Synapse Manual

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Synapse Manual

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Notices

The latest versions of TDT documents are always online at
https://www.tdt.com/support/user-manuals.html

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Synapse: Next Generation Performance Today

Synapse is the software you'll use to design, manage and collect data from your neurophysiology experiments using System 3 hardware. With Synapse's advanced automation, underlying relational database, and sophisticated hardware interface; the power and flexibility of TDT's proven multi-DSP hardware platform is never more than a few clicks away.

Design

In the design phase of your experiment, Synapse automates all but the highest level set-up tasks. You interact with the software using a streamlined interface where the most commonly modified options are available on easy options tabs. Automated processes combine what Synapse knows about your hardware and what TDT has learned in over 25 years of working closely with researchers like you to deliver smart experiment design.

Let Synapse Remember the Details of Your Hardware for You

Synapse auto-detects your hardware and uses a hardware abstraction layer (or HAL) between the device specific processes for your equipment and your experiment building selections. When you are configuring recording, data storage, and detection tasks; you don't have to think about the particulars of your hardware system. As you design your experiment, Synapse uses information about your hardware and selections you've already made to show only the relevant choices. You select the parts of the experiment you want and Synapse generates the required code instructions, optimized for your hardware. With only a few mouse clicks, you can build custom experiments and be collecting data in minutes.

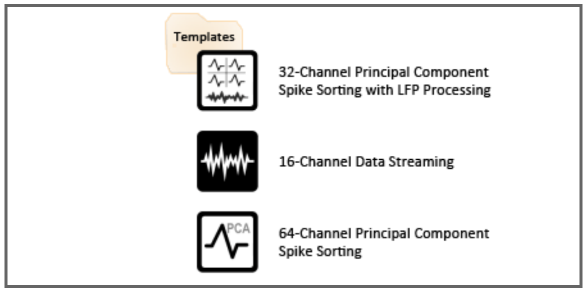
Get the Power of Customization without Complexity

Most Synapse users will be able to run out-of-box experiments and acquire data with minimal configuration changes. If you need to do more, there are progressively more detailed levels of design options available. Three powerful paths can be used or combined to support differing levels of flexibility and control.

Experiment Templates

For the fastest design experience, select a pre-made template as the starting point for your experiment. The growing list of TDT designed templates includes multi-channel recording, LFPs, spike sorting, tetrode recordings, and experiments that combine these elements. If the template matches your needs, you can use it as is.

For more customized experiments, adjust configuration settings or add gizmo task blocks to make it your own.

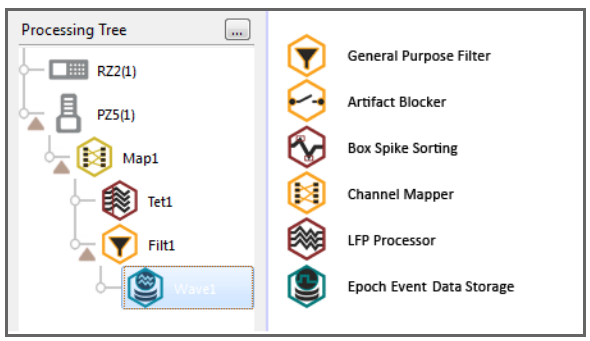


Templates

TDT Gizmos

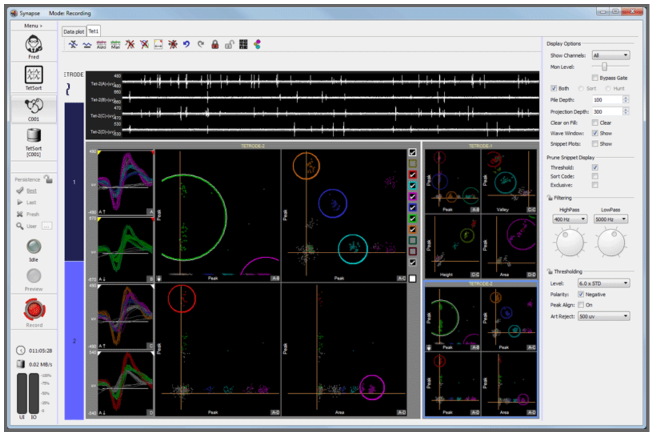
For a balance of flexibility and design speed, select and arrange ready-made building blocks called 'gizmos'. You add them in the order you want each task to occur, for example you would add a filter before a storage task. Synapse adjusts the available options as you work so that only relevant choices are available.

Gizmos are available for a variety of tasks, including reading input signals, filtering, online spike sorting, data storage, channel mapping, stimulation, and much more. Each gizmo can also comprise a group of tasks bundled together for a particular type of experiment, such as online spike sorting and data storage.



TDT Gizmos (partial list)

Many gizmos include runtime interfaces that enable you to make adjustments to your experiment as data is being collected. For example, the Tetrode Processor includes plots to display the four channels of the tetrode as streamed waveforms and as snippets in a pile plot. A specialized 2D feature plot for viewing and selecting different projections is also provided. You can draw clusters or units and apply them from the runtime interface. You can even make changes to the filter settings or threshold levels dynamically and see the changes to the data immediately.

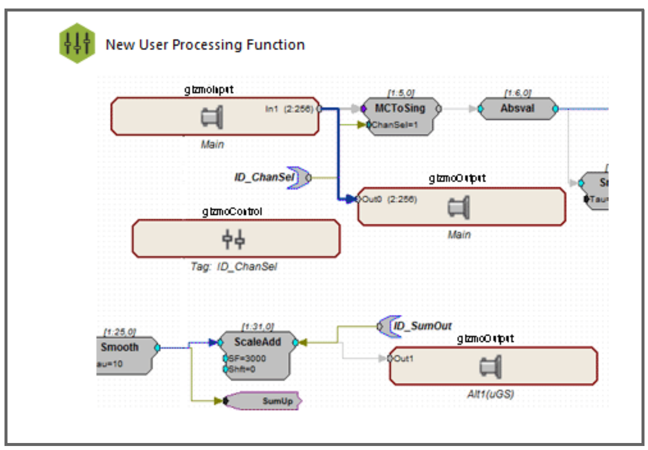


Runtime Interface

User Designed Gizmos

For maximum flexibility and control, build your own custom processing tasks. The gizmo building tools link directly into the signal flow, and include parameter tags or 'hooks' that allow you to control timing, triggering, data storage, and modification of other parameter values dynamically at runtime. For example, you can create a gizmo that runs a novel stimulus protocol, accessing signal parameters directly in the Synapse interface or through a custom application you've developed using TDT provided development tools and MATLAB® or Python™.

Designing your own gizmos may take a little more time upfront, but once a user gizmo has been created it can be reused in future experiments as easily as the built-ins.



User Designed Gizmo Creation Tools

Get More from Your System with Automation

No matter which method or combination of techniques you use to define your experiment, the Synapse compilation engine determines how to most efficiently utilize your available hardware to run it. One of the reasons System 3 processors are so powerful is that they run multiple DSPs in parallel. Each DSP is capable of running many combinations of tasks, but each task takes a different amount of processing power. Automating the distribution of the tasks that make up your experiment allows you to tap in to the full power of the multiple DSP architecture of the processors in your system from day one and without any special training. With Synapse, you let the computer do the logic based tasks it does so well; giving you more time to do what you do best—consider big ideas, get creative, and develop insightful conclusions.

Manage

Much of what makes Synapse innovative goes on behind the scenes. Like the automation tools at work as you design your experiments, the relational database is the power behind Synapse's experiment management capabilities. Synapse tags three special categories of information: users, experiments, and subjects; then tracks all runtime settings and any modification made to parameters during each experiment run.

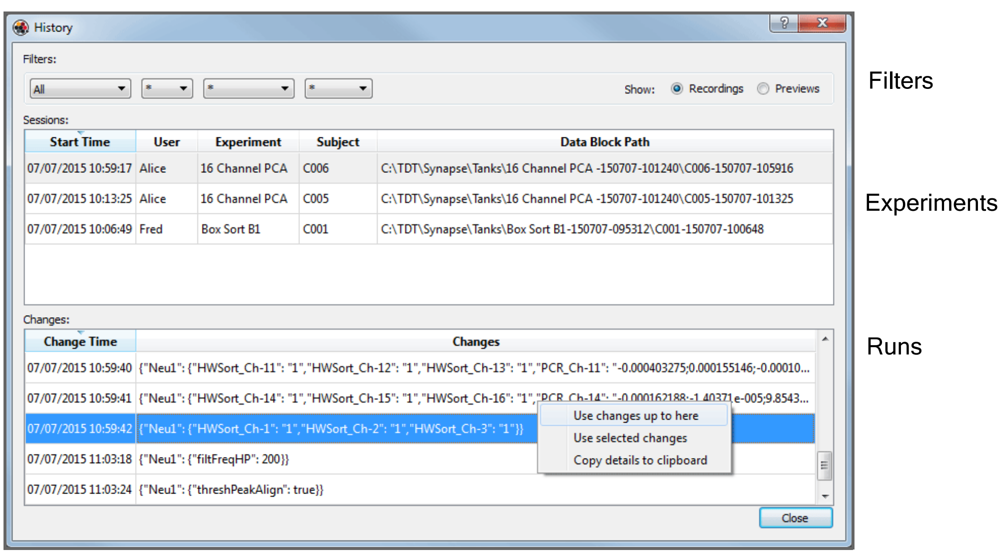
Persistence

You control how Synapse uses the stored runtime configuration data by selecting a Persistence—or way of choosing how settings carryover from user to user, subject to subject, or session to session. Tagging the visual layout and runtime parameters with subject and user information gives your lab several options for customizing the experience for each user. Different users can run a shared experiment with completely different settings. Or individual users can choose to:

- Use the most recent settings for that project or that subject.
- Start over with a fresh interface.
- Start with settings from any previous session.

The Digital Lab Notebook

You can access the complete record of all settings and changes made during each session in the History Window. The relational nature of the database where they're stored enables you to filter sessions in the window by user, experiment, or subject. When you select a session, you can see every change that was made to settings during each run. All of this data is recorded automatically and available at any time.



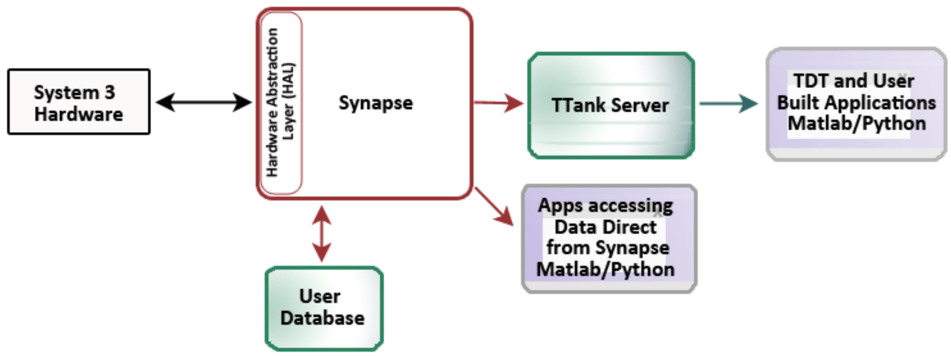
History Window

This window acts as a digital lab notebook where you can see the automatically generated log of all experiments. Select a Session row and the timestamped record of what settings were used or changed in each run (or block) during that session are displayed below. You can even choose a previous set of changes as a launching point for your next session, effectively rewinding your experiment to an earlier state.

The Session rows in the History window can also be used like an export utility, to send experiment data to other applications for visualization and analysis.

Collect

When you are ready to run your experiment, Synapse automatically generates the user interfaces for all gizmos in your configuration. The pre-made user interfaces save time and allow you to make adjustments to your experiment dynamically. OpenEx users will find many of these runtime interfaces familiar, as many got their start as SpikePac tool-sets. The interfaces have been improved and expanded for Synapse.



System Communication Flow Diagram

Synapse communicates directly with System 3 hardware for fast, precisely timed operations. With Synapse you can immediately access the data for display while the data is being stored to disk. No system that stores the data before allowing access can compare to Synapse's speed. As data is acquired it is passed to the powerful TTank data server that also got its start in OpenEx. This time-tested data server indexes and stores the data then makes the data available for post hoc visualization and analysis.

Your own custom applications written in MATLAB®, Python™, or any language that supports ActiveX, can control parameters dynamically at runtime or access the data stored in the Tank format using TDT developed tools.

Synapse not only ensures the integrity of the data you will collect, it also supports integration with existing OpenEx applications such as OpenScope, OpenSorter, and OpenExplorer and maintains compatibility with existing data sets.

Next Generation Performance Today

For current OpenEx users, the upgrade path is fast and painless. Many of the components of your current OpenEx experiment are replaced by updated TDT Gizmos. Any parts of the experiment that don't match existing built-in tasks will be easily ported into Synapse through user designed gizmos.

At TDT we take pride in leading innovation, but we know innovation doesn't mean continually scrapping what you have and starting over. When developing tools for your research, building on what we've learned and asking fresh new questions yields solid results. We take the best of today's technology and springboard forward to deliver tools you can build on. Synapse gives you the power to design, manage and collect data from your experiments using next generation technology, today.

Part One: Getting Started with Synapse

Before You Begin

Installation

Synapse can be installed from the TDT Installation CD or downloaded from the TDT website as part of the Synapse Essentials or Synapse Suite bundle.

TDT Drivers should be installed first.

Synapse Essentials includes:

- Synapse
- TDT Drivers
- TTankMin
    - TTankX
    - OpenScope
    - OpenBrowser
- OpenBridge
- Synapse API

Synapse Suite includes:

- Synapse Essentials (above)
- OpenExplorer
- OpenController
- OpenSorter

PC Requirements

The recommended operating systems for all TDT systems is Windows® 7 or 10.

PC Hardware Requirements:

- 2.0 GHz or faster processor (Intel® Core™2 Duo or AMD Phenom® II processor; 64-bit support recommended)
- 2 GB of RAM (more recommended)
- 1 GB of available hard-disk space for installation (recommended space depends on number of channels and research requirements - contact Tech Support for best options)
- 1080p HD Monitor (1920x1080 display) with OpenGL-compatible graphics card, and 64MB of VRAM (128MB or higher recommended)

- CD-ROM drive
- Full height PCIe slot

TDT Hardware Requirements

Synapse requires a System 3 Processor and Optibit PC Interface. For best performance, TDT recommends using an RZ Multi-DSP Processor.

See the "System 3 Installation Guide" for hardware installation and set-up instructions.

File Types

Synapse uses three main user file types:

.synexp	Experiment Configuration
.synrig	Hardware Rig
.rcx	Circuit Files for User Gizmos and Legacy Hardware

Synapse can also generate and track user log files associated with a specific experiment, subject, or user. Log files are simple text files that can be read using any text editor.

Data Files

Data is stored using TDT's DataTank format. DataTanks and blocks are treated as folder/file structures. Each new data tank acts as a folder that contains multiple block folders. The files associated with each block are stored within each block folder. They include .tbk, .tsq, .tev, .tdx, and .tin (Synapse experiment information for the block).

Blocks accessed by OpenScope may contain .tnt files, which are used for annotating data.

Tanks and blocks can be browsed and managed just as you would with other Windows-based folders and files. Individual blocks can be deleted or transferred between tanks using standard Windows methods. However, the underlying file structure for each block should always be maintained. If a block must be moved, move the block folder. Never move or delete an individual file. Blocks and files are named with a consistent naming structure to help keep blocks intact.

Organization of the Manual

This manual will help you get started using Synapse software and serve as a long-term source of reference information.

Getting Started with Synapse

This section provides a high level walk through of building and running a basic experiment along with an introduction to many important Synapse concepts and techniques.

Synapse Fundamentals

A reference is provided for each phase of using Synapse. Reference guides include detailed references for windows, menus, dialog boxes, and settings.

HAL and Gizmo Reference Guides

References are provided for each Synapse hardware configuration (HAL) and gizmo. Reference guides include configuration options and runtime interfaces.

Custom User Gizmos

A detailed guide to building and adding custom gizmos is also provided for customers transitioning from OpenEx.

Using the Manual

This manual uses the following icons to alert you to important content:

Tip

Technical Details

Core Concept

Video Demonstration Available

Launching Your First Experiment

The quickest way to start collecting data with Synapse is to use a template. After initial system set-up, you can use these ready-to-go experiments to collect data on day one or use them as a starting point for a more customized experiment. This section covers:

- Editing your Rig
- Creating an Experiment from a Template
- Using the Runtime Interface

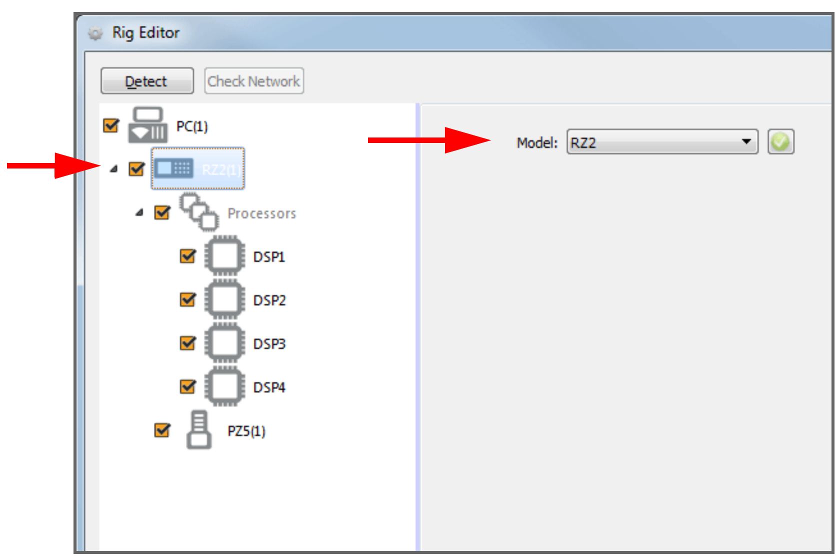
Editing the Rig

Before you can run an experiment you must allow Synapse to gather information about the System 3 hardware components in your system. TDT processors come in many configurations that have different capabilities. Once Synapse knows which devices you're using, it will keep track of the device details for you.

In Synapse, your hardware system is referred to as the 'rig' and it is remembered each time you open the software. The first time you launch the software, the Rig Editor is displayed automatically.

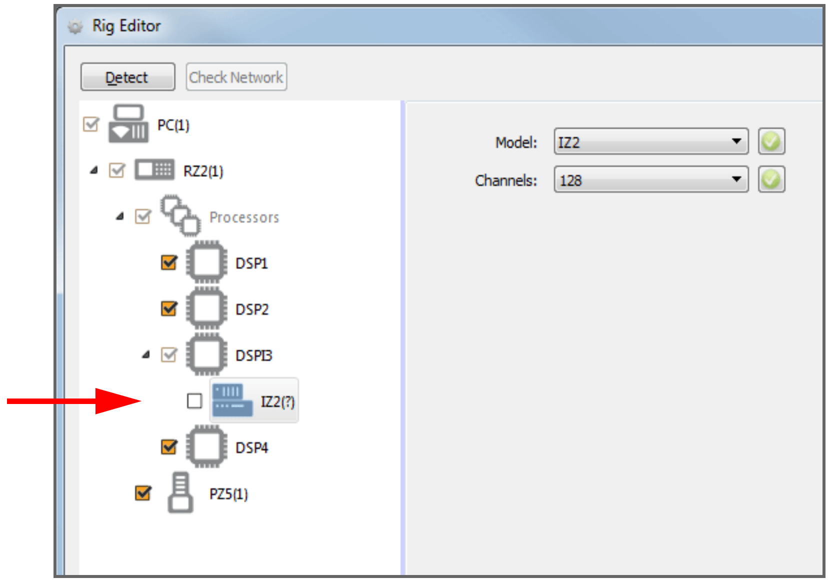
Configuring the rig starts with letting Synapse detect your system devices.

Make sure your TDT hardware is set-up, connected, and powered on before using the DETECT button to begin configuring the rig.



Rig Editor: RZ2 Selected

Detected devices in your hardware configuration are displayed in a hierarchical diagram. Configuration settings for the selected (highlighted) device are displayed in the area to the right.



Rig Editor: IZ2 Selected

Enabling Devices

There are some device and configuration information that Synapse can't automatically detect. In the illustration above, based on the equipment detected, such as the RZ2 and DSP-I, an IZ2 stimulator is likely to be a part of the attached system. Synapse added the IZ2 to the diagram, but it hasn't been enabled. You would need to click the check box to enable it.

You can also enable or disable devices to control whether they are automatically added to the Processing Tree in new experiments. Only enabled devices are added by default. Disabled devices can still be added later and enabled manually in the Processing Tree. See "Disabled Devices and the Processing Tree" on page 44 for more information.

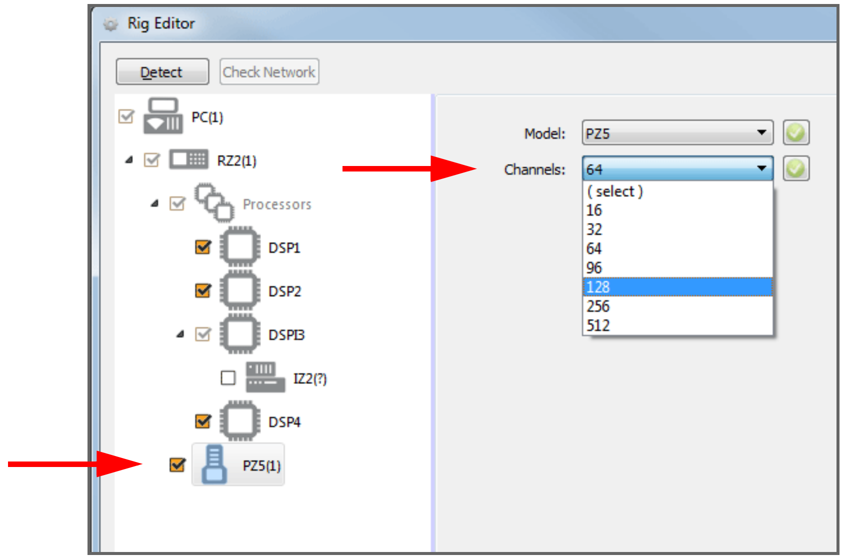
Adding a Device

The UDP interface, a USB Camera, and RA (Medusa) amplifiers are examples of devices that might be part of your system, but can't be detected by Synapse. These devices can be added to the rig manually using the RZ shortcut menu. Right-click your system's processor device (such as RZ2 or RX8) and select the device from the menu.

Medusa PreAmp	Add RAn
USB Camera	Add CAM
UDP Interface	Add UDPRecv and Add UDPSend

Configuring a Device

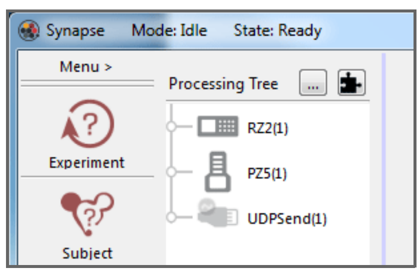
Some devices require that you configure some aspect of the device, even if it is automatically enabled.



Selected Amplifier Icon with Channels Drop-Down Menu

The most common item you will need to configure is your PZ amplifier. You'll need to select the number of channels available in your amplifier. In the rig, your device settings should exactly match your hardware. You'll be able to reduce the number of channels actually used or make other experiment-specific changes to settings in individual experiments.

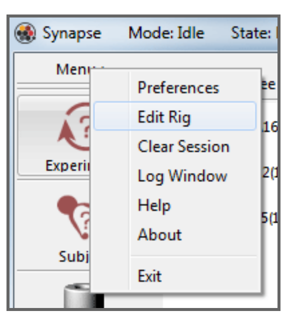
When everything is configured, you can update the rig by clicking OK to commit the changes and return to the Processing Tree.



Processing Tree with UDP Added

In the illustration above, the UDP device icon has been added but is displayed with a warning indicator. The UDP requires an input source. It can be set now or it can be set later when the desired input is available.

After the rig is initially configured, you won't need to repeat this process in future sessions unless your hardware changes. If you do need to make changes, you can return to the Rig Editor, using the EDIT RIG command on the main menu.



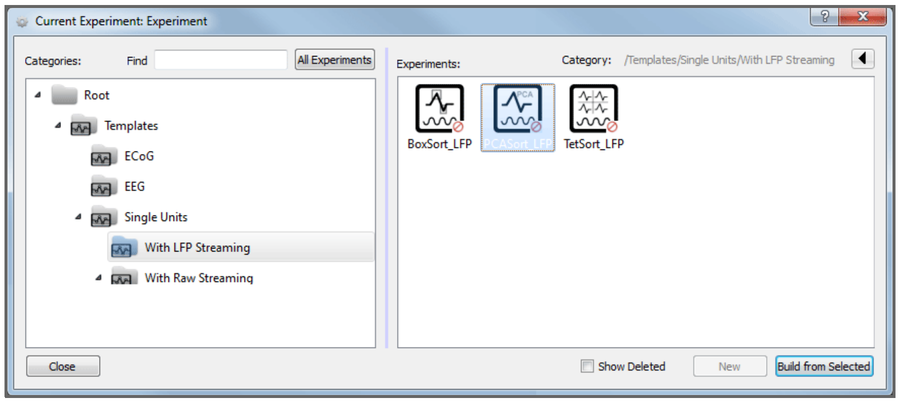
Main Menu

For more information on working with the rig, see "The Rig" on page 43.

Creating an Experiment from a Template

Templates are pre-built experiments created by TDT to speed up experiment creation. Each Synapse template is a basic working experiment that can be run as configured or modified to meet your needs.

You can access any saved experiments by clicking the EXPERIMENT button on the command bar, then clicking MORE. Templates are stored in special category folders within the Templates folder.

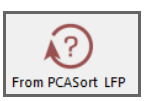


Current Experiment Window

The Current Experiment or Experiment Selection window is similar to a standard Windows Explorer window with folders, or categories, on the left and experiments in the category on the right.

The rest of this section will take a look at the following template:

Templates | Single Units | With LFP Streaming | PCAsort_LFP



Template files are locked to ensure you will always have an unaltered set in their original state. Select the desired experiment template and click the BUILD FROM SELECTED button, to create an editable copy.

The Rig and the HAL

Synapse has two ways of remembering information about your hardware.

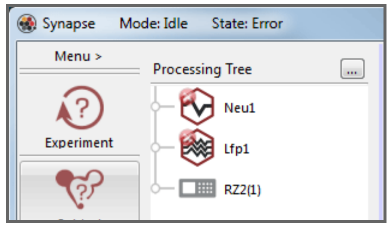
The Rig HAL

The Rig Hardware Abstraction Layer (HAL) is the collection of hardware information that **stays with your copy of Synapse.** It's used to execute your experiments.

The Experiment HAL

The Experiment Hardware Abstraction Layer (HAL) is a collection of hardware information that is **stored with the experiment.** It remembers the hardware used to create the experiment.

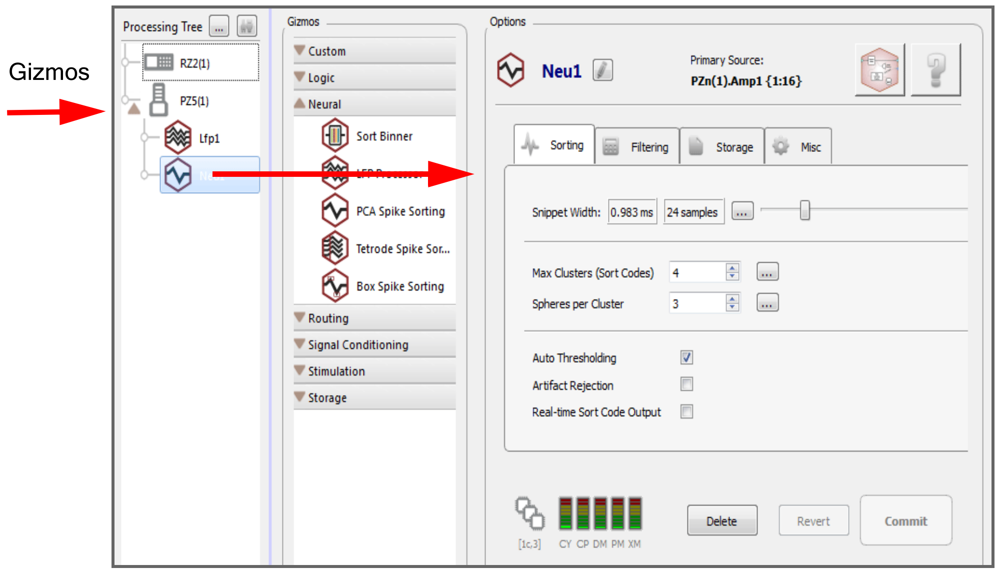
Each template contains HAL information about the system used to design it. When the template is launched, Synapse tries to adapt it to run on your rig. If it's unable to do so, alert symbols are added to the problem elements in the Processing Tree.



Processing Tree with Error Alerts

In the illustration above, the necessary PZn wasn't enabled in the rig where the template was opened. The problem is easily corrected by enabling the PZn.

Viewing the New Experiment

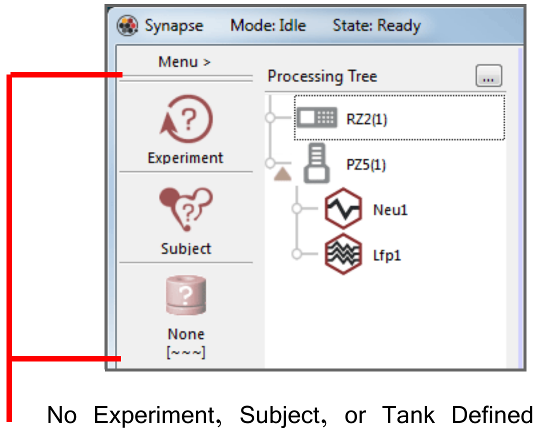


PCA Spike Sorting Gizmo Options in Synapse Window

In the new experiment, two task blocks called 'gizmos' are added to the Processing Tree beneath the PZ amplifier: one for LFP filtering (Lfp1) and another for PCA spike sorting (Neu1). The Processing Tree represents the path of data flow and in the example above the hierarchy shows that the LFPs and Single Units are being acquired in parallel from the same signal source (PZ5). When a gizmo is selected in the tree, its configuration options are displayed in the Options area to the far right. For information on modifying gizmo options, see the corresponding reference in the "Gizmo Reference" on page 109.

Naming the Experiment

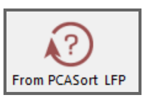
Before you name the experiment, take a quick look at the Synapse interface.



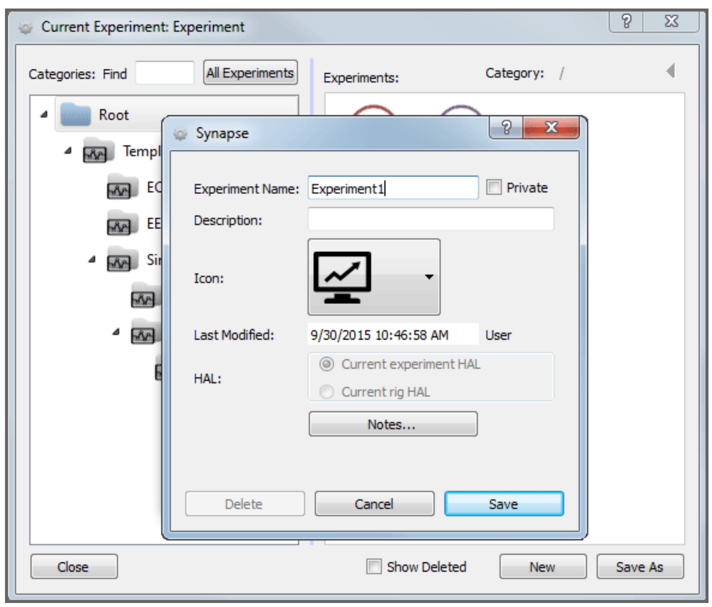
No Experiment, Subject, or Tank Defined

Synapse Designtime Interface

Notice the large buttons at the top of the command bar, seen on the left side in the illustration above. The buttons that are initially displayed in red and are switched to black as each area is configured. Until configuration is complete the experiment RECORD button is unavailable.

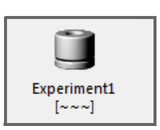


Before you can begin collecting data, the new experiment needs to be named and saved. Click the EXPERIMENT (FROM PCASORT LFP) button and click SAVE AS.



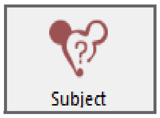
Current Experiment Window and New Experiment Dialog

In the dialog box you can enter an experiment name, description, or add notes. The experiment is saved under the ROOT directory. You can add and move categories and experiments using right-click menus.

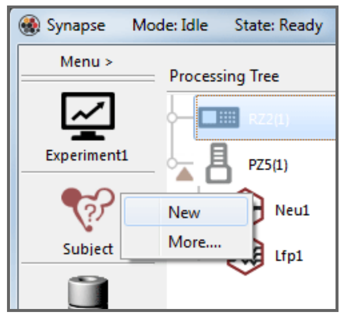


When you return to the main designtime interface, the experiment has been saved, a new tank name is displayed under the tank icon, and the RECORD button is available.

The experiment name is one of three special categories of information that Synapse tags and uses in its relational database to index and track designtime and runtime settings and any modification made to parameters during each experiment run. The other two categories are users and subjects. Which of these buttons is displayed is controlled by Synapse preferences. In the default configuration only the experiment and subject are displayed and both must be configured before recording.



To add a subject, click the Subject button in the command bar, then click New.



Subject Menu

You'll need to enter a name in the Subject Name field. You can also enter a description, password, or notes and choose an icon. When you're done adding information, click Save.

The steps to add users and subjects are much the same. For more information about the user, subject, and experiment features, see "Managing Users and Subjects" on page 33.

Using the Runtime Interface

When an experiment is fully configured and saved, the Preview and Record buttons are enabled. In preview mode you can display data, adjust plots, and change runtime settings without any of the data being permanently stored to the data tank. This is particularly useful for tasks like spike sorting, where you might want to establish the sorting parameters before collecting data. For more straightforward tasks, like recording streamed data, you might choose to skip preview and go straight to record mode.

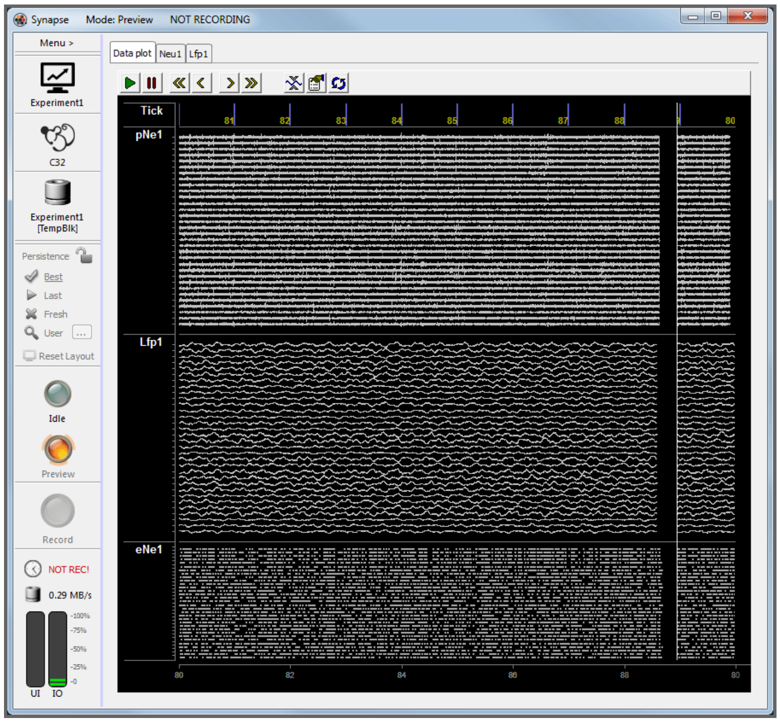
Mode Buttons

Idle Mode	Devices are not loaded and are not running.
Preview Mode	Data is acquired, but deleted after the recording ends.
Record Mode	Data is acquired and stored to the data tank permanently.

The Runtime Window

The runtime window includes tabs with the main data plot and runtime controls for each gizmo. The data displayed is pulled directly from the hardware and sent to the display in parallel with data storage (rather than after).

The basic window includes a plot for each type of data being stored and each plot is automatically configured according to the type of data, for example: snippet, streamed waveforms, or epoch events. You might need to scale the plots to display the waveforms appropriately. This window is explained in more detail in “Runtime” on page 65.



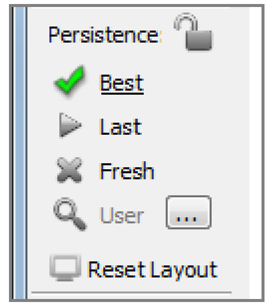
Main Plot at Runtime - Streamed LFPs, Plot Decimated Waveforms, and Snippets

The second tab in the template is derived from the PCSort gizmo and is an interactive display with plots for cluster cutting and provides runtime access to many of the configuration setting, such as filter values, display options and even the sorting algorithm. You can find more information on this interface in “PCA Spike Sorting” on page 147.

