

Content

CONTENT
RELEASE NOTES4
HARDWARE AND SOFTWARE REQUIREMENTS5
FILES ON YOUR COMPUTER
G.TEC HIGHSPEED LIBRARY7
REAL TIME CLOCK
PARADIGM
PARADIGMPRESENTER
G.SENSORADAPTATION
G.SCOPE
G.THRESHOLDSCOPE
G.VECTORSCOPE
G.EPSCOPE
G.MATFILE
G.TOFILE BLOCK
G.FROMFILE BLOCK
GMATREVISE FUNCTION41
GMATPARAM FUNCTION42
MARKER BLOCK43
CUT SAMPLES
SELECT CHANNELS
SELECT EVENTS46
TRIGGER
SOURCE DERIVATIONS
EEG/ECG BW FILTER
BP BW FILTER
NOTCH FILTER
PRE/POST PSD
ERD ONLINE
ONLINE FFT
ONLINE AVERAGING
SIGNIFICANCE ANALYSIS
ONLINE PLOT

ONLINE SPECTROGRAM PLOT	64
ONLINE SPECTROGRAM PLOT + CALC	
AUDIOSTREAM	
AUDIOSTIMULATION	
G.CAMERACAPTURE	
BINARY DECODER	
SPASTICITY CONTROL	
EOG SELECTION	
EMG SELECTION THRESHOLD	77
EMG SELECTION CALIBRATION	
EMG 2D SELECTION CALIBRATION	
G.MOUSE	80
G.SQCHECK	
G.SQDISPLAY	82
AUTOSTARTBATCH	84
INTERFACE TO EXTERNAL STIMULATION UNITS	
EEGLAB DATA IMPORT	
PRODUCT PAGE	

Release Notes

Release notes bring to your attention new features of, and changes to, the Simulink Highspeed Library when upgrading to a newer version of the driver.

New features

- g.SCOPE: visualize amplitude spectrum, power spectrum or power spectral density next to EEG data
- ParadigmPresenter: generic audio, video, text and picture paradigm presenter

Changes

- EEGlab importer: changed naming of events
- Online FFT

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	
СРИ	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 2015a
Simulink	Release 2015a
Signal Processing Blockset	Release 2015a
DSP System Toolbox	Release 2015a
Windows	Windows 10 Pro Threshold 2 Win64
Acrobat Reader	2015.009.20069
.net Common Language Runtime	4.6.1

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 library files are located:

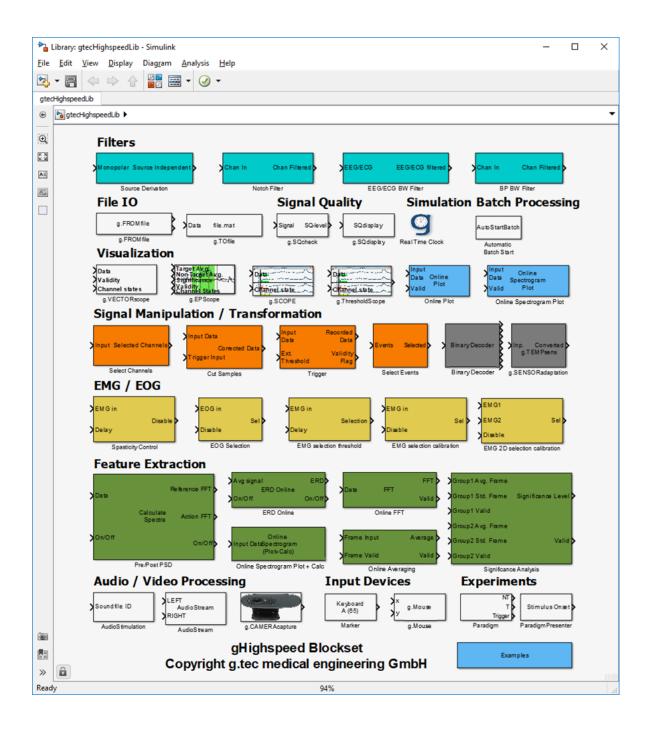
\gtecHS\Help	Contains library block description and manuals of amplifiers
\gtecHS\Lib	Contains binaries of library blocks
\gtecHS\EEGlab importer	Contains functions for importing g.tec files to EEGlab

The users documents folder contains examples for the library blocks.

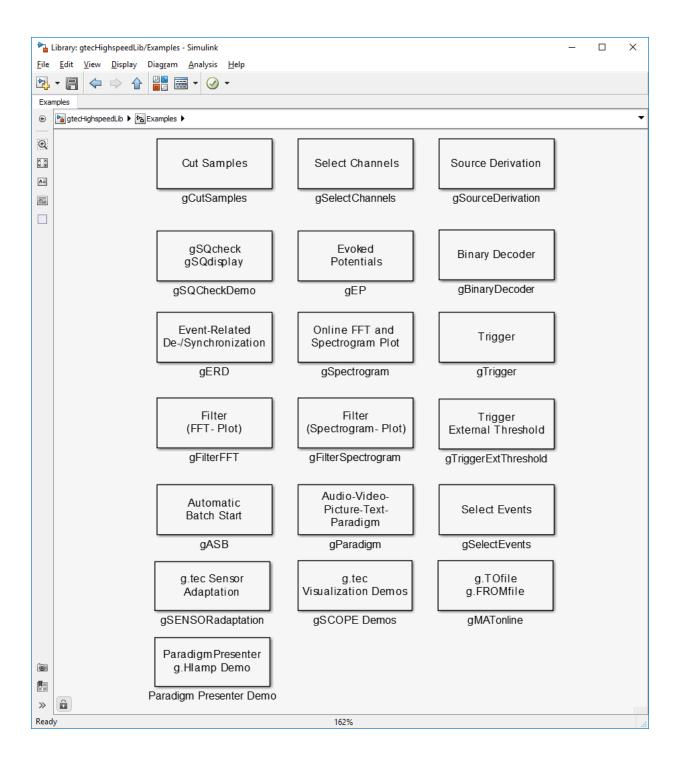
..gtec\gtecHS\Examples Contains Simulink example models and data for the library blocks

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



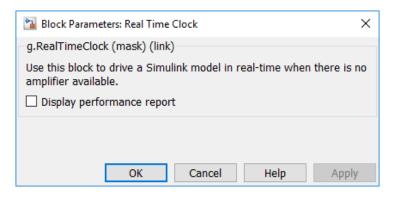
Description Real Time Clock can be used if no block is in a Simulink model that is able to drive it in real time (such as g.USBamp, g.HIamp, g.STIMbox in driving mode).

When the checkbox **Display performance report** is checked, the Real Time Clock will print a summary performance report on the MATLAB command line. This report includes the time simulated, the wall clock time elapsed, the difference between simulated and elapsed time and the time the Real Time Clock spend on idling while waiting for the next sample time to be reached.

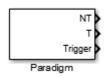
NOTE: If there is a g.tec amplifier in the Simulink model, do **NOT** use Real Time Clock block.

Your model must include at least one source block explicitly defining a sample time > 0. Alternatively the fundamental sample time may be defined along with the solver settings. Solver must be fixed step type in this case.

Dialog Box



Paradigm

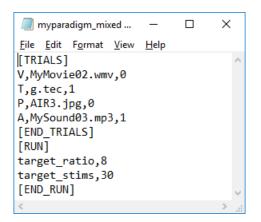


Description The **Paradigm** block can be used for audio, picture, video and text paradigms. It uses the ActiveX plugin of the VLC media player, which must be installed to present audio, picture and video stimulations.

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>

	V	Video stimulation identifier
	Р	Picture stimulation identifier
STIM_TYPE	Т	Text stimulation identifier
	А	Audio stimulation identifier
	Video	Filename of Video to present (mp4, avi, mpeg, wmv supported)
STIM_CTX	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.

🔁 Source Block Parameters: Paradigm	×
Paradigm (mask) (link)	
Allows you to present audio, video, picture and text stimulations.	
Parameters	
Folder:	
C:\Users\gtec\Documents\MATLAB	
Stimulus file:	_
myparadigm_pics.txt	
Start time [s]:	
5	
Pre stimulus waring at [s]:	
0.2	
Display time [s]:	
1	
Post stimulus period:	
0	
Inter-stimuli time [s]:	
0.5	
User screen: Primary	•
OK Cancel Help Apply	/

Folder

Specify the path where paradigm files and stimulation context is located. The path can be specified using an absolute path or a relative path relative to the current MATLAB workspace path.

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.

In the paradigm description file make sure that there are no spaces or tabs at the end of the line.

ParadigmPresenter

Overview



- **Description** The ParadigmPresenter block allows the playback of a paradigm defined in an XML file. It features audio, digital, picture, text, and video stimuli. See the respective manual "Paradigm Schema and Definition" for more details about paradigm definition.
- **Output** The output signal "Stimulus Onset" is usually zero, and it delivers an impulse of length 1 sample each time a task switch occurs. The amplitude of this impulse evaluates to the numeric task ID of the respective task (see below for more information on numeric task IDs). The output is internally synchronized with the data of the amplifier block (g.HIamp, g.USBamp).
- **Note** To ensure synchronous playback and data acquisition for time-critical paradigms, please observe the CPU load during model execution. If the CPU runs at high level, the task switches may jitter. However, the block is designed in a way such that the Stimulus Onset output signal reflects the *actual* task switch and not the nominal task switch. This allows a narrow specification of the stimulus arrival limits.

Dialog Box

🔁 Source Block Parameters: ParadigmPresenter	×	
Paradigm		
Currently loaded paradigm:		
C:\Paradigms\VerbGeneration.xml		
Load Paradigm		
Windows New Subject Window New Operator Window Close all Window	/S	
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>Appl</u>	y	

Figure 1. ParadigmPresenter Simulink mask.

