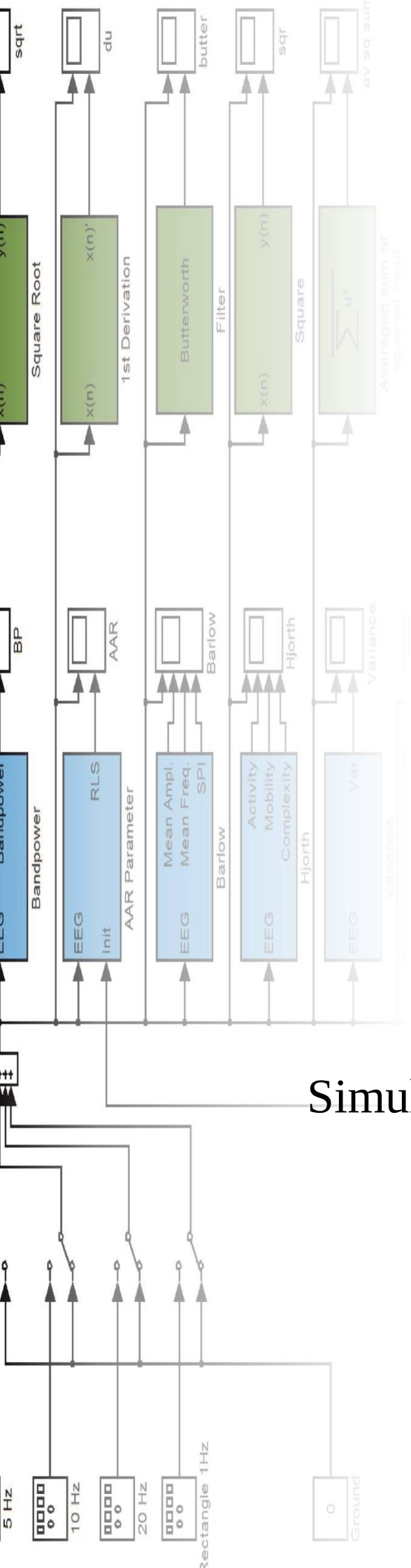

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GUGER TECHNOLOGIES

Simulink Highspeed Library

SIMULINK highspeed ONLINE processing

USER MANUAL V3.15.01

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Hardware and Software Requirements

Hardware Requirements

g.tec Highspeed requires a PC compatible desktop or notebook workstation running Microsoft Windows.

The table below lists optimal settings:

Hardware	**Properties**
CPU	Pentium working at 3000 MHz
Hard disk	100 gigabyte
RAM	8 gigabyte
USB 2.0 high speed port	One free USB port for the Hardlock Dongle

Software Requirements

Make sure that the MATLAB installation works correctly before installing the g.tec Highspeed software. Depending on your Windows operating system, administrator rights might be necessary for the installation.

Software	**Version**
MATLAB	Release 2014a
Simulink	Release 2014a
Signal Processing Blockset	Release 2014a
DSP System Toolbox	Release 2014a
Windows	Windows 7 Professional Service Pack 1 English Win64
Acrobat Reader	11.0.04
.net Common Language Runtime	4

Files on your Computer

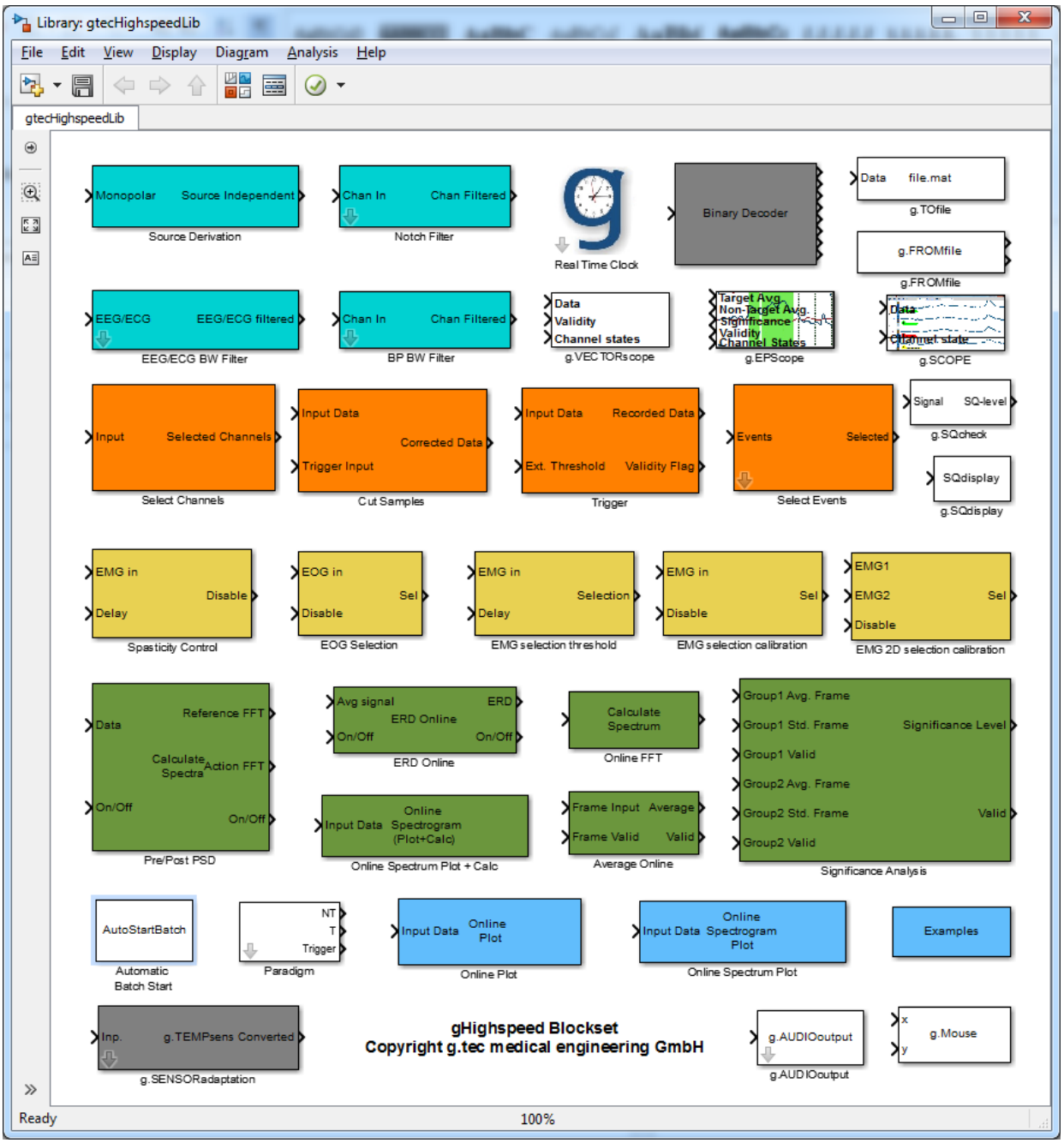
The default installation directory for g.tec products is C:\Program Files\gtec\ .

Within this directory, a subdirectory named `gtecHS` is generated, where all installed files are located:

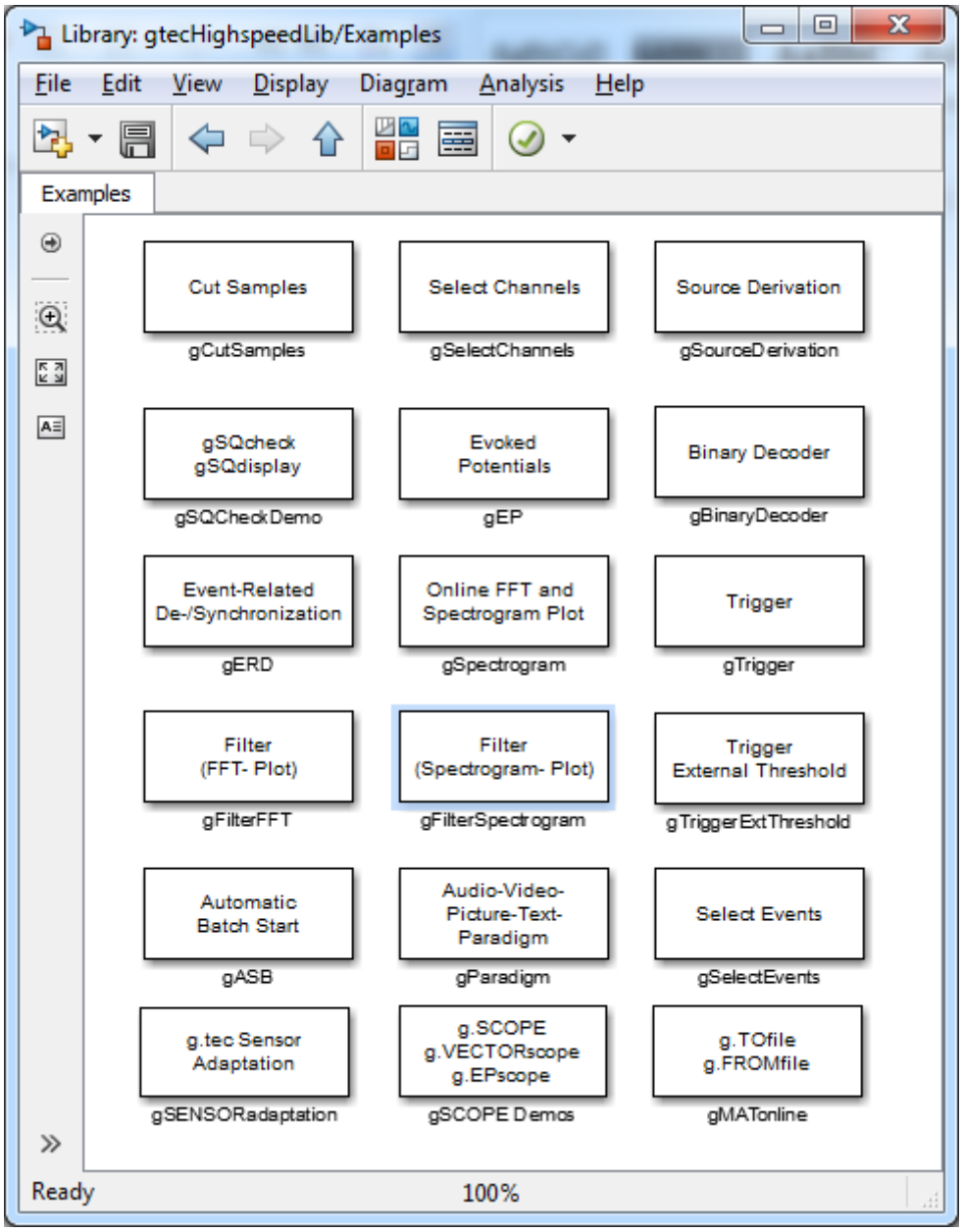
`..\gtecHS\Examples`	Contains Simulink models for the library blocks
`..\gtecHS\Help`	Contains library block description and manuals of amplifiers
`..\gtecHS\Lib`	Contains binaries of library blocks

g.tec Highspeed Library

The g.tec Highspeed Library contains the following blocks:



The Examples block contains links to all Simulink models referenced in this manual. The name of each block corresponds to the Simulink model, and the text displayed on the block names the blocks demonstrated by that model.



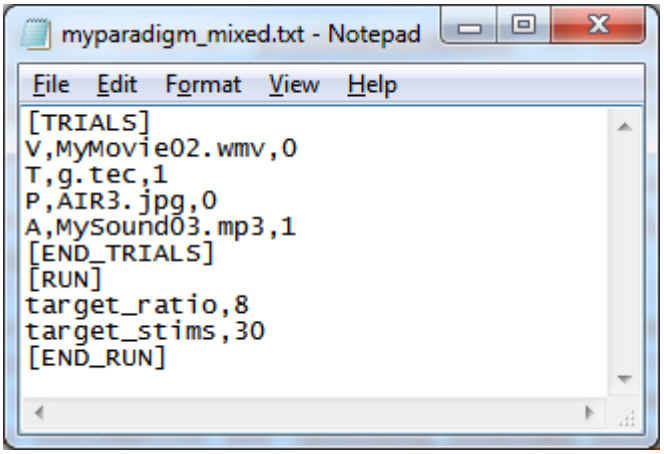
Real Time Clock

Description Real Time Clock can be used if no block is in a Simulink model that is able to drive it in real time (such as g.USBamp, g.HIamp, g.STIMbox in driving mode).
NOTE: If there is a g.tec amplifier in the Simulink model, do **NOT** use Real Time Clock block.

Paradigm

Description The **Paradigm** block can be used for audio, picture, video and text paradigms. It uses the ActiveX plugin of the VLC media player, which must be installed to present audio, picture and video stimulations.
The block provides timing information of targets, non-targets and stimulation onset.
The paradigm is configured using a standard text editor.

Input: The paradigm block is configured with a *.txt file which specifies timing and stimulation constraints.



Paradigm File Description:

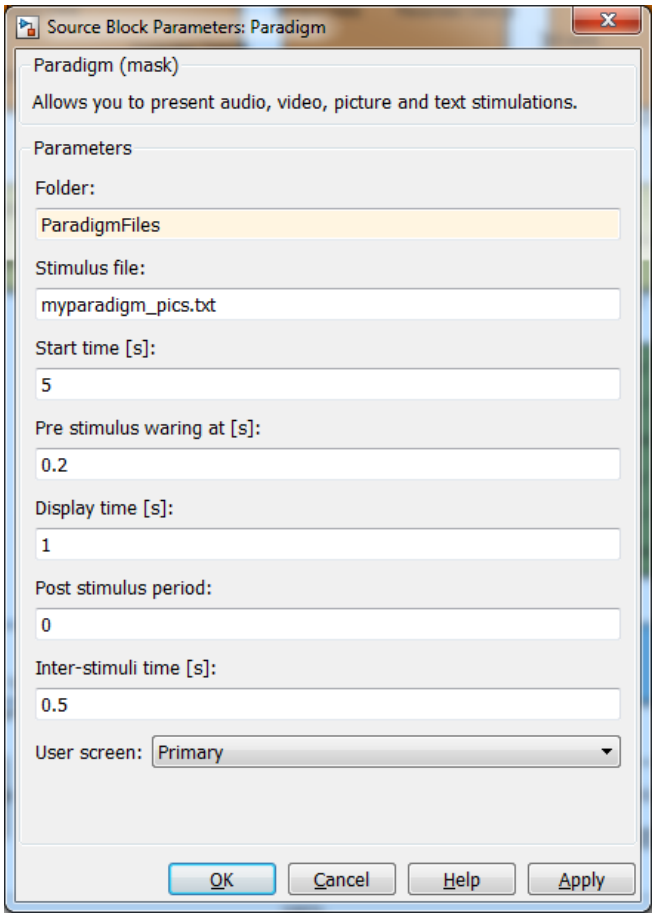
Trials- Section: Use tags [TRIAL] and [END_TRIALS] to specify the section of trial definition. Each trial is specified by stimulation type, stimulation context and stimulation processing (target or non-target).
<STIM_TYPE>, <STIM_CTX>, <STIM_PROCESS>

STIM_TYPE	V	Video stimulation identifier
	P	Picture stimulation identifier
	T	Text stimulation identifier
	A	Audio stimulation identifier
STIM_CTX	Video	Filename of Video to present (mp4, avi, mpeg, wmv supported)
	Picture	Filename of Picture to present (jpg, png, bmp, tif, tiff, jpeg supported)
	Text	Text to present
	Audio	Filename of Audio to present (mp3, wav supported)

Run- Section: Use tags [RUN] and [END_RUN] to specify the section of run definition. You can specify the target ratio (1 out of x stimulations is a target) and the number of targets to be presented.

target_ratio	Specify the target presentation ratio (1 out of target_ratio stimulations should be a target)
target_stim	Specify the number of target stimulations which should be presented

Dialog Box



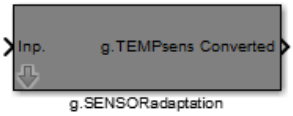
Double click Paradigm block to modify the parameters.

Folder	Specify the path where paradigm files and stimulation context is located
Stimulus file	Specify the filename of the paradigm file, which is used for stimulation
Start time	Specify the time in seconds before the paradigm creates the first stimulation
Pre stimulus warning at	Specify the time before a stimulation to create an attention warning
Display time	Specify the time the stimulation is presented (audio and video will be cropped)
Post stimulus period	Specify the time the stimulation trigger is active after the stimulation

	(indicated by a value of 1)
Inter-stimuli time	Specify the time between 2 stimulations
User screen	Specify the screen (primary or secondary) where the presentation window should be opened
Example Simulink Model	gParadigmDemo.slx

ATTENTION: This block requires VLC media player 64- bit version 2.2.1 to be installed on the computer.

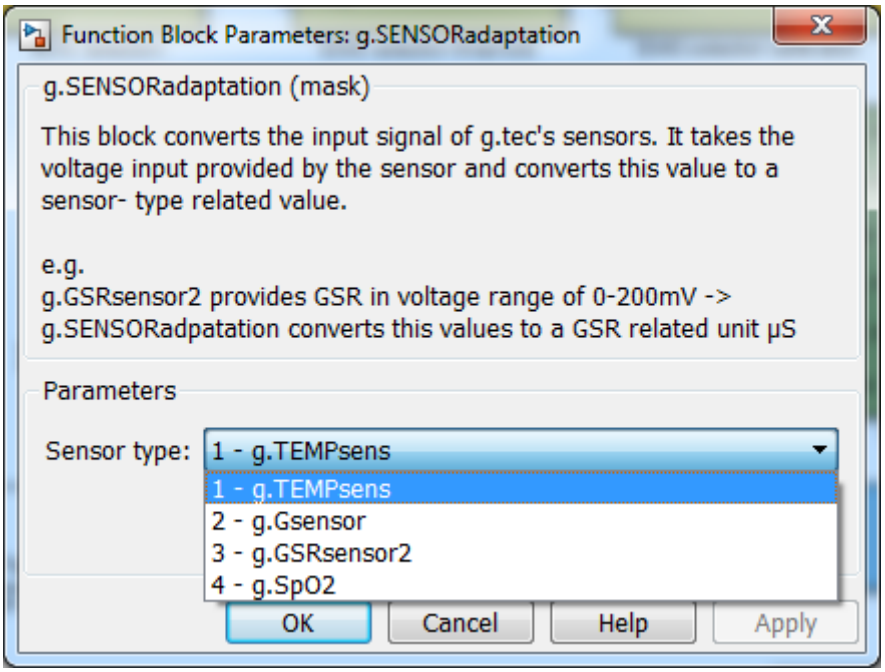
g.SENSORadaptation Block



The **g.SENSORadaptation** block is for converting input data from a g.tec sensor (such as a temperature sensor, G sensor, GSR sensor and SpO2 sensor) into meaningful outputs according to the sensor.

Description This block converts the input signal of g.tec's sensors. It takes the voltage input provided by the sensor and converts it to sensor- type related values.

Dialog Box

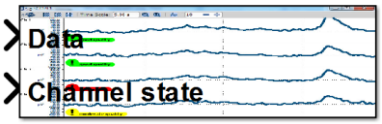


Double click on the **g.SENSORadaptation** block to edit the parameters

Sensor type — Select the sensor type the adaption should be used for from the provided list. Currently g.TEMPsensor, g.Gsensor, g.GSRsensor2 and g.SpO2 sensors are supported.

Example Simulink Model — gSENSORadaptation_Demo.slx

g.SCOPE



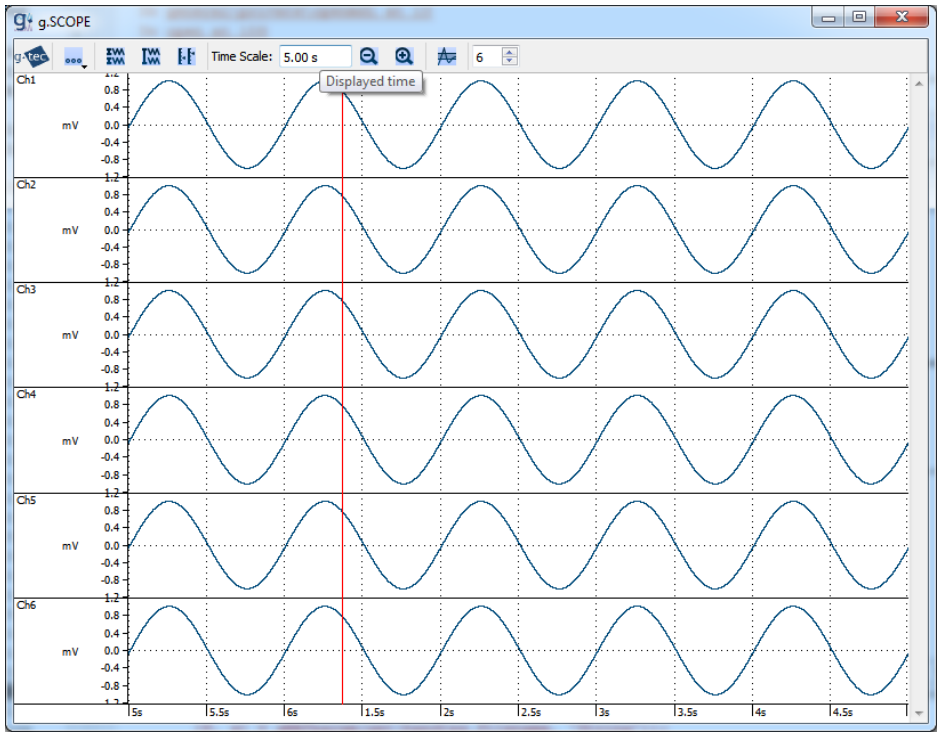
g.SCOPE

The **g.SCOPE** block provides a convenient way to display biosignal data. It was designed with a focus on performance and is able to visualize large amounts of data with high sampling rates.

Description g.SCOPE is a sample-based scope for high sampling rates and a large amount of channels, with easy-to-use scaling facilities.

Input The data to be displayed is fed into the block using the **Data** input port. It can either receive sample-based data or frame-based data.
An additional input port named **Channel states** can be used to display additional information for each channel (see description of channel states below). This input accepts sample-based signals. If the Channel states input is used, its number of elements has to be equal to the number of channels of the Data input signal.
Make sure that the sample time of the input signals is the same.
The input format can be single (float32) or double. Use a Multiplexer block to input multiple channels.

g.SCOPE



1) Double click the **g.SCOPE** block to open the scope.

The toolbar of the **g.SCOPE** window provides access to the following actions.

g.SCOPE configuration menu, contains
- Edit channel states
- Import channel names
- Edit color settings

Auto-scales all the channels individually to their minimum and maximum data value (plus 10%).

