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Research Central Software Suite

Instructions for Use

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What This Manual Covers

The Blackrock Central Software Suite serves three primary functions:

1. Configuring hardware settings on the Cerebus and CerePlex Direct Neural Signal Processors.
2. Visualizing continuous signals and sorted spikes in real time.
3. Saving experimental data including continuous signals (.nsx) and digital events (.nev).

System Description

The flow of data through the Blackrock Data Acquisitions system begins with a biopotential of interest. Potentials are acquired by an electrode well suited to the signal and location being recorded. Acquired signals are buffered, amplified, and digitized by Blackrock headstages. Finally, data is processed, visualized, and saved by the Central Software Suite utilizing a Blackrock Neural Signal Processor. The system can perform real-time signal processing algorithms including: noise cancellation, digital filtering, simultaneous extraction of spike and field potentials, manual and automatic online spike sorting.

Minimum System Requirements

Microsoft Windows 7 Professional or Windows 10 Professional

AMD or Intel 2.0 GHz Quad Core CPU

4 GB of RAM

1GHz Ethernet adapter

1 TB 3 Gbit/s SATA II HDD

A Host PC that is configured and tested by our engineers is available. Please contact sales@blackrockmicro.com for more information.

Setup

Installing Central Software Suite

1. Uninstall any previously existing versions of Central Suite through Programs and Features in Windows Control Panel.
2. Run the Central Suite installer (.msi) from the installation CD or Blackrockmicro.com.
3. Install the MATLAB Compiler Runtime from the supplied installation CD or Blackrockmicro.com.

Blackrock recommends that a dedicated PC be used to run Central. Refrain from installing any additional software or connecting the PC to the internet.

Configuring an Ethernet Port

The Blackrock Neural Signal Processor communicates with a host PC over the UDP Ethernet protocol. Before installing the Central Software Suite, configure the Ethernet connection as shown below.

Note: If you purchased the Blackrock Host PC, an Ethernet card is pre-installed and configured in your PC.

1. Click on Start and search for “View Network Connections”.
2. Right click on the correct Ethernet Adaptor, usually Local Area Connection, and click on Properties.
3. Uncheck all services except for Internet Protocol (TCP/IP) or Internet Protocol Version 4 (TCP/IPv4).
4. Click on Internet Protocol (TCP/IP) and click on Properties.
5. Set IP Address to 192.168.137.1 and Subnet Mask to 255.255.255.0 Leave all other fields blank.
6. Click on OK to save changes.

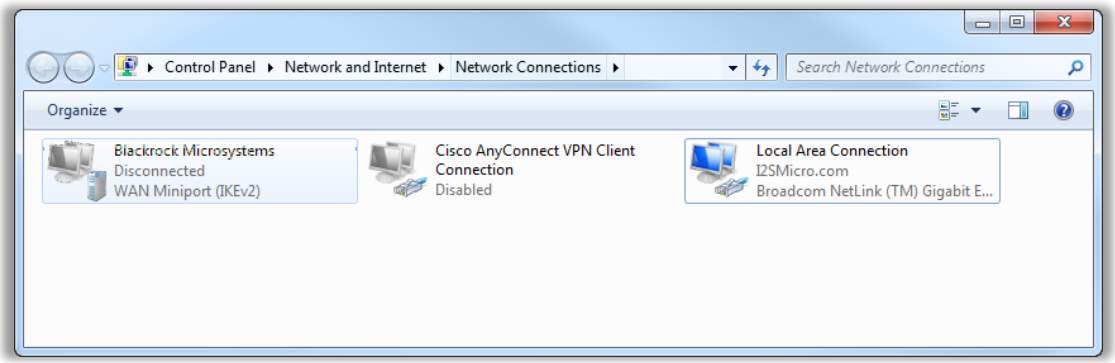


Figure 1 – Network Connections Window

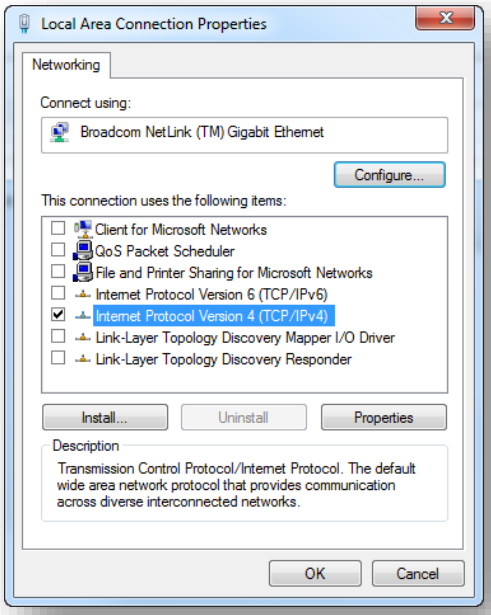


Figure 3 – Local Area Connections

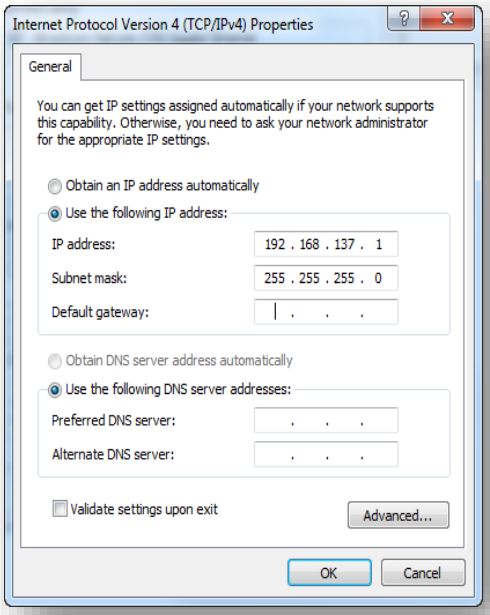


Figure 2 – IPv4 Properties

Connecting Multiple PCs to One NSP

A single Neural Signal Processor can connect to up to 16 PCs running the Central Software

1. Connect the NSP and all PCs to a 1-Gbps network switch which has QoS enabled.
2. Configure each PC as per instructions above, however, IP addresses should increment like so: 192.168.137.2, 192.168.137.3, etc.

Note: For your reference, the NSP's IP address is 192.168.137.128.

Connecting Two NSPs to One PC

A single PC can connect to two NSPs by running two instances of Central.

3. 1Connect both NSPs to separate Ethernet ports on the PC.
1. Follow the Configuring an Ethernet Port instructions, for both ports.
2. Use an IP address of 192.168.137.17 for the second port.
3. Navigate to the Central executable found in *Program Files* > *Blackrock Microsystems*.
4. Create a shortcut to the Central executable. Right click the shortcut and edit the Target field to read: "C:\Program Files (x86)\Blackrock Microsystems\Cerebus Windows Suite\Central.exe --network inst=192.168.137.128 --network central=192.168.137.17 --instance 1
5. Edit the shortcut name to indicate its connection to the second NSP.

Central

Central can be run from the desktop shortcut, the Start menu shortcut, or by navigating to the executable in the Blackrock Microsystems directory in Program Files. The Central main application connects to a Blackrock Neural Signal Processor to configure hardware channels and acquire data. Incoming data can be processed and visualized in various ways before being saved for future analysis.

Central Main Window

Figure 4 – Central Main Application

The Central Main window provides access to all functions, features, and settings within the Central Software Suite.

Hardware Configuration contains individual channel configurations as well as system settings. The main panel displays channels in icon or list view as selected in the tool bar. Double clicking selected channels will open the channel properties window for editing. Channels are filtered by clicking the categories listed on the left pane of the window. Additional settings are found under the Settings heading at the bottom of the left pane.

Spike Panel displays detected spikes on the front-end amplifier channels in a grid-graph form and is often the fastest way to visualize overall system function. If spike-sorting rules are defined, the spikes belonging to different units will be displayed in different colors. Double click any channel to display the Single Neural Channel Window.

Raster Plot displays the occurrence of spike events on many channels over time. All channel types may be shown in this window. Continuous traces and comments can also be shown on the plot.

Single Neural Channel displays the selected channel in a continuous data trace, strip chart, and waves panel. Use this window to define spike sorting rules and to view single channel activity.

Activity Map color codes the firing rate of neurons recorded by each electrode on a two-dimensional grid. An electrode map file dictates the spatial arrangement of channels. Use this window to quickly visualize spike rates over all channels.

File Storage contains the controls to start and stop recording. Additional settings, such as file type, name and path may be edited here.

Signal to Noise Ratio displays the ratio of signal to noise for each channel. Use this window to view and record valuable information about signal quality and electrode functionality.

Neural Modulation displays a histogram of changes in firing frequency over time. Use this window to see which channels are recording from neurons with variable firing rates.

Thresholding allows the user to set a global spike detection threshold as a value or a multiplier of the root mean squared signal energy.

Impedance Tester measures and displays the impedance of each electrode. Use this window to assess electrode functionality.

Crosstalk measures and displays the amount of signal shared between channels. Use this window to mark and disable redundant channels.

N-Trode allows configuration and visualization of N-Trode groups. The Spike Display at the top of the window shows spikes on each channel. The Peak/Valley panel is used to define spike units for the group. The Continuous Data Display shows the full signal from the group.

Oscilloscope visualizes the signal acquired by any channel. Use this window to view, measure and compare signals with custom triggers.

Digital Filter Editor is a MATLAB utility that creates custom digital filters which can be applied to acquired signals.

Add Comment creates a time-stamped text comment which is included in the neural events (.nev) file.

nPlay loads and replays saved data files for analysis and re-recording.

System Load displays the volume of incoming data from the Neural Signal Processor.

Menu Bar

The menu bar is found at the top of the Central Main window and contains File, Tools, and Windows drop-downs.

File

The File menu contains functions to load and save various configuration files as well as the option to close applications and shut down the Neural Signal Processing hardware.

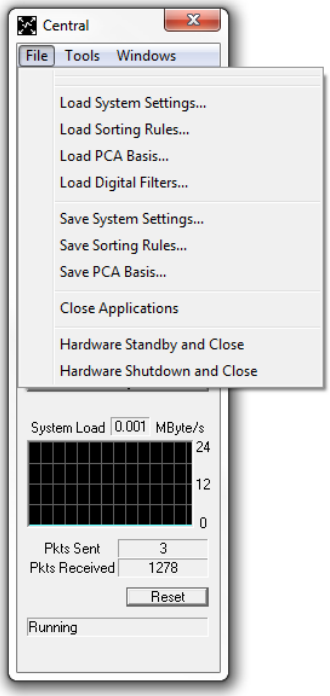


Figure 5 – Central File Menu

Load System Settings: Load channel settings in the '.ccf' and '.rcf' formats.

Load Sorting Rules: Load system-calculated Histogram Peak Count sorting rules in the '.csr' format.

Load PCA Basis: Load system-calculated principle component analysis basis vectors in the '.cfsd' format.

Load Digital Filters: Load digital filters in the '.xml' format created by the Digital Filter Editor.

Save System Settings: Saves the channel settings currently set in Hardware Configuration.

Save Sorting Rules: Saves spike-sorting parameters.

Save PCA Basis: Saves PCA basis vectors calculated during spike sorting.

Close Applications: Closes Central Suite programs while leaving the hardware running.

Hardware Standby and Close: Closes Central Suite programs and puts hardware into standby mode. The system must be in standby mode for firmware updates.

Hardware Shutdown and Close: Closes Central, all its associated applications and shuts down the Neural Signal Processor. Manually turn off the system power switch to complete hardware shutdown.

Tools

The Tools menu contains functions regarding thresholding, spike-sorting and general application settings. The spike sorting options are discussed on Page 23.

Options

Sets various general options for the Central Software Suite.

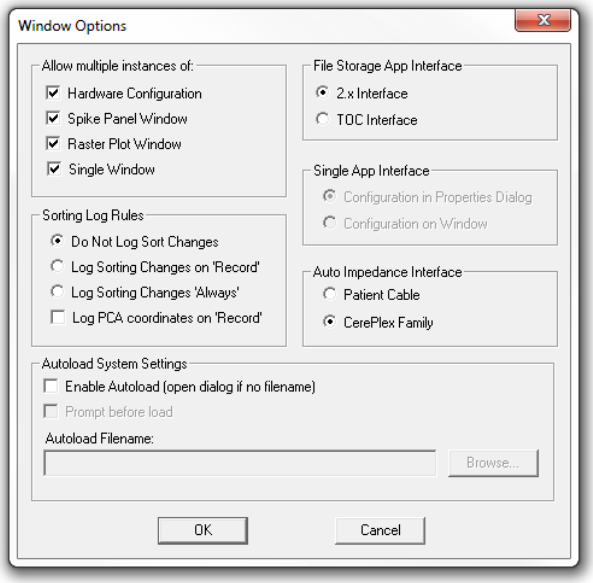


Figure 6 – Central Options

Allow Multiple Instances Of

Allows more than one instance of each checked window type to be opened.

Sorting Log Rules

Sorting rules are the manually or automatically defined spike unit classifications used to recognize and separate neural spike events.

Do Not Log Sort Changes: Disables sort change logging.

Log Sorting Changes on 'Record': Will automatically log the spike-sorting model, the signal to noise ratio summary, and the crosstalk summary if rebuilt during recording.

Log Sorting Changes 'Always': Will log the spike-sorting model, the signal to noise ratio summary, and the crosstalk summary any time it is rebuilt.

Log PCA coordinates on 'Record': Will log the spike-sorting model only when recording begins.

File Storage App Interface

Choose to save files in the 2.x interface or the TOC interface. The TOC interface is designed to be used in a clinical setting where patient information is entered. The 2.x interface is preferable in a research setting where files are manually named. For more information of file types see Page 32.

Single Neural Channel App Interface

Allows changes to the channel configuration in Single Neural Channel viewer or in the *Edit* > *Properties* menu.

Auto Impedance Interface

Configures impedance testing for the Patient Cable or CerePlex headstages.

Autoload System Settings

Upon opening Central, the '.ccf' file input below will be loaded. If the field is left blank, Central will prompt the user to select a '.ccf' file.

Windows

The Windows menu contains system and software summary information as well as shortcuts to Central applications

About: Displays the version of the software and the firmware of the system. These version numbers may be needed if you contact Blackrock support.

System Summary: Displays average number of units per channel if using automatic histogram peak-count sorting. Options to disable cross talking channels and launch the impedance tester are also found here.

Hardware Configuration

The Hardware Configuration panel contains individual channel configurations as well as system settings. The main panel displays channels in icon or list view as selected in the tool bar. Double clicking selected channels will open the channel properties window for editing. Channels are filtered by clicking the categories listed on the left pane of the window. Additional settings are found under the Settings heading at the bottom of the left pane.