Currently loaded paradigmShows the absolute path of the currently loaded paradigm XML
file.Load Paradigm...Opens a file open dialog box to choose a valid XML paradigm
file.

New Subject Window New Operator Window Close all Windows Opens a new subject window (see below). Opens a new operator window (see below). Closes all windows.

Windows

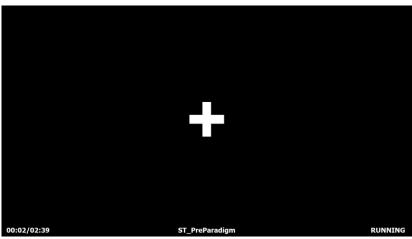


Figure 2. Exemplary operator window during playback.

Subject Window	A subject window is completely empty and just displays the visual stimuli. Per default, on startup one subject window is opened.		
Operator Window	An operator window additionally shows information about the current time, total playback time, currently active task, and current ParadigmPresenter state (cf. Figure 2).		
Interaction	 ParadigmPresenter state (cf. Figure 2). ParadigmPresenter windows feature the following user interaction: Move via mouse drag Resize via dragging the window corners Toggle fullscreen/window mode via double click Context menu via right mouse click: Close Window (Hotkey: Ctrl+W) New Subject Window (Hotkey: Ctrl+N) New Operator Window 		

Task Info Table

Each paradigm task is internally assigned a unique numerical ID. This ID is persistent over repetitive playbacks of the same paradigm. The task info table allows associating this somewhat arbitrary number with more meaningful task information assigned in the paradigm XML file (such as task ID, task label, group ID). This table is generated once a paradigm is successfully loaded. It is written to the MATLAB workspace (variable *taskInfo*) and printed to the console.

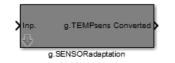
NumId	StringId	Label	Group
1	'ST PreParadigm'	'Start'	0
2	'ST Bsl1'	'Baseline'	1
3	'ST Act1'	'Action'	2
4	'ST Bsl2'	'Baseline'	1
5	'ST_Act2'	'Action'	2
6	'ST Bsl3'	'Baseline'	1
7	'ST_Act3'	'Action'	2
8	'ST Bsl4'	'Baseline'	1
9	'ST Act4'	'Action'	2
10	'ST PostParadigm'	'Finish'	0

Code Listing 1. Exemplary task info table.

For detailed information concerning paradigm definition, please read **ParadigmSchemaAndDefinition.pdf**.

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

g.SENSORadaptation



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

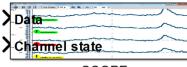
🛅 Function B	ock Parameters: g	.SENSORadapt	ation	Х				
-g.SENSORada	aptation (mask) (link)						
This block converts the input signal of g.tec's sensors. It takes the voltage input provided by the sensor and converts this value to a sensor- type related value.								
	e.g. g.GSRsensor2 provides GSR in voltage range of 0-200mV -> g.SENSORadpatation converts this values to a GSR related unit μS							
Parameters								
Sensor type:	1 - g.TEMPsens 1 - g.TEMPsens 2 - g.Gsensor			-				
	3 - g.GSRsenso 4 - g.SpO2	r2						
	ОК	Cancel	Help	Apply				

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

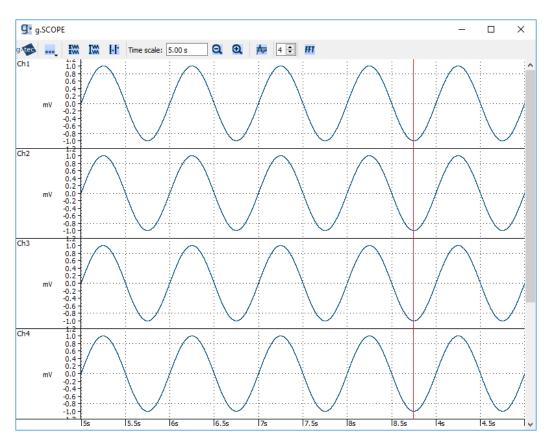
g.SCOPE



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. It offers a spectrum analysis panel which shows FFT of the incoming channels.
- 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.

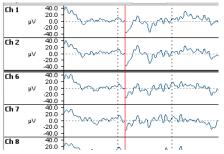
	g.SCOPE configuration menu, contains Edit channel states Import channel names Edit color settings
	Store screenshot Load / Save configuration
1 00	Auto-scales all the channels individually to their minimum and maximum data value (plus 10%).
IXX	Auto-scales all channels to the global minimum and maximum level of the incoming data (plus 10%).
11	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.
Q	Button for increasing the displayed time interval (i.e. zooming out).
ର ଭ	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.
	Opens the spectrum analysis panel.
# visible Channels	Spin button to increase and decrease the number of visible channels.
FFT	Make Quick FFT panel visible

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

g, o	Channel	setting	IS				×
Inc	dividual s	ettings					
	Nr.	Vis.	Name	Туре	Sensitivity Low High	Offset	Unit
1		\checkmark	Ch1	EEG 🔻	-1.2 1.2	0	mV 🔻
2		\checkmark	Ch2	EEG 👻	-1.2 1.2	0	mV 🔻
3		\checkmark	Ch3	EEG 🔻	-1.2 1.2	0	mV 👻
4		\checkmark	Ch4	EEG 🔻	-1.2 1.2	0	mV 🔻
5		\checkmark	Ch5	EEG 🔻	-100 100	0	- νμ
6		\checkmark	Ch6	EEG 🔻	-100 100	0	μV 🔻
Co	mmon se	ttings					
			Visible	Apply ->			
		Ţ	ype EEG	▼ Apply ->			
	Sens L	. Sens	H. Offset Unit		Start channel: 1	End chi	annel: 6
	-50	50	0 μV	•			
	For cha	annel ty	pe: EEG	✓ Apply ->			
						ОК	Cancel

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:

Low	High
-50 μV	50 µV
-1 mv,	1 mV
-500 μV	500 μV
-5 mV	5 mV
-500 μV	500 μV
20 °C	45 °C
-3 G	3 G
0 %	100 %
$0 \ \mu S / \mu Mho$	30 µS / µMho
-500 μV	500 μV
0 V	5 V
-100 μV	100 µV
	-50 μV -1 mv, -500 μV -5 mV -500 μV 20 °C -3 G 0 % 0 μS / μMho -500 μV 0 V

- **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.

Common settings					
	Visible Apply ->]			
Type EEG	Apply ->]			
Sens L. Sens H. Offset	Unit	Start channel:	1	End channel:	6
-50 50 0	µV ▼ Apply ->]			
For channel type: EEG	•				

- 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.

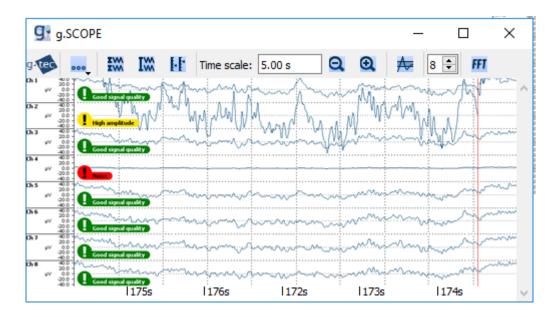
Ch 1	-50/50µV		Ch 1	<u> </u>
Ch 2	-50/50µV		Ch 3	
Ch 3	-50/50µV		Ch 5	
Ch 4	-50/50µV		Ch 7	
Ch 5	-50/50µV		Ch 9	
Ch 6	-50/50µV		Ch 11	
Ch 7	-50/50µV		Ch 13	
Ch 8	-50/50µV		Ch 15	
Ch 9	-50/50µV	······································	Ch 17	
Ch 10	-50/50µV	······································	Ch 19	
Ch 11	-50/50µV		Ch 21	
Ch 12	-50/50µV		Ch 23	

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

🖁 Channel state settings		×
aveform plots. Up to 255 states	play the results of signal analysis or other calculations on top o can be defined with a status message and a color. Once the d ned state not equal to zero, the scope will display the defined s s no message.	nannel state
	Message	Color
1 Noise		
		1.1.1
	Add channel state Remove chan	nel state
Display options		
Full size Compact size	☑ Display message	
	ОК	Cancel

- 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 stateCompact size: do not show icon in channel stateDisplay 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.

	×
OK	Cancel
	OK

- 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.

Greatings Color settings				×
Individual colors				
Channel	Pen	Cursor line	Paper	Grid
Ch1				
Ch2				
Ch3				
Ch4				
Ch5				
Ch6				
Ch7				
Ch8				
Common colors				
Pen color 🛛 🔻	Appl	y -> Start channel	End ch	nannel: 8
			OK	Cancel

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.

Store screenshot

g.SCOPE allows you to take a screenshot of the current state of the scope and export it as *.png or *.pdf file.

- 1) Double-click the **g.SCOPE** block.
- 2) Open the g.SCOPE configuration menu and select Store screenshot

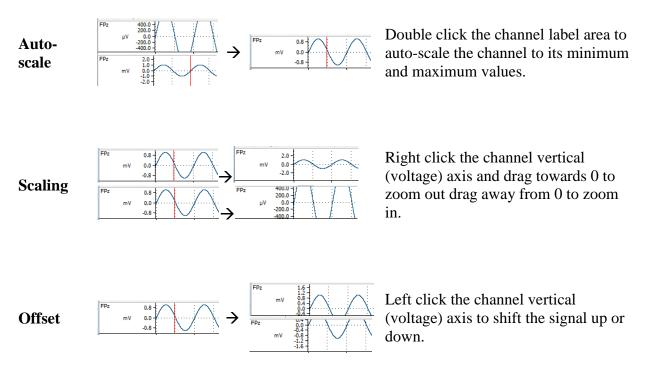
G Screenshots	Х
Select a storage location for the screenshots:	
<current directory="" path="" working=""></current>	Browse
Enter a filename (without extension; will be extended b	by date/time):
screenshot	
Select a file format:	
.png	☑ Open file after saving
○ .pdf	Take screenshot
	Close

- 3) You can specify a location where to store the screenshot via the **Browse** button or by editing the path manually. The default value is the current working directory of the Simulink model.
- 4) Enter a filename for the screenshot. The default value is *screenshot*
- 5) Select the output file format which can be **.png** or **.pdf**

- 6) Specify whether the created screenshot should be opened (using the default program specified for the given file format) after the screenshot is taken or not by checking the **Open file after saving** check box.
- 7) Clicking the **Take screenshot** button will create a file with the selected settings. The filename will be extended by a post-fix string of the format '_dd_mm_yyyy_hh_mm_ss'. Each second you can produce one screenshot.