Auto-scales all channels to the global minimum and maximum level of the incoming data (plus 10%).

Opens the channel settings dialog.

Time Scale

Sets the time interval displayed by each scope. Allowed units are h (hours), m/min (minutes), s/sec (seconds), ms (milliseconds) and smp (samples). If no unit is specified, the entered value is interpreted as seconds.

Button for increasing the displayed time interval (i.e. zooming out).

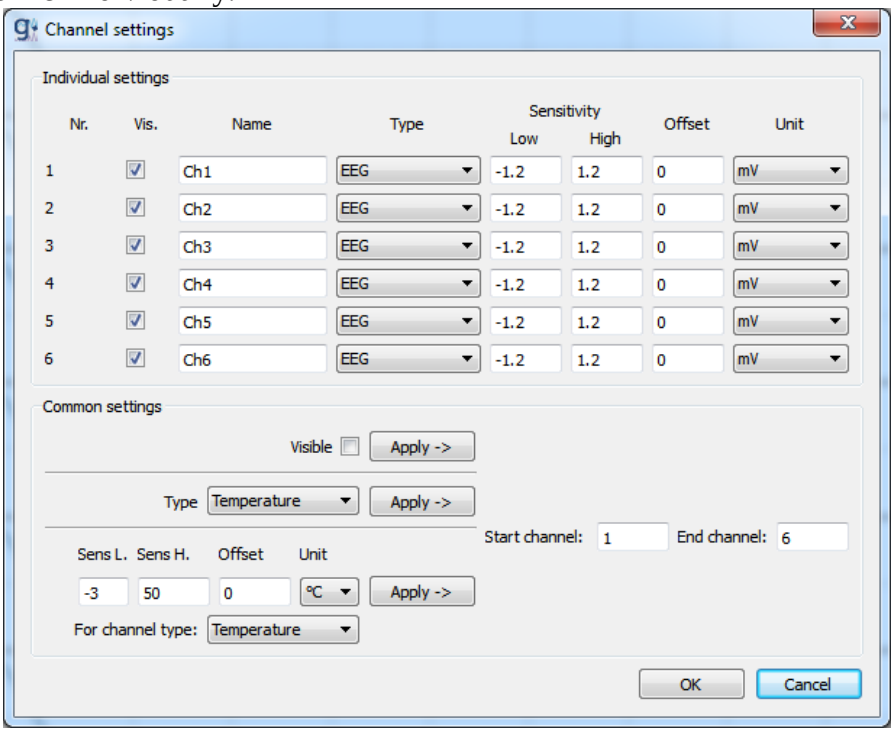
Button for decreasing the displayed time interval (i.e. zooming in).

Switch signal cropping on or off. If signal cropping is on, which is the default setting, then the signal will be cropped as soon as it exceeds the vertical limits of the display. If it is switched off, all data will be displayed overlapping the displays of the adjacent channels. Examples are given below.

 # visible Channels

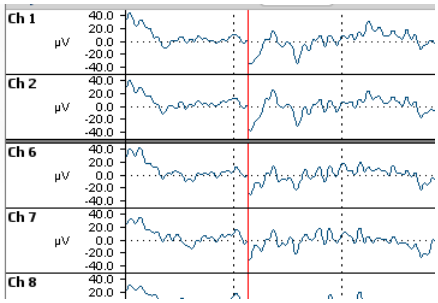
Spin button to increase and decrease the number of visible channels.

2) Open the **Channel settings** dialog by clicking the button to define the scaling and offset for each channel individually.



Nr The number of the channel.

Vis Sets the visibility of the channel. If not checked the channel is replaced by a grey bar.



Name The channel name.

Type The signal type. The following channel types with appropriate default values are predefined:

Type	Low	High
EEG:	-50 µV	50 µV
ECG:	-1 mv,	1 mV
EOG:	-500 µV	500 µV
EMG:	-5 mV	5 mV
ECoG:	-500 µV	500 µV
Temperature	20 °C	45 °C
Acceleration	-3 G	3 G
Saturation	0 %	100 %
GSR / EDA	0 µS / µMho	30 µS / µMho
Resp.:	-500 µV	500 µV
TRIG:	0 V	5 V
OTHER:	-100 µV	100 µV

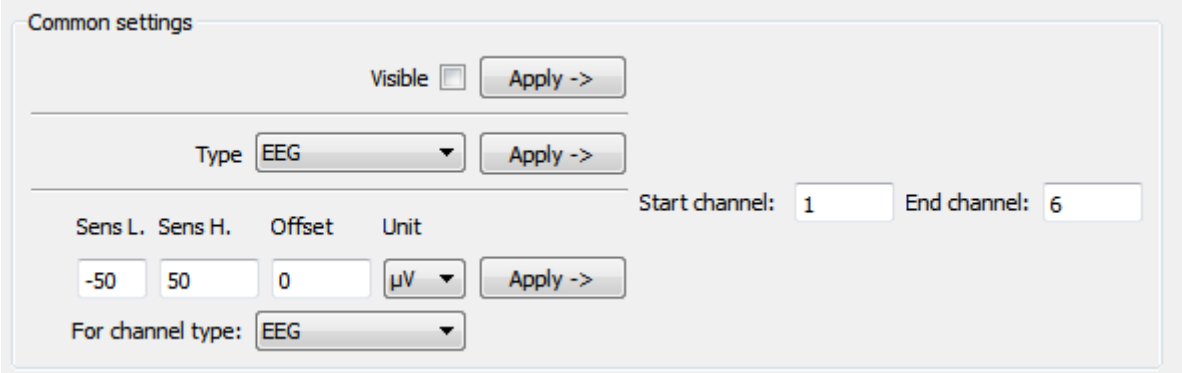
Low The lower limit of the signal display.

High The upper limit of the signal display.

Offset The vertical offset of the displayed signal.

Unit The unit of the selected **Low** and **High** limits .

3) In the **Common settings** frame set the **Start channel** to 1 and the **End channel** to 6.



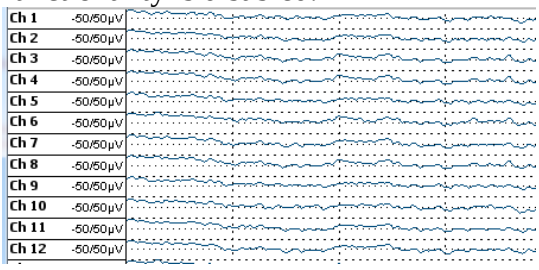
4) Check **Visible** in the **Common settings** frame and press **Apply**.

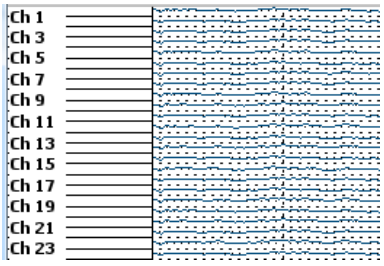
5) Select `EEG` as signal **Type** and press **Apply**.

6) Set the **Offset** to be applied to all channels to `0` and the **Unit** to `µV` and press **Apply**.

7) Press **OK** to apply the settings.

If a high number of channels are displayed in one scope and the height of the scope is limited, the layout of the axes is changed for better visibility. In the compact display mode, the dragging functionality is disabled.



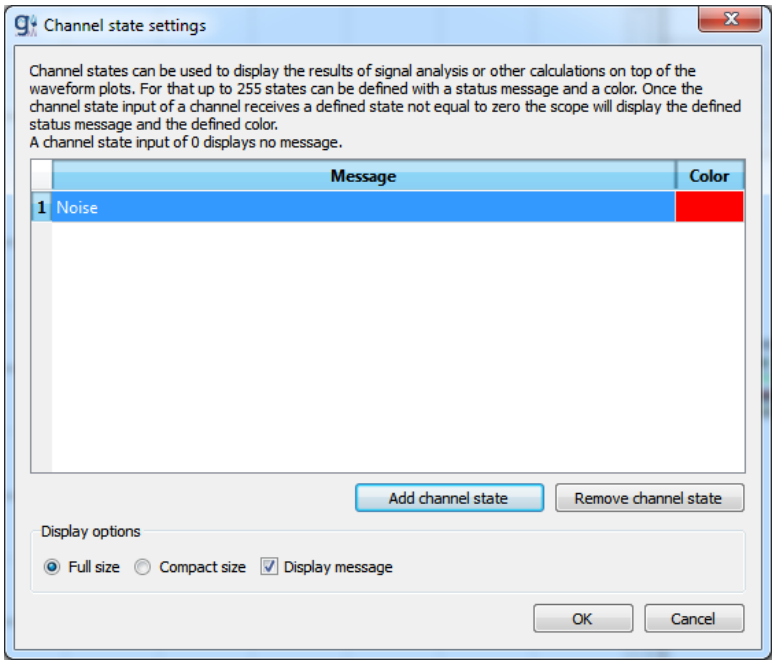


Channel states:

1) Attach the output of the **g.SQcheck** block to the **Channel states** port of the **g.SCOPE** block

2) Double-click the **g.SCOPE** block.

3) Open the g.SCOPE configuration menu and select **Edit channel states** to define the possible states



4) Click **Add channel state** to add the first state.

5) Set **Message** to `Noise` for the first state.

6) Click on the **Color** display left of **Message** and select the `red` color for this state.

7) Define a second state whenever a `High amplitude` is detected displayed in `yellow` **Color**.

8) Define a third state for the case that the signal is of `Good signal quality` use the `green` **Color** for this state.

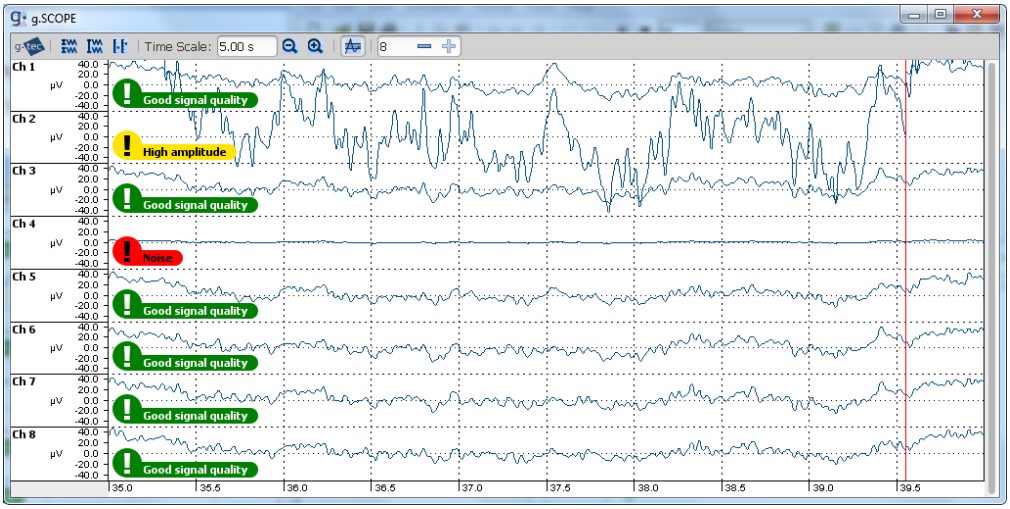
9) To remove a state, select it and press **Remove channel state.**

10) Define the outline of the channel state icon by choosing the Display option:
    Full size: show icon in channel state
    Compact size: do not show icon in channel state
    Display message: enable this option to show the message

11) Press **OK** to apply the new states.

12) Start the model.

13) Double click the **g.SCOPE** block.



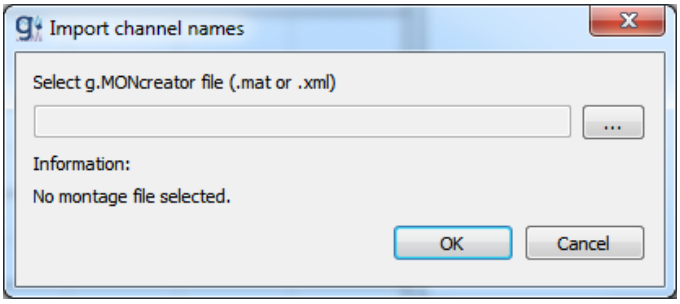
Channel **Ch 2** in the above example shows atypical high amplitude, and therefore is marked with the yellow message. Channel four has very low amplitude and is therefore marked red, while the amplitudes of all other signals are within range. Therefore, they are marked green.

Import channel names

g.SCOPE allows you to import channel names from montages created by g.MONcreator.

1) Double-click the **g.SCOPE** block.

2) Open the g.SCOPE configuration menu and select **Import channel names**.



3) Click to browse to the montage file you want to import the channel names from.

4) Check the **Information** section to see whether the loaded montage is valid.

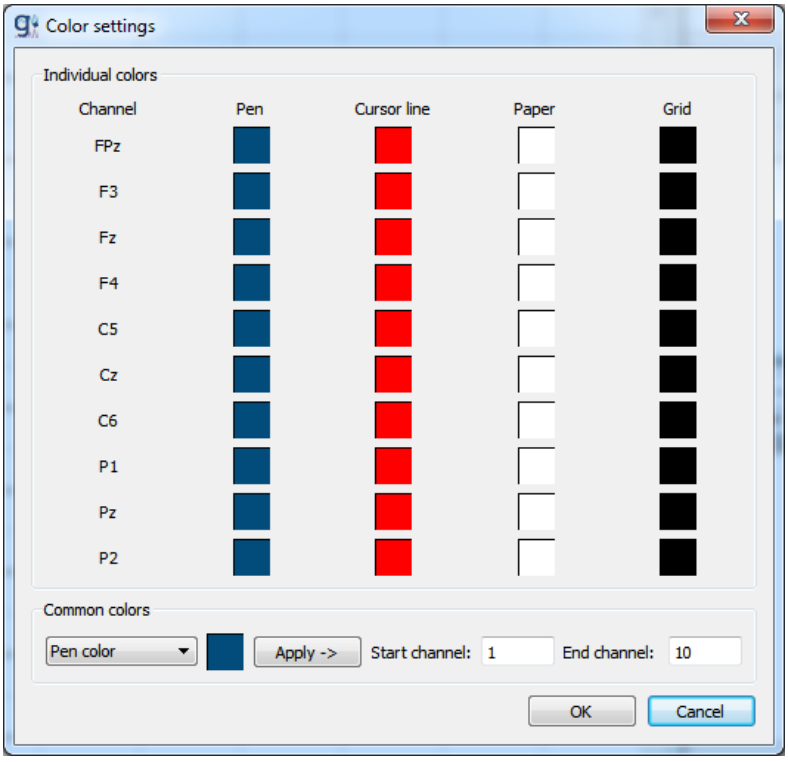
5) Click **OK** to apply channel names.

Color settings

For you convenience, g.SCOPE allows you to customize the colors of the paper, grid, pen and the cursor lines.

1) Double-click the **g.SCOPE** block.

2) Open the g.SCOPE configuration menu and select **Edit color settings**.

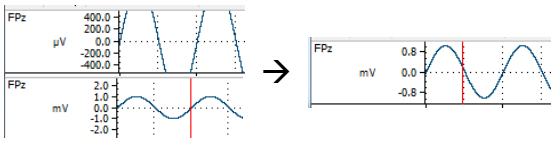


3) Click the color of one channel and item to open the color picker dialog. To specify the color for a range of channels, use the **Common colors** panel.

Mouse actions

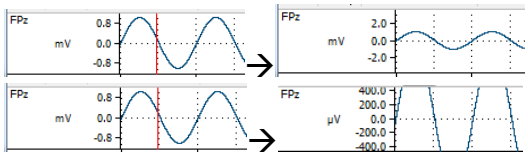
The axis configuration functions auto-scale, scaling and offset can be controlled using the mouse.

Auto-scale



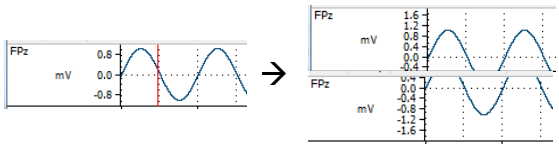
Double click the channel label area to auto-scale the channel to its minimum and maximum values.

Scaling



Right click the channel vertical (voltage) axis and drag towards 0 to zoom out drag away from 0 to zoom in.

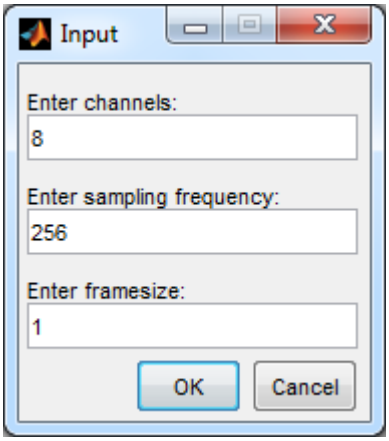
Offset



Left click the channel vertical (voltage) axis to shift the signal up or down.

Configuration of g.SCOPE

The configuration of g.SCOPE (and of all other g.SCOPE types) is only possible if the number of channels, sampling frequency and frame size is known. Before g.SCOPE opens, the block tries to compile the Simulink model. If the Simulink model can be compiled the needed information is retrieved automatically. If the model is not compiling, a dialog box opens, which prompts for the needed information (number of channels, frame size and sampling frequency).



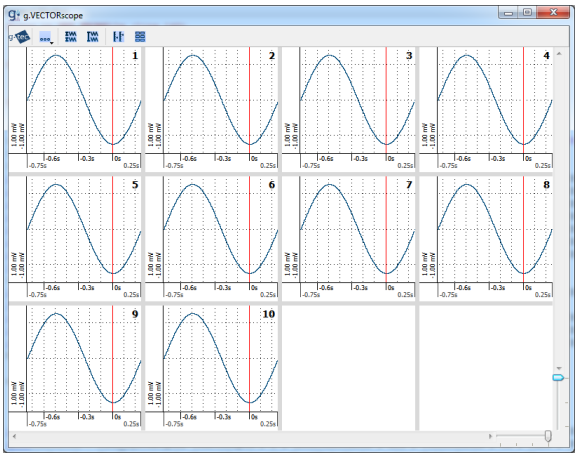
g.VECTORscope

The g.VECTORscope provides a convenient way to display frame-based data. It is designed with a focus on performance and is able to visualize large amounts of data with high sampling rates.

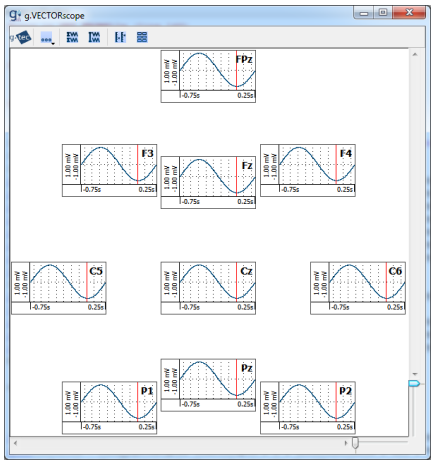
Description g.VECTORscope is a frame-based scope for high sampling rates and a large amount of channels, with easy-to-use scaling facilities.

Input The data to be displayed is fed into the block using the **Data and Validity** input ports. Data is frame-based while Validity is sample-based.
Beside frame based data for each channel g.VECTORscope can display a channel state value. Connect the channel state specific data to the **Channel States** input port and configure the channel states to activate the display.

g.VECTORscope

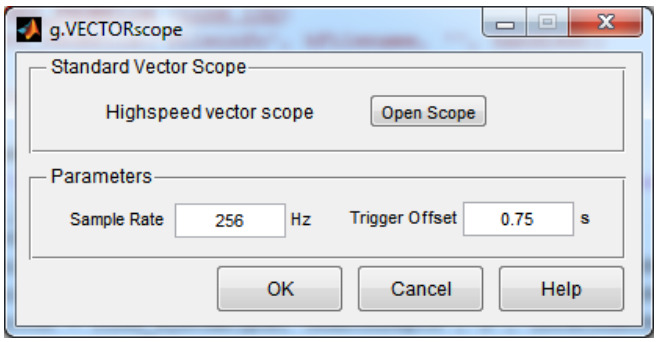


square channel arrangement



topographic channel arrangement

Parameters Double click on the **g.VECTORscope** block to open the scope parameters.



Sample Rate sample rate in Hz in which the sample based raw data is running.

Trigger Offset position of the vertical trigger occurrence line.

Open Scope click this button to open the scope.

Vector- Scope configuration

1) Double click the **g.VECTORscope** block. If model is running, then g.VECTORscope is opened. Otherwise click **Open Scope** to open g.VECTORscope.

The toolbar of the **g.VECTORscope** window provides access to the following actions.

g.SCOPE configuration menu, contains
Edit channel states
Edit color settings

Auto-scales all the channels individually to their minimum and maximum data value (plus 10%).

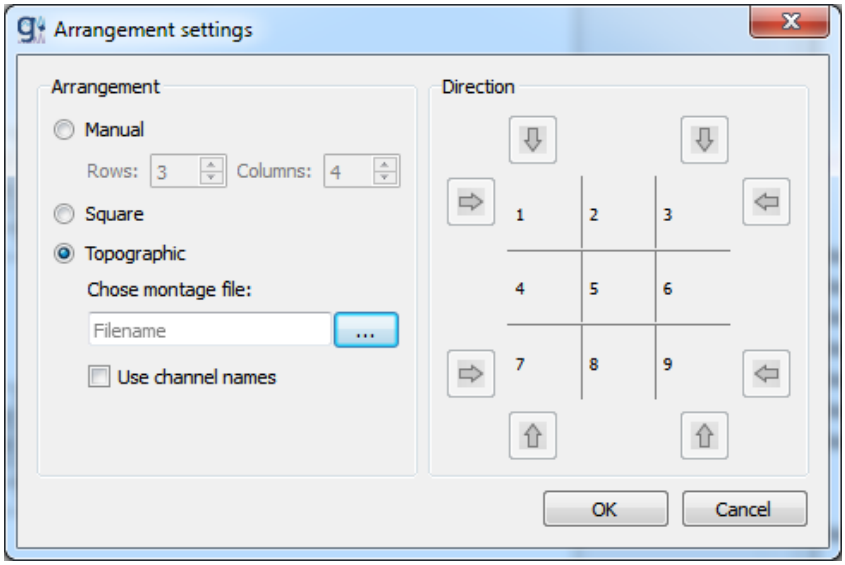
Auto-scales all channels to the global minimum and maximum level of the incoming data (plus 10%).

Opens the channel settings dialog.

Opens the channel **Arrangement settings** dialog.

2) Open the **Channel settings** dialog by clicking the button to define the scaling and offset for each channel individually. For details, please see above.

