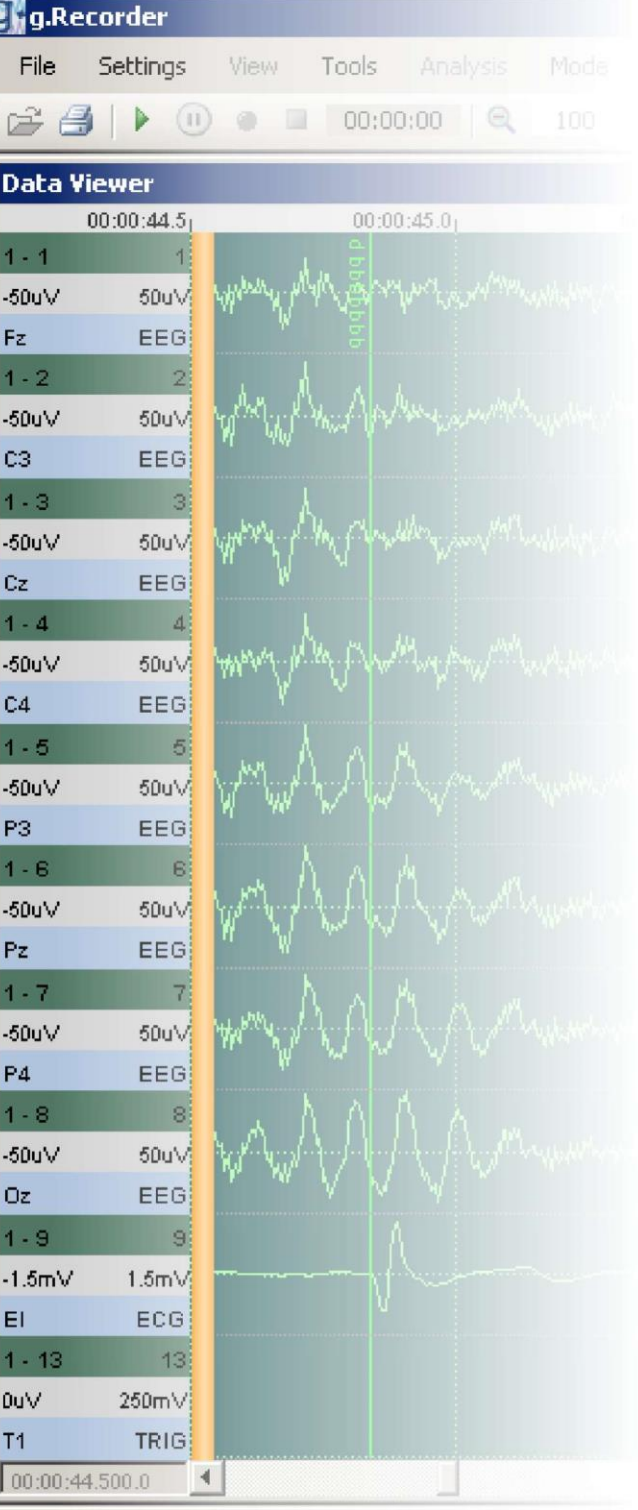

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g.tec GUGER TECHNOLOGIES

g.Recorder BIOSIGNAL RECORDING SOFTWARE

USER MANUAL V5.16.00

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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.
Flexibly choose and combine the elements for biosignal amplification, signal processing and stimulation to perform even real-time feedback.

Our team is prepared to find the best 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 by relying on g.tec's new software features to handle ICA, AAR or online Hjorth's source derivation.

Study design and data analysis

Are you 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. Trigger information and video sequences can also be captured. An easy-to-use *Replay* mode allows for the inspection of data after recording.

g.Recorder has been designed to work with the g.tec biosignal amplifiers, g.HIamp and g.USBamp, and with the portable devices g.MOBIlab+ and g.Nautilus.

g.Recorder offers raw data inspection and also the extraction and presentation of different parameters. These include, but are not limited to, heart rate variability, heart rate, compressed spectral arrays, 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.

Intended use

g.Recorder is intended to be used for acquisition, processing, recording and review of biosignal data measured by common g.tec biosignal amplifiers. These biosignals may include electroencephalogram (EEG), electromyogram (EMG), electrooculogram (EOG), and electrocardiogram (ECG), for example.

The device must not be used for patient monitoring. The device must not be used for the determination of brain death. Additional examinations are needed for diagnosis, and no diagnosis may be done only based on using this device.

Indications for use

We have attempted to write this manual as accurately as possible. However, 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, updates or new extensions please visit our homepage www.gtec.at or just send us an email at office@gtec.at.

Related Documents

g.Recorder Quickstart – A short introduction on how to use g.Recorder with g.USBamp, g.HIamp, and g.MOBIlab+ devices.

g.Recorder Parallel Port Qickstart – A short introduction on how to use stimulus delivery software **E-Prime**® (Psychology Software Tools, Inc., www.pstnet.com) and **Presentation**® (Neurobehavioral Systems, Inc., www.neurobs.com) over the parallel port with g.HIamp or g.USBamp devices and g.Recorder.

g.Recorder Evoked Potentials Quickstart – A short introduction on calculation and display of evoked potentials in g.Recorder with g.USBamp devices using g.HIsys for stimulus presentation.

Furthermore, g.tec can provide tutorials on how to load g.Recorder data into **EMSE**® **Suite**, **BESA**®, and **EEGLAB/ERPLAB Toolbox**.

Conventions

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

Release Notes

Release notes bring to your attention new features of, and changes to, g.Recorder when upgrading to a newer version.

New features

- Biosignal amplifier g.Nautilus is now supported.

Changes

- Windows 10, 64-bit is now supported; Windows 7 support retired.
- Updated g.HIamp impedance measurement window and corresponding description according to new driver version.
- The g.HIamp configuration dialog shows an information message now if channel-specific settings should be applied but no channels are highlighted.
- Added performance hint to feature definition section in manual (regarding CFM/CSA).
- The system requirements have changed.

Installation and Configuration

Hardware and Software Requirements

g.Recorder requires a PC compatible desktop or notebook workstation running Microsoft® Windows® operating system[1] and, optionally, a color printer. The table below lists optimal settings (depending on the acquisition hardware):

Hardware	**Properties**
CPU	2 GHz or faster processor
Harddisk	30 GB or higher
RAM	4 GB or higher
USB 2.0 port	One free USB port for the hardlock dongle
USB 2.0 port (optional)	One free USB port for each g.HIamp device One free USB port for each g.USBamp device One free USB port for each g.Nautilus device One free USB port for attaching a color printer
Bluetooth® interface[2] (optional)	*Bluetooth*® interface for g.MOBIlab+ devices
Screen resolution	1920 x 1080 pixels
Video camera	Webcam

g.Recorder acquires data from g.tec's biosignal amplifiers. Depending on the used devices, the corresponding drivers for g.HIamp, g.USBamp, g.Nautilus (g.NEEDaccess) or g.MOBIlab+ must be installed. Depending on the Windows® operating system, administrator rights might be necessary for the installation.

Software	**Version**
Microsoft® Windows®	Windows 10 Pro English 64-bit
g.HIamp driver	2.16.00
g.USBamp driver	3.16.00
g.MOBIlab+ driver	1.16.00
g.MONcreator	5.16.00
g.NEEDaccess	1.16.01
Sentinel HASP® Runtime Environment[3]	7.50
Adobe® Acrobat® Reader® [4]	DC 2015

[1] Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

[2] The *Bluetooth*® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. Other trademarks and trade names are those of their respective owners.

[3] HASP®, Sentinel HASP®, Hardlock®, are registered and/or unregistered trademarks of SafeNet, Inc., or Aladdin Knowledge Systems, Ltd., in the United States and other countries.

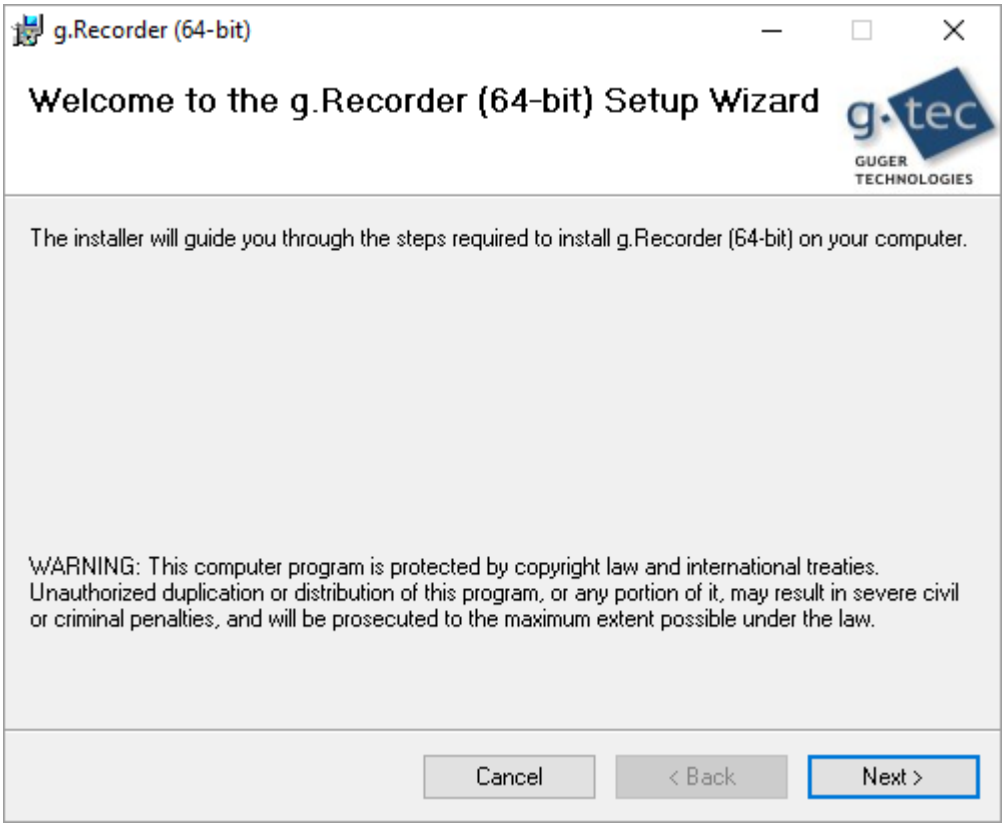
[4] Adobe, Acrobat, and Reader are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.

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

Perform the following steps to install **g.Recorder** software:

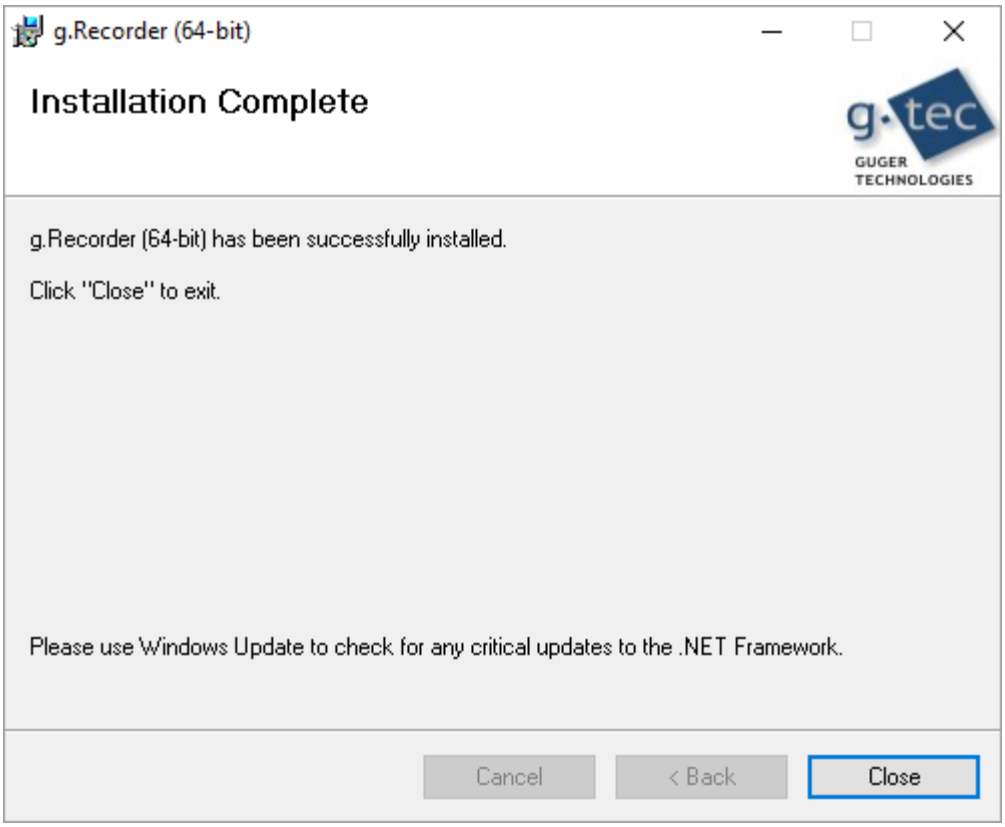
1. Insert the g.tec product CD, open the `g.Recorder` directory on the CD, open the correct directory for the architecture of your PC (`Win64`) and double-click `setup.exe`. If **User Account Control** is turned on, additional dialogs may ask for permission. Confirm the dialogs to allow installation of **g.Recorder** through **User Account Control**. The installation starts and displays the welcome message.



2. Click **Next** to read the **License Agreement**. If you agree with the terms, click **I Agree** and **Next**.

3. Choose the installation folder (default is `C:\Program Files\gtec\`) where the install routine should copy all necessary files and press **Next**.

4. Follow the instructions on the screen to install **g.Recorder**. When the following window informs you about completion of installation, click **Close** to complete.



5. After successful installation, insert the hardlock dongle into a free USB port of your PC or notebook.

   If the computer is connected to the internet, let Windows Update download and install the correct driver for the hardlock. For manual installation, run the `HASPUserSetup.exe` from the `prerequisites/HASP HL` folder on your g.tec CD.

   The red light of the hardlock must be on after successful installation.

Uninstall

To remove **g.Recorder** in Windows 10, use the **Programs and Features** tool in the **Control Panel**.

Note that you have to uninstall the hardlock driver software 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\gtec\gRecorder
```

Example configurations - are stored in the subdirectory

```
C:\Program Files\gtec\gRecorder\Config
```

Help files - are stored under

```
C:\Program Files\gtec\gRecorder\Help
```

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

```
C:\Program Files\gtec\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 six elements:

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

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

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

Selected parameters, for example, heart rate and cerebral function are displayed in the **Feature Viewer** window. 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.

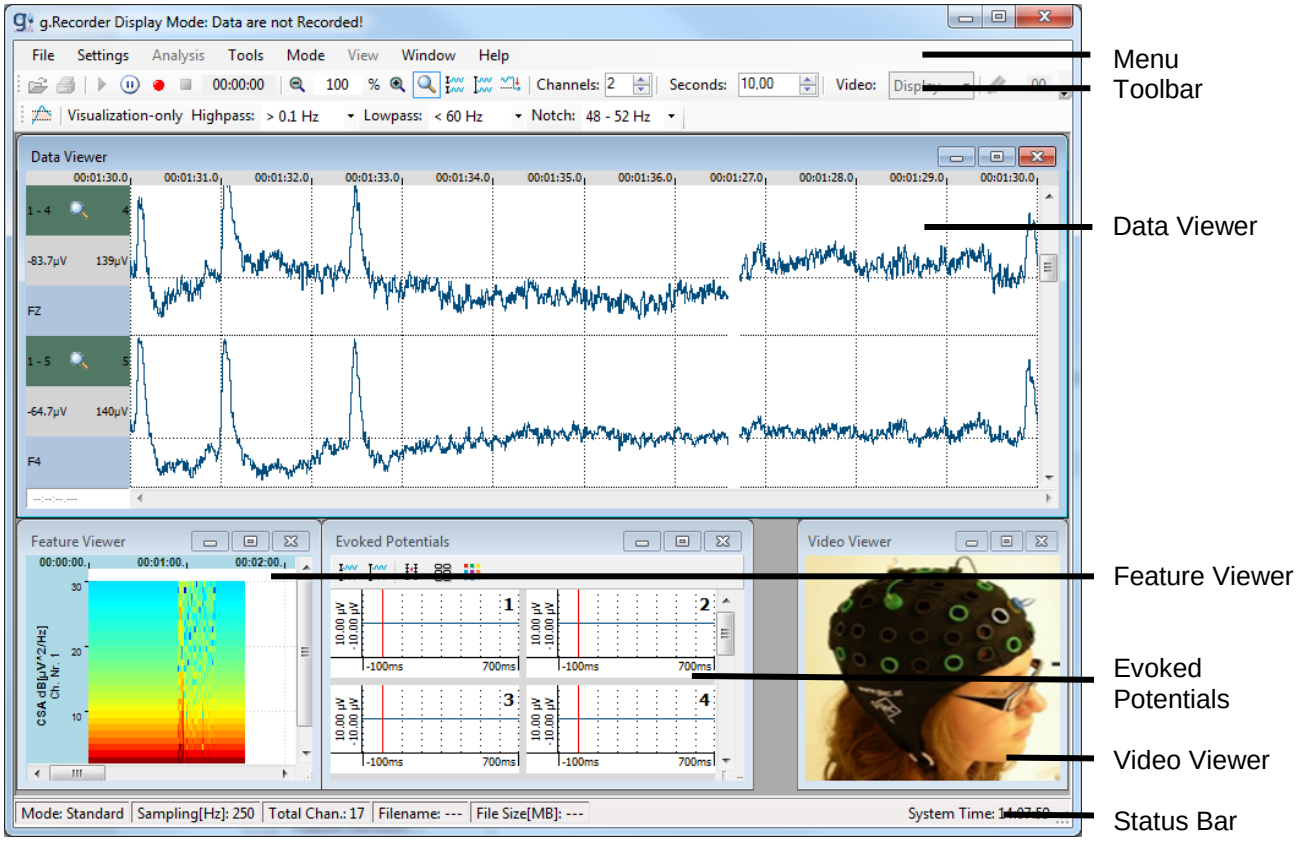
In the **Video Viewer** window the actual video sequence is displayed.

The **Evoked Potentials** viewer displays calculated evoked potentials for each acquired raw data channel, if configured. Zooming, scrolling and scaling for the evoked potential plots can be adapted directly in this viewer.

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 easy continuation of your studies. You can of course load another configuration.


g.Recorder Display Mode: Data are not Recorded!
File Settings Analysis Tools Mode View Window Help
Channels: 2
Seconds: 10,00
Video:
Visualization-only Highpass: > 0.1 Hz
Lowpass: < 60 Hz
Notch: 48 - 52 Hz
Data Viewer
FZ
F4
Feature Viewer
Evoked Potentials
Video Viewer
Mode: Standard
Sampling[Hz]: 250
Total Chan.: 17
Filename: ---
File Size[MB]: ---
System Time:
Menu
Toolbar
Data Viewer
Feature Viewer
Evoked Potentials
Video Viewer
Status Bar

Status Bar

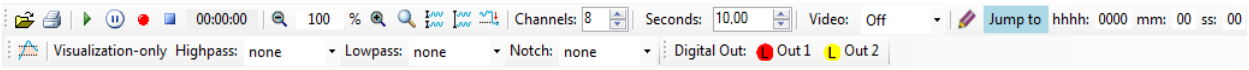
The actual status of **g.Recorder** is displayed in the **Status Bar** at the bottom of the main window. The **Status Bar** shows information that relates to the current recording. The first field shows the current **g.Recorder Mode**. When data are stored to the hard disk the mode is set to *Recording*.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

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

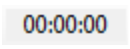
Pause Data Viewing
Pause displaying data in **Standard Mode**. If the pause button is pressed in *Recording* mode, then only the raw data display in the **Data Viewer** is stopped. The **Video Viewer** and the **Feature Viewer** are still updated in real-time.

- 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 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 also be inserted directly by typing in the desired zooming level

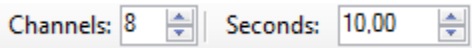
Auto Scale
The data in the **Data Viewer** are scaled to the actual maximal absolute value of the displayed data sequence. If **Auto Scale** is activated, a small icon is displayed in the channel information area on the left side of the **Data Viewer** window and the data is rescaled for every new page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

Global Maximum Auto Scale
Auto-scale all channels to the global minimum and maximum value of the displayed data sequence (plus 10%). This scaling is applied only once per click.

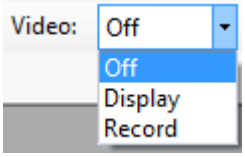
Individual Maximum Auto Scale
Auto-scale all the channels individually to their minimum and maximum value of the displayed data sequence (plus 10%). This scaling is applied only once per click.

Offset Auto Scale
Auto-scale each channel to its individual offset, preserving its previously configured amplitude range. This scaling is applied only once per click.

Signal Cropping
Enable or disable signal cropping. If signal cropping is enabled, the signal will be cropped at its displayed vertical channel range. If signal cropping is disabled, the data of the displayed channels may overlap the other channels' ranges. Examples are given below. Signal cropping is disabled by default.



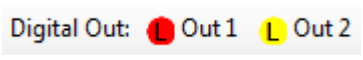
Set the number of channels and the number of seconds to be displayed in the **Data Viewer**



Off: no video is displayed.
Display: the video is displayed.
Record: the video is displayed and recorded (in recording mode).

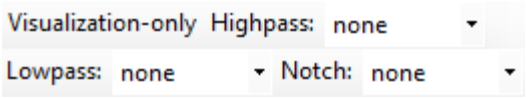
Activate/Deactivate displaying the marker information on screen.

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 the top to the bottom of the window including 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.

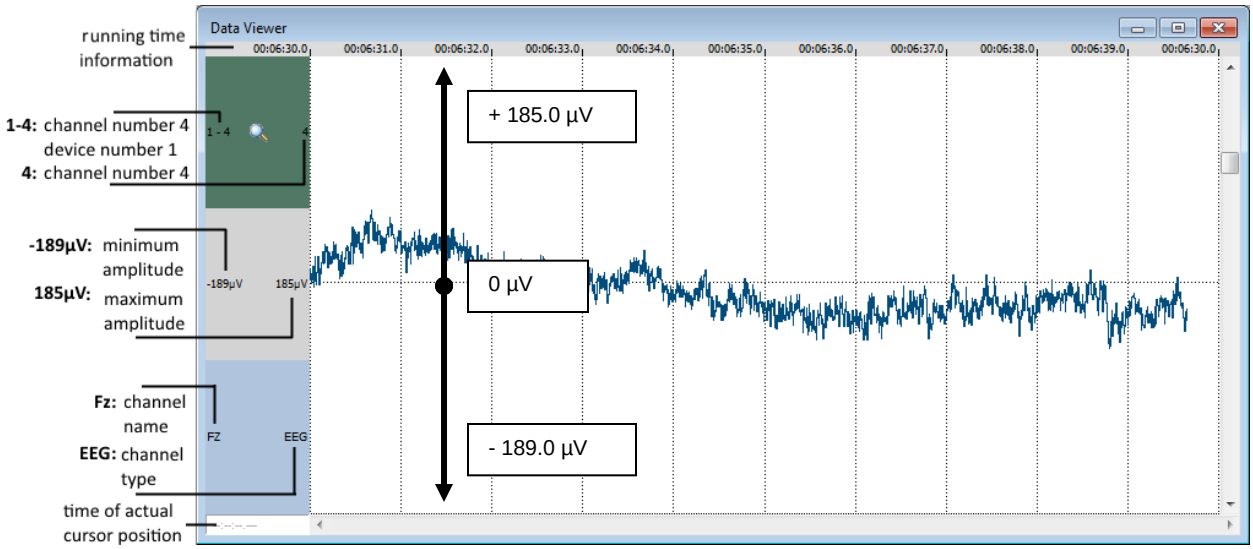
Jump to a specific point in time in *Replay* mode



Visualization-only Filters
Customizable digital filters can be applied to the analog input channels in the data viewer for visualization purposes only. The filters are not applied to the recorded or analyzed data.
To apply filters on recorded and analyzed data, use the configuration dialog of the selected amplifier instead.

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.

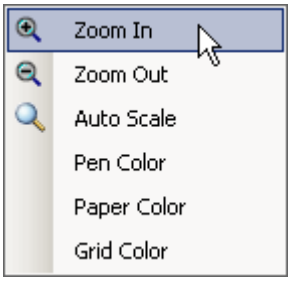


The number on the left side of the green box represents the channel number used on the amplification device. This information is useful if more than one biosignal amplifier is used. Here, channel 4 of the first amplifier 1 is displayed. The number on the right side of the green box is the logical channel number in the actual recording setup. In this case the logical channel number is also 4.

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 µV. 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 `FZ`. The text on the right side shows the selected channel type (e.g. `EEG`). The channel name and channel type information can be set via the menu **Settings/Channels**.

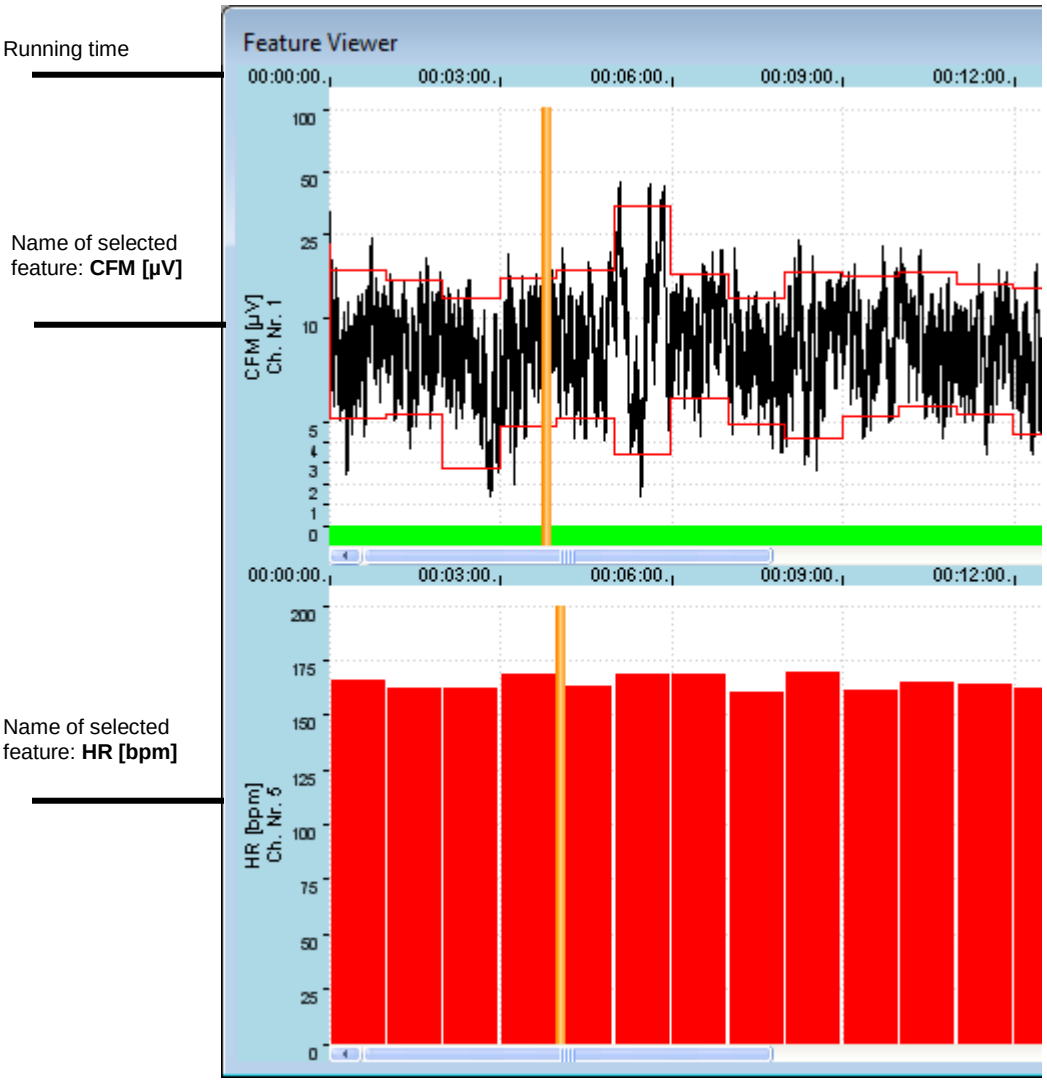
The zooming level of the **Data Viewer** as well as the color for the paper, pen and grid can also be defined via a context menu by clicking with the right mouse button of a specific channel in the **Data Viewer**.



