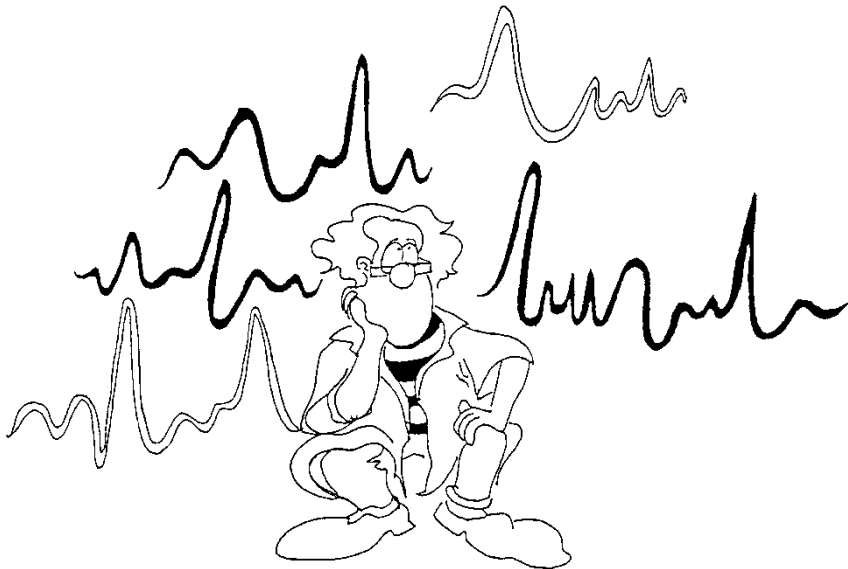




AlphaLab SnR Stimulation and Recording System User's Manual

Version 2.0.4.1



ALPHA OMEGA

Home Office: P.O. Box 2268, Nazareth 1612102, Israel

Email: info@alphaomega-eng.com

Web site: www.alphaomega-eng.com

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Contact Information:

**ALPHA OMEGA ENGINEERING
NAZARETH INDUSTRIAL PARK BUILDING
2015 MOUNT PRECIPICE ST.
P.O. BOX 2268
NAZARETH 1612102
ISRAEL**

Tel: +972-4-656-3327

Fax: +972-4-657-4075

info@alphaomega-eng.com

support@alphaomega-eng.com

<http://www.alphaomega-eng.com>

U.S. Office: Toll Free: 1-877-919-6288, Fax: 1-877-471-2055

Europe Office: Toll Free: 00-800-2-574-2111, Tel +49-7-251-440-6620

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Table of Contents

1	Introduction.....	1
1.1	About This Manual	1
1.2	Reference Documents	1
1.3	List of Abbreviations	1
1.4	AlphaLab SnR Overview	1
1.5	Applications	1
1.6	Highlights and Significant Features	2
2	Getting Started	3
2.1	The AlphaLab SnR Application GUI	3
2.1.1	Menu Options.....	4
2.1.2	Main Control Banner	7
2.1.3	Toolbar	8
2.1.4	Main Window Pane.....	8
2.1.4.1	Hot menu controls (Right Click).....	8
2.1.4.2	Scale Controls	10
2.1.5	Standard Window Controls.....	10
2.1.6	Status Bar	11
2.2	The AlphaLab SnR Hardware.....	12
2.2.1	Main Processing Unit.....	13
2.2.2	Signal Integration Unit.....	13
2.2.3	Digitizing Headstage Unit.....	13
2.2.4	Other Accessories	14
2.2.5	Initial Hardware Definition.....	14
3	AlphaLab SnR Initialization.....	16
3.1	Building a New Workspace File	16
3.2	Display Group Editing	17
3.2.1	Defining Main Display Group	17
3.2.2	Defining Current Monitor Display Group	19
3.2.3	Defining Digital Display Groups	19
3.2.4	Defining Analog Display Groups	21
3.3	Workspace Display Groups	24
3.3.1	Main Electrode Display Group	26
3.3.2	Stimulation Current Monitor.....	27
3.3.3	Segmented Display Group	27
3.3.4	Spike Filtered Continuous Display Group.....	29
3.3.5	Raw Continuous Display Group	30
3.3.6	LFP Filtered Continuous Display Group	30
3.3.7	Featured Continuous Display Group	30
3.3.8	Spike Filtered Triggered Display Group.....	30
3.3.9	LFP Filtered Triggered Display Group.....	31
3.3.10	Selected group display	31
3.3.11	General Purpose Analog Inputs Display Group.....	32
3.3.12	User Defined Analog Channels Display Group.....	32
3.3.13	Single-Bit Digital Inputs Display Group	33
3.3.14	Digital Input Port Display Group.....	34
3.3.15	Digital Output Port Display Group	34

3.3.16	Tetrode/Multitrode Display Group	34
3.3.17	Statistics windows.....	35
3.3.18	X/Y Display window	37
3.4	Logging Options	38
3.4.1	Selecting Logging Mode.....	39
3.4.2	Logged Files Settings.....	40
3.4.3	Video Recording/Tracking Synchronization	42
3.4.4	Digital Out Logging Sync.....	43
3.4.5	Selecting Channels for Saving	43
3.5	Impedance Settings	43
3.6	Contacts Settings.....	45
3.7	Channels Settings.....	46
3.8	Multitrode Settings.....	50
3.9	Port Definition	50
4	AlphaLab SnR Operations.....	51
4.1	Data Acquisition	51
4.2	Data Logging	52
4.3	Level Data Segmentation.....	52
4.3.1	Setting the Threshold Crossing Direction.....	53
4.3.2	Setting the Threshold Level	53
4.3.3	The Info Line	54
4.3.4	The Level Crossing Dead-Time Parameters	55
4.3.5	Automatic Level Setting	55
4.4	Online Spike Sorting.....	55
4.4.1	Template Definition Stage	56
4.4.1.1	Defining the Template	59
4.4.1.2	Setting the Right Threshold	61
4.4.1.3	Adding an “Include Window”	63
4.4.2	Include/Exclude Bars Definition Stage.....	63
4.4.3	Spike Sorting Stage.....	65
4.4.4	The Segmentation Dead-Time Parameters	66
4.4.5	Online Spike sorting on more than 32 channels	66
4.5	Stimulation.....	68
4.5.1	Simple Stimulation.....	68
4.5.2	Complex Stimulation	71
4.5.2.1	Stimulation in low latency system mode	72
4.5.3	Stimulation Markers.....	74
4.5.4	Advanced Stimulation Controls.....	75
4.5.4.1	Stimulation Switching Mode	75
4.5.4.2	Stimulation Artifacts.....	77
4.5.4.3	Stimulation and Switching Artifact Removal	79
4.5.4.4	Setting the Artifact Removal Parameters.....	79
4.6	Impedance Checking.....	81
4.7	Sensors modules.....	82
4.7.1	Defining sensors contacts:	82
4.7.1	Sensors settings:.....	83
4.8	Audio Channels.....	84
4.8.1	MPU Audio 1 Control.....	84
4.8.2	MPU Audio 2 Control.....	84
4.8.3	SIU Audio 1 and Audio 2 Control	85

4.9	Routing Channels to Analog Outputs	85
4.10	User Events	86
4.10.1	Predefined Events	87
4.10.2	Remarks	89
4.11	Scripting	89
4.11.1	Script General Terms	91
4.11.2	Script Commands and Statements	93
4.12	Defining and Loading Waves	102
4.13	User Defined Analog Channels	104
4.14	Tetrode/Multitrode Processing.....	106
4.15	Flexible Referencing.....	106
4.16	Online Statistics	107
4.17	Client Server Operations- AlphaLab SnR multi user	107
4.18	Video Tracking/Recording Synchronization	108
4.18.1	EthoVision (Noldus).....	108
4.18.2	StreamPix 5 (Norpix).....	108
4.19	EPS (Electrode Positioning System) Connection	108
4.19.1	Making the connection to EPS.....	108
4.19.2	Showing the Electrode Depth on the GUI	110
4.20	MATLAB/ C++ tool:	111
4.21	Optogenetics System Control	111
4.21.1	Defining the System.....	111
4.21.2	Controlling the System	112
4.22	Special Detection Filter.....	115
4.23	Monitoring Panel LED's.....	116
5	AlphaLab SnR Specifications	117
5.1	Technical Specifications	117
5.1.1	General System Specifications	117
5.1.2	PreAmp HeadStage for Free Moving Animals.....	118
5.1.3	HeadStage for Restrained Animals.....	120
5.1.4	General Purpose Analog Inputs	121
5.1.5	General Purpose Analog Outputs.....	122
5.1.6	Audio Outputs.....	122
5.1.7	General Purpose Single Bit Digital Inputs.....	122
5.1.8	General Purpose Digital Input 16-bit Ports.....	122
5.1.9	General Purpose Digital Outputs	123
5.1.10	User Defined Analog Channels	123
5.2	Connector Pin Layouts.....	124
5.2.1	PreAmps HeadStages	124
5.2.1.1	8-Channel PreAmps Headstages.....	124
5.2.1.2	16-Channel PreAmps Headstages.....	125
5.2.1.3	32-Channel PreAmps Headstages.....	126
5.2.2	Headstage.....	127
5.2.2.1	Headstage 16-Channel Module (V.1)	127
5.2.2.2	Headstage 16-Channel Module (V.2)	129
5.2.3	Signal Integration Unit.....	129
5.2.3.1	Analog Inputs (A.In).....	130
5.2.3.2	Analog Outputs (A.Out).....	130
5.2.3.3	Digital Input Port (D.In Port).....	131
5.2.3.4	Single Bit Digital Inputs (D.In)	131

5.2.3.5	Digital Output (D.Out).....	132
5.2.4	Main Processing Unit.....	133
5.2.4.1	Analog Inputs (A.In and BNC's).....	133
5.2.4.2	Analog Outputs (BNC's).....	134
5.2.4.3	Single Bit Digital Inputs (BNC's).....	134
5.2.4.4	Digital Input Port (D.In Port 1).....	134
5.2.4.5	Digital Outputs (D.Out or BNC's).....	135
6	AlphaLab SnR File Format	136
6.1	Type h – File Header Block.....	136
6.2	Type 2 – Continuous Analog Channel Definition	137
6.3	Type 2 – Segmented Analog Channel Definition	138
6.4	Type 2 – Digital Input Channel Definition	139
6.5	Type S – Stream Data Definition.....	140
6.6	Type b – Digital Input/Output Port Definition	140
6.7	Type 5 – Channel Data Block.....	141
6.8	Type E – Stream Data Block	142

Figures

Figure 1 – A Typical AlphaLab SnR Interface	3
Figure 2 – Main Control Banner	7
Figure 3 - Standard Windows Controls	10
Figure 4 - Icon Click Windows Controls	11
Figure 5: AlphaLab SnR Hardware	12
Figure 6 - AlphaLab SnR Digitizing Headstage	13
Figure 7 - System State widow	14
Figure 8 - Rack Mount Unit Label.....	15
Figure 9 – Create New Workspace Dialog	16
Figure 10 - Group Settings Window	17
Figure 11 - Main Group Definition Window	18
Figure 12 - Digital Group Definition Window	20
Figure 13 - Analog Group Definition Window.....	22
Figure 14: Continuous group advanced settings	23
Figure 15 - Advanced Setting Window	24
Figure 16: saving layout.....	24
Figure 17 – Main Group Display Options	26
Figure 18 – Current Monitor Bar	27
Figure 19 – Current Stimulation Controls	27
Figure 20 – Segmented Channel Display Group	28
Figure 21 – Stimulation Current Monitor in Segmented Display.....	29
Figure 22 – Spike Filtered Continuous Display.....	30
Figure 23 – Spike Filtered Triggered Display	31
Figure 24: Selected channels option	32
Figure 25 – User Defined Channels Display Group	33
Figure 26 – Single-Bit Digital Inputs Display	33
Figure 27 – Tetrode Display Group	34
Figure 28 – Tetrode Clustering Window	35
Figure 29 – Raster Display	35
Figure 30: Raster display window when trigger is connected	36
Figure 31 – Evoked Potential Display	36
Figure 32: PSTH options window.....	37
Figure 33 – X/Y Display.....	37
Figure 34 – Logging Options.....	38
Figure 35 – Open Saving File	41
Figure 36 – Video Synchronization	42
Figure 37 – Impedance Settings.....	44
Figure 38 – Contacts Settings Window	45
Figure 39 – Contacts Properties Window	45
Figure 40 – Channel Settings Window	47
Figure 41 – Filter Properties Dialog	47
Figure 42 – Multitrode Settings Dialog	50
Figure 43 – Loading the DSP's	51
Figure 44: saving description.....	52
Figure 45 – Main Electrode Display.....	53

Figure 46 – Setting the Crossing Slope.....	53
Figure 47 – Setting the Crossing Slope.....	54
Figure 48 – Setting the Info Line.....	54
Figure 49 – Auto setting the threshold level.....	55
Figure 50 – Unsorted Spike Segments.....	57
Figure 51 – Several Distinct Spike Shapes.....	57
Figure 52 – Spike Sorting Control Buttons.....	58
Figure 53 – Displaying Template 2.....	59
Figure 54 – Template Definition Mode.....	59
Figure 55 – Grouping Spikes to Form a Template.....	60
Figure 56: Template editor option.....	60
Figure 57 – Template Definition – Two groups.....	61
Figure 58 – Sorting Using Two Templates.....	61
Figure 59 – The Detection Histogram Area.....	62
Figure 60 – Include Window.....	63
Figure 61 – Unsorted Spike Segments.....	64
Figure 62 – Include/Exclude Spike Sorting Control Buttons.....	64
Figure 63 - Include/Exclude Bar Window.....	65
Figure 64 - Units in separate windows.....	66
Figure 65: Activating the spike sorting mode.....	67
Figure 66 : restarting the SW.....	67
Figure 67 – Current Stimulation Controls.....	68
Figure 68 – Stimulation Setup.....	69
Figure 69: Low latency mode in system state window.....	73
Figure 70: detection window.....	73
Figure 71: load script from script settings window.....	74
Figure 72: Setting a channel as dedicated stimulation.....	76
Figure 73 - Artifact Removal Setting.....	80
Figure 74 – Impedance Result Dialog.....	81
Figure 75: Admin tab.....	82
Figure 76: Choosing sensor type.....	83
Figure 77: Sensors settings window.....	83
Figure 78 – RM Box Audio 1 Control.....	84
Figure 79: Quick Menu view.....	84
Figure 80 – RM Box Audio 2 Control.....	85
Figure 81 – Analog Output Dialog.....	86
Figure 82 – Empty Events Control Panel.....	87
Figure 83 – Events Definition Dialog.....	87
Figure 84 – Defined User Events.....	88
Figure 85 – Text Remarks.....	89
Figure 86 – Script Control Dialog.....	90
Figure 87 – Wave Definition Window.....	103
Figure 88 - UD Channel Definition.....	105
Figure 89 - EPS Connection Dialog.....	109
Figure 90 - EPS Connection Dialog after the connection.....	109
Figure 91 – Mapping Electrode to Contact Names.....	110
Figure 92 - Showing Electrode Depth.....	110
Figure 93 - Optogenetics Settings Dialog.....	112
Figure 94 - Optogenetics system controls.....	112
Figure 95 – Optogenetics Stimulation Setup.....	114

Figure 96 - Special Detection Filter.....	115
Figure 97 – 16-Channel PreAmp	124
Figure 98 – AlphaLab SnR HeadStages	127
Figure 99 – 16-Channel HeadStage Module.....	127
Figure 100 - Grounding input on the Headstage.....	129
Figure 101 – SIU A/D I/O Package Panel	129
Figure 102 – MPU Rear Panels	133

1 INTRODUCTION

1.1 About This Manual

This manual describes the features and usage of the AlphaLab SnR (Stimulation and Recording) system for research use only, in animals' subjects.

1.2 Reference Documents

Mapfile Converter Manual

Matlab connection documentation

Video tracking/recording documentation

1.3 List of Abbreviations

SnR - Stimulation and Recording

SIU - Signal Integration Unit (Front End Unit)

MPU - Main Processing Unit (Rack Mount Unit)

1.4 AlphaLab SnR Overview

The **AlphaLab SnR System** is a powerful system that allows the user to:

1. Amplify, filter, and acquire up to 128 analog signals from electrodes or electrode arrays. Several systems may be cascaded to do higher channel count.
2. Stimulate one or more electrodes simultaneously.
3. Measure and report impedance of all electrodes simultaneously.
4. Acquire signals from other analog and digital sources.
5. Send out analog and digital signals per user's definition.

1.5 Applications

The main purpose of **AlphaLab SnR System** is to coordinate pre-processing, visualization and data logging during neurophysiological experiments on animal subjects using multi-channel recording. **AlphaLab SnR** software allows the researcher to control a large number of channels on-line, while providing appropriate data reduction for posterior analysis.

It can also be used as a data logging system to save the analog and digital inputs continuously at a high rate to a disk. The user can display all acquired input on screen. The system can detect input events like spikes and other significant signals by means of level triggering or online sorting.

1.6 Highlights and Significant Features

- Large number of analog and digital channels with user controlled sampling rates.
- Analog Inputs from Electrodes – Sampled in 16-bit ADC, and acquired in continuous or segmented mode. Segmented modes include segmentation based on simple level crossing or online sorting.
- Analog Inputs from other sources – Sampled in 12-bit ADC, and acquired in continuous mode.
- Analog Outputs - 16-bit DAC, used to reroute any signal to an external device.
- Digital Inputs - Sampled as single bits or 16 bit ports.
- Digital Outputs – used in various applications.
- Simple and complex stimulation paradigms.
- Impedance check.
- User event logging
- Single and multi-user computer platform.

2 GETTING STARTED

2.1 The AlphaLab SnR Application GUI

The AlphaLab SnR application is the user's graphical interface to the AlphaLab SnR system (see [Figure 1](#)).



Figure 1 – A Typical AlphaLab SnR Interface

The main application window has the following main components:

- Menu Options – section [0](#)
- Main Control Banner – section [02.1.2](#)
- Toolbar – section [02.1.3](#)
- Main Window Pane – section [2.1.4](#)
- Status Bar – section [2.1.6](#)

2.1.1 Menu Options

The Menu options and their functions are listed below.

Option	Sub-option	Description	Comments
File	New	Starts a blank workspace	All display groups must be added after this. It is not possible to create a new workspace named workspaces.xml as this is the default workspace name that includes all the default parameters for building new workspaces.
	Open	Open an existing workspace.	Opening a different workspace file will close the application and reopen it
	Save	Save current workspace. Changes made to the workspace will not be automatically saved. User will be asked on exit if save should be done.	
	Save As	Save current workspace under a different name.	
	Recent File	Shows a list of recent workspace files used	
	Exit	Exit the Application.	
View	Toolbar	Enable/Disable the display of the toolbar.	
	Script	Enable/Disable the display of the Scripting controls in the application banner.	
	Current Stimulation	Enable/Disable the display of the Current Stimulation controls in the application banner.	
	Optogenetics Stimulation	Enable/Disable the display of the Optogenetics Stimulation controls in the application banner.	
	Audio 2	Enable/Disable the display of the Audio 2 controls in the application banner.	
Options	Logging options	Open the Disk Logger Window (See section 3.4)	This option is disabled if saving data is in process

Option	Sub-option	Description	Comments
	Impedance Settings	Opens the Impedance Setting Window that allows the user to set all options related to Impedance measurement (See section 3.5)	
	Contact Settings	Shows information about contacts, including type of contact, gain, preamp information and also allows defining preamps and their properties. (See section 3.6)	
	Channels Settings	Open the Channels Settings that allows the user to set the digital filters, sampling rates, and other properties of all channels (See section 3.7)	
	Multitrode Settings	Opens an informational window that lists the multitrodes setting (See section 3.8)	
	Port Definition	Opens the Port Definition window that allows enabling/disabling strobing the acquisition of ports (See section 3.9)	
	Optogenetics Settings	Opens the Optogenetics Setting dialog that allows setting the type of system will be connected. (See section 4.21)	This options exists only of optogenetics stimulation mode is set in the workspace
Tools	Wave Definition	Opens a dialog that allows defining waves to be used for User Defined channels and for stimulation. (See section 4.12 below)	
	UD Channel Definition	Opens a dialog that maps defined arbitrary waves to one of the 4 User Defined channels. (See section 4.13 below)	
	EPS Connection	Opens a dialog that allows connection to Electrode Positioning System and mapping the recording electrodes to EPS channels. (See section 4.19 below)	
	Auto Set Level	Opens a dialog that allows setting the detection thresholds automatically based on RMS values. (See section 4.3.5 below)	
	Detection	Opens a window that allows a special scheme of level detection, which will allow faster response based on spike level detection. (See section 4.22 below). For systems running 32 channels or less only.	

Option	Sub-option	Description	Comments
	Artifact Removal Setup	Opens a window that allows to set the parameters for stimulation artifact removal. Section 4.5.4.4 describes how this function works	
Window	Group Settings	Opens a dialog that allows adding, deleting, and editing display groups. See section 3.2 for more details.	
	List of defined groups	Opened groups will have a check box, and closed one will not. Selecting a group will bring that group to focus.	
Help	About	Open the About AlphaLab SnR window	
	Users Info	Shows the MAC Addresses of all computers connected to the AlphaLab SnR system	

2.1.2 Main Control Banner

The Main Control Banner is an area that may vary depending on the settings, features, and hardware of the system. It includes clear controls of all the critical functions of the system, such as Logging, Stimulation, and Impedance Checking. *Figure 2* below shows a snapshot of a typical Control Banner, followed by a reference of where they are explained and how they are used. Other options may be available and explained later separately.

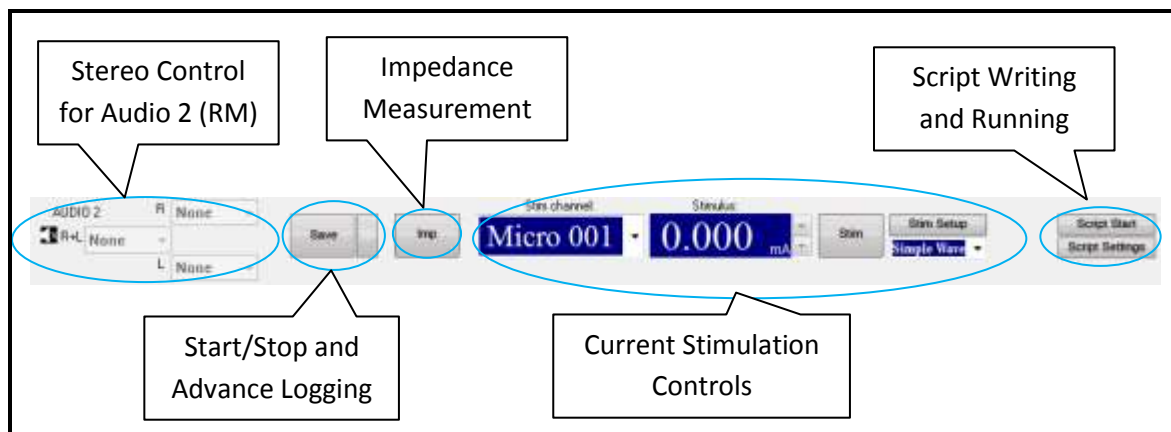










Figure 2 – Main Control Banner

- Stereo Control for Audio 2 on Rack Mount – See section [4.8.2](#) below.
- Start/Stop and Advance Logging – See section [4.2](#) below.
- Impedance Measurement – See section [4.6](#) below.
- Current Stimulation Control – See section [4.5.1](#) below.
- Script Writing and Running – See section [4.11](#) below.

2.1.3 Toolbar

The Tool Bar buttons and their functions are listed below:

Icon	Icon Name	Description
	Open Workspace	Open a previously saved workspace.
	Save Workspace	Save current workspace. This option is disabled if saving data is in process
	Clear windows	Clear all Windows. Ctrl/C is also available to clear signals from all windows.
	Freeze image	Freeze image (data acquisition is continued even when the drawing is frozen).
	Restore Layout	Set the layout to the last saved layout
	Windows List	Opens a dialog that allows enabling/disabling window display groups.
	Events	Open the Events Control Panel to allow the definition and logging of user defined events. See section 4.10 .
	Analog Outputs	Open the Analog Outputs Dialog to allow routing channels to analog outputs. See section 4.8.2 .

2.1.4 Main Window Pane

The main windowpane is located between the tool bar and the status bar. This area is used to display the user defined channel groups, which may include analog data and digital data. Analog data is displayed in continuous and/or segmented modes. Digital data is displayed as single bits or 16-bit ports. Each one of these types will be discussed in a later section.

2.1.4.1 Hot menu controls (Right Click)

Depending on the signal type displayed, hot menu functions (right click) will be available in each window. The table below lists all possible functions:

Option	Description
Select Channel	Opens a dialog to allow selecting what channel will be displayed.

Option	Description
Level Line	In Statistics windows – Turns the display of level detection on or off
Template1 - Template4	In Segmentation windows - Turns detection on or off using the specified template In Statistics windows – Turns the display of template detection on or off
Templates...	Open a dialog that allows turning templates on/off for several or all channels.
Include	Enable/Disable Include windows. See section 4.4.1.3 for details.
Reset level	Sets the level line to zero.
Ground	Grounds the electrode channel at the input of the headstage
Clear	Clears the signals on the selected channel window
Acquisition On	Acquisition for this channel is on when this is checked.
Save On	Saving for this channel is on when the is checked
Select Channel...	Opens a dialog that allows select the channel that will be displayed in this window.
Select Multitrode	Select which multitrode will be displayed in a multitrode subgroup of the standalone clustering window
Select X	Select the X contact of the multitrode clustering window
Select Y	Select the Y contact of the multitrode clustering window
Mode	Select Peak/Valley of the multitrode clustering window
Options...	Opens a dialog to set configuration parameter for certain windows when applicable. This is also accessible by double clicking the channel in some display windows.
Set Group Level	Opens a dialog that allows setting the level threshold and slope for all channels in this group to a certain value.
Set group Scales	Opens a dialog that allows setting time and voltage scales for the whole group.
Set group Amplitude	Opens a dialog that allows setting the voltage scales for the whole group.
Set group Time	Opens a dialog that allows setting the time scales for the whole group.
Show Elect. Depth	Shows the electrode depth if EPS system is connected. This is available on the main window display only.
Port With Strobe	Indicates if this digital port works with a strobe bit.

Option	Description
Set Color	Opens a dialog that allows setting the color of the channel signal. This color will take effect anywhere this channel is displayed, for example, if you set the color of SPK001 channel and then display this channel in a triggered channel display, the selected color will hold true here also.

2.1.4.2 Scale Controls

Also, depending on the signal type displayed, time and amplitude scales may be changed using mouse click and drag functions. The table below lists all possible functions:

Scale	Option	Description
Voltage	Left Click & Drag Down or Up	Increases or decreases the viewed voltage range
Voltage	Right Click & Drag Down or Up	Moves the scale up or down, keeping the viewed voltage range. Scale will be off centered
Voltage	Double Click	Center and reset the scale to a voltage predefined range
Voltage	Mouse wheel	Increases or decreases the viewed voltage range
Time	Left Click & Drag Left or Right	Increases or decreases the viewed time duration
Time	Double Click	Reset the scale to a predefined time duration
Time	Ctrl + Mouse wheel	Increases or decreases the viewed time duration

When scale is changed, double click on the scale returns the default values.

In some subgroup that includes multiple channels, it is possible to set scale changes in a way that any change on any scales is applied to all other channels.

2.1.5 Standard Window Controls

On the top right corner of each window you will find the standard windows controls to minimize, maximize, and restore.



Figure 3 - Standard Windows Controls

While by clicking on the Icon in the top left corner, these option and others will appear. The options are self-explanatory and are shown in the figure below. Pay special attention to the “Pop In” and “Pop Out” options which dynamically allow moving any window into or out of the main application window.

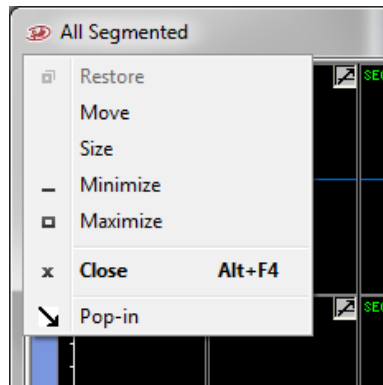
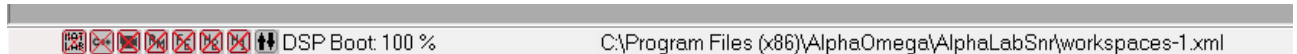


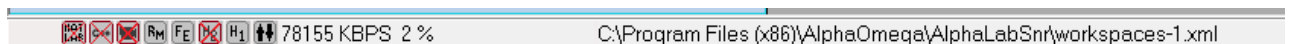
Figure 4 - Icon Click Windows Controls

2.1.6 Status Bar

The status bar is located at the bottom of the main application window. Initially, it shows that all hardware components are not connected, but once system in turned on it shows the DSP’s loading status on the MPU.











Once the DSP’s are loaded, it then displays an indicator of the TCP/IP throughput efficiency, and it shows what hardware components are connected.



In addition, the status bar shows the name of the current workspace file being used.

The icons shown from left to right are:

-  MATLAB connection
-  C++ connection
-  Video tracking or recording
-  Rack mount unit
-  Front End Unit
-  Headstage 2
-  Headstage 1
-  Ethernet communications

2.2 The AlphaLab SnR Hardware

The AlphaLab SnR Hardware is shown in *Error! Reference source not found.* below. In addition to the computer, it consists of the following main components:

1. The Main Processing Unit (rack mount)
2. The Signal Integration Unit (front end)
3. The Digitizing Headstage
4. Other Accessories

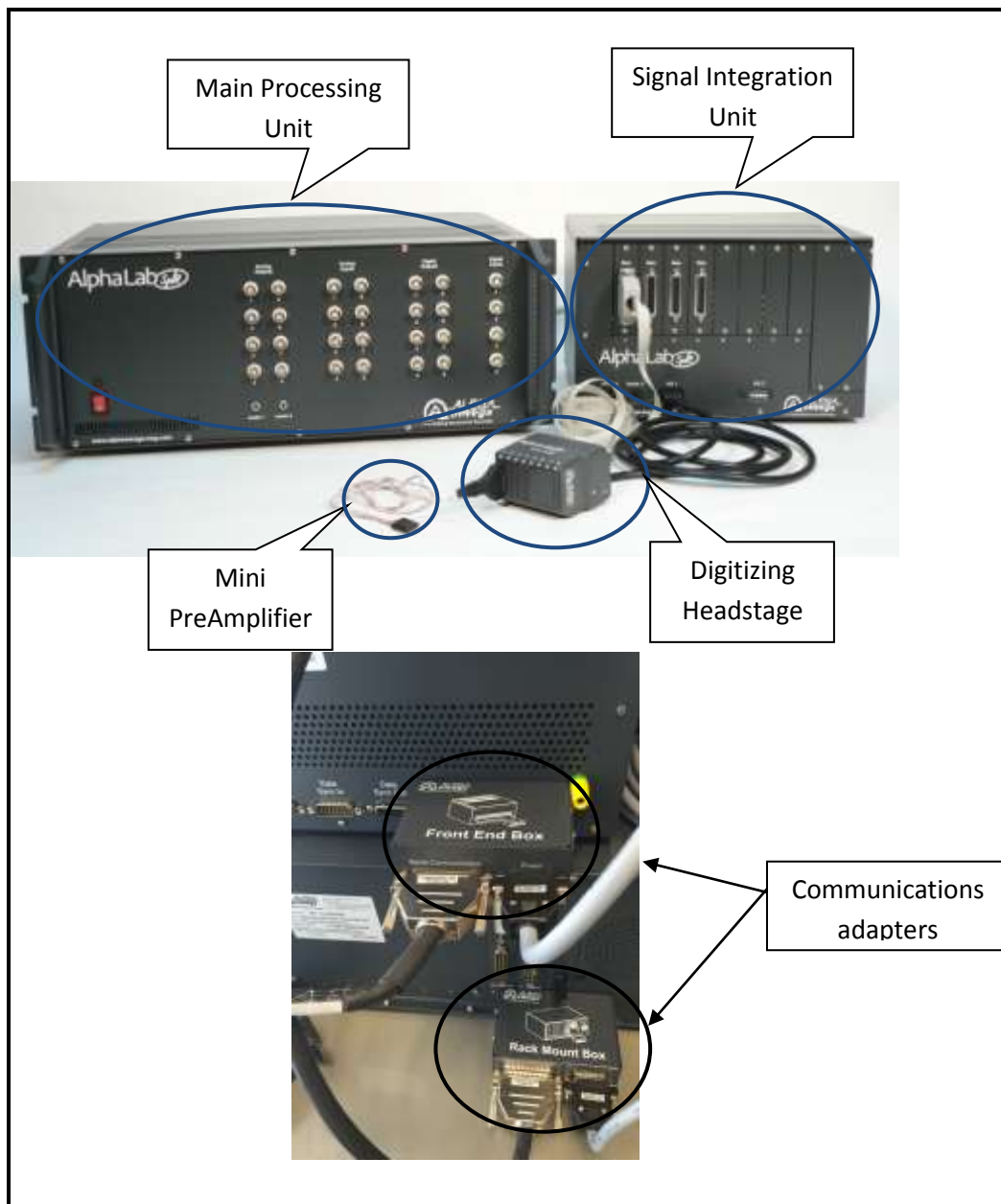


Figure 5: AlphaLab SnR Hardware

Newer model of the digitizing Headstage is shown in the figure below.



Figure 6 - AlphaLab SnR Digitizing Headstage

2.2.1 Main Processing Unit

The Main Processing Unit, which is also referred to as the Rack Mount Unit, is the part of the system that handles the following:

1. Two way digital communication with the computer through a 1GB Ethernet connection
2. Digital processing, including filtering, segmentation, and down-sampling
3. Acquisition of general purpose digital and analog inputs
4. Emitting general purpose digital and analog outputs including audio
5. Script processing
6. Stimulation definition and processing
7. Supplying power to all other components

2.2.2 Signal Integration Unit

The Signal Integration Unit, which is also referred to as the Front End Unit, is the part of the system that handles the following:

1. Two way digital communication with the Main Processing Unit
2. Stimulation analog waveform generation and supply to the Headstage
3. Optional Acquisition of general purpose digital and analog inputs, and analog and digital output emission
4. Supplying Impedance check waveforms

2.2.3 Digitizing Headstage Unit

The Digitizing Headstage Unit is the part of the system that handles the following:

1. Acquisition and digitization of all neuro-physiological signals
2. Basic hardware filtering
3. Switching capabilities, necessary to change an electrode from recording to stimulation mode or to ground and back

2.2.4 Other Accessories

Accessories for the AlphaLab SnR system may include one or several of the following:

1. Communication adapter for protecting and improving the communications.
2. Input cables and/or adapters for recording from restrained subjects
3. Mini preamplifiers with suitable cables for recording from free moving subjects
4. Commutator (Swivel) that works in conjunction with the preamplifiers to allow the animal to move freely in a certain area
5. Audio input cables for feeding a test signal into the headstage, the input cables, or the preamplifier for training purposes

2.2.5 Initial Hardware Definition

Before starting the software the first time, it is necessary to define the AlphaLab SnR hardware used with the system. This needs to be done only once, if you are setting up the system yourself. If you receive the system with a computer, this step will be done already by Alpha Omega technical staff. It may also need to be done on site if you receive a software upgrade, which requires a full uninstall of the existing software version beforehand, or if you are trying to setup a new client workstation.

Steps required to do the initial hardware definition are as follows:

1. Start the AlphaLab application, and press OK if the empty workspace message pops up.
2. Press Ctrl-Shift-A to open the “**System State**” window. This window is used by technical staff for monitoring the system. The figure below shows the bottom right corner of the “**System State**” window, which is where you need to make the changes listed below.

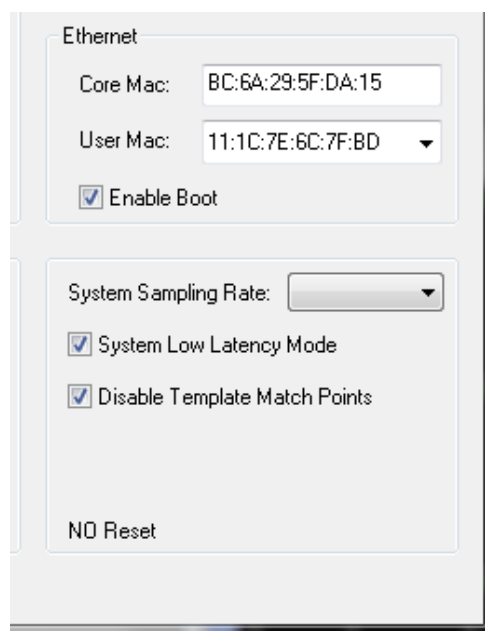


Figure 7 - System State widow

3. **Core Mac:** - Specify the MAC address of AlphaLab SnR system. The MAC address is a unique hardware address available for any communication adapter, such as Ethernet. The MAC address is specified on the label of the Rack Mount Unit (MPU). Make sure you that what you enter is the full 6 pairs of characters separated with colons (:), as shown in the figures above and below. See label below for an example:

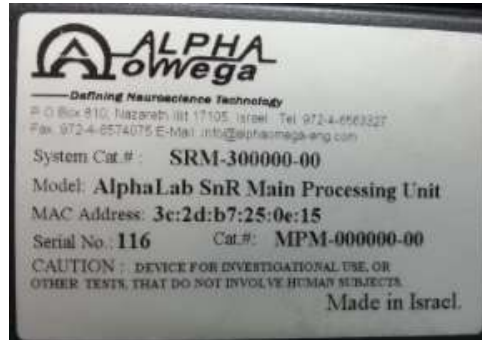


Figure 8 - Rack Mount Unit Label

4. **User Mac:** - Select the MAC address of AlphaLab SnR Computer Ethernet Board that will be connected to the AlphaLab SnR system. This is specifically important if you will have more than one station connected to the system. If you do not know which one to select, simply select the first one available.
5. **Enable Boot** – Check this box if the computer being setup may boot the system.
6. **System Sampling Rate** – Select the Max sampling rate of your system. All newer system have a 44,000 sampling rate, If you do not know what sampling rate your system is running on you should check that with AO technical staff.
7. **System Low Latency Mode** – This option applies to systems of up to 32 channels. When checked it enables a faster reaction or response time to certain events. For operation instructions, see [4.5.2.1](#).
8. **Disable Template Match Points** – This option allows using online sorting using Include/Exclude Bars. When checked it disables the template match algorithm and sorting will take place using 3 Include and 1 Exclude Bars.
9. **Press OK** to close the “System State” window.

