Data Acquisition Software
User's Manual

Version 2.1

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Document Overview

This document is intended to educate users about the full functionality of TBSI's online data acquisition software. NeuroWare© has the capability to graphically display and store up to 32 simultaneous channels of neural data.

System Overview

NeuroWare© is designed to interface seamlessly with all
TBSI tethered and wireless (shown above) neural recording systems.

Standard Shipped items list

- 1 Wireless headstage
- 1 Magnet on/off wand
- 1 Wireless receiver/demux base station
- 2 receiver antenna
- 2 receiver antenna extension cables
- 2 antenna clamps
- 1 USB A-B cable
- 1 6v power supply
- 1 headstage charger
- 1 headstage test cable
- 1 headstage shorting plug

System Requirements

The recommended minimum PC requirements are as follows:

- At least i7 Quad Core Processor
- 8 GB RAM, DDR1333 or higher
- 512MB of video memory
- C: drive (OS) SATA 2 3GB/S or faster, 250GB or greater
- D: drive (storage) SATA 3 6GB/S SSD 500GB or greater **RECOMMENDED HARDWARE IS A SATA 3 (6GB/S) SAMSUNG EVO SSD 500GB OR LARGER.**
- USB 2.0 port
- Windows 7 64 bit OS

System I/O

- **POWER INPUT** – This is to be connected to the 6V DC power supply provided by TBSI only.
- **Analog Input** - TTL input, ±5V, 30kS/s.
- **DATA A** – Digital Events input
- **DATA B** – Digital Events input
- **USB A** – Primary ADC I/O connection
- **USB B** – Secondary ADC I/O connection
- **GND** – Earth ground connection lug
- **DATA I/O** – Not supported
- **Headstage input pinout** – refer to appropriate channel hardware manual

NeuroWare© Installation

Install the driver for the USB-2533 DAQ card

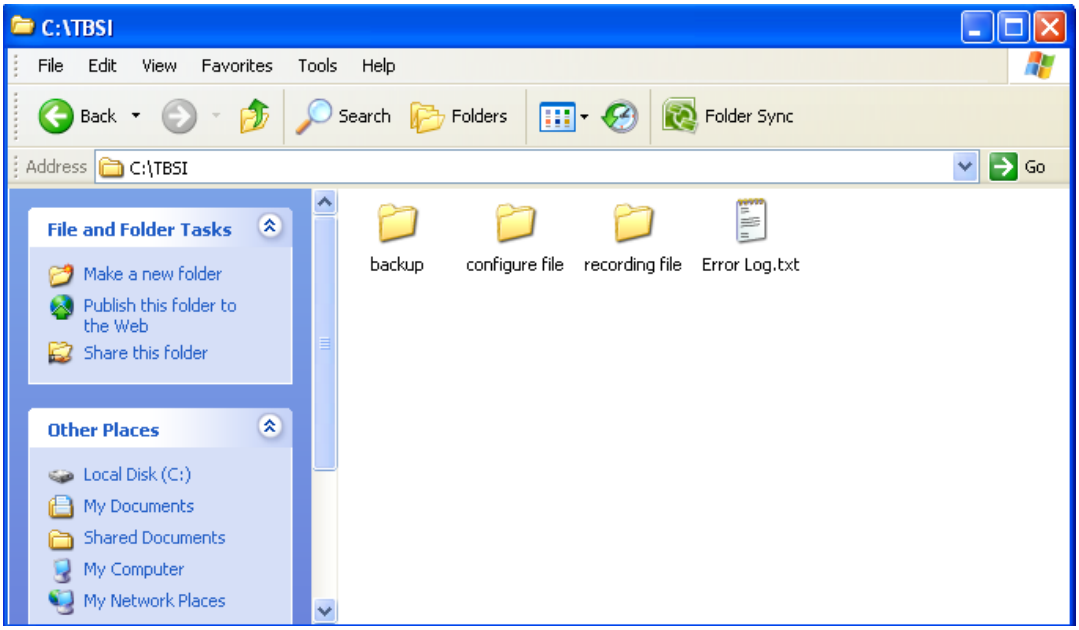
- Navigate to CD drive:\NeuroWare\DAQ Drivers and run **mccdaq.exe**.
- Follow the prompts to install the DAQ drivers and the Instacal and TracerDAQ software tools.
- You may be required to restart your computer once installation is complete.

Install NeuroWare

- Navigate to CD drive:\NeuroWare Installer\Volume and run the file labeled **setup.exe**.
- Follow the prompts to install the NeuroWare© software.

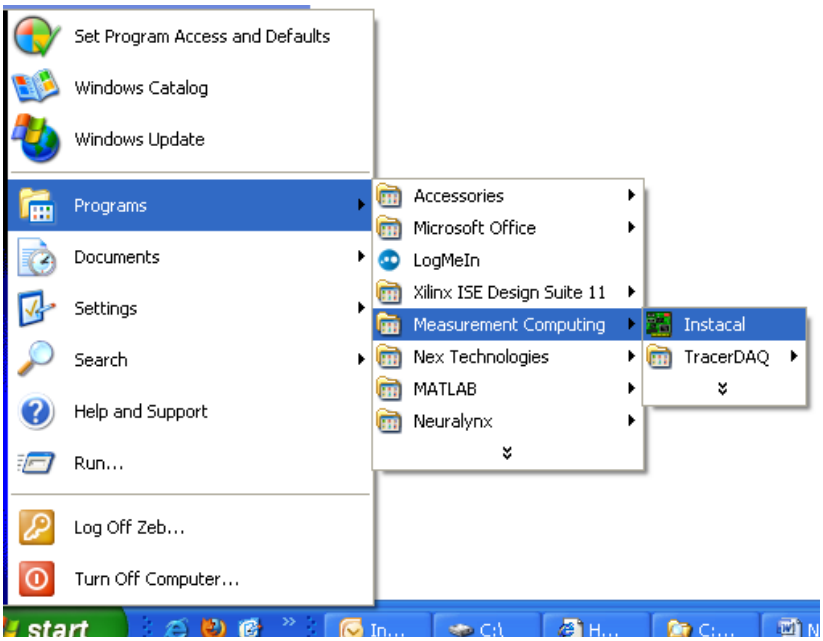
Copy files from Installation CD to PC

- Copy the TBSI folder on the installation CD to the C:\ drive on your PC.

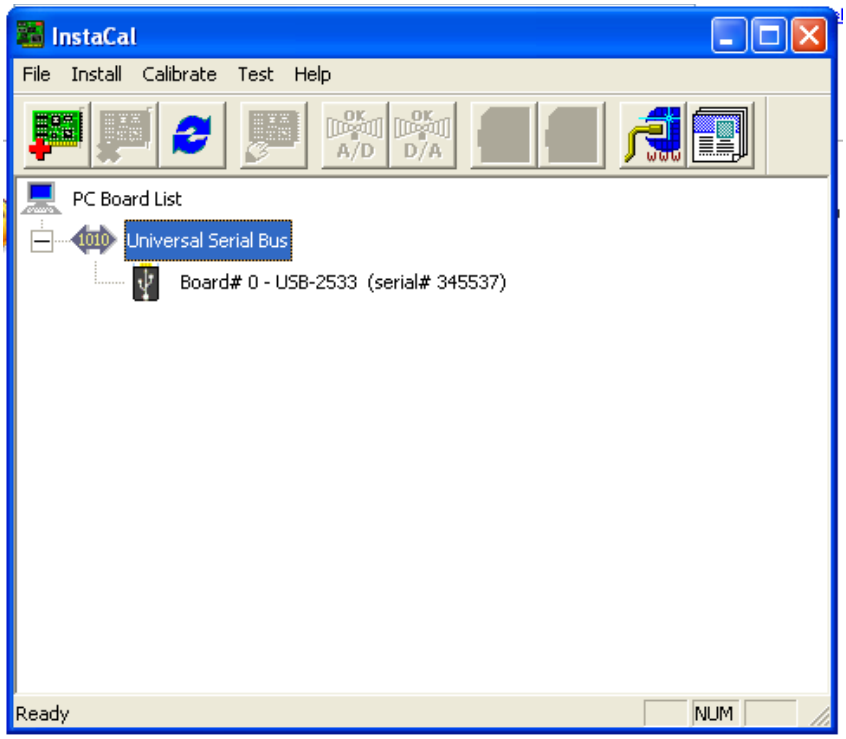


Configure the DAQ card's channel number in Instacal

- Connect the receiver to your computer with the USB cable.
- Your computer will detect this as a new device and install additional drivers automatically.
- Once the drivers are installed, you may navigate to the Device Manager on your computer and check to see if "**DAS-COMPONENT-USB 2533**" is included the list of available devices.
- Run the newly installed **Instacal** program.

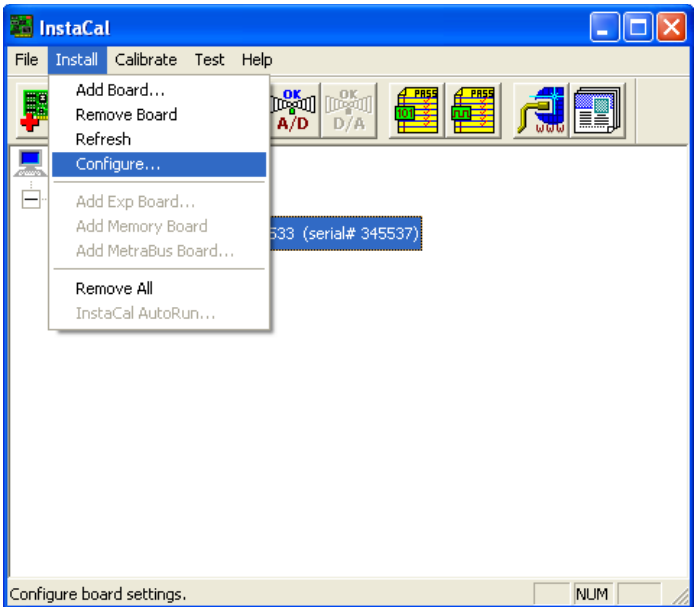


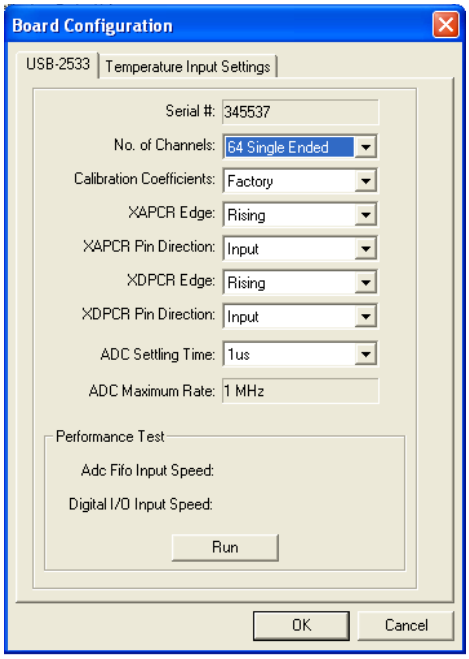
- In Instacal, you will see **Board# 0 - USB-2533 (serial#******)** under Universal Serial Bus. (Note: Each DAQ board is assigned a different serial number, but the board number in Instacal should always be "0".)



If you can't see a device like this, check the system's USB and power connections.

- Right-click the DAQ board shown in the list, then click Configure. Select **64 Single Ended** in the field for **No. of Channels**. Click OK to accept these changes. You may now close the Instacal program window.





A screen resolution of at least 1280x1024 is recommended to run NeuroWare©.

Loading and Configuration

• Start NeuroWare

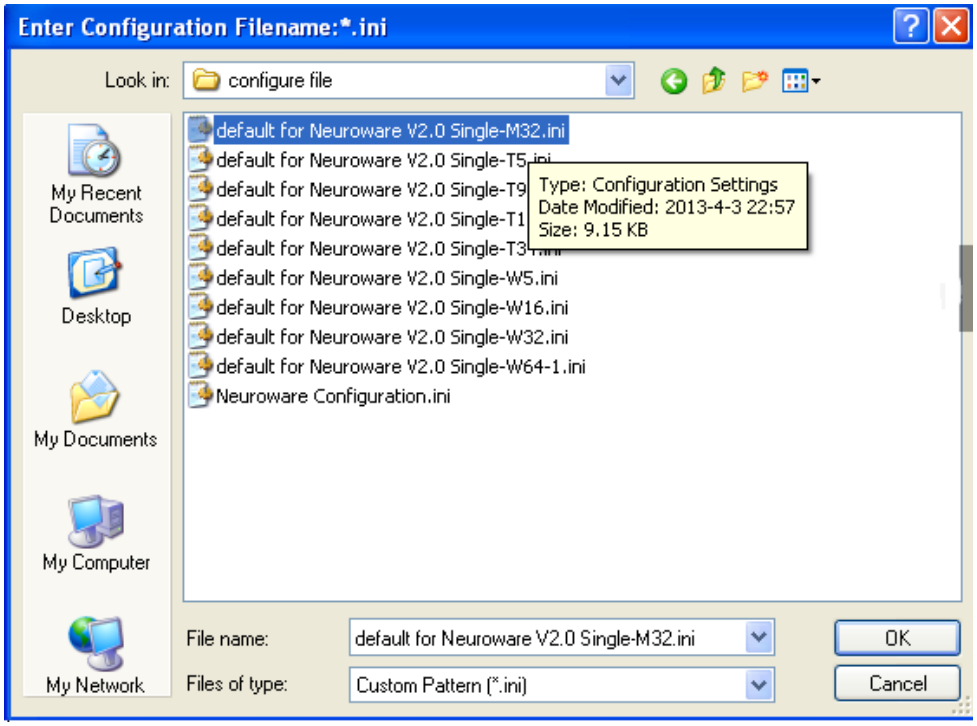
You can run NeuroWare© via the Windows Start Menu by navigating to **Start/All Programs/NeuroWare.**

If there is no right license file named as "NeuroWare licence.dat" in C:\TBSI\configure file, NeuroWare may run in demo mode. In demo mode Recording is disabled.