Mouse actions

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



Configuration of g.SCOPE

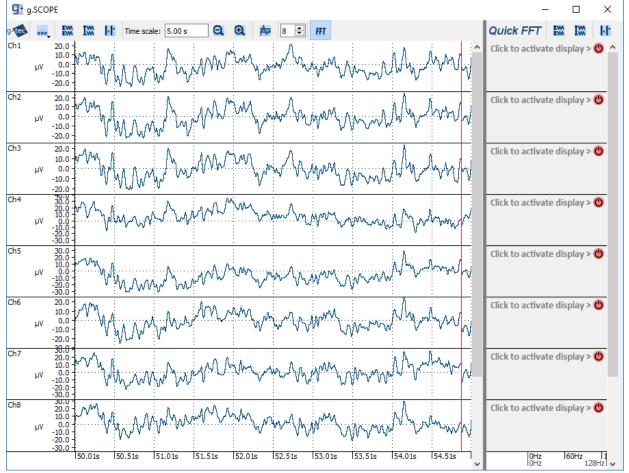
g.SCOPE allows to save and load the configuration files. To do so, open g.SCOPE and select **Load configuration** / **Save configuration** from the menu bar. A file dialog opens which allows to load or a save the g.SCOPE configuration file.

The configuration of g.SCOPE 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).

承 I	_		×
Enter chan	nels:		
8			
Enter samp	ling frea	uency	:
Enter frame	size'		
1	520.		
	ОК	C	Cancel

FFT panel of g.SCOPE

As described above, you can make the **Quick FFT** panel visible by clicking the *H* button in the toolbar.



The QuickFFT panel comes with 3 toolbar items. The first 2 items are for "Per Channel" and "Global" auto-scale. The 3rd item will open the FFT settings dialog:

FFT settings					×			
Individual settings								
Nr.	Visibility	Sensitivity Low High	Offset	Unit				
1		-10 10	0	mag*1e-6 🔻				
2		-10 10	0	mag*1e-6 🔻				
3		-10 10	0	mag*1e-6 🔻				
4		-10 10	0	mag*1e-6 🔻				
5		-10 10	0	mag*1e-6 🔻				
6		-10 10	0	mag*1e-6 🔻				
7		-10 10	0	mag*1e-6 🔻				
8		-10 10	0	mag*1e-6 🔻				
9		-10 10	0	mag*1e-6 🔻				
10		-10 10	0	mag*1e-6 🔻				
X Axis Settings								
Frequency scale:	Lin 🔻 Limits [Hz]: 0 to 128	Base for tick divi	isions: 10				
Common settings	Common settings							
	Visibility Apply ->							
Sens L. Sens H. (Offset Unit 0 mag*1e-6		t channel: 1	End channel: 10				
			[OK Cance	el			

This dialog allows you to configure the Quick FFT up to your needs.

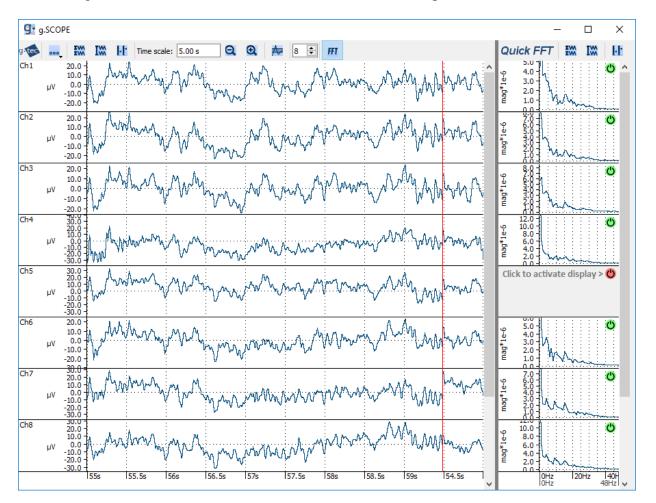
Туре	 3 different FFT types are available: PSD (Power Spectral Density) PS (Power Spectrum) FFT (Fast- Fourier Transform)
Buffer length	Specifies how many samples from the incoming data stream are used to create a FFT frame and are used to calculate the FFT. This value changes automatically, if the Frequency resolution parameter changes.
Frequency resolution	Specifies the frequency resolution for each sample in the resulting FFT length (buffer length / 2). This value is automatically updated when the Buffer length parameter changes.
Downsample factor	Specifies for values > 1 that a down- sampling should be performed before calculating the FFT.
Windowing Function	 Specifies the windowing function which is applied to the FFT frame before calculating the FFT. Available functions are Boxcar (no window function) Hanning Hamming
Window overlap	Specifies the number of samples the FFT frames are overlapping.

Nr. Averages	Specifies how many FFT frames are averaged before calculating the FFT.
Frequency scale	 Sets the type of the frequency scale Lin → linear scaling Log → logarithmic scaling
Limits	Set the lower and upper limits of the frequency scale.
Base for tick division	Specifies the base of the frequency scale.

There are 3 ways to activate / deactivate a channel for FFT calculation

- 1. use the **Visibility** check box for each channel to set it active.
- 2. use the **Visibility** check box in the *Common Settings* to set a range of channels specified by **Start channel** and **End channel**
- 3. use the On / Off (🙆 / 🧐) buttons in the Quick FFT panel to activate / deactivate a channel.

Once you have activated a channel for calculation and a FFT frame was formed according to the FFT settings, the FFT result will be visualized in the Quick FFT panel.



As for g.VECTORscope and g.EPscope, you can zoom in to the resulting FFT result by dragging a range. Reset the zoom area by double clicking into the result FFT window.

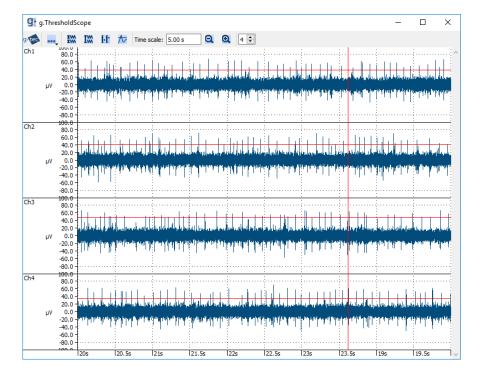
You can adjust the size of the Quick FFT panel by hovering the border of Scope panel and Quick FFT panel. The mouse arrow will change to \Leftrightarrow indicating that the size is able to change. Drag the border to either direction (within minmum size constraints).

g.THRESHOLDscope



The **g.THRESHOLDscope** block provides a convenient way to display biosignal data and generate trigger information for the Trigger block.

- **Description** g.THRESHOLDscope is a sample-based scope with easy-to-use threshold trigger 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 in g.SCOPE description). 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
- **Output** The **Threshold** output port holds a threshold value for each channel. If the threshold is activated, a threshold value according to the horizontal bar location is generated. If one channel's threshold is not activated, *NaN* values will be output.



g.THRESHOLDscope

input multiple channels.

Double click the **g.THRESHOLDscope** block to open the scope.

The figure shows a g.THRESHOLDscope with 3 channels. The threshold feature is activated for channels 1 and 3. The threshold output holds a value of approx. 70 μ V for channel 1 and a threshold value of approx. 40 μ V for channel 3. Due to channel 2 is not activated for generating threshold information, the corresponding threshold channel holds *NaN* value. This threshold information can be used to trigger the data as soon as the data drops below or rise above the specified threshold. Use g.tec's Trigger block to trigger data.

Threshold- Scope configuration	
Open the threshold settings by clicking the threshold icon in the toolbar.	4

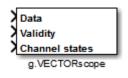
Threshold se	ettings					×
Individual settir	ngs					
Nr.	Name		Туре	Value	Unit	Active
1	Ch1		EEG	39.1	µ V ▼	
2	Ch2		EEG	42	μV •	
3	Ch3		EEG	48.2	μV 🔻	
4	Ch4		EEG	35.3	μV 🔻	
Common setting	gs					
	Active	Apply ->]			
Thresh 10 For channel typ	hold Unit	Apply ->	Start channel:	1	End channel: 4	
					ОК С	ancel

Once you have activated the threshold feature by checking the **Active** checkbox of the single channels there are 2 ways to set the threshold. You can either set the value of the threshold to an exact value within this configuration dialog by entering the threshold value in the edit box of the desired channel or you can drag the horizontal bar displayed in the channel up and down using the mouse. Once you hover the displayed threshold line the mouse changes to a move

arrow **Common settings** in the line can be dragged up and down now. Use the **Common settings** in the Threshold settings dialog to apply settings of multiple channels.