Feature Viewer

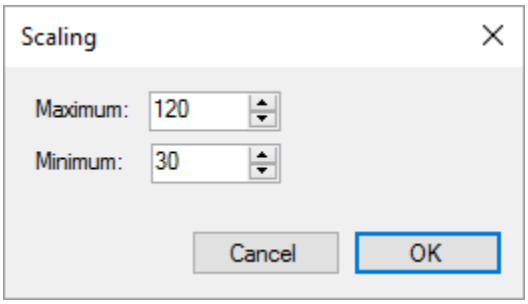
This window displays the parameters extracted from the raw data displayed in the **Data Viewer**. Data are displayed in an overwrite mode from left to right. The features that are computed from the raw data can be defined in the menu **Analysis/Feature Definition…**. In this example the feature CFM (cerebral 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].



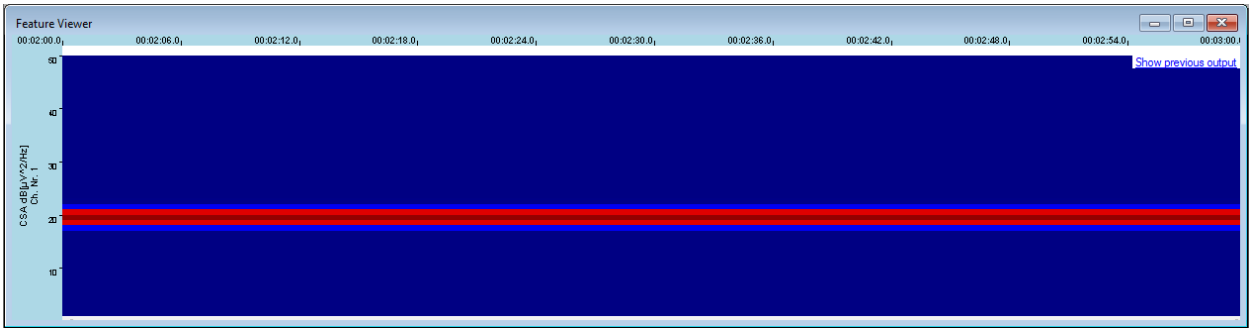
Context Menu Scaling

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.

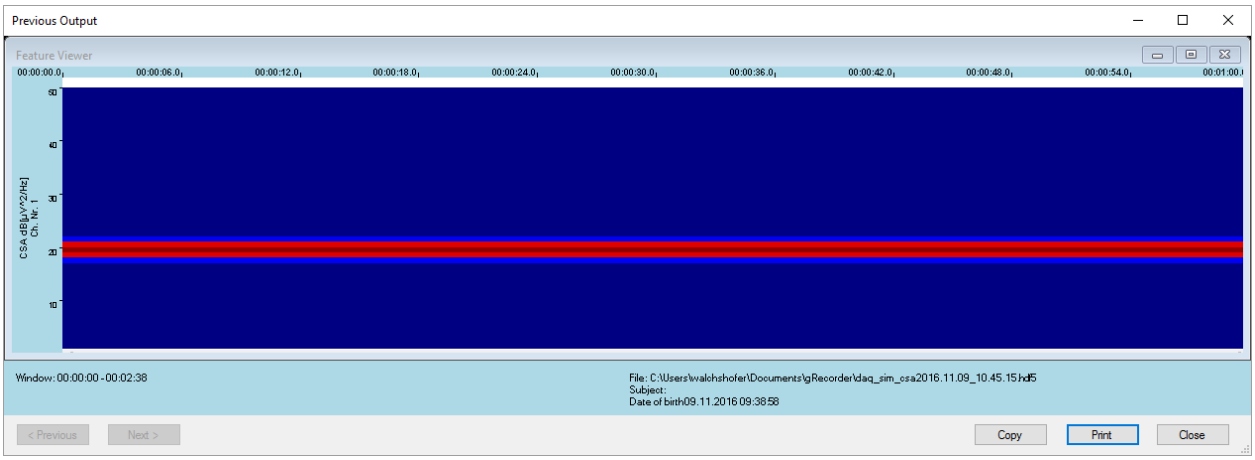


The Feature Viewer review mode during data acquisition

The Feature Viewer review mode allows for the inspection of 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 the user to scroll trough 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 the **Previous Output** window click on **Close**.

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

Evoked Potentials Viewer

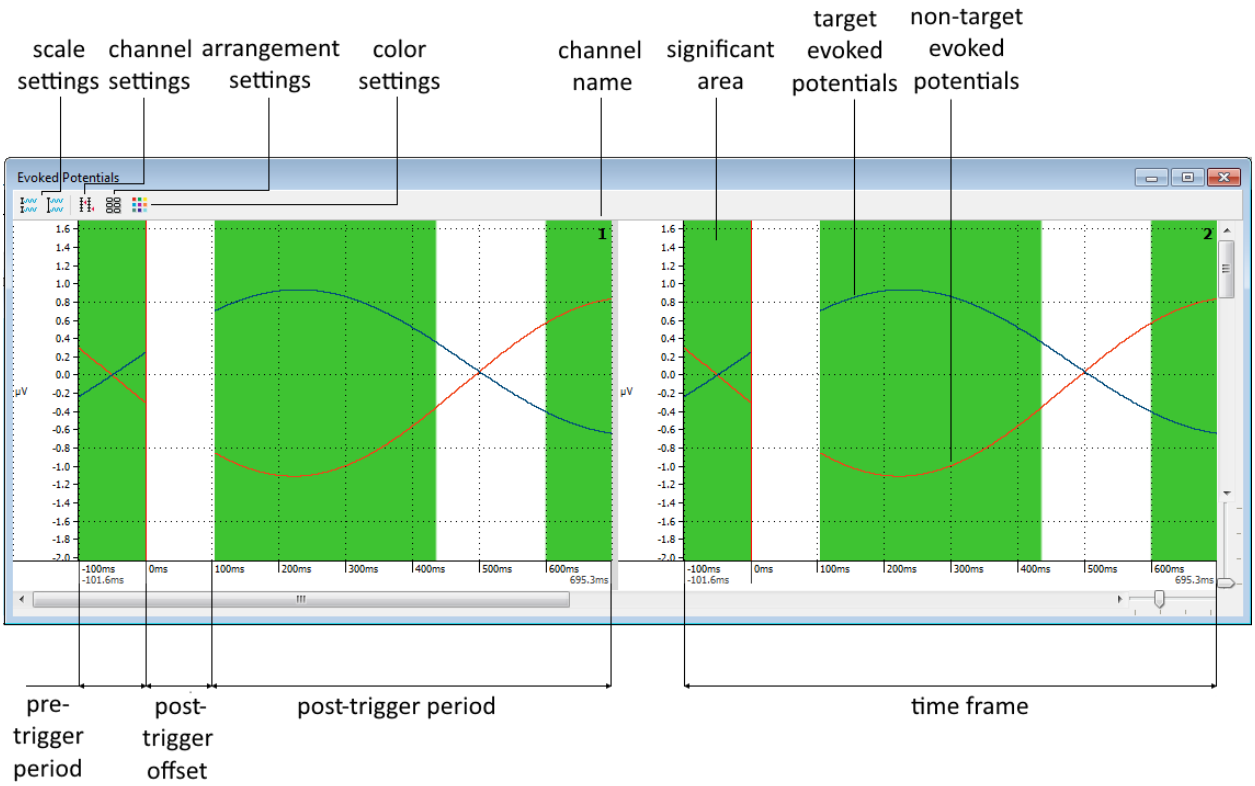
The **Evoked Potentials Viewer** displays averaged data frames for each acquired analog input channel. An evoked potentials plot is created for each acquired analog input channel. The time frame represents a defined time period, consisting of a pre-trigger period, a post-trigger offset and a post trigger period. The viewer displays the trigger's occurrence and an averaged time frame for target and non-target evoked potentials. Significant differences between target and non-target evoked potentials can be calculated and highlighted.

It is possible to configure the **scale settings**, to scale the data to the individual minimum/maximum of each acquired channel or to the global minimum/maximum of all acquired channels.

It is possible to change channel names, signal type, units and sensitivity range in the **channel settings** dialog. Channel names can be loaded from montage files.

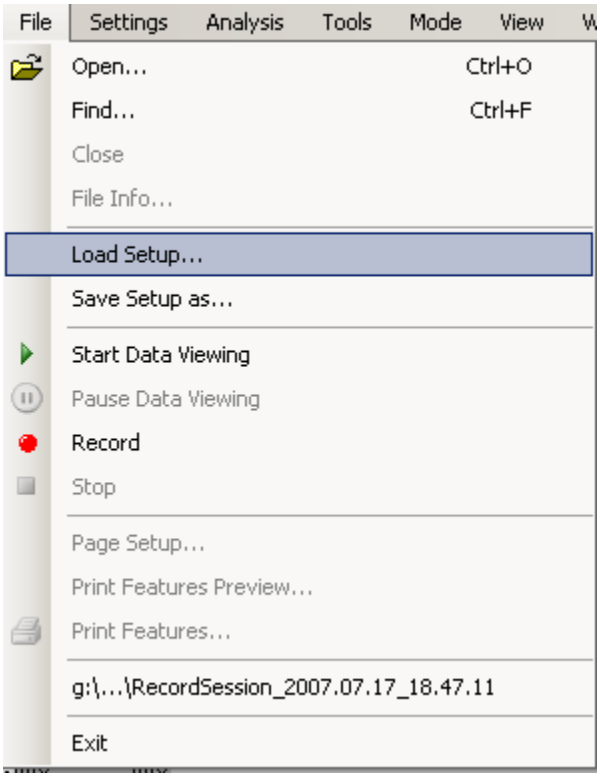
By default, all plots are arranged in a square matrix. It is possible to change rows columns and arrangement in the **arrangement settings**. Topographic arrangement of the plots can be loaded from montage files.

The **color settings** allow the user to change the appearance of all elements of the evoked potential plots.



Load Configuration

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

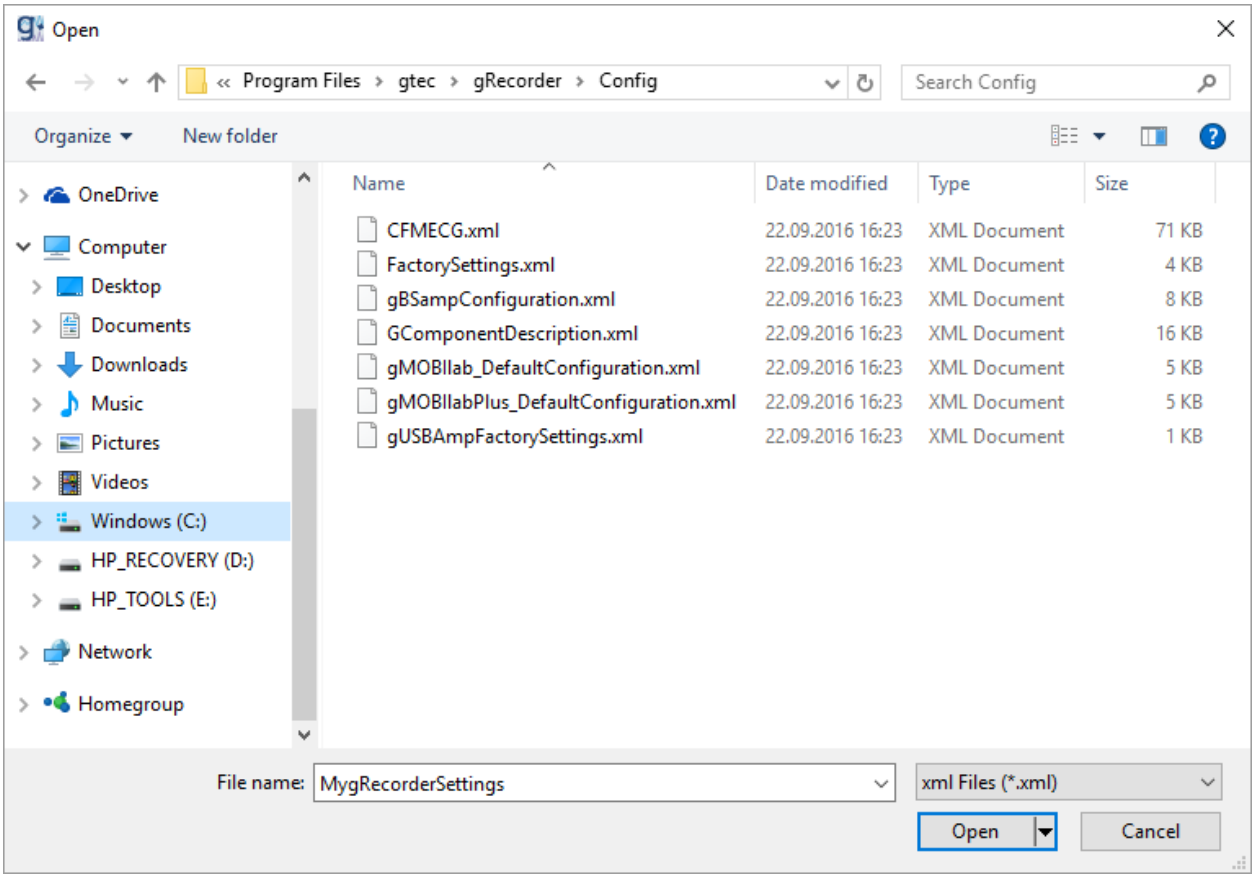


The configuration used in this example is for recording one EEG channel and one ECG channel to calculate the CFM and Heart Rate features using g.USBamp.

Select the corresponding file `CFMECG.xml from`

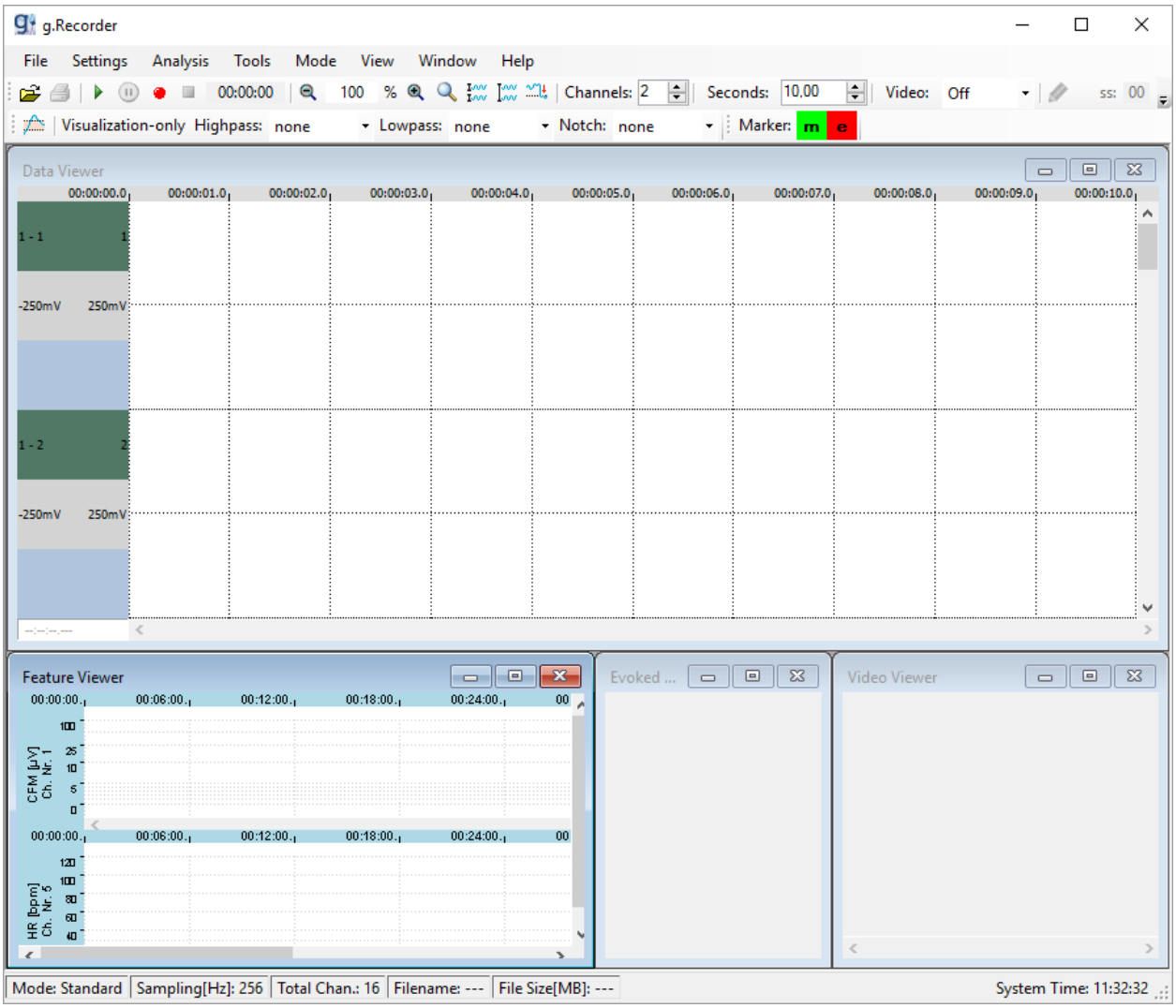
`c:\Program Files\gtec\gRecorder\Config`

and click **Open**.

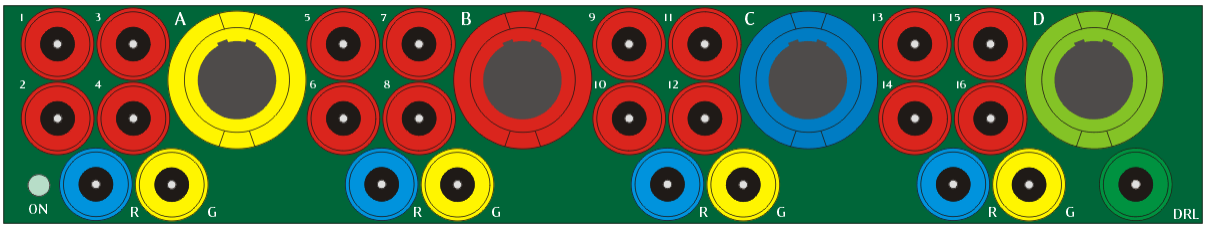


g.Recorder will be initialized with all necessary hardware and software settings.

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 a g.USBamp.



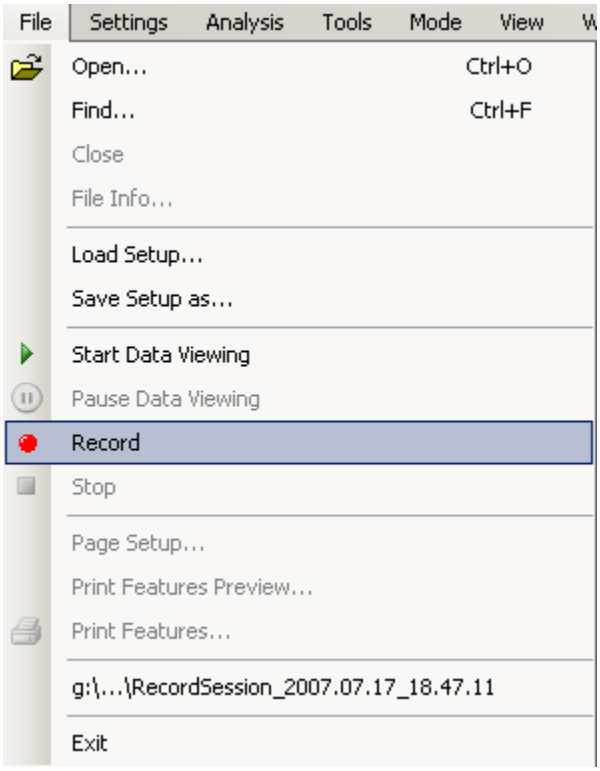
The picture above displays the front side of the g.USBamp. The front side is divided into four groups (**A,B,C,D** from left to right). Each group consists of four red connectors (**1**-**4**, **5**-**8**, **9**-**12**, **13**-**16**) for connecting biosignal electrodes (EEG, ECG, EMG, etc.), one blue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

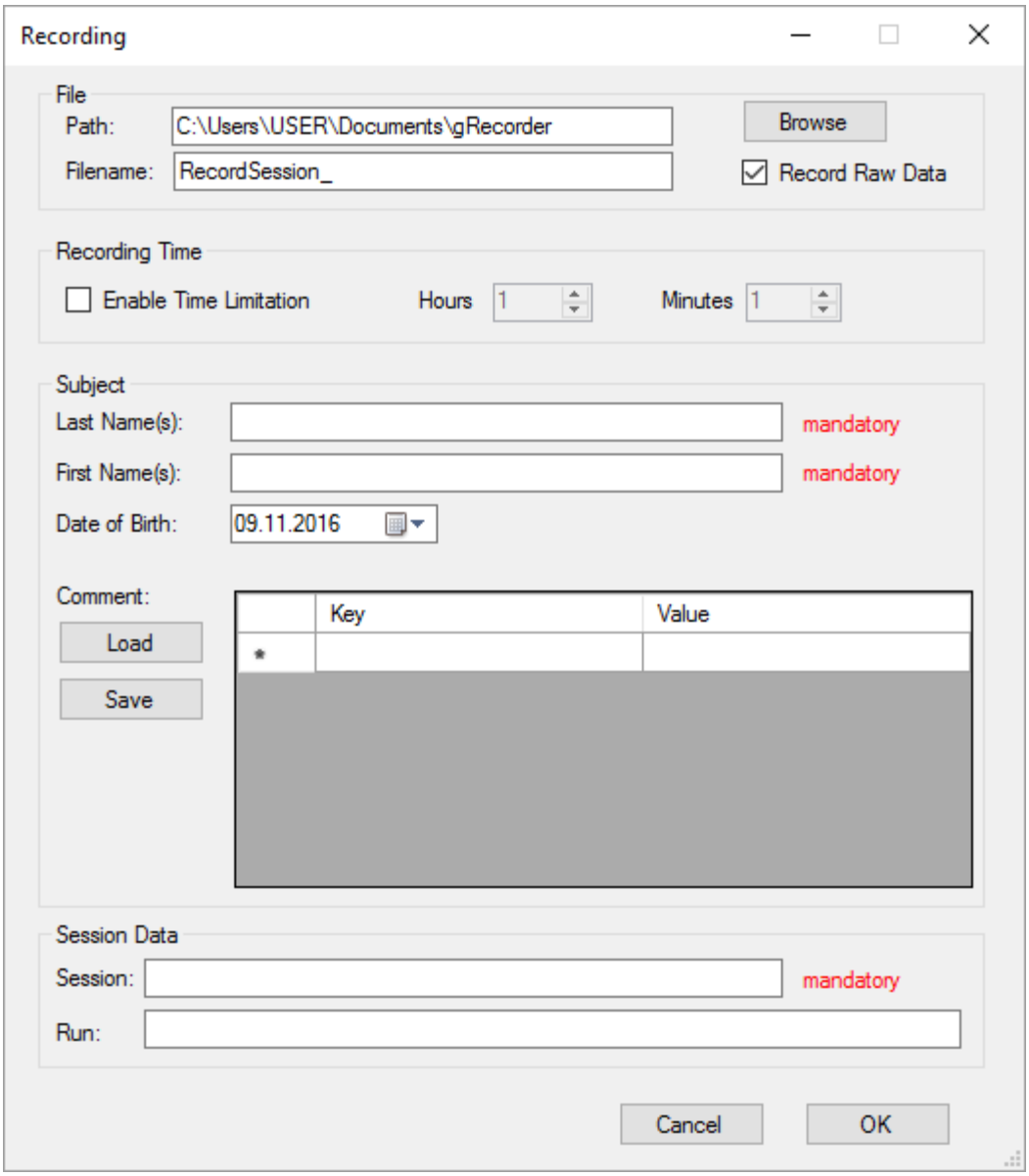
For EEG measurements, all electrodes for EEG are connected to Group **A** (first group on the left side of the g.USBamp). One EEG electrode is connected to channel **1** of Group **A** (red connector), the reference electrode to reference **R** of group **A** (blue connector) and the ground electrode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





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_2016.11.09_11.36.02.hdf5`). The data is stored in the HDF5 file format. For more information about this format see www.hdfgroup.org or refer to the MATLAB help.

The **Record Raw Data** checkbox toggles 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

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

Subject

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

Session Data

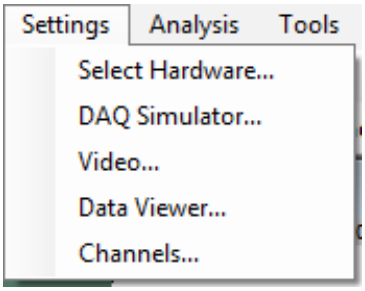
Enter the **Session** and **Run** identifier for your recordings.

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

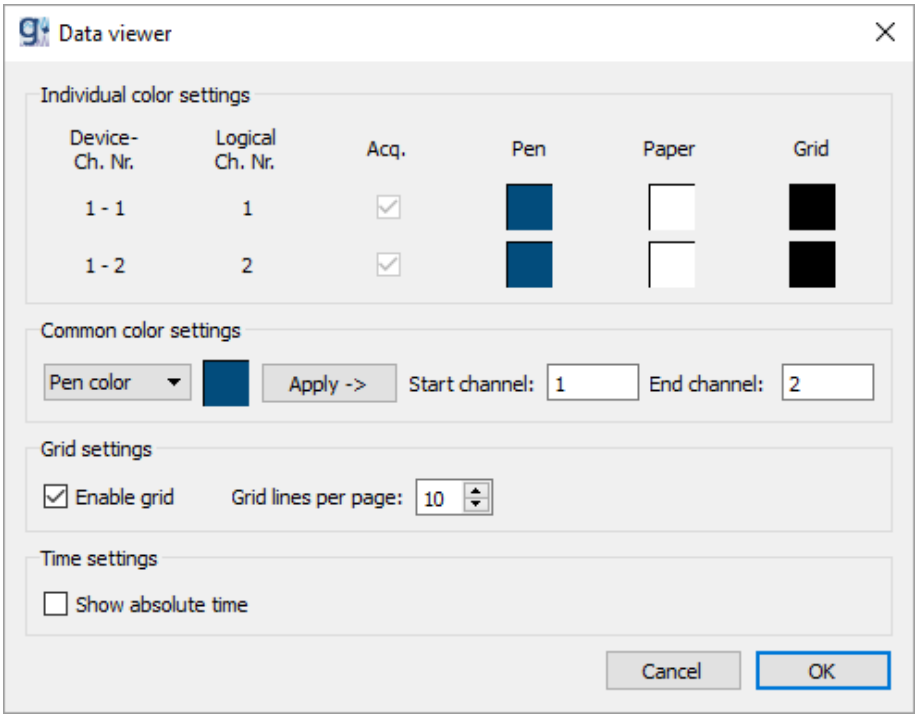
From the **Settings** menu choose **Data Viewer...** to change the data representation.



The **Color Settings** can be set in the **Data Viewer** dialog. 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. It is possible to change the settings of each channel individually in the **Individual color settings** group, or for multiple channels at once in the **Common color settings** group.

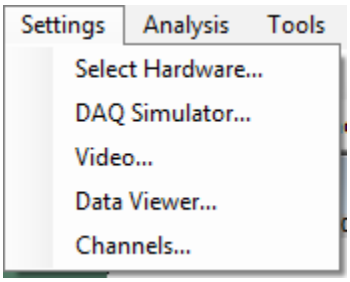
In the **Grid settings** area the grid can be enabled and the number of vertical grid lines can be selected.

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.