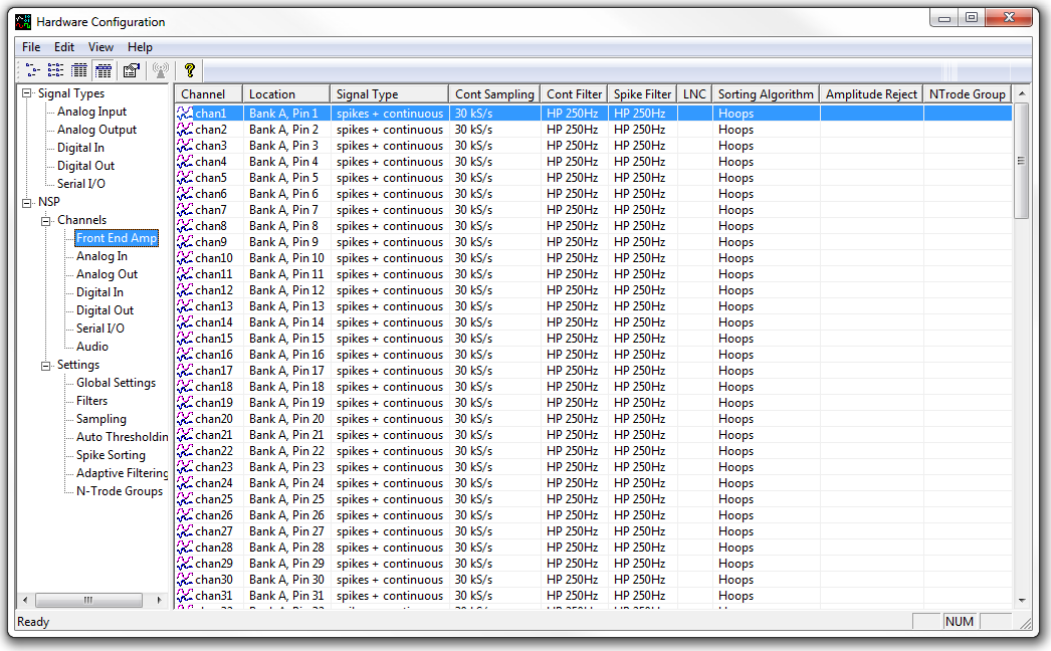


Figure 7 – Hardware Configuration

Channel Sorting

Central Suite supports front end amplifier inputs, as well as analog, digital and serial inputs and outputs. Channels can be viewed in icon, list, or full row detail modes selectable in the tool bar on the toolbar. Each channel can be sorted based on function under Signal Types, or based on physical location under NSP Channels.

Configuring Channel Properties

Select one, or multiple channels in the right pane of the Hardware configuration window. Once all channels of interest are selected, right-click then select properties, or click the Channel Properties icon in the toolbar. Each channel type, and their respective options are described below.

Front End Analog Inputs

All parameters for front end input channels are listed below.

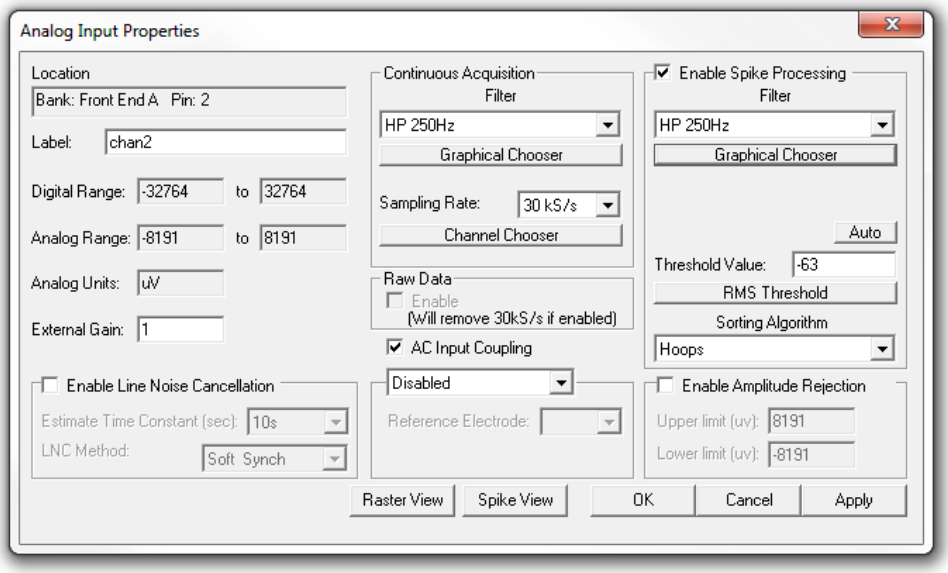


Figure 8 – Analog Input Properties

Label: A user-defined name for the specific channel. Multiple channels labels can be automatically assigned

Digital Range: Fixed entry showing the range of digital values that analog signals are mapped to.

Analog Range: Fixed entry showing the range of analog values measured.

Analog Units: Unit of analog signal measurement displayed for reference.

External Gain: Gain value of the headstage. All Blackrock systems use a gain of 1.

Figure 9 – Edit Multiple Labels

Enable Line Noise Cancellation: Enables cancellation of 50 or 60 Hz noise.

Estimate Time Constant: The period over which line noise parameters are determined.

LNC Method: Selects software or hardware line noise cancellation.

Filter: Select a digital filter to apply to continuous data.

Graphical Chooser: Visualize the continuous signal filter in place.

Sampling Rate: Select the sampling rate of data acquisition.

Channel Chooser: Select the sampling rate for data acquisition on any channel.

Raw Data: Record raw data stream before filtering or sorting is applied.

AC Input Coupling: High pass filter to remove DC offset.

Software Reference Selection: Apply software referencing to local field potential or both Local field potential and spike data.

Reference Electrode: Select channel to use as software reference.

Enable Spike Processing: Allow detection of spike events on channel.

Filter: Filter selection for spike event processing.

Graphical Chooser: Allows visualization of the spike processing filter in place.

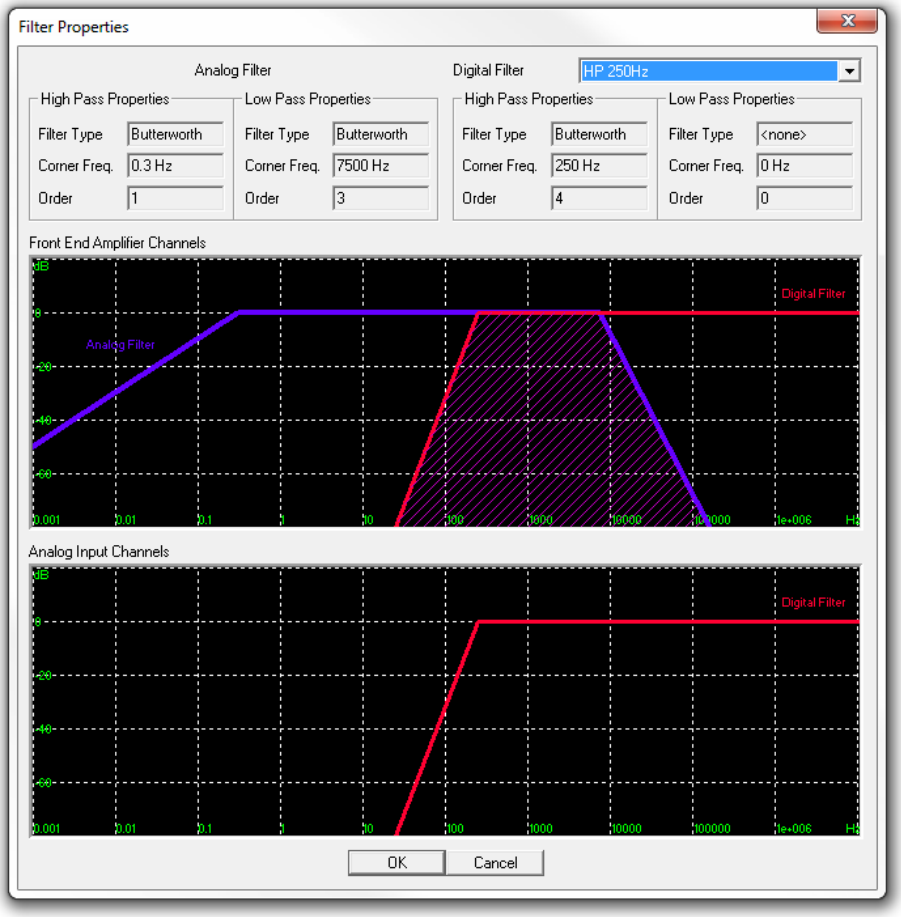


Figure 10 – Filter Properties

Threshold Value: Voltage threshold for classification of a spike event in mV.

RMS Threshold: Set parameters for auto-threshold calculation.

Sorting Algorithm: Set the sorting algorithm for a channel as described in Spike Sorting on Page 23.

Enable Amplitude Rejection: Rejects waveforms exceeding a specified amplitude.

Upper/Lower Limit (uV): Voltage limits for amplitude rejection.

Analog Output

Analog output properties are accessed from the left side bar of the Hardware Configuration window and allows the user to set the properties of the analog

output ports. Analog outputs can function as monitor channels, directly mirroring signals of interest, or as waveform generators. Each modality has output and triggering parameters defined below.

Label: User-defined channel label.

Function: Assigns the analog channel function.

Analog Output: Continuous Monitor

An analog output channel configured as a continuous monitor will scale a user input signal into a plus or minus 5 V output signal.

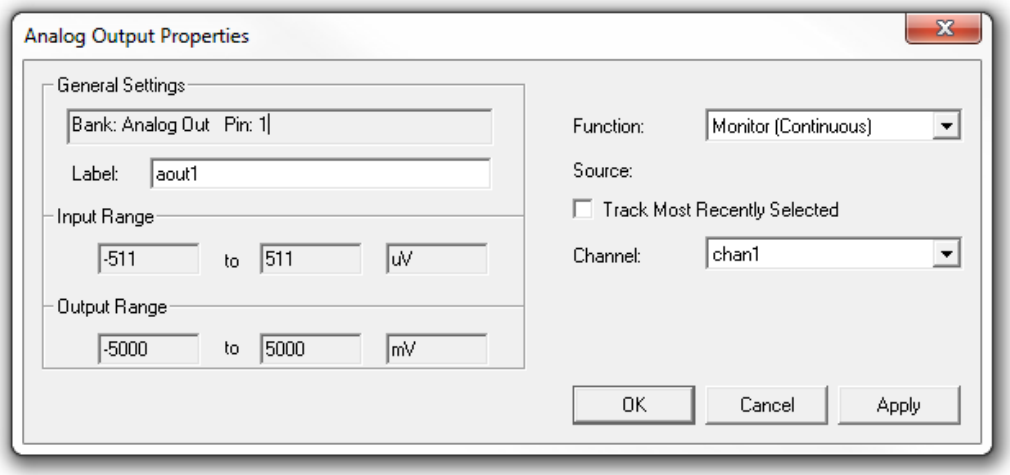


Figure 11 – Analog Output: Continuous Monitor

Input Range: Input voltage range displayed for reference.

Output Range: Output voltage range displayed for reference.

Track Most Recently Selected: When enabled, the channel selected in Spike Panel, Single Neural Channel, or Raster Plot view is used as the monitor input.

Channel: An analog output channel configured as a spike monitor will scale a user selected input signal into a plus or minus 5 V output signal.

Analog Output: Spike Monitor

An analog output channel configured as a spike monitor will scale a user selected input signal into a plus or minus 5 V output signal containing only identified spike events.

Input Range: Input voltage range displayed for reference.

Output Range: Output voltage range displayed for reference.

Track Most Recently Selected: When enabled, the channel selected in Spike Panel, Single Neural Channel, or Raster Plot view is used as the monitor input.

Channel: An analog output channel configured as a spike monitor will scale a user input signal into a plus or minus 5 V output signal containing only identified spike events.

Analog Output: Sine Waveform

An analog output channel configured as a sine waveform generator will produce a user defined sine wave on a user defined trigger stimulus.

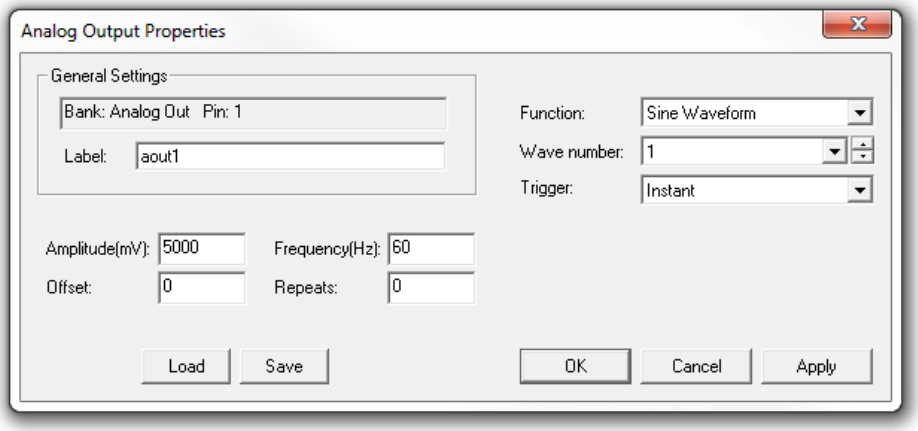


Figure 12 – Analog Output: Sine Generator

Amplitude (mV): Amplitude of the output sine wave.

Frequency (Hz): Frequency of the output sine wave.

Offset (mV): DC offset of the output sine wave.

Wave Number: Select which of five waveforms are configured and used.

Trigger: Triggering options are explained on Page 18.

Analog Output: Custom Waveform

An analog output channel configured as a custom waveform generator will produce a user defined waveform on a user defined trigger stimulus.

Wave Number: Select which of five waveforms is configured and used.

Number of Phases: Number of voltage phases in the waveform. 248 are available.

Offset (mV): DC offset of the waveform.

Phase: Selects which phase is being configured.

Amplitude (mV): Phase amplitude.

Duration (ms): Phase duration.

Repeats: Indicates the number of times to repeat the waveform once triggered. A value of 0 will repeat the waveform indefinitely.

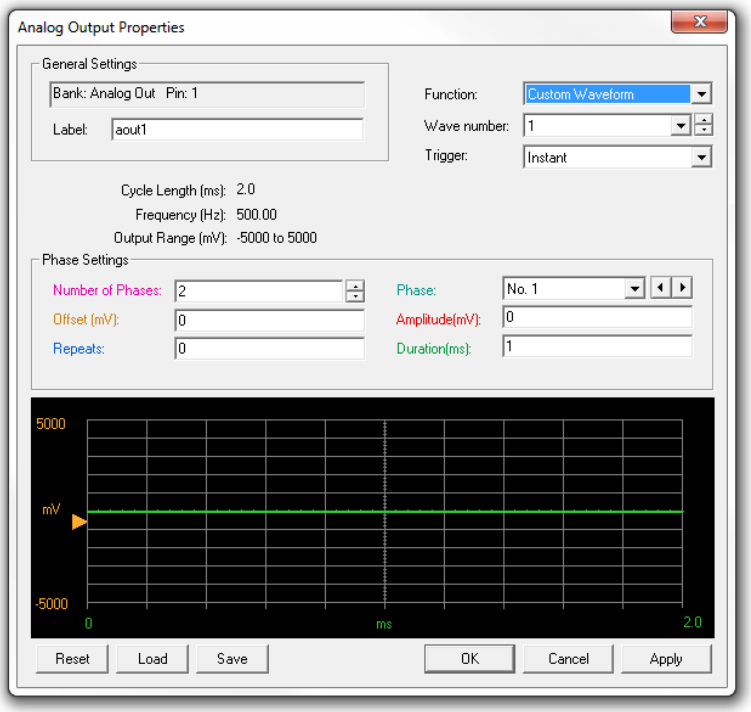


Figure 13 – Analog Output: Custom

Analog Output: Triggering

Sine and custom waveforms can be triggered by different conditions listed below.

Instant: Waveform triggers when OK or Apply are clicked.