To make sure you don’t lose your cluster definitions and other settings between runs, Synapse will remember them according to your persistence setting.

Persistence

By default, Synapse saves the state of all experiment variables, including filter settings, threshold values, and cluster definitions in its relational database during each recording sessions. Any changes made to a setting is logged in the database as well as the user and/or subject information. All of these values are retained and saved as part of a history of the experiment. This database of experiments and history of it’s past states (collection of settings for a user and/or subject at a given time) support several useful features including persistence and history browsing, filtering, and export features.



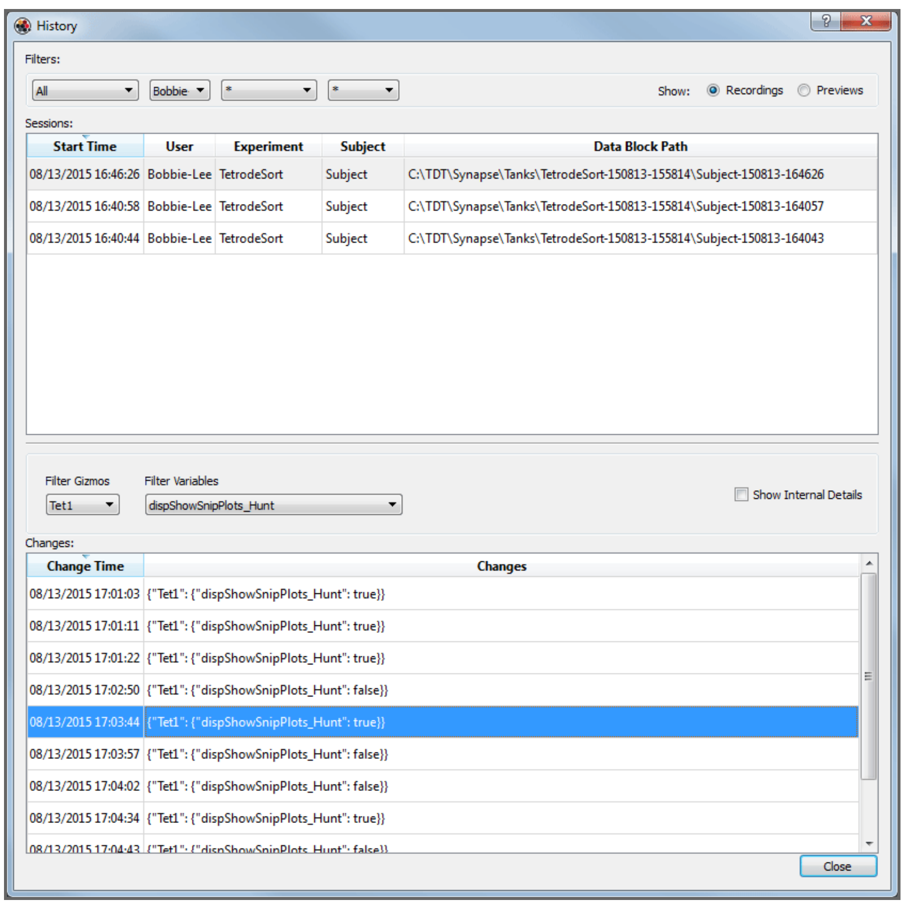
In the runtime window, 'persistence' refers specifically to how past experiment states are applied the next time the experiment is run. You can choose this behavior using the Persistence choices on the command bar.

LOCK	Locks selected persistence.
BEST	Uses the last settings of any runtime controls for the current experiment and user/subject.
LAST	Uses the last settings of any runtime controls for the current experiment (regardless of subject or user).
FRESH	Uses the settings in the designtime Options area and clears any past runtime settings.

Unless you lock the choice, persistence returns to the BEST default behavior after each recording session.

User History

The History Window is available from the  USER BROWSE HISTORY button, in the Persistence section of the command bar.



History Window

This window includes a variety of filtering mechanisms to help you quickly find the data, experiment state, or specific setting value you are looking for. Using shortcut (right-click) menus you can select and return to start and end states for each session or any change state during the session. The top section of the window also displays the path and location for the data recorded during that session. You can begin working with the data set immediately from this window, using the same shortcut (right-click) menus.

Window Layout

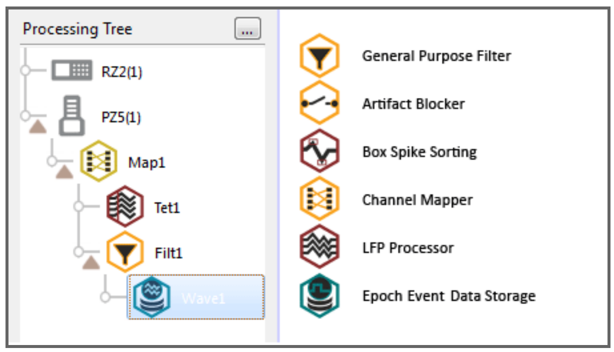
Synapse can also remember information about tab layout. You can drag tabs to float them in new windows or right-click the tab to control placement inside the main window. Information about the window layout is specific to the user and is separate from persistence information. When you return to Idle, you can return to the default layout using the RESET LAYOUT button on the command bar.

The Data Tank

TDT's TTank data server indexes and stores recorded data then makes the data available for post hoc visualization and analysis. By default, Synapse names data tanks (a grouping of recordings) automatically based on the experiment's name. Blocks (single recordings) are automatically named based on the subject ID for that recording session. These default preferences are ideal for labs that run an experiment on multiple subjects then move on to another experiment. If your lab does things differently, such as running experiments on the same subject to compare results over time you can change the Synapse preferences to organize the data is different ways. For more information, see "Managing Data for Your Lab" on page 29.

Using Gizmos to Build an Experiment

Synapse experiments are a collection of building blocks, called "gizmos", that you can combine to assemble your experiments. Gizmos are available for a variety of tasks; including reading input signals, filtering, online spike sorting, data storage, channel mapping and much more. Each gizmo can be a single task or comprise a group of tasks bundled together for a particular type of experiment, such as online spike sorting and data storage.



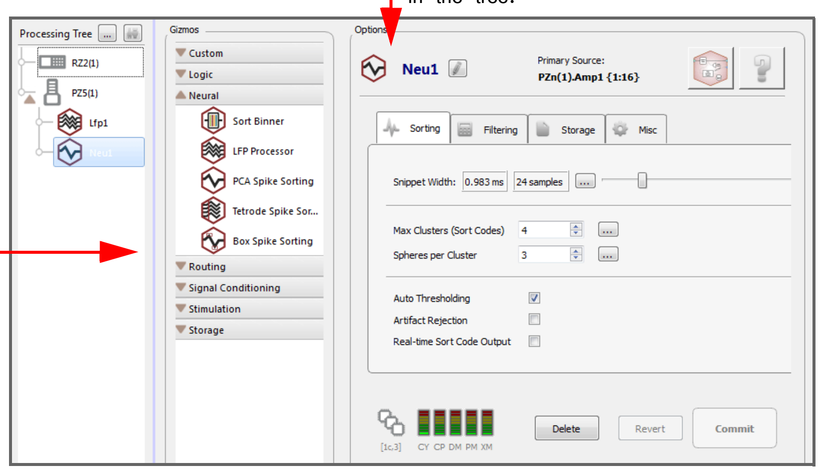
TDT Gizmos (partial list)

Synapse's designtime experiment interface in streamlined to show what you need when you need it. As you make selections, relevant options are displayed. In addition to the command bar, the interface is divided into four areas.

Options
Configuration options for the item selected in the tree.

Processing Tree
Your selections here, determine what's displayed in other areas.

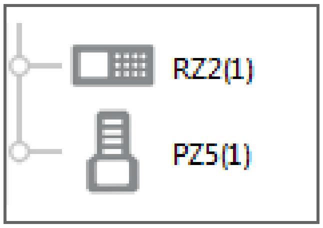
Processor List
Gizmos that can be added to the item selected in the tree are organized by type.



Designtime Window

The Processing Tree

The Processing Tree shows the parts of your experiment in a hierarchical diagram. Each experiment can have many parts or branches that form your experimental "machine." It's easiest to identify each branch by looking at the point where signals are input or output.



RZ processors and other devices that represent the starting point (or potential starting point) for a branch form the trunk of the tree. Biological signals are typically acquired by an amplifier, so amplifiers also appears on the trunk of the tree. It is important to note that most acquired signals pass through the RZ for processing and storage, but that does not necessarily mean all acquisition gizmos should be added to the RZ branch. They should be attached to the device that serves as the input source for a particular signal set.

If a device in your system does not show up automatically in the Processing Tree, you will need to edit the Rig. See "The Rig" on page 43.

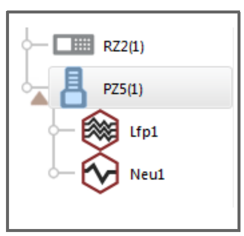
Gizmos for tasks, such as filtering, signal processing, and data storage, form the branches of the tree diagram. They are added to the device or gizmo that will be used to input or output the signals associated with the particular task.

To add a gizmo:

- After you have selected an item in the Processing Tree, double-click the gizmo in the Processors list or drag it into place.

Where to Add a Gizmo

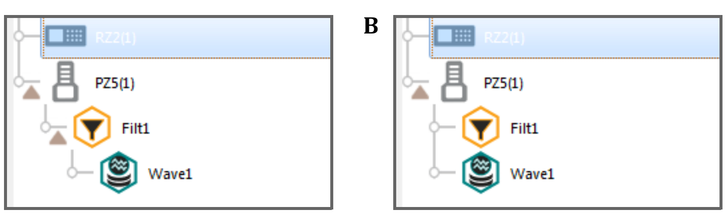
Neural processes, like spike detection, are acquired using an electrode and headstage connected to an amplifier, so they are added to the PZ Amplifier in the tree.



Spike Sorting Gizmos added to PZ5 Amp

Multiple tasks can be added to any branch, in parallel or in a chain, with tasks ordered according to data or signal flow.

A B



Filter and Store Gizmos (A) in a Chain and (B) in Parallel

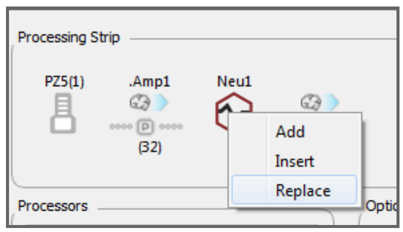
In figure A, a stream store gizmo is added to a filter. So, filtered waveforms are stored. In figure B, the store and filter are added in parallel. So, raw waveforms directly from the amplifier are stored. The stored waveforms have not passed through the filter.

Synapse adjusts the available options as you work so that only relevant choices are available. At each step of the design process, Synapse uses information about your hardware and selections you've already made to show only the relevant choices.

Working with Gizmos

Drag and Drop

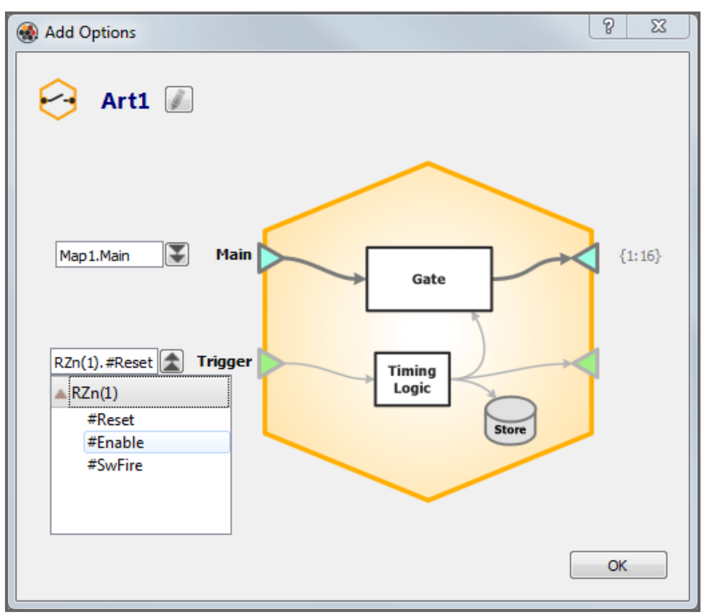
You can drag gizmos from the Processor List or within the Processing Tree to add or reorder them. You can also drag a gizmo to the Processing Strip (enabled in the Synapse Preferences) to replace a gizmo in an existing branch displayed there.
When you drop the gizmo, a shortcut menu appears to allow you to add, replace or insert. The Processing Tree will update to reflect these changes.



Processing Strip Menu

Data Types

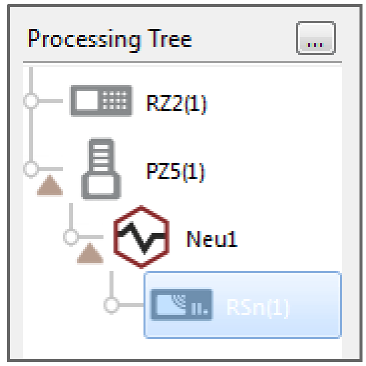
If a gizmo that requires you to select a source is added to the Processing Tree, the gizmo's block diagram is displayed. In the drop-down menus for each input the available list of inputs is arranged and filtered by accepted data types (multi-channel, single-channel, float, integer, TTL).



Gizmo Block Diagram with Trigger Source Selector

Adding a Device to a Gizmo

Some devices, such as the RS4 data streamer, initially appears at the trunk of the Processing Tree and must be moved to the end of a branch. You can drag a device to any gizmo with a multi-channel signal output or change its primary source in the Options area.



Processing Tree with RS4

Two-Sample Delays

Each branch in the processing tree represents a signal flow or processing path. Each gizmo or device in a branch adds a two sample delay to that path. The path pictured above, from the PZ5 to the RSn, will have a four sample delay. You'll need to be aware of these small delays for experiments with complex processing paths that include many gizmos, custom user gizmos, or where timing is critical.

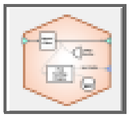
See "Creating User Gizmos" on page 305 for more information on user gizmos.

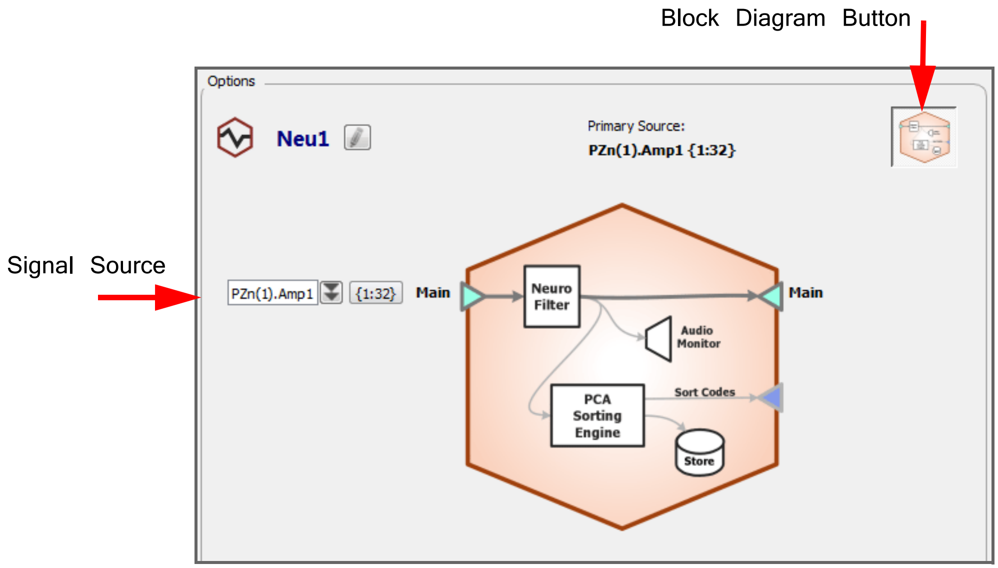
The Options Area

When a gizmo is selected (highlighted) in the tree, its configuration options are displayed in the Options area to the far right. This area also includes a block diagram that provides a logical view of the processes in the gizmo.

The diagram is displayed by clicking the BLOCK DIAGRAM button.

The Block Diagram





Block Diagram with Signal Source Selector

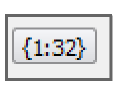
The block diagram in the Options area of the designtime window provides a quick reference for what inputs, outputs, and data is stored by the gizmo. The input source or number of channels and external triggers can also be modified here. The drop-down menus are populated with relevant and valid options.

Gizmo Naming Scheme

Synapse automatically generates and uses consistent naming wherever possible. For example, the gizmo name is generated automatically for you and is based on the type of gizmo selected as well as the index number, so you can use multiple gizmos of the same type in one experiment. In the illustration above, the name "Neu1" is automatically generated for the PCA Spike Sorting gizmo, added from the Neural group of gizmos, and the name and gizmo index are used to name the corresponding data store.

TDT recommends using the auto-generated naming schemes to help make experiments and data consistent across users and subjects.

Channel Counts



The Channel button displays the first channel number and the number of channels (or count), indicating the current range of channels included in the primary source input to the gizmo. By default, all available channels are selected. Clicking the button displays the Select Channel Range dialog box where you can change the range to select a subset of available channels. For example: to sort and store spikes for channels 33-48, clear the All check box and enter: First: "33" and Count: "16."

Automatic Propagation of Changes

Changes to channel count in the data stream automatically propagate through the tree branch to attached gizmos.

For information on modifying gizmo options, see the corresponding gizmo in the "Gizmo Reference" on page 109.

Global Buttons

Located below the options tabs, the DELETE, REVERT, and COMMIT buttons are applied across all tabs.

The experiment is saved each time you make or "Commit" a change. If you need to roll back a change in the experiment design after it has been committed, you can do so in the Experiments Revision Log. See "Experiment Changes and the Revision Log" on page 55 for more information.

Managing Data for Your Lab

Data Tanks and Blocks

After you've created an experiment, the next step is to consider how and where the data will be saved. Synapse preferences allow you to choose where tanks are stored. By default the tank path is: C:/TDT/Synapse/Tanks

Tank and Block Naming

Synapse provides a structured but flexible automated solution for tank and block naming based on your preferences. To understand how this works, you first need to understand that Synapse recognizes experiments and subjects as key categories of information that play a special role in managing data storage and retrieval.

Large buttons for these key categories are positioned prominently at the top of the command bar. These buttons are both functional for configuring experiments and serve to display current selections. Below the key category buttons, an icon displays a truncated version of the current tank and block names, which are generated from the experiment and subject names. The full names also include date and time information.

By default, Synapse names data tanks automatically based on experiment name and the start time of the first recording. Blocks of data are named based on subject for each recording session and the start time. For example, an experiment named "LFPbase" run for the first time on October 8, 2015 at 10:51:34 is named:

LFPbase-151008-105134
{ExperimentName}-{yymmdd}-{hhmmss}

The blocks are named based on the subject. Three blocks might be:

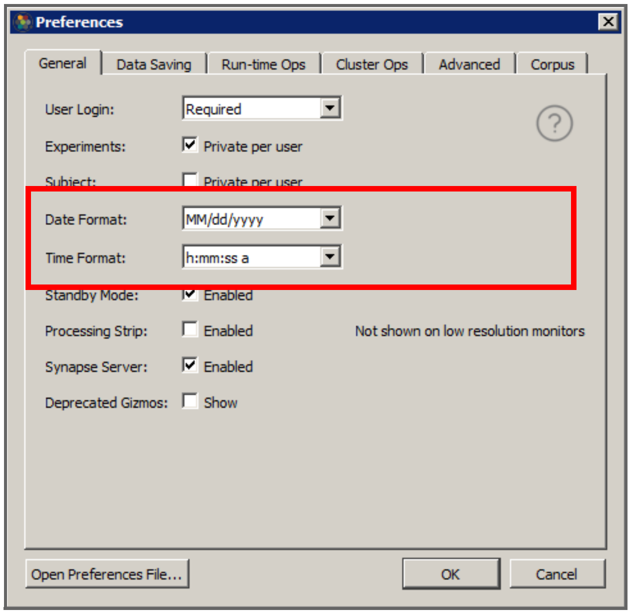
MouseC5-151008-105134
MouseC6-151008-110526
MouseC7-151008-112049
{SubjectName}-{yymmdd}-{hhmmss}

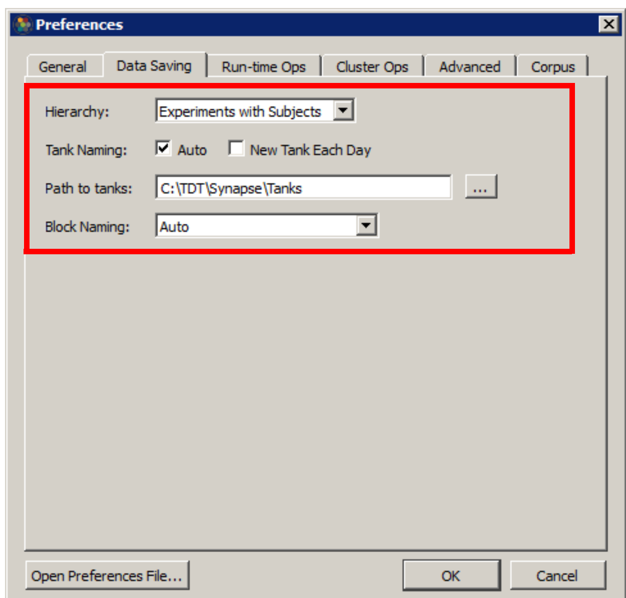
Note: The maximum block name length is 31 characters.

These default preferences are ideal for labs that run an experiment on multiple subjects then move on to another experiment. If your lab does things differently, such as running experiments on the same subject to compare results over time, you can change the hierarchy preference to SUBJECTS WITH EXPERIMENTS. With this hierarchy, tank names are generated using the subject name and blocks are named using the experiment name. Synapse preferences also allow you to choose a tank path, a different time and date format, when to generate a new tank, or to name tanks manually.

To view the Synapse Preference dialog:

- Click **Menu** at the top of the bar and then click **Preferences.**





Accessing Stored Data

Synapse uses TDT's DataTank format. Data can be can be viewed using OpenScope, OpenExplorer, and OpenSorter, or accessed for analysis via Matlab. The location for data storage can be set in the Preferences dialog. Data can also be accessed using the History window.

History Window

The History window displays a filtered list of all recording sessions and displays a timestamped list of all changes made to experiments during each session. It is used primarily to access the experiment configurations settings and changes, but it also provides a number of quick data access tools.

To open the History window, click the USER SEARCH/BROWSE button beneath the Persistence selections on the command bar.

To open the History window:

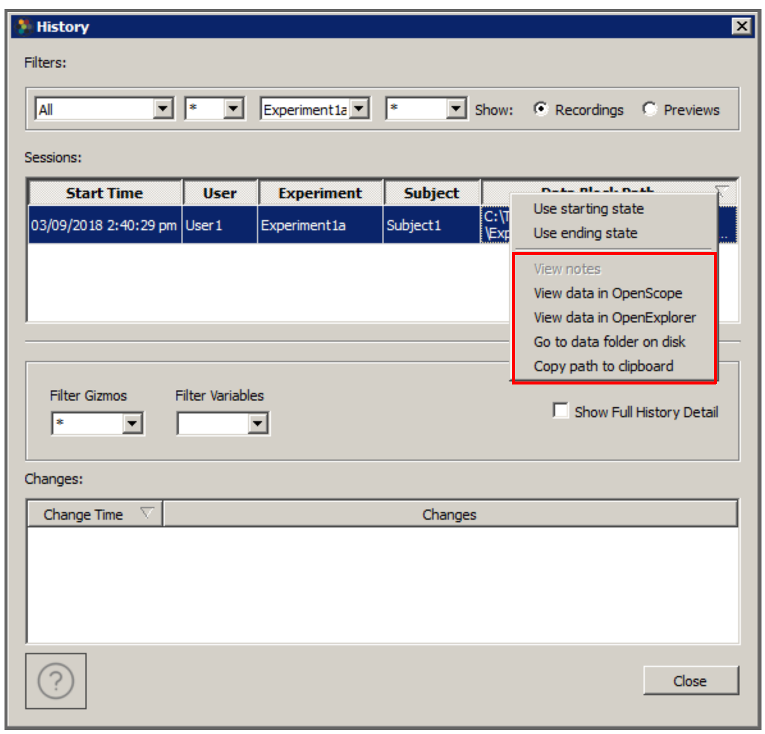
- Click the **User Search/Browse** button or go to Menu > History.

Sessions

The sessions area is the top section of the window. Each row in the upper section contains information about the data collected for a single recording session, including the data path. Several commands for accessing data are available on the shortcut menu.

From the shortcut menu (right-click a row), you can:

- View any notes you made during that recording.
- View the selected data in OpenScope.
- View the selected data in OpenExplorer.
- Open the folder containing the selected data Tank.
- Copy the path for the selected data to Clipboard, for pasting into Matlab.



History Window

Managing Users and Subjects

Lab Management

The Synapse relational database is the key to the software's powerful lab management features. Synapse uses it to track and save all aspects of your experiments and every aspect of your interaction with the interface. It contains the who, how, and what of each Synapse session, virtually everything except the acquired data. "Managing Data for Your Lab" on page 29, explains how Synapse uses key categories of information in its relational database, like experiments and subjects, along with Synapse preferences; to name and manage acquired data files. This section explains how Synapse user and subject features help you manage how people in your lab interact with the software.

Users

Lab managers can use Synapse preferences related to users, to create and assign user accounts to lab groups or individuals, decide whether passwords are required at log in, and control how experiments are shared within the group. In the relational database, user names are linked to experiments, subjects, parameter changes, and the windows layout.

By default, user features are not enabled. Some features, such as filtering and the History window, that will be discussed in this section can be used in the default state. However, enabling user login greatly increases their utility and benefit.

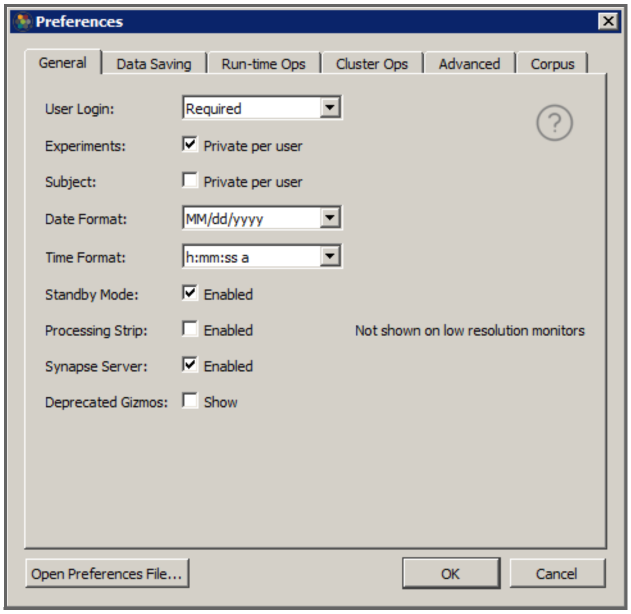
The user functionality allows for individual labs to determine how user names will be used, with the most common being that every person might have there own user name. However, user names can be used to create roles or groups. You'll need to consider how your choice will work with other preferences settings, such as privacy options, before making a final decision.

There are also two different user modes available: with or without passwords. The password functionality is not a security feature. It provides an extra layer of caution to encourage users to login to their own user ID so that logs, change tracking, and filtering will be more effective.

Passwords apply only to experiment configurations, all data are available to all users in the data tank.

To enable User login:

1. Click **Menu** at the top of the command bar and then click **Preferences.**



2. Choose **Required** or **Required with Password.**
3. Optionally, select any of the following options:

   Experiments Check Box – select to make experiments private per user.

   Subject Check Box – select to make subjects private per user.

   Runtime Window Layout Check Box – select to make layout unique per user.

Privacy

The purpose of privacy is to aid in filtering and to minimize mistakes and confusion. When experiments or subjects are private, they are only available to the user that created them. It's important to understand that privacy is controlled in two places.

In the Preferences dialog, the EXPERIMENTS PRIVATE PER USER and SUBJECT PER USER check boxes make privacy the default sate for new experiments or subjects created. It doesn't change the privacy of existing experiments or subjects.

Selecting either check box in the Preferences dialog makes privacy the default, by enabling the PRIVATE check box in the dialog used for creating new users or subjects. However, this check box is available and can be selected or cleared, regardless of the preference setting. This allows users to choose to make particular experiments or subjects private.

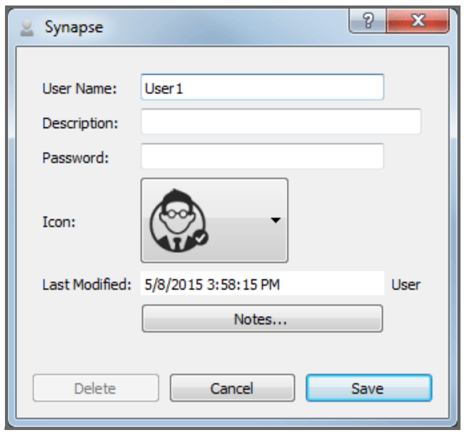
Adding and Selecting Users

When user login is required (in the Preferences dialog). A USER button is added to the command bar.

Adding Users

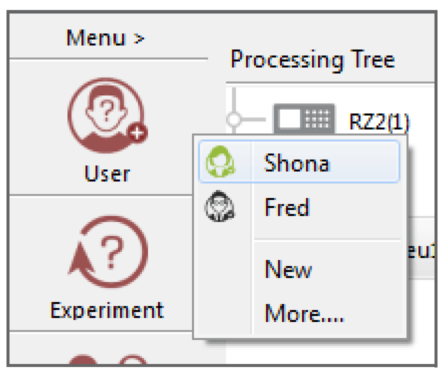
To add a new user:

1. Click the **User** button on the command bar, then click **New**.



2. Enter a name in the **User Name** field. You can also enter a description, password, or notes and choose a user icon.
3. Click **Save**.

After users have been added, they are available on the shortcut menu or by clicking MORE.



User Category Menu

When users are assigned, Synapse is able to store windows layouts for each user and for each experiment. Runtime configuration settings can also be saved by user and experiment and this information becomes part of the 'best' persistence, that is, the best persistence is the most recent runtime settings for the current experiment AND the current user. See Window Layouts, Runtime, and Persistence, below.

Subject

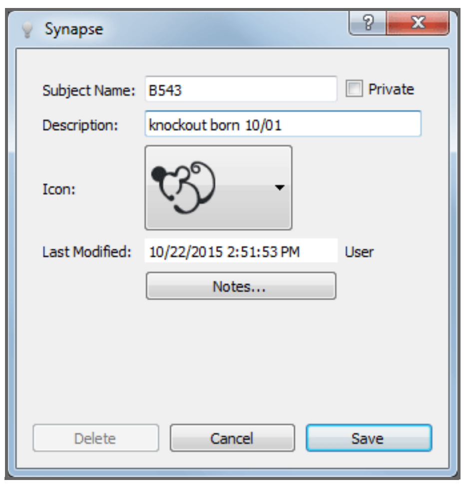
Depending on the work done in your lab, you may have just a few chronically implanted subjects or you may have many subjects used for screening. Whatever, your lab's work style, the subject name plays a special role in naming data tanks. Synapse easily adapts to either style using the settings in the Preferences dialog and in the category dialogs.

You can select, edit, or add subjects using the SUBJECTS category button on the command bar.

Adding A Subject

To add and a Subject:

1. Click the **Subject** button in the command bar, then click **New**.



2. Enter a name in the **Subject Name** field. You can also enter a description, password, or notes and choose a user icon.
3. Click **Save**.

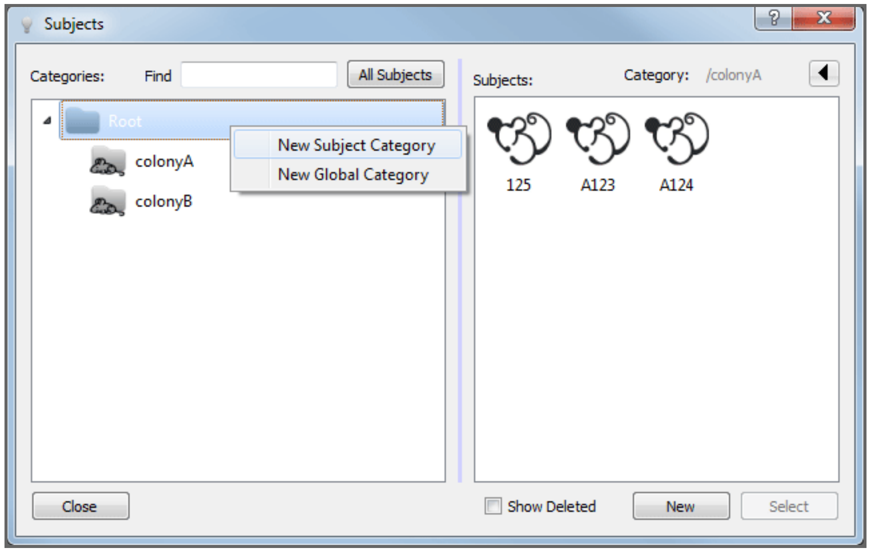
The subject is added.

The new/edit subject dialog also includes a check box to make a subject private. This setting is tied to the SUBJECT: PRIVATE PER USER option in the Preferences dialog. It has no meaning unless user names are enabled.

Synapse makes it easy to add many subjects in advance of your experiments. Instead of choosing NEW on the Subjects menu, choose MORE. The Subjects Window will be displayed and you can add new subjects one after another without returning to the main Synapse window.

Organizing Subjects

Making subjects private by user is one way to help organize subjects. Another way it to use subject categories in the Subject window. You can find this window by clicking MORE on the Subject shortcut menu. It works similarly to a Windows folder window, with categories (or folders) on the left and subjects (the contents of the folder) on the right. You can create new categories and subcategories by right-clicking the ROOT folder or an existing category folder.



Subjects Window

Using Persistence with Users and Subjects

The Persistence runtime interface was introduced in "Launching Your First Experiment"-"Using the Runtime Interface" on page 20. It is worth taking another look at how persistence relates to users and subjects.

With a single user and a single subject, persistence ensures that your runtime settings, such as clustering definitions, filter settings, and display options are retained when you switch from preview or record mode to idle.

Fresh

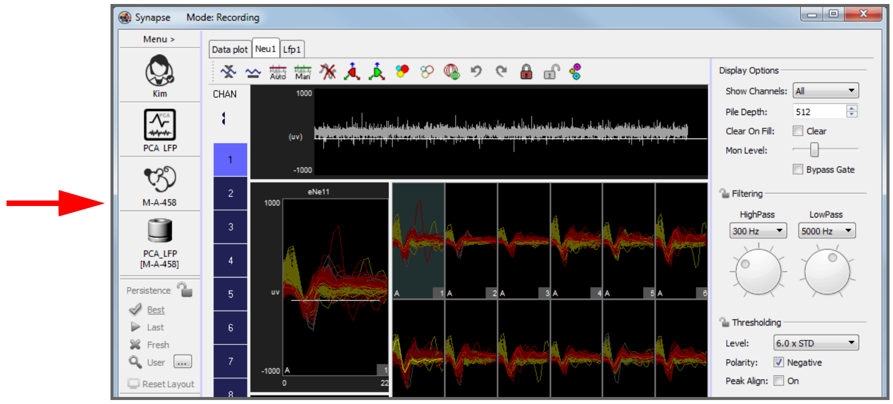
The FRESH option is the easiest to explain and understand. It allows you to return to a fresh start by using the experiment's default settings for each gizmo at run time.

Best and Last

By default, Synapse uses the BEST option, which applies the most recent settings for the current experiment and current subject.

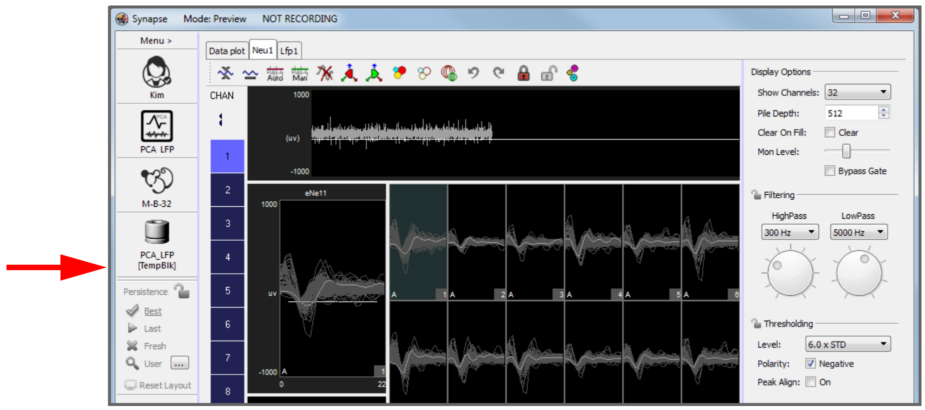
The LAST option uses the most recent settings, regardless of subject or experiment. This is useful if you set up your cluster parameters for an animal, but then switch experiments. You can import the settings from the previous run directly into this new experiment.