• Load a Configuration File

Upon loading NeuroWare© for the first time, you will be asked to select a configuration file. Each configuration file contains program functionality settings for a specific TBSI recording device.

Choose the configuration file which matches your data acquisition hardware model (ex. a file ending in M32 should be used with a 32 channel M-Series recording system).



- ## Configure NeuroWare©

Adjusting Settings in a Configuration File

To change and save selected DAQ settings to be loaded in future instances of NeuroWare©, navigate to the **Tools** menu at the top left of the program, then select **Configuration** from the drop-down menu to open the **Configuration Dialog**.
Many settings in the Configuration Dialog are unique to that menu and can't be accessible in **NeuroWare** . It is recommended to review all settings in the Configuration Dialog to ensure that each parameter is appropriately defined. Refer to other sections for how to set up those settings that are only accessible in **Configuration.** Be sure to stop DAQ before opening the configuration dialog.

- ## Load New Config

Use this button when you want to load a new configuration file.

- **Save**

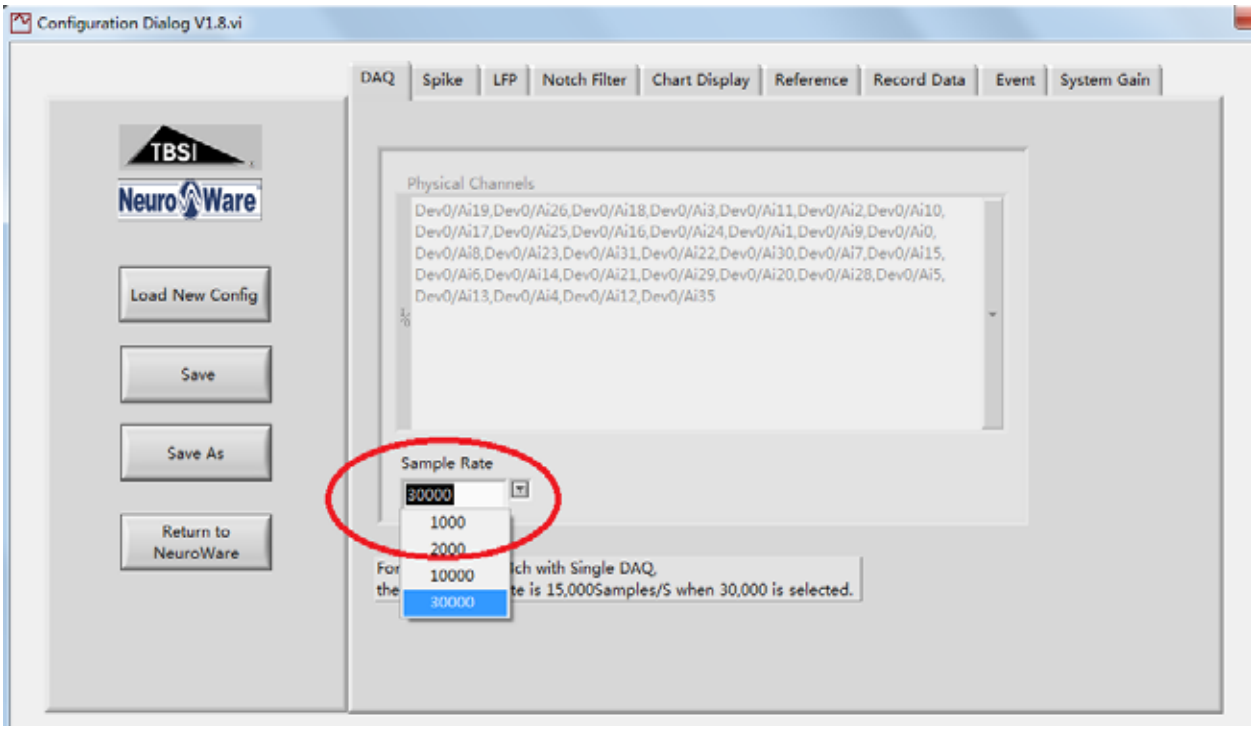
Use this button to overwrite the default configuration file provided by TBSI or **Save As** to open a prompt for saving a new configuration file.

- **Return to NeuroWare**

Use this button when you have completed and saved all changes to your configuration file.

- **Daq tab**

Under the DAQ tab of the Configuration Dialog you will see a mapping of the physical channels (this cannot be edited) and the **Sample Rate** drop down box. The default sample rate is 30k cycles/second which is the ideal sample rate for spike recordings. This can be lowered significantly if only LFP data will be recorded.



- **Spike Tab**

Minimum Spike Width: Sets the minimum number of DAQ samples required to cross the threshold(s) to allow that portion of data to be registered as a spike.

Pre Spike Samples: the number of samples the spike chart displays to the left of the triggered data.

Windows Samples: This is the number of samples shown in the **Spike Display Window**.

Spike Repeat(<200): the number of detected spike waveform overlapped in the **Spike Display**

Window

Spike Filter: A low cutoff frequency of more than 100Hz is recommended to remove the low-frequency component signal. Taps determine the order of the digital filter. **Selecting an odd number larger than 101 is recommended.**

Threshold Selection: There are two threshold are available to set up the threshold levels.

***Threshold1*:** Only Threshold1 is enabled.

***Threshold2*:** Only Threshold2 is enabled.

***Threshold1 and Threshold2*:** Both Threshold1 and Threshold2 are enabled.

Only Spikes crossing Threshold1 and Threshold2 will be detected.

Threshold1 or Threshold2: Both Threshold1 and Threshold2 are enabled.

Spike crossing either Threshold1 or Threshold2 will be detected.

Trigger Oder: (only available when Threshold1 and Threshold2 is selected in ***Threshold Selection***)

Threshold Level: This displays the amplitude in uV. That each channels Threshold is set at.

- ## LFP Tab

LFP sample rate: This is the sample rate at which LFP signal is acquired and displayed. Since LFPs do not require as high a sample rate as Spike recordings this tab gives you the option to sample LFPs at a much lower sample rate.

LFP filter: A lowpass filter is used to remove unwanted high frequency noise and signals. Adjust filter bandwidths by changing low cut frequency. The high cut frequency will be ignored when you use the lowpass filter. The "taps" is the order of digital filter. **An odd number more than 101 is recommended.** The "window" option affects the digital filter performance. If the "Click to enable" button is on, the current filter is used. If the "Click to enable" button is of", the current filter is off.

- ## Notch Filter Tab

A Notch Filter can be applied to the raw data of all channels from DAQ card. The default cutoff frequencies are set around 60Hz rejection. It is recommended to review the Notch Filter Settings under the Filters tab before setting up spike triggering conditions and browsing spike and LFP waveform.

Filter Selection: The default filter is Butterworth filter.

- ## Chart Display Tab

Display Mode/Strip Display Mode:
Strip Chart: displays the selected channel's data as a constantly scrolling stream
Scope Chart: refreshes entire window with new data after chart is filled
Sweep Chart: same as scope chart, but continues to display previous data until it is overwritten by newer data
Multiple chs Window Config:
Window Width (ms): adjusts the maximum amount of x-data displayed at a time
Display Zoom: increases or decreases the zoom of the Y-axis.
Strip Window config:
Data Select
Raw Data: displays the incoming raw data (unfiltered)
Spike Waveform: displays the selected channel with spike filter settings applied
LFP Waveform: displays the selected channel with LFP filter settings applied

- ## Reference Tab

Neuroware is set default to reference from the headstage "AGND" which should be connected to an animal ground implant. If you wish to instead use differential referencing from a specific recorded channel click the oval **Enable Referencing button**. When enabled, the green light on the oval button will be lit.
Reference Channel Setting: This function is also available through the Reference Tab in Neuroware . For each channel you are able to set up separate reference channels for Spike data and LFP data recordings.

- ## Record Data Tab

File save path: The default file path is "C:\TBSI\recording file. However, it is highly recommended that you change this path to an appropriately sized SATA 3 Solid state storage drive or high speed RAID array.
Recording Data Selection: You can select to record simultaneous spike waveform, LFP, and continuous raw data by checking associated boxes. Spike chain is checked by default.
Comments: You can add additional information to recording files before starting record.
Recording time: Use this box to set the duration (in seconds) of your recordings.
Recorded channel setting: Set up if the channel is recorded and select what type of continuous data are selected.

- ## Record Data Tab

Max Event num: This is the max number of events showed in Event Table. For example, if we set it up to 50, the 51st event will be displayed on the first line of Event Table.

Min Event Interval: This box sets the minimum time expected for an event to take place. Default this is set to 100mS. If more than one event input is to be recorded this needs to be set to 1.

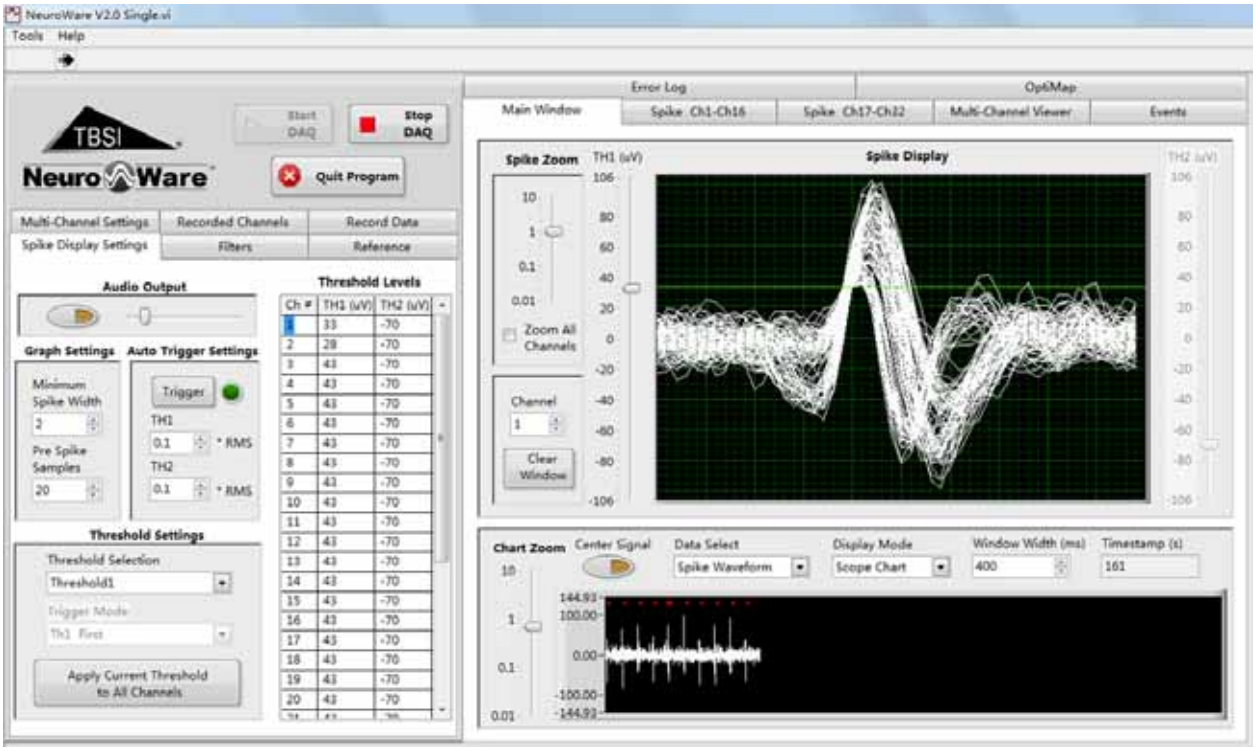
Event Definition Table: Use this table to change the definition of the events recorded.

- ## System Gain Tab

System Gain: This displays the gain applied to the signal acquired by the DAQ. This cannot be changed.

Start Data Acquisition

After the configuration file has been loaded, you can tell the program to start acquiring data by clicking the **Start DAQ** button. Starting the DAQ does NOT initiate a recording session.



The Timestamp counter will begin to increase as soon as you start the DAQ.

The raw data acquired by the DAQ will then be processed by NeuroWare©'s digital spike and LFP filters (if they are enabled under the **Filters** tab).

NeuroWare©'s spike detection functions utilize the data generated by the designated spike filter settings. Only one spike filtered channel can be displayed at a time within the **Main Window** tab.

Refer to the settings provided under the **Spike Display Settings** tab to configure spike thresholding and trigger conditions for each channel as they are displayed in the Main Window. Use the **Channel** counter to the left of the **Spike Display** chart under the Main Window tab to cycle through your system's available channels.

Navigate to the **Spike Ch1-Ch16**, **Spike Ch17-Ch32**, **Spike Ch33-Ch48**, and **Spike Ch49-Ch64** tabs to simultaneously view those channels' Main Window data streams. This is a good way to quickly determine which channels still require trigger/zoom/filter adjustments.