3) Open the channel **Arrangement settings** dialog



Manual: select the number of rows and columns to arrangement the axes.

Square: auto-arrangement in square shape.

Topographic: use the g.tec montage file created by g.MONcreator to arrange channels topographically. Optionally the channel names can be imported.

Direction: use the arrow to change the order of the axes.

Zooming

g.VECTORscope allows you to zoom in to interesting data regions.

1) Press the left mouse button on an displayed axis.
2) Keep the mouse button pressed and select the range of the zooming by moving the mouse along the time axis → a zoom bar is shown.
3) Releasing the mouse button when you reached the end of the region will zoom all channels to the specified range.
4) Double click one axis will zoom out all channels to the 100 % view.

NOTE: For detailed information on color and channel state settings and mouse actions please read the g.SCOPE description (pg. 13ff)

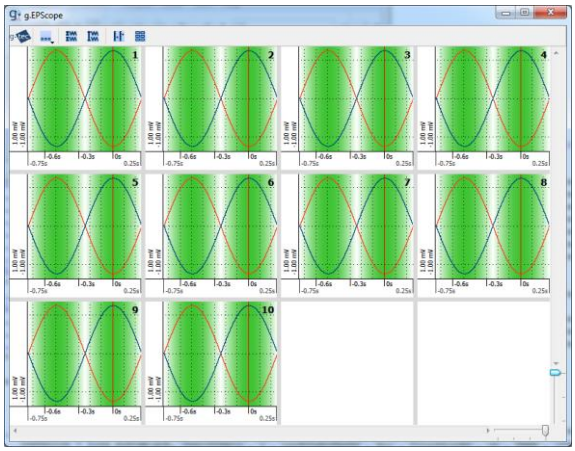
g.EPscope

The **g.EPscope** block provides a convenient way to display evoked potentials. It is designed with a focus on performance and is able to visualize large amounts of data with high sampling rates.

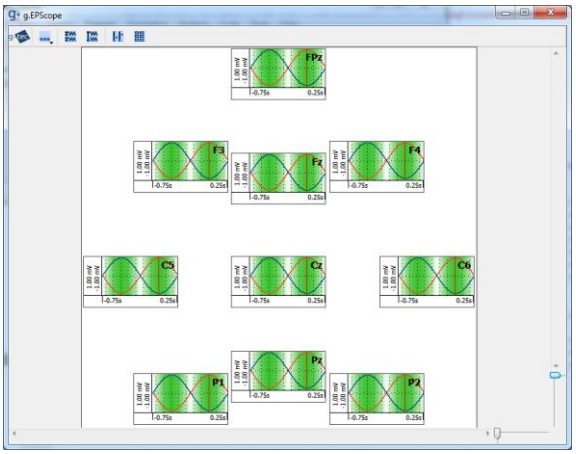
Description g.EPscope is a frame-based scope for high sampling rates and a large amount of channels, with easy-to-use scaling facilities.

Input The data to be displayed is fed into the block using the **Target Avg., Non-Target Avg., Significance and Validity** input ports. Data on Target Avg., Non-Target Avg. and Significance is frame-based while Validity is sample-based.
Target and Non-Target Averages for one channel are shown in the same channel axis that forms the EP. The result of the statistical analysis (see Statistical Analysis, Pg. 53) can also be shown in g.EPscope. Areas where the averages of target and non-target show statistically significant differences are indicated by a green background.
Beside target, non-target and significance each channel can display a channel state value. Connect the channel state specific data to the **Channel States** input port and configure the channel states to activate the display.

g.EPscope

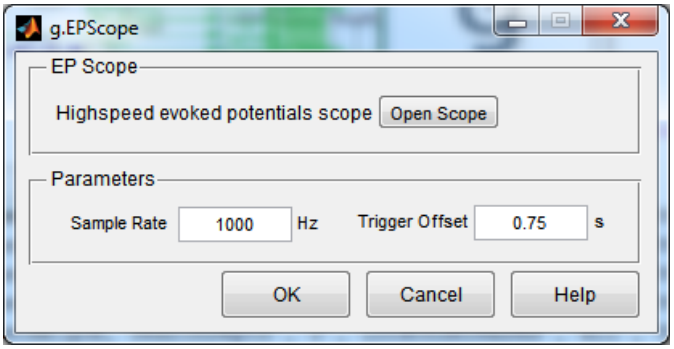


square channel arrangement



topographic channel arrangement

Parameters Double click on the **g.EPscope** block to open the scope parameters.



Sample Rate sample rate in Hz in which the sample based raw data is running

Trigger Offset position of the vertical trigger occurrence line

Open Scope click this button to open the scope

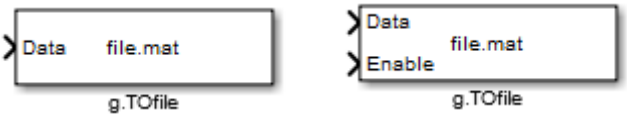
EP-scope configuration

Please check g.VECTORscope description (pg**.** 20ff)

NOTE: For detailed information on color and channel state settings and mouse actions please read the g.SCOPE description (pg. 13ff) for information on zooming please read the g.VECTORscope description (pg. 20ff).

g.MATfile

g.TOfile Block

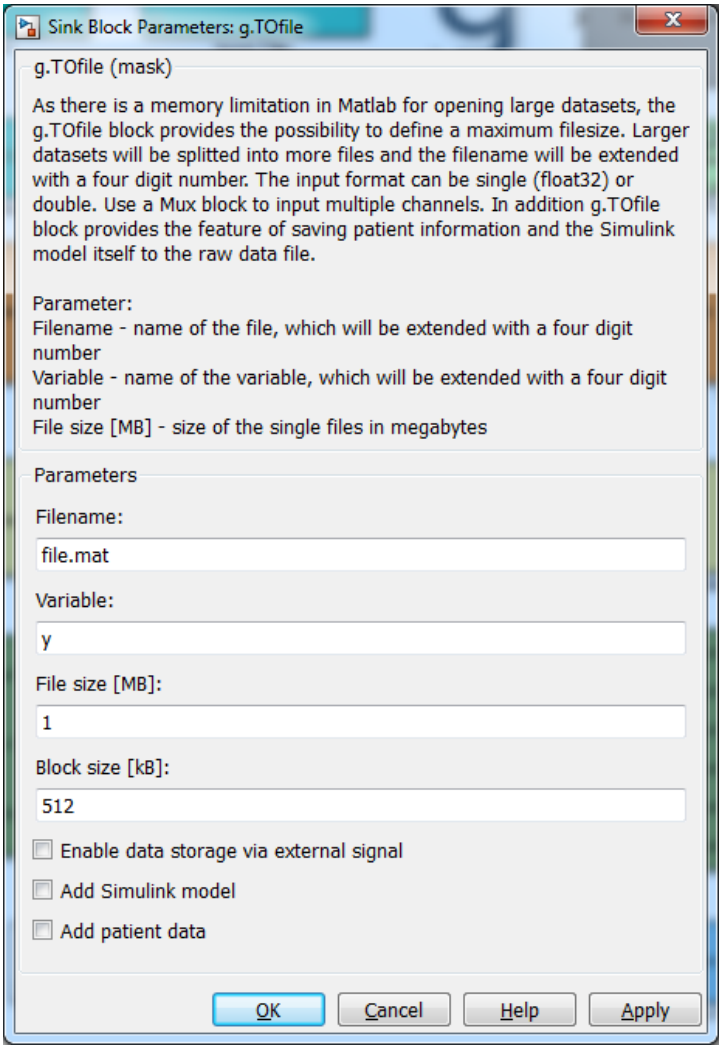


The **g.TOfile** block is for saving large datasets in real-time to files.

Description

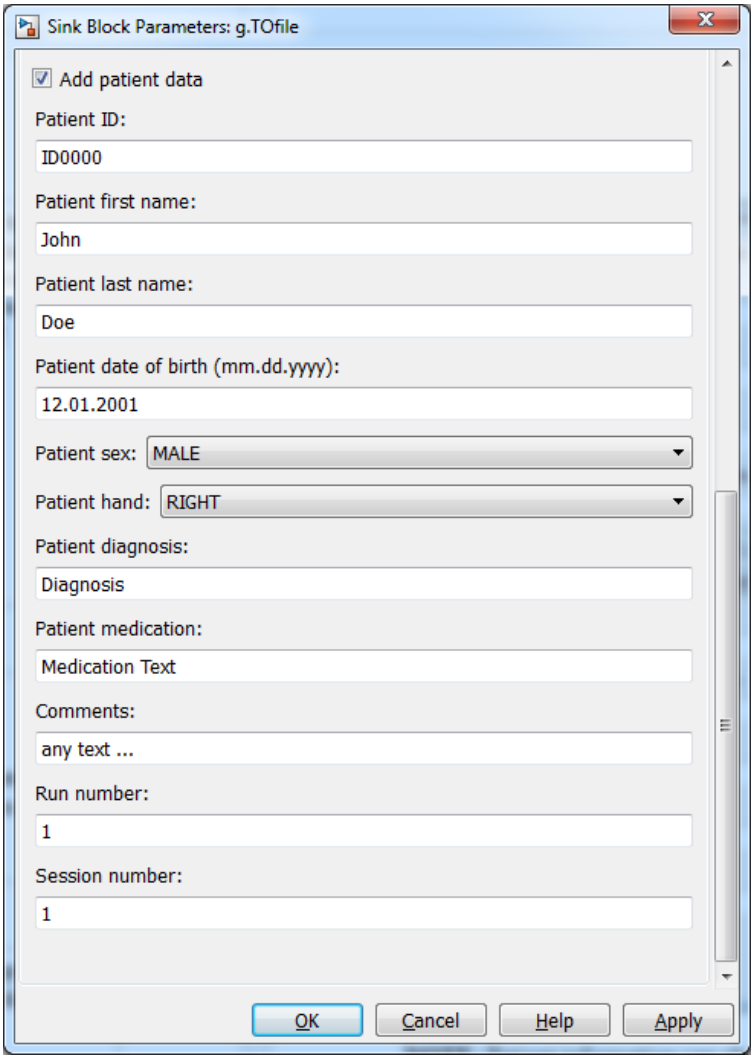
As there is a memory limitation in MATLAB for opening large datasets, the **g.TOfile** block provides the possibility to define a maximum file size. Larger datasets will be split into more files and the filename will be extended with a four digit number. The input data format is double. Use a **Mux** block to input multiple channels. In addition, the g.TOfile block can save both patient information and the Simulink model itself to the raw data file.

Dialog Box



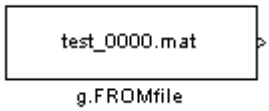
Double click on the **g.TOfile** block to edit the parameters.

Filename	The filename will be extended automatically with a timestamp representing the start time of the recording in local system time and a four digit number, starting with 0000. The number is incremented for each file of the recording – the timestamp is updated every time a new recording is started. The filename has the following format: `<filename>_DD_MM_YYYY_HH_mm_SS_NNNN` DD day of month MM month of year YYYY year HH hour (24 hour format) mm minute SS seconds NNNN filenumber in sequence
Variable	data matrix name
File size [MB]	maximum size of one file in megabyte data exceeding this limit will be split up in more files *NOTE:* Use the **gBSmerge** available through the **Transform/Merge** from the **g.BSanalyze** menu to concatenate these files into a single data set
Block size [kB]	minimum size of data that is written to the hard disk
Enable data storage via external signal	Activate this feature to control data storage via an external input, only a value higher 0 at the added *Enable* input port will activate data storage
Add Simulink model	Activate this feature to store the Simulink model along with the raw data. The Simulink model is saved when the model finishes, and the model is stored in all files created by the g.TOfile block.
Add patient data	Activate this feature to store patient information along with the raw data. The patient information will be stored to all files please check available patient info fields in the next figure



NOTE: Patient information can also be retrieved from g.BSanalyze.

g.FROMfile Block

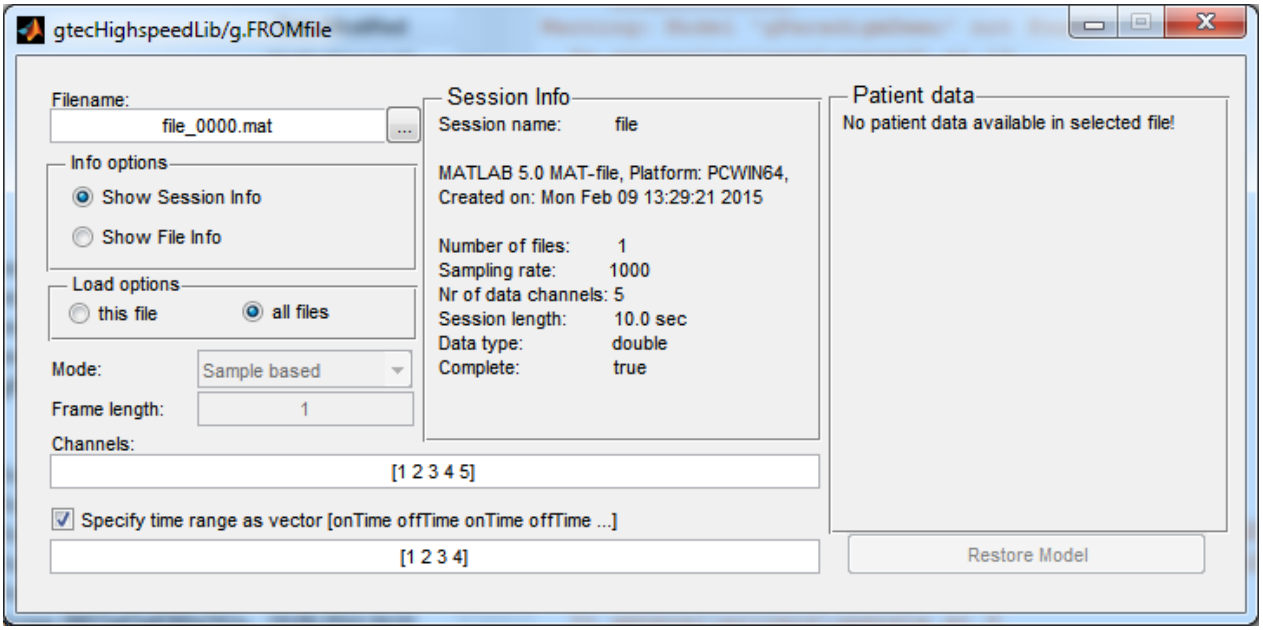


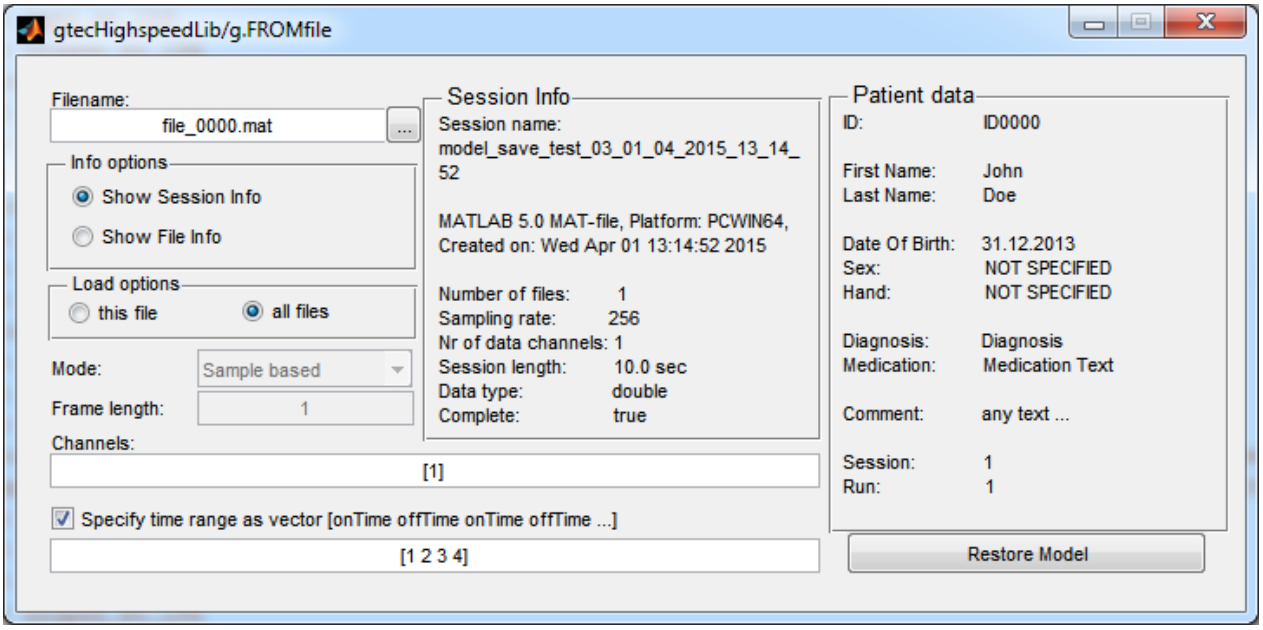
The **g.FROMfile** block is for streaming data from a g.MATfile session in real-time.

Description

The **g.FROMfile** block output provides the recorded data stored with **g.TOfile**. The data format can be single (float32) or double. Use a **Demux** block to de-multiplex multiple channels. The file to load must be on the MATLAB search path.

Dialog Box





Double click on the **g.FROMfile** block to edit the parameters

Filename	enter the filename of the session to read the data into Simulink or use the browse button (…) to select the file	
Info options	Show Session Info	Show stored recording session information
	Show File Info	Show file information
Load options	this file	only load this file
	all files	load all files of the session
Mode	indicates whether the loaded data is sample or frame based	
Frame length	indicates the frame length of loaded data 1 for sample based data number of samples per frame for frame based data	
Channels	shows the number of channels and allows selecting channels for output	
Specify time range	this function is only available for sample based data, and provides the functionality of cutting specified time ranges from the signal e.g. [0 10 30] → output first 10 seconds and from second 30 to the end	
Restore Model	if this button is enabled, a Simulink model was stored to the loaded file click this button to restore the model **NOTE:** the model will be restored in the file restored.mdl or restored.slx depending on the saved file format **ATTENTION:** restored.mdl / .slx model in the path will be replaced!	

gMATrevise Function

```
gMATrevise(sessionname, newsessionname, filesize, timechannel,
channels, begintime, endtime, datatype)
```

Description Convert data files recorded with the **g.TOfile** block to a defined size

Parameters

sessionname	string	data filename without four digit number
newsessionname	string	new data file
filesize	double	size in megabytes of the new files

Optional

timechannel	int	convert the time stamp (0 … no, 1 … yes)
channels	int or char	vector with the channels, that should be saved in the new session files or `all` for all channels
begintime	double	start time of the data
endtime	double	end time of the data
datatype	string	can be ‘single’ (float32) or ‘double’

gMATparam Function

```
[file, session] = gMATparam(fname)
```

Description Get information about a g.MATfile and the associated session.

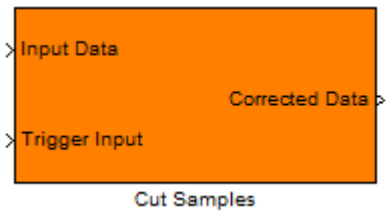
Parameter

fname	string	name of the g.MATfile

Output

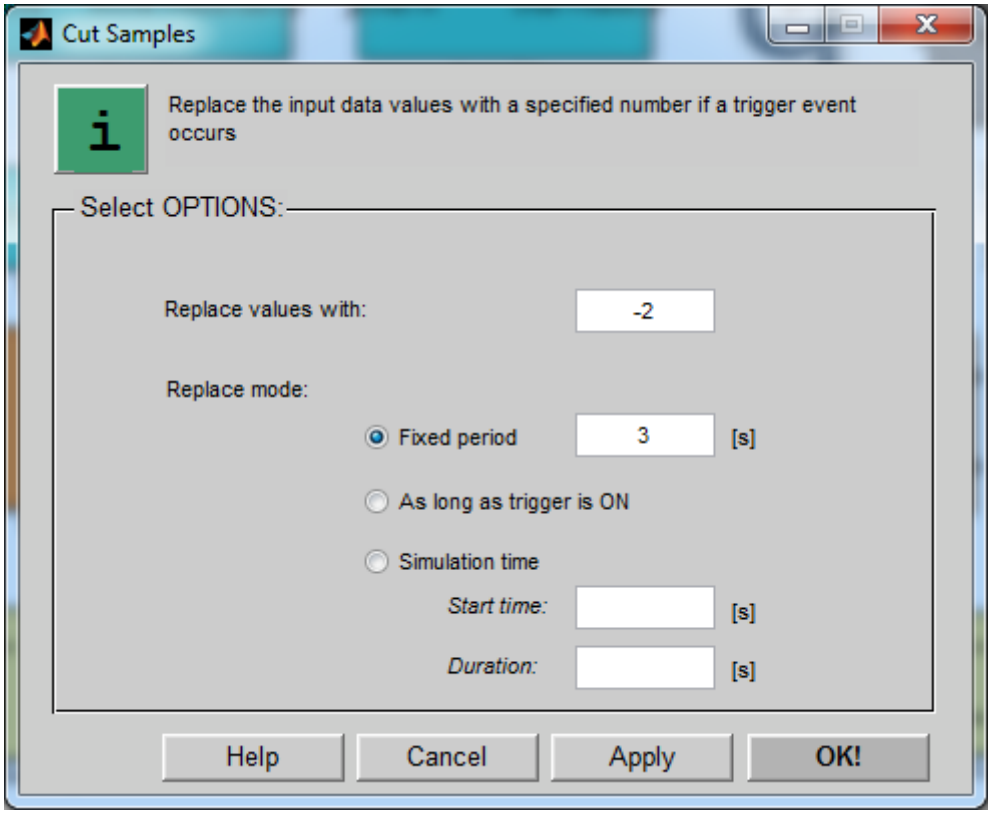
file	name (string)	name of the file
	info (string)	information about the version and recording date/time
	nr (int)	number of the file within the session
	startt (double)	start time of the file within the session
	endt (double)	end time of the file within the session
	channels (int)	number of channels in the file (excluding time stamp channel)
	lastFile (string)	indicates the last file (`true` if last file, `false` otherwise)
	varname (string)	name of the variable data is saved in the file
	datatype (string)	can be `single` (float32) or `double`
	sampleRate (int)	sample rate of recorded data
session	name (string)	name of the session (extended by the file number)
	complete (string)	`true` if all files are available in the current folder, `false` otherwise
	IsFrameBased (double)	`1` if session is frame based, `0` otherwise
	IsSampleBase (double)	`1` if session is sample based, `0` otherwise
	FrameLength (double)	number of samples per frame (1 for sample based data)
	length (double)	total recording time
	nrOfFiles (int)	total number of files

Cut Samples



Description The **Cut Samples** block replaces input data values with a specified number if a trigger event occurs.

