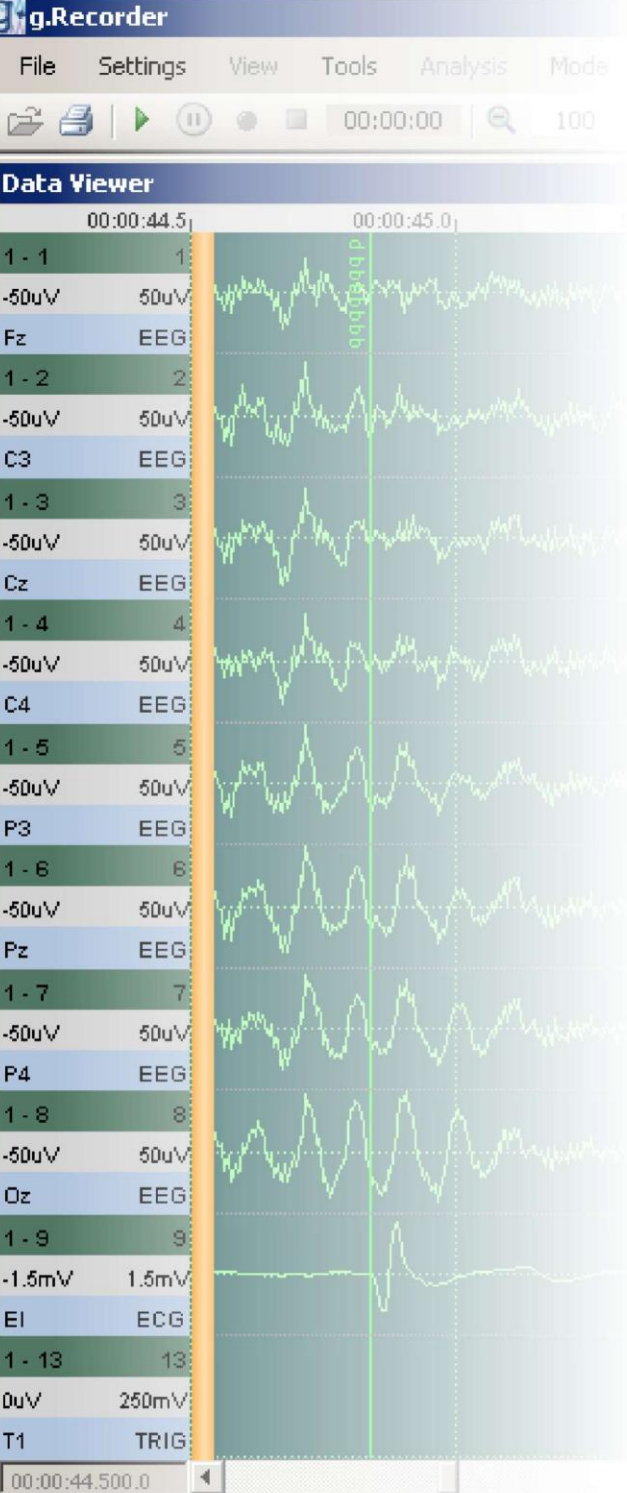




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g. Recorder
BIOSIGNAL RECORDING SOFTWARE

USER MANUAL V4.12.03

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To the Reader

Welcome to the medical and electrical engineering world of g.tec!
Discover the only professional biomedical signal processing platform under MATLAB and Simulink. Your ingenuity finds the appropriate tools in the g.tec elements and systems.
Choose and combine flexibly the elements for biosignal amplification, signal processing and stimulation to perform even real-time feedback.

Our team is prepared to find the better solution for your needs.

Take advantage of our experience!

Dr. Christoph Guger

Dr. Guenter Edlinger

Researcher and Developer

Reduce development time for sophisticated real-time applications from month to hours.
Integrate g.tec's open platform seamlessly into your processing system.
g.tec's rapid prototyping environment encourages your creativity.

Scientist

Open new research fields with amazing feedback experiments.
Process your EEG/ECG/EMG/EOG data with g.tec's biosignal analyzing tools.
Concentrate on your core problems when relying on g.tec's new software features like ICA, AAR or online Hjorth's source derivation.

Study design and data analysis

You are planning an experimental study in the field of brain or life sciences? We can offer consultation in experimental planning, hardware and software selection and can even do the measurements for you. If you have already collected EEG/ECG/EMG/EOG, g.tec can analyze the data starting from artifact control, do feature extraction and prepare the results ready for publication.

Introduction

Welcome to the **g.Recorder**.

g.Recorder is a novel, user-friendly software package for the recording of biosignal data such as EEG, ECoG, ECG, EOG, EMG and sensor data. Along with these signals also trigger information and video sequences can be captured. An easy to use *Replay* mode allows the inspection of the data after the recording.

g.Recorder has been designed for working with the g.tec biosignal amplifiers g.HIamp, g.USBamp, g.BSamp and with the portable device g.MOBIIab.

g.Recorder offers next to raw data inspection also optionally the extraction and presentation of different parameters, for example the heart rate variability, the heart rate, the compressed spectral array and cerebral function.

g.Recorder data can be exported seamlessly to g.tec's biosignal analysis software g.BSanalyze for in depth offline evaluation and data processing.

Indications for use

The software is intended for visualization and analysis of data recorded with g.tec amplifiers. For investigational purposes only. Not for clinical use. This software is not a medical product.

We have attempted to write this manual as accurately as possible. However, mistakes are bound to occur, and we reserve the right to make changes to **g.Recorder**, which may render parts of this manual invalid. We assume no liability as a result of the use or application of this product.

No part of this manual may be copied or reproduced without the express permission of the authors.

Related Products

g.tec provides several biosignal analysis elements that are especially relevant to the kinds of tasks you perform with **g.Recorder** and g.tec's biosignal amplifiers.

For more detailed information on any of our elements, up-dates or new extensions please visit our homepage www.gtec.at or just send us an email to office@gtec.at.

Conventions

Item	Format	Example
String Variables	Courier New	Enter filename e.g. MygRecorderSettings.xml
Menu items	Boldface	Select Save from the File menu

Installation and Configuration

Hardware and Software Requirements

g.Recorder requires a PC compatible desktop or notebook workstation running Microsoft Windows and optionally a color printer.

The table below lists optimal settings (depending on the acquisition hardware):

Hardware	Properties
CPU	Pentium working at >= 2000 MHz
Harddisk	20-30 gigabyte
RAM	> = 1 GB
USB 2.0 port (EHCI – enhanced Host controller interface)	One free USB port for each g.HIamp One free USB port for each g.USBamp One free USB port for the g.MOBIIlab connection One free PCI or PCMCIA slot for the data acquisition card for the g.BSamp connection One free USB port for the Hardlock Dongle
USB port (optionally)	One free port for attaching the color printer
Screen resolution	1280 x 1024
Video camera	Webcam

g.Recorder acquires data from g.tec's biosignal amplifiers and therefore the drivers for g.HIamp, g.USBamp, g.MOBIIlab+ and for the data acquisition boards must be installed. Depending on the Windows operating system administrator rights might be necessary for the installation.

Software	Version
g.HIamp driver	2.12.00
g.USBamp driver	3.12.00
g.MOBIIlab+ driver	1.12.00
Data Acquisition card driver from National Instruments	ni-daqmx 9.5.1f1
Windows	Windows 7 Professional English Win32 or Win64
Acrobat Reader	10.1.3

Make sure that your Microsoft Windows installation works correctly before installing the **g.Recorder** software. Other software packages except the packages listed above **MUST NOT** be installed on the Windows PC. During operation of **g.Recorder** other software as listed above **MUST NOT** be operated.

Installation from a CD

The installation of **g.Recorder** consists of two steps

1. Installation of **g.Recorder** software

Insert the g.tec product CD into the CD-drive and change to the `g.Recorder` directory of your CD-drive and double-click on the `Setup.exe` file. The installation starts and displays the welcome message.



Click **Next** to read the **License Agreement**. If you agree with the terms, click **I Agree** and **Next**. Then follow the instructions on the screen.

2. Hardlock installation

The **g.Recorder** installation installs automatically the driver software for the Hardlock. For manual installation click the `HASPUserSetup.exe` in the `Prerequisites/HaspHL` folder on your g.tec CD.

After successful installation insert the Hardlock into a free USB slot of your PC or notebook. The red light of the Hardlock must be on.

Uninstall

To remove **g.Recorder** in Windows 7 use the **Programs and Features** tool in the **Control Panel**.

Note that you have to uninstall the Hardlock driver separately if you uninstall the **g.Recorder** software.

Files on your Computer

g.Recorder files - are stored under (it is assumed that the default path setting is used)

C:\Program Files\gttec\gRecorder

Example configurations - are stored in the subdirectory

C:\Program Files\gttec\gRecorder\Config

Help files - are stored under

C:\Program Files\gttec\gRecorder\Help

Tools - import tool to import HDF5 files to MATLAB stored in

C:\Program Files\gttec\gRecorder\MATLAB Tools

Before running g.Recorder

It is recommended to turn off Microsoft Windows' automatic updates while operating **g.Recorder**. Concurrent Windows updates could interfere with **g.Recorder** functionality.

Running g.Recorder in User Mode

After finishing the installation, **g.Recorder** can be operated in *User Mode* with the g.tec biosignal amplifiers as described in this chapter.

Recorder Main Window

By double clicking on the **g.Recorder** icon on the desktop **g.Recorder** is started in *User Mode*. This mode is the standard mode and typically used to acquire data within a specific study using predefined configurations. Such configurations can be adapted and created by advanced users in the *Administrator Mode*.

g.Recorder consists of four elements:

- the **Status Bar**
- the **Toolbar**
- the **Data Viewer**
- the **Feature Viewer**
- the **Video Viewer**

In the **g.Recorder Menu** and **Toolbar** you can select and set different recording parameters, filenames and start/stop the actual measurement, etc.

In the **Data Viewer** window the biosignal raw data are presented. Using the menu and toolbar window the number of channels and the seconds on screen can be adapted, etc. On the left side of the window, the channel information (number and name) and the channel scaling is displayed.

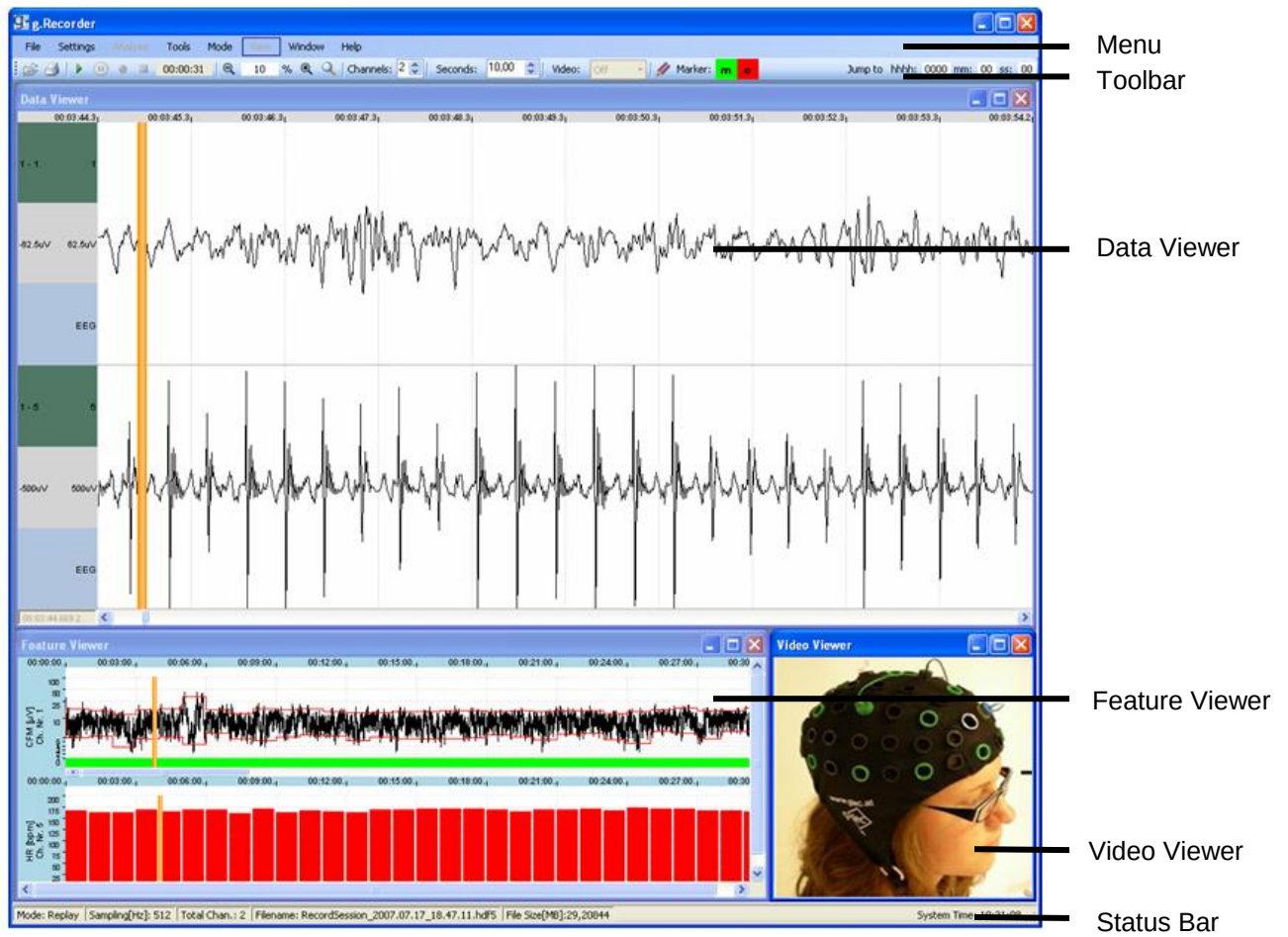
In the **Feature Viewer** window selected parameters, for example, the heart rate and cerebral function are displayed. The parameters are displayed from left to right. On the left side of the window the y-axis scaling as well as the specific feature name are displayed.

In the **Video Viewer** window the actual video sequence is displayed.

The **Status Bar** indicates the actual state of **g.Recorder**.

You can resize all windows according to your preferences and needs. Individual windows can be hidden to enlarge for example the area of the **Feature Viewer**.

Note: The actual layout of the screen and the specific settings are stored to a default configuration file when **g.Recorder** is closed. This default configuration is used the next time you start **g.Recorder**. This allows an easy continuation of your studies. You can of course load another configuration.



Status Bar

The actual status of **g.Recorder** is displayed in the **Status Bar** at the bottom of the main window. The **Status Bar** shows information that relates to the current recording. The first field shows the current **g.Recorder Mode**. When data are stored to the hard disk the mode is set to *Recording*, if data is loaded for off-line visualization it is set to *Replay* and otherwise to *Standard*.

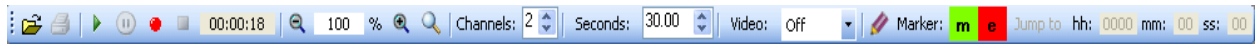
Mode: Replay	Sampling[Hz]: 256	Total Chan.: 16	Filename: RecordSession_2007.10.22_16.04.12.hdf5	File Size[MB]:0,1662493	System Time: 09:04:30
--------------	-------------------	-----------------	--	-------------------------	-----------------------

The next fields display information about the:

- **Sampling** frequency per channel in Hertz [Hz],
- **Total Chan.** number,
- selected **Filename**,
- actual **File Size** in Megabytes [MB]
- actual **System Time** in the format hh:mm:ss AM/PM.

Toolbar

The **Toolbar** is always shown below the **Menu** and includes functions for file opening, printing, starting and stopping the data acquisition and video capturing, setting markers and navigating to a certain instant in the data.



Open...

Load an already recorded file for offline replay



Print Features...

Print selected features



Start Data Viewing

Start displaying data on the screen for visual inspection

- Note: **No** data are stored to disk in this mode



Pause Data Viewing

Pause displaying data in **Standard Mode**. If the pause button is pressed in *Recording* mode, then only the raw data display in the **Data Viewer** is stopped. The **Video Viewer** and the **Feature Viewer** are still updated in real-time.

- Note: **All** data are still stored to the hard disk if this button is pressed in *Recording* Mode



Record

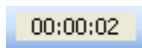
Start data acquisition to harddisk. Depending on the selected options raw data from the amplifiers, the video and features are saved.

- Note: For immediate recordings, no specific filename or subject information must be provided. The filename for the recording will be predefined as a standard file name including the actual date and system time.

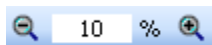


Stop

Stop data acquisition



Actual recording time in the format hh:mm:ss from the beginning of the recording to hard disk



Zoom Out and **Zoom In** into the raw data in the Data Viewer. The percentage can be inserted also directly by typing in the desired zooming level

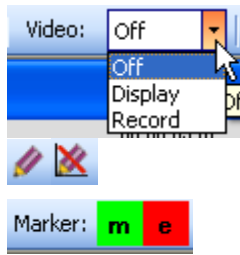


Auto Scale

The data in the **Data Viewer** are scaled to the actual maximal absolute value of the displayed data sequence. If **Auto Scale** is activated a small icon is displayed in the channel information area on the left side of the **Data Viewer** window.



Set the number of channels and the number of seconds to be displayed in the **Data Viewer**



Off: no video is displayed

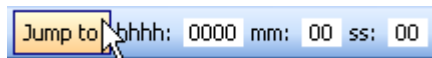
Display: the video is displayed

Record: the video is displayed and recorded (in recording mode)

Activate/Deactivate displaying the marker information on screen

Click on the icon to insert a specific marker into the **Data Viewer** and **Feature Viewer**

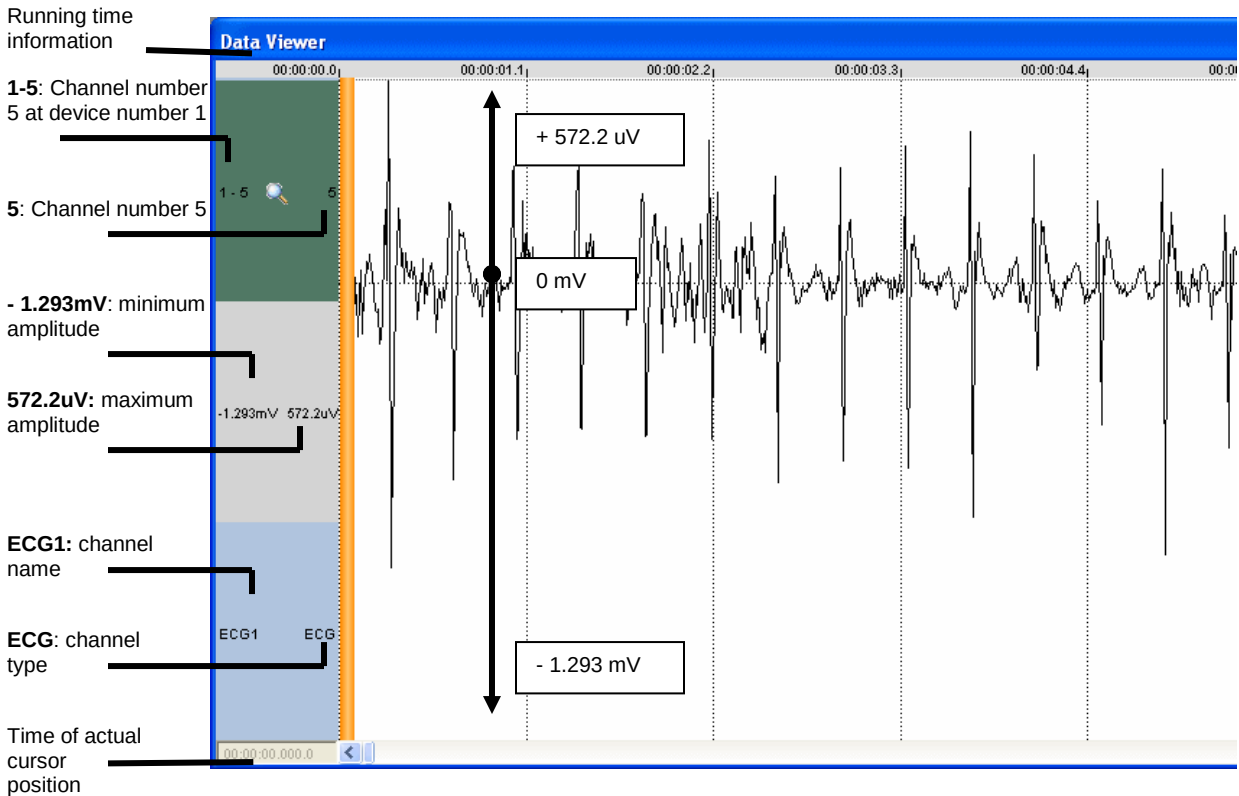
- Note: In the Data Viewer the markers are presented as vertical color coded lines from top to the bottom of the window including also the names of the markers
- In the Feature Viewer the marker information is shown as short color coded line on top of the individual feature



Jump to a specific point in time in *Replay* mode

Data Viewer

This window displays the raw data acquired with the g.tec amplifiers. Data are displayed in an overwrite mode from left to right. The number of channels displayed on the screen is set via the **Toolbar** to 1. The actual time is given at the top of the first channel.

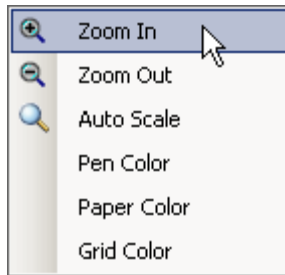


The number on the left side of the green box represents the channel number used on the amplification device. This information is useful if more than one biosignal amplifier is used. Here, channel 5 of the first amplifier 1 is displayed. The number on the right side of the green box is the logical channel number in the actual recording setup. In this case also the logical channel number is 5.

The gray box shows the scaling of the channel. The minimal and maximal input amplitude range displayed on the screen is given by the 2 numbers. The horizontal dotted gridline represents 0 μ V. The minimal and maximal values can be adapted via the menu **Settings/Channels**.

The light blue box shows the channel name and channel type. The text on the left side gives the chosen channel name. Here the selected channel name was `ECG1`. The text on the right side shows the selected channel type (e.g. `ECG`). The channel name and channel type information can be set via the menu **Settings/Channels**.

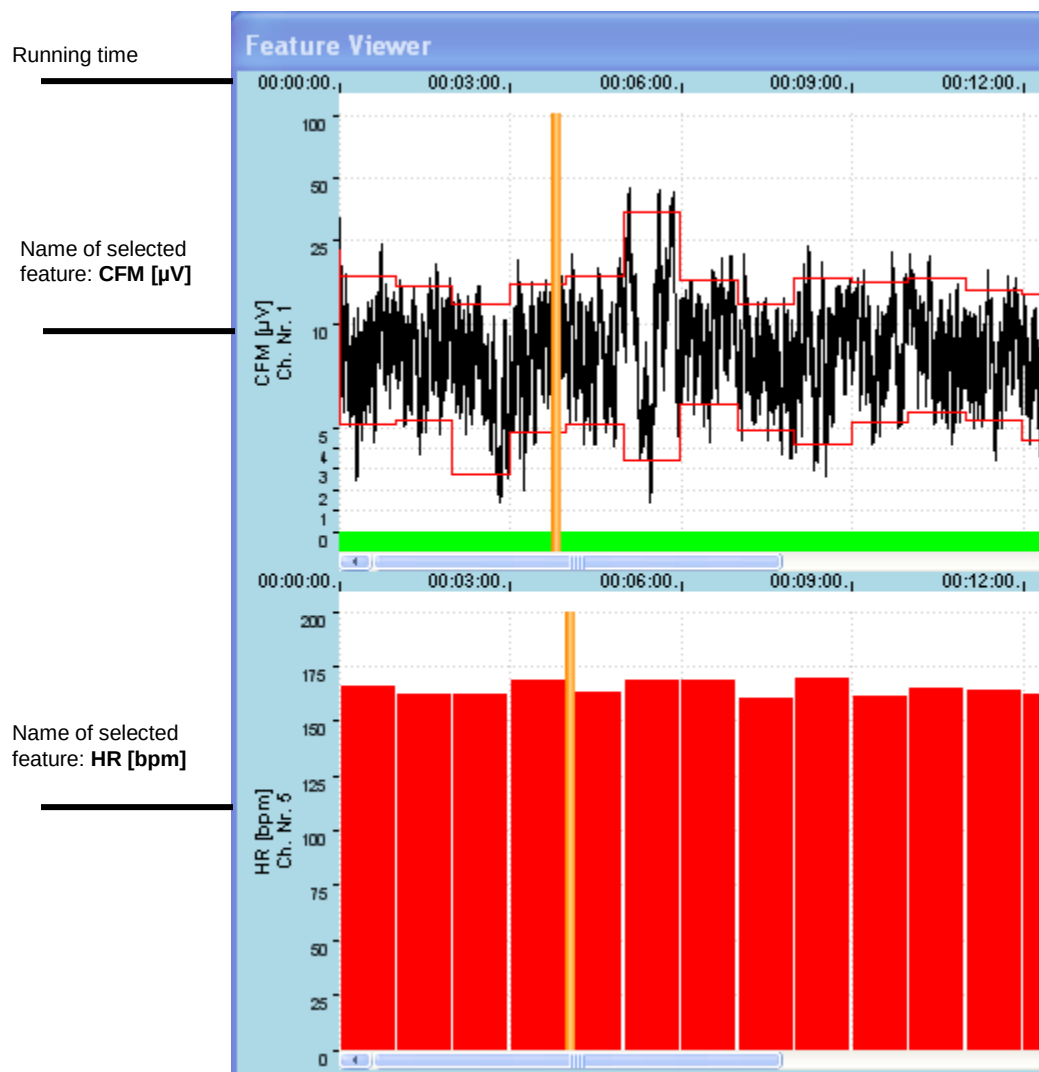
The zooming level of the **Data Viewer** as well as the color for the paper, pen and grid can also be defined via a context menu by clicking with the right mouse button of a specific channel in the **Data Viewer**.



Feature Viewer

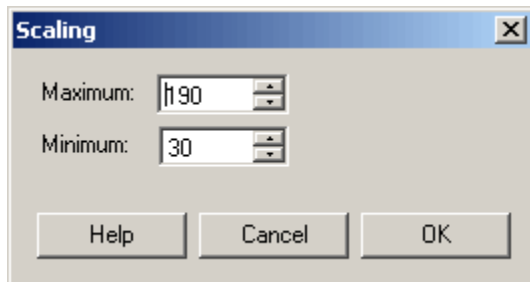
This window displays the parameters extracted from the raw data displayed in the **Data Viewer**. Data are displayed in an overwrite mode from left to right. The features that are computed from the raw data can be defined in the menu **Analysis/Feature Definition....** In this example the feature CFM (cerebral function monitor) is displayed in the upper panel and the feature HR (heart-rate) is displayed in the lower panel.