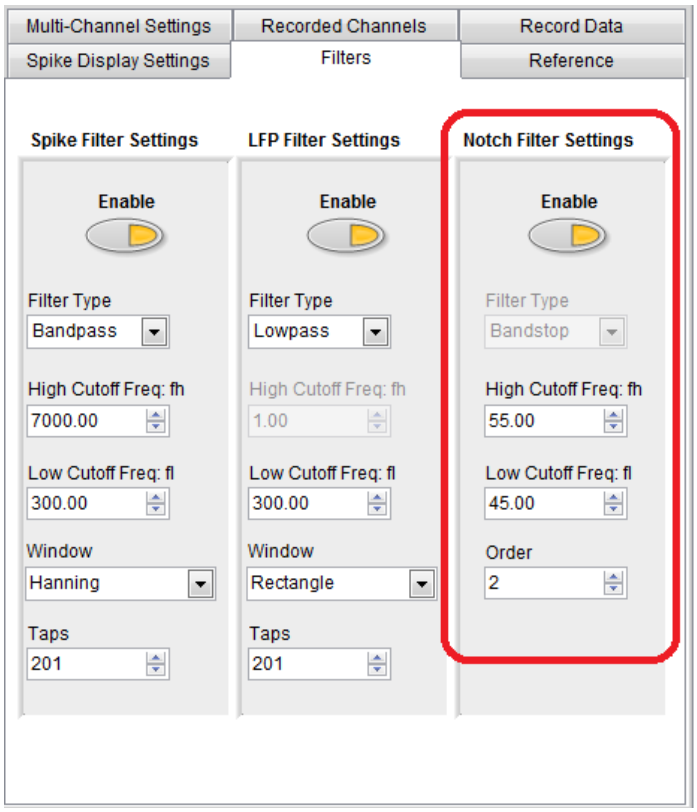
Clicking the **Clear Window** button will clear the Spike Display and the corresponding **Spike Ch** tab chart of all detected spike waveforms. This is for viewing purposes only and will not delete any recorded data.

Notch Filter

Notch Filter can be applied to the raw data of all channels from DAQ card. It is recommended to review the **Notch Filter Settings** under the **Filters** tab before setting up spike triggering conditions and browsing spike and LFP waveform.

NeuroWare© defaults the notch filter enabled(Yellow) as shown below. You can choose to disable it by clicking the **Enable** button.

NeuroWare© defaults the filter settings to the ones shown below. You can adjust the high, low cutoff frequencies and order any time.
Note: You may adjust the cutoff frequency based on local power line frequency


Multi-Channel Settings
Recorded Channels
Record Data
Spike Display Settings
Filters
Reference
Spike Filter Settings
LFP Filter Settings
Notch Filter Settings
Enable
Enable
Enable
Filter Type
Bandpass
Filter Type
Lowpass
Filter Type
Bandstop
High Cutoff Freq: fh
7000.00
High Cutoff Freq: fh
1.00
High Cutoff Freq: fh
55.00
Low Cutoff Freq: fl
300.00
Low Cutoff Freq: fl
300.00
Low Cutoff Freq: fl
45.00
Window
Hanning
Window
Rectangle
Order
2
Taps
201
Taps
201

Spike Detection and Display

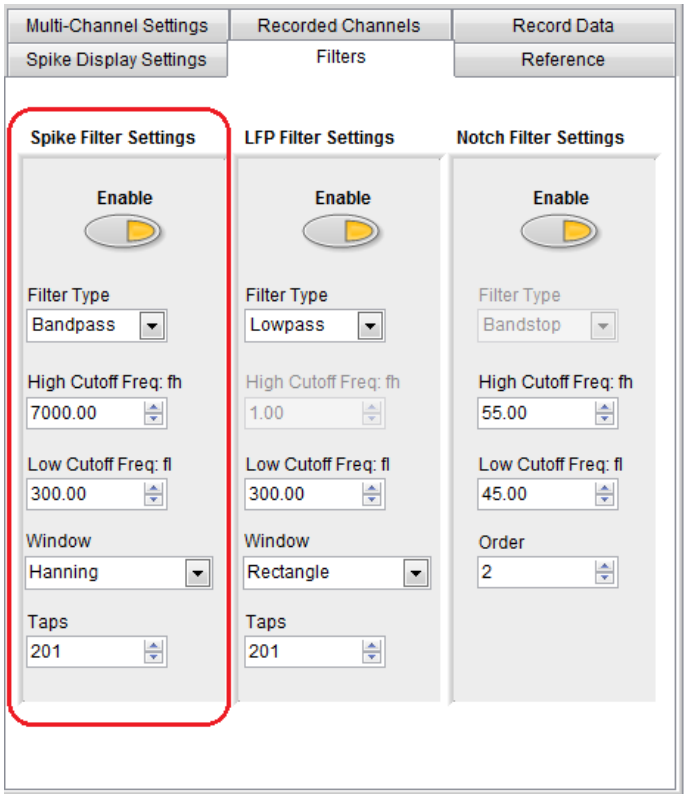
• Spike Filter

It is recommended to review the **Spike Filter Settings** under the **Filter**s tab before setting up spike triggering conditions.

NeuroWare© defaults the filter settings to the ones shown below. You can adjust the high and low cutoff frequencies any time before or during a recording.

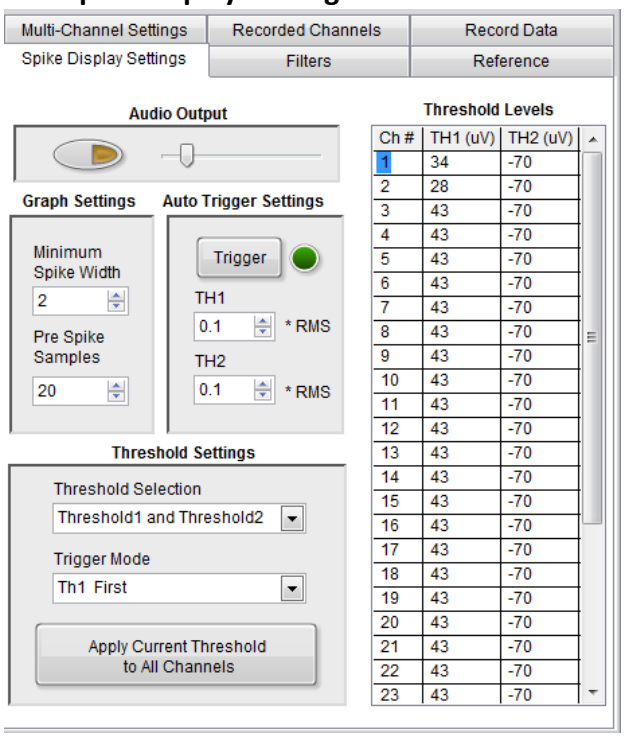
A low cutoff frequency of more than 100Hz is recommended to remove the low-frequency component signal.

Taps determine the order of the digital filter. Selecting an odd number larger than 101 is recommended.

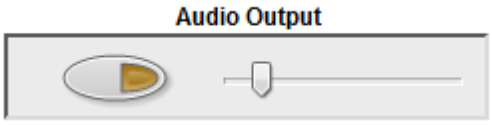


- ## Spike Triggering

Once you have finalized your Spike Filter Settings, you can begin setting up the spike trigger conditions, found within the **Spike Display Settings** tab.



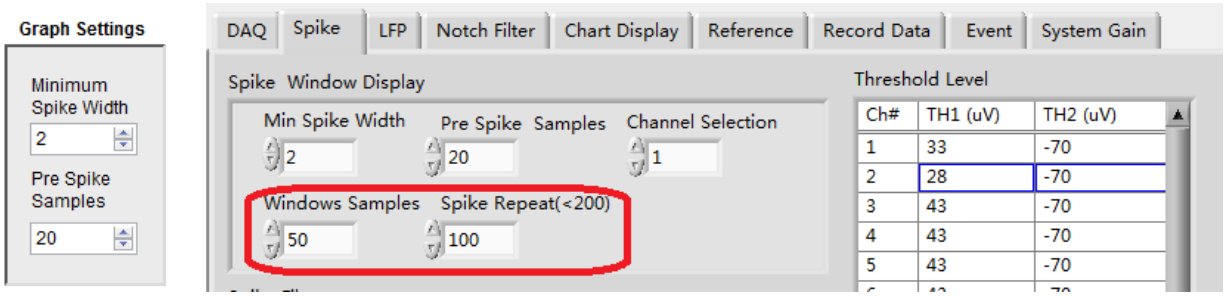
- ## Audio Output



If any spike is detected in the current selected channel, you will hear "pu" if Audio output is enabled.

Use the oval button to enable/disable audio output. The audio corresponds to the channel currently displayed in the **Spike Display** chart. Drag the slider to adjust the volume output.

- ## Graph Settings



Note: **Windows Samples** and **Spike Repeat(<200)** are only accessible in **Configuration Dialog** and you can't change them when DAQ is going.

Minimum Spike Width: the minimum number of DAQ samples required to cross the threshold(s) to allow that portion of data to be registered as a spike

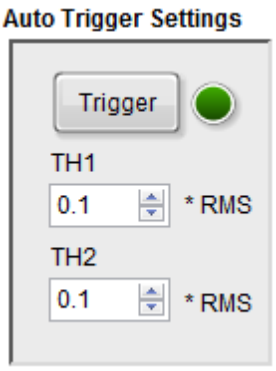
Pre Spike Samples: the number of samples the spike chart displays to the left of the triggered data

Windows Samples: the number of samples the **Spike Display Window**.

Spike Repeat(<200): the number of detected spike waveform overlapped in the **Spike Display Window**

- ## Auto Trigger Settings

Trigger Settings are located in **Spike Display Settings** tab



Auto triggering applies to all channels and will take a few seconds to complete as it processes samples from the current channel's data. Clicking the **Auto trigger** button will automatically set up trigger threshold(s) for every available channel, which can be useful for quickly identifying

possible spikes on any given channel. This function sets the spike threshold(s) by calculating each channel's root mean square (RMS) voltage and multiplying it by a user-defined rational number.

If you wish to use auto triggering with both available thresholds (TH1 and TH2), you must enable them by selecting **Threshold1 and Threshold2** from the dropdown list in the **Threshold Selection** of **Threshold Settings** section found in the same tab.

- ## Threshold Settings

Two threshold sliders (green and yellow) are available to set up the threshold levels. Simply drag the sliders up and down to control the thresholds.

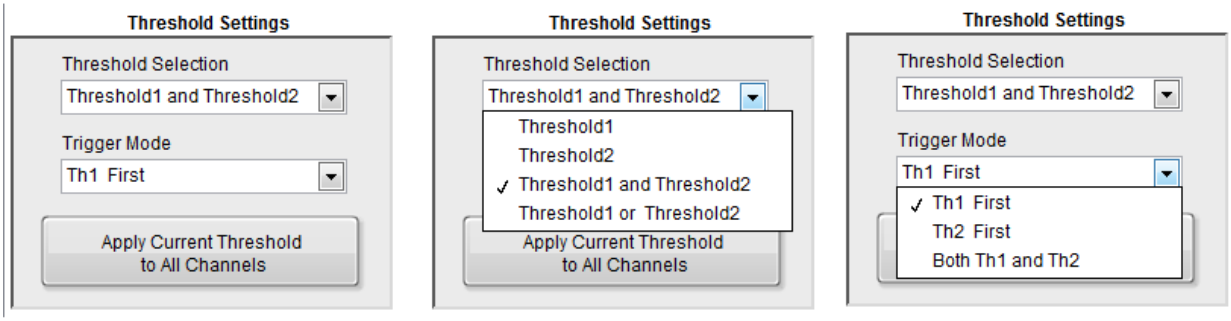
- Threshold1 (green cursor) is used to detect positive spikes.
- Threshold2 (yellow cursor) is used to detect negative spikes.

Threshold Selection

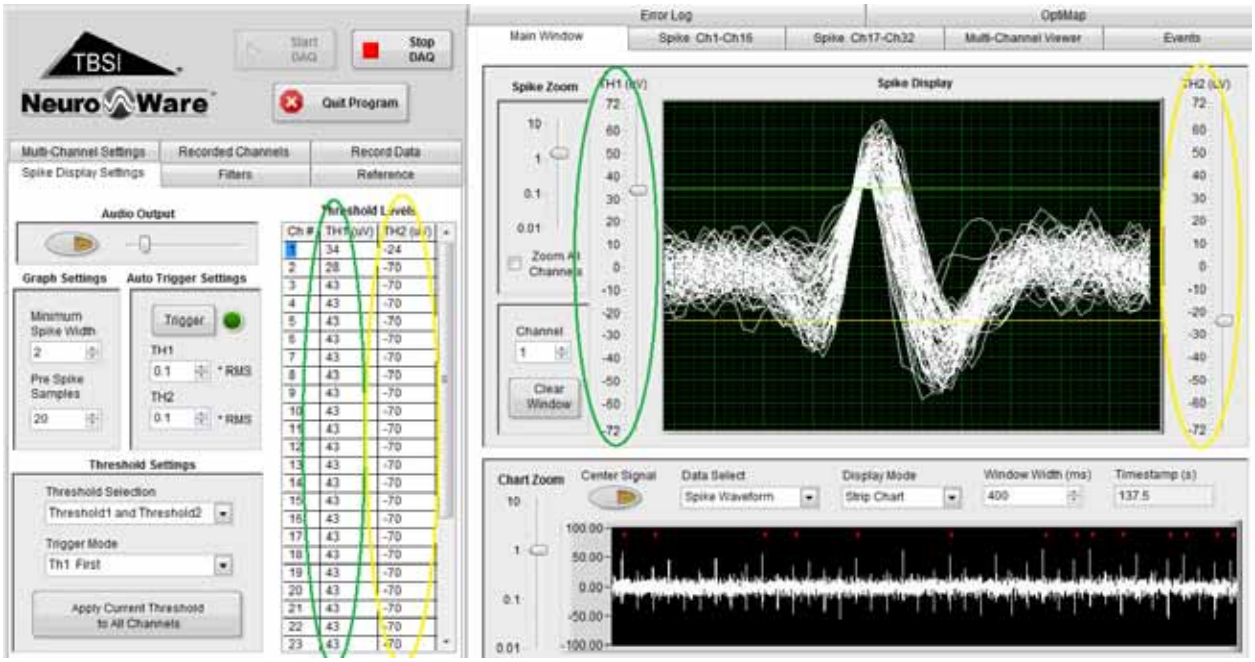
Threshold1: Only Threshold1 is enabled.
Threshold2: Only Threshold2 is enabled.
Threshold1 and Threshold2: Both Threshold1 and Threshold2 are enabled. Spike crossing Threshold1 and Threshold2 will be detected.
Threshold1 or Threshold2: Both Threshold1 and Threshold2 are enabled. Spike crossing either Threshold1 or Threshold2 will be detected.

