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# NIRScout Interface for Simulink USER MANUAL V1.12.00

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### **Related Products**

g.tec provides several biosignal analysis elements that are especially relevant to the kinds of tasks you perform with the NIRScout Interface for Simulink.

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

g.BSanalyze	Off-line biosignal analysis package for MATLAB with EEG, ECG, classification and high resolution EEG toolboxes
g.USBamp	Multimodal biosignal amplifier for any type of electrophysiological signals like EEG, ECG, EOG, EMG, ECoG, and external sensors
g.MOBIlab+	Portable biosignal amplifier that transmits the data via Bluetooth to a PC or notebook
g.BSamp	Stand-alone multimodal biosignal amplifier for EEG, ECG, EOG and EMG
Highspeed On-line Processing for Simulink	Allows users to perform real-time analysis under Simulink and to interface the biosignal amplifiers g.USBamp, g.MOBIlab+ and g.BSamp

### Installation and Configuration

### Hardware Requirements

The NIRScout Interface for Simulink requires a PC running Microsoft Windows. The table below lists the minimum hardware requirements:

Hardware	Properties		
CPU	Pentium working at 2000 MHz		
Hard disk	20-30 gigabyte		
RAM	1 gigabytes		
USB 2.0 high speed port	One free USB port for the NIRScout device		
USB 2.0 high speed port	One free USB port for the Hardlock Dongle		
Optional:			
USB 2.0 high speed port	One free USB port for each g.USBamp		
Bluetooth dongle	One Bluetooth dongle for g.MOBIlab+		
PCI slot	One free slot for each National Instruments board for the g.BSamp data acquisition		

#### Software Requirements

The NIRScout Interface requires the installation of MATLAB, Simulink (The MathWorks, Inc. USA) and NIRStar (NIRx Medical Technologies LLC., USA). Make sure that the MATLAB and NIRStar installations work correctly before installing the NIRScout Interface software. Depending on your Windows operating system, administrator rights might be necessary for the installation. Additionally, one of the following packages is required to acquire biosignal data: g.USBamp, g.MOBIlab+ or g.BSamp Highspeed On-line Processing for Simulink.

Software	Version		
MATLAB	Release 2012a		
Simulink	Release 2012a		
NIRStar	10.8.3		
Windows	Windows 7 Professional English Win32		
Acrobat Reader	10.1.3		
Optional:			
g.USBamp Highspeed On-line Processing for Simulink	Release 2012		
g.MOBIIab+ Highspeed On-line Processing for Simulink	Release 2012		
g.BSamp Highspeed On-line Processing for Simulink	Release 2012		

#### Installation from a CD

The installation consists of the following steps:

- 1. Make sure that you correctly installed MATLAB, Simulink and either g.USBamp, g.MOBIlab+ or g.BSamp Highspeed On-line Processing for Simulink by typing ver into the MATLAB command window. The correct version numbers must be reported.
- 2. Insert the g.tec product CD into the CD-drive and change to the root directory of your CD-drive. Then copy the directory NIRScout Interface to the following path:

C:\Program Files\gtec\NIRScout Interface

3. To make the path settings, start MATLAB and open the **Set Path** window from the **File** menu. Then click on the **Add with Subfolder** button and select:

C:\Program Files\gtec\NIRScout Interface

to add all subdirectories:

📣 Set Path	
All changes take effect immed	iately.
	MATLAB search path:
Add Folder	C:\Program Files\gtec\NIRScout Interface
Add with Subfolders	C:\Users\Holzner\Documents\MATLAB C:\Program Files\gtec\gRTanalyze
Move to Top	C:\Program Files\gtec\gRTanalyze\BCI C:\Program Files\gtec\gRTanalyze\Examples
Move Up	C:\Program Files\gtec\gRTanalyze\Help C:\Program Files\gtec\gRTanalyze\Help\gRTanalyze
Move Down	C:\Program Files\gtec\gRTanalyze\Lib
Move to Bottom	C:\Program Files\gtec\g.UDPinterface 2.12.01\Help
Remove	C:\Program Files\gtec\g.UDPinterface 2.12.01\win64 +
Save Close Re	vert Default Help

Click **Save** and **Close** to finish the installation.

Insert the Hardlock into a free USB slot of your PC or notebook. The light on the Hardlock will be on if the installation was successful.