Digital Input Rising Edge: Waveform triggers when a user defined digital input pin transitions from low to high. A digital input bit must be selected.

Digital Input Falling Edge: Waveform triggers when a user defined digital input pin transitions from high to low. A digital input bit must be selected.

Spike Unit: Waveform triggers when a sorted unit is detected on a defined channel.

NeuroMotive ROI: Triggers when a subject enters or exits a selected region of interest.

Extension: Waveform triggers based on custom extension code loaded onto hardware.

Digital Input

Digital input properties are accessed from the left side bar of the Hardware Configuration Window and allows the user to set the properties of the digital input ports. Digital inputs can synchronize external hardware and pass digital data into neural recordings. Digital Inputs may take on the functions listed below.

16-bit on word strobe: Reads 16 bits on the rising edge of the strobe pin.

16-bit on bit changes: 16-bit read when any bit changes from LOW to HIGH or from HIGH to LOW.

16-bit on rising edge: 16-bit read when any bit changes from LOW to HIGH. Each bit indicates if a LOW to HIGH change occurred on each digital pin.

16-bit on falling edge: 16-bit read when any bit changes from HIGH to LOW. Each bit indicates if a HIGH to LOW change occurred on each digital pin.

8-bit strobe / 8-bit bit changes: Reads bits 0-7 on the rising edge of the strobe pin and reads bits 8-15 if bits 8-15 changed from LOW to HIGH or HIGH to LOW.

8-bit strobe / 8-bit bit rising edge: Reads bits 0-7 on the rising edge of the strobe pin, and bits 8-15 indicate if digital pins D8-D15 changed from LOW to HIGH.

8-bit strobe / 8-bit bit falling edge: Reads bits 0-7 on the rising edge of the strobe pin, and bits 8-15 indicate if digital pins D8-D15 changed from HIGH to LOW.

Digital Output

The Digital Output Window is accessed from the left side bar of the Hardware Configuration Window and allows the user to set the properties of the digital outputs. Digital outputs can function as spike detection monitors, timed function generators, or triggered events.

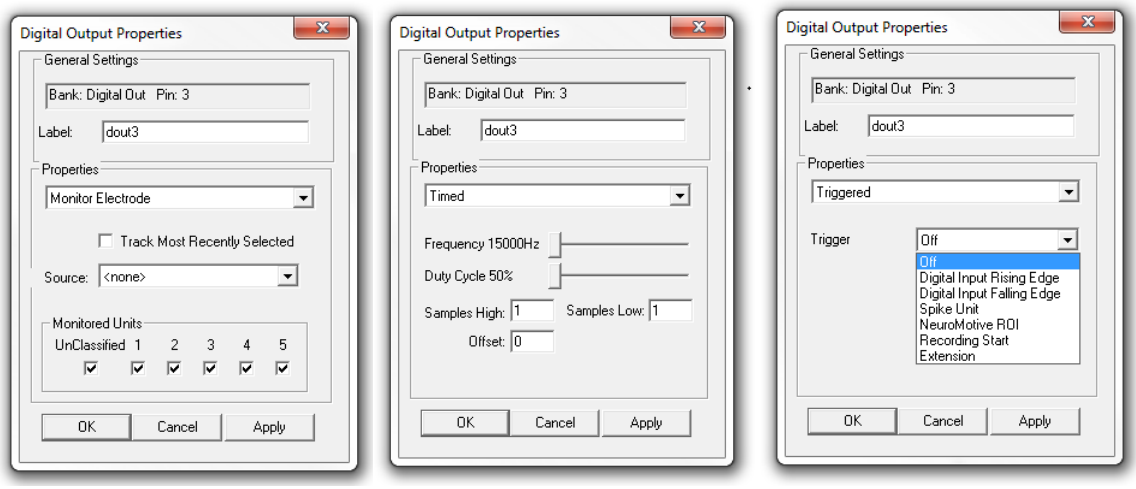


Figure 14 – Digital Output Properties

Digital Output: Monitor Electrode

A digital output in monitor electrode mode will send a high pulse when a sorted spike unit is detected on a defined channel.

Track Most Recently Selected: When enabled, the channel selected in Spike Panel, Single Neural Channel, or Raster Plot view is used as the monitor input.

Source: Select which channel to monitor.

Monitored Units: Select which spike unit classifications to trigger on.

Digital Output: Timed

A digital output in timed mode will send a pulse train with specified parameters. The signal can be configured by setting frequency and duty cycle, or samples high and low.

Frequency (Hz): The number of pulses per second.

Duty Cycle: The percentage of time a pulse train is high.

Samples High: Number of 30kHz sample periods output should be held high.

Samples Low: Number of 30kHz sample periods output should be held low.

Offset (mV): DC offset voltage of the digital output.

Digital Output: Triggered

A digital output in triggered mode will send a pulse when the selected trigger stimulus occurs.

Digital Input Rising Edge: Waveform triggers when a user defined digital input pin transitions from low to high. A digital input bit must be selected.

Digital Input Falling Edge: Waveform triggers when a user defined digital input pin transitions from high to low. A digital input bit must be selected.

Spike Unit: Waveform triggers when a sorted unit is detected on a defined channel.

NeuroMotive ROI: Waveform triggers when a subject enters or exits a region of interest.

Extension: Waveform triggers based on custom extension code loaded onto hardware.

Serial I/O

The Serial I/O Properties window displays the serial communication parameters and allows the user to name and enable the serial port. Serial communication parameters cannot be changed.

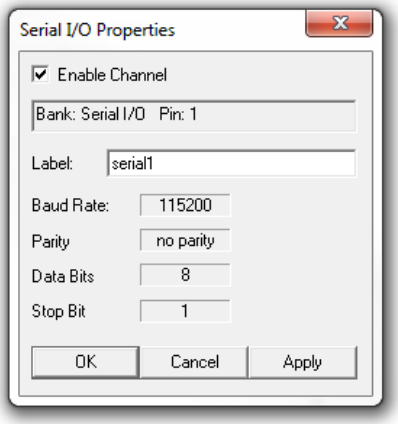


Figure 15 – Serial I/O

Settings

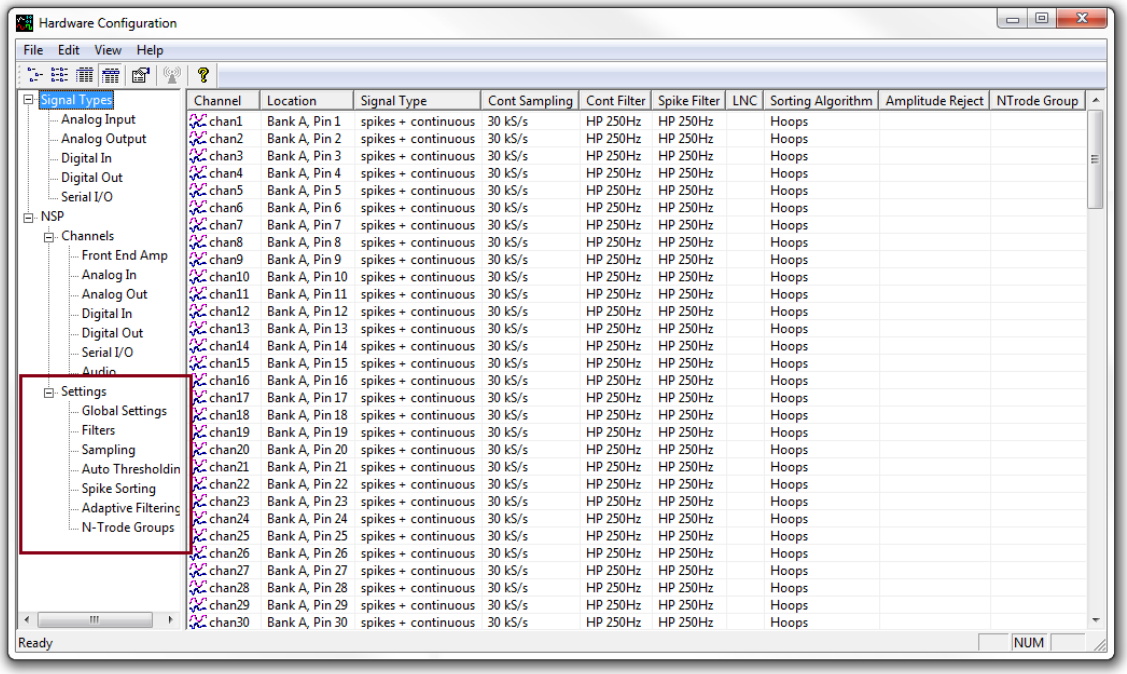


Figure 16 – Hardware Configuration Settings

Global Settings

Spike Width (samples): The number of samples recorded around a detected spike event.

Pre-threshold Samples: The number of samples to record preceding a threshold crossing.

Line Noise Frequency (Hz): The line frequency of the system, either 50 Hz or 60 Hz.

LNC Reference Channel: The reference channel used to compute system line noise. The extracted line noise template for each channel can be viewed in Single Neural Channel when the Raw/LNC button is checked.

Filters

This window displays the details of a selected digital filter in a bode plot and key numerical parameters.

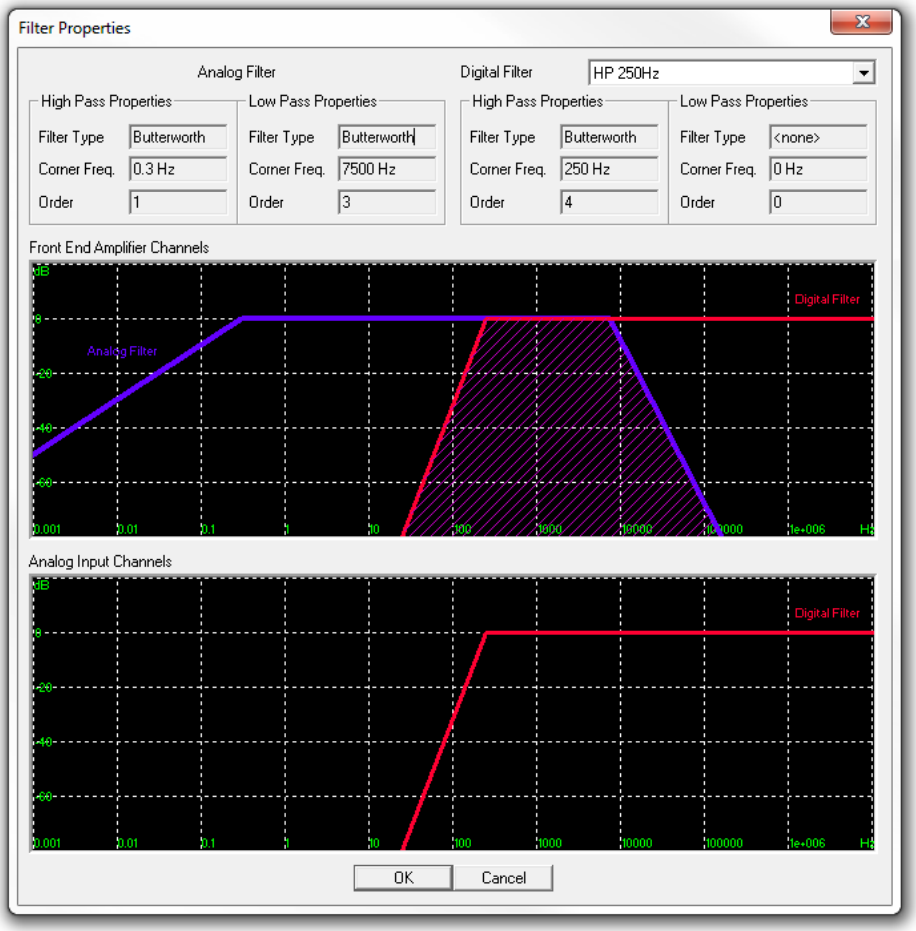


Figure 17 – Filter Properties Display

Auto Thresholding

This window allows the user to specify the auto thresholding properties for spike detection.

Threshold Multiplier: To register as a spike event, signal energy between 1 and 5 kHz must exceed the energy of the noise by a factor of the threshold multiplier level.

Channel: Applies noise boundary properties to this channel.

Dimensions of the Ellipsoid: Radius of the noise ellipsoid in the along each axis.

Center of Ellipsoid: Center of the noise ellipsoid in cartesian coordinates.

Rotation of Ellipsoid: Rotation angle of the noise ellipsoid around each axis.

Spike Sorting

The Spike Sorting Properties Window allows the user to specify the rules and settings for the spike sorting algorithms. The default settings are recommended but altered settings may produce better results in unique use cases. Four spike sorting methods are available: Manual PCA, k-means PCA, DBSCAN PCA, and Histogram Peak Count. Each method is described below.

Manual PCA

Manual PCA uses principle component analysis to generate a feature point for each spike event. The user manually defines unit classifications by drawing an ellipsoid around each cluster of feature points within the feature space.

Wave Basis Size: The number of waveforms to use to calculate the PCA basis vectors.

Update Basis Multiplier: The PCA basis vectors will be recalculated after the number of samples exceeds the basis size times the basis multiplier. Zero means don't recalculate.

k-means PCA

k-means PCA algorithms automatically generate ellipsoids around k number of clusters to sort recorded units.

Wave Basis Size: The number of waveforms to use to calculate the PCA basis vectors.

Update Basis Multiplier: The PCA basis vectors will be recalculated after the number of samples exceeds the basis size times the basis multiplier. Zero means don't recalculate.

Outlier Removal: Removes outliers exceeding this number of standard deviations from the centroid of each group.

Minimum Group Size: Remove any groups that have fewer than this number of spikes.

Merge Centroids: Merge two groups if the merged group has a standard deviation less than this multiplier times the product of the standard deviations of both groups.

Number k-means groups: Number of k-means groups to use for sorting.

DBSCAN PCA

Density Based Spatial Clustering of Applications with Noise is a principle component analysis method that automatically chooses the quantity, radius, and position of each cluster based on point density.

Wave Basis Size: The number of waveforms to use to calculate the PCA basis vectors.

Update Basis Multiplier: The PCA basis vectors will be recalculated after the number of samples exceeds the basis size times the basis multiplier. Zero means don't recalculate.

Histogram Peak Count

Collected waveforms are broken down into high frequency and low frequency components. Each spike event is plotted on an axis composed of these two components. A histogram is constructed and clusters are estimated by determining peaks and valleys.

Valley Percentage: A valley is identified at a height less than the first peak height times the valley percentage value.

Close Peak Percentage: The second peak is identified at the height of the valley plus the height of the three-point mean centered at the valley multiplied by the close peak percentage.

Freeze Time (minutes): Time spent analyzing the number of units on each channel.

Update Rate (# spikes): The number of spikes that must be collected within each unit before the histogram is updated.

Minimum Peak Percentage: Minimum peak height is calculated by adding the valley height to the total number of samples used times the minimum peak percentage.

Artifact Rejection

Maximum Simultaneous Channels: If more than the maximum number of channels contain simultaneous spike events, the events are all rejected.

Refractory Period: The number of samples for which spike detection is barred after a spike event.