Trigger Mode: (only available when **Threshold1 and Threshold2** is selected in ***Threshold Selection***)

Th1 First: Spike crossing Threshold1 first and, then, Threshold2 is detected and displayed.
Th2 First: Spike crossing Threshold2 first and, then, Threshold1 is detected and displayed.
Both Th1 and Th2: Any spike crossing both Threshold1 and Threshold2 is detected and displayed.



The manually adjustable spike trigger thresholds apply only to the channel currently displayed in the Spike Display chart. These two threshold sliders (green and yellow), found on either side of the chart, update the current channel's trigger settings in real time. Simply drag the sliders up and down or enter a new value into the **Threshold Levels** table (found in the Spike Display Settings tab) to control the individual positions of the thresholds.



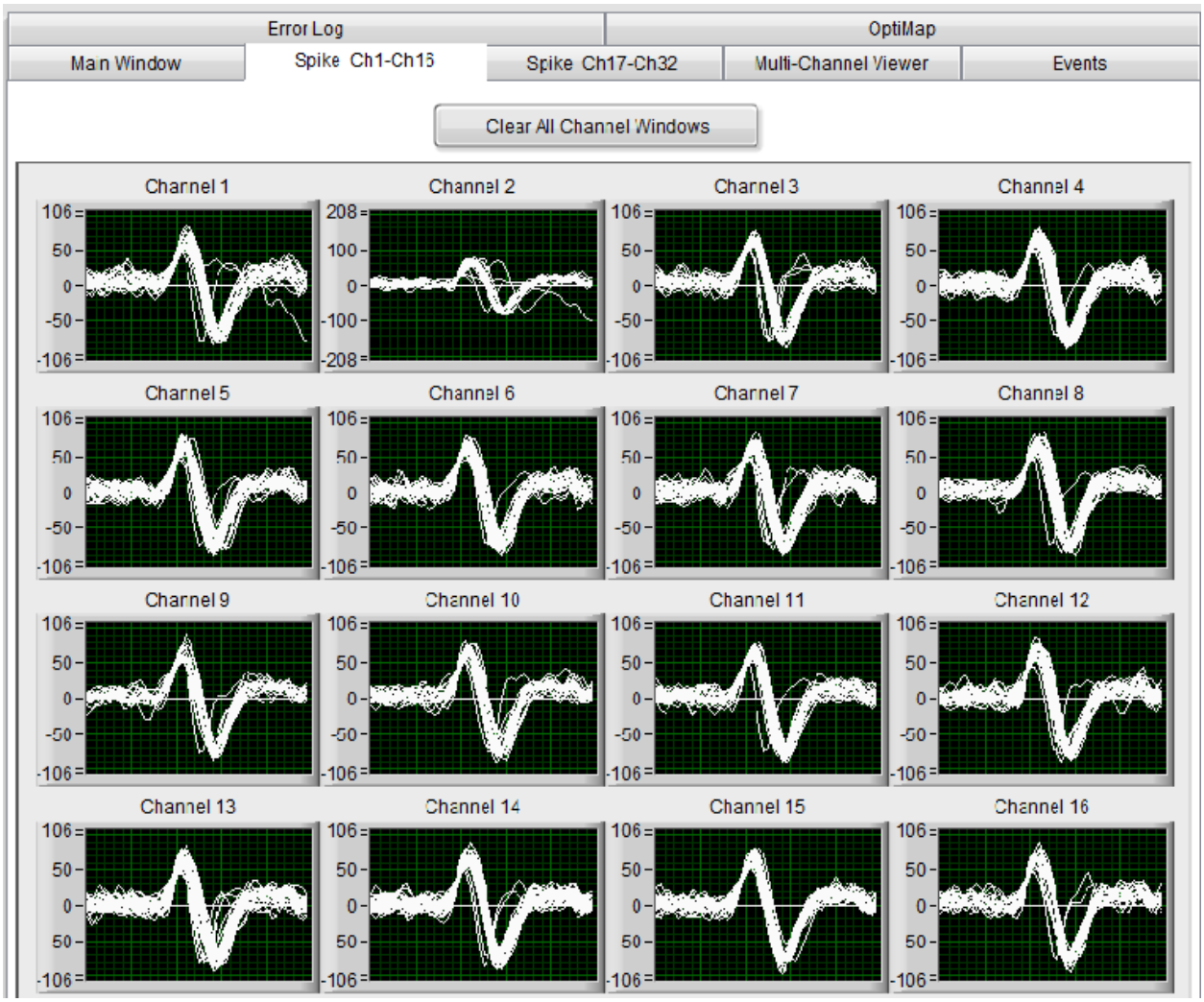
Spike Zoom slider will increase or decrease the vertical zoom within the Spike Display window. If **Zoom All Channels** is checked, **Spike Zoom** will be applied to all Spike windows.

Clicking the **Clear Window** button will clear the Spike Display and the Spike Ch1-64 windows of all detected spike waveforms. This will not delete any recorded data.

Channel will select which channel is shown **Spike Display** and **Strip Chart.**

Spike Channels Tabs

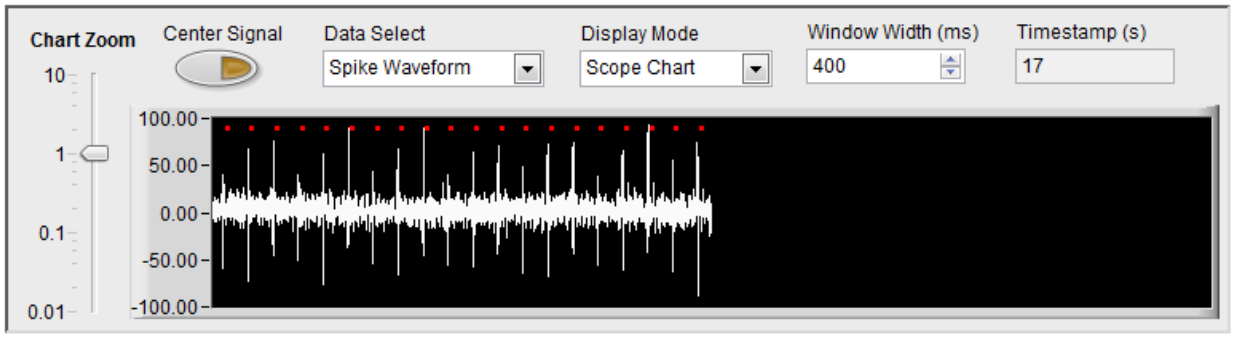
Each of the Spike ChX-ChX panels contain up to 16 individual spike channel windows.



The same spikes detected by the thresholds from the Main Window are shown in these small charts. Clicking the **Clear All Channel Windows** button will clear the Spike Display and the Spike Ch1-64 tabs of all detected spike waveforms. This is for viewing purposes only and will not delete any recorded data.

Strip Chart

The **Strip Chart** is located at the bottom of the Main Window tab and displays the real-time waveform of the channel selected for display within the Spike Display window.



Center Signal

Click the oval **Center Signal** button to automatically center the incoming signal to 0V.

Data Select

Raw Data: displays the incoming raw data (unfiltered)
Spike Waveform: displays the selected channel with spike filter settings applied
LFP Waveform: displays the selected channel with LFP filter settings applied

Display Mode

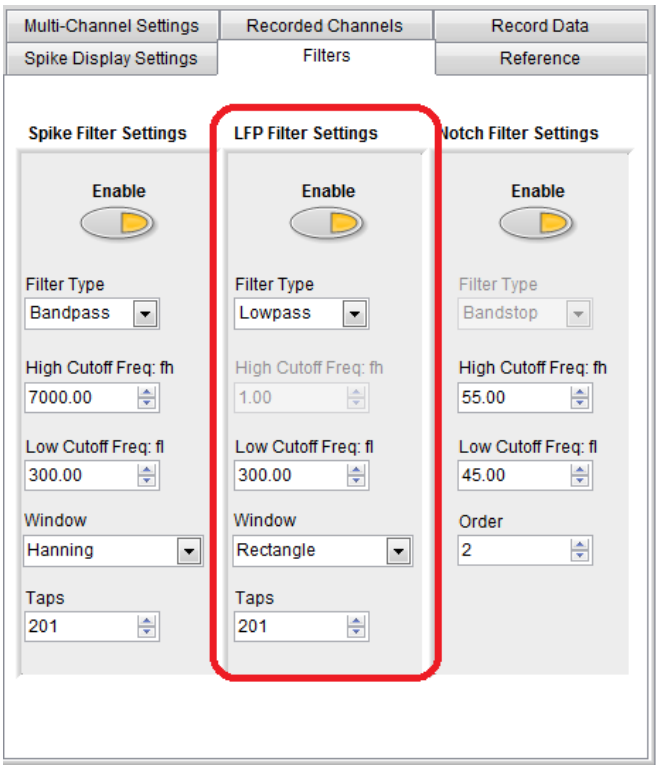
Strip Chart: displays the selected channel's data as a constantly scrolling stream
Scope Chart: refreshes entire window with new data after chart is filled
Sweep Chart: same as scope chart, but continues to display previous data until it is overwritten by newer data

Window Width (ms): adjusts the maximum amount of x-data displayed at a time

Chart zoom: increases or decreases the zoom of the Y-axis.

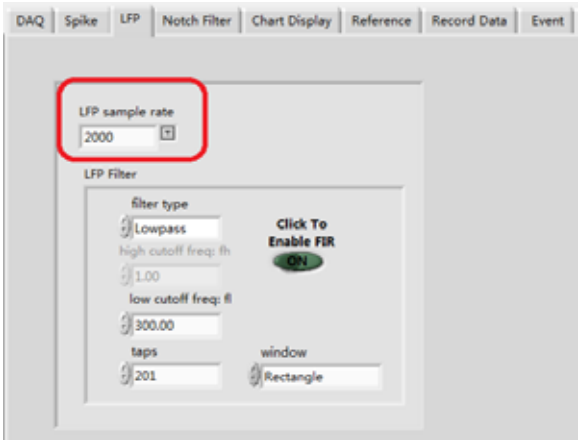
LFP Waveform

LFP waveform can be viewed by **Strip Chart** or **Multi-Channels Viewer** when selecting the right data type. It is recommended to review the Filter tab before viewing LFP. NeuroWare defaults the filter settings to the ones shown as follows.



The high cutoff frequency will be ignored, but you can change the low cutoff frequency at any time, even during an experiment.

LFP signals are of a much lower frequency than spikes, so three lower sampling rates (2K/s, 1K/s, and 7.5K/s) are available. But, the sample rate for LFP can only be accessible in **Configuration Dialog** and you can't change them when DAQ is going**.**



Multi-Channel Viewer

Every channel's real-time waveform can be viewed within the Multi-Channel Viewer page. Channels may be added or removed from the **Charted Chart** in the **Multi-Channel Settings** tab. A channel legend can be found to the left of the M-C chart.

Charted Channels: Select the channels that are displayed in Multi-Channel by **Add** or **Remove** buttons

Center Signal

Click the oval **Center Signal** button to automatically center the incoming signal to 0V.

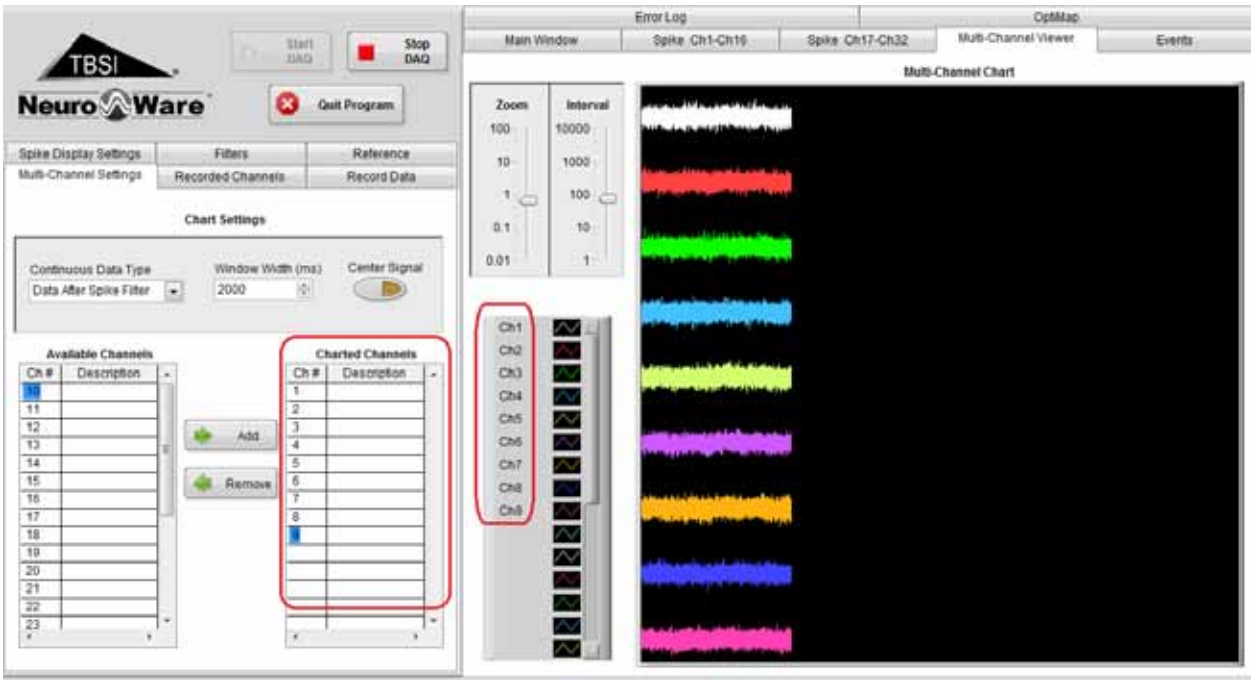
Continuous Data Type

Raw Data: displays the incoming raw data (unfiltered)
Spike Waveform: displays the selected channel with spike filter settings applied
LFP Waveform: displays the selected channel with LFP filter settings applied

Window Width (ms): adjusts the maximum amount of x-data displayed at a time

Zoom: increases or decreases the zoom of the Y-axis.