NOTE: For detailed information on basic scope configuration, please read the g.SCOPE description (pg. 17ff)

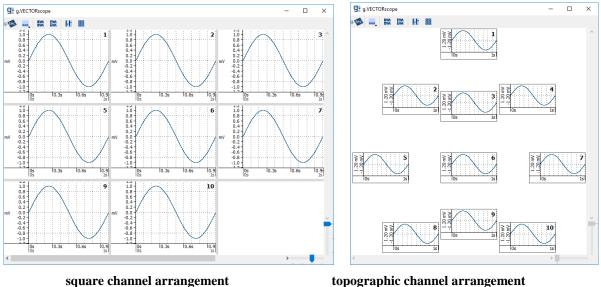
g.VECTORscope



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



Parameters

topographic channel arrangement

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

承 g.VECTORscope			_		Х
Standard Vector Scope					
Highspeed vector scope			Open Scop	e	
Parameters					
Sample Rate 256	Hz	Trig	gger Offset	0	s
	ОК		Cancel	H	lelp

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

- Trigger Offsetposition of the vertical trigger occurrence line (in respect to the
data frame which is visualized).
- **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.

n data
e

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

Grangement settings ×					
Arrangement	Direction				
O Manual Rows: 3 ♀ Columns: 4 ♀	₽	Ŷ			
O Square	□ 1 2	3			
Topographic					
Chose montage file:	4 5	6			
Filename	☆ 7 8	9			
	企	仓			
	OK	Cancel			

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 \rightarrow 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. 17ff)

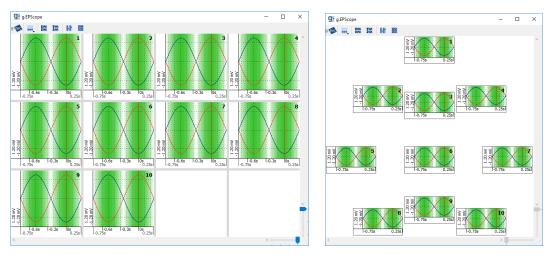
g.EPscope



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. 62) 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.

承 g.EPScope		_				
EP Scope						
Highspeed evoked potentials scope Open Scope						
Parameters						
Sample Rate 1000 Hz Trigger Offset -0.75 S						
	ОК	Cancel	Help			

Sample Ratesample rate in Hz in which the sample based raw data is runningTrigger Offsetposition of the vertical trigger occurrence line (in respect to
the data frame which is visualized)Open Scopeclick this button to open the scope

EP-scope configuration

Please check g.VECTORscope description (pg. 29ff)

NOTE: For detailed information on color and channel state settings and mouse actions please read the g.SCOPE description (pg. 17ff) for information on zooming please read the g.VECTORscope description (pg. 29ff).

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. The data storage can be controlled via the **Enable** input port. The file will be created as soon as there is data available and data storage is enabled. In addition to the raw data, the g.TOfile block can save both patient information and the Simulink model itself to the data file.

Dialog Box

Sink Block Parameters: g.TOfile × g.TOfile (mask) (link) As there is a memory limitation in Matlab for opening large datasets, the g.TOfile block provides the possibility to define a maximum filesize. Larger datasets will be splitted into more files and the filename will be extended with a four digit number. The input format can be single (float32) or double. Use a Mux block to input multiple channels. In addition g.TOfile block provides the feature of saving patient information and the Simulink model itself to the raw data file. Parameter: Filename - name of the file, which will be extended with a four digit number. Variable - name of the variable, which will be extended with a four digit number. File size [MB] - size of the single files in megabytes Parameters Filename: file.mat Variable:		
As there is a memory limitation in Matlab for opening large datasets, the g.TOfile block provides the possibility to define a maximum filesize. Larger datasets will be splitted into more files and the filename will be extended with a four digit number. The input format can be single (float32) or double. Use a Mux block to input multiple channels. In addition g.TOfile block provides the feature of saving patient information and the Simulink model itself to the raw data file. Parameter: Filename - name of the file, which will be extended with a four digit number Variable - name of the variable, which will be extended with a four digit number File size [MB] - size of the single files in megabytes Parameters Filename: file.mat Variable: y File size [MB]: 1 Block size [kB]: 512 Genable data storage via external signal Add Simulink model Add patient data	🔁 Sink Block Parameters: g.TOfile	×
g.TOfile block provides the possibility to define a maximum filesize. Larger datasets will be splitted into more files and the filename will be extended with a four digit number. The input format can be single (float32) or double. Use a Mux block to input multiple channels. In addition g.TOfile block provides the feature of saving patient information and the Simulink model itself to the raw data file. Parameter: Filename - name of the file, which will be extended with a four digit number Variable - name of the variable, which will be extended with a four digit number Variable - name of the variable, which will be extended with a four digit number File size [MB] - size of the single files in megabytes Parameters Filename: file.mat Variable: y File size [MB]: 1 Block size [kB]: 512 C Enable data storage via external signal Add patient data	g.TOfile (mask) (link)	
Filename - name of the file, which will be extended with a four digit number Variable - name of the variable, which will be extended with a four digit number File size [MB] - size of the single files in megabytes Parameters Filename: file.mat Variable: y File size [MB]: 1 Block size [MB]: 1 Block size [kB]: 512 Size Enable data storage via external signal Add Simulink model Add patient data	g.TOfile block provides the possibility to define a maximum filesize. Large datasets will be splitted into more files and the filename will be extended with a four digit number. The input format can be single (float32) or double. Use a Mux block to input multiple channels. In addition g.TOfile block provides the feature of saving patient information and the Simulink	er I
Filename: file.mat Variable: Y File size [MB]: 1 Block size [kB]: 512 Enable data storage via external signal Add Simulink model Add patient data	Filename - name of the file, which will be extended with a four digit number Variable - name of the variable, which will be extended with a four digit number	
file.mat Variable: Variable: Y File size [MB]: 1 Block size [kB]: 512 Enable data storage via external signal Add Simulink model Add patient data	Parameters	
Variable: Y File size [MB]: 1 Block size [kB]: 512 ✓ Enable data storage via external signal Add Simulink model Add patient data	Filename:	
y File size [MB]: 1 Block size [kB]: 512 ✓ Enable data storage via external signal Add Simulink model Add patient data	file.mat	
File size [MB]:	Variable:	
1 Block size [kB]: 512 ✓ Enable data storage via external signal Add Simulink model Add patient data	У	
Block size [kB]: 512 Enable data storage via external signal Add Simulink model Add patient data	File size [MB]:	
512 Enable data storage via external signal Add Simulink model Add patient data	1	
Enable data storage via external signal Add Simulink model Add patient data	Block size [kB]:	
Add Simulink model Add patient data	512	
Add patient data	✓ Enable data storage via external signal	
Summarian	Add Simulink model	
QK <u>C</u> ancel <u>Help</u> Apply	Add patient data	
<u>OK</u> <u>C</u> ancel <u>Help</u> <u>Apply</u>		
	<u>Q</u> K <u>C</u> ancel <u>H</u> elp <u>A</u> pply	

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</filename>
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<i>NOTE:</i> 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 <i>Enable</i> 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

🚡 Sink Block Parameters: g.TOfile 🛛 🕹	
Add patient data	•
Patient ID:	
ID0000	
Patient first name:	
John	
Patient last name:	
Doe	
Patient date of birth (mm.dd.yyyy):	
12.01.2001	
Patient sex: MALE 🗸	
Patient hand: RIGHT	
Patient diagnosis:	
Diagnosis	
Patient medication:	
Medication Text	
Comments:	
any text	
Run number:	
1	
Session number:	
1	
~	,
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>A</u> pply	

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. If the selected file is frame-based, an additional block output is created, which outputs the activation of a frame. Use a **Demux** block to demultiplex multiple channels. The file to load must be on the MATLAB path.

Dialog Box

gFROMfile_framed/g.FROMfile			-		×
Filename: gTO file_sampled_11_12_2017_15_39_{ Info options Show Session Info Show File Info Load options O this file Mode: Sample based	Session Info Session name: gTO file_sampled_11_12_2017_15_39_51 MATLAB 5.0 MAT-file, Platform: PCV/IN64, Created on: Mon Dec 11 15:39:51 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5 Session length: 1.8 sec. Data Type: double	Patient data ID: First Name: Last Name: Date Of Birth: Sex: Hand: Diagnosis: Medication:	ID0000 John Doe 12.01.2001 MALE RIGHT Diagnosis Medication T	ext	
Frame length: 1 Channels:	Complete: true	Comment:	any text		
[1	2 3 4 5] ffTime onTime offTime]	Session: Run:	1 1		
	1234]		Restore Mode	1	
gFROMfile_framed/g.FROMfile			_		>
- · ·	Session Info	⊤ Patient data	_		>
ilename:	Session name:	Patient data			
;ilename: ;TOfile_sampled_11_12_2017_15_40_{	Session name: gTOfile_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1				
Filename: gTO file_sampled_11_12_2017_15_40_4 Info options Show Session Info Show File Info Load options this file Info	Session name: gTOfile_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5 Session length: 2.7 sec.				
Filename: gTO file_sampled_11_12_2017_15_40_{ Info options Show Session Info Show File Info Load options this file all files Mode: Sample based Frame length: 1	Session name: gTO file_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5				
filename: gTO file_sampled_11_12_2017_15_40_{ info options Show Session Info Show File Info Load options O this file all files Node: Sample based frame length: 1 Channels:	Session name: gTOfile_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5 Session length: 2.7 sec. Data Type: double Complete: true				
filename: gTO file_sampled_11_12_2017_15_40_{ Info options Show Session Info Show File Info Load options O this file file fode: Sample based frame length: 1 Channels: [1	Session name: gTOfile_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5 Session length: 2.7 sec. Data Type: double Complete: true 2 3 4 5]				
Show File Info Load options this file Mode: Sample based Trame length: 1 Channels: [1 Specify time range as vector [onTime optime range]	Session name: gTOfile_sampled_11_12_2017_15_40_53 MATLAB 5.0 MAT-file, Platform: PCWIN64, Created on: Mon Dec 11 15:40:53 2017 Number of files: 1 Sampling rate: 1000 Hz Nr of data channels: 5 Session length: 2.7 sec. Data Type: double Complete: true 2 3 4 5]			elected file	9!