### Files on your Computer

NIRScout Interface for Simulink files are stored under (it is assumed that the default path setting is used):

c:\Program Files\gtec\NIRScout Interface

Help files - are stored under:

c:\Program Files\gtec\NIRScout Interface\Help

## The NIRScout Block



The **NIRScout** block provides a graphical interface to the NIRStar software, which can be used under Simulink to acquire NIRs data.

Description

The **NIRScout** block provides NIRs data from a NIRx NIRScout device on the network in real-time. The data format is single. The number of channels depends on the device settings. Use a **Demux** block to demultiplex the channels.

#### **Dialog Box**

Source Block Parameters: NIRScout
NIRScoutBlock (mask) (link)
Performs data acquisition from a NIRx NIRScout device on the network.
<ul> <li>&gt; Port 1: device timestamp</li> <li>&gt; Port 2: data</li> <li>&gt; Port 3: trigger lines</li> </ul>
Click the 'Help' button for a detailed description of the parameters and the output data.
Parameters
IP address:
'127.0.0.1'
Port:
45342
Number of channels:
32
Number of wavelengths:
2
Block sample rate [Hz]:
3
Receive Timeout [ms]:
1000
Latch
<u>OK</u> <u>Cancel</u> <u>H</u> elp <u>A</u> pply

#### Parameters

IP address	Enter the IP address of the computer with the NIRStar software	
Port	The port, which is configured at the NIRStar software	
Number of channels	Number of channels to receive	
Number of wavelengths	Number of wavelengths to receive	
Block sample rate [Hz]	Sampling rate of the block. It must be greater than or equal to the device's sample rate	
Receive Timeout [ms]	Specifies the maximum amount of time in milliseconds that the block should wait for data from the device before it reports an error. It is recommended to set this value to at least to twice the device's sample rate.	
Latch	If the latch checkbox is checked, the values of the most recent sample will be hold until a new sample is available. In that case, the initial values, until the first sample is available, are zeros.	
Outputs		
Timestamp	Timestamp of the device	
Data	Each data output sample is a one-dimensional array organized the following way (wavelength index 'w' is zero based): channel + w * number of channels	
Trigger	The trigger lines are represented by decimal value. This value bitwise encodes the four trigger lines into an integer, where trigger line 1 is assigned to be the LSB (least significant bit) of the value's binary representation, trigger line 2 the bit following the LSB and so on.	

### Running NIRScout Inferface

To test the NIRScout Interface configuration on your system, please follow these steps:

- 1. Start the MATLAB command window. See your MATLAB documentation if you are not sure how to do this.
- 2. Open the Simulink Library Browser by typing Simulink into the MATLAB command window.



This shows the **NIRScout** block that interfaces the NIRScout with the Simulink model for realtime data analysis, visualization and storage. 3. Type gUSBampNIRxBCI into the MATLAB command window to open the following model:



The Simulink model contains a **g.USBamp** block, which reads in the data from the amplifier over USB. Then the biosignal data is converted to double precision and the **Scope** block is used for data visualization.

The Paradigm block presents the experimental paradigm in real-time on the computer screen. Here, we present one example of a subject's experience using the default settings. The subject sat in a comfortable armchair 150 cm in front of a computer-monitor and was instructed not to move, to relax the arms and feet, and to fixate on a cross in the center of the monitor throughout the experiment. The experiment started with the display of a fixation cross that was shown in the center of a monitor. After two seconds, a warning stimulus was given in the form of a "beep" and a trigger signal was set at the output of the Paradigm block. From second 3 until 4.25 an arrow (cue stimulus), pointing to the left or to the right, was shown on the monitor. The subject was instructed to imagine a left or right hand movement, depending on the direction of the arrow, until second 20. If the experiment was performed with feedback, a horizontal bar indicated the classification result. The bar extended to the right side if a right hand imagination was performed and vice versa for the left side.

One trial lasted 20 seconds and the time between two trials was randomized between 0.5 to 2.5 seconds to avoid adaptation. The subject performed 4 runs, each consisting of 40 trials

- 4. Switch g.USBamp on and connect it to one free USB port. The power LED on g.USBamp must be on.
- 5. Double click on the g.USBamp block and select a sampling frequency of 256 Hz. This setting will update the whole Simulink model every 1/256 s and will ensure that the analysis runs in real-time. Then select channels 1, 2, 5 and 6 to be acquired to acquire 4 EEG channels. Assign the Bandpass filter a HP of 0.5 Hz and a LP of 30 Hz. Also, enable the 50 Hz Notch filter for the four channels. Assign the Bipolar channel 3 for the first channel, 4 for channel 2, 7 for channel 5 and 8 for channel 6.