Interval: adjust the interval among the channels of Y-axis.



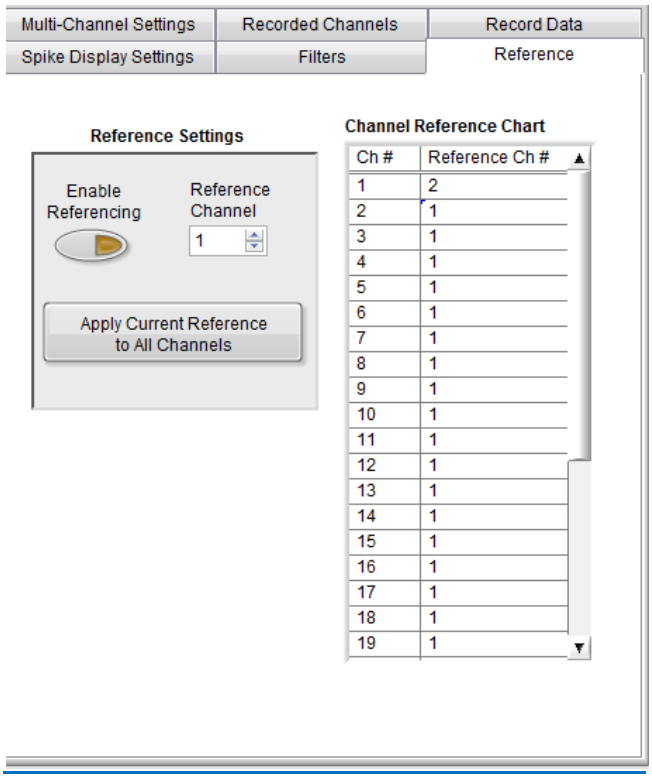
Channel Reference

Under the **Reference** tab, click the oval **Enable Referencing** button to enable channel referencing. These settings may be adjusted during a recording if necessary, and any changes will be reflected in real time.

When channel referencing is enabled, the selected **Reference Channel** (within the **Reference Settings** box) will be applied to the channel currently being viewed in the Spike Display chart.

Click the **Apply Current Reference to All Channels** button to change every channel's reference channel or manually enter any channel number into the **Channel Reference Chart** to change reference channel for individual channel. So, you are able to select different channel as reference channel.

Note: If Reference is enabled, both Spike and LFP filter will function based on referenced data.

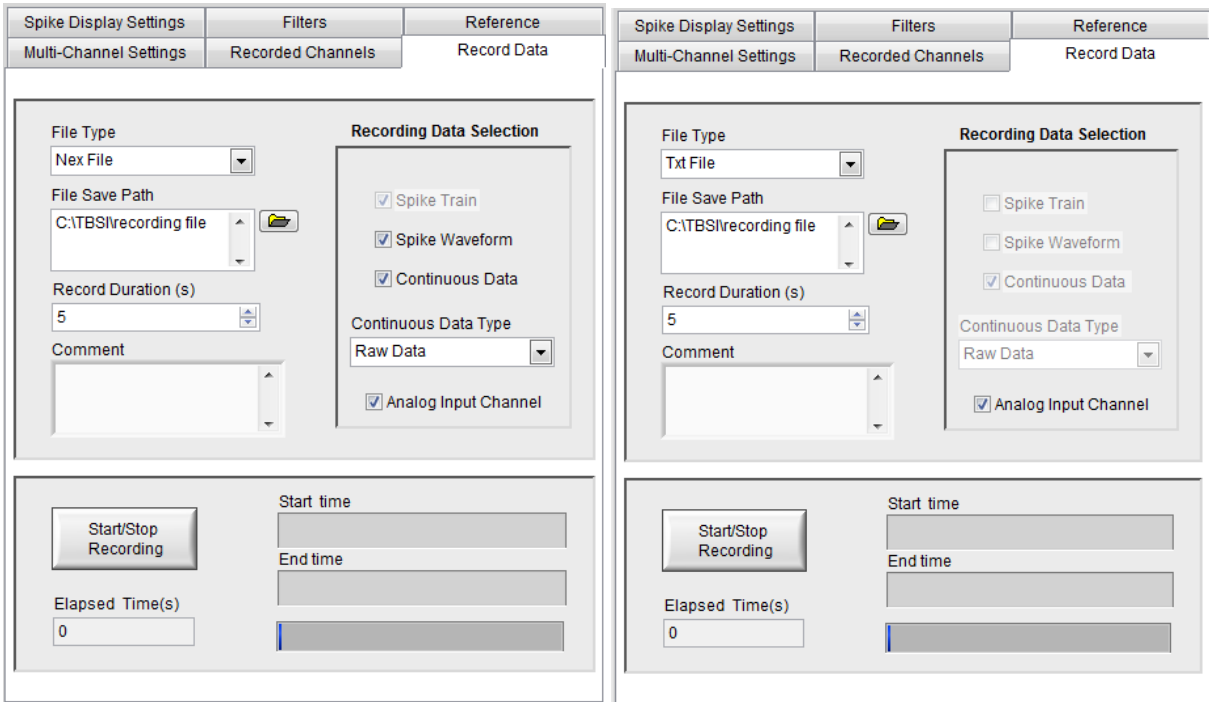


Record Data

- ## File Types

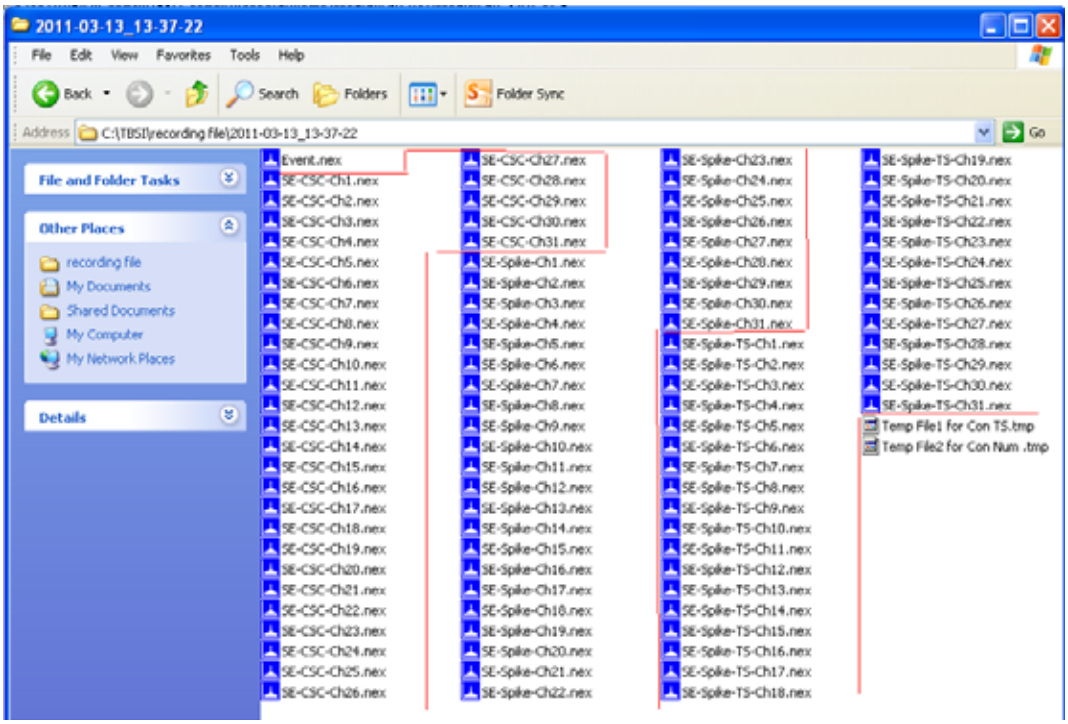
IT IS IMPORTANT THAT CUSTOMERS RECORDING MULTIPLE SIMULTANIOUS, CONTINUOUS DATA TYPES CHANGE THE RECORD FILE LOCATION TO A D DRIVE. RECOMMENDED HARDWARE IS A SATA 3 (6GB/S) SAMSUNG EVO SSD 500GB OR LARGER.

Nex File: a type of binary file with predefined file header and data body.



If **Nex File** is selected, Seven types of data may be generated by NeuroWare after a recording is complete upon the selected options in **Recording Data Selection**.

Event.nex: Digital event log (ex. lever press or audio tone).
SE-CSC-LFP-Ch#.nex: Continuous LFP filtered and referenced neural signal from channel #.
SE-CSC-RAW-Ch#.nex: Continuous neural signal referenced from AGND channel #.
SE-CSC-SPIKE-Ch#.nex: Continuous SPIKE filtered and referenced neural signal from channel #.
SE-Spike-Ch#.nex: – spike waveform detected by NeuroWare threshold on channel #.
SE-Spike-TS-Ch#.nex: Timestamp train of detected spikes on channel #.
Analog Input Ch#.nex: Analog signal from BNC connector.



- **File Save Path**

NeuroWare defaults the file path for recorded file to C:\TBSI\recording file. Change the file path before start recording if needed.

- **Recording Data Selection**

If **Nex File is** selected, Spike Train is selected by default. **Spike Waveform**, Continuous **Data** and **Analog Input Channel** are ready for being selected.

If **Continuous Data** is checked, you get a chance to select what kind of data is recorded.

Raw Data: the incoming raw data (unfiltered)
Spike Waveform: data with spike filter settings applied
LFP Waveform: data with LFP filter settings applied

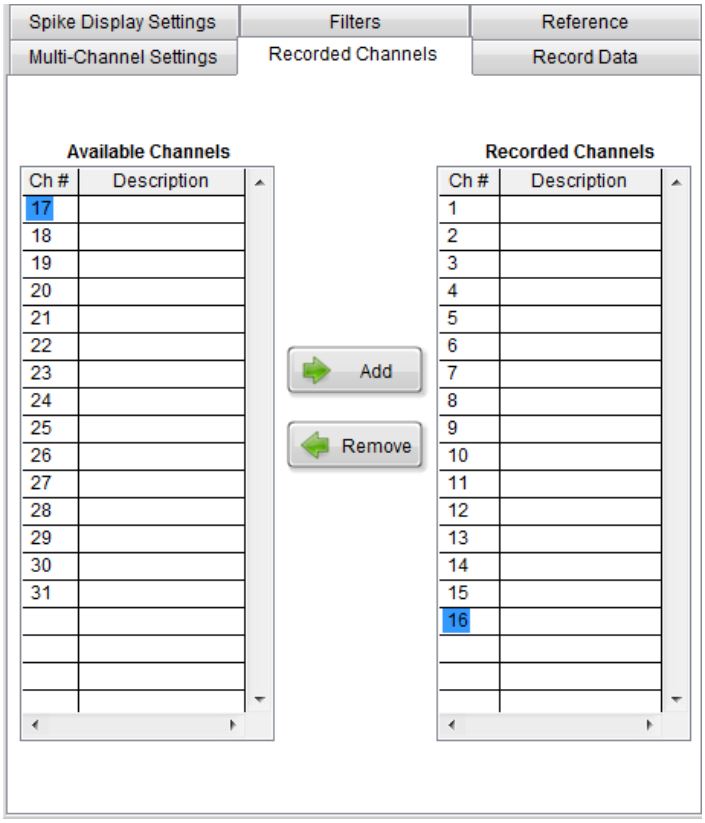
Analog Input Channel is particularly for BNC analog input.

- **Comments**

Any information less than 256 char typed in Comment will be not only saved in Nex file, but also in "Note.txt" file which is in the same folder as Nex or Txt file.