At this point you have defined the basic connection parameter between the AlphaLab SnR system and the AlphaLab SnR computer. Other hardware configurations including what hardware exists in the MPU and what hardware exist in the SIU will be done automatically when the first actual connection is made between the AlphaLab SnR system and the AlphaLab SnR computer.

Note: if preamps are used with the system, they will need to be defined from the User Interface options after software is started.

3 ALPHALAB SnR INITIALIZATION

Before using the AlphaLab SnR system, the user must set all the hardware (see section 2.2.5) and software parameters will be used, and create a workspace in which signals will be displayed and controlled.

Note that windows 7 & windows 10 users might need to give administrator permission to run the AlphaLab SnR.

In addition, Anti-virus (not provided from AO) might block the system connections. Users might have to block the Anti-virus to run the AlphaLab SnR software.

3.1 Building a New Workspace File

Workspace definition is the process of defining how signals of all input channels will be displayed on the screen. There is no relationship between logging and display, meaning that a certain channel may be displayed but not saved, or saved but not displayed. Adding, deleting, and editing display groups are explained in Section 3.2 below. At any time is possible to save the workspace under any selected name.

To start a new workspace from scratch, select the menu option File/New and the following dialog pops up. Follow the steps below:

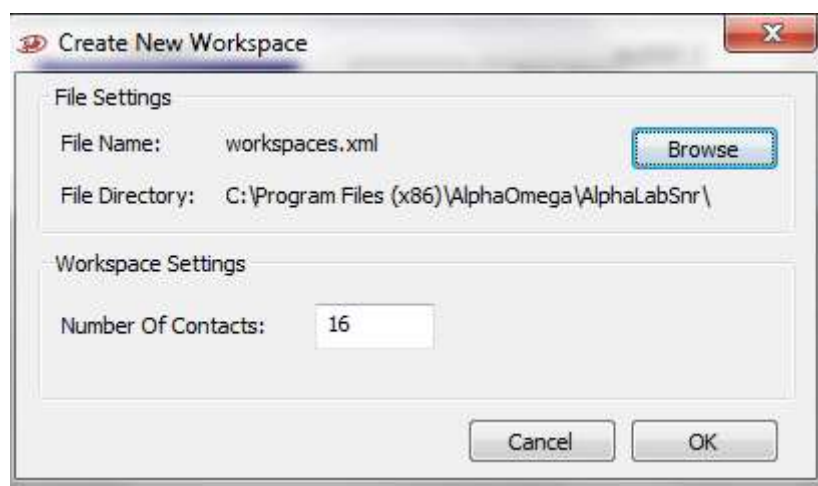


Figure 9 – Create New Workspace Dialog

1. In the File Settings section select the name of the new workspace by pressing the **Browse** button and selecting a folder and a name.
2. On the Workspace Setting specify the number of recording electrode contacts you want in this workspace. The system will allow you to define any number of contacts regardless of what you have available in the system. Meaning if you have a 64 channel system, it is possible to define a 16 channel workspace.
3. Press OK, and the software will automatically restart.
4. Add new Display groups as explained below.

This process can be repeated every time a new work space needs to be build based on the experiment.

3.2 Display Group Editing

Defining display groups is done by using the “**Group Settings**” option under the “**Windows**” menu option. Clicking this option opens the group settings window shown below. As shown it will show a list of defined groups and it allows deleting any group, editing any group and it allows creating new groups. To create a new group, select the group type from the drop down box in the lower right corner and press the “**Create**” button. The table in the section 3.3 below details which display groups may be defined from the UI and which Create type to use.

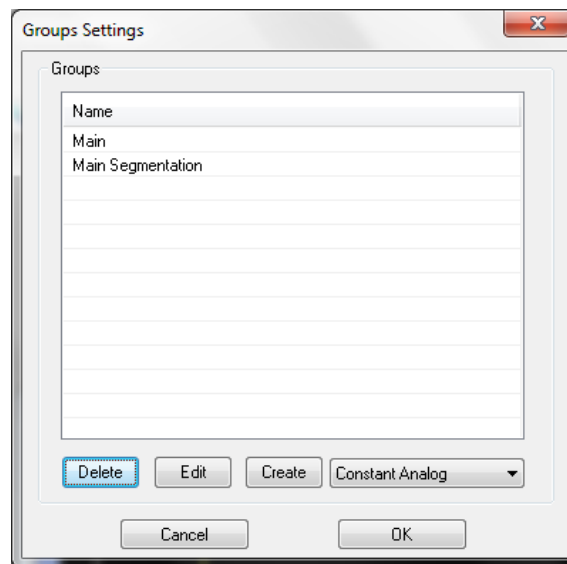


Figure 10 - Group Settings Window

Note that when editing any group, the group layout and parameters setting will be reset to default values.

3.2.1 Defining Main Display Group

Select the “**Main**” option from the drop down to create the main display group where all different signals available of one electrode channel are displayed in addition to defining the segmentation options. The channel displayed in this group is set by other groups defined to control the main display group. When this option is selected it may define two separate displays named “Main” and “Main Segmentation”. The figure below shows the definition window followed by a detailed explanation of each field.

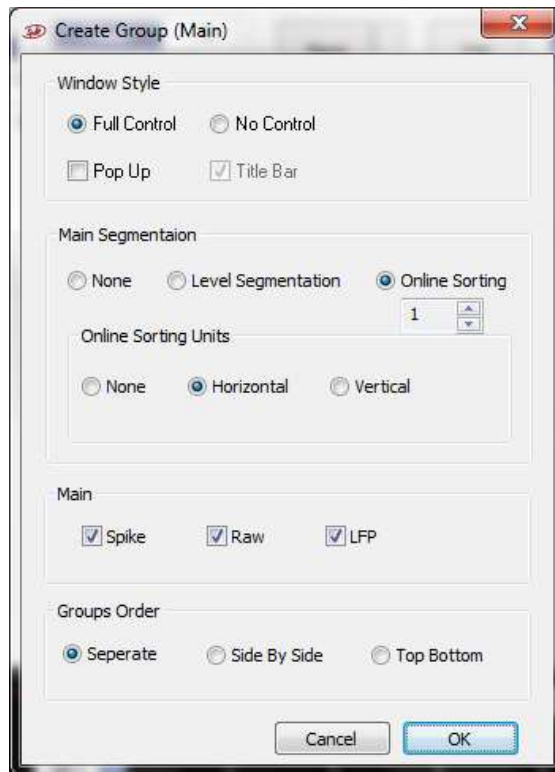


Figure 11 - Main Group Definition Window

Window Style – Select the window style of the group. Options are as follows:

Full/No Control – Show/Do not show the window maximize, minimize, and/or restore buttons for this group.

Pop Up – When checked this group will be displayed outside of the main application pane.

Title Bar – If unchecked with the “No Control” option it will remove the top title bar.

Main Segmentation – Select the options for the main segmentation window. Options are as follows:

None – Do not show a segmentation window.

Level Segmentation – Show a segmentation window that will allow segmentation based on threshold crossing only.

Online Sorting – Show one or more segmentation windows that will allow segmentation based online sorting. When this option is used it is possible to define up to 4 segmentation windows. By default if more than one segmentation window is defined the first window will default to the first unit and the second window to the second unit, etc. It is also possible to display the units in separate window adjacent to the segmentation window by selecting Horizontal or Vertical options. .

Main – Select the options for the main window. Options are as follows:

Spike – Show/Do not show SPK signal for the selected channel.

Raw – Show/Do not show Raw signal for the selected channel.

LFP – Show/Do not show LFP signal for the selected channel.

Not selecting any of the option will not show the main group at all.

Groups Order – Define how to show the Main and Main Segmentation groups if defined. Options are as follows:

Separate – Show “Main” and “Main Segmented” groups in separate groups. Groups will be named “Main” and “Main Segmented” accordingly.

Side By Side – Show “Main” and “Main Segmented” as two subgroups side by side in a single group. The single group will be named “Main”.

Top Bottom – Show “Main” and “Main Segmented” as two subgroups above each other in a single group. The single group will be named “Main”.

3.2.2 Defining Current Monitor Display Group

Select the “**Current Monitor**” option from the drop down to add the current monitor display. This creates the group without any further option settings.

3.2.3 Defining Digital Display Groups

Selecting the “**Digital/Port/I/O**” opens the digital group definition window. Each time this is opened it will allow you to define one group of digital input or output channels or ports.

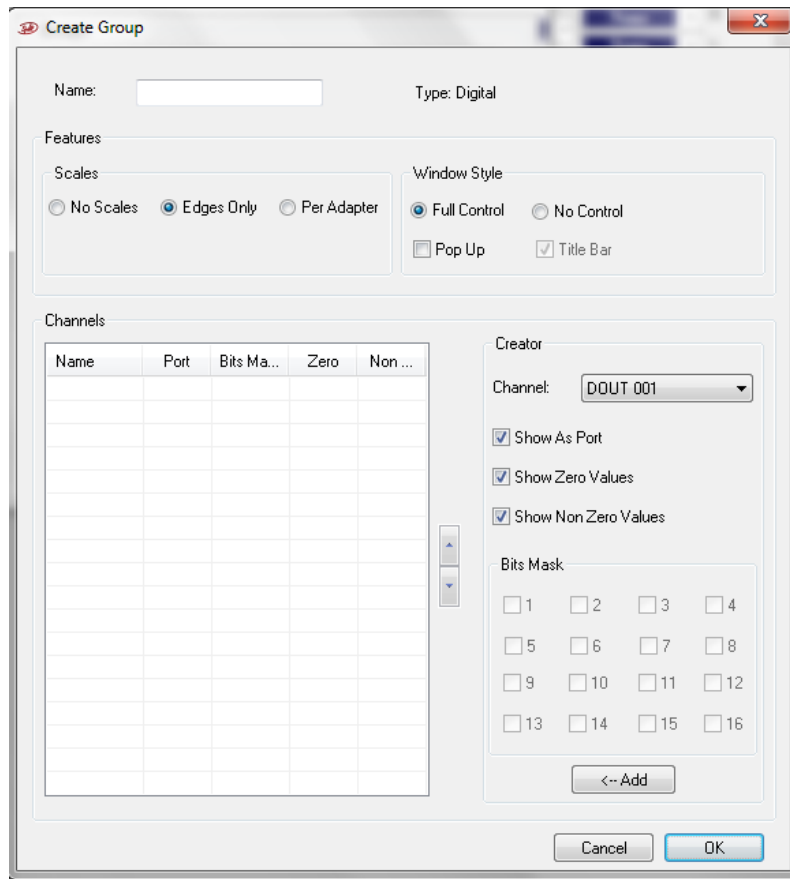


Figure 12 - Digital Group Definition Window

Name – Specify a name for the group. This will appear in the top horizontal title bar and also in the vertical left title bar if they exist.

Scales – Select what scales will be displayed. Options are as follows:

No Scales – No time scales will be displayed, and changing the duration of the display will be done only using the right click hot key functions.

Edges Only – Only one scale at the bottom will be displayed, and changing this scale will take effect on all channels displayed in this group.

Per Adapter – Each channel will have its own scale, and changing this scale will not affect all channels displayed in this group.

Window Style – Select the window style of the group. Options are as follows:

Full/No Control – Show/Do not show the window maximize, minimize, and/or restore buttons for this group.

Pop Up – When checked this group will be displayed outside of the main application pane.

Title Bar – If unchecked with the “No Control” option it will remove the top title bar.

Channels – Select the list of channels or ports that will be displayed. Selected channels will be shows in the grid below. Once they are displayed in the grid,

the Up/Down button to the right of the grip can be used to move the channels up or down the window.

Creator – Select and use the “**Add**” button to add lines to the grid. Once group is created, the value in parenthesis next to the channel name shows the last value received for digital channel and full ports, while it shows “0” or “1” when Bits Mask is used for a port. In this case “0” means all bits are zero, and “1” means that at least one of the bits is “1”. Remember that displaying a port using the Bits Mask does not affect the logging of the port, which is always saved as a full 16 bit port.

Channel: Select what channel or port to add.

Show as Port – Available only when port is selected. Checking this means display the whole 16bit port as one display channel/line. When unchecked, the user can select one or any combination of bits out of this port to be displayed as one display channel.

Show Zero Values – If checked a white tick mark will be shown every time the channel or port gets a zero value.

Show Non Zero Values – If checked a green tick mark will be shown every time the channel or port gets a non-zero value.

Bits Mask – Select which bit or bits to track on the display. This may be used only when port is selected and the “**Show as Port**” option is unchecked.

3.2.4 Defining Analog Display Groups

Selecting any of the analog display groups opens the analog group definition window. Each time this is opened it will allow you to define one group of analog inputs, which include Segmented, SPK, Raw, LFP, Triggered SPK or LFP, User Defined, additional Analog inputs, or any statistical display which is a result of the analog channels. Multitrode display (section 3.8) and X/Y display (section 3.3.18) definitions are explained separately later. If you define a group of which only one group is allowed, this group type will not appear again as a

selection option. Some options may be filled in automatically or grayed out based on which type was selected.

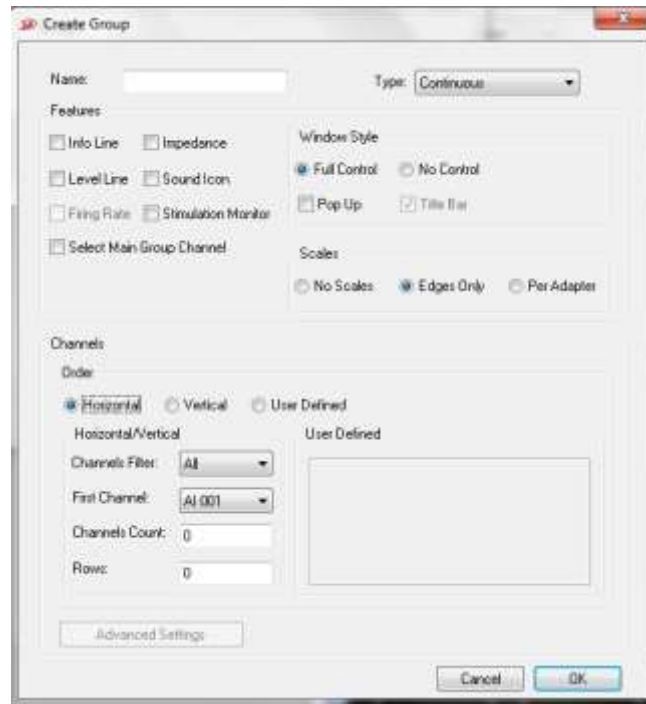


Figure 13 - Analog Group Definition Window

Name – Specify a name for the group. This will appear in the top horizontal title bar and also in the vertical left title bar if it exists.

Type – Select Segmented, Continuous, Continuous Triggered, Spike Raster, or PSTH.

Features - On the left side select the type of information or controls you would like to see on each channel display.

Window Style – Select the window style of the group. Options are as follows:

Full/No Control – Show/Do not show the window maximize, minimize, and/or restore buttons for this group.

Pop Up – When checked this group will be displayed outside of the main application pane.

Title Bar – If unchecked with the “No Control” option it will remove the top title bar.

Scales – Select what scales will be displayed. Options are as follows:

No Scales – No time scales will be displayed, and changing the duration of the display will be done only using the right click hot key functions.

Edges Only – Only one scale at the bottom will be displayed, and changing this scale will take effect on all channels displayed in this group.

Per Adapter – Each channel will have its own scale, and changing this scale will not affect all channels displayed in this group.

Channels – Select the list of channels that will be displayed in the group and in what order.

Order – Horizontal - Arrange selected channels starting from top row from left to right in order, and once a row is full, go to the next row starting from the left, and so on. One must select the First Channel to be displayed if not filled in already, Channels Count, and Number of Rows.

Order – Vertical - Arrange selected channels starting from left column from top to bottom, and once column is full, go to the next column starting from the top, and so on. One must select the First Channel to be displayed if not filled in already, Channels Count, and Number of Rows.

Order – User Defined – If available and checked, you must leave the First Channel ID, Channels Count, and Number of Rows at 0, and fill in the area to the right under “User Defined” caption with channel ID’s separated with commas. To go to the next line, press **Ctrl Enter**. In this case channels will be arranged in the display group exactly in the order they were entered here.

Channels filter – Choose the suitable hardware filter for the specified channel.

First channel- first channel for the current display group.

Channels counts- number of channels for the specified input. Note that you can only display 64 channels in the same display window.

Rows- number of rows the group display will contain.

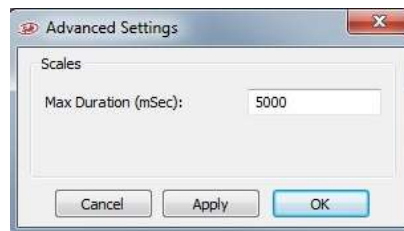


Figure 14: Continuous group advanced settings

Advanced Settings – Allow the user to choose the time range of the displayed window for continuous groups (see [Figure 14](#)). When triggered display or other statistical option is used, this button allows selecting the trigger that will be used and the Pre and Post duration, and number of segments to display on each window before erasing as shown in the figure below. Options for different displays may be different, and will also be available after displaying the group using right click hot menu item. Note that if colors are set Average and Last Signal the colors will hold true on any triggered display.

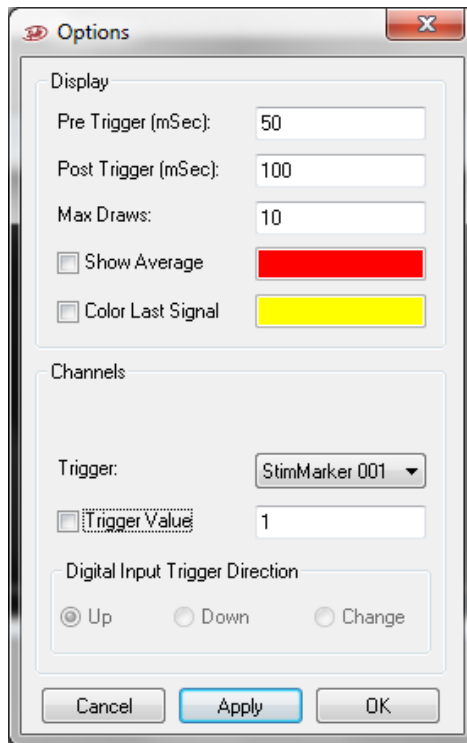


Figure 15 - Advanced Setting Window

3.3 Workspace Display Groups

Any display group may be defined to be displayed within the application main window pane, or totally outside the AlphaLab SnR application as a standalone window. Any display group inside or outside the main window pane has the 3 standard Windows controls of Close, Maximize/Restore, and Minimize/Restore and the operate according the normal standards of Windows. Groups outside the main pane will always be on top, or may be moved away to other monitors. The table below details all display groups possible, and gives information on how they can be defined in the User Interface “**Group Settings**”. The table is followed by a detailed description and sometimes screen shots of the display groups.

*Note: After defining all desired windows and arranging the layout, you may save your layout by pressing **ctrl+shift+S** to get admin permission, and then select **save as default layout** (see [Figure 16](#))*

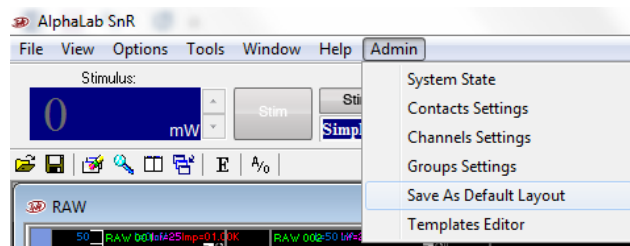


Figure 16: saving layout

Described in Section	UI Definition Limitation	UI Group Settings Create Type
3.3.1	One group for main and one group for main segmentation definition created and edited together. Both may also be defined as one group.	Main
3.3.2	One group only	Current Monitor
3.3.3	Multiple groups	Constant Analog
3.3.4	One group only	Selected SPK
3.3.4	Multiple groups – works as Featured	Constant Analog
3.3.5	One group only	Selected Raw
3.3.5	Multiple groups – works as Featured	Constant Analog
3.3.6	One group only	Selected LFP
3.3.6	Multiple groups – works as Featured	Constant Analog
3.3.7	Multiple groups	Constant Analog
3.3.8	One group only (Evoked Potential)	Selected SPK Triggered
3.3.8	Multiple groups (Evoked Potential)	Constant Analog
3.3.9	One group only (Evoked Potential)	Selected LFP Triggered
3.3.9	Multiple groups (Evoked Potential)	Constant Analog
3.3.11	Multiple groups	Constant Analog
3.3.12	Multiple groups	Constant Analog
3.3.13	Multiple groups	Digital/Port/IO
3.3.14	Multiple groups	Digital/Port/IO
3.3.15	Multiple groups	Digital/Port/IO
3.3.16	Multiple groups	Multitrode

Described in Section	UI Definition Limitation	UI Group Settings Create Type
3.3.16	Multiple groups	Multitrode Cluster
3.3.17	One group	Selected SPK Raster
3.3.17	Multiple groups	Constant Analog
3.3.17	One group only	Selected PSTH
3.3.17	Multiple groups	Constant Analog
3.3.18	One group only	X/Y Display

3.3.1 Main Electrode Display Group

The main electrode display group may display one or more signal types, such as Spike filtered, LFP filtered, or Segmented, coming from a certain electrode. The selection of what electrode will be displayed in this group takes place by clicking on that electrode in the segmented display group. As shown in [Figure 17](#) below, Spike and/or LFP are displayed in one subgroup, and the Segmented is displayed in a second subgroup. The two subgroups can be displayed, in a Side-by-Side, Top-Bottom, or Two-Group mode.

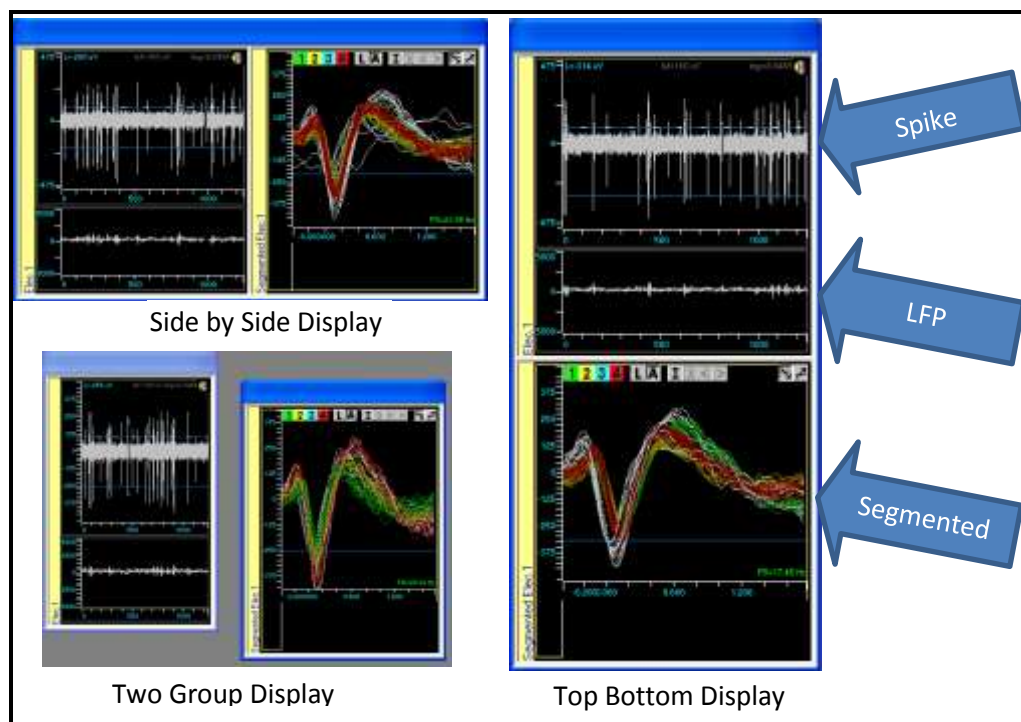


Figure 17 – Main Group Display Options

This group is where the user defines all the segmentation and online sorting parameters. This is described in detail in sections [4.3](#) and [4.4](#) below.

3.3.2 Stimulation Current Monitor

The Stimulation Current Monitor window shows an indication of the current injected in a selected electrode. *Figure 18* below shows an example of the current monitor bar with a value of 286uA.



Figure 18 – Current Monitor Bar

The Current Monitor works in conjunction with the part of the user interface that is responsible for handling the stimulation, shown in *Figure 19* below.



Figure 19 – Current Stimulation Controls

Pressing the Stim button will stimulate the electrode selected in the drop down box, and the actual current injected in that electrode will display in the Current Monitor Bar. The value shown for square stimulation pulses is the instantaneous absolute maximum value, while for arbitrary wave forms it shows the maximum absolute current reached within the stimulation period. If the measured value below or above requested value by 30% or more, then the bars will be displayed in pink color.

3.3.3 Segmented Display Group

In the basic AlphaLab SnR system, spike filtered data is segmented by simple level crossing method. When the signal crosses a certain threshold set by the user, a short segment of data is extracted, starting shortly before and ending shortly after the crossing time. In more advanced AlphaLab SnR systems, spike filtered data is segmented by online sorting algorithms. In both cases, the extracted segments are displayed in the Segmented Display group, which clearly shows the sorted spikes in different colors for each electrode. *Figure 20* below shows an example of segmented channel display group. It is also possible to display segmented channels

in several such groups to allow better display on smaller monitors. Displayed segments will be erased on a first-in-first-out basis by specifying a count or a period of time. This can be done after the display group is defined using the Hot Menu option “Options”. This may also be done on the Main segmentation windows as well.

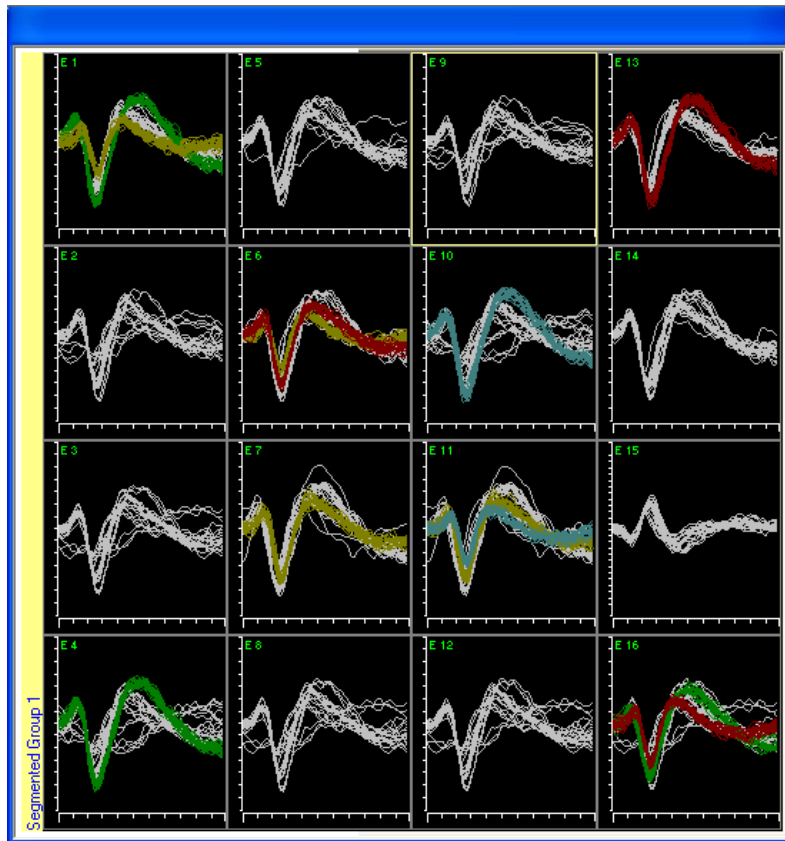


Figure 20 – Segmented Channel Display Group

In addition to displaying segmented data, the segmented channel display acts as a control panel for other groups or signals coming from electrodes. For example, when a channel is clicked on in this group, it is displayed in the Main Electrode Display Group. The effect of selecting a channel in the segmented display group on other groups will be explained under the section that explains that group.

A right click hot menu option, or by double clicking on any of the channels, it is possible to set a limit of how long a spike will be displayed, after which it is erased regardless of the number of spike that came after it.

In addition to showing the segmented data, it is also possible to see the stimulation current monitor of each electrode next to its corresponding segmented display. This is very useful when using scripts to stimulate several electrodes, and allows the user to monitor stimulation on all channels simultaneously. The figure below show an example of a segmented display with the corresponding current monitor amplitude bar display next to it.

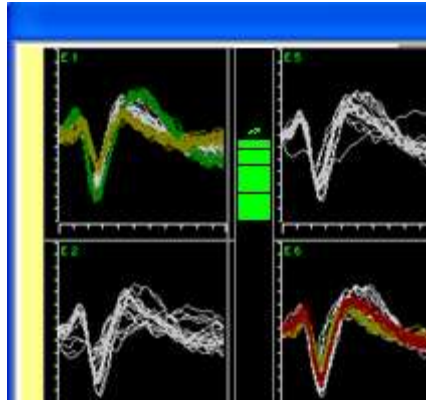


Figure 21 – Stimulation Current Monitor in Segmented Display

3.3.4 Spike Filtered Continuous Display Group

Spike filtered continuous signals coming from electrodes are displayed in this group. Two display modes are possible here, one is displaying a constant channel in each channel window, and the other is display a variable channel based on the focus channel. It is recommended to display either 16 or 32 channels in this group. When using the variable display mode, especially in high channel count systems, the channels that are displayed in this group will depend on the selection made in the segmented channel display group.

For example, if the system is recording from 64 electrodes and the continuous display group is set to display 16 channels, channels 1-16 will display when any of these channels are selected in the segmented group, channels 17-32 will display when any of these channels are selected in the segmented group, channels 33-48 will display when any of these channels are selected in the segmented group, and channels 49-64 will display when any of these channels are selected in the segmented group. *Figure 22* below shows an example of how 16 spike-filtered channels are displayed when channel 18 is selected in the segmented group display.

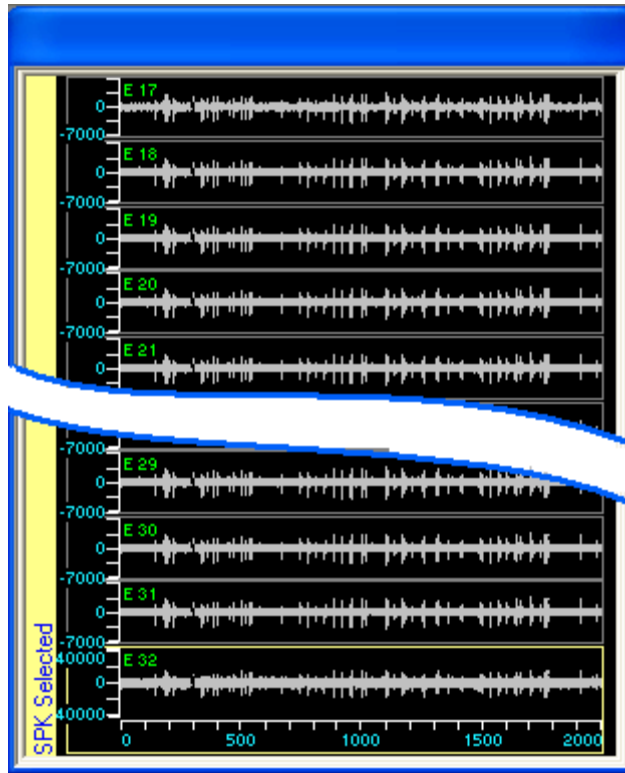


Figure 22 – Spike Filtered Continuous Display

3.3.5 Raw Continuous Display Group

The RAW continuous display group behaves exactly as the spike filtered continuous display group, except that it will display the unfiltered signals coming to the GUI.

3.3.6 LFP Filtered Continuous Display Group

The LFP filtered continuous display group behaves exactly as the spike filtered continuous display group, except that we are dealing with the Local Field Potential activity, which is a low frequency activity.

3.3.7 Featured Continuous Display Group

This group displays continuous channels where the user has the option to select what channel will be displayed in each sub-window using a right click option.

3.3.8 Spike Filtered Triggered Display Group

As the title implies, spike filtered continuous data is displayed in this group for a defined period of time every time a certain defined trigger occurs. Two display modes are possible here, one is displaying a constant channel in each channel window, and the other is display a variable channel based on the focus channel. It is recommended to display either 16 or 32 channels in this group. When using the variable display mode, especially in high channel count systems, channels displayed in this group will depend on the selection that is made in the segmented

channel display group. Selection behaves exactly like the continuous channels described above.

Figure 23 below shows an example of how 16 spike-filtered triggered channels are displayed when channel 5 is selected in the segmented group display. In this case, the user selected 50 mSec before the trigger, and 200 mSec after, so the total duration is 250 milliseconds. Trigger for this group may be selected as one of the available digital inputs or one of the StimMarker ports. This can be done using the right click option.

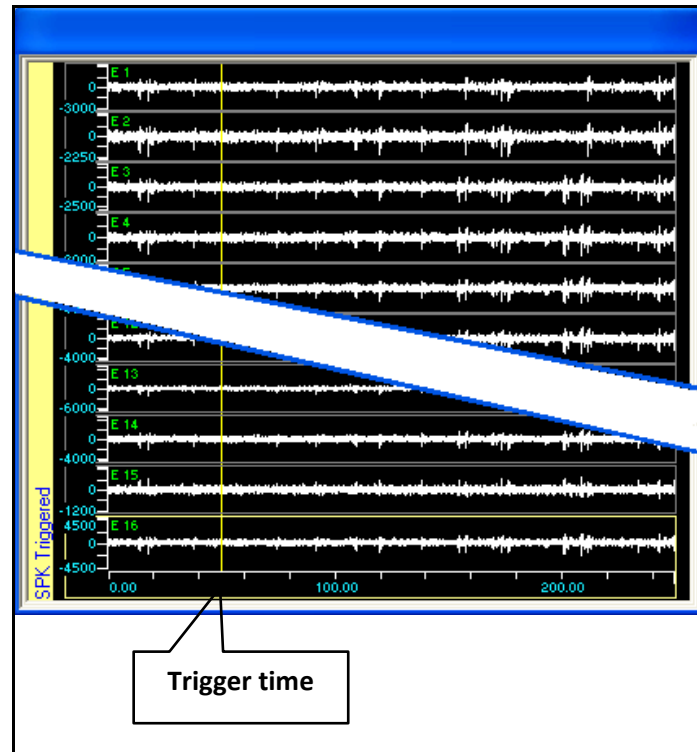


Figure 23 – Spike Filtered Triggered Display

Triggered display may behave as Evoked Potential display by selecting the Show Average option at definition time in the Advanced setting, or later using the right click hot menu option.

3.3.9 LFP Filtered Triggered Display Group

The LFP filtered triggered display group behaves exactly as the spike filtered triggered display group, except that we are dealing with the Local Field Potential activity, which is a low frequency activity.

3.3.10 Selected group display

When choosing the selected signal option for any type (LFP/SPK/RAW- see *Figure 24*), you can select specific channel to display in this group window. Note that you can only display following channels in this window when choosing more than channel.

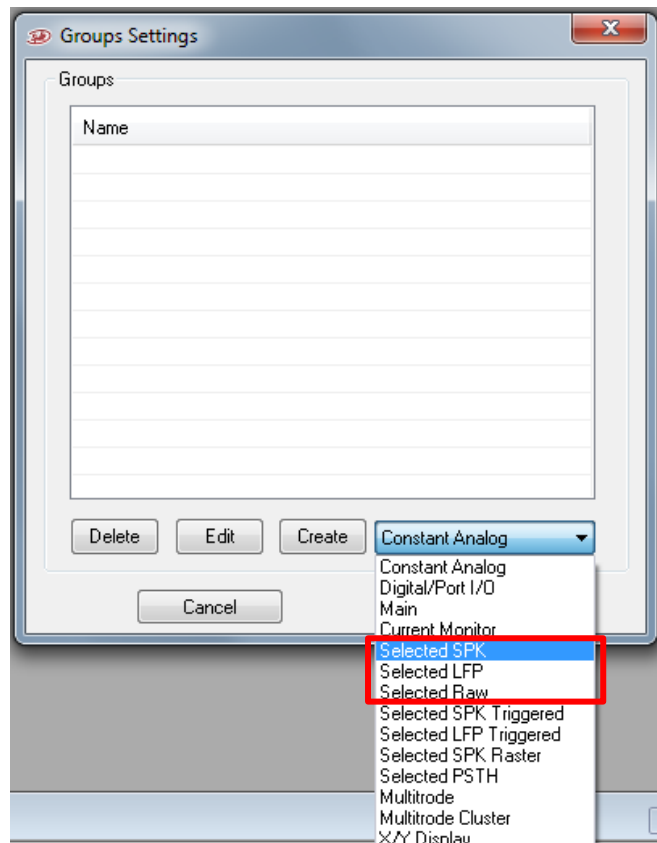


Figure 24: Selected channels option

3.3.11 General Purpose Analog Inputs Display Group

The basic AlphaLab SnR system comes with 16 general purpose analog inputs located on the Main Processing Unit (Rack Mount Unit). A second set of 16 general purpose analog inputs may be optionally added to the Signal Integration Unit (Front End Unit). These channels may be displayed in one or more groups. Display of these channels is similar to the Spike Filtered channels.