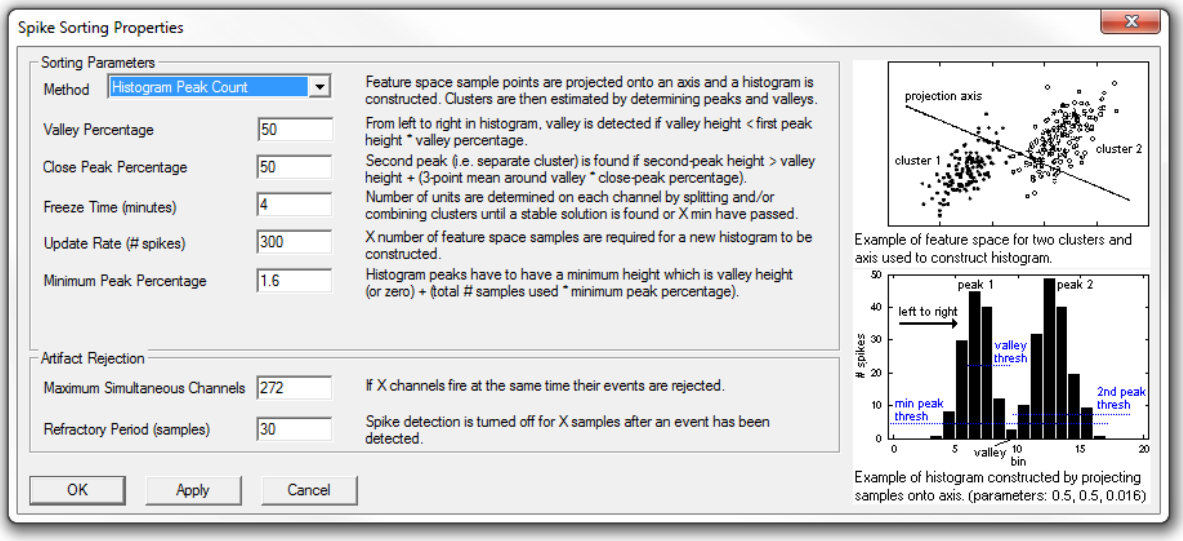


Figure 18 – Spike Sorting Properties

Tools Menu

The main Central Window Tools menu contains several Spike Sorting options.

Thresholding: Set the manual threshold level for all channels as an RMS multiplier or a fixed voltage value.

Options: See below.

Lock Unit Statistics: Disables continuous updates of spike sorting rules.

Rebuild Spike-sorting Model: Restarts the automatic spike-sorting function.

Continuous Spike Sorting: Selecting this item will continuously adjust the spike-sorting statistics including the splitting and merging of units. This is not recommended for use while recording.

Build PCA: Builds the PCA basis vectors for all channels with PCA based spike sorting.

Assisted Spike Sorting: Enable k-means, DBSCAN, or all PCA methods for spike sorting.

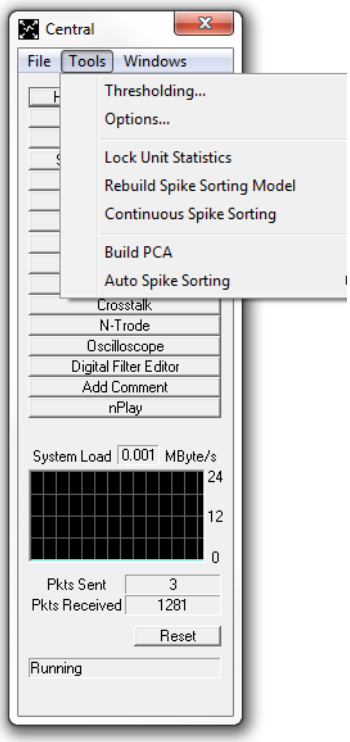


Figure 19 – Tools Menu

Adaptive Filtering

Recorded signals may contain unwanted information from sources of external noise, such as magnetic eye-tracking systems, monitors, and subject reward systems. The Adaptive Filtering feature can use a noise signal as a reference for neural signal channels.

Adaptive Filtering: Choose one or two channels to reference.

Reference Channels: Select channels to be used as references.

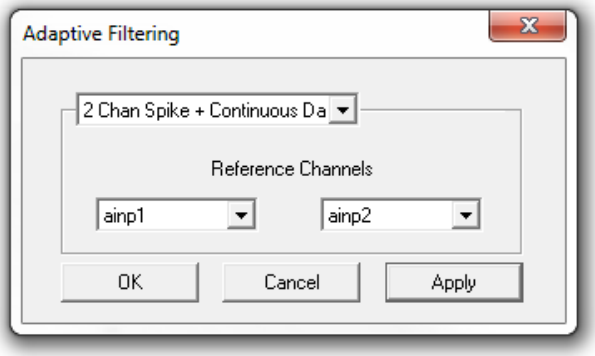


Figure 20 – Adaptive Filtering

N-Trode Groups

N-Trode channel groupings are user defined electrode subsets created to record signals from proximal regions. When any single unit spike is detected within the N-Trode, the signals from all component electrodes are saved and registered as events. The Central Suite supports multiple N-Trode sets containing up to four electrodes each. Multiple single channels are linked and spike sorting occurs on the N-Trode as a single entity. To define N-Trode groups, open a group and add channels to it with the arrow buttons or by double clicking.

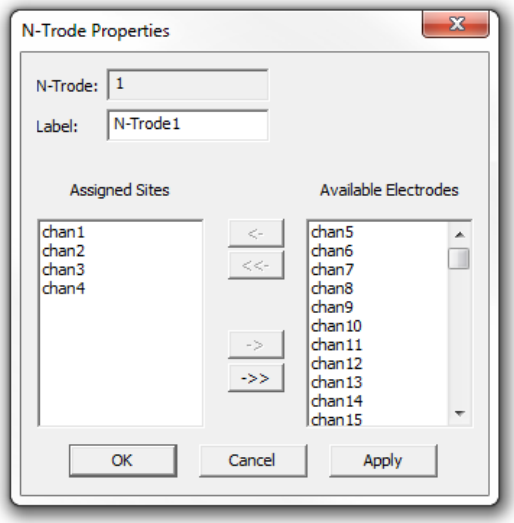


Figure 21 – N-Trode Properties

Spike Panel

Spike panel displays detected spikes on the front-end amplifier channels in a grid-graph form and is often the fastest way to visualize overall system function. Double click any channel to display the Single Neural Channel window. The layout and graphical settings of the grid and individual channels can be changed in the right-click menu or the toolbar. A map file can be applied to the display to change the spatial arrangement of the channels on the screen to match the electrode array in use. If spike-sorting rules are defined, the spikes belonging to different units will be displayed in different colors.

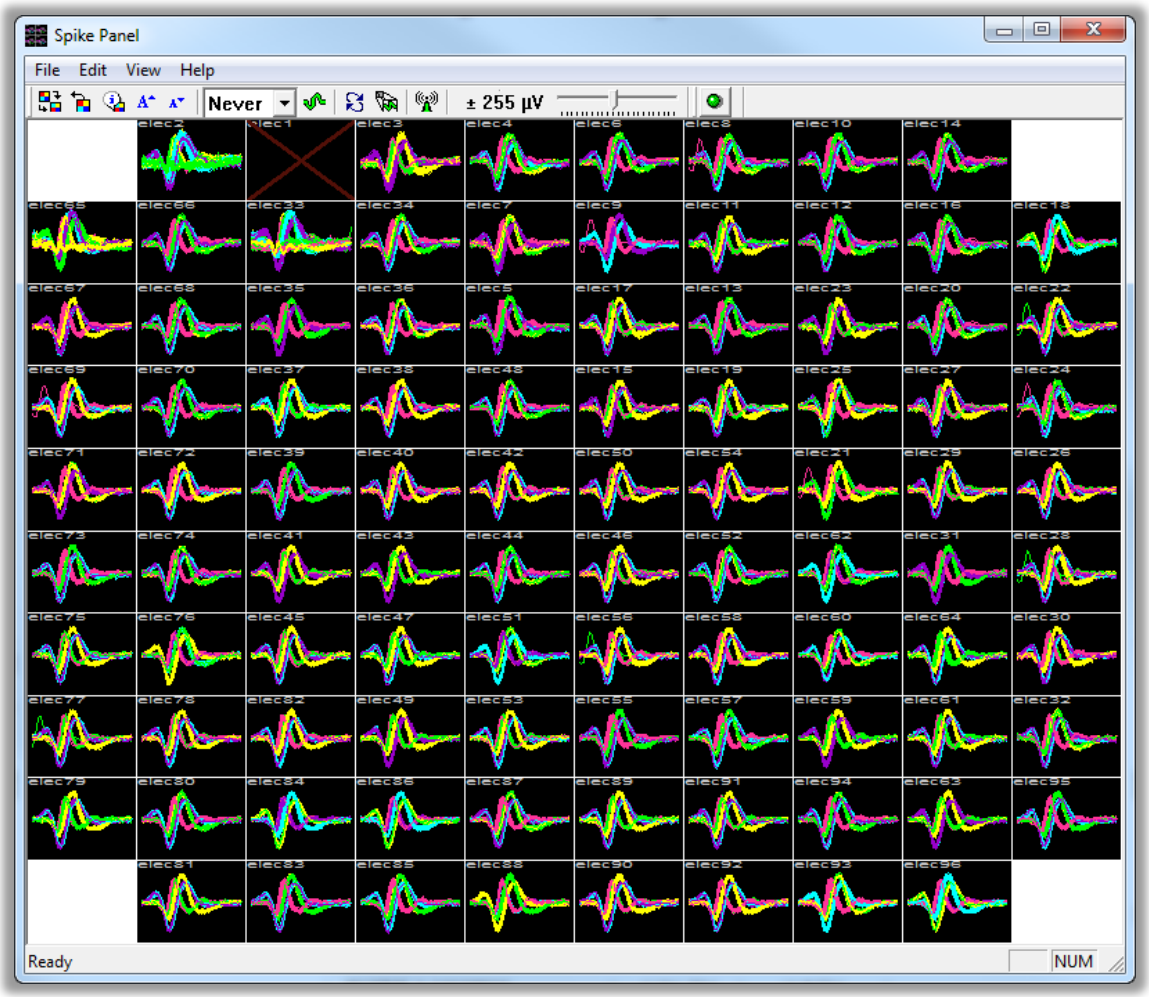


Figure 22 – Spike Panel

Spike Panel Settings

Load Map File: The default map file for the spike panel is a 16x8 grid. Custom map files matching the spatial arrangement of your electrode ship with each Blackrock Electrode Array. Contact Blackrock Support at support@blackrockmicro.com for an additional copy of this file.

Load Default Map File: The default channel map will be loaded.

Map File Information: Display information about the current map file.

2 sec **Time to Screen Refresh**: Set the length of time spike waveforms will trace without refreshing.

Open Selected Channels: Individual or groups of channels can be viewed by selecting Open Selected Channels in the right-click menu or the top menu bar.

Show Labels: Display channel information on the cursor.

Refresh Screen: Manually refresh the spike panel display.

Magnify Current Channel: Toggle mouse-hover magnification

± 255 µV **Spike Scale**: Adjust the visual amplitude of displayed spikes.

Broadcast Channel Selections: Duplicate channel selection on other instances of Central running on computers connected to an Ethernet switch.

Level of Criticality: Display the current application load.

Raster Plot

The Raster Plot displays the occurrence of spike events on many channels over time. All input channel types may be added, removed, moved, and scaled in this window. Continuous traces and comments can also be shown on the plot.

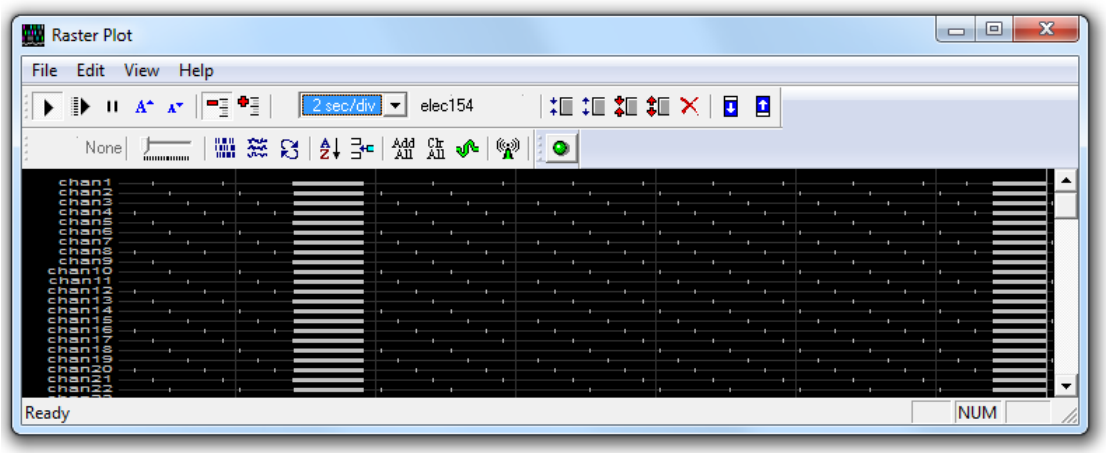


Figure 23 – Raster Plot

Tool Bar

Play: Configure the display to fill and then refill repeatedly.

Scroll: Configure the display to scroll right to left.

Pause: Pause the display.

Increase/Decrease Font Size: Change the font size of channel labels.

One Line per Channel: Display all units from each channel on one line.

Split Channels: Display each unit on a separate line.

2 sec/div Seconds per Division: Change the time scale markers on the plot.

Decrease/Increase Size: Change the size of selected channels.

Minimize/Maximize Size: Minimize or maximize the size of selected channels.

Delete: Remove selected channel from the plot.

Move Up/Down: Move selected channels through the channel list.

± 511 uV Continuous Data Scale: Set the amplitude of continuous signals.

Show Neural Events: Display neural events as impulses on the raster plot.

Show Continuous Data: Display continuous channel trace.

RAW Raw Toggle: Toggle between filtered continuous and raw data.

Update: Refresh the display.

Sort: Sort channels in the raster plot display by Channel ID, Recording Mode, or Unit ID.

Choose Channels: Select channels to display.

Add All Add All: Display all channels.

Clr All Clear All: Remove all channels from display.

Open Selected Channels: Open selected channels in Single Neural Channel.

Broadcast Channel Selections: Duplicate channel selection on other instances of Central running on computers connected to the Ethernet switch.

Level of Criticality: Display the current application load.

Single Neural Channel

Single Neural Channel visualizes the selected channel in a continuous data trace, strip chart, and waves panel. Spike sorting is configured in this window.