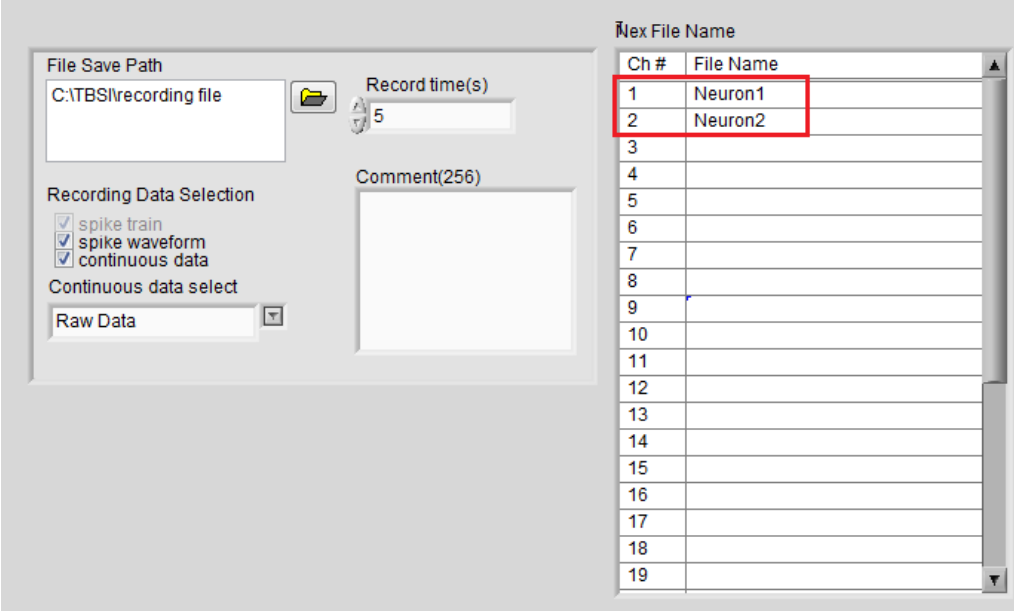
- **Recorded Channel**

All channels will be recorded by default. You can add or remove the channel by clicking **Remove** or **Add** button in **Recorded Channels** tab.



- **Recorded File Name**

By default, the Nex files are named as SE-CSC-Ch#_.nex/ SE-Spike-Ch#_.nex/ SE-Spike-TS-Ch#_. If you want to change them, you can go to **Configuration Dialog** to add suffix to each channel. For example, if you type in Neuron1 in Ch1 and Neuron2 in Ch2, the recorded file name will be SE-CSC-Ch1_Neuron1.nex.



- ## Start/Stop Recording

It is recommended to review the **Charted Channel**, **File type**, **Recording Data Selection** and **Record Duration** before recording. **Record Duration** is required to be a number with the unit Second, which means you have to convert the recording time to time with the unit second.

Click **Start/Stop recording** button to start recording. The recording process can be monitored either by **Elapsed Time** or by progress bar.

Whenever you want to stop recording before **Record Duration** run out, you can click **Start/Stop recording.**

- ## How to Load Nex File

The .nex files generated by NeuroWare can be loaded directly into NeuroExplorer for analysis. These binary files can also be loaded into Matlab – please refer to the Appendix for details.

- ## How to Load Text Data

The .txt file generated by NeuroWare is an ASCII file which can be loaded directly into MS Excel.

Recorded test file.txt

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1	TBSI														
2	sample rate = 30000														
3	10/19/2010 17:27														
4	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6	ch 7	ch 8	ch 9	ch 10	ch 11	ch 12	ch 13	ch 14	ch 15
5	2.51801	2.52548	2.52136	2.5267	2.52182	2.52304	2.53204	2.52594	2.52716	2.52151	2.51617	2.52304	2.5322	2.52396	2.5
6	2.51785	2.52075	2.51968	2.52457	2.52304	2.52594	2.53418	2.52518	2.52838	2.52808	2.52457	2.52319	2.5383	2.52502	2.5
7	2.52655	2.52991	2.52365	2.53036	2.52609	2.52914	2.53662	2.52686	2.52197	2.52243	2.5293	2.52335	2.53876	2.5264	2
8	2.53326	2.5354	2.52991	2.53311	2.52487	2.52914	2.53372	2.52701	2.52594	2.52121	2.52594	2.52869	2.53235	2.5267	2.5
9	2.52853	2.53326	2.52716	2.53357	2.52823	2.52716	2.53281	2.52838	2.53265	2.52548	2.52518	2.53052	2.52243	2.5235	2.5
10	2.52808	2.53799	2.52457	2.53403	2.52823	2.52747	2.52869	2.5264	2.53082	2.52441	2.52472	2.52975	2.52991	2.52914	2.5
11	2.52853	2.5383	2.52319	2.53326	2.52472	2.53372	2.53052	2.52716	2.52335	2.52625	2.53021	2.52731	2.53983	2.53372	2.5
12	2.53296	2.52869	2.5235	2.53387	2.53113	2.53418	2.53067	2.52441	2.52625	2.52914	2.53296	2.52731	2.53967	2.52625	2.5
13	2.53754	2.52991	2.52747	2.53586	2.53601	2.53113	2.53098	2.5354	2.53189	2.52747	2.5293	2.52914	2.53525	2.51953	2.5
14	2.53555	2.53525	2.53357	2.53403	2.53113	2.53433	2.52975	2.54181	2.52899	2.52945	2.52701	2.53006	2.53326	2.52655	2.5
15	2.53113	2.53372	2.52975	2.53586	2.52487	2.53006	2.52808	2.53632	2.52258	2.53006	2.52747	2.53036	2.53403	2.53494	2.5
16	2.52853	2.53174	2.52853	2.53952	2.52777	2.52609	2.52808	2.52945	2.52182	2.53067	2.52747	2.5267	2.53616	2.52838	2.5
17	2.53159	2.53128	2.53326	2.53479	2.52335	2.52625	2.52869	2.52975	2.52548	2.53555	2.5325	2.52472	2.53052	2.52853	2.5
18	2.53418	2.53021	2.53265	2.53433	2.5235	2.52487	2.52686	2.53204	2.52747	2.53296	2.52914	2.53189	2.52853	2.53143	2
19	2.53387	2.52808	2.53357	2.53174	2.53021	2.52579	2.52411	2.53784	2.52838	2.5293	2.52243	2.53067	2.53311	2.52563	2
20	2.52914	2.52823	2.5354	2.52777	2.52914	2.52808	2.52319	2.53418	2.5267	2.53067	2.52563	2.52975	2.53571	2.52243	2.5
21	2.52716	2.5235	2.53845	2.53143	2.52472	2.53372	2.52655	2.52792	2.53159	2.53128	2.53204	2.5354	2.53296	2.52289	2.5
22	2.52716	2.51907	2.53677	2.53052	2.5264	2.53632	2.52182	2.52243	2.53052	2.52625	2.5322	2.53296	2.52625	2.51709	2.5
23	2.52655	2.52945	2.53586	2.53036	2.52518	2.52747	2.51877	2.52609	2.52228	2.52426	2.5325	2.52823	2.53098	2.51556	2.5

Events

NeuroWare can detect the status change of up to 24 digital lines within the ADC DAQ board. Digital level changes (such as 0→1 or 1→0) are thought of as an event and can be displayed and recorded in NeuroWare.

**The ADC cannot support simultaneous changes on different channels. For this reason TBSI does not support the use of more than one Digital Data input at a time.*

• Digital Lines Connection

All 24 digital lines are accessible with a 68-pin SCSI connector. A couple of digital lines are also accessible with BNC connector.

Connect the digital signals of interest to your system via pins A0-A7,B0-B7,C0-C7 (shown below).

• Digital Events

Digital level changes of 24 digital lines are defined as different **Event ID** within NeuroWare (see table and image below).

Any changes to the event variables A0→A7,B0→B7 , C0→C7, will be shown in the **Event Table**. For example, if the digital level of the A0 line changes, you will see an event in the Event Table as shown below.

Event Definition Table

11	A0_high
10	A0_low
21	A1_high
20	A1_low
31	A2_high
30	A2_low
41	A3_high
40	A3_low
51	A4_high
50	A4_low
61	A5_high
60	A5_low

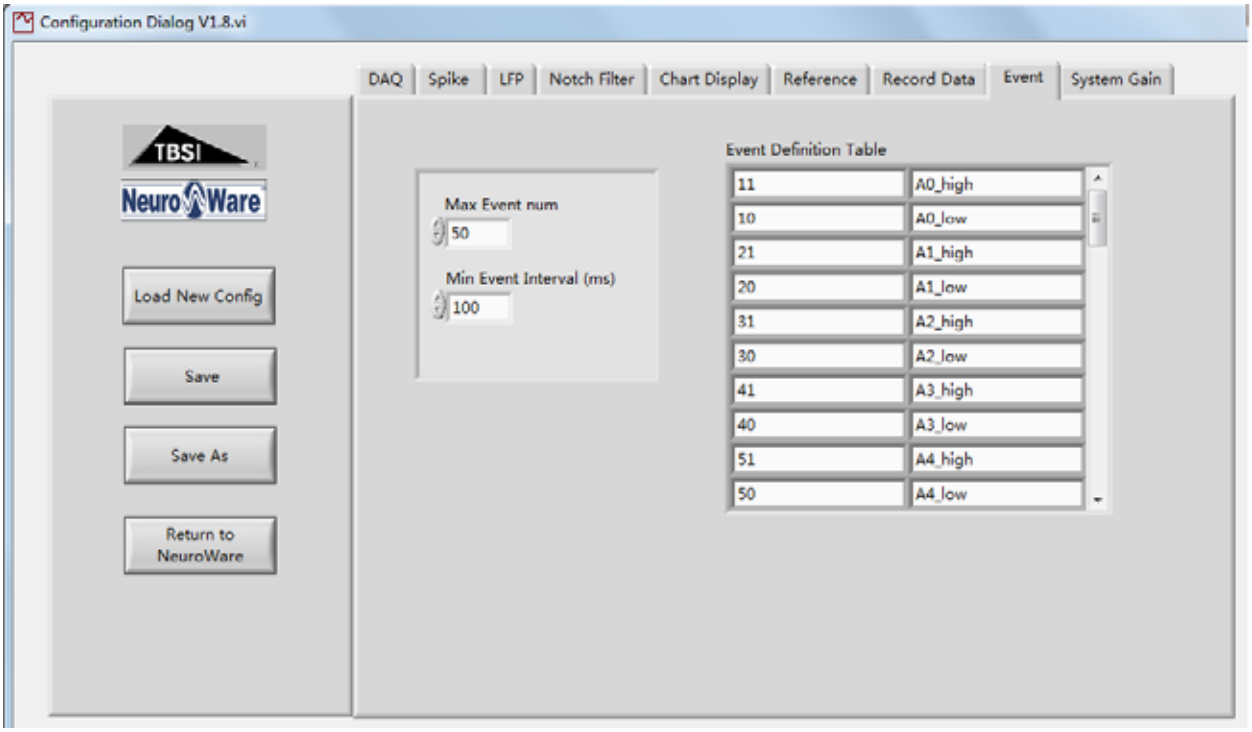
Event table

Timestamp	Port_status	Event_ID	Event_String
13.8030	00000000000000000000	10	A0_low
12.8030	10000000000000000000	11	A0_high
11.8030	00000000000000000000	10	A0_low
10.8020	10000000000000000000	11	A0_high
10.3020	00000000000000000000	10	A0_low
8.9020	10000000000000000000	11	A0_high

The Event String can be changed to better describe the details of the event. You can define your own **Event Definition Table** by the page of **Event** of Configuration **Dialog** as shown below.

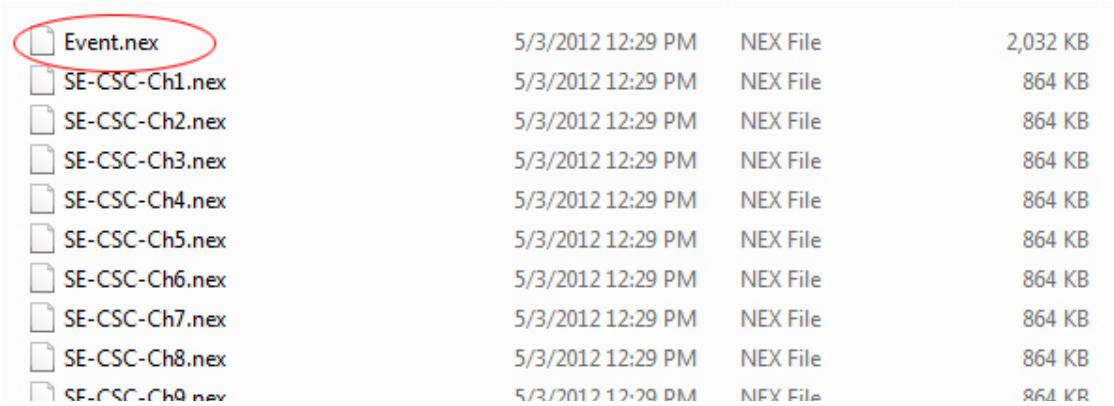
Event Definition Table: the default string is named as PortNum_High / PortNum_Low
Max Event Num: the max number of events that's displayed in Event Table. It's for display purpose only.
***Max Event Interval (ms)*:** the min width of pulse that can be detected as digital event is decided by this number. You are able to change it down to 1ms while the default is 100ms, but the measurement difference of tens of ms may still be seen depending on your computer performance.