Dialog Box



Double click on the **Cut Samples** block to edit the parameters

Replace values with — enter number that is used to correct the input data

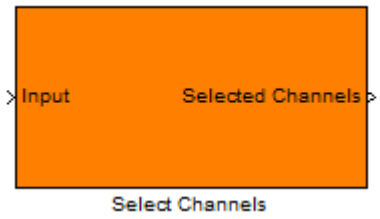
Replace mode

Fixed period [s]	all input data values in this period are replaced
As long as trigger is ON	all input data values are replaced as long as trigger is on
Simulation time	all input data values are replaced for a specific duration starting after the trigger onset

Start time [s]	starting time
Duration [s]	length

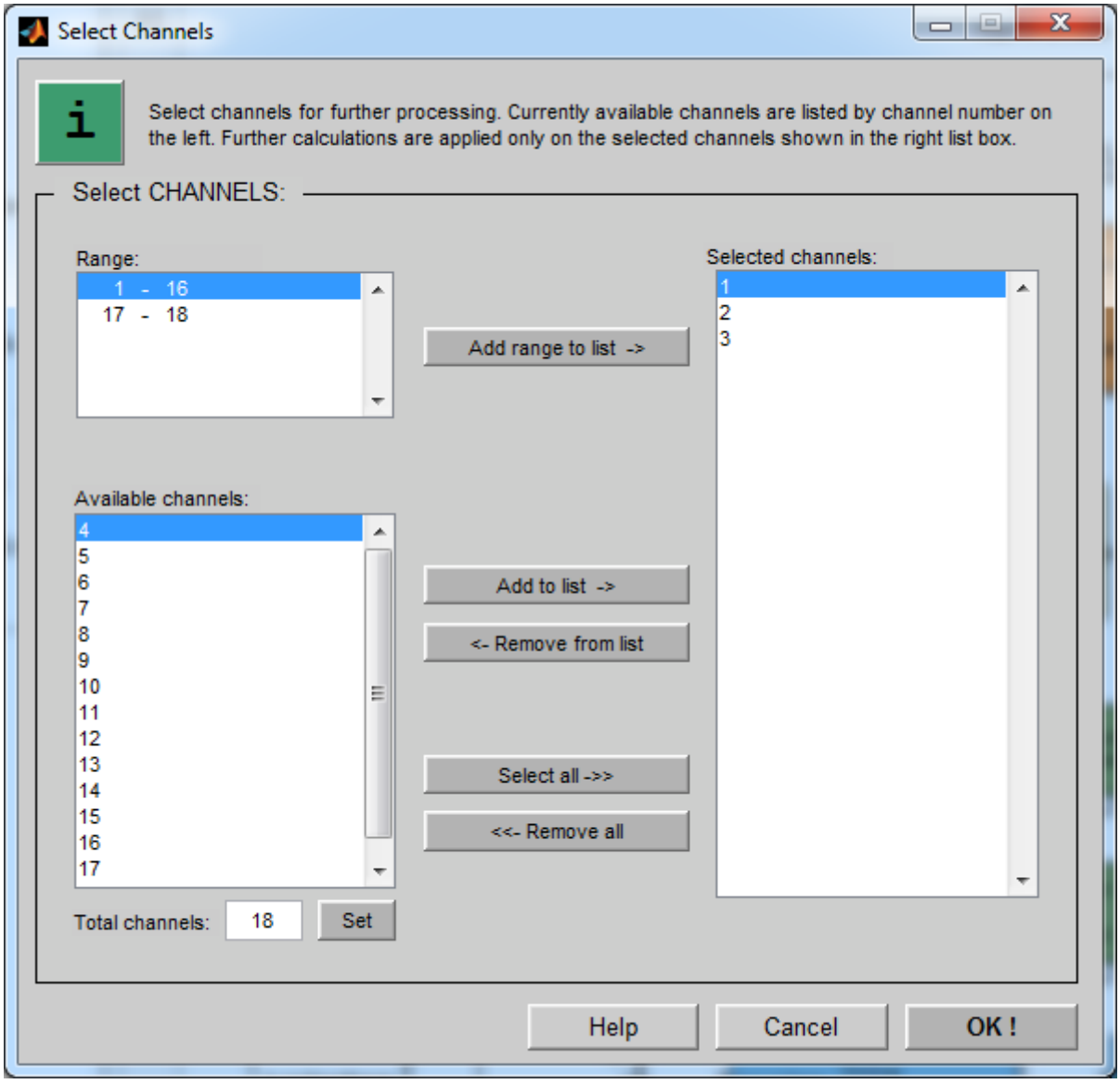
Example Simulink model `gCutSamples.mdl`

Select Channels



Description The **Select Channels** block specifies channels for further processing. Available channels are listed by the channel number on the left. Further calculations are only applied to selected channels listed in the right box.

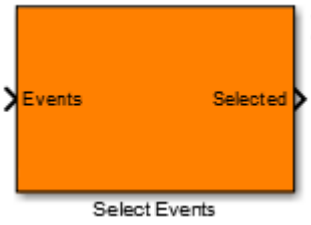
Dialog Box



Double click on the **Select Channels** block to edit the parameters

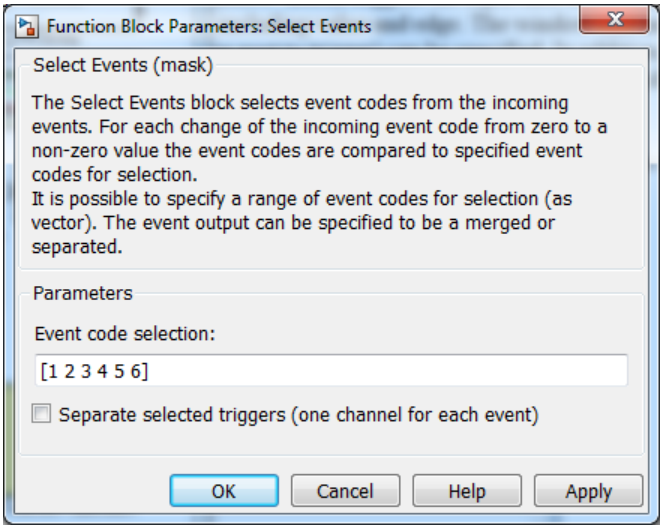
Range	specify a range of available channels
Available channels	shows all available channels
Total channels	specify the number of available channels
Selected channels	shows the specified channels
Example Simulink model	`gSelectChannels.mdl`

Select Events



Description The Select Events block selects event codes from the incoming events. For each change of the incoming event code (from zero to a non-zero value), the event codes are compared to specified event codes for selection.
It is possible to specify a range of event codes for selection (as a vector). The event output can be specified to be a merged or separated.

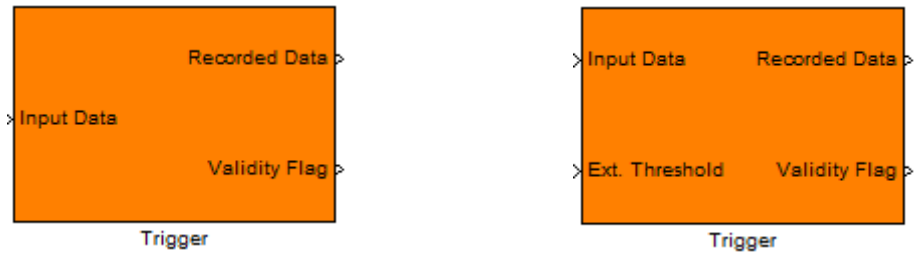
Dialog Box



Double click on the **Select Events** block to edit the parameters

Event Code Selection	specify the event codes to be selected from the incoming events
Separate selected events	specifies whether the selected event codes are output in a single channel or in separate channels for each event code checked → one channel for each selected event code unchecked → one channel for all selected event codes
Example Simulink model	gSelectEvents

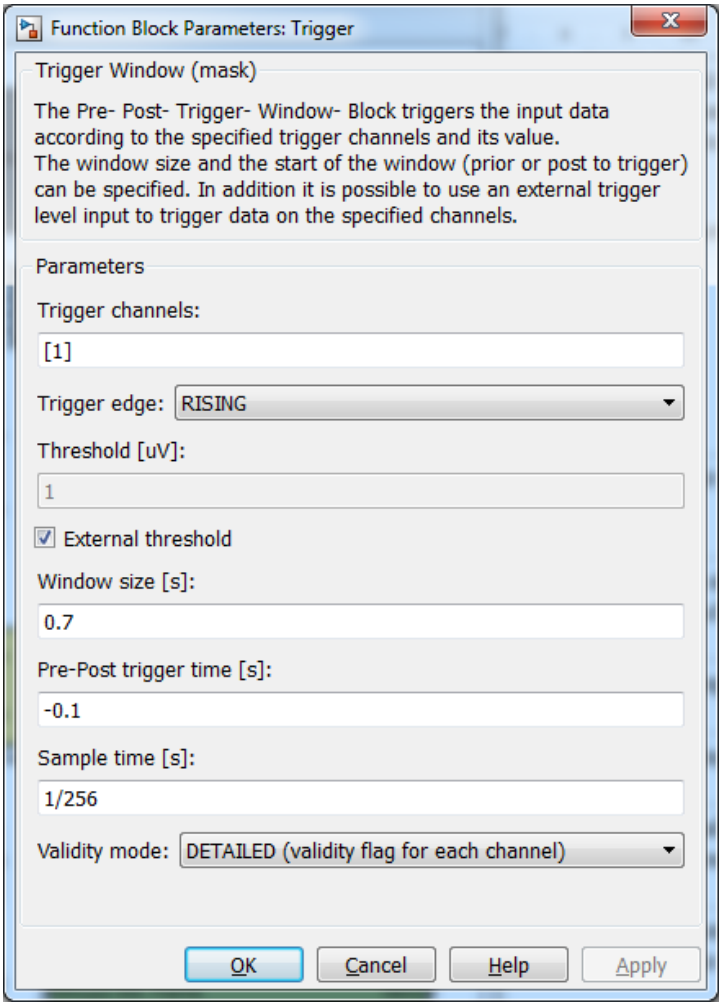
Trigger



Description The Pre- Post- Trigger- Window- Block triggers the input data according to the specified trigger channels, including value and edge. The window size and the start of the window (prior or post to trigger) can be specified. In addition, it is possible to use an external trigger level input to trigger data on the specified trigger channels.

Note Since this block uses the Sample time- Parameter for trigger timing, it is not allowed to use DC sampling frequency.
The data type of the **Input Data** input port is double.

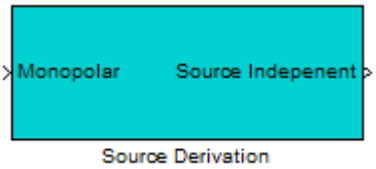
Dialog Box



Double click on the **Trigger** block to edit the parameters.

Trigger channel	select the used trigger channel it is possible to enter a vector of channels
Threshold	specify level for triggering it is also possible to enter a vector of thresholds one threshold for each channel
Window size [s]	specify the interval for triggering (total length of window)
Trigger edge	specify whether a rising or falling edge should be detected
External threshold	check the box to use an external signal as ther trigger level for all channels an addition input appears for the block
Pre-Post trigger time [s]	time before or after triggering starts use < 0 for pre- and > 0 for post- trigger timepoint
Sample time [s]	specify the sampling time
Validity mode	specify the mode of the `Validity Flag` output port STANDARD: merged triggers to a single channel DETAILED: one channel for each trigger
Example Simulink model	gTriggerDemo.mdl, gTriggerExternalThreshold.mdl

Source Derivations

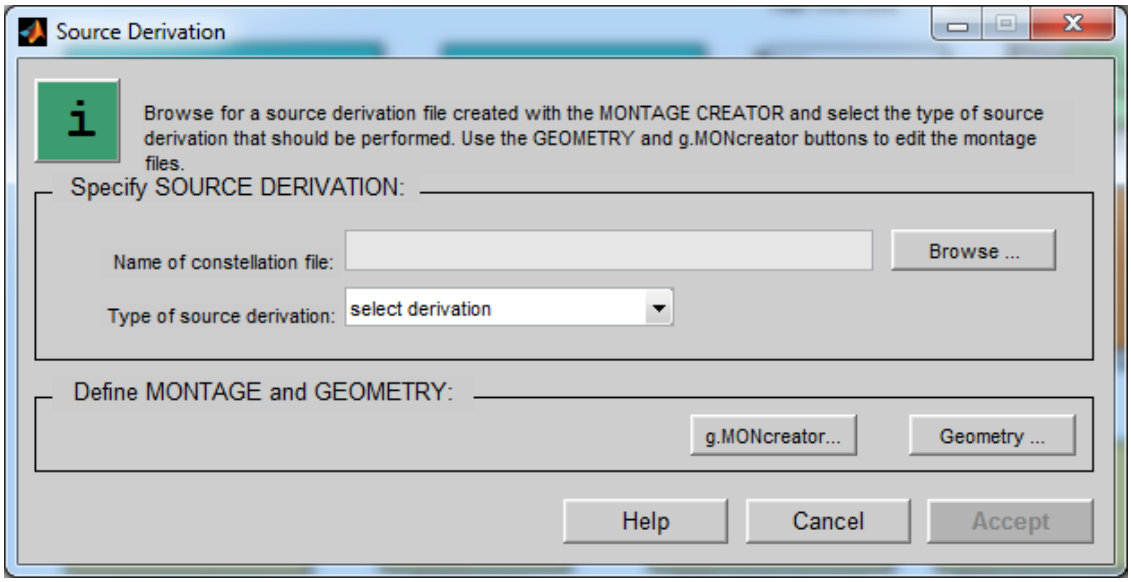


Description

The **Source Derivation** block performs different types of source derivations (CAR, Laplacian, bipolar, …) of the input data. The source derivation file can be created with the Montage Creator.

NOTE: Source Derivation block requires g.BSanalyze to be installed on your system.

Dialog Box

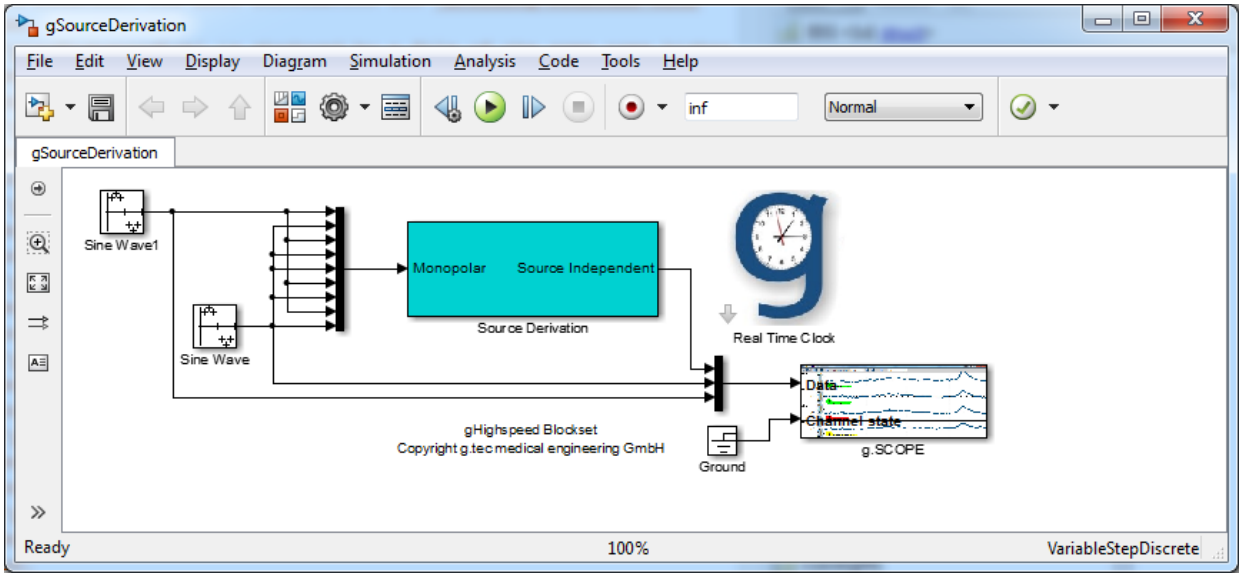


Double click on the **Source Derivation** block to edit the parameters

Name of constellation file	name of the source derivation file
Browse	open the explorer window to search for the file
Type of source derivation	specify the type of source derivation that should be performed
g.MONcreator	press button to create new constellation or inspect a constellation file with the Montage Creator
Geometry	edit the electrode positions of the montage
Example Simulink model	`gSourceDerivation.mdl`

Example:

1.) Open the Simulink model gSourceDerivation by double clicking the corresponding icon on the **g.tec Highspeed Library/Examples** section of the **Simulink Library browser** or enter gSourceDerivation.mdl at the Matlab command line.

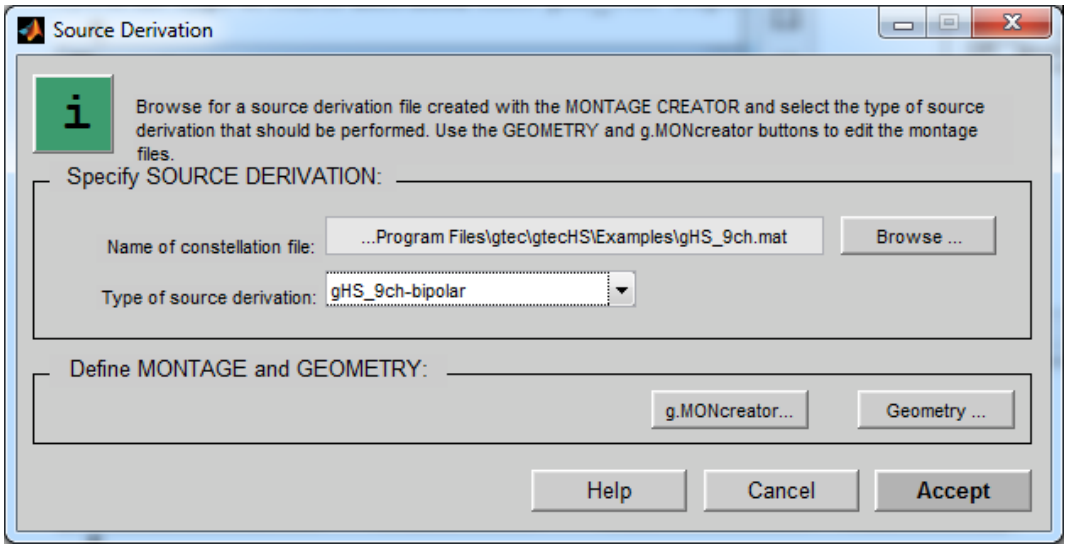


2.) Double click on the **Source Derivation** block.

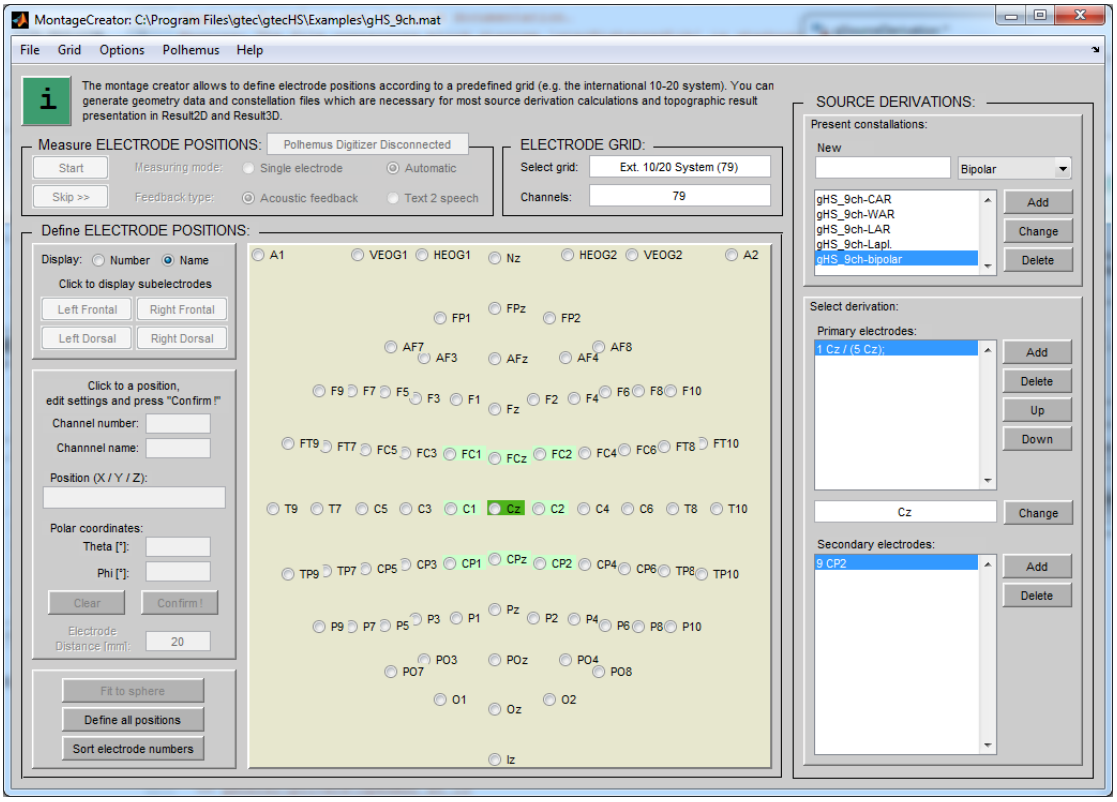
3.) Click on the **Browse…** button and open the file `gHS_9ch.mat` from the folder

`C:\Program Files\gtec\gtecHS\Examples`

4.) For the **Type of source derivation** select `gHS_9ch-bipolar`



5.) Click on the **g.MONcreator…** button to open the constellation file in the Montage Creator.

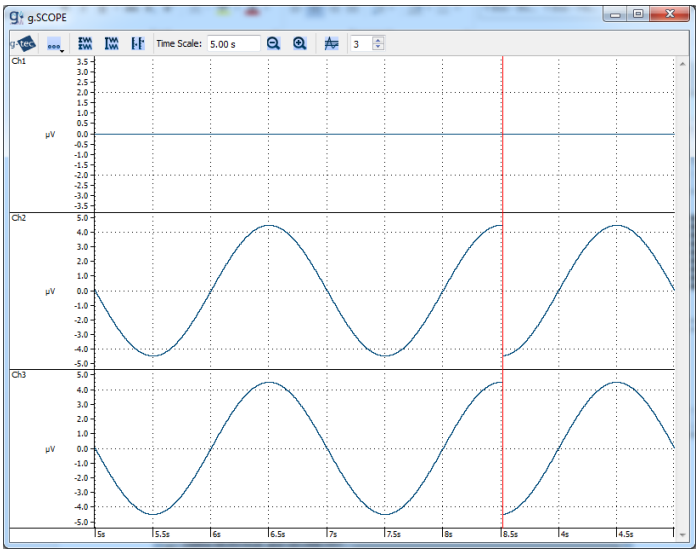


In the bipolar constellation the electrode `CP2` will be subtracted from the electrode `Cz`. Then close the Montage Creator.