3.3.12 User Defined Analog Channels Display Group

These are internal analog channels that the user can define and they will be generated by the system. Up to 4 channels can be defined. They can be displayed, logged, and routed through analog outputs if needed. The figure below shows an example.

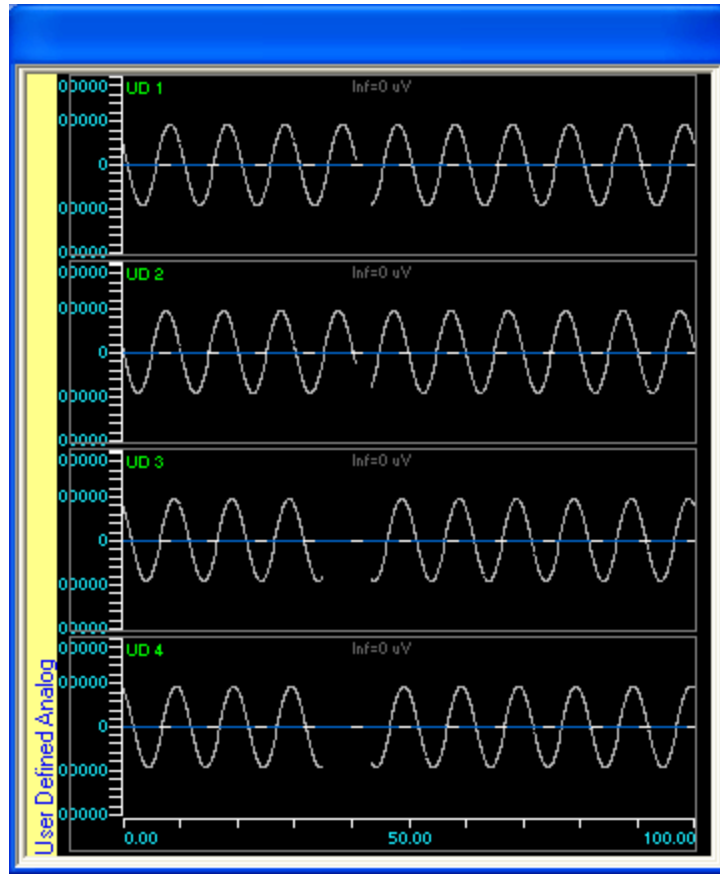


Figure 25 – User Defined Channels Display Group

3.3.13 Single-Bit Digital Inputs Display Group

The basic AlphaLab SnR system comes with 4 digital (standard TTL) inputs located on the Main Processing Unit. A second set of 4 digital inputs may be optionally added to the Signal Integration Unit. These channels may be displayed in one or more groups. For each channel, a colored tic mark indicates going to active high (1), and a white tic mark indicates the change to active low (0). It is possible to optionally display only 1's or only 0's for any channel. The last status of every channel is also displayed by the channel label. *Figure 26* below shows an example of how 4 digital inputs are displayed.

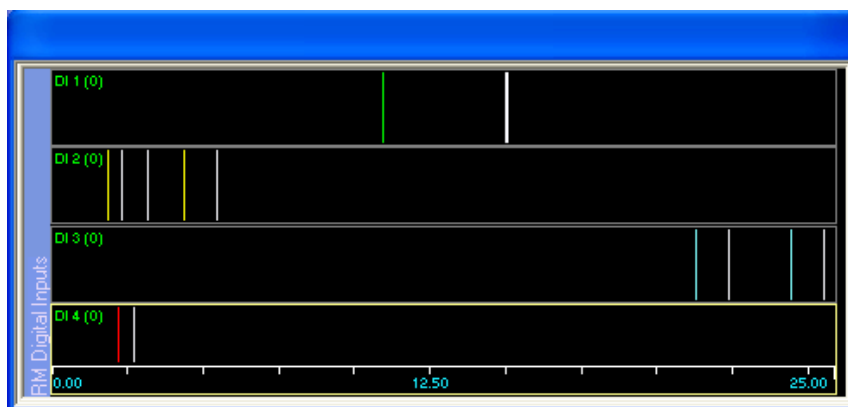


Figure 26 – Single-Bit Digital Inputs Display

3.3.14 Digital Input Port Display Group

The basic AlphaLab SnR system comes with one 16-bit digital input port located on the back panel of the Main Processing Unit. One additional 16-bit input port may be optionally added to the Signal Integration Unit, and 8 additional 16-bit ports may be added to the Main Processing Unit. These channels may be displayed in one or more groups. A Colored tic mark is displayed every time a new value comes in and the value is displayed by the label.

3.3.15 Digital Output Port Display Group

In this group digital output channel are displayed in a very similar manner as the input port. These channels may be displayed in one or more groups. A Colored tic mark is displayed every time a new value comes in and the value is displayed by the label.

3.3.16 Tetraode/Multitrode Display Group

In this type of group defined tetrodes/multitrodes are displayed. Many tetrode subgroups may be defined within this group. Each subgroup works in selectable mode, where with a right click option it is possible to change the tetrode displayed in it. In addition to the segmented data belonging to the tetrode, it is also possible to display a clustering window next to each tetrode as a quality assurance tool. See section 4.14 for details. [Figure 27](#) below shows the Tetraode display group with clustering window next to each tetrode, while [Figure 28](#) shows the standalone clustering window.

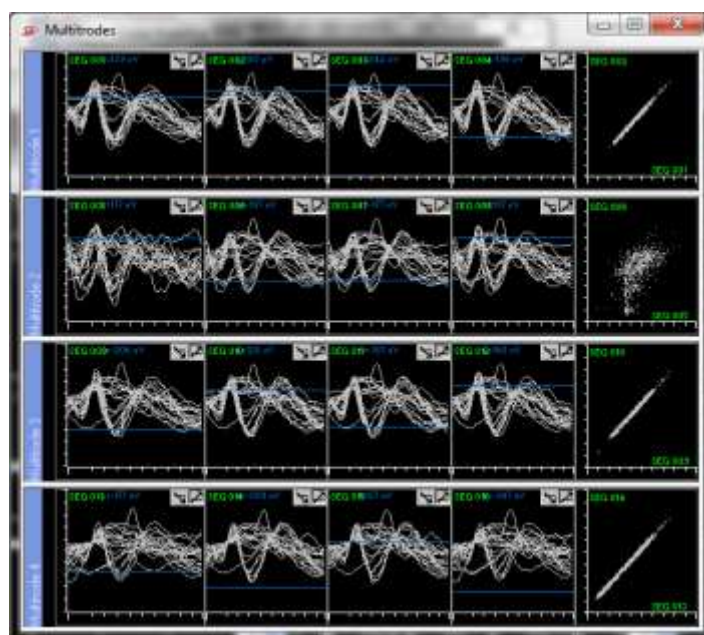


Figure 27 – Tetraode Display Group

Note: When using tetrode/Multitrodes, the online sorting will be deactivated and templates cannot be applied.

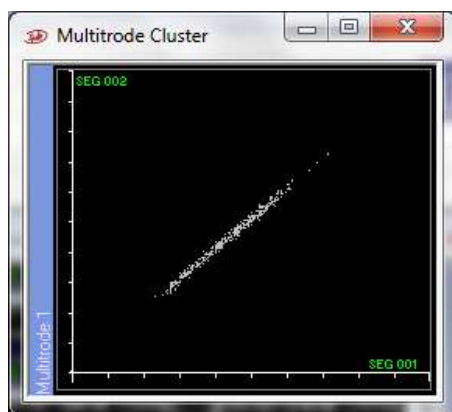


Figure 28 – Tetrode Clustering Window

3.3.17 Statistics windows

It is possible to display the following online statistical tools. On each tool it is possible to change the display options with a right mouse click. The options window for each statistical tool is self-explanatory, and the options for them:

1. Raster –

To define Raster window, go to group setting-> create constant analog-> Spike Raster. The user can change the time duration and the number of displayed rows in advanced setting.

- a. Displays bins for segmentation detections when crossing the level line. At any time it is possible to select what channel and what detections are displayed on each raster display. It is possible to display a group or one featured channel. Bins are colored based on the color of the template that it belongs to. Below is an example.

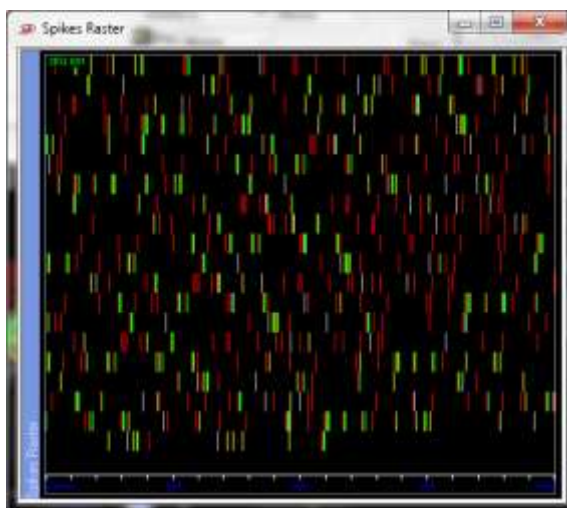


Figure 29 – Raster Display

- b. Detection according to a trigger (digital input (TTL1-4)). The raster window displays a cross when the trigger changes from down to up (number 4 in *Figure 30*) and a circle when it changes from up to down (number 3 in *Figure 30*).

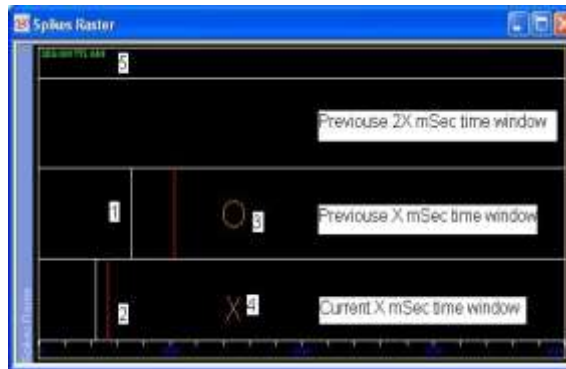


Figure 30: Raster display window when trigger is connected

- 2. Evoked Potential – displays a time window of LFP or SPK signal based on a trigger. And on top of the signals displayed it display a colored line showing the average of all displayed signals. Trigger for the evoked potential may be set as one of the digital inputs or any of the StimMarker ports. Below is an example.

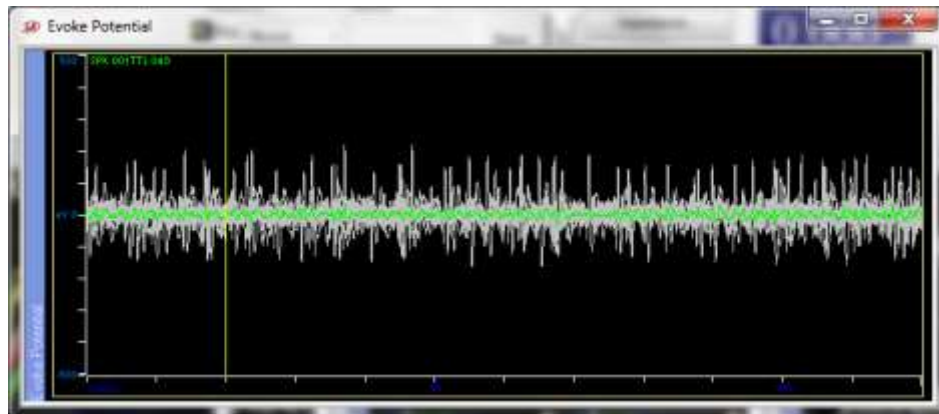


Figure 31 – Evoked Potential Display

- 3. PSTH – Similar to Raster display except that it is triggered, and count bins are displayed above the tic marks. System can handle up to 20 triggers per second.

PSTH can be triggered either via TTL inputs, digital input port (D-type) or stim markers. To define a trigger, right click on the PSTH window, choose options and select the digital trigger according to your needs (see *Figure 32*).

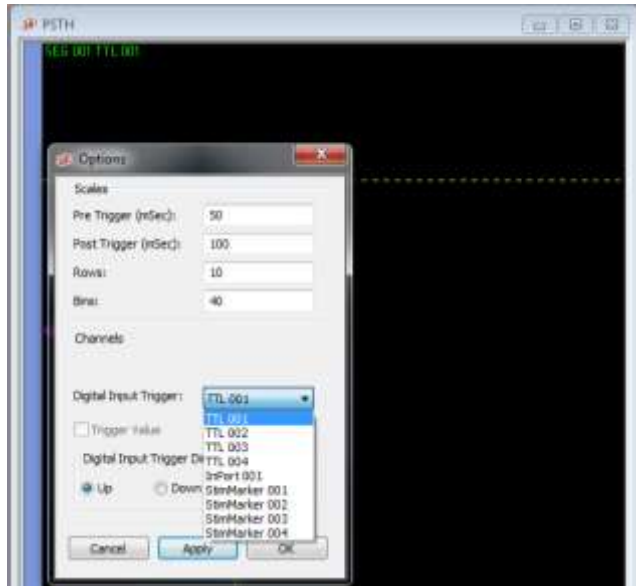


Figure 32: PSTH options window

Note: Only up to 32 windows of each type may be defined simultaneously.

3.3.18 X/Y Display window

Display two analog channels, from the same group type, in an x/y mode. This may be used to show things such as eye movement. Only one such group may be displayed at a certain time. It is possible though to change which channels are displayed in it using its Options hot menu item which is self-explanatory. The figure below shows an example of the X/Y display window.



Figure 33 – X/Y Display

3.4 Logging Options

“Logging Options” is used to set what will be saved to data files and how it will be saved. To set the logging options, select “Logging Options” from the “Options” menu. The “Logging Options” dialog box appears (see [Figure 34](#)):

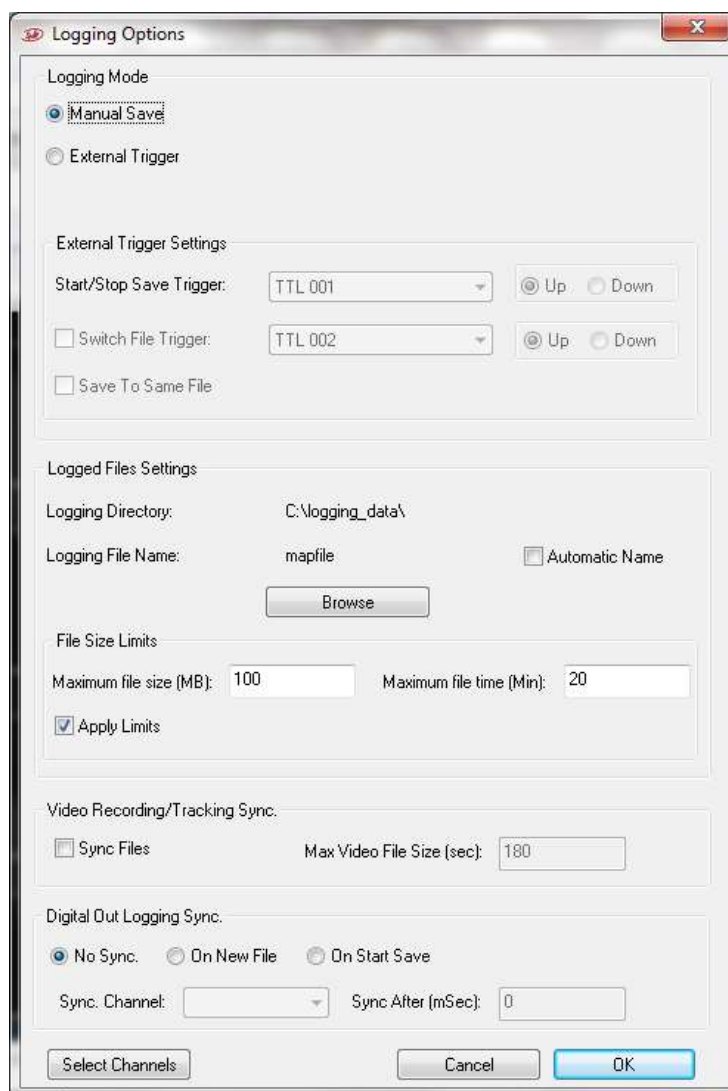


Figure 34 – Logging Options

The AlphaLab SnR saves files in *.mpx format, which is Alpha Omega proprietary binary format. For each recording session, which starts with starting the AlphaLab SnR software, it will also save a *.lsx files, which is a text files that lists all the files saved in the recording session.

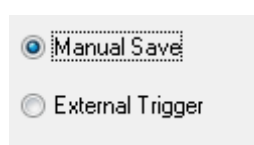
Important Note: *Logging data is one of the most important functions in the system. Once you start data logging it is not recommended to move or size windows in the GUI, or to jump between channels very quickly as such functions may interfere with the data logging and cause minor gaps in the data.*

Make sure the system is on, when setting the logging data options, otherwise the settings will not be saved.

Starting from the top left to the bottom, below is an explanation of options in each section.

3.4.1 Selecting Logging Mode

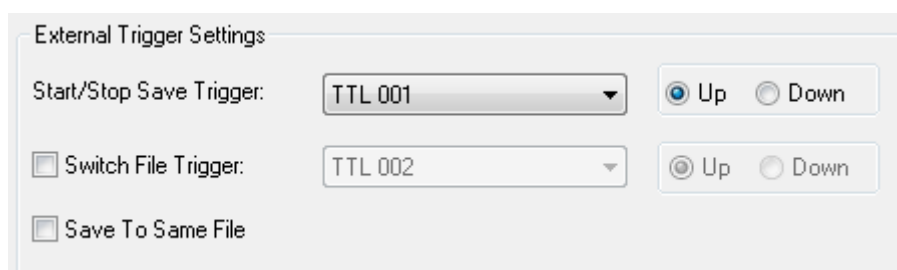
Logging could be manual by pressing a button, or triggered by a digital input. User must select one of the two options.



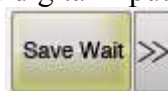
Below is an explanation of how pressing the “Save” button in the application banner behaves when each option is selected:

Manual save – When the user presses the “Save” button in the application banner, the “Save” button changes color to red and logging data begins immediately. Logging stops when the user presses the “Save” button again.

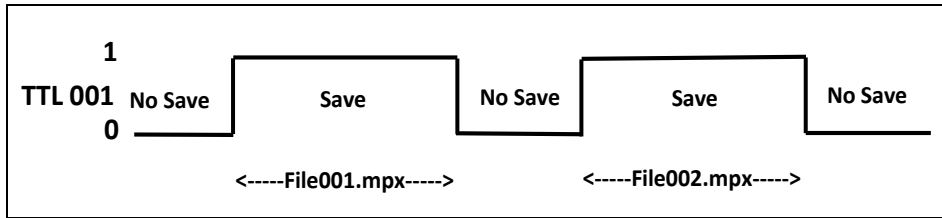
External trigger – This option works in conjunction with the section below it, where the user has to select a digital channel to be the saving trigger, and also when to save, on active high (Up) or active low (Down). In the screen shot below, “TTL 001” / “Up” was selected; meaning the digital input number 1 on the rack mount box will be used as the saving trigger, and saving will start when the TTL 001 is on active high (logical 1)



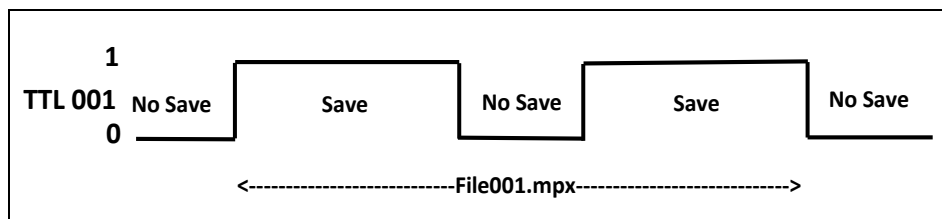
When the user presses the “Save” button in the application banner, the program then waits for a trigger on the specified digital input. When the “Save” button



is pressed it changes to the Save Wait () mode, and the program begins logging after receiving the value 1 on the selected digital input channel and stops saving after receiving the value 0. The figure below lays out the logging by trigger behavior **after** the “Save” button is pressed.



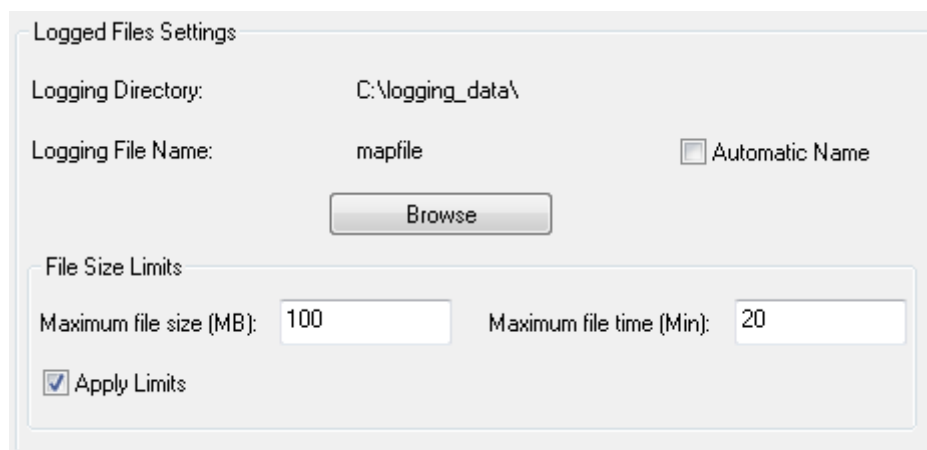
External trigger – save to same file – This option works exactly as the **External trigger** option, except that data is saved into the same file. The figure below lays out the logging behavior **after** the “Save” button is pressed.



Switch File Trigger: When this checkbox is checked, every time the specified digital channel goes to active high if “Up” was selected or low if “Down” was selected, the current file is closed and a new file is opened. Pay attention that the digital channel used here must be different than the one specified in the “Digital input trigger” line. This trigger has an effect only while logging is on; meaning if the save by trigger is used using active high of digital TTL 001, changes on TTL 002 in this case do not have any effect while TTL 001 is on active low.

3.4.2 Logged Files Settings

This section allows controlling the file name and folder as well as file size limitations. To change the logging file name and/or saving folder, press the “Browse” button.



The “Open Saving File” dialog box appears (see [Figure 35](#)).

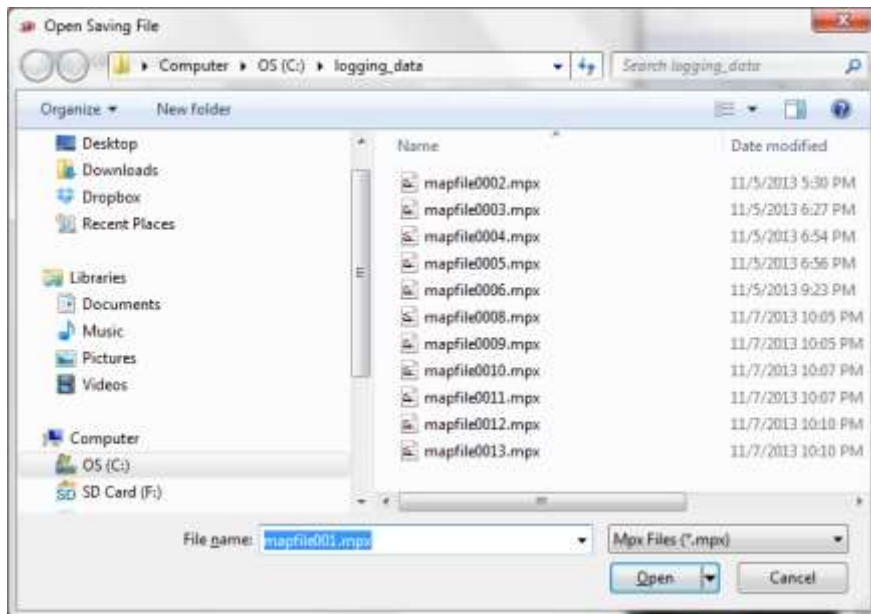


Figure 35 – Open Saving File

Select the desired folder and specify the file name and press Open. Files will be saved using the specified name and in the specified folder. The selected folder must be under C:\logging data.

If “Automatic Name” check box is checked the system automatically gives a name of **Fyymmdd** followed by an index as specified above where:

F = ‘F’ (the letter F)

yy = current year

mm = current month

dd = today's date

In both cases, an incremental index starting with 001 is added to the file name. If one or more files exist in the folder using the same name, the program automatically looks for the highest existing index and starts logging with the following index.

File Size Limits – This section allows setting the file size limits. Limits apply when the Apply Limits Check box is checked. When reaching one of the limits, the saved files will be separated.

Maximum file size (MB) - When the data file size reaches the value specified here, the current file is closed and a new file is opened automatically. The new file will have the same name as the one that was closed, but with an incremental running index. Maximum file size saved is about 1GB (1024MB) in all cases.

Maximum file time (min) - When the lapsed time since opening the current file exceeds the value defined here, the program closes the current file and begins saving data in a new file as above. If the value in

this field is 0, the program does not check the saving time. This limit will not be applied when triggered saving to same file is used.

Apply Limits - When this is not checked the, only the max file size of 1GB applies.

3.4.3 Video Recording/Tracking Synchronization

The AlphaLab SnR allows synchronizing file saving with certain video recording/tracking equipment, if connected. The dialog below is used to request such synchronization and followed by an explanation of behavior under compatible systems.

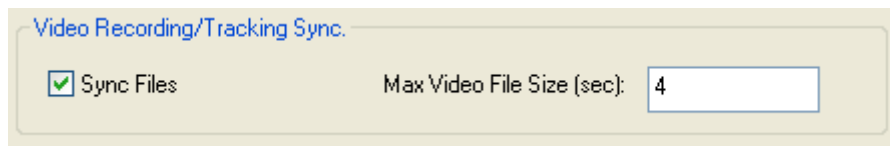


Figure 36 – Video Synchronization

Sync Files - If checked, the system will synchronize file saving and naming with the connected video recording or tracking system. If not checked, the AlphaLab SnR will still log records coming from the video recording or tracking system, but the systems will work independently as far as saving and file naming. When this option is checked, the following applies:

- Save Channels – Applies as usual
- Manual Save file size – Applies as usual within the synchronized files. Meaning that for one video file there could be several MPX files that are synchronized with it.
- Logging Mode – “Triggered” or “Manual save” may be selected
- File Name and Location – Only “Logging Directory” should be set. Other options in this section do not apply. Pay attention the naming convention of the files as you may have to set logging for different days into different folders

Max Video File Size – This parameter is applicable only to StreamPix 5 video recording system. It dictates the video file size limit in StreamPix 5.

File synchronization behaves differently for different connected applications, as follows:

EthoVision (9, 11.5) by Noldus (Position tracking) – EthoVision controls the logging on both systems, so logging starts and stops as trials are started and stopped in EthoVision. File Size limits apply here. Adding dll file into the noldus folder will save the x,y,z coordinates and timestamps into the mpX file saved by the SnR system.

StreamPix 5 by Norpax (Video recording) –StreamPix 5 file saving is controlled by the SnR, so video saving starts and stops when saving starts and stops in the SnR. “Max Video File Size” applies here, and within that several corresponding MPX files can be saved as well.

3.4.4 Digital Out Logging Sync.

This section of the logging options allows sending out a digital pulse to synchronize logging with other systems. When defined the system send out a 5mS active high TTL pulse. Options available are:

No Sync – Do not send out a sync pulse.

On New file – Send a pulse every time a new file is started.

On Start Save – Send a pulse only when logging is started.

Sync. Channel – Allows selecting the digital output channel the sync pulse will be sent out through.

Sync After (mSec) – Allows the user to send the pulse after a defined time delay.

3.4.5 Selecting Channels for Saving

To select a sub set of channel to be logged, press the “Select Channels” button on the bottom left corner, which opens a window where user can select specific channels for saving. This dialog also allows for changing the name of the channel as it is saved in the data file.

3.5 Impedance Settings

“Impedance Settings” is used to define the sine wave that will be used to test the impedance of the recording electrodes. The “**Impedance Settings**” dialog box appears (see [Figure 37](#)):

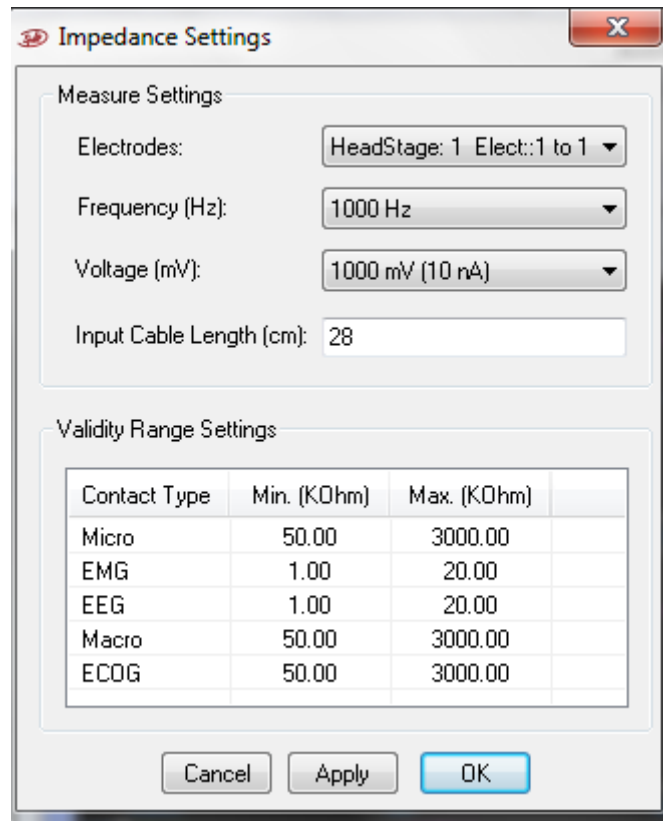


Figure 37 – Impedance Settings

Electrodes – Select which set of electrodes is being set. Electrode sets are in modules of 16 channels. “ALL Electrodes” means that the setting will be applied to all electrodes; otherwise, it is possible to select a set of 16 electrodes and specify settings for them.

Impedance Freq. – Select the sine wave frequency that the impedance will be checked with.

Impedance Voltage – Select the voltage of the sine wave that the impedance will be checked with. When a preamp with gain is connected, 100mV must be selected.

Input cable length – The length of the wire or cable used before the first amplifier. When a preamp is used with the free moving animal, this length has no effect.

Validity Range Settings – Define the range of impedance for each type of contact that you consider valid. Values below the minimum will appear as Low, and values above the maximum will appear as high.

Once these options are selected, Apply or OK should be pressed to apply the new parameters. OK closes the dialog, while Apply keeps the dialog open to allow for additional changes.

3.6 Contacts Settings

“Contacts Settings” is used to see all properties of each contact. A contact may be a micro electrode, a macro electrode, or EMG/EEG electrodes. Setting the contact type is done by Alpha Omega trained personnel or with their assistance. The contact type dictate what type or types of signals may be acquired and viewed for each contact. For example, it is possible to see LFP, SPK, SEG, and RAW signal from a micro contact, while it is only possible to see LFP signal from a macro contact. Selecting the “Contacts Settings” opens the “Contacts Settings” window shown below.

Contact	ID	HS Module	Pin	Type	Base Gain	Pre Amp Exists	Pre Amp Gain	Always Grounded
1	10000	1	1	MICRO	20.00	No	1.00	False
2	10001	1	2	MICRO	20.00	No	1.00	False
3	10002	1	3	MICRO	20.00	No	1.00	False
4	10003	1	4	MICRO	20.00	No	1.00	False
5	10004	1	5	MICRO	20.00	No	1.00	False
6	10005	1	6	MICRO	20.00	No	1.00	False
7	10006	1	7	MICRO	20.00	No	1.00	False
8	10007	1	8	MICRO	20.00	No	1.00	False
9	10008	1	9	MICRO	20.00	No	1.00	False
10	10009	1	10	MICRO	20.00	No	1.00	False
11	10010	1	11	MICRO	20.00	No	1.00	False
12	10011	1	12	MICRO	20.00	No	1.00	False
13	10012	1	13	MICRO	20.00	No	1.00	False
14	10013	1	14	MICRO	20.00	No	1.00	False

Figure 38 – Contacts Settings Window

Selecting one or more rows and clicking the Properties button opens the contact’s properties window show below, which is followed by an explanation of each field.

Properties

Contacts: 5

Properties

Type: MICRO

Pre Amp Gain: 1

Always Grounded

Buttons: Cancel, Apply, OK

Figure 39 – Contacts Properties Window

Contacts – Select which set of contacts is being set. It is possible here to select a list or a single contact number or range of contact numbers separated by comma. Ranges are separated by a hyphen.

Type – Shows the type of the selected contacts. This is informational only. If more than one type of contact exists in the selected list, the word mixed will be shown.

Pre Amp – Check this box if a pre amp is installed on this contact. This Check box must be checked even if the gain in the preamp is 1 to allow the impedance check to work properly. In preamps that have stimulation channels, the stimulation channel should be marked as not having a preamp and the right cable length must be specified in the Impedance Settings Window. If a Preamp (gain 1) is used, this option must be checked to make sure impedance checking works properly.

Gain – Specify Pre Amp gain, or 1 for Preamp HeadStage.

Always Grounded – If checked, it means that this contact will never be in recording mode; it will rather be always grounded except if stimulated. This function is used when a pre amp with stimulation capability is used to help reduce noise introduced by the stimulation lines. Pay attention that stimulation contacts in preamps can be used only for stimulation and not for recording because their input and output pins are shorted to allow the passage of the stimulation current to the electrode and their pre amp electronics are disconnected and neutralized. To make this clearer, we will take an example of a 16 channel system that uses one preamp with 14 recording and 2 stimulation electrodes. Normally the stimulation contacts in this case are 1 and 9 and should be always grounded unless when stimulation is applied. This can be accomplished in two steps in the Contact Properties, as follows:

1. Enter “1, 9” in the contacts field, uncheck the “Pre Amp” check box, check the “Always Grounded” check box, and press “**Apply**”
2. Enter “2-8, 10-16” in the contacts field, check the “Pre Amp” check box, enter 10 in the “Gain” field, uncheck the “Always Grounded” check box, and press “**OK**”

3.7 Channels Settings

“**Channel Settings**” is used to see and set the different digital filter values and sampling rates for different signal types, where possible, for the signals coming from the electrodes. It also allows turning the acquisition on or off for certain signal types. To set the properties, select “**Channel Settings**” from the “**Options**” menu. The “**Channel Settings**” dialog box appears (see [Figure 40](#)):

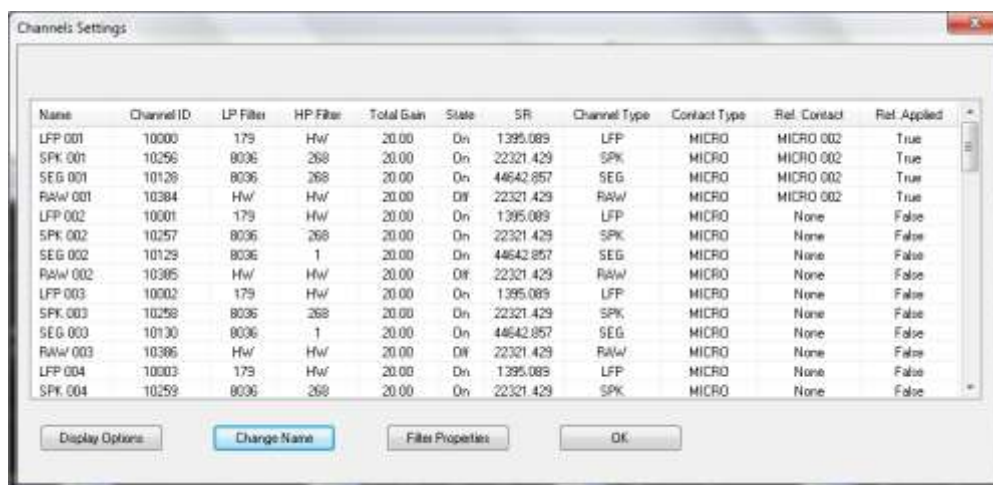


Figure 40 – Channel Settings Window

This dialog shows relevant information of electrodes connected to the system, and under each electrode it optionally shows the different signal types coming from each electrode and their settings. Buttons on this dialog are:

Display Options - Controls what is displayed in the list; both rows and columns.

Change Name - Opens a dialog that allows you to change the type and name for one or more channels. Channel type is informational only for now, but will be utilized in future releases. You have to make your selection of rows by using standard windows methods on marking, such as the Ctrl and Alt keys. Changing channel name is also available from logging options.

Filter Properties - Opens a dialog that allows you to change the filter settings, grounding, referencing, and sampling rates for one or more channels. You can make your selection of rows by using standard windows methods on marking such as the Ctrl and Alt keys. Figure below shows the Filter Properties dialog followed by an explanation of each field.

OK – Exits this window.

Below is the Filter **Properties** dialog that allows changing the parameters. This window may look different depending on the type of contact.