Even if you switch to another to another type of persistence, such as LAST, Synapse will return to BEST when you return to Idle mode unless you lock  the Persistence. Initially, the difference between these two options can be difficult to see.



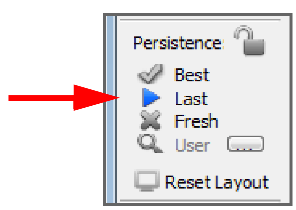
Runtime Window After User Adjustments

Because a different subject is being used, the saved settings are not applied. You see a fresh window.



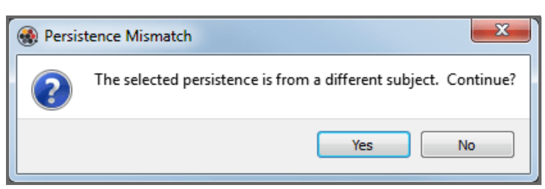
Runtime Window with Best Persistence and New Subject

You may or may not want this behavior depending on the type of experiment. For example, if you are doing a behavioral experiment and using synapse primarily to present stimuli, you might want to apply the last settings regardless of a change of subject. In that case, you would select LAST persistence.



Persistence Interface - Last Selected

If you choose LAST and Synapse detects a new subject being used, you will see a warning like the one below. Click YES to continue or NO to stop and either change the subject or choose BEST preference.



New Subject Alert - Persistence Mismatch

The more you become comfortable with the persistence features, the more you will realize how helpful they are and how much you already rely on them.

Window Layout

It is important to note that the arrangement of windows/tabs, called the 'Layout', is tied to the current User and Experiment. Click the **Layout** button at the bottom of the Persistence area on the command bar to change the layout.

To clear the Window Layout:

- Click **Reset Layout.**

To choose a different layout for the next recording:

- Select the User/Experiment combination you want to load.

Part Two: Synapse Fundamentals Reference

Hardware Configuration

The hardware devices that make up your system were carefully selected from System 3's diverse group of signal processors, amplifiers, and input/output devices. Each device has particular features; such as the number of DSPs in an RZ processor, maximum number of recording channels, or types of optical ports available for amplifiers or other peripheral devices. Synapse keeps track of these details for you and offers choices suitable for your system as you're building an experiment. You select the parts of the experiment you want and Synapse generates it, optimized for your hardware.

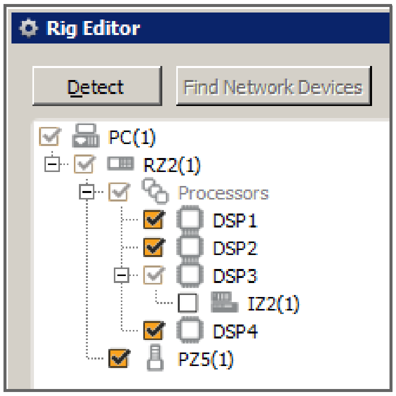
The Rig

Synapse stores information about your hardware in a rig (*.synrig) file. The first time you run the software, you will need to configure the rig. "Launching Your First Experiment" on page 13 includes information about how Synapse does some of this for you, detecting principle hardware components and making suggestions for devices that might be present, but can't yet be detected.

Often your rig needs to be configured once then you can forget about it. Your rig configuration selections should match your actual physical system. The rig is not specific to an experiment and limiting the capabilities of your system by disabling I/O channels on a device or disabling a device completely is likely to cause problems in designing future experiments.

How Auto-Detection Works

When you click the DETECT button in the Rig Editor, your equipment should be displayed in a hierarchical tree diagram.



Hardware Rig

If your devices are not detected, check to ensure your system is properly connected and powered on then retry.

If you are currently unable to connect devices, but want to continue to use the software for design or debugging, see "Working Without your Hardware" on page 47.

The Detect feature communicates with the RZ processors to determine which RZ device is connected and to identify the DSPs installed in the device. Common devices which **could** logically be connected are added to the tree in a disabled state, which means that device won't automatically be available when you build a new experiment. You need to review the tree to verify that it correctly represents your system and to enable/disable, add, or configure devices as needed.

RX devices are identified, but information about the number of DSPs (2 or 5) and analog I/O configuration of the RX8 is **not** automatically detected and must be set by confirmed by the user.

Understanding the Hardware Tree Diagram (Rig)

The tree diagram in the Rig Editor represents your hardware in a hierarchical way and all branches start or end with the PC at the top of the tree. The icons below the PC represent the devices detected, added by a user, or predicted/suggested by Synapse as a device that might exist based on known information it has about the processor device(s) in the system.

For example:

An IZ2 will be added if your RZ2 houses a DSP-I card, but the device is disabled by default.

DSP-I with predicted IZ2 (disabled)

Disabled Devices and the Processing Tree

Disabled devices can later be added to an experiment in the Processing Tree using the ADD HAL command in the right-click menu of the parent RZ device. Also, if an experiment requires a device that is disabled in the Rig, it will be added to the Processing Tree automatically when an experiment is opened.

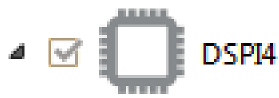
Specialized DSPs and Related Devices

DSP labels provide additional information about the type of DSP and its associations. The label takes the form **DSPX#** where:

X = device type to which the DSP connects, such as amplifier or RS4 data streamer (omitted if none) or indicator for multi-core DSP

= logical number (or index) assigned to the DSP within the RZ device

For example:



Fourth DSP in an RZ, specialized DSP-I for IZ2 stimulator

DSP Type/Device Connection Key

S RS4 data streamer

V RV2 video processor

I IZ2 electrical stimulator

U PO8e streamer

P PZ amplifier

Q Quad Core processor

Note: The optical version of the DSPQ card can also support any of the device connections (such as video processor or amplifier). This is not indicated in the DSP name.

Amplifier Connections

If Synapse detects an RZ2, a PZ5 icon is added below the RZ2 icon. This is because the RZ2 has an amplifier port and a PZ5 is typically used with this device, but Synapse can't detect the amplifier model (PZ5, PZ2, or PZ3) or number of channels.

RZ2 with Predicted PZ5

If you are using a different amp or a different number of channels than the default, you will need to change the configurations options as described below.

Each device can be individually configured using its device options. When a device is selected in the rig tree, any configurable features are displayed to the right. Options may include model number, channel count, and so forth.

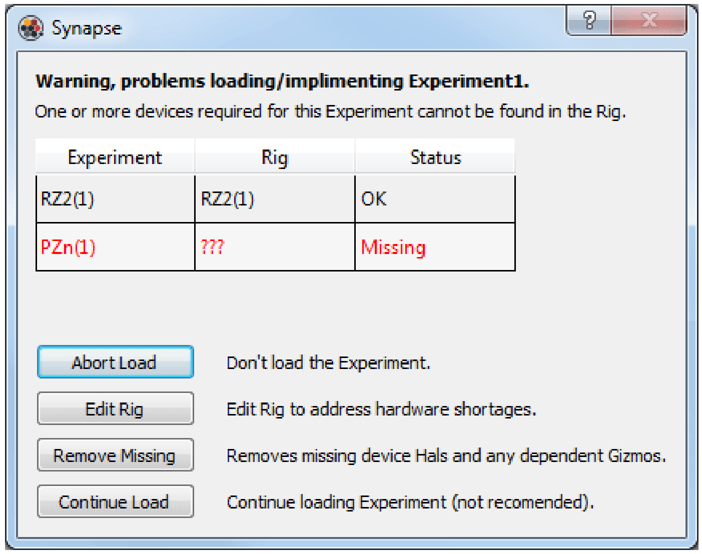
Add/Remove Devices

Use the right-click menu in the rig tree to add any devices in your rig that didn't automatically configure.

To prevent loss of existing experiment hardware configuration, keep the **Merge Previously Saved Configuration** check box selected. To refresh all of the hardware objects in the Processing Tree to their default state, uncheck this box.

Experiment - Rig Mismatch

When you open an experiment, Synapse checks the Rig to determine if the devices required for the experiment are available in the processing tree. If a mismatch is detected, a warning window is displayed. The top of the window displays the devices required by the experiment and their status in a grid.



Rig - Experiment Warning Window

The lower half includes a variety of options for handling any problem.

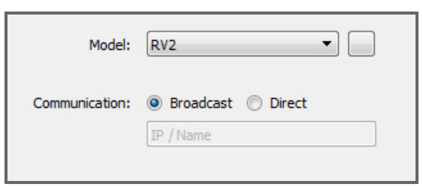
Rig Specific Device Options

Network Devices

Network enabled devices, that is the RS4 and RV2, must be configured for network communications in the rig.

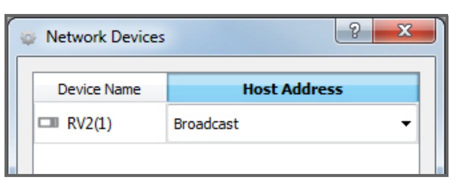
To configure a network device:

1. Make sure the devices is enabled in the hardware tree, then click to select it.
2. In the Options area, select the Broadcast or Direct connection radio button, then enter the IP address.



3. Alternatively, click the Find Network Devices button.

4. In the Network Dialog bog, select the IP address in the Host Address drop-down for the selected device.



Working Without your Hardware

If you have installed Synapse to a computer that is not connected to a hardware system, you can build a phantom rig for planning and debugging. You can also spec out a system that would run any experiment you designed.

1. In the Rig Editor, right-click the computer icon and click **Add RZn** on the shortcut menu.

   If necessary, select the RZn check box.

   In the area to the right, the default Model and I/O settings for the selected hardware is displayed.
2. If the model shown doesn't match, click the **Model** drop-down menu and click your model in the list.
3. Repeat this process to add DSPs, amplifiers, and any additional device to the diagram.
4. When all the necessary hardware has been added, click the **OK** button.

In the Synapse designtime window, the Processing Tree is populated with the hardware in your rig. With your phantom rig you can configure your experiment.

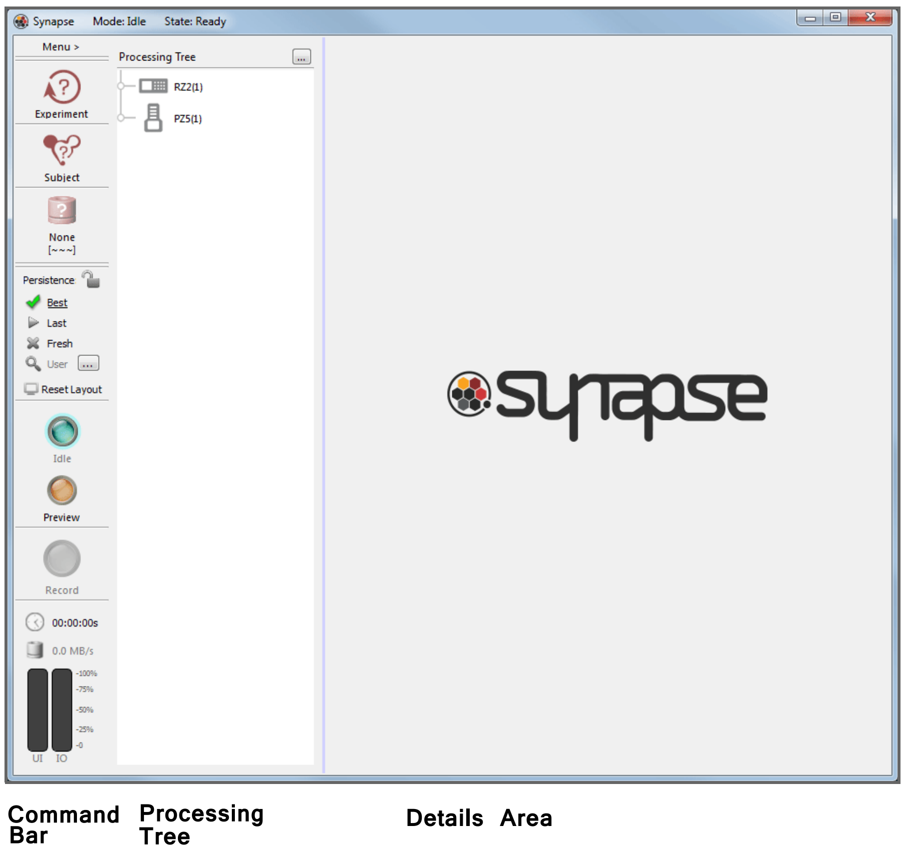
Before running your experiment, make sure your actual hardware system matches your rig configuration before running your experiment.

Import or Export Rigs

The Rig Editor includes IMPORT and an EXPORT buttons. These buttons can be used to open an existing rig file (Import) or preserve the current rig for future use (export). These buttons launch Select a Hardware Rig or Save the Hardware Rig dialogs that function much like a typical Open or Save as dialog.

Designtime Reference

When you launch Synapse, you see a streamlined user-interface that automates all but the highest level set-up tasks for you. This is the designtime interface where you can make choices about things like what type of data to collect and what threshold, sorting, or other processing tasks to include in your experiment.



The Synapse Designtime Window

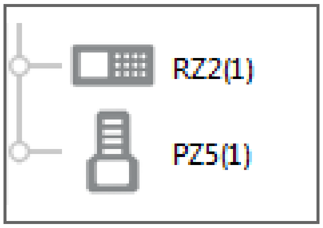
The window is divided into three areas:

The Command Bar	contains the most often used elements of Synapse.
The Processing Tree	displays a graphical representation of your experiment.
The Details Area	displays setting and configuration options at designtime or plotting and control windows at runtime.

At each step of the design process, Synapse uses information about your hardware and selections you've already made to show only the relevant choices. Once added, you can review and modify the settings in the details area. Often, you won't need to make any changes at all. While Synapse supports drilling down to every detail of how the system works, it has also been designed to make that unnecessary for most Synapse users.

The Processing Tree

The Processing Tree is both a graphical representation of the processing tasks that make up your experiment and a design tool. The tasks added to the tree along with how they are ordered and connected forms the processing instructions that will be loaded to the hardware at runtime. Each tree can have many parts or branches.



Devices with input/output functionality form the trunk of the tree. They represent the starting point (or potential starting point) for a branch.

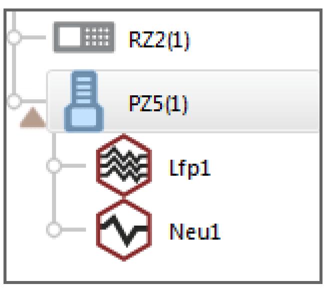
RZ devices appear in the Processing Tree to represent their front panel analog or digital inputs.

Acquired biological signals are often input by a PZ amplifier, so it also appears on the trunk of the tree.

If an input/output device does not show up automatically in the Processing Tree, you will need to edit the rig. See "The Rig" on page 43.

Tasks, such as filtering, signal processing, and data storage; form the branches of the tree diagram. They are added to the device that will be used to input or output the signals associated with a particular task.

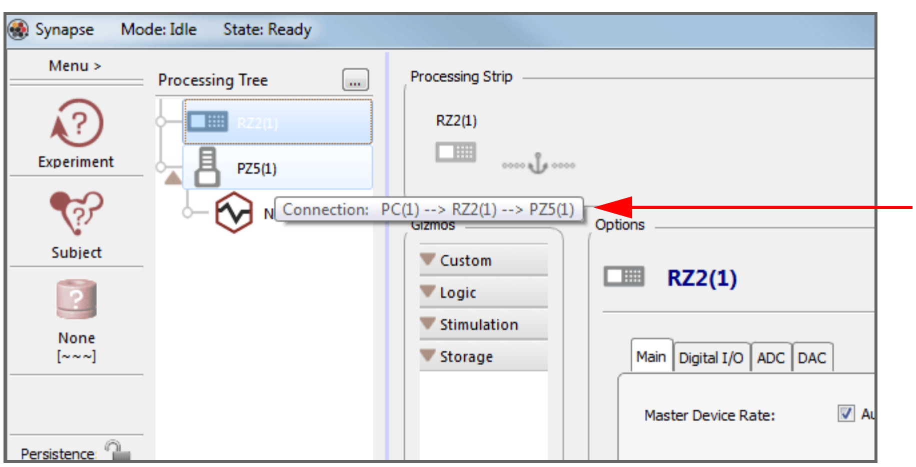
Click the triangle/arrow to expand or collapse a branch.



Biological signals are typically acquired on a PZ amplifier; so neural processes, like spike detection, are added to the PZ in the tree.

Multiple tasks can be added to any branch, in parallel or one after another with tasks ordered logically.

Mouse over a device to see how the hardware devices are connected.



Context Sensitive Hardware Connection Tip

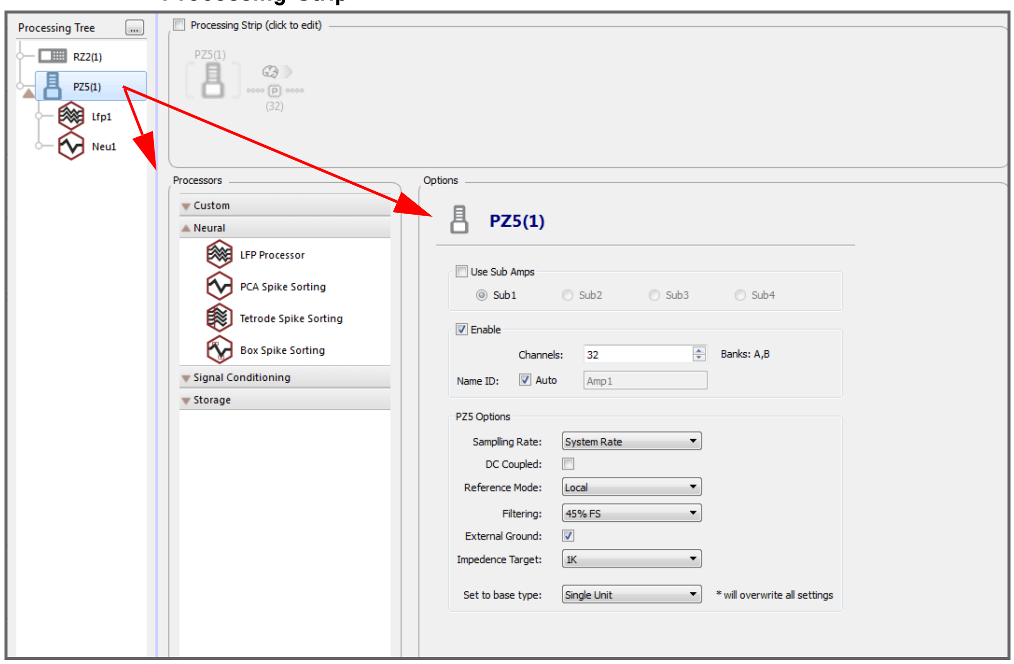
Using the Processing Tree

The Processing Tree is a simplified view of the experiment. The specifics can be more closely examined in the details area. When an item is selected in the tree, the details area is divided into three sub-areas: the Processing Strip, the Gizmos list, and the Options area.

The information displayed in these three subareas is specific to the selected item or branch:

The Processing Strip	displays a drilled down look at the corresponding branch of a signal or data path
The Gizmos list	displays tasks that can be added to the selected item
The Options area	displays configuration options for the selected item

Processing Strip



Processor list **Options area**

Synapse Designtime Window

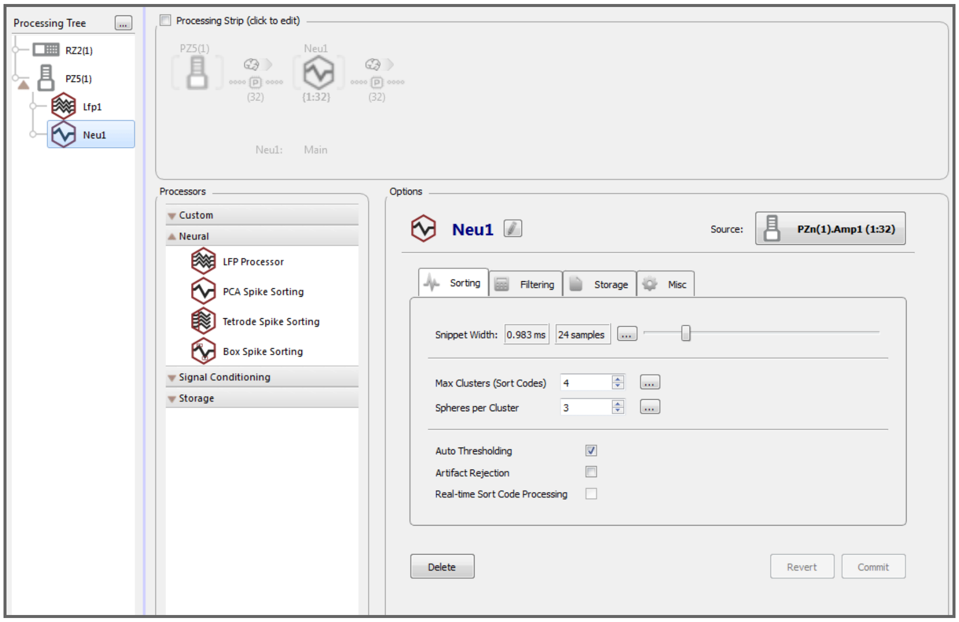
Selecting a hardware device in the Processing Tree updates the Gizmos list to show only the tasks appropriate for that device and displays configuration information for the device in the Options area. This information is saved as part of the experiment and is also referred to as a HAL (Hardware Abstraction Layer) because it gives Synapse everything it needs to manage the hardware-related low level programming tasks.

Similarly, selecting a gizmo in the tree displays the settings for the gizmo, typically arranged on tabs in the Options area.

To display configuration options for an item in the Processing Tree:

- Click the corresponding icon in the tree diagram.

  The settings are displayed in the Options area.



Designtime Window with the Neu1 Gizmo Options Displayed

To delete a device or gizmo:

- Right-click the corresponding icon in the Processing Tree and click **Delete** on the shortcut menu.

  The item is removed from the experiment (this does not remove a device from your rig, but you must return to the Rig Editor to make it visible again).

To reset a device or gizmo:

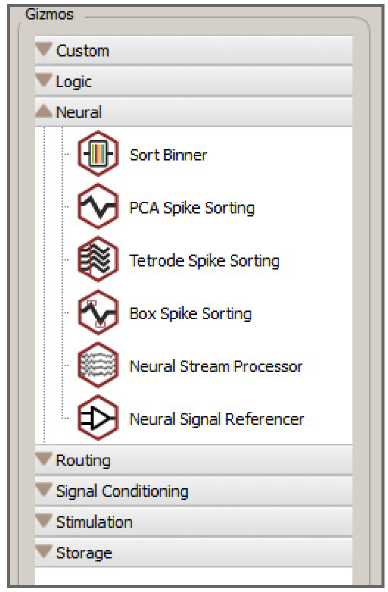
- Right-click the corresponding icon in the Processing Tree and click **Reset to Default** on the shortcut menu.

To add a previously unused HAL:

- Right-click a related icon in the Processing Tree and click **Add HAL** on the shortcut menu.

This option allows you to add a HAL for a device that is present in your Rig, but previously not in use in the experiment. By adding the HAL directly in the Processing Tree, you avoid returning to the Rig Editor which resets all of your device HALs.

The Gizmos List



The Gizmos List

Only gizmos that can connect to the currently selected object in the Processing Tree are shown. Select a different item in the Processing Tree and different gizmos will be displayed.

The gizmos are grouped by task type, such as storage or signal conditioning.

To expand or collapse a group:

- Click the or triangle/arrow to the left of the group name.

To add a gizmo to the selected item in the Processing Tree:

- Double-click the gizmo icon.

Gizmos in the list are like menu choices, they can be added to the Processing Tree more than once and for more then one input/output source.

Gizmo Groups

Custom

User designed gizmos or TDT customized functions. See “Creating User Gizmos” on page 305.

Logic

Gizmos that perform logical tests and generate logic pulses. See “Logic” on page 119.

Neural

Tasks associated with neural processing, including runtime visualization and sort code processing. See “Neural” on page 141.

Routing

Gizmos that group, extract, or direct signals. See “Routing” on page 189.

Signal Conditioning

Tasks associated with refining or improving signals. See “Signal Conditioning” on page 207.

Stimulation

Gizmos that design, generate, and control stimuli. See “Stimulation” on page 231.

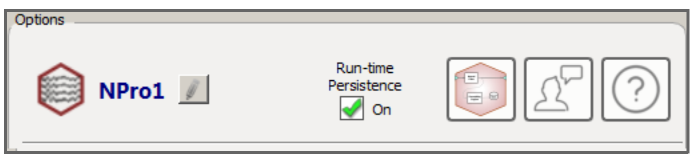
Storage

Gizmos that store various types of data. See “Storage” on page 283.

The Options Area

Name/Source/Block Diagram

The top section of the options area differs slightly depending the device or gizmo selected. It typically displays an editable device or gizmo icon and name. It may also display the Primary Source for the device or gizmo and the BLOCK DIAGRAM toggle button.



Gizmo Configuration Options

The Gizmo Name

The gizmo name is generated automatically for you and is based on the type of gizmo selected. If needed, click the EDIT icon to modify the name. The name must be at least three letters long and the first three letters are used to form the Storage ID for any related data stores in the data tank. The field turns red if the minimum three letters are not included.

Changing the name of a gizmo that includes data storage will change the name(s) of the storage ID(s) in the data tank. Synapse will display a warning dialog box the first time you attempt to do this. It is best not to change the store name after you have collected data with the experiment.

Run-time Persistence

When checked, the run-time persistence for this gizmo is reloaded for each recording. When disabled, the persistence is always fresh, meaning the designtime settings are always loaded when the recording begins.

The Block Diagram Button

The BLOCK DIAGRAM button provides access to source settings and the block diagram. See the reference section for the selected gizmo for more information.

The Feedback Button

Send TDT feedback on Synapse, this gizmo, or anything else you want to let us know about.

The Help Button

Opens the Synapse Manual PDF to the current gizmo to learn more about it.

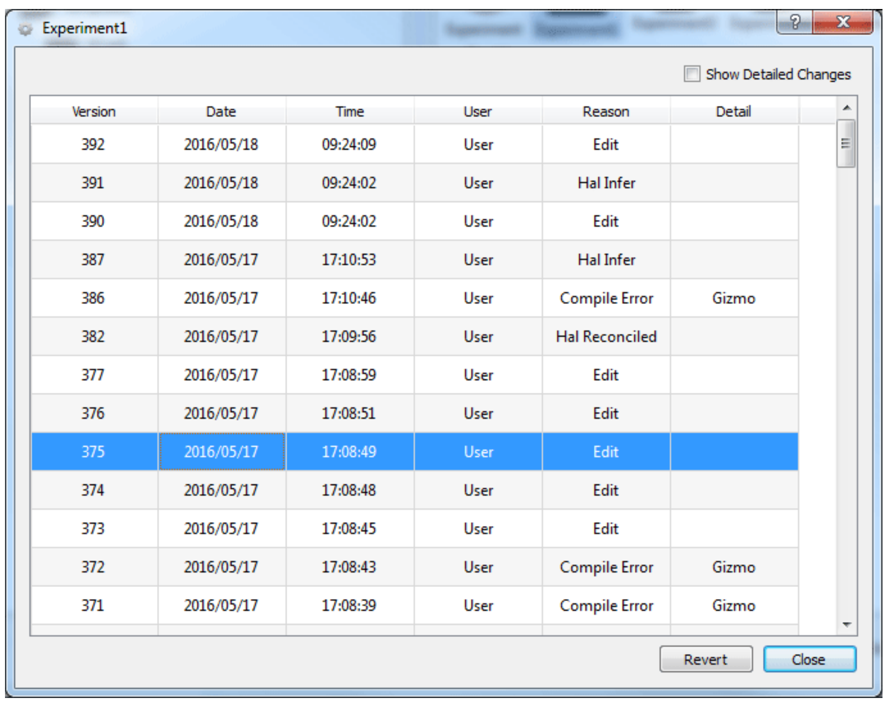
Global Options Buttons

Located below the options tabs and applied across all tabs.

Delete button	Delete the gizmo from the Processing Tree.
Revert button	Return to the last saved or 'committed' state.
Commit button	Save changes on all tabs.

Experiment Changes and the Revision Log

In Synapse, the experiment is saved each time you make or "Commit" a change. If you need to roll back a change in the experiment design, you can do so in the Experiments Revision Log.



Version	Date	Time	User	Reason	Detail
392	2016/05/18	09:24:09	User	Edit	
391	2016/05/18	09:24:02	User	Hal Infer	
390	2016/05/18	09:24:02	User	Edit	
387	2016/05/17	17:10:53	User	Hal Infer	
386	2016/05/17	17:10:46	User	Compile Error	Gizmo
382	2016/05/17	17:09:56	User	Hal Reconciled	
377	2016/05/17	17:08:59	User	Edit	
376	2016/05/17	17:08:51	User	Edit	
375	2016/05/17	17:08:49	User	Edit	
374	2016/05/17	17:08:48	User	Edit	
373	2016/05/17	17:08:45	User	Edit	
372	2016/05/17	17:08:43	User	Compile Error	Gizmo
371	2016/05/17	17:08:39	User	Compile Error	Gizmo

Experiment Revisions Log

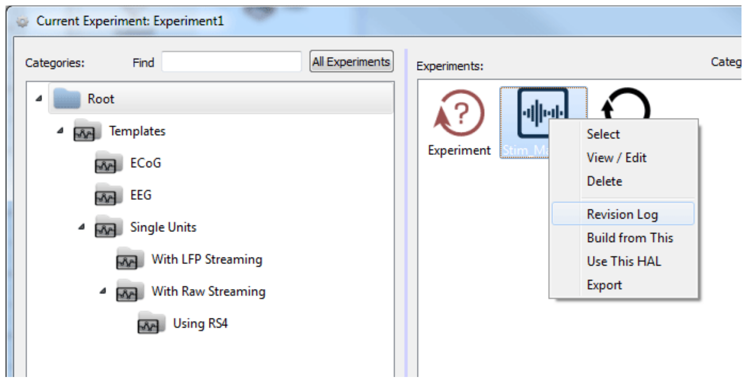
In the log, information about experiment changes is organized into columns and rows. By default, changes are shown with the most recent changes at the top. You can sort the information by clicking a column header. When you find the version you need, select it and click the REVERT button.

Opening the Revision Log

If you have the experiment open and it has a revision history, a "Revision Log" command is added to the Experiment Button menu.

If the experiment is not open:

1. Click the Experiment Button and MORE.
2. In the Experiment Selection Window, right-click the experiment icon and click REVISION LOG.



Experiment Selection Window with Experiment Shortcut Menu Shown

The Connections Diagram

The Connections diagram provides a top-level view of experiment design. The diagram is available from the MENU or the  CONNECTIONS button, and can be printed.

Each node shows available inputs and outputs. The color of arrowheads on the connection arrows indicates the data type (such as logic or floating point). The arrows are also labeled with the channel range for any multi-channel signals.

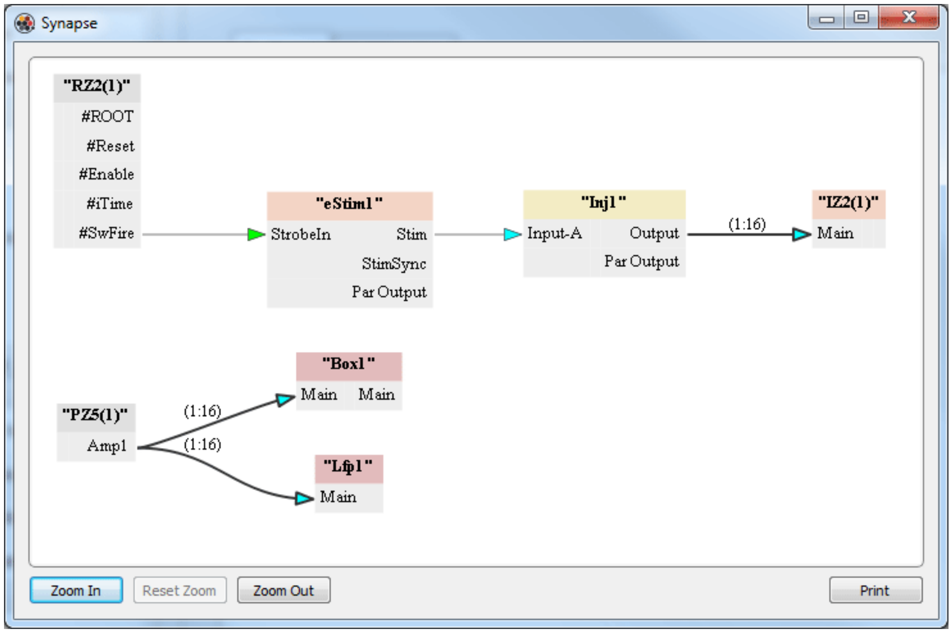
Common data types include:

 floating point type

 integer type

 logical type

The diagram also functions as a debugging tool. You can double-click a node to jump to the selected gizmo or HAL and make changes.

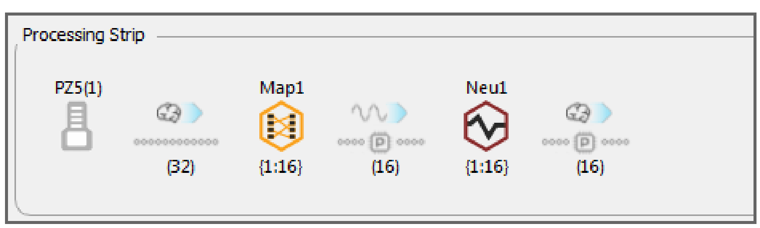


Connections Diagram

In the diagram above, a logic signal from the RZ2 triggers electrical stimulation. A single channel, floating point signal is passed from the stimulation gizmo to an injector gizmo where it becomes a 16 channel data stream routed to the IZ2 HAL. The diagram also shows data acquired from a PZ5 is passed to two different gizmos for parallel processing.

The Processing Strip

The Processing Strip can be shown as part of the Synapse main window using the Preferences dialog (see "Synapse Preferences" on page 59). It displays a branch of the signal or data path, from the signal source to the item selected in the Processing Tree. The primary purpose of the Processing Strip is to provide information about the signal path at a glance.



The Processing Strip

The number of channels in the signal stream are displayed beneath the gray line representing the signal path. The number shown is the number of channels in the signal at the output of the device or gizmo (process) to the left. In the illustration above, the number of channels at the output of the MAP1 process is 16. The number of signals fed into the process was 32, so the illustration shows that the number of channels mapped and passed through does not include all channels.

The numbers below a gizmo display the first channel number in the signal and the number of channels in the signal, that is {first channel:number of channels}. Many gizmos allow the user to change the channel range. This makes it possible to split up a multi-channel signal into several different branches so they may be processed differently.

Menu and Command Bar

Main Menu

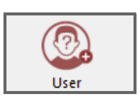
Click **Menu** to display.

Preferences	Launch the Preferences dialog.
Edit Rig	Auto-detect hardware or configure devices manually.
Clear Session	Clear all experiment settings and return to the default state.
Log Window	Open the Log window.
Connections	Open the Connections dialog.
Notes	See the Notes for the currently selected User, Subject, or Experiment.
Clean Storage	Clear database records from old Preview recordings or Empty Data Tank folders that have no blocks in them.
Help	Launch the software manual (PDF).
About	View version number and copyright.
Exit	Close the program; will prompt to save open experiments.

Categories

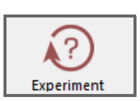
Click corresponding button to display.

Menu options are available in IDLE mode only, unless otherwise specified.



User (optional)

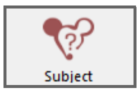
User Names	Select a user name from the list.
New	Launch a User dialog box to add a new user profile.
More....	Launch the User window where you can choose an existing user or launch the User dialog box to create a new one.



Experiment

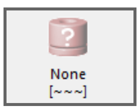
Experiment Names	Select an experiment from the list.
Undo	Return to the state before the last change.
Redo	Redo last action that was undone.
Locked	Locks the current experiment so that no accidental changes can be made to it.
Save As	Launch the Experiment dialog box, where you save the experiment with a name, description, and icon.

Export	Export the experiment along with last persistence and supporting files, such as parameter, stimulation, and map files.
Logs	Open a memo dialog box.
New	Launch the Experiment dialog, where you can create a new experiment.
Revision Log	Open an experiment specific history of changes that can also be used to return to an earlier version of the experiment.
More....	Launch the Experiment window where you can choose an existing experiment or launch the Experiment dialog box to create a new one.



Subject

Subject Names	Select a subject name from the list.
New	Launch the Subject dialog, where you can create a new subject.
More....	Launch the Subject window where you can choose an existing subject or launch the Subject dialog box to create a new subject.



Tank

Displays current tank and block names. Experiment and subject are used to generate the names according to hierarchy set in the Synapse Preferences. Main label is the string appended to the tank name, sub label is the string appended to the block name.