6.) Press the button **Accept** button in the **Source Derivation** dialog box

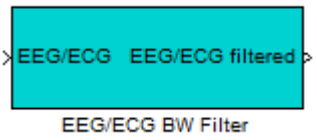
7.) To start the simulation, click on **Start** under the **Simulation** menu

8.) Double click the **g.Scope** block to view the following screen:



The first channel shows the bipolar derivation of the two sine-waves, which results in a zero line.

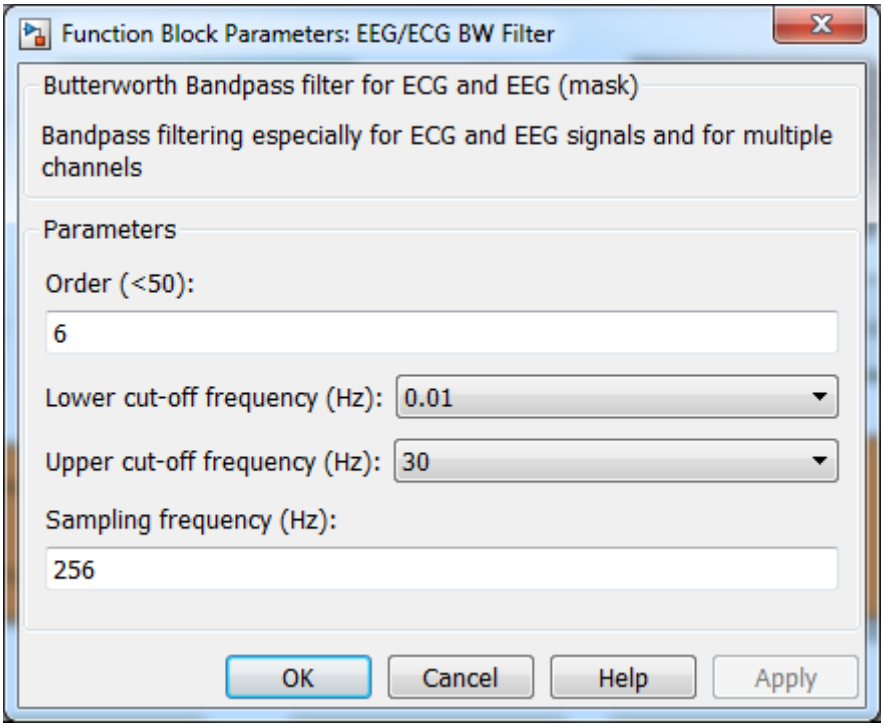
EEG/ECG BW Filter



Description

The **EEG/ECG BW Filter** block can be used for Butterworth bandpass filtering. The filters were designed especially for ECG and EEG signals, and work for multiple channels with optimized speed. Use the block to filter the incoming biosignal data to extract activity in specific frequency bands. The filter is realized using a Butterworth band-pass filter with twice the specified order.

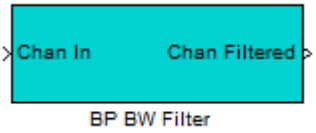
Dialog Box



Double click on the **EEG/ECG BW Filter** block to edit the parameters

Order (<50)	filter order of the Butterworth filter
Lower cut-off frequency (Hz)	lower cut-off frequency
Upper cut-off frequency (Hz)	upper cut-off frequency
Sampling frequency (Hz)	sampling rate of the used amplifier
Example Simulink model	gFilterDemo_FFTPlot.slx, gFilterDemo_SpectrumPlot.slx

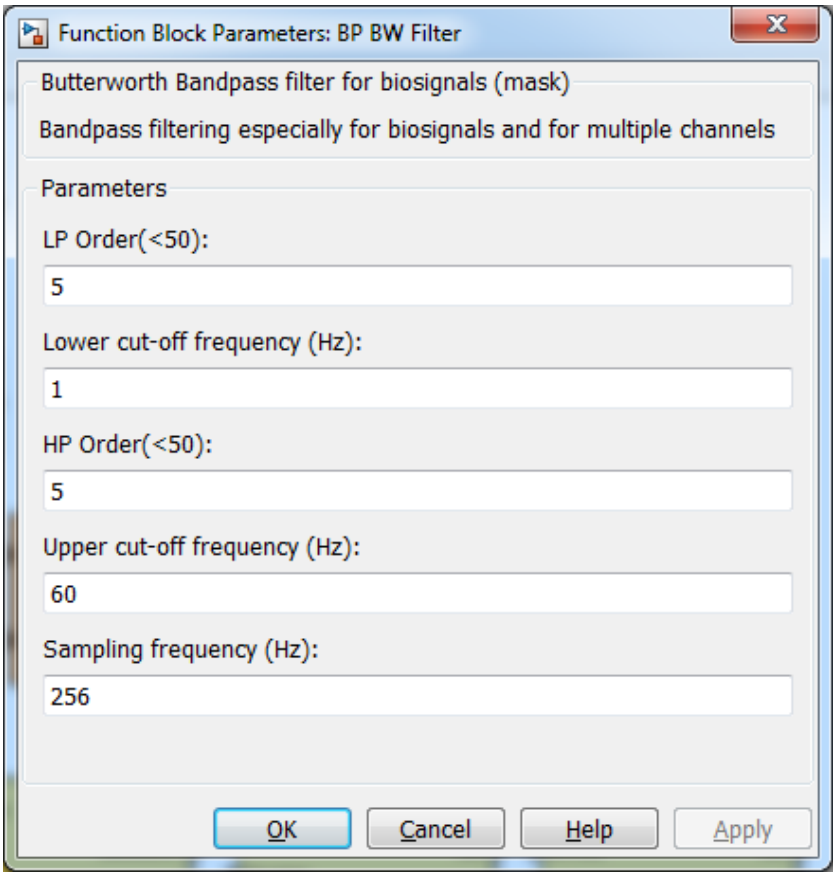
BP BW Filter



Description

The **BP BW Filter** block can be used for Butterworth bandpass filtering, especially for biosignals and for multiple channels. Use the block to filter the incoming biosignal data to extract activity in specific frequency regions. The filter is realized using a cascaded Butterworth high-pass and low-pass filter with the specified filter order.

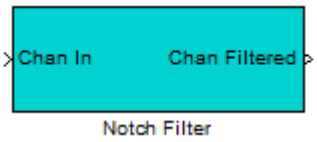
Dialog Box



Double click on the **BP BW Filter** block to edit the parameters

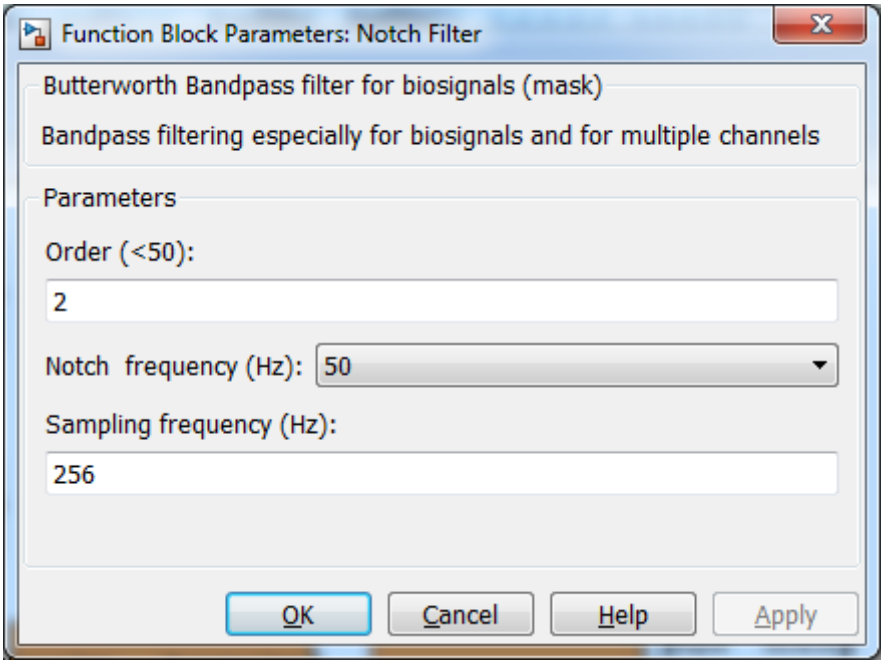
Order HP (<50)	filter order of the Butterworth high-pass filter
Lower cut-off frequency (Hz)	lower cut-off frequency
Order LP (<50)	filter order of the Butterworth low-pass filter
Upper cut-off frequency (Hz)	upper cut-off frequency
Sampling frequency (Hz)	sampling rate of the used amplifier
Example Simulink model	gFilterDemo_FFTPlot.slx, gFilterDemo_SpectrumPlot.slx

Notch Filter



Description The **Notch Filter** block is used to suppress power line interference with a frequency of 50 or 60 Hz. It works for multiple channels and is optimized for speed.

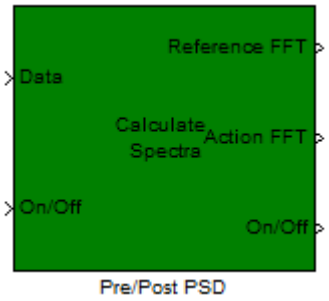
Dialog Box



Double click on the **Notch Filter** block to edit the parameters

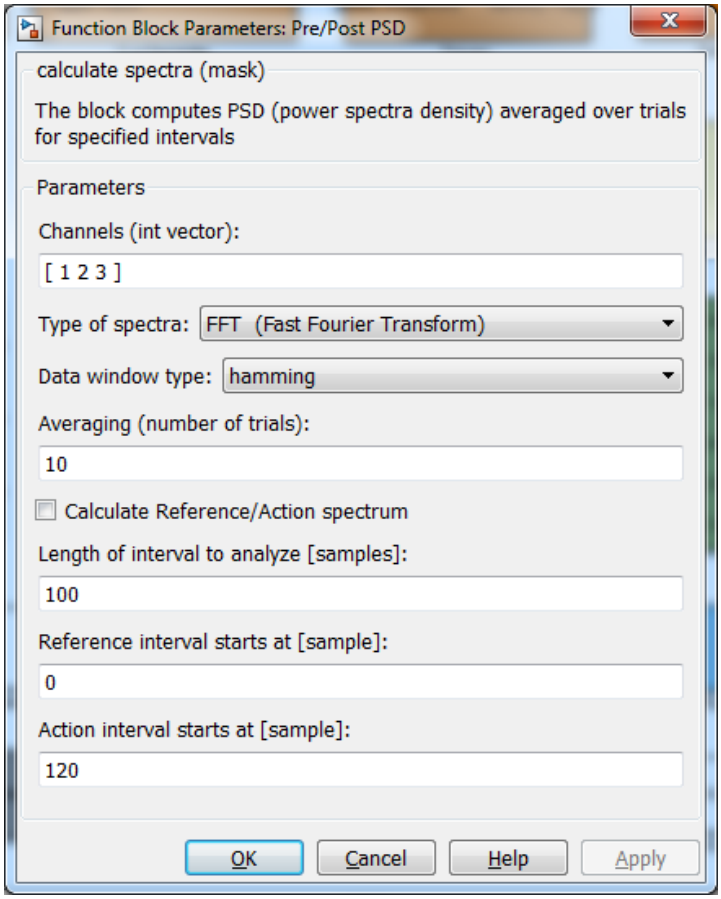
Order (<50)	filter order of the band-stop filter
Notch frequency (Hz)	band-stop frequency
Sampling frequency (Hz)	sampling rate of the used amplifier
Example Simulink model	gFilterDemo_FFTPlot.slx, gFilterDemo_SpectrumPlot.slx

Pre/Post PSD



Description The **Pre/Post PSD** block computes PSD (power spectra density) averaged over trials for specified intervals. If a reference interval and an action interval are analysed, a significance test is applied to identify reactive frequency bands.

Dialog Box

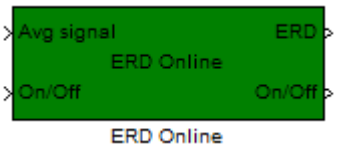


Double click on the **Pre/Post PSD** block to edit the parameters

Channels (int vector)	select the channels
Type of spectra	select type of spectrum **FFT (Fast Fourier Transform)** **PSD (Power Spectrum Density)**

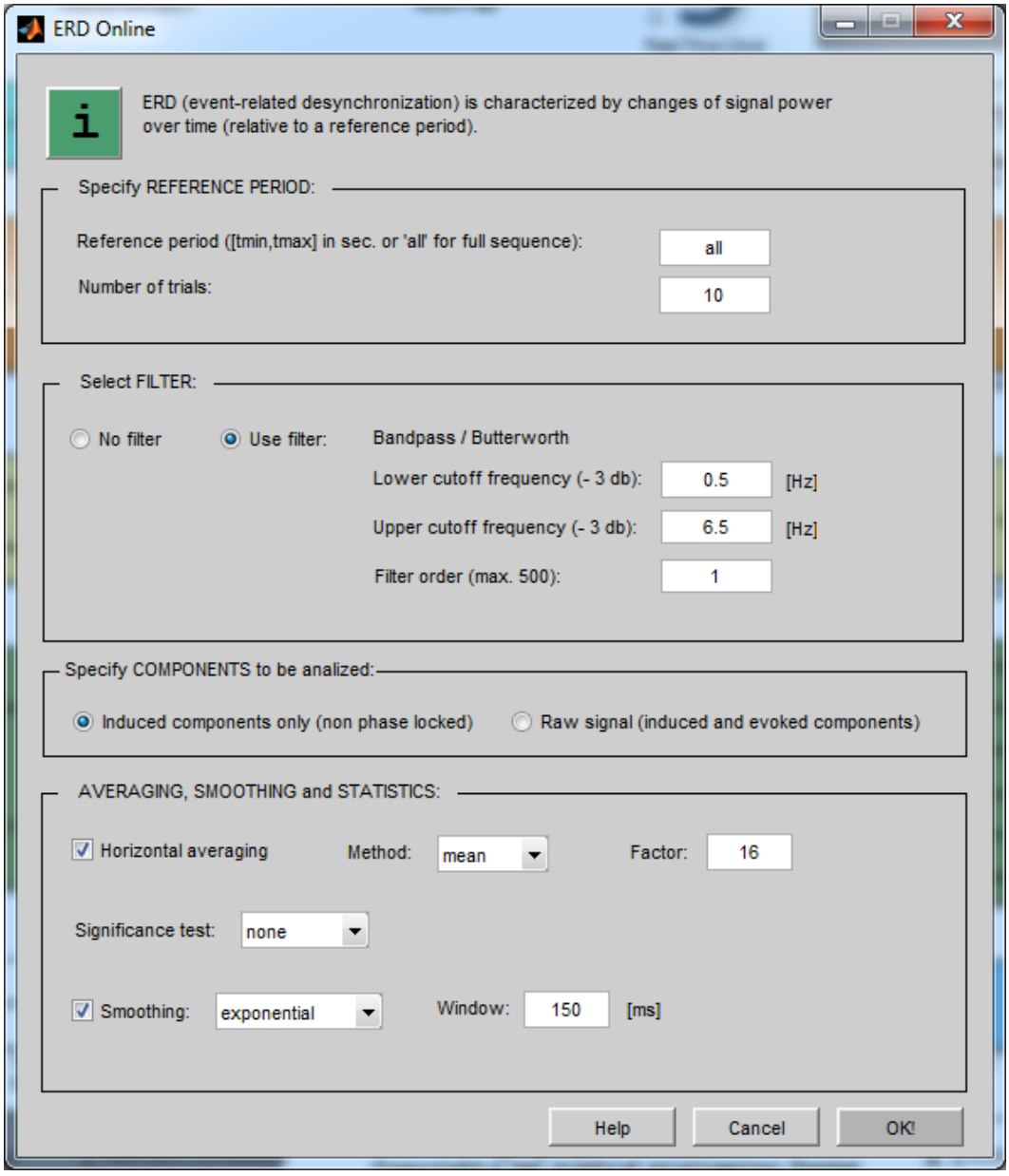
Data window type	select the data window type for action and reference interval. Window type can be **boxcar**, **hamming** or **hanning**.
Averaging (number of trials)	specify the number of trials to average
Calculate Reference/Action spectrum	check the box to calculate the spectrum of the reference interval and of the action interval and compare the results
Length of interval to analyze [samples]	specify the length of the reference and action interval in samples
Reference interval starts at [sample]	insert the start point of the reference interval in samples
Action interval starts at [sample]	insert the start point of the action interval in samples

ERD Online



Description The **ERD Online** block calculates the ERD (event-related desynchronization). ERD is characterized by changes in signal power over the time (relative to a reference period).

Dialog Box



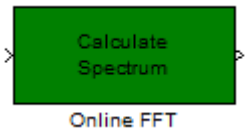
Double click on the **ERD Online** block to edit the parameters

Reference period ([tmin,tmax] in sec. or 'all' for full sequence)	select a specific interval `[tmin, tmax]` in sec. as reference period or use the entire trial `all`
Number of trials	number of used trials for the ERD calculation
Use filter	Check this box to use a bandpass filter.
Lower cutoff frequency (-3 db) [Hz]	lower cut-off frequency
Upper cutoff frequency (-3 db) [Hz]	upper cut-off frequency
Filter order (max. 500)	filter order of the bandpass filter
Specify COMPONENTS to be analyzed	select **Induced components only (non phase locked)** where phase locked components will be removed or **Raw signal,** where non-phase locked and phase locked components will be analyzed
Horizontal averaging	average over consecutive samples
Method	can be **mean** or **median**
Factor	number of samples to average
Significance test	perform the significance test
Smoothing	smooth the result **average** - average over the specified window length in ms **exponential** - exponential window with window length in ms **cosine** - cosine window with a window length in ms
Window [ms]	window length for smoothing
Example Simulink model	`gERD.mdl`

Load the file `erd_data.mat` from path `C:\Program Files\gtec\gtecHS\Examples` to run the example `gERD.mdl`.

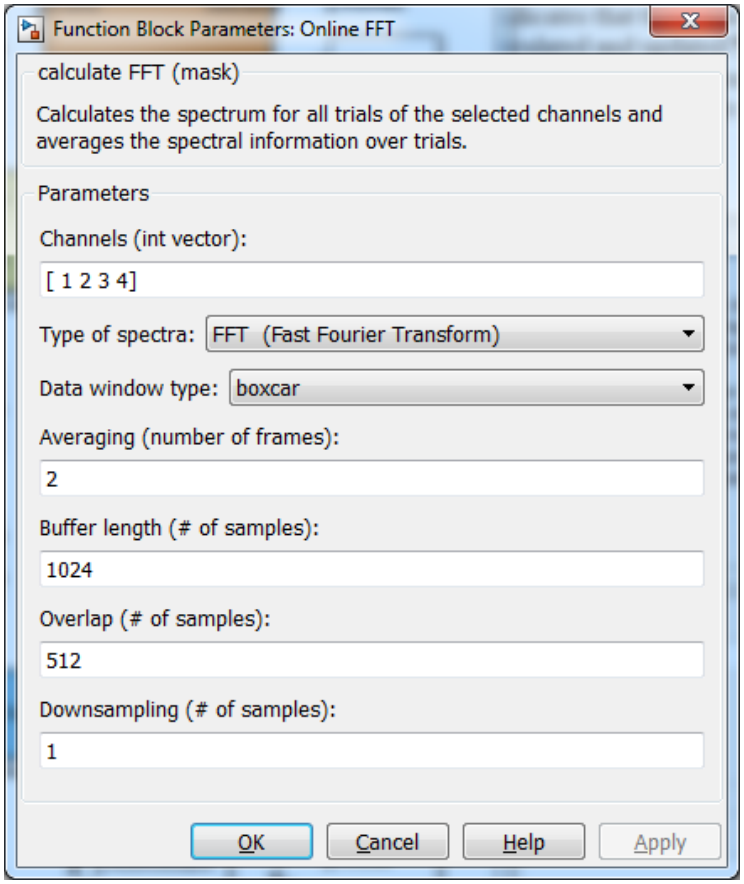
In the **Buffer** block, the **Output buffer size (per channel)** must be set to `512`.

Online FFT



Description The **Online FFT** block calculates the spectrum for all trials of the selected channels and averages the spectral information over trials.

Dialog Box

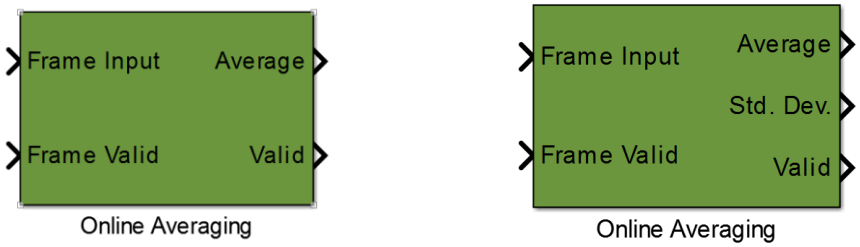


Double click on the **Online FFT** block to edit the parameters.