The actual time is given on top of individual feature panels as the time on screen can vary depending on the specific user settings. The format of the time is hh:mm:ss. The y-axis scaling and units depend on the specific selected feature. The minimal and maximal values can be adapted via the feature specific context menu. The y-scaling for the CFM feature is fixed to 0 and 100 μV . The scaling for the HR feature is set to 0 and 200 beats per minute [bpm].



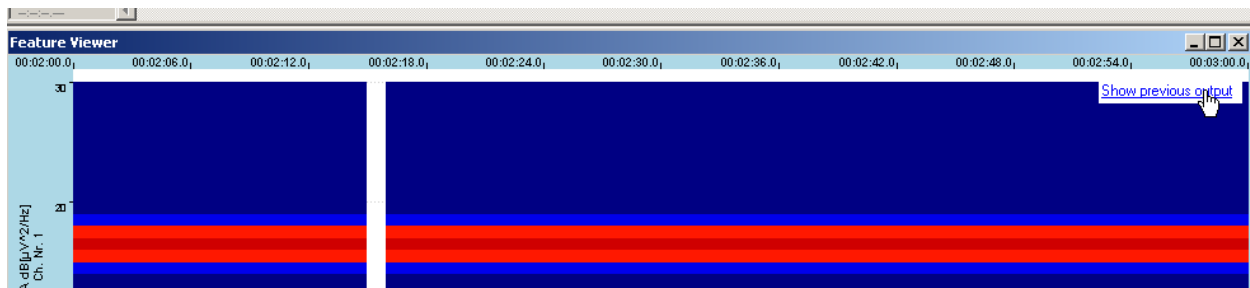
Context Menu Scaling

The scaling values of the **Heart Rate** feature can be set via a context menu by clicking on the right mouse button in the feature panel.

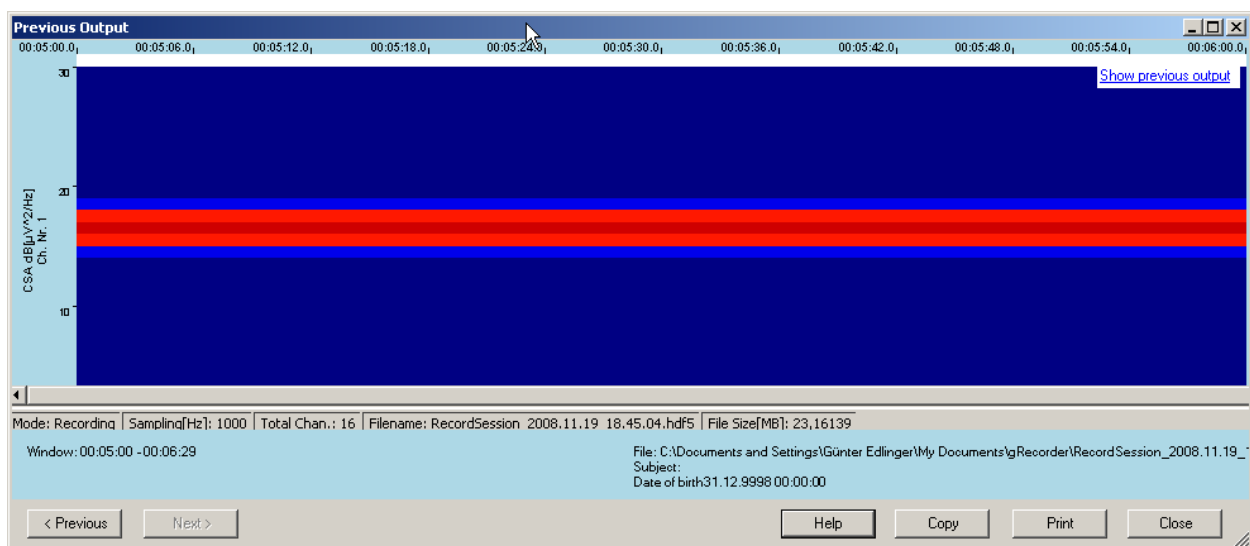


The Feature Viewer review mode during data acquisition

The Feature Viewer review mode allows inspecting previous epochs of feature signals. If the time on screen is elapsed, then a menu entry appears in the upper right corner of the Feature Viewer window.



By clicking on the **Show previous output** a review panel is displayed.



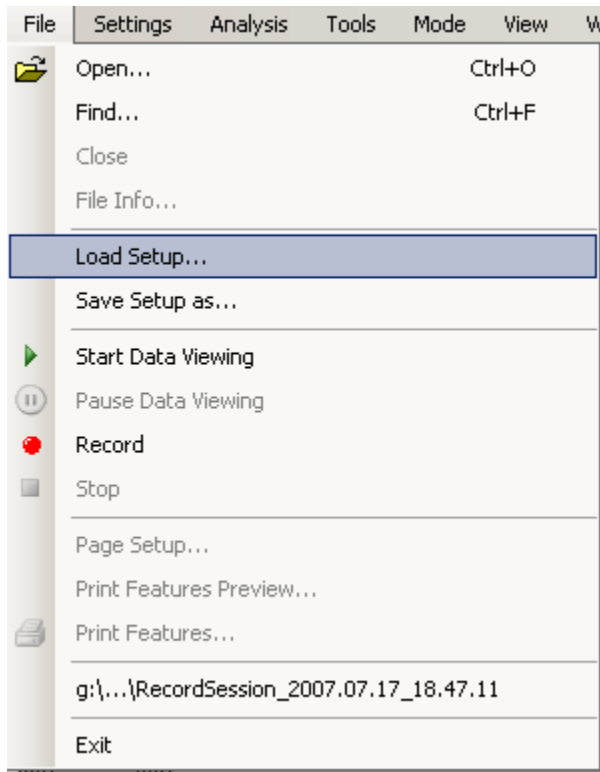
The **Previous Output** review panel allows scrolling through past feature signals. The upper panel area displays the already recorded features and the lower panel area yields more specific information about the time interval **Window**, the **File** name of the actual recording and **Subject** specific information.

The content of the panel can be copied to the clipboard for further use by clicking the **Copy** button or directly printed to the default printer by using the **Print** button. To close **Previous Output** window click on **Close**.

Note: This review panel is only available during data recording.

Load Configuration

Previously saved configurations can be loaded by clicking on the **Load Setup...** button in the **File** menu.

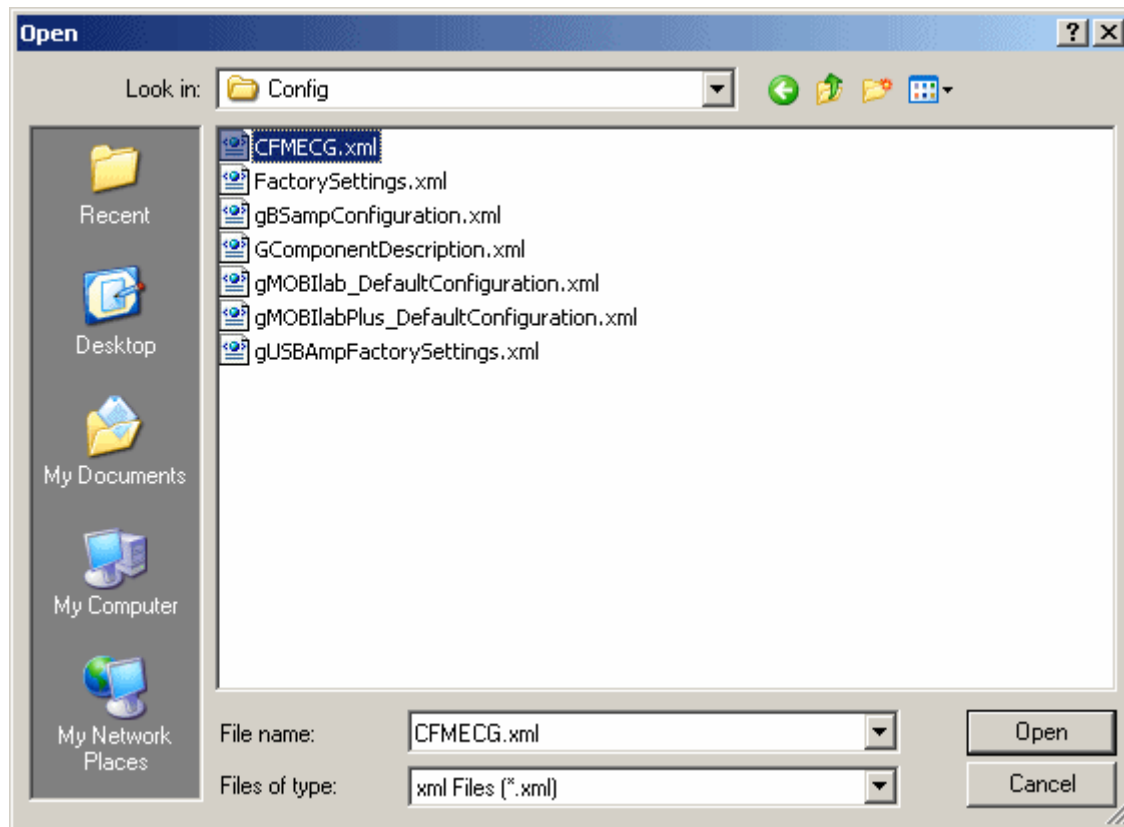


The configuration used in this example is for recording one EEG channel and one ECG channel to calculate the CFM and Heart Rate features using g.USBamp.

Select the corresponding file CFMECG.xml from

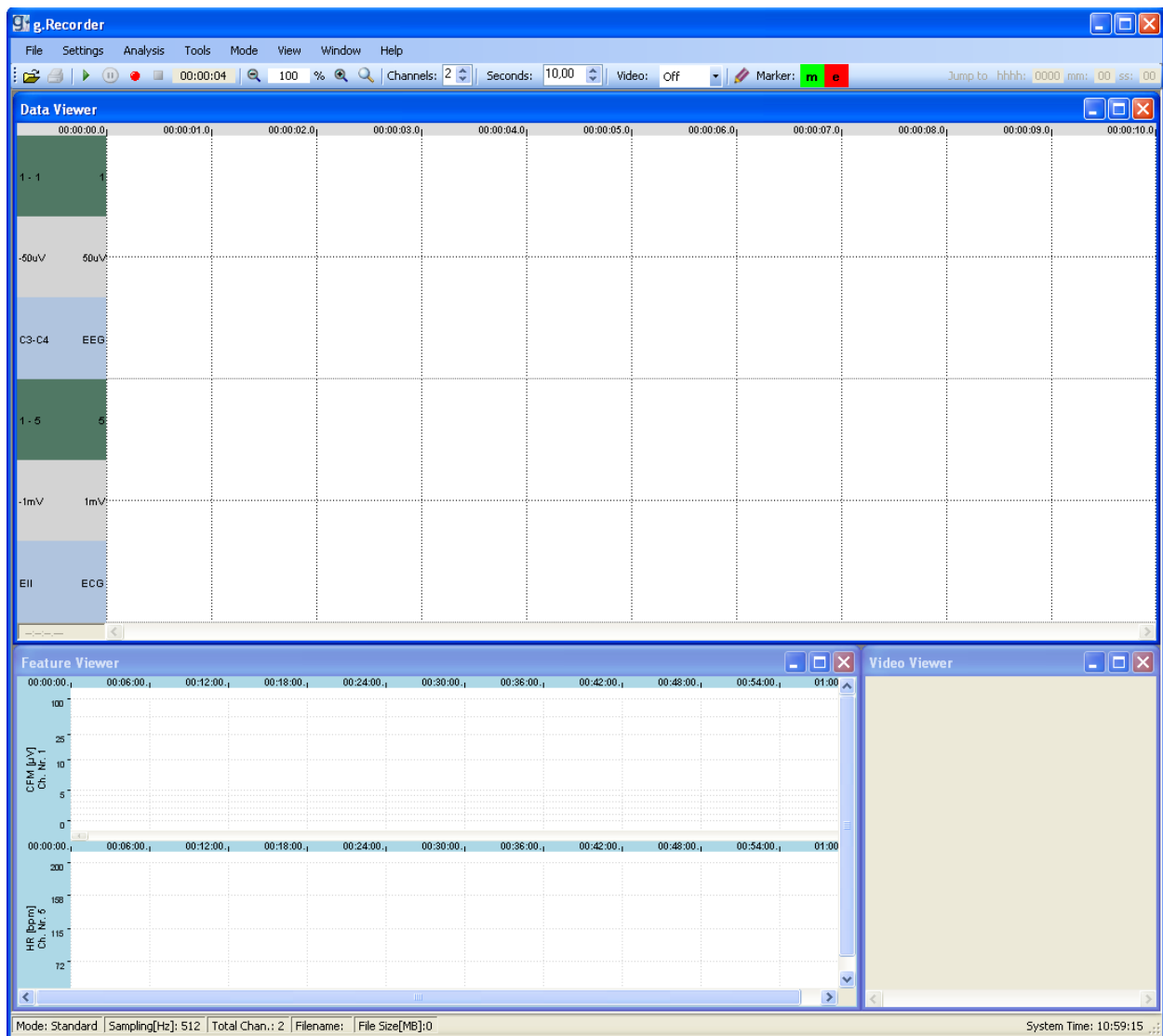
c:\Program Files\gtec\gRecorder\Config

and click **Open**.

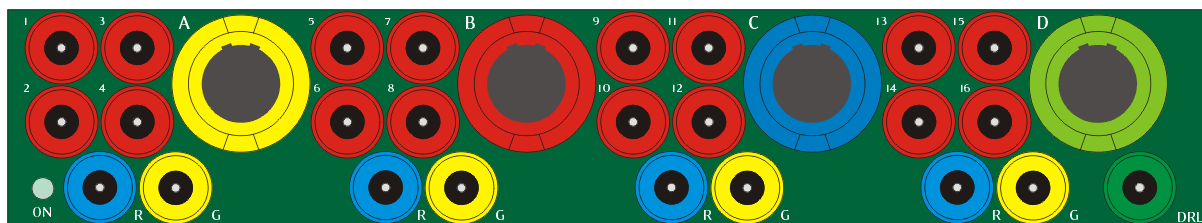


g.Recorder will be initialized with all necessary hardware and software settings.

Previously saved configurations can be loaded by clicking on the **Load Setup...** button in the **File** menu.



For the recordings in this example the electrodes are connected to g.USBamp.



The picture above displays the front side of g.USBamp. The front side is divided into four groups (A,B,C,D from left to right). Each group consists of four red connectors (1-4, 5-8, 9-12, 13-16) for connecting biosignal electrodes (EEG, ECG, EMG, etc.), one blue connector for the reference electrode (R) and one yellow connector for the ground electrode (G).

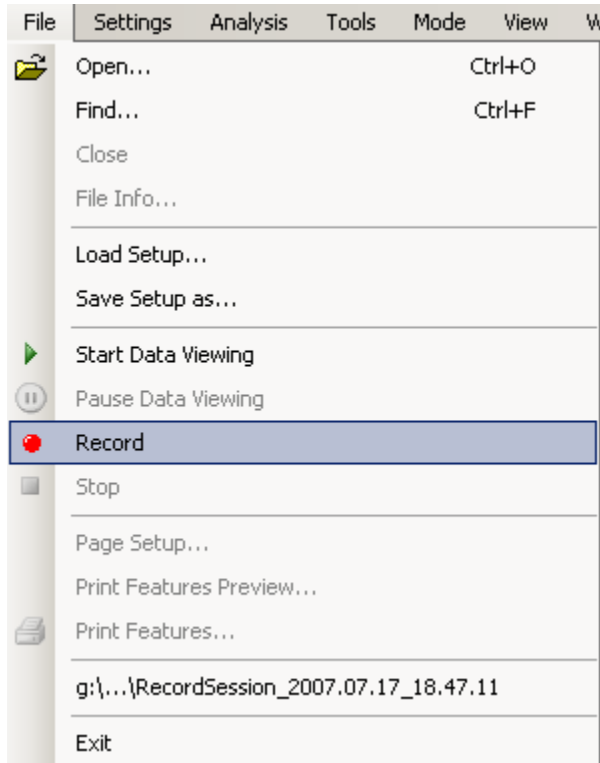
For the EEG measurement all electrodes for EEG are connected to Group A (first group on the left side of g.USBamp). One EEG electrode is connected to channel 1 of Group A (red connector), the reference

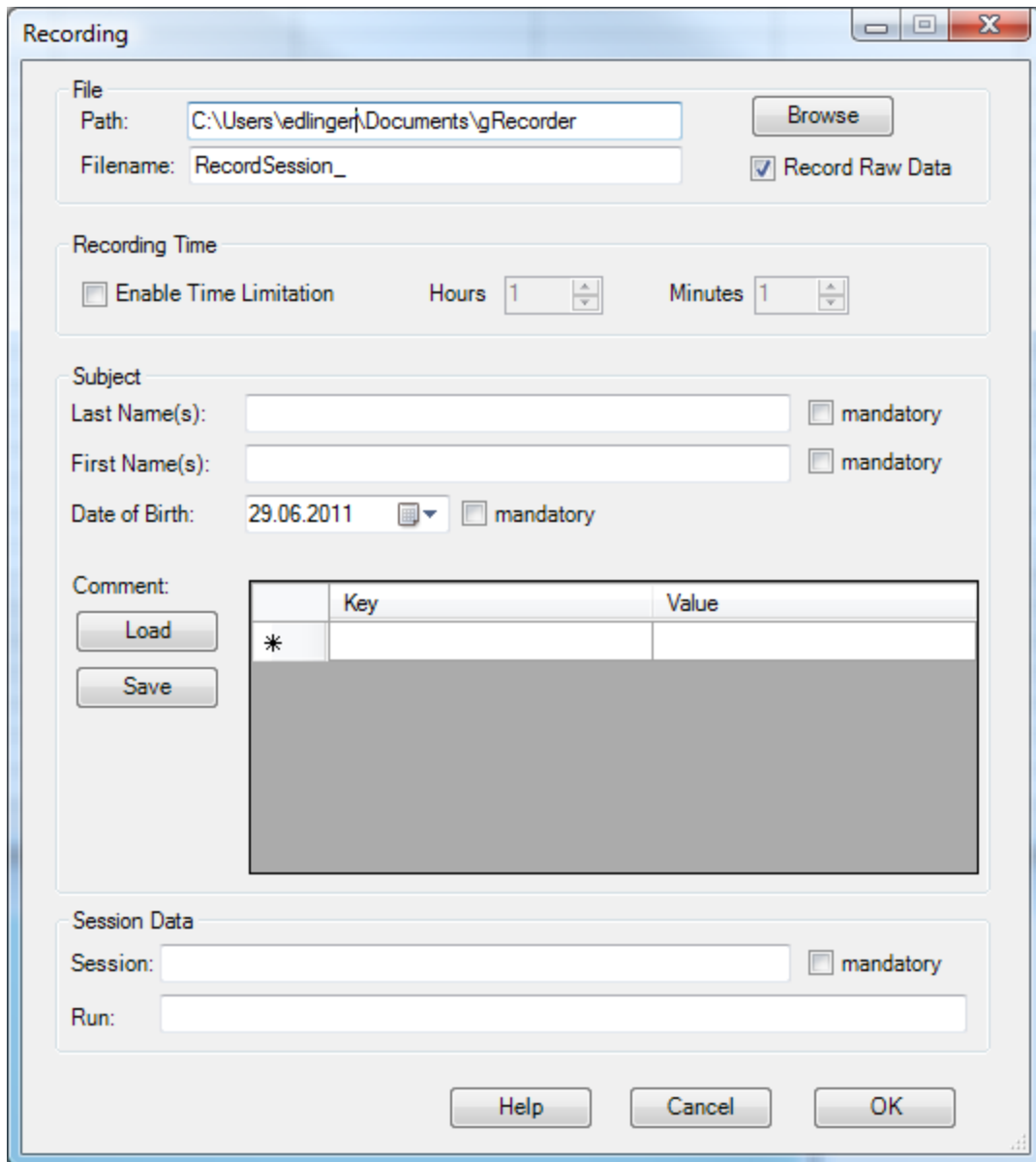
electrode to reference **R** of group **A** (blue connector) and the ground electrode is connected to ground **G** of group **A** (yellow connector).

For the ECG measurement all electrodes for ECG are connected to Group **B** (second group from left). One ECG electrode is connected to channel **5** of group **B** (red connector), the reference electrode to reference **R** of group **B** (blue connector) and the ground electrode is connected to ground **G** (yellow connector).

Recording Information

The **Recording** dialog opens when the **Record** button either in the **File** menu or the task bar is pressed.





The image shows a 'Recording' dialog box with the following sections:

- File:**
 - Path: C:\Users\edlinger\Documents\gRecorder
 - Filename: RecordSession_
 - Record Raw Data: ☒
- Recording Time:**
 - Enable Time Limitation: ☐
 - Hours: 1
 - Minutes: 1
- Subject:**
 - Last Name(s): mandatory
 - First Name(s): mandatory
 - Date of Birth: 29.06.2011 mandatory
- Comment:**
 - Buttons: Load, Save
 - Table:

	Key	Value
*		
- Session Data:**
 - Session: mandatory
 - Run:
- Buttons:** Help, Cancel, OK

File

A **Path** for the data file can be entered or the desired path can be chosen by clicking on the **Browse** button.

The **Filename** defines the name of the data file. The default filename is `RecordSession_` with date and time added. When the measurement is started the data and the time are added automatically to the filename (e.g. `RecordSession_2007.07.17_18.47.11.hdf5`). The data is stored in HDF5 file format. For more information about this format see www.hdfgroup.org or refer to the MATLAB help.

With the checkbox **Record Raw Data** it can be chosen whether the raw data from the amplifier is stored to the HDF5 file or not. For offline processing after measurement it is recommended to record raw data.

Recording Time

In the **Recording Time** section with the **Enable Time Limitation** checkbox a time limitation for the measurement can be set. After this time the measurement is stopped automatically.

Subject

In the **Subject** section information about the subject like **Last Name(s)**, **First Names(s)** and **Date of Birth** can be entered. In the **Comment** section additional information (e.g. medications) can be added.

Session Data

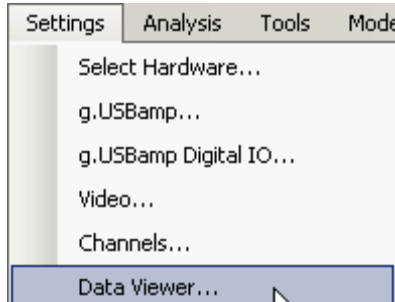
Enter the **Session** and **Run** identifier for your recordings.

After finishing these settings click **OK**.

Note: **Mandatory** fields (the keyword mandatory is displayed next to this field) must be filled out correctly. Otherwise the recording cannot be started.

Display Settings

From the **Settings** menu choose **Data Viewer...** to change the data representation.

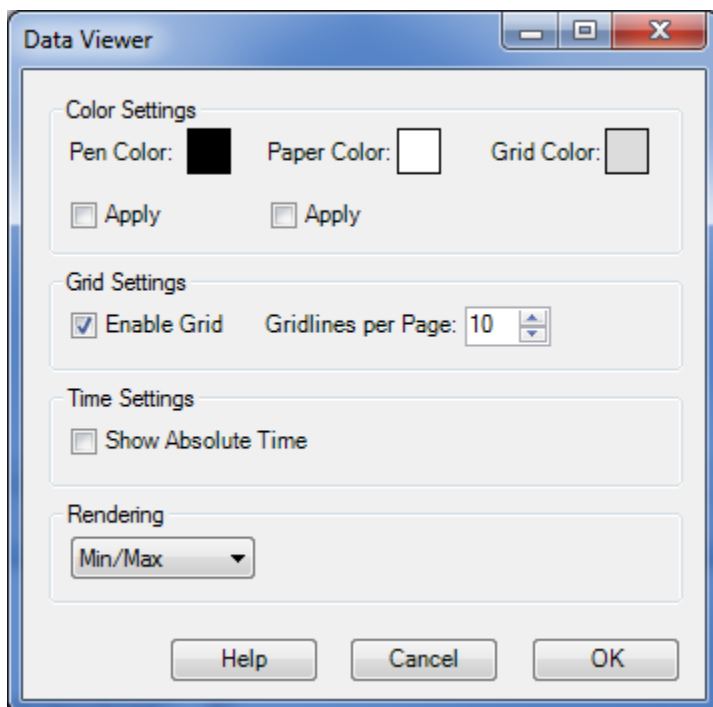


In the **Data Viewer** dialog the **Color Settings** can be set. The **Pen Color** sets the color of the data recorded, the **Paper Color** sets the background color and **Grid Color** sets the color of the grid.

In the **Grid Settings** area the grid can be enabled and the number of vertical grid lines can be selected.

The normal time scale of the **Data Viewer** is the elapsed measurement time. If the **Show Absolute Time** checkbox is checked, then the system time is shown.

In the **Rendering** section the rendering section can be set with the dropdown menu. The default rendering mode is set to Min/Max.

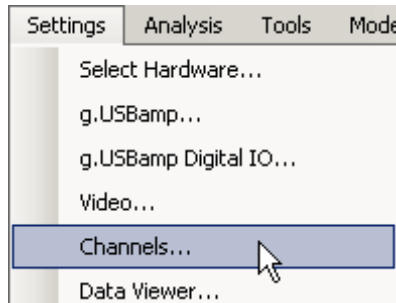


The rendering mode can be set:

Rendering mode	description
Fast	Every i^{th} sample per channel is taken from the raw data for display on the screen.
Average	The average over a certain time period per channel from the raw data is taken for display on the screen.
Min/Max	The minimal and maximal data within a certain time interval are taken per channel from the raw data for display on the screen. This rendering method preserves best the shape of the raw signal.

Channel Settings

To every acquired channel a specific number, name, sensitivity and channel type can be assigned. Click onto **Channels...** in the **Settings** menu to open the dialog.



Individual Settings

The first column, **Device-Ch Nr.**, shows the device number and also the channel number (e.g. 1-1 for the first amplifier and channel 1, 2-1 for the second amplifier and channel 1). The second column, **logical Ch Nr.**, shows the logical channel number. If two amplifiers with each 16 channels are used then the **logical Ch Nr.** goes from 1 to 32.

In the **Name** column a name for the channel can be entered and in the **Type** column EEG, ECG, EMG, EOG, ECoG, Resp., TRIG can be selected. With the channel type selection the **Sensitivity** of the channel is changed automatically.