Important Note: *This dialog allows setting the sampling rate of the SPK and Raw channels. Raw channels acquisition is not available for systems above 32 channels, yet in an indirect way it is possible to turn raw channel acquisition on in such systems. Pay attention that the total amount of continuous data the system is capable of acquiring is about 3 million samples per second from all channels.*

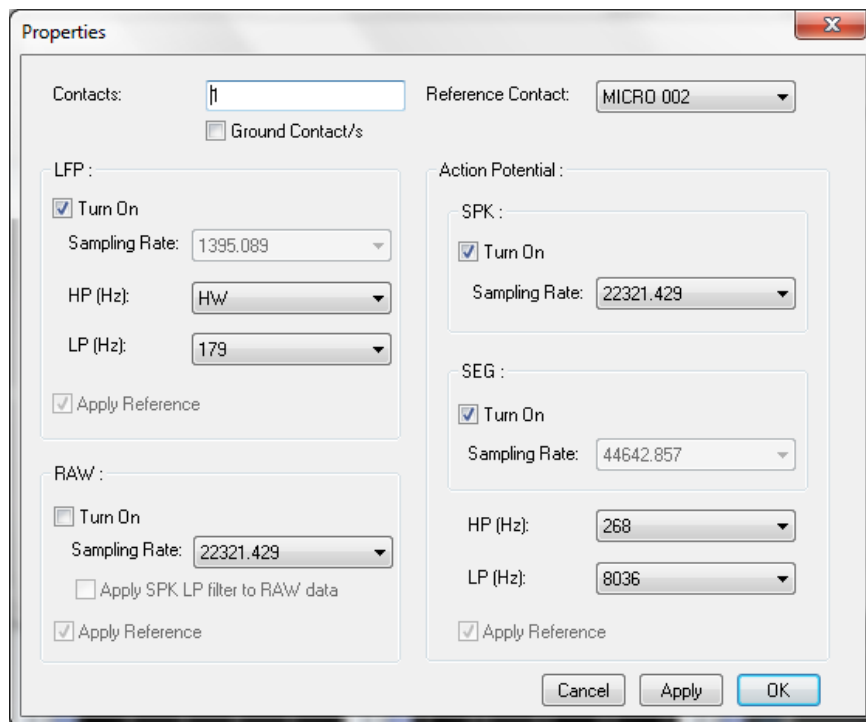


Figure 41 – Filter Properties Dialog

Contacts – Select which electrodes are being affected. Listing electrode number is either by a single electrode number or a range of electrodes separated by a comma. For example selecting electrodes 1, 3, 4, 5, and 7 is done by specifying 1, 3-5, 7. It is also possible to pre-select electrodes from the **Channels Properties** window.

Reference Contact – Select which contact is to be used as the reference in recording. Pay attention to use a contact that has not spike activity, as this referencing process is done by the means of straight forward subtraction. In the example show above raw signal of contact 2 is subtracted from the raw signal of contact 1 using the full sampling rate. The result is what will be the signal of contact 1, which is then taken through the normal process of filtration and down sampling to extract the spike and LFP signals.

Limitations: This feature is available only on systems using up to 96 channels and will be disabled for system with systems with higher channels.

Ground Contact/s – When this check box is checked the selected contact will be grounded. Grounding a contact is also available as a right click option on any signal displayed for the contact. The option here is to allow grounding a group of contacts simultaneously.

LFP - This section is related to the LFP filtered continuous signals.

Turn On – Turn on acquisition of LFP signals.

Sampling Rate – Set the Sampling Rate of the LFP signals.

Limitations: Maximum sampling rate of LFP signal is 1/32 of the full system sampling rate. Meaning in systems with 44K max sampling rate, the maximum sampling rate of LFP signal is 1375.

HP (Hz) – Select the High pass Filter of LFP signals.

LP (Hz) – Select the Low pass Filter of LFP signals.

Apply Reference (Informational only) – This check box indicates that a different contact was specified as a recording reference. This check box will be available for more flexible use in the future, but for now it is automatically checked and unchecked based on the existence of a reference contact.

RAW - This section is related to the raw continuous signals.

Turn On – Turn on acquisition of raw signals.

Limitations: It is not possible to acquire both RAW and SPK signals simultaneously in system with more than 32 channels. Only one should be selected for each channel.

Sampling Rate – Set the Sampling Rate of raw signals.

Limitations: Maximum sampling rate of RAW signal in systems above 32 channels is 1/2 of the full system sampling rate.

Meaning in systems with 44K max sampling rate, the maximum sampling rate of RAW signal is 22K.

Apply SPK LP filter to RAW data – This option may be selected only if the prior one is selected. When selected, the system will apply the SPK LP filter to the RAW data before it sends it to the GUI.

Apply Reference (Informational only) – This check box indicates that a different contact was specified as a recording reference. This check box will be available for more flexible use in the future, but for now it is automatically checked and unchecked based on the existence of a reference contact.

Action Potential

This section covers all signals filtered for action potential, including continuous and segmented.

SPK - This section is related to the spike filtered continuous signals.

Turn On – Turn on acquisition of SPK signals.

Limitations: It is not possible to acquire both RAW and SPK signals simultaneously in system with more than 32 channels. Only one should be selected for each channel.

Sampling Rate – Set the Sampling Rate of SPK signals.

Limitations: Maximum sampling rate of SPK signal in systems above 32 channels is 1/2 of the full system sampling rate. Meaning in systems with 44K max sampling rate, the maximum sampling rate of SPK signal is 22K.

SEG - This section is related to the spike filtered segmented signals.

Turn On – Turn on acquisition of segmented signals.

Sampling Rate (informational only) – Shows the Sampling Rate of Segmented signals, which is the full sampling rate of the system.

HP (Hz) – Select the High pass Filter of SPK and SEG signals.

LP (Hz) – Select the Low pass Filter of SPK and SEG signals.

Apply Reference (Informational only) – This check box indicates that a different contact was specified as a recording reference. This check box will be available for more flexible use in the future, but for now it is automatically checked and unchecked based on the existence of a reference contact.

Once these options are selected, Apply or OK should be pressed to apply the new parameters. OK closes the dialog, while Apply keeps the dialog opened to allow for additional changes.

Signals that are turned off will still come and get displayed for the selected electrode. The word “OFF” will still appear above the signal in these cases. This allows reviewing if something changed on a certain channel that was turned off.

3.8 Multitrode Settings

In this section is possible to define multitrodes that will be used for recording. *Before defining multitrodes, open a Multitrodes display window (see section 3.3.16).* Multitrode should have 2 to 8 contacts. Any contact that will be defined as a multitrode will have its online sorting capabilities disabled. The figure below shows the Multitrode Settings Dialog.

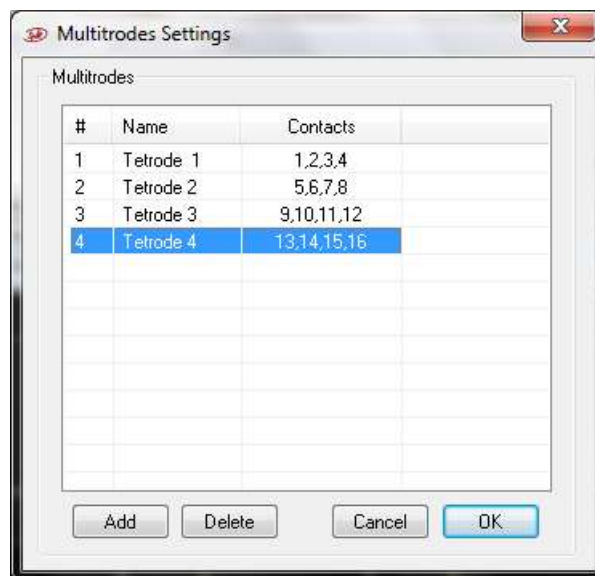


Figure 42 – Multitrode Settings Dialog

To add a tetrode, press the **Add** button, and then go to the added multitrode line and edit its name and contacts. Contacts are channel number from 1 to 128 separated by a comma. After filling each field the *enter key* must be pressed.

To delete one or more multitrode definitions, select them using standard windows selection rules, and press the **Delete** button.

3.9 Port Definition

“Port Definition” option is used to enable or disable the acquisition of certain digital ports according to a strobe input. To enable strobing on a certain port, check the box next to it. For every port that has this option enabled, the system will save the value of the port only when the strobe input of that port receives an active high pulse. This means that the port value is saved when the strobe bit switches from 0 to 1. In addition to the strobe pin, there is a ready pin in each 25 pin digital input port connector. See section 5.2.3.3 for pinout details. The ready signal stays in active high. When the strobe pulse goes high, then the ready signal goes to zero (active low) for a period of time (about 125 uSec) indicating that the system is not ready for another strobe. If the ready is not used by the strobing system, it is possible to send events that are not less than 125 uSec apart. (8 KHz frequency)

4 ALPHALAB SNR OPERATIONS

In this section, all principles of operations of the AlphaLab SnR are described. These are all functions that will be used throughout the experiment.

4.1 Data Acquisition

Data acquisition is the process of getting the digitized time stamped data to the computer. Data acquisition starts automatically when a connection is established between the AlphaLab SnR hardware and its software through Ethernet communication. The first time this connection is made after switching the hardware on, the AlphaLab SnR downloads all necessary executable (*.hex files) embedded programs to the Main Processing Unit. There are 3 main pieces that are downloaded; one for data filtration, one for segmentation, and the third one deals with the Ethernet communications with the computer. The progress of downloading the files is shown on the bottom left corner on the AlphaLab SnR application's status bar. See [Figure 43](#).

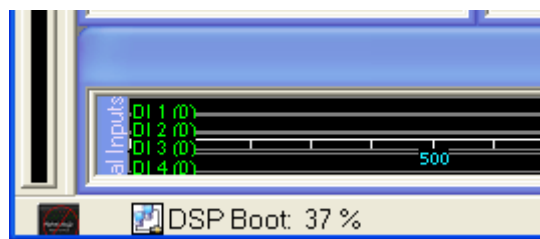


Figure 43 – Loading the DSP's

Once the *.hex files are downloaded, they are automatically started. Starting the hex file triggers the beginning of sampling, meaning this is when sample number 1 is acquired. LED's on the front panel of the Main Processing Unit will flash, which indicates that they are running. Refer to section [4.18](#) below for a full explanation of the meaning of each LED.

Regardless of where the data is fed into the system, and regardless of the type of data, it is all funneled through the Main Processing Unit to the computer. There are several types of data that can come to the computer:

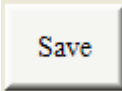

1. Analog signals coming from electrodes, which include spike filtered continuous data, segmented spike data, and LFP filtered data. Signals from all electrodes are digitized in the headstage, and the wide band digitized signal reaches the Main Processing unit. Further digital filtering is done there to split the signal into Spike filtered and LFP continuous data, and the spike filtered data is processed further to be segmented by thresholding or online sorting. All three types make it to the computer and the user has the option to define how this data is displayed, and what part of this data will be logged into files.
2. Analog signals coming from the general purpose inputs on the Main Processing Unit or from the Signal Integration Unit (optional). In both cases, these analog signals are digitized on the corresponding units and passed to the computer for display and logging.
3. Digital signals also coming from both the MPU and the SIU (optional). In basic systems, there are 4 single bit inputs and one 16-bit port. Additional 16-bit ports may

be optionally added to the system. The single bit inputs are used for triggering certain functions, such as data logging, stimulation, or other user defined functions, or they can simply be used for putting markers in the data files for synchronization purposes. The 16-bit port is used to feed event codes into the system. All digital inputs are standard TTL pulse type inputs.

4. General use events that are defined by the user. Such events can be defined by the user as buttons on the user interface that the user can press at any time to log the defined event, or they can be created in the script and sent to the computer for saving.

4.2 Data Logging

Data Logging refers to actually storing the acquired data to disk. Data logging is started when

the user presses the “Save” button  or “Save & Rec.” button  in the AlphaLab SnR application banner, and stopped by pressing the same button again. “Save & Rec.” button is available when a video recording system is connected and file synchronization is requested in the logging options. At any time the use may advance the file name manually


by pressing the advance button  adjacent to the Save button. The user has full control over what will be saved, when it will be saved, and how it is saved by using the “Logging Options” in the “Options” menu item. A complete description of all the logging option is in section 3.4 above. Once save is on, a line describing the file path, size and duration appears on the left up of the software window (see [Figure 44](#)).



Figure 44: saving description

In addition to the channels defined in the logging options, the system keeps track of changes made throughout the experiment and logs them; this includes filtering parameters, channel state, impedance values, template and level definition or changes, and others. In every file, that starting state of all channels is saved, and then every time one of the parameters is changed a record is made of that also. All these events are logged in the Stream Data Blocks, and a DLL called StreamFormatParsed.dll is available under the Mapfile converter to decipher these stream blocks. When Mapfile is used to convert the MPX files to txt or mat formats, it also outputs all relevant stream block data into a corresponding txt file (see converter manual: C:\Program Files\AlphaOmega\Converter\doc\).

4.3 Level Data Segmentation

Data segmentation is the process of extracting the parts of the data, specifically the spike filtered data, which are of interest to the user; for example, the parts that have an action potential. The threshold segmentation may be show as only a level segmentation window or as part of the online sorting. This section describes the segmentation process outside of online sorting. The segmentation is done by means of threshold crossing, where a threshold is set by

the user for each channel, and every time the signal crosses that threshold in a certain direction that the user also specifies, a short segment of the data around the crossing is extracted and sent to the computer. To prevent unnecessary over-detections a dead-time parameter is considered while doing these detections. Dead time means that every time the system finds a spike, it will wait for a certain amount of time before it starts looking for the next spike. See section 4.4.4 below for detailed information. The threshold and direction setting is done in the Main Electrode Display shown in *Figure 45* below.

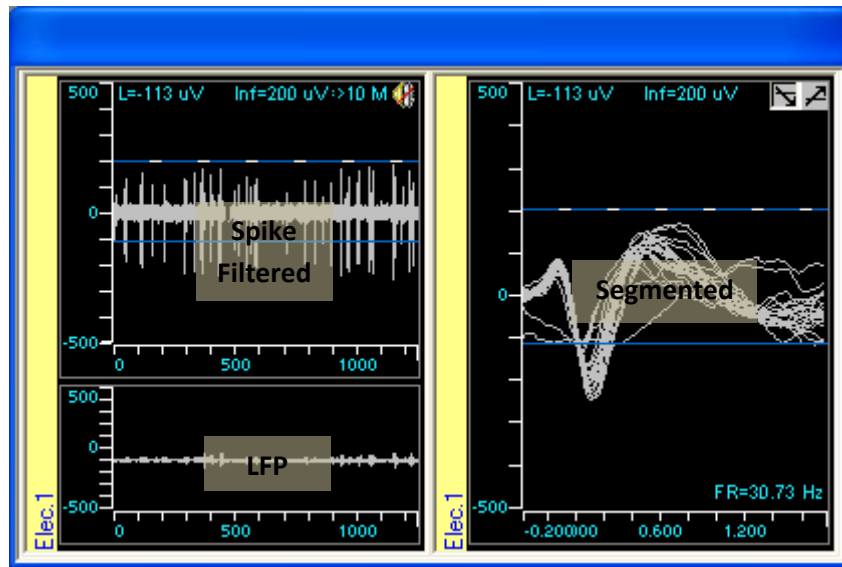


Figure 45 – Main Electrode Display

4.3.1 Setting the Threshold Crossing Direction

Setting the direction of the threshold crossing, or the slope, is done in the segmented display by selecting the downwards or upwards slope, as shown in the figure below.

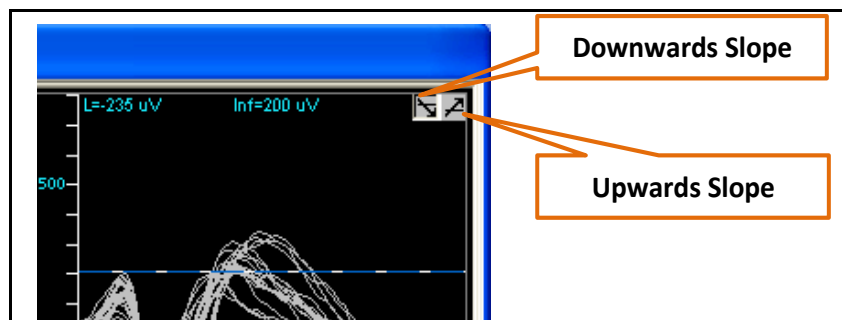


Figure 46 – Setting the Crossing Slope

4.3.2 Setting the Threshold Level

Setting the threshold value is done by moving the threshold line either in the segmented or the continuous display by a mouse left click and drag. Moving one of them will move the other, and the new level value will be shown on the top left corner of the continuous display window. See the figure below.

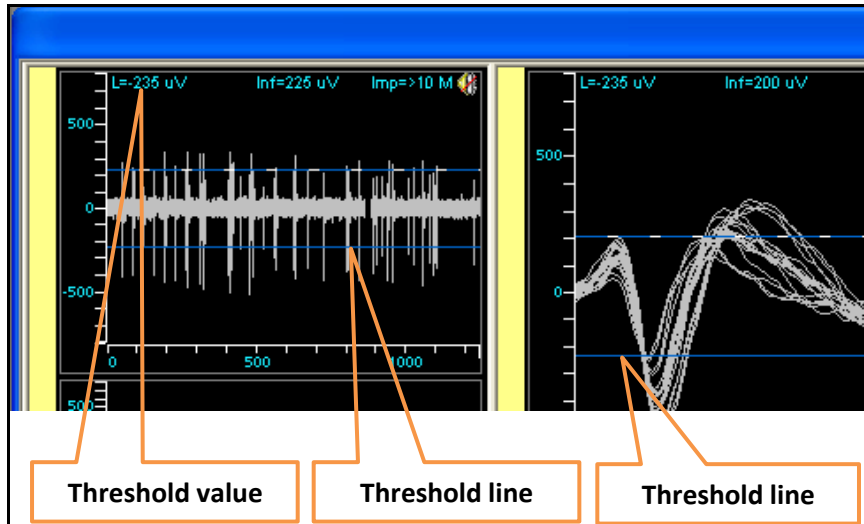


Figure 47 – Setting the Crossing Slope

Note: If level is set between $-30\mu\text{V}$ and $+30\mu\text{V}$, the system automatically assumes that this is in the range of noise and sends a limited number of detections per second only to give a feel of how the noise looks like. This is to prevent overloading the system. Also, in this case the Firing Rate for that channel will be displayed as “N/A” as it is not real.

4.3.3 The Info Line

On the continuous display there are two level lines; one is blue and one is pink. The blue line is the actual threshold crossing line, and the pink line is informational only. It basically allows the user to measure the amplitude of the signal. It is a display only figure and has no effect on segmentation. The value of the info line is shown in top center as shown in the figure below.

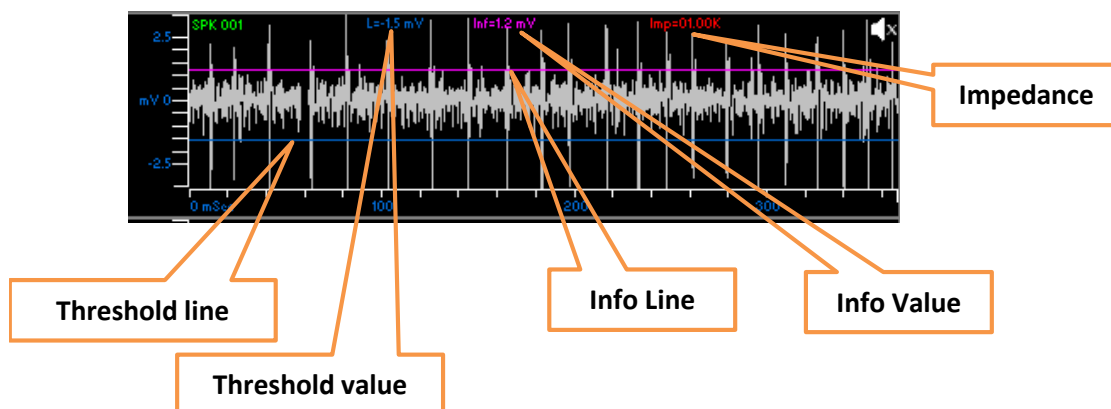


Figure 48 – Setting the Info Line

In addition, the last measured impedance value for the selected electrode is shown in the top right corner as shown in the figure above.

4.3.4 The Level Crossing Dead-Time Parameters

Dead Time refers to the amount of time the system waits when it detects one spike segment before it starts looking for another one. This wait is done to prevent unnecessary detections. The amount of dead time between a level detection to the next one is shown in the table below. Parameters below refer to detections from the same electrode only, except when multitrode such as a tetrode is used, where every group of electrodes in the same multitrode are handled as one electrode. When multitrodes are used it is possible only to do level crossing segmentation and template match is disabled.

<i>Detection type</i>	<i>Next detection type</i>	<i>Dead time in number of samples</i>	<i>Dead time in mSec using the sampling rate :44,000(*) samples/sec</i>
Level Crossing	Level Crossing	70	~1.59 mSec

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

4.3.5 Automatic Level Setting

The system includes an option to go in and automatically set the detection threshold of one or more of the spike filtered channels based on RMS levels. This option is available under the menu option *Tools/Auto Set Level*, which opens the dialog below, which is self-explanatory.

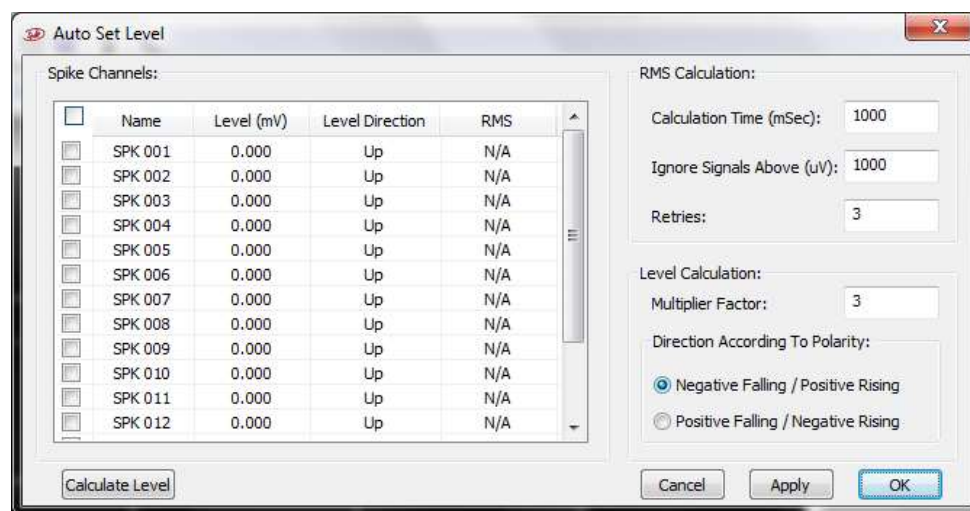


Figure 49 – Auto setting the threshold level

Calculation Time (msec) - The time window where the signals are included in the calculation.
 Ignore Signals Above (uV)- Enter the amplitude you want to start ignoring the signal (used for ignoring noise levels).

Retries: no. of calculation cycles done before displaying the values.

Multiplier Factor: the level value is the multiplier of the RMS value.

Direction according to polarity: positive or negative level value.

4.4 Online Spike Sorting

Online spike sorting is an optional feature of the AlphaLab SnR and it is used to separate spikes coming from different neurons on the same electrode. An eight point template matching algorithm is used to separate the units. The distance between the spike segment and the template is determined by calculating the sum of squares of the distances between each

template point amplitude value and its corresponding sample point amplitude value. If this sum is below a threshold value that the user sets, then it is considered a match.

Note: This feature is available upon request, if not purchased the templates buttons will be grayed out.

The process of operating the online sorting is divided into two stages:

- ***Template Definition Stage or Include/Exclude Definition Stage***

In this stage, spikes are displayed as they cross the threshold level. From these displayed spike segments, templates or Include/Exclude bars are defined. See Section [4.4.1](#) and [4.4.2](#) below. The definition is done only in the main electrode display. It is possible to define sorting parameters for any electrode as it is selected.

- ***Spike Sorting Stage***

In this stage, spikes are detected and tagged using the defined templates. After receiving every sample and matching the segment against all defined templates, if it turns out that it did not match any of them, the segment is checked to determine if it crosses a defined level, and, if it does, it is extracted and marked as an unsorted spike segment. The sorting results are displayed in the main electrode display group for the selected electrode and also in the segmented channel display for all electrodes.

4.4.1 Template Definition Stage

By default, when the AlphaLab SnR program opens, it automatically starts from Spike Sorting stage. In this stage, spikes are sorted according to the last defined template settings. However, when running AlphaLab SnR for the first time, all predefined parameters may be invalid for the current recording; thus, you must start from the Template Definition stage.

Initially, all spikes are detected and displayed using a level threshold. The level threshold is set as described in section [4.3](#) above. Once level and slope are defined, white spike segments start appearing in the online sorting window, as shown in the figure below. The white color indicates that the spikes have not been sorted. The figure below shows a group of unsorted spikes.

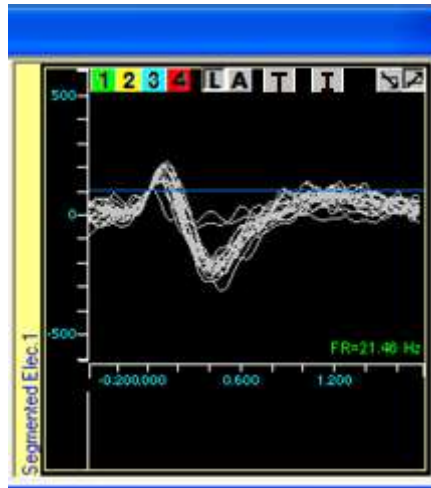


Figure 50 – Unsorted Spike Segments

At this stage, this portion of the Main Electrode Display looks very much like a digital oscilloscope. Spikes are displayed and superimposed on the screen. When more than a certain predefined number of spikes are collected or after a certain period of time, the first spike is deleted from the screen and the next spike is displayed instead, just as in FIFO. Once the user identifies one or more distinct spike shapes, the next step would be to start defining templates to isolate these distinct shapes. *Figure 51* below is an example showing 3 distinct shapes.

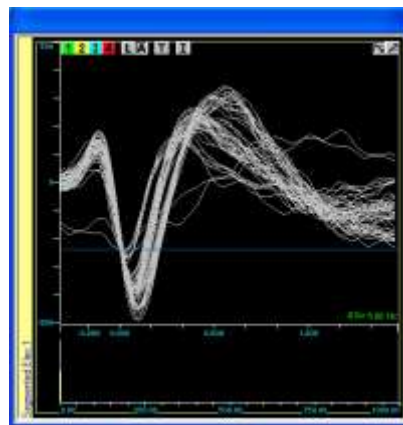


Figure 51 – Several Distinct Spike Shapes

There are three main actions to isolate good spikes, as follows:

- a) Defining the template
- b) Setting the right threshold
- c) Adding an examination window for further fine tuning

There is no specific order in which actions b) and c) need to be done. As long as 1 or more templates have been defined, simultaneously or separately, actions b) and c) can be done on

those templates in any order. The figure below shows the control buttons shown on the spike sorting window, followed by an explanation of each button.

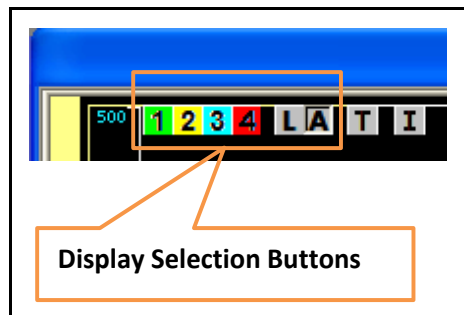


Figure 52 – Spike Sorting Control Buttons

Display Selection Button – These buttons are grouped together, as only one of them can be selected at any certain point of time. When any of them are selected, they will appear as a pressed button, as **A** appears. These buttons indicate what will be displayed in the spike sorting window as follows:

1 - When this is selected, only spikes matching template 1, its template points, its window discriminator, if active, and its histogram will be displayed, in addition to the unsorted spike segments.

2 - When this is selected, only spikes matching template 2, its template points, its window discriminator, if active, and its histogram will be displayed, in addition to the unsorted spike segments.

3 - When this is selected, only spikes matching template 3, its template points, its window discriminator, if active, and its histogram will be displayed, in addition to the unsorted spike segments.

4 - When this is selected, only spikes matching template 4, its template points, its window discriminator, if active, and its histogram will be displayed, in addition to the unsorted spike segments.

L - When this is selected, only unsorted spikes are displayed. No template points, window discriminator, or histogram will be shown.

A - When this is selected, all spikes matching all four templates and unsorted spikes are displayed. No template points, window discriminator, or histogram will be shown.

T – Define Templates – This button freezes the display of the spike segments and puts the display in template definition mode.

I / \bar{I} – Active/Deactivate Inclusion Windows – This button adds the first Include window or removes all includes windows used for fine tuning the spike selection. This can be used in conjunction with the right click “Include” option on the sorting window to add or remove inclusion windows.

Just for clarification, the figure below shows how the display looks when the template 2 button is selected. As shown, it displays spikes detected by template 2, template 2 points, and the histogram of template 2.

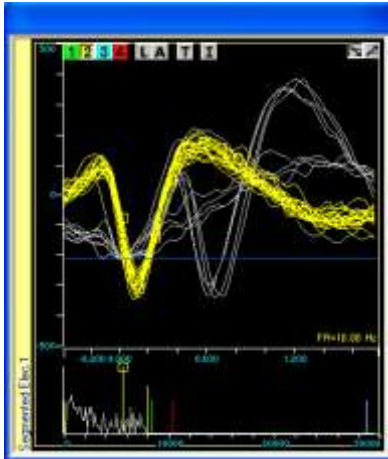


Figure 53 – Displaying Template 2

A detailed description of each of the spike isolation actions is described in the following section.

4.4.1.1 Defining the Template

To start defining templates, press on the Template Definition button **T** shown in the online sorting window. The sorting window freezes and turns into template definition mode, as shown in the figure below.

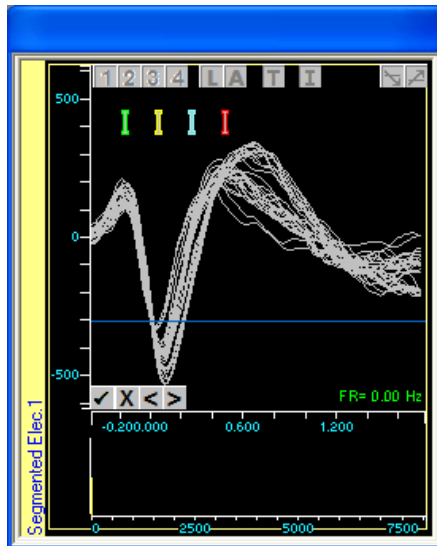


Figure 54 – Template Definition Mode

Note that a new set of buttons appears on the bottom left corner of the window. These buttons are:

- ✓ - Approve and save defined templates and go back to the sorting window.
- X - Cancel all changes made and go back to the sorting window without saving.
- < - Move selected (displayed) template points one sample to the left.

➤ - Move selected (displayed) template points one sample to the right.

At this stage, you may define up to four groups of spikes, which your templates will be built upon. Four *elongated cursors* (called the WINDOW cursors) are located at the top of the screen in four different colors (See [Figure 54](#) above). These cursors are dragged while the left mouse button is pressed to mark and select the spikes you wish to gather into each group. The windows cursor may also be lengthened or shortened by dragging one of its ends up or down to include more or less spikes. For example, [Figure 55](#) below shows the group for the first template and also shows the calculated template points. The spikes are marked and the template points are calculated and shown as the window cursor is moved over the spikes.

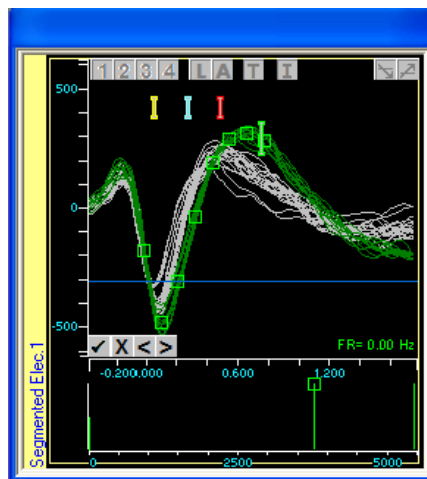


Figure 55 – Grouping Spikes to Form a Template

To define additional groups of spike for additional templates, simply repeat what was described above using the other window cursors. [Figure 57](#) below shows 2 groups of spikes defined. Notice that the software always shows the last defined template points. If you need to see the points of the first template again, simply click on the window cursor of template 1.

For copying the templates to different channel, press shift+ctrl+S to get admin permission and then to template editor (see [Figure 56](#)). In the template editor window you can choose the specific channel and the template you want to copy and then click on copy templates.

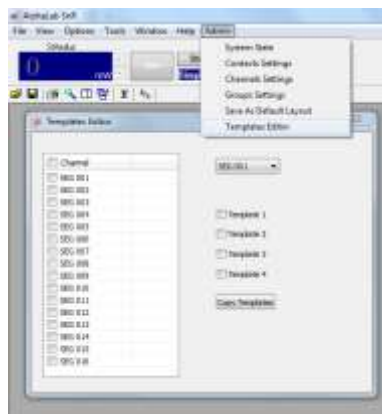


Figure 56: Template editor option



Figure 57 – Template Definition – Two groups

By default, the system puts the second template point on the first negative or positive peak. It's possible to adjust that by using the left (<) and right (>) buttons. Once you are happy with the defined templates, or you would like to simply cancel out without making any changes, you can use approve (✓) or cancel (X) button, respectively.

Right click on the main segmented and unchecking specific template, stops the online sorting based on the specific template. Yet, the template definition is saved.

4.4.1.2 Setting the Right Threshold

Once the template definition is complete, the display goes back to its original mode for showing detected spikes. When the template match mode is entered and exited, the spike display selection goes automatically to the “Display All” mode, showing the button **A** pressed. The figure below shows the result of defining two templates after exiting the template definition mode.

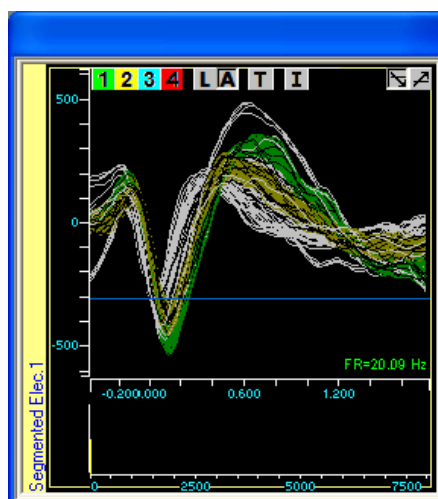


Figure 58 – Sorting Using Two Templates

Ongoing detected spikes are displayed in their corresponding colors using a default detection threshold. At this point, to the user should check if the default threshold that was set for each template is accurate or if it needs adjustment. To check and adjust the detection threshold for a certain template, click on its corresponding numbered button on the top left corner of the screen, which, as described above, will show spikes detected by that template and unsorted spikes. In addition, on the bottom of that window, a live histogram with some vertical lines is shown. *Figure 59* below shows the detection histogram area, followed by an explanation of all its components in a logical order.

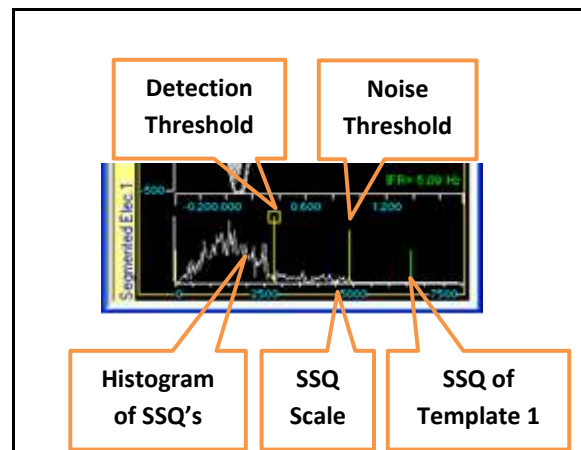


Figure 59 – The Detection Histogram Area

Histogram of SSQ's – This histogram shows the distribution of the sum of squared differences between the ongoing spike activity and the template, which is also called "the distance between the spike and its template" or briefly the "SPIKE DISTANCE".

In this histogram, the left-most point is "zero distance" or "perfect match". This histogram is used as a statistical tool for the definition of the "Detection Threshold". The detection threshold is displayed as a vertical bar with a small square at its top and it can be moved along the SPIKE DISTANCE histogram or the Histogram of SSQ's.

SSQ Scale – This is a scale that shows the SSQ values. The maximum scale value is the SSQ between the template point values and zeros. It is possible to expand or collapse the scale using left mouse click and drag. A double click on the scale sets the scale in a way that the Noise threshold is at the right most of the display.

Detection Threshold – This is the SSQ threshold value that is set by the user. All spikes where the SSQ is smaller than the detection threshold are declared as spikes that match the template. Spikes where the SSQ is greater than the detection threshold are rejected as matching this template, but are, of course, still candidates for the other templates. In normal recordings, the histogram will have a heap toward the zero side of the threshold scale, and, after that, it gets flat. It is recommended to put the detection threshold to the right side of the heap.

Noise Threshold – This threshold denotes how much of the histogram to display beyond the detection threshold.

SSQ of Template 1 – *Figure 59* above, which is only one example of a given situation, shows the histogram of template 2. SSQ's of all the other 3 templates (in this case, 1, 3, and 4), if active, are calculated in relation to template 2, and displayed on the scale

using the designated color of the template. In this example, it shows where the SSQ of template 1 is in relation to that of template 2. This is a quick indication of the quality of the separation between the defined templates.

4.4.1.3 Adding an “Include Window”

Sometimes it is possible to catch a group of spikes that match a certain template because the spike waveform at the template points are close to the template point, yet, part of the spikes may have a different tail before or after the template area. In this case, it is possible to add an “Include Window”, which is used as a second stage fine tuning tool. After the spike satisfies the template criteria, it will be checked to determine if it passes through the defined “Include Window/s”. To add the “Include Window”, press the **I** button; One “Include Window” appears on top of the detected spike. The “Include Window” can then be sized and moved anywhere in the display area. It takes effect immediately. To add additional “Include Windows” use the right click function “Include” on the template is selected. Right click “Include” option can be also used to unselect (deactivate) “Include Windows”. To disable and hide all “Include Windows”, simply press the **I** button again. *Figure 60* below shows an example of a sorting window with an “Include Window”.