Channels (int vector)	select the channels
Type of spectra	select type of spectrum **FFT (Fast Fourier Transform)** **PS (Power Spectrum)** **PSD (Power Spectrum Density)**
Data window type	select the data window type. Window type can be **boxcar**, **hamming** or **hanning**.
Averaging (number of frames)	specify the number of frames to average

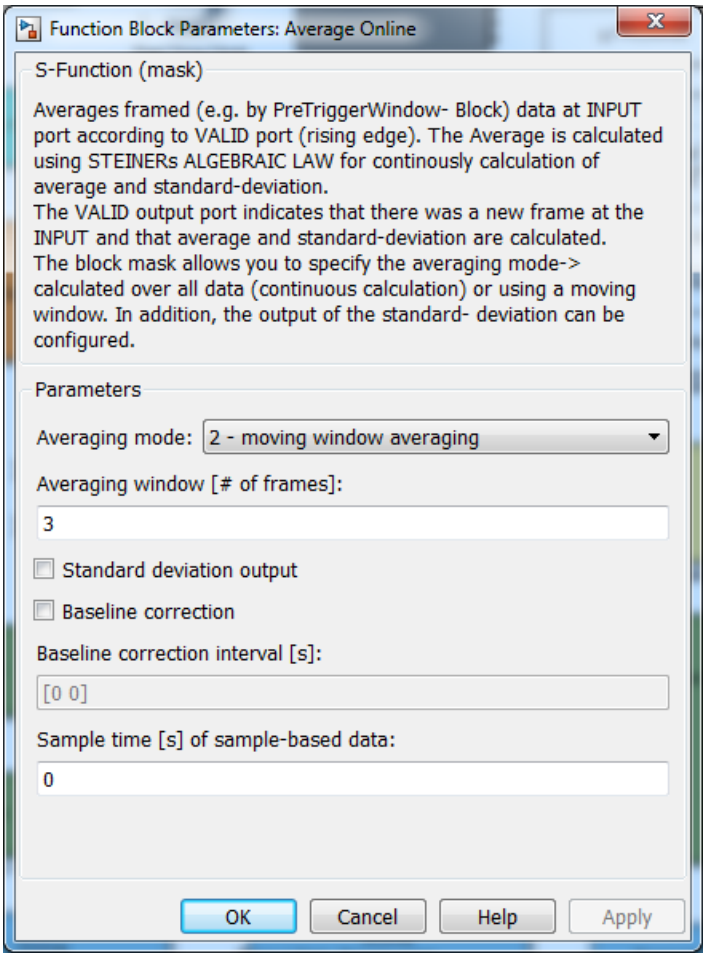
Buffer length (# of samples)	specify the length of the interval in samples
Overlap (# of samples)	define the overlap of the interval in samples
Downsampling (# of samples)	reduce the frequency scale range by the specified factor
Example Simulink model	`gOnlineSpecs.mdl`

Online Averaging



Description Averages framed (see TriggerBlock, Pg. 36) data according to the 'Frame Valid' port. The Average is calculated using STEINERs ALGEBRAIC LAW for continuous calculation of average and standard-deviation.
The 'Valid' output port indicates that there was a new frame and average and standard-deviation are calculated and updated.
The block mask allows you to specify the averaging mode-> calculated over all frames or using a moving window. The output of the standard-deviation can also be configured.

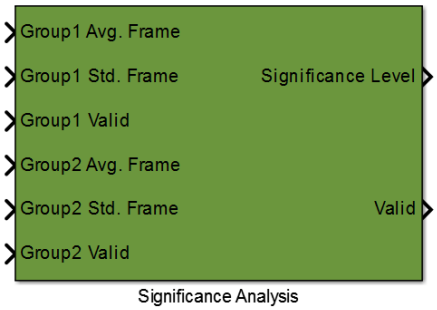
Dialog Box



Double click on the **Online Averaging** block to edit the parameters.

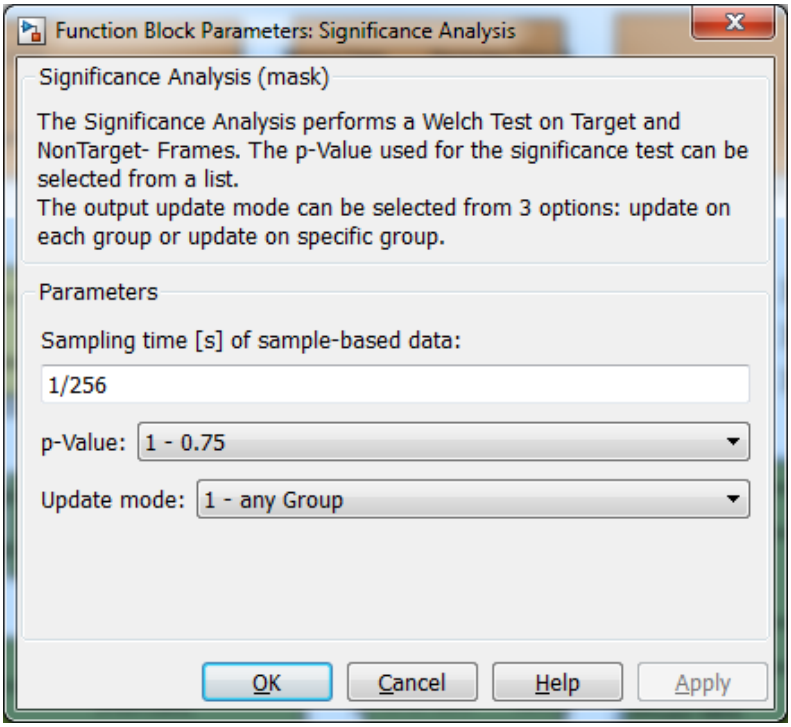
Averaging Mode	`1-average all data:` running average will use all incoming trials `2-moving window averaging:` specify the number of trials to average over the last N trials only
Averaging Window	only enabled in moving window averaging mode. Specifies the number of trials of the window
Standard-Deviation Output	If this box is checked/selected, an additional output is presented that holds the standard-deviation of the incoming data frames
Sample Time	Sample time of the incoming frame data (original sample time) in seconds
Example Simulink model	`gEP.mdl`

Statistical Analysis



Description The Significance Analysis block performs a Welch test of the 2 populations represented by average and standard deviation, Group1 and Group2. The p-value used for the significance of the Welch test can be selected from a list.
The output update mode can be selected from 3 options: update on each group change or update on group1 or group2 changes only.

Dialog Box



Double click on the **Statistical Analysis** block to edit the parameters.

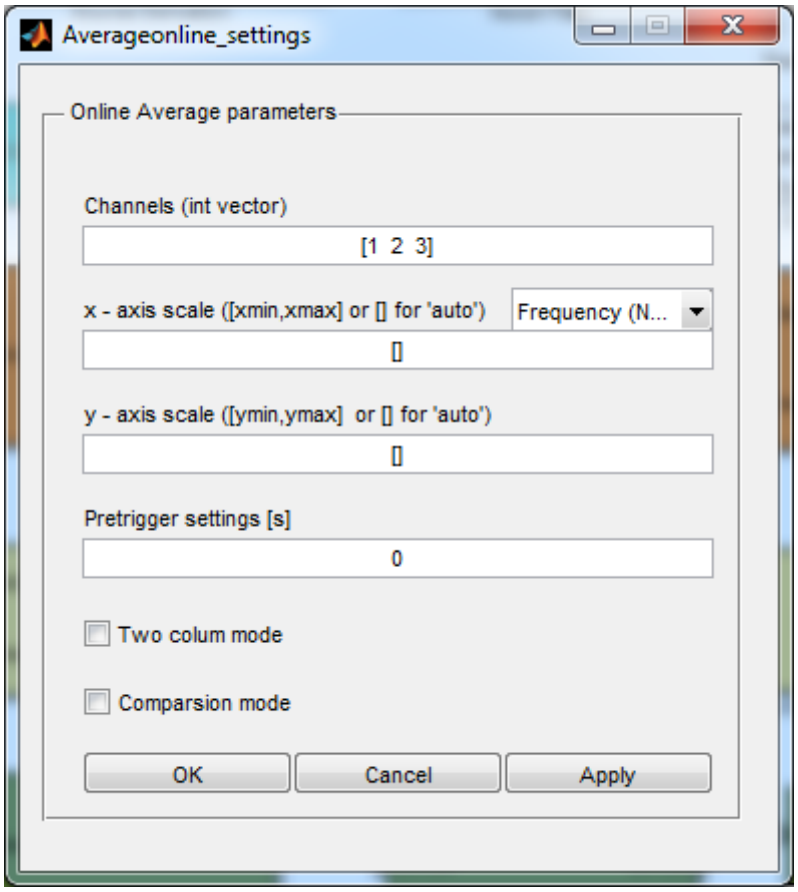
Sampling time	Sample time in seconds the block is running
p-Value	Set the p-Value for significance calculation.

	Available p-Values: 0.75, 0.875, 0.9, 0.95, 0.975, 0.99, 0.995, 0.999
Update Mode	`1-any Group` update output with changed input of any Group `2-Group1 only` update output only if Group1 input changed `3-Group2 only` update output only if Group2 input changed
Example Simulink model	`gEP.mdl`

Online Plot

Description The **Online Plot** block plots the forwarded input data. This block can also be run in a comparison mode with two input data.

Dialog Box



Double click on the **Online Plot** block and click on **Parameters** in the menu bar to edit the parameters

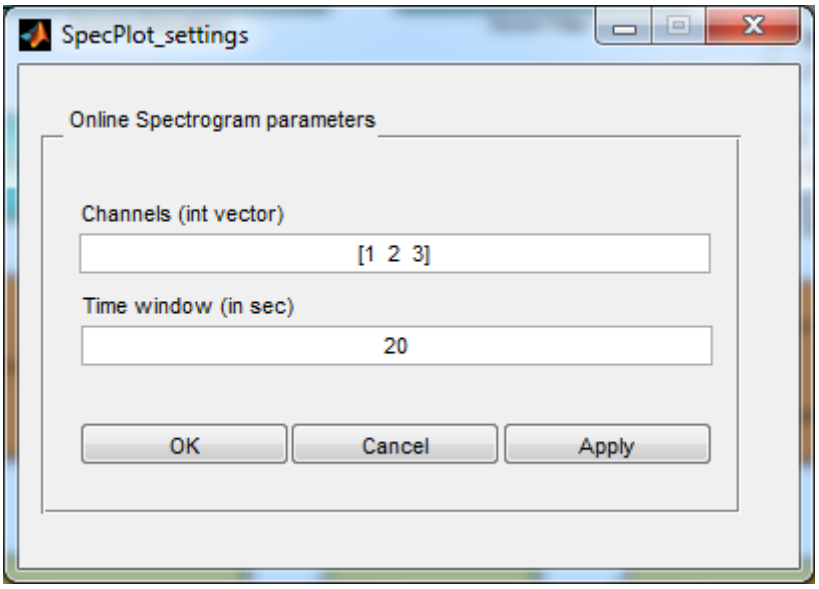
Channels (int vector)	select the channels
x-scale ([xmin, xmax] or [] for ‘auto’)	scale x - axis
x-label	the label of the x-axis could be **Normalized Frequency** or **Time in sec**
y-scale ([ymin, ymax] or [] for ‘auto’)	scale y axis
Pretrigger [s]	specify a pretrigger line point

Two columns mode	plot windows are arranged in two columns
Comparison mode	whether selected comparison mode is used
Example Simulink model	`gOnlineSpecs.mdl`

Online Spectrogram Plot

Description The **Online Spectrogram Plot** block plots the results of the **Calculate Spectrum** block.

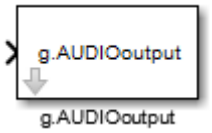
Dialog Box



Double click on the **Online Spectrogram Plot** block and click on **Parameters** in the menu bar to edit the parameters

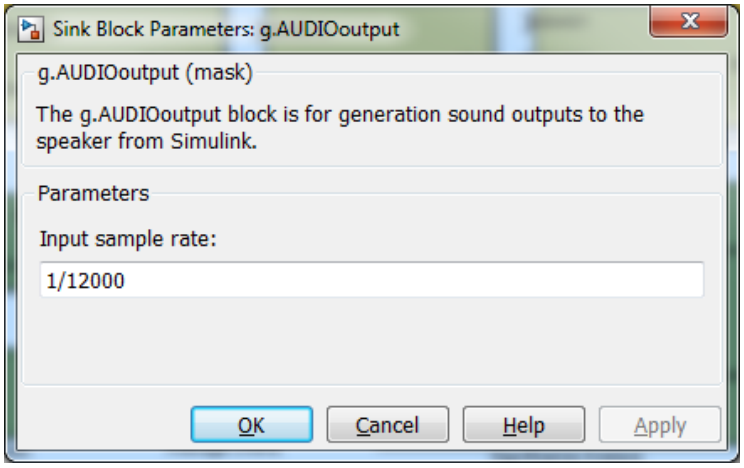
Channels (int vector)	select the channels
Time window (in sec.)	displayed time window in the plot
Example Simulink model	`gOnlineSpecs.mdl`

gAUDIOoutput



Description The **g.AUDIOoutput** block generates sound outputs to the speaker from Simulink.

Dialog box

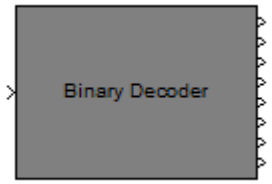


Double click the g.AUDIOoutput block to edit the parameter.

Input sample time	Sample time of the input signal
Example Simulink model	`gAUDIOoutput_DEMO.slx`

ATTENTION: This block requires ASIO4ALL – Universal ASIO Driver For WDM Audio version 2.12 to be installed on the computer.

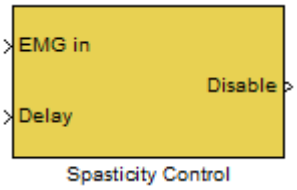
Binary Decoder



Description The **Binary Decoder** block converts an incoming double or single data into a binary value.

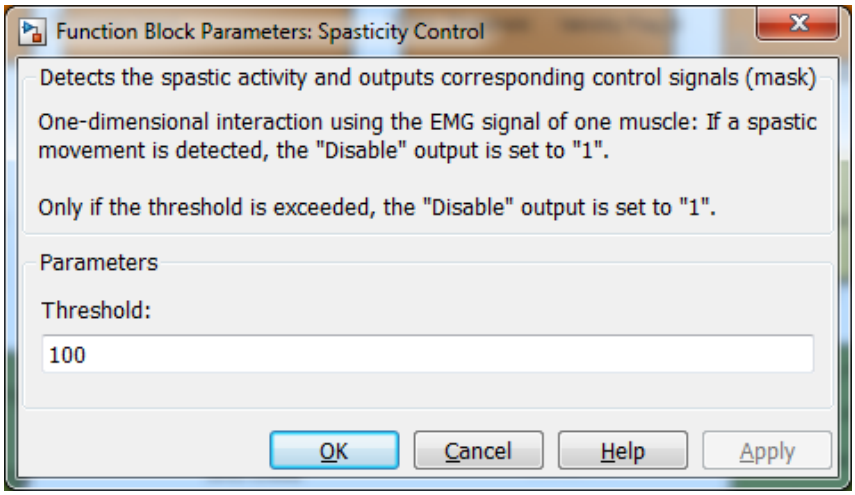
Example Simulink model `gBinaryDecoder.mdl`

Spasticity Control



Description The **Spasticity Control** block detects the muscle spastic activity in muscles and outputs corresponding control signals.

Dialog box

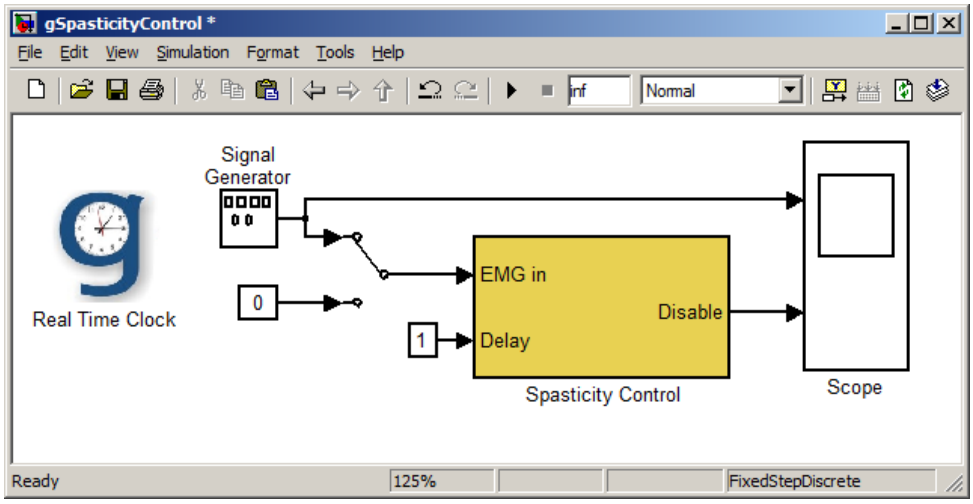


Double click on the **Spasticity Control** block to edit the parameters

Threshold	threshold value for determining the spastic movements. If this amplitude threshold is exceeded, the **Disable** output of the block will be set to 1
Example Simulink model	`gSpasticityControl.mdl`

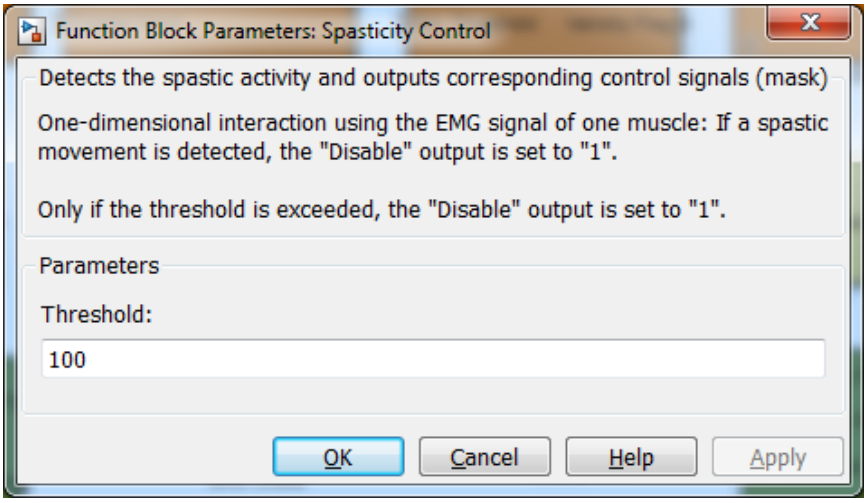
Example:

1.) Open the Simulink model `gSpasticityControl.mdl`



2.) Double click on the **Spasticity Control** block.

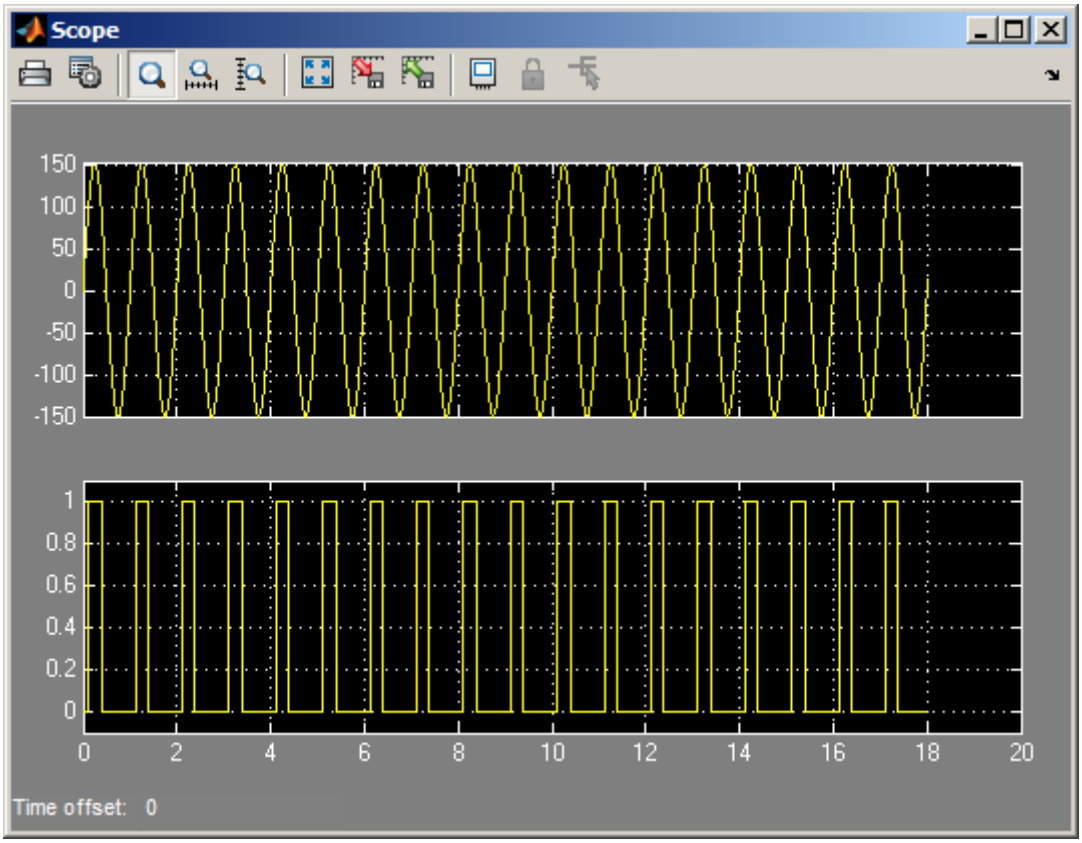
3.) For the **Threshold** select `100` mV



4.) Press the button **OK**

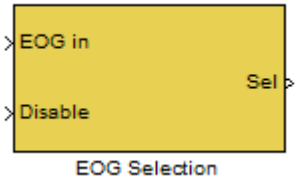
5.) To start the simulation, click on **Start**

6.) Double click on the **Scope** block to view the following screen:



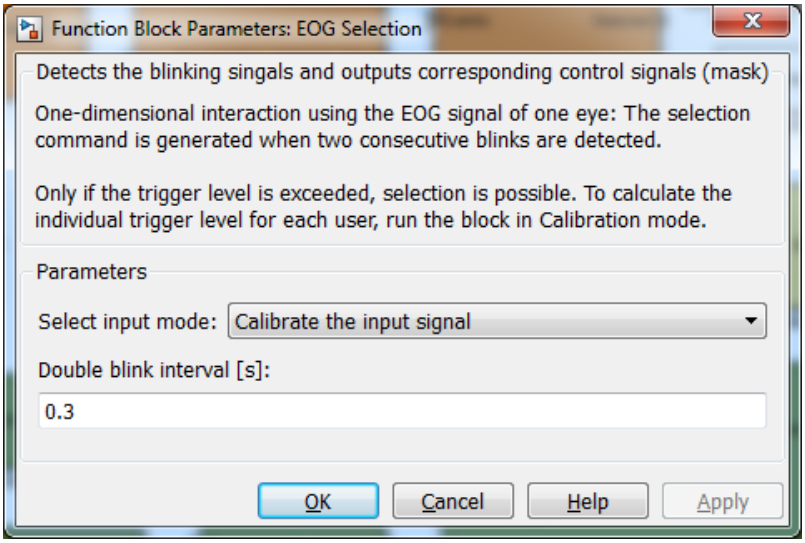
The first channel shows the input signal and the second channel displays the Disable signal which is 1 whenever the amplitude of the sine wave is higher than 100 mV.

EOG Selection



Description The **EOG Selection** block detects the blinking signals and outputs corresponding control signals.