Channel Settings

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

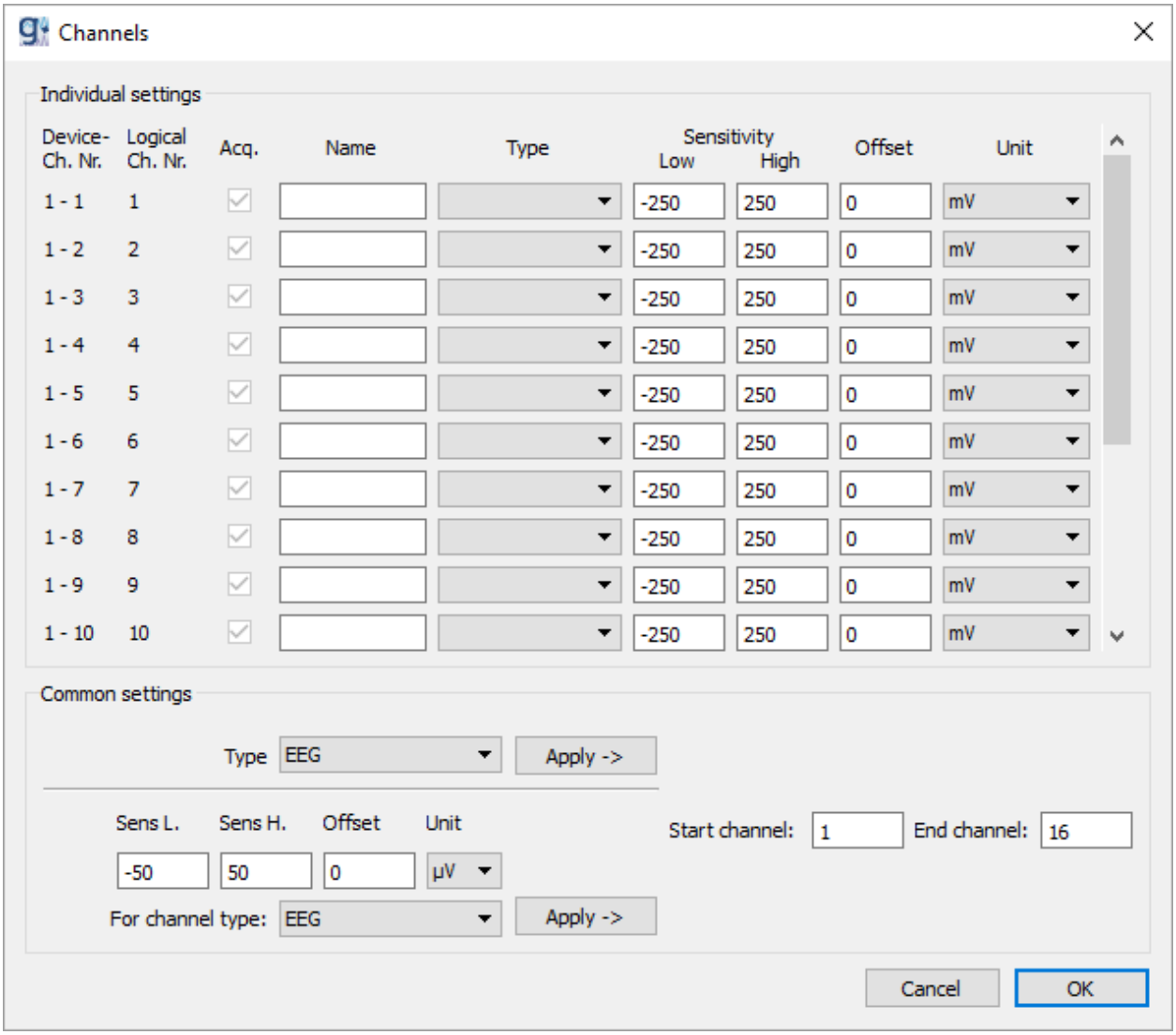


Individual settings

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.



Common Settings

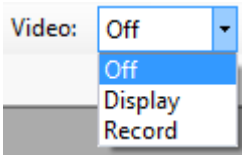
The same settings can be applied to multiple channels at once in the **Common settings** section.

To only apply a **Type** to a range of channels, select the **Start channel** and the **End channel** and the **Type** in the upper half and click **Apply** next to it.

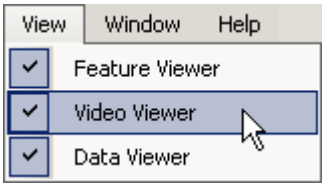
To apply a common sensitivity, an offset and a unit to a specific **Type** of channels, select the lower sensitivity (**Sens L.**), the upper sensitivity (**Sens H.**), the **Offset** and the **Unit** and choose the **Type** of the channels you want to apply those settings on, and click **Apply**.

Video Camera

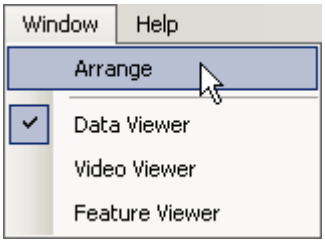
When a video camera is connected to the PC, the video images can be displayed and recorded with **g.Recorder**. In the menu bar it can be chosen if the video should not be displayed (**OFF**), just be displayed but not recorded (**Display**) or be displayed and recorded (**Record**).



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.



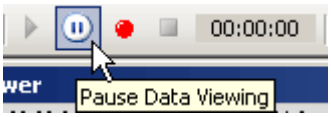
Start and Stop Recording

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.MOBIlab+.

To record data to the hard disk on your PC, click the **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.

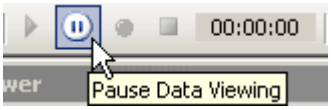


Note: If the button is pressed in *Recording* mode, only the visualization of the data on the display is stopped, but the **g.Recorder** continues to store data to the HDF5 file.

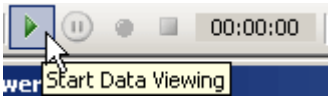
Click on the **Stop** button or select **Stop** from the **File** menu to stop data acquisition.

g.MOBIlab+ specific functions

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



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

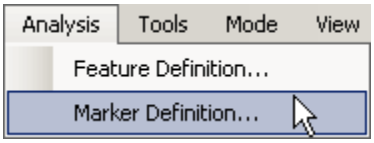


Note: For g.MOBIlab+, data can either be stored the local hard disk of your PC or streamed to the built-in SD card.

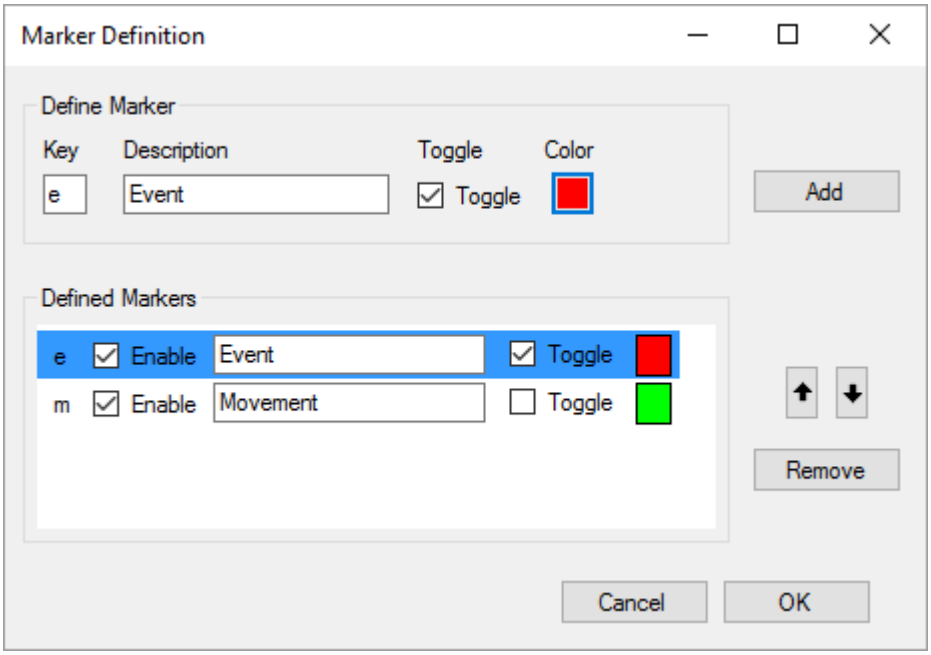
Markers

Markers can be used during measurement to highlight certain events. **g.Recorder** allows the user to define 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.



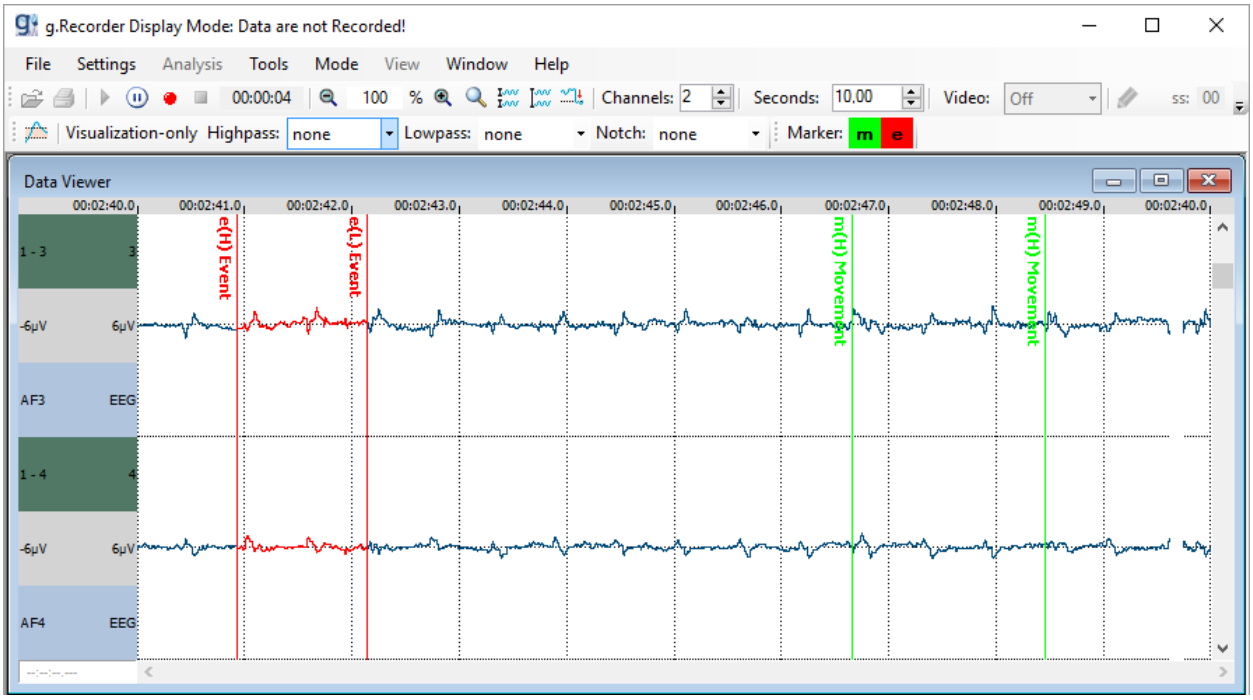
to open the following window:



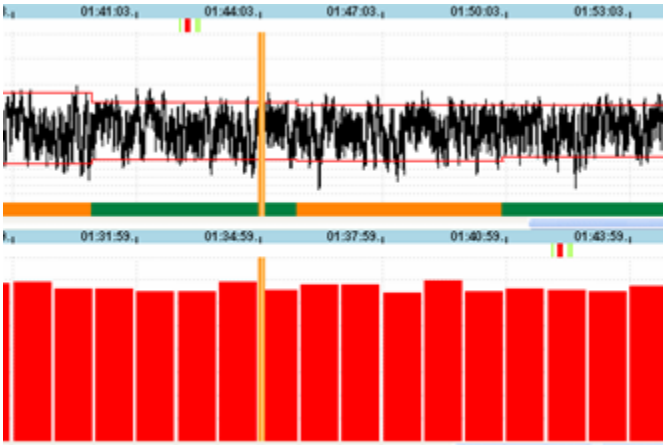
Here, two markers are defined that can be set either by clicking on the marker button in the **Toolbar** of **g.Recorder** or by pressing the keys on the keyboard. Marker `e` – Event is a Toggle marker, marker `m` – Movement is a time marker.

If `e` is pressed the signal is marked in the selected marker color until the marker button is pressed again. If `m` is pressed then only the event at a certain time point is marked.

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



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



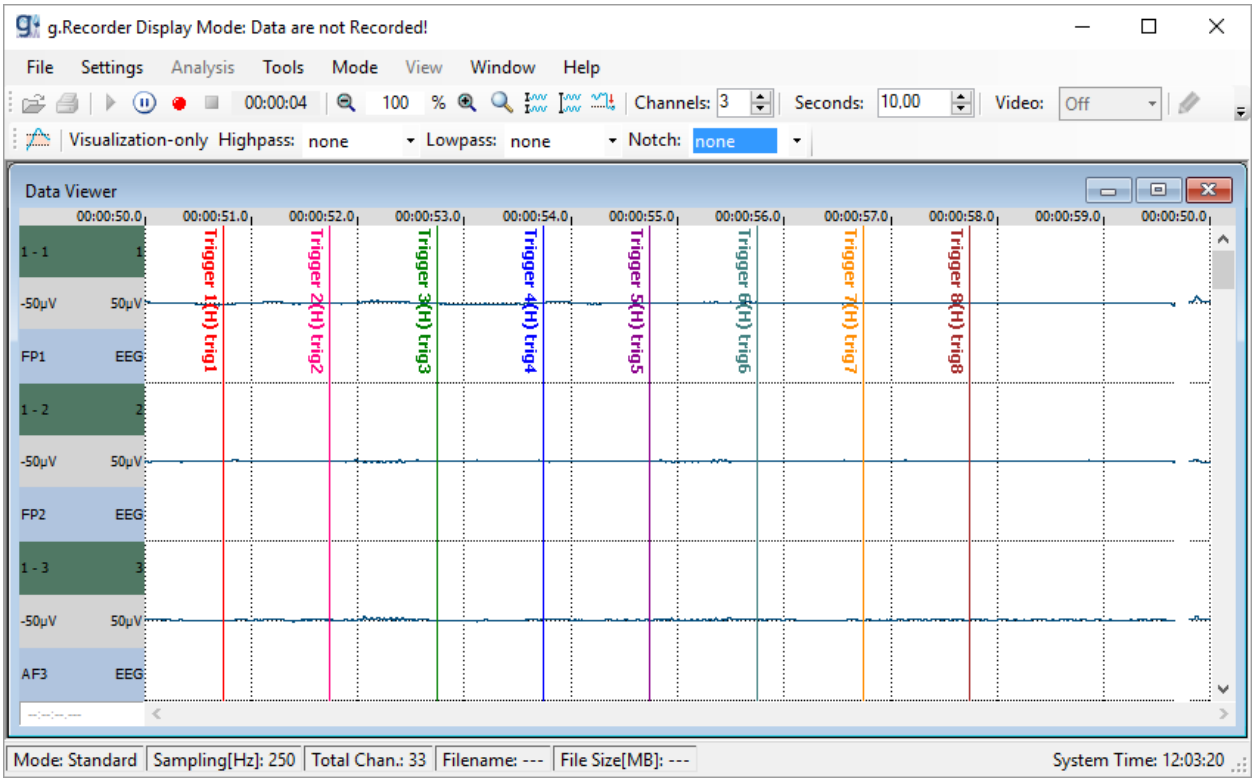
Digital Inputs

Devices may provide digital inputs that are sampled synchronously with the raw data samples. Digital inputs can be acquired and displayed with g.Recorder. A rising or falling edge of an acquired digital input is represented as a vertical line including a description consisting of trigger number, value and name.

Some types of devices allow the user to choose if each of those trigger channels should be treated individually or if several trigger channels should be combined.

Individual Triggers

By default, trigger channels selected for acquisition are treated individually. Depending on their configuration, each occurrence of such a trigger channel is represented as a separate event with a value of HIGH **(H)** for rising edges or LOW **(L)** for falling edges.

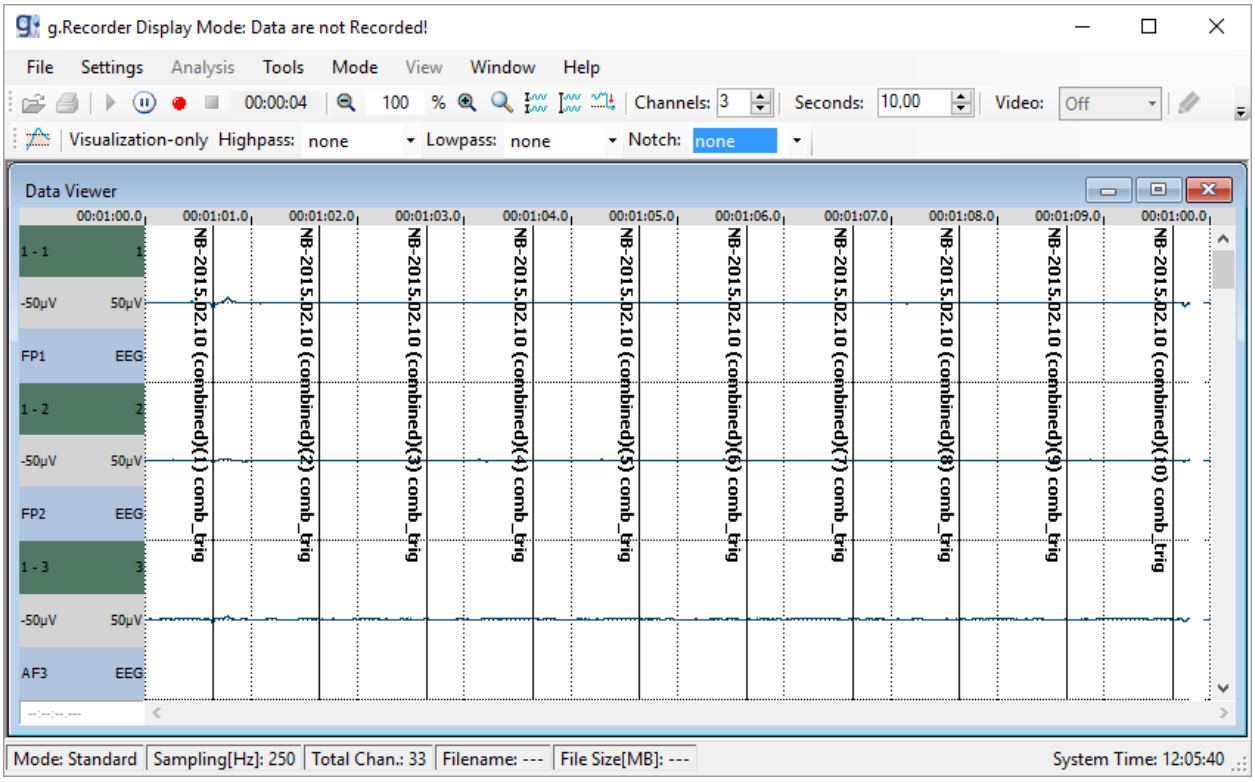


Combined Triggers

Combined triggers are supported by g.USBamp and g.HIamp devices only. In this mode, all trigger channels of a device are represented by the same event for that device and the value is a binary coded decimal made up of the current high or low values of the individual trigger channels. The triggers are represented as vertical lines including a description consisting of device's serial number, combined trigger tag, event code and name.

This enables reception and interpretation of binary coded trigger values sent via the parallel port. **g.Recorder** supports external stimulation software like **Presentation®** (Neurobehavioral Systems, Inc., www.neurobs.com) and **E-Prime®** (Psychology Software Tools, Inc., www.pstnet.com) by acquiring event codes sent via parallel port.

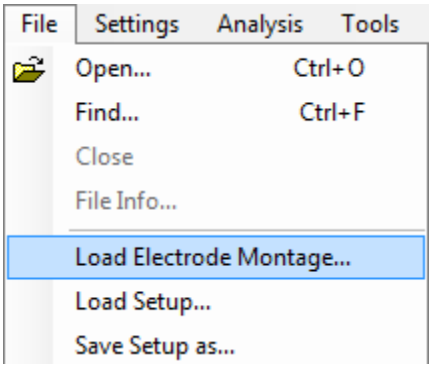
Note: E-Prime® and Presentation® are trademarks by their respective owners.



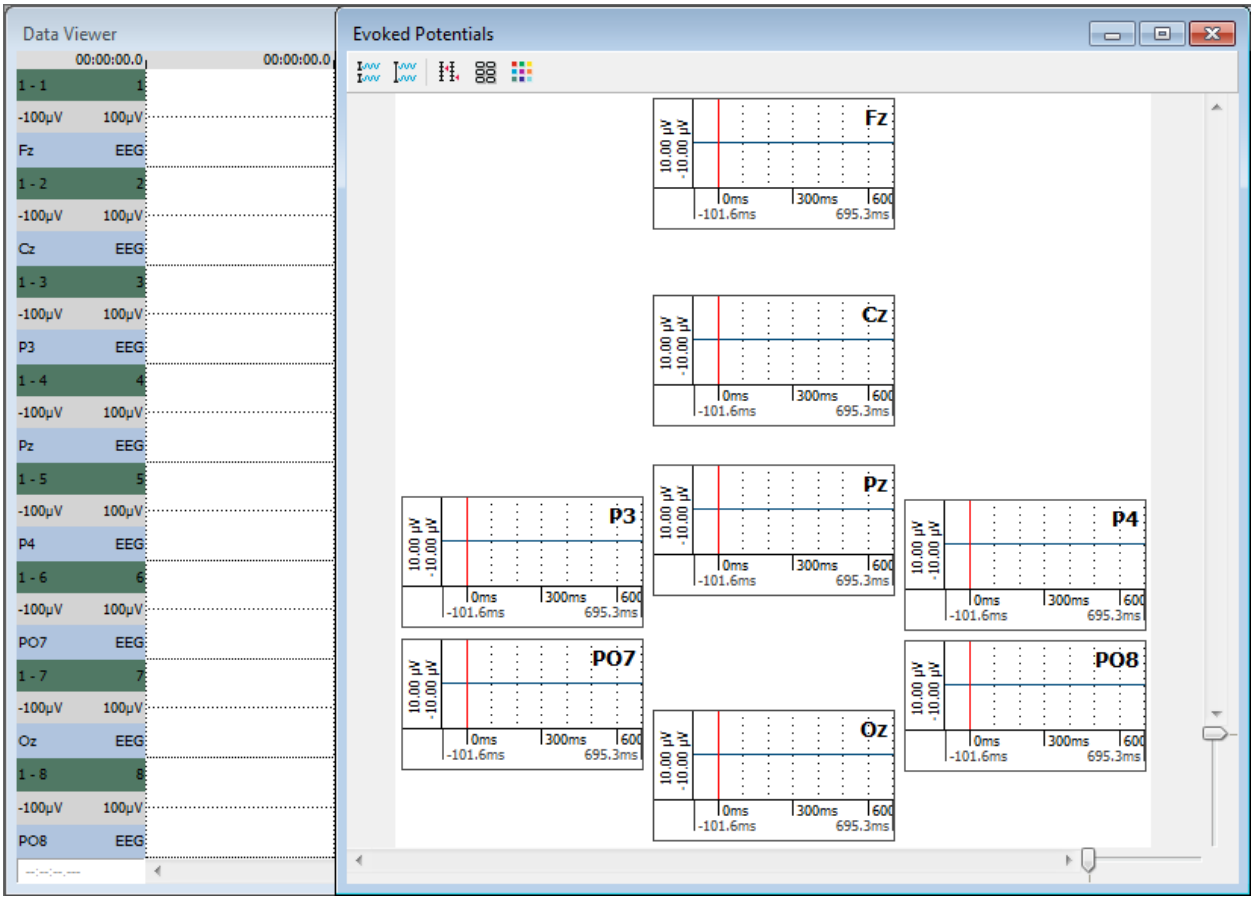
Load Electrode Montage

XML montage files created with **g.MONcreator** (g.tec medical engineering GmbH, Austria) can be loaded to assign predefined names and the topographic arrangement of an electrode cap to the current configuration.

Montage files can be loaded by selecting **Load Electrode Montage…** in the **File** menu.



The **Data Viewer** assigns channel names to the acquired analog channels. The **Evoked Potentials Viewer**, if enabled, arranges the evoked potential plots in a topographic way according to the 2D electrode positions in the file.

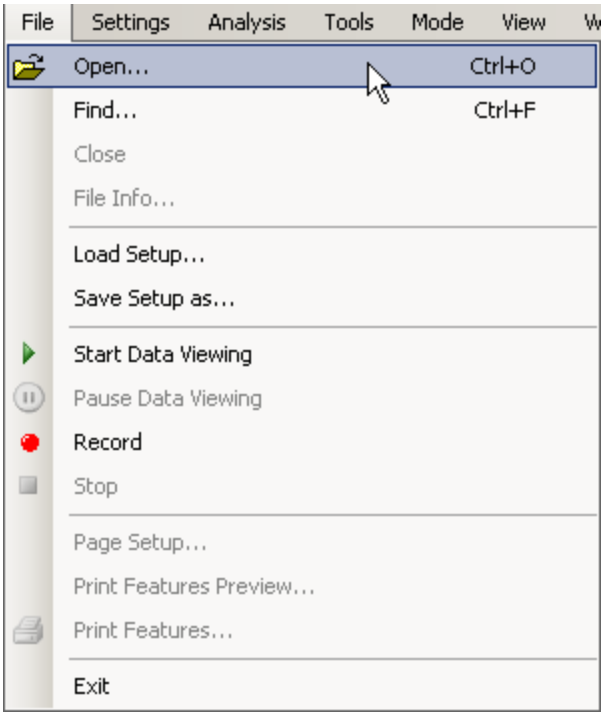


Load, Find, Convert and Replay Recorded Files

Load, Find and Replay HDF5 files

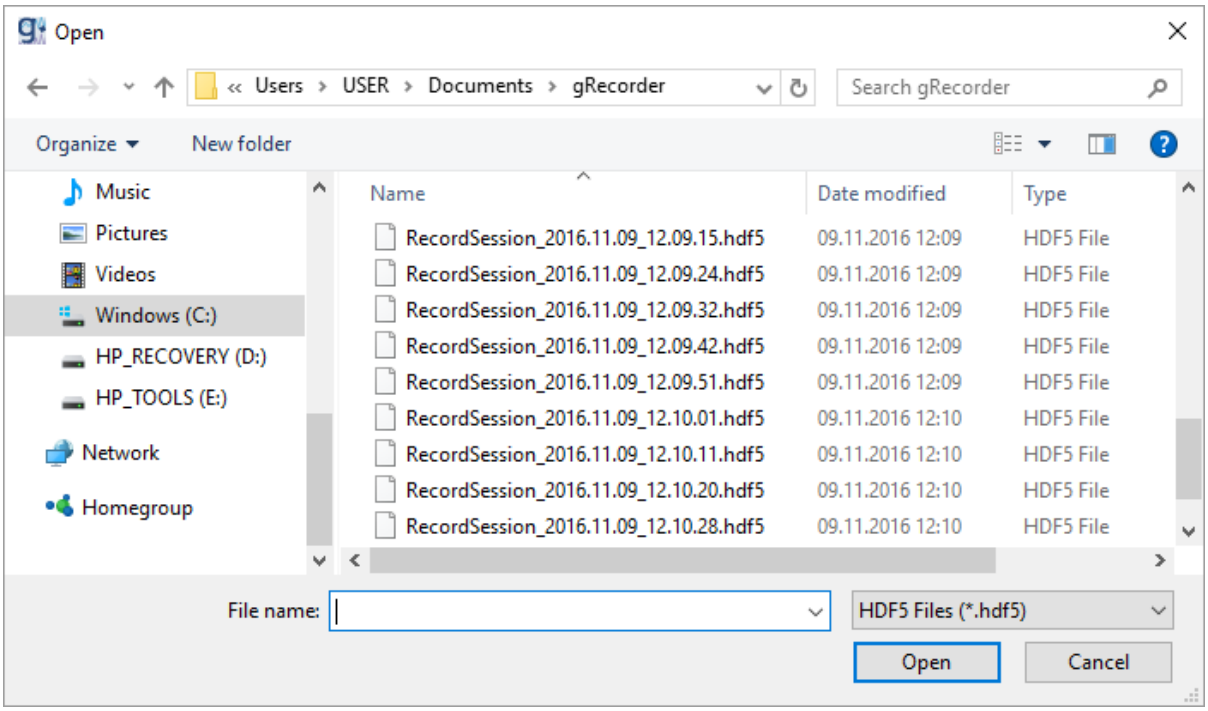
A recorded data file in HDF5 format can be loaded and reviewed with **g.Recorder**.