The **Sensitivity** and an **Offset** of each channel can be entered manually. The **Unit** can be μV , mV or V . This **Sensitivity** affects only the visualization of the raw data.

Channels

Individual Settings

Device- Ch Nr.	logical Ch Nr.	Acq.	Name	Type	Sensitivity		Offset	Unit
					Low	High		
1-1	1	☒	EEG1	EEG	-50	50	0	uV
1-2	2	☐			-250000	250000	0	uV
1-3	3	☐			-250000	250000	0	uV
1-4	4	☐			-250000	250000	0	uV
1-5	5	☒	ECG1	ECG	-1000	1000	0	uV
1-6	6	☐			-250000	250000	0	uV
1-7	7	☐			-250000	250000	0	uV
1-8	8	☐			-250000	250000	0	uV
1-9	9	☐			-250000	250000	0	uV
1-10	10	☐			-250000	250000	0	uV
1-11	11	☐			-250000	250000	0	uV
1-12	12	☐			-250000	250000	0	uV

Common Settings

Type

Apply ->

Start channel:

1

End channel:

1

Sens. L:

-1000

Sens. H:

1000

Offset:

0

Unit:

uV

Apply ->

Start channel:

1

End channel:

1

☐ Use default values of device

Help

Cancel

OK

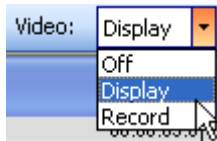
Common Settings

In the **Common Settings** section the same settings can be applied to multiple channels at once. Select the **Type**, the **Sensitivity**, the **Offset** and the **Unit** and the **Start channel** and **End channel**. Then click **Apply**.

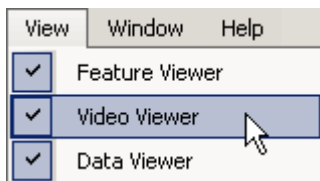
If the checkbox **Use default values of device** is selected then the **Sensitivity**, **Offset** and **Unit** is set to the amplifier default values.

Video Camera

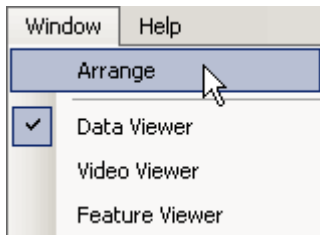
When a video camera is connected to the PC, the video images can be displayed and recorded with **g.Recorder**. In the menu bar it can be chosen if the video should not be displayed (**OFF**), just be displayed but not recorded (**Display**) or be displayed and recorded (**Record**).



To see the video images in the main window of **g.Recorder** select **Video Viewer** from the **View** menu.



The **Data Viewer**, the **Video Viewer** and the **Feature Viewer** can be automatically arranged by selecting **Arrange** in the **Window** menu.



Start and Stop Recording

When all desired settings are done, the measurement can be started.

To display data in the **Data Viewer** without saving it, click on the **View Data** button in the **Toolbar** or select **Start Data Viewing** from the **File** menu.

Note: This button is also used to start streaming to SD Card with g.MOBllab+.



To record data to the hard disk on your PC, click **Record** button or select **Record** from the **File** menu.



To stop data acquisition in **Standard** mode or pause the data display in the *Recording* mode press the **Pause Data Viewing** button or select **Pause Data Viewing** from the **File** menu.



Note: If the button is pressed in *Recording* mode, only the visualization of the data on the display is stopped, but the **g.Recorder** continues to store data to the HDF5 file.

Click on the **Stop** button or select **Stop** from the **File** menu to stop data acquisition.

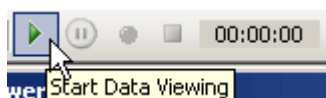


g.MOBllab+ specific functions

The **Pause Data Viewing** button is the only button activated, if a g.MOBllab+ is streaming to SD Card.



If **g.Recorder** is used to reconnect to a streaming g.MOBllab+ only the **Start Data Viewing** button is activated.

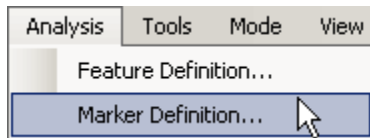


Note: For g.MOBllab+ data can either be stored the local hard disk of your PC or streamed to the built-in SD card.

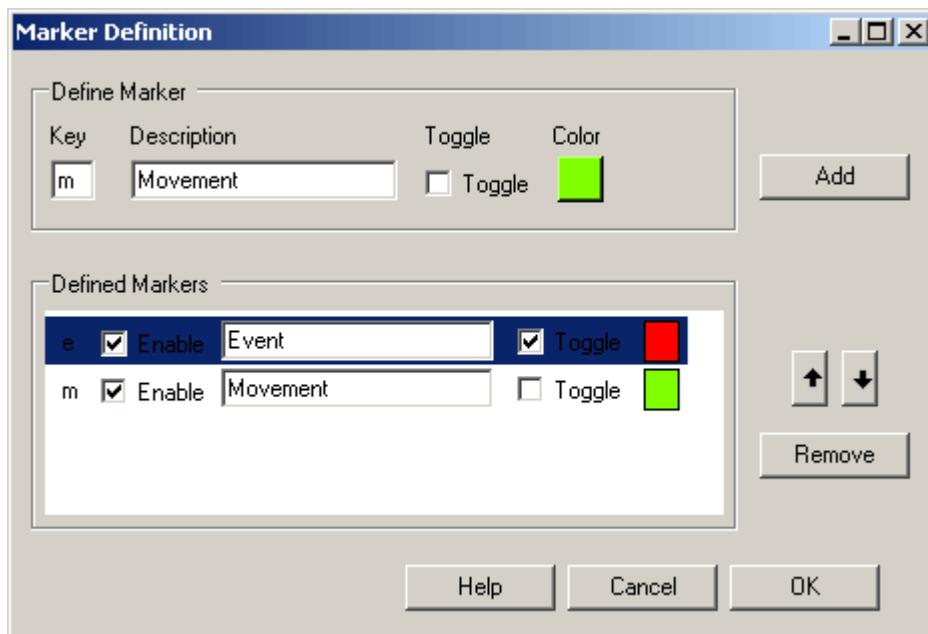
Markers

Markers can be used during measurement to highlight certain events. **g.Recorder** allows defining keyboard markers which (i) indicate an event specific at a certain time point and (ii) region markers or toggle markers which can be switched on and switched off to mark a longer lasting event.

Click on **Marker Definition** under the **Analysis** menu.

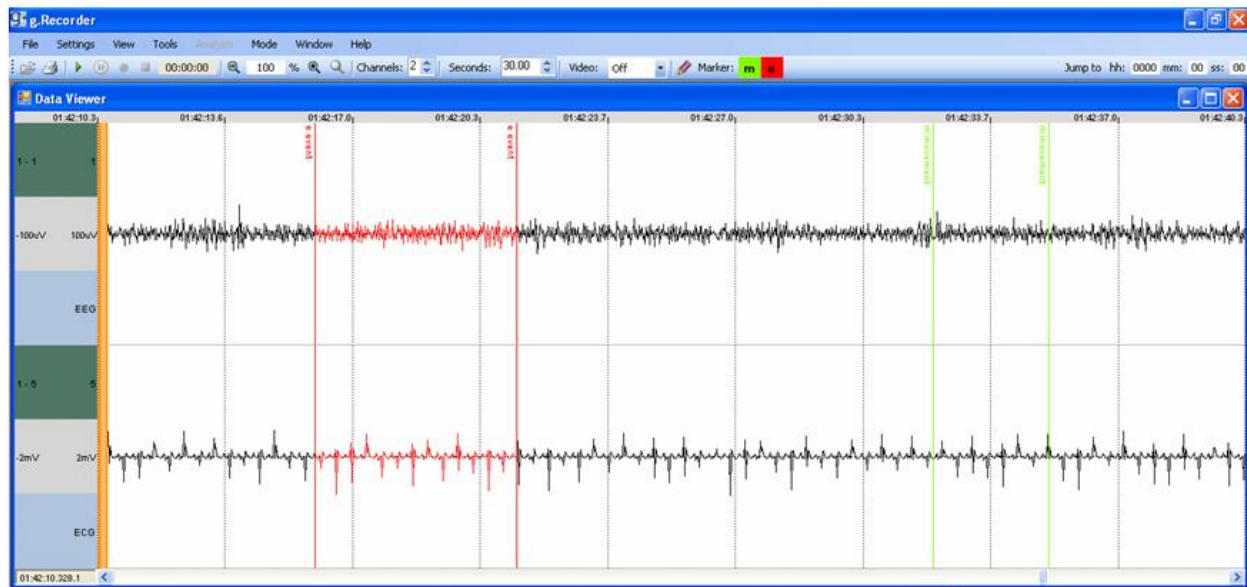


to open the following window:

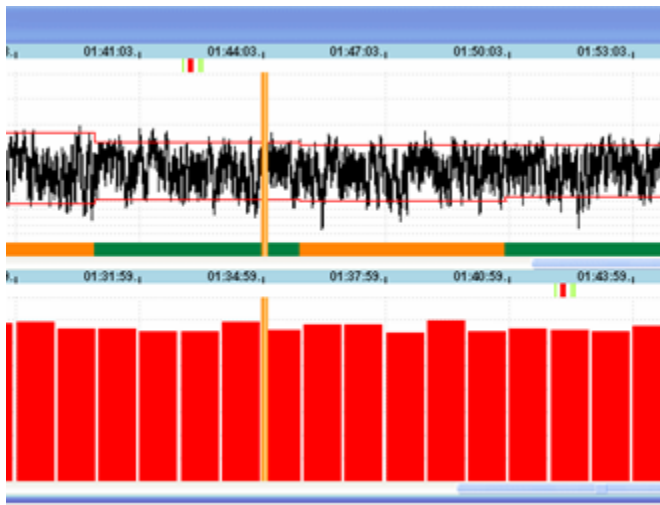


Here, two markers are defined that can be set either by clicking on the marker button in the **Toolbar** of **g.Recorder** or by pressing the keys on the keyboard. Marker **e** – Event is a Toggle marker, marker **m** – Movement is a time marker.

The window below shows the visualization of the markers in the **Data Viewer**:



In the **Feature Viewer** the set markers for the different events are also indicated by small bars near the top of the individual features channels:

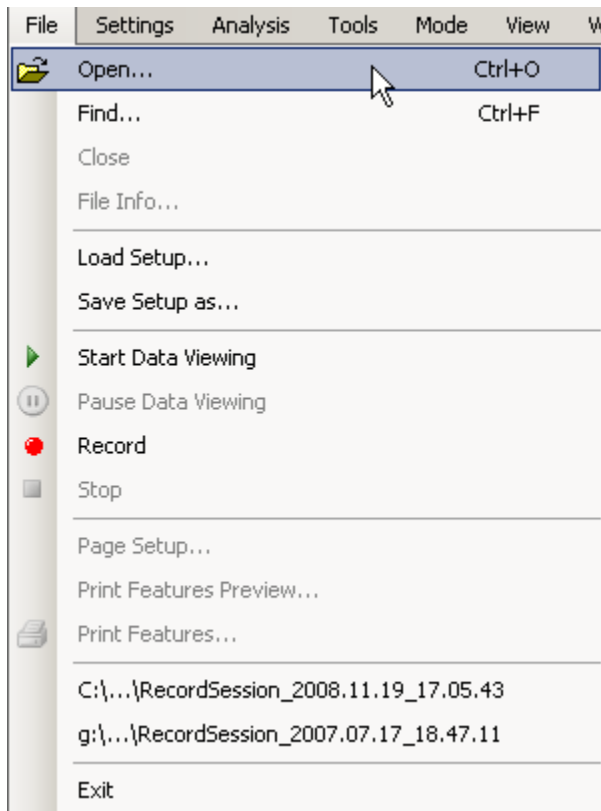


Load, Find, Convert and Replay Recorded Files

Load, Find and Replay HDF5 files

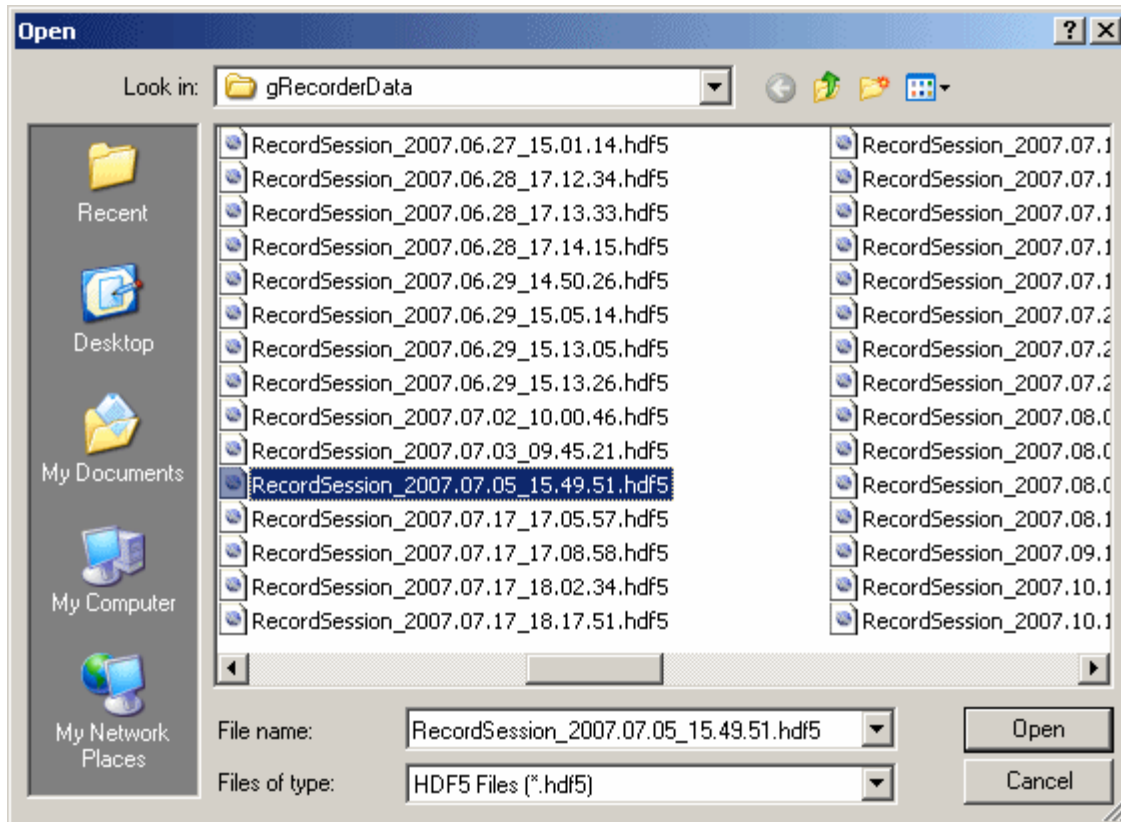
A recorded data file in HDF5 format can be loaded and reviewed with **g.Recorder**.

In the **File** menu select **Open...**



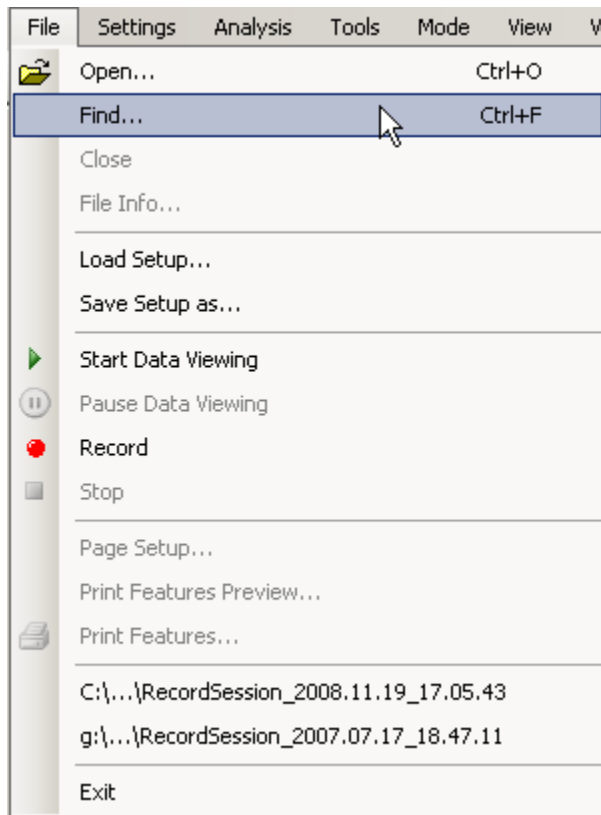
Then select the data file you want to load into **g.Recorder**. The default path of the recorded files is

My Documents/gRecorder



Select file `RecordSession_2007.07.05_15.49.51.hdf5` and press **Open**.

If you want to find a specific file from the database then in the **File** menu select **Find...**



This displays all hdf data files found in your specific working directory.

Find File

Search Directory

Path: ☒ Include Subfolders

Define Dataset

Last Name:

First Name:

☐ Date of Birth:

Found Datasets

Total available Datasets:

Matching your Search:

Select from matching Datasets

	Last name	First name	Date of birth	Recording date	Recording length	Filename	Video
			07.08.2008	07.08.2008 09:11:48	00:00:55	\RecordSession_2008.08.07_11.11.46.hdf5	yes
			07.08.2008	07.08.2008 09:07:47	00:00:57	\RecordSession_2008.08.07_11.07.43.hdf5	yes
			07.08.2008	07.08.2008 09:21:09	00:13:53	\RecordSession_2008.08.07_11.21.07.hdf5	yes
▶	Edlinger	Günter	07.08.2008	07.08.2008 08:29:31	00:00:21	\RecordSession_gMOBilabplus_ezurio2008.08.07_1...	yes
			06.07.2007	02.08.2007 09:56:09	00:00:01	\RecordSession_2007.08.02_11.56.08.hdf5	no
			06.07.2007	02.08.2007 09:56:47	00:00:01	\RecordSession_2007.08.02_11.56.47.hdf5	no
			06.07.2007	06.08.2007 10:58:15	00:20:32	\RecordSession_2007.08.06_12.58.14.hdf5	no
			06.07.2007	06.08.2007 13:50:39	00:00:01	\RecordSession_2007.08.06_15.50.38.hdf5	no
			11.10.2007	11.10.2007 12:31:02	00:00:12	\RecordSession_2007.10.11_14.31.02.hdf5	no
			11.10.2007	11.10.2007 13:09:01	00:05:21	\RecordSession_2007.10.11_15.09.00.hdf5	no
			11.10.2007	11.10.2007 13:25:37	00:00:04	\RecordSession_2007.10.11_15.25.37.hdf5	no
			11.10.2007	11.10.2007 13:35:21	00:00:26	\RecordSession_2007.10.11_15.35.21.hdf5	no
			06.07.2007	31.07.2007 13:01:17	00:00:02	\RecordSession_2007.07.31_15.01.17.hdf5	no
			19.10.2007	19.10.2007 06:54:20	00:00:00	\RecordSession_2007.10.19_08.54.20.hdf5	no
			22.10.2007	22.10.2007 07:52:34	00:00:01	\RecordSession_2007.10.22_09.52.34.hdf5	no
			21.11.2007	21.11.2007 08:07:03	00:00:10	\RecordSession_2007.11.21_09.07.01.hdf5	no
			21.11.2007	21.11.2007 08:52:54	00:00:04	\RecordSession_2007.11.21_09.52.54.hdf5	no
			21.11.2007	21.11.2007 09:14:52	00:01:18	\RecordSession_2007.11.21_10.14.52.hdf5	no

The **Search Directory** of data files can be set in the **Path:** field. Use the **Browse** button to find the desired directory. If the **Include Subfolders** option is enabled then the data files found in the selected path including all subdirectories are listed.

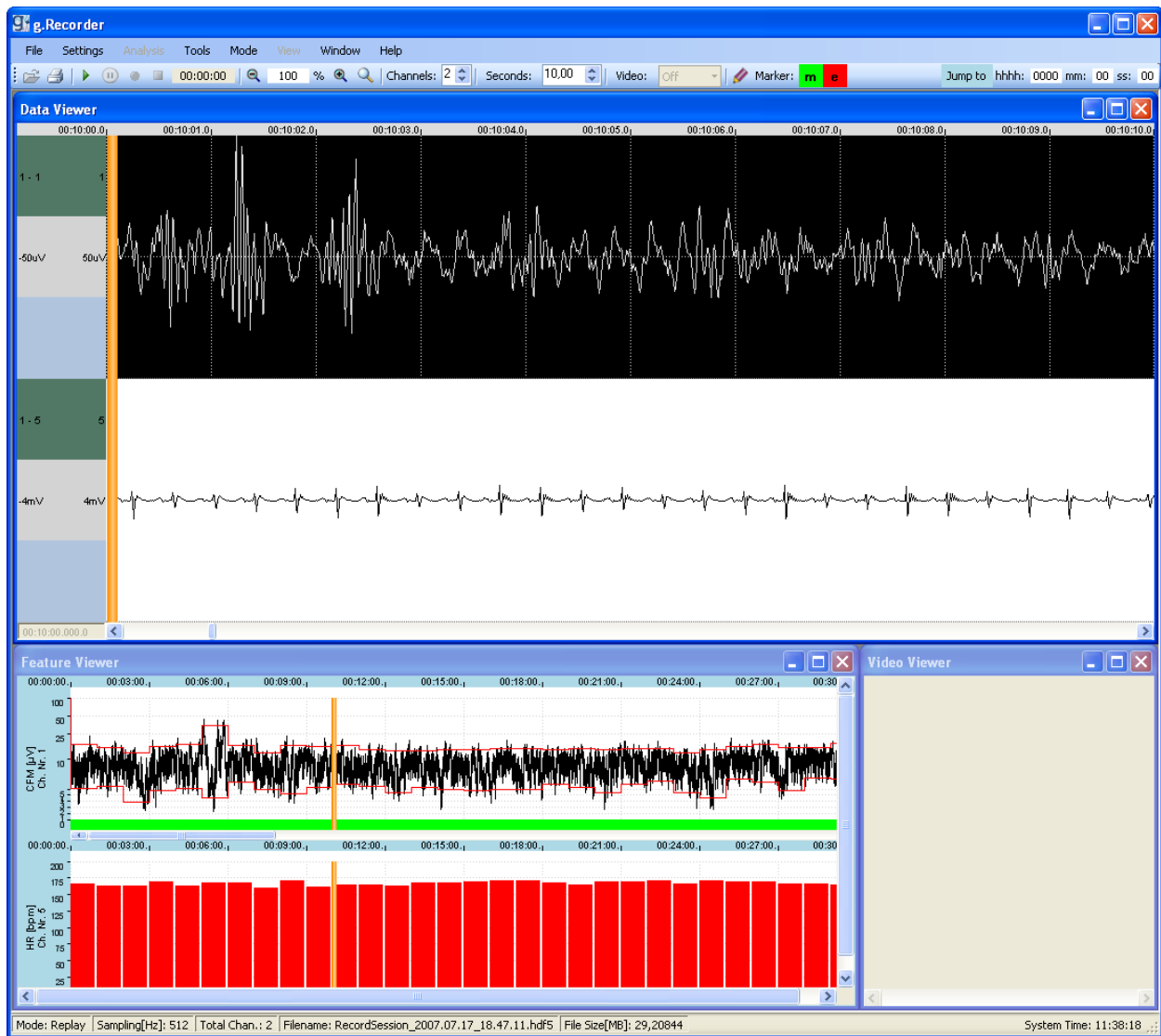
Define Datasets enables optionally searching for data sets including **Last Name** and **First Name** and if selected the **Date of Birth** of a subject. Results are displayed immediately after typing in the first letter.

Found Datasets yields information about the search request.

The desired data set can be selected by highlighting the data set. Double clicking or selecting the **OK** button loads the data set for review. Additional short information is given for the data set including the Last name, first name, Date of Birth, Recording data, Recording length, Filename and if a video information is available. Data sets can be sorted by clicking on one of the row headers e.g. on the Video entry.

The entire table can be copied to the clipboard for further use by clicking the **Copy Table** button.

g.Recorder opens the acquired data for off-line visualization. The **Data Viewer** shows the recorded EEG data on channel 1 and the acquired ECG data on channel 2. The **Feature Viewer** shows the calculated CFM and HR features.



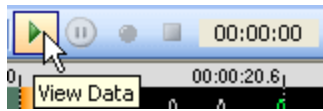
In the **Status Bar** the information of the recorded measurement is displayed.

Mode: Replay | Sampling [Hz]: 512 | Total Chan.: 2 | File Name: RecordSession_2007.07.17_18.47.11.hdf5 | File Size [MB]: 29.20844 | System Time: 3:41:57 PM

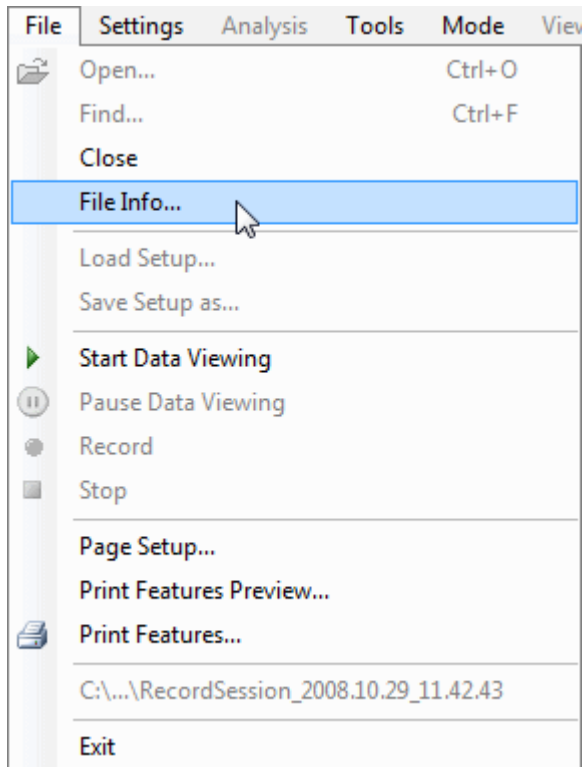
The **Mode** is *Replay*, the **Sampling** frequency is 512 Hz, the number of recorded channels (**Total Chan.**) is 2. The **File Name** is *Record_Session_2007.07.17_18.47.11.hdf* and the **File Size** is 29 megabytes.

You can use the scroll bars on the bottom of a window or the orange vertical position marker in any of the **g.Recorder** windows to move to an arbitrary position in the file.

To review data on-line from the selected position click on the **View Data** button.