Double click on the **g.FROMfile** block to edit the parameters. Click **OK** to apply or **Cancel** to discard parameter changes.

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 File Info	Show stored recording session information Show file information	
Load options	this file all files	only load this file load all files of the session	
Mode	indicates whether the	e loaded data is sample or frame based	
Frame length	indicates the frame le 1 for sample ba number of sam	•	
Channels	shows the number of	f channels and allows selecting channels for output	
Specify time range	functionality of cutti	available for sample based data, and provides the ng specified time ranges from the signal → output first 10 seconds and from second 30 to the end	
Restore Model	this button to restore NOTE: the me	led, a Simulink model was stored to the loaded file click e the model odel will be restored in the file restored.mdl or pending 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 $(0 \dots no, 1 \dots yes)$		
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.

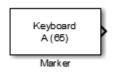
Parameter

fname	string	name of the g.MATfile	
-------	--------	-----------------------	--

Output

	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
file	endt (double)	end time of the file within the session
file	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
	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
session	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

Marker Block



Description

The **Marker** block is for generating keyboard and mouse markers in Simulink.

The **Marker** checks the system for keyboard and mouse events and generates markers in Simulink. To generate multiple markers in Simulink use one **Marker** block for each marker.

Dialog Box	
Source Block Parameters: Marker X	🔊 Source Block Parameters: Marker X
g.Marker (mask) (link)	g.Marker (mask) (link)
Check the system for mouse or keyboard events and send them to the Simulink model.	Check the system for mouse or keyboard events and send them to the Simulink model.
Parameters Marker source: () 1 - Mouse () 2 - Keyboard	Parameters Marker source: O 1 - Mouse
Mouse marker settings Action: 1 - PRESSED Button: 1 - LEFT	Mouse marker settings Action: 1 - PRESSED Button: 1 - LEFT
Keyboard marker settings Key code: 65 Key name: A Sample time [s]: 1/256	Keyboard marker settings Key code: 65 Key name: A Sample time [s]: 1/256
QK <u>Cancel</u> <u>H</u> elp <u>Apply</u>	<u>QK</u> <u>C</u> ancel <u>H</u> elp Apply

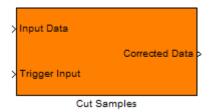
Double click on the Marker block to edit the parameters.

Marker Specify if the block should check for keyboard or mouse events source

Mouse marker	Action	Pressed: generate marker when the button is pressed RELEASED: generate marker when the button is released ANY: generate marker when the button is pressed or released
settings	Button	LEFT: generate markerwhen the left button of the mouse is used RIGHT: generate marker when the left button of the mouse is used
Keyboard	Key code	the key code the block is listening to
marker setting	Key name	the key name of the corresponding key code
Set	Opens a windo	ow to specify key code and key name by keyboard hit

Example Marker_Demo.slx

Cut Samples



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

Dialog Box

承 Cut San	nples			-		×
i	Replace the input occurs	data values with a spe	cified number if a	trigger	event	
Select	OPTIONS:					_
	Replace values w	ith:	-2			
	Replace mode:					
		Fixed period	3	[s]		
		🔿 As long as trigge	r is ON			
		O Simulation time				
		Start time:		[s]		
		Duration:		[s]		
1	Help	Cancel	Apply		OK!	

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] Duration [s]	starting time 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.

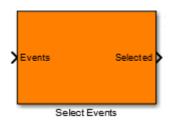
Dialog Box

Select Channels		-	• ×
	e applied only on the selected c		
Select CHANNELS:			
Range:		Selected channels:	
1 - 16 17 - 18		<mark>1</mark> 2 3	^
Available channels:	Add to list ->		
7 8 9	<- Remove from list		
10 11 12			
13	Select all ->>		
14 15 16 17 V	< Remove all		Ų
Total channels: 18 Set			
	Help	Cancel	OK !

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

🔁 Function Block Parameters: Select Events 1	Х
Select Events (mask) (link)	
The Select Events block selects event codes from the incoming events. For each change of the incoming event code from zero to 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 vector). The event output can be specified to be a merged or separated.	a
Parameters	
Event code selection:	
[1 2 3]	
$\hfill {\ensuremath{\square}}$ Separate selected triggers (one channel for each event)	
<u>O</u> K <u>C</u> ancel <u>H</u> elp Ap	ply

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

	Recorded Data	> >	Input Data	Recorded Data >
>Input Data	Validity Flag	> >	Ext. Threshold	Validity Flag >
	Trigger		Trig	ger

- **Description** The Trigger- 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. To use the Trigger- Block in combination with g.THRESHOLDscope, select all channels in the Trigger channels parameter.
- NoteSince 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

🔁 Function Block Parameters: Trigger	×
Trigger Window (mask) (link)	_
The Pre- Post- Trigger- Window- Block triggers the input data according to the specified trigger channels and its value. The window size and the start of the window (pre- or post- trigger) can be specified. In addition, it is possible to use an external trigger level input to trigger data on the specified channels.	
Parameters	
Trigger channels:	
1:4	
Trigger edge: FALLING	•
Threshold [uV]:	
[0.5,0.9,-0.5,-1]	
External threshold	
Window size [s]:	
1	
Pre-Post trigger time [s]:	
-0.5	
Sample time [s]:	
1/256	
Validity mode: DETAILED (validity flag for each channel)	•
OK Cancel Help Apply	

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

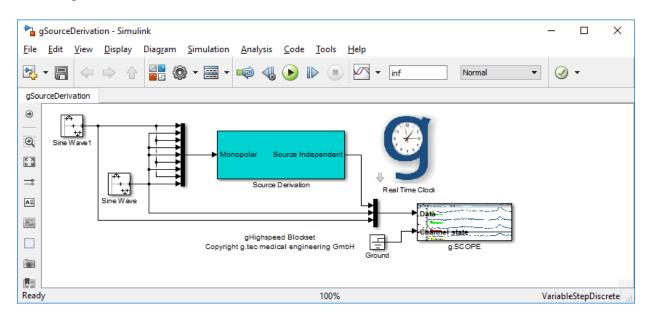
Source Derivation	—		\times
Browse for a source derivation file created with the MONTAGE CREATOR and sel derivation that should be performed. Use the GEOMETRY and g.MONcreator button files.			
Specify SOURCE DERIVATION:			
Name of constellation file:	Br	owse	
Type of source derivation: select derivation \sim			
Define MONTAGE and GEOMETRY:	G	eometry	
Help Cancel		Accep	t

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.



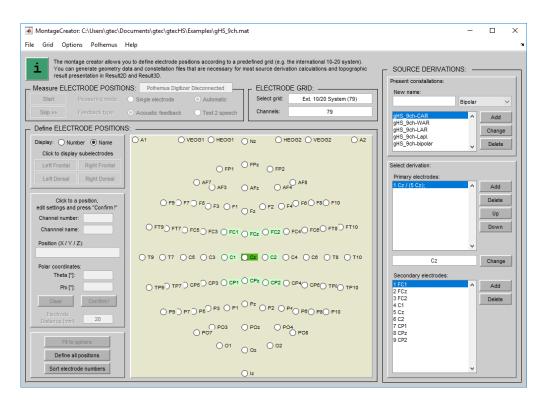
- 2.) Double click on the Source Derivation block.
- 3.) Click on the Browse... button and open the file gHS 9ch.mat from the folder

C:\Program Files\gtec\gtecHS\Examples

4.) For the Type of source derivation select gHS 9ch-bipolar

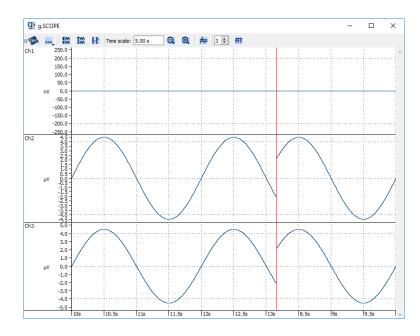
Source Derivation	_		Х
Browse for a source derivation file created with the MONTAGE CREATOR and select derivation that should be performed. Use the GEOMETRY and g.MONcreator buttons files.			
_ Specify SOURCE DERIVATION:			
Name of constellation file:tec\Documents\gtec\gtecHS\Examples\gHS_9ch.mat	Bro	wse	
Type of source derivation: gHS_9ch-CAR			
Define MONTAGE and GEOMETRY:	Ge	eometry	
Help Cancel		Accept	

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

🚹 Function Block Parameters: EEG/ECG BW Filter 🛛 🗙
Butterworth Bandpass filter for ECG and EEG (mask) (link)
$\ensuremath{Bandpass}$ filtering especially for ECG and EEG signals and for multiple channels
Parameters
Order (<50):
6
Lower cut-off frequency (Hz): no 🔻
Upper cut-off frequency (Hz): 100 -
Sampling frequency (Hz):
256
OK Cancel Help Apply

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



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

🚡 Function Block Parameters: BP BW Filter)
Butterworth Bandpass filter for biosignals (mask) (link)	
Bandpass filtering especially for biosignals and for multiple cha - Setting Lower cut-off-frequency to 0 compares to a Lowpass - Setting Upper cut-off-frequency to inf compares to a Highpas	filter
Parameters	
LP	
LP Order(<50):	
5	
Upper cut-off frequency (Hz):	
60	
HP	
''' HP Order(<50):	
5	
-	
Lower cut-off frequency (Hz):	
30	
Sampling frequency (Hz):	
256	
OK Cancel Help	<u>A</u> pply

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

Order LP (<50)	filter order of the Butterworth low-pass filter
Upper cut-off frequency (Hz)	upper cut-off frequency (inf \rightarrow no filter)
Order HP (<50)	filter order of the Butterworth high-pass filter
Lower cut-off frequency (Hz)	lower cut-off frequency (0 \rightarrow no filter)
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