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



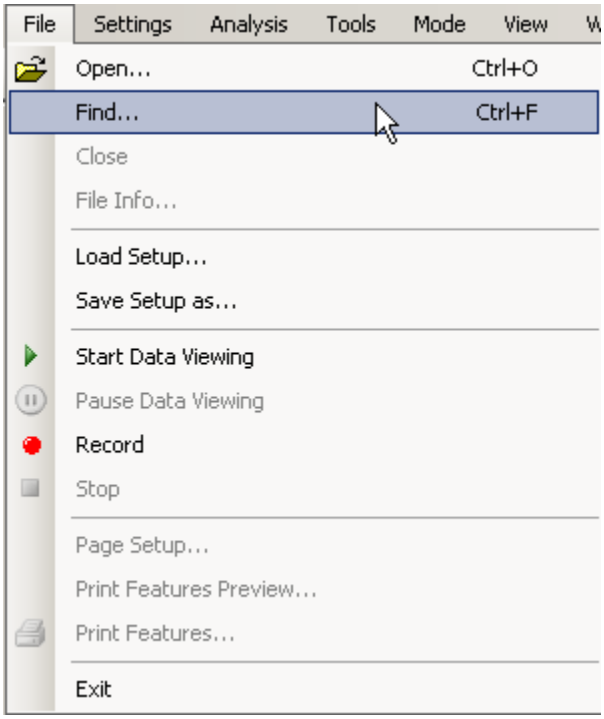
Then select the data file you want to load into **g.Recorder**. The default path of the recorded files is

```
My Documents/gRecorder
```

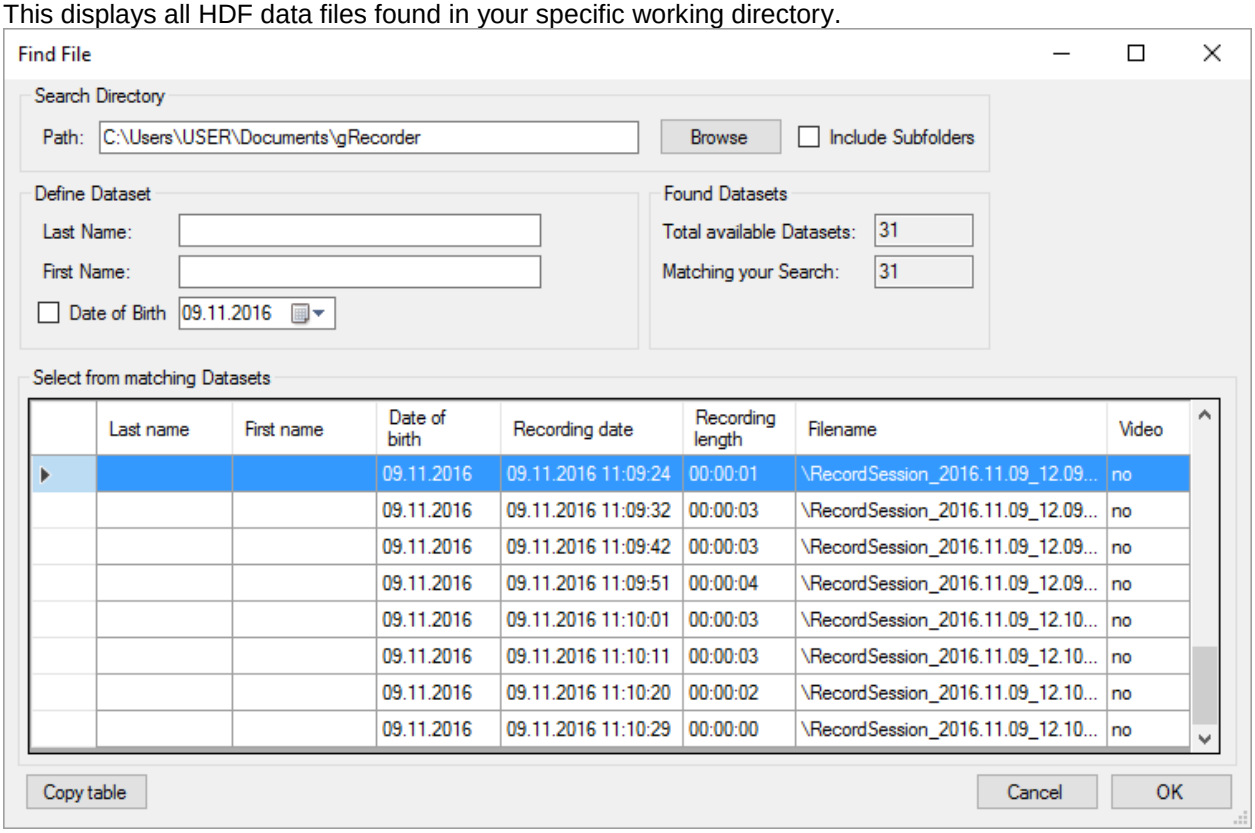


Select file `RecordSession_2016.11.09_10.10.28.hdf5` and press **Open**.

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



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



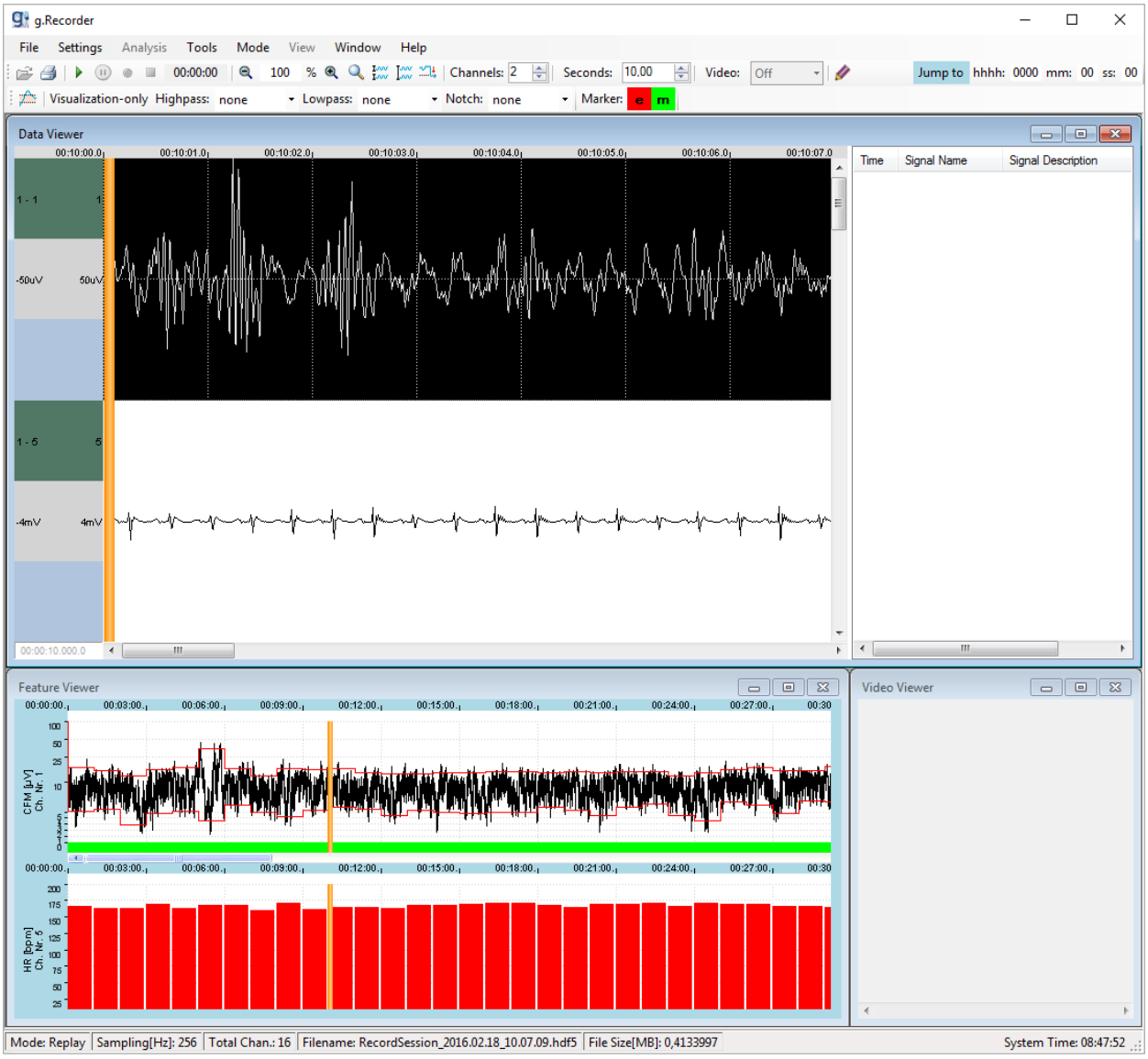
The **Search Directory** of data files can be set in the **Path:** field. Use the **Browse** button to find the desired directory. If the **Include Subfolders** option is enabled, the data files found in the selected path including all subdirectories are listed.

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.

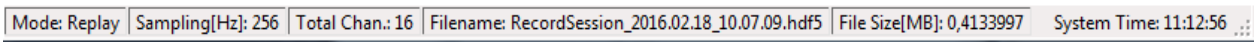
The desired data set can be selected by highlighting the data set. Double clicking or selecting the **OK** button loads the data set for review. Additional short information is given for the data set including the Last name, first name, Date of Birth, Recording data, Recording length, Filename and if 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.



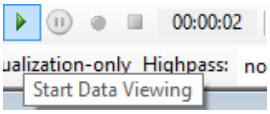
The recorded measurement's information is displayed in the **Status Bar**.



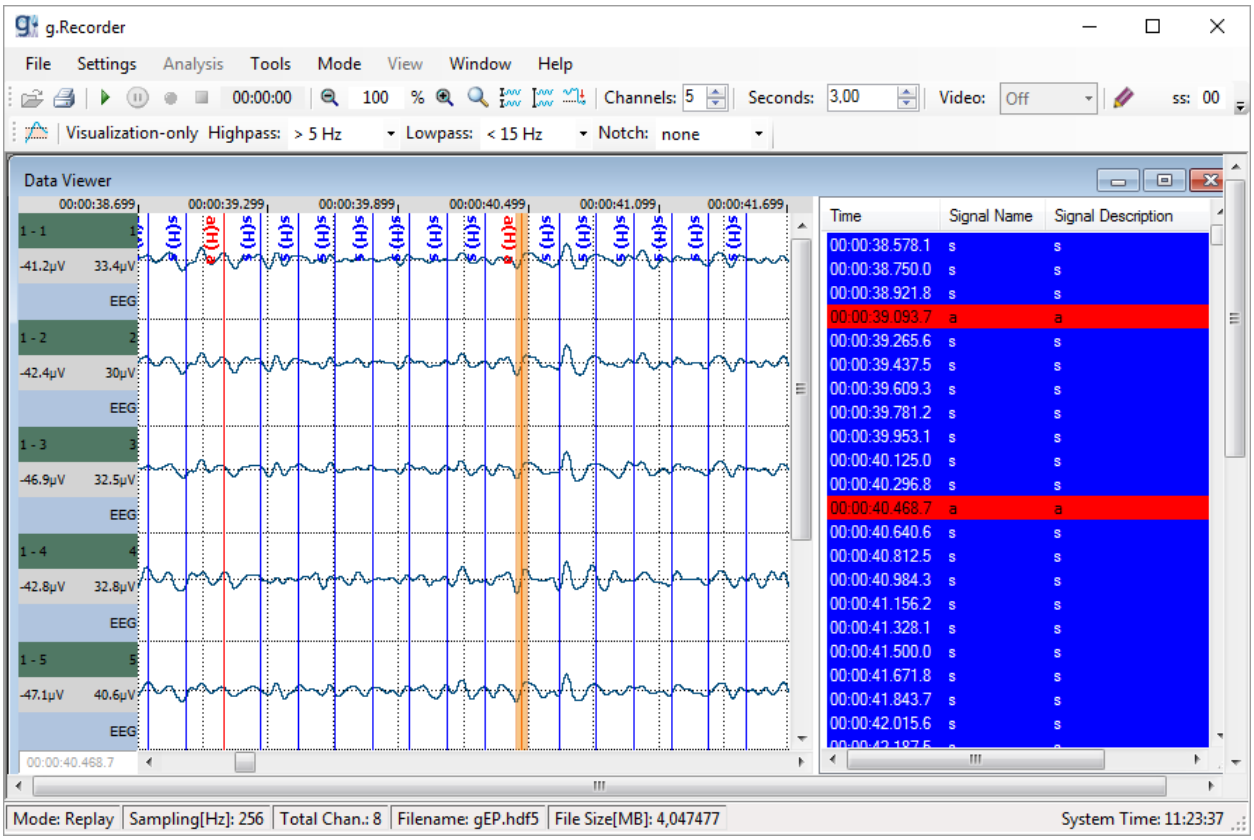
The **Mode** is *Replay*, the **Sampling** frequency is 256 Hz, the number of recorded channels (**Total Chan.**) is 16. The **File Name** is `Record_Session_2016.02.18_10.07.09.hdf` and the **File Size** is 0.413 megabytes.

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.

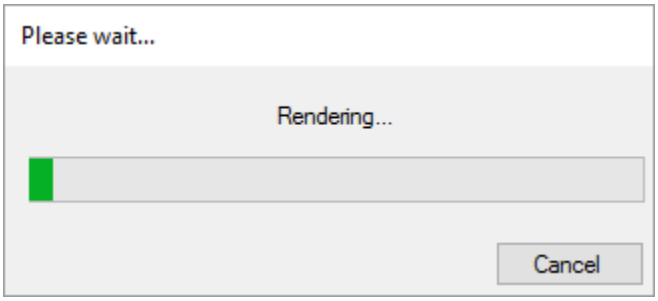
To review data on-line from the selected position, click on the **Start Data Viewing** button.



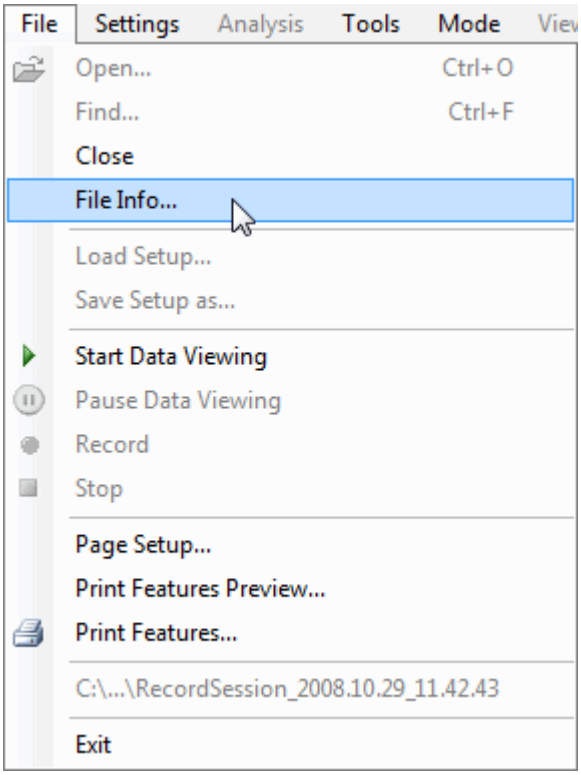
Synchronous and asynchronous events are loaded and displayed on the right-hand side of the **Data Viewer** in *Replay* mode. The navigator on the right-hand side allows the user to jump to a specific event by selecting it in the list. The ruler is set to the selected signal's time of occurrence and the current page is updated. The event list features the time of occurrence, signal name, signal description, and selected color.



Visualization Filters can be applied to the recorded analog signals in *Replay* mode. A progress bar is displayed for filtering and rendering a large amount of data.

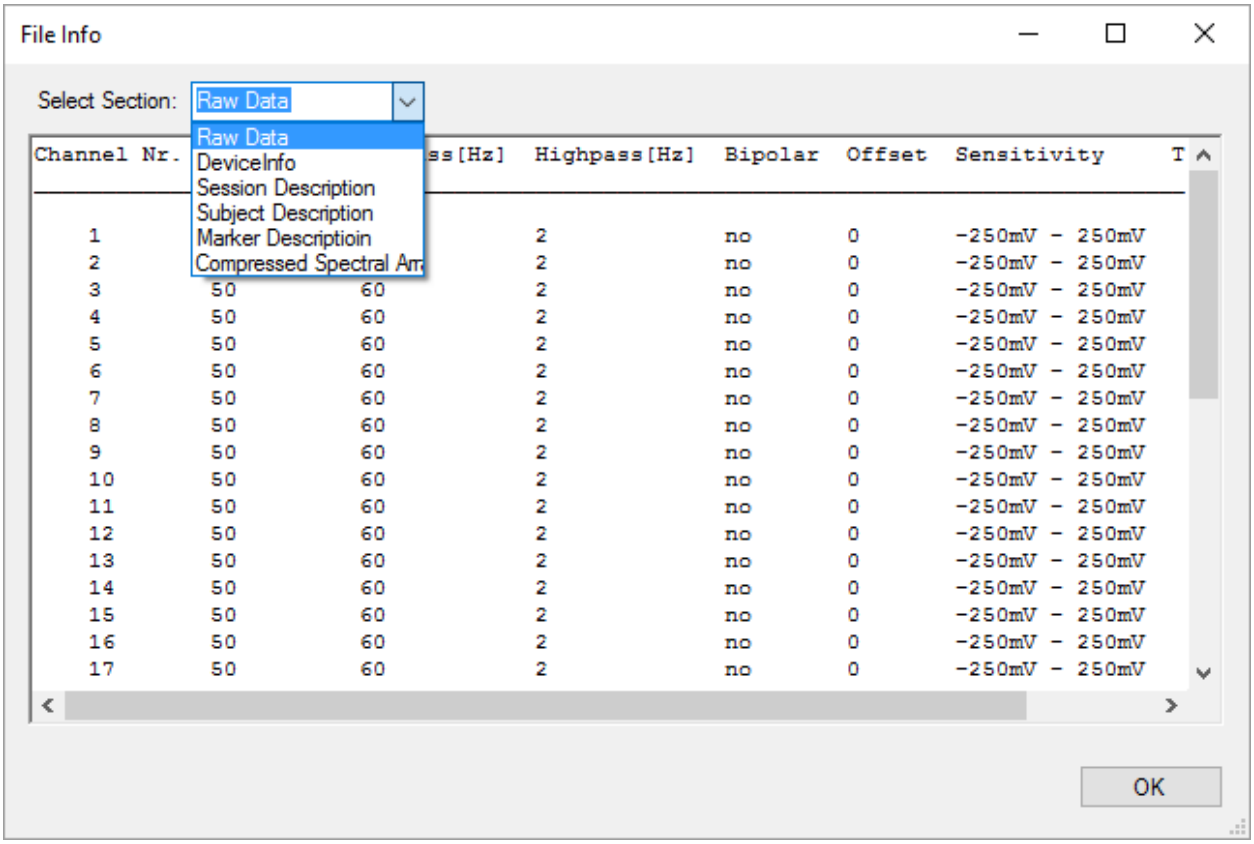


To view the file information, select **File Info…** from the **File** menu.



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:

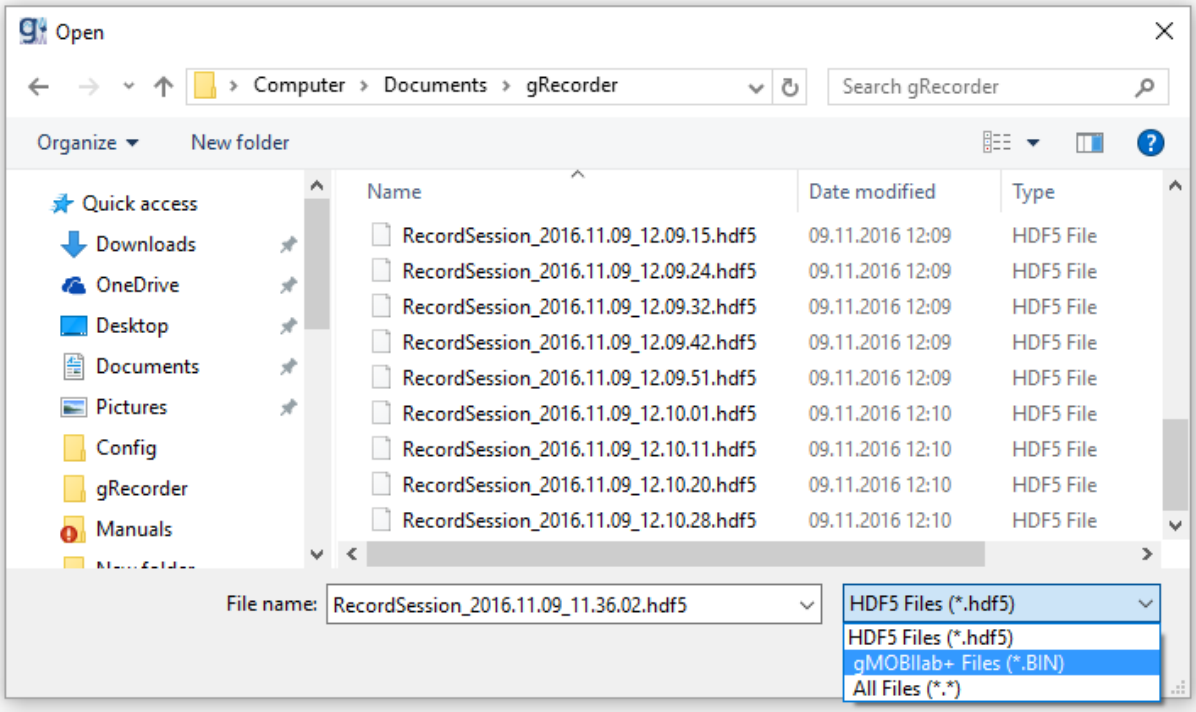


Click **OK** to close the dialog.

Convert g.MOBIlab+ BIN files to HDF5 format

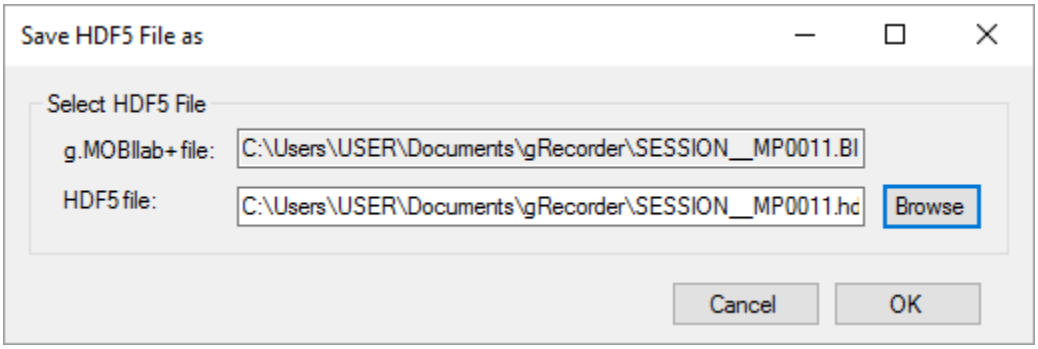
g.Recorder contains a tool to import g.MOBIlab+ data files stored on the built-in SD Card of g.MOBIlab+. Data are converted to the **g.Recorder** file format HDF5.

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**.

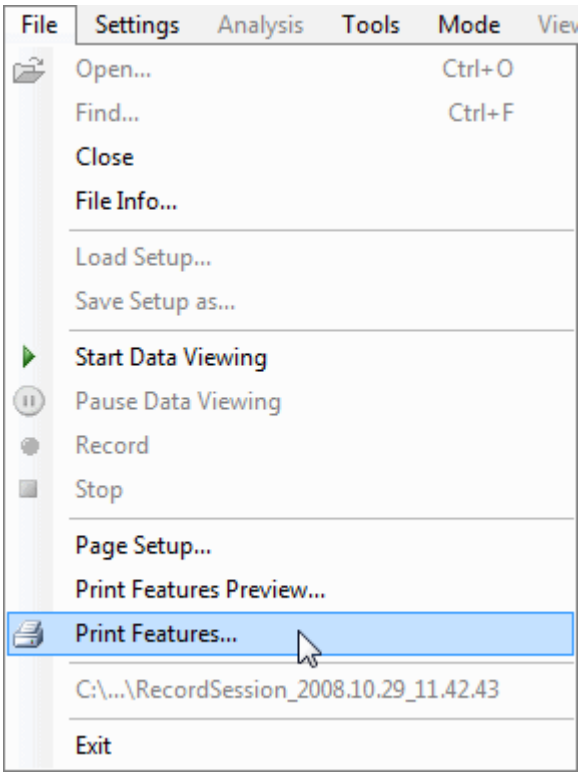
The **Save HDF5 File As** dialog will open, where the path for the converted HDF5 file can be set.



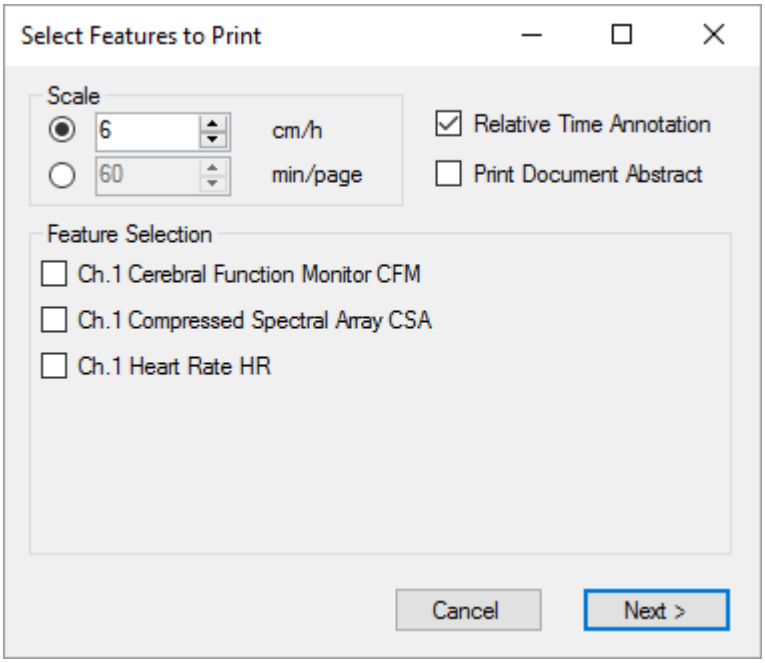
Click **OK** to convert and display the file.

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-hour data set is printed with the selection of 60 min/page then 3 pages would be printed.

The time scale in the printed document can be set with the checkbox **Relative Time Annotation**. 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.

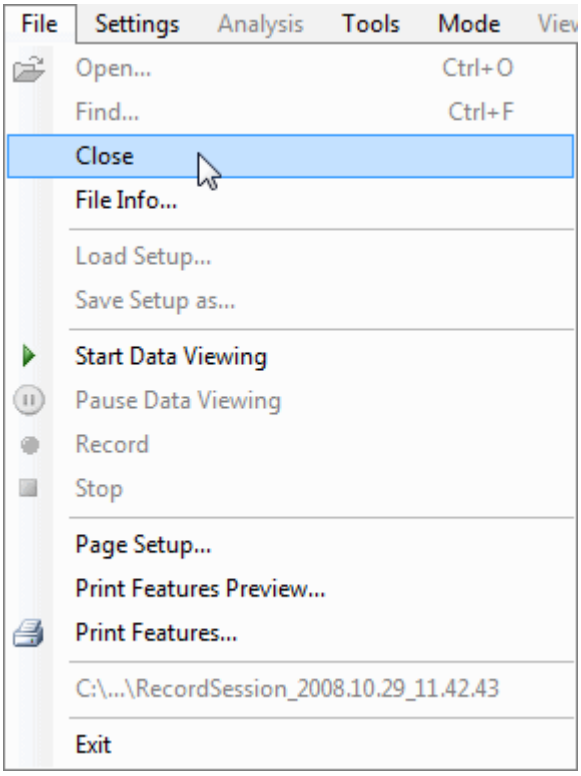
Feature Selection

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

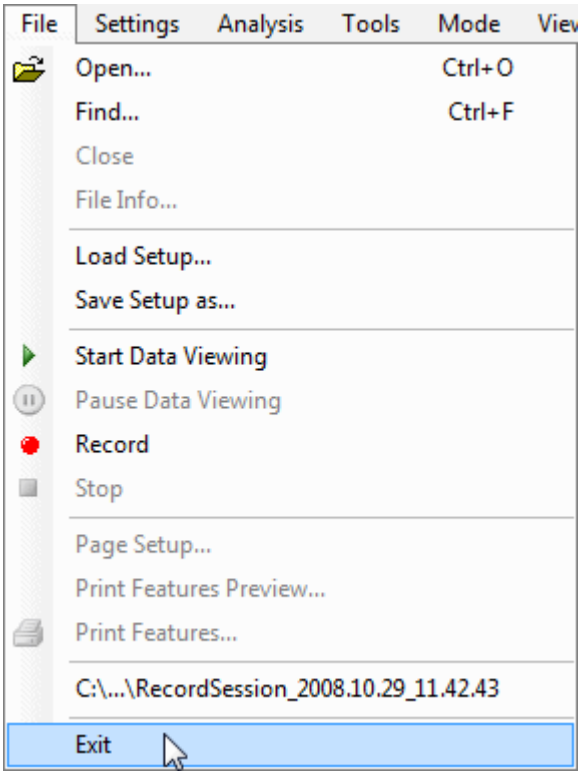
To return from *Replay* mode to *Recording* mode select the **Close** button from the **File** menu.



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.

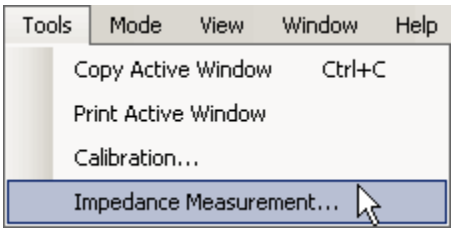
Note: If you are in *Replay* mode you must close the file first with the **Close** function in the **File** menu before you can exit **g.Recorder**.