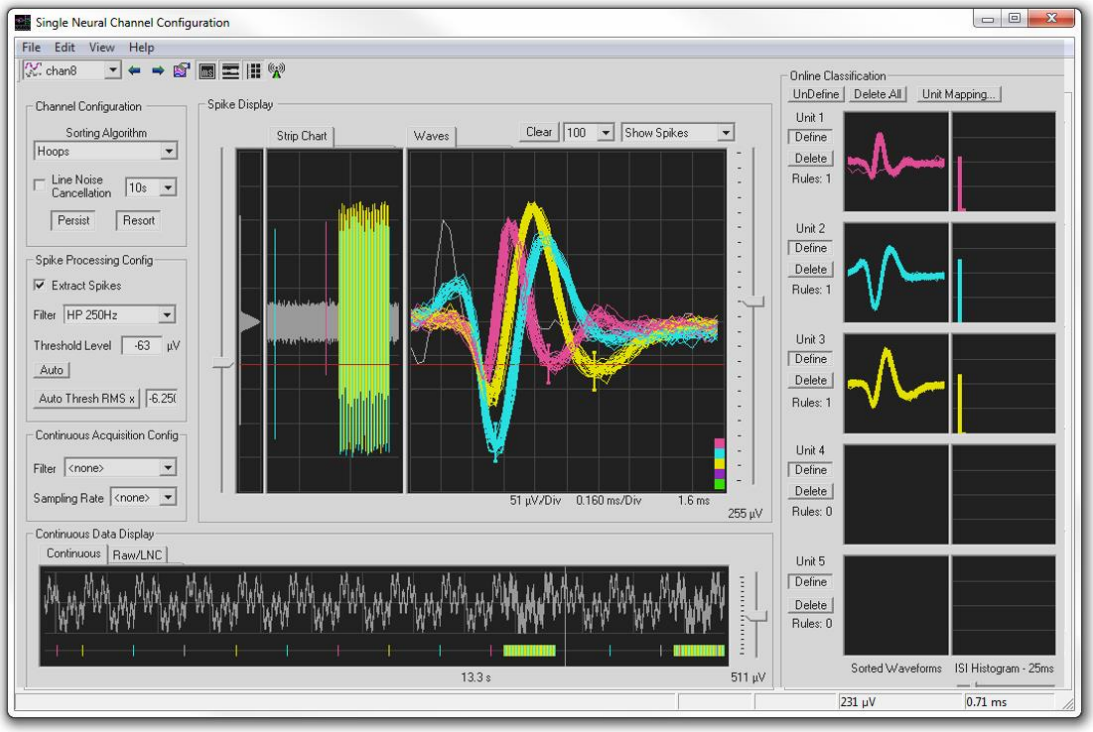


Figure 24 – Single Neural Channel

Channel Configuration

chan3 Channel ID: Select a channel from the drop-down menu.

Channel Selector: Scroll through channels.

Channel Properties: Open the Channel Properties window.

P Persist Spikes: When selected, the last detected spikes will remain in the wave viewer for sorting.

View Tool Tip: Display time and amplitude values at the cursor position.

View Continuous: Toggle the Continuous Data Display.

View Classification: Toggle the Online Classification Display.

Broadcast Channel Selections: Duplicates channel selection on other instances of Central running on computers connected to the Ethernet switch.

Spike Display

The spike display panel shows neural events. It contains the wave panel where spikes can be visualized and sorting hoops can be defined, as well as the strip chart. Use the vertical slide button at the right of the panel to set the voltage range. The default time scale of the spike display window is 1.6 milliseconds. The samples width of each spike can be defined in the Global Settings section in the Hardware Configuration module within a range of 1.0 to 4.3 milliseconds.

Clear: Clear the spike display. Automatic clearing will occur as well, maintaining the number of spikes shown in the drop-down menu.

Show Spikes: Select which spike units to display.

Hoops Spike Sorting: To define a spike unit, click Define next to a unit window box on the right side of the window. A color box will appear in the lower right of the spike window. Drag the selector to include all contacted waveforms in the unit. Only waveforms within a selection will be classified. The Define All button will initialize all five units.

Unit Mapping: Select unit definitions to remap, combine, or map to noise.

3D PCA On-line Spike Classification: If manual PCA is selected, spike sorting is performed using online PCA analysis within the PCA space. PCA spike sorting can classify up to five different signals per channel, each selected signal receives a separate color. An ISI Histogram is also displayed for each classified spike.

A user can sort an individual channel by clicking on the Feature tab. Click the Define button next to the classified spike to sort that unit. Hold the Ctrl key and draw around the cluster. An ellipsoid will be created which is used to define a unit. You may also change the size of the ellipsoid by pressing R then moving the handle.

k-means & DBSCAN PCA: Generates ellipsoids when the k-means or DBSCAN PCA is selected in the Feature tab.

Manual Override Options

Automatic spike sorting can be overridden on an individual channel by clicking on the Pattern view. Click the Edit button next to the classified spike to resort to a manual sorting option. Press <C> to see all available controls. Hold down the <Ctrl> key and draw an ellipse in the Pattern view around the cluster that you would like to define as a spike. You may also change the diameter of the ellipse. Once the ellipse is placed around a cluster of points. The word “Overridden” will appear next to the sorted unit.

File Storage

Central Software Suite supports file storage via the TOC and 2.x interfaces. 2.x is the most common basic file interface for research. The TOC interface names files with a timestamp and patient name, as well as file splitting long recordings. Data files are saved in .nsx format. .nsx data is stored in bits with 250 nV/bit resolution. Timestamps appended to filenames by Central use Greenwich Mean Time (GMT) referencing your local computer's clock and time zone information.

TOC Interface

The TOC interface allows the user to enter patient information and select a path for the files that are created when the session is initiated. The Central Software Suite assigns a numeric name to the files which indicates the date and time of the recording. For example, 20110124-152145 indicates that the data file was recorded on January 24, 2011 at 3:21:45 PM GMT. System settings will be saved in the same folder as the data file.

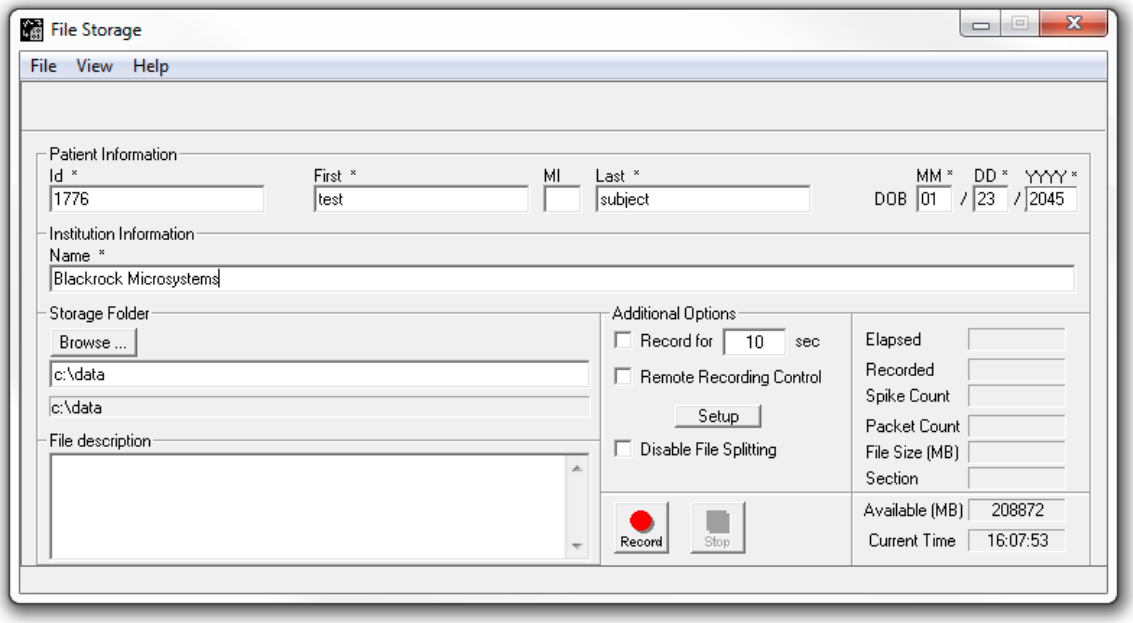


Figure 25 – TOC Interface

File Splitting: Splitting large files into smaller sizes may aid offline analysis. File size limit is defined in the *View* > *Options* menu. To disable file splitting, check the disable file-splitting box in the file storage module.

File Description: Up to 256-character comments can be entered here to be saved with the file. Comments need to be entered prior to recording a data file.

Record For: Specify an amount of time that the Central Software Suite will record data. Once the time has expired, the recording will stop automatically.

Remote Recording Control: Allows digital in signals to Start, Stop, Pause, and Resume file recording through the digital input port, or the serial I/O port. Click the Setup button below the remote recording check box to set user-defined hex values for each remote recording function. For an example of remote recording control see Page 50.

Record: Begin recording data.

Pause: Pause recording.

Stop: Stop recording and save file.

2.x Interface

The 2.x interface allows the user to specify a file name and path for the next data set. Recording can be started and stopped from this window or set to stop after a specified duration.

File Options: Select sampling frequency of recorded data.

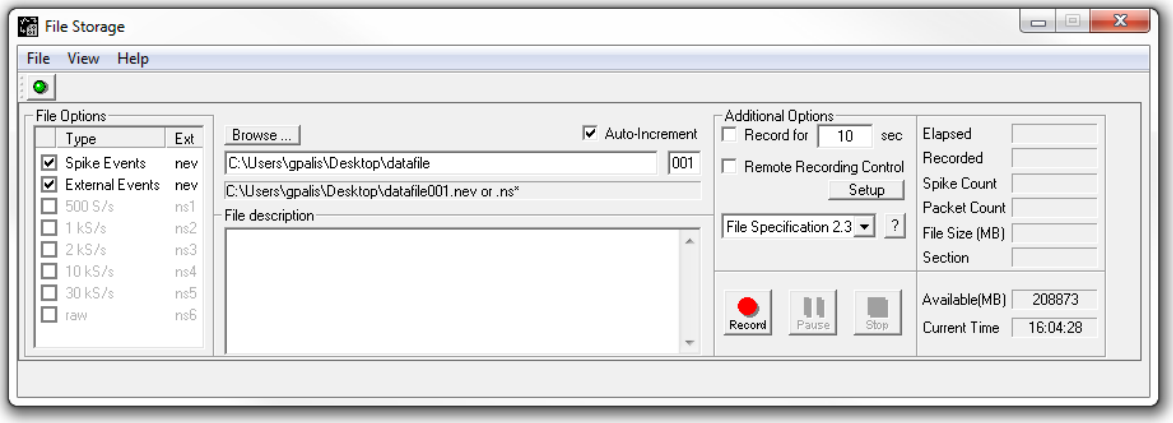


Figure 26 – 2.x Interface

File Name and Path: Browse to, or type in, the desired file name and path.

Auto-Increment: Enable automatically incrementing the data file names with an appended numeral.

File Specification: Choose between the different file specifications. It is advised to always use the most current specification.

File Storage Options

After opening the File Storage Window, options can be found under View menu.

Enable Sync Pulse: Send a unique waveform pattern every 14 seconds and repeat patterns hourly.

Invert Sync Pulse: Invert the high and low phases of the sync pulse.

Remove Noise: Do not save waveforms classified as noise during spike sorting.

Sync with NeuroMotive Recording: Enable syncing with the NeuroMotive video recording and tracking system.

Split File Interval: Enter either a duration or file size limit for each file segment. If file size is specified, click on “Calculate Time” to automatically populate the “Estimated Time” field.

Digital Oscilloscope

The digital oscilloscope can display and measure two input channels on screen at a resolution of 0.1 milliseconds per division. Signals can be viewed continuously or on a specified trigger. Frequency spectra can also be displayed.

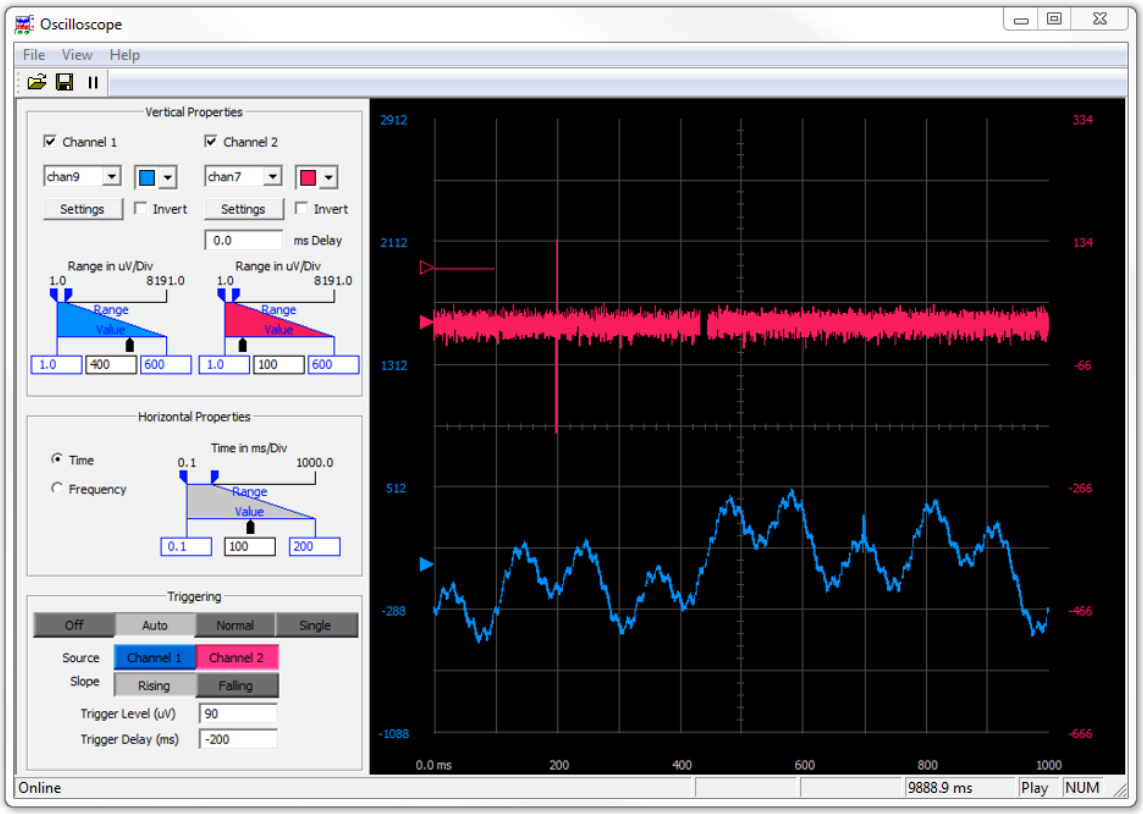


Figure 27 – Digital Oscillloscope View

Channel Enable: Two channels may be viewed per instance of the oscilloscope.

Channel Selection: Select any channel from the drop-down menu.

Color Selection: Select a color for either trace.

Settings: Open the properties window for the selected channel.

Invert: Invert the trace for a given channel.

Trace Amplitude: Modifying the sliders for each channel will change the signal amplitude. The top slider changes the range and the lower slider selects a value within the given range.

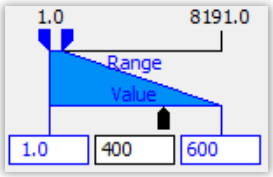


Figure 28 – Trace Amplitude

Time/Frequency selection: Set the oscilloscope into time or frequency mode.

Time Resolution: Modifying the sliders will change the time resolution of the trace. The upper sliders change the range of resolution and the lower slider is used to choose a value within the given range.

If no continuous trace is visible on the oscilloscope, confirm that the channel of interest is being sampled from in the Analog Input Properties window. If no trace appears despite sampling from the channel there may be a compatibility issue with your graphics adapter. Please contact Blackrock at support@blackrockmicro.com.

Trigger Type

Different triggers can be used to position and display waveforms on the oscilloscope.

Auto: Continuous signal will be displayed until the trace crosses the user defined trigger level. When the trigger level is crossed, the trace will pause for two seconds, then resume until another triggering event occurs.

Normal: The trace will freeze as soon as the trace crosses threshold until the trace crosses the trigger level again in which case the screen will update with the new trace.

Single: A single trace is captured as soon as it crosses the trigger level. To capture another threshold-crossed trace click on Single again.

Trigger Level: Trigger level can be entered in the field or by manually sliding the trigger line on the display.