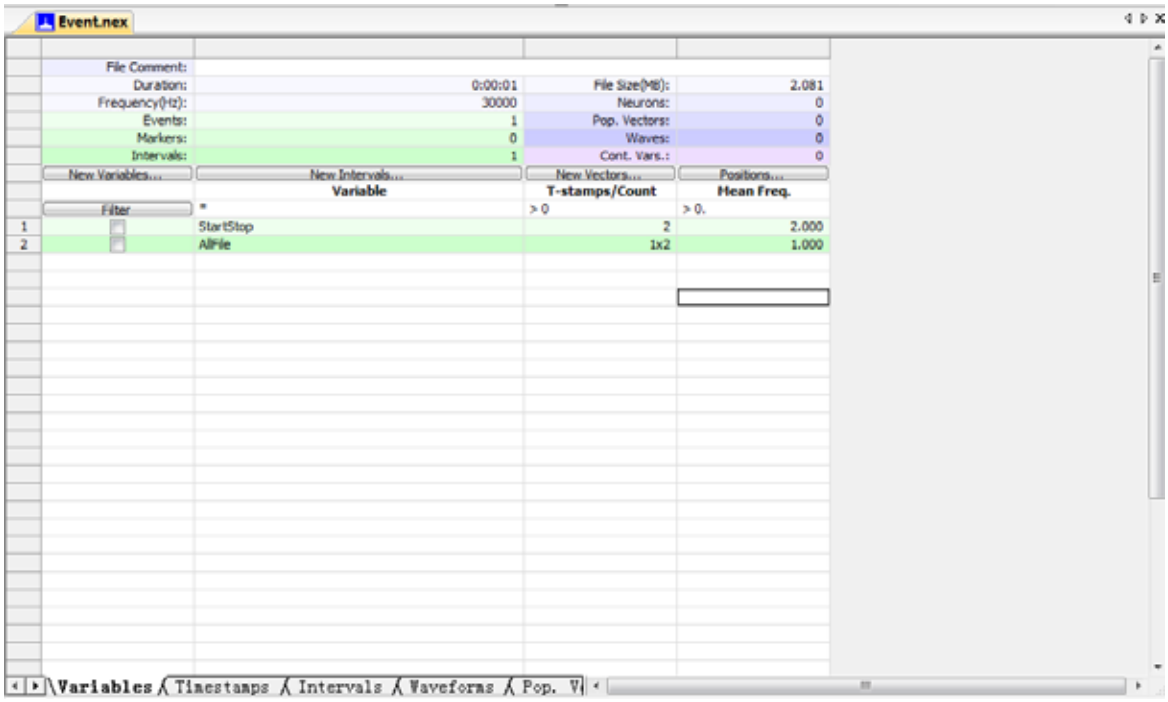
Note: Event Definition Table can't be edited in NeuroWare.



- **Event File**

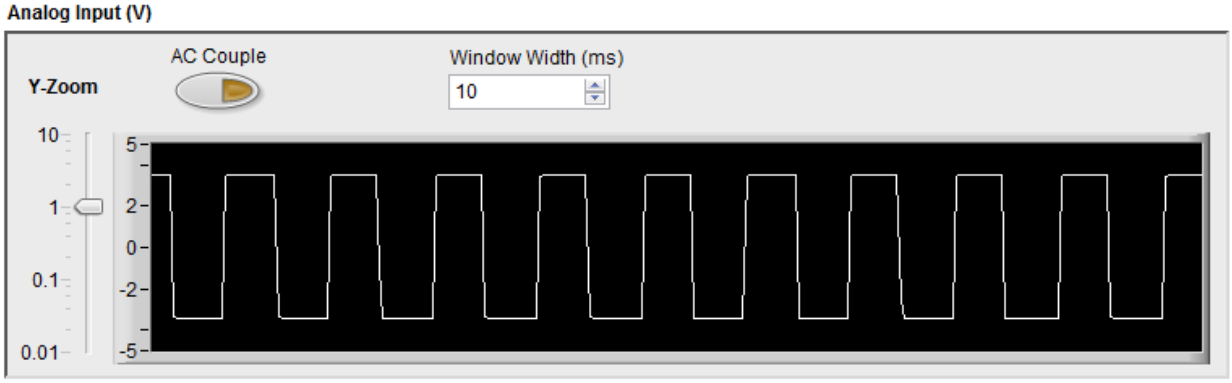
Digital event information stored within the event.nex file (shown below) can be loaded into NeuroExplorer.





Analog Input Channel

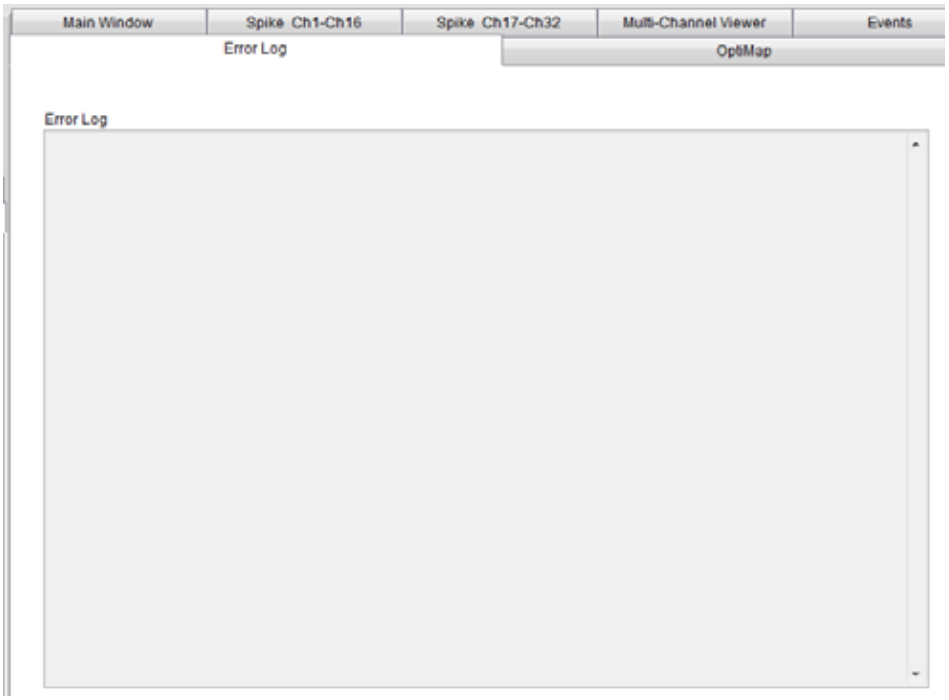
An analog input channel separated from the other neural channels is provided for custom purpose. The TTL waveform up to +/- 5V can be acquired by DAQ directly at up to 30kS/s. Also, no filter will be applied to this channel.



Error Log Window

The Error Log window helps trace problems that have occurred within NeuroWare. Please consult this page if you experience problems during recording.

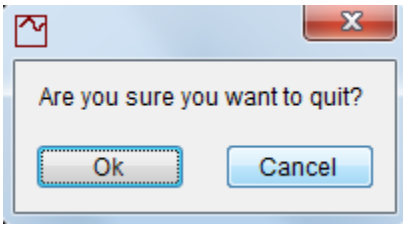
All errors are logged into a .txt file located in the directory specified within the Error Log File Path field.



Quit NeuroWare

To quit the program, click the **Quit Program** button which is located beneath the **Start DAQ** button or close panel directly. It's recommended to check if you like to save the current setting to the current config file or save as a new config file by **Configuration Dialog** (Tools/Configuration)

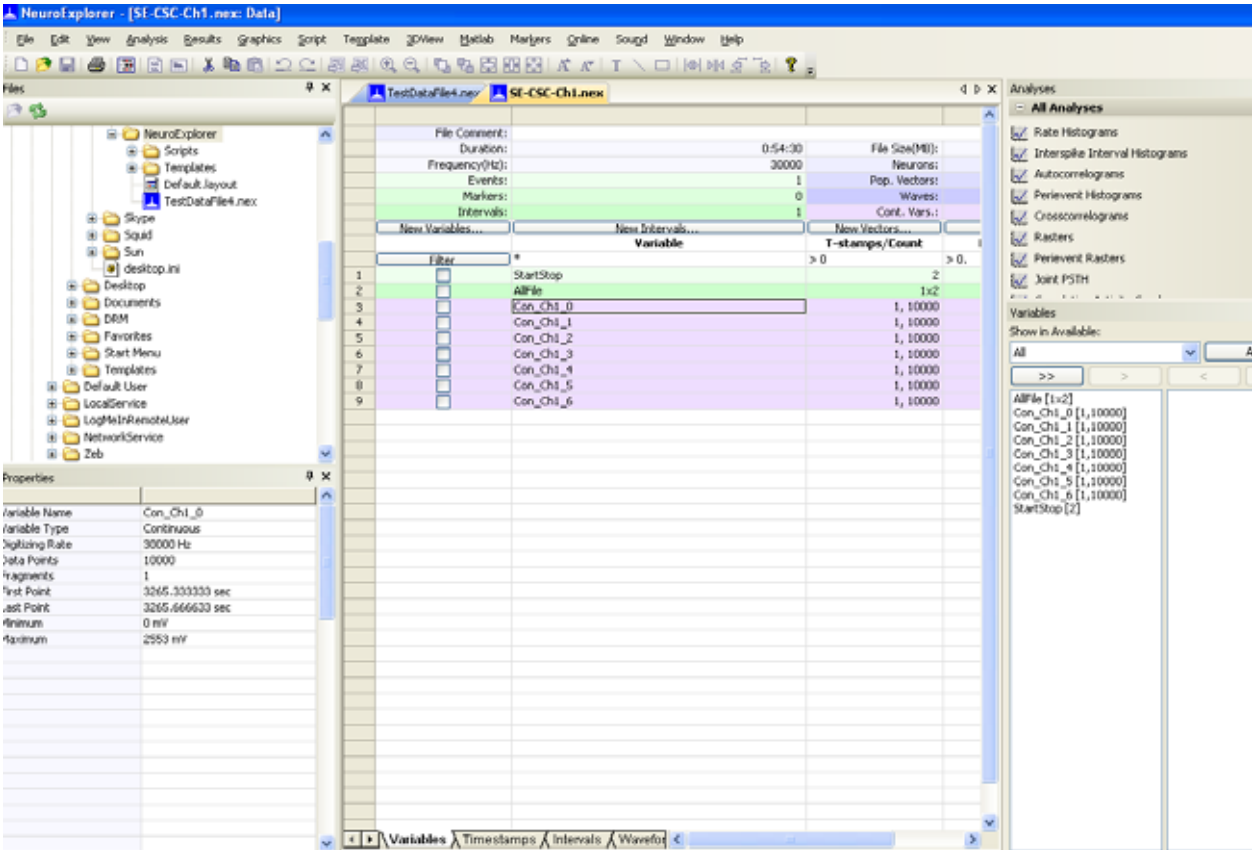
Click **OK** in the next dialog box to confirm that you want to quit.

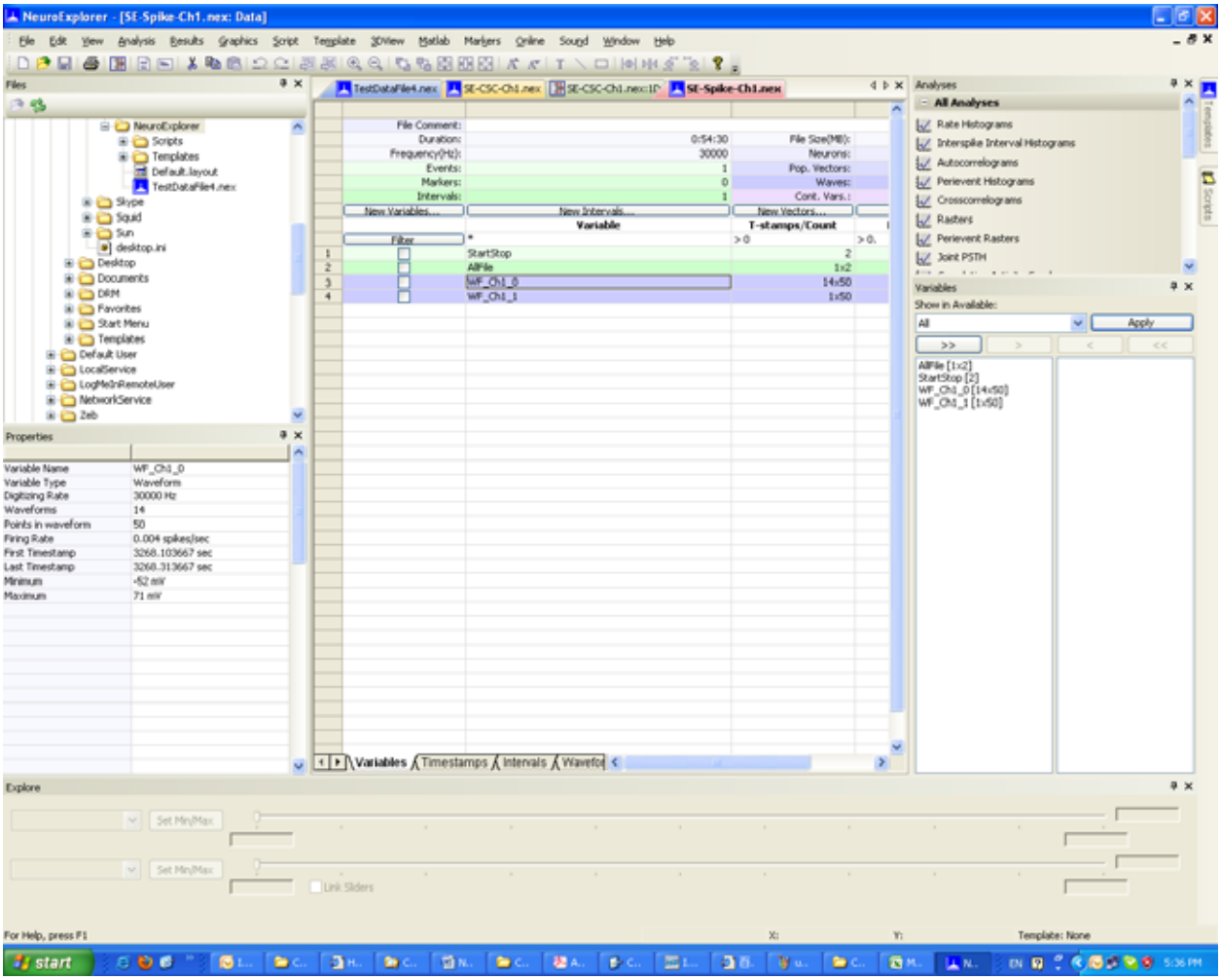


Reading files

- ## Load Data into NeuroExplorer

Load the NeuroExplorer program, navigate to *File→Open* and open SE-CSC-Ch#.nex (where # is the channel of your choice).