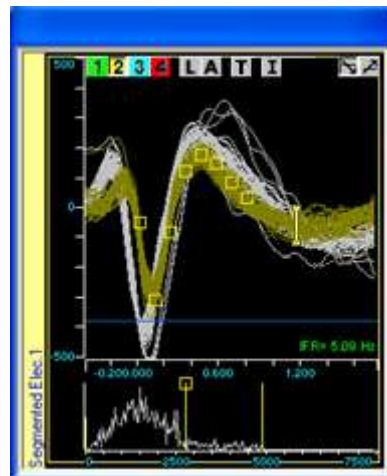


Figure 60 – Include Window

4.4.2 Include/Exclude Bars Definition Stage

To use this option you must disable the template match points as described in section 2.2.5 above. Here also, all spikes are initially detected and displayed using a level threshold. The level threshold is set as described in section 4.3 above. Once level and slope are defined, white spike segments start appearing in the online sorting window, as shown in the figure below. The white color indicates that the spikes have not been sorted. The figure below shows a group of unsorted spikes.

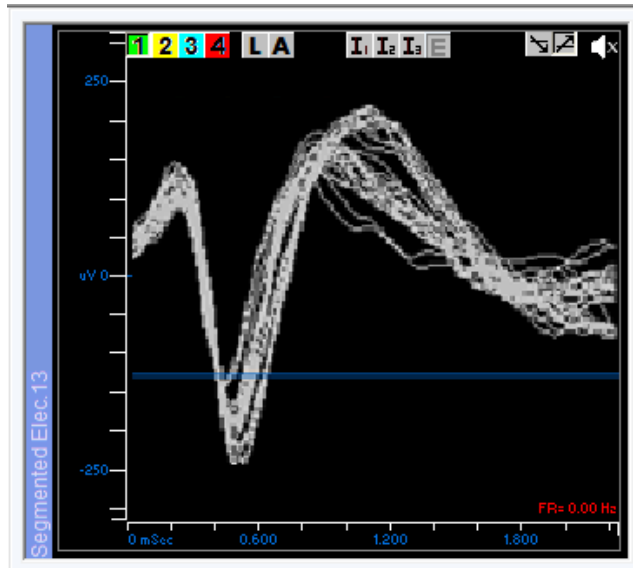


Figure 61 – Unsorted Spike Segments

At this stage, this portion of the Main Electrode Display looks very much like a digital oscilloscope. Spikes are displayed and superimposed on the screen. When more than a certain predefined number of spikes are collected or after a certain period of time, the first spike is deleted from the screen and the next spike is displayed instead, just as in FIFO. Once the user identifies one or more distinct spike shapes, the next step would be to start defining different shapes by the means of adding Include and exclude bars. *Figure 61* above is an example showing 2 distinct shapes.

At this stage it is possible to add Include and Exclude bars by selecting the Unit using the unit buttons and then adding 1, 2, or 3 Include Bars and 1 Exclude Bar using the Include/Exclude buttons. See *Figure 62* below.

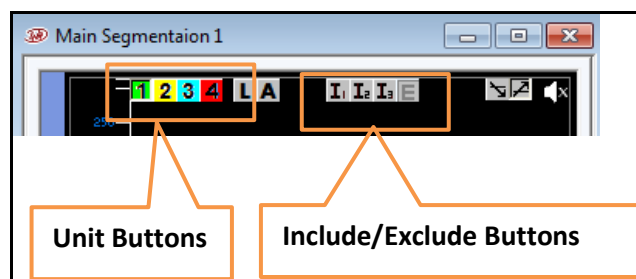


Figure 62 – Include/Exclude Spike Sorting Control Buttons

Exclude Bar can be added only if at least one Include Bar is defined. All bars can be stretched from the ends or moved by using the computer mouse. Include/Exclude bar changes take effect immediately as they are handled. Include Bars have the same color like the unit button, while all Exclude bars have the same color. The Figure below shows an example. As shown Include bars are numbered, and Exclude Bar is labeled with the letter “E”.

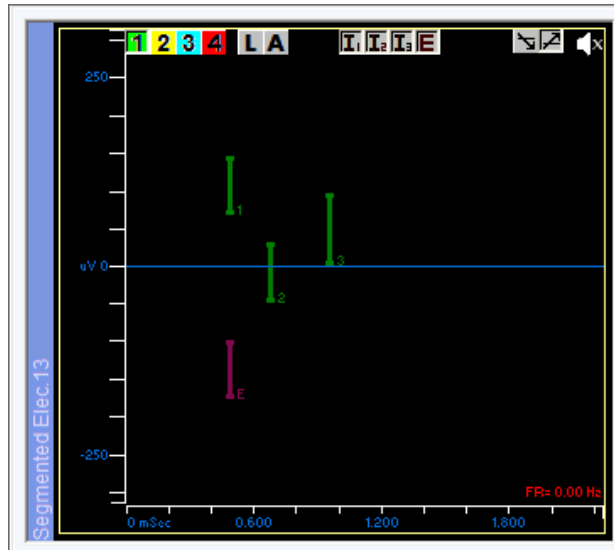


Figure 63 - Include/Exclude Bar Window

4.4.3 Spike Sorting Stage

This stage is actually the monitoring stage, in which the user has already defined all templates, thresholds, and examination windows, and has already started saving these spike segments to file. To prevent unnecessary over-detections a dead-time parameter is considered while doing these detections. Dead time means that every time the system finds a spike, it will wait for a certain amount of time before it starts looking for the next spike. See section 4.3.4 above for detailed information.

In this stage, the user monitors the sorting and may, at any time, repeat any of the steps described above to add a template, deactivate a template, change the threshold, or add or remove an examination window. The main sorting window has the firing rate displayed in the bottom right corner. What All “**A**” or Level “**L**” is selected the firing rate show the Level detection firing rate, while is one of the templates is selected the firing rate shown will be for that template.

To help monitoring, it is possible to display units in separate windows below or next to the sorting window, or for that matter as a separate window. Each unit will also have its firing rate shown. The figure below shows an example.

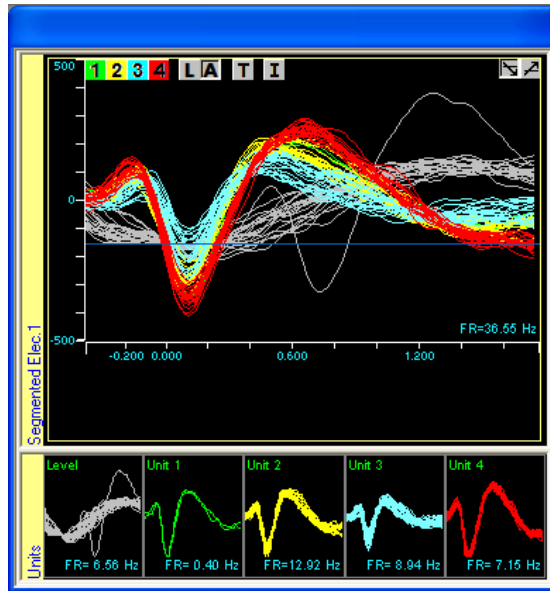


Figure 64 - Units in separate windows

4.4.4 The Segmentation Dead-Time Parameters

Segmentation Dead Time refers to the amount of time the system waits when it detects one spike segment before it starts looking for another one. This wait is done to prevent unnecessary detections. The amount of dead time may be different based on what was detected. The table below lists all the different dead times considered for both level detections and online sorting using the template match algorithm. Of course all parameters below refer to detections from the same electrode only.

<i>Detection type</i>	<i>Next detection type</i>	<i>Dead time in number of samples</i>	<i>Dead time in mSec using the sampling rate:44kHz</i>
Level Crossing	Level Crossing	70	~1.59 mSec
Unit Detection	Level Crossing	70	~1.59 mSec
Unit Detection	Same Unit Detection	30	~0.68mSec
Unit Detection	Different Unit Detection	16	~0.36mSec
* Level Crossing (See below)	Unit Detection	10 (Hold Time)	~0.22mSec

*When template match is used, there is a hold time on reporting level crossing of 10 samples, while looking for a template match. Meaning, if level is detected, it is not reported until additional 10 samples go by without a template match. If a template match was detected within the next 10 samples the level detection is thrown away.

4.4.5 Online Spike sorting on more than 32 channels

When working with more than 32 channels, the default state of the SW will enable online spike sorting without saving the raw data. To activate the option of saving the raw data and

preserve the online sorting in the main segmented window, you should follow the below steps:

- Click ctrl+shift+s to activate the admin tab
- Click on Spike sorting mode (see Figure 65)
- The SW will need to restart, click yes on the pop up message (see Figure 66)
- Turn off the system, and then when the SW reopens turn on the system



Figure 65: Activating the spike sorting mode



Figure 66: restarting the SW

Activating Spike sorting mode, will enable the user to save the raw data (the spike data won't be saved), in addition to the sorted data, local field potential and other analog/ digital data. The user will be able to display the spike data on main window for specific channels, and perform the online sorting.

Note 1: This mode is relevant only for systems with more than 32 channels.

Note 2: After activating or deactivating this mode, make sure that the desired data is saved in the logging option window

4.5 Stimulation

AlphaLab SnR is capable of doing both analog and digital stimulation, meaning it can use stimulate with square pulses as well as arbitrary waveforms. Stimulation in the AlphaLab SnR works in two modes, a simple one and a more complex one. The simple mode, as it implies, is a simple stimulation paradigm where the user, by using GUI controls, selects a specific electrode, selects a defined stimulation pulse or waveform, defines duration and frequency, and presses a trigger button to start stimulation. The more complex paradigm works through writing a script. In the script, the user defines many stimulation pulses and/or waveforms and different frequencies and applies any of the defined pulses or waveforms at the defined frequencies to any number of electrodes. In this section, the simple stimulation paradigm is described, while the complex one is described as part of the scripting section.

4.5.1 Simple Stimulation

All the controls for the simple stimulation are in the AlphaLab SnR application banner. For these controls to appear in the banner use the menu option **View/Current Stimulation**. [Figure 67](#) below shows the controls, followed by a description of each one starting from left to right.



Figure 67 – Current Stimulation Controls

Stim channel – This is drop down filed is where a specific electrode is selected to be the stimulation electrode. This drop down will show only electrodes available for stimulation based on the hardware installed. Any electrode from the same 16-channel group as the stimulation electrode may be selected as the stimulation return electrode in the “Return electrode” field in the stimulation setup dialog shown in [Figure 68](#) below. To stimulate one electrode and return through an electrode from a different 16 channel group a script must be used directional stimulation.

Stimulus – This filed is applicable only when the **Simple Wave** is used, and it specifies the value of the current that will be injected. The value can be either entered in mA, or the up/down arrows can be used to step up or down the current. The step value is specified in the Amplitude step size in the stimulation setup dialog shown in [Figure 68](#) below. Values specified here will be applied the next time the “Stim” button is pressed, or immediately if stimulation is already running.

Stim button – When this button is pressed, stimulation begins. The selected stimulation pulse is applied at the specified frequency to the selected electrode. When the button is pressed, its color changes to red; a beep will sound if the “Sound during stimulation” was checked in the stimulation setup dialog shown in [Figure 68](#) below. To stop stimulation, the “Stim” button can be pressed again. If stimulation is not stopped by the user, it automatically stops after the time specified in the Duration field in the stimulation setup dialog shown in [Figure 68](#) below elapses. In addition, while stimulation is being applied, one of the

LED's on the panel of the MPU is lit. Refer to section 4.18 below for details. In addition, Stim button will become red when stimulation is applied from script.

It is possible to change the settings in the dialog shown in Figure 68 below to make the button behave differently where stimulation starts when you press the button and stops when you release it.

Stimulation pulse/waveform selection drop down – This is where can select the pulse to be used for stimulation. By default the **Simple Wave** appears as an option. Other waveforms defined and loaded will also appear in the selection drop down list. Refer to section 4.12 below on how to define and load square and arbitrary wave forms.

Stim Setup button – This button opens the Stimulation Setup dialog shown below, and an explanation of each field follows:

Speaker Button – Turns on/off sound during stimulation without having to go into the setup window.

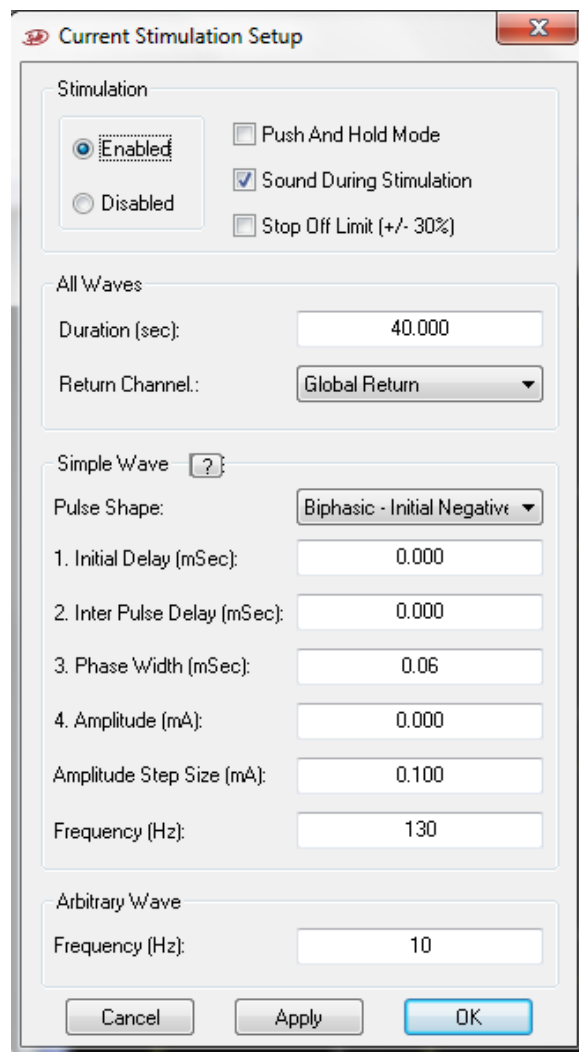


Figure 68 – Stimulation Setup

Stimulation section

Disabled/Enabled – Disables/Enables the **Stim** button. This is meant to be for safety to make sure that no one presses the Stim button by mistake.

Push and Hold Mode – When this option is checked, it changed the behavior of the **Stim** button. In the case stimulation starts when the button is pressed and stops when the button is released. Time limitation still applies here if button is not released.

Sound during stimulation – When this option is checked, a beep is sounded when stimulation is applied, both from user interface and from script.

Stop Off Limits (+/- 30%) – When this option is checked, and measured current monitor is outside the +/- 30% limit of requested current, then the system stops stimulation automatically.

All Waves section

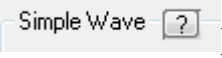
These are parameters that apply to every selected pulse/waveform.

Duration – This is a safety parameter. If the user does not stop stimulation, it stops automatically after time specified here elapses.

Return electrode – This is where the stimulation return path is specified. Either Global Return or any of the electrodes can be selected. By default and in normal recording conditions the Stimulation Global Return wire is shorted to recording ground. Return contact must be of the same type as the stimulation contact. See Note2 below.

Simple Wave section

These are the definitions of the **Simple Wave**:

? Button () – Shows a drawing to explain the parameters below.

Pulse Shape – Drop down to select the stimulation pulse shape. Available shapes are self-explanatory.

Initial Delay (mSec) – Delay in mSec before starting the first pulse.

Inter Pulse Delay (mSec) – Delay between phase 1 and phase 2 of the pulse.

Phase width – Stimulation pulse phase width in mSec. When biphasic pulse is selected, this would be the duration of each phase. Range from 10uSec to 1mSec.

Amplitude – Stimulation pulse phase amplitude in mA. When biphasic pulse is selected, this would be the amplitude of each phase, negative and positive. Up to 3.5mA for micro contacts.

Amplitude step size – This sets the behavior of the up/down selectors on the stimulation amplitude control in the banner shown in [Figure 67](#) above.

Frequency (Hz) – Square wave frequency specified in Hz. See Note1 below. Up to 500, but also depends in the pulse total width defined. Frequency specified here is used only when square pulse stimulation waveforms are used.

Note1: To try to maintain synchronization, to partially overcome calculation rounding issue, and to prevent drifting when different frequencies are used, the actual frequency applied is about 0.47% higher than the requested for older systems with max sampling rate of 44,632.857, and about 0.98% lower than the requested for newer systems with max sampling rate of 44,000. If you are simultaneously using different frequencies, do not try to compensate for this, and rather take what the system gives. Below is a list of frequencies between 1 and 500 that will not have any drifting if used together, but remember that actual frequencies applied will be different as indicated earlier.

500, 480, 450, 432, 400, 375, 360, 320, 300, 288, 270, 250, 240, 225, 216, 200, 192, 180, 160, 150, 144, 135, 125, 120, 108, 100, 96, 90, 80, 75, 72, 64, 60, 54, 50, 48, 45, 40, 36, 32, 30, 27, 25, 24, 20, 18, 16, 15, 12, 10, 9, 8, 6, 5, 4, 3, 2, and 1

Note2: It is very important to make sure that a good contact is available for stimulation return.

Note3: If the Global return is not used, the return electrode must be from the same 16 channel group as the stimulation electrode. To accomplish stimulating one electrode and return from an electrode from a different 16 channel group, directional stimulation must be used using script.

Arbitrary Wave section

These are the definitions of the **Arbitrary Wave**:

Frequency (Hz) – Arbitrary wave frequency specified in Hz. Pay attention that when arbitrary waveforms are used, truncation or zero padding may occur depending on the duration of the waveform used. - 1 in this field means repeat specified wave. Frequency specified here is used only when analog stimulation waveforms are used. See Note1 below.

4.5.2 Complex Stimulation

Complex stimulation refers to the capability to stimulate several electrodes simultaneously and controlling stimulation parameters based on external or internal factors or events. Advanced stimulation is done strictly by writing and running scripts. Refer to section [4.11](#) for details on what types of things can be done.

The main thing to remember when using scripting to do advanced stimulation is to know what hardware you have, as there exist many different hardware configurations.

The script will not prevent you from doing things that you should not do, or things that the system cannot track. To explain this, we will take a case and explain it and show what type of things may happen.

Let us take the case where a 16-channel module has a simulation package that is defined as “2 sources – non-dedicated”. The explanation of such a package is that for these 16 channels there are two stimulation sources; with source number 1 you can stimulate electrodes 1 – 8, and with source number 2 you can stimulate electrodes 9 – 16. In other words, you will not be able to stimulate electrode 1 and electrode 2 simultaneously because they use the same stimulation source, yet you can stimulate them consecutively. If in the script you choose to stimulate electrodes 1 and 10 simultaneously, and you define a 600uAmp pulse for electrode 1 and 800uAmp for electrode 10, then this is what you will get. The system will try to inject the specified currents to the specified electrodes, and the current monitor will show exactly what was injected. On the other hand if you make a mistake and specify electrode 2 instead of 10, then one of the defined pulses will be used which is the last one defined, and let us assume that the 800uAmp was defined last. What will happen when you start stimulation is that both electrodes 1 and two will be switched to stimulation mode and a total of 800uAmp will be injected in both of them, and the 800uAmps will be split between the two electrodes based on their impedances. The current monitor for both electrodes will show the same number which is the total current injected in both electrodes.

4.5.2.1 Stimulation in low latency system mode

The low latency mode provides the user with fast response in several events. In this section we will focus on the stimulation using this feature. Operating the system with low latency mode for stimulation enables the user to get a stimulation response after 800-980 μ sec of spike detection in specific channel using a script. Below are listed the instructions for operating this mode:

1. Activate low latency mode:
 - a. Press ctrl+shift+A to get the system state window
 - b. Check the system low latency mode box (see [Figure 69](#)**Error! Reference source not found.**)
 - c. Press OK (the software will restart)

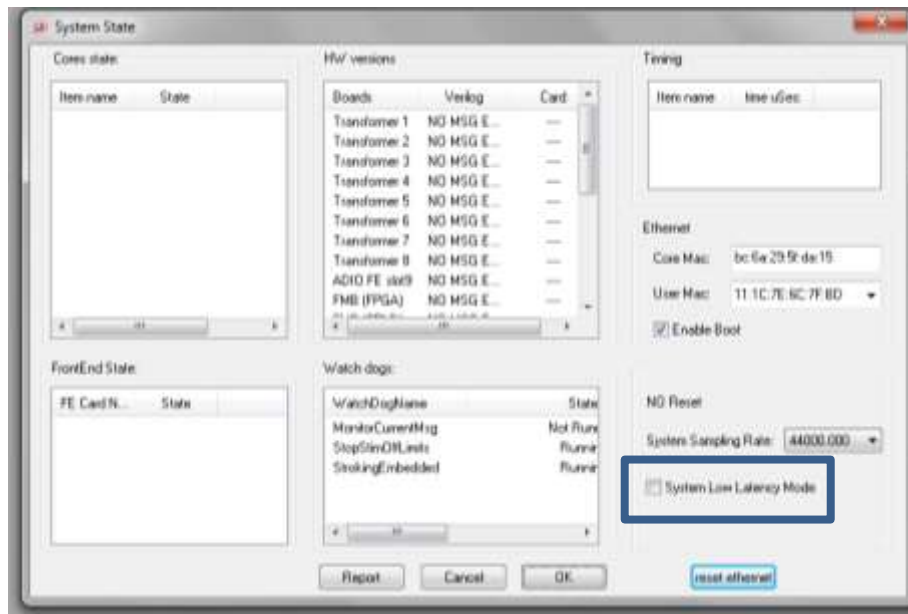


Figure 69: Low latency mode in system state window

2. Activate the detection tool:
 - a. Go to tools\ detection (*Figure 70*)
 - b. Select the detection channel
 - c. Stimulation channel must be none, this channel is defined in the script.
 - d. Click on start detection

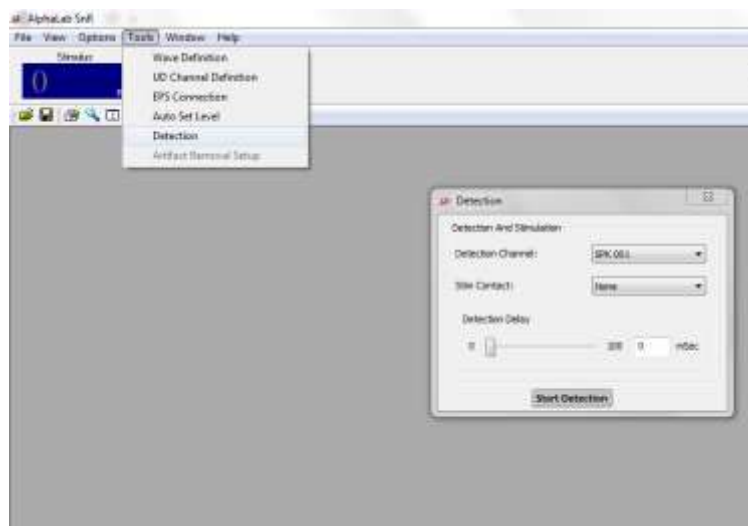


Figure 70: detection window

- e. Leave this window open
3. Activate script:
 - a. Go to script settings (*Figure 71*)



Figure 71: load script from script settings window

- b. Load the script, an example is presented below.
- c. Press load
- d. Press run (you will be able to see that a stimulation is on the channel specified in the txt file).

Script example:

This script waits for detection in the channel specified in the detection window according to the level line crossing, then stimulates the specified channel (array ch) with the pulse defined in the script.

```
array a =[11225,0];           // internal port detection // 0 for level line
array ch=[10001];           // stimulation channel 2
array pls=[0,100,-3500,0,100,3500];           // pulse shape
array bst=[1,50];           // frequency and duration of stimulation
stimex channels=ch by waveform=pls and burst=bst; // load stimulation setup
i=0;
while (i<1)
{
wait data a;                 // detection
start stimulation ch;        // stimulation
}
```

4.5.3 Stimulation Markers

Stimulation Markers are markers that AlphaLab SnR puts in the data files to indicate the start of a stimulation pulse. Markers can mark only square pulses as when using arbitrary stimulation waveform it is not possible to decide where a pulse starts. Stim markers behave different based on if you have dedicated or non-dedicated stimulation sources. See important note below on non-dedicated sources.

Stimulation markers are stored as 16 bit ports, where the values stored in these ports are the number on the channel or electrode that had a stimulation pulse. Up to 4 Stimulation Markers can be used; StimMarker1, StimMarker2, StimMarker3, and StimMarker4 and they are stored in ports 22, 23, 24, and 25 accordingly.

StimMarker1 (port 22) by default tracks the last electrode stimulated, and may not be programmed from the script. So, all simple stimulation done using the GUI is tracked by StimMarker1. In addition, when running stimulation through scripting, StimMarker1 tracks the last electrode specified in the last Start Stimulation command. In other words if the last Start Stimulation command started stimulation on electrode 1, 3, 7, and 9 in this order, only electrode 9 is tracked.

On the other hand, StimMarker2, 3, and 4 are definable in the script, and each one of them can track one channel at any given time. Refer to section [4.11](#) for details on how this is done.

*Important Note: In systems that have non dedicated stimulation sources the stim marker tracks the source. For example, if you have 1 source for every 8 channels, where source number 1 applicable to channels 1-8, and you program stim marker 2 to follow electrode number 7, then stim marker 2 will have an event of **10000** (channel 1) any time any of the 8 channels is stimulated.*

4.5.4 Advanced Stimulation Controls

Advanced stimulation controls refer to the following topics:

- How switching a channel between recording and stimulation takes place, and Will stimulation artifacts be removed from the signal in real time on the recording channels and if yes how much will be removed.

4.5.4.1 Stimulation Switching Mode

Stimulation switching modes refer to when and how channels are switched to stimulation and back to recording mode. Two switching modes are available as follows:

1. Switch the channel to stimulation mode, apply a train of defined stimulation pulses at a certain frequency and for a defined period of time, and once this train is done, only then switch the channel back to recording mode. **(SAP off)**
2. Define the stimulation train you want to apply and let the system automatically switch to stimulation mode and back to recording around each pulse. **(SAP on)**

The default is option 1, but **the advantage of option 2 is that if you are stimulating at low frequencies you may be able to see recording activity between pulses.** Setting the system to work in mode 2 is done per 16 channel module, and is activated or deactivated by physically changing a variable in the workspace file you are using. This is not available for change as a GUI option, so you should be very careful if you decide to use it, or you should contact Alpha Omega trained staff to help you with it. To make the change in the work space, open it using any text editor or using first object software, and find the line that looks like this and change its value.

<SwitchAroundPulse>0</SwitchAroundPulse>

The value used here is an integer between 0 and 255 which is an 8 bit binary value and each bit specifies if this feature is activated or deactivated for the corresponding 16 channel module. Meaning if a value of 3 (Binary 00000011) is used, this means that the SAP (Switch Around Pulse) is active for modules 1 and 2.

When option 1 is used (**SAP off**), the stimulation channel is switched to stimulation mode about 250uSec before the first pulse and switched back to recording when the specified duration ends or when the system get a command to stop stimulation. In this mode you will see a switching artifact at the beginning and the end. The artifact is larger in adjacent channels, but very little on farther channels. In addition there will be a simulation artifact on other channels, which is also larger on adjacent channels.

When option 2 is used (**SAP on**), the stimulation channel is switched to stimulation mode about 330uSec before each pulse and switched back to recording mode either 1mSec or 3mSec after the pulse depending on the characteristics of the pulse. If the pulse phases are less than 100uSec in width **AND** less than 200uAmp in amplitude that the 1mSec applies, otherwise it is 3mSec. If global return is used, it is also switched on and off with every pulse, while if other channel was used for stimulation return, it will be switched to return mode at the beginning of stimulation and switched back to recording mode at the end of stimulation.

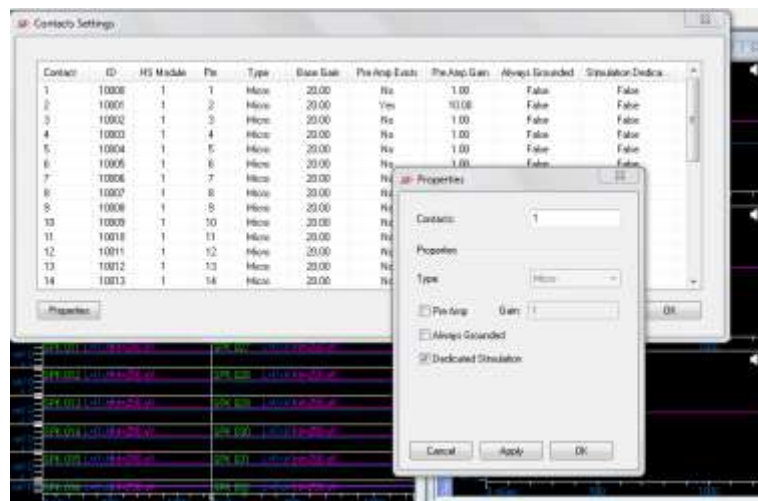


Figure 72: Setting a channel as dedicated stimulation

When using a dedicated stimulation sources, with preamplifier, the user can choose to define the stimulation channels as stimulation dedicated. This way, no switching artifacts will be presented to the stimulation and recording channels.

To define channel as dedicated stimulation, go to options-> contact settings, then double click on the stimulation channel, properties window will be opened, see Figure 72. Check the dedicated stimulation channel option and apply.

4.5.4.2 Stimulation Artifacts

The stimulus artifact is typically spike-shaped followed by an exponential decay whose amplitude and time is dependent on several factors. These factors include experimental technique, amplifier design, electrode orientation, stimulation shape and frequency, and electrode tissue interface.

The stimulation artifact is defined as the time from the end of the stimulation pulse until the specific channel base line becomes different from the base line before the stimulation by less than +/-10%

In addition to the stimulation pulse artifact itself, switching a channel from recording mode to stimulation mode or back the other way will also introduce an artifact on the stimulation channel, and may also introduce artifacts of other channels.

The switching artifact is defined as the time from the moment when a channel is switched from recording to stimulation or back until the specific channel base line becomes different from the base line before the switch by less than +/-10%

Recovery time on stimulation channel and recording channels may vary depending on pulse shape, amplitude, and duration, and frequency. It also depends on the switching mode used. The table below gives an example of artifact and recovery time in a specific scenario where an electrode with 300KΩ impedance was used to stimulate; the electrodes around it had impedances of 100KΩ to 500KΩ; the Distance between the electrodes is 1mm; stimulation pulse was biphasic initial negative with 100uSec x 100uA pulse Amplitude at a frequency of 10Hz.

Time to get 10% around the base line on RAW/LFP channels		
Recording To Stimulation Switch artifact	Same channel	Not relevant
	Other Recording channels	250uSec
Stimulation To Recording Switch artifact	Same channel	1Sec
	Other Recording channels	0.4Sec
Stim pulse artifact	Same channel	Not relevant – Current monitor signal
	Other channels	220mSec

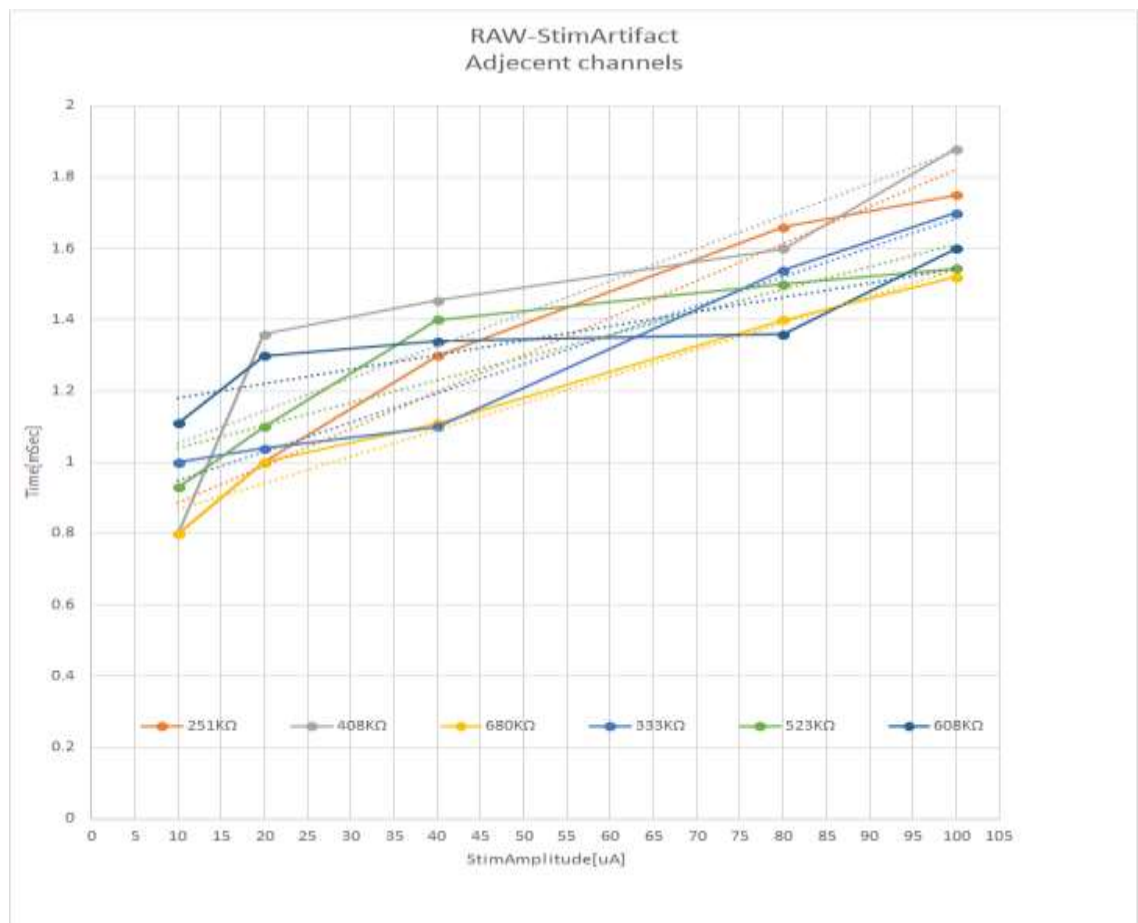
With Offline processing capability the signals can be extracted out on the same channels 1-3mSec after switching back to recording, and 200-250uSec on other recording channels

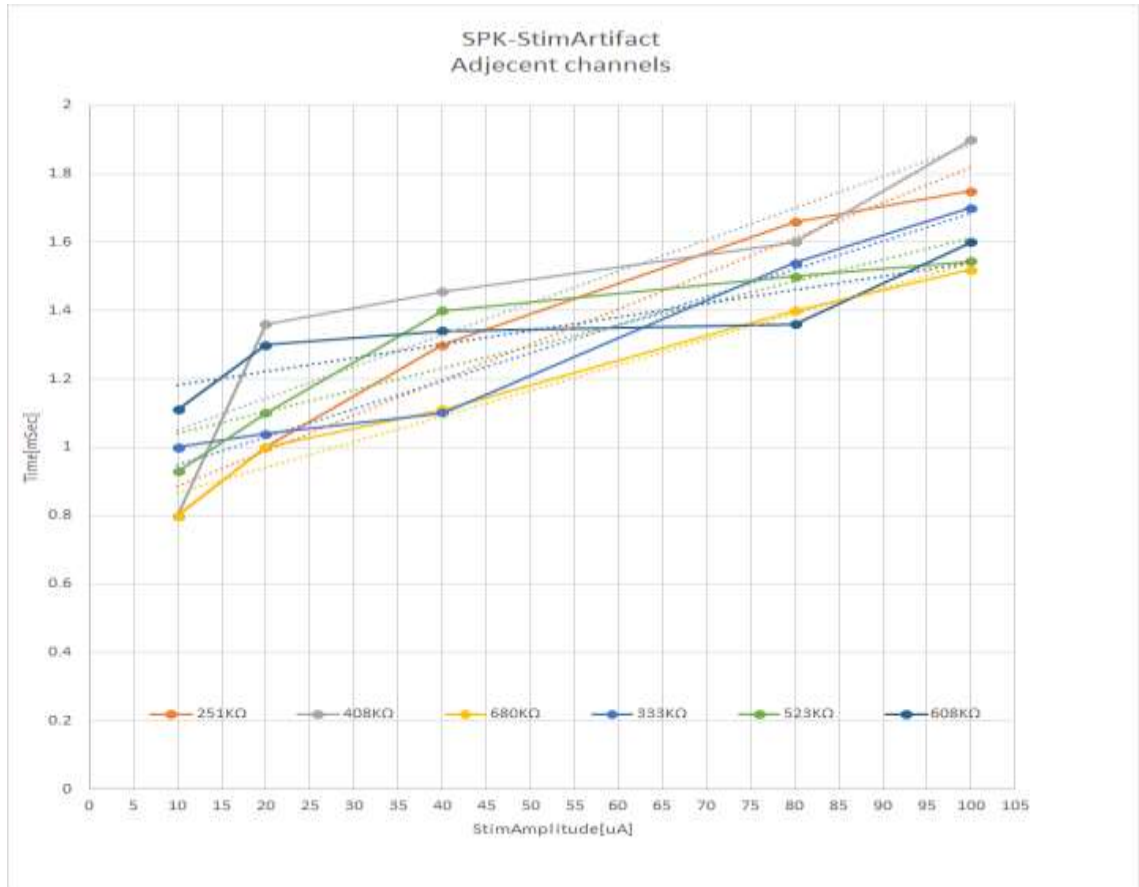
Time to get 10% around the base line on SPK channels		
Recording To Stimulation Switch artifact	Same channel	Not relevant
	Other Recording channels	250uSec
Stimulation To Recording Switch artifact	Same channel	7mSec
	Other Recording channels	5mSec

Stim pulse artifact	Same channel	Not relevant – Current monitor signal
	Other channels	1.6mSec

The table above is only an example of a specific scenario and values may be different using other stimulation parameters.

The charts below show results of stimulation artifacts in other scenarios in SPK and RAW channel in defendant Setups of electrodes and arrays (LMAs).





4.5.4.3 Stimulation and Switching Artifact Removal

The AlphaLab SnR allows for online stimulation artifact removal using a very basic algorithm from selected recording 16-channel modules. The artifact will be removed by stopping the filtration of the signals for a period of time, and replacing the signal for that period by repeating the last sample before the pause. Stimulation artifact removal parameters are set globally for all channels, but selecting what channels to apply artifact removal to is set per 16channel module. See section 4.5.4.4 below on how to set the parameters.