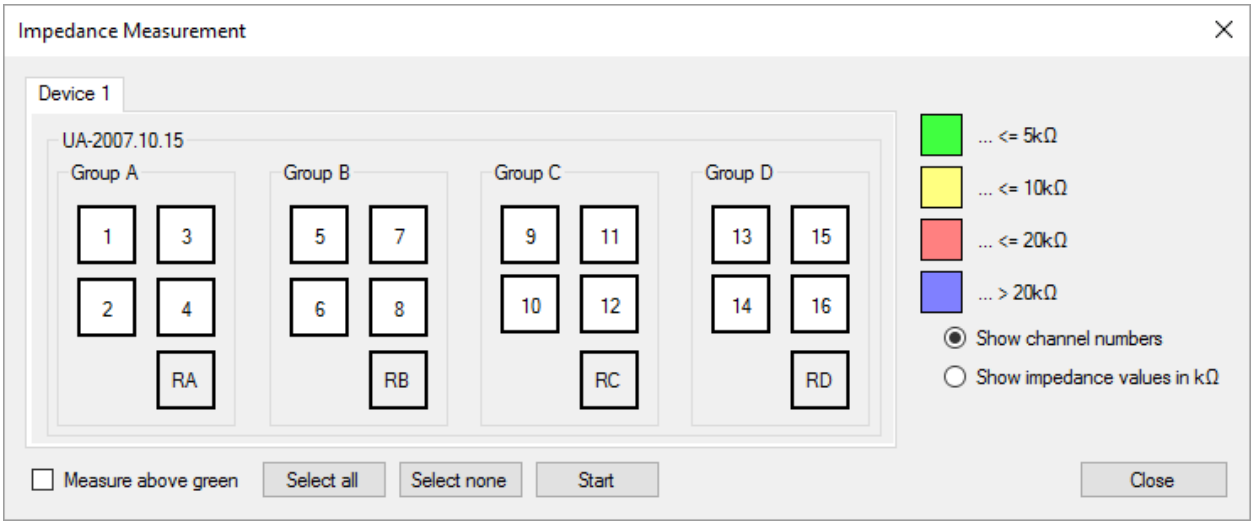
g.USBamp Specific Features

Impedance Measurement with g.USBamp and g.Recorder

The impedance of electrodes connected to a g.USBamp can be measured in g.Recorder. To start this tool, click on the **Impedance Measurement…** button in the **Tools** menu.



This opens the dialog shown below.

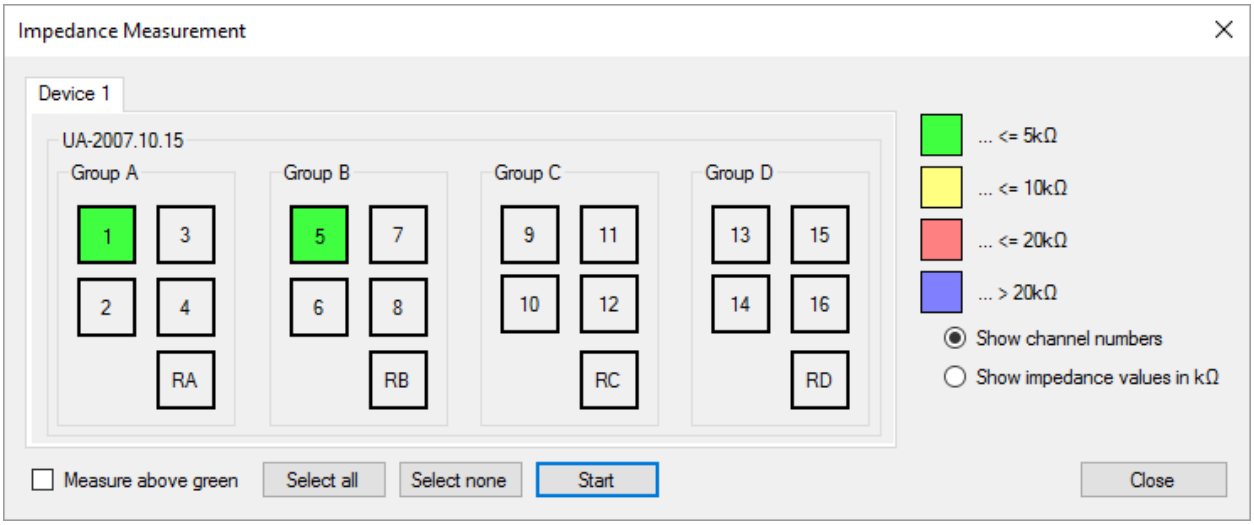


Select the channels for impedance checking individually by clicking on the boxes next to the channel numbers and click **Start**. The channel coloring indicates the impedance of the connected electrode. Optimal values (e.g. values below 5 kilo-ohm for EEG recordings) are color-code green. Acceptable impedance values are in the range of up to 20 kilo-ohm (color code yellow or red). Non-connected channels or electrodes with impedance values of more than 20 kilo-ohm 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. This will only check impedances on electrodes with impedance values greater than 5 kilo-ohm.

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

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



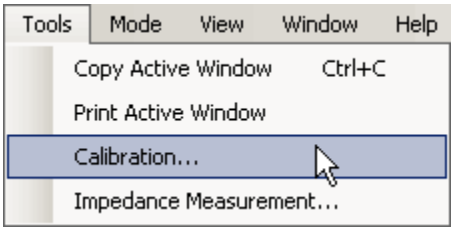
To exit from the **Impedance Measurement** dialog click on the **Close** button.

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**.

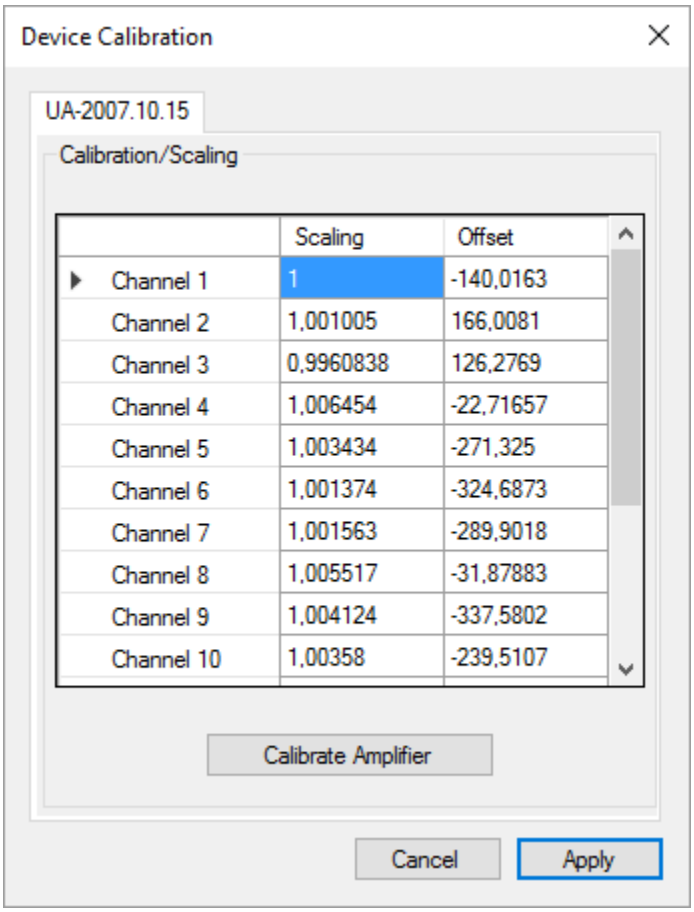
Calibration of g.USBamp with g.Recorder

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

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.

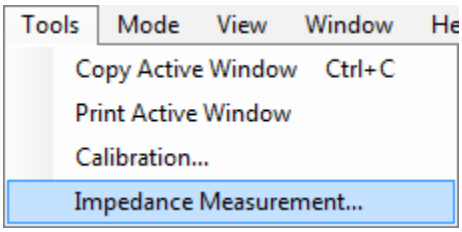


Press the **Apply** button to transmit the settings to the g.USBamp and to close the dialog.

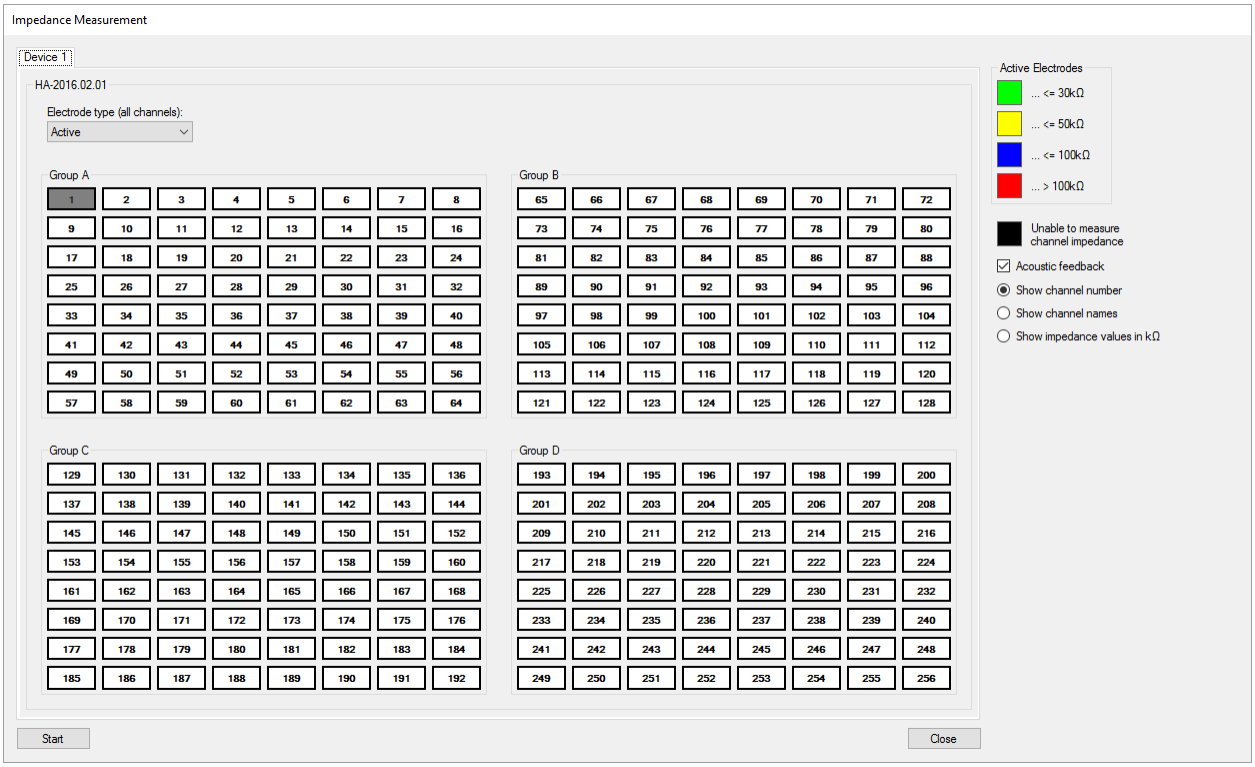
g.HIamp Specific Features

Impedance Measurement with g.HIamp and g.Recorder

The impedance of electrodes connected to a g.HIamp can be measured in g.Recorder. 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.HIamp in the **Electrode Types** area. Either passive or active electrode connector boxes can be used. All groups must use the same type of electrodes even if no box is connected to a specific group. At least channel 1 (Group A) and the ground 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 should be below 5 kilo-ohm (color-code light green). Acceptable impedance values are in the range of up to 20 kilo-ohm (color code light yellow or light blue). Bad impedance values above 20 kilo-ohm are color coded light red. Channels whose impedance couldn't be measured properly are color coded black.

Optimal values e.g. for EEG recordings with active electrodes should be below 30 kilo-ohm (color code green). Acceptable impedance values are in the range of up to 100 kilo-ohm (color code yellow or blue). Bad impedance values above 100 kilo-ohm are color coded red. Channels whose impedance couldn't be measured properly are color coded black.

Channel 1 and the ground electrode are used as the reference for impedance measurement of all other channels. 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 the skin contact is too poor, or when no electrode is connected on that channel, or when artifacts mess up the measured signal on that channel), no impedance value can be calculated and color code black will be assigned to all other channels.

Otherwise, if the reference signal measured on a specific channel is not valid (which might occur when the skin contact is too poor, or when no electrode is connected on that channel, or when artifacts mess up the measured signal on that channel), no impedance value can be calculated and color code black will be assigned to that specific channel.

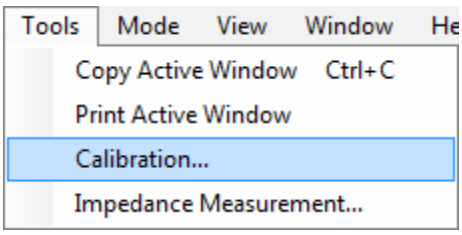
Click **Stop** to stop impedance measurement (even if impedance measurement has aborted with a connection error, for example if the device was disconnected during measurement) and close the dialog by clicking **Close**.

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.

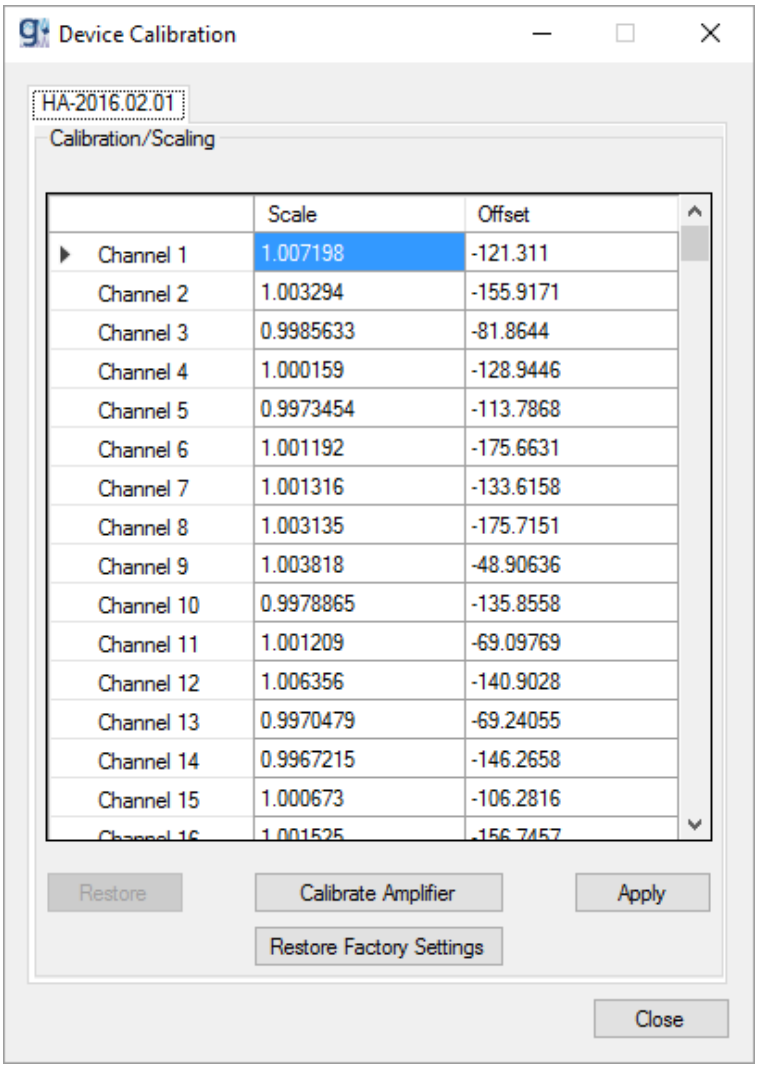


This opens the g.HIamp calibration dialog. To calculate new calibration values for the device, ensure that the calibration set is applied onto the amplifier at first. See the manual of the calibration set for detailed instructions on how to do this. Then click the **Calibrate Amplifier** button to measure 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 calibrate due to broken channels or a 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**.



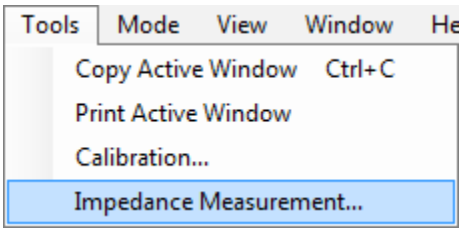
Press the **Apply** button to transmit the newly calculated or restored factory calibration values to the g.HIamp and apply them on the device. Press the **Restore** button to restore the old values on the amplifier. To edit the calibration values manually, double-click the desired cell and enter your 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.

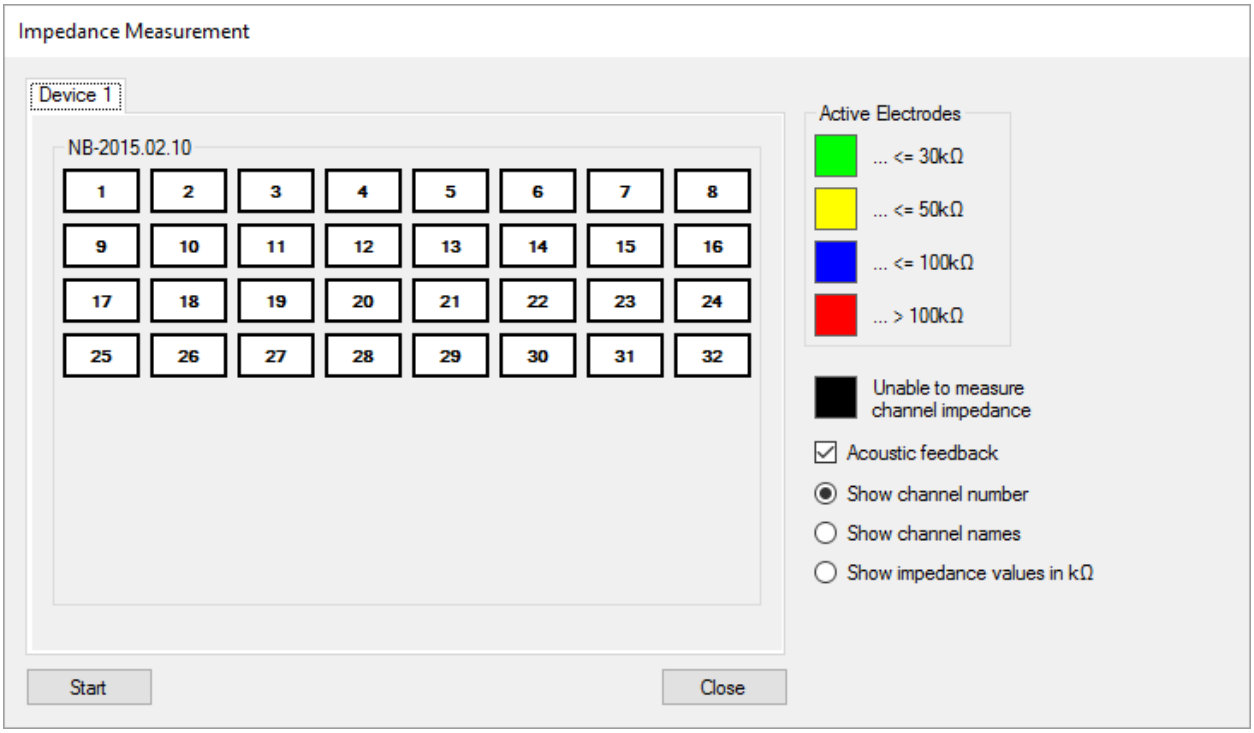
g.Nautilus Specific Features

Impedance Measurement with g.Nautilus and g.Recorder

The impedance of electrodes connected to a g.HIamp can be measured in g.Recorder. To start this tool, click on the **Impedance Measurement…** button in the **Tools** menu.



This opens the dialog shown below.



Select or deselect the channels to use for impedance measurement by clicking on the appropriate channel number. Deselected channels have 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 simultaneously, and lasts a few seconds for each run.

The channel coloring indicates the impedance of the connected electrode. The color code for the impedance measurement is listed in the **Active Electrodes** box.

Optimal values e.g. for EEG recordings with active electrodes should be below 30 kilo-ohm (color code green). Acceptable impedance values are in the range of up to 100 kilo-ohm (color code yellow or blue).

Bad impedance values above 100 kilo-ohm are color coded red. Channels whose impedance couldn't be measured properly are color coded black.

The Cz electrode and the ground electrode are used as the reference for impedance measurement of all other channels. If the reference signal measured on channel Cz is not valid (which might occur when the skin contact is too poor, or when no electrode is connected on that channel, or when artifacts affect the measured signal on that channel), no impedance value can be calculated and color code black will be assigned to all other channels.

Otherwise, if the reference signal measured on a specific channel is not valid (which might occur when the skin contact is too poor, or when no electrode is connected on that channel, or when artifacts affect the measured signal on that channel), no impedance value can be calculated and color code black will be assigned to that specific channel.

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**.

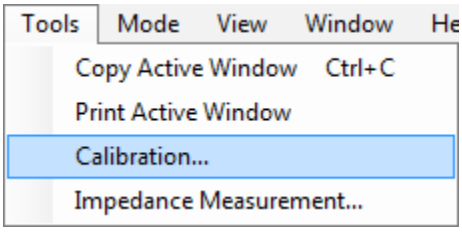
If **Acoustic feedback** is checked, the PC speaker presents a short beep when the impedance of any of the electrodes changes from red to any better impedance value. The greater the improvement in the impedance value, the higher the frequency of the beep. If the impedance of any electrode changes to 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.

Check **Show impedance values in kΩ** to display the measured impedance in kilo-ohm. If the measured impedance value is very low, **LOW** is displayed instead of a value in kilo-ohm. If the impedance value is very high, **HIGH** is displayed instead of a value in kilo-ohm.

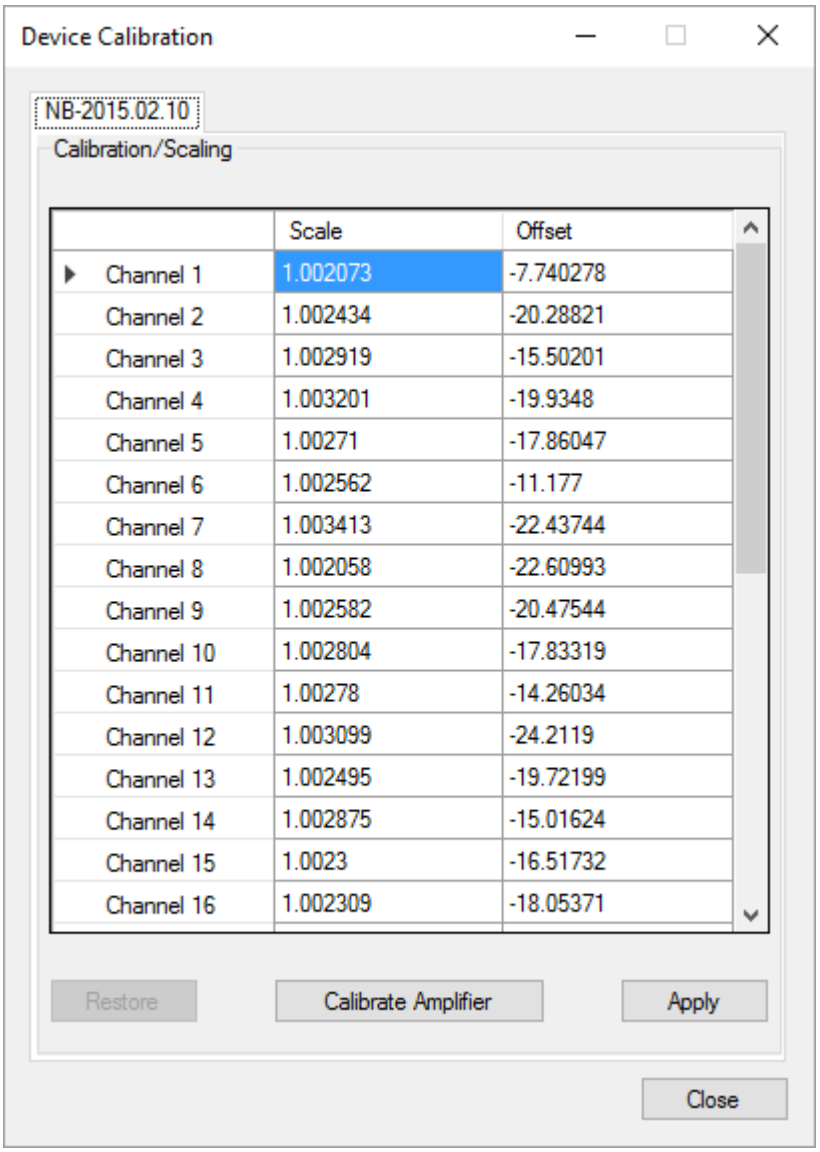
Calibration of g.Nautilus with g.Recorder

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



This opens the g.Nautilus calibration dialog. 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**.

A dialog will inform you after calculation has been completed. The actual calibration values are then visualized for each channel, but not applied yet.


Device Calibration
NB-2015.02.10
Calibration/Scaling
Scale
Offset
Channel 1 1.002073 -7.740278
Channel 2 1.002434 -20.28821
Channel 3 1.002919 -15.50201
Channel 4 1.003201 -19.9348
Channel 5 1.00271 -17.86047
Channel 6 1.002562 -11.177
Channel 7 1.003413 -22.43744
Channel 8 1.002058 -22.60993
Channel 9 1.002582 -20.47544
Channel 10 1.002804 -17.83319
Channel 11 1.00278 -14.26034
Channel 12 1.003099 -24.2119
Channel 13 1.002495 -19.72199
Channel 14 1.002875 -15.01624
Channel 15 1.0023 -16.51732
Channel 16 1.002309 -18.05371
Restore
Calibrate Amplifier
Apply
Close

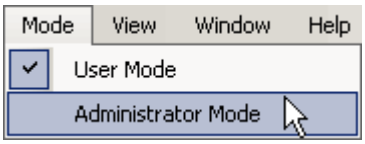
Running g.Recorder in Administrator Mode

The **Administrator Mode** allows the user to configure a g.HIamp, g.USBamp, g.MOBIlab or g.Nautilus amplifier and add and configure the different feature extraction methods of **g.Recorder**.

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

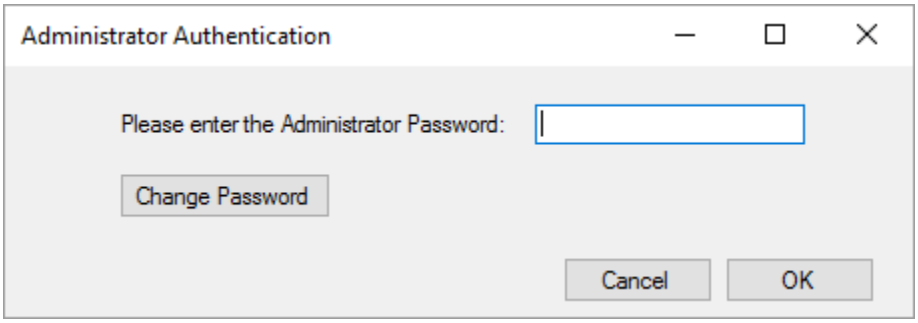
Activate Administrator Mode

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

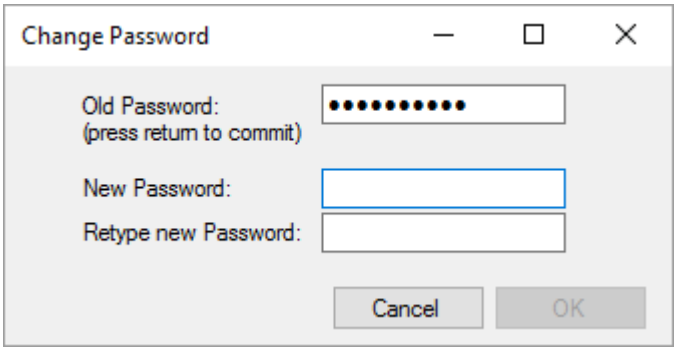


Note: Per default no Administrator Password is set.

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



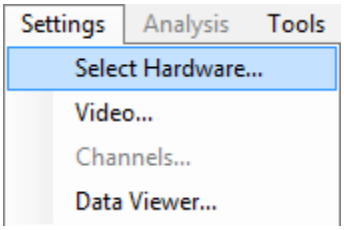
To change the password, click on **Change Password** and enter the **Old Password**. Then, press the Enter key and enter the **New Password**, then enter the password again in the **Retype new Password** field and click **OK**.