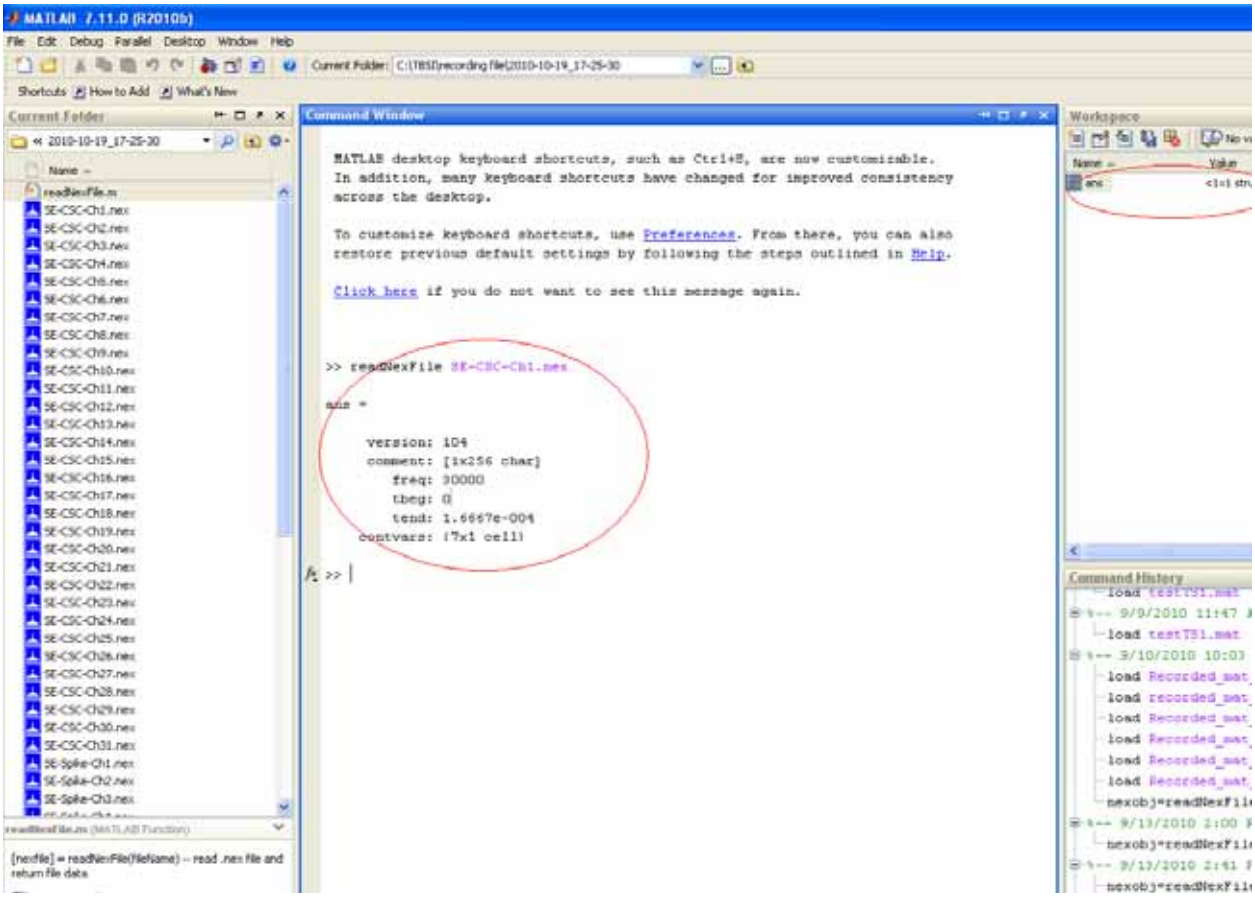

NeuroExplorer - [SE-Spike-Ch1.nex: Data]
File Edit View Analysis Results Graphics Script Template 3DView Matlab Markers Online Sound Window Help
Files
Properties
Analyses
All Analyses
Rate Histograms
Interspike Interval Histograms
Autocorrelograms
Perievent Histograms
Crosscorrelograms
Rasters
Perievent Rasters
Joint PSTH
Variables
Explore
For Help, press F1
Template: None
start

- ## Load Data into MatLAB

Visit the NeuroExplorer website at http://www.neuroexplorer.com/code.html to download the .nex file reader/writer function for MatLAB, titled: *HowToReadAndWriteNexFilesInMatlab.zip.*

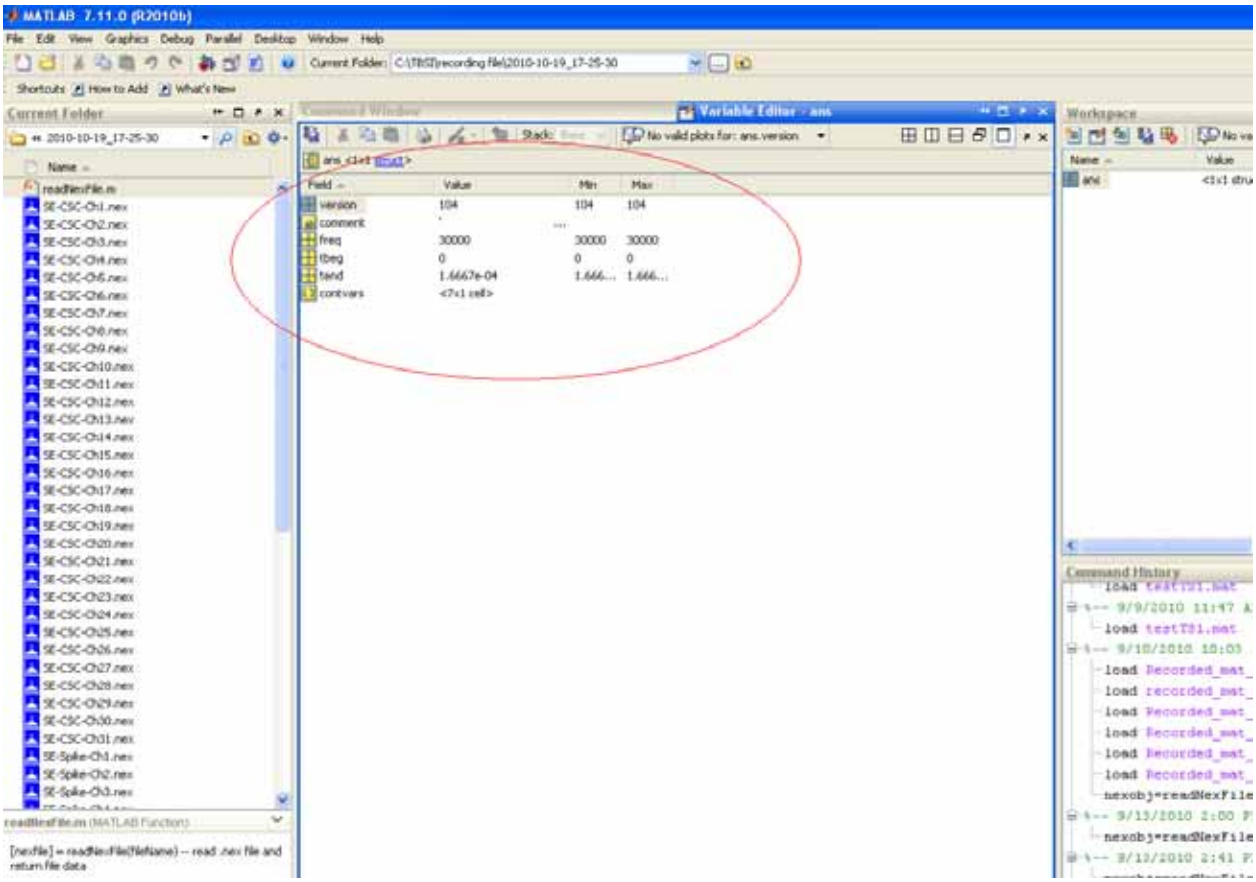
Copy the readNexFile function in the archive to the folder containing your recorded data. In the MatLAB command window, execute:

```
readNexFile SE-CSC-Ch#.nex
```
(where # is the channel of your choice)

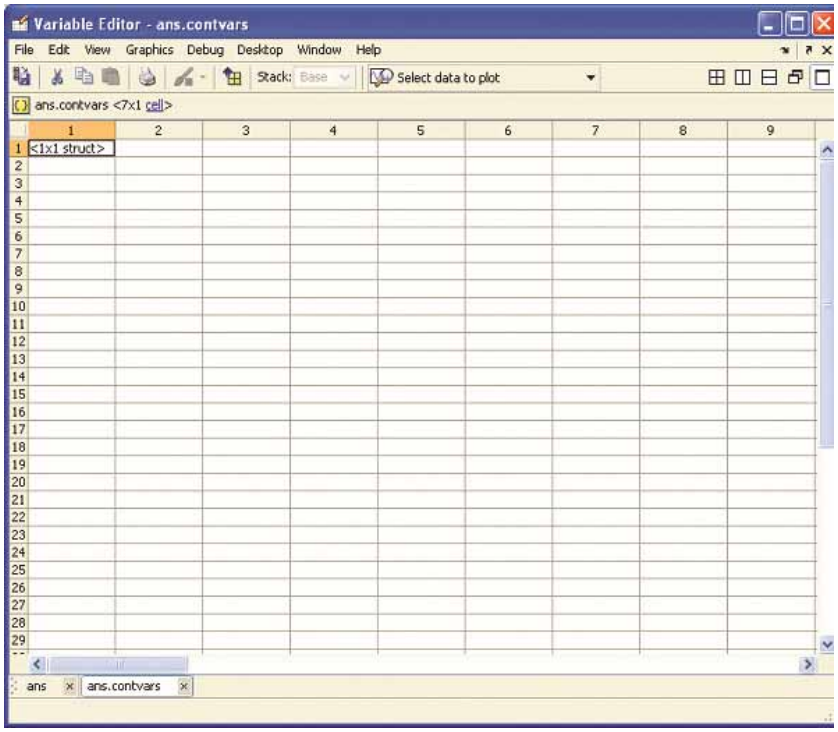


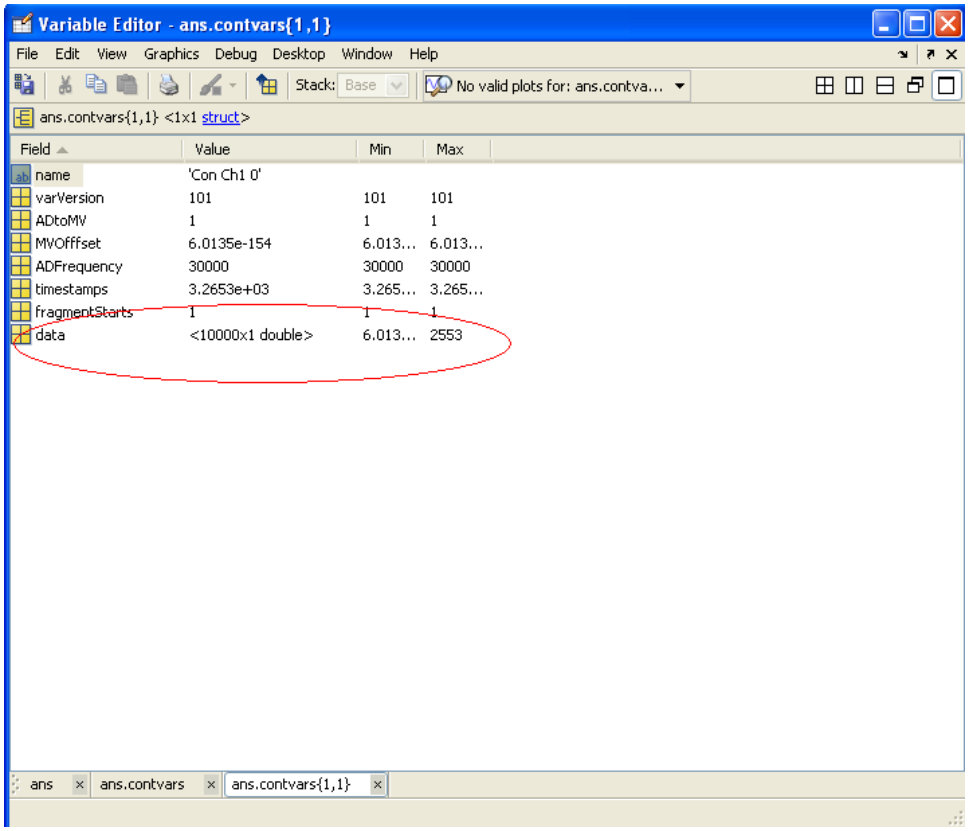
In the MatLAB workspace, double-click the variable labeled **ans**. The Variable Editor window will appear.

In the Variable Editor, double-click **contvars**.



Double-click the <1x1 struct> cell to extract the data content.





Technical Support

All technical support and application questions should be directed to John McIntyre at Triangle BioSystems.

Contact Information

Phone: (919) 361-2663
Fax: (919) 544-3061
http://trianglebiosystems.com/contact-us.html

Version history for this manual

1.0 Initial release with Specifications 11/2013
1.1 Removed functionality table, added I/O 1/2014
1.2 Added info for config dialog box 1/2014