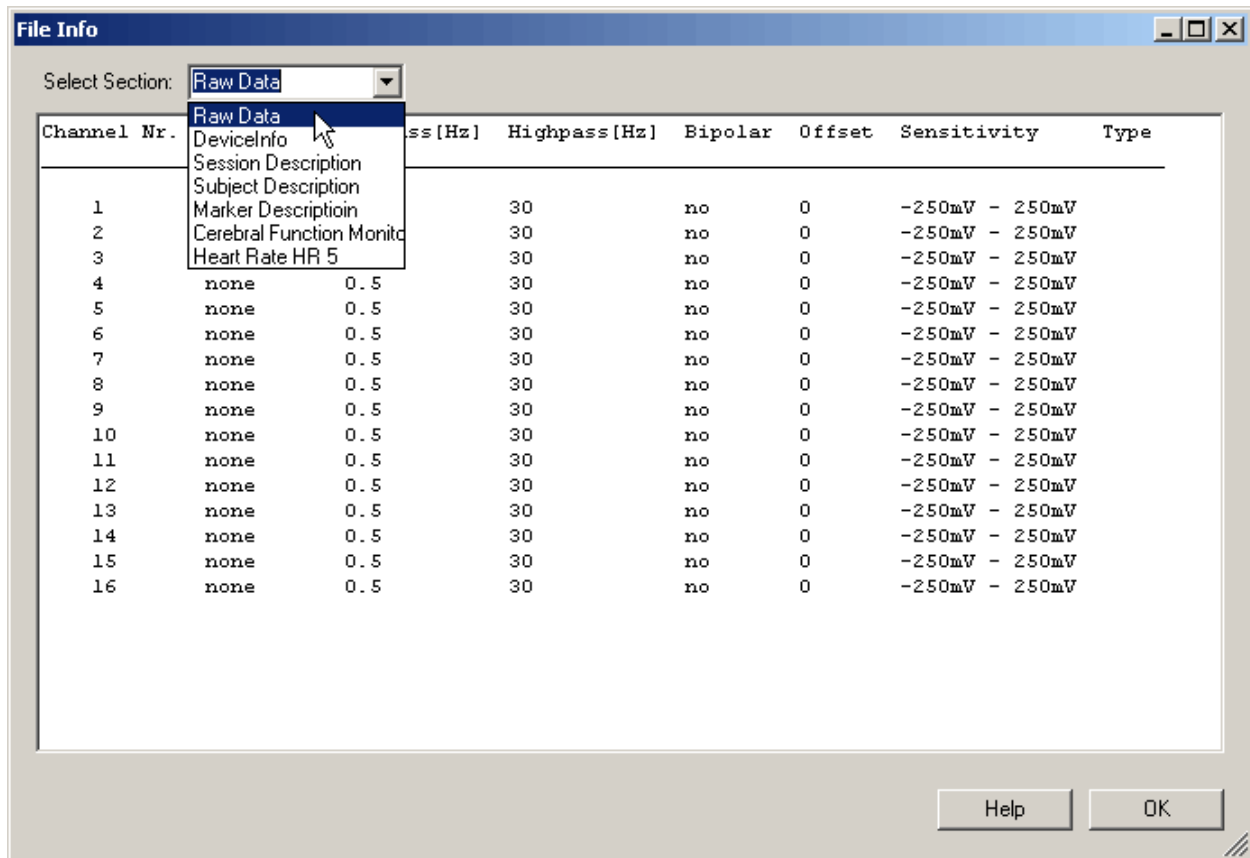


To view the file information select **File Info...** from the **File** menu.



This opens the **File Info** window yielding information about the data set. To view the file information use the **Select Section** pull down menu (the list contains **Raw Data**, **DeviceInfo**, **Session Description**, **Subject Description**, **Marker Description** and the recorded features).

Select Raw Data to show the settings for each channel:

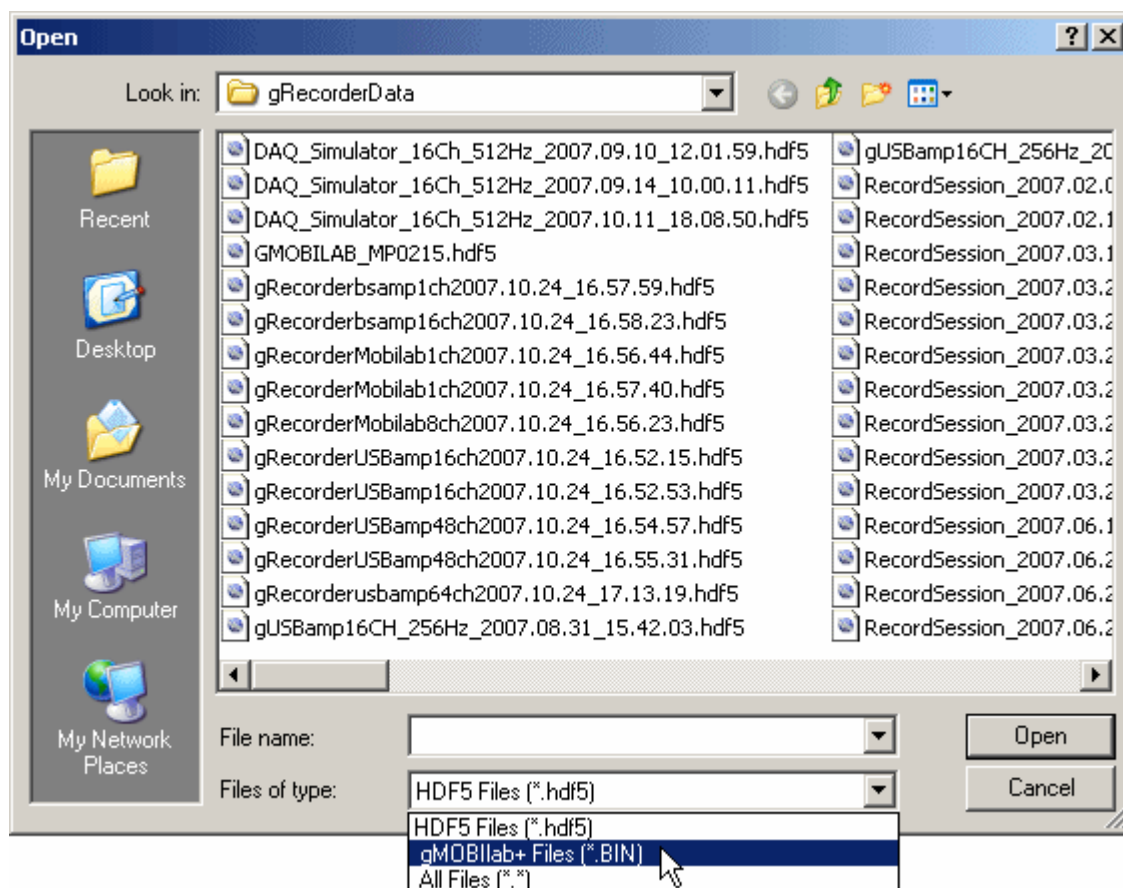


Click **OK** to close the dialog.

Convert g.MOBILab+ BIN files to HDF5 format

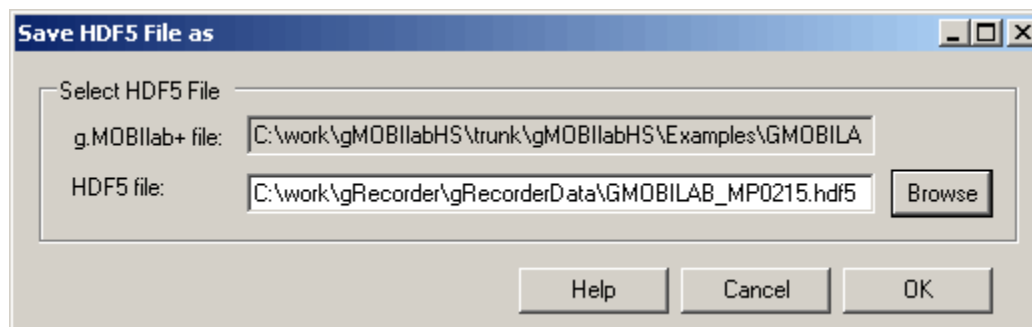
g.Recorder contains a tool to import g.MOBILab+ data files stored on the built-in SD Card of g.MOBILab+. Data are converted to the **g.Recorder** file format HDF5.

In the **File** menu click **Open...**



In the **Files of type** section of the Open dialog select **g.MOBILab+ Files (*.BIN)** files and browse to the folder containing the file to convert. Select the desired file and click **Open**.

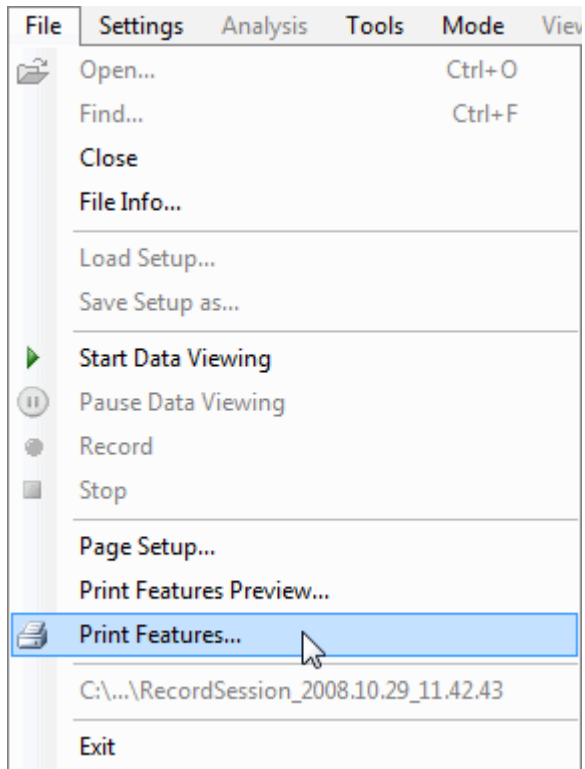
The **Save HDF5 File As** dialog will open, where the path for the converted HDF5 file can be set.



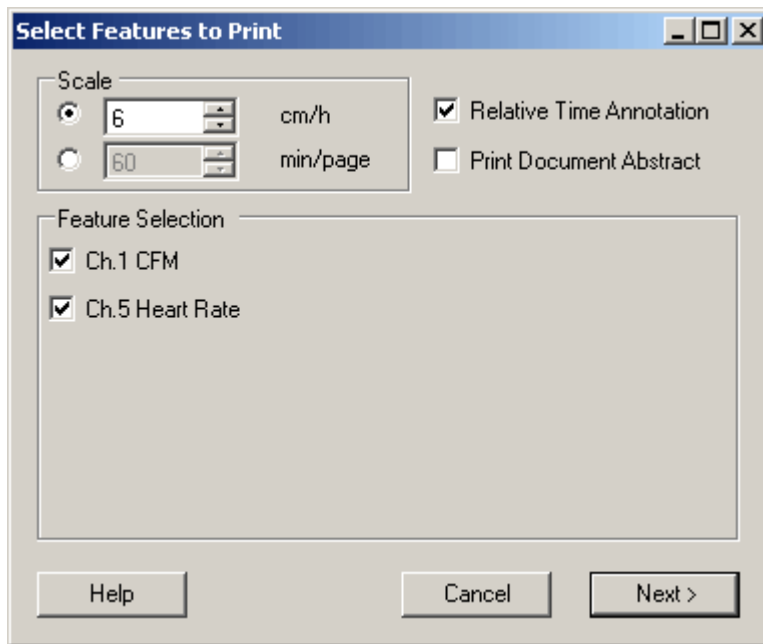
Click **OK** to convert and display the file.

Print Recorded Files

The recorded features and the recording information can be printed by selecting **Print Features...** from the **File** menu.



In the **Select Features to Print** dialog you can choose the features to be printed.



Scale

The **Scale** of the printed feature can either be in cm/h (centimeters per hour) or min/page (minutes per page). When selecting the setting 6 cm/h a dataset of 3 hours would need a total space of 18 cm on the paper. If the same 3 hours data set is printed with the selection of 60 min/page then 3 pages would be printed.

With the checkbox **Relative Time Annotation** the time scale in the printed document can be set. Therefore the time is given in absolute format (e.g. 17:05:01) or relative to the measurement time (e.g. 00:05:14).

Select the **Print Document Abstract** to print the file and subject information.

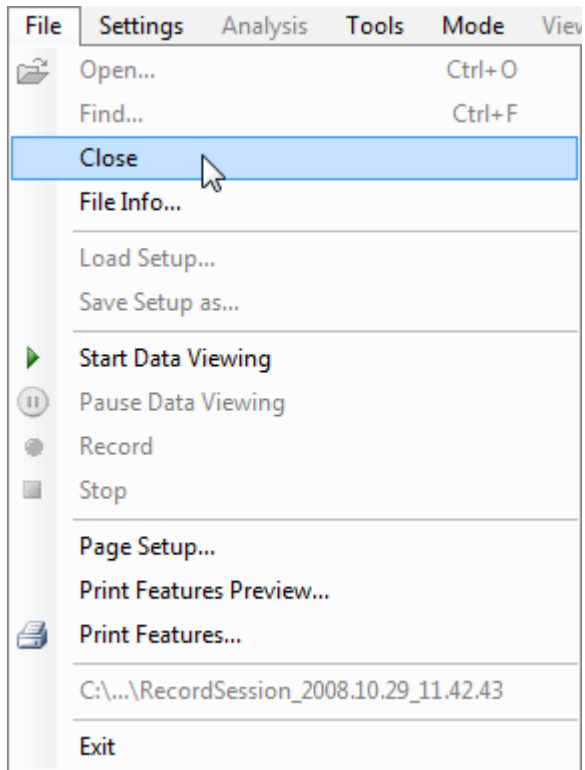
Feature Selection

Under **Feature Selection** select the features that should be printed.

Click **Next** to go to the **Print** dialog, select a printer and print the file.

Closing the review mode in g.Recorder

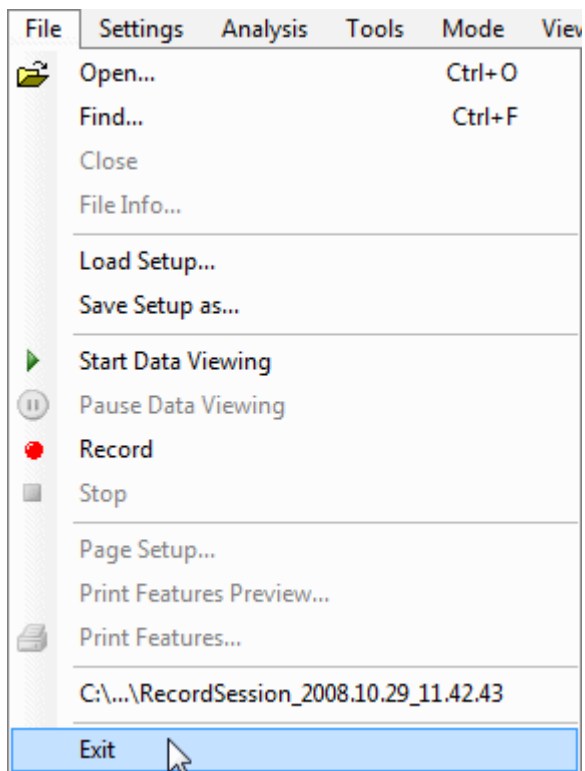
To return from *Replay* mode to *Recording* mode select the **Close** button from the **File** menu.



Closing g.Recorder

In the **File** menu select **Exit** or click on the cross button in the top right corner of **g.Recorder** to close the application.

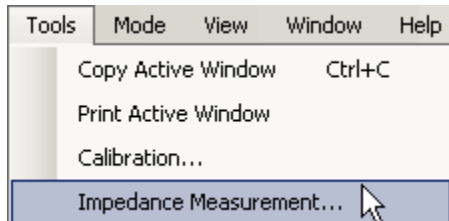
Note: If you are in *Replay* mode you must close the file first with the **Close** function in the **File** menu before you can exit **g.Recorder**.



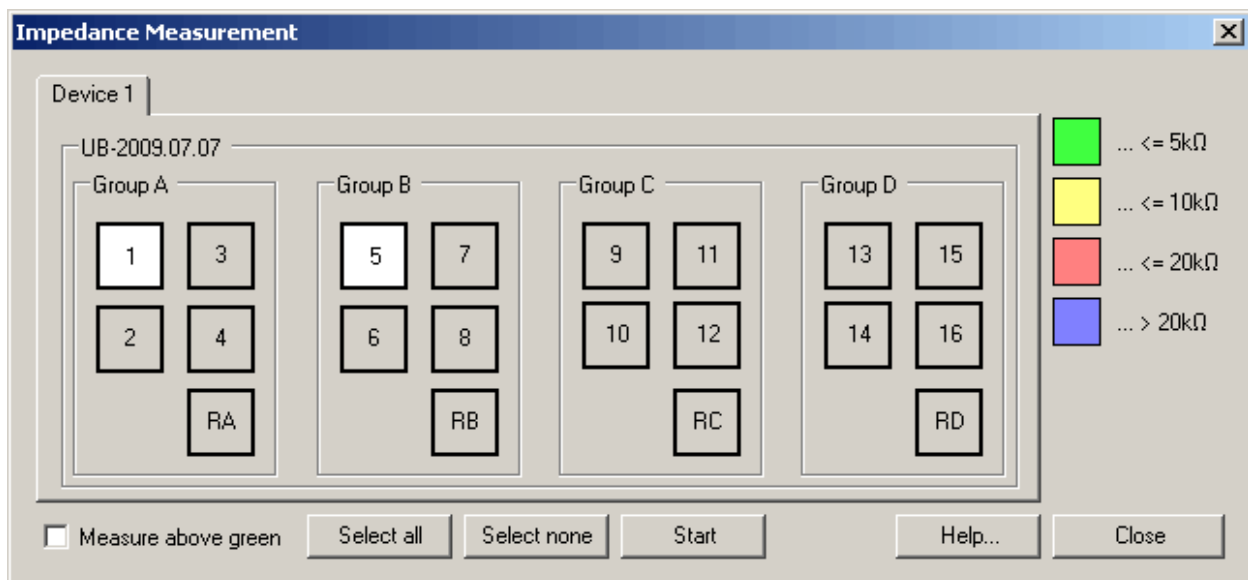
g.USBamp Specific Features

Impedance Measurement with g.USBamp and g.Recorder

With g.USBamp the impedance of the connected electrodes can be measured. To start this tool click on the **Impedance Measurement...** button in the **Tools** menu.



This opens the dialog shown below.

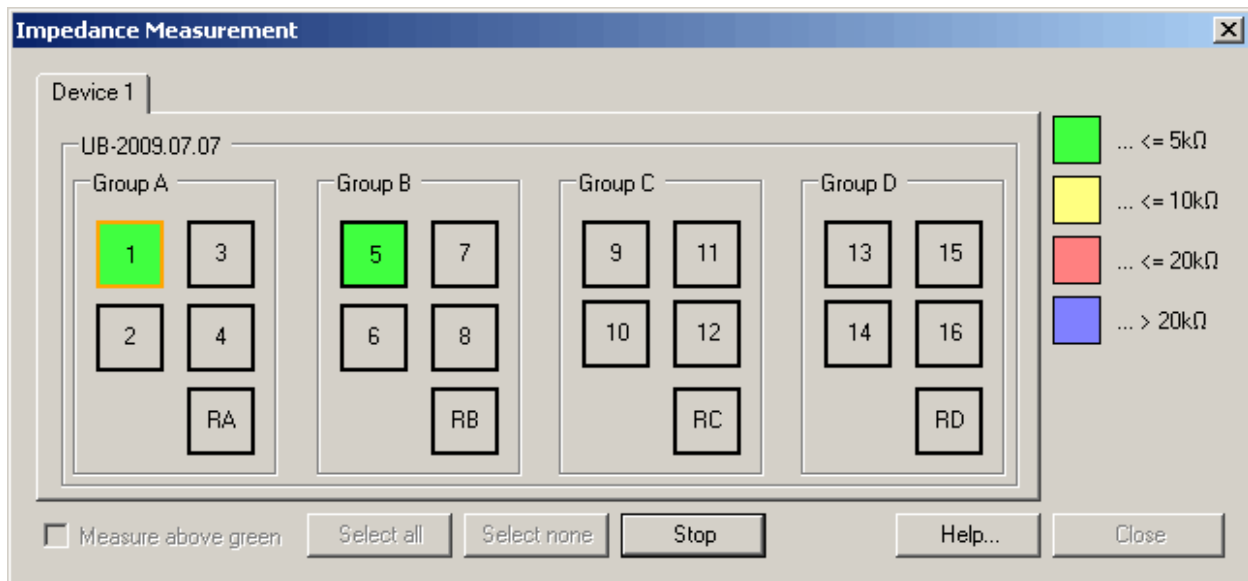


Select the channels for impedance checking individually by clicking on the boxes next to the channel numbers and click **Start**. The channel coloring indicates the impedance of the connected electrode. Optimal values e.g. for EEG recordings would be impedance values below 5 kOhm (color code green). Acceptable impedance values are in the range of up to 20 kOhms (color code yellow or red). Non connected channels or electrodes having bad impedance values of more than 20 kOhm are color coded blue. You can also click on the **Select All** button to include all electrodes for impedance checking or deselect the electrodes pressing the **Select None** button.

In order to accelerate the impedance check, you can check the **Measure above green** checkbox. Hence only electrodes with impedance values of more than 5 kOhms are checked.

The figure below shows good impedance values for channels 1 and 5.

Note: For EEG measurements the impedance should be below 10 kOhm for optimal recording quality.



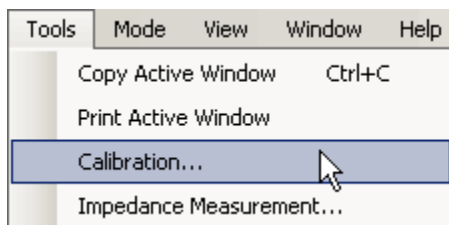
To exit from the **Impedance Measurement** dialog click on the **Close** button.

Note: The impedance of electrodes connected to channels 1-16 and the reference channels are measured against the ground **G** of each group. To measure the impedance of all 16 channels and 4 references against only one ground connect the ground electrode to ground **G** of group **D**.

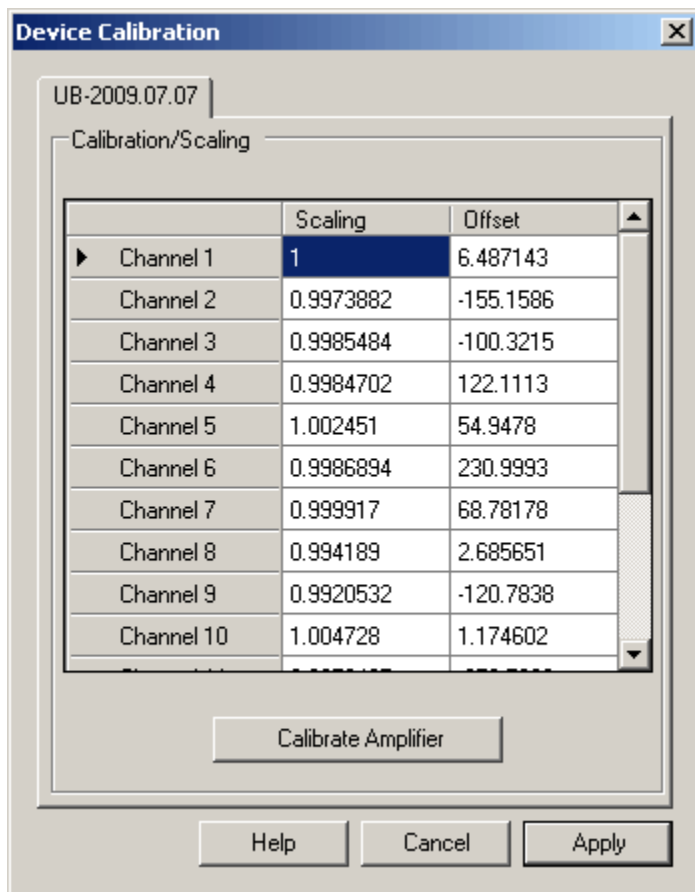
Calibration of g.USBamp with g.Recorder

g.Recorder has a built-in function to calibrate g.USBamp.

Select **Calibration...** from the **Tools** menu.



This opens the **g.USBamp Calibration** dialog. Click on the **Calibrate Amplifier** button to measure the offset and the gain of each channel. The actual calibration values are then visualized for each channel.

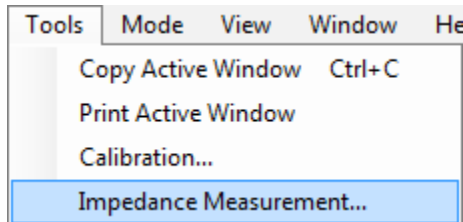


Press the **Apply** button to transmit the settings to g.USBamp and to close the dialog.