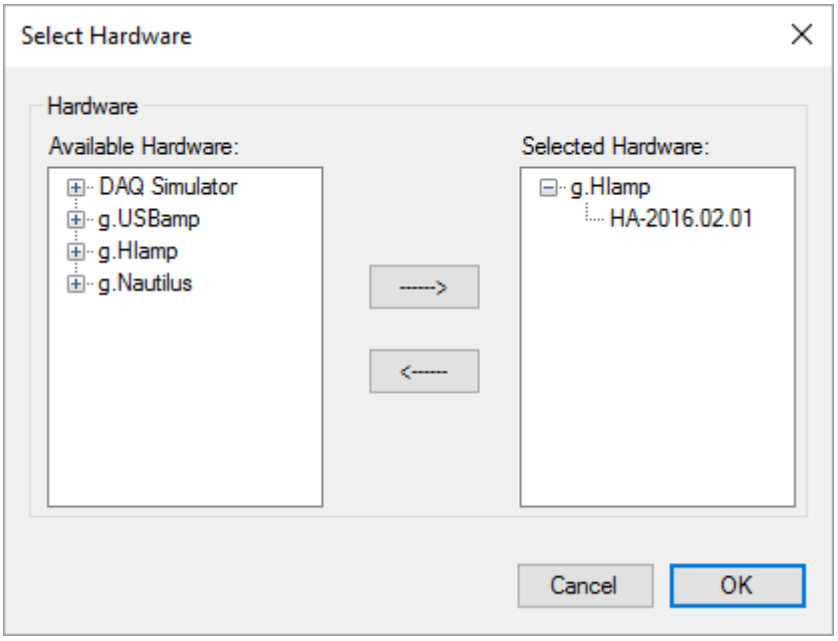
Select and Configure Hardware

g.HIamp

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



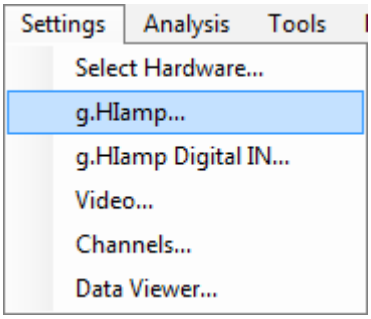
The **Select Hardware** dialog opens:



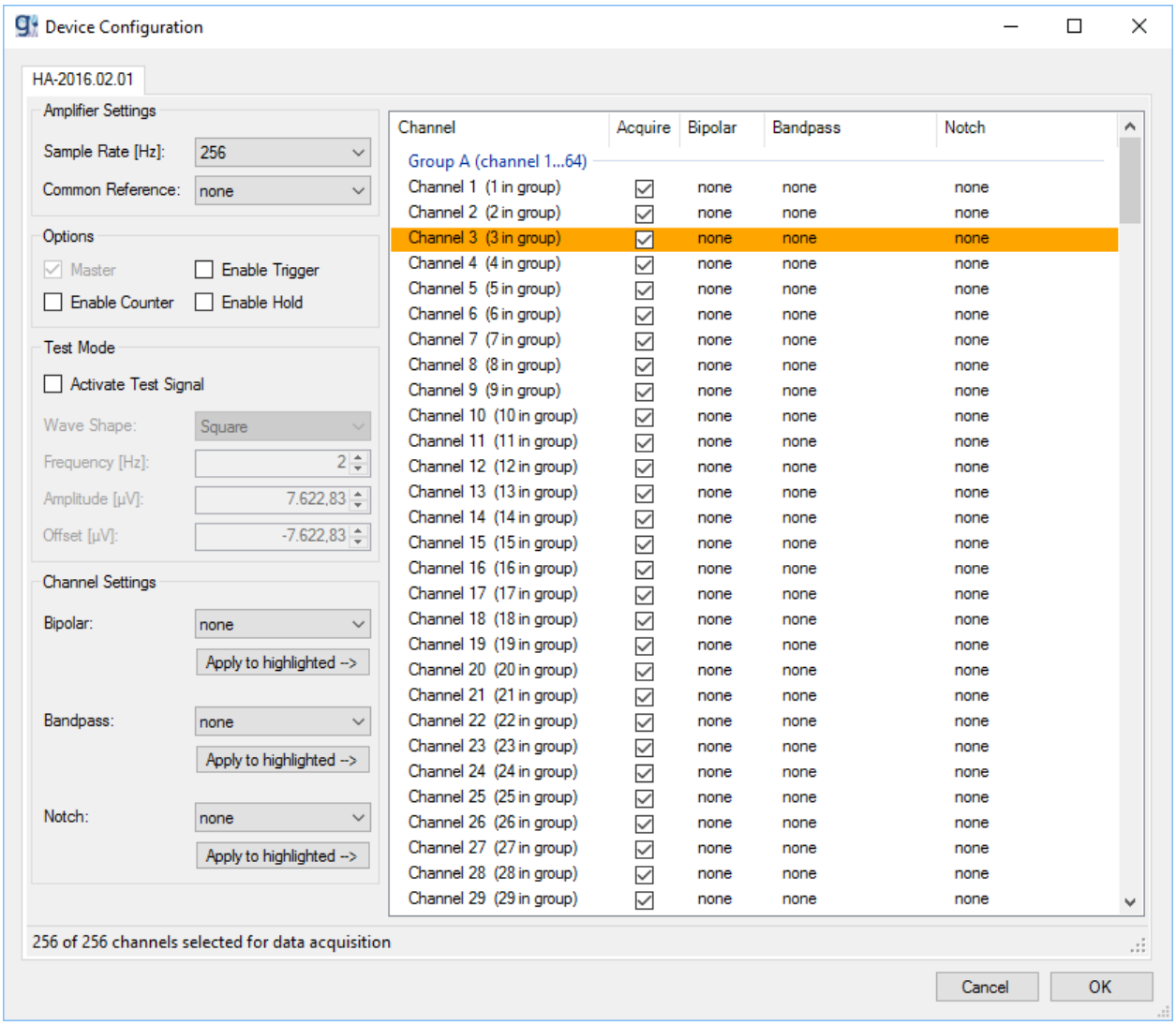
Select the desired g.HIamp device that should be used for measurement from **Available Hardware** and click on the arrow button. This g.HIamp and its serial number are displayed in the **Selected Hardware** box.

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-2016.02.01):



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 the common reference channel. This is a quick way to set the selected channel as a 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 highlighted channels:

1. Highlight the channels in the list box that should be edited. Use the Ctrl key or the Shift key to highlight multiple channels. To select all channels, use Ctrl+A. To highlight all channels of one group, click the group header. Highlighted channels are represented with an orange background color, as illustrated for channel 3.

2. Check or uncheck the checkbox of one of the selected channels in the **Acquire** column to include the highlighted 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 highlighted** button right below.

4. Select a bandpass filter from the **Bandpass** list and press the corresponding **Apply to highlighted** button right below.

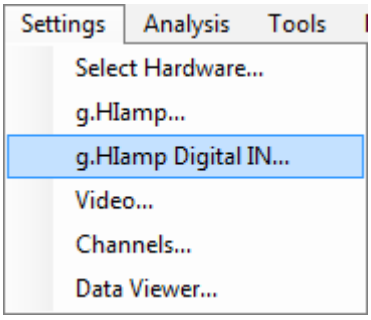
5. Select a notch filter from the **Notch** list and press the corresponding **Apply to highlighted** button right below.

If no channel is highlighted when one of the **Apply to highlighted** buttons is clicked, the system instead informs the user of this error and the settings do not change.

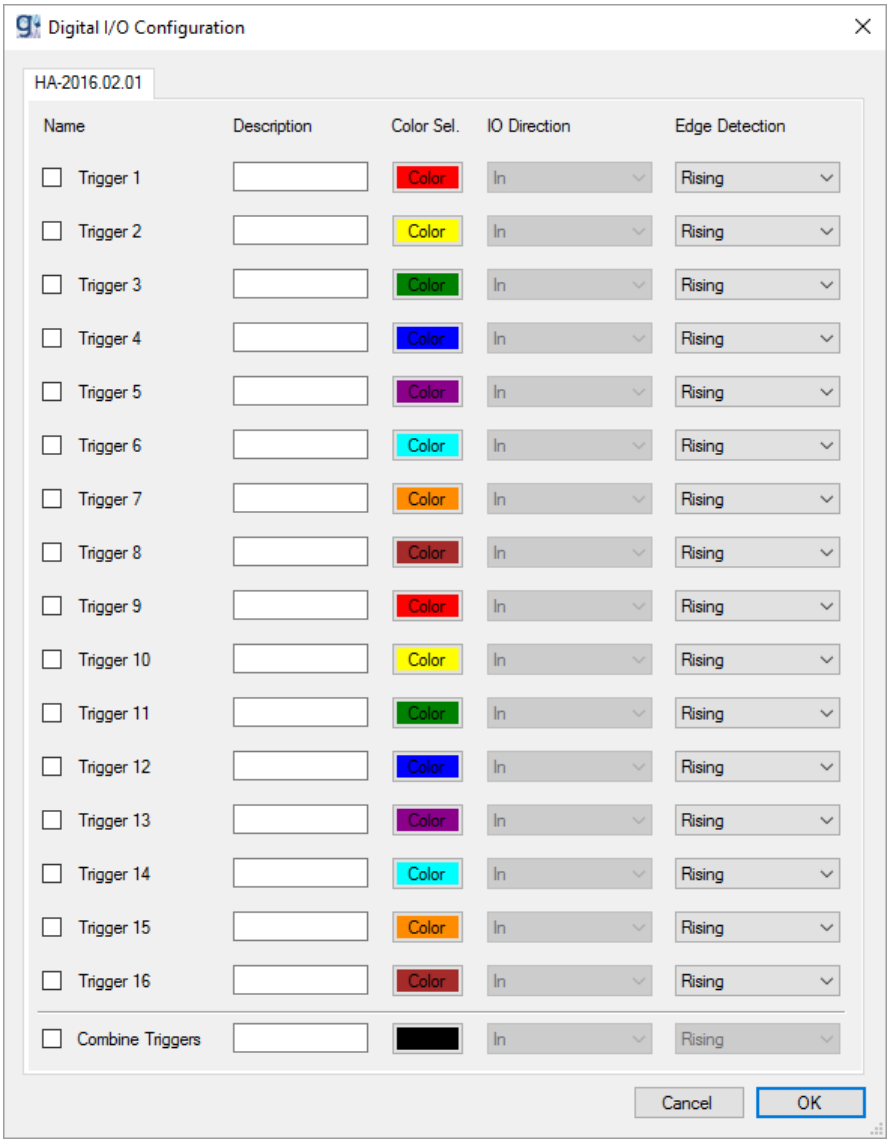
Click **OK** to finish the configuration of the g.HIamp and apply it to the device.

Digital IN for g.HIamp

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



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



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**).

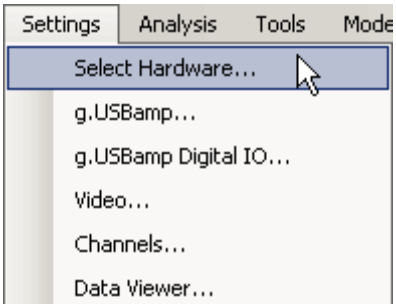
Confirm the settings and close the dialog with **OK**.

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

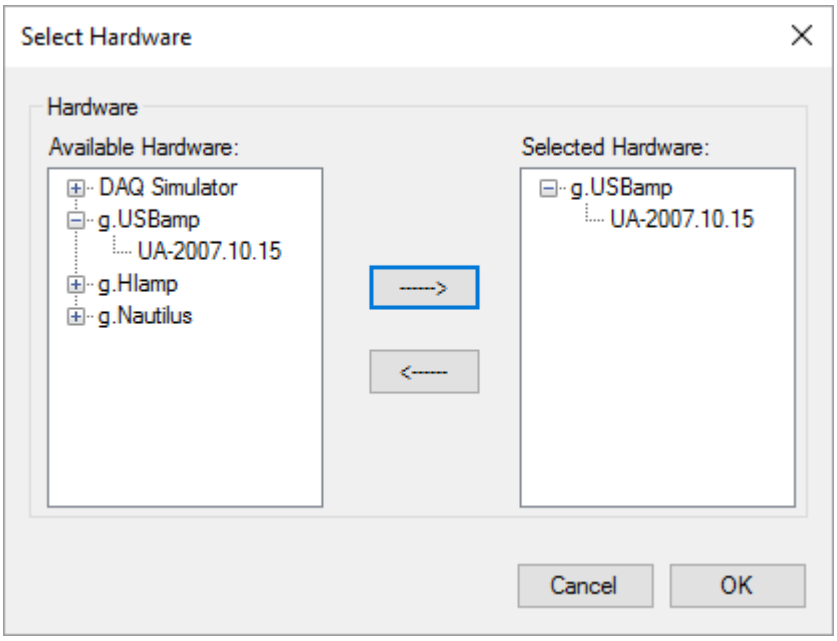
If **Combined Triggers** are selected, all individual trigger channels are enabled and the individual channel selection becomes disabled. Combined triggers are always configured to detect rising edges. It is possible to change the **Color** and **Description** for combined triggers. The displayed marker name and color for a combined trigger are always the same. The marker's value will be the binary coded decimal made up of the current HIGH and LOW values of all individual trigger channels with trigger channel 1 as least significant bit and trigger channel 16 as most significant bit.

g.USBamp version 2.0 and version 3.0

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



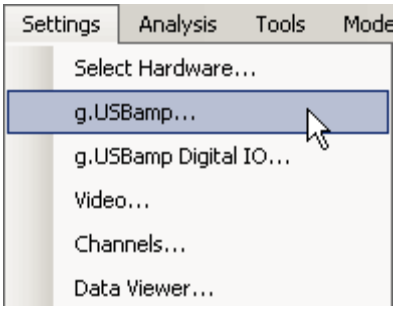
The **Select Hardware** dialog opens:



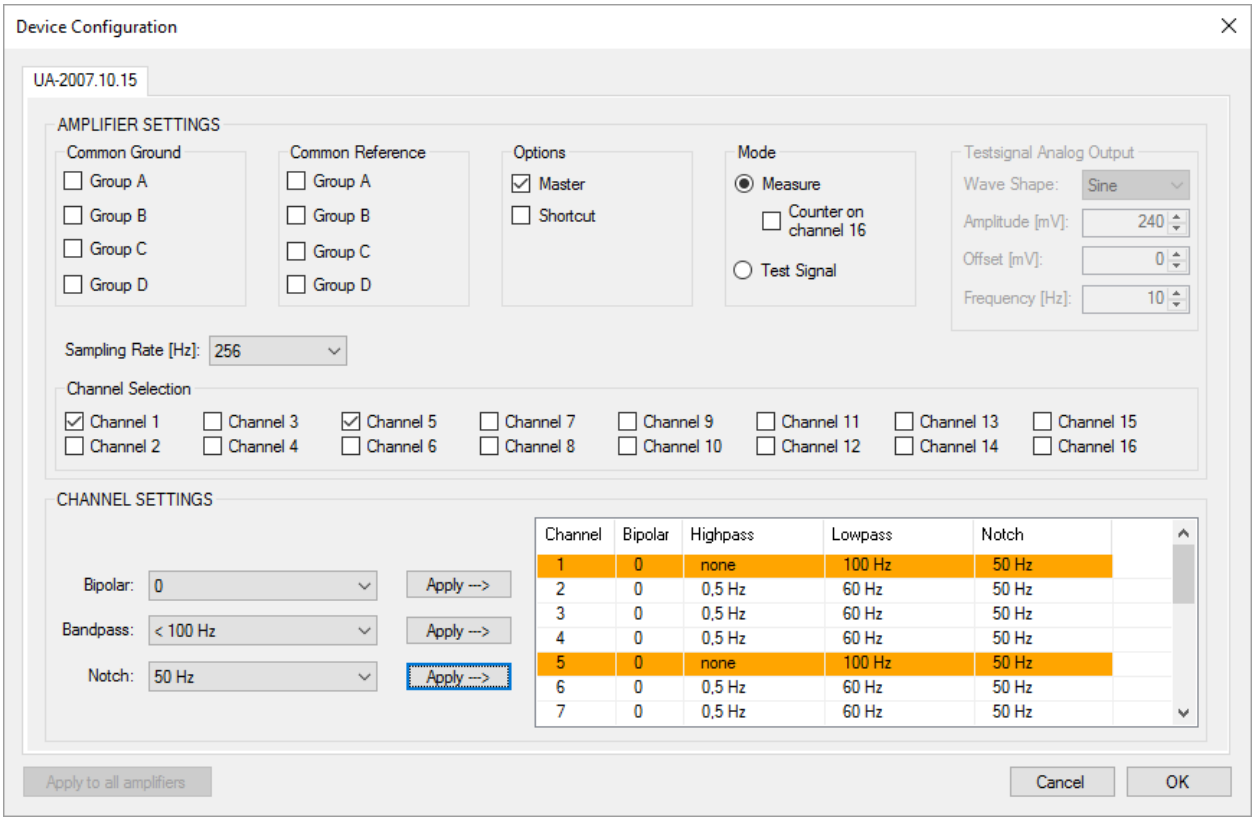
From **Available Hardware, select** the g.USBamp device that should be used for the measurements and click on the arrow button, as shown in the figure above. This g.USBamp with the serial number is now displayed in the **Selected Hardware** box. Repeat these steps If multiple g.USBamps are connected to the PC.

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. UA-2007.10.15):



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. Highlight the channels in the listbox that should be edited. Use the Ctrl key or the Shift key to highlight multiple input channels.

2. Select the **Bandpass** filter HP: 0.5 / LP: 30 and press the **Apply** button to assign the bandpass to the highlighted channel(s). 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.

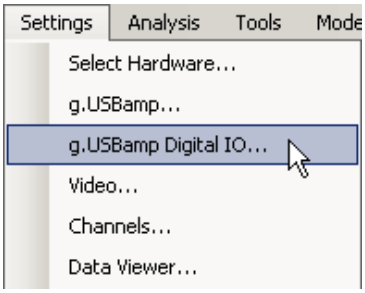
   NOTE: Select 0 under **Bipolar** and assign it to the channel if no bipolar derivation should be performed

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

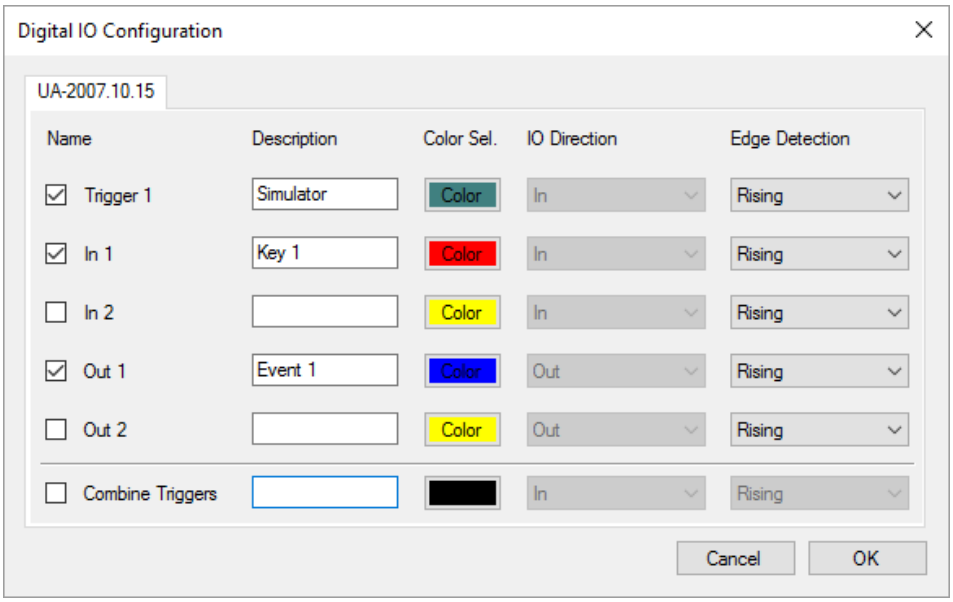
Digital IO for g.USBamp version 2.0

The serial number for a g.USBamp 2.0 starts 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 therefore gives 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.

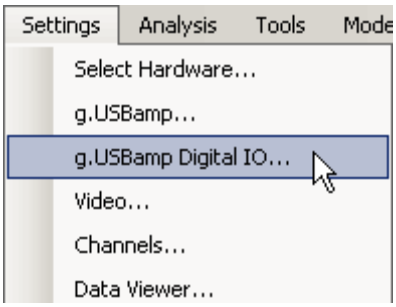
If **Combined Triggers** are selected, all individual trigger channels are enabled and the individual channel selection becomes disabled. Combined triggers are always configured to detect rising edges. It is possible to change the **Color** and **Description** for combined triggers. The displayed marker name and color for a combined trigger are always the same. The marker's value will be the binary coded decimal made up of the current HIGH and LOW values of all individual trigger channels with trigger channel 1 as the only bit in that value.

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

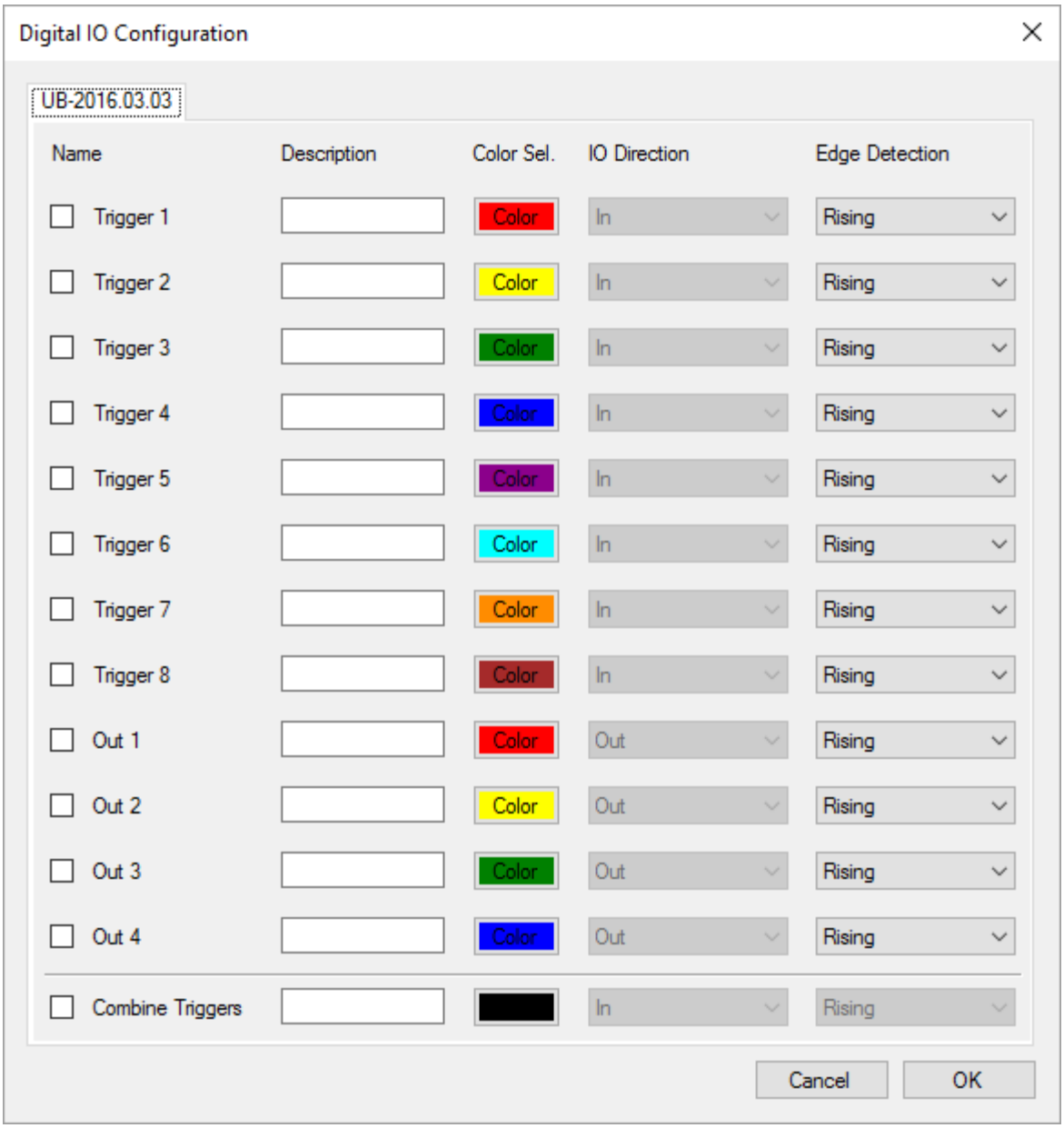
Digital IO for g.USBamp version 3.0

The serial number for a g.USBamp 3.0 starts 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 **Trigger 1** to **Trigger 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**.

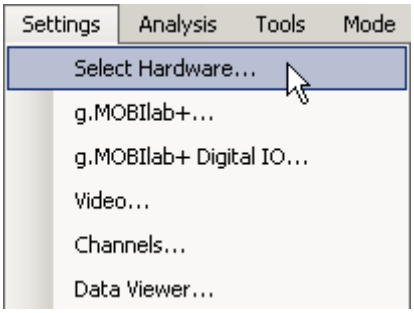
If the corresponding trigger event occurs, a marker is generated and visualized along with the biosignal data.

If **Combined Triggers** are selected, all individual trigger channels are enabled and the individual channel selection becomes disabled. Combined triggers are always configured to detect rising edges. It is possible to change the **Color** and **Description** for combined triggers. The displayed marker name and color for a combined trigger are always the same. The marker's value will be the binary coded decimal made up of the current HIGH and LOW values of all individual trigger channels with trigger channel 1 as least significant bit and trigger channel 8 as most significant bit.

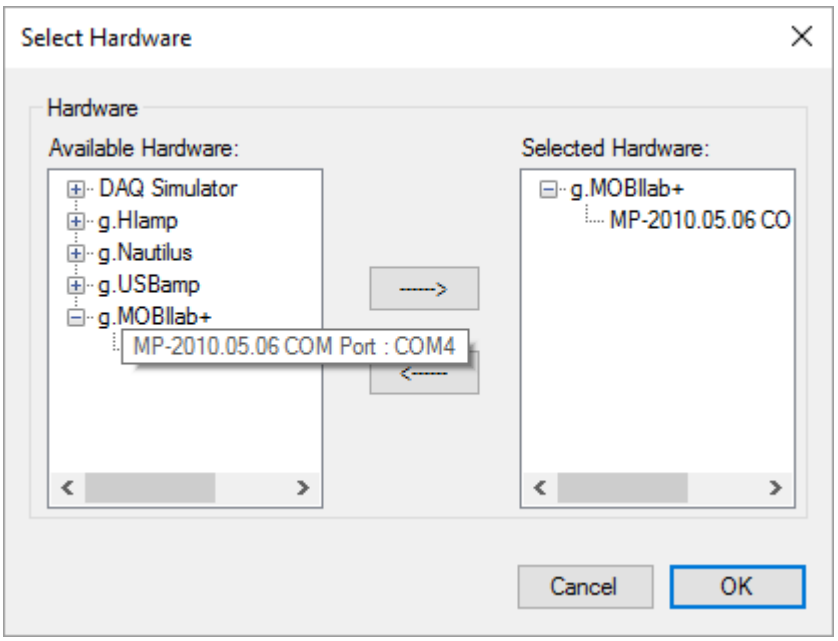
NOTE: A very accurate timing is obtained for all input channels.

g.MOBIlab+

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



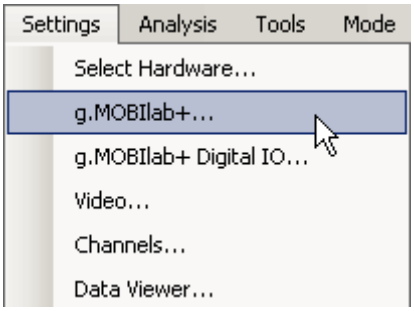
The **Select Hardware** dialog opens:



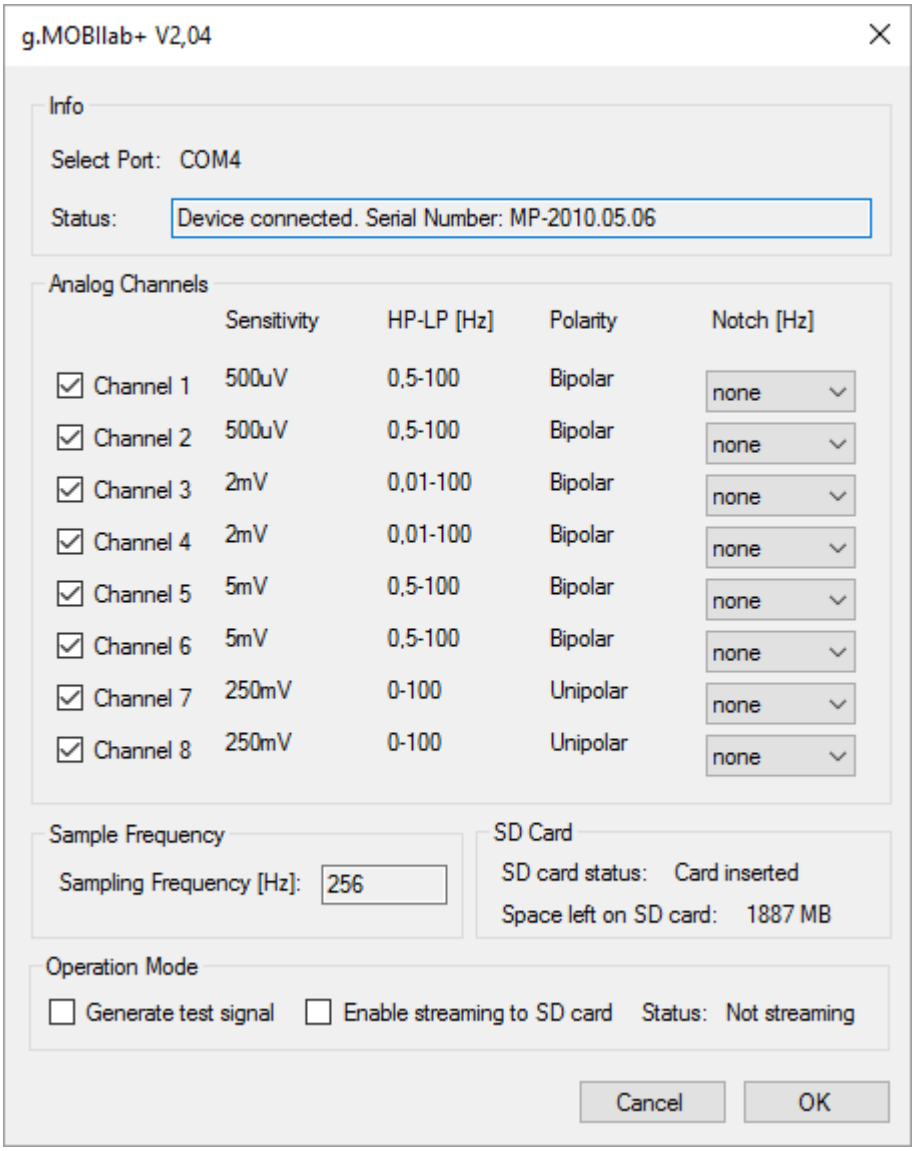
From **Available Hardware**, select the **g.MOBIlab+** that should be used for the measurements and click on the arrow button as shown in the figure above. Now this **g.MOBIlab+** with the serial number and the COM port number is displayed in the **Selected Hardware** box. The COM port of your **g.MOBIlab+** 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

The channels to be recorded can be selected in the **Analog Channels** section. 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.MOBIlab+, then the **SD card status** is displayed in the **SD Card** section including the space left on the SD Card.