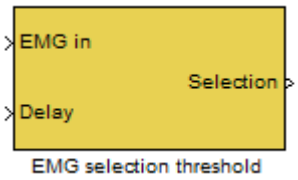
Dialog box



Double click on the **EOG Selection** block to edit the parameters

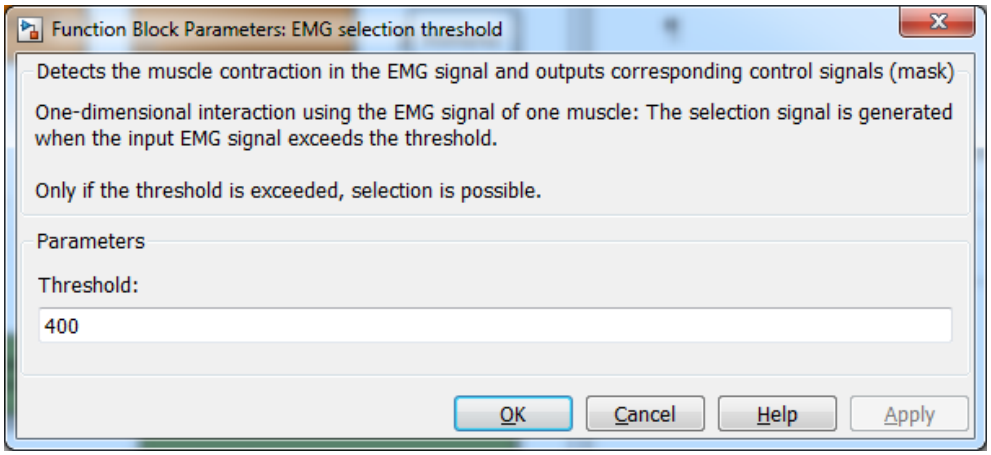
Select input mode	select `Calibrate the input signal` to calculate the trigger level for the user or `Use the input sensor` to activate the selection mode
Double blink interval [s]	time window within which the second eye blink must occur for a valid selection
Min. time between 2 blinks [s]	minimum time between two blinks to be treated as two individual events.
Example Simulink model	`g.EMGEOGcontrol/g.BCI_EOG_gUSBamp`

EMG Selection threshold



Description The **EMG Selection threshold** block detects the muscle contraction in the EMG signal and outputs corresponding control signal. The control signal is thereby compared to a manually configurable threshold.

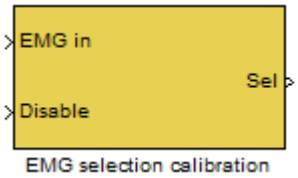
Dialog box



Double click on the **EMG Selection threshold** block to edit the parameters

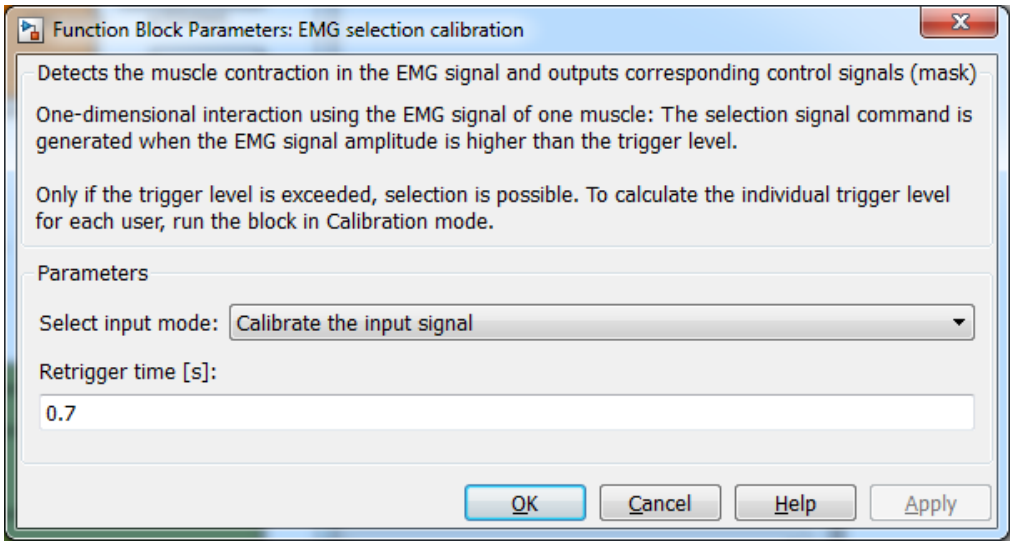
Threshold threshold value the selection command

EMG Selection calibration



Description The **EMG Selection calibration** block converts the EMG signal from one muscle to selection commands. Unlike the **EMG selection block**, the control signals are generated by comparing the input signal to a threshold that has been determined during an initial calibration phase.

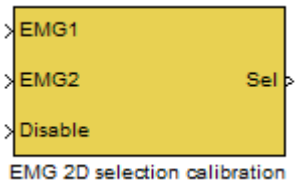
Dialog box



Double click on the **EMG Selection 2** block to edit the parameters

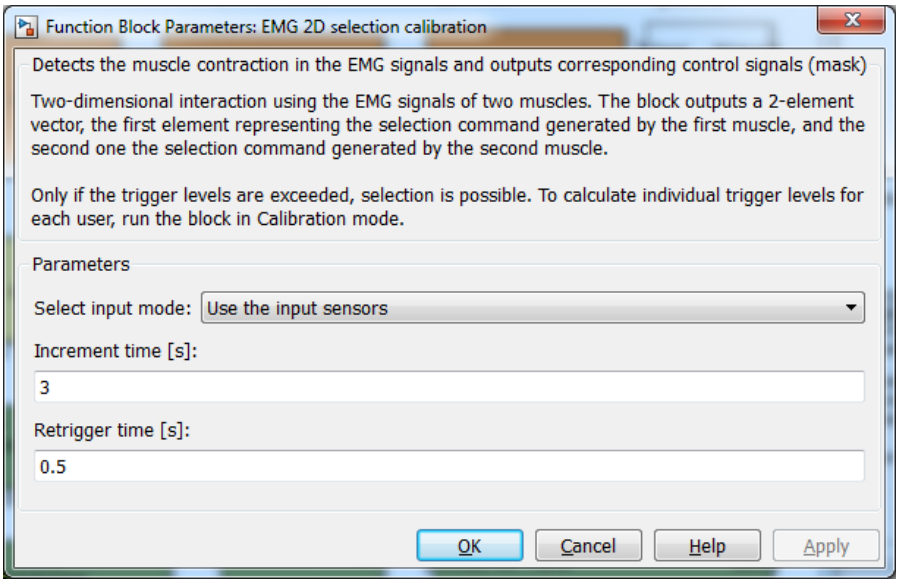
Select input mode	select `Calibrate the input signal` to calculate the trigger level for the user or `Use the input sensor` to activate the selection mode
Retrigger time [s]	minimum time between two selections
Example Simulink model	`g.EMGEOGcontrol/gBCI_EMG_gUSBamp.mdl`

EMG 2D selection calibration



Description The **EMG 2D selection calibration** detects the muscle contraction in the EMG signals and outputs corresponding control signals.

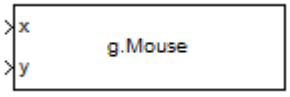
Dialog box



Double click on the **EMG 2D selection calibration** block to edit the parameters

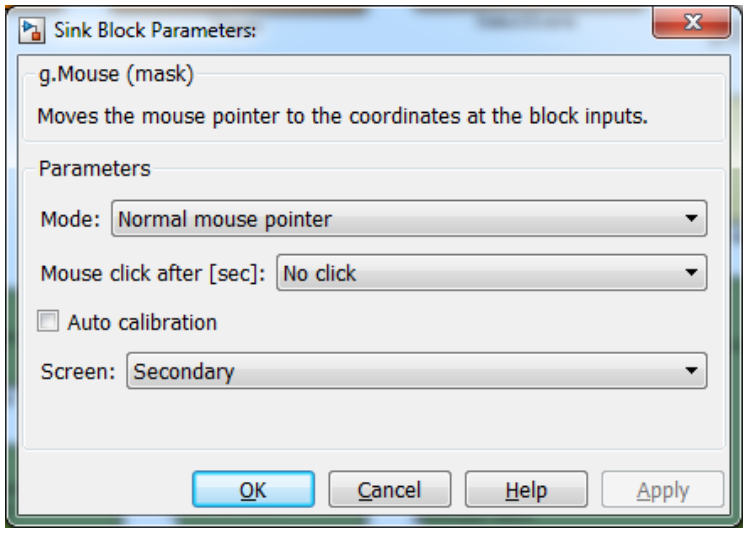
Select input mode	select `Calibrate the input signal` to calculate the trigger level for the user or `Use the input sensor` to activate the selection mode
Dwell time [s]	time window between two selections
Retrigger time [s]	minimum time between two triggers
Example Simulink model	`g.EMGEOGcontrol/g.BCI_EMG_2D_gUSBamp`

g.Mouse



Description The **g.Mouse** block controls the mouse pointer with respect to the input coordinates **x** and **y**.

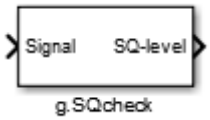
Dialog box



Double click on the **g.Mouse** block to edit the parameters

Mode	the pointer control mode could be: **Normal mouse pointer**, **Incremental mouse pointer** or **Scroll mouse pointer.**
Mouse click after [sec]	time interval between the moment when the cursor stopped on a point and the moment when the automatic click command is given. Select **No click** to control only the pointer movement.
Auto calibration	calibrate the pointer position based on the minimum and maximum values reached by the input coordinates **x** and **y** during a pre-defined **Calibration time [sec]**.
Screen	select **Primary** to control the mouse pointer on the primary screen of the PC, or select **Secondary** to move the pointer on the secondary attached screen.

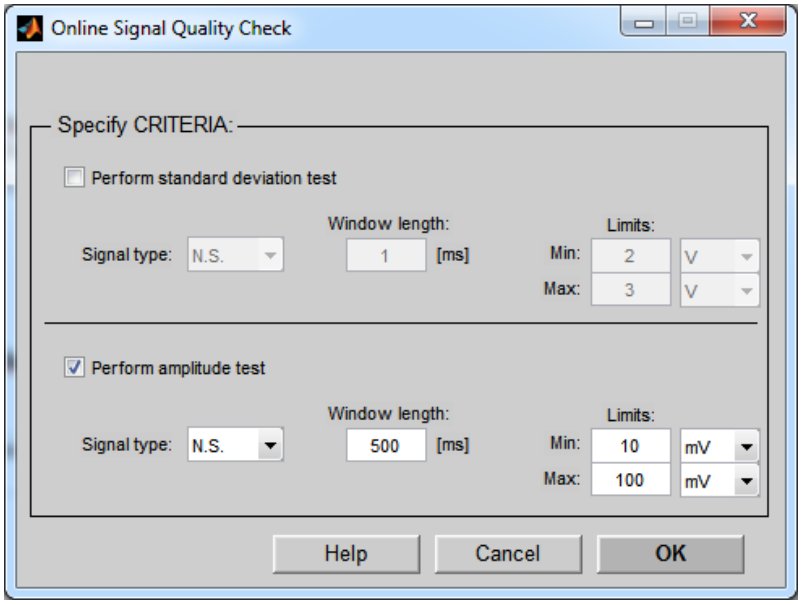
g.SQcheck



Description

The **g.SQcheck** block analyzes the incoming signal with respect to amplitude range and variability and outputs the quality rating 1 (bad, low limit), 2 (poor/high limit) 3 (good/within limits) for each input channel. You can configure the window length and the limits for the amplitude and the standard deviation criteria, or you can select the signal type from the provided list, which will set the default configuration. It is possible to activate and deactivate the test separately.

Dialog box



Double click on the **g.SQcheck** block to edit the parameters

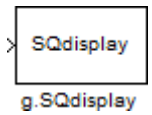
Window length [ms]	Specifies the length of the window used for the criteria.

Signal Quality Levels

Standard deviation test	1 (bad) – standard deviation exceeds MAX limit 2 (poor) – standard deviation falls below MIN limit 3 (good) – standard deviation satisfies MIN and MAX limits
Amplitude test	1 (bad) – < 17 % of evaluation window samples satisfies limits 2 (poor) – < 50 % of evaluation window samples satisfies limits 3 (good) – > 50 % of evaluation window samples satisfies limits

If tests are combined, each test creates its quality level and voting for a quality level. The quality level with the highest number of votes will be the overall result. If there are quality levels with the same vote, the poorer quality of both is chosen.

g.SQdisplay

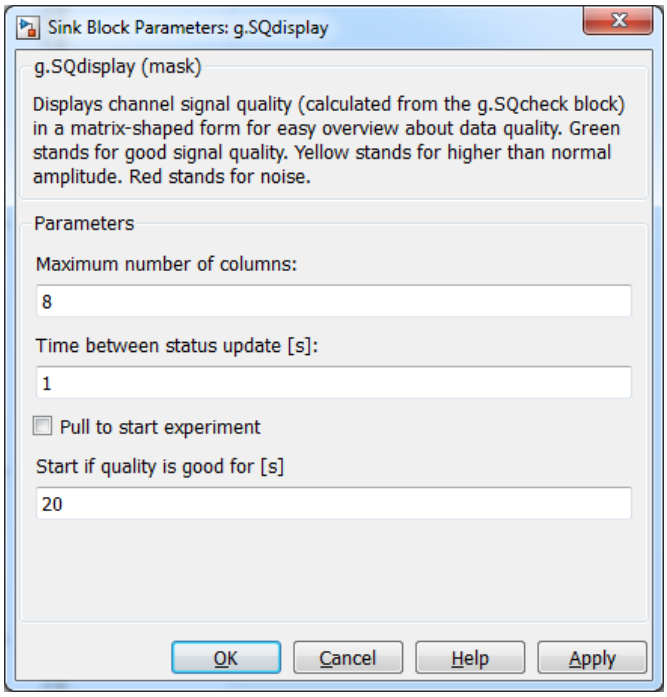


Description

The **g.SQDisplay** displays a matrix showing the signal quality of each input channel. The colors correspond to the quality ratings generated by the **gSQcheck** block.

A red or yellow color indicates poor signal quality, or low and high limits exceeded (respectively) and good quality is indicated in green.

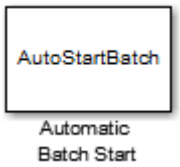
Dialog box



Double click on the **g.SQdisplay** block to edit the parameters

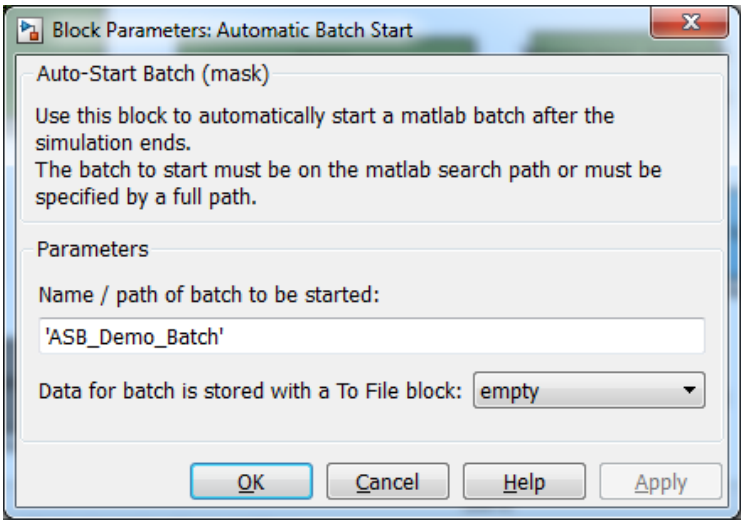
Maximum number of columns:	Defines the number of columns of the display matrix
Time between status update [s]	The interval defining how often the status display is updated.
Start trigger	Output a start trigger. 0 wait, 1 start. A Start button is displayed. When pressed, trigger is changed to 1.
Start if quality is good for [s]	Automatically change trigger to 1 when all signals are good for the specified amount of seconds.
Example Simulink model	gSQCheckDemo.mdl

AutoStartBatch



Description The **AutoStartBatch** block allows you to start a MATLAB function for data processing (Batch) when the Simulink model ends. The **AutoStartBatch** block requires a MATLAB **To File** block in the Simulink model, which is used as intermediate data storage.
Once the Simulink model ends, the specified MATLAB function will be started and a workspace variable *AutoStartBatchData* will be created, which holds the acquired data. Use this variable to access your data.

Dialog box

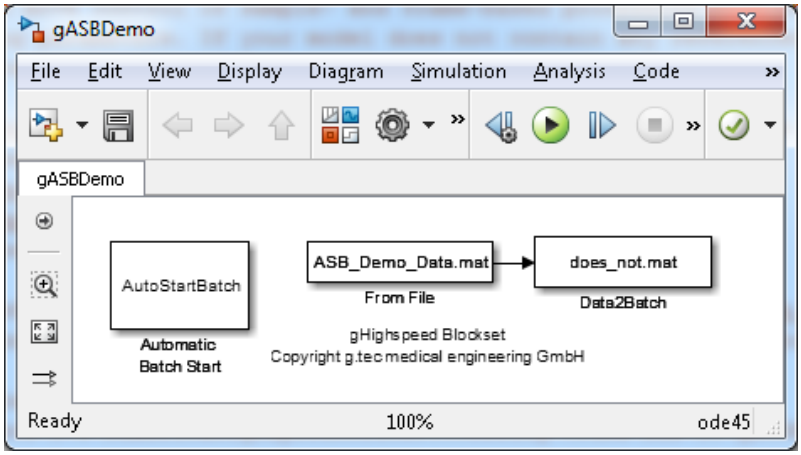


Double click on the **AutoStartBatch** block to edit the parameters

Name / Path of batch to be started	Define the batch file name with this parameter. For batch files not located on the MATLAB search path use the full file path.
Data for batch is stored in To File block	Define the **To File** block in the Simulink model from which data should be passed to the MATLAB function
Example Simulink model	gASB_Demo.slx

Example

1. Enter `gASBDemo` in the MATLAB command window to open the **gASBDemo.slx** Simulink model.
2. The following Simulink model which demonstrates the basic functionality of the **AutoStartBatch** opens:



3. Double click the **AutoStartBatch** block and check that the right To File block is selected.
4. Open the demonstration batch file by typing `edit ASB_Demo_Batch` to the MATLAB command window.
5. Click to run the Simulink model. Due to the fact that there is no **Real Time Clock** block in the model, the simulation only lasts a few seconds. After the simulation has ended, the ASB_Demo_Batch batch should be called and result in an evoked potential analysis plot.

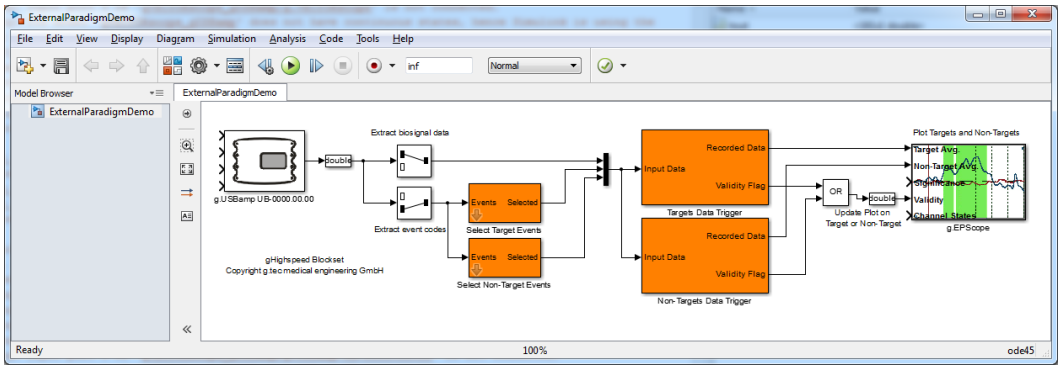
Interface to external stimulation units

g.HIsys interfaces external stimulation units like *Presentation* and *E-Prime* using event codes sent via parallel port. The parallel port is connected to the digital IO module of the g.tec amplifier (available for g.USBamp, g.HIamp, g.Nautilus) using an amplifier specific adapter cable (see product catalogue). The amplifier driver acquires the parallel port data as well as the biosignal raw data synchronously and streams it to MATLAB Simulink.
The **Select Events** block (pg. 36ff) can be used to select specific event codes only and use these event codes for triggering the biosignal raw data.

Example E-Prime

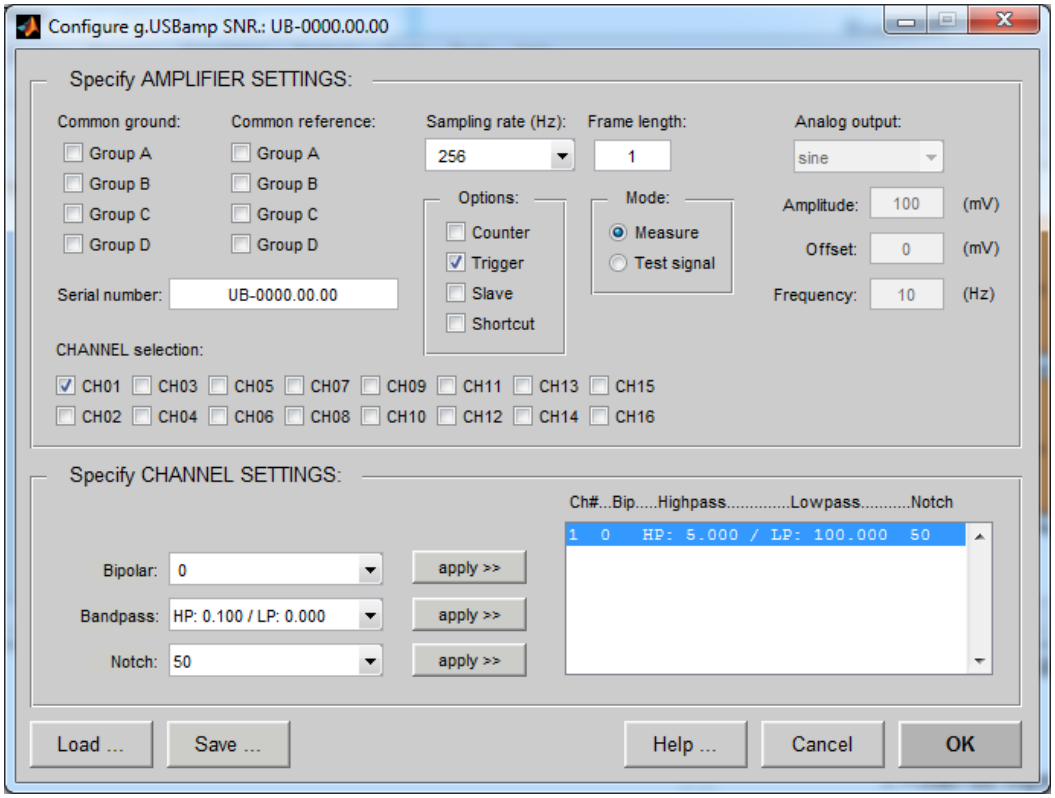
1. Enter `ExternalParadigmDemo` in the MATLAB command window to open the **ExternalParadigmDemo.slx** Simulink model.