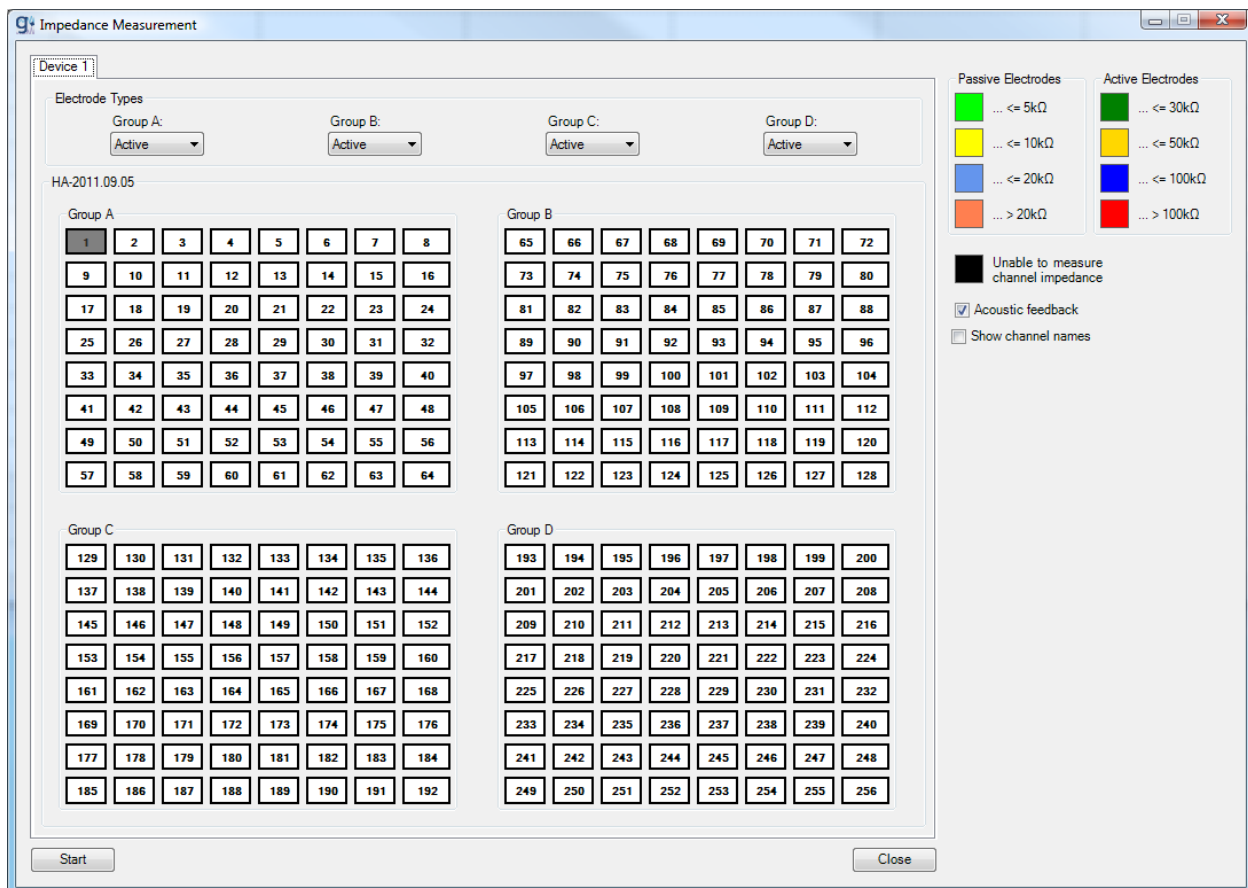
g.Hlamp Specific Features

Impedance Measurement with g.Hlamp and g.Recorder

With g.Hlamp, the impedance of the connected electrodes can be measured. To start this tool, click on the **Impedance Measurement...** button in the **Tools** menu.



This opens the dialog shown below.



Select the type of electrode connector boxes that are currently connected to each of the four groups of the g.Hlamp in the **Electrode Types** area. Either passive or active electrode connector boxes can be used for a whole group. If a group is not used, it doesn't matter which type of electrodes you specify for that group. At least on channel 1 (Group A) an electrode must be connected.

IMPORTANT: If an active electrode box is connected to group A, a special electrode has to be used at channel 1. Please see the documentation of the 64-channel active electrode connector box for details on impedance measurement.

Select or deselect the channels to use for impedance measurement by clicking on the appropriate channel number. Deselected channels get a dark gray background while selected channels have a white background.

Click **Start** to start impedance measurement. Impedance measurement is performed periodically for all channels at once and lasts a few seconds for each run.

The channel coloring indicates the impedance of the connected electrode. Channels with passive electrodes get assigned one of the colors listed in the **Passive Electrodes** box. Channels with active electrodes get assigned one of the colors listed in the **Active Electrodes** box.

Optimal values e.g. for EEG recordings with passive electrodes would be below 5 kOhms (color code light green). Acceptable impedance values are in the range of up to 20 kOhms (color code yellow or light red), while non-connected channels or electrodes have a very bad impedance value of more than 20 kOhms (color code light blue).

Optimal values e.g. for EEG recordings with active electrodes would be below 30 kOhms (color code dark green). Acceptable impedance values are in the range of up to 100 kOhms (color code orange or dark red), while non-connected channels or electrodes have a very bad impedance value of more than 100 kOhms (color code dark blue).

Channels whose impedance couldn't be measured properly get color code black.

Channel 1 and the ground electrode are used as reference for impedance measurement of all other channels. Therefore, no impedance can be measured for those channels. Hence, channel 1 is always grayed and no impedance value will be assigned. However, if the reference signal measured on channel 1 is not valid (which might occur when no electrode is connected on channel 1), no impedance value can be calculated and color code black will be assigned to all other channels.

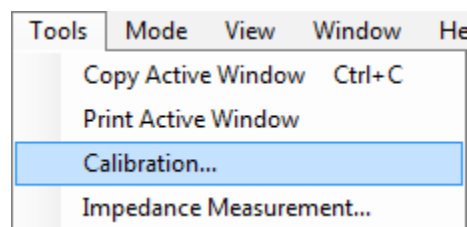
Click **Stop** to stop impedance measurement (even if impedance measurement has aborted with a connection error, for example if the device was disconnected during measurement) and close the dialog by clicking **Close**.

If **Acoustic feedback** is checked, a short beep is produced on the PC speaker when the impedance of any of the electrodes changes from red to any better impedance value. The better the impedance value the electrode changes to, the higher the frequency of the beep. If the impedance of any electrode changes to red, a long beep sounds. To turn off acoustic feedback, uncheck the **Acoustic feedback** checkbox.

Check **Show channel names** if the names of the channels should be displayed instead of their numbers. This only works for channels that got a name assigned before in the **Channel Settings** dialog. Nothing additional is displayed for channels that got no name assigned that way.

Calibration of g.HIamp with g.Recorder

g.Recorder has a built-in function to calibrate a g.HIamp device. Select **Calibration...** from the **Tools** menu.

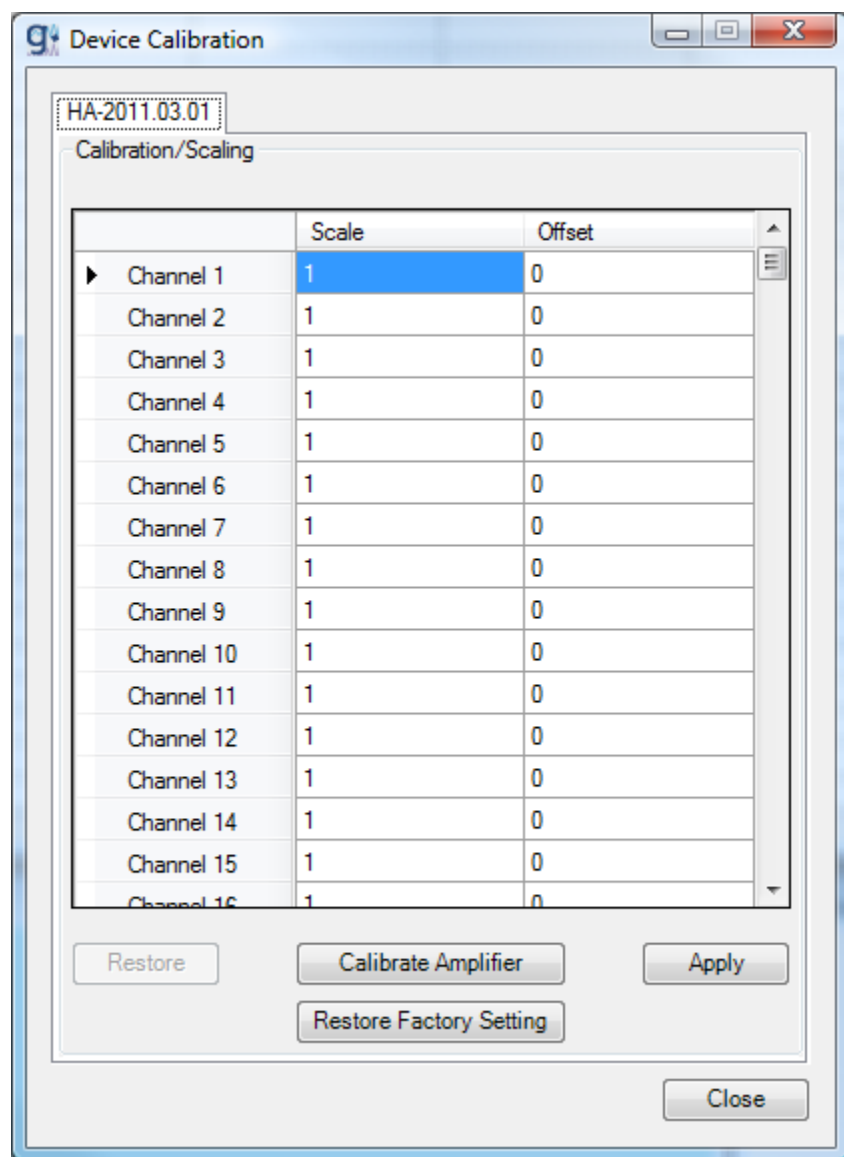


This opens the g.HIamp calibration dialog. To calculate new calibration values for the device, ensure that the calibration set is applied onto the amplifier at first. See the manual of the calibration set for detailed instructions on how to do this. Then click the **Calibrate Amplifier** button to measure offset and gain of each channel. Confirm the following dialog reminding you to apply the calibration set by clicking **OK**.

Calculation of new calibration values lasts about 10 seconds. A dialog will inform you after calculation has been completed. The actual calibration values are then visualized for each channel, but not applied yet.

If at least one channel could not be calibrated due to broken channels or broken calibration set for example, a dialog will inform you about the involved channels and their calibration value entries are displayed as **NaN** ("not a number").

To restore the initial factory calibration values, click **Restore Factory Settings**.



Press the **Apply** button to transmit the newly calculated or restored factory calibration values to the g.HIamp and apply them on the device. Press the **Restore** button to restore the old values on the amplifier. To edit the calibration values manually, double-click the desired cell and enter your value for scaling and offset (the settings will actually be transmitted and applied after the **Apply** button is pressed).

For channels that received **NaN** values as calibration result, 1.0 will be set for scaling and 0.0 for offset on pressing the **Apply** button.

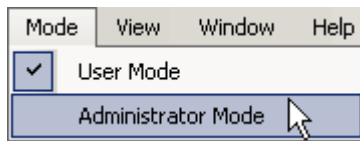
Running g.Recorder in Administrator Mode

The Administrator Mode allows configuring g.USBamp, g.MOBilab and g.BSamp amplifiers and to add and configure the different feature extraction methods of **g.Recorder**.

- Note: This mode requires an administrator password for the software

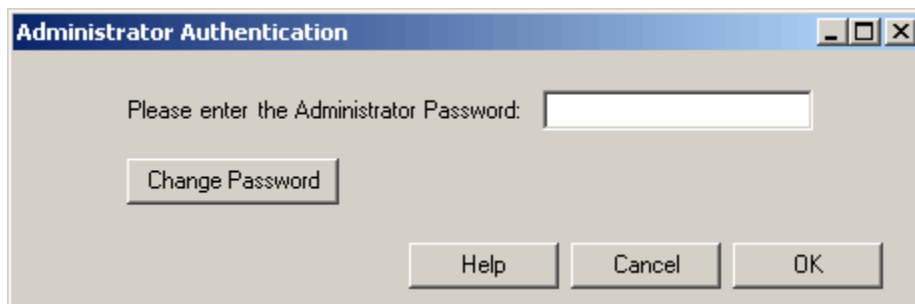
Activate Administrator Mode

To change from *User Mode* into the *Administrator Mode* click on **Administrator Mode** under the **Mode** menu.

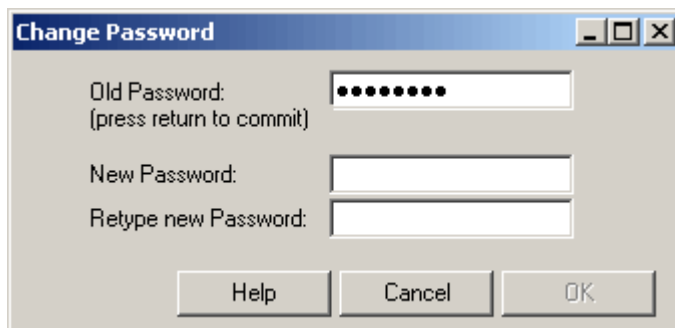


Note: Per default no Administrator Password is set.

To activate the Administrator mode just click **OK** in the **Administrator Authentication** dialog. If a password is set, enter the password and click **OK**.



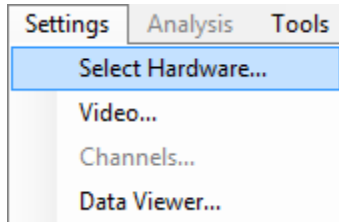
To change the password click on **Change Password** and enter the **Old Password**. Then press the return key and enter the **New Password**, enter the password again in the **Retype new Password** field and click **OK**.



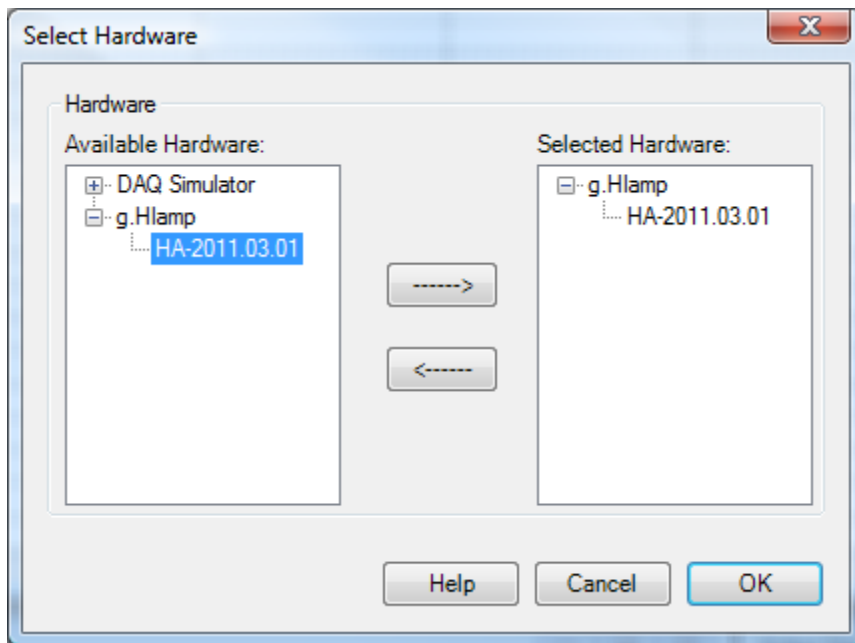
Select and Configure Hardware

g.Hlamp

In the Settings menu, select **Select Hardware...**



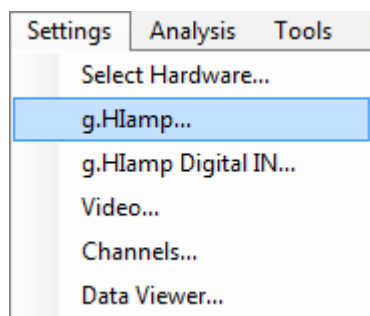
The **Select Hardware** dialog opens:



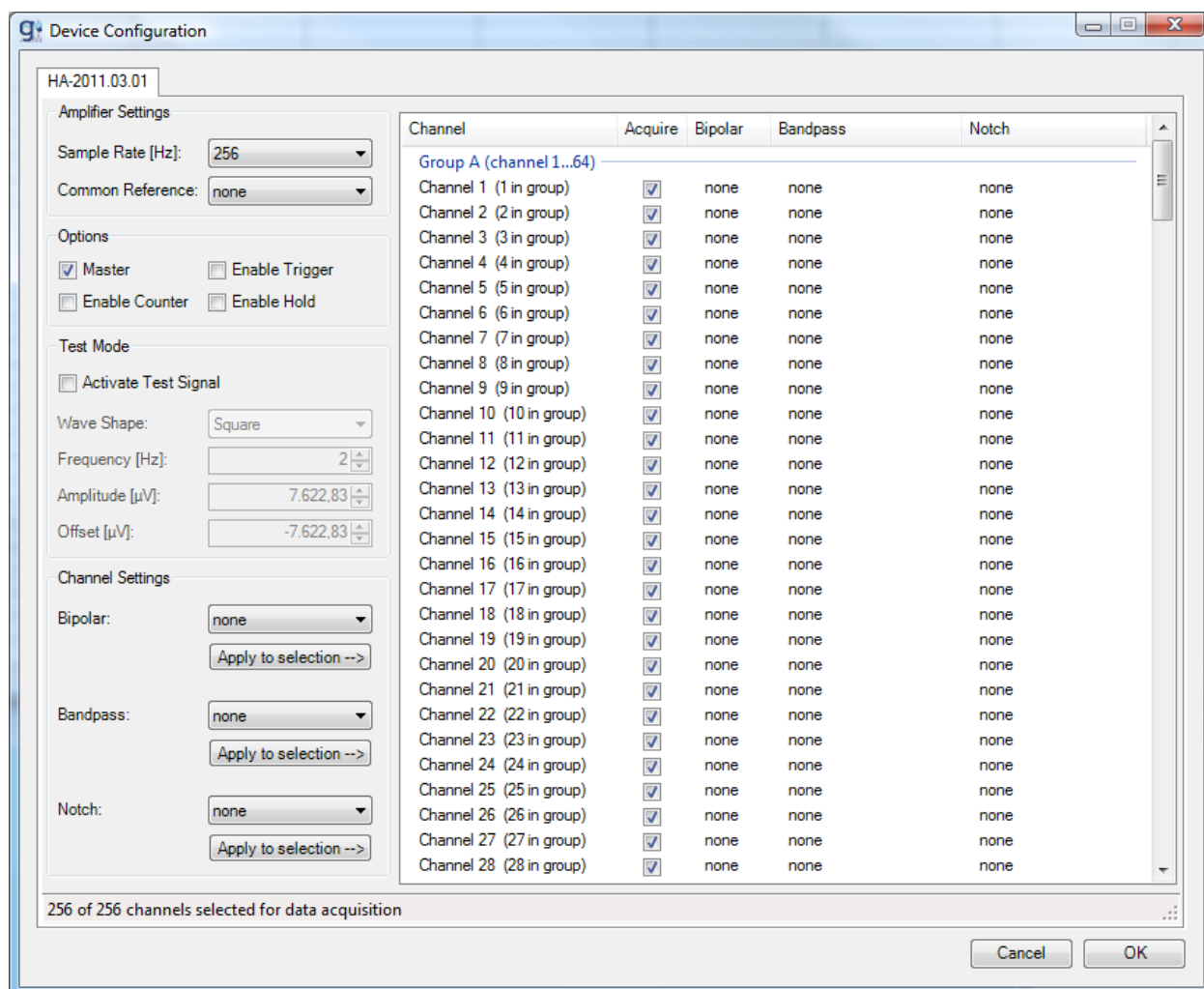
Select the desired g.Hlamp device that should be used for measurement from **Available Hardware** and click on the arrow button. Now, this g.Hlamp and its serial number is displayed in the **Selected Hardware** box.

Click **OK** to finish hardware selection.

To configure the selected g.HIamp device, click on **g.HIamp...** in the **Settings** menu.



The configuration dialog opens with the amplifier's serial number (here e.g. HA-2010.08.00):



AMPLIFIER SETTINGS

Sample Rate [Hz] specify the sampling frequency of the g.HIamp in Hz.

Common Reference specify one of the device's channels as common reference channel. This is a quick way to set the selected channel as bipolar channel for all other channels of the device. Existing settings for bipolar channels will be overwritten.

OPTIONS

Master	set the amplifier to master mode.
Enable Trigger	indicates if the digital trigger input line is acquired as well. This checkbox will be enabled automatically if at least one trigger line is selected to acquire (see the digital IN settings section for further details). If this checkbox gets disabled by the user, the trigger input line will not be acquired.
Enable Counter	a sample counter is applied on the first acquired channel, which overruns at 1000000.
Enable Hold	enable/disable the signal hold function.

TEST MODE

Activate Test Signal	enable/disable the internal test signal generator, which generates a test signal using the specified settings on the GND (ground) connector.
Wave Shape	specify the wave shape of the test signal.
Frequency [Hz]	specify the frequency of the test signal.
Amplitude [μV]	specify the amplitude of the test signal in microvolts.
Offset [μV]	specify the offset of the test signal in microvolts.

CHANNEL SETTINGS

Bipolar	perform a bipolar derivation between 2 input channels.
Bandpass	perform a digital bandpass filtering of the input channels.
Notch	perform a bandstop filtering to suppress the power line frequency of 50 Hz or 60 Hz.

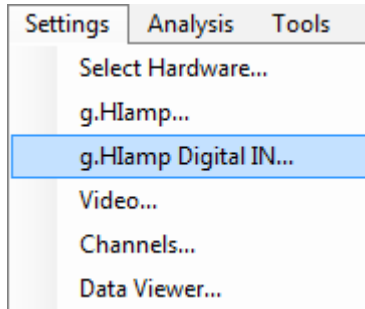
Perform the following steps to configure the selected channels:

1. Select the channels in the list box that should be edited. Use the Ctrl key or the Shift key to select multiple channels. To select all channels, use Ctrl+A. To select all channels of one group, click the group header. Selected channels are highlighted with orange background color.
2. Check or uncheck the checkbox of one of the selected channels in the **Acquire** column to include the selected channels in data acquisition or exclude them.
3. If no common reference has been set before or you want to change the reference/bipolar channel for a specific channel, select the desired bipolar channel from the **Bipolar** list and press the corresponding **Apply to selection** button right below.
4. Select a bandpass filter from the **Bandpass** list and press the corresponding **Apply to selection** button right below.
5. Select a notch filter from the **Notch** list and press the corresponding **Apply to selection** button right below.

Click **OK** to finish the configuration of the g.Hlamp and apply it to the device.

Digital IN for g.Hlamp

In the **Settings** menu, click on **g.Hlamp Digital IN...** to open the configuration dialog for the digital I/O settings.



The **Trigger** inputs are sampled synchronously with the analog input channels.

g. Digital I/O Configuration

HA-2010.08.00

Name	Description	Color Sel.	IO Direction	Edge Detection
☒ Trigger 1	BUTTON_1		In	Rising
☒ Trigger 2	FLASH_LAMP		In	Rising+Falling
☒ Trigger 3	TMS_TRIG		In	Rising
☒ Trigger 4	RESPONSE		In	Falling
☐ Trigger 5			In	Rising
☐ Trigger 6			In	Rising
☐ Trigger 7			In	Rising
☐ Trigger 8			In	Rising
☐ Trigger 9			In	Rising
☐ Trigger 10			In	Rising
☐ Trigger 11			In	Rising
☐ Trigger 12			In	Rising
☐ Trigger 13			In	Rising
☐ Trigger 14			In	Rising
☐ Trigger 15			In	Rising
☐ Trigger 16			In	Rising

Cancel OK

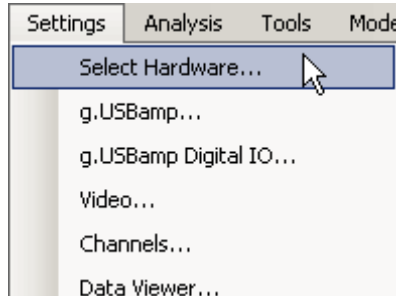
Check the box of the desired channels, enter a **Description**, select a color by clicking on the **Color** button (**Color Sel.**), and define the edge (**Edge Detection**).

Confirm the settings and close the dialog with **OK**.

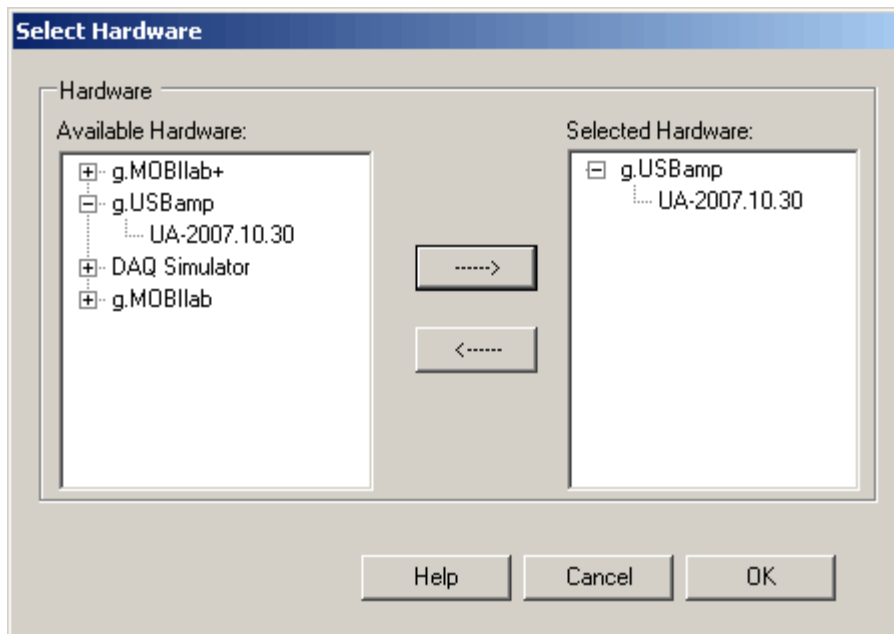
If the event occurs, a marker is generated and visualized with the biosignal data.

g.USBamp version 2.0 and version 3.0

In the **Settings** menu select **Select Hardware...**



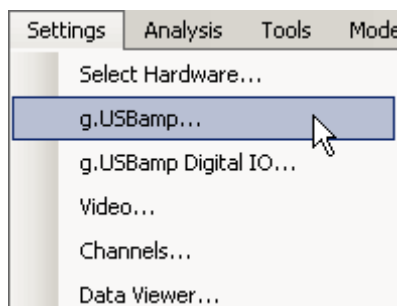
The **Select Hardware** dialog opens:



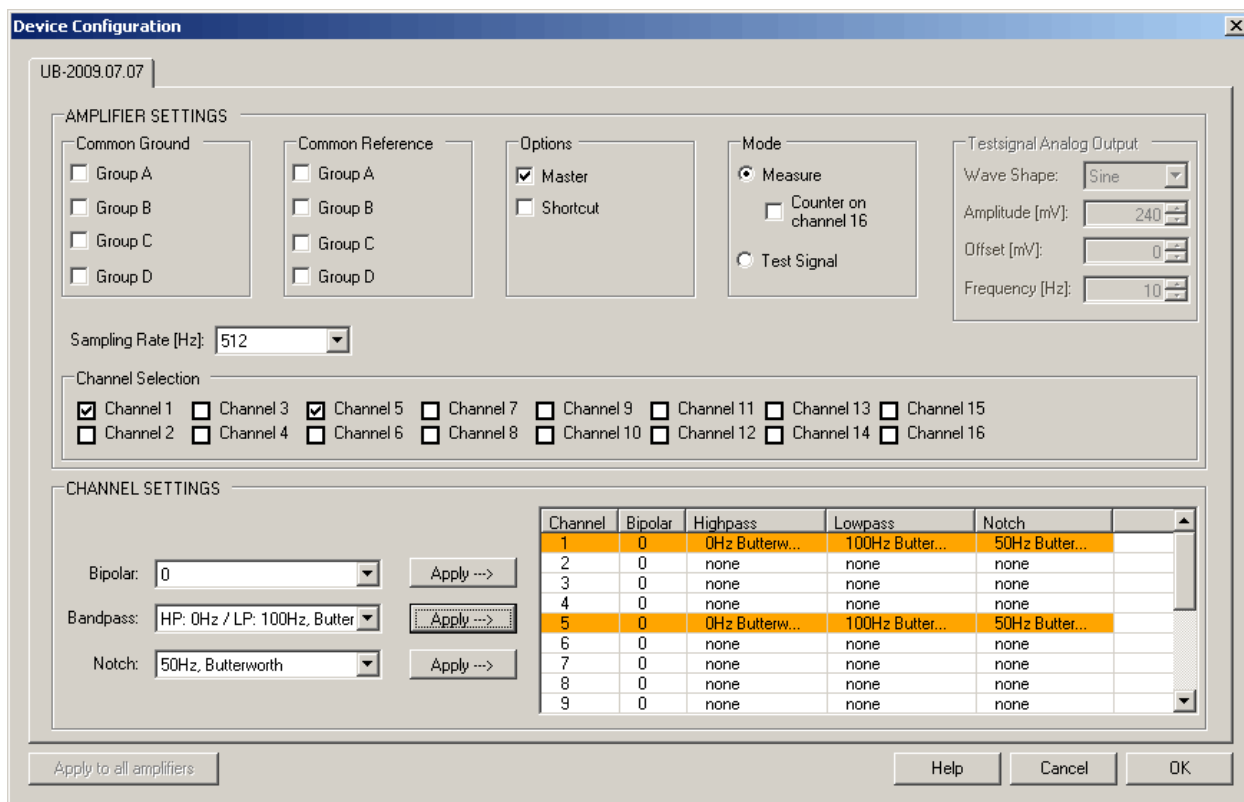
Select from **Available Hardware** the desired g.USBamp device that should be used for the measurements and click on the arrow button as shown in the figure above. Now this g.USBamp with the serial number is displayed in the **Selected Hardware** box. If several g.USBamps are connected to the PC repeat the steps.