It is not recommended to use artifact removal when Switching Around Pulse mode is used as each pulse will have a switching artifact around it also.

4.5.4.4 Setting the Artifact Removal Parameters

Warning: *You should be very careful if you decide to use it, or you should contact Alpha Omega trained staff to help you with it. You always need to select a combination of two check boxes to make any type of removal work.*

To change the Artifact remove setting, go to **Tools/Artifact Removal Setup**, and this will open the window below.

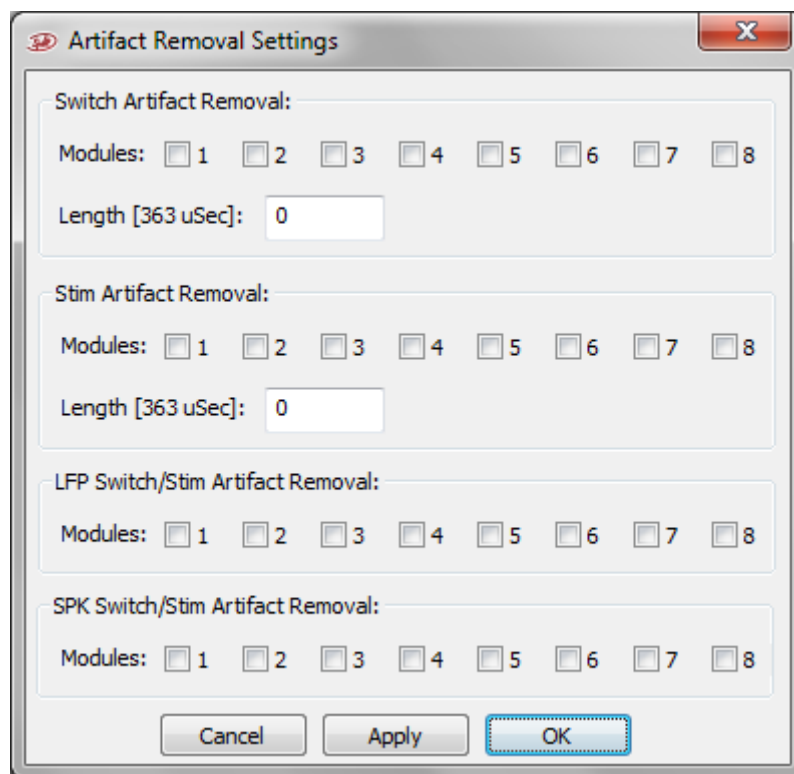


Figure 73 - Artifact Removal Setting

Before each group of check boxes and fields is explained, it is necessary to give some basic rules:

1. Switching artifact removal is done only on the stimulation channel if its module is selected. It is applied when the channel goes back to recording mode only, meaning at the end of the stimulation train.
2. Stim artifact removal is done on ALL recording channels of ALL selected modules.

Follows is a brief description for each group of check boxes.

Group 1 - Switch Artifact Removal

Modules: Select the modules you want switching artifact removal to be applied to.

Length: Specify how many block of 363uSec (16 samples at the full sampling rate) to be removed.

Group 2 - Stim Artifact Removal

Modules: Select the modules you want stim artifact removal to be applied to.

Length: Specify how many block of 363uSec (16 samples at the full sampling rate) to be removed.

Group 3 - LFP Switch/Stim Artifact Removal

Modules: Check the box for each module you want the removal to be applied to LFP signal

Group 4 - SPK Switch/Stim Artifact Removal

Modules: Check the box for each module you want the removal to be applied to SPK signal

To explain further, for any type of removal to happen on a specific module you need to select *one or both* of its check boxes in groups 1 and 2, **AND** *one or both* of its check boxes in groups 3 and 4.

4.6 Impedance Checking

Impedance checking in the AlphaLab is triggered by pressing the “Impedance” button, which opens the Impedance dialog to show the impedance of all electrodes. The Impedance Dialog may look different depending on the number of electrodes tested. Below the values of each 16 channel headstage, this dialog shows also the parameters used to check the impedance for it. These parameters may be changed in the “**Impedance Setting**” dialog under the “**Options**” menu item. “**Recalculate**” button is also available to run the impedance check again if necessary.

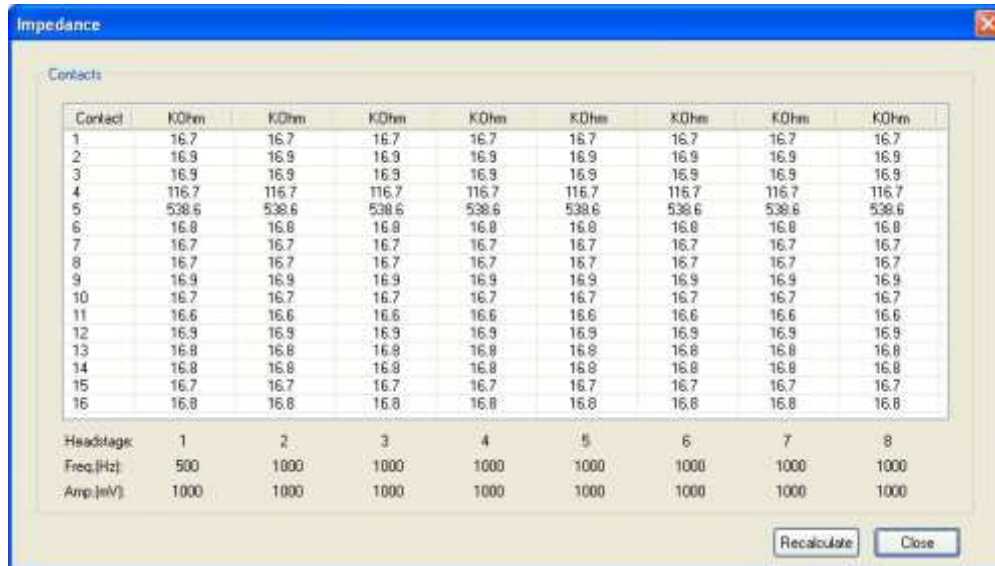


Figure 74 – Impedance Result Dialog

It takes about 3-4 seconds to measure and report impedance if all headstage modules have the same impedance sine wave definition. See section 3.5 above for details. If different modules have different sine wave definition, it will take longer. All audio outputs will be muted during impedance check.

User may also set the limits of what will be displayed. This is done manually in the workspace. Values above the maximum limit will show as “High”, and values below the minimum will show as “Low”.

Note: This feature is available upon request, if not purchased the button won't exist in the workspace.

Note: The system is capable of measuring impedances of up to 9MΩ; Impedances reported above these figures may mean that there is no electrode is connected.

4.7 Sensors modules

There are four types of sensors that can be connected to the AlphaLab SnR:

1. 3D Accelerometer. The Accelerometer is used to detect and monitor acceleration.
2. Goniometer. The Goniometer is used to measure angles in degrees.
3. Precision Dynamometer. The Dynamometer measures force of strength.
4. Precision Pinchmeter. The Pinchmeter measures proper force in the range of 0-22 Kg.

4.7.1 Defining sensors contacts:

For defining contact as a sensor, you need to activate the admin permission, by clicking ctrl+shift+s. Then click on contact setting under the admin tab (see Figure 75).

By double clicking the specific contact, a window will open that allows you to choose the sensor type to the specific contact.



Figure 75: Admin tab

After selecting the contact and the specific sensor type click apply and OK, see Figure 76.



Figure 76: Choosing sensor type

4.7.1 Sensors settings:

Each sensor has different specifications that define its setting, units and measurements range. Before selecting the settings for every sensor type, please review the sensors data sheet. And then insert the values in the setting window, see Figure 77.

- For example, for 3D accelerometer: Units are $[g] \cong 10 * [m/s^2]$, for specific accelerometer the voltage range varies between 1-2.3 V, where 0g is 1.65 V and the range is $\pm 1g$.

Note: Gravity should be considered.



Figure 77: Sensors settings window

Note: The sensor settings window is under the admin tab. To get admin permission click ctrl+shift+s.

4.8 Audio Channels

Audio outputs are stereo outputs that are used to listen to any spike filtered channel. There are two audio outputs available on the MPU and two on the SIU. When a channel is sent to any of the audio outputs, it is amplified to a total of 2000 or 4000 times, including headstage gain and preamp gain if it exists, depending on what hardware exists.

4.8.1 MPU Audio 1 Control

When the speaker icon in any of the display adapter group is pressed, the signal from the displayed channel is amplified and sent out through Audio 1 jack of the MPU. *Figure 78* below shows the Rack Mount Box Audio 1 control as an example. Speaker icons are available for use on all analog channels including SPK, LFP, and Raw, as well as on segmented channels for listening to units. For the latter a sound pulse is sent out and not the signal itself.

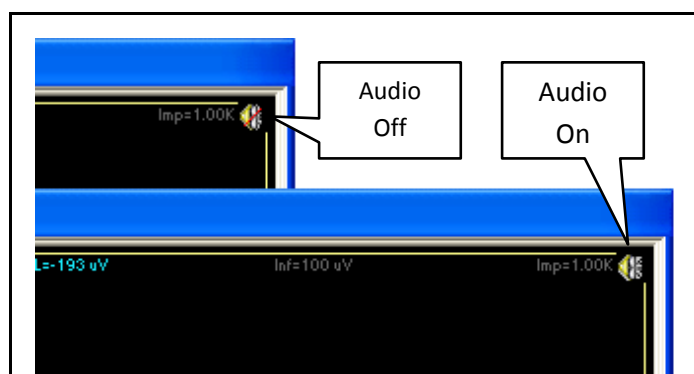


Figure 78 – RM Box Audio 1 Control

Note: In order to follow the selected channel sound in the main window, you have to select the option for follow sound icon by right click on the main window. See Figure 79.

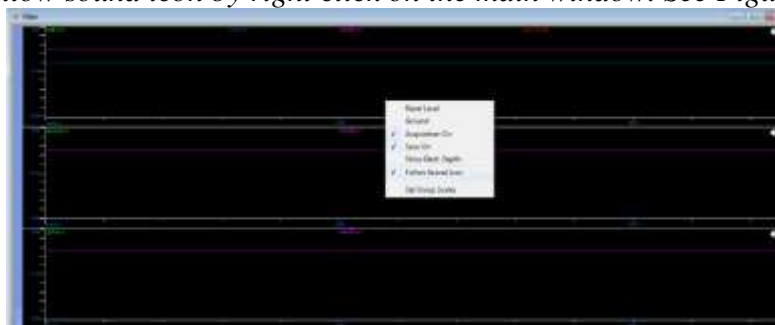


Figure 79: Quick Menu view

4.8.2 MPU Audio 2 Control

Audio 2 on the MPU has separate controls for left and right speakers. When the speaker icon is pressed, the selected spike filtered data is amplified and sent out through the Audio 2 jack of the MPU. *Figure 80* below shows the Rack Mount Box Audio 2 control, which is part of the application banner. For these controls to appear in the banner use the menu option **View/Audio 2**.

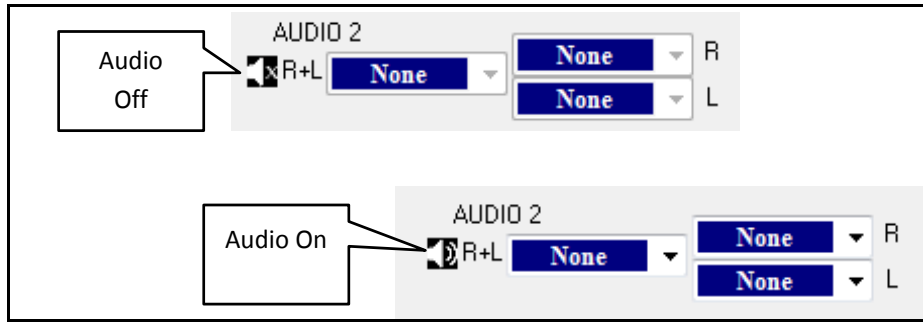



Figure 80 – RM Box Audio 2 Control

4.8.3 SIU Audio 1 and Audio 2 Control

SIU Audio 1 and Audio 2 receive the same output as MPU Audio 1.

4.9 Routing Channels to Analog Outputs

The AlphaLab SnR system comes standard with 8 analog outputs on the Rack Mount Box’s front panel through BNC connectors. Optionally, the Front End Unit may also have 8 analog outputs through a 15pin d-type connector on its front panel. It is possible to route any of the continuous electrode filtered signals to any of the available analog outputs. Any electrode signal sent to the analog output is amplified to a total of 4000 times, which includes the Headstage gain and preamp gain, if any. *Figure 81* below is opened when the user presses the  icon from the tool bar. The window may look different based on what hardware exists in the system. Once electrodes are selected in each desired drop down selection boxes, the “Apply” or “OK” button must be pressed to apply the changes. “OK” closes the dialog, while “Apply” keeps it opened to make additional changes.

The gain scroll bar allows controlling the output level electrode signals are selected.

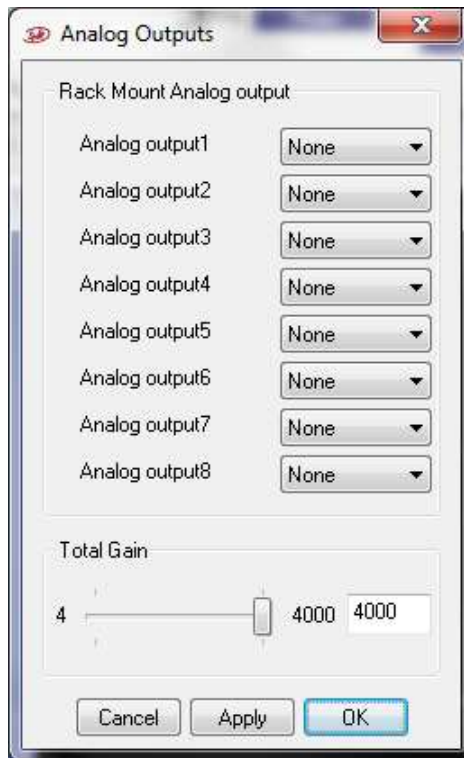


Figure 81 – Analog Output Dialog

Another option is also to make one of these analog outputs follow the channel in focus. This is done by selecting the “Selected” option from the drop down. Here again the filtered channel of the selected electrode is amplified and outputted through the selected analog output channel. An example of this is shown in Analog output 1 on the right side of the figure above.

Additionally, it is also possible to route any of the 4 User Defined channels, if defined, to the analog outputs. See Analog output 4 on the right side of the figure above. In this case these channels are outputted exactly at the same amplitude they are defined. Again, the gain control does not affect the output level when UD channels are used here.

4.10 User Events

This section refers to manual events that the user can define and log into the files with the data acquired from the electrodes and general purpose analog and digital inputs. Before the experiment, users should decide and define what events he/she is going to face throughout the experiment. During the experiment, the Events Control Panel should be opened and used to log these events. In addition to logging events manually by the user by pressing a button, part of the experiment events may also come from a running script. This section will describe how to define events and events controls in the application’s user interface. Events coming from scripts will be described in the scripting section. In both cases, all events values are stored in user defined digital port number 21, while remarks are stored in Stream Format.

To define events, the **E** icon from the tool bar is pressed, which opens the Events Control Panel shown in [Figure 82](#) below. As the figure caption says, this is an empty control panel, meaning that no events have been defined yet. To make this control panel functional, one or more events should be defined. Both Predefined Events and Remarks are described below.

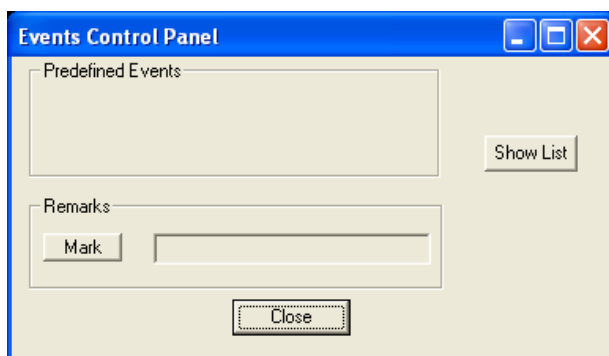


Figure 82 – Empty Events Control Panel

4.10.1 Predefined Events

Predefined Events are stored in digital port number 21. To define new events, the “Show List” button should be pressed, which opens the Events Definition dialog shown below, with a complete description following the figure:

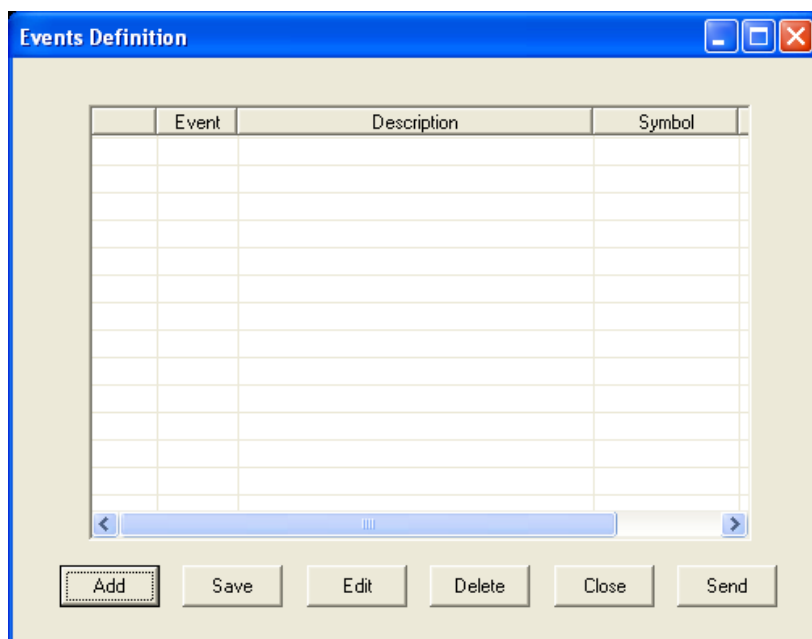


Figure 83 – Events Definition Dialog

One defined event appears in each line in the list. A single click on the event line will select it, while double clicking on any event line will open it for editing. Each defined event will appear on the Events Control Panel list, either as a button for fast access, or in a drop down list for events that are less commonly used. Clicking on a column heading puts events in ascending order by values in the clicked column. Clicking again on the same column heading reverses the order of the events in the list. A description of each column is detailed below:

First column – A check box appears here after an event is defined. When this check box is checked, the event on that line appears in the Events Control Panel dialog as a button; otherwise, it will appear in the drop down list.

Event – The event code is shown in this column. Event codes could be any number from 5 to 65536, or any 16-bit value starting with 5, as values 0 through 4 are reserved for system use.

Description – Description of the event.

Symbol – A 3 digit alpha-numeric symbol that will appear on the event button or in the drop down list of the Events Control Panel.

Color – This color will be saved in the data file and can be used later in offline review. Also when a button is shown for that event it will have a background of that color.

A description of each button follows:

Add – Opens a dialog to add an event. When the dialog is opened, the first available event ID is specified but can be changed by the user. In the dialog, users can define the event ID, the description, the symbol, and the color. All these fields are what make up the list shown in *Figure 84* below.

Save – Saves changes made and closes the dialog.

Edit – Opens a dialog that allows editing the description, the symbol, or the color of the event.

Delete – Deletes selected event.

Close – Closes dialog without saving.

Send – Sends selected event for logging, if logging is in progress.

The 2 figures below show an event list of 5 events, and illustrate the way the Event Control Panel appears after saving changes in the Events Definition dialog. Any event can be logged, if logging is in progress, by clicking the predefined event's button, or by selecting it from the drop down list and clicking the "Send" button.

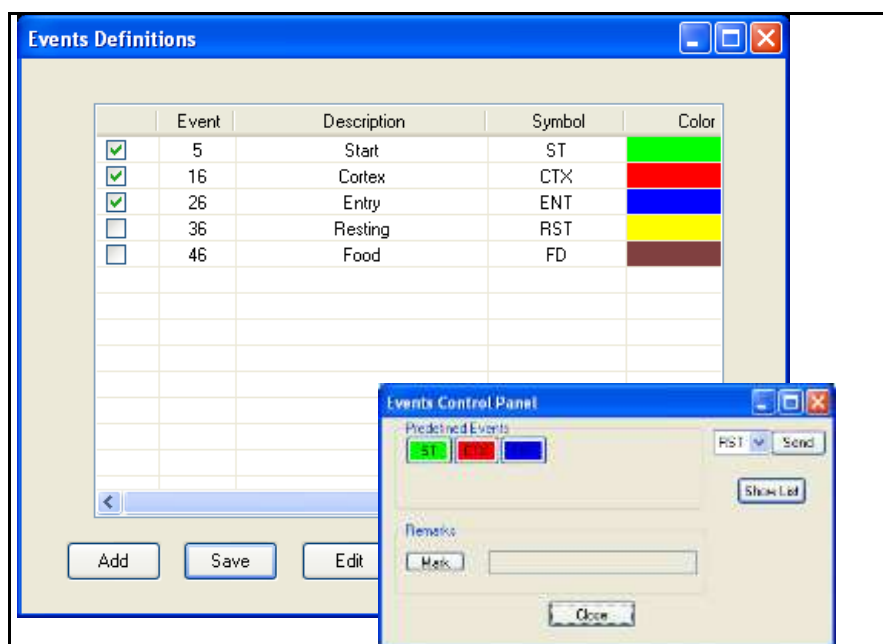


Figure 84 – Defined User Events

4.10.2 Remarks

Remarks are text comments that are stored in the file as stream format. Saving a text message in the file happens as follows:

1. Getting a time stamp from the system – Pressing the Mark button acquires an immediate time stamp from the system that will be stored with the message once keying the message is finished. When the Mark button is pressed the text field will be enabled to allow keying the message, and also two additional buttons will appear. See the figure below.

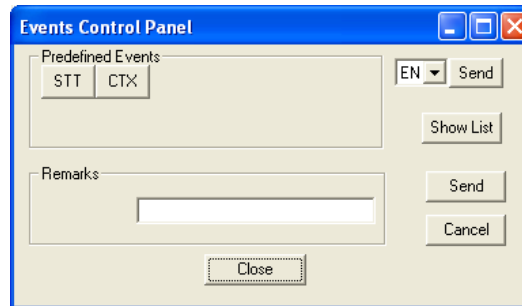


Figure 85 – Text Remarks

2. Keying the text message – This is the process of keying the actual message in the text field. Once the text is keyed, the user can press the Send button next to the message to save it, or can cancel by pressing the Cancel button.
3. Storing the message – This is the process of storing the text message in the file. The message will have two time stamps attached to it, one is the time stamp acquired when the Mark button was pressed and the other is the actual time the message was saved.

4.11 Scripting

All the controls for scripting are in the AlphaLab SnR application banner. For these controls to appear in the banner use the menu option *View/Script*. This section describes the process of writing and running a text script to accomplish a certain task. The script has Alpha Omega's proprietary syntax and is compiled using a program (sccompiler.exe) resident in the application folder. Editing the script can be done using any text editor, but the AlphaLab SnR application uses notepad.exe to build and edit scripts.

Pressing the “Script” button in the application banner opens the Script Control dialog. In this dialog, it is possible to select a script, load it, run it, and monitor its execution if desired. [Figure 86](#) below shows the Script Control dialog, followed by an explanation of its components.

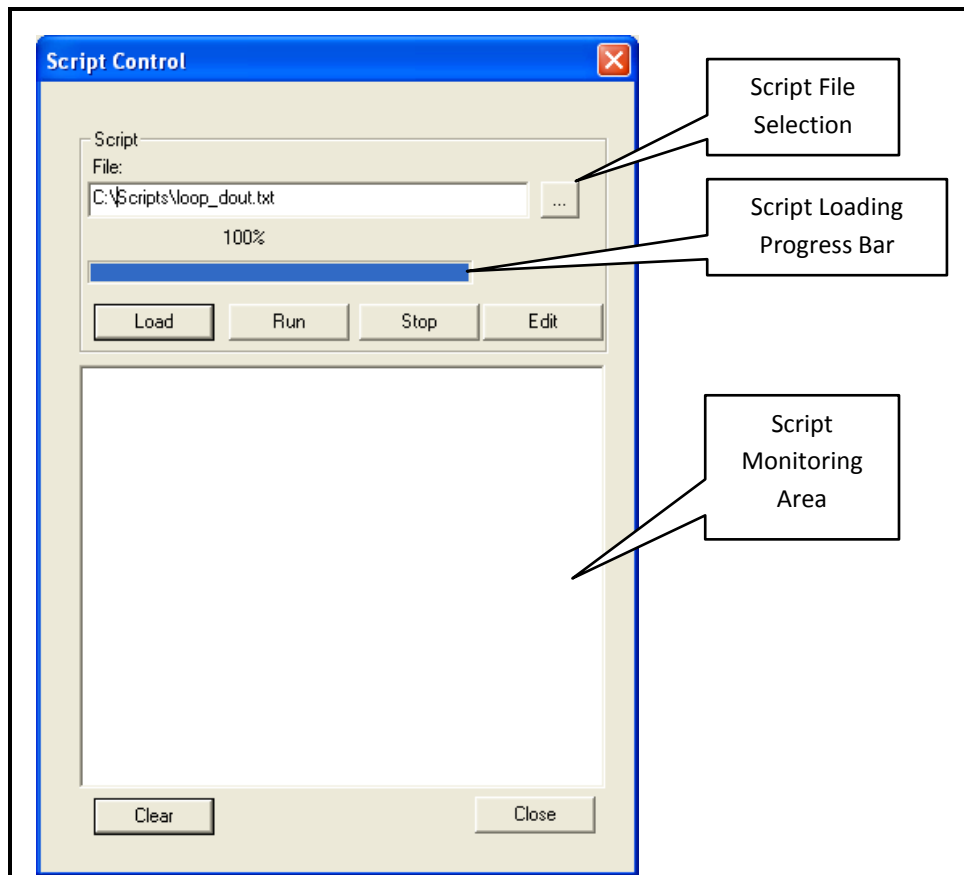


Figure 86 – Script Control Dialog

File – Shows the full name of the selected script file.

Script File Selection – A button that opens a standard Windows file selection dialog.

Script Loading Progress Bar – Shows the progress of loading a script onto the DSP.

Load – Loads the script into DSP. This button first triggers the script compiler, and if the script is compiled without errors, then the loading will take place. If errors are detected, a “Compilation Errors” message appears, and a text file showing the errors is opened in notepad.

Run – Starts the execution of the script. This also will light one of the LED’s on the front panel of the MPU.

When the script is started, the script button in the application banner changes color to red (**Script Running**) indicating that the script is running. If within the script there is a wait command for data or trigger, then the script button changes color to yellow (**Script Waiting**) indication that the script is in wait mode.

Stop – Stops the execution of the running script.

Edit – Opens the script for editing in notepad.

Script Monitoring Area – One of the commands used in the script is the Print command. All strings printed in the scripts appear in this area.

Clear – Clears the monitoring area.

Close – Closes the Script Control dialog. “Close” does not stop a running script. If dialog is closed while a script is still running, the user must open it again to stop the script, if it does not stop on its own.

4.11.1 Script General Terms

The script language is an interpreter style language similar in its definitions as ANSI C language. It uses variables, reserved word and characters, commands, arithmetic operators, while loop, etc. This section will give a general description of some of these.

Note: This feature is available upon request, if not purchased the button won't exist in the workspace.

Variables – Singles or array variables – They start with a letter and have 6 characters at the most. Allowed characters are 'a'-'z', 'A'-'Z' and '0'-'9'.

Array variable elements may be individually referenced by using an index, for example:

```
array a = [10,20,30,40,50,60]; // This defines array a and sets it elements.  
b = a[3]; // This sets variable b value to 30.
```

Numbers and values – All values are 16bits signed values, meaning that the range of any value accepted is [-0x7fff - 0x7fff]. However with some commands values can [0 - 0xffff], for example dout command.

Hexadecimal values – All values preceded by "0x" are considered as 16 bits hex values

Arithmetic operators – Expression results and values are all in 16 bits integers.

Operator	Use
-	Subtraction
+	Addition
*	Multiplication
/	Division

Other operators – Other available operators as in the table below:

Operator	Use
=	Substitution
.length	Array_variable.length is the number of elements in an array.

Electrode numbers – any reference to electrodes in the script is done by their ID. AlphaLab SnR system has the following electrode ID's:

Electrode	ID
Electrode 1 – 128	10000 – 10127

Data Channel numbers – All channel in the AlphaLab SnR have ID's, and any reference to any type of channel including analog or digital, input or our output is also done by their ID. The table below shows a sub set of the Channel ID list that shows only the ones that may be in the script. (All channels ID are listed in options-> channel setting window)

Channel	Type/Description	ID's
Electrode 1 – 128	Segmented Signal	10128 – 10255
Digital in Ports 1 – 2	Input Ports on Front end	11200 – 11201
Digital in Port 3 – 20	Input Ports on Rack Mount	11202 – 11219
Digital in channels on port2 - 1-4	Single bit input channels on Front End	11316 – 11319
Digital in channels on port`4 - 1-4	Single bit input channels on Rack Mount	11348 – 11351
Digital out Port 1	Output Port on Front end	11700
Digital out Port 2	Output Port on Rack Mount	11701
Detection Port	Internal	11225

Comments and notes – Every time two slashes (//) are detected anywhere in a line, the rest of the line is treated as a comment.

Reserved words and characters – The table below list all reserved word and characters.

These words and characters may not be used as variable names.

String	Used for
{ and }	Opening and closing statements
[and]	Enclosing array values
>=	Greater than or Equals to condition
<=	Less than or Equals to condition
==	Equals to condition
!=	Not Equals to condition
>	Greater than condition
<	Less than condition
while	While loop - similar to ANSI C syntax
if	If statement - similar to ANSI C syntax
else	Else statement - similar to ANSI C syntax
print	Used to print a value or variable
waveform	Used in defining a stimulation pattern command
burst	Used in defining a stimulation pattern command
and	Used in defining a stimulation pattern command
channels	Used in defining a stimulation pattern command
by	Used in defining a stimulation pattern command

String	Used for
stim	Used in defining a simple stimulation square pulse
stimex	Used in defining an advanced stimulation square pulse
stiman	Used in defining an arbitrary stimulation wave form
array	Used for defining an array variable
start	Used for starting stimulation
stop	Used for stopping stimulation
stimulation	Used in start/stop stimulation commands
wait	Used to wait for a period of time or for certain data
data	Used in waiting for data command
dout	Used to send digital outputs
send	Used for sending 16 bit events
event	Used for sending 16 bit events
all	Used in stop stimulation command
exit	Used to exit the script
length	Used to test the length of data received from a wait data
startimpedance	Used to start impedance test
setchannelstate	Used to set what mode the channel will operate is
ret	Used in setting the stimulation return channels
setstimmarker	Used to map stimulation markers to channels
startud	Used to define and start user defined channel
stopud	Used to stop user defined channel
“chn” followed by a number	the string “chn” followed by an integer is used in the wait data command

4.11.2 Script Commands and Statements

<p>In the table below all commands and statements used in the script are described.</p> <p>Command Syntax</p>	<p>Function and example</p>
<p>print expression;</p>	<p>Execute the expression and print the 16 bit result into the script status area. Expression can also be a variable or an integer.</p> <p>Examples:</p> <pre> print 5; // print the value 5 a=6; // set variable a to 6 print a; // print the value of variable a (6) print a+5; // print the value of a+5 (11) </pre>
<p>while (condition) { statements }</p>	<p>Repeat the statements while the condition is true.</p> <p>Example:</p> <pre> i=0; // set i to 0 while (i<5) // execute the following commands while i<5 { print i; // print the value of i i=i+1; // increment the value of i by 1 } </pre> <p><i>Note: DO NOT use a number for a condition, e.g. 0, 1....</i></p>
<p>if (condition) { statements 1; } else { statements 2; }</p>	<p>Execute statements 1 if the condition is true and statements 2 if condition is not true. The “else” part is not needed if no action is required.</p> <p>Example:</p> <pre> if (i<5) // execute the following commands if i<5 { print i; // print the value of i } else // execute the following commands if i=>5 { i=i+1; // increment the value of i by 1 } </pre> <p><i>Note: DO NOT use a number for a condition, e.g. 0, 1....</i></p>
<p>exit;</p>	<p>Exit or stop the script.</p>
<p>send event expression;</p>	<p>Execute the expression and sends the 16 bit result through the system, including GUI, where it is displayed in the status window of the script dialog and gets logged in port 21. Expression can also be a variable or an integer.</p>

<p>setchannelstate (array_variable, state);</p>	<p>The setchannelstate will switch the channels state immediately of all the electrodes listed in the <i>array_variable</i> to the specified <i>state</i>.</p> <p>Available electrode states are:</p> <ul style="list-style-type: none">1 - Electrode as stimulation return4 - Electrode as recording5 - Electrode off - to recording ground7 - Electrode as stimulation – Electrode will return to its prior mode once stimulation is done.8 - Electrode as stimulation – Electrode will stay in Stim mode till user changes its state.
--	---

stim

```

channels =
  array_variable1
by waveform=
  array_variable2
and burst=
  array_variable3;

```

Define stimulation pattern for electrodes specified in array_variable1.

stim command is used to define simple square monophasic or biphasic pulses.

array_variable1 is an array that holds electrode ID's.

array_variable2 is a 6 element array that defines the square stimulation pulse. It holds 3 pairs on time in uSec and amplitude uAmp.

Note: Elements 1 and 6 must be zeroes and if they are not they are changed to zeros by the compiler.

array_variable3 is a two elements array defining the burst parameters to be used. The two elements are frequency in HZ and duration in mSec.

After defining the stimulation patterns, you can use the command **start stimulation** in order to actually stimulate the defined channels.

Example:

```

array ch=[10000,10001];
array pls=[0,-500,100,500,200,0];
           // at 0 time go to -500uAmp, at 100uSec go to +500uAmp,
           // and at 200uSec go back to 0 uAmp
array bst=[100,1000];
stim channels=ch by waveform=pls and burst=bst;

```

The command above says: the stimulation that will be used for electrodes 1 and 2 is a square pulse where phase 1 is 100uSec long (from 0uSec to 100uSec) and -500uAmp high and phase 2 is 100uSec long (from 100uSec to 200uSec) and +500uAmp high, using a frequency of 100. After stimulation is started it will stop automatically after 1 second (1000mSec) if not otherwise stopped.

Note1: *all delays and pulse widths are rounded to the closest 4.608uSec, as this is the resolution boundary of all stimulation parameters. Also please refer to section 4.5.1 above for details on how frequencies are handled.*

Note2: *Pay close attention to the situations where the system has non-dedicated stimulation sources. In these cases it is not possible to predefine different stimulation pulses to different channels that use the stimulation source. Hence, the **stim** command must be issued for each electrode separately right before the **Start Stimulation** command is issued for that electrode.*

stimex

```
channels =  
  array_variable1  
by waveform=  
  array_variable2  
and burst=  
  array_variable3;
```

Define stimulation pattern for electrodes specified in `array_variable1`.

stimex command is used to define square monophasic or biphasic pulses with the possibility to include a delay before the pulse, or between the phases. **stimex** can be used to accomplish everything **stim** can. **stim** is an older command that was kept for backward compatibility.

array_variable1 is an array that holds electrode ID's.

array_variable2 is a 6 element array that defines the square stimulation pulse. The 6 elements are: initial delay in uSec, phase 1 duration in uSec, phase 1 amplitude in uAmp, inter pulse delay in uSec, phase 2 duration in uSec, and phase 2 amplitude in uAmp in this order

array_variable3 is a two elements array defining the burst parameters to be used. The two elements are frequency in HZ and duration in mSec.

After defining the stimulation patterns, you can use the command **start stimulation** in order to actually stimulate the defined channels.

Example:

```
array ch=[10000,10001];  
array pls=[0,100,-500,150,100,500];  
    // 0 initial delay, phase 1 is 100uSec wide and -500uAmp  
    // high, phase 2 is 100uSec wide and +500uAmp high,  
    // and there is a 150uSec delay between the two phases.  
array bst=[100,1000];  
stim channels=ch by waveform=pls and burst=bst;
```

The command above says: the stimulation that will be used for electrodes 1 and 2 is a square pulse where phase 1 is 100uSec long and -500uAmp high, phase 2 is 100uSec long and +500uAmp high, and inter-pulse delay of 200uSec, using a frequency of 100. After stimulation is started it will stop automatically after 1 second (1000mSec) if not otherwise stopped.