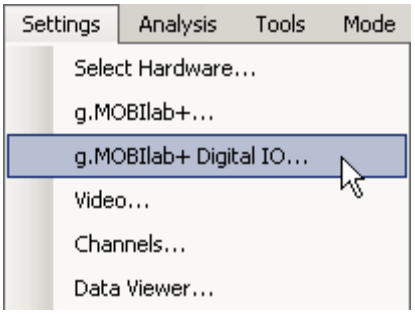
Operation Mode

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

With the **Generate test signal** checkbox selected, g.MOBIlab+ 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.MOBIlab+ 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.MOBIlab+. If the checkbox is selected then it is possible to disconnect g.MOBIlab+ from the **g.Recorder** environment and the device will continue to stream data to the built-in SD Card. If a connected g.MOBIlab+ is already streaming data then this **Status** is also displayed in the **Operation Mode** section.

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

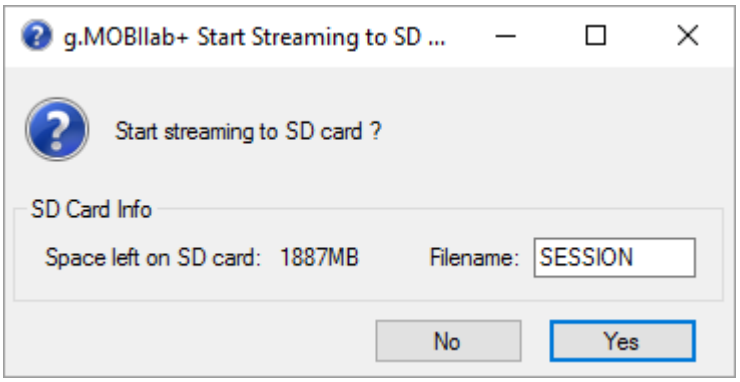


DIO1 to **DIO4** can be configured as digital inputs or outputs. **DI1** to **DI4** are digital inputs. Set the **Edge Detection** to either detect only **Falling** or **Rising** edges or to detect both, **Rising+Falling**.

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.

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.



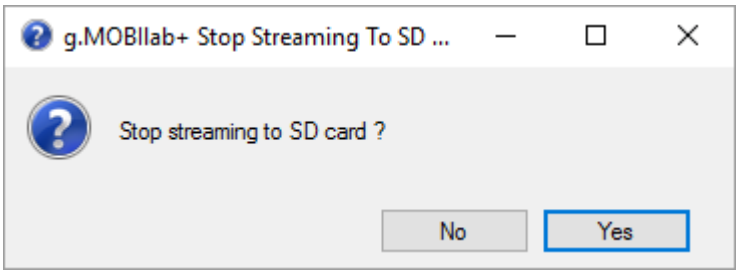
The **Start Streaming to SD Card** dialog asks the user to provide a **Filename** for the data recorded to the SD card.

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.

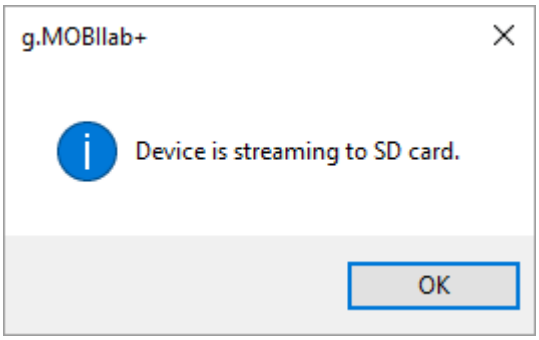
The **Space left on SD Card** in MB is also displayed

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

When the data acquisition is stopped, then **g.MOBIlab+ 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.MOBIlab+ click **Yes**. To continue streaming data to the SD Card click **No**.

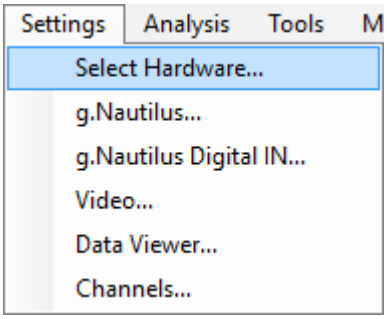


If g.MOBIlab+ is already streaming data to the SD card, then you can reconnect the device to **g.Recorder**. An information dialog will appear. Click **OK** to display data again from g.MOBIlab+ in **g.Recorder**.

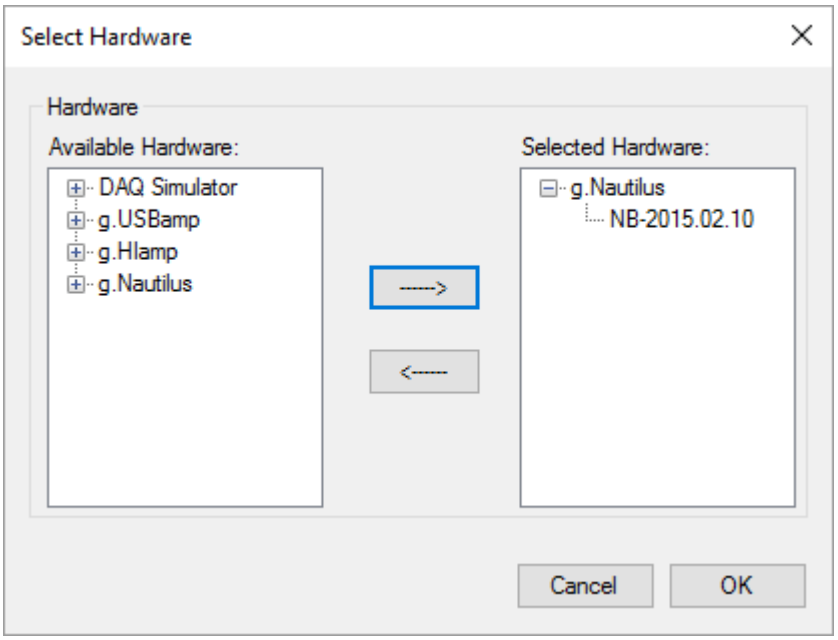


g.Nautilus

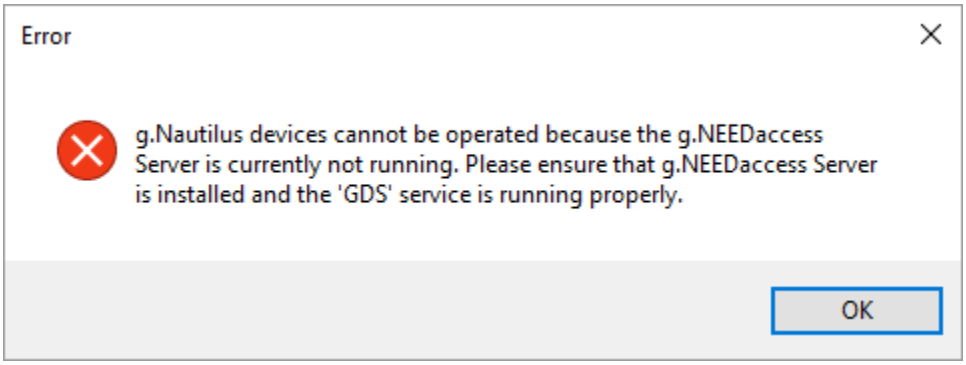
In the Settings menu, select **Select Hardware…**



The **Select Hardware** dialog opens:



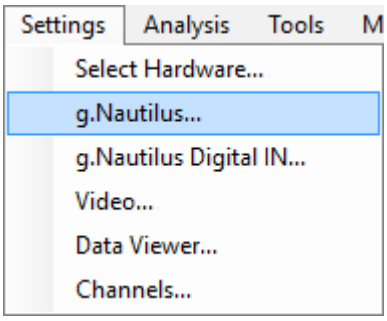
Select the **g.Nautilus** that should be used for the measurements from **Available Hardware** and click on the arrow button as shown in the figure above. Now this **g.Nautilus** with the serial is displayed in the **Selected Hardware** box.



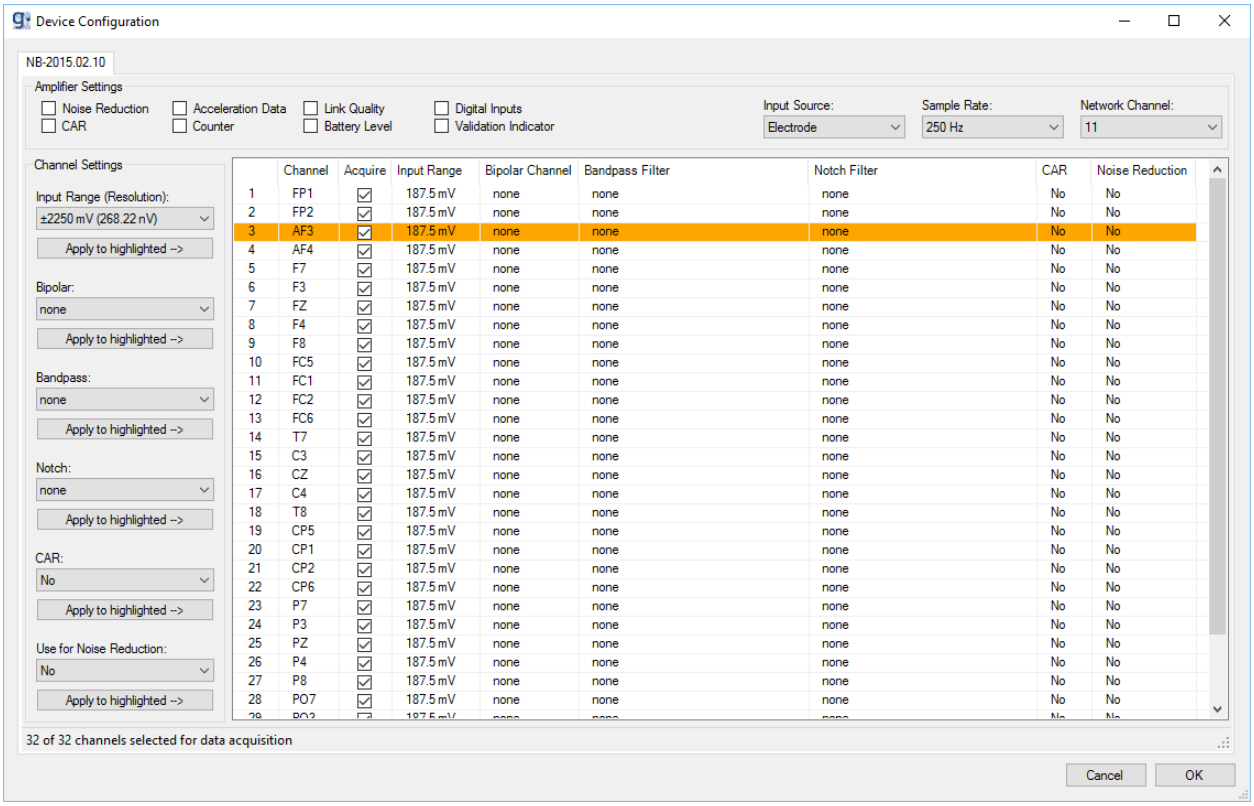
If the g.NEEDaccess Server is not running, g.Nautilus devices cannot be used. An error message will be shown. The installation and GDS service status should be checked, if this error message appears.

Click **OK** to finish hardware selection.

To configure the g.Nautilus, select **g.Nautilus…** from the **Settings** menu.



The configuration window opens with the amplifier serial number:



AMPLIFIER SETTINGS

Input Source specify the input source for data acquisition.

Electrode: record EEG data
Shortcut: record with shortcut of inputs
Testsignal: enables the internal test signal generator, which generates a square wave test signal on each channel.

Sample Rate specify the sampling frequency in Hz.

Network Channel	Set the network channel used for data transmission.
Noise Reduction	enable noise reduction using DRL (driven-right leg) algorithm of activated channels.
CAR	enable common average reference of activated channels (see column CAR).
Acceleration Data	if enabled, the measured acceleration in x, y, and z directions in the range of ± 6 g come as three additional channels after the analog channels.
Counter	if enabled, a sample counter comes as an additional channel after the acceleration data channels.
Link Quality	if enabled, wireless link quality in percent comes as an additional channel after the counter channel.
Battery Level	if enabled, battery level (state of charge) in percent comes as an additional channel after the link quality channel.
Digital Inputs	indicates if the digital trigger input line is acquired as well. This checkbox will be enabled automatically if at least one trigger channel is selected to be acquired (see the digital IN settings section for further details). Setting or clearing this checkbox by the user has no effect. if enabled, the digital input channels come encoded in a single additional channel after the battery level channel.
Validation Indicator	if enabled, the validation indicator indicating successful wireless transmission of a sample (1 for valid, 0 for invalid) comes as an additional channel after the digital inputs channel.

Channel SETTINGS

Sensitivity	set channel sensitivity of analog input channels.
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.
CAR	select channels for common average reference calculation (CAR checkbox must be enabled to active the filter).
Noise Reduction	select the channels that should be used for calculating the DRL signal for noise reduction (Noise reduction checkbox must be enabled to active the DRL function).

Perform the following steps to configure the highlighted channels:

1. Highlight the channels in the list box that should be edited. Use the Ctrl key or the Shift key to highlight multiple channels. To select all channels, use Ctrl+A. To highlight all channels of one group, click the group header. Highlighted channels are represented with an orange background color, as illustrated for channel 3.

2. Check or uncheck the checkbox of one of the selected channels in the **Acquire** column to include the highlighted channels in data acquisition or exclude them.

3. If 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 highlighted** button right below.

4. Select a bandpass filter from the **Bandpass** list and press the corresponding **Apply to highlighted** button right below.

5. Select a notch filter from the **Notch** list and press the corresponding **Apply to highlighted** button right below.

6. If the **CAR** checkbox is checked and you want to include the highlighted channels in CAR calculation, select **Yes** from the **CAR** list and press the corresponding **Apply to highlighted** button right below.

7. If the **Noise reduction** checkbox is enabled and you want to consider the highlighted channels for noise reduction, select **Yes** from the **Use for Noise Reduction** list and press the corresponding **Apply to highlighted** button right below.

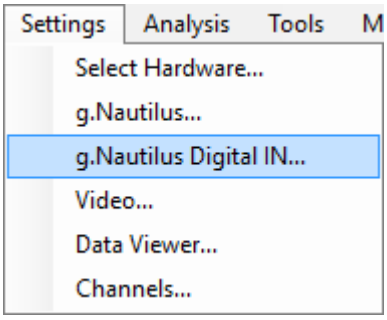
If no channel is highlighted when one of the **Apply to highlighted** buttons is clicked, the system instead informs the user of this error and the settings do not change.

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

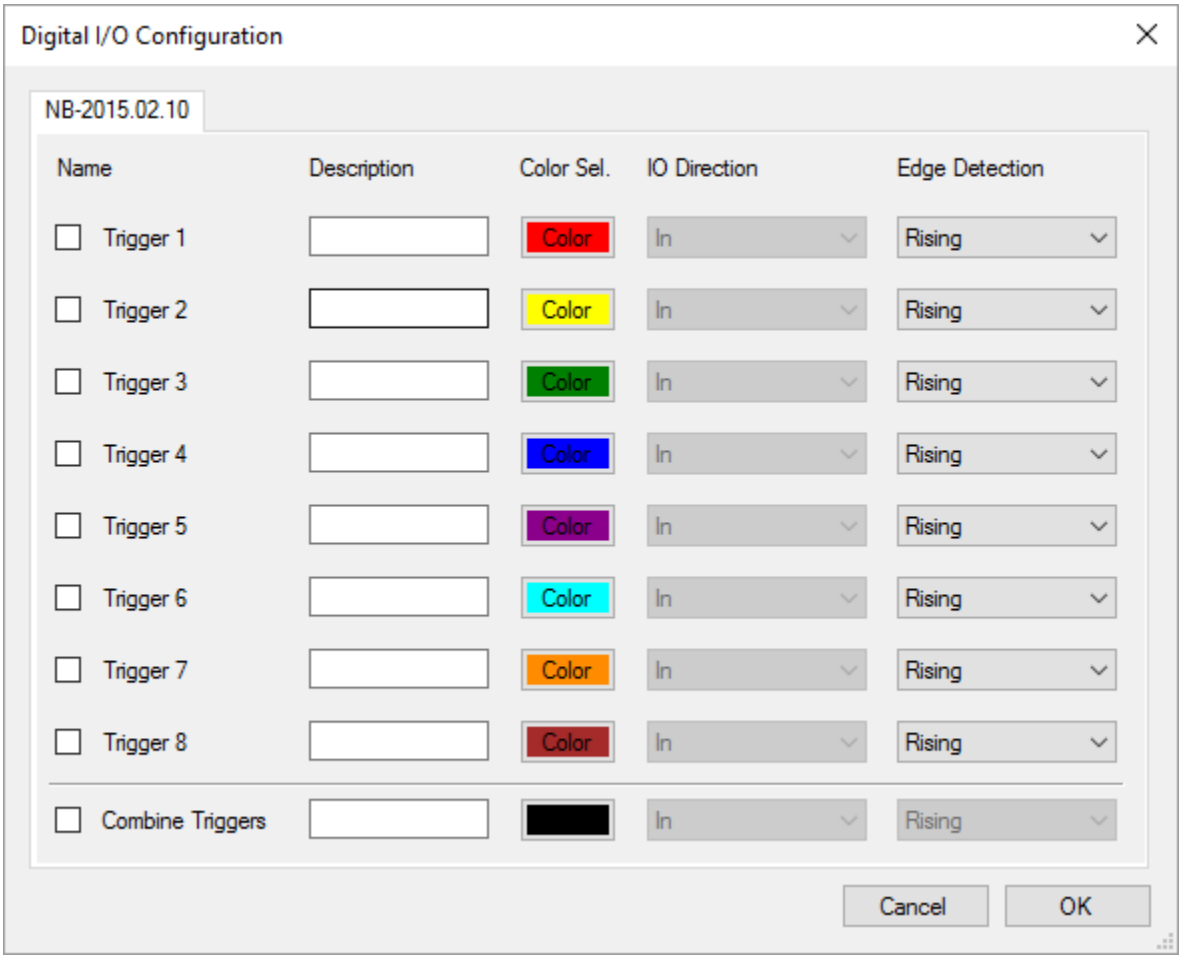
Digital IN for g.Nautilus

The serial number for a g.Nautilus starts with NB-xxxx.xx.xx

g.Nautilus has 8 digital inputs. In the **Settings** menu, click on **g.Nautilus Digital IN…** to open the dialog.



The trigger inputs **Trigger 1** to **Trigger 8** are sampled synchronously with the analog input channels.



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

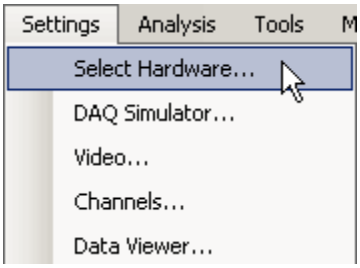
Then close the dialog with **OK**.

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

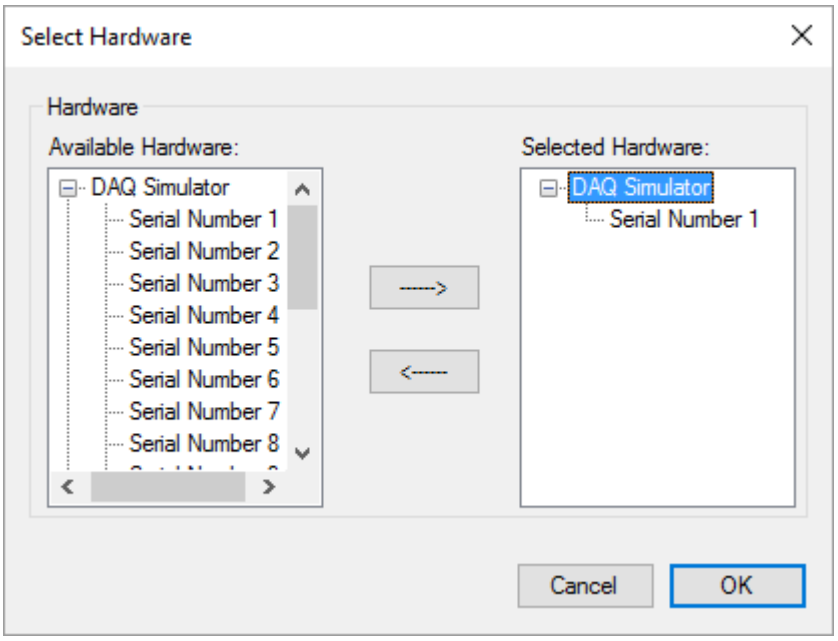
If **Combined Triggers** are selected, all individual trigger channels are enabled and the individual channel selection becomes disabled. Combined triggers are always configured to detect rising edges. It is possible to change the **Color** and **Description** for combined triggers. The displayed marker name and color for a combined trigger are always the same. The marker's value will be the binary coded decimal made up of the current HIGH and LOW values of all individual trigger channels with trigger channel 1 as least significant bit and trigger channel 8 as most significant bit.

DAQ Simulator

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



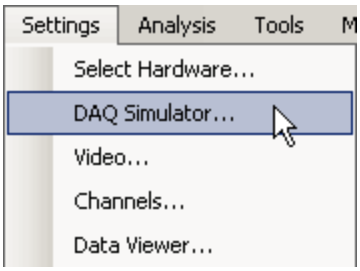
The **Select Hardware** dialog opens:



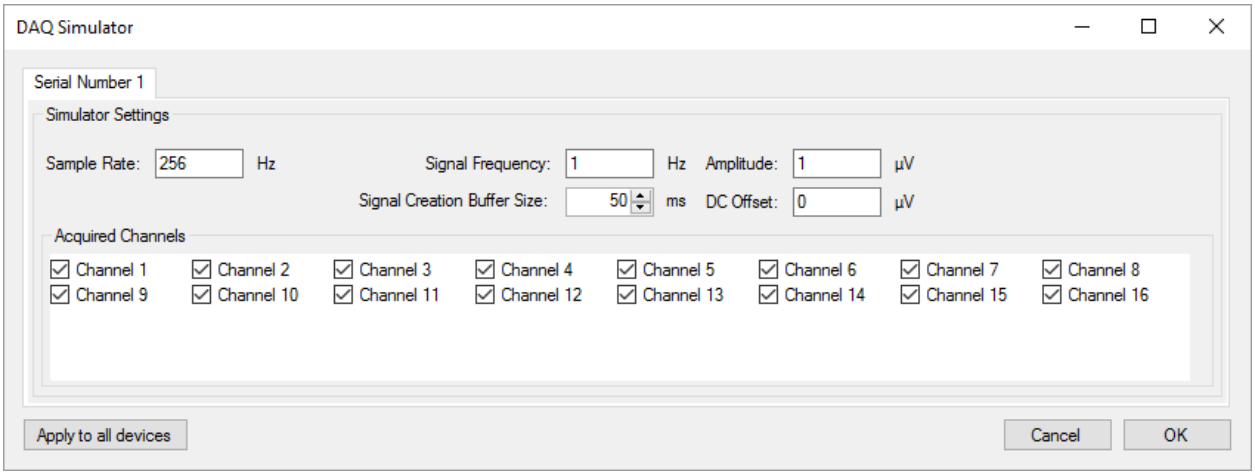
Select **Serial Number 1** from the **Available Hardware** list and click on the arrow button to add it to the **Selected Hardware** list. If more than 16 channels should be simulated, add as many **DAQ Simulators** as needed.

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.

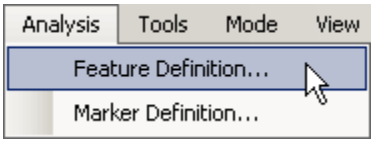
Note: data in the **DAQ Simulator** is not sampled equidistantly!

Feature Definition

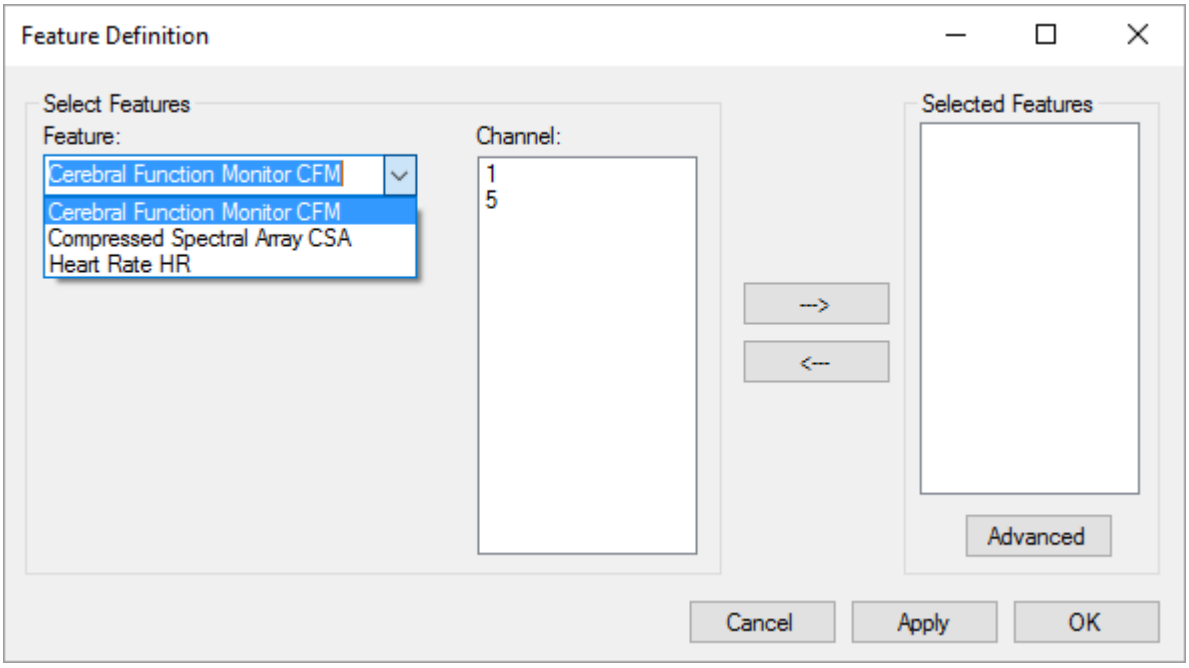
g.Recorder allows the user to calculate in real-time specific features which are shown in the Feature Viewer. **g.Recorder** supports the Cerebral Function Monitor (CFM) parameter, the Heart Rate (HR) and the Compressed Spectral Array (CSA).

Warning: High sampling rates, many channels or extensive feature calculation can overload the PC's hardware resources, resulting in data loss. This might occur immediately or even after some time after starting acquisition. Please plan feature calculation meaningfully and carefully.