Click **OK** to finish hardware selection.

To configure the g.USBamp click on **g.USBamp...** in the **Settings** menu.



The configuration window opens with the amplifier serial number (here e.g. UB-2009.07.07):



AMPLIFIER SETTINGS

Common Ground check the ground that should be connected to common ground

Common Reference check the reference that should be connected to common reference

Channel Selection check the analog input channels that should be acquired

Sampling Rate [Hz] specify the sampling frequency of the g.USBamp in Hz

Options

Master	set the amplifier to master mode if multiple units are used
Shortcut	enable the shortcut input

Mode

Measure	amplify the inputs and send the data to the PC
Counter	A counter is applied to channel 16
Test Signal	apply internal test signal to all inputs NOTE: The test signal works for sampling rates equal or below 600 Hz
Analog Output	generate a Sine-, Square-, Sawtooth- or Noise-signal as test signal
Amplitude	specify the amplitude of the test signal (max: 244 mV)
Offset	specify the offset of the test signal
Frequency	specify the frequency of the test signal

CHANNEL SETTINGS

Bipolar	perform a bipolar derivation between 2 input channels
Bandpass	perform a digital bandpass filtering of the input channels
Notch	perform a bandstop filtering to suppress the power line frequency of 50 Hz or 60 Hz

Perform the following steps to configure the selected channels:

1. Select the channels in the listbox that should be edited. Use the Strg key or the Shift key to select multiple input channels.
2. Select the **Bandpass** filter HP: 0.5 / LP: 30 and press the **Apply** button to assign the bandpass to the specific channel. The selection is shown in the listbox.
3. Select the 50 Hz **Notch** filter to suppress the power line interference at 50 Hz and then press the **Apply** button
4. To perform a bipolar derivation between channels 1 and 2 select the first channel in the listbox. Then select channel 2 under **Bipolar** and press the **Apply** button. The settings appear in the listbox. This configuration subtracts channel 2 from channel 1 and the bipolar derivation will be visible on channel 1.

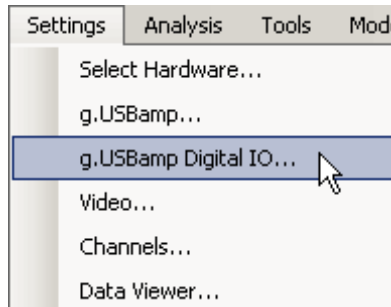
NOTE: Select 0 under **Bipolar** and assign it to the channel if no bipolar derivation should be performed

Finish the configuration of g.USBamp by clicking the **OK** button.

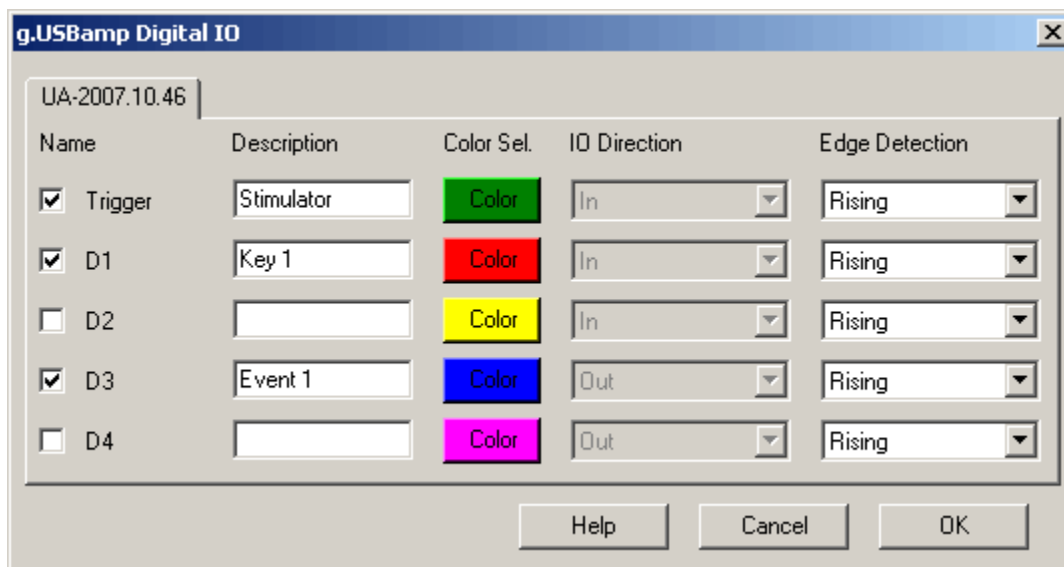
Digital IO for g.USBamp version 2.0

The serial number for g.USBamp 2.0 start with UA-xxxx.xx.xx

g.USBamp 2.0 has 3 digital inputs and 2 digital outputs. In the **Settings** menu click on **g.USBamp Digital IO...** to open the dialog.



The **Trigger** input is sampled together with the analog input channels and gives therefore a synchronous response. The inputs and outputs **D1**, **D2**, **D3** and **D4** are sampled asynchronously.



Check the box of the desired channels, enter a **Description**, select a color (**Color Sel.**) and define the edge (**Edge Detection**).

Then close the dialog with **OK**.

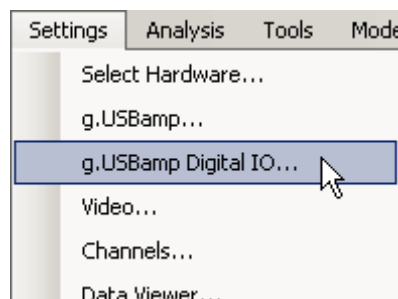
If the event occurs a marker is generated and visualized with the biosignal data.

NOTE: if a very accurate timing is needed the **Trigger** input must be used.

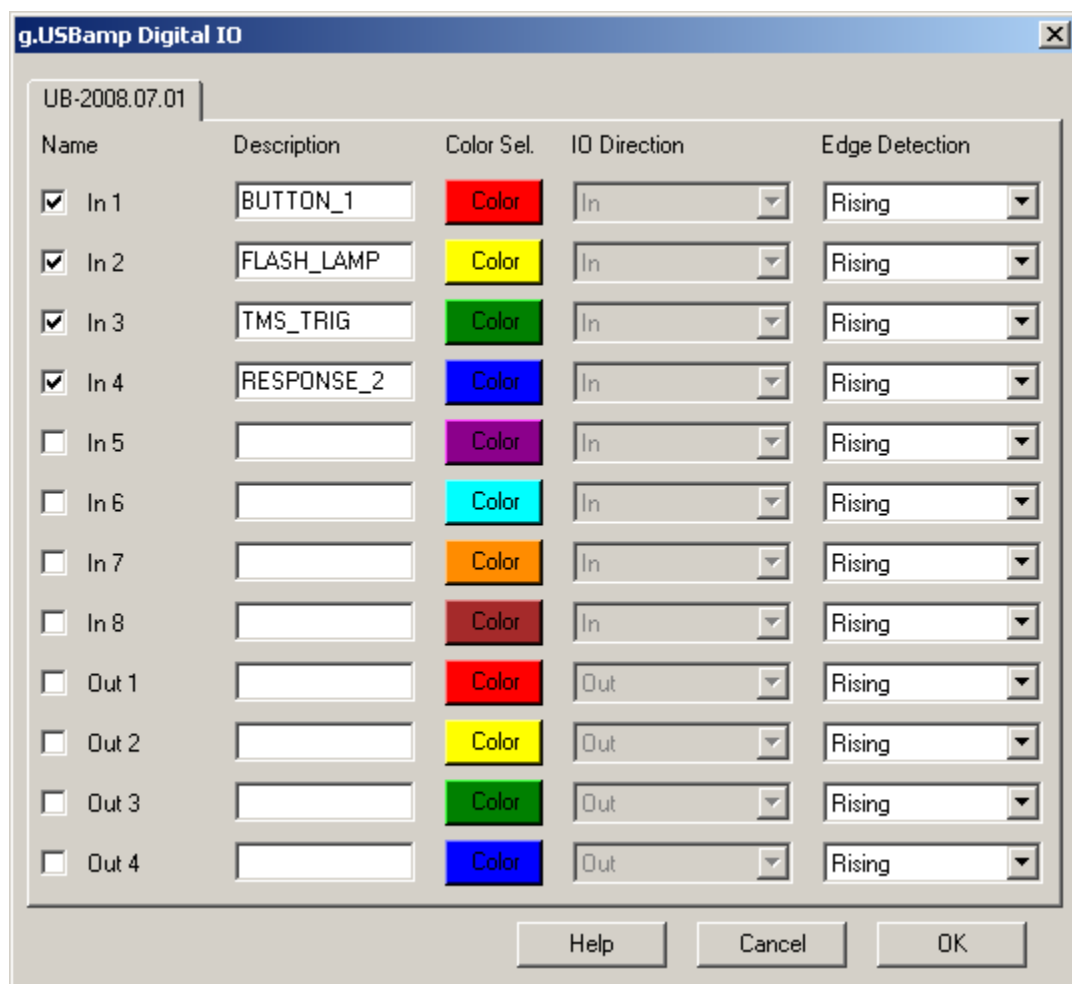
Digital IO for g.USBamp version 3.0

The serial number for g.USBamp 3.0 start with UB-xxxx.xx.xx

g.USBamp 3.0 has 8 digital inputs and 4 digital outputs. In the **Settings** menu click on **g.USBamp Digital IO...** to open the dialog.



The **Trigger** inputs **In 1** to **In 8** are sampled synchronously with the analog input channels. The outputs Out 1 to Out 4 are sampled asynchronously.



Check the box of the desired channels, enter a **Description**, select a color (**Color Sel.**) and define the edge (**Edge Detection**).

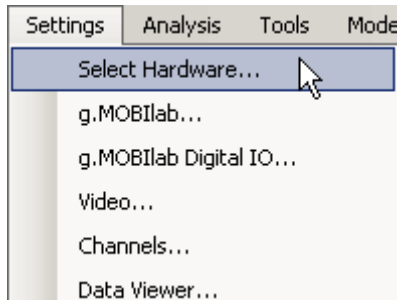
Then close the dialog with **OK**.

If the corresponding trigger event occurs, a marker is generated and visualized along with the biosignal data.

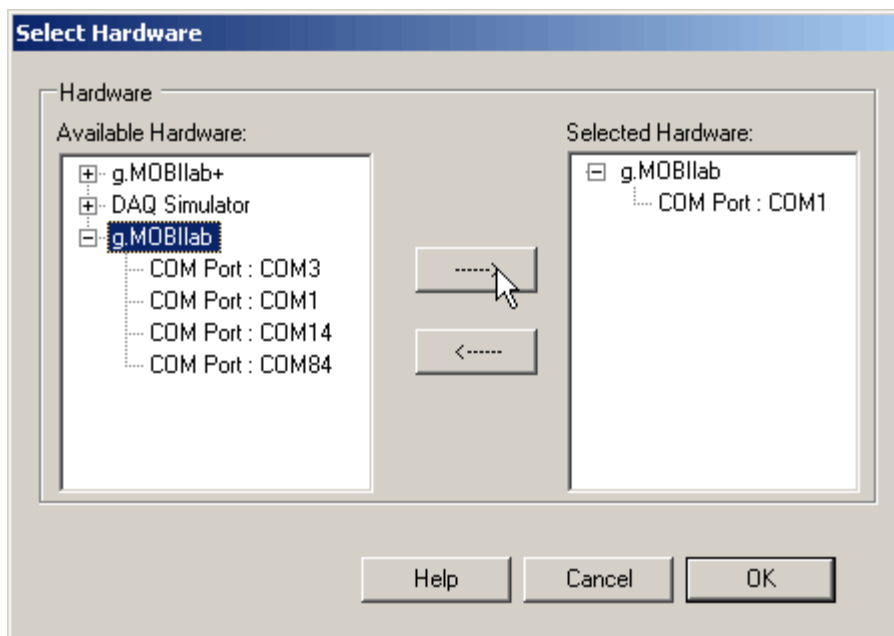
NOTE: A very accurate timing is obtained for all input channels.

g.MOBILab

In the **Settings** menu select **Select Hardware...**



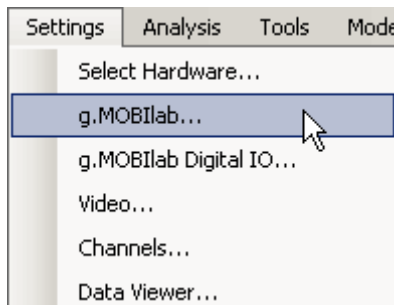
The **Select Hardware** dialog opens:



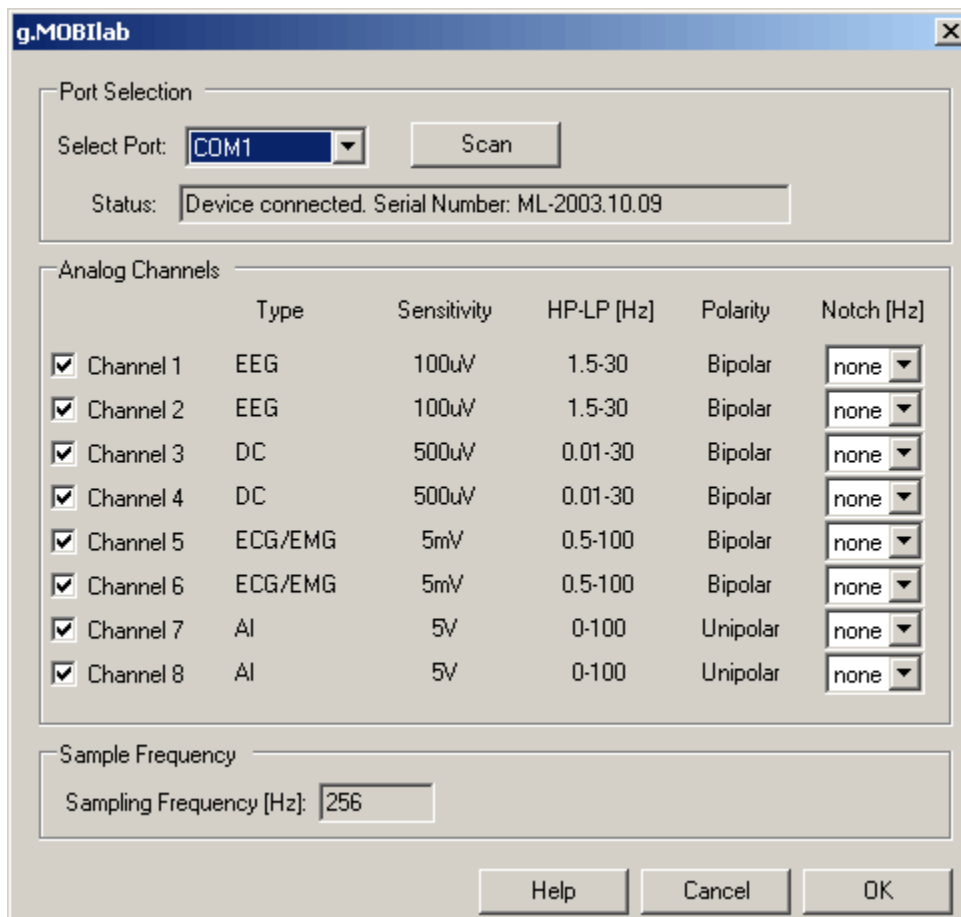
Select from **Available Hardware** the g.MOBILab that should be used for the measurements and click on the arrow button as shown in the figure above. Now this **g.MOBILab** with the **COM port** number is displayed in the **Selected Hardware** box. The COM port of your **g.MOBILab** can be found in the Device Manager.

Click **OK** to finish hardware selection.

To configure g.MOBilab click on the **g.MOBilab...** button in the **Settings** menu.



The configuration window opens:



Port Selection

If you do not know the COM port of g.MOBilab please press the **Scan** button. Then **g.Recorder** is searching for the correct port. If the device is not connected to the selected port the **Status** will be set to Not Connected!

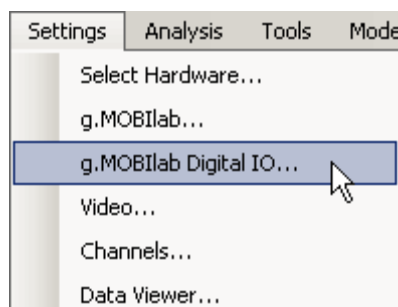
Analog Channels

In the **Analog Channels** section the channels that should be recorded can be selected. The **Type**, the **Sensitivity**, the highpass **HP** and the lowpass **LP** and the **Polarity** are displayed. Additionally a 50 or 60 Hz **Notch** filter can be applied.

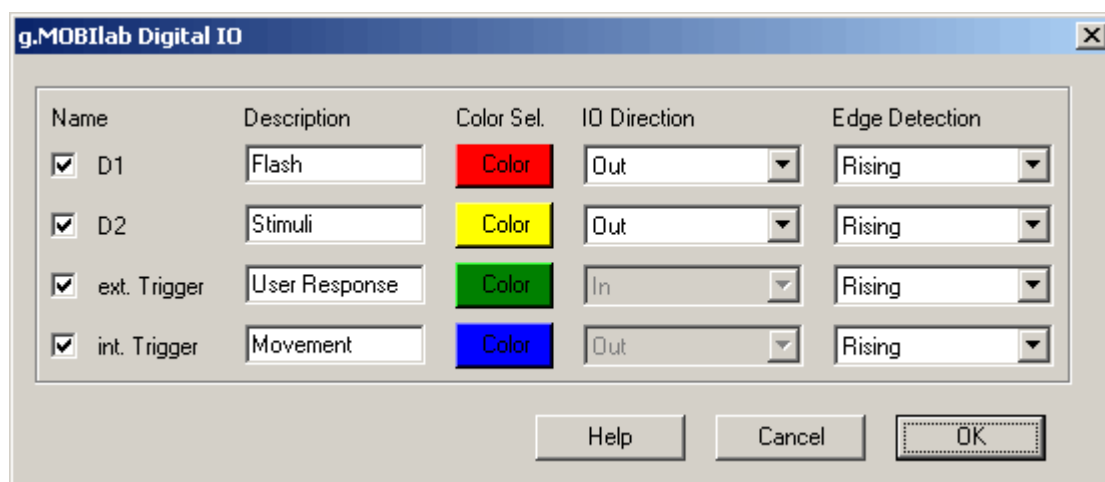
Sample Frequency

The **Sampling Frequency** is 256 Hz.

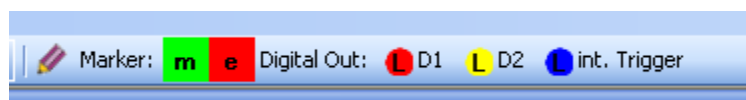
g.MOBILab provides four digital channels. To configure the digital inputs and outputs click on the **g.MOBILab Digital IO...** button in the **Settings** menu.



D1 and **D2** can be configured as digital input or as output. The **ext. Trigger** is always a digital input and reads the trigger button response. The **int. Trigger** is an internal trigger line that can be set with a button in **g.Recorder**.



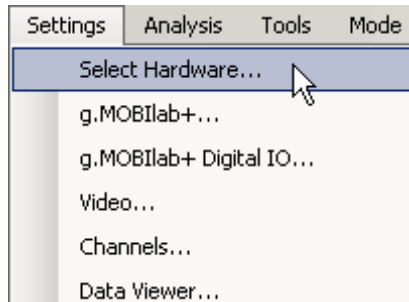
Perform the settings as shown in the figure above and close the dialog with **OK**. Then the following controls will be visible in **g.Recorder**:



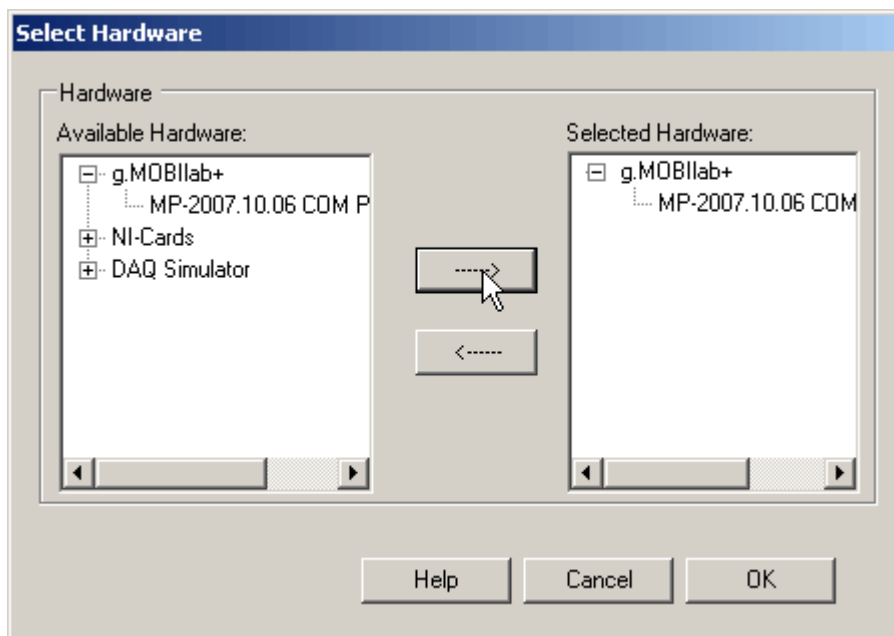
Click on the buttons to set the markers. All markers are stored together with the biosignal data. The digital inputs and outputs are sampled together with the biosignal data.

g.MOBilab+

In the **Settings** menu select **Select Hardware...**



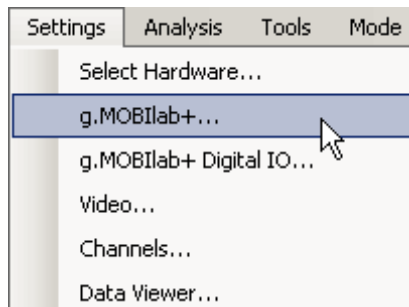
The **Select Hardware** dialog opens:



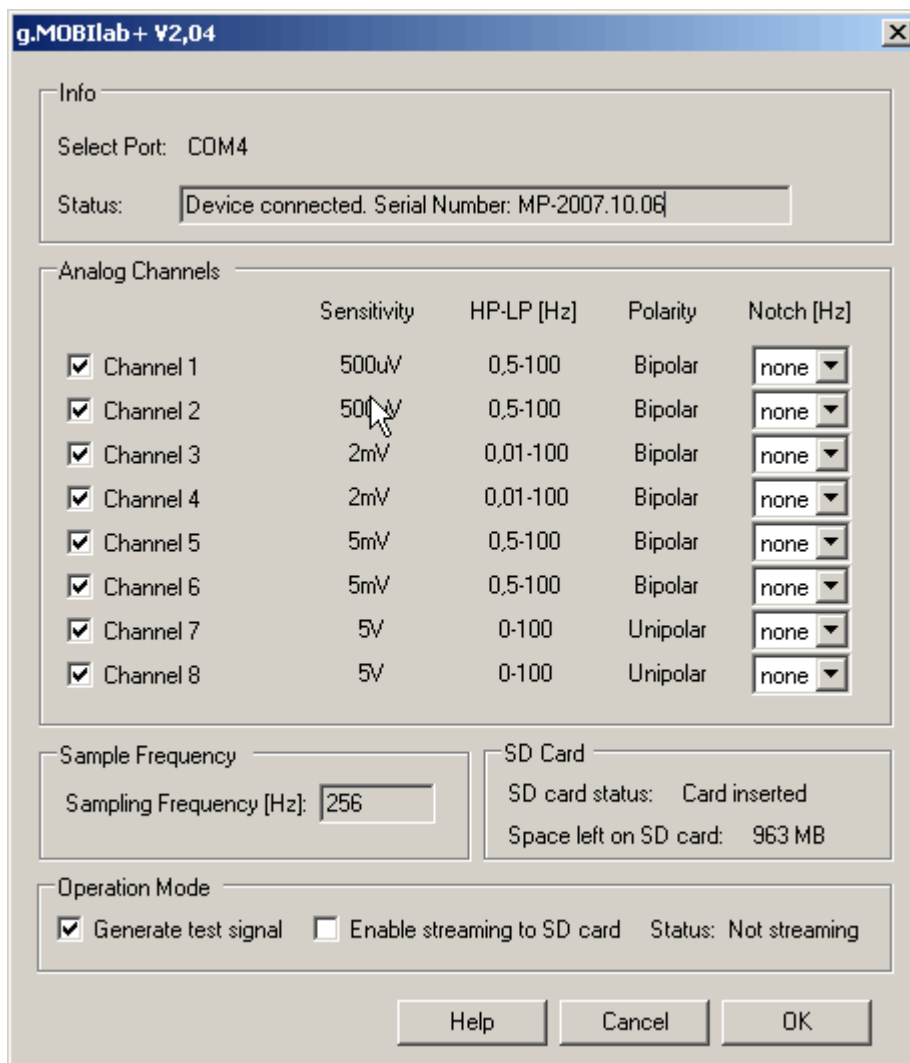
Select from **Available Hardware** the **g.MOBilab+** that should be used for the measurements and click on the arrow button as shown in the figure above. Now this **g.MOBilab+** with the serial number and the COM port number is displayed in the **Selected Hardware** box. The COM port of your **g.MOBilab+** can be found in **Bluetooth Devices** in the **Control Panel**.