Assign a trigger delay: Adjust the trigger position on the time axis. At 0 delay, the trigger will be placed at the left edge of the screen and may not be visible. Set a negative value to push the trigger point to the right.

Digital Filter Editor

The Digital Filter Editor can generate custom filters to be used in Central Suite. It requires the Matlab Compiler Runtime to be installed. Contact support@blackrockmicro.com for a copy of this software.

Filter type and corner frequencies are defined in the Editing Tools section on the left side of the window. The stability of the filter is shown in the Filter Status section below. The Bode Plot and the Nyquist Plot of the designed filter are displayed. Once the filter parameters are set, click on Save to save the digital filter.

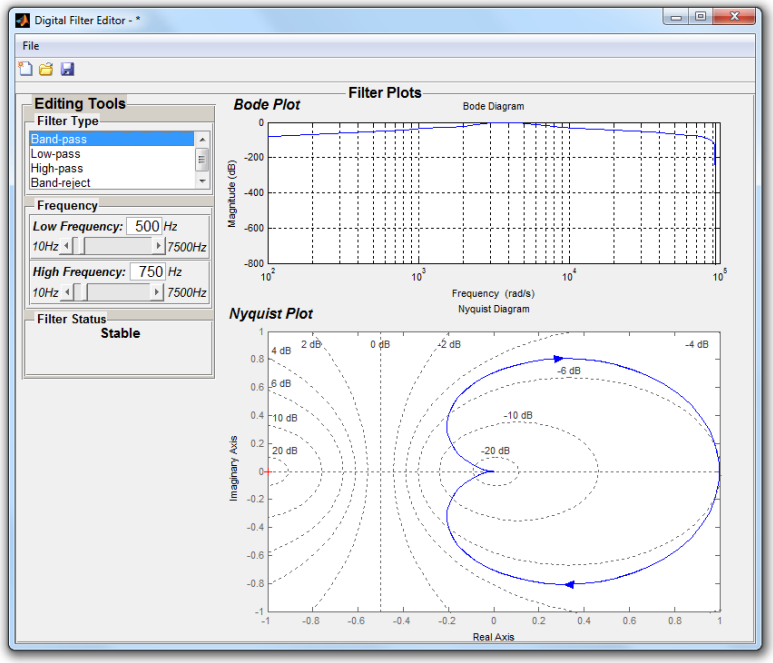


Figure 29 – Digital Filter Editor

Activity Map

The activity map color codes the firing rate of neurons on a two-dimensional map. An electrode map file assigns each channel to a location. The spiking activity of each channel is binned and smoothed over a fixed time window of 20 milliseconds. Smoothing adds steps between events and non-events both between channels and over time.

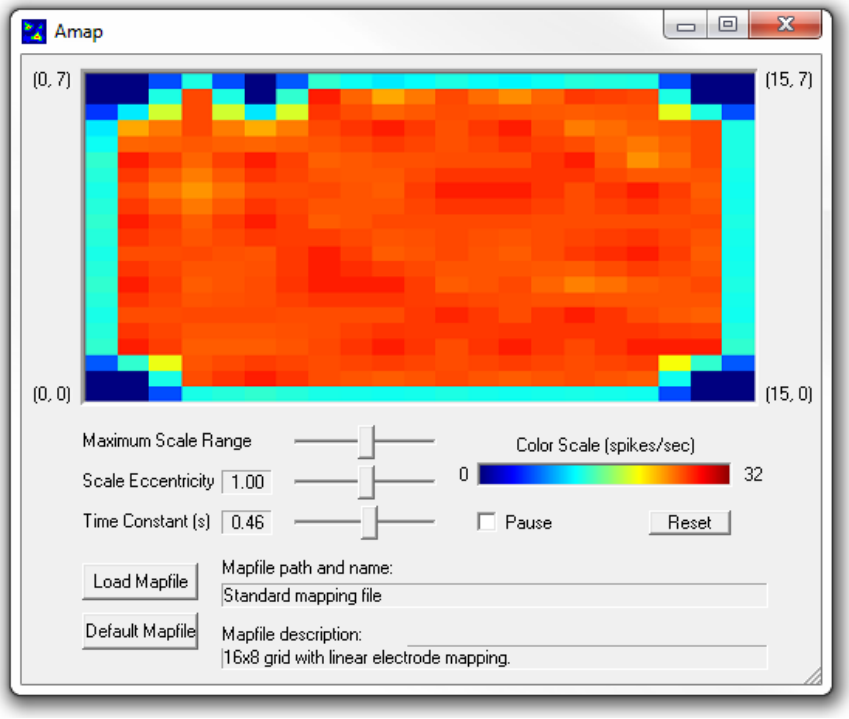


Figure 30 – Activity Map

Maximum Scale Range: Set the maximum value of the color scale in spikes per second.

Scale Eccentricity: Skews the mapping of spike rate to color towards high or low values.

Time Constant: Set the time constant controlling activity decay.

Pause: Pause the display until unchecked.

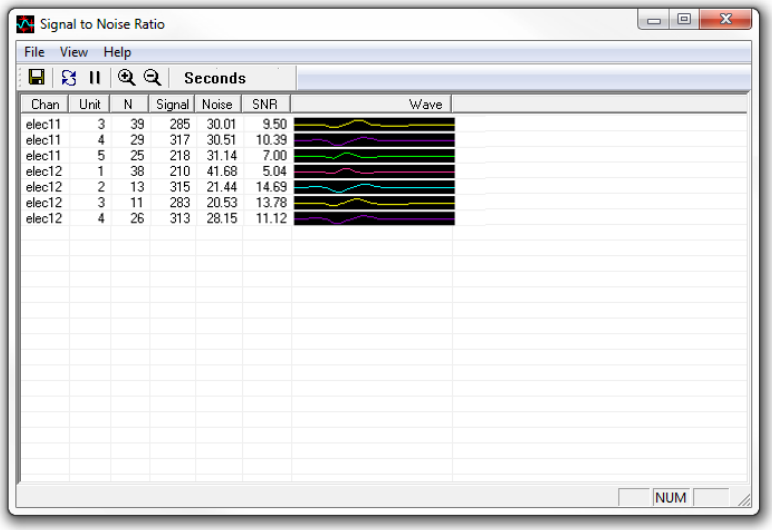
Reset: Clear current activity data and refresh visualization.

Load Map File: Load a map file to change the orientation of the display.

Default Map File: Return to the default 16x8 grid map file.

Signal-to-Noise Ratio

Signal-to-Noise Ratio (SNR) displays the running amplitudes of the signal, noise, and signal-to-noise ratio for units on each channel. It also displays the signal-to-noise ratio as a function of time, which allows changes in signal quality to be monitored. This information can be saved as a tab-delimited text file and opened in Excel or a compatible program for further analysis. In the example below the SNR for elec11 unit 3 is 9.50 meaning that the signal is 9.5 times bigger than the noise.



Chan	Unit	N	Signal	Noise	SNR	Wave
elec11	3	39	285	30.01	9.50	
elec11	4	29	317	30.51	10.39	
elec11	5	25	218	31.14	7.00	
elec12	1	38	210	41.68	5.04	
elec12	2	13	315	21.44	14.69	
elec12	3	11	283	20.53	13.78	
elec12	4	26	313	28.15	11.12	

Figure 31 – Signal to Noise Ratio

Neural Modulation

Neural Modulation displays a histogram of changes in firing frequency over time. The Modulation Index is the variance of the histogram entries and covers a range of 0 to 12.0. A range of 2 to 5 is considered normal when recording neural signals.

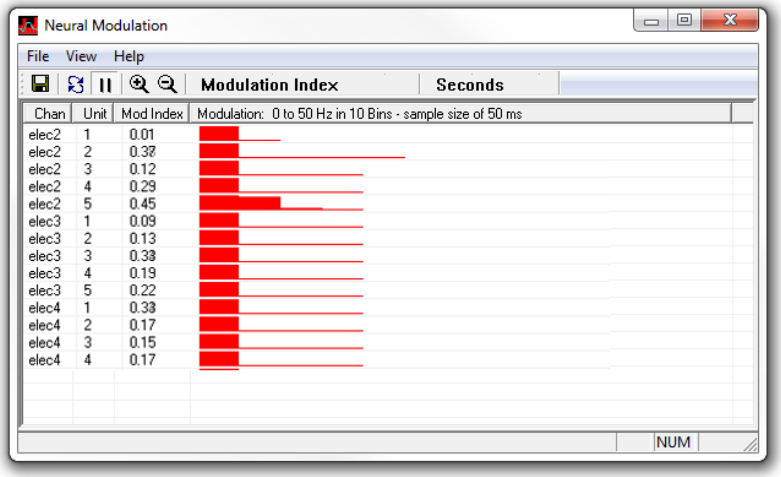


Figure 32 – Neural Modulation

Impedance Tester

Impedance Tester measures and reports electrode impedance on each channel. To function properly the impedance mode must be selected in Central, click *Tools* > *Options* > *Auto Impedance* Interface. Either mode begins by asking for array information, including the serial number, implantation date, type of sterilization and comments.

Special equipment may be required for impedance measurements. Contact Blackrock Microsystems sales at sales@blackrockmicro.com for more information.

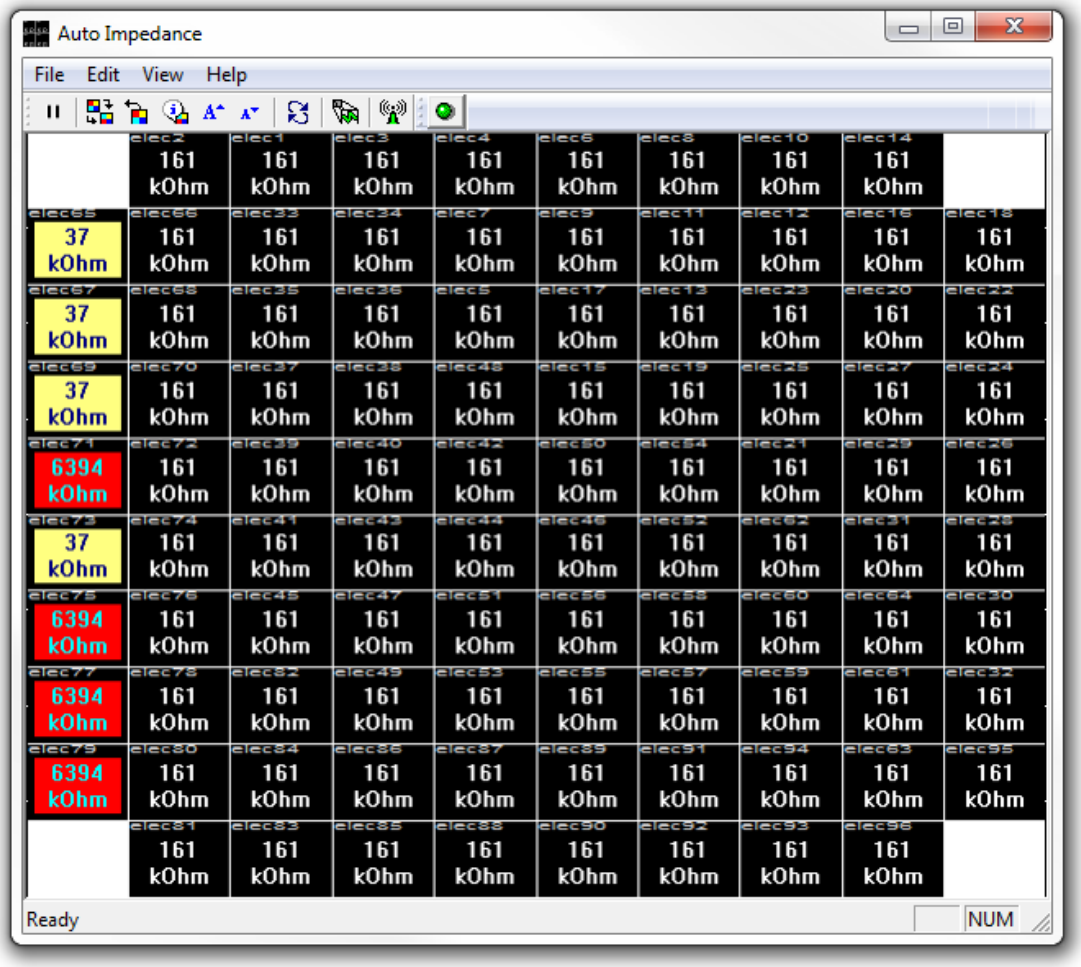


Figure 33 – Auto Impedance

Crosstalk

The Crosstalk Diagnostic window compares each channel to identify cross correlation. The Crosstalk Diagnostic feature will display each channel as green, yellow, or red, indicating the amount of unique signal on each electrode.

Green: No cross correlation to any other channel was found.

Yellow: Possible cross correlation found. Examine signals closely to determine best use.

Red: High levels of cross correlation found. Consider removing these channels from recordings.

Figure 34 – Crosstalk

N-Trode

Multiple single channels can be linked into N-Trode channel groupings. These are user defined electrode subsets created to record signals from proximal regions when any single unit spike is detected within the N-Trode. N-Trodes allow for neural events detected on one channel within an N-Trode to force the creation of neural events on the other N-Trode channels. When an event is detected on a channel within an N-Trode, all other N-Trode channels record a neural event with the same timestamp, spike width samples, pre-threshold samples, and refractory period (see Global Settings). Central supports multiple N-Trode sets containing up to four electrodes each. Define N-Trode configurations in the Hardware Configuration window or within the N-Trode application window.

Note: Spike sorting occurs on the N-Trode as a single entity. This causes neural events on all N-Trode channels to be subject to refractory periods caused by a neural event detected on any N-Trode channel.

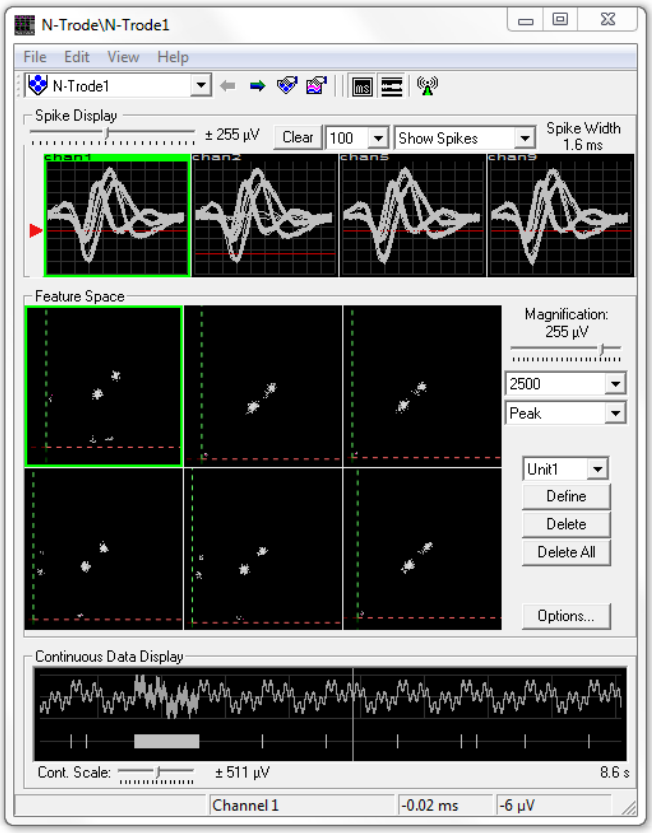
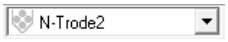


Figure 35 – N-Trode Utility



N-Trode: Use the drop-down menu to select an N-Trode group.