2. The following Simulink model opens:



3. Open your g.tec Highspeed Library installation folder and browse to **Examples – External Paradigms** folder. Double click **ParallelPortDemo_E_Prime.es** to open the E-Prime demonstration project (expecting that E- Prime is installed on your system). If you use a newer version of E- Prime, follow the instructions on the screen to upgrade the project file.

4. Double click **g.USBamp** block and configure it according to the settings below:



5. Start the experiment in the E-Prime GUI. The paradigm will generate packets of event codes. Each packet contains the event codes 1 to 5 which are sent consecutively with a time interval of 400 milliseconds. The event code packets are sent with an interval of 3 seconds.

6. Click to start the Simulink model.

The model splits the incoming data into raw data and event code data. The target event codes 1, 3 and 5 as well as the non-target event codes 2 and 4 are selected using the **Select Events** block. The incoming raw data of channel 1 is triggered according to the selected target and non-target event codes and the trigger result is presented using **g.EPscope**.

EEGlab data import

Installation

To install the g.tec data importer for eeglab, copy the folder `gtecimport` located in

`C:\Program Files\gtec\gtecHS\EEGlab Importer`

to

`eeglab13_3_2b\plugins` folder of your eeglab installation.

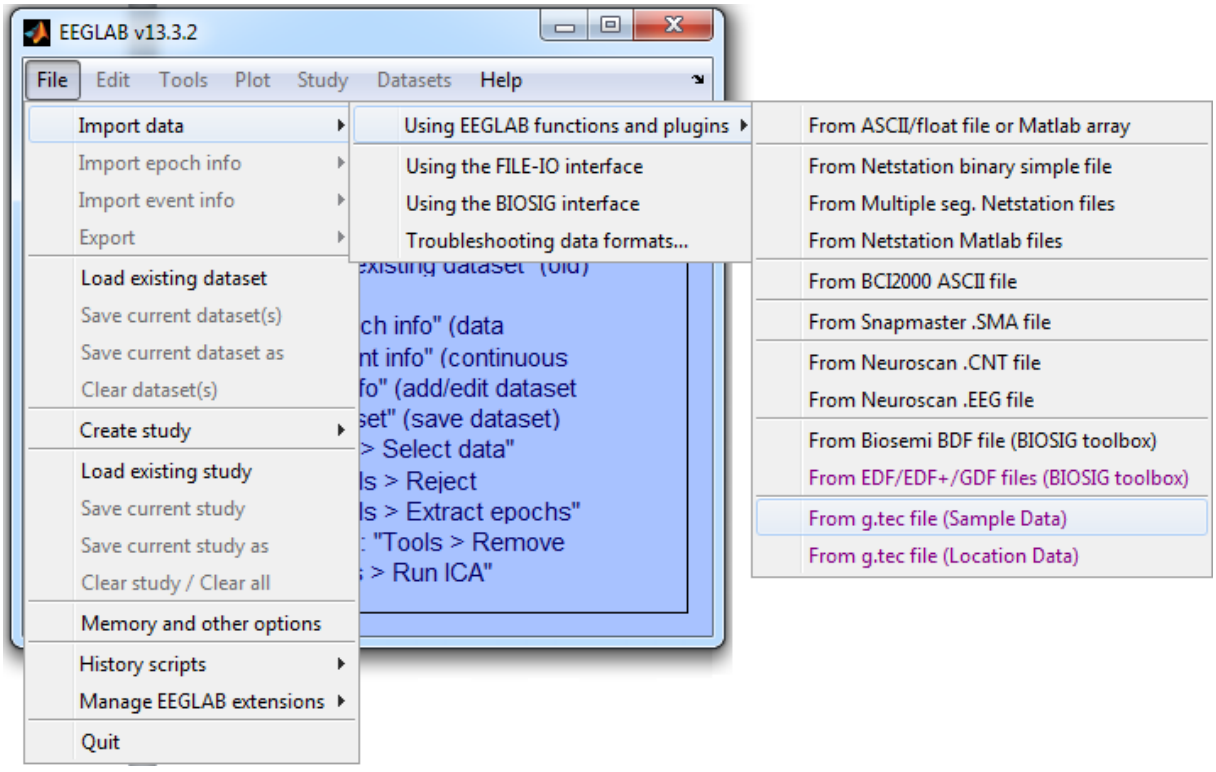
How to load *.mat files to eeglab

To open eeglab, enter `eeglab` to the MATLAB command window. While eeglab is loading a message

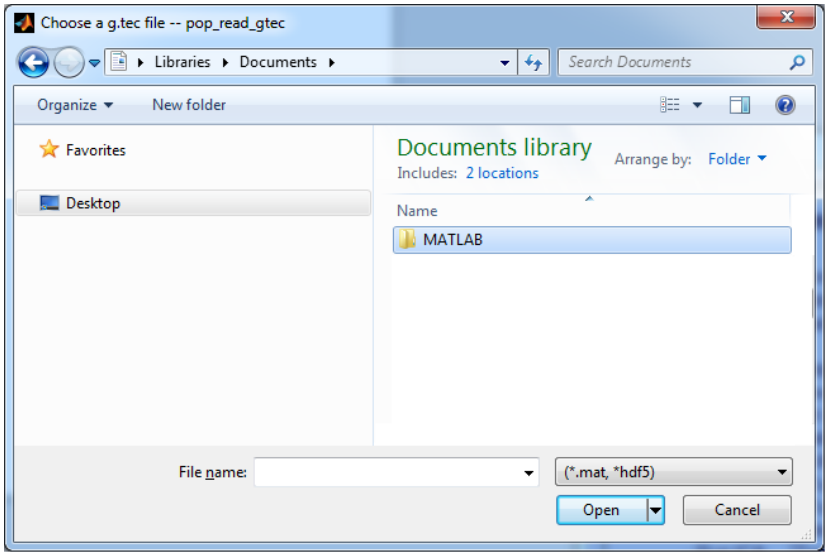
```
EEGLAB: adding "gtecimport" v3.15.01 (see >> help
eegplugin_gtecimport)
```

should appear in the MATLAB command window. This message indicates that the g.tec data import plugin was loaded successfully to eeglab.

To load data to eeglab, use the **From g.tec file (Sample Data)** function which is located in the menu **File** – **Import data** – **Using EEGLAB functions and plugins**.

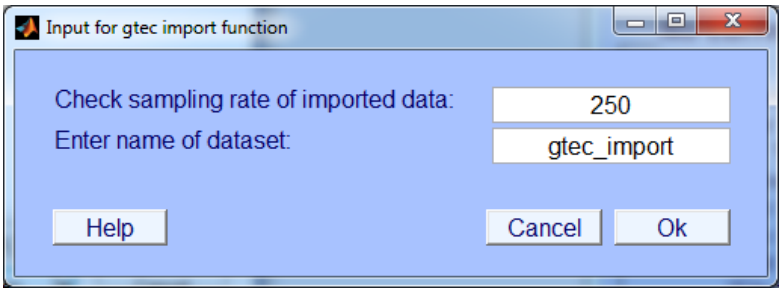


Clicking the function will bring up a file browser:



The file browser accepts only *.mat files, generated by MATLAB or Simulink and *.hdf5 files, generated by g.Recorder.

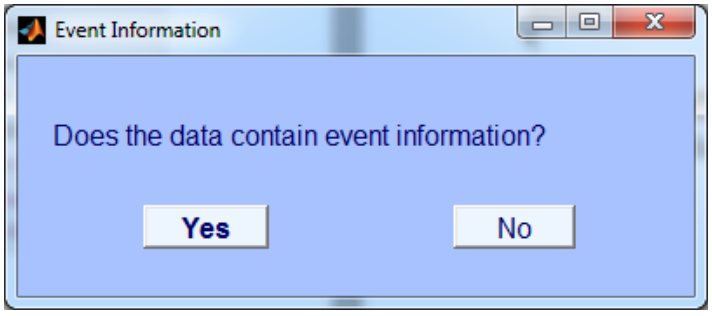
Choose a *.mat file and click **Open**. The following input dialog opens:



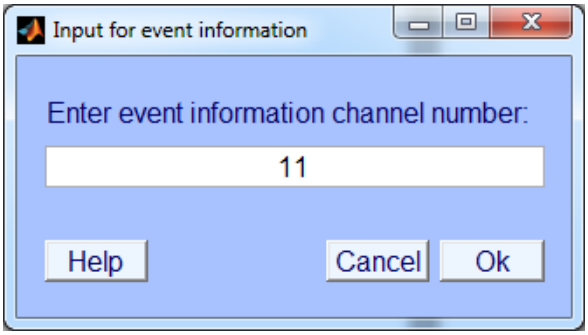
The dialog asks for the sampling rate of the acquired data and the name of the dataset. By default, the function reads the sampling rate of the data file and shows the value. The default name for the dataset is `gtec_import` which can be modified. Click **Ok** to continue.

Load event information from channels

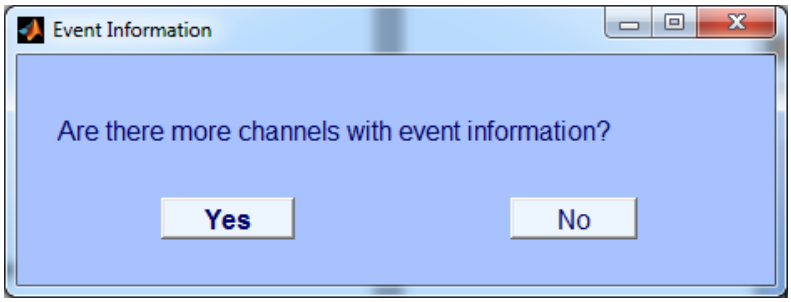
Due to the fact that *.mat files do not contain markers or events in the dataset (as *.hdf5 files do), event information is often provided in data channels which represent special conditions (trigger, events, …). The import function prompts if the loaded data contain such event information and if you want to import it.



Clicking **Yes** will bring up the next screen for the configuration of the event channels. Enter the channel number of the channel which contains event information and click **Ok**.



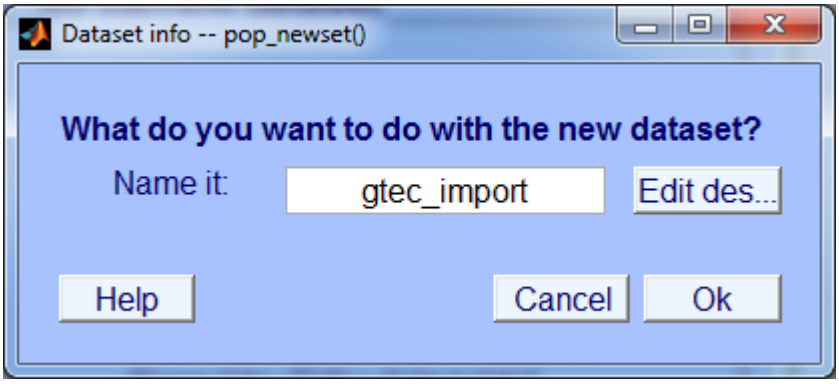
Due to the fact that the loaded data file consist of more channels containing event information, the importer asks if there are more channels with event information.



By clicking **Yes** the input dialog for the event channel is opened again.
All event information for all channels are combined, e.g. if you have 2 channels and 50 events the final event information will consist of 100 events.
This procedure goes on as long as there are channels with event information and the dialog above is not canceled with **No**.

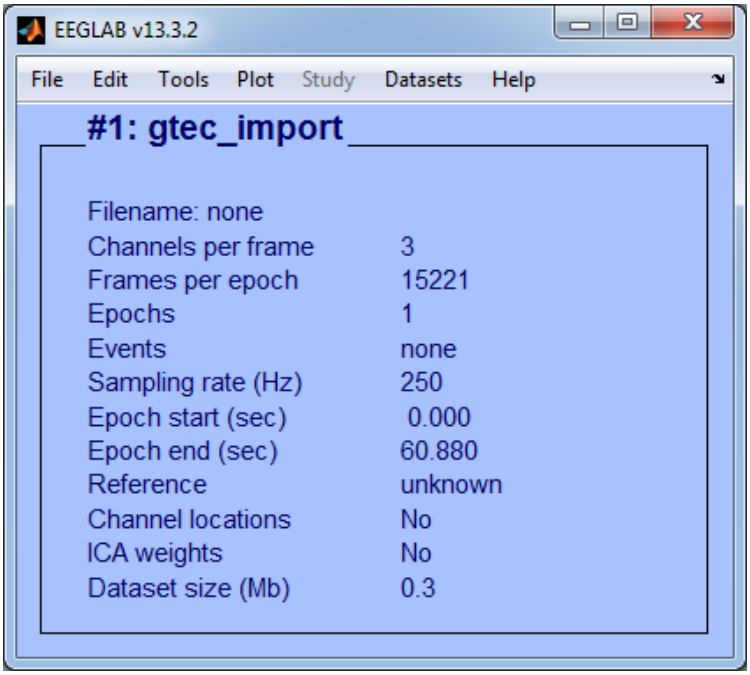
For information on how the events are named please refer to eeglab help on function `pop_chanevent`.

The dataset is added to eeglab, which prompts the following window:



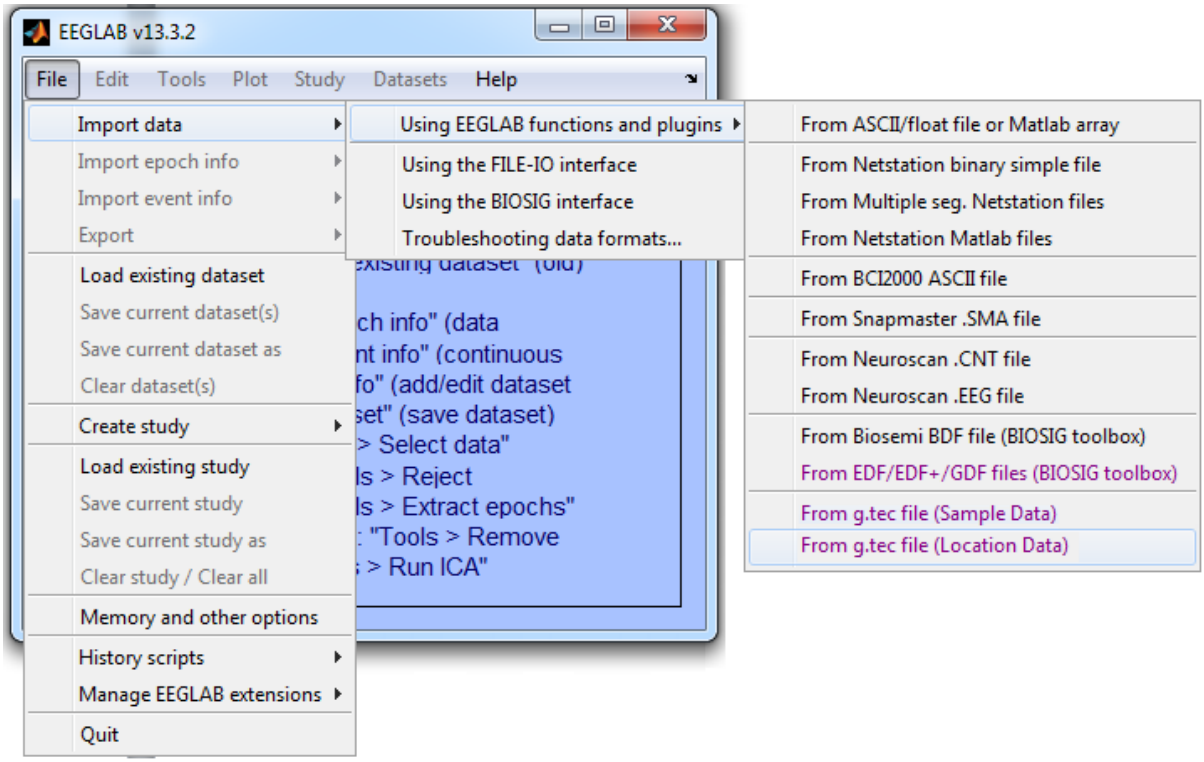
Click **Ok** to load the dataset to eeglab.

The data is now loaded to eeglab. The importer created a new dataset called **gtec_import** which consists of 3 data channels, a sampling rate of 250 Hz and a dataset length of 60.88 seconds.

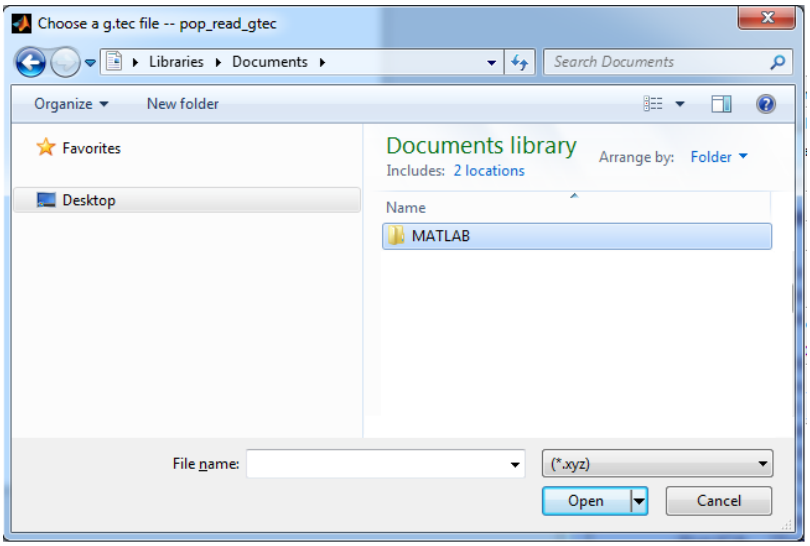


How to load electrode positions to eeglab
Once you have loaded your data correctly to eeglab one may want to add electrode position information to eeglab.

To load electrode position information to eeglab, use the **From g.tec file (Location Data)** function which is located in the menu **File** – **Import data** – **Using EEGLAB functions and plugins**.



Clicking the function will bring up a file browser:

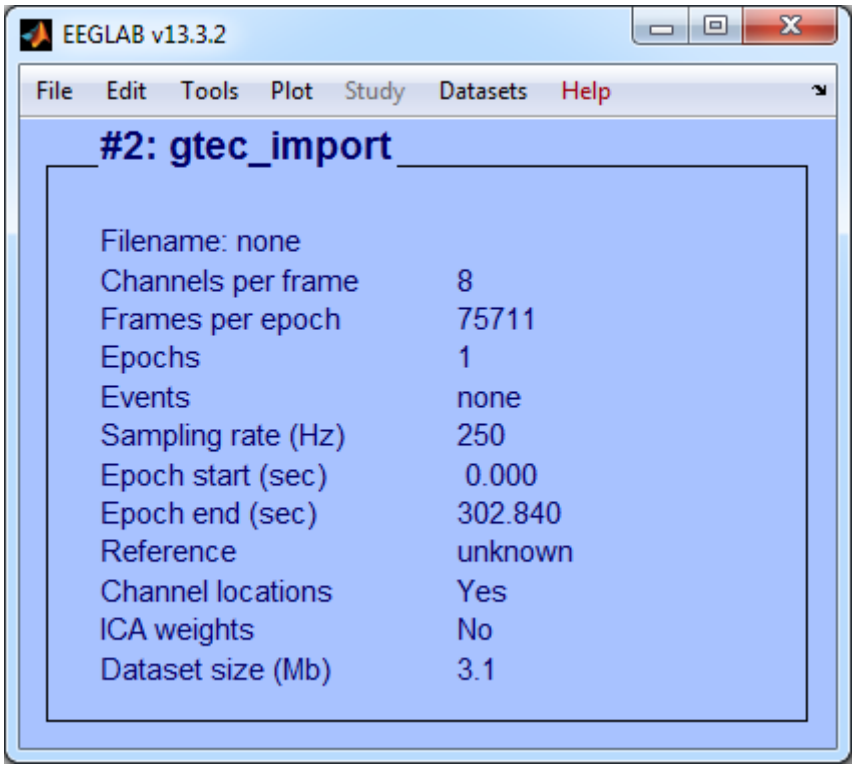


The file browser only accepts MATLAB *.xyz files.
The MATLAB *.xyz file for an 8 channel electrode montage looks like this:

```
1 0.0000 1.0000 0.0000 FPz
2 0.0000 0.7100 0.7100 Fz
3 0.0000 0.0000 1.0000 Cz
4 -0.0000 -0.7100 0.7100 Pz
5 0.6900 0.3800 0.6200 FC4
6 -0.6900 0.3800 0.6200 FC3
7 0.6900 -0.3800 0.6200 CP4
8 -0.6900 -0.3800 0.6200 CP3
```

The basic format of this file is
`<CH Nr.> <X-Coord> <Y-Coord> <Z-Coord> <CH Name>`

Choose a file and click **Open**. If the import succeeded, the eeglab panel should show **Yes** next to **Channel locations**.



NOTE

If the channel numbers does not match, the import is ignored by eeglab. Check the MATLAB command window for the error message `Wrong channel structure size, changes ignored`*. If this message occurs try loading an electrode position file with the correct number of channels.*

Create *.xyz files from g.tec montage files

In the g.tec g.BSanalyze environment montage files are specified using g.MONcreator. g.MONcreator is a g.tec tool which allows you to specify electrode location information. If you have g.BSanalyze installed you can start g.MONcreator by typing `gMONcreator` to the MATLAB command line (see help file of g.MONcreator for detailed help).

After you have created and saved your g.tec montage, this montage can be converted to the MATLAB *.xyz format by using the montage2EEGlab function which is located in the **gtecimport** folder located in the **plugins** folder of your eeglab installation.

Load the created montage to the MATLAB workspace (variable Mon is created), make sure that the function is on the MATLAB path or you are in the same folder, and call the function

```
montage2EEGlab(Mon, 'converted_montage.xyz');
```

which creates the *.xyz file loadable to eeglab.

Help

g.tec Highspeed provides printable documentation.

The printable documentation is stored under

```
C:\Program Files\gtec\gtecHS\help
```

as

```
gHIsysLibraryDescription.pdf
```

Use Acrobat Reader to view the documentation.

Product Page

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