Note1: *all delays and pulse widths are rounded to the closest 4.608uSec, as this is the resolution boundary of all stimulation parameters. Also please refer to section 4.5.1 above for details on how frequencies are handled.*

Note2: *Pay close attention to the situations where the system has non-dedicated stimulation sources. In these cases it is not possible to predefine different stimulation pulses to different channels that use the stimulation source. Hence, the **stim** command must be issued for each electrode separately right before the **Start Stimulation** command is issued for that electrode.*

<p>stiman channels = array_variable1 by waveform= string_variable and burst= array_variable2;</p>	<p>Define stimulation pattern for electrodes specified in array_variable1.</p> <p>stiman command is used to define arbitrary waveforms. Waveforms used here are referenced by their name and must have been pre-defined and pre-loaded from the GUI controls. Refer to Section 4.12 on how to define and load arbitrary waves.</p> <p>array_variable1 is an array that holds electrode ID's.</p> <p>string_variable is the name of the string variable that holds the wave name.</p> <p>array_variable2 is a two elements array defining the burst parameters to be used. The two elements are frequency in HZ and duration in mSec. Specifying -1 for frequency means repeat.</p> <p><i>Note: Arbitrary waves are stored in text files as sample integers of amplitudes in uAmp. Pay attention the frequency used is suitable to the number of samples and their specified sampling rate. Truncation or zero padding may occur.</i></p> <p>Caution: Only up to two analog waveforms may be used in a certain 16 channel module, but each one can be sent to as many channels as needed.</p> <p>After defining the stimulation patterns, you can use the command start stimulation in order to actually stimulate the defined channels.</p> <p>Example:</p> <pre>array brst1 = [-1, 1000]; wfa = "Wave 0"; array b = [10000,10002];</pre> <p>stiman channels=b by waveform=wfa and burst=brst1;</p> <p>The command above says: the stimulation that will be used for electrodes 1 and 3 is the arbitrary wave named "Wave 0". This wave will be repeated. After stimulation is started it will stop automatically after 1 second (1000mSec) if not otherwise stopped.</p>
<p>stimret channels = array_variable;</p>	<p>Set all electrodes specified in the array_variable to stimulation return mode immediately.</p> <p>In order to return an electrode from the stimulation return mode to recording mode within the script, you need to issue the setchannelstate command or stop stimulation. Ending the script also resets all channels to their default state.</p>

<p>setstimmarker (array_variable);</p>	<p>Map electrodes to stimulation markers.</p> <p><i>array_variable</i> is an array which contains pairs of numbers, the first is the stimulation marker number and the second is the electrode ID. Stimulation markers 2, 3, and 4 are available for mapping, while stimulation marker 1 by default tracks the last electrode stimulated. If a start stimulation command is issued for multiple electrodes, on the last electrode in the list is tracked in stimulation marker 1. Stimulation markers 1 to 4 are stored in digital ports 22 to 25 accordingly.</p> <p>Example:</p> <pre>array a =[2,10008,3,10010];</pre> <p>setstimmarker (a);</p> <p>The command above sets stimulation marker 2 to track electrode 9 and stimulation marker 3 to track electrode 11.</p>
<p>start stimulation array_variable;</p>	<p>Start stimulating all the channels defined by the <i>array_variable</i>.</p> <p><i>Note: Only 2 Arbitrary waveforms may be used in any 16-channel modules.</i></p> <p>Example:</p> <pre>array a = [1,3,5]; // set array variable a to [1,3,5] start stimulation a; // start stimulation on channels 1,3, and 5</pre>
<p>stop stimulation array_variable;</p> <p>or</p> <p>stop stimulation all;</p>	<p>Stop stimulating all the channels defined by the <i>array_variable</i>. If <i>array_variable</i> is substituted with “all”, stimulation stops on all channels.</p> <p>Example:</p> <pre>array b = [1,5]; // set array variable b to [1,5] stop stimulation b; // stop stimulation on channels 1 and 5</pre>
<p>wait expression;</p>	<p>Execute the expression and waits the 16 bit result in mSec. <i>Expression</i> can also be a variable or an integer.</p> <p>Examples:</p> <pre>wait 5;// wait 5 mSec a=6; // set variable a to 6 wait a; // wait 6 mSec wait a+5; // wait 11 mSec</pre>

<p>wait burst array_variable;</p>	<p>Pause until time defined by the defined burst <i>array_variable</i> has elapsed.</p>
<p>wait data array_variable;</p>	<p>Wait data is used to wait for segmented data, digital port data, or single digital input data. Script will pause until data is received to any of the channels indicated by the <i>array_variable</i> elements. <i>Array-variable</i> takes pairs of numbers, where the first one is a channel ID and the second is a unit number or value. Unit number is used for segmented channels and it can be 0 for level detection or 1-4 for units 1-4 accordingly. On the other hand value is used with digital ports and channels. For ports one can wait for a value up to 32767, while for single channels one can wait for a switch from low to high (1), or vice versa from high to low (0). After wait data is satisfied unit number or port value data is received and it will be available through array_variables chn0-chn999 which corresponds to the <i>array_variable</i> element pairs.</p> <p>Example1:</p> <pre>array a = [10128,1,10128,2]; wait data a; // wait for a detection on channel ID 10128 // (segmented channel 1) unit 1 or unit 2</pre> <p>Once the wait data command is satisfied, the wait command will be exited and script will continue to run. To check which one was satisfied, the following if statement can be used:</p> <pre>if (chn0.length > 0) // This means that unit 1 was found and // chn0 will have the value of 1. {.....} if (chn1.length > 0) // This means that unit 2 was found and // chn1 will have the value of 2. {.....}</pre> <p>Example2:</p> <pre>array a = [11348,1]; wait data a; // Wait for an active high (change from 0 to 1) on // the first digital input on the rack mount box</pre> <p>Once the wait data command is satisfied, the wait command will be exited and script will continue to run. In this case it is clear what satisfied the wait, and chn0.length is 1, and chn0 is also 1.</p>

<p>dout (array_variable, mask, value);</p>	<p>Send digital outputs or set the bits of certain digital output ports. <i>Array_variable</i> is a list of ID's of output ports. Having one element of -1 in this array means all available output ports. <i>Mask</i> indicates which bits are to be changed; while <i>value</i> indicates what values (0 or 1) will be written to these bits. Both <i>mask</i> and <i>value</i> are unsigned 16 bit words. Yet, keep in mind that only 8 digital outputs are available in each port, so we would be dealing with the lower 8 bits of each port.</p> <p>Example:</p> <pre>array d=[-1]; // All output ports dout(d,0xff,0x0); // Set all channel on all ports to low (0) // Mask (hex ff = binary 11111111) // value (hex 0 = binary 00000000)</pre> <p>The result of the command above is that all bits on all output ports are set to low(0). If we continue with :</p> <pre>array d=[11701]; // port 1 on Rack Mount dout(d,0x7,0x2); // Set channels on port 11701 // Mask (hex 7 = binary 00000111) // Value (hex 1 = binary 00000010)</pre> <p>The result of the command above is that bit 1 and 3 are set to low (0), bit 2 is set to high (1), and the remaining bit are not affected. So the result is 00000010.</p>
---	---

<p>startud (array_variable, sting_variable variable1, variable2);</p>	<p>Start a specific pre-defined and loaded waveform on one of the user-defined channels. 4 UD channels are available with channel ID's 11150 – 11153.</p> <p><i>array_variable</i> is an array of channel ID's that will be started in this command.</p> <p><i>sting_variable</i> is a variable that contains the name of the waveform as defined using the GUI.</p> <p><i>variable1</i> is the duration in mSec of how long this user-defined channel/s will receive the specified waveform. This can be substituted by an integer. Duration of -1 means “don't stop”.</p> <p><i>variable2</i> is the frequency in units of 1/1000 Hz in which the specified waveform will be sent to the specified user-defined channel/s. . This can be substituted by an integer. Frequency of -1 means repeat.</p> <p>Example:</p> <pre>array a=[11150,11152]; // UD channels 1 and 3. wv="Wave 1"; dur = 1000; // Duration of 1Sec (1000mSec) freq = 30000; // Frequency of 30Hz (30000mHz)</pre> <p>startud (a, wv, dur, freq);</p>
<p>stopud (array_variable);</p>	<p>Stop sending data to one or more of the 4 user-defined channels.</p> <p><i>array_variable</i> is an array of channel ID's that will be stopped in this command.</p>

4.12 Defining and Loading Waves

The Wave Definition function of the AlphaLab SnR is used to internally generate analog (Arbitrary) and/or digital (Square) waveforms. Both analog and digital waveforms can be used for stimulation, while analog waveforms can also be displayed and saved as User Defined Channels. The later part and in conjunction with the Analog Output function of the AlphaLab SnR allows to AlphaLab SnR to become a wave generator for that can send analog waveforms to any other device including external stimulus isolators.

This section describes the process of defining different waveforms. Selecting the **Tools/Wave Definition** menu item opens the Wave Definition window shown in [Figure 87](#) below and it is followed by an explanation of its components and functions.

treated as a 16 bit values for $\pm 5V$ when the waveform is used for user defined channels or for optogenetics.

Note: file must include a number of samples that is divisible by 16.

SR – Sampling Rate. For Square waves, this shows the sampling rate of the generated pulse. For Arbitrary waves, this specifies the sampling rate of the samples stored in the text files specified under format.

Note – User notes on the waveform.

Full path – This is the full name of the wave file including the full path.

The buttons on the bottom are:

New Arbitrary Wave – Opens a dialog that allows defining a new arbitrary wave.

New Square Wave – Opens a dialog that allows defining a new square wave.

Delete – Deletes selected waveform.

Cancel – Exits window.

Load/Unload – As the button indicates, this button loads any new checked waveforms, and unloads and waveforms that were previously checked and they were unchecked.

4.13 User Defined Analog Channels

Up to 4 user-defined channels can be used in the system and these are analog channels that can be defined internally. For Example the user may define a sine wave for a specific user defined channel. These channels are handled as regular analog channels and can be displayed, saved, and sent to analog outputs.

To define and or activate a user define channel select the menu option *Tools/UD Channel Definition* and the dialog below will be opened. This dialog allows defining what goes to each one of the 4 UD channels, for what duration, and at what frequency. It also allows you to start/stop any or all of the 4 UD channels. An explanation of how each UD channel is defined follows the figure below.

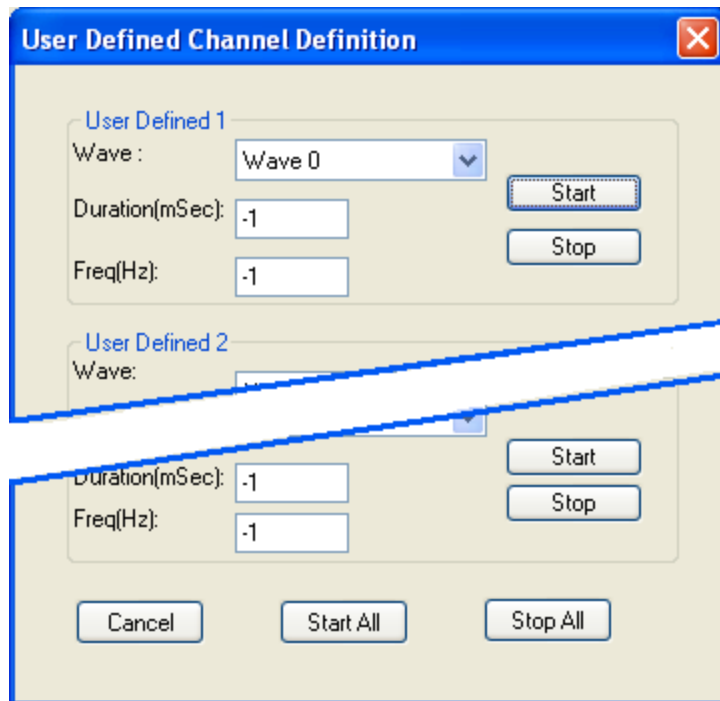


Figure 88 - UD Channel Definition

Wave – Selection of what **arbitrary** wave will be applied to this UD channel. The drop down list will show waveforms that have been defined and already loaded onto the system. Refer to section 4.12 on how arbitrary waveforms are defined and loaded.

Duration – Specifies the duration in mSec that the selected waveform is sent to this UD channels. Specifying -1 in the duration indicates that the waveform will be sent till it is manually stopped.

Freq(Hz) – Specifies the frequency that the selected waveform will be sent by. Specifying -1 in the frequency indicated that the selected wave for will repeated. When frequency is specified truncation or zero padding may occur depending on the length of the defined waveform.

Start/Stop buttons – Starts/stops sending the waveform for this UD channel.

Start All/Stop All button - Starts/stops sending selected waveforms for all UD channels.

User defined channels are handled as totally separate entities, so there is no synchronization between them, even if you start them together.

In addition, it is possible to deal with UD channels from the scripts and this is discussed in the script section.

4.14 Tetrode/Multitrode Processing

The AlphaLab SnR allows for online acquisition of multitrodes that include any number of contacts from 2 to 8. The most commonly used today are the tetrodes which have 4 contacts each, so will use the term tetrode in the rest of this section, but anything said here apply to any multitrode.

Below are the major points that relate to tetrode processing:

1. The segmentation of tetrode contacts is done only by the means of level crossing. Any contact that is defined as belonging to a tetrode will automatically have the online sorting disabled. Sorting will be done only in offline using lab's own tools.
2. The level crossing threshold and slope for each contact is set separately.
3. Every level detection on any of the contacts leads to the acquisition of matching segments on the other contacts. Meaning if Tetrode 1 has contacts 1, 2, 3, and 4, and a level crossing was detected on contact 1, then segments from all 4 contacts for the same time frame will come to the computer for display and logging.
4. X/Y Clustering of detections from two different contacts within the tetrode may be done based on peak or valley of the segment. User has quick control of changing X and Y configuration.

Self-explanatory right click hot menu items are available on all tetrode windows, but they are also explained in the section [2.1.4.1](#) above.

4.15 Flexible Referencing

Flexible referencing refers to the options to specify one of the recording electrodes as the recording reference to one or more other electrodes. This is usually done to reduce the amount of noise. In general, an electrode that has not action potential activity is used as the reference contact. Specifying what contact is to be used as reference is done in the filter settings window. This is covered in section [3.7](#) above.

Important things to consider while using the flexible referencing function:

1. Referencing is done by the means of simple subtraction and it is done on the raw signal before any filtration. Hence all signal types for a specific contact are affected, including Raw, SPK, LFP, and SEG. This is also true for EMG and EEG.
2. Contacts are handled one by one in order from top to bottom, meaning contact 1, then 2, then 3, etc. The result of the subtraction substitutes the original values immediately.
3. Pay attention not to use a contact that already has another contact as a reference, as a reference to a different contact.
4. Make sure to use reference contacts that are in close vicinity of the referenced contact.

4.16 Online Statistics

Online statistical tools are available and may be displayed and are handled just like any other display group. Available statistical tools are:

1. Raster Display
2. Evoked Potential Display
3. Peri Stimulus Histogram

Defining which of the above will be displayed was explained earlier (section 3.3.17). Setting the options of the display of each one of them is done by available right mouse click options.

4.17 Client Server Operations- AlphaLab SnR multi user

It is possible to install and run the AlphaLab SnR software on several computers and monitor the same system (see hardware requirements). When two clients are operating AlphaLab SnR software, close attention should be paid in order to operate the system properly.

Below is a list of changes applied by one user and observed in other AlphaLab SnR stations:

1. All parameters that may change the behavior of a channel, including filters, acquisition on/off, level line, template definition or changes, and detection and noise thresholds.
2. Impedance checking parameters.
3. Analog output selections.
4. Audio channel selections.
5. Digital port strobing definitions.
6. Indication that a script is running.
7. Indication that stimulation is running from UI, but channel selection does not change.

Below is a list of changes applied by one user and not observed in other AlphaLab SnR stations:

1. Channels grounding
2. Analog waveform definitions. Yet, a loaded waveform may be used by any station for stimulation and for user defined channels.
3. Scripts
4. Channel name changes
5. Logging definitions.
6. Tetrode definition
7. Events definition (pay close attention here as different stations may define different meaning to same even number).
8. User defined channel wave selection.
9. Workspace changes.
10. Stimulation setup changes and stimulation channel selection.

Note: Save file can be only performed from the server.

Hardware requirements for client operator:

- One giga Ethernet connection

- Ethernet cable cat 6 from the network adapter to the switch of the AlphaLab SnR

4.18 Video Tracking/Recording Synchronization

The AlphaLab SnR is capable of communicating with Video recording and tracking equipment and it saves synchronization data in the MPX file in the stream format record types. For each equipment type it is necessary to configure the computer running the video recording or tracking to allow communication with the AlphaLab SnR. Once one type of equipment is connected its icon is shown on the status bar indicating that it is connected.

Below is a list of what is supported today. The list will be updated as more equipment is supported.

4.18.1 EthoVision (Noldus)

EthoVision is used for video tracking. It can track the position of an animal, such as a rat or mouse, and it will send position information and video frame number to the AlphaLab SnR for logging. EthoVision should be installed on a separate computer other than the AlphaLab SnR computer, and the connection between the two computers is done through Ethernet switch. It is necessary to refer to documentation for installation instructions for the EthoVision video tracking computer and the connection between the two computers. Also refer to Mapfile document on how to view the data. Refer to the logging options (section 3.4.3) for special synchronization capabilities.

Note 1: Follow the installation instructions of Alpha Omega for synchronization with EthoVision.

Note 2: Make sure the Mac address of AlphaLab SnR system is updated in the ini file of the EthoVision installation folder.

Note 3: Make sure the video icon in the AlphaLab SnR software status bar is on when opening EthoVision software.

4.18.2 StreamPix 5 (Norpix)

StreamPix 5 is used for video recording; currently supporting version 5.18 only. Once connected, it will send video frame number and timing information to the AlphaLab SnR for logging. It is necessary to refer to documentation for installation instructions for the StreamPix 5 video recording computer, and also refer to Mapfile document on how to view the data. Refer to the logging options (section 3.4.3) for special synchronization capabilities.

Note 1: Follow the installation instructions of Alpha Omega for synchronization with StreamPix 5.

4.19 EPS (Electrode Positioning System) Connection

The AlphaLab SnR is capable of communicating with Alpha Omega EPS system, which allows seeing and logging the depth of the electrodes for later review.

4.19.1 Making the connection to EPS

To make the connection, select to the menu option “Tools/EPS Connection”, this will open the dialog shown below.

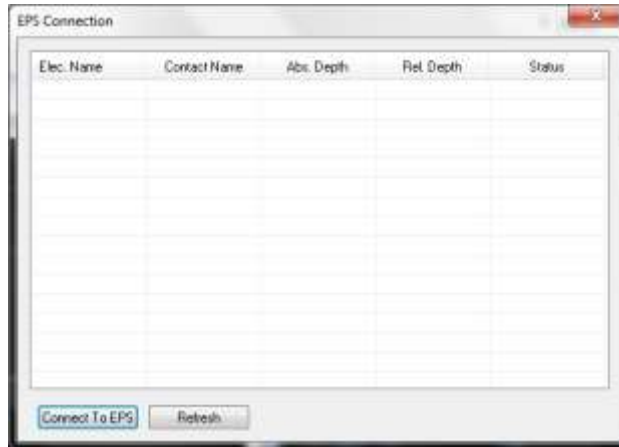


Figure 89 - EPS Connection Dialog

Connect To EPS – Opens the window shown below.



In this window you should enter the IP address and port number of the computer running the EPS software. Clicking the Start button will make the connection and show the electrodes defined on the EPS system.

Refresh – This button is used after making the connection to refresh the connection and show any changes made on the EPS system.

Once the connection is made, the EPS connection dialog will have information regarding the electrodes defines on the EPS system as shown below.

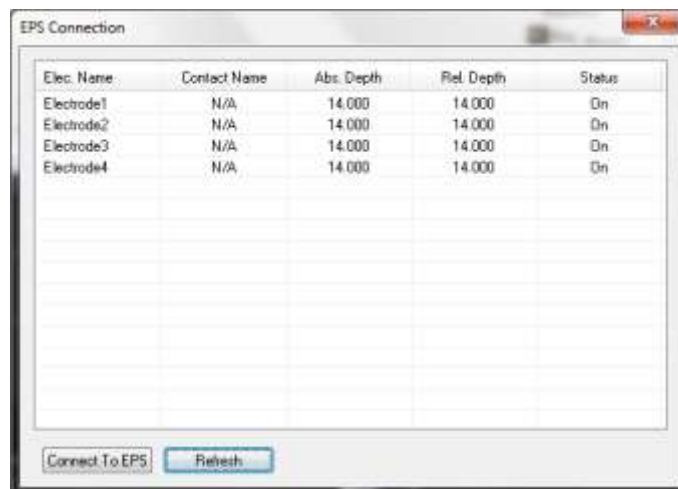


Figure 90 - EPS Connection Dialog after the connection

All information shown are acquired from the EPS system except for the Contact name, which can be added by clicking on the name filed itself and mapping electrodes to the AlphaLab SnR contact names. See dialog below.

Elec. Name	Contact Name	Abs. Depth	Rel. Depth	Status
Electrode1	MICRD 001	14.000	14.000	On
Electrode2	MICRD 002	14.000	14.000	On
Electrode3	MICRD 003	14.000	14.000	On
Electrode4	N/A	14.000	14.000	On

Figure 91 – Mapping Electrode to Contact Names

At this point the connection is made, and no further action needs to be taken to log the depths into the MPX files, and the EPS connection can be closed.

4.19.2 Showing the Electrode Depth on the GUI

The electrode depth can be shown on the main window only. This can be done by right clicking on the main window and selecting “Show Elect. Depth”. See window below.

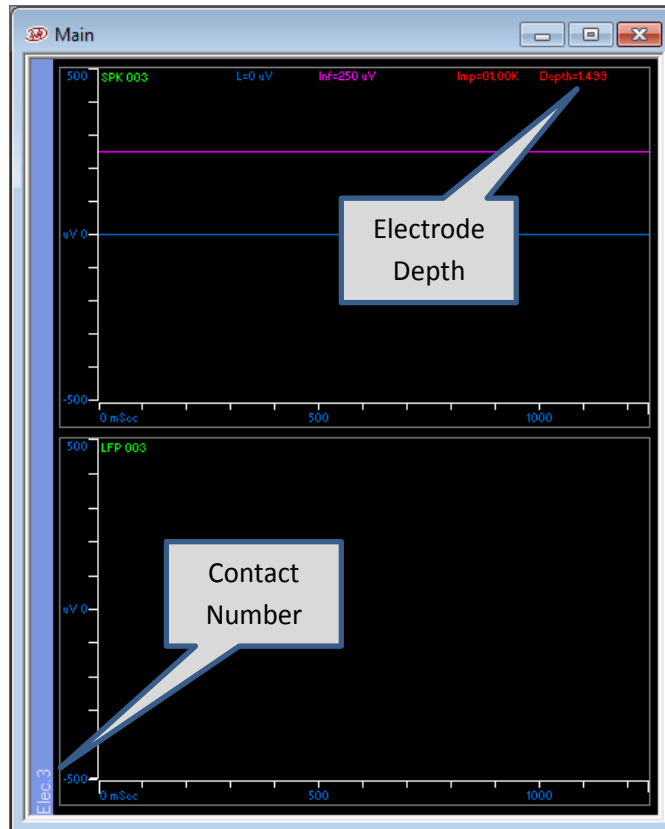


Figure 92 - Showing Electrode Depth

4.20 MATLAB/ C++ tool:

The AlphaLab SnR software can be controlled by MATLAB/ C++ commands. The data can be streamed out and analyzed via MATLAB and C++ tools. In addition, several functions are available such as: save data, check Impedance, start/stop stimulation, etc. For details see AlphaLab SnRSDK User Manual.

4.21 Optogenetics System Control

All the controls for the Optogenetics stimulation are in the AlphaLab SnR application banner. For these controls to appear in the banner use the menu option *View/Optogenetics Stimulation*. The AlphaLab SnR is capable of controlling various optogenetics systems available in the market, by the means of outputting synchronized analog or digital outputs or both depending on the connected system configuration.

There are 4 types of basic systems on the market as follows:

1. Systems that are controlled solely by TTL pulses (Digital) – In such systems it is possible to control the on/off of the laser. The intensity is controlled manually on the system itself.
2. Systems that are controlled by variable arbitrary voltage input in the range of 0V-5V – in such systems the maximum intensity is set on the system manually by the user, which is applied, and the laser intensity changes from 0W to the maximum value set on the system, when a voltage is applied. If 0V is supplied, no light is applied, while if 5V is supplied the maximum value set applied.
3. Systems that are configurable to 1 or 2 above – Same explanation for each applies
4. Systems that need both TTL pulse and arbitrary voltage – in these system the voltage controls the intensity, while the TTL controls the on/off. Meaning one can set the voltage to constant 2V, but no light will be applied unless the TTL pulse is supplied.

4.21.1 Defining the System

This section describes how to define the Optogenetics system that will controlled by the AlphaLab SnR. To start this process Select the *Options/Optogenetics Setting* from the menu, which will open the dialog below.

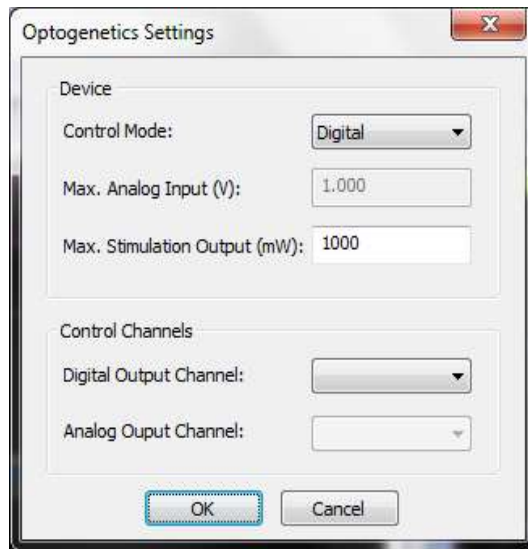


Figure 93 - Optogenetics Settings Dialog

Device – Under this section you must select what type of Optogenetics device you are using.

Control Mode – Select the device control mode; digital, analog (arbitrary), or both.

Max. Analog Input(V) – Specify the maximum voltage the optogenetics system can receive. This is for analog control systems only.

Max. Stimulation Output(mW) – Specify the power in mW the optogenetics system can emit at the full voltage. Pay attention that this value is set at the optogenetics system. Meaning that if a TTL pulse control is used, this is the value that will be emitted when the pulse is high, and if the control is analog, this is the value that will be emitted when the system receives the full voltage specified.

Control Channels – Specifies which output channels in the AlphaLab SnR will be used to control the Optogenetics device.

4.21.2 Controlling the System

This section describes how to control the connected Optogenetics system. If the workspace was defined correctly, you should see the following controls in the AlphaLab SnR GUI banner area, either on the right side or the left side depending on other selected stimulation options.



Figure 94 - Optogenetics system controls

Follows is an explanation of each control.

Stimulus Power Selection – This field is applicable only when the **Simple Wave** is used, and it specifies the power of the light in mW. The value can be either entered, or the up/down arrows can be used to step up or down the power values. The step value is specified in the Amplitude step size in the stimulation setup dialog shown in [Figure 95](#) below. Values specified here will be applied the next time the “Stim” button is pressed, meaning that changing this value while stimulation is being applied will not change the stimulation power.

Stim button – When this button is pressed, stimulation begins. The applicable analog and/or digital outputs are sent out of the AlphaLab SnR system. When the button is pressed, its color changes to red; a beep will sound if the “Sound during stimulation” was checked in the stimulation setup dialog shown in [Figure 95](#) below. To stop stimulation, the “Stim” button can be pressed again. If stimulation is not stopped by the user, it automatically stops after the time specified in the Duration field in the stimulation setup dialog shown in [Figure 95](#) below elapses.

Stimulation pulse/waveform selection drop down – This is where you can select the pulse to be used for stimulation. By default the **Simple Wave** appears as an option. Other waveforms defined and loaded will also appear in the selection drop down list. Refer to section [4.12](#) below on how to define and load square and arbitrary waveforms.

Setup button – This button opens the Stimulation Setup dialog shown below, and an explanation of each field follows. Pay attention that based on the connected and defined optogenetics system some of these fields may be disabled.

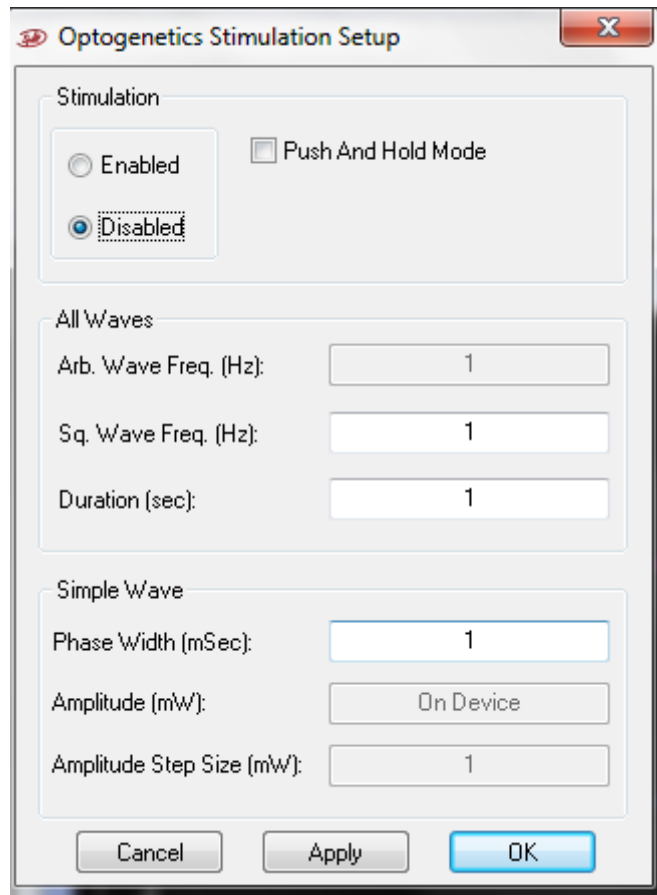


Figure 95 – Optogenetics Stimulation Setup

Disabled/Enabled – Disables/Enables the **Stim** button. This is meant to be for safety to make sure that no one presses the Stim button by mistake.

Push and Hold Mode – When this option is checked, it changed **the** behavior of the **Stim** button. In the case stimulation starts when the button is pressed and stops when the button is released. Time limitation still applies here if button is not released.

All Waves section

These are parameters that apply to every selected pulse/waveform.

Arb. Wave Frequency (Hz) – Arbitrary wave frequency specified in Hz. Pay attention that when arbitrary waveforms are used, truncation or zero padding may occur depending on the duration of the waveform used. -1 in this field means repeat specified wave. Frequency specified here is used only when analog stimulation waveforms are used. See Note1 below.

Sq. Wave Frequency (Hz) – Square wave frequency specified in Hz. See Note1 below. Up to 500, but also depends in the pulse total width defined. Frequency specified here is used only when square pulse stimulation waveforms are used.

Duration – This is a safety parameter. If the user does not stop stimulation, it stops automatically after time specified here elapses.

Simple Wave section

These are the definitions of the **Simple Wave**

Phase width – Stimulation pulse phase width in mSec.

Amplitude (mW) – Power in mW.

Amplitude step size – This sets the behavior of the up/down selectors on the stimulation amplitude control in the banned shown in [Figure 94](#) above.

4.22 Special Detection Filter

The AlphaLab SnR has a special feature that is handled by running code on the system's DSP. Because of performance issues, this feature is available only for systems up to 32 electrodes and that are running in the fast latency mode. This feature allows the script to respond to level detection within 4 system cycles. A system cycle length when fast latency mode is used is 180uSec. The fast latency mode is selected in the System State window in the initial hardware definition.

This detection mode works in conjunction with an internal digital port called Internal Detection Port 001 (ID number is 11225). When a level crossing is detected on the selected channel, then port 11225 is filled in with the selected channel ID. The port is made available for the script just like any other port and for the GUI as well for display and saving.

To start this Special Detection Filter, select the menu option **Tools/Detection** and the window below will open.

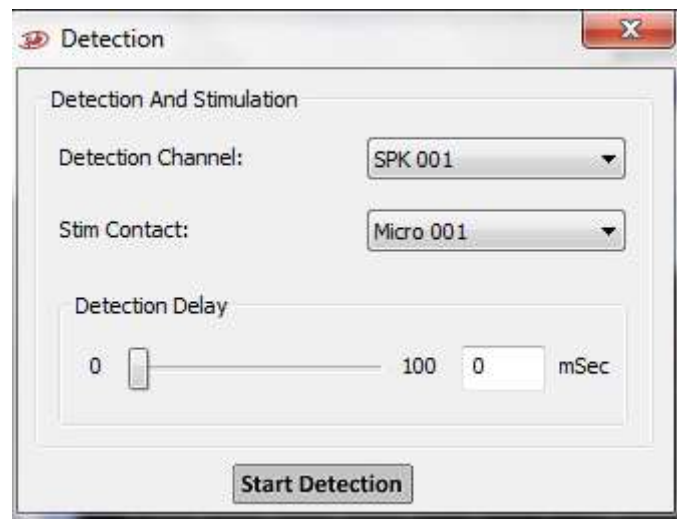


Figure 96 - Special Detection Filter

As shown, the user can select one channel to run the detection on. The detection level and slope are taken as defined by the user in the Main window display for that channel. In this window the user may also select a contact to stimulate, as well as defining a delay from the level detection time.

Once a set of channels is selected, press the *Start Detection* button to initiate the detection process. To change the selected channel, press the *Stop Detection*, change the parameters and press the *Start Detection* again.

When a delay is used, and the system detects a level crossing, the system stops the detection till the delay time elapses, and then sends the port value through the system, and starts the detection process again. **The Detection Port itself will have the detection time without the delay.** A Stream Data record is stored every time the detection is started or stopped specifying the detection channel, the stimulation channel, and the delay. Stream data records 307 and 308 are used. Refer to the Mapfile converter manual for details.

4.23 Monitoring Panel LED's

On the front panel of the Main Processing Unit, there are 12 LED's (3 groups of 4 LED's), where each LED has a certain behavior and meaning. The table below explains these behaviors starting from the left LED to the far right one.



LED Number	Behavior	Meaning
1	None	Not in use yet
2	None	Not in use yet
3	On	Script is running
4	On	Stimulation is being applied on one or more electrodes
5	Flashing	Online Sorting is running
6	Flashing	Filtering is running
7	On for a short while at startup, then goes off	Normal behavior indicating that no errors occurred while booting the system
8	Flashing	Ethernet communication is running
9	None	Not in use yet
10	None	Not in use yet
11	None	Not in use yet
12	None	Not in use yet

5 ALPHALAB SNR SPECIFICATIONS

5.1 Technical Specifications

5.1.1 General System Specifications

<i>Parameter</i>	<i>Value</i>
Operating System	AlphaLab SnR Software runs on Windows XP, on Windows 7 32bit or 64bit, or on Windows 10. Software should be set up using a user account with Admin permissions.
Digital Filtering	All Digital Filters are applied in addition to the Hardware Filters, and not as a compliment. LFP: Software Controlled HP and LP Spike : Software Controlled HP and LP
Segmentation	Method: Level Threshold Segment length: 2.15mSec (96 samples at full sampling rate, and crossing sample is 18)
Online Sorting	Method 1: 8 point template match Sorting Templates per channel: 4 Include bars per template: 3 Exclude bars per template: 0 Segment length: 2.15mSec (96 samples at full sampling rate, template points are 5 samples apart starting in sample 18) Method 2: Include/Exclude Bar Sorting Templates per channel: 0 Include bars per template: 3 Exclude bars per template: 1 Segment length: 2.15mSec - 96 samples at full sampling rate, template points, when available, are 5 samples apart starting in sample 18. Include and Exclude bars can be moved and stretched anywhere on the signal.