Scroll: Use the arrows to scroll through N-Trodes.

N-Trode Properties: Define or modify an N-Trode group.

Channel Properties: Open the Analog Input Properties window for all channels in the selected N-Trode group.

View Tool Tip: Display time and amplitude values at the cursor position.

Hide Continuous: Toggle the Continuous Data Display on the bottom of the window.

Broadcast Channel Selections: Duplicates channel selection on other instances of Central running on computers connected to the ethernet switch.

Options…: See a list of keyboard and mouse commands to manipulate the N-Trode GUI.

Spike Display

Spike Threshold: Adjust the voltage threshold for spike detection on all channels.

Clear: Clear the spike display. Automatic clearing will occur to maintain the number of spikes shown in the drop-down menu.

Show Spikes: Select which spike units to display.

Add Comment

The Add Comment feature allows the user to add a timestamped text comment to the Neural Event file. Comments can be visualized in the Raster Plot view. When in the Raster Plot window or the Central Main Window, a comment time stamp is initiated by typing and completed when the <Enter> key is pressed.

nPlay Server

nPlay Server loads and replays recorded neural data in '.nsx' or '.nev' formats for viewing and analysis in Central. When playing back the continuous data files, the user can filter, sort spikes, and down sample. A Neural Signal Processor does not need to be connected to the PC to use this utility.

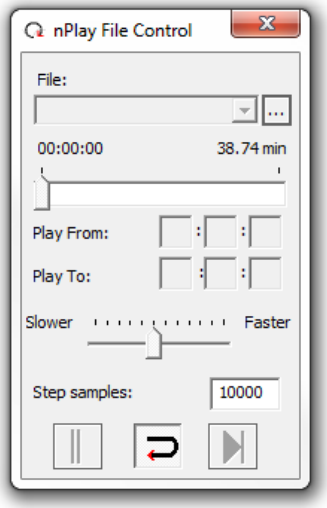


Figure 36 – nPlay Server

How To

Setup Channels for Data Acquisition

Central Suite can be configured to work with many distinct combinations of electrodes, subject types, and signals of interest. Central Suite can record three data types concurrently: Unfiltered continuous signal sampled at 30 kHz, filtered continuous signal at a lower sampling rate, and timestamped sorted spike waveforms. Typical channel setup is outlined below.

1. Open Central.
2. Click on Hardware Configuration.
3. Select a channel to configure from the nested Signal Types, or NSP menus on the left. You can select multiple channels by holding down <control> or select a range of channels by holding down the <Shift> key while making the selection.
4. Right click the selected channel(s) and choose Properties. Alternatively, you can click on the Properties icon on the toolbar.
5. We recommend enabling Raw Data to preserve all recorded data for future analysis by checking the Enable box.
6. The Continuous Acquisition section allows you to select a preset filter and sampling rate for recording and visualization. A lower sampling rate may be suitable for your studies and will reduce the file size.

Filter selection depends upon your specific study. In general, local field potentials are best measured with a low pass filter, such as LP 150. To properly extract spikes, a high pass filter, such as HP 250, needs to be applied to the channel.

If extracting spikes, check the Enable Spike Processing box and then click Spike View in the bottom of the Input Properties window. This will open the Single Neural Channel view where spike sorting rules can be configured.

Sort Spike Units

The Central software offers three automatic and manual methods for real-time spike sorting.

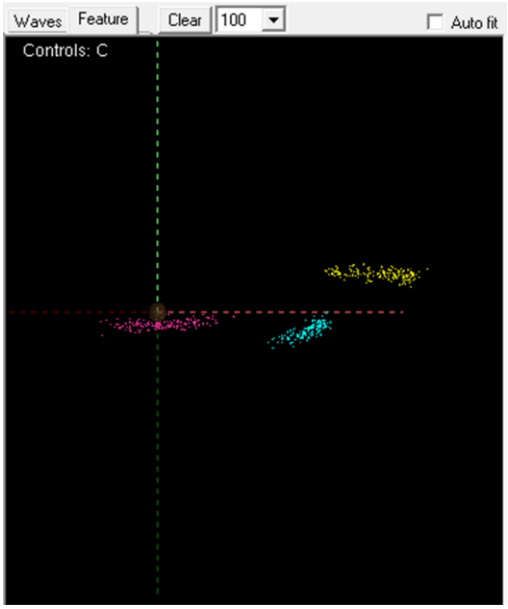


Figure 38 – PCA Space

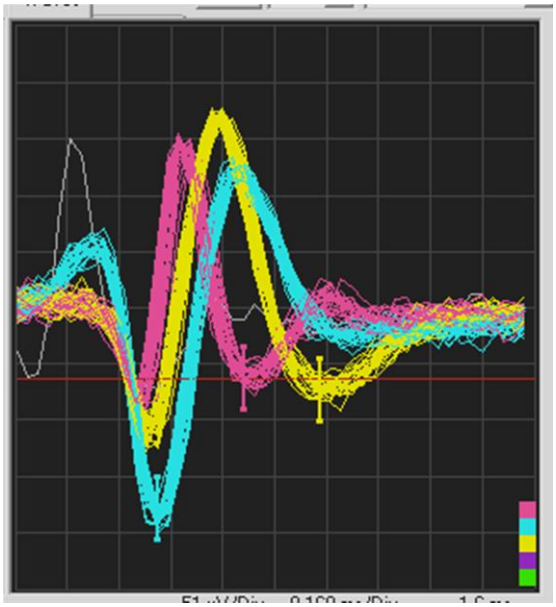


Figure 38 – Sorted Spikes

Histogram Peak Count (Automatic)

1. Open the Hardware Configuration window and select channels of interest.
2. Right click and choose Properties or click on the “Properties” icon.
3. Choose Histogram Peak Count from the spike-sorting drop down menu.
4. Click OK.
5. In Central, click *Tools* > *Rebuild Spike Sorting*. This step may take a few minutes and must be repeated for each experimental session. Each time the sorting is rebuilt, new classifications are calculated based on current data.

Note: To save Histogram Peak Counts sorting rules in Central, click *File* > *Save Sorting Rules….* To load Histogram Peak Counts sorting rules, click *File* > *Load Sorting Rules….*

Hoops (Manual)

1. Open the Hardware Configuration window and select channels of interest.
2. Right click and choose Properties or click on the “Properties” icon.
3. Choose “Hoops” from the spike-sorting drop down menu.
4. Open Single Neural Channel and select the desired channel.
5. Make sure the view classification icon is pressed down so you can see the units window.
6. Click on the define button for a unit. A series of colored boxes will appear on the spike panel in the lower right corner.

7. Drag each colored box out of its place and an amplitude band will appear.
8. Place the band so that it intersects spikes to be classified in this unit.
9. Four bands may be placed for each unit classification.
10. Five individual units may be defined on each channel.

Note: To save Hoops sorting rules in Central, click *File* > *Save System Settings….* To load Hoops sorting rules, click *File* > *Load System Settings….*

Manual PCA

1. Open the Hardware Configuration window and select channels of interest.
2. Right click and choose Properties or click on the “Properties” icon.
3. Choose “Manual PCA” from the spike sorting drop down menu.
4. Open Single Neural Channel and select the desired channel.
5. Make sure the unit icon is pressed down so you can see the units window.
6. Click on the Feature tab.

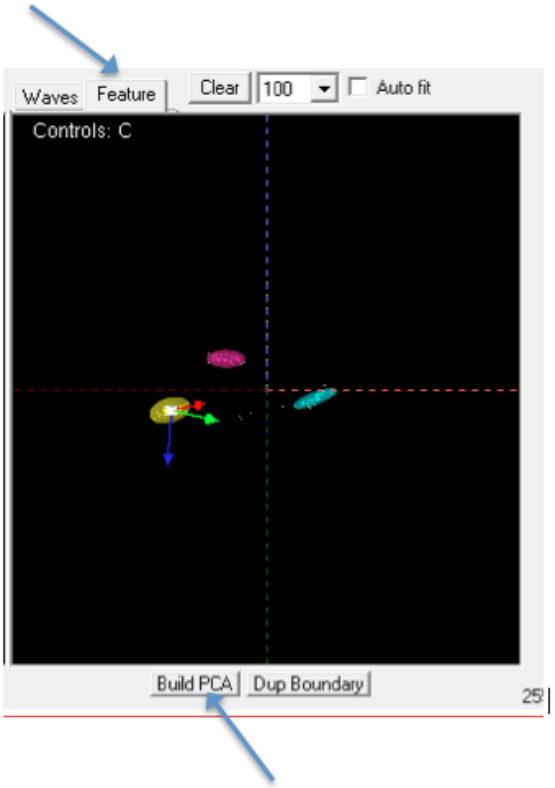


Figure 39 – PCA Space

7. Click on Build PCA. By default the program needs 250 waveforms to build the PCA basis vectors. The time required to record 250 waveforms will depend on your spike rates and may take several minutes. You can modify the number of waveforms used in *Hardware Configuration* > *Spike Sorting*.
8. Click the Define button for your first unit.

9. Hold down the <Control> key and draw a line around a given cluster. The program will automatically create an ellipsoid around the cluster. Repeat this process for all the other units and channels.

Note: To save Manual PCA sorting rules in Central, click on *File > Save System Settings….* To load Manual PCA sorting rules, click *File > Load System Settings….* To save PCA basis vectors, click *File > Save PCA Basis….* To load PCA basis vectors, click *File > Load PCA Basis….*

k-means PCA

1. Open the Hardware Configuration window and select one channels of interest. Multiple channels may be selected and sorted at once.
2. Right click and choose Properties or click on the “Properties” icon.
3. Choose “k-means PCA” from the spike sorting drop down menu.
4. From the Central Suite main window select *Tools > Auto Spike Sorting Method > All PCA Spike Sorting* to begin the sorting process on all channels previously selected.
5. Open Single Neural Channel and select the channel of interest from the drop-down menu.
6. Make sure the unit icon is pressed down so you can see the units window.
7. Click on the Feature tab.

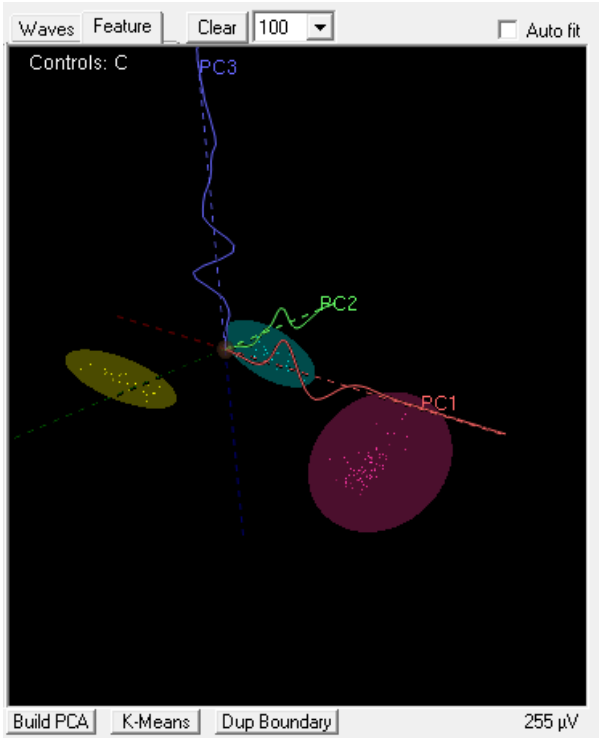


Figure 40 – PCA Basis Waveforms

8. Click on Build PCA. By default the program needs 250 waveforms to build the PCA basis vectors. The time required to record 250 waveforms will depend on your spike rates and may take several minutes. You can

modify the number of waveforms used in *Hardware Configuration* > *Spike Sorting*.

9. Wait for feature points to be generated. Clustering accuracy will improve as the number of feature points increases.
10. Click on the k-means button to define separate groups.

Note: To save k-means PCA sorting rules in Central, click *File* > *Save System Settings….* To load k-means PCA sorting rules, click *File* > *Load System Settings….* To save PCA basis vectors, click *File* > *Save PCA Basis….* To load PCA basis vectors, click *File* > *Load PCA Basis….*

DBSCAN PCA

1. Open Hardware Configuration window and select the channels of interest.
2. Right click and choose Properties or click on the “Properties” icon.
3. Choose “DBSCAN PCA” from the spike sorting drop down menu.
4. Open Single Neural Channel and select the channel of interest from the drop-down menu.
5. Make sure the unit icon is pressed down so you can see the units window.
6. Click on the Feature tab.
7. Click on Build PCA. By default the program needs 250 waveforms to build the PCA basis vectors. The time required to record 250 waveforms will depend on your spike rates and may take several minutes. You can modify the number of waveforms used in *Hardware Configuration* > *Spike Sorting*.
8. Wait for feature points to be generated. Clustering accuracy will improve as the number of feature points increases.
9. Click on the DBSCAN button.

Note: To save DBSCAN PCA sorting rules in Central, click *File* > *Save System Settings….* To load DBSCAN PCA sorting rules, click *File* > *Load System Settings….* To save PCA basis vectors, click *File* > *Save PCA Basis….* To load PCA basis vectors, click *File* > *Load PCA Basis….*

Use Adaptive Filtering

Adaptive filtering can be used to remove a known noise signal from neural data. Common noise sources include experimental monitors, subject reward systems, and equipment racks. Identify the potential external noise source and connect it to the NSP using an analog input BNC connector.

1. Plug the peripheral noise source into an analog input channel.
2. Open *Hardware Configuration* > *Adaptive Filtering*.
3. Right click the channel icon and select properties.
4. Select one or two channel operation.
5. Select the analog inputs used for the noise sources as reference channels.

Create a Digital Filter

Central Suite includes preset high pass, low pass and band pass filters. Filter parameters can be viewed in *Hardware Configuration* > *Settings* > *Filters*. The Digital Filter Editor allows you to construct custom filters.

1. Open Central.
2. Click on Digital Filter Editor. This tool requires MATLAB Compiler Run-time which is available on the Central Software Suite Installation CD and Blackrockmicro.com.
3. Choose a filter type and the corner frequencies desired. If the filter is unstable the filter design tool will warn you and suggest ways to make the filter more stable.
4. Save the filter in a known location and exit the Digital Filter Editor.
5. In Central, click on *File* > *Load Digital Filters*.
6. Select up to four custom filters in the loading dialog.
7. All newly added filters will be available in the drop-down menu under Hardware Configuration for analog inputs.

Rename Multiple Channels

Central has a built-in automatic channel naming scheme with several parameters.

Figure 41 – Label Options

1. Open Hardware Configuration.
2. Select non-contiguous channels by holding down <Control> while selecting or select a range of channels by holding down the <Shift> key and clicking the upper and lower bounds of your selection.
3. Right click and choose Properties. Alternatively, you can click on the “Properties” icon in the toolbar.
4. Click the Edit button next to Label.
5. Enter a label prefix you want across all selected channels.
6. Choose a numbering scheme to be applied to each file after the prefix:
   a. **Use current numbering**: Maintain current channel numbering.
   b. **Number channels sequentially starting at**: Increment numbering from the start value by adding one to each additional channel.
   c. **Number using channel ID**: Number with the channel ID value going from 1 to 128.
   d. **Use terminal numbering**: Number with the pin and bank value of the channel location on the front-end amplifier.