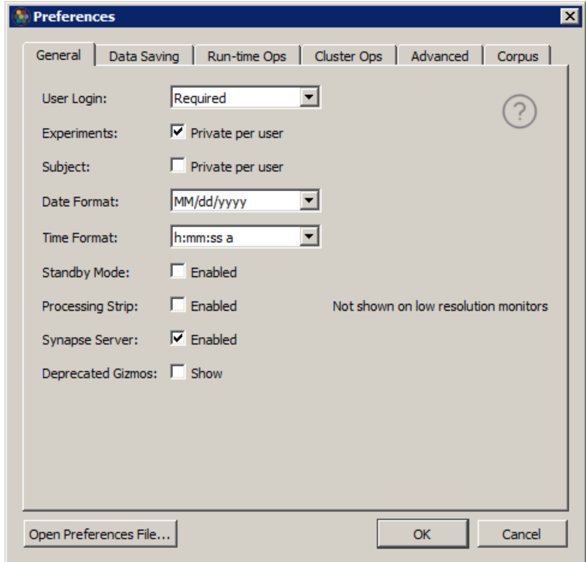
Templates

Templates are experiment files that have been created by TDT. Each template is a basic working experiment that can be run as configured, but you will more likely begin with the template and modify it to meet your needs. Templates have been designed to work with rigs suitable for the type of experiment. When opened, Synapse will attempt to adapt the configuration to your hardware rig and alert you to any conflicts it is unable to resolve automatically.

Synapse Preferences

To view the Synapse Preference dialog:

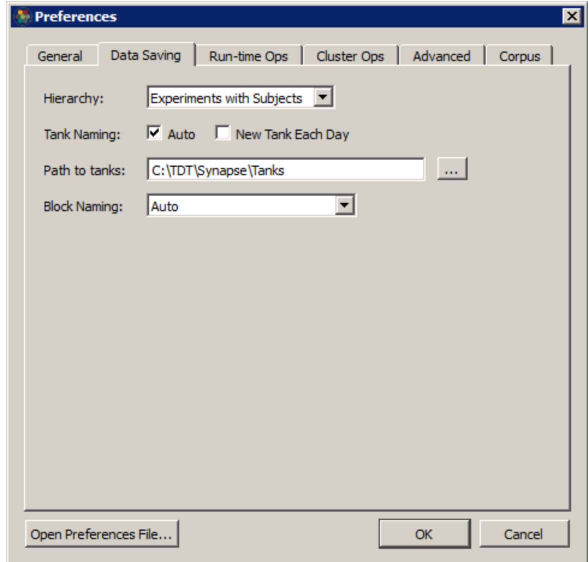
- Click **Menu** at the top of the bar and then click **Preferences**.



Preferences Dialog, General Tab

General

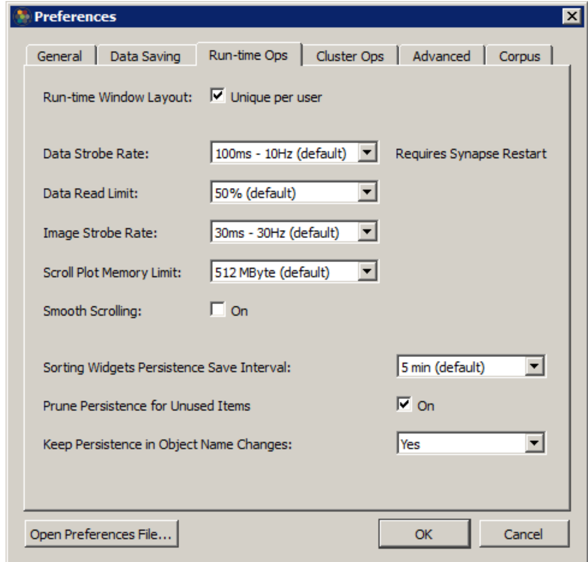
User Login	Choose a user tracking method. None - No user tracking. Required - Users must log in with a user name. Required with Password - Each user must log in with a user name and password.
Experiments	Select check box to make experiments private per user.
Subject	Select check box to make subjects private per user.
Date Format	Choose a date format: MM/dd/yyyy, dd/MM/yyyy, or yyyy/MM/dd
Time Format	Choose a time format: h:mm:ss or hh:mm:ss
Standby Mode	Enable Standby option at runtime. This mode loads the circuits and starts them but does not send the global trigger to begin acquisition. This mode is useful if loading memory buffers through SynapseAPI; it gives the system enough time to load the buffers before starting the recording.
Processing Strip	Show in the main Synapse window.
Synapse Server	Add Synapse Server button in gizmo options so that SynapseAPI parameters and syntax can be displayed. Requires a Synapse restart. See the *SynapseAPI Manual* for more information.
Deprecated Gizmos	LFP Processor gizmo has been replaced with Neural Stream Processor. The Electrical Stimulation gizmo had a major upgrade to the Electrical Stim Driver gizmo. Check this box to show the old gizmos in the gizmo list.



Preferences Dialog, Data Saving Tab

Data Saving

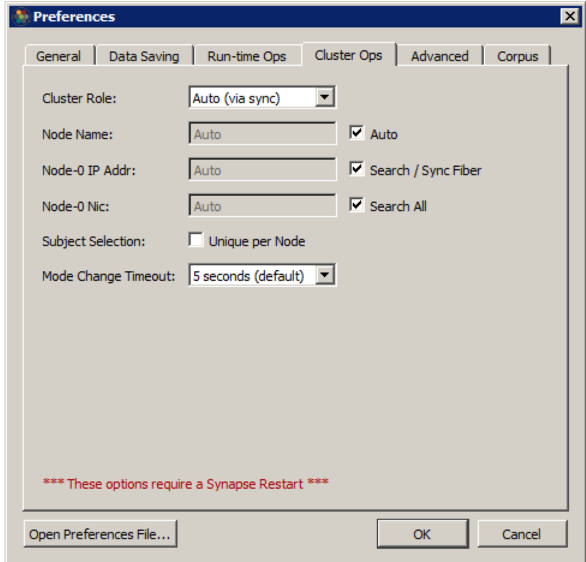
Hierarchy	Choose how tanks and blocks are associated and named. Experiments with Subjects – Experiments are the primary category under which data is stored. Subjects with Experiments – Subjects are the primary category under which data is stored.
Tank Naming	Choose how tanks are named. Auto – Tanks are named automatically based on preferences. New Tank Each Day – A new tank is created automatically each day. When NOT selected same tank is used until the user chooses to create or select a new tank. **Note:** When using New Tank Each Day, instead of including both data and time, Tank names include the date and Block names include the start time.
Path to Tanks	Enter or browse to choose a folder where tanks will be stored.
Block Naming	Choose how blocks are named. Auto – Blocks are named automatically based on preferences. Prompt – User is prompted to name each new block.



Preferences, Runtime Ops Tab

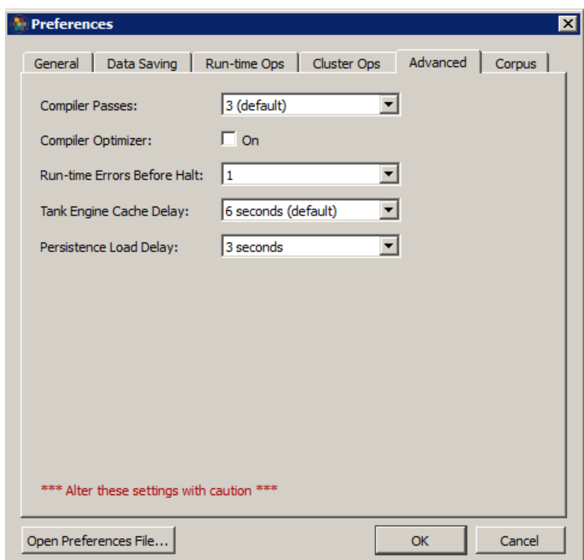
Run-time Ops

Runtime Window Layout	Save a unique window layout for each user.
Data Read Limit	Choose how much of the server resources are allocated to reading/storing data compared to distributing data to user interfaces. Increase this value if you are getting zBus limited readback warnings.
Data Strobe Rate	Choose how often data is saved to the tank and made available for plotting. Change requires Synapse Restart.
Image Strobe Rate	Choose how often plots are visually updated.
Scroll Memory Limit	Choose the maximum amount of memory that will be used for the main data plot time span and history.
Smooth Scrolling	Enable Smooth Scrolling to improve the look of the Data Plot. Note that this adds a 1 second delay between when the data occurs and when it is shown in the Data Plot.
Sorting Widgets...	Save Interval Choose determines how often the sort settings are logged into the database. Increasing this value reduces the amount of non-event related change data is recorded while setting up the sort codes.
Prune Persistence...	Removes persistence settings associated with gizmos that have been deleted from the Processing Tree. Also removes the persistence for channels in a sorting gizmo that are no longer used, for example when the channel count is reduced.
Keep Persistence...	When a gizmo name changes, you typically don't want to reset the persistence. Keep this set to Yes.



Preferences Dialog, Cluster Ops Tab

These settings are only used in Cluster Processing mode and are not available in Synapse Lite. See “Preferences” on page 317 for more information.

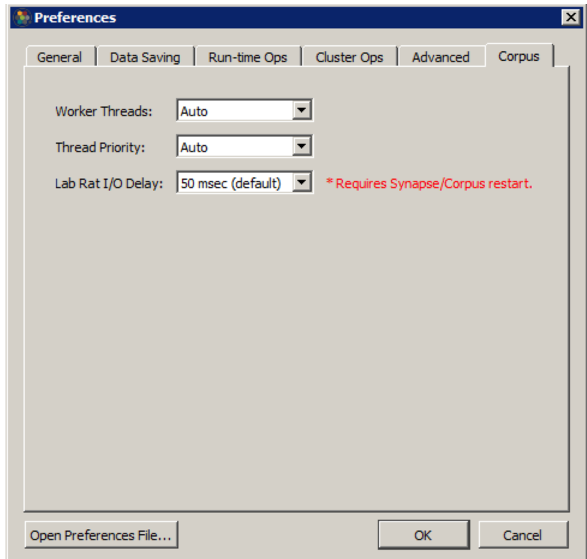


Preferences Dialog, Advanced Tab

Advanced

Compiler Passes	Set the number of attempts the compiler makes to compile the experiment. More passes may be required for larger more complex experiments.
Compiler Optimizer	When checked, Synapse will remove any unused DSP components during compilation. Compilation will take longer, but this may be required for complex experiments to run on the current rig.
Runtime Errors Before Halt	Set the number of reported errors that will cause Synapse to switch to Idle mode. The count is restarted each time Synapse is switched to Record mode.

Tank Engine Cache Delay	The size of the temporary memory buffers. Although a higher setting requires more system RAM, it makes data storage errors less likely.
Persistence Load Delay	Choose the amount of time allowed when switching from Standby to Preview. This ensures all the persistence settings are loaded onto the hardware before the timer starts. Useful for more complex experiments.



Preferences Dialog, Corpus Tab

Corpus

Worker Threads	Set the number of CPU threads allocated to Corpus.
Thread Priority	Set the priority for the Corpus application relative to other applications running on your PC, e.g. Synapse, Matlab.
Lab Rat I/O Delay	Determines the duration of the event loop running on Corpus and the round-trip delay between Corpus and the Lab Rat.

Global Buttons

Open Preferences File	Click to open text based ini file with all preferences.
OK Button	Apply changes and close dialog.
Cancel Button	Close dialog without applying changes.

Runtime

This chapter covers run modes, persistence in the Flow Plot, tank/block naming prompts, and log files.

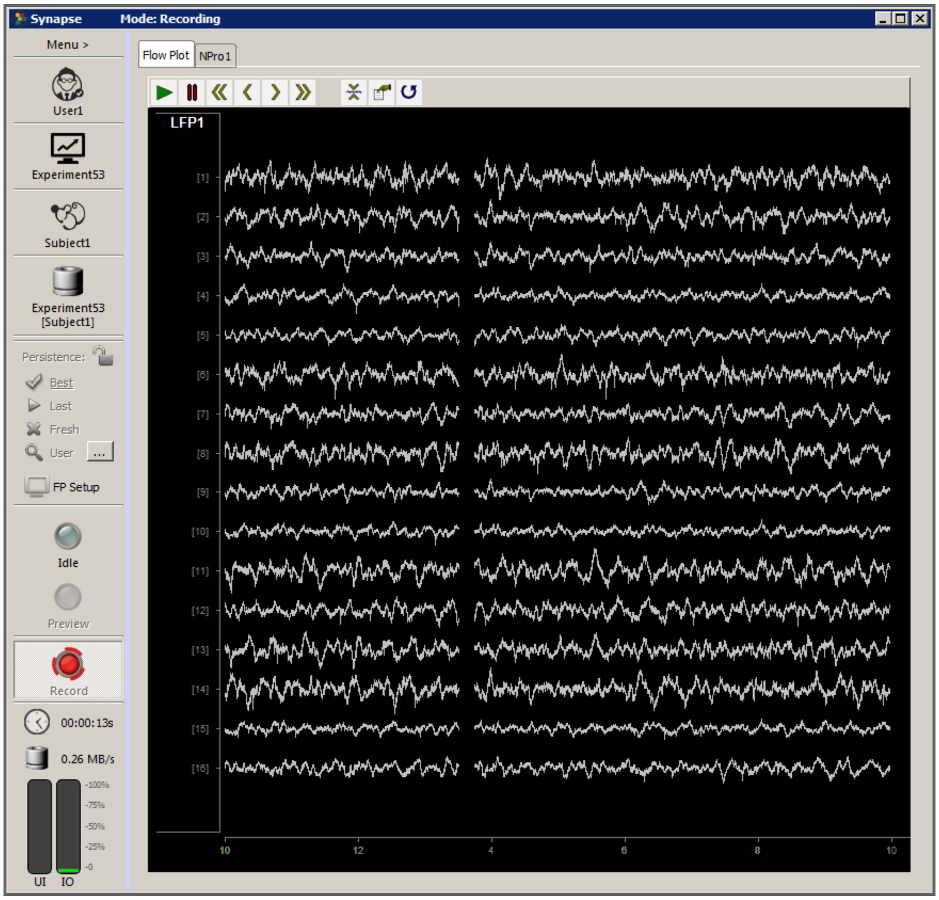
Controlling an Experiment

Runtime Modes

The control buttons allow the user to run or halt the experiment. They are enabled or disabled (grayed out) based on the available choices.

Idle	Devices are not loaded and are not running.
Preview	Data is saved to a temporary block in the tank. Users can examine data in the Flow Plot. This allows users to modify parameter values before starting the experiment. Data is deleted when switching to Idle mode.
Record	Devices are loaded and running and data is saved to the tank. The Experiment and Subject must be configured before the Record button becomes active.
Standby	Disabled by default and enabled in the Synapse preferences (See “Synapse Preferences” on page 59). In this mode devices are loaded and running but signals are not being acquired and saved to disk.

Flow Plot



Runtime Window

The Flow Plot window is automatically displayed in Preview and Record modes for fast, easy visualization of data.

The Flow Plot Tab

The primary plot includes a default plot configuration for each type of data being recorded. Users can adjust the plot settings to refine the display. The example plot above shows a subplot labeled LFP1 that displays 16 channels of streamed biological data using the Neural Stream Processor gizmo.

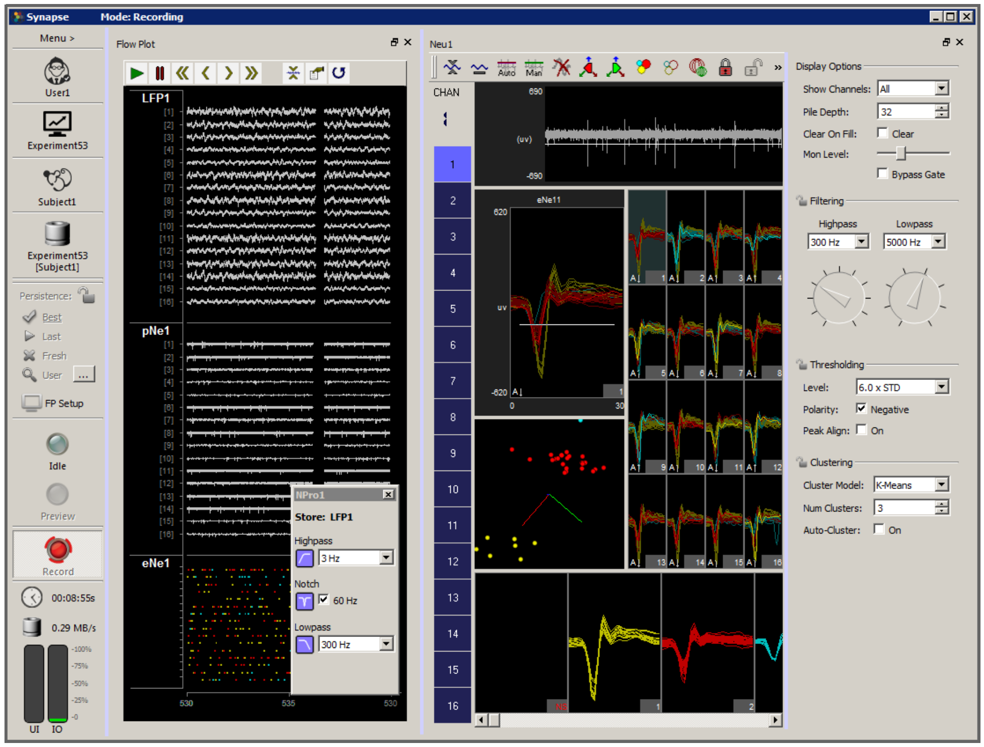
Subsequent Tabs

Many gizmos add a tab to the tabbed window. The added tab contains runtime control features such as threshold and filtering controls.

Working with Tabs

Tabs can be floated, split, and merged back into the tab framework.

Float	Click and drag a tab to float and reposition the window.
Split	Right-click a tab then select an option on the shortcut menu to split the main window.



PCA Spike Sorting and Neural Stream Processor Interfaces

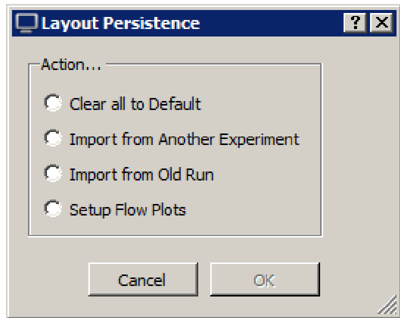
Persistence

Any changes to the run-time settings are saved with the Experiment and Subject in the Synapse database. This allows you to The Persistence options on the left toolbar determine how these run-time parameters are saved and reloaded.

Lock icon	Locks the currently selected persistence. Otherwise the persistence selection always returns to BEST when the experiment ends.
Best	Use the last settings for the current experiment and subject combination.
Last	Use the last settings for the previous recording, regardless of subject or experiment. This is useful if you are using the same subject with a new experiment. For example, if you have PCA space sorting parameters defined for the subject and want to use them in a different experiment.
Fresh	Don't load any persistence, use the default experiment settings instead.
User	Launch the History window. Right-click on a previous recording and choose "User starting state" or "Use ending state", or right-click in the Changes list at the bottom to select a subset of changes from that recording to use for the next recording.
RT Layout	Choose the window layout configuration. See below.

Layout Persistence

Information about the window layout and Flow Plot settings (scale factors, plot positioning, etc) is specific to the User and is separate from experiment persistence information. Options are accessible in the RT Layout button. You must have a named User for the layout to be saved.



Layout Persistence Dialog

Clear all to Default

Reset everything to the default layout and Flow Plot configuration scaling.

Import from Another Experiment

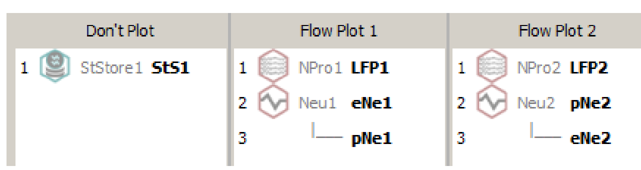
Choose a previous User and Experiment combination from the Synapse database to load the layout from.

Import from Old Run

Load the layout from a previous recording. This uses the block folder directly from disk and does not need the Synapse database for this.

Setup Flow Plots

Configure the ordering of the stores for the current experiment within the Flow Plot. This option also lets you split out different stores to entirely different Flow Plot tabs. This is useful for organizing the layout, particularly when doing multi-subject recordings.



Multi-Subject Example Layout

During run-time, the RT Layout button turns into an FP Setup button, which allows you to edit the location of the stores within the Flow Plot(s) and to hide them altogether.

Toolbar and Menu Reference

The Toolbar

A toolbar at the top of the Flow Plot allows the user to control plot animation.

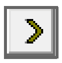
The toolbar contains the following commands:

 Play

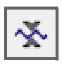
 Pause

 Scroll back by plot window width (e.g. if span is set to 60 seconds, this button will scroll back in 60 second chunks)

 Scroll back (increments of span/10)

 Scroll forward (increments of span/10)

 Scroll forward by plot window width

 Auto Scale

 Data Monitor Setup (launch dialog)

 Refresh

The Shortcut Menu

Additional commands for scaling and shifting plots are available from a right-click shortcut menu on the Store name in the plot.

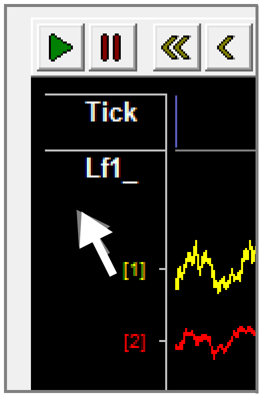
Auto Scale	Scale the display so that it best fits in the available subplot area.
Scale Up/Down	Incrementally scales the display up or down.
No Shift	Removes any offset that was placed on the display in the subplot window.
Shift Up/Down	Shifts the display up or down in the subplot window.
Make larger/smaller	Makes the available subplot area larger or smaller. The other plots are resized accordingly.

Plot Display Options

Users can change the plot type, modify the number of channels viewed, and choose to color traces by channel or sort code in the Display Options dialog.

To modify the display options:

- Double-click the desired subplot.



Data Monitor Setup

Users can change settings related to the time span and tracking of the plot window in the Data Monitor Setup window.

To view data monitor settings for the plot:

- Click the  **Data Monitor** button on the plot toolbar.

Time Span Control

Span	Set the time span (sec) of the plot window.
History	Determine how much plot history will be available to view.

Note how the memory requirements change as these settings are adjusted.

Tracking Mode

Reference Epoch	If a reference epoch is selected, the left side of the Plot window will always coincide with the start of the reference epoch event.
Time Axis Overlap	Set the amount of the time axis that is repeated when the plot rolls over. For example, if the span is 10 seconds and Time Axis Overlap is set to 50%, the plot will show seconds 0-10, 5-15 etc.
Time Display Mode	Set the display units of the time axis.

More Settings

Press Shift + Ctrl and double-click the dialog box to display additional settings for the plot appearance, such as background color and labels.

Part Three: HAL Reference

Hardware Reference

The hardware choices that you make in the Rig Editor appear as gray icons in the Processing Tree. Your experiment choices are mapped to the hardware in your rig and Synapse generates the required code instructions, optimized for your hardware. While Synapse provides this automation and optimization, it also exposes the configuration options through an Options page for each piece of hardware. This gives you a streamlined way to make experiment-specific hardware choices, such as the number of recording channels, operational modes, and input sources.

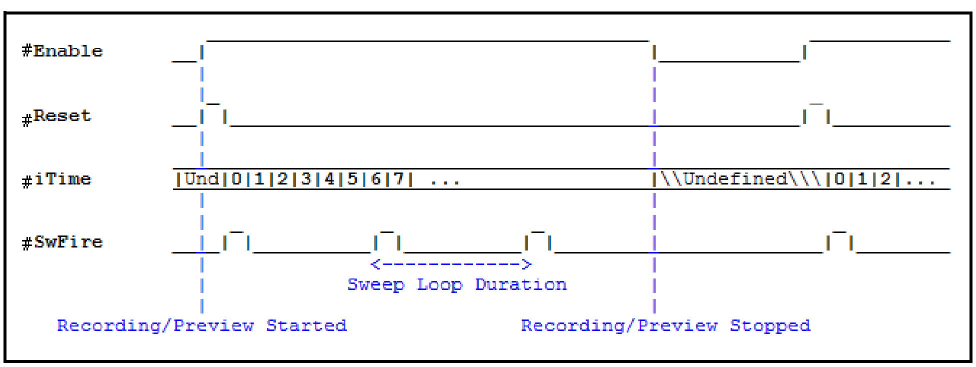
Device settings for an experiment are displayed in the Options area of the designtime interface when the device is selected in the Processing Tree. Any change to hardware options must be committed or reverted by clicking the corresponding button in the Options area.

RZ Processor Options

Timing Signals

Before looking at the specific experiment HAL options, it is important to know that whenever an RZ Device is included in your Rig, the following timing signals will be available from the device. They will typically show up as drop down menu options when you are configuring a signal source for a gizmo.

#Enable	Logic	Enables processes, such as data storage, through the duration of each block.
#Reset	Logic	Resets counters at the start of each block.
#iTime	Integer	TimeStamp that denotes elapsed since device synchronization (beginning of each block).
#SwFire	Logic	A pulse that triggers the onset of each sweep in sweep-based protocols (such as stimulation).

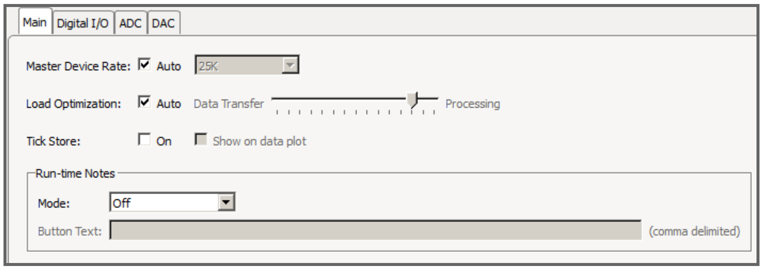


Time Control Waveform Diagram

RZ Options

Some options may not be available for some RZ devices.

Main Tab



Main RZ Options Tab

Master Device Rate

Auto Check Box

Select to allow Synapse to determine the master sample rate based on the gizmos assigned to this RZ, or clear it to enable the drop-down menu and set the sampling rate manually.

Load Optimization

Auto Check Box

Select to allow Synapse to balance the processing load between data processing and data transfer automatically.

Clear to enable the slider and then drag the slider to set manually. For experiments that require heavy data transfer rates, move the slider to the left. For experiments with heavier processing loads, move the slider to the right.

Tick Store

On Check Box

Select to enable the Tick data store, which fires once per second. You can also choose whether to display this on the Data Plot during run time.

Run-time Notes

Mode

Turn this feature on to record notes during run time that are associated with the current block. An additional run time tab lets you add custom notes. These will be included in the database and will be available as a text file inside the block folder.

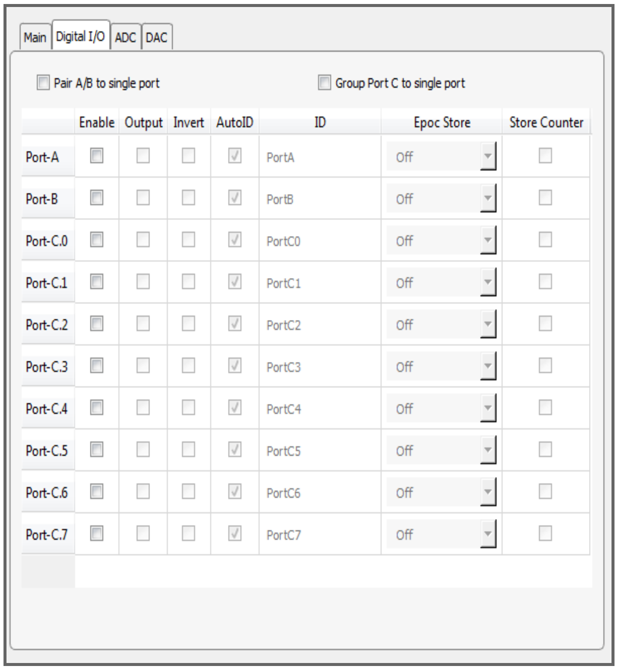
If 'Notes File + Epocs' is selected, a timestamp of when the note occurred along with a value code will be included in the data tank in the 'Note' epoc store.

Note: This only works In Record mode and is not available in Preview mode. The 'Note' epoc store will always be hidden by default.

Button Text

If you want to quickly mark events as they are happening during the recording, add a comma separated list of the notes you want. This text will appear on individual buttons that will add the note when clicked.

Digital I/O Tab



Digital I/O Options Tab

The RZ has 24 total bits of digital I/O, configured in two bytes (Port-A and Port-B) and eight bits (Port-C). Enable the desired I/O and set the direction with the OUTPUT check box. When the OUTPUT check box is selected for a given row, a data source must be selected in the ID column. If the OUTPUT check box is cleared, that row turns into a data source that can be connected to other gizmos. The name of the data source is set in the ID column.

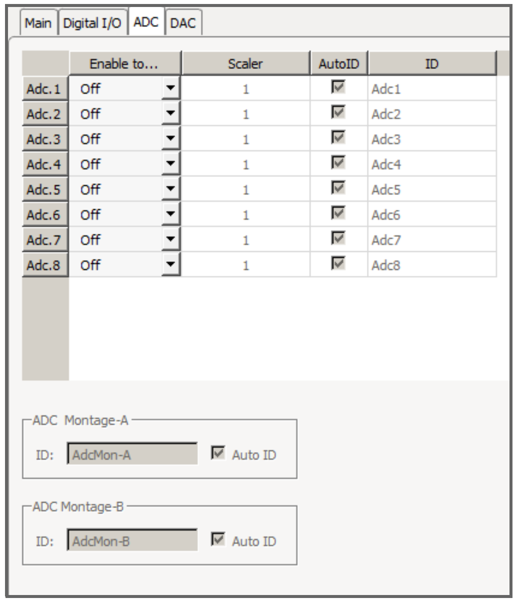
A counter may also be stored for bits in port C. The counter may be useful for synchronizing to an external camera system.

Select the PAIR A/B TO SINGLE PORT check box to combine A and B into a single 16-bit integer source or input link.

Select the GROUP PORT C TO SINGLE PORT check box to combine the eight bits into a single byte.

Set EPOC STORE to ON CHANGE to automatically add an Epoc Store for the corresponding byte or FULL, ONSET, or OFFSET for corresponding bit. When this method is used, you don't have to add an Epoch Event Storage gizmo to the processing tree.

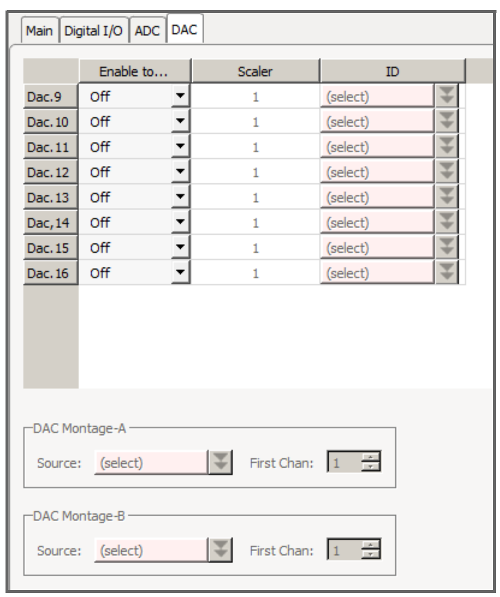
ADC Tab



ADC Options Tab (shown for RZ2)

Analog input channels appear on the ADC tab. Each channel can be used individually as a single channel floating point data source for other gizmos, or can be grouped into one of two montages, which are multi-channel floating point data sources. You can also apply a scale factor to each channel to convert to the correct units.

DAC Tab

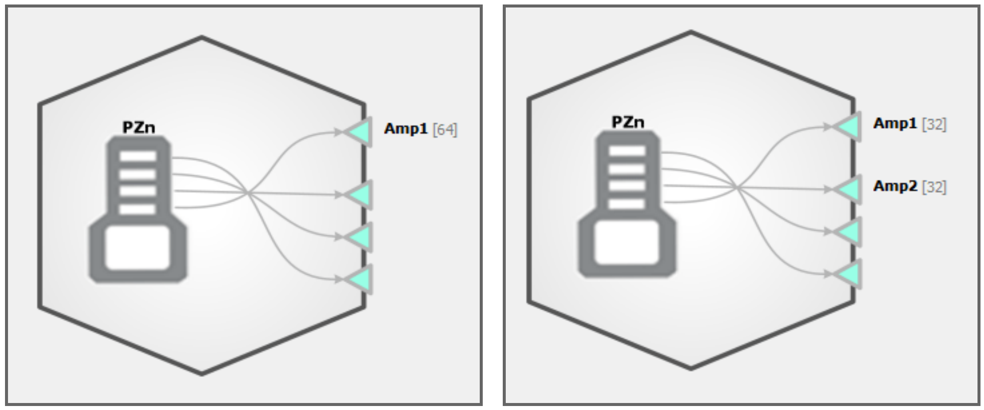


DAC Options Tab (shown for RZ2)

Analog output channels appear on the DAC tab. For RZ6, the built in attenuators also appear on the DAC tab.

Each channel can be used individually as a single channel floating point data sink, or can be grouped into one of two montages, which are multi-channel floating point data sinks. You can also apply a scale factor to each channel to convert to the correct units before it is sent out of the RZ. A data source for the enabled output channels/montages must be selected.

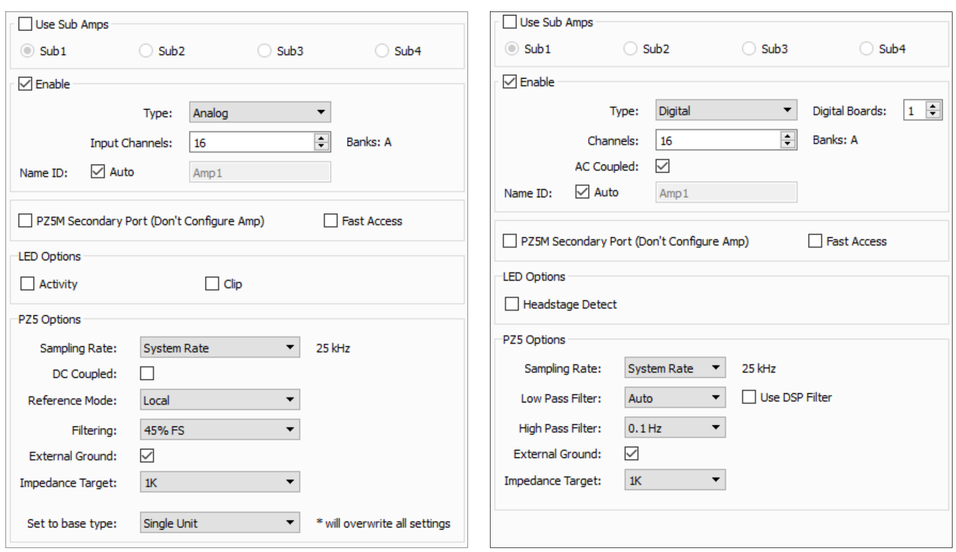
PZ Amplifier Options



PZ Block Diagrams, showing a single amp (left) and sub amps (right)

The PZ amplifier HAL reads data from a connected PZn amplifier. The options vary for each amplifier model. The PZ5 amplifier can have up to four logical sub amps; each sub amp is individually configurable and forms a multi-channel floating point data sources that can be linked to other gizmos. All other PZs have one multi-channel floating point data source.

PZ5 Options



PZ5 Analog (left) and Digital (right) Options

Use Sub Amps check box	Select to divide input channels into logical sub amps that can be used to record different types of signals, at different rates, referencing modes, and other settings.
Sub Amps radio buttons	Select a radio button to view and edit settings for the corresponding sub amp: Sub1, Sub2, Sub3, or Sub4.

When sub amps are used, all of the below configuration options apply only to the selected sub amp. Each sub amp that will be used must be configured separately.

If a conflict or error is detected as a result of any changed settings, Synapse displays the relevant sub amp settings and a red warning.

Enable	Select to enable the selected sub amp.
Type	Use an Analog or Digital amp board. When using Digital Amps, specify the number of boards. Selectable values are limited by the Rig configuration.
Channels	Type or click arrow keys to set the number of channels. The channel count must be at least four and must be a multiple of 2. The corresponding physical bank of channels on the PZ5 is displayed to the right. Note: In Differential Reference Mode, the channels from the PZ5 sub-amp are mapped for you to remove duplicates.
Name ID	Choose the name for this sub amp data source that will be visible to other gizmos.

PZ5M Secondary Port (Don't Configure Amp)

When using a PZ5M with either 256 or 512 channels, two PZ5 HALs may be specified in the Rig Editor, one for each fiber optic connection from the PZ5M. Only the fiber connected to the Primary port can configure the PZ5M. Use this check box on the PZ5 HAL connected to the Secondary port on the PZ5M. This setting disables the HAL configuration options and only reads the channel data from the port.

Fast Access	For a PZn connected to a DSPP card, select to perform 16-bit data reads to reduce cycle usage on the DSP.

LED Options

Tell the PZ5 whether to flash the green activity LEDs on its front panel when activity is detected, the red clipping LEDs when the signal is close to saturating the amplifier, or both.

PZ5 Options Sub-Group

The PZ5 Options contain the logical amplifier settings for each sub amp.

Sampling Rate	Set the Sampling Rate to match the desired frequency band of your incoming signals (or leave at 'System Rate' if you are unsure). By default, the sampling rate matches that of the RZ.
External Ground	Connect this sub-amp ground to the external ground plug on the physical PZ5 device. Use caution when using multiple sub-amps that they aren't all sharing the External Ground connection or else they won't be isolated!

PZ5 Logical Analog Amps

DC Coupled	Remove the 0.4Hz high pass filter on the input signals and record DC potentials.

Reference Mode	Select the mode from the drop-down menu. Local - each bank of 16 uses its own reference (pin 5 on the DB26). Shared - all channels in sub-amp share the same reference (pin 5 of first bank in sub-amp). None - the ground connection is used as the reference. Differential - each even channel acts as a reference for the odd channel before it. Note: the output channels will be mapped for you to remove duplicate channels.
Filtering	Set the anti-aliasing low pass filter cutoff as a percentage of the sampling rate.
Impedance Target	This only affects the displayed impedance text colors on the touchscreen when running an impedance check. Must be using a passive headstage to run impedance check.
Set to base type	If you are unsure, use Set to Base Type to configure the amp with default settings based on common signal types.

PZ5 Logical Digital Amps

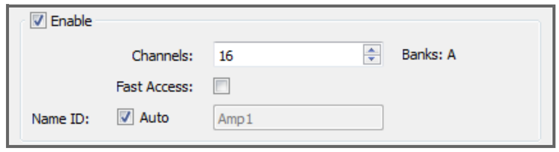
AC Coupled	Apply a 0.4Hz high pass filter to the incoming signals.
Low Pass Filter	Select a cutoff frequency for a lowpass filter that is implemented on the digital headstage. Set to 'Auto' to match it to the sub-amp sampling rate.

Sampling Rate	LP Auto Filter
750 Hz	300 Hz
1.5 kHz	750 Hz
3 kHz	1.5 kHz
6 kHz	3 kHz
12 kHz	5 kHz
25 kHz	10 kHz

Use DSP Filter check box	Add an additional lowpass digital filter implemented on the RZ, set to the same frequency as the Low Pass Filter setting above, to remove high frequency digital noise from the incoming signal that was added by the digitizing chip.
High Pass Filter	Select a cutoff frequency for a highpass filter that is implemented on the digital headstage.
Impedance Target	Use to intelligently control the impedance checking circuit on the headstage.

See the PZ5 section of the **System 3 Manual** for more information about configuring and using the PZ5 amplifier.

PZ2 / PZ3/ PZ4 Options



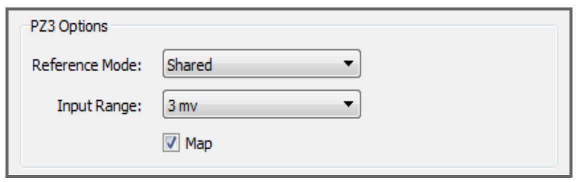
PZ Options

Channels — Type or click arrow keys to set the number of channels.

Fast Access — For a PZn connected to a DSPP card, select to perform 16-bit data reads to reduce cycle usage on the DSP.

Name ID — Choose the name for this data source that will be visible to other gizmos.

More PZ3 Options



PZ3 Additional Options

Options include the PZ2/PZ3/PZ4 options above and these additional choices.

Reference Mode — Select the mode from the drop-down menu.

Shared - all channels use a separate shared reference.

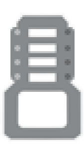
Differential - each even channel acts as a reference for the odd channel before it.

Input Range — Select the desired maximum input range.

Map — Select to remove the even channels and use only the signal channels in the data source output.

See the PZ3 section of the *System 3 Manual* for more information about the operational modes of the PZ3 amplifier.

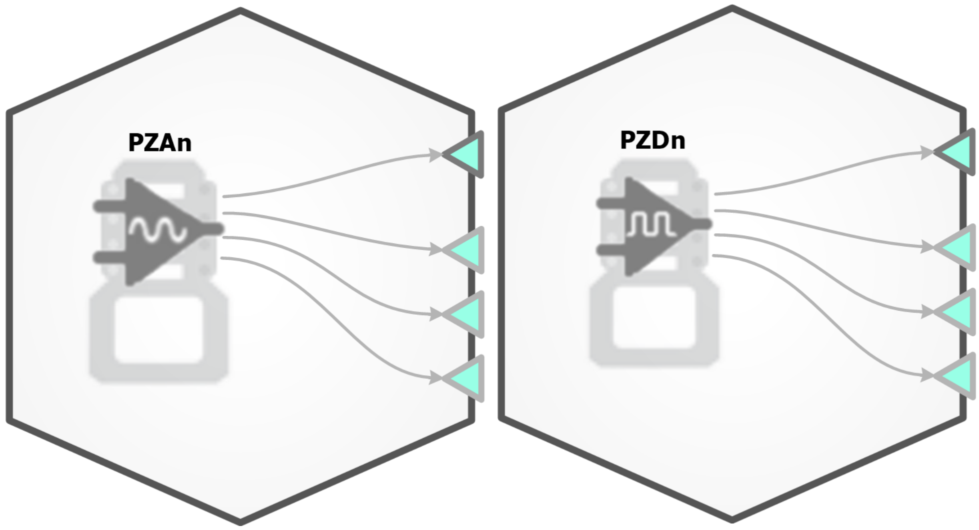
SIM Subject Interface Module



The SIM is the parent object for the SI2, SI4, SI8 Subject Interface module. It connects to a special DSP-M card in your rig. The Subject Interface is configurable with stimulator cards (IZV), analog amplifier cards (PZA), or digital headstage interface cards (PZD). Because of the diversity in functionality of this device, each type of card has its own "Sub-HAL" object within Synapse. The acquisition and stimulation all happen within the Sub-HALs, which are all independent objects in the Processing Tree.

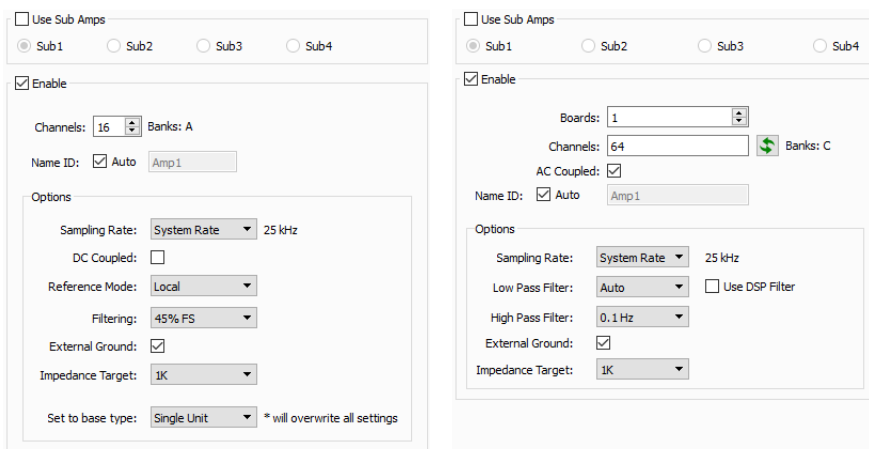
PZA Analog Amplifier & PZD Digital Headstage Interface

Like the PZ5, the PZA & PZD can split the available boards into sub-amps which are completely isolated from one another.



PZA and PZD Block Diagrams

PZA & PZD Options



PZA Analog Options (left) and PZD Digital Options (right)

USE SUB AMPS to divide the input channels into "logical amplifiers" that can record different types of signals, at different rates and referencing modes with independent grounds. All of the below configuration options apply only to the selected sub amp.

BOARDS — When using Digital Amps, specify the number of boards to include in this sub-amp. Selectable values are limited by the Rig configuration.

CHANNELS — The channel count must be at least four and must be a multiple of 2. The corresponding physical banks on the SI are displayed to the right.

For the PZD, click the Refresh button to automatically detect the connected headstage count (your

	RZ hardware must be turned on and connected for this to work).
	For the PZA, in Differential Reference Mode set the total electrode count here. The channels from the PZA sub-amp are mapped for you to remove duplicates on the output link.
Name ID	Choose the name for this sub amp data source that will be visible to other gizmos.

Options Sub-Group

The Options contain the logical amplifier settings for each sub amp.

Sampling Rate	Set the Sampling Rate to match the desired frequency band of your incoming signals (or leave at 'System Rate' if you are unsure). By default, the sampling rate matches that of the RZ.
External Ground	Connect this sub-amp ground to the external ground plug on the physical SIM device. Use caution when using multiple sub-amps that they aren't all sharing the External Ground connection or else they won't be isolated!

PZA Logical Analog Amps

DC Coupled	Remove the 0.4Hz high pass filter on the input signals and record DC potentials.
Reference Mode	Select the mode from the drop-down menu. Local - each bank of 16 uses its own reference (pin 5 on the DB26). Shared - all channels in sub-amp share the same reference (pin 5 of first bank in sub-amp). None - the ground connection is used as the reference. Differential - each even channel acts as a reference for the odd channel before it. Note: the output channels will be mapped for you to remove duplicate channels.
Filtering	Set the anti-aliasing low pass filter cutoff as a percentage of the sampling rate.
Impedance Target	This only affects the displayed impedance text colors on the touchscreen when running an impedance check. Must be using a passive headstage to run impedance check.
Set to base type	If you are unsure, use Set to Base Type to configure the amp with default settings based on common signal types.

PZD Logical Digital Amps

AC Coupled	Apply a 0.4Hz high pass filter to the incoming signals.

Low Pass Filter	Select a cutoff frequency for a lowpass filter that is implemented on the digital headstage. Set to 'Auto' to match it to the PZD sub-amp sampling rate.

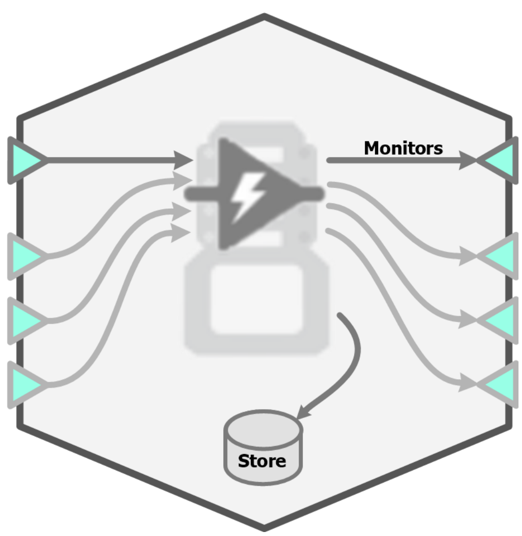
Sampling Rate	LP Auto Filter
750 Hz	300 Hz
1.5 kHz	750 Hz
3 kHz	1.5 kHz
6 kHz	3 kHz
12 kHz	5 kHz
25 kHz	10 kHz

Use DSP Filter check box	Add an additional lowpass digital filter implemented on the RZ, set to the same frequency as the Low Pass Filter setting above, to remove high frequency digital noise from the incoming signal that was added by the digitizing chip.
High Pass Filter	Select a cutoff frequency for a highpass filter that is implemented on the digital headstage.
Impedance Target	Use to intelligently control the impedance checking circuit on the headstage.

See the SIM section of the **System 3 Manual** for more information about configuring and using the PZA amplifier and PZD interface.

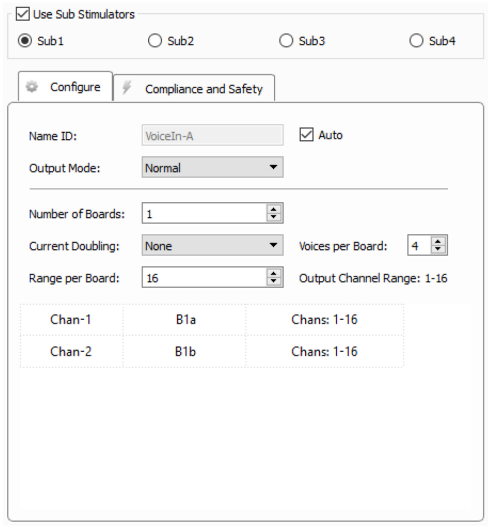
IZV Stimulator

The IZV can split the available boards into sub-stimulators which are completely isolated from one another. It is typically controlled by the Electrical Stim Driver gizmo.



IZV Block Diagram

IZV Options



IZV Stimulator Configure Tab Options

When using Sub Stimulators, each sub-stimulator must be configured independently. Each sub-stimulator has its own multi-channel input signal. For example, the first sub-stimulator uses the gizmo input called "VoiceIn-A", the second sub-stimulator uses "VoiceIn-B" gizmo input, and so on. It is generally expected that this signal comes from an Electrical Stim Driver gizmo so that it has the proper format. The format is a multi-channel signal where the lower channels contain the actual stim waveforms and the upper half contain the target stim channel. For an input that has 4 unique stim signals, it will be an 8-channel signal where channels 1-4 are the stim signals and channels 5-8 are the target stim channel.

Each physical IZV board has 4 unique hardware voices that can route to its 16 output channels.

The data table at the bottom shows the mapping between the gizmo input voices and the physical hardware voices. The first column is the voice of the "VoiceIn" for this sub-stimulator. The middle column is the board number within the sub-stimulator that it uses and the hardware voice on that board it uses (a, b, c, d). The last column is the range of channel numbers that the VoiceIn stim channels should address.

Output Mode

The settings in this group determine how the input VoiceIn signals are mapped to a particular hardware voice on a board of the sub-stimulator. It handles this channel mapping for you, so the stim channels you give it from the Electrical Stim Driver gizmo make sense for how the headstage is physically connected.

PARALLEL assumes boards in this sub-stimulator are wired in parallel, so you can get more than 4 unique voices per 16 channels or up to 4 higher current voices per 16 channels. The VoiceIn input to the sub-stimulator must contain enough voices/channels.

SERIAL assumes channel 16 on all sub-stimulator boards is physically shorted together. Allows one channel of bipolar stimulation with a higher compliance range.

REPEATED repeats the same input voices on all boards of the sub-stimulator.

Number of Boards — Number of boards in sub-stimulator.

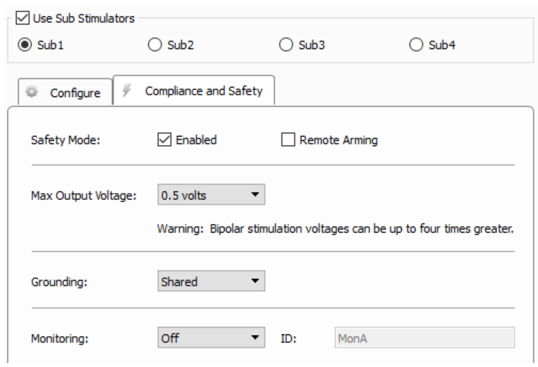
Current Doubling — None - all four hardware voices on each board are unique.

By two - connect pairs of hardware voices together on each board to achieve 2x current output.

By four - connect all four hardware voices together on each board to achieve 4x current output.

Voices per Board — How many unique stim signals for each stimulator board.

Range per Board — How many channels are available to stim on each board.



IZV Stimulator Compliance and Safety Tab Options

Safety Mode — If enabled, IZV checks total output current and will disarm if system is outside specs. The device requires arming before it will operate. To arm, run your experiment and make sure no stim presentation is sent to the device.

The physical IZV card will light all LEDs red if it is not ready to be armed. It will like all LEDs green when it is ready to be armed. When armed, it will light the LEDs on the stimulation channels during stimulation.

Remote Arming — Enable this to force the user to arm the device via the SIM touchscreen interface. Otherwise, the user can arm the device via a button in Synapse at run-time.

Max Output Voltage — Set the maximum allowed output voltage for this sub-stimulator. Max is 15-18V, depending on the current battery level. If Safety Mode is Enabled and any channel goes beyond 1V of this maximum, a Fault occurs and disarms the device.

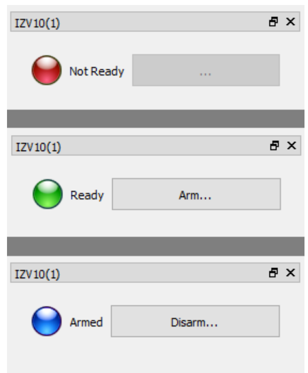
Grounding — Isolated - each bank of 16 uses its own ground connection for return path.

Shared - all banks in sub-stimulator share the same ground return path (ground on first bank of sub-stimulator).

To Banana Jack - connect sub-stimulator ground to the external banana jack on physical SIM device. Use caution when using multiple sub-stimulators that they aren't all sharing the External Ground connection or else they won't be isolated!

Monitoring	Off - disable compliance voltage monitoring. View Only - visualize the compliance voltage for each voice in the Flow Plot at runtime but do not save it to disk. Store - visualize and save the compliance voltage for each voice.

Runtime Interface



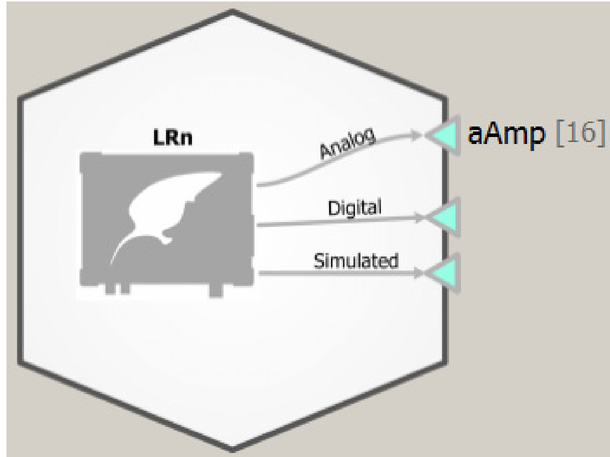
States of the IZV Runtime Interface

If SAFETY MODE is enabled on the **Safety and Compliance Tab**, then an LED will show the state of the compliance monitor. If REMOTE ARMING is disabled, the Arm/Disarm button is shown and the device can be armed when ready.

The system can only Arm if the fiber is connected and a zero current command is sent to the SIM device, so make sure the gizmo controlling stimulation (typically an Electrical Stim Driver) is muted.

LR10 Lab Rat Interface Module

The Lab Rat HAL is the nexus for all interactions with the Lab Rat interface module. The Lab Rat is only available in Synapse Lite software. The LR10 HAL is an independent object in the Processing Tree. However, the acquisition processing and I/O functionality are internally dependent on Corpus software and emulated RZ2 hardware.



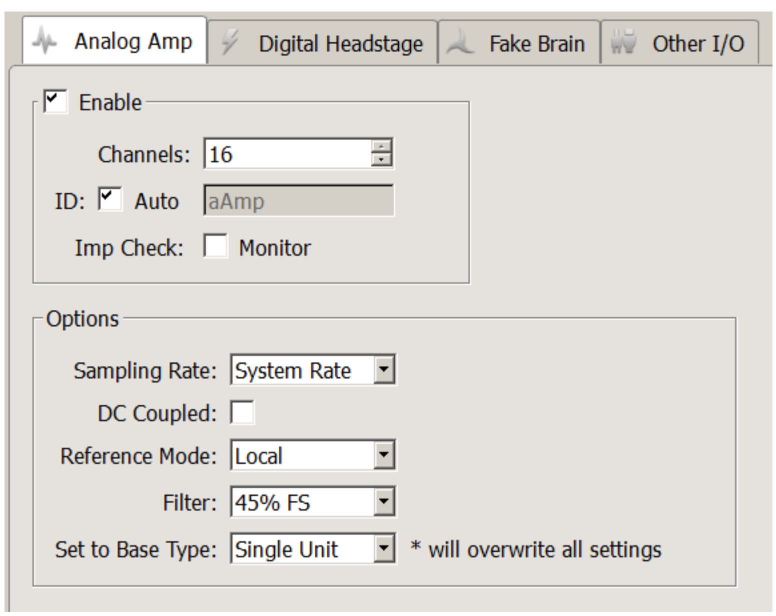
LR10 Block Diagram, showing the analog amplifier enabled

LR10 Options

Controls for analog and digital amplifiers, synthetic neural data generation for experiment testing, and multi I/O communications are modified within the Lab Rat object. Here, subcomponents can be enabled or disabled, and their settings can be adjusted prior to experimental run time. The four tabs of the LR10 are: Analog Amp, Digital Headstage, Fake Brain, and Other I/O.

Analog Amp

The Analog Amp page controls the 16-channel analog neural input on the Lab Rat interface module. From this page, the user can: enable/disable the amplifier, control how many channels of input to read, and adjust the sampling rate and filter settings of the amplifier. When the amplifier is enabled, the amplifier ID will appear as a Gizmo output at the top of the HAL and can be connected to other gizmos for further signal processing, with your selected channel count and amp ID.

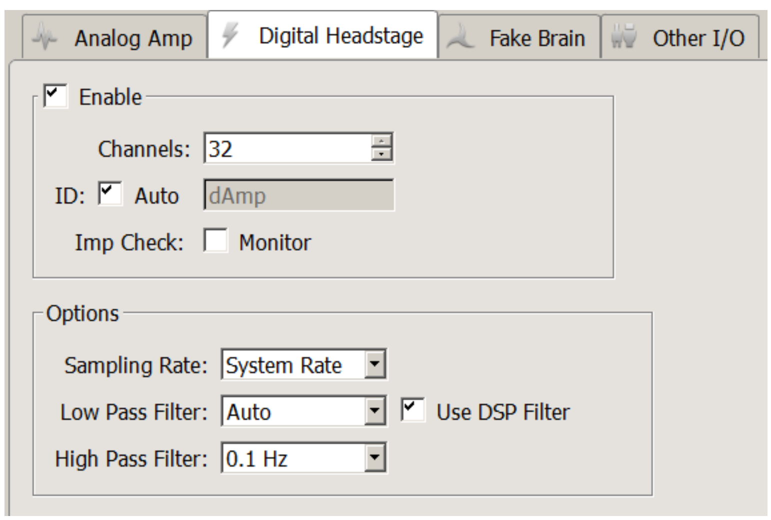


LR10 Analog Amp Options

Imp Check	Show online impedance testing results for the connected electrodes. See “Runtime Interface” on page 1-91.
Sampling Rate	Set the Sampling Rate to match the desired frequency band of your incoming signals (or leave at ‘System Rate’ if you are unsure). By default, the sampling rate matches that of the emulated RZ2.
DC Coupled	Remove the 0.4Hz high pass filter on the input signals and record DC potentials.
Reference Mode	Select the mode from the drop-down menu. Local - all channels use a single reference (pin 5 on the DB26). Differential - each even channel acts as a reference for the odd channel before it. Note: the output channels will be mapped for you to remove duplicate channels.
Filter	Set the anti-aliasing low pass filter cutoff as a percentage of the sampling rate.
Set to Base Type	If you are unsure, use Set to Base Type to configure the amp with default settings based on common signal types.

Digital Headstage

Enable the Digital Headstage when using an Intan-based digital headstage.



LR10 Digital Headstage Options

Imp Check	Show online impedance testing results for the connected electrodes. See “Runtime Interface” on page 1-91.
Sampling Rate	Set the Sampling Rate to match the desired frequency band of your incoming signals (or leave at ‘System Rate’ if you are unsure). By default, the sampling rate matches that of the emulated RZ2.
Low Pass Filter	Choose a value for the low pass filter implemented on the digital headstage chip. If LOW PASS FILTER is set to

"Auto," the cutoff frequency will be configured according to the conversion table below:

Digital Amp Sampling Rate	LP Auto Filter
750 Hz	300 Hz
1.5 kHz	750 Hz
3 kHz	1.5 kHz
6 kHz	3 kHz
12 kHz	5 kHz
25 kHz	10 kHz

Use DSP Filter

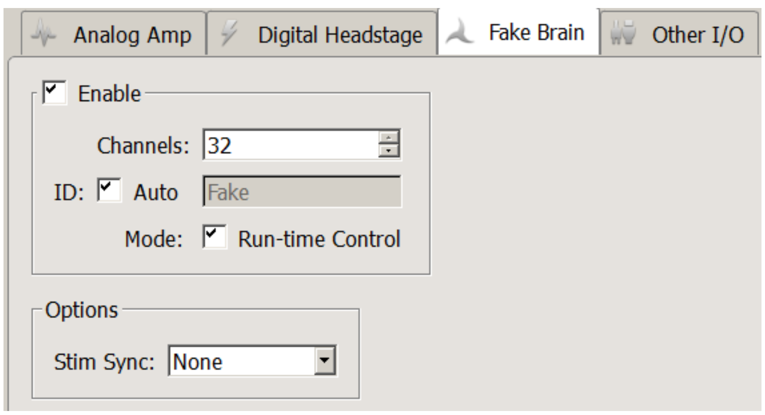
Adds additional low pass filtering (performed by Corpus), matched to the selected Low Pass Filter frequency. This removes high-frequency digital noise that is added by the digital headstage chip.

High Pass Filter

Implemented on chip.

Fake Brain

The Fake Brain is a synthetic data generator. This is a useful tool for designing experiments with well-behaved signals. The Fake Brain acts like an amplifier, and streams generated signals from the Lab Rat into Corpus. This means that you can connect Gizmo inputs to the Fake Brain output. Please take care to double-check that you are not handling and saving synthetic data during real experiments.



LR10 Fake Brain Options

Mode

Enable the Run-time Control to change the type of generated waveforms dynamically. These include:

Normal: default mode, includes LFP and spikes.

Hash: like Normal, but spikes reduced by a factor of 2.

LFP Only: like Normal but no spikes.

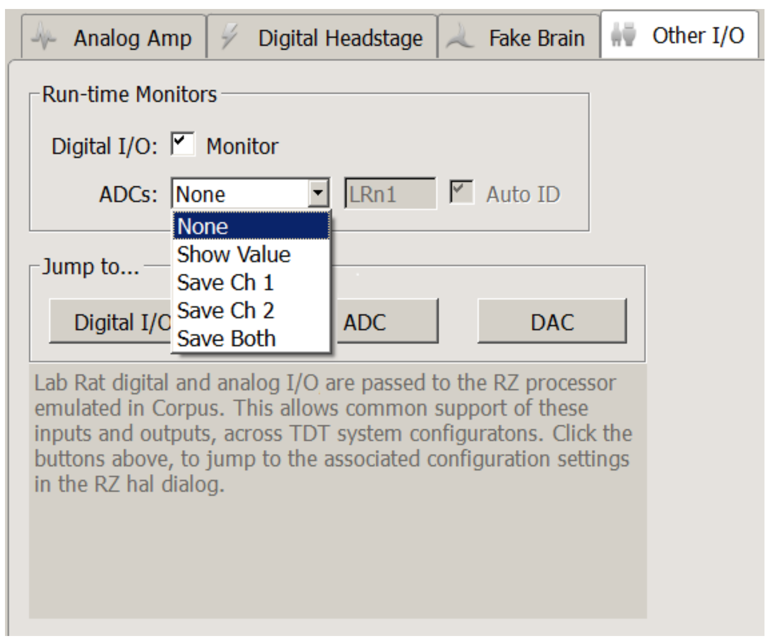
Tetrode: like Normal, but spikes on each group of four channels fire synchronously.

Sync 100 Hz: spikes fire at 100Hz on all channels.

	Tone 30 Hz: A 30Hz ~700uV sine wave on all channels. Tone 1 kHz: A 1kHz ~70uV sine wave on all channels. Tone Ref: A 100Hz ~700uV sine wave on all channels.
Stim Sync	Simulate inhibitory or excitatory input to the fake spike modes (Normal, Hash, Tetrode) with the Stim Sync option. You can enable this with an external device input, like the Bit0 BNC connector on the front of the LR10, to modulate firing rate with external hardware. When the Stim Sync input is activated, certain spike shapes are inhibited (fire less) and others are excited (fire more). To control the stim sync using only the LR10, use Bit0 as the stim sync and Bit1 as an output signal, then drive your sync signal through a BNC cable between Bit1 and Bit0.

Please see the FB128 section of the TDT System 3 Manual for more information on the Fake Brain modes.

Other I/O Tab



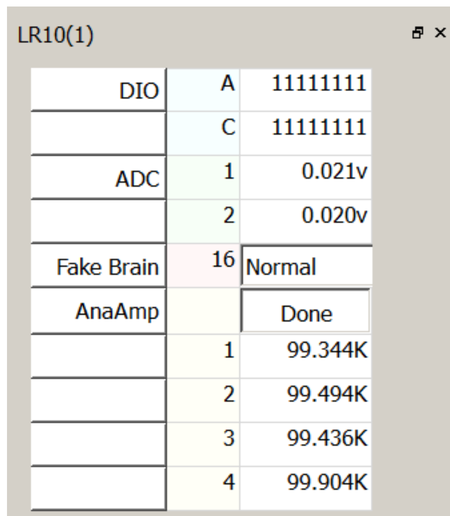
LR10 Other I/O Tab

Digital I/O Monitor	Shows you the logic state of all digital I/O on the Lab Rat at run time.
ADCs	You can choose to save the analog inputs coming into the "A/D" connector to disk or just view them during your experiment.

Lab Rat digital and analog I/O are passed to the emulated RZ2 processor in Corpus. This allows common support of these inputs and outputs across TDT system configurations. Software configuration of the multi I/O parameters is controlled in the RZ HAL. The JUMP TO... section takes users to the appropriate RZ HAL page for I/O configuration. For more information, please overview "RZ Options" on page 1-74.

Digital I/O	16 bits of digital input (8 bit-addressable, 8 word-addressable) are available.
ADC	Two channels of ADC input are available as single-channel inputs or combined into a multi-channel signal for further processing.
DAC	Two channels of DAC output are available as single-channel outputs or can be combined and controlled by a multi-channel signal. Each DAC channel can be tied to the output of a Gizmo, such as the Electrical Stimulation or File Stimulation gizmos.

Runtime Interface



LR10 Runtime Interface

When DIGITAL I/O MONITOR is enabled on the **Other I/O Tab**, the state of all 16 bits is shown on the runtime interface in binary format.

If SHOW VALUE is selected for the ADCs option on the **Other I/O Tab**, the current voltage on the ADC inputs will be shown at runtime.

If RUN-TIME CONTROL MODE is enabled in the **Fake Brain Tab**, you can change the fake signal type dynamically.

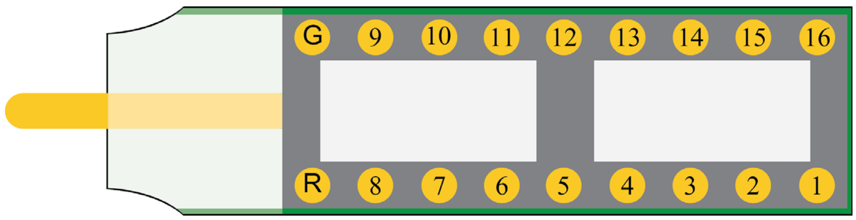
If the IMP CHECK option is enabled for the analog and/or digital headstage, use the interface button to switch the LR10 into impedance checking mode. The current impedance values of the connected electrode will update on the user interface. During the impedance check, the signals returned from the amplifier will be the value of the impedance, in MOhm.

If the impedance of an electrode is above 500 kOhm, the monitor will return a value of "High Imp."

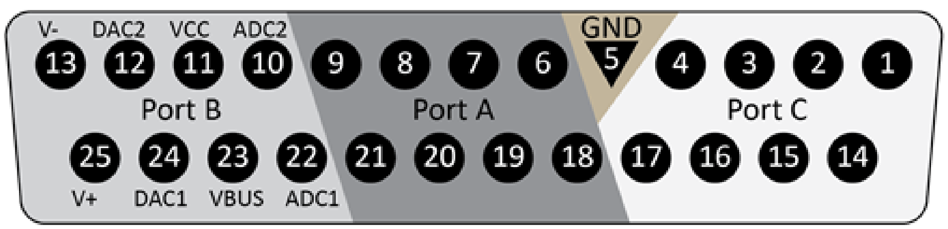
Pinouts

The pinouts are looking into the connector.

AC16LR Headstage



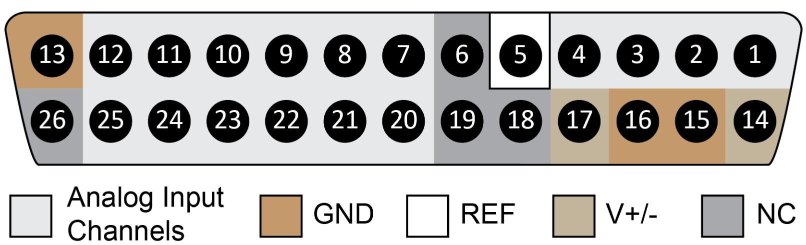
DB25 Connector



Pin	Name	Description	Pin	Name	Description

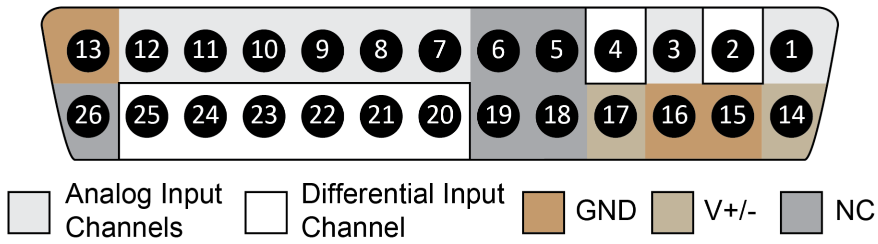
1	C0	Port C Bit Addressable Digital I/O Bits 0, 2, 4, 6 +3.3V, 10mA max per bit	14	C1	Port C Bit Addressable Digital I/O Bits 1, 3, 5, 7 +3.3V, 10mA max per bit
2	C2		15	C3	
3	C4		16	C5	
4	C6		17	C7	
5	GND	Ground	18	A0	Port A Word Addressable Digital I/O Bits 0, 2, 4, 6 +3.3V, 10mA max per bit
6	A1	Port A Word Addressable Digital I/O Bits 1, 3, 5, 7 +3.3V, 10mA max per bit	19	A2	
7	A3		20	A4	
8	A5		21	A6	
9	A7		22	ADC1	Analog Input Channel 1 +/-3V, 20mA max
10	ADC2	Analog Input Channel 2 +/-3V, 20mA max	23	VBUS	+5V, 150mA max
11	VCC	+3.3V, 250mA max	24	DAC1	Analog Output Channel 1 +/-3V, 20mA max
12	DAC2	Analog Output Channel 2 +/-3V, 20mA max	25	V+	+3.3V, 150mA max
13	V-	-3.3V, 150mA max			

DB26 Neural Input - Local Reference Mode



Pin	Name	Description	Pin	Name	Description
1	A1	Analog Input Channels	14	V+	Positive Voltage (+2.5V)
2	A2		15	GND	Ground
3	A3		16	GND	Ground
4	A4		17	V-	Negative Voltage (-2.5V)
5	Ref	Reference	18	HSD	Headstage Detect
6	HSD	Headstage Detect	19	HSD	
7	A5	Analog Input Channels	20	A6	Analog Input Channels
8	A7		21	A8	
9	A9		22	A10	
10	A11		23	A12	
11	A13		24	A14	
12	A15		25	A16	
13	AltRef	Not Used	26	NA	Not Used

DB26 Neural Input - Differential Reference Mode



Note: There are 8 (+) channels and 8 (–) channels per DB26 connector.

Pin	Name	Description	Pin	Name	Description
1	A1(+)	Analog Input Channel	14	V+	Positive Voltage (+2.5V)
2	A1(–)	Differential Analog Input Channel	15	GND	Ground
3	A2(+)	Analog Input Channel	16	GND	
4	A2(–)	Differential Analog Input Channel	17	V–	Negative Voltage (–2.5V)
5	NA	Not Used	18	HSD	Headstage Detect
6	HSD	Headstage Detect	19	HSD	
7	A3(+)	Analog Input Channels	20	A3(–)	Differential Input Channels
8	A4(+)		21	A4(–)	
9	A5(+)		22	A5(–)	
10	A6(+)		23	A6(–)	
11	A7(+)		24	A7(–)	
12	A8(+)		25	A8(–)	
13	GND	Ground	26	NA	Not Used

Note: Contact TDT technical support (+1 386 462 9622 or support@tdt.com) before attempting to make any custom connections.

UDP Interface

The UDP interface can send and/or receive single or multi-channel data UDP packets from the Ethernet port labeled "UDP" on the back of the physical RZ device.

In the Rig and in the Processing Tree, the UDP functionality is split into two device objects, one for sending data (UDPSend) and one for receiving data (UDPRecv).

Adding UDP to your Rig and Processing Tree

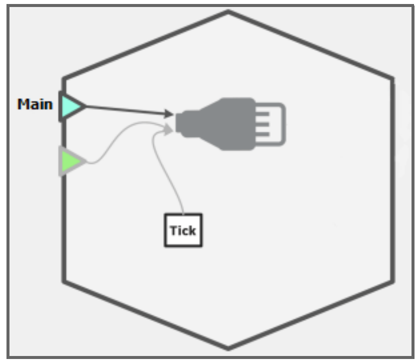
The UDPSend and UDPRecv aren't added to the rig automatically.

To add a them:

1. Click MENU, then EDIT RIG.

2. In the Rig Editor, right-click your system's RZ processor, then click ADD UDPSEND or ADD UDPRECV.
3. Click OK to close the Rig Editor and update the Processing Tree.

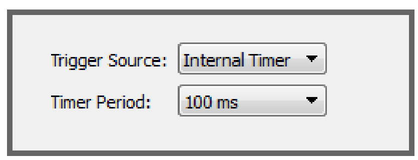
UDPSend



UDPSend Block Diagram

UDPSend sends UDP packets out the RZ to external devices. You can select the source and range of channels from the block diagram drop-down menu, or drag the UDPSend icon in the Processing Tree and drop it on a source gizmo.

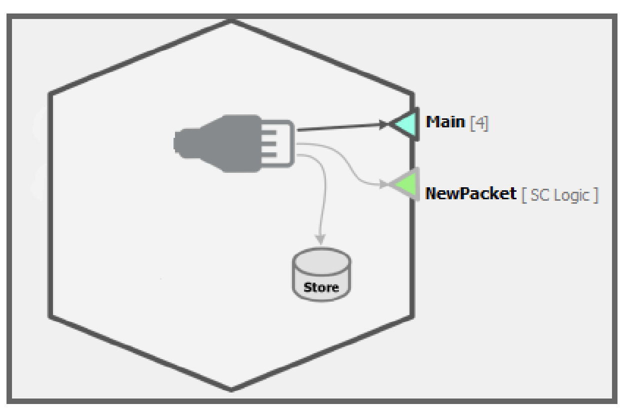
UDPSend Options



Send to UDP Options

You can set the time period for triggering and choose either an internal real-time clock, or a secondary gizmo input as the trigger source.

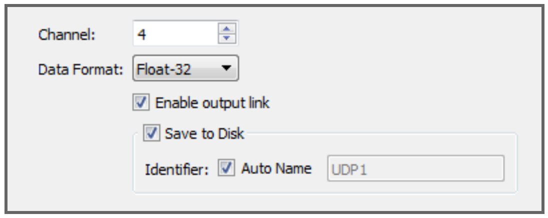
UDPRecv



UDPRecv Block diagram

UDPRecv receives data packets through the UDP interface from an external device and makes them available for further real-time processing.

UDPRecv Options



Receive from UDP Options

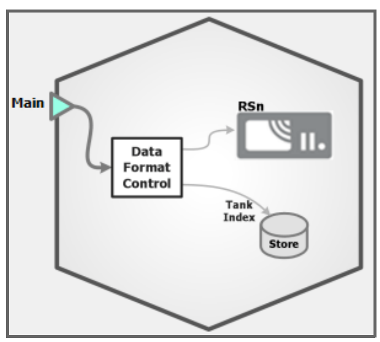
You can choose the number of expected channels in the incoming UDP packets and select the data type from a drop down list, so that the RZ device knows how to convert the received bits into the correct data source output.

You can select the ENABLE OUTPUT LINK check box to make the received packet and timing signal data source outputs available to use with other gizmos.

Select the SAVE TO DISK check box to store the received packet in the data tank as a timestamped event.

See the UDP section of the *System 3 Manual* for more information about UDP operations.

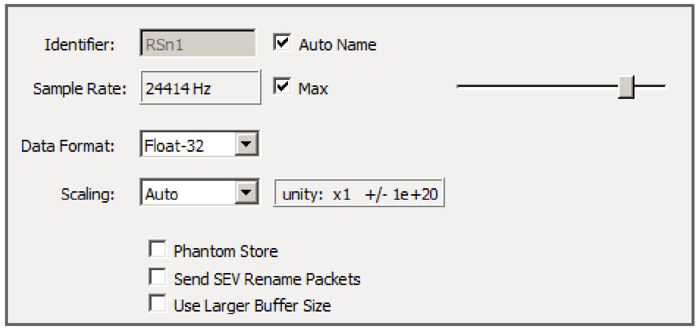
RS4 Streamer



RS4 Block Diagram

The RS4 is a storage device with a fiber optic connection to an optical DSP on your RZ device. It is likely also connected to the same network as the computer running Synapse.

RS4 Options



RS4 Options

By default, the RS4 uses the RZ device sampling rate. You can set a rate manually by clearing the Sample Rate Max check box to enable the slider. You can also select the data format and any scaling. If streaming from a PZ5, due to the large input range, the Float-32 format is recommended.

Phantom Store generates header information in the data tank for this streaming data so that the raw files stored on the RS4 can be merged with the rest of the data and read by TDT applications. This consumes extra hard disk space on your Synapse computer, so if you are going to read the files directly from the RS4 then leave this unchecked.

Send SEV Rename Packets sends a UDP packet containing the tank and block name over the local network to the RS4, so that the RS4 can rename the data files correctly.

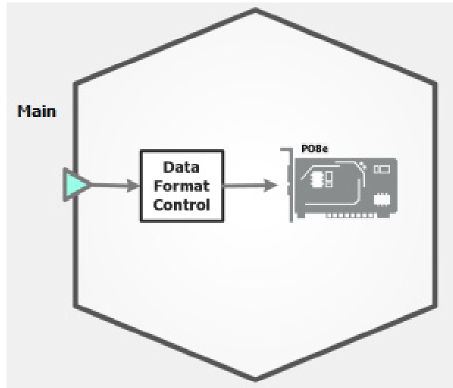
When Phantom Store is selected, Send SEV Rename Packets is selected for you.

If you aren't using TDT applications to read the data saved on the RS4, you don't need to select Phantom Store but you likely want to select Send SEV Rename Packets so that the RS4 data is organized.

Use Large Buffer Size allocates more DSP memory to buffer the data before it's sent out to the RS4. This improves reliable when streaming very high bandwidth, high channel count data to multiple RS4 ports. The RS4 should be updated to v1.19 firmware to most effectively use this setting.

See the RS4 section of the *System 3 Manual* for more information about Data Streamer operations.

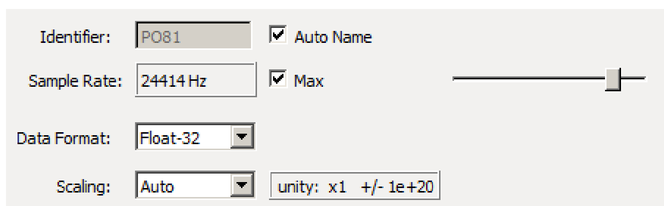
PO8e Streamer



PO8e Block Diagram

The PO8e is a data streaming device and requires a multi-channel data source, which you can select from the drop-down menu in the block diagram or drag the PO8e in the Processing Tree and drop it on the source gizmo. You can also choose the range of input channels.

PO8e Options

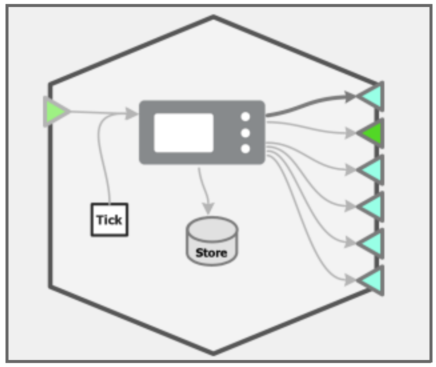


PO8e Options

By default, the PO8e uses the RZ device sampling rate. You can set a rate manually by clearing the SAMPLE RATE MAX check box to enable the slider. You can also select the data format and any scaling. If streaming from a PZ5, due to the large input range, the Float-32 format is recommended.

See the PO8e section of the *System 3 Manual* for more information about Data Streamer operations.

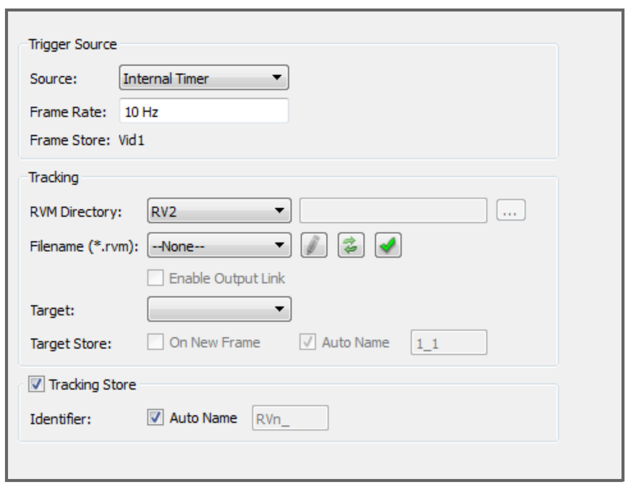
RV2 Video Tracker



RV2 Block Diagram

The RV2 receives triggers from the RZ, processes video frames, and returns tracking information to the RZ for storage and/or further processing. The RV2 must be on the same local network as the PC running Synapse. Its IP address must be set in the Rig Editor.

RV2 Options



RV2 Options

The trigger source can be either an internal clock or an input from another gizmo. The frame number is timestamped and stored to disk. Make sure the frame rate is less than the free run frame rate which is displayed on the RV2 Live tab. Otherwise you will see frames dropped and missing from your video file.

RVM files define the tracking algorithm and the tracked data that the RV2 returns. They are created in RVMap software, which installs with TDT Drivers, and are stored in the *configs* directory on the RV2. The Filename list contains the RVMs found on your RV2 device. Choose the appropriate one for your experiment.

The buttons next to the list perform the following actions:

 Open the selected file in RVMap for editing.

 Refresh the configurations list.

Send the selected map file to the RV2 to preview the tracking algorithm on the RV2 screen.

Note: Whatever RVM file is selected is also sent to the RV2 when you exit designtime. The RVM Directory allows you to select a local directory of RMV files for offline experiment design when the RV2 is not available.

Each RVM file defines a number of tracked targets. For each FIXED or RELATIVE target defined in the RVM file, positional data consisting of X, Y, and region values is returned to the RZ on each frame. REFERENCE targets also contain heading information.

When an RVM file is selected from the drop-down list, the target information is parsed and the total number of data points is displayed next to the CHANNEL label and the TARGET SELECTOR drop-down is updated with the list of available tracked targets.

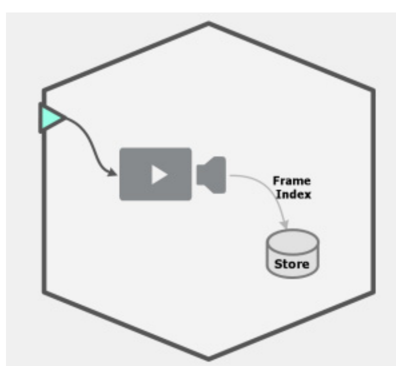
When ENABLE OUTPUT LINK is selected, the target information is available for real-time processing by other gizmos. If the RVM file contains a target called 'T1', and 'T1' is selected in the TARGET SELECTOR, then data sources 'T1X', 'T1Y', 'T1R' can be used by other gizmos for real-time processing. For example, if you want to trigger an event when the subject is in a particular region, you can feed the 'T1R' output to the State Maker gizmo and use it to choose an outcome based on subject position, all in real-time.

All target positional information is output on the ALLTRACKING output link, so if you need to extract more than one target for real-time processing you can connect a Signal Selector gizmo to the ALLTRACKING link and pick off a signal channel for additional real-time processing.

The TRACKING STORE option saves all target positional data to disk as a Strobe Store when the frame is received. The SELECTED TARGET option creates an Epoch Store with information from the target chosen in the TARGET SELECTOR drop-down.

See the RV2 section of the *System 3 Manual* for more information about Video Tracker operations and RVMap software.

USB Camera



Camera Block Diagram

The Camera HAL captures images from a USB camera for general subject behavior monitoring. Frames are captured, stored to disk and timestamped in the data block.

Camera frames are saved as a DIVX-encoded AVI file in the same folder as your data block, in the form **{TANK}_{BLOCK}_{HalName}.avi**. The frame numbers are stored in the data tank as epoch events. The AVI file can be used with the OpenScope Video Viewer and annotation tools.

Synapse supports up to two cameras per Rig and frame rates up to 20 fps. For best practice when using two cameras, keep cameras on separate USB Buses. Typically, PCs use separate buses for rear and front accessible USB inputs.

Note: Frame rate is controlled by a software timer and is prone to jitter. For real-time synchronized video capture and tracking, use the RV2.

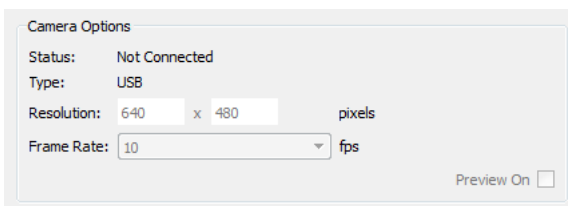
Adding the HAL

Camera's aren't added to the rig automatically.

To add a camera:

1. Click MENU, then EDIT RIG.
2. In the Rig Editor, Right-click your system's processor (such as RX or RZ devices), then click ADD CAM.
3. Click OK to close the Rig Editor and update the Processing Tree.

Camera Options

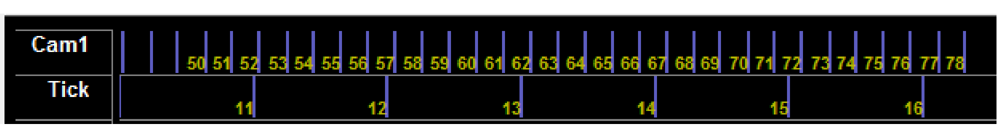


Camera Options

Status	Shows if camera is connected or not.
Resolution	Select a screen resolution.
Frame Rate	Select a frame rate.
Preview On	Shows a live stream from the camera in the Options area. The preview can be used to verify correct Camera placement and connection before recording.

Runtime Interface

The runtime tab displays the raw camera video for online monitoring. Please note that high-demand user interface tasks, like resizing windows, can increase jitter.



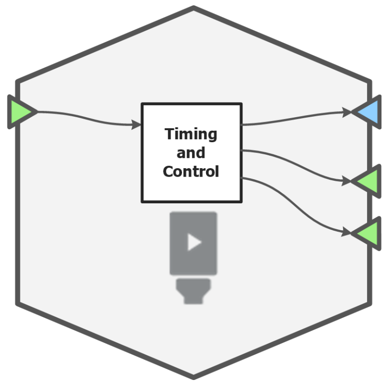
Runtime Plot with Camera Set to 5 Frames per Second

A subplot is also added to the main runtime multiplot to preview the frame index alongside other plot data.

Improving Performance

If you are having problems with things like dropped frames, we recommend installing the camera drivers to get access to more settings and controls for your camera. Some features like auto-adjust and "RightLight" can cause problems like increased jitter and dropped frames.

Scope



Scope Block Diagram

The Scope HAL captures images from an Ethernet endoscope for fluorescence microscopy. Frames are captured, stored to disk and timestamped in the data block. Camera frames are saved as a DIVX-encoded AVI file in the same folder as your data block, in the form **{TANK}_{BLOCK}_{HalName}.avi**. The frame numbers are stored in the data tank as epoch events. The AVI file can be used with the OpenScope Video Viewer and annotation tools.

Synapse supports up to two cameras per Rig and frame rates up to 20 fps. For best practice when using two cameras, keep cameras on separate USB Buses. Typically, PCs use separate buses for rear and front accessible USB inputs.

Note: Frame rate is controlled by a software timer and is prone to jitter. For real-time synchronized video capture and tracking, use the RV2.

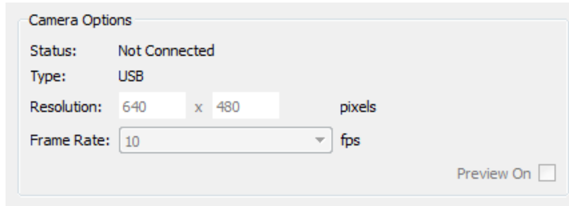
Adding the HAL

Camera's aren't added to the rig automatically.

To add a camera:

1. Click MENU, then EDIT RIG.
2. In the Rig Editor, Right-click your system's processor (such as RX or RZ devices), then click ADD CAM.
3. Click OK to close the Rig Editor and update the Processing Tree.

Scope Options



Camera Options

Status	Shows if camera is connected or not.
Resolution	Select a screen resolution.
Frame Rate	Select a frame rate.
Preview On	Shows a live stream from the camera in the Options area. The preview can be used to verify correct Camera placement and connection before recording.

Runtime Interface

The runtime tab displays the raw camera video for online monitoring. Please note that high-demand user interface tasks, like resizing windows, can increase jitter.

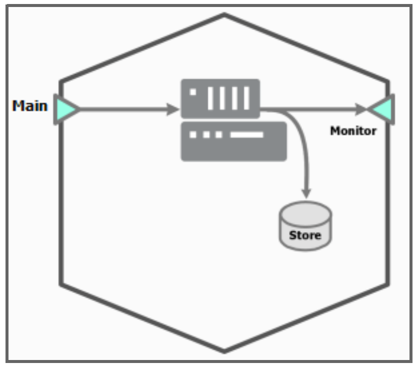
Runtime Plot with Camera Set to 5 Frames per Second

A subplot is also added to the main runtime multiplot to preview the frame index alongside other plot data.

Improving Performance

If you are having problems with things like dropped frames, we recommend installing the camera drivers to get access to more settings and controls for your camera. Some features like auto-adjust and "RightLight" can cause problems like increased jitter and dropped frames.

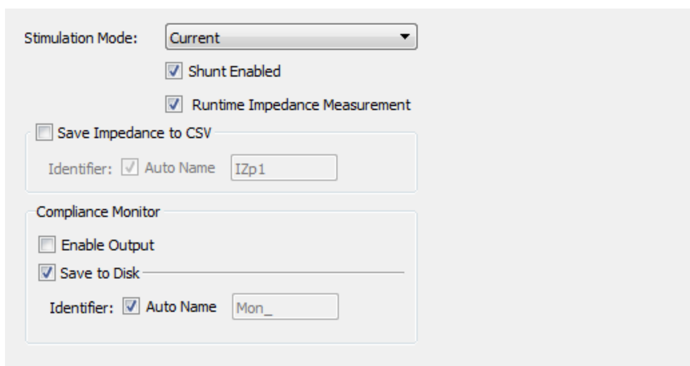
IZ2 Stimulator



IZ2 Block Diagram

The IZ2 requires a multi-channel floating point data source.

IZ2 Options



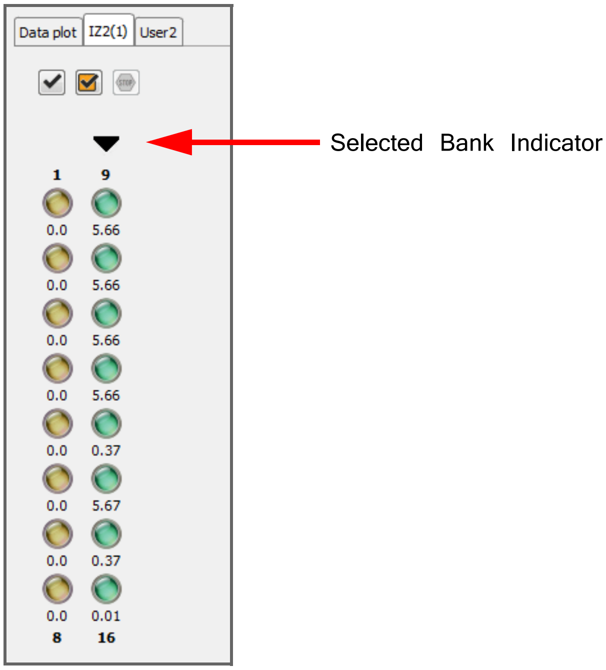
IZ2 Options

Stimulation Mode	Select current or voltage (IZ2/IZ2H only) mode from drop-down menu.
Save Impedance to CSV	Log impedance values into CSV file stored within the block folder, whenever an impedance check runs either manually or through the Synapse API.
Compliance Monitor	This represents the actual voltage on the output of the stimulator for the currently selected bank (see Runtime Interface, below). Check ENABLE OUTPUT to make this a data source other gizmos can use.

See the Stimulus Isolator section of the *System 3 Manual* for more information about stimulator operations.

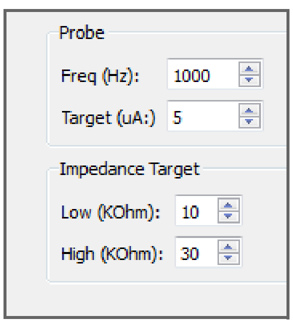
Runtime Interface

When RUNTIME IMPEDANCE MEASUREMENT is checked, a user interface appears at runtime.



The IZ2 Tab provides an interface for impedance checking on all channels. The display represents the stimulation channels divided into banks of eight channels. Channel numbers are labeled above and below the bank column in the diagram. The currently selected bank is indicated by an arrow above. This is also the bank that is actively monitored in the Compliance Monitor. To change the selected bank, click any LED in the desired bank.

Defining the Probe and Target



In the area beneath the probe diagram, you can set test signal frequency and amplitude, and define the high and low impedance threshold targets for visualization.

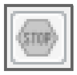
Running the Check


Run an impedance check on the currently selected bank

The test signal (sine wave of frequency defined by Freq (Hz) parameter and amplitude defined by Target (uA) parameter) is presented iteratively on each channel in the currently selected bank for 500ms and the impedance is measured.


Check All

Run an impedance check for all channels by cycling through each bank of eight channels using the test signal as described above.

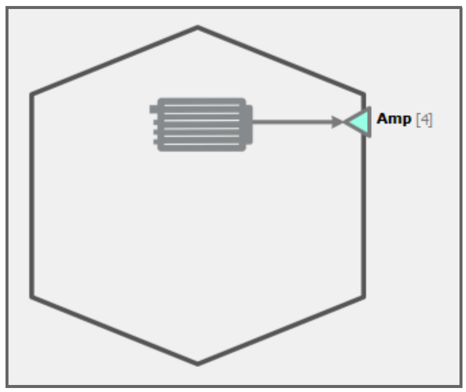


Stop Checking

Stop impedance checking prematurely.

Results of impedance check are indicated by color: below low impedance threshold (green), above high impedance threshold (red), between low and high impedance thresholds (yellow). The actual impedance values (in KOhm) are displayed beneath each indicator.

RA Amps



RA Amp Block Diagram

RA Amp Options

RA Amp Options

Select the number of channels and apply an optional scale factor to the incoming signals. If using an RA8GA, the voltage range must also be set to match the voltage selected on the device front panel. If AC Coupled is selected, a 0.4 Hz highpass filter is applied to the incoming signals.

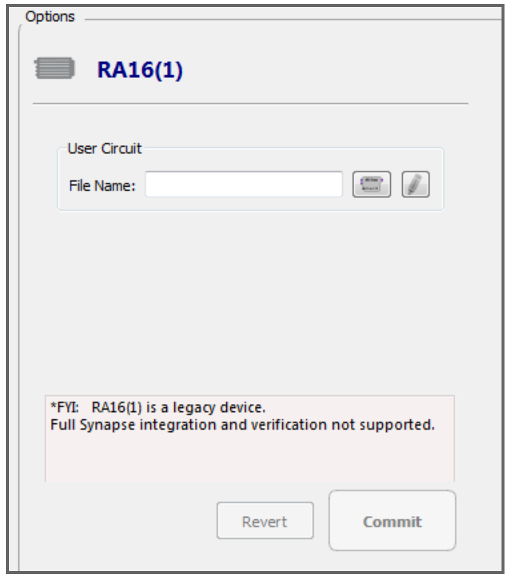
RX Processors

See RZ Processors above. There are additional options in the Digital I/O tab to determine which port the front panel lights on the RX display.

Legacy Mode

Legacy mode can be used to directly load experiment circuit files (*.rcx) to System 3 processors. This feature allows customers who are transitioning from OpenEx or user-developed TDT applications to port existing experiments directly into Synapse.

The RP2.1, RA16, and RX7 can only be used in legacy mode. Other processors can be switched into legacy mode in the Rig Editor.



Legacy Mode Device Options

The illustration above shows the legacy device options for the RA16 Medusa Base Station. The Options are the same for legacy mode, regardless of the device.

Note: Parameter tags in the legacy *.rcx file can be accessed using Synapse API.

Options

User Circuit

File Name

Enter the path and file name of the circuit to load.

Select Circuit File button

Launches an Open window. Select the desired file.

Edit Circuit in RPvdsEx button

Launches RPvdsEx. Edit or create a circuit file.

Part Four: Gizmo Reference

Analysis

Analysis gizmos perform online signal averaging that can be stored and used by other gizmos for decision making, all in real-time.

The group includes:

Signal Accumulator

Signal Accumulator

The Signal Accumulator gizmo performs online summation over user-defined windows with optional average computation and thresholding of the outcome.

Data stored:

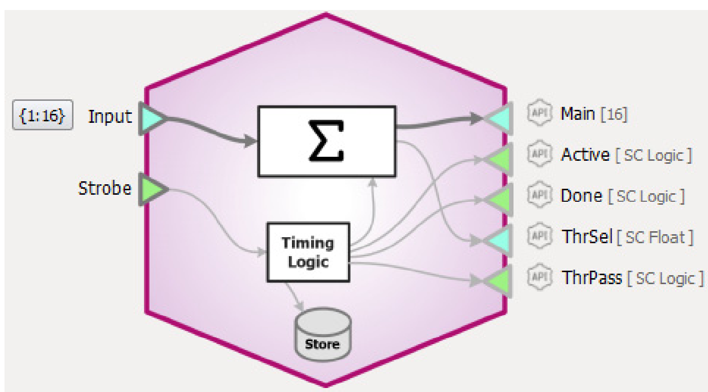
Scalars (optional)	timestamped accumulator output
Epoc (optional)	if thresholding is enabled, stores timestamp and selected channel accumulator output when threshold conditions are met

Outputs:

Main	accumulator output for all input channels
Active	true while accumulator is running
Done	true when accumulator is finished and new value is ready on output
ThrSel	accumulator output for selected channel in plot
ThrPass	true if selected channel accumulator value meets threshold criteria

Key features:

- Signal summation
- Signal averaging
- Threshold detection



Accumulator Block Diagram

The Runtime Interface

Runtime Plot

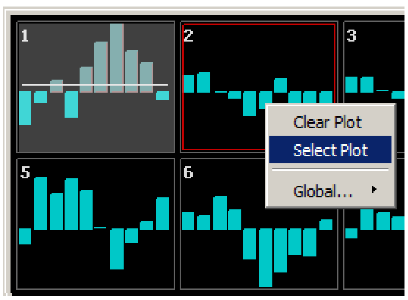
Scalar and epoch plots, if enabled, are added to the runtime window for visualization when enabled in the gizmo options. See "Flow Plot" on page 66 for more information on using and customizing the plots.

Signal Accumulator Plot

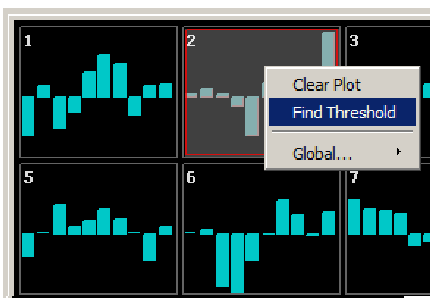
The runtime Signal Accumulator plot must be configured in the Edit mode options before it can be used. See "Plot Preview Tab" on page 1-117 for more information.

Important!: Accumulator is unique in that the runtime changes modify the experiment setup. Any changes you make to the plot configuration at runtime are available at designtime and vice versa.

Use the right-click menu to choose which channel is actively used with the threshold detector.



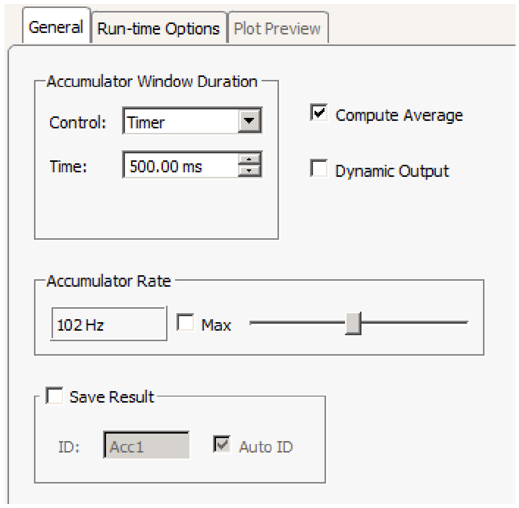
Once the desired plot is selected, if the threshold is not visible then right-click and select Find Threshold.



Once the threshold is visible, use the left mouse button to click-drag the threshold bar into place.

Signal Accumulator Configuration Options

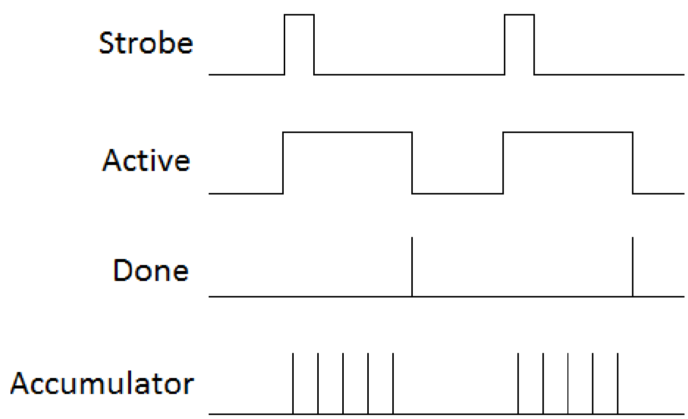
General Tab



General Tab

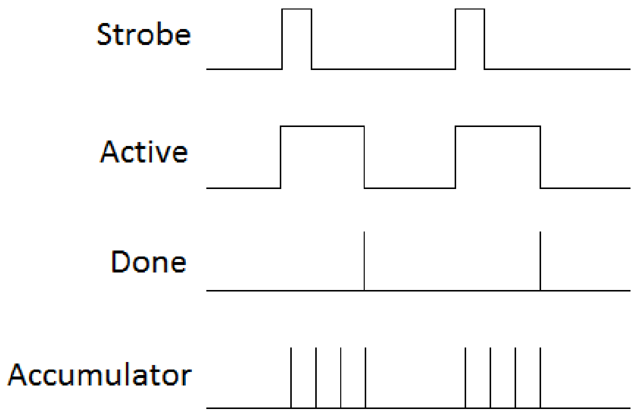
Accumulator Window Duration

The Accumulator samples at the Accumulator Rate. The start and end of the accumulation period is controlled by the Accumulator Window Duration. The different control methods for controlling the window duration are shown below. The accumulator output is ready when the Done signal goes high.



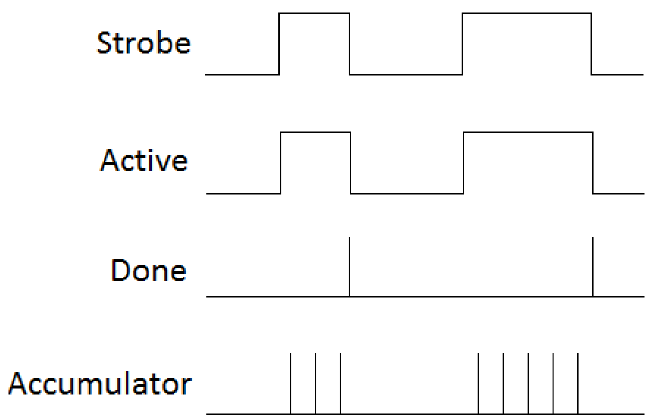
Timer Control Mode

In Timer mode, the accumulator runs for a fixed duration when the Strobe input signal goes high.



Counter Control Mode

In Counter mode, the accumulator runs for a fixed number of ticks of the accumulator clock. In the above example, the Count is set to 4.



Strobe Input Control Mode

In Strobe Input mode, the accumulator start and stop times are determined exclusively by the Strobe gizmo input, which can be variable durations.

Compute Average

When checked, the sum over the accumulation window is divided by the number of accumulation samples to get the signal average.

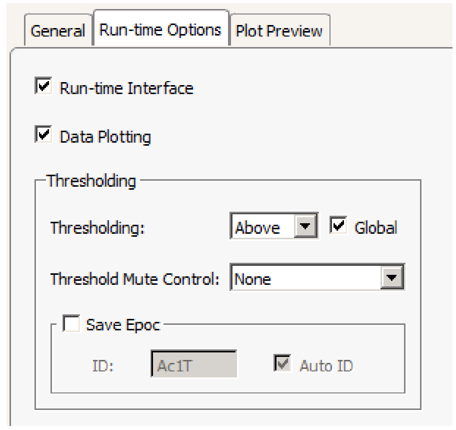
Dynamic Output

The gizmo Main and ThrSel outputs latch when the Done signal goes high. When Dynamic Output is enabled, the Main and ThrSel outputs also update on each tick of the accumulator clock with the current values in the accumulator.

Run-time Options

The Signal Accumulator has an optional run-time interface that shows a bar graph of the accumulator results. You can optionally set a threshold on this plot to convert this value into a logic signal for decision making. This threshold crossing drives the ThrPass gizmo output.

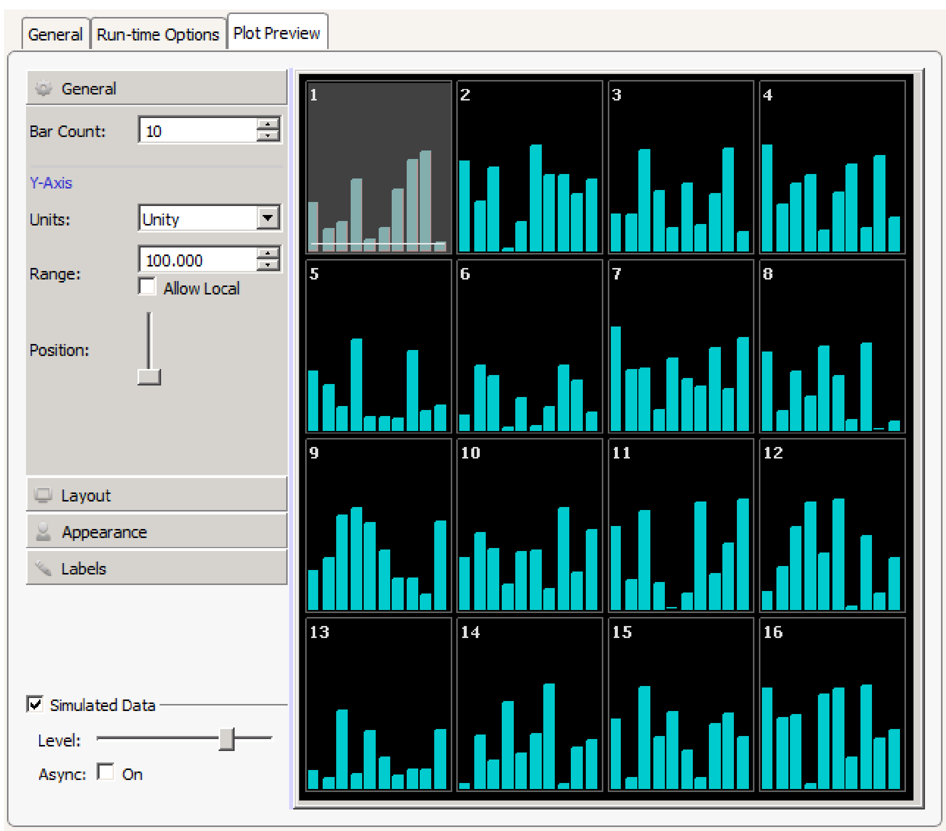
An optional Mute Control allows the user to dynamically disable the ThrPass output at run-time.



Run-time Options Tab

If Global Thresholding is selected then any changes to the threshold at run-time apply to all channel thresholds.

Plot Preview Tab



Plot Preview Tab

Allow Local

If Allow Local is selected, Ctrl + left-click-drag will change the range of the individual plot and Shift + left-click-drag will adjust the range of all plots.

Note that only the Y-axis range (Shift + left-click-drag or mouse wheel) and offset (Alt + left-click-drag) are adjustable at run-time, as well as the threshold (if enabled). All other visualization settings are adjusted at design-time in the Plot Preview tab.

Important!: Accumulator is unique in that the runtime changes modify the experiment setup. Any changes you make to the plot configuration at runtime are available at designtime and vice versa.

Logic

Logic gizmos combine logical signals originating from external hardware or other gizmos into meaningful logic states, from simple to complex, that can be stored and used by other gizmos for decision making, all in real-time.

The group includes:

State Maker

Timer

Pulse Generator

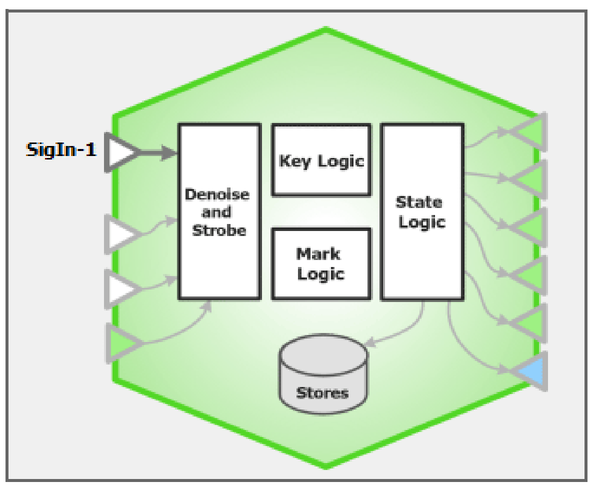
User Input

State Maker

State Maker provides an interface for performing logical tests on single channel inputs and combining the results into output states for storage and/or further processing.

Key features:
Multi-level logical states
Outputs:
Logic (multiple)
Data Stored:
Epoch (x4) Selectable: Full, Onset, of Offset
Source: Value, Counter, K/M Bits, Inputs

Inputs are first conditioned to extract the interesting bits. The conditioned inputs are used in logical truth tests, which create 'keys'. Logical combinations of keys are used to create 'marks'. Logical combinations of marks and/or keys are used to create 'states', which are exported to other gizmos and can be stored to disk. If a Strobe is used, the logic tests are only processed when the strobe is true.

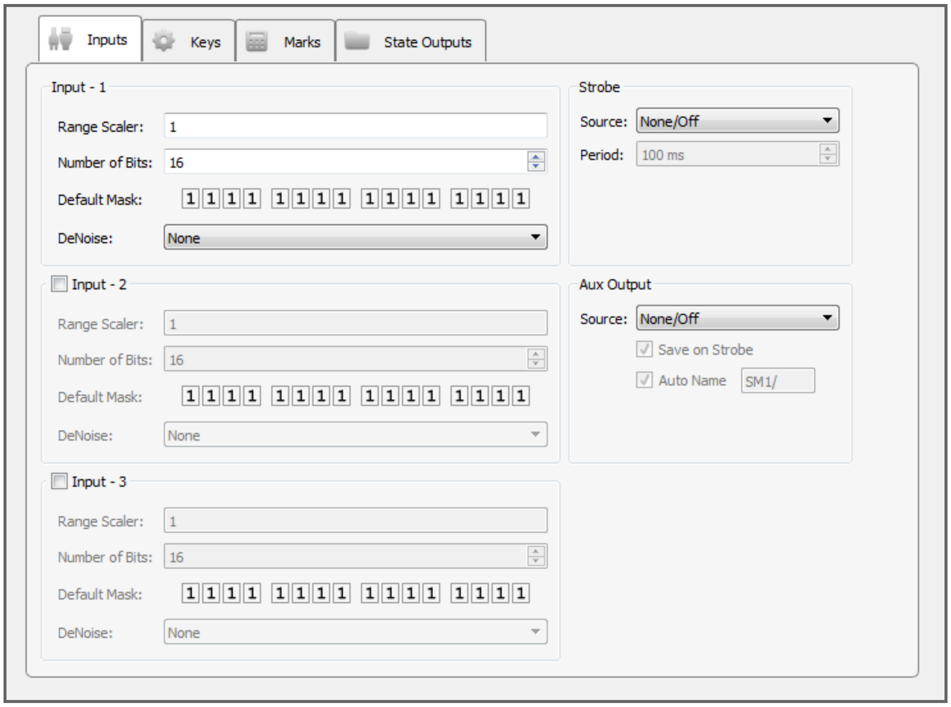


State Maker Block Diagram

State Maker Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Inputs etc Tab

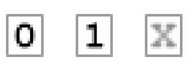


Inputs etc Tab

Input - 1..3

State Maker performs integer-based logic, but can accept any single channel signal (float, integer, logic). Each input is first scaled (RANGE SCALER), which is particularly useful if the input is a floating point signal, such as an eye tracker. Tell it the total NUMBER OF BITS in the input signal. For a logic input signal, this number will be 1. Set the DEFAULT MASK to tell which bits are important.

Click the bit icon to toggle between possible values, that is, 0, 1, or X.



DeNoise ensures the value is stable for the specified amount of time before processing it. This is useful if the input is, for example, a button press on an external device being read through the digital input on the hardware. This type of signal may 'bounce' when pressed or released, which will create several rapid state changes in that moment, whereas we only want StateMaker to see a single state change on that input. Adding denoising ensures that the State Maker doesn't process these bounces as individual events and instead waits until the signal is stable before moving on.

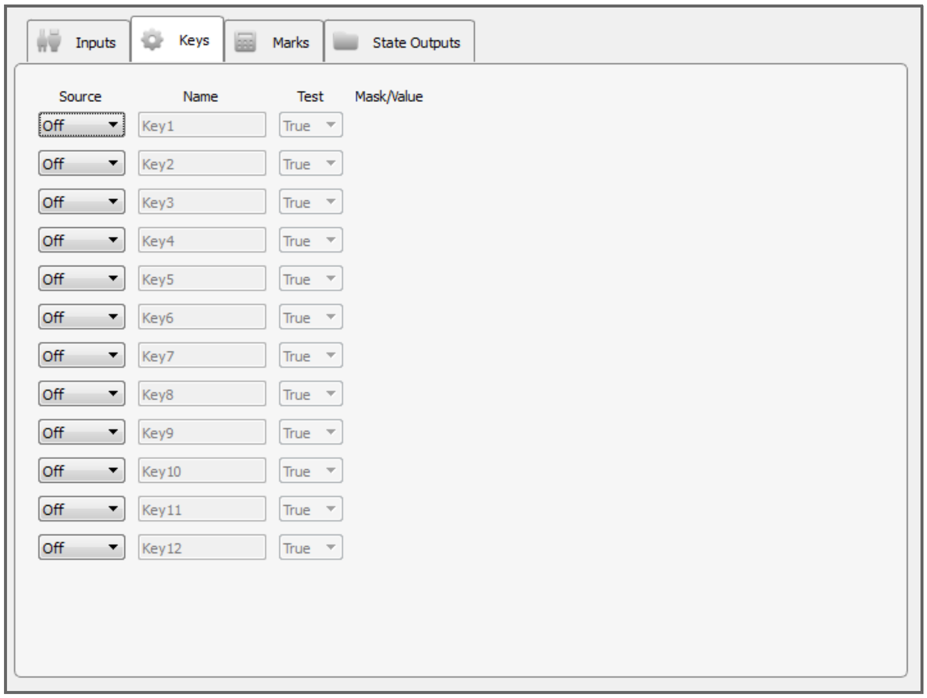
Strobe

By default, State Maker processes the inputs and updates the output states on every tick of the sample clock. Set a STROBE SOURCE if you want to control when the logic testing takes place. The strobe can come from an Internal Timer running on the hardware, fed from an additional gizmo input (called STROBEIN), or triggered when the value of Input-1 changes (ON DATA CHANGE).

Aux Output

State Maker can output any or all states generated. Set the AUX OUTPUT to output any of the input lines as a pass through or to output a key, mark, or state output (KEY/MARK/STATE WORD). If a strobe is used, the AUX OUTPUT value can also be saved on the strobe.

Keys Tab



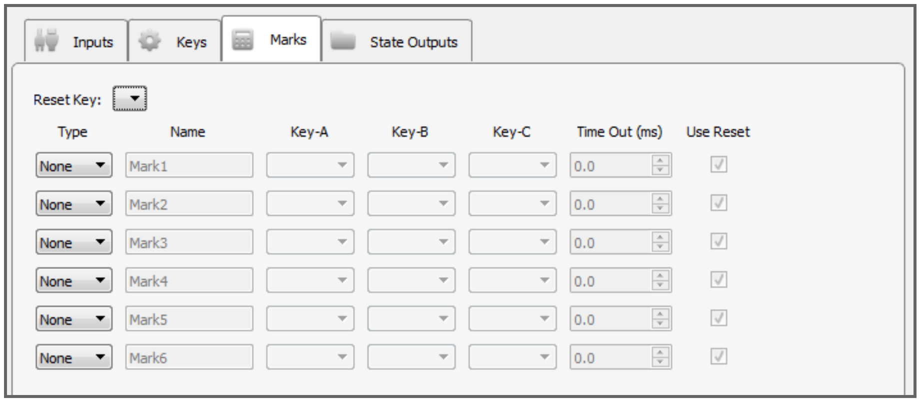
Keys Tab

Perform up to twelve logic tests to create keys. Each key uses one of the inputs as its source, and is given a meaningful name that is referenced later on the Marks and State Outputs tabs. It performs a conditional test comparing the key source to the mask/value based on the Test selection.

The Mask tells you which bits to look at or ignore. If a bit in the mask contains an 'x' icon, this bit is ignored during the logic test. If it contains a 0 or 1, that is used for the value. When Test is 'True', the mask/value is ignored and any source value greater than 0 is considered true.

Right-click on a bit icon in the Mask/Value column to change the data format from binary to decimal or hexadecimal.

Marks Tab



Marks Tab

Use logical combinations of keys to create up to six marks. Each mark uses at least one key as an input and is given a meaningful name that is referenced later on the State Outputs tab.

Keys defined in the Keys tab are listed in the Key-A, Key-B and Key-C drop-downs. At the bottom of the list are the same keys with a '~' prefix - these are the inverse keys, so ~Key1 means 'not Key1'.

Mark Types

The different mark types are described below. Note that any key input (Key-A, Key-B or Key-C) that is left blank is ignored.

On/Off

When Key-A is true, this mark is true and stays true until either Key-B is true or until the TIME OUT (MS) period has expired (if TIME OUT (MS) is non-zero). If USE RESET is selected, the Reset Key can also be used to turn off this mark.

And

When all keys specified in Key-A, Key-B, and Key-C are true, this mark is true.

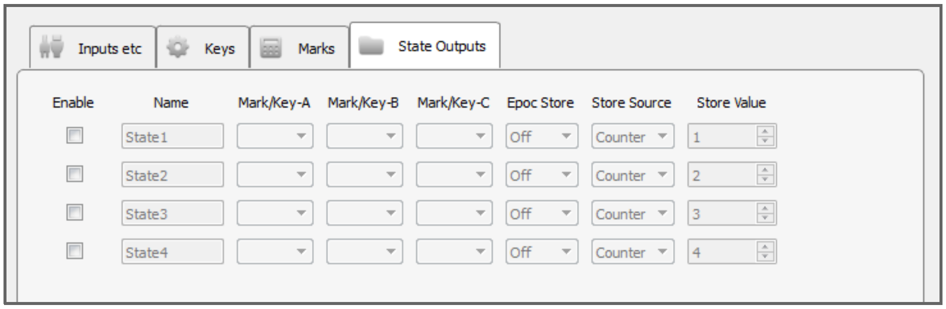
Or

When any key specified in Key-A, Key-B, and Key-C is true, this mark is true.

Xor

When one and only one key specified in Key-A, Key-B, and Key-C is true, this mark is true.

State Outputs Tab



State Output Tab

Use logical combinations of keys and/or marks to create up to four states. Each state uses at least one key/mark as an input and is given a meaningful name that is used when linking to other gizmos and/or storing state values to disk. The states are determined by an 'AND' operation on Mark/Key-A, Mark/Key-B, and Mark/Key-C. Any Mark/Key drop-down left blank is ignored.

You can optionally choose to store the state onset, offset, or onset and offset timestamps into the data tank.

Timer

Timer measures the elapsed time between logical events or calculates the frequency of events.

Key features:

Multiple temporal measurements between logical true events on one or two channels.

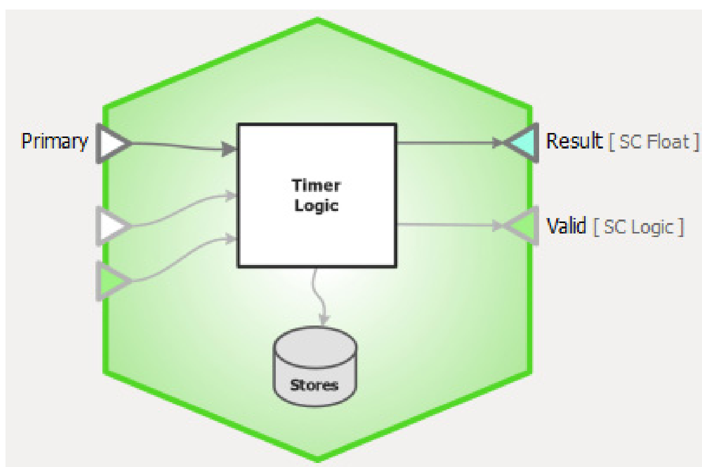
Outputs:

Result	single channel floating point, the outcome of the timer measurement
Valid	single channel logic signal, true when the measurement is taken

Data Stored:

Epoch event (optional)	timestamp and store the Result when a valid measurement is taken
Continuous (optional)	store the Result continuously

The Timer gizmo accepts all single channel signal types. The input first passes through a truth test. For a logic signal, this is simply a true/false test. If an integer or floating point input is used, the test can be that the signal is above/below a certain threshold, or inside/outside a range of values.



Timer Block Diagram

The Runtime Interface

Runtime Plot

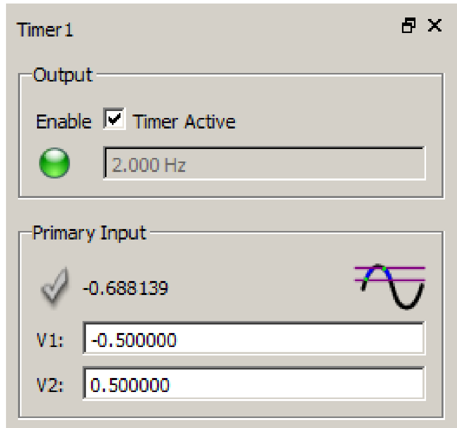
At runtime, the standard Synapse data plot displays any stored data. The timer can save timestamped epoch events when the measurements are taken, and/or a continuous stream of the measurement results. See "Flow Plot" on page 66 for more information on using and customizing the plot.

Timer Tab

The runtime interface must be enabled in the *General Tab* before it can be used.

If a signal input is integer or floating point type, the values used for the truth test are adjustable at runtime.

If ENABLE CONTROL is turned on, a check box on the UI shows if the timer is enabled or not.



Timer Runtime UI

In the above example, the ENABLE CONTROL option is set to 'Manual/API'. The input signal is floating point with the truth test set to 'Between'. The signal will be true if it is between -0.5 and 0.5.

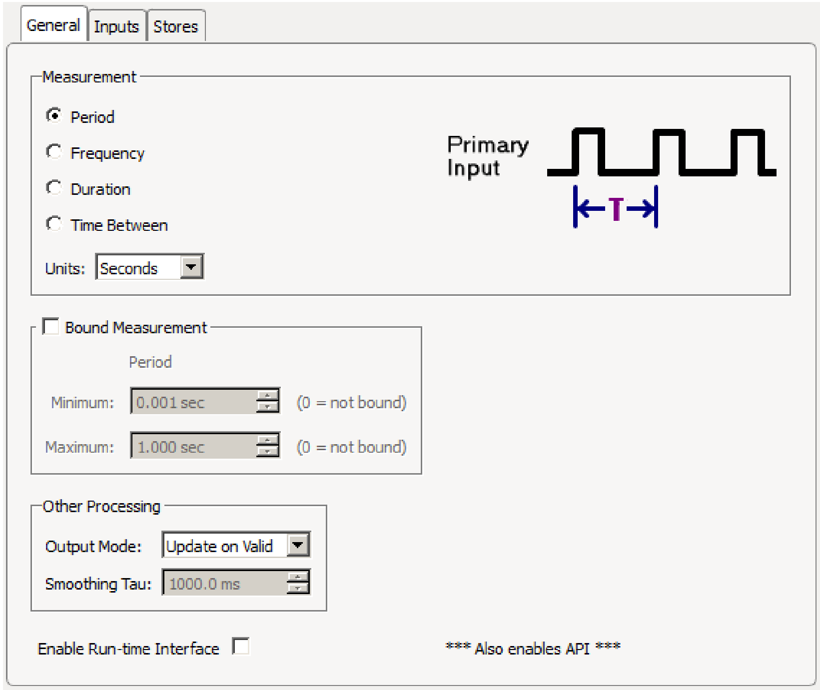
The value in the Output box is the most recent measurement. The green LED is active to indicate that a measurement recently took place.

The check mark for Primary Input is not lit because the test condition is not met; the current signal value is outside the bounds.

Timer Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

General Tab

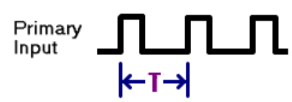


General Tab

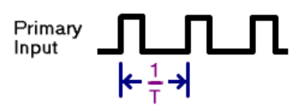
Measurement

Choose which measurement to make and the output units. The smallest possible measurement is two samples of the system clock.

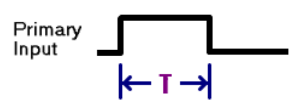
PERIOD measures the time between consecutive onsets of the primary input signal in units of seconds, milliseconds, microseconds, or samples.



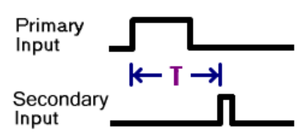
FREQUENCY measures the frequency of consecutive onsets of the primary input signal in units of hertz, kilohertz, or beats per minute (BPM).



DURATION measures the time between the onset and offset of the primary input signal in units of seconds, milliseconds, microseconds, or samples.



TIME BETWEEN measures the time between the onset of the primary input signal and the onset of the secondary input signal in units of seconds, milliseconds, microseconds, or samples.



Bound Measurement

If BOUND MEASUREMENT is enabled, the calculated measurement result will never be outside of the chosen minimum and maximum values.

In PERIOD or FREQUENCY measurement mode, if the measurement is outside of the limits, it will clamp to the nearest limit.

In DURATION measurement mode, if the maximum bound is exceeded or the minimum bound isn't met, then this will not count and a measurement will not be made.

In TIME BETWEEN measurement mode, when bounding is used the primary input is ignored when the timer is running and less than the minimum bound, so it can't re-trigger. Also, the secondary input is ignored before the minimum bound is reached and after the maximum bound is reached, so valid measurements are only taken in between the given bounds.

Other Processing

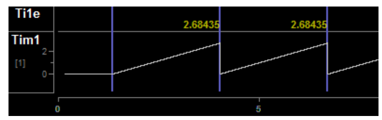
OUTPUT MODE controls how the measurement signal (Result) is handled.

UPDATE ON VALID means the Result is latched when the measurement occurs and Result holds that value until the next measurement is made.

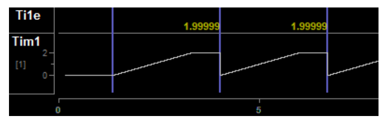
SMOOTHED behaves like UPDATE ON VALID but also applies an exponential smoothing filter with the desired SMOOTHING TAU. The larger the SMOOTHING TAU, the smoother the Result signal.

HOT TRACKING provides a more instantaneous approximation of the Result while the measurement is occurring. This is useful for tracking irregular waveforms like spike firing rate.

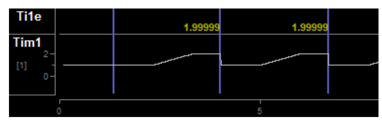
For PERIOD measurements, the Result resets to 0 when a new Primary Input onset occurs and rises linearly until the next Primary Input onset, at which point a measurement is taken and it resets again.



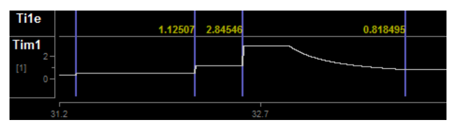
If the maximum bound is reached, Result latches at the maximum bound value until the next onset/measurement.



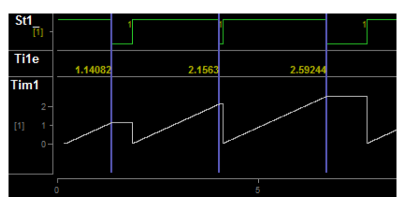
If the minimum bound is greater than zero, the Result will reset to this value (instead of 0) and will stay there until enough time has elapsed to meet the minimum bound requirement, and will then rise linearly until the next onset (or the maximum bound is reached).



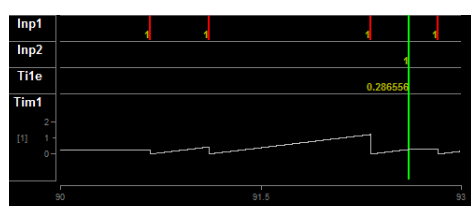
For FREQUENCY measurements, the Result value latches until enough time has elapsed between onsets such that the next frequency measurement must be lower than the previous Result, at which point the Result begins decreasing in real-time until the next onset occurs (or the minimum bound is reached) and latches the new measurement value. If the frequency between onsets increases, the Result will immediately increase to the new value.



For DURATION, the Result resets to 0 when an onset occurs and rises linearly until the offset occurs, or until the maximum bound is reached, and latches this value until the next onset.

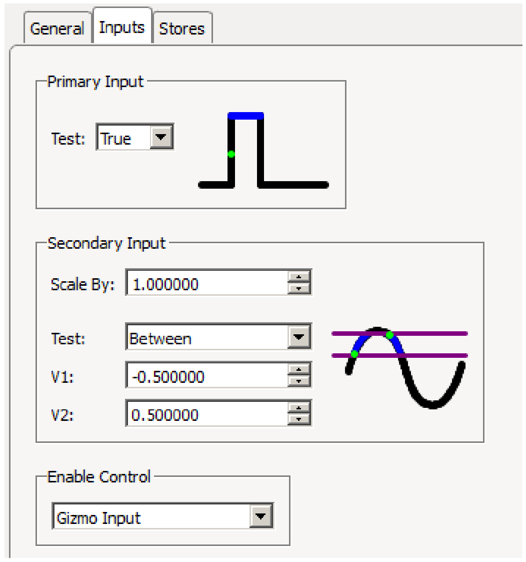


For TIME BETWEEN, the output resets to 0 when the Primary Input onset occurs and rises linearly until the Secondary Input offsets occurs, or until the maximum bound is reached, and latches this value until the next Primary Input onset.



Inputs Tab

Select the truth tests for the input signal(s) and determine when to activate the timer processing and storage.



Inputs Tab

Primary Input

If the primary input is a Logic signal, the test can either be True or False. If the primary input is an Integer or Floating Point signal, the input can first be scaled and then a threshold Test is applied. For ABOVE and BELOW, V1 is the only value shown and used for the threshold test. For BETWEEN and OUTSIDE, V1 is the minimum bound and V2 is the maximum bound.

Secondary Input

The Secondary Input is only visible if the Measurement type is TIME BETWEEN. This contains the same truth test options as the Primary Input above.

Enable Control

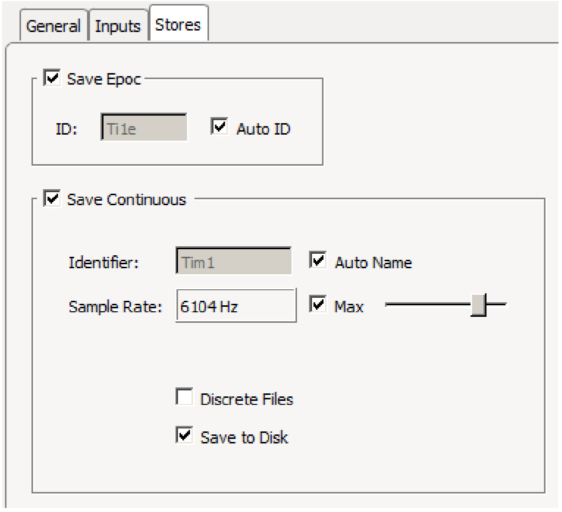
NONE means the timer is always active.

GIZMO INPUT means the timer is only active when an additional gizmo input signal (a Logic signal called 'Enable') is True.

MANUAL/API enables user control of timer processing. Note that this is only available if the Run-Time Interface is Enabled on the Misc Tab.

Stores Tab

Choose what data (if any) to store.



Stores Tab

Save Epoc

Store the timestamp and Result when Valid is true (when a measurement is taken).

Save Continuous

Saves the Result continuously and makes it visible on the runtime Data Plot.

Pulse Generator

Pulse Generator creates a user-defined pulse train.

Key features:

Generates pulses of varying widths and timing.

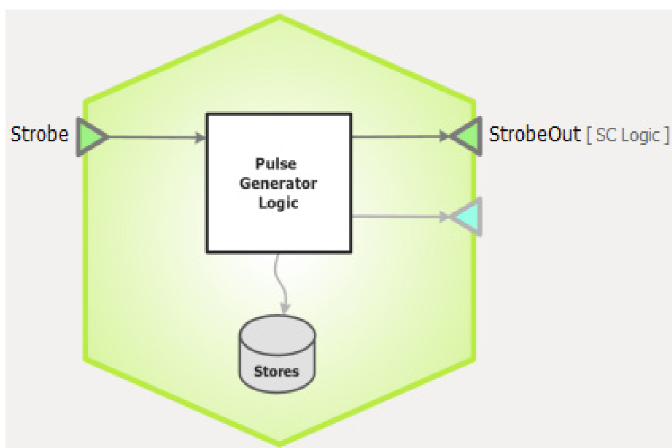
Outputs:

StrobeOut	single channel logic, the pulse train
FloatOut (optional)	single channel floating point, a scaled pulse train signal

Data Stored:

Epoch event (optional)	store each pulse as onset/offset epoch events
Continuous (optional)	store the pulse stream continuously

The Pulse Generator gizmo accepts a single logic signal and generates a user-defined pulse train. It outputs a single logic signal and optionally a floating point signal.



Pulse Generator Block Diagram

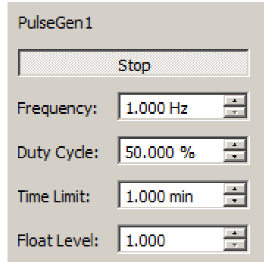
The Runtime Interface

Runtime Plot

At runtime, the standard Synapse data plot is available to display any stored data. The pulse generator can store its output waveform as onset/offset epoch events and/or as a continuous stream. See "Flow Plot" on page 66 for more information on using and customizing the plot.

Pulse Generator Tab

When ENABLE RUN-TIME INTERFACE is selected, the user can dynamically control the pulse timing and pulse width, as well as enable/disable pulse output in some modes.

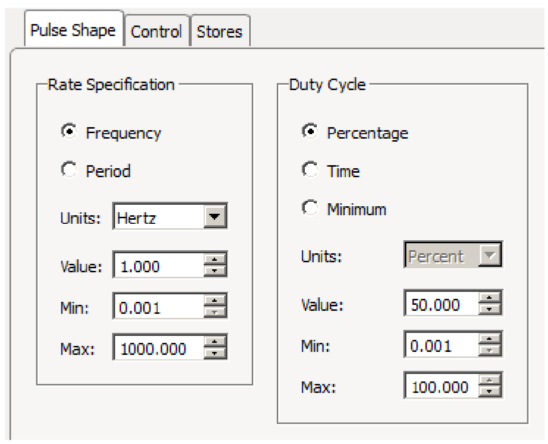


Pulse Generator Runtime UI

Pulse Generator Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Pulse Shape Tab



Pulse Shape Tab

Rate Specification

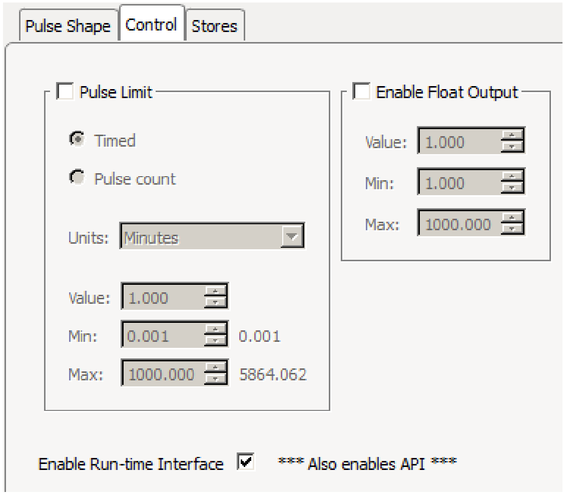
Choose whether the pulse rate is defined by FREQUENCY or pulse PERIOD.

FREQUENCY defines the onset to onset time in units of hertz, kilohertz, or beats per minute (BPM). PERIOD defines the onset to onset time in minutes, seconds, milliseconds, microseconds, or samples. The default VALUE as well as bounds on the MIN and MAX values are set.

Duty Cycle

Choose the pulse high time as either a PERCENTAGE of the onset to onset time, or by a fixed TIME duration, in units of minutes, seconds, milliseconds, microseconds, or samples. Select MINIMUM for single sample pulse width.

Control Tab



Control Tab

Pulse Limit

Determine when to activate the pulse generator. If this box is unchecked, the pulse generator is active as long as the Enable gizmo input is active or the user has pressed the 'Enable' button on the runtime interface (Run-time Interface must be enabled for the button to appear).

TIMED means the pulse generator runs for the specified duration whenever it is triggered. PULSE COUNT means the pulse generator runs for the specified number of pulses. It can be stopped by clicking the 'Stop' button on the runtime interface.

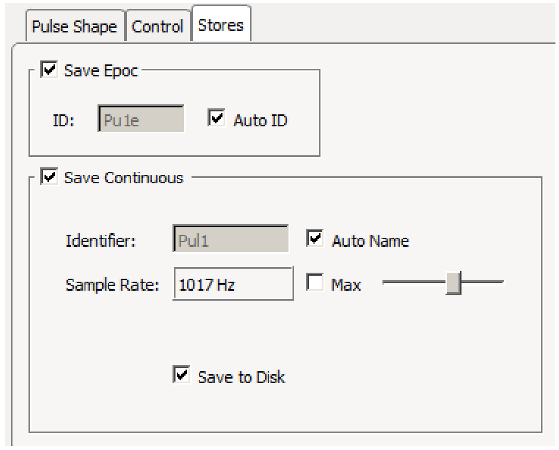
Float Value Output

If enabled, adds a secondary floating point gizmo output with the user-defined scale factor.

If ENABLE RUN-TIME INTERFACE is checked, all Control and Pulse Shape values can be adjusted by the user at run time, subject to the Min/Max bounds specified at design time.

In TIMED and PULSE COUNT modes, the user interface button changes to 'Start/Stop' and only the rising edge of the input is used to trigger the pulse train. The user has the ability to end the pulses before they are finished by disabling the runtime interface button. If the pulse train is initiated by the gizmo input, the button detects this and changes to 'Stop', letting you prematurely halt the pulse train by clicking the button.

Stores Tab



Stores Tab

Choose what data (if any) to store.

Save Epoc

Store the timestamp of the pulse onset/offset events.

Save Continuous

Saves the pulse train continuously. If the floating point output is enabled, this is the value that is stored.

User Input

User Input gizmo creates dynamic stores and logic outputs based on digital inputs to the hardware or a software button pressed by the user.

Key features:

Conditions external digital inputs and converts to another logic signal

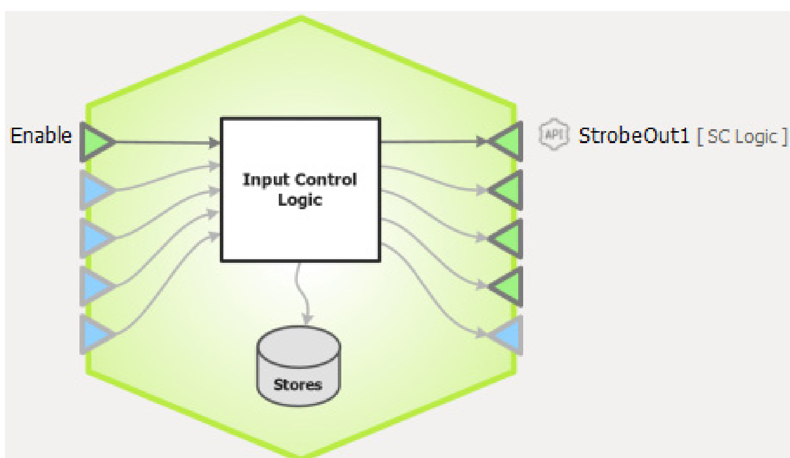
Outputs:

StrobeOut	single channel logic, conditioned output signal
Exclusive (optional)	single channel integer, button number that was pressed

Data Stored:

Epoch events (optional)	store each input as onset/offset epoch events

The User Input reads digital inputs from the hardware directly or accepts user button presses and outputs logic signals. The output Strobes can only be true when the Enable input is true. Typically the Enable input is connected to the #Enable signal on your RZ or RX, which remains high for the duration of the recording.



User Input Block Diagram

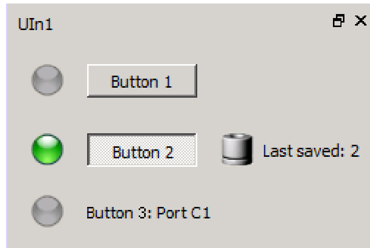
The Runtime Interface

Runtime Plot

At runtime, the standard Synapse data plot is available to display any stored data. The User Input can store its logic signals as onset/offset epoch events. See "Flow Plot" on page 66 for more information on using and customizing the plot.

User Input Tab

Software buttons appear in the user interface at run time. Other bit inputs are labeled with their port name and a state indicator. For inputs with an associated data store, the last value saved is shown on the interface.

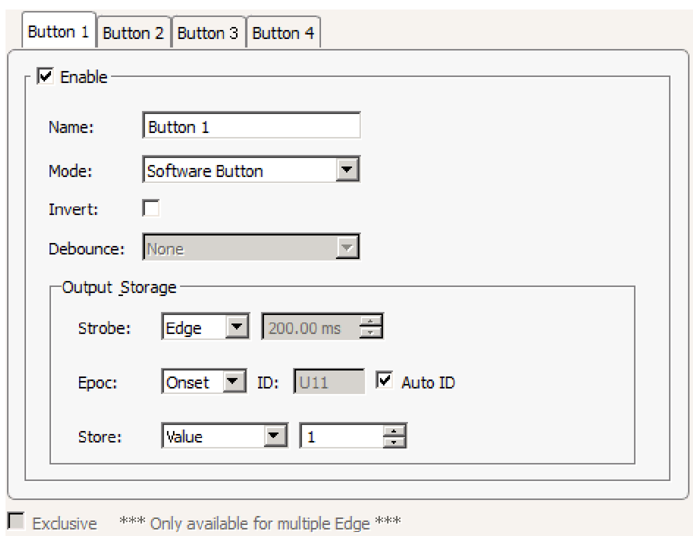


User Input Runtime UI

User Input Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Button Tabs



Button Tab

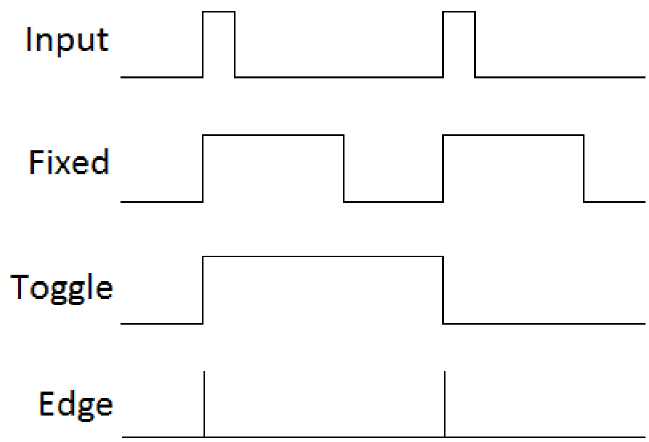
The NAME is how the input is shown on the user interface.

Button MODE can be directly wired to a digital input on the hardware, or set as a software button the user presses.

If MODE is a digital input, DEBOUNCE lets you set a duration of time for an input to settle before being detected (good for lever presses or hardware button presses).

Output Storage

Control how the output strobe behaves. An example input signal and the three Strobe options are shown below. Epoc events can be stored on the onset of the Strobe output or on the onset and offset (FULL).



Exclusive

If all of the buttons are set to EDGE mode, the Exclusive option is available. When this option is selected, an additional gizmo output is available that contains the value of the button that was pressed.

Neural

The Neural group contains all-in-one gizmos for LFP filtering and storage, online spike sorting and sort code processing, and fiber photometry applications. The spike sorting gizmos filter, threshold, and perform online PCA, time-voltage window, or tetrode feature space spike sorting and storage on multi-channel neural signals at sampling rates up to 50 kHz.

The Neural gizmo group includes:

- Local Field Potentials (LFP)
- PCA Spike Sorting
- Tetrode Spike Sorting
- Box Spike Sorting
- Sort Binner
- Neural Stream Processor
- Neural Signal Referencer

Local Field Potentials (LFP)

Important! The LFP gizmo will be replaced by the Neural Stream Processor in future releases. See "Neural Stream Processor" on page 181.

The Local Field Potentials (LFP) gizmo filters multi-channel waveforms to display and record LFP activity.

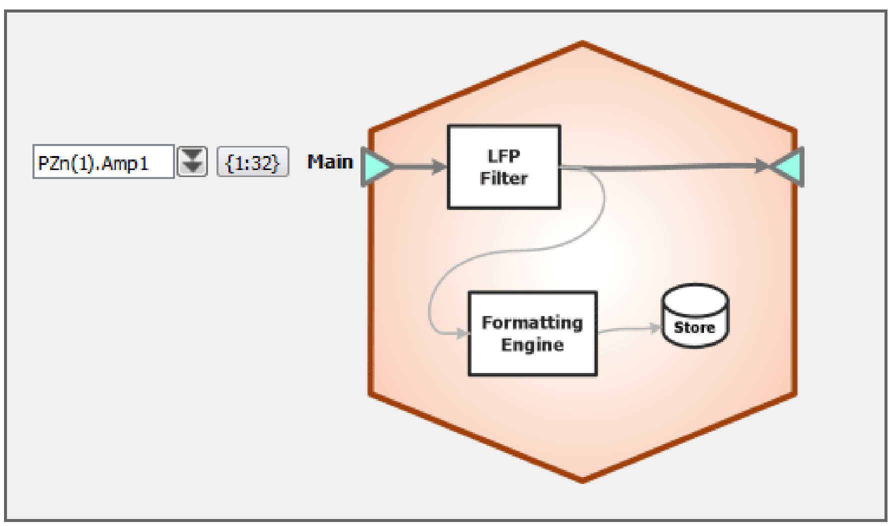
Data stored:

Stream	continuous filtered waveforms (optional)

Key features:

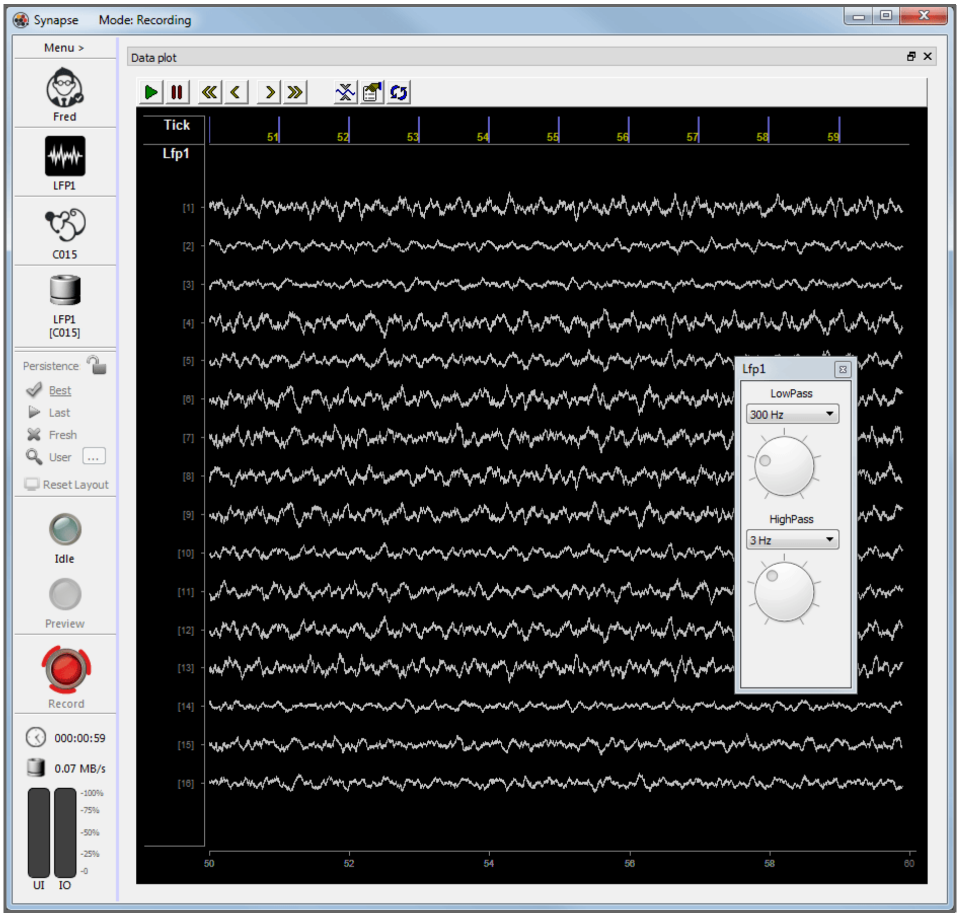
Runtime control	filter corner frequencies (optional)

The LFP gizmo takes multi-channel floating point signals, filters the signals and optionally formats and stores into the data tank. The filtered data can also be available as an output to other gizmos for further processing.



LFP Filter Block Diagram

The LFP Runtime Interface



Runtime Window

Runtime Plot

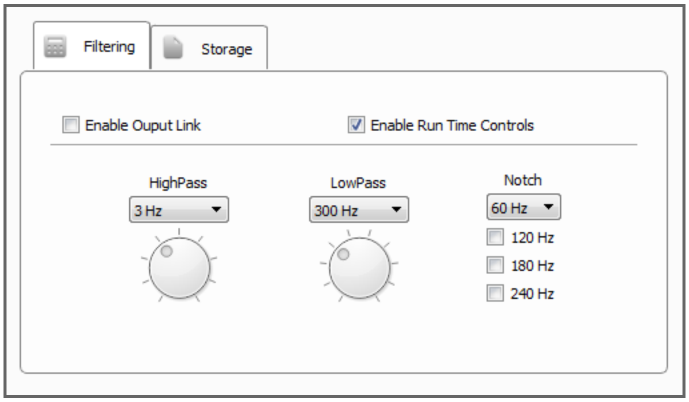
A multichannel streaming plot is included in the data plot tab when storage is enabled. See “Flow Plot” on page 66 for more information on using and customizing the plot.

LFP Tab

The LFP tab contains controls for runtime highpass and lowpass filter adjustments, if the ENABLE RUN TIME CONTROLS option is selected at designtime.

LFP Configuration Options

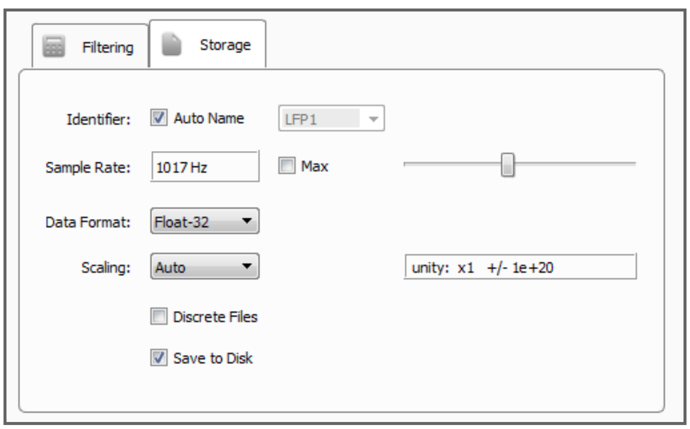
Filtering Tab



Filtering Options Tab

Select the initial highpass, lowpass, and notch filter values. To modify the highpass and lowpass filter settings during runtime, select the ENABLE RUN TIME CONTROLS check box. Use the ENABLE OUTPUT LINK check box to make filtered waveforms available as an output from this gizmo.

Storage Tab



Storage Options Tab

Set the name, data format, scaling factor, and sampling rate of the stored data. Drag the slider until the desired rate is displayed.

Use the DISCRETE FILES check box to save each channel of data as a discrete file (*.sev file) in the data tank.

Clear the SAVE TO DISK check box to view data in the runtime plots without storing data to the Tank.

Local Field Potentials (LFP)

PCA Spike Sorting

The PCA Spike Sorting gizmo performs filtering, thresholding and online principal component-based spike sorting and storage on multi-channel neural signals at sampling rates up to 50 kHz (up to 100 kHz for very low channel count).

Data stored:

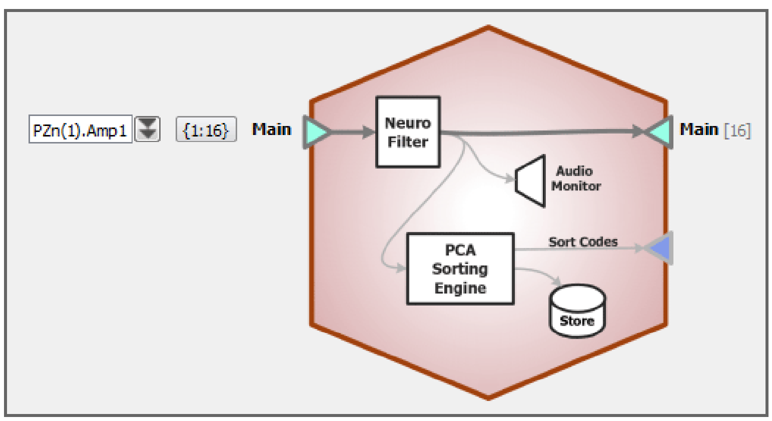
Snippets (optional)	timestamped spike waveforms
Stream (optional)	plot decimated waveforms

Outputs:

Main	filtered, multi-channel floating point signal
Sort Codes	multi-channel integer signal

Key features:

Threshold detection	deviation from RMS
Manual threshold	available per channel
Clustering algorithms	Bayesian (default), K-Means (alternate)
Manual cluster cutting	in waveform or feature space
Audio Monitor	single channel (selectable) of analog output



PCA Spike Sorting Block Diagram

Data Storage

This gizmo generates two types of data for storage: snippet data (includes timestamp, short waveform, and sort code) and plot decimated data streams. The stream data generated by this gizmo is a highly decimated version of the waveforms that keeps local maximum and minimum values of the filtered signals, which makes it ideal for visualizing high frequency spike activity on a computer monitor with a fixed number of pixels.

In plots and in the data tank, each type of data is designated with a prefix: 'e' for snippets and 'p' for streams. You can opt to save only snippets or to disable storage in the gizmo's configuration settings. The sort codes can be configured as an output to be used in other gizmos.

Threshold Detection

At runtime, candidate spikes are detected based on a calculation of the deviation of a waveform from its RMS. By default, the timestamp and position of the waveform in the snippet is dependent on the time of the threshold crossing for the signal. An alternative setting allows waveform timestamp and positioning to be determined by the waveform's highest peak, aligning snippets to their respective peaks. By default, detection is automated and you can make adjustments in the threshold control plot in the runtime window.

Spike Sorting

The sorting interface works in three phases:

1. Training
2. Classification
3. Sorting

Training

During an initial training period, candidate waveforms are collected and used to compute the first three principal components with the largest possible variance for each recording channel. Incoming waveforms are transformed and appears as dots in the three-dimensional feature space.

Classification

Dots in the feature space are then clustered to isolate waveforms that were recorded from the same neuron. By default, auto-clustering is disabled and no clustering (or sorting) takes place until it's initiated. The default clustering method is a Bayesian algorithm, but you can choose a K-Means method or use manual cluster cutting techniques. Preliminary identification of units is indicated by color coding in the plots provided for visualization; however, all candidate spikes are saved to the data tank with a sort code of 0 during this phase. During this phase you can explore the data and modify sort parameters without affecting saved data.

Sorting

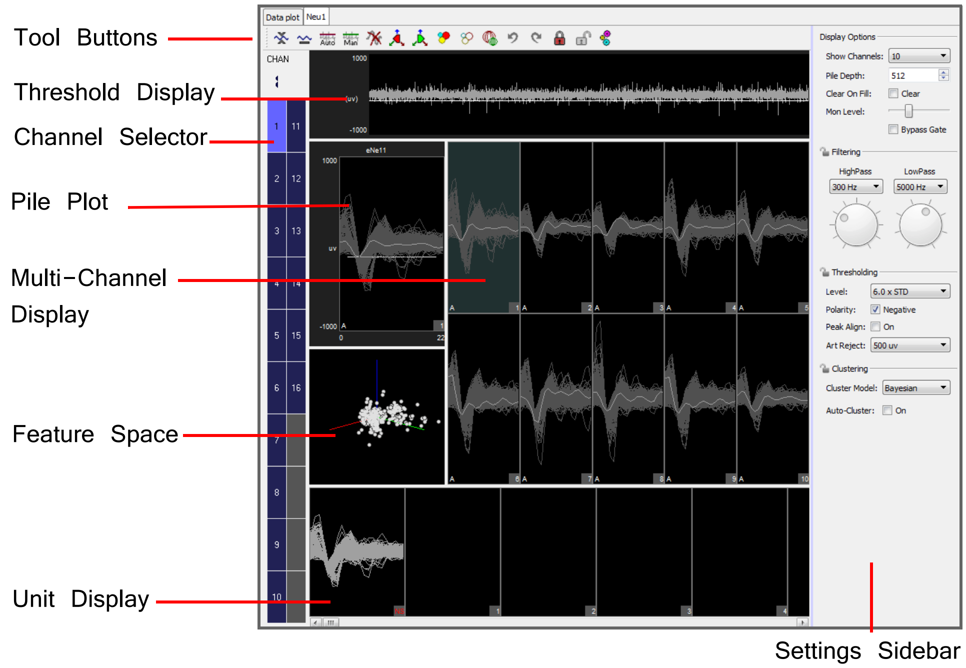
When you're satisfied with the clustering, you can apply HARDWARE SORTS . The clustering parameters are sent to the hardware and sort codes will be applied to new data as it is acquired in real-time. This toolbar button **must** be 'pressed' for online sorting to take place on the hardware.

The Runtime Interface

Runtime Plot

Streamed waveform and snippet plots are added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the plots.

PCA Spike Sorting



PCA Spike Sorting Window

The runtime window includes:

Tool Buttons	Perform actions that are global to all channels.
Threshold Display	Displays the plot decimated waveform of the currently selected channel and the threshold marker. When automatic threshold tracking is active the threshold bar is locked.
Channel Select	Selects the active channel and indicates channel status. Red color indicates training is active and the PCA feature space is being calculated. Blue indicates training is complete. Gray indicates the channel is locked and you can't change sorting parameters.
Pile Plot	Displays candidate spikes for the active channel. Indicators in the bottom left corner denote scaling and threshold tracking states ('A' for automatic, 'M' for manual). Users can manually classify waveforms by shape (hold the CTRL key and left-click drag to select waveforms that you want to classify).
Multi-Channel Display	Displays a pile plot for each channel. The channel number is shown in the bottom right corner and new waveforms are highlighted as they are added to the plot. Clicking a subplot makes that channel the active channel for other plots on the tab. Indicators in the bottom left corner denote scaling and threshold tracking states.
Feature Space	Displays the active channel of candidate spikes in three-dimensional PCA space. Manually select waveforms by holding the CTRL key and drawing an arbitrary shape around a visible cluster.

Unit Display	Displays a single channel of candidate waveforms by unit—each plot displays all waveforms classified with a single sort code.
Settings Sidebar	Includes settings for display options, filtering, and threshold settings.

Simple Zoom

You can zoom any plot to see more or less detail without affecting the actual data.

To change the zoom level, hold down the SHIFT key and left-click-drag the mouse up or down.

To reset the zoom level, hold down the SHIFT key and double-click the mouse within the display area.

Display Scale

To make it easier to see waveform shapes for channels with lower magnitude, you can scale individual channels manually or normalize all channels to fit to a similar scale, all without altering the data being stored.

To normalize all channels, click the AUTO SCALE button in the toolbar and choose to normalize the display. Each channel is scaled individually to fit around 80% of the signal's vertical size in each plot. An up or down arrow is displayed in the bottom left corner of the plot or subplot to indicate whether the display has been scaled up or down. This does not change the scale of the feature space.

To adjust the scale of a single channel, press and hold down the CTRL key, and click-and-drag the mouse up or down in the Multi-Channel Display. While adjusting the display scale, the numeric value in the lower right corner of the channel plot indicates the new scale value.

To reset the scale for all channels, click the RESET BASE SCALE button. This does not remove any Zoom applied to a plot.

To return a single channel to its base scale, right-click the desired channel and select RESET SCALING from the menu.

Settings Sidebar

Display Options

Show Channels	Select the number of channels to display in the Multi-Channel Display.
Pile Depth	Enter a number to set the maximum number of events displayed in pile plots. The oldest waveform traces are removed as new events are added.
Clear on fill	Select the check box to refresh plots, clearing all traces for a given channel whenever the pile depth is reached on that channel.
Mon Level	Slide the indicator to adjust the level of the audio monitor output, when enabled.

Bypass Gate	A noise gate on the audio monitor removes background noises so only the spikes are heard. Select this check box to turn off the noise gate.

Filtering

Set the highpass and lowpass digital filter settings.

Thresholding

Level	Set the automatic threshold level for spike detection, in number of standard deviations from the baseline.
Polarity	Set automatic threshold search polarity, either positive or negative.
Peak Align	If enabled, aligns spikes according to their peak values, altering the timestamp of the snippet.
Art Reject	When artifact rejection is enabled in the configuration options, sets the artifact rejection level in microvolts. If any sample of the candidate waveform is above this level, the waveform is ignored.

Clustering

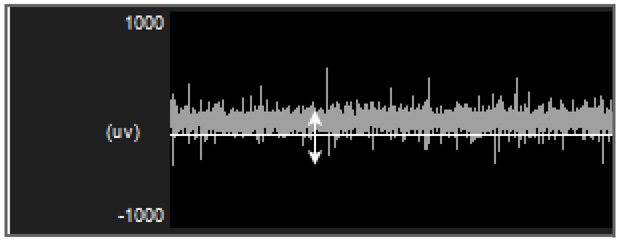
Clustering Model	Select between Bayesian and K-Means sorting algorithms. Bayesian performs automated clustering based on expectation-maximization analysis of Bayesian probabilities. K-Means performs semi-automated clustering using a binary split algorithm that attempts to find the optimum locations of the cluster centers through an iterative process and a defined number of clusters (specified by the NUM CLUSTERS setting, below).
Num Clusters	Set the max number of clusters (2-6) for the K-Means sorting algorithm. If adding another cluster does not improve the efficiency of the algorithm it is not added.
Auto-Cluster On	Select to automatically update clusters for all channels as the feature space is being calculated during training.

Threshold Control

Click the AUTO THRESHOLD  button to initiate automatic threshold tracking on all unlocked channels. If auto thresholding is enabled in the designtime interface, real-time tracking will begin on all channels, otherwise the channels will remain in manual threshold mode and the threshold will be set based on a one-time calculation using the current window data and the THRESHOLDING LEVEL and POLARITY settings.

Click the MANUAL THRESHOLD  to enable manual thresholding on all unlocked channels.

In manual threshold mode, the threshold bar may be adjusted by clicking and dragging the white bar in the threshold display window (shown below) or in the pile plot.

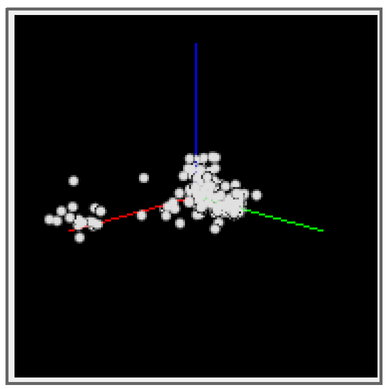


Threshold Display in Manual Mode

You can also right-click the plot at the desired threshold location and choose SET THRESHOLD HERE from the menu to move the threshold to that location on one channel. You have the option to apply this new location to all channels in manual thresholding mode.

Right-click the pile plot or threshold display and use the AUTO/MANUAL THRESHOLD options to change the threshold mode of an individual channel.

Feature Space



Feature Space

Viewing Events in the Feature Space

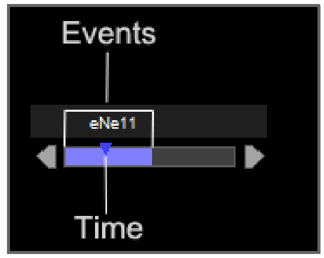
Click-and-drag in the feature space to rotate the view.

Press and hold the ALT key on the keyboard and click-and-drag to pan the feature space.

Press and hold the SHIFT key on the keyboard and double-click anywhere in the feature space to reset the feature space view.

Training

During training, as events are added to the display they become part of the data set used for feature space calculation. The feature space for each channel is periodically recalculated using all data in the history at that time, until the training is complete. Training ends when either the required number of events is reached or the training time period expires.



Training Bar

During the training period, a colored progress bar (shown above) is added to all pile plots to show how many events are required, or how much time has elapsed. By default, the progress bar is colored blue. If Auto-Cluster is enabled in the settings sidebar, the progress bar is red.

Arrows located on either end of the training progress bar can be used to restart the training period (left arrow) or to accept the current feature space (right arrow) for the active channel.

Click the ACCEPT CURRENT SPACE button to accept the current feature space for all channels. Accept the feature space on individual channels by right-clicking on any plot of an actively training channel and selecting ACCEPT SPACE.

Training on all channel can be initiated by clicking the RECALCULATE SPACE button. Training can be initiated on individual channels by right-clicking any plot and selecting RECALCULATE SPACE.

Using Clusters for Classification

Click the CLUSTER AUTOMATICALLY button to calculate clusters for all channels using the options in the settings sidebar. If training is active, this stops training and accepts the feature space before clustering. Each waveform identified by a sort code is represented by a single color on all plots. To cluster an individual channel, right-click on the pile plot or threshold display and choose AUTO CLUSTER.

Click the CLEAR CLUSTERS button to remove all clusters on unlocked channels. To clear clusters from an individual channel, right-click on the channel plot and choose CLEAR CLUSTERS. Sort codes already saved to disk remain unchanged.

Click the **Show Spheres** button to view the boundaries of spheres used to define cluster shapes in the feature space.

Applying Sorts to New Data

Sort codes are not saved to the data tank until you apply sorts. You can re-sort or make adjustments as needed to get the best results.

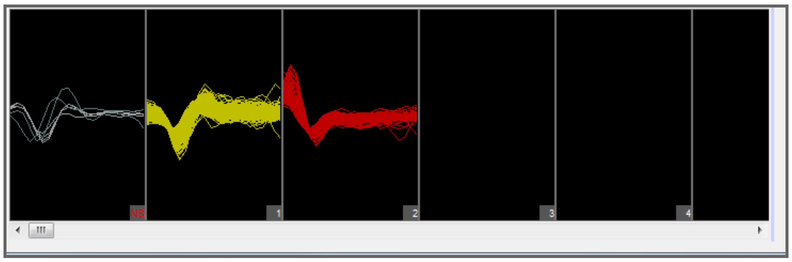
Click the HARDWARE SORT button to send the sorting parameters to the hardware and begin saving sort codes to the data tank. Sort codes are applied as new data is acquired. While this button is down, any changes in sorting parameters in the display will be sent to the hardware and applied automatically to new data.

Locking Channels

Click the LOCK ALL button to lock the clusters for all channels, or right-click individual channels and choose LOCK. If training is active, locking any channel also ends any the training and accepts the feature space.

Click the UNLOCK button to unlock all channels, or right-click individual channel plots and choose UNLOCK.

The Unit Display



Unit Display

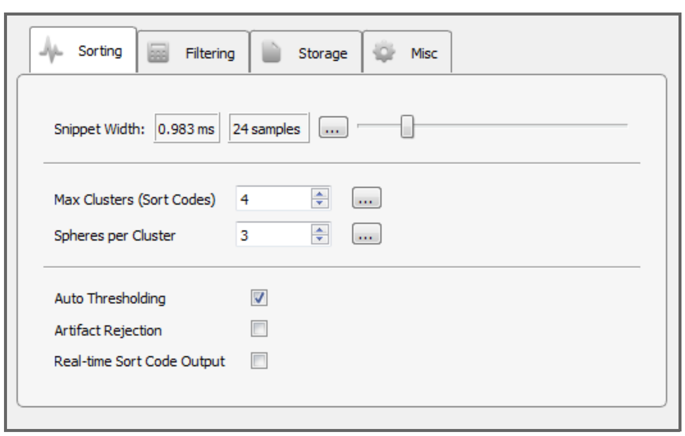
In the Unit Display, candidate waveforms from the currently selected channel are grouped by sort code. Unsorted (sort code 0) and outlier (sort code 31) waveforms are displayed to the left with the label NS.

The maximum number of sort codes (up to five) that can be sorted on the hardware is determined by the MAX CLUSTERS (SORT CODES) configuration setting. Assigned sort codes larger than this value are displayed in red to indicate they are only visible in the software interface. These waveforms will be given a sort code of 31 (outlier) in the data tank.

The Unit Display can be used to reassign units to different sort codes or combine two or more units together into a single unit by dragging the units.

PCA Spike Sorting Configuration Options

Sorting Tab



Sorting Options Tab

Snippet Width

Drag slider to select the desired width (displayed in milliseconds and samples) of recorded snippets.

Max Clusters (Sort Codes)

Events that contain similar characteristics are grouped into clusters and are given the same sort code. The maximum number of clusters supported in hardware sorting is five. Allowing a larger number of clusters increases processing overhead, but accommodates greater variability in the data set.

Spheres per Cluster

Spheres in the three-dimensional PCA feature space are used to define each cluster. The maximum number of spheres supported is five, per cluster per channel. Allowing a larger number of spheres to the sorting algorithm increases processing overhead, but provides a more accurate fit for a cluster's shape.

Auto Thresholding

In automatic thresholding, the threshold used to record snippets is adjusted in real-time to changes in each channel waveform's RMS. The previous five seconds of data are used in the RMS calculation.

Artifact Rejection

When artifact rejection is enabled, snippets that contain at least one sample greater than the artifact rejection level set on the runtime interface are ignored.

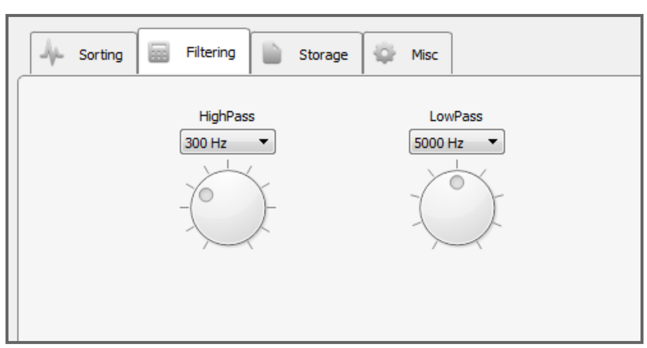
Real-time Sort Code Output

Make the multi-channel integer stream of compressed sort codes available to other gizmos, such as Sort Binner or UDP output.

Note: The sort code output is delayed by (window width + 2) samples from when the threshold is crossed. When artifact rejection is enabled, the sort code output is delayed by an additional window width, so (2 * window width + 2) total samples.

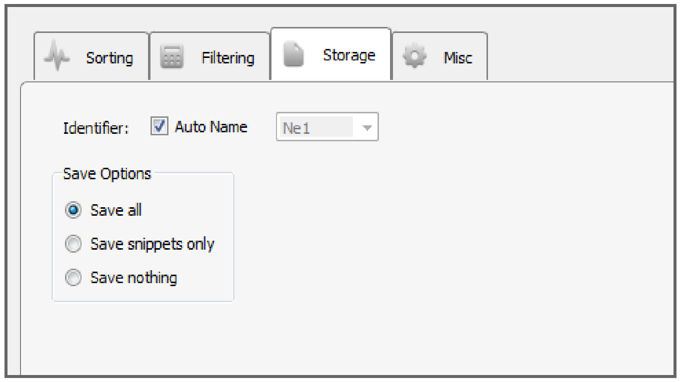
Filtering Tab

The gizmo applies a highpass and lowpass filter to all channels before spike detection. The runtime interface includes controls for dynamic adjustments to the filter settings. You also set default values in the Filtering Options tab.



Filtering Options Tab

Storage Tab

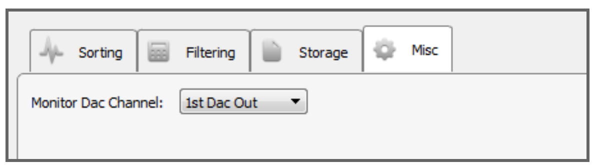


Storage Options Tab

Save Options

Select whether to save only snippet waveforms or to include the plot decimated waveforms used by the sorting gizmo or to save nothing at all to the data tank.

Misc Tab



Misc Options Tab

Monitor DAC Channel

Select an output channel to send the monitor signal to, or set to DISABLE to turn monitoring off.

Tetrode Spike Sorting

The Tetrode Spike Sorting gizmo performs filtering, thresholding and online tetrode feature space spike sorting and storage on multi-channel neural signals at sampling rates up to 50 kHz.

Data stored:

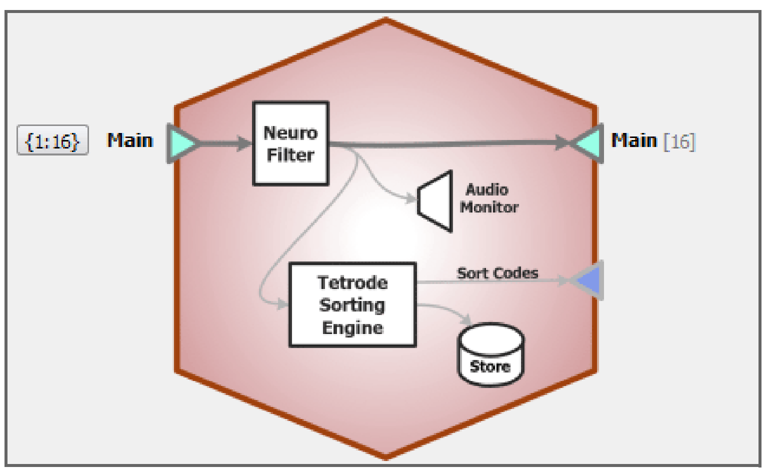
Epoc (optional)	feature state
Epoc (optional)	on pass
Waveform (optional)	on pass

Outputs:

Filtered waveforms	multi-channel float
Sort Codes	multi-channel integer

Key features:

Threshold detection	deviation from RMS
Manual threshold	available per channel
Hunt Mode	search for nearby neurons
2-D projections	select and customize the 2-D feature space
Manual cluster cutting	in 2-D feature space
Audio monitor	single channel (selectable) of analog output



Tetrode Spike Sorting Block Diagram

Data Storage

This gizmo generates two types of data for storage: snippet data (includes timestamp, short waveform, and sort code) and plot decimated data streams. The stream data generated by this gizmo is a highly decimated version of the waveforms that keeps local maximum and minimum values of the filtered signals, which makes it ideal for visualizing high frequency spike activity on a computer monitor with a fixed number of pixels.

When a waveform crosses a threshold on any channel in tetrode, a snippet on all four channels in that tetrode is recorded. The four snippets are concatenated and stored in the data tank as one large snippet, with a timestamp and a sort code. The sort code is determined by visual spike sorting in the runtime interface.

In plots and in the data tank, each type of data is designated with a prefix: 'e' for snippets and 'p' for streams. You can opt to save only snippets or to disable storage in the gizmo's configuration settings. The sort codes can be configured as an output to be used in other gizmos.

Threshold Detection

At runtime, candidate spikes are detected based on a calculation of the deviation of a waveform from its RMS. By default, the timestamp and position of the waveform in the snippet is dependent on the time of the threshold crossing for the signal. An alternative setting allows waveform timestamp and positioning to be determined by the waveform's highest peak, aligning snippets to their respective peaks. By default, detection is automated and you can make adjustments in the threshold control plot in the runtime window.

Spike Sorting

Each channel within a tetrode is displayed in a separate snippet waveform subplot. Events are projected onto a 2D space by first calculating user-selected metrics for one or two channels and then mapping one metric against another. Up to four 2D feature projections can be used to visualize spike clustering. Users may select from the following metrics: peak, valley, height, energy, non-linear energy, average, area and Slope. User-defined circles in each projection plot determine each cluster's boundaries. Snippets falling inside a circle are given a sort code corresponding to that circle's color.

The interface works in two modes:

Hunt Mode

In hunt mode the projection plots default to peak vs. peak for all six combinations of tetrode channels to provide a general overall picture of activity. Use this mode during electrode placement to search for active neurons.

Sort Mode

After the electrode has been placed, use sort mode to choose new metrics for the projection plots and add sort circles to these plots.

This gizmo allows simultaneous recordings from multiple tetrodes. The multi-channel input stream must be arranged in groups of four; each group corresponding to one physical tetrode (a Mapper gizmo may be used, see "Mapper" on page 191).

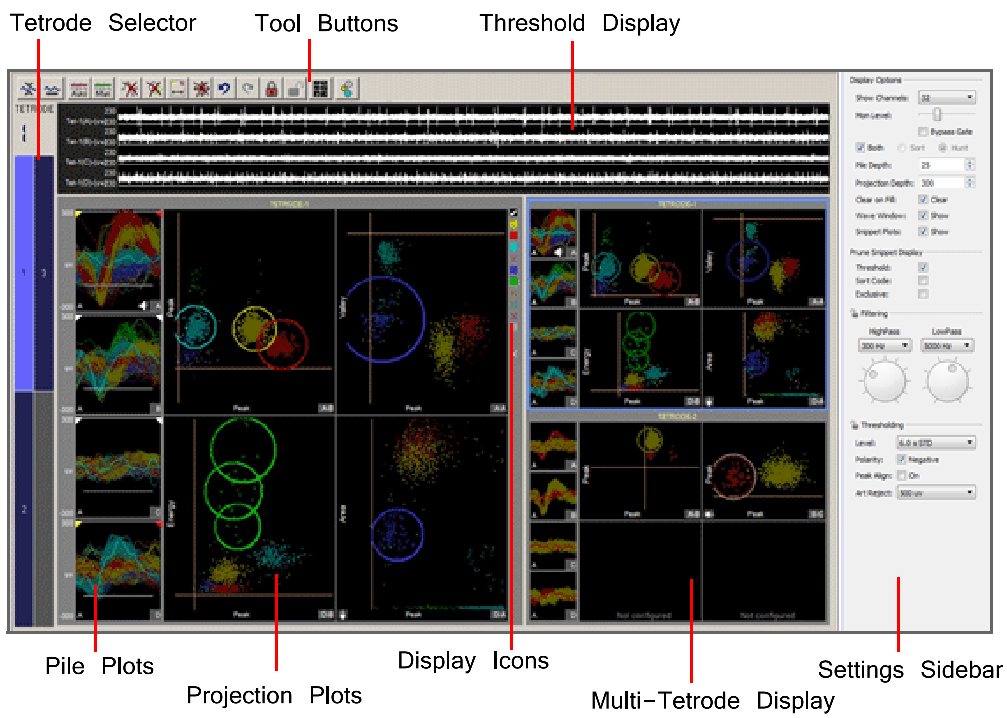
Settings for configuring the maximum number of sorting circles per projection, thresholding method and window width of the snippets can be found on the Sorting Tab in the Options area of the designtime interface.

The Runtime Interface

Runtime Plot

Streamed waveform and Snippet plots are added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the plot.

Tetrode Spike Sorting Tab



Tetrode Spike Sorting Tab

The runtime window includes:

Tool Buttons	Performs actions that are global to all channels.
Threshold Display	Displays the plot decimated waveforms for the currently selected tetrode and the threshold marker for each channel. When automatic threshold tracking is active the threshold bar is locked.
Tetrode Selector	Selects the active tetrode and indicates channel status. Gray indicates the channel is locked and you can't change the sorting parameters.
Pile Plots	Displays candidate spikes for the active tetrode. Indicators on the bottom left corner denote scaling and threshold tracking mode ('A' for automatic, 'M' for manual). The letter on the bottom right indicates the channel's position within the tetrode (A, B, C, D), which is used in the Projection Plots. A speaker icon indicates the channel that is currently playing out of the

	audio monitor. Hold down the "C" key and click a pile plot to send that channel to the audio monitor.
Projection Plots	Displays the active tetrode in several projection plots for easy comparison of candidate waveforms and visual sorting. Double-click one of the plots to choose the features/channels used for its projection. Hold down the CTRL key and click-and-drag to draw a sorting circle on the plot. Hold down the ALT key and click-and-drag to draw an arbitrary shape that will be converted into sorting circles. If the origin point is not in view, and arrow in the bottom left corner indicates the direction to the origin.
Display Icons	Choose which sort codes are displayed in the pile and projection plots. The bottom icon turns off any custom highlighting.
Multi-Tetrode Display	Displays each tetrode in a smaller version of the projection plots to allow the user to monitor all tetrodes while working with the active tetrode.
Settings Sidebar	Includes settings for display options, filtering, and threshold settings.

Zoom and Pan

You can zoom any plot to see more or less detail without affecting the actual data.

To change the zoom level, hold down the SHIFT key and click-and-drag the pointer up or down.

To reset the zoom level, hold down the SHIFT key and double-click the pointer within the display area.

To pan in snippet plots, hold down the ALT key and click-and-drag to move the snippets vertically.

To pan in projection plots, click-and-drag the pointer to move the view.

Display Scale

To make it easier to see waveform shapes for channels with lower magnitude, you may scale individual channels manually or normalize all channels to fit to a similar scale, all without altering the data being stored.

To normalize all channels, click the AUTO SCALE  button in the toolbar and choose to normalize the display. Each channel is scaled individually to fit around 80% of the signal's vertical size in each plot. An up or down arrow is displayed in the bottom left corner of the plot or subplot to indicate whether the display has been scaled up or down. This does not change the scale of the feature space.

To adjust the scale of a single channel, press and hold down the CTRL key, and click-and-drag the pointer up or down in the pile plot. While adjusting the display scale, the numeric value in the lower right corner of the channel plot indicates the new scale value.

The gizmo stores two sets of scale factors, one set for sort mode and another for hunt mode. Each set (sort or hunt) of scaling information includes a scale factor for the tetrode and any individual scale factors set for individual plots. This allows you to switch between modes without rescaling or losing scaling information