🚰 Function Block Parameters: Notch Filter	
	×
Butterworth Bandpass filter for biosignals (mask) (link)	
Bandpass filtering especially for biosignals and for multiple channels	
Parameters	
Order (<50):	
10	
Notch frequency (Hz): 50	1
Sampling frequency (Hz):	_
256	
	_
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>A</u> pply	

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



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

🚡 Function Block Parameters: Pre/Post PSD 🛛 🗙
calculate spectra (mask)
The block computes \ensuremath{PSD} (power spectra density) averaged over trials for specified intervals
Parameters
Channels (int vector):
[123]
Type of spectra: FFT (Fast Fourier Transform)
Data window type: hamming
Averaging (number of trials):
10
Calculate Reference/Action spectrum
Length of interval to analyze [samples]:
100
Reference interval starts at [sample]:
0
Action interval starts at [sample]:
120
<u>Q</u> K <u>C</u> ancel <u>H</u> elp <u>Apply</u>

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

承 ERD Online		_	□ X
ERD (event-related desyn over time (relative to a re	nchronization) is characterized by cha ference period).	anges of signal pow	er
C Specify REFERENCE PERIOD:			
Deference period (Itmin trav) in a	ac or 'all' for full sequence):		
Reference period ([tmin,tmax] in sec. or 'all' for full sequence): all			
Number of trials:		10	
C Select FILTER:			
	Deadaces / Dutter wette		
◯ No filter	Bandpass / Butterworth		
	Lower cutoff frequency (- 3 db):	0.5 [Hz	
	Upper cutoff frequency (- 3 db):	6.5 [Hz	
	Filter order (max. 500):	1	
Specify COMPONENTS to be analize	d:		
Induced components only (nor	n phase locked) 🛛 🔘 Raw signal (in	duced and evoked of	components)
AVERAGING, SMOOTHING and ST	ATISTICS:		
Horizontal averaging	Method: mean V Fa	ctor: 16	
	induit i i i i i i i i i i i i i i i i i i		
Significance test: none	~		
Smoothing: exponential	Vindow: 150 [ms	1	
Smoothing: exponential	V 1110011. 150 [III3	u U	
	Uala	Cancel	ок
	Help	Cancer	

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 and data mat from noth	

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 channels passed to the block. Different FFT and window types can be selected as well as frame overlaps and averaging.

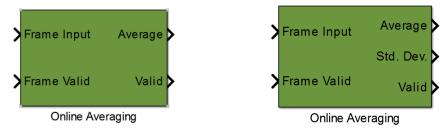
Dialog Box

🔁 Function Block Parameters: Online FFT	\times
FFT (mask)	
Calculates FFT of incoming sample- based data according to the selected type. The selected window function is applied to the input data.	
Parameters	
Buffer length [samples]:	
128	* *
FFT type: FFT	•
Window type: BOXCAR	•
Overlap [samples]:	
0	•
Average [frames]:	
10	•
<u>OK</u> <u>Cancel</u> <u>H</u> elp <u>A</u> pph	Y

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

select type of spectrum
FFT (Fast Fourier Transform)
PS (Power Spectrum)
PSD (Power Spectrum Density)
select the data window type. BOXCAR, HAMMING or HANNING.
specify the number of frames to average
specify the length of the interval in samples
define the overlap of the interval in samples
gOnlineSpecs.mdl

Online Averaging



Description Averages framed (see TriggerBlock, Pg. 46) 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.

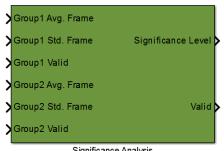
Dialog Box

🔁 Function Block Parameters: Average Targets	×
S-Function (mask) (link)	
Averages framed (e.g. by PreTriggerWindow- Block) data at INPUT port according to VALID port (rising edge). The Average is calculated using STEINERS ALGEBRAIC LAW for continously calculation of average and standard-deviation. The VALID output port indicates that there was a new frame at the INPUT and that average and standard-deviation are calculated. The block mask allows you to specify the averaging mode-> calculated over all data (continuous calculation) or using a moving window. In addition, the output of the standard- deviation can be configured.	d
Parameters	
Averaging mode: 1 - average all data	•
Averaging window [# of frames]:	
3	
Standard deviation output	
Baseline correction	
Baseline correction interval [s]:	
[0 0]	
Sample time [s] of sample-based data:	
1/256	
<u>Q</u> K <u>C</u> ancel <u>H</u> elp <u>A</u> pply	

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

Significance Analysis



Significance 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

Function Block Parameters: Significance Analysis Significance Analysis (mask) (link)	×		
The Significance Analysis performs a Welch Test on Target and NonTarget- Frames. The p-Value used for the significance test can l selected from a list. The output update mode can be selected from 3 options: update on each group or update on specific group.			
Parameters			
Sampling time [s] of sample-based data:			
1/256			
p-Value: 1 - 0.75	•		
Update mode: 1 - any Group	•		
<u>OK</u> <u>Cancel Help</u> Apply	,		

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	<pre>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</pre>		
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

\Lambda Averageonline_setting	gs	_		X
Online Average paramete	ers			
Channels (int vector)				
	[1 2 3]			
x - axis scale ([xmin,x	(max) or 0 for 'auto')	Frequenc	v (N	\sim
		Trequenc	y (iv	•
	and an I fee leadely			
y - axis scale ([ymin,y	maxjor[]for auto)			
Pretrigger settings [s]				
	0			
Two colum mode				
Comparsion mode				
ОК	Cancel	Ар	pły	

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.

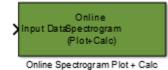
Dialog Box

SpecPlot_settings		-		×
Online Spectrogram para	meters			
Channels (int vector)	Sample r	rate		
[1 2 3]		0]
Time window (in sec)			_
	20			
ОК	Cancel	Apph	у	

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

Online Spectrogram Plot + Calc



Description

The **Online Spectrogram Plot** + **Calc** block calculates and plots the forwarded input data.

Dialog Box

Spectrogram_settin	gs		_		
Online Spectrogram pa	irametei	8			
Channels (int vector)				
		[1 2 3]			
Type of spectrum pl	at	FFT (Absolute			
Type of spectrum p	UL.	FFT (Absolute	value)	*	
Window type bo	xcar			~	
Averaging (number	of fram				
		1			
Buffer length (# of s	amples)			
		1024			
Overlap (# of sampl	es)				
	,	256			
Downsampling (# of	fsample				
		2			
Time window (in se	c)				
		10			
-					
ОК		Cancel	Appl	У	

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
Type of spectrum plot	 select the type from the following options: FFT (Absolute values) PS (Power Spectrum) PSD (Power Spectral Density)
Window type	select the from the following options: - boxcar - hanning - hamming
Buffer length (# of samples)	Number of samples used for spectrum

calculcation

Overlap (# of samples)	specify how many samples the frames for calculation should overlap
Downsampling (# of samples)	specify how many samples should be combined for downsampling
Time window (s)	length of the plot

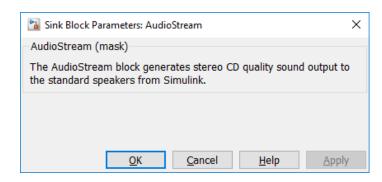
AudioStream



Description

Dialog box

The **AudioStream** block generates stereo CD quality sound output to the standard speakers from Simulink.



Double click the AudioStream block to edit the parameter.

Example Simulink model

AudioStream Demo.slx

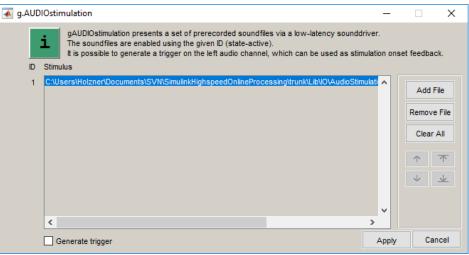
ATTENTION: This block requires ASIO4ALL – Universal ASIO Driver For WDM Audio version 2.12 or later to be installed on the computer.

AudioStimulation



Description The AudioStimulation block presents a set of pre-recorded sound files via a low-latency sound driver. The sound files are enabled using the given sound ID (see column ID in AudioStimulation GUI). As long as the sound ID input holds an ID of a sound files, this file is replayed. Setting the ID to 0 or to another ID will stop the file replay or start the other file replay respectively. It is possible to generate a trigger on the left audio channel, which can be used as stimulation onset feedback. Use mindBEAGLE audio trigger adapter box to split the output signal into a trigger and a stimulation line.

Dialog box



Double click the AudioStimulation block to edit the parameter. Use **Add File**, **Remove File** and **Clear All** to modify the sound file list. Specify the ID of one sound file by using the arrow buttons to move the sound files up and down in the list.

Example Simulink model

AudioStimulation_Demo.slx

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

g.CAMERAcapture



Description The **g.CAMERAcapture** block allows you to record a video from a webcam and synchronize the video with biosignal data. The synchronization is done using the video frame number which is output from the g.CAMERAcapture block. Save this output along with the biosignal data for synchronization.

Double click g.CAMERAcapture block to start the video recording tool.



The toolbar allows you to configure the webcam, the camera settings and to control the video recording.

To configure the webcam click **Config** to open the configuration dialog:

G Video configuration	×
Select a video camera:	
Logitech HD Webcam C270	•
Select a video format:	
640 x 480 @ 30.000 fps RGB24	•
Select average bitrate for video compression:	
4,00 ➡ Mbit/s	
Enter a filename (without extension; will be extended by date/time):	
gcameracapture	
File storage path (for information):	
C:\Users\gtec\Documents\MATLAB	
Done	

- 1) Pick the camera to use from the **Select a video camera** list.
- 2) Depending on the used camera and depending on the needed video quality select a video format from the **Select a video format** list
- 3) Use the **Select average bitrate for video compression** parameter to specify the final size of your video (see table below). Select a bitrate in the range of 0.1 and 10 Mbit/s.