Click **OK** to finish hardware selection.

To configure g.MOBilab+ click on the **g.MOBilab+...** button in the **Settings** menu.



The configuration window opens:



Info

In this section the COM port where g.MOBilab+ is connected and the serial number of g.MOBilab+ are shown.

Analog Channels

In the **Analog Channels** section the channels to be recorded can be selected. The **Sensitivity**, the highpass **HP**, the lowpass **LP** and the **Polarity** are displayed. Additionally a 50 or 60 Hz **Notch** filter can be applied.

Sampling Frequency

The **Sampling Frequency** is 256 Hz.

SD card

If a SD Card is inserted into g.MOBllab+, then the **SD card status** is displayed in the **SD Card** section including the space left on the SD Card.

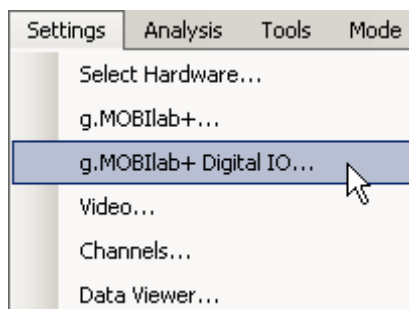
Operation Mode

In the **Operation Mode** section on the bottom of the dialog the checkboxes **Generate test signal** and **Enable streaming** are located.

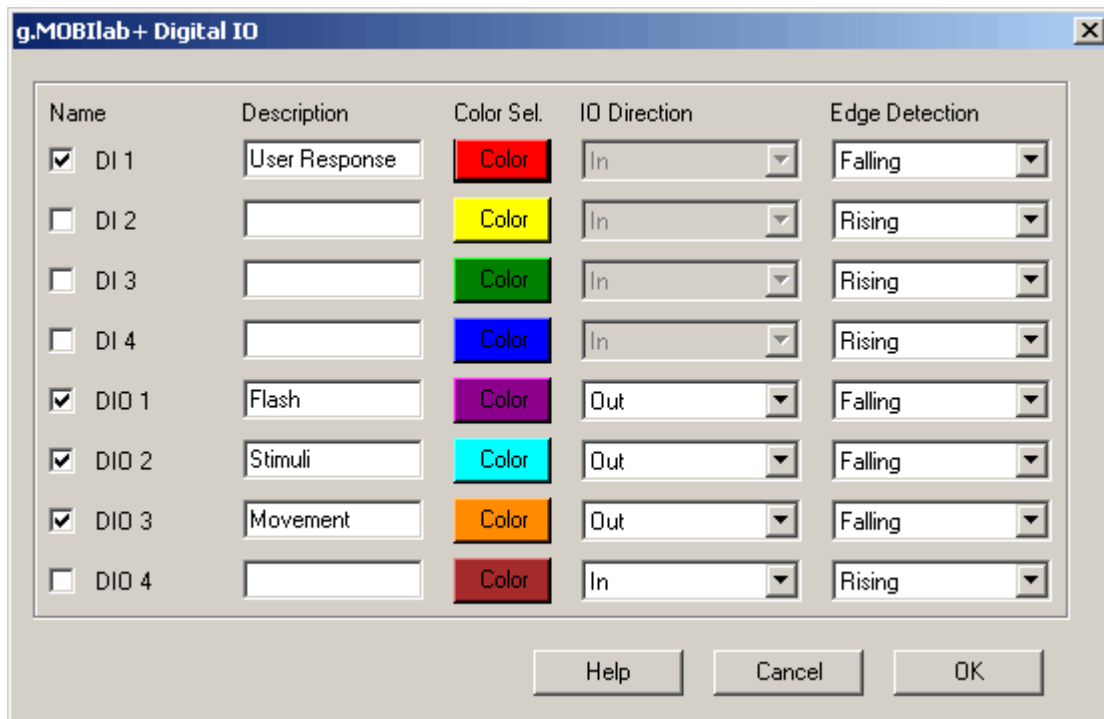
With the **Generate test signal** checkbox selected, g.MOBllab+ will output a test signal consisting of ramps with different slopes on the eight analog channels and the digital channels will toggle at different rates. This function is implemented to test the connection between g.MOBllab+ and PC or laptop. It is recommended that the markers are turned off for this function.

The **Enable streaming to SD card** checkbox is only enabled if a SD Card is inserted into g.MOBllab+. If the checkbox is selected then it is possible to disconnect g.MOBllab+ from the **g.Recorder** environment and the device will continue to stream data to the built-in SD Card. If a connected g.MOBllab+ is already streaming data then this **Status** is also displayed in the **Operation Mode** section.

g.MOBllab+ provides eight digital channels. To configure the digital inputs and outputs click on the **g.MOBllab+ Digital IO...** button in the **Settings** menu.



DIO1 to DIO4 can be configured as digital input or as output. **DI1 to DI4** are digital inputs. Set the **Edge Detection** to either detect only **Falling** or **Rising** edges or to detect both, **Rising+Falling**.



Name	Description	Color Sel.	IO Direction	Edge Detection
☒ DI 1	User Response	Color	In	Falling
☐ DI 2		Color	In	Rising
☐ DI 3		Color	In	Rising
☐ DI 4		Color	In	Rising
☒ DIO 1	Flash	Color	Out	Falling
☒ DIO 2	Stimuli	Color	Out	Falling
☒ DIO 3	Movement	Color	Out	Falling
☐ DIO 4		Color	In	Rising

Buttons: Help, Cancel, OK

Perform the settings as shown in the figure above and close the dialog with **OK**. Then the following controls will be visible in **g.Recorder**:

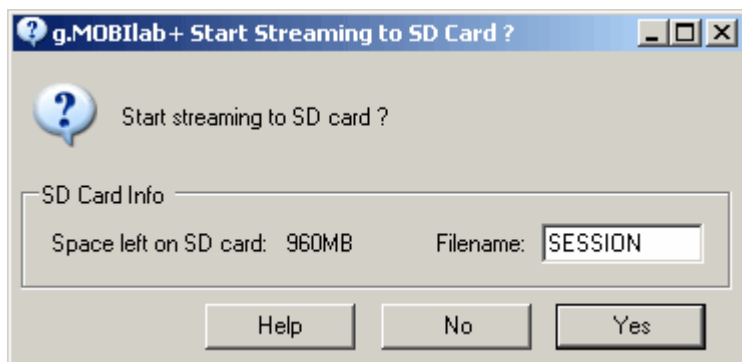


Digital Out: H DIO 1 H DIO 2 H DIO 3

Click on the buttons to set the markers. All markers are stored together with the biosignal data. The digital inputs and outputs are sampled together with the biosignal data.

If **Enable streaming** in the g.MOBILab+ dialog is selected and the data acquisition is started by clicking on the Display button the **g.MOBILab+ Start Streaming to SD Card** dialog will appear.

If g.MOBILab+ is already streaming, the **Status** in the **Device** section will be set to Streaming. The **SD Card** section will be disabled.



Start streaming to SD card ?

SD Card Info

Space left on SD card: 960MB Filename: SESSION

Buttons: Help, No, Yes

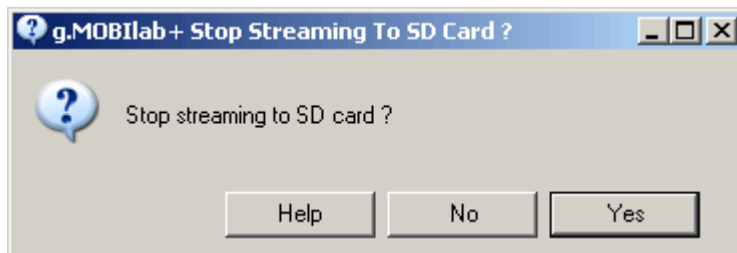
The **Start Streaming to SD Card** dialog asks the user to provide a **Filename** for the data recorded to the SD card.

The default filename is `SESSION`, characters entered are set to uppercase automatically. Characters not allowed for a filename are <, >, \, /, :, *, |, ? and ". Numbers can also be used.

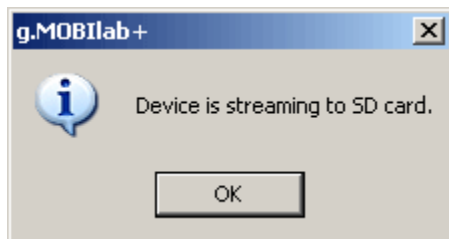
The **Space left on SD Card** in MB is also displayed

To confirm streaming to SD card click **Yes**. Then data are displayed in **g.Recorder** for control purpose and data are streamed to the built-in SD card on g.MOBllab+
Click **No** to simply display data in **g.Recorder**.

When the data acquisition is stopped, then **g.MOBllab+ Stop Streaming To SD card** dialog will appear. To stop the data transfer to the PC and data acquisition to the SD Card in g.MOBllab+ click **Yes**. To continue streaming data to the SD Card click **No**.

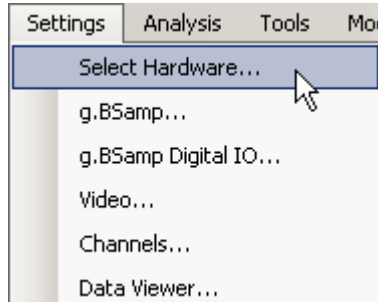


If g.MOBllab+ is already streaming data to SD card, then you can reconnect the device to **g.Recorder**. Therefore an information dialog will appear. Click **OK** to display data again from g.MOBllab+ in **g.Recorder**.

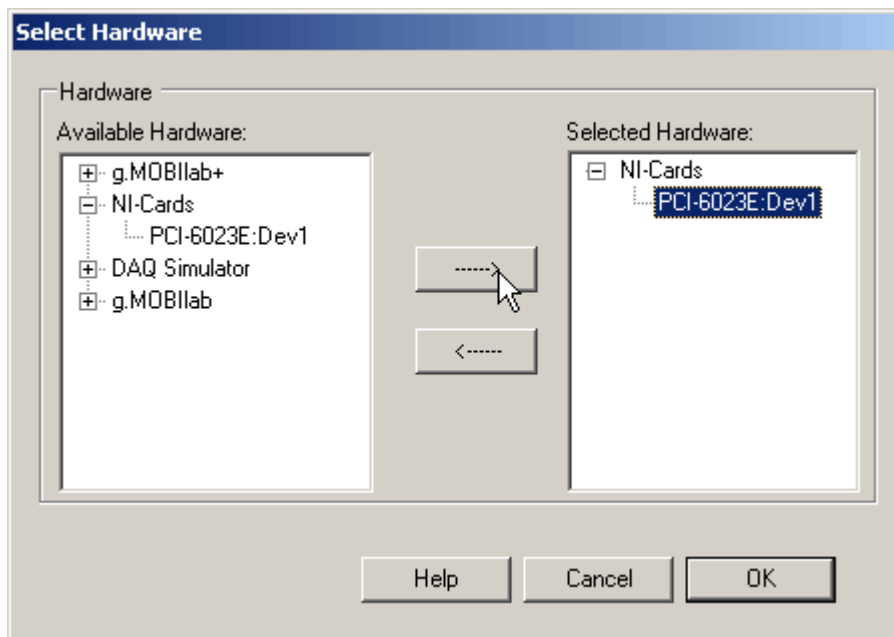


g.BSamp

In the **Settings** menu select **Select Hardware...**

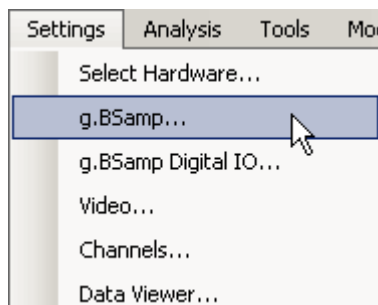


If the National Instruments data acquisition card (DAQ card) is installed correctly the NI-Card is listed under **Available Hardware**. Add the correct DAQ card to the **Selected Hardware** listbox.

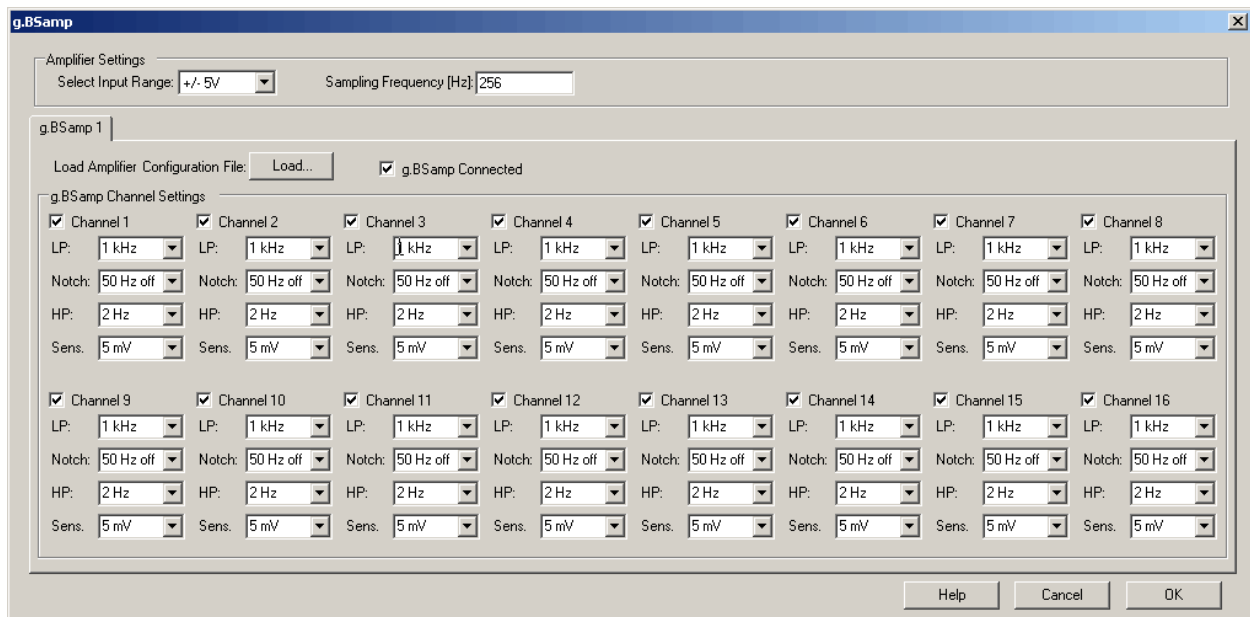


Then close the window with the **OK** button.

After finishing the hardware selection choose **g.BSamp...** in the **Settings** menu.



The **g.BSamp** configuration dialog provides all the settings needed for your measurement.



Amplifier Settings

Input Range – select the correct input range of the DAQ card (+/- 10V or +/- 5V). For g.BSamp select + / - 5V

Sampling Frequency [Hz] - select the sampling frequency

Then for each **g.BSamp** the **Channel Settings** are shown:

Load... - an amplifier configuration file can be loaded

LP – select the lowpass filter of the amplifier

Notch – select the Notch filter

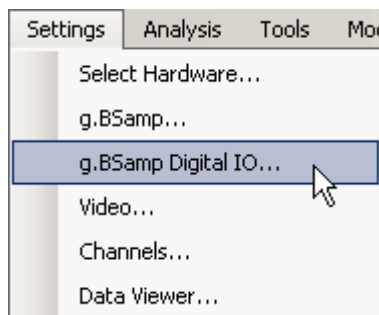
HP – select the highpass filter

Sens – select the sensitivity

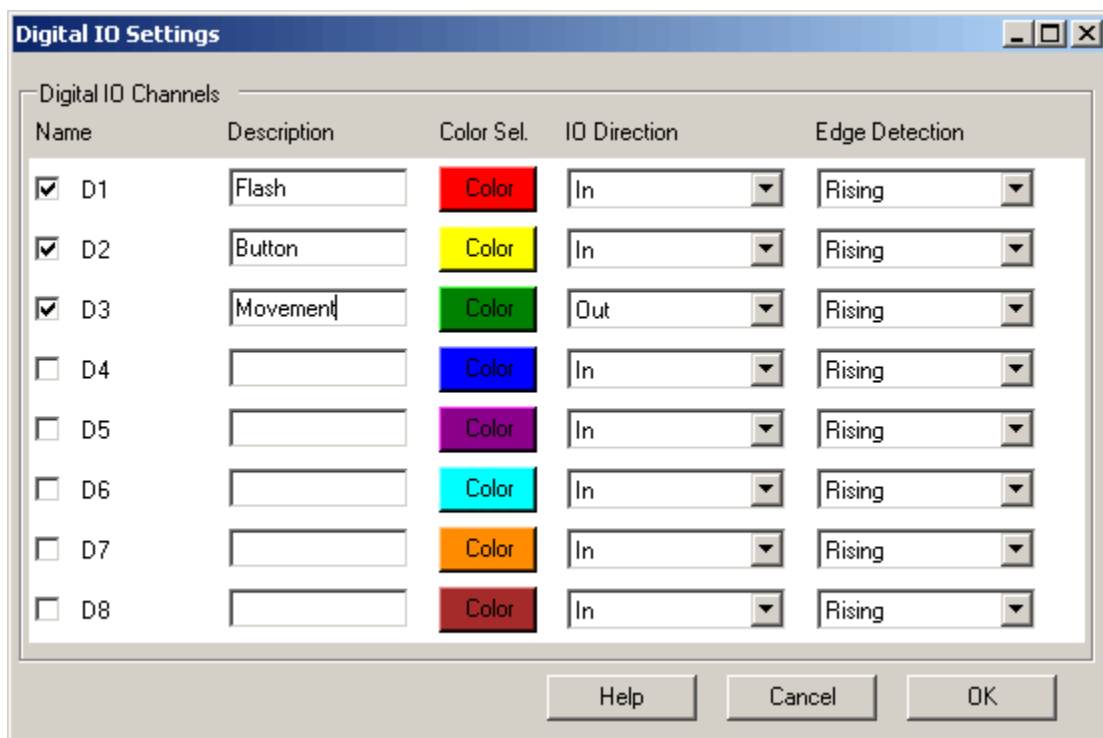
Note: All these settings are only status information and do NOT affect the settings of the amplifier.

Click **OK** to confirm settings.

The DAQ card provides 8 digital input and output channels. To configure the channels select **g.BSamp Digital IO...** in the **Settings** menu

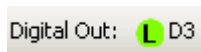


This opens the **Digital IO Settings** dialog.



Select the digital inputs and outputs and assign a **Description** and a **Color** to each one. Then define each channel as input **In** or as output **Out** and if a **rising** and/or **falling** edge should be detected.

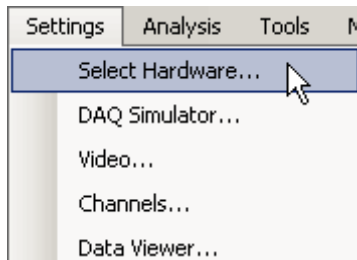
Outputs are listed in the Toolbar:



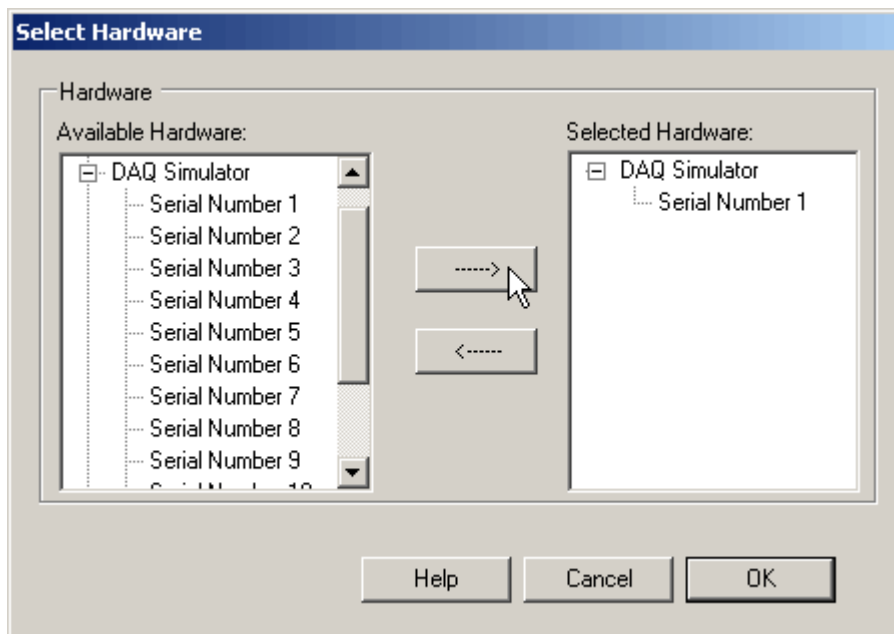
Press on the button to set the output to high H or low L level. The digital inputs and outputs are logged together with the biosignal data.

DAQ Simulator

In the **Settings** menu select **Select Hardware...**



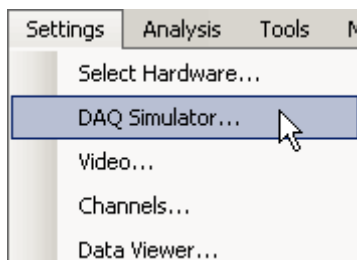
The **Select Hardware** dialog opens:



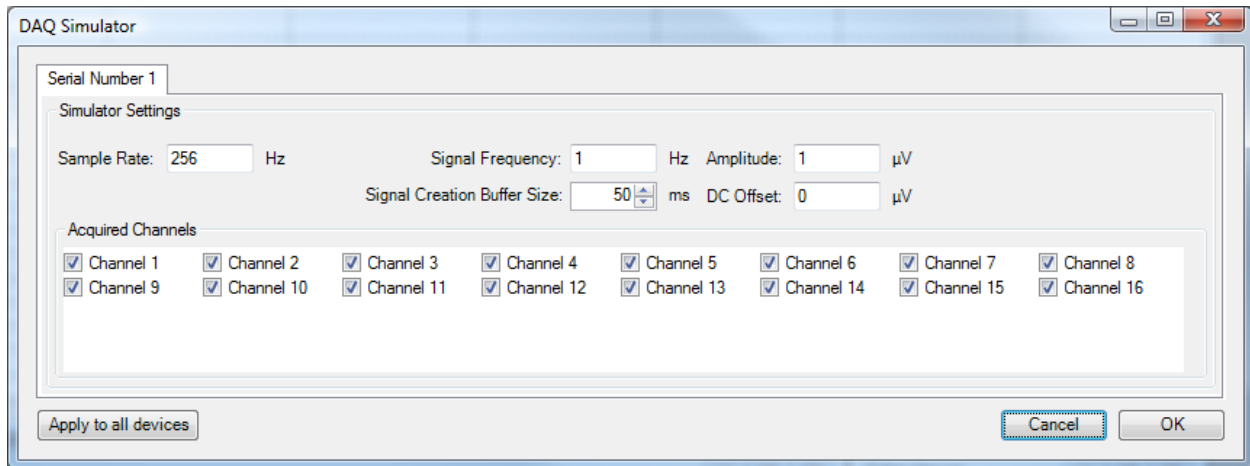
Select **Serial Number 1** from the **Available Hardware** list and click on the arrow button to add it to the **Selected Hardware** list. If more than 16 channels should be simulated add as many **DAQ Simulators** as needed.

Click **OK** to close the dialog.

To configure the DAQ Simulator select **DAQ Simulator** from the **Settings...** menu.



The configuration window opens with the simulator serial number (e.g. 1):



Sampling Rate [Hz]	specify the sampling frequency of the DAQ Simulator in Hz
Signal Frequency [Hz]	specify the frequency of the test signal
Amplitude [μV]	specify the amplitude of the test signal
Time Interval [ms]	set the interval between the imports of the samples. (e.g. set the Timer Interval to 50 ms at a sampling rate of 1 kHz then every 50 ms 50 samples are drawn)
DC Offset [μV]	specify the offset of the test signal
Channel Selection	select the channels to be recorded

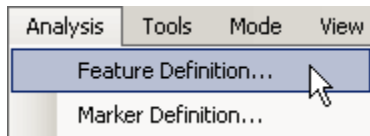
If multiple simulators are configured use the **Apply to all Amplifiers** button to perform the settings for all amplifiers.

Note: data in the **DAQ Simulator** is not sampled equidistantly!

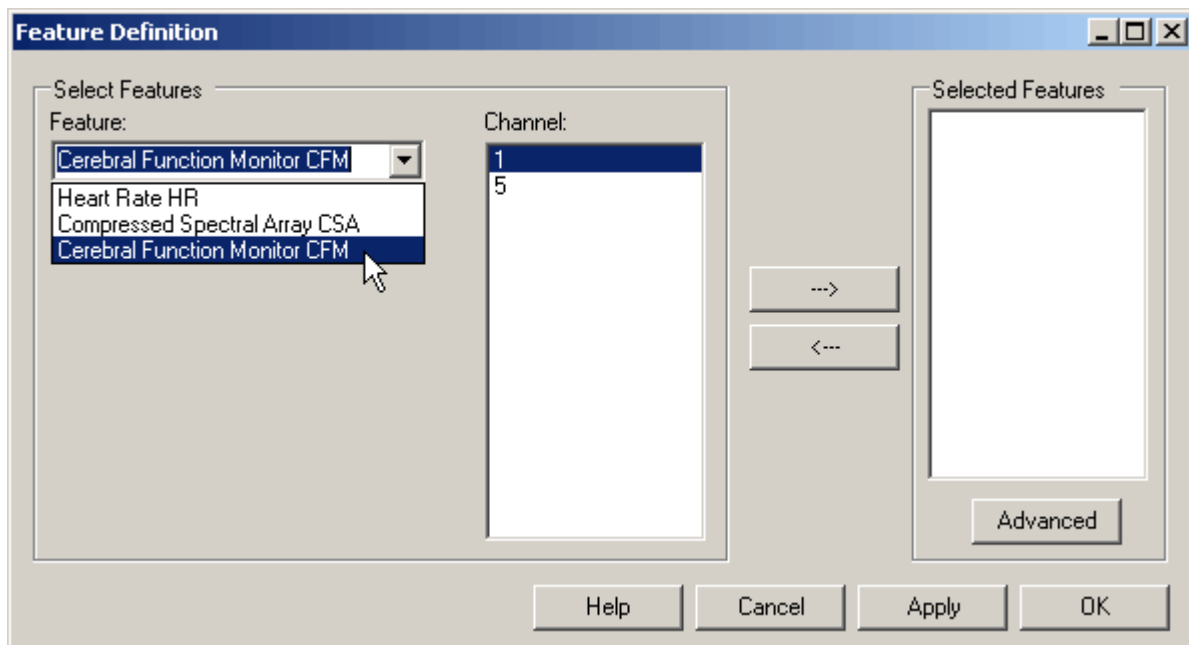
Feature Definition

g.Recorder allows calculating in real-time specific features which are shown in the Feature Viewer. **g.Recorder** supports the Cerebral Function Monitor (CFM) parameter, the Heart Rate (HR) and the Compressed Spectral Array (CSA).