Remotely Control Data Recording

Central software can be configured to start and stop recording when triggered by a digital input coming from other hardware, such as a behavioral control system. When using the TOC file format, the recording can be remotely started, stopped, resumed, or a new session can be initiated. When using the2.x file format, the recording can be remotely started, stopped, paused, and resumed. To setup remote recording using the DB-9 serial port or DB-37 digital input port do the following:

1. Open the File Storage app, check the Remote Recording box, and click Setup.
2. Select Digital Bit Input for any of the four remotely controllable tasks.
3. On the second column choose a bit to be used for this function.
4. On the third column choose high or low for triggering.

For example, to remotely begin recording when digital bit 3 on the digital input port is set high, configure as shown below.

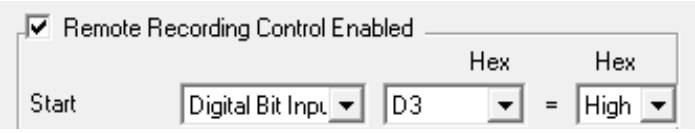


Figure 42 – Example Settings for Remote Recording

Visualize an Input Channel on the Digital Oscilloscope

The Digital Oscilloscope enables you to visualize two channels at high resolution. Setting a trigger can improve visualization of signals. To setup the oscilloscope, follow the instructions below.

1. Open Central and in the main window click the Oscilloscope.
2. Enable Trace 1 and/or Trace 2.
3. Select a channel for each trace from the drop-down menu.
4. Click on Settings to verify all channel settings. Make sure a sampling rate is selected for the given channel. If <none> is selected for sampling rate then a trace will not appear in the Oscilloscope.
5. Set the amplitude of each trace by changing the slider bar for each channel. The upper slider modifies the range of values and the lower slider selects a value within the selected range. The units are µV/division.
6. Move the trace location up or down by dragging the small triangle on the left of the trace.
7. Set the time resolution by changing the resolution slider bar. The upper slider modifies the range of values and the lower slider selects a value within the selected range. The highest resolution is 0.1 milliseconds.
8. A trigger can be set for the traces.
   a. Choose a channel source for the trigger.
   b. You can set the trigger level by entering a voltage value in the field or by sliding the trigger line up and down on the display.
   c. Assign a trigger delay. At a default of zero, the trigger will be placed at the left edge of the screen and may not be visible. Negative values move the trigger to the right.

9. Select a trigger type of Single, Normal, or Auto.
   a. **Auto**: Continuous signal will be displayed until the trace crosses the user defined trigger level. When the trigger level is crossed, the trace will pause for two seconds, then resume until another triggering event occurs.
   b. **Normal**: The trace will freeze as soon as the trace crosses threshold until the trace crosses the trigger level again in which case the screen will update.
   c. **Single**: A single trace is captured as soon as it crosses the trigger level. To capture another threshold-crossed trace click on Single again.

Configure Raster Plot

The Raster Plot can display the occurrence of spike events or continuous signals for many channels over time. The plot can be configured to match your experimental setup.

1. Begin by removing all channels from the display using the clear all button.
2. Open the choose channels display and select the channels of interest.
3. Use the move buttons to order the selected channels.
4. All channels can be split into component channels. This will display a line for each classified spike unit as well as a continuous signal trace
5. Delete any unwanted channel components.
6. Resize channels of interest. It is often helpful to increase the size of continuous data traces.
7. Adjust the 2 sec/div seconds per division of the markers on the plot.
8. Change the font size for channel labels to be easily read.

For an explanation of further Raster Plot functionality see Page 28.

Change Electrode Map (Create a Map File)

It is possible to re-arrange the electrode positions on Spike Panel and Activity Map. A plain text “map” file contains the location assignments of each channel. A sample map file is included below.

```
// 8-Channel NSP map file demo
//
// Data is as follows, 'C(olumn) r(ow) b e l'
//   c - 0 based column from left to right
//   r - 0 based row from bottom up
//   b - bank name - values can be A, B, C, or D
//   l - label used to rename channels in Central
//
// Comments begin with '//'
// First non-comment line is the Mapfile description
//
8 Channel NSP mapping
0   1   A   4 elec08
1   0   A   8 elec07
2   1   A   3 elec06
3   0   A   6 elec05
0   0   A   5 elec01
1   1   A   2 elec02
2   0   A   7 elec03
3   1   A   1 elec04
```

Figure 43 – Sample CMP File

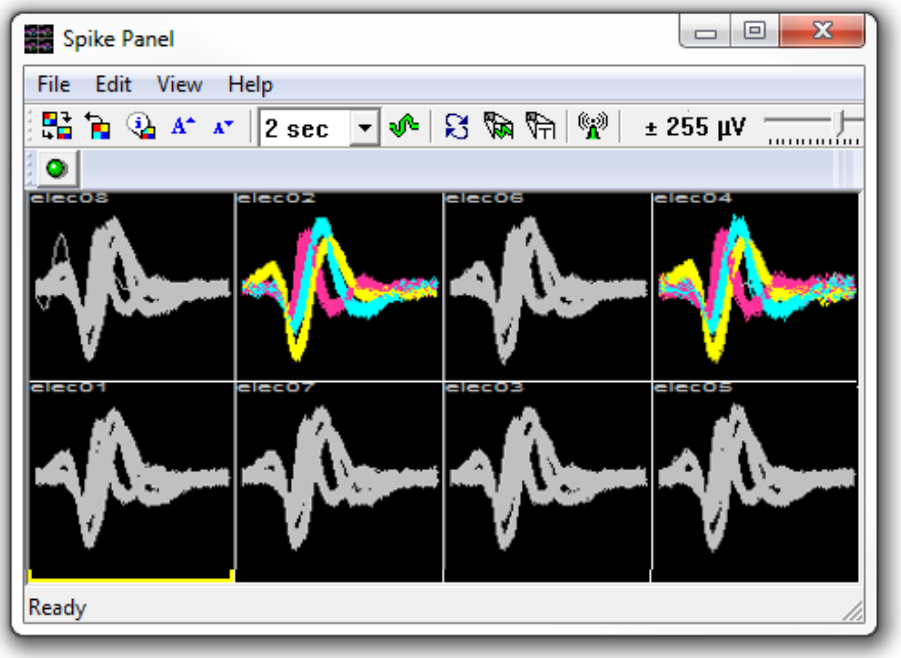


Figure 44 – Sample Spike Panel

The map file contains five columns. The first column indicates the location of the spike window on the x-axis. The second column indicates the location of the spike panel on the y-axis. Point 0,0 is on the lower left corner of the screen. The third column indicates the bank the physical channel is located on (A, B, C, or D) and the fourth column indicates the bank pin the channel is connected to. The fifth column is optional and defines the label for the channel.

In the example above, the first line indicates that the channel on bank A pin 4 is named elec08 and it's located on the 1st column from left (0) and the 2nd row from the bottom (1). The last line indicates that the channel on bank A pin 1 (channel 1) is named elec04 and it should be placed on the 4th column (3) from left and the 2nd row from bottom (1). Location positions start from 0. Any line that starts with "//" will be used as comment and will be ignored. The first line after the last // line is the name of the map file as referenced in the apps and will also be ignored.

Test Impedance with a CerePlex Headstage

1. Set headstage switch to impedance mode.
2. Click on Impedance Tester in the main window of Central. The Auto Impedance app will open. If data is being recorded, you will be prompted to stop recording or cancel the impedance test.
3. Impedance data is collected then the Auto Impedance screen is displayed. All channels are measured sequentially in less than one minute. Impedance readings are displayed for every channel with a default tolerance of 100-800 Ω. Channels out of tolerance will turn yellow (below) or red (over) to indicate out of range values.
4. Open *View* > *Options* to display the Impedance Calculation Settings.
5. Open the Edit menu or right-click one of the bad channels to display the properties menu.
6. Select Disable Bad Channels to mark out-of-tolerance channels, the disabled channels will be blank or marked with an "X" throughout Central.
7. Click *File* > *Save Values* to save impedance values.
8. Click *File* > *Exit* to quit Impedance testing.
9. Return switch to recording mode.

Record a Video using NeuroMotive

A video file can be recorded in sync with neural data recorded using NeuroMotive.

1. Connect an NSP or CerePlex Direct to the Host PC.
2. Run Central.
3. Start NeuroMotive and make sure the video camera is connected properly and selected.
4. Open File Storage in Central and prepare it for recording as desired.
5. Make sure File Specification is 2.3, TOC 2.0, or higher and the File application is synchronized with NeuroMotive. In the File application go to *View* > *Options* > *Sync* with NeuroMotive if present.
6. A NeuroMotive indicator should appear in the File application dialog.

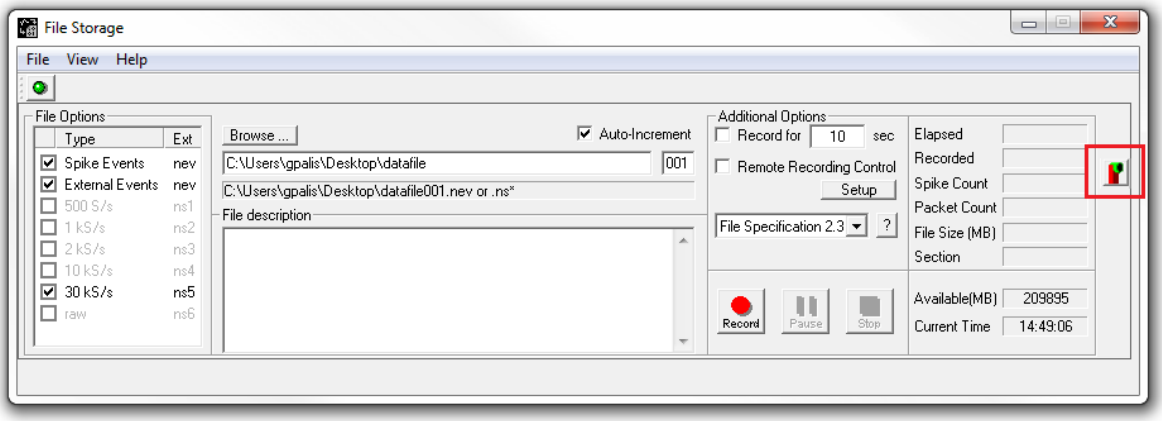


Figure 45 – File Application Connected to NeuroMotive™

7. Record continuous data for later analysis in nPlay Server.
8. Start neural recording through the Central File Storage application.
9. Video recording will start automatically in NeuroMotive. NeuroMotive will duplicate the filename specified in the Central File Storage application. If the filename chosen is already being used by another video file in the recording directory, then NeuroMotive will automatically append an incrementing counter to the filename.
10. NeuroMotive will continue recording when Central is paused.

Troubleshooting/Error Messages

Central error messages and common solutions are listed here. Once these steps are exhausted please contact Blackrock Support.

Files are currently being recorded. Do you want to stop recording and close the app?

The user has attempted to close the Central Main Window while recording is ongoing. To avoid this error, always stop recording before attempting to close the software.

Unable to allocate shared Memory

Both Central Software Suite and another utility have attempted to connect to the NSP via UDP. To remedy this, shut down any utilities, such as cbMEX, or cbSDK, that may be attempting to communicate with the NSP.

Recording is currently blocked by another utility. Please close that utility and try again.

A utility within the Central Suite is interfering with recording. Check to see if impedance mode is running. If not, restart your Host PC and try recording again.

Unable to open the Central Application!

An error has occurred within the Central Main Window startup. Restart your Host PC and reinstall Central Suite.

The basis vectors have not yet been calculated for this channel.

Please Build PCA then retry

The user has attempted to save spike sorting settings before generating sorting rules. Define spike sorting rules in the Single Channel Viewer Window before saving.

There may not be enough data points to effectively calculate the ellipsoids.

Would you like to continue?

An insufficient number of detected spikes have been recorded to create ellipsoid groupings on the PCA space. Wait until more spikes are recorded before attempting to define ellipsoids. Proceeding with fewer spike events is possible but may not produce accurate unit definitions.

CerePlex Direct is not Connected to a High Speed USB Port.

The CerePlex Direct requires a USB 2.0 port or higher to work.

The CerePlex Direct is connected to a USB 1.0 port. It is advised to connect the Direct through a high-speed USB 2.0 port.

No CerePlex Direct Detected.

This error occurs when the Central Software Suite does not recognize a connection to the Cereplex Direct. To remedy this, attempt the following steps:

1. Confirm that a CerePlex Direct is connected and powered on.
2. Try connecting the CerePlex Direct to a different USB port.
3. Restart the CerePlex Direct, and the Host PC.
4. Uninstall the Cereplex Direct software and the USB driver for the Direct.
5. Disconnect the Direct, reinstall the Cereplex Direct software and reconnect the Direct.

Unable to Open Instrument Network

OR

It appears that the instrument network has failed.

Central cannot communicate with the NSP. If this occurs, confirm that:

1. The NSP is powered on.
2. An ethernet cable connects the NSP and the Host PC.
3. If a switch is used, it is connected correctly and powered on.
4. The Ethernet port has been configured as described in the Setup section on Page 7.

Once confirmed, restart the NSP and Host PC.

Network packets have been lost between the NSP and this PC.

This is most likely caused by the system load being higher than 8 MB/s.

OR

Network packets have been lost between the PC and the instrument

These errors occur when the Central Software Suite intermittently fails to communicate with the NSP over ethernet. To remedy this, confirm that:

1. The NSP is still powered on, and is connected to the Host PC with an ethernet cable.
2. No other applications are consuming significant system resources.

If so, attempt the following:

1. Disable Windows Firewall, Defender, Restore, Sound, Automatic Update, System Notifications, and other Ethernet ports.
2. Uninstall anti-virus and any unnecessary software.

The system is initializing, please wait.

If the system doesn't respond, click the Reset NSP button below.

This error occurs when the Central Software Suite recognizes an NSP that is not initialized. When this error message occurs, confirm that the NSP screen also shows the “Initializing” message. If so, wait for up to a minute before resetting the NSP. Attempt to reset with the software button included in the error message before doing a hardware reset with the switch on the front of the NSP.

Network packets have been lost between the NSP and this PC.

This is caused by the system load being higher than 12 MB/s

This error occurs when data is possibly lost within the NSP and is not sent to the PC. To remedy this error, confirm that your NSP is running the latest firmware available in the Software Downloads section of Blackrockmicro.com.

Data Recording Restarted.

The data load to the PC is extremely high and data storage has been restarted. Please reduce the burden on your PC and restart data collection.

This error occurs periodically in very long duration recordings. To remedy this, attempt the following:

1. Disable Windows Firewall, Defender, Restore, Sound, Automatic Update, System Notifications, and other Ethernet ports.
2. Uninstall anti-virus and any unnecessary software.
3. Close any other active applications.
4. Reduce the number and rate of continuously sampled channels.
5. Consider a faster PC or hard drive, such as a solid state drive.

Support

Blackrock prides itself in its customer support. For additional information on this product or any of our products, you can contact our Support team through the contact information below:

Manuals, Software Downloads, and Application Notes
www.blackrockmicro.com/technical-support

Complaints

When filing a complaint, please provide the product description, product number, software version, lot number, complainant's name and address, and the nature of the complaint.

Issues or Questions
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Europe: +49 (0) 511 132 211 10

Notice to the user and/or patient that any serious incident that has occurred in relation to the device should be reported to the manufacturer and the competent authority of the member state in which the user and/or patient is established.