Length of video	Bitrate	Size of video
[min]	[Mbit/s]	[MB]
1	0.1	0.75
1	4	30
1	10	75
15	0.1	11.25
15	4	450
15	10	1125
60	0.1	45
60	4	1800
60	10	4500

- 4) The filename specified in the **Enter a filename** parameter will be extended by a post-fix string with the format '______yyyy_hh_mm_ss'.
- 5) The **File storage path** parameter is set automatically to the MATLAB workspace path of the Simulink model and cannot be modified.

To set the camera settings click **Camera settings** in the menu bar to open the settings dialog box:

Gamera settings		×
Brightness:		
Contrast:		
Hue:	N/A	
Saturation:		
Sharpness:	_	
Gamma:	N/A	
Color enable:	N/A	
White balance:		Auto
Backlight compensation:		
Gain:		
Pan:	N/A	
Tilt:	N/A	
Roll:	N/A	
Zoom:	N/A	
Exposure:		🗹 Auto
Iris:	N/A	
Focus:	N/A	
	Default values	Done

Change the camera settings up to your needs. The changes will take effect immidiately so you can check the settings with the resulting video output. The parameters **White balance** and **Exposure** provides the option for auto-calibartion leading to adjustment of the white balance and exposure during your video recording. This could have an impact to the frame rate. To restore the camera default parameters click **Default values** button.

Control the video recording via the record and pause button in the toolbar.

g.CAMERAcapture is ready to record a video. Click the red record button to start recording.

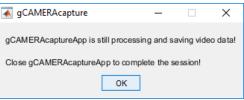


NOTE: You can only record one video file per run of the Simulink model.



g.CAMERAcapture is currently recording a video. Stop recording of the video by clicking the blue pause button

Best practise is to start and stop the video recording while the Simulink model is running. If the Simulink model ends and g.CAMERAcapture is still recording video a warning message will pop up.



Example Simulink model

gCAMERAcapture_Demo.slx

INFO: We tested g.CAMERAcapture with Logitech c270 HD Webcam.

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

>	EMG in	
>	Disable > Delay	
	Spasticity Control	

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

Dialog box

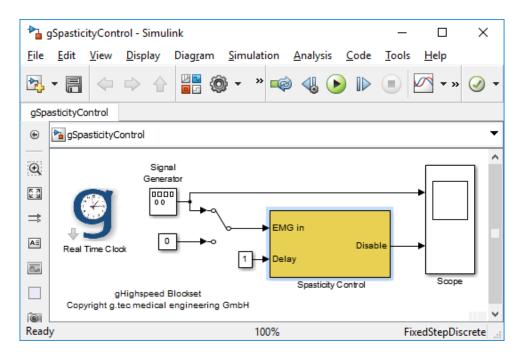
Description

🔁 Function Block Parameters: Spasticity Control	×	
Detects the spastic activity and outputs corresponding control signals (mask) (link)		
One-dimensional interaction using the EMG signal of one muscle: If a spastic movement is detected, the "Disable" output is set to "1".		
Only if the threshold is exceeded, the "Disable" output is set to "1".		
Parameters		
Threshold:		
100		
<u>QK</u> <u>Cancel</u> <u>H</u> elp Apply		

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:	

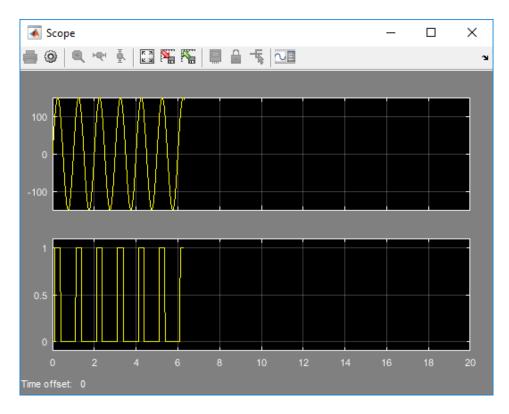
1.) Open the Simulink model gSpasticityControl.mdl



- 2.) Double click on the **Spasticity Control** block.
- 3.) For the Threshold select 100 mV

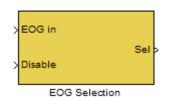
🔁 Function Block Parameters: Spasticity Control	\times	
Detects the spastic activity and outputs corresponding control signals (mask) (link)		
One-dimensional interaction using the EMG signal of one muscle: If a spastic movement is detected, the "Disable" output is set to "1".		
Only if the threshold is exceeded, the "Disable" output is set to "1".		
Parameters		
Threshold:		
100		
<u>QK</u> <u>C</u> ancel <u>H</u> elp <u>A</u> ppl	у	

- 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



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

Dialog box

Description

Function Block Parameters: EOG Selection	×	
Detects the blinking singals and outputs corresponding control signals (mag	1	
One-dimensional interaction using the EOG signal of one eye: The selection command is generated when two consecutive blinks are detected.		
Only if the trigger level is exceeded, selection is possible. To calculate the individual trigger level for each user, run the block in Calibration mode.		
Parameters		
Select input mode: Calibrate the input signal 👻		
Double blink interval [s]:		
0.3		
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>Apph</u>	/	

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, Use the input sensor to activate the selection mode or Use input sensor & blink detector to distinguish between voluntary eye movements and blinks.
Double blink interval [s]	time window within which the second eye blink must occur for a valid selection
Output:	During calibration 0, when Select input mode is set to Use the input sensor is selected than a positive peak is generated when upper limit is crossed. Select input mode Use input sensor & blink detector generates a second peak which is positive for eye movements and negative for blinks.
Example Simulink model	g.EMGEOGcontrol/g.BCI_EOG_gUSBamp

EMG Selection threshold

×	MG in	
>1	Selection >	•
	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

🔁 Function Block Parameters: EMG selection threshold	×	
Detects the muscle contraction in the EMG signal and outputs corresponding control signals (mask	k) –	
One-dimensional interaction using the EMG signal of one muscle: The selection signal is generated when the input EMG signal exceeds the threshold.		
Only if the threshold is exceeded, selection is possible.		
Parameters		
Threshold:		
400		
<u>OK</u> <u>C</u> ancel <u>H</u> elp <u>A</u> pply		

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

Threshold

threshold value the selection command

EMG Selection calibration

>	EMG in	
>	Sel Disable	Þ
	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

🔁 Function Block Parameters: EMG selection calibration	Х		
Detects the muscle contraction in the EMG signal and outputs corresponding control signals (mask)			
One-dimensional interaction using the EMG signal of one muscle: The selection signal command is generated when the EMG signal amplitude is higher than the trigger level.			
Only if the trigger level is exceeded, selection is possible. To calculate the individual trigger level for each user, run the block in Calibration mode.			
Parameters			
Select input mode: Calibrate the input signal			
Retrigger time [s]:			
0.7			
	_		
<u>QK</u> <u>Cancel H</u> elp <u>A</u> pply			

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

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

EMG 2D selection calibration

>EMG1		
>EMG2	Sel>	
> Disable		
EMG 2D selection calibration		

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

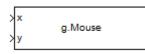
Dialog box

🚹 Function Block Pa	ameters: EMG 2D selection c	alibration			\times	
Detects the muscle	Detects the muscle contraction in the EMG signals and outputs corresponding control signals (mask)					
Two-dimensional interaction using the EMG signals of two muscles. The block outputs a 2-element vector, the first element representing the selection command generated by the first muscle, and the second one the selection command generated by the second muscle.						
	vels are exceeded, selectio lock in Calibration mode.	on is possible.	To calculate indi	vidual trigger leve	ls for	
Parameters						
Select input mode:	Use the input sensors				•	
Increment time [s]:						
3						
Retrigger time [s]:						
0.5						
		<u>O</u> K	<u>C</u> ancel	<u>H</u> elp <u>A</u> p	ply	

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 \mathbf{x} and \mathbf{y} .

Dialog box

Sink Block Parameters:	×		
g.Mouse (mask)			
Moves the mouse pointer to the coordinates at the block inputs.			
Parameters			
Mode: Normal mouse pointer	•		
Mouse click after [sec]: No click			
Auto calibration			
Screen: Secondary	•		
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>Appl</u>	у		

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 mome cursor stopped on a point and when the automatic click comm Select No click to control only movement.			
Auto calibration	calibrate the pointer position based on the minimum and maximum values reached by the input coordinates x and y during a predefined 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



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

承 Online Signal Quality Check		-	-		×
Specify CRITERIA:	fest				
Signal N.S. V	Window length: 1000 [ms]	Min: Max:	Limits: 2 3	μV μV	~ ~
Perform amplitude test					
Signal N.S. 🗸	Window length: 500 [ms]	Min: Max:	Limits: 10 100	ΨV ΨV	~ ~
	Help Car	ncel	O	ĸ	

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	 (bad) – standard deviation exceeds MAX limit (poor) – standard deviation falls below MIN limit (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

Sink Block Parameters: g.SQdisplay	×			
g.SQdisplay (mask) (link)				
Displays channel signal quality (calculated from the g.SQcheck block) in a matrix-shaped form for easy overview about data quality. Green stands for good signal quality. Yellow stands for higher than normal amplitude. Red stands for noise.				
Parameters				
Maximum number of columns:				
8				
Time between status update [s]:				
1				
Pull to start experiment				
Start if quality is good for [s]:				
20				
<u>QK</u> <u>Cancel H</u> elp <u>Apply</u>	(

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 modelgSQCheckDemo.mdl

AutoStartBatch



Description

ion 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

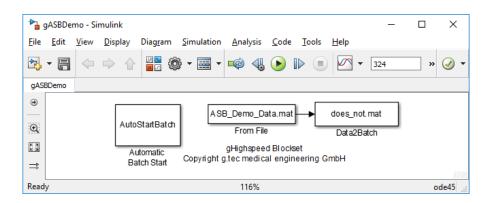
🔁 Block Parameters: Automatic Batch Start				
Auto-Start Batch (mask) (link)				
Use this block to automatically start a matlab batch after the simulation ends. The batch to start must be on the matlab search path or must be specified by a full path.				
Parameters				
Name / path of batch to be started:				
'ASB_Demo_Batch'				
Data for batch is stored with a To File block: Data2Batch 👻				
<u>O</u> K <u>C</u> ancel <u>H</u> elp <u>A</u> pply				

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. 46ff) 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.
 - ង ExternalParadigmDemo Simulin <u>File Edit View Display Diagr</u>am Simulation Analysis Code Helr (= => 1 📲 🚳 = 🔜 = 📫 🔩 🕟 🗈 🗐 = 🗺 = 🖬 • 🕢 • 🖏 • 🗐 Evt Plot Targets and Non-Targets Extract biosignal data Ð sf aUSBamp double K A ⇒ A± 10 gHighspeed Blockset Copyright g.tec medical engineering Gmbl 0 朗 View 1 warning 119%
- 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:

ode45

承 Configure g.U	SBamp SNR.: UB-0000.00.00			_	
Specify AM	PLIFIER SETTINGS:				
	Group A Group B Group C Group D UB-0000.00.00			Offset:	00 (mV) 0 (mV) 10 (Hz
Specify CH4	ANNEL SETTINGS:	C		•	Notch
Bipolar:	0 ~	apply >>	. 0 AP. 0.300	/ LP. 30.000	
Bandpass	HP: 0.500 / LP: 30.000 🗸	apply >>			
Notch:	50 ~	apply >>			~
Load	Save		Help	Cancel	ок

- 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

eeglab14_1_0b\plugins folder of your eeglab installation.

How to load *.mat files to eeglab

To open eeglab, enter <code>eeglab</code> to the MATLAB command window. While eeglab is loading a message

EEGLAB: adding "gtecimport" v3.16.01.bbb (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**.

EEGLAB v14.1.0	_	
File Edit Tools Plot Study	Datasets Help	۲.
Import data	Using EEGLAB functions and plugins	From ASCII/float file or Matlab array
Import epoch info	Using the FILE-IO interface	From Netstation binary simple file
Import event info	Using the BIOSIG interface	From Multiple seg. Netstation files
Export	Troubleshooting data formats	From Netstation Matlab files
Load existing dataset	<pre>> Load existing dataset"</pre>	From BCI2000 ASCII file
Save current dataset(s)	> hour existing dataset	From Snapmaster .SMA file
Save current dataset as	ort epoch info" (data	From Neuroscan .CNT file
Clear dataset(s)		From Neuroscan .EEG file
Create study	ort event info" (continuous	From Biosemi BDF file (BIOSIG toolbox)
Load existing study	aset info" (add/edit	From EDF/EDF+/GDF files (BIOSIG toolbox)
Save current study	e dataset" (save dataset)	From g.tec file (Sample Data)
Save current study as	"Edit > Select data"	From g.tec file (Location Data)
Clear study / Clear all	: "Tools > Reject	
Memory and other options	"Tools > Extract epochs"	
History scripts	line: "Tools > Remove	
Manage EEGLAB extensions	"Tools > Run ICA"	
Quit		

Clicking the function will bring up a file browser:

→ * ↑	nis PC > Documents > MATLAB >		√ Ö	Search MATLAB	۶
ganise 🔻 🛛 New fold	er				
Ouick access	Name	Date modified	Туре	Size	
	Apps	13.11.2017 07:54	File folder		
Desktop 🖈	1 currentDCcharacterization_20171211_110	11.12.2017 11:04	MATLAB Data	1 KB	
🖊 Downloads 🖈	1 currentDCcharacterization_20171211_110	11.12.2017 11:05	MATLAB Data	2 KB	
🗄 Documents 🖈	1 currentDCcharacterization_20171211_110	11.12.2017 11:07	MATLAB Data	2 KB	
Nictures 🛛 🖈	1 gTOfile_sampled_11_12_2017_15_39_51_0	11.12.2017 15:39	MATLAB Data	85 KB	
Examples	1 gTOfile_sampled_11_12_2017_15_40_53_0	11.12.2017 15:40	MATLAB Data	129 KB	
MATLAB	🛅 lds_vs_Vgs	11.12.2017 11:22	MATLAB Data	18.189 KB	
NG	🛅 minimumsave	10.11.2017 08:17	MATLAB Data	1 KB	
System32	1 NeuroGraphene_DC_Rawdata	11.12.2017 11:22	MATLAB Data	33.275 KB	
Systemsz V	脑 profiling_rung_at_full_speed_256hz_28_11	28.11.2017 11:10	MATLAB Data	294 KB	
File n	ame:		~	(*.mat, *hdf5)	

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:

承 Input for gtec import function	_		×
Check sampling rate of imported data:	256	;	
Enter name of dataset:	gtec_im	port	
Help	Cancel	Ok	

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.

Kent Information	_	×
Does the data contain event info	ormation?	
Yes	No	

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**.

承 Input for event information	-		×
Enter event information c	hanne	l numb	er:
6			
Help	Cance	I C)k

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.

承 Event Information	_	×
Are there more channels with event in	nformation?	
Yes	No	

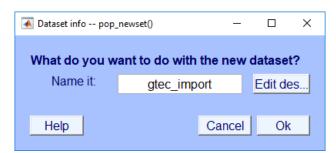
By clicking **Yes** the input dialog for the event channel is opened again.

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.

-	EEGLAB	v14.1.0					-	×
File	Edit	Tools	Plot	Study	Datasets	Help		r
Г	#1	: gte	c_im	port			 	
	Fil	lename	: non	e				
	Cha	nnels	per	frame		6		
	Fra	ames p	er ep	och		17		
	Epo	chs				1		
	Eve	ents				9		
	San	npling	rate	(Hz)		256		
	Epo	och st	art (sec)		0.000		
	Epo	och en	d (se	c)		0.063		
	Ref	erenc	e			unknown		
	Cha	annel	locat	ions		No		
	ICA	A weig	hts			No		
	Dat	aset	size	(Mb)		0		

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**.

ស EEGLAB v14.1.0				—		\times	
ile Edit Tools Plot	Study	Datasets	Help			Ľ	
Import data	;	Using	EEGLAB func	tions and plugins	->	From AS	SCII/float file or Matlab array
Import epoch info	>	Using	the FILE-IO i	nterface		From Ne	etstation binary simple file
Import event info	2	Using	the BIOSIG ir	nterface		From M	ultiple seg. Netstation files
Export	>	Troub	leshooting d	ata formats		From Ne	etstation Matlab files
Load existing dataset	L	> Toad 4	existing	dataget"		From BC	CI2000 ASCII file
Save current dataset(s)		> LUAU (existing	uataset		From Sn	apmaster .SMA file
Save current dataset as				(1-+-		From Ne	euroscan .CNT file
Clear dataset(s)		-	ch info"			From Ne	euroscan .EEG file
Create study	>			(continuous		From Big	osemi BDF file (BIOSIG toolbox)
Load existing study			fo" (add/			From ED)F/EDF+/GDF files (BIOSIG toolbox)
Save current study				dataset)		From a.t	tec file (Sample Data)
Save current study as			> Select				tec file (Location Data)
Clear study / Clear all		: "Tools	s > Rejec	:t		Ť	
Memory and other opti	ons	"Tools	> Extrac	t epochs"			
History scripts	>	line: "1	Tools > R	lemove			
Manage EEGLAB extens	ions >	"Tools	> Run IC	'A"			
Quit							

Clicking the function will bring up a file browser:

→ • ↑	> This P	C > Documents > MATLAB >		~ [™]	Search MATLAB	
rganise 🔻 🛛 New	v folder				•== •	
	^	Name	Date modified	Туре	Size	
Quick access		Apps	13.11.2017 07:54	File folder		
Desktop 🔋		l currentDCcharacterization_20171211_110	11.12.2017 11:04	MATLAB Data	1 KB	
🕂 Downloads 🦻	e	locurrentDCcharacterization_20171211_110	11.12.2017 11:05	MATLAB Data	2 KB	
Documents >	e 🔤 🖓	locurrentDCcharacterization_20171211_110	11.12.2017 11:07	MATLAB Data	2 KB	
📰 Pictures 🛛 🦻	e	b gTOfile_sampled_11_12_2017_15_39_51_0	11.12.2017 15:39	MATLAB Data	85 KB	
Examples		11_12_2017_15_40_53_0	11.12.2017 15:40	MATLAB Data	129 KB	
MATLAB		🛅 lds_vs_Vgs	11.12.2017 11:22	MATLAB Data	18.189 KB	
NG		🛅 minimumsave	10.11.2017 08:17	MATLAB Data	1 KB	
System32		🛅 NeuroGraphene_DC_Rawdata	11.12.2017 11:22	MATLAB Data	33.275 KB	
- system52	v	brofiling_rung_at_full_speed_256hz_28_11	28.11.2017 11:10	MATLAB Data	294 KB	
	File <u>n</u> ame			~	(*.mat, *hdf5)	

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**.

▲ EEGLAB v14.1.0	- 🗆 X
File Edit Tools Plot Study Datasets	Help
#2: gtec_import	
Filename, none	
Channels per frame	8
Frames per epoch	75711
Epochs	1
Events	none
Sampling rate (Fz)	250
Epoch start (sec)	0.000
Epoch end (sec)	302.840
Reference	unknown
Channel locations	Yes
ICA weights	No
Detabet bize (Mb)	3.1



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

Please visit our homepage <u>www.gtec.at</u> for

- Update announcements
- Downloads
- Troubleshooting
- Additional demonstrations



contact information

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