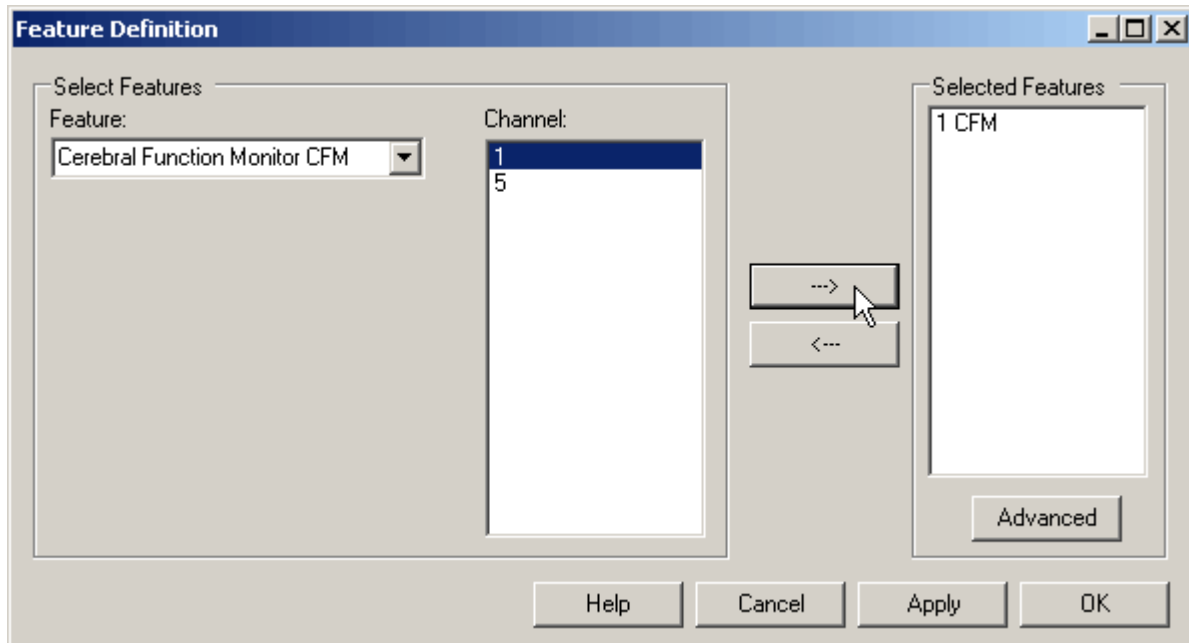
Select **Feature Definition...** from the **Analysis** menu



In the **Feature Definition** dialog select the Cerebral Function Monitor (CFM)

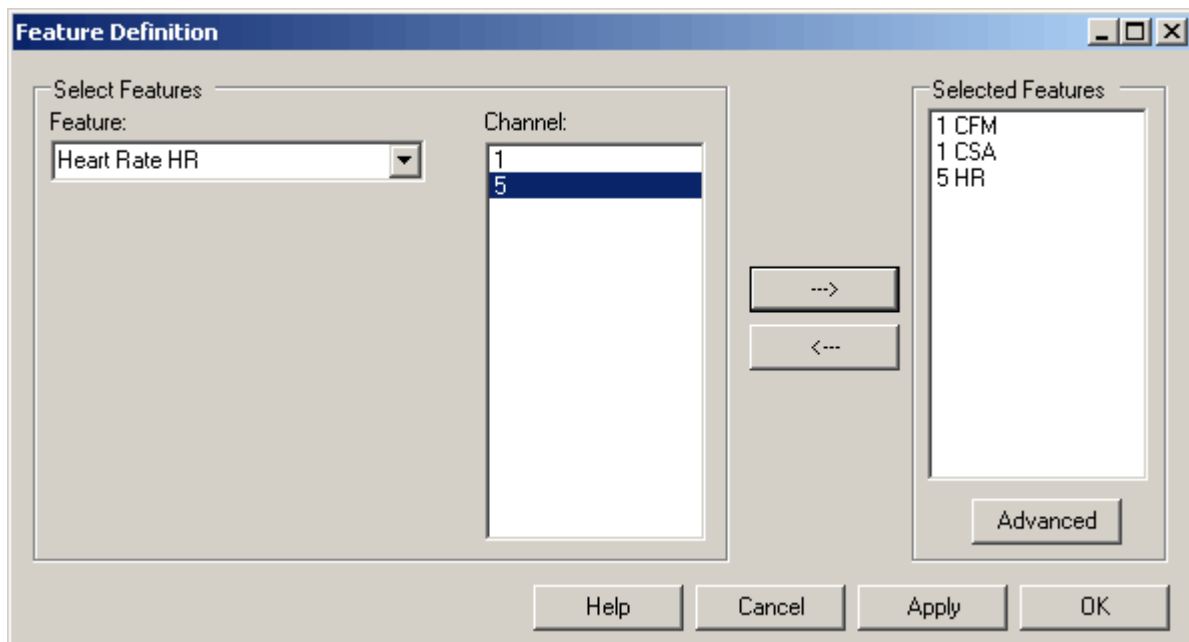


Then select the EEG **Channel** that is used to calculate the feature and add the feature with the arrow button.



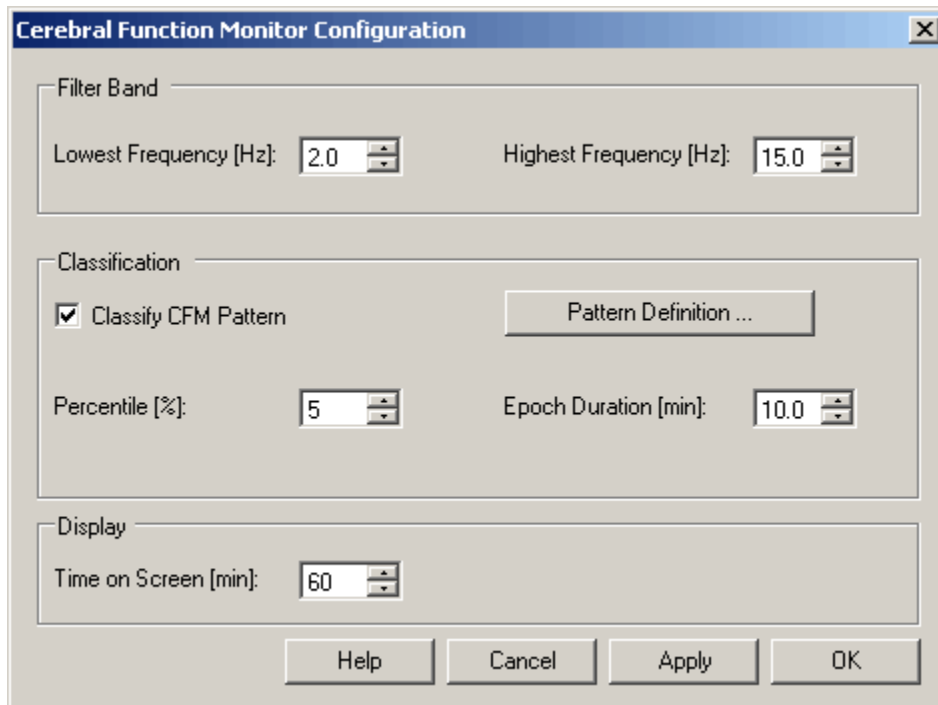
On the right side the channel number and the selected feature are displayed.

Furthermore calculate the **HR** from the ECG channel 5 and the **CSA** also from EEG channel 1.



Configure CFM

To configure the CFM feature select it and click on the **Advanced** button. This opens the **CFM Configuration** dialog below.



The screenshot shows the 'Cerebral Function Monitor Configuration' dialog box. It has a title bar with a close button. The dialog is divided into three main sections: 'Filter Band', 'Classification', and 'Display'. The 'Filter Band' section contains two spinners: 'Lowest Frequency [Hz]' set to 2.0 and 'Highest Frequency [Hz]' set to 15.0. The 'Classification' section has a checked checkbox 'Classify CFM Pattern', a 'Pattern Definition ...' button, a 'Percentile [%]' spinner set to 5, and an 'Epoch Duration [min]' spinner set to 10.0. The 'Display' section has a 'Time on Screen [min]' spinner set to 60. At the bottom are four buttons: 'Help', 'Cancel', 'Apply', and 'OK'.

Filter Band

Lowest Frequency [Hz] – select the lower cutoff frequency for the CFM calculation

Highest Frequency [Hz] – select the upper cutoff frequency for the CFM calculation

Classification

Classify CFM Pattern – check to automatically classify the CFM signal

Percentile [%] – the percentile specifies the lower and upper signal amplitude border for the segmentation

Epoch Duration [min] – specify the segment size in minutes

Pattern Definition – specify the segmentation rules

Display

Time on Screen [min] – enter the minutes shown on one page in the Feature Viewer

Press on the **Pattern Definition...** button to open the following dialog:

The dialog box is titled "CFM Pattern Definition". It contains a "Pattern" section with fields for Name, Lower level [μV], Upper level [μV], Color, and a Visible checkbox. Below this are buttons for Add, Remove, and Apply changes. At the bottom are buttons for Help, Cancel, Apply, and OK.

Pattern settings shown:

- Name: BURST
- Lower level [μV]: From: >10 To: <10
- Upper level [μV]: From: >70 To: <70
- Color: Magenta
- Visible: ☒

Name	Lower level From	Lower level To	Upper level From	Upper level To	Color	Visible
CVP	>0	<5	>=10	<=70	Red	TRUE
DLVP	>0	<3	>=15	<=70	Yellow	TRUE
DHVP	>=3	<=5	>=10	<=70	Green	TRUE
ISO	>0	<3	>10	<10	Cyan	TRUE
BSP	>0	<3	>=10	<15	Blue	TRUE
BURST	>10	<10	>70	<70	Magenta	TRUE

Then enter a **Name**, the **Lower level**, the **Upper level** and define a **Color** for the specific pattern.

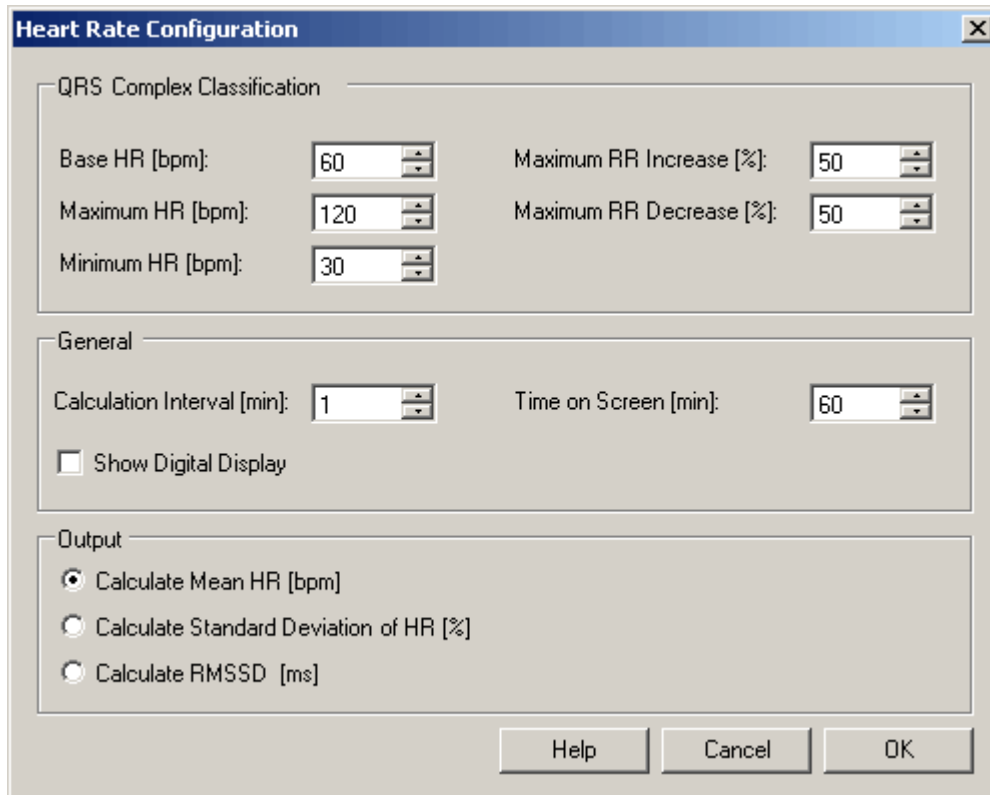
Click the **Add** button to add the pattern to the list. With **Remove** a selected pattern can be removed from the list and with the **Apply changes** button the settings for a selected pattern in the list can be applied.

The figure above shows the standard classification used for neonatal recordings.

Close the dialog with the **OK** button.

Configure Heart Rate

Select the **HR** feature and click on the **Advanced** button to open the following dialog:



The dialog box is titled "Heart Rate Configuration" and contains three sections: "QRS Complex Classification", "General", and "Output".

QRS Complex Classification

Base HR [bpm]:	60	Maximum RR Increase [%]:	50
Maximum HR [bpm]:	120	Maximum RR Decrease [%]:	50
Minimum HR [bpm]:	30		

General

Calculation Interval [min]:	1	Time on Screen [min]:	60
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☐ Show Digital Display

Output

☒ Calculate Mean HR [bpm]
☐ Calculate Standard Deviation of HR [%]
☐ Calculate RMSSD [ms]

Buttons: Help, Cancel, OK

QRS Complex Classification

Base HR [bpm] - base heart rate in beats per minute

Maximum HR [bpm] - maximum heart rate in beats per minute

Minimum HR [bpm] - minimum heart rate in beats per minute

Maximum RR Increase [%] - maximum allowed increase of interval between two QRS complexes in percent

Maximum RR Decrease [%] - maximum allowed decrease of interval between two QRS complexes

General

Calculation Interval [min] – specify the interval that is used to calculate the HR

Time on Screen [min] - enter the minutes shown on one page in the Feature Viewer

Show Digital Display – if selected the actual information for the heart rate or heart rate variability is displayed right next to the feature channel.

Output

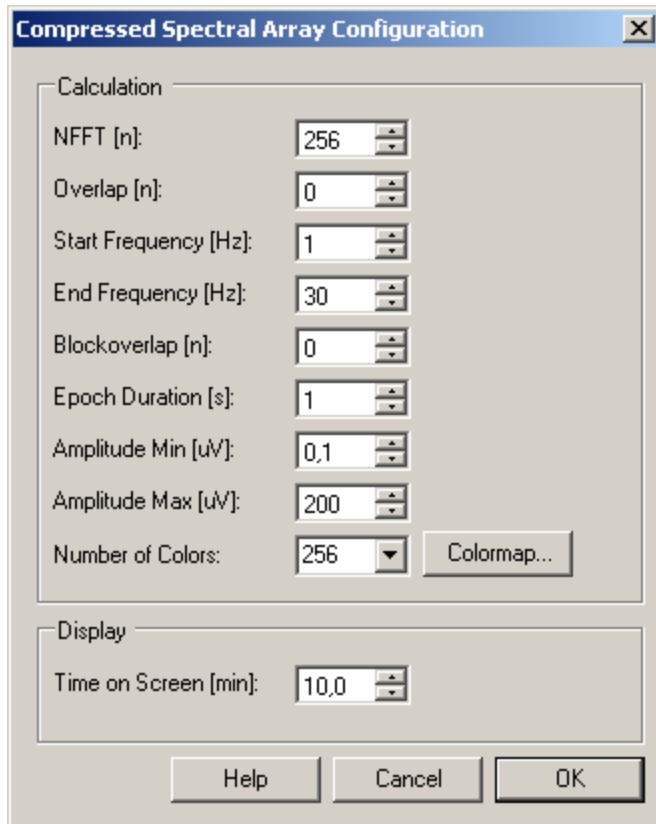
Calculate Mean HR [bpm] – mean HR of **Calculation Interval**

Calculate Standard Deviation of HR [%] – standard deviation of HR in **Calculation Interval**

Calculate RMSSD [ms] - root mean square of successive differences of HR in the **Calculation Interval**

Configure CSA

Select the **CSA** feature and click on the **Advanced** button to open the following dialog:



The image shows a software dialog box titled "Compressed Spectral Array Configuration". It is divided into two main sections: "Calculation" and "Display".

Calculation Section:

- NFFT [n]: 256
- Overlap [n]: 0
- Start Frequency [Hz]: 1
- End Frequency [Hz]: 30
- Blockoverlap [n]: 0
- Epoch Duration [s]: 1
- Amplitude Min [uV]: 0,1
- Amplitude Max [uV]: 200
- Number of Colors: 256 (with a dropdown arrow)
- A "Colormap..." button is located to the right of the "Number of Colors" field.

Display Section:

- Time on Screen [min]: 10,0

At the bottom of the dialog are three buttons: "Help", "Cancel", and "OK".

Calculation

NFFT - number of samples for the FFT

Overlap - number of samples that overlap

Start Frequency - lower value of y-axis scaling in Hz

End Frequency - higher value of y-axis in Hz

Blockoverlap - number of samples that overlap with preceding epoch

Epoch Duration - duration between calculated FFT outputs

Amplitude Min [uV] – minimal amplitude coded in the colormap

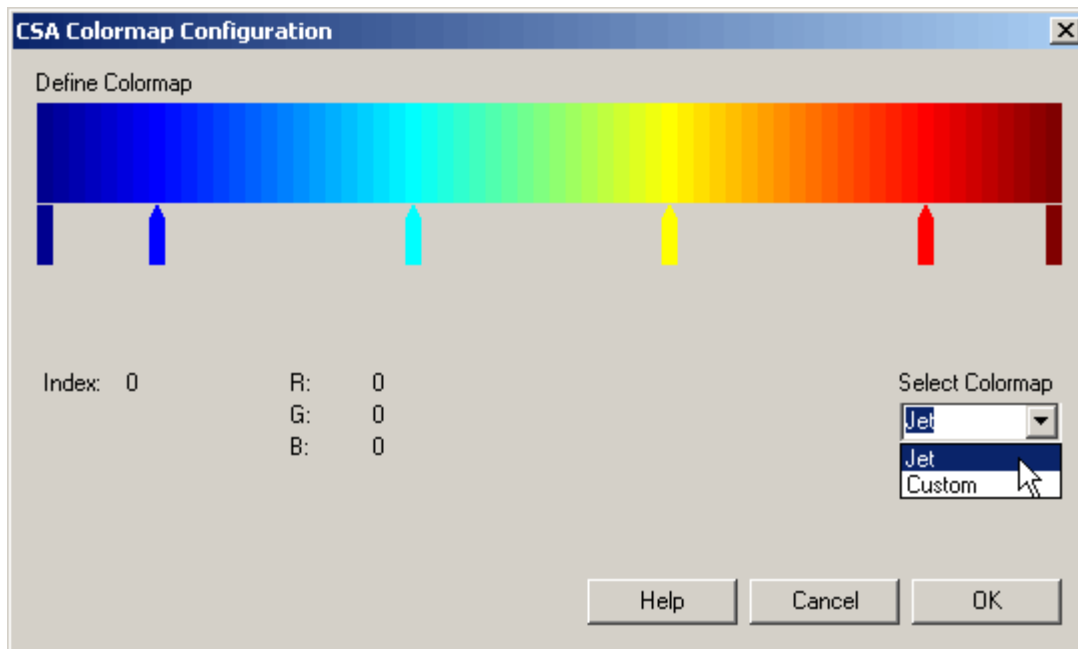
Amplitude Max [uV] – maximal amplitude coded in the colormap

Number of Colors – number of color used for the CSA colormap

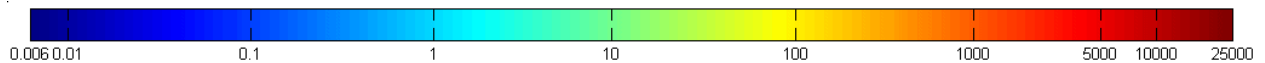
Display

Time on Screen [min] - enter the minutes shown on one page in the Feature Viewer

Click the **Colormap...** button in the **Calculation** section to define the colormap used for the CSA. This opens the following dialog:



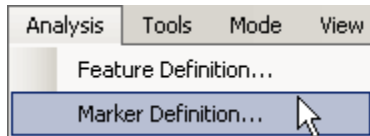
The CSA is plotted in $\mu V^2/Hz$ ranging from **Amplitude Min** to **Amplitude Max**. E.g. the different colors in the color bar below represent the power of the signal recorded with a logarithmic scale ranging from 0.006 to 25.000 $\mu V^2/Hz$ with 256 colors.



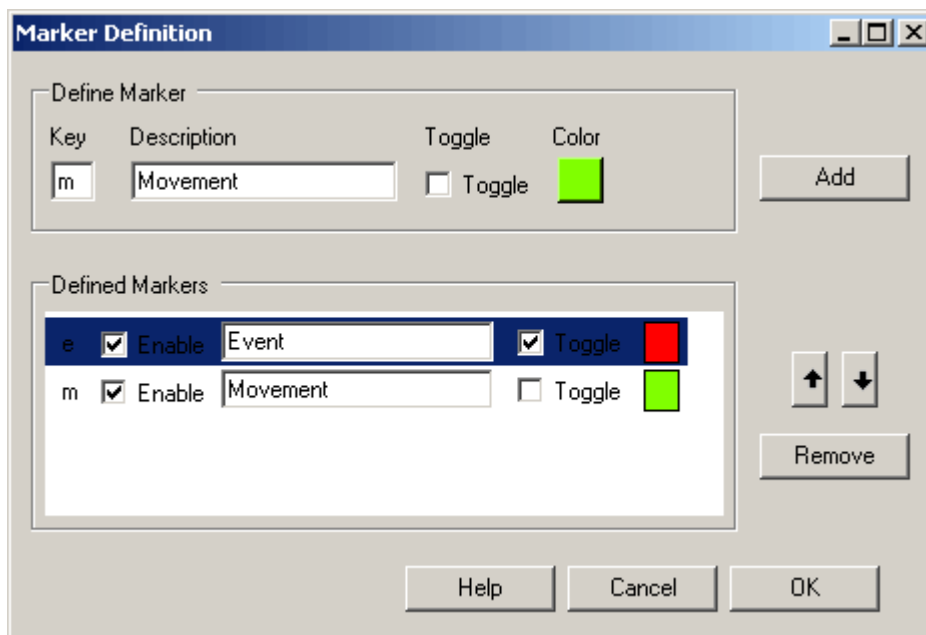
Marker Definition

Markers can be used during measurement to highlight certain events. **g.Recorder** allows defining markers which indicate a specific time point and region markers which indicate a time window.

Click on **Marker Definition** under the **Analysis** menu.



to open the following window:



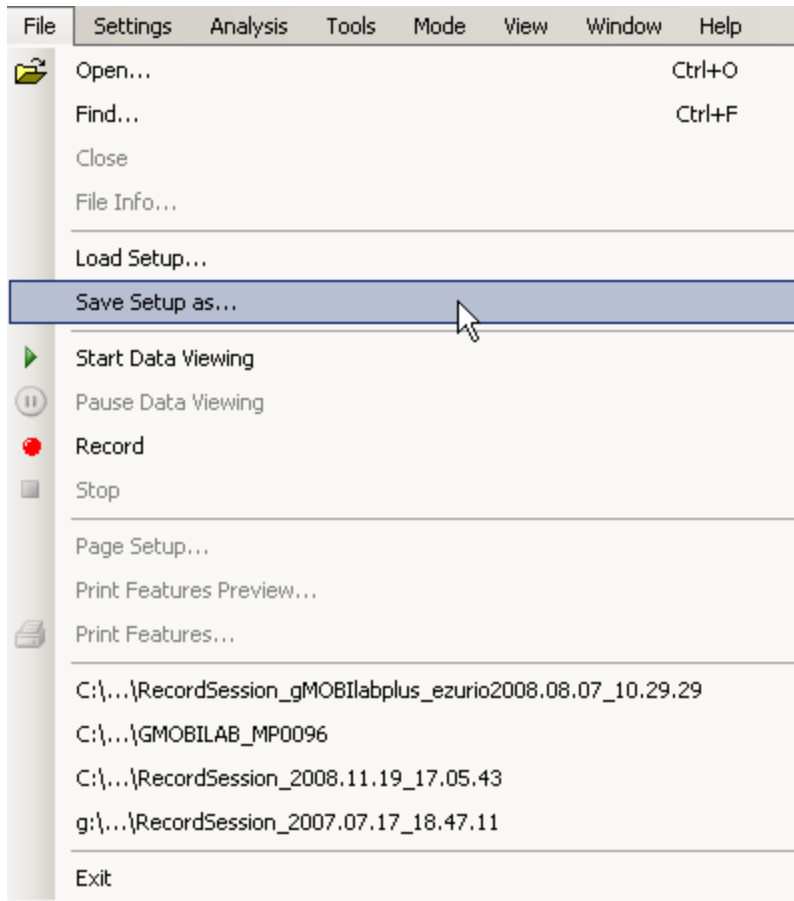
Define one marker with the key `m` and name `Movement`, select the green color. Do not check the **Toggle** checkbox to have a marker that indicates a specific point in time. Use the **Add** button to define the marker.

Then define key `e` as region marker by checking the **Toggle** checkbox. Set the description to `Event`.

Finally close the window.

Save Configuration

To store the settings select **Save Setup as...** function in the **File** menu.



The last configuration is loaded automatically at the next program start.

Load Configuration from the command line

g.Recorder can be initialized by previous stored configuration using command line option `grecorder \d [Configuration file]`.

If the configuration file cannot be found at startup, then the last used configuration will be loaded. This option is useful for providing specific study setups.



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