Parameter	Value
Sampling Rate at DSP (Digital down Sampling)	<p>Sampling rates indicated below are in systems with 44K full sampling rate at headstage. Other systems have sampling rates prorated based on the full sampling rate of the system.</p> <p>LFP –Up to 1375s/Sec (Sample/ Second) SPK –Up to 44Ks/Sec in systems up to 32 channels Up to 22Ks/Sec in systems with more than 32 channels SEG – 44K (not changeable) RAW –Up to 44Ks/Sec in systems up to 32channels Up to 22Ks/Sec in systems with more than 32 channels</p> <p><i>Note: Acquisition of the Continuous RAW or SPK is limited to one of the two for each channel in a system with more than 32 channels.</i></p>
Flexible Referencing	Available in systems up to 96 channels and is applied on RAW signal. This is digital flexible referencing.
Stimulation Current Monitor	<p>Tolerance for currents from 40μA-550μA and 700μA - 3.5mA - is +/- 30%</p> <p>Outside above ranges, current monitor tolerance will be higher than 30%</p>
Statistical tools	Up to 32 windows of each type (PSTH / Spike Raster) may be defined and viewed simultaneously.
Power	100V–240V, 50Hz–60Hz
Communication with PC	1GB Ethernet using crossed cable or Ethernet switch
Recommended UPS type	<p>EATON UPS Model: 5E 1100i USBC Input voltage= 220-240 Volt AC Output = 220-240 Volt AC 1100VA/660W</p>

5.1.2 PreAmp HeadStage for Free Moving Animals

Parameter	Value
Number of Electrode Physiological Inputs	16 – 128 (128 channel system can be cascaded and run using the same clock to reach higher channel count)
Input Connector	<p>10 pin Omnetics (8 channel PreAmps) 18 pin Omnetics (16 channels PreAmps) 36 pin Omnetics (32 channel PreAmps)</p>
First Amplifier Input Impedance	PreAmp - 10 G Ω 2pF
Hardware High Pass Filter	1 Hz
Hardware Low Pass Filter	10 KHz
Total Gain	<p>PreAmp gain 1 – total is 20 PreAmp gain 10 – total is 200 PreAmp gain 20 – total is 400</p>

<i>Parameter</i>	<i>Value</i>
Dynamic Input range	PreAmp (gain 1) => $\pm 62.5\text{mV}$ PreAmp (gain 10) => $\pm 6.25\text{mV}$ PreAmp (gain 20) => $\pm 3.1\text{mV}$
Input Type	1 analog reference and 1 ground
A/D Resolution	16 bits
Input Bit Resolution	PreAmp (gain 1) => $1.9\mu\text{V}$ PreAmp (gain 10) => $0.19\mu\text{V}$ PreAmp (gain 20) => $0.09\mu\text{V}$
Sampling Rate at HS*	44,000 Samples per second
Input Referred Noise (RMS)	$< 5\mu\text{V}$ @ 500Kohm electrode in Saline $< 3\mu\text{V}$ @ ground
Stimulation Sources	Up to 4 channels out of each 16 channel module can be converted to Dedicated stimulation channels
Stimulation Pulse	Square Pulses: <ul style="list-style-type: none"> Phase Width** - $40\mu\text{Sec} - 500\mu\text{Sec}$ ($\sim 4.675\mu\text{Sec}$ boundary resolution with max sampling rate of 44000s/Sec, rounded to the closest boundary) <i>Notes:</i> <i>Pulses below $40\mu\text{Sec}$ are possible to use, but pulse amplitude may be up to 40% lower than the requested value.</i> <i>Pulses above $500\mu\text{Sec}$ are also useable but may be deformed.</i> Amplitude Biphasic - $10\mu\text{A} - 3.5\text{mA}$ (up to $\pm 50\text{V}$) <i>Notes:</i> <i>Amplitude tolerance within $\pm 15\%$.</i> <i>Pulses below $30\mu\text{A}$, the Amplitude tolerance is within $\pm 30\%$.</i> <i>Pulses below $10\mu\text{A}$ are possible to use, but may not be possible to monitor.</i> Frequency – up to 300Hz Arbitrary waveforms: <ul style="list-style-type: none"> Use text files of samples – sampling rate is definable Frequency and duration are definable Up to two different waves per 16-channel module
Impedance Check	Measured, calculated, and reported – Possible to check with different frequencies and different amplitudes
Standard cable length between PreAmp and HS	Default is 70cm, can be customizable up to 2 meters Flexible cable- better for torque transmission
PreAmp Weight & Size	<ul style="list-style-type: none"> 8 channel – 0.5 grams – 13mm x 10.2mm 16 channel – 0.75 grams – 10.5mm x 15.5mm 32 channel – 1.3 grams – 15.5mm x 19mm
Commutator	10 line commutator for recording only for any number of channels. Stimulation adds commutator lines based on the number of stimulation channels

(*) System that were produced before 2013 may have $\sim 44,642.857$ Samples per second

(**) $4.608\mu\text{Sec}$ boundary resolution for systems with max sampling rate of $44,642.857\text{s/Sec}$

5.1.3 HeadStage for Restrained Animals

<i>Parameter</i>	<i>Value</i>
Number of Electrode Physiological Inputs	16 – 128
Input Connector	Samtec ERF8-020-01-L-D-RA-L-TR for HS V.2
First Amplifier Input Impedance	100 GΩ 2pF
CMRR	DC to 60 Hz : 100db 4KHz: 90db
Hardware High Pass Filter	1Hz – 2 Pole (HS V.2 for MER recording)
Hardware Low Pass Filter	10.0KHz – 3 Pole Butterworth
Total Gain	20
Dynamic Input range	±62.5mV
Input Type	Differential
A/D Resolution	16 bits
Input Bit Resolution	1.9uV
Sampling Rate at HS*	44,000 Samples per second
Input Referred Noise (RMS)	< 5μV @ 500Kohm electrode in Saline < 3μV @ ground
Standard input cable length	28cm
Stimulation Sources	1-16 sources for every 16 channel module

<i>Parameter</i>	<i>Value</i>
Stimulation Pulse	<p>Square Pulses:</p> <ul style="list-style-type: none"> Phase Width** - 40µSec – 500µSec (~4.675uSec boundary resolution with max sampling rate of 44000s/Sec, rounded to the closest boundary) <i>Notes:</i> <i>Pulses below 40µSec are possible to use, but pulse amplitude may be up to 40% lower than the requested value.</i> <i>Pulses above 500µSec are also useable but may be deformed.</i> Biphasic - 10µA – 3.5mA (up to ±50V) <i>Notes:</i> <i>Amplitude tolerance within ±15%.</i> <i>Pulses below 30µA, the Amplitude tolerance is within ±30%</i> <i>Pulses below 10µA are possible to use, but may not be possible to monitor.</i> Frequency – up to 300Hz <p>Arbitrary waveforms:</p> <ul style="list-style-type: none"> Use text files of samples – sampling rate is definable Frequency and duration are definable Up to two different waves per 16-channel module
Impedance Check	Measured, calculated, and reported – Possible to check with different frequencies and different amplitudes
Headstage Size	73mm x 68mm x 48mm
Headstage Weight	80 Gram for 16chan – 150Gram for 128chan

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

(**) 4.608uSec boundary resolution for systems with max sampling rate of 44,642.857s/Sec

5.1.4 General Purpose Analog Inputs

<i>Parameter</i>	<i>Value</i>
Number of Inputs	16 Standard 16 Optional on SIU (Part of a package)
Input Connector	BNC's and/or 25 d-type Female connector
Input Range	±5V
Gain	0.25
Hardware High Pass Filter	None
Hardware Low Pass Filter	1KHz Passive (0.7@1KHz, 0.8@500Hz)
A/D Converter Input Range	± 1.25Volts
A/D Resolution	12 bits
Input Bit Resolution	2.5mV
Sampling Rate*	2,750 Samples per second

(*) System that were produced before 2013 may have ~2,790.18 Samples per second

5.1.5 General Purpose Analog Outputs

<i>Parameter</i>	<i>Value</i>
Number of Outputs	8 Standard (4 on the Mini MPU) 8 Optional on SIU (Part of a package)
Purpose	Output the filtered signal of any of the 128 electrodes to any of the output channels
Output Connector	BNC's
Bandwidth	DC-6KHz
Gain	Electrode channels - 4000 (Total gain including PreAmp and Headstage gain) User defined channel – 4
D/A Converter Output Range	± 5Volts (Some older versions have ± 2.5Volts)
D/A Resolution	16 bits
Sampling Rate*	2,750 Samples per second

(*) System that were produced before 2013 may have ~2,790.18 Samples per second

5.1.6 Audio Outputs

<i>Parameter</i>	<i>Value</i>
Number of Outputs	2 Stereo
Purpose	Output the filtered signal of any of the 128 electrodes to any of the audio channels
Output Connector	Audio Jacks
Bandwidth	DC-6KHz
Gain	2000 (Total gain including PreAmp and HeadStage gain) (Some older versions have a total gain of 4000)
D/A Converter Output Range	±2.5 Volts
D/A Resolution	16 bits
Sampling Rate*	44,000 Samples per second

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

5.1.7 General Purpose Single Bit Digital Inputs

<i>Parameter</i>	<i>Value</i>
Number of Inputs	4 Standard 4 Optional on SIU (Part of a package)
Input Connector	BNC's or 9 pin d-type Male connector
Input Type	Standard TTL
Sampling Rate*	44,000 Samples per second

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

5.1.8 General Purpose Digital Input 16-bit Ports

<i>Parameter</i>	<i>Value</i>
Number of Input Ports	1 Standard 1 Optional on SIU (Part of a package) 8 Optional on MPU
Input Connector	25 pin d-type Male connector
Input Type	Standard TTL

<i>Parameter</i>	<i>Value</i>
Sampling Rate*	44,000 Samples per second
Strobe	Strobe pulse is sampled at the full sampling rate of the system. Strobe is handled when pulse goes from 0 to 1.
Ready	Ready stays in Active high by default. It goes to active Low for about 125uSec when strobe is received.

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

5.1.9 General Purpose Digital Outputs

<i>Parameter</i>	<i>Value</i>
Number of Outputs	8 Standard 8 Optional on SIU (Part of a package)
Output Connector	BNC's or 15 pin d-type Female connector
Input Type	Standard TTL
Sampling Rate*	44,000 Samples per second
Control	Script only
Display and Logging	Yes

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

5.1.10 User Defined Analog Channels

<i>Parameter</i>	<i>Value</i>
Number of Channels	4
Output Connector	None – This are internally generated channels, that can be displayed, saved, and /or routed to analog outputs
Input Type	Standard TTL
Generation Sampling Rate*	44,000 Samples per second
Control	Through GUI, script, and DLL
A/D Resolution	16 bits for +/- 5V
Display and Logging	Yes

(*) System that were produced before 2013 may have ~44,642.857 Samples per second

5.2 Connector Pin Layouts

This section details the pin layouts of all connectors accessible by the user. These may be referenced to either modular(Standard) or non-modular(Mini) AlphaLab SnR systems and their components, as the system can come in a very compact packaging for 16 channels non upgradeable, or in the modular packaging for up to 128 channels.

5.2.1 PreAmps Headstages

There are 3 different PreAmp types that can be supplied with the AlphaLab SnR; 8-channel, 16-channel, and 32-channel. These all use Omnetics connectors as the input connectors. [Figure 97](#) below shows the 16-channel Preamp. In the layout specifications below, assume that you are looking at the same angle and orientation for all of the different connector types shown in the figure below.

Note: For preamps/followers old versions please refer to manuals V2.0.3 and below.


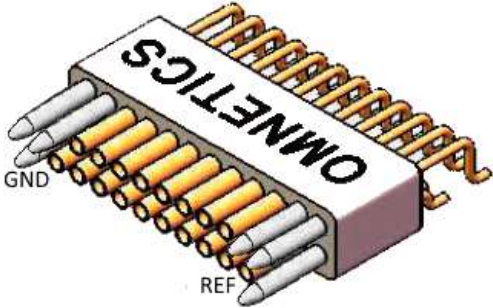
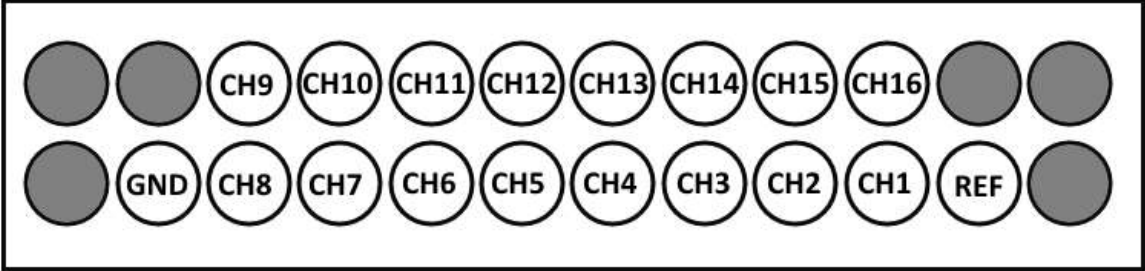


Figure 97 – 16-Channel PreAmp


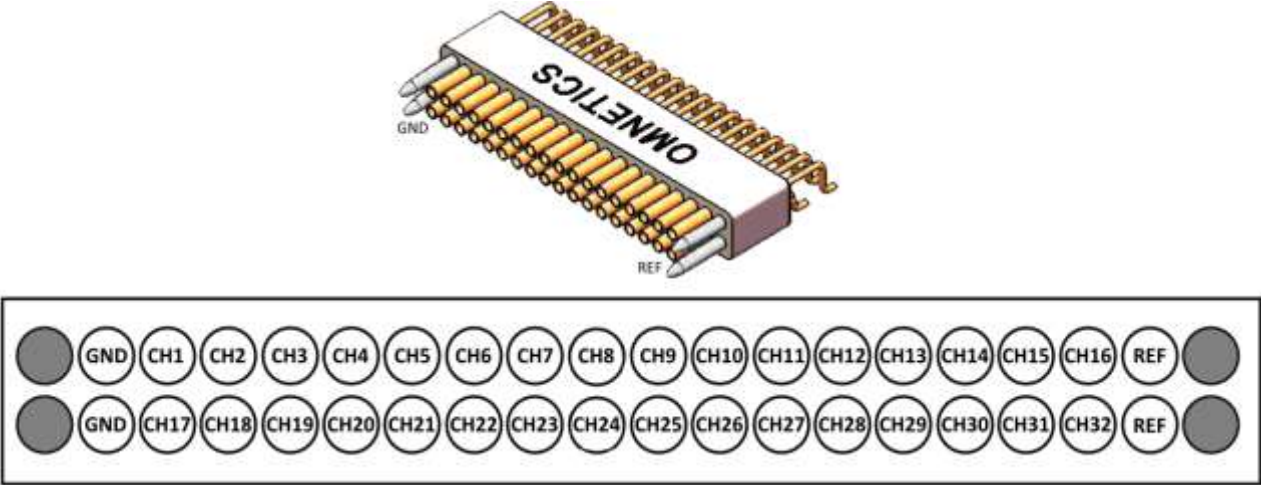
5.2.1.1 8-Channel Preamp Headstages

Type →	Preamp-8 HS1 Gain (X 1 / 10X / X 20)	Preamp-8 HS2 Gain (X 1 / 10X / X 20)
Picture		
Connector	Omnetics 10Pin Female, one row, 50mil	Omnetics 10Pin Female, one row, 25mil
Guide Posts on each side	None	1
Preamp-8 Pinout		

5.2.1.2 16-Channel Preamp Headstage

Type →	Preamp-16 HS Gain (X 1 / 10X / X 20)
Picture	
Connector	Omnetics 18Pin Female, Two rows (10+8), 25mil
Guide Posts on each side	3
Preamp-16 Pinout	 

5.2.1.3 32-Channel Preamp Headstage

Type →	Preamp-32 HS Gain (X 1 / 10X / X 20)
Picture	
Connector	Omnetics 36Pin Female, Two rows (2x18), 25mil
Guide Posts on each side	2
Preamp Pinout	

5.2.2 Headstage

The AlphaLab SnR headstages come in two shapes; one is a non-modular 16-Channel Headstage and the other is a modular Headstage suitable for up to 128 channels in modules of 16 channels. Both headstages use the same input connector. In the modular headstage, there may be 1 to 8 input connectors, clearly labeled 1 to 8 respectively. *Figure* below shows both of these models, where the modular headstage is partially shown.

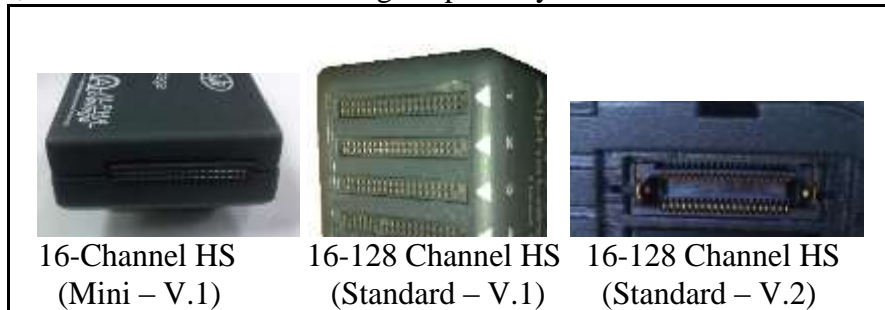


Figure 98 – AlphaLab SnR HeadStages

5.2.2.1 Headstage 16-Channel Module (V.1)

Connector type is the Samtec 40 Pin Female, 2 rows (2x20, including 2 key pins), 50mil. Manufacturer Catalog Number is SFMH-120-02-L-D-LC.

Pinout of module 1 also applies to the only connector on the 16-Channel HeadStage

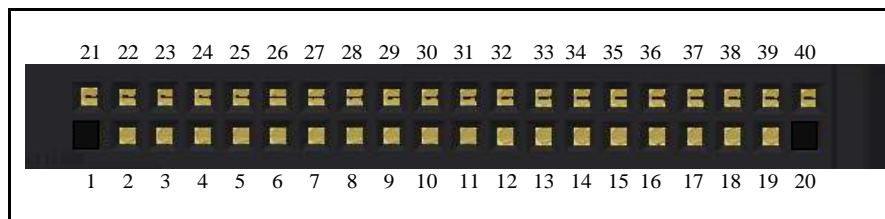


Figure 99 – 16-Channel HeadStage Module

Pin Number	Use in Module1	Use in Module2	Use in Module3	Use in Module4	Use in Module5	Use in Module6	Use in Module7	Use in Module8
1	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)
2	- 3.3V	- 3.3V	- 3.3V	- 3.3V	- 3.3V	- 3.3V	- 3.3V	- 3.3V
3	IN1 -	IN17 -	IN33 -	IN49 -	IN65 -	IN81 -	IN97 -	IN113 -
4	IN2 -	IN18 -	IN34 -	IN50 -	IN66 -	IN82 -	IN98 -	IN114 -
5	IN3 -	IN19 -	IN35 -	IN51 -	IN67 -	IN83 -	IN99 -	IN115 -
6	IN4 -	IN20 -	IN36 -	IN52 -	IN68 -	IN84 -	IN100 -	IN116 -
7	IN5 -	IN21 -	IN37 -	IN53 -	IN69 -	IN85 -	IN101 -	IN117 -
8	IN6 -	IN22 -	IN38 -	IN54 -	IN70 -	IN86 -	IN102 -	IN118 -
9	IN7 -	IN23 -	IN39 -	IN55 -	IN71 -	IN87 -	IN103 -	IN119 -

Pin Number	Use in Module1	Use in Module2	Use in Module3	Use in Module4	Use in Module5	Use in Module6	Use in Module7	Use in Module8
10	IN8 -	IN24 -	IN40 -	IN56 -	IN72 -	IN88 -	IN104 -	IN120 -
11	IN16 -	IN32 -	IN48 -	IN64 -	IN80 -	IN96 -	IN112 -	IN128 -
12	IN15 -	IN31 -	IN47 -	IN63 -	IN79 -	IN95 -	IN111 -	IN127 -
13	IN14 -	IN30 -	IN46 -	IN62 -	IN78 -	IN94 -	IN110 -	IN126 -
14	IN13 -	IN29 -	IN45 -	IN61 -	IN77 -	IN93 -	IN109 -	IN125 -
15	IN12 -	IN28 -	IN44 -	IN60 -	IN76 -	IN92 -	IN108 -	IN124 -
16	IN11 -	IN27 -	IN43 -	IN59 -	IN75 -	IN91 -	IN107 -	IN123 -
17	IN10 -	IN26 -	IN42 -	IN58 -	IN74 -	IN90 -	IN106 -	IN122 -
18	IN9 -	IN25 -	IN41 -	IN57 -	IN73 -	IN89 -	IN105 -	IN121 -
19	GND	GND	GND	GND	GND	GND	GND	GND
20	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)	Key (Plugged)
21	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
22	+3.3V	+3.3V	+3.3V	+3.3V	+3.3V	+3.3V	+3.3V	+3.3V
23	IN1 +	IN17+-	IN33 +	IN49 +	IN65 +	IN81 +	IN97 +	IN113 +
24	IN2 +	IN18 +	IN34 +	IN50 +	IN66 +	IN82 +	IN98 +	IN114 +
25	IN3 +	IN19 +	IN35 +	IN51 +	IN67 +	IN83 +	IN99 +	IN115 +
26	IN4 +	IN20 +	IN36 +	IN52 +	IN68 +	IN84 +	IN100 +	IN116 +
27	IN5 +	IN21 +	IN37 +	IN53 +	IN69 +	IN85 +	IN101 +	IN117 +
28	IN6 +	IN22 +	IN38 +	IN54 +	IN70 +	IN86 +	IN102 +	IN118 +
29	IN7 +	IN23 +	IN39 +	IN55 +	IN71 +	IN87 +	IN103 +	IN119 +
30	IN8 +	IN24 +	IN40 +	IN56 +	IN72 +	IN88 +	IN104 +	IN120 +
31	IN16 +	IN32 +	IN48 +	IN64 +	IN80 +	IN96 +	IN112 +	IN128 +
32	IN15 +	IN31 +	IN47 +	IN63 +	IN79 +	IN95 +	IN111 +	IN127 +
33	IN14 +	IN30 +	IN46 +	IN62 +	IN78 +	IN94 +	IN110 +	IN126 +
34	IN13 +	IN29 +	IN45 +	IN61 +	IN77 +	IN93 +	IN109 +	IN125 +
35	IN12 +	IN28 +	IN44 +	IN60 +	IN76 +	IN92 +	IN108 +	IN124 +
36	IN11 +	IN27 +	IN43 +	IN59 +	IN75 +	IN91 +	IN107 +	IN123 +
37	IN10 +	IN26 +	IN42 +	IN58 +	IN74 +	IN90 +	IN106 +	IN122 +
38	IN9 +	IN25 +	IN41 +	IN57 +	IN73 +	IN89 +	IN105 +	IN121 +
39	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave	Imp. Sine Wave
40	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)	GND_ISO (Stim Ret.)

5.2.2.2 Headstage 16-Channel Module (V.2)

Input connector type is the Samtec 40 Pin connector with manufacturer Catalog Number is **ERF8-020-01-L-D-RA-L-TR**. Pinout for this connector is not relevant.

Grounding pin is 1 mm. See figure below, upper right corner.



Figure 980 - Grounding input on the Headstage

5.2.3 Signal Integration Unit

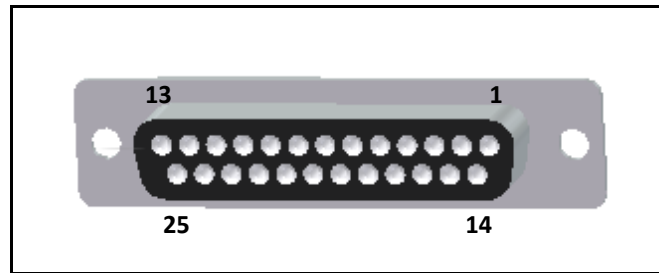
The Signal Integration Unit may optionally have an Analog/Digital Input/Output package. In that case, all inputs and outputs would be available on d-type connectors on the front panel of the unit. This option is available only on the [Figure](#) below shows that panel, followed by a complete pinout on each connector.



Figure 101 – SIU A/D I/O Package Panel

5.2.3.1 Analog Inputs (A.In)

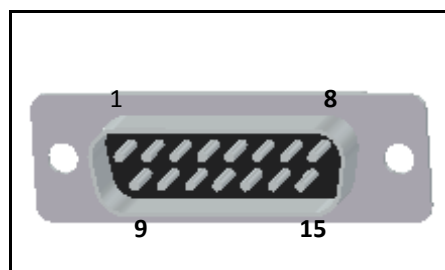
Connector type is the D-Type 25Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	GND	14	GND
2	GND	15	A.In 1
3	A.In 9	16	A.In 2
4	A.In 10	17	A.In 3
5	A.In 11	18	A.In 4
6	A.In 12	19	GND
7	GND	20	A.In 5
8	A.In 13	21	A.In 6
9	A.In 14	22	A.In 7
10	A.In 15	23	A.In 8
11	A.In 16	24	GND
12	GND	25	GND
13	GND		

5.2.3.2 Analog Outputs (A.Out)

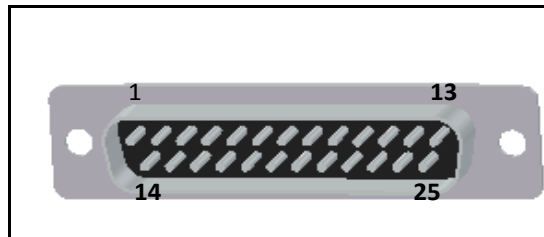
Connector type is the D-Type 15Pin Male. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	A.Out 1	9	A.Out 2
2	A.Out 3	10	A.Out 4
3	A.Out 5	11	A.Out 6
4	A.Out 7	12	A.Out 8
5	GND	13	GND
6		14	
7		15	
8			

5.2.3.3 Digital Input Port (D.In Port)

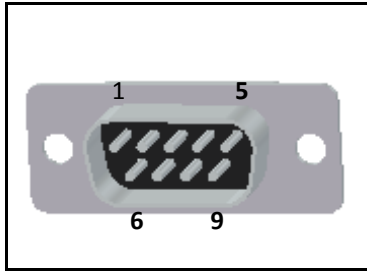
Connector type is the D-Type 25Pin Male. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	D.In 1	14	D.In 2
2	D.In 3	15	D.In 4
3	D.In 5	16	D.In 6
4	D.In 7	17	D.In 8
5	D.In 9	18	D.In 10
6	D.In 11	19	D.In 12
7	D.In 13	20	D.In 14
8	D.In 15	21	D.In 16
9	Strobe	22	GND
10	GND	23	GND
11	Ready	24	GND
12	GND	25	GND
13	GND		

5.2.3.4 Single Bit Digital Inputs (D.In)

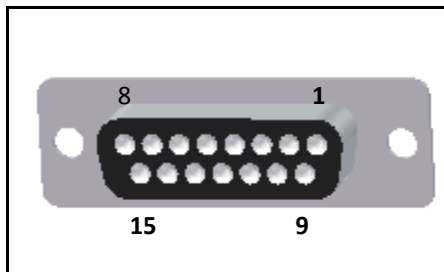
Connector type is the D-Type 9Pin Male. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	D.In 1	6	D.In 2
2	D.In 3	7	D.In 4
3	Not used	8	Not used
4	Not used	9	Not used
5	GND		

5.2.3.5 Digital Output (D.Out)

Connector type is the D-Type 15Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector. Older versions of hardware may have different pin layout. See below.



Pin Number	Use	Pin Number	Use
1	D.Out 1	9	D.Out 2
2	D.Out 3	10	D.Out 4
3	D.Out 5	11	D.Out 6
4	D.Out 7	12	D.Out 8
5	GND	13	GND
6	Not used	14	Not used
7	Not used	15	Not used
8	Not used		

Older versions of mini system may have this pinout.

Pin Number	Use	Pin Number	Use
1	D.Out 1	9	GND

Pin Number	Use	Pin Number	Use
2	D.Out 2	10	GND
3	D.Out 3	11	Not used
4	D.Out 4	12	Not used
5	D.Out 5	13	Not used
6	D.Out 6	14	Not used
7	D.Out 7	15	Not used
8	D.Out 8		

5.2.4 Main Processing Unit

The Main Processing Unit comes standard with an Analog/Digital Input/Output package. Some of these channels are available on the front panel in BNC connectors, and the rest are on the rear panels of the unit in d-type connectors. *Figure* below shows the rear panels of both the Standard and Mini MPU, followed by a complete pinout on each connector.

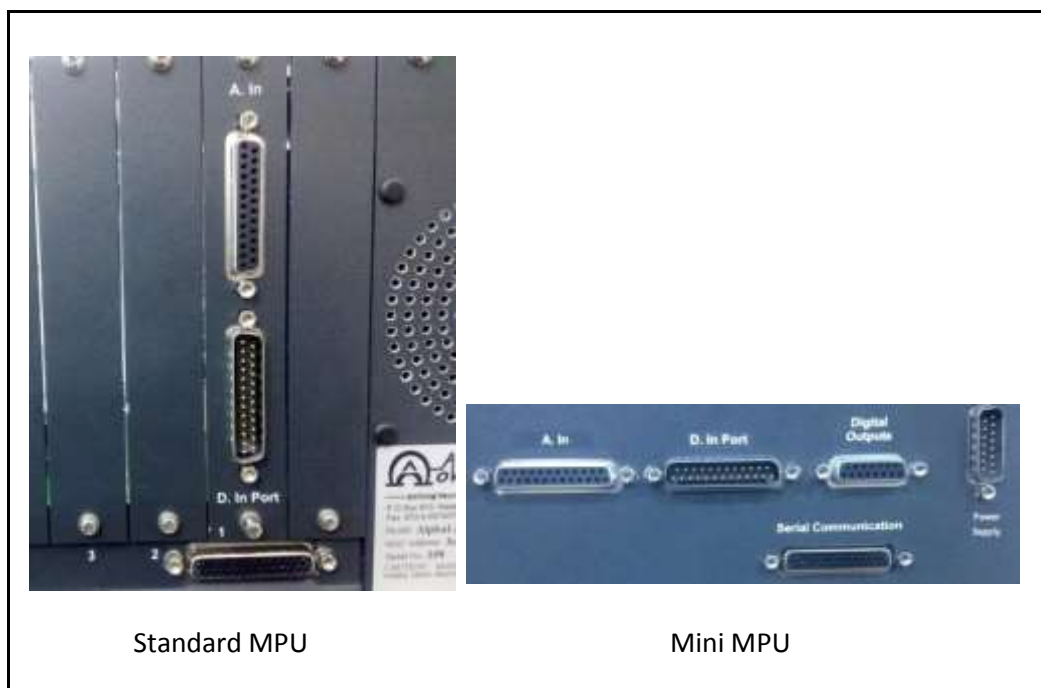
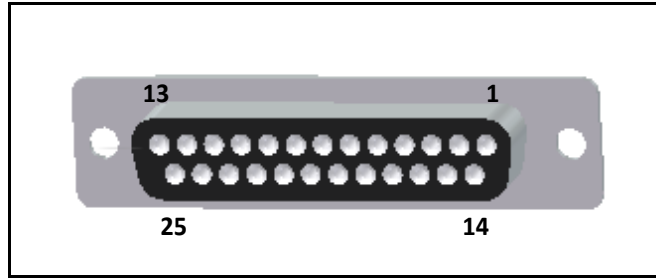


Figure 102 – MPU Rear Panels

5.2.4.1 Analog Inputs (A.In and BNC's)

Connector type is the D-Type 25Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector. On the Standard MPU, channel 1 through 8 are available in clearly marked BNC connectors on the front panel.



Pin Number	Use	Pin Number	Use
1	GND	14	GND
2	GND	15	A.In 1 (Mini Only)
3	A.In 9	16	A.In 2 (Mini Only)
4	A.In 10	17	A.In 3 (Mini Only)
5	A.In 11	18	A.In 4 (Mini Only)
6	A.In 12	19	GND
7	GND	20	A.In 5 (Mini Only)
8	A.In 13	21	A.In 6 (Mini Only)
9	A.In 14	22	A.In 7 (Mini Only)
10	A.In 15	23	A.In 8 (Mini Only)
11	A.In 16	24	GND
12	GND	25	GND
13	GND		

5.2.4.2 Analog Outputs (BNC's)

All analog outputs in both the Standard and Mini MPU's are available on the front panels. They are all clearly marked BNC connectors. There are 8 on the Standard MPU, and 4 on the Mini MPU.

5.2.4.3 Single Bit Digital Inputs (BNC's)

All single bit digital inputs in both the Standard and Mini MPU's are available on the front panels. They are all clearly marked BNC connectors. There are 4 on the Standard MPU, and 4 on the Mini MPU.

5.2.4.4 Digital Input Port (D.In Port 1)

Connector and pinout of the MPU Digital Input Port are exactly as specified in section [5.2.3.3](#) above.

On the Standard MPU, it is possible to add up to 8 additional 16-bit digital input ports. These additional ports will be available on panels 2 through 9 on the rear panel accordingly. See [Figure](#) above, which partially shows these panels.

5.2.4.5 Digital Outputs (D.Out or BNC's)

On the Standard MPU all digital outputs are on the front panel. They are all clearly marked BNC connectors.

Connector and pinout of the Mini MPU Digital Outputs are exactly as specified in section [5.2.3.5](#) above.

6 ALPHALAB SNR FILE FORMAT

Each **MPX** file contains a set of consistent blocks. **MPX** format started with the AlphaLab SnR system, which also started Version 4 of the file format. AlphaLab Pro, TeleSpike, MicroGuide, and NeuroNav still use the **MAP** extensions. There are two types of blocks, **Definition blocks** and **Data blocks**. Both block types contain a **header** and a **data** part. The **data** part of the definition blocks describes the system and the channels recorded.

The **data** part of the data blocks contains digitized signals or information that was received during acquisition. The file structure uses standard 'C' programming terms. All numeric fields in the blocks are aligned to 2 bytes.

Each file starts with a number of definition blocks. The **first block** of the file is a special type "h" or **header** block. The following pages show the structure of both the header and data blocks. Any block type other than the ones described below should be ignored.

6.1 Type h – File Header Block

Block Type: h - File Header	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDataHeader			File Header	
USHORT	m_length	2		Block Length (60)	
char	m_TypeBlock	1		h	
		1		Not used - 2 byte alignment	
long	m_nextBlock	4		Offset of next block from beginning of file	
short	m_version	2		Program version number	
_dostime_t	m_time	4		PC start time of data saving	
_dosdate_t	m_date	6		PC date of data saving	
double	m_MinimumTime	8		minimal acquisition time (sec)	
double	m_MaximumTime	8		maximal acquisition time (sec)	
long	m_EraseCount	4		Number of the erase messages in the file	
BYTE	m_mapVersion	1		Format Version	V2 and higher
char	m_ApplicationName[10]	10		Application name up to 10 characters	V2 and higher
char	m_ResourceVersion[4]	4			V2 and higher
		1		Not used - 2 byte alignment	
long	m_Reserved	4		Not used yet	V2 and higher

6.2 Type 2 – Continuous Analog Channel Definition

Block Type: 2 - Continuous Analog	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDefContinAnalog	Variable		Continuous Analog Channel Header	
USHORT	m_length	2	0	Block Length	
char	m_TypeBlock	1	2	2	
		1	3	Not used - 2 byte alignment	
long	m_nextBlock	4	4	Offset of next block from beginning of file	
short	m_isAnalog	2	8	1 (0=Digital, 1-Analog)	
short	m_isInput	2	10	1 (0=Output, 1=Input)	
short	m_Number	2	12	Channel Number	
long	m_SpikeColor	4	14		
short	m_Mode	2	18	0 (0=Cont., 1=Level or Seg)	Other mode types are for V3 or lower
float	m_Amplitude	4	20	Bit resolution in uV (If value =< 5 use 1,250,000 / 2 ¹⁵)	This is true for When application name is "ALab SNR" (Format 4.0).
float	m_SampleRate	4	24	In KS/Sec	
short	m_nSpikeCount	2	28	Data block size	
short	m_ModeSpike	2	30	Shape	
float	m_Duration	4	32		
short	m_nTotGainX100	2	36	100 x Total Gain applied to this channel. I.e. if 25 is specified that means there was attenuation of 4, and if 20000 is specified that means there was a total gain of 200.	0 in this field means unknown
char	m_Name[n]	n = m_length - 38	38	Channel Name	

6.3 Type 2 – Segmented Analog Channel Definition

Block Type: 2 - Segmented Analog	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDefLevelAnalog	Variable		Level or TM Analog Channel Header	
USHORT	m_length	2	0	Block length	
char	m_TypeBlock	1	2	2	
		1	3	Not used - 2 byte alignment	
long	m_nextBlock	4	4	Offset of next block from beginning of file	
short	m_isAnalog	2	8	1 (0=Digital, 1-Analog)	
short	m_isInput	2	10	1 (0=Output, 1=Input)	
short	m_Number	2	12	Channel Number	
long	m_SpikeColor	4	14		
short	m_Mode	2	18	1 (0=Cont., 1=Level or Seg)	Other mode types are for V3 or lower
float	m_Amplitude	4	20	Bit resolution in uV (If value ≤ 5 use $1,250,000 / 2^{15}$)	This is true for When application name is "ALab SNR" (Format 4.0).
float	m_SampleRate	4	24	In KS/Sec	
short	m_nSpikeCount	2	28	Data block size	
short	m_ModeSpike	2	30	Shape	
float	m_nPreTrigmSec	4	32		
float	m_nPostTrigmSec	4	36		
short	m_LevelValue	2	40		
short	m_TrngMode	2	42		
short	m_YesRms	2	44	1 if automatic level calculation based on RMS, is used.	
short	m_nTotGainX100	2	46	100 x Total Gain applied to this channel. I.e. if 25 is specified that means there was attenuation of 4, and if 20000 is specified that means there was a total gain of 200.	0 in this field means unknown

char	m_Name[n]	n = m_length - 48	48	Channel Name	
------	-----------	-------------------------	----	--------------	--

6.4 Type 2 – Digital Input Channel Definition

Block Type: 2 - Digital Input (Single Bit)	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDefDigitalInput	Variable		Single Bit Digital Channel Header	
USHORT	m_length	2	0	Block Length	
char	m_TypeBlock	1	2	2	
		1	3	Not used - 2 byte alignment	
long	m_nextBlock	4	4	Offset of next block from beginning of file	
short	m_isAnalog	2	8	0 (0=Digital, 1-Analog)	
short	m_isInput	2	10	1 (0=Output, 1=Input)	
short	m_Number	2	12	Channel Number	
long	m_SpikeColor	4	14		
float	m_SampleRate	4	18	In KS/Sec	
short	m_SaveTrigger	2	22		
float	m_Duration	4	24		
short	m_PrevStatus	2	28		
char	m_Name[n]	n = m_length - 30	30	Channel Name	

6.5 Type S – Stream Data Definition

Block Type: S - Stream Data	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDefStream	Variable		Stream Data Header	V4 and higher
USHORT	m_length	2	0	Block Length	
char	m_TypeBlock	1	2	S	
		1	3	Not used - 2 byte alignment	
long	m_nextBlock	4	4	Offset of next block from beginning of file	
short	m_Number	2	8	Channel Number	
float	m_SampleRate	4	10	In KS/Sec	
char	m_Name[n]	n = m_length - 18	14	Channel Name	

6.6 Type b – Digital Input/Output Port Definition

Block Type: b - Digital Input Port(16 Bit)	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDefPortX	Variable		Digital Port Header	V4 and up
short	m_length	2	0	Block Length	
char	m_TypeBlock	1	2	b	
		1	3	Not used - 2 byte alignment	
int	m_BoardNumber	4	4		
int	m_Port	4	8	Port number	
float	m_SamplingRate	4	12	In KS/Sec	
ushort	m_PrevValue	2	16		
char	m_Name[n]	n = m_length - 18	18	Port Name	

6.7 Type 5 – Channel Data Block

The channel data block covers all different types of data. The data block include the channel number, which can be used to go back to the header blocks to figure out what type of channel this is.

Block Type: 5 - Data for Single Channels	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SDataChannel	Variable		Data Block for single channel	
ushort	m_length	2	0	Block length	
char	m_TypeBlock	1	2	5	
char	m_uUnitNumber	1	3	For Analog Segmented channels, this is the unit number in binary. (0=Level, 1=Unit1, 2=Unit2, 3= Unit3, 4=Unit4)	
short	m_Number	2	4	Channel Number	

Above is followed by this for analog channels

short	m_SampleValue[n]	2 x n	6 and every 2	An array of A/D Values $n=(m_length-10)/2$	
ulong	m_FirstSampleNumber	4	$m_length - 4$	For continuous channels, this is the number of the first sample in the block. For segmented channels, this is the sample number of the level crossing point or the first template point for units. Looking at the header of the segmented channel you can find the number of samples before the crossing.	

Or followed by this for digital channels and ports

ulong	m_SampleNumber	4	6	For digital channels, ports, and events, this has the sample number of that event.	
short	m_Value	2	10	The value of the event.	

6.8 Type E – Stream Data Block

Block Type: E - Stream Data	Variable	Length in Bytes	Offset from block start	Description	Compatibility (Version or Application)
Srtuct	SAOEvent	Variable		Stream Data Event	V4 and up
USHORT	m_length	2	0	Block length	
char	m_TypeBlock	1	2	E	
char	m_TypeEvent	1	3	Event Type (Now we have only S)	
ULONG	m_uTimeStamp	4	4	Time stamp (Sample Number) of when the event is stored.	
char	m_StreamData[n]	n = m_length - 8	8	Stream Data - Refer to SreamFormat.h or use dll to decipher this stream of data.	