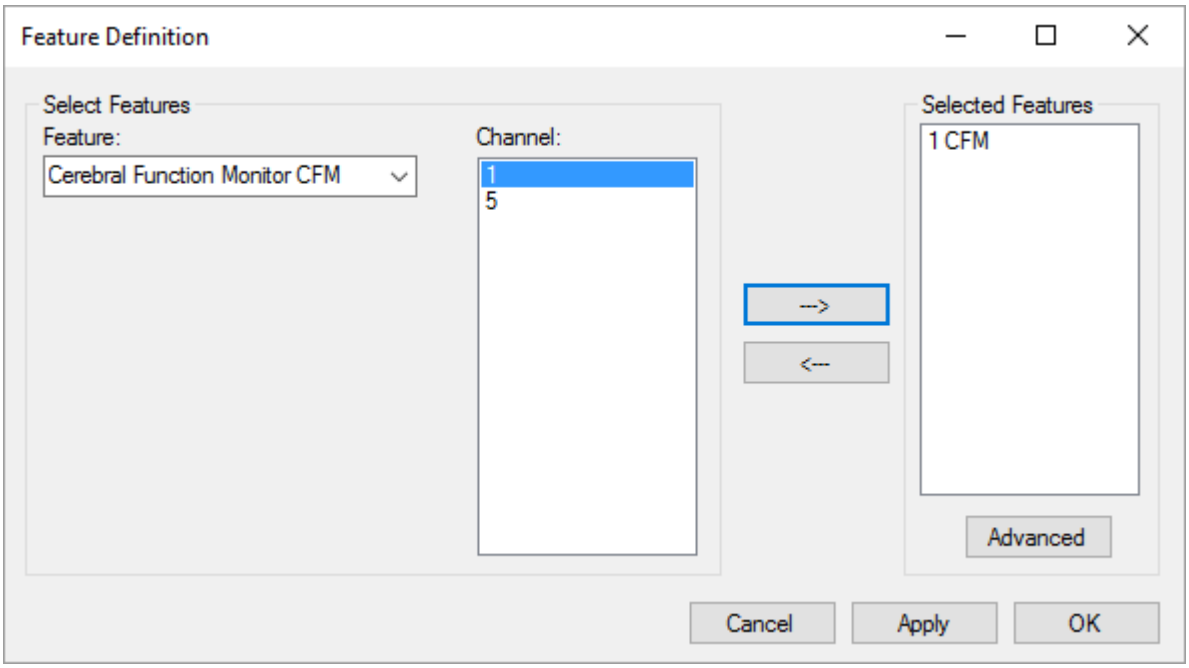
Select **Feature Definition…** from the **Analysis** menu



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

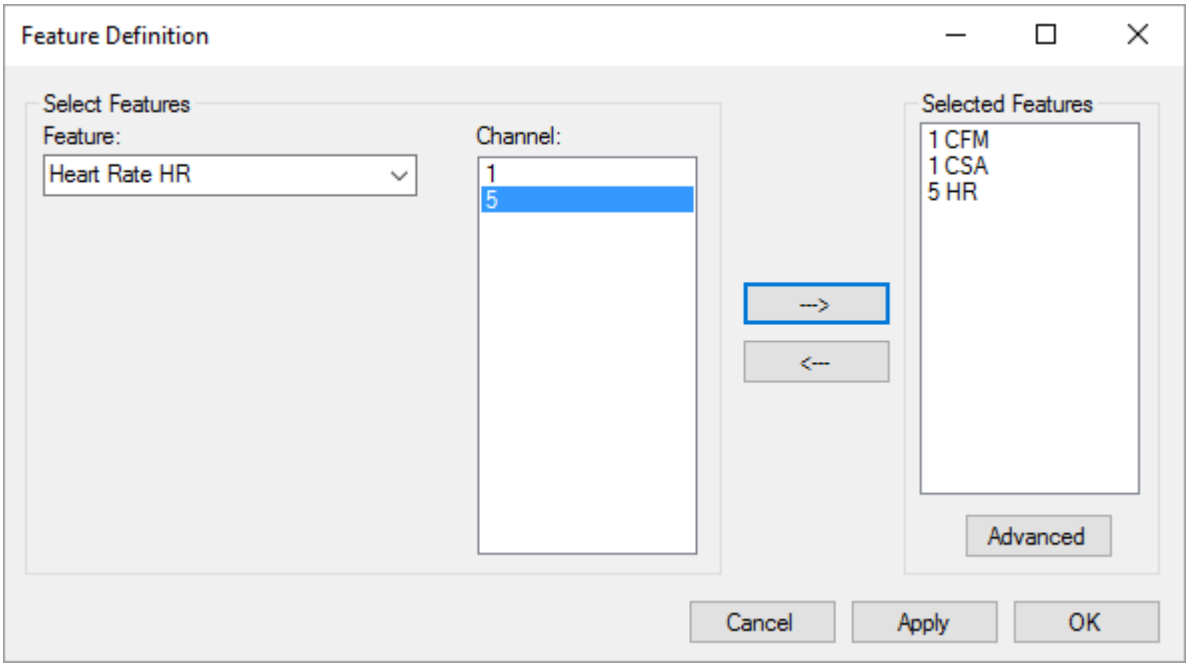


Then select the EEG **Channel** that is used to calculate the feature and add the feature with the arrow button.



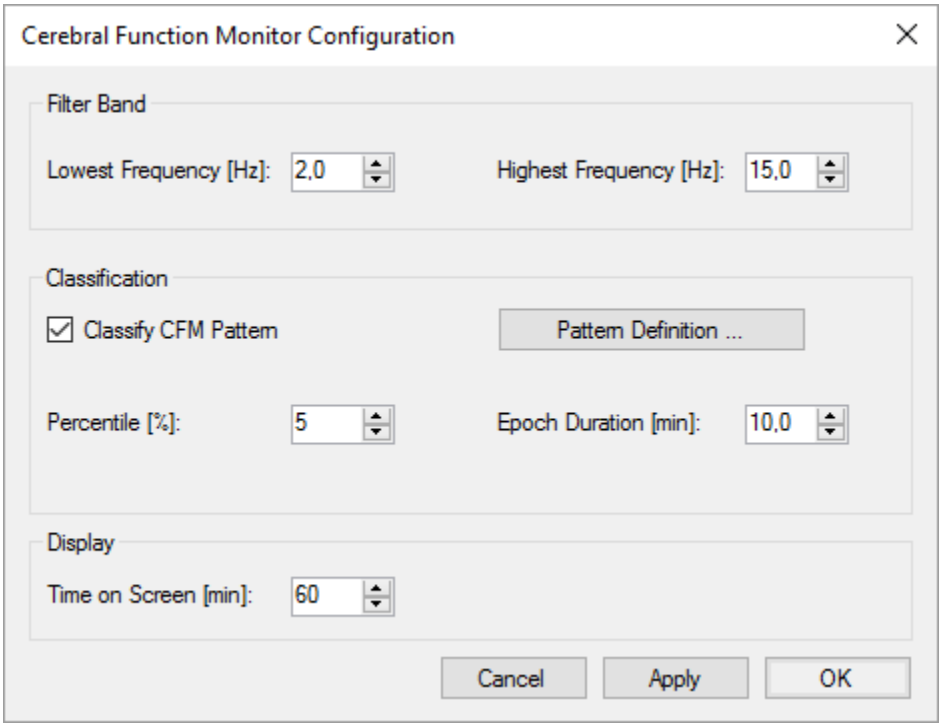
The channel number and the selected feature are displayed on the right side.

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.



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

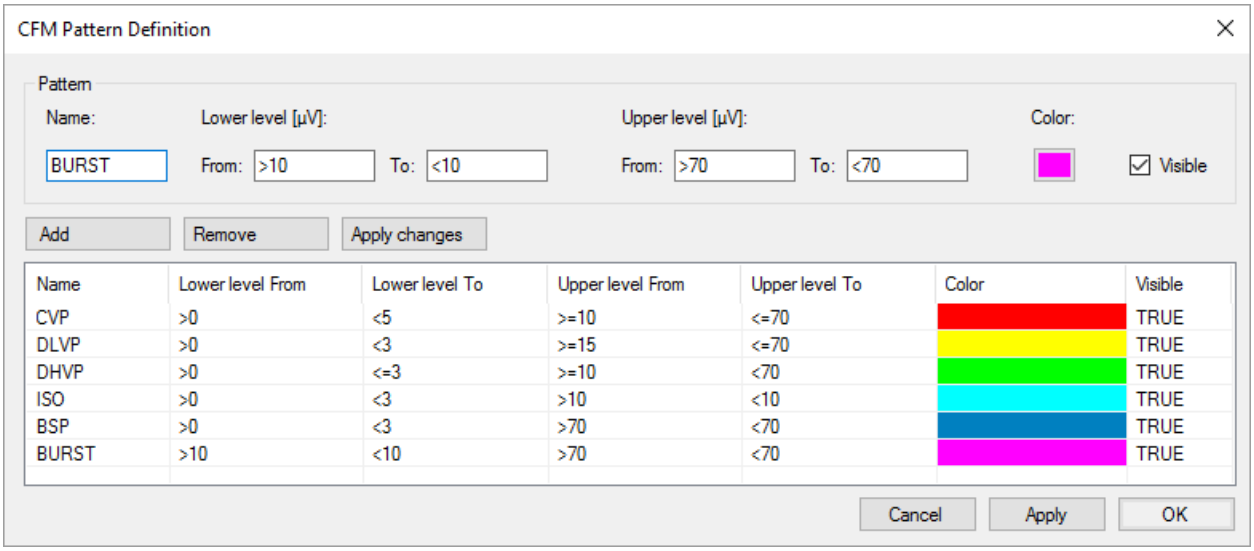
Classification

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:



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

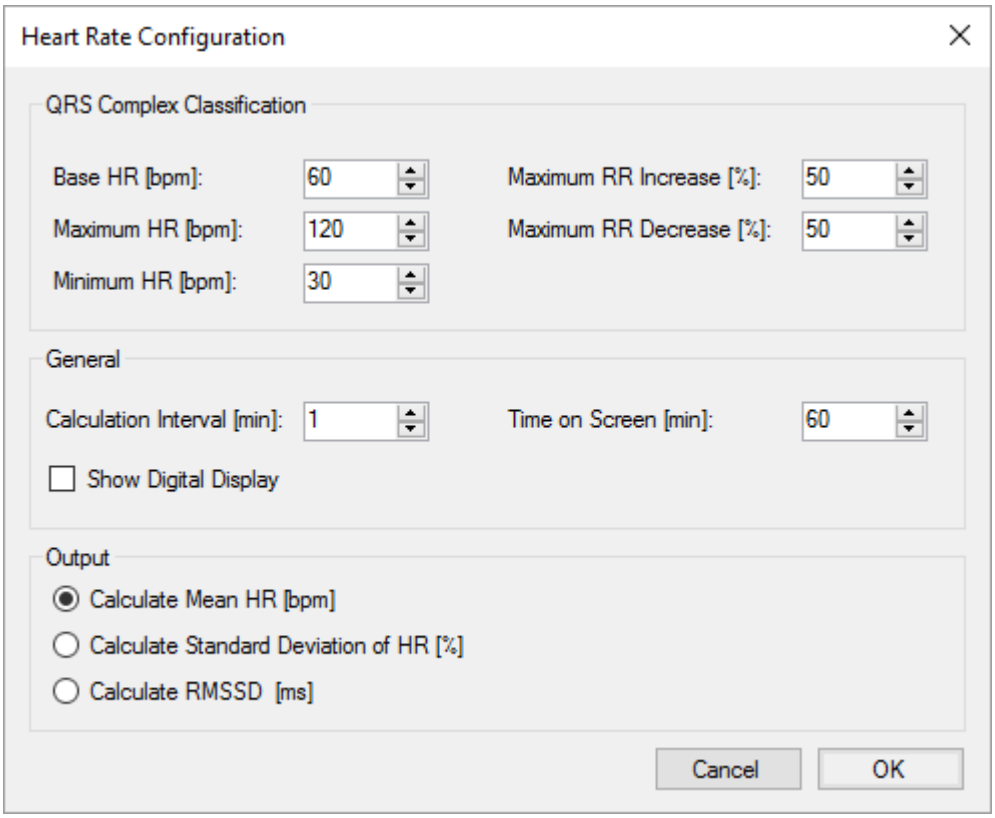
Click the **Add** button to add the pattern to the list. With **Remove**, a selected pattern can be removed from the list. With the **Apply changes** button, the settings for a selected pattern in the list can be applied.

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:



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

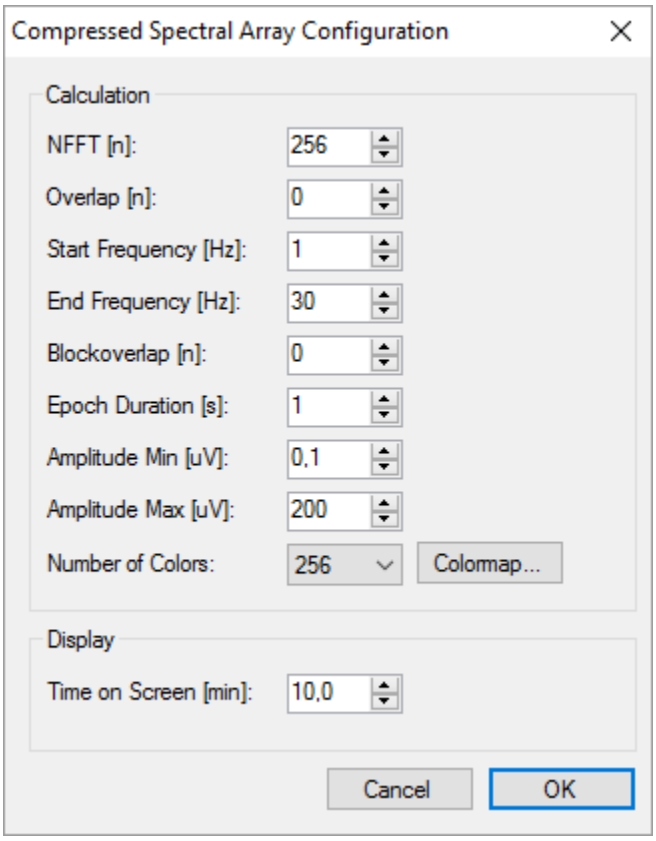
Calculation Interval [min] – specify the interval that is used to calculate the HR
Time on Screen [min] - enter the minutes shown on one page in the Feature Viewer
Show Digital Display – if selected, the actual information for heart rate or heart rate variability is displayed right next to the feature 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:

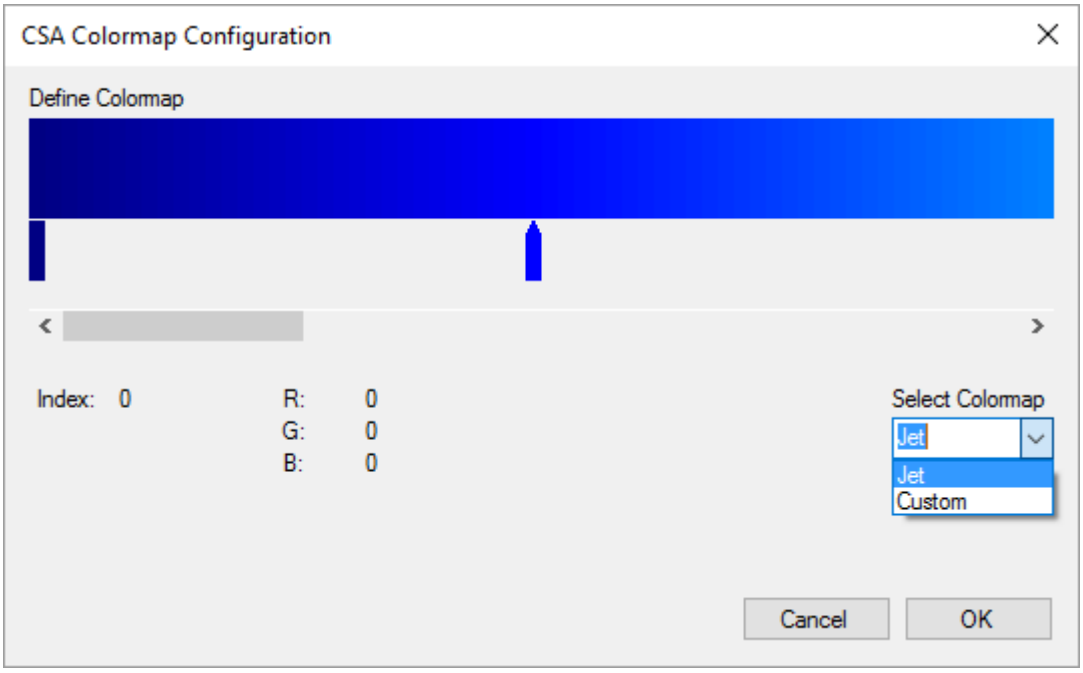


Calculation

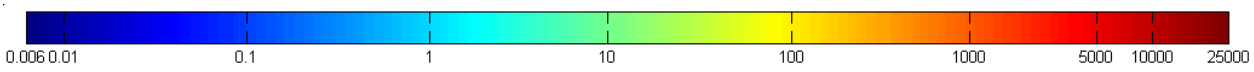
NFFT - number of samples for the FFT
Overlap - number of samples that overlap
Start Frequency - lower value of y-axis scaling in Hz
End Frequency - higher value of y-axis in Hz
Blockoverlap - number of samples that overlap with preceding epoch
Epoch Duration - duration between calculated FFT outputs
Amplitude Min [µV] – minimal amplitude coded in the colormap
Amplitude Max [µV] – 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:



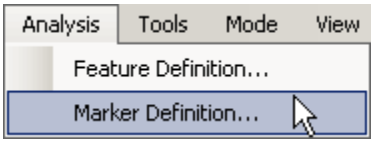
The CSA is plotted in $\mu V^2/Hz$ ranging from **Amplitude Min** to **Amplitude Max**. In the example below, the different colors in the color bar represent the power of the signal recorded with a logarithmic scale ranging from 0.006 to 25.000 $\mu V^2/Hz$ with 256 colors.



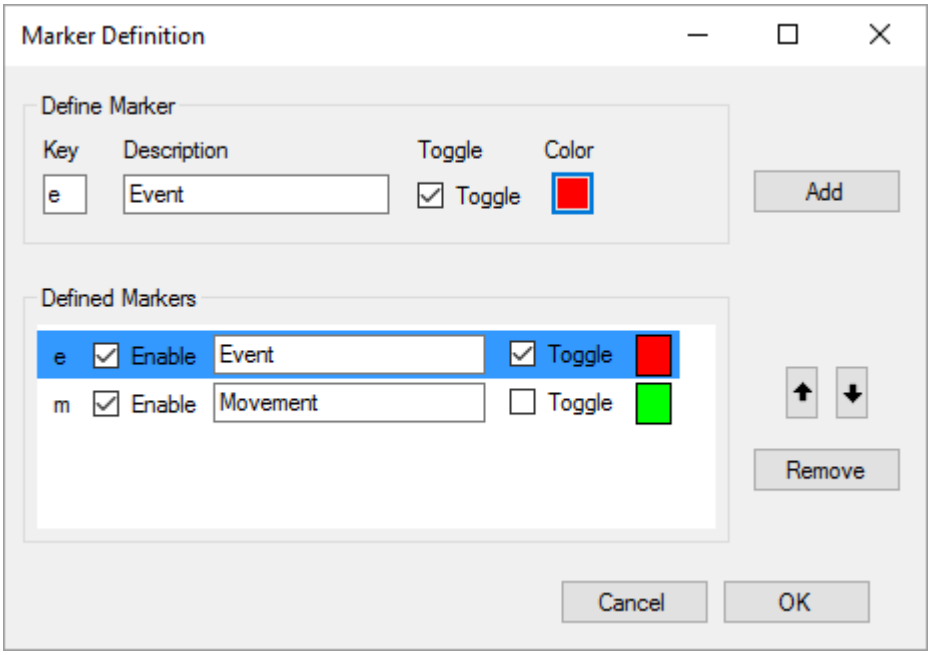
Marker Definition

Markers can be used during measurement to highlight certain events. **g.Recorder** allows the user to define 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.

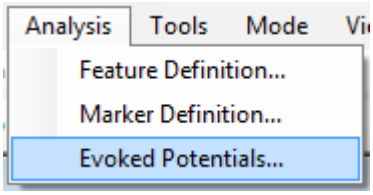
Then define key `e` as a region marker by checking the **Toggle** checkbox. Set the description to `Event`.

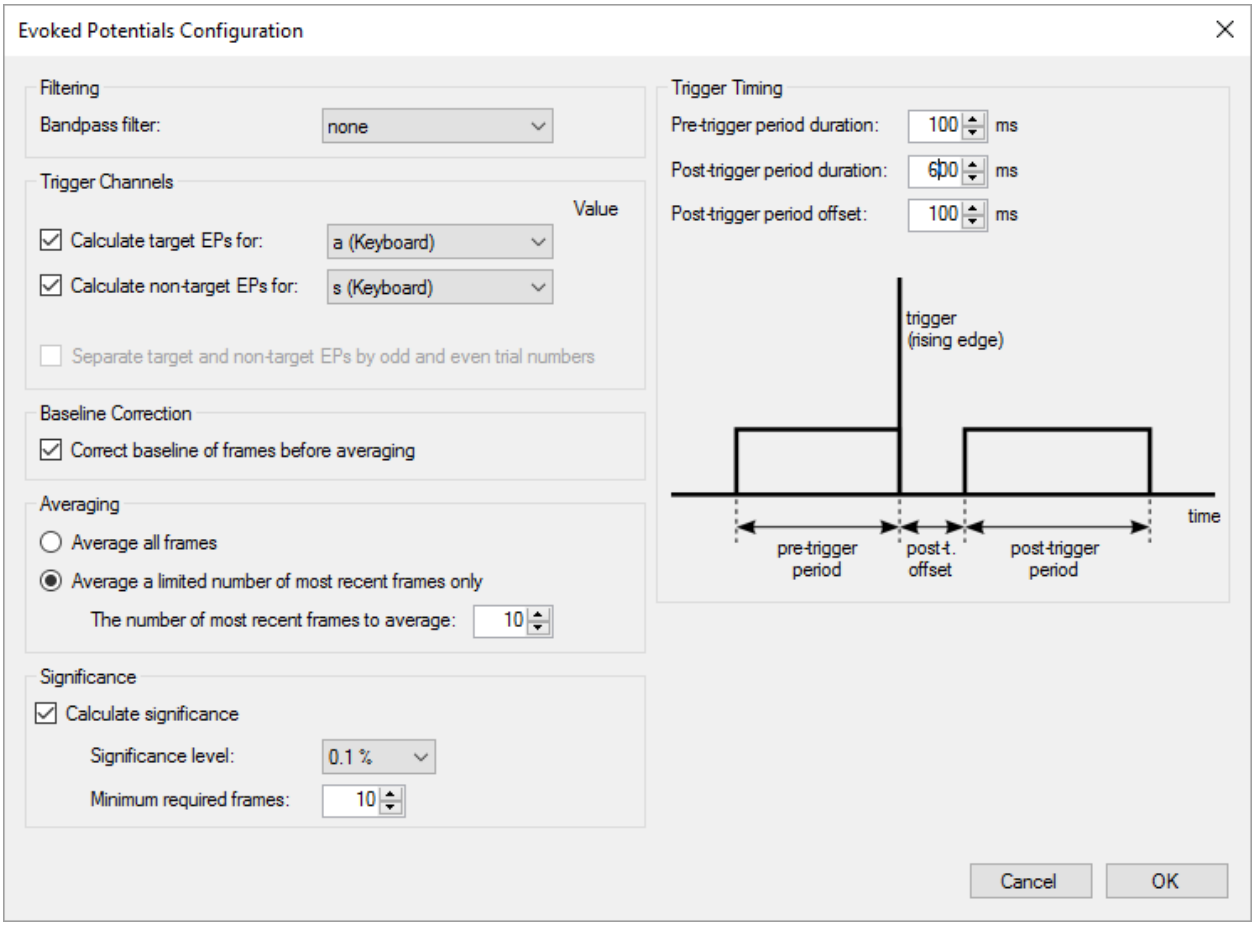
Finally, close the window.

Evoked Potentials Definition

The **Evoked Potentials Configuration** dialog allows the user to configure the calculation of evoked potentials.

Click on **Evoked Potentials** at the **Analysis** menu.





Filtering:

- **Bandpass filter** – contains a list of previous defined filters to preprocess incoming raw data. The filter is applied before the data is framed by the occurrence of a trigger. The filter is only applied for EP calculation, not to recorded or displayed raw data in the **Data Viewer**.

Trigger Channels:

- Enable/disable calculation of evoked potentials for **target** and/or **non-target EPs**.
- Select a trigger source from the list of acquired digital inputs or defined keyboard markers. In the example above, keyboard marker **a (Keyboard)** is selected as the trigger for calculation of target EPs and keyboard marker **s (Keyboard)** is selected as the trigger for calculation of non-target EPs.

- If a combined trigger is used, define the **Value** that triggers calculation of the corresponding class of evoked potentials.
- If only one class of evoked potentials (e.g. target EPs) is selected and has a trigger assigned, the **Separate target and non-target evoked potentials by odd and even trial numbers** option can be used to assign each second occurrence of the same trigger to the other class of evoked potentials (non-target EPs) automatically.

Baseline Correction:

- Enable/Disable **Correct baseline of frames before averaging** to either remove or allow offsets for evoked potential calculations. If enabled, the offset of the pre-trigger period is removed from the whole frame for each channel and each trial individually.

Averaging:

- Select **Average all frames** to average up each triggered frame of the same class as long as the session lasts. Select **Average a limited number of most recent frames only** to only include the selected number of most recently triggered frames of the corresponding class in the averaged result.

Significance:

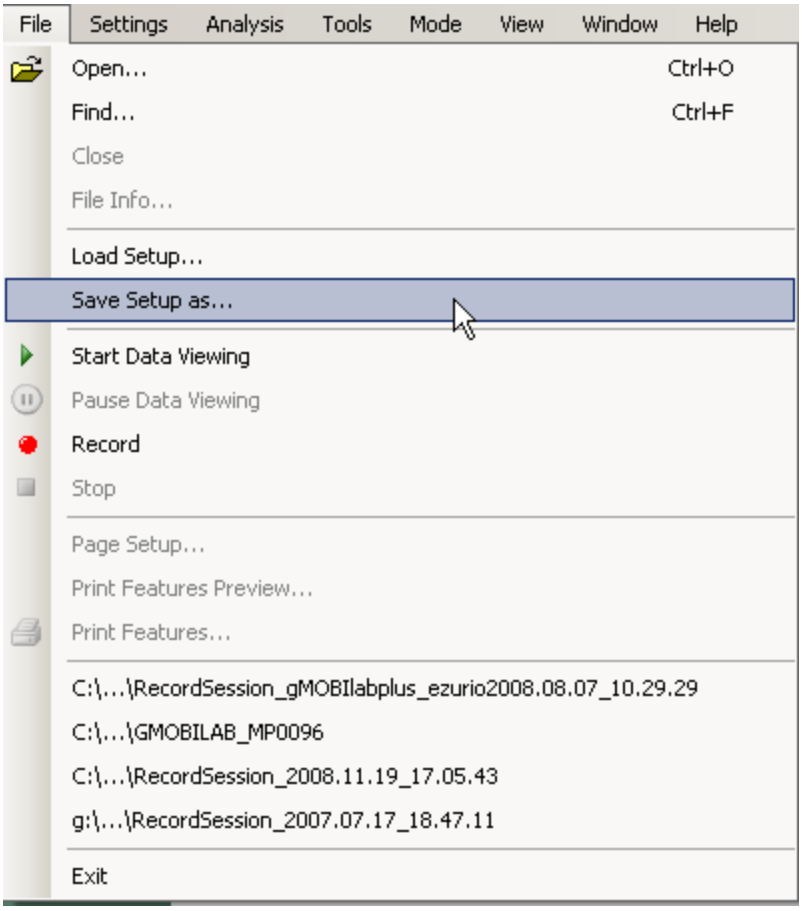
- **Calculate significance** – Enable/Disable highlighting of statistical significant differences between the target and non-target evoked potential classes. This option will only be available if two classes of evoked potentials are calculated.
- The **Significance level** is the maximum acceptable probability of error for significance calculation in percent.
- Select the number of **Minimum frames required** for calculation and display of significance.

Trigger Timing:

- Set the **Pre-Trigger period duration** to define the acquired time before the trigger occurrence.
- Set the **Post-Trigger period offset** to define the gap to leave blank after the trigger occurrence. This can be useful to suppress artifacts that accompany the stimulus (e.g. audio trigger artifacts) in display only. The **Post-trigger period offset** gap is not excluded from calculation.
- Set the **Post-Trigger Period duration** to define the acquired time after **Post-Trigger period** offset.

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 configurations using the 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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