📣 Configure g.US	Bamp SNR.: UA-2006.01.05				
- Specify AN	IPLIFIER SETTINGS:				
Common groun	d: Common reference:	Sampling rate (Hz):	Frame length:	Analog outpu	ut:
Group A	Group A	256 💌	8	square	-
Group B	Group B	_ Options:	Mode:	Amplitude:	0 (mV)
Group D	Group D	Counter	<ul> <li>Measure</li> <li>Test signal</li> </ul>	al Offset:	0 (mV)
Serial number:	UA-2006.01.05	Slave		Frequency:	10 (Hz)
CHANNEL select CH01 C CH02 C Specify CH	etion: H03 V CH05 CH07 CH0 H04 V CH06 CH08 CH1 ANNEL SETTINGS:	9 CH11 CH1 0 CH12 CH1	3 CH15 4 CH16 Ch# Bin Highpa	ss Lownass	Notch
			1 3 HP: 0.	500 / LP: 30.000	50
Bipolar:	0 🔹	apply >>	2 4 HP: 0. 5 7 HP: 0.	500 / LP: 30.000 500 / LP: 30.000	50 50
Bandpass:	HP: 0.100 / LP: 0.000 🔹	apply >>	6 8 HP: 0.	500 / LP: 30.000	50
Notch:	50 💌	apply >>			*
Load	Save		Help .	Cancel	ОК

- 6. Place the NIRs optodes over the left and right motor cortex. Place source 1 and 2 and detector 1 and 2 over the right motor cortex and source 3 and 4 and detector 3 and 4 over the left motor cortex. For further information how to place see the NIRStar manual.
- 7. Connect your EEG electrodes to the amplifier. Place channels 1 to 4 on the right side of the brain around the NIRs optodes over the motor cortex. Channel 1 should go just in front of the ear, and channel 3 should be just behind the ear. Channel 2 should go just in front of the middle, and channel 4 should go just behind the middle. Channel 5 8 are mounted similarly over the left motor cortex. Channel 5 ahead near the ear and channel 7 back near the ear, channel 6 ahead near the middle and channel 8 back near the middle. The ground electrode should be fixed on the forehead and the reference to the right ear lobe.



This picture shows the placement of the optodes and electrodes over the left motor cortex. The red optodes in the middle are the sources of the NIRScout device and the white ones are the detectors. The red electrodes in front and back are EG channels 5 - 8.

- 8. Start the NIRStar software and configure it correctly for measuring 8 channels over the motor cortex. Furthermore, configure the TCP connection with IP '127.0.0.1' for the local computer and port 45342. For information how to configure the NIRStar software, please read the NIRStar manual.
- 9. The **NIRScout** block communicates with the NIRStar software and the NIRScout device over TCP and sends data to the Simulink model in real-time. Double click on the **NIRScout** block and enter the **IP address** of the computer where the NIRStar software is installed:

`127.0.0.1'

Source Block Parameters: NIRScout
NIRScoutBlock (mask) (link)
Performs data acquisition from a NIRx NIRScout device on the network.
<ul> <li>&gt; Port 1: device timestamp</li> <li>&gt; Port 2: data</li> <li>&gt; Port 3: trigger lines</li> </ul>
Click the 'Help' button for a detailed description of the parameters and the output data.
Parameters
IP address:
'127.0.0.1'
Port:
45342
Number of channels:
8
Number of wavelengths:
2
Block sample rate [Hz]:
16
Receive Timeout [ms]:
1000
✓ Latch
<u>OK</u> <u>Cancel</u> <u>H</u> elp <u>A</u> pply

10. Enter the Port, configured at the NIRStar software

45342

- 11. Insert the Number of channels measured with the NIRScout device
  - 8

12. Enter the Number of wavelengths recorded with the NIRStar software

2

13. Enter the Block sample rate [Hz] for the block. It has to be greater than or equal to the sample rate of the NIRScout device!

16

14. Enter the **Receive Timeout [ms]**, which reflects how long the system will wait for data from the NIRStar software. It should be around twice the sample rate of the device.

1000

- 15. Check the **Latch** checkbox to get the most recent sample when no data are available.
- 16. Double click on the **To File** block and enter **Filename** test1.mat. The data is stored into the variable y.
- 17. Start the model by pressing the Start button in the Simulink model



- 18. To view the signals, double click on the **Scope** block. Channels 1 and 2 show the EEG from channels 2 and 4. Channel 3 shows the NIRs data.
- 19. Stop the model with the Stop button and close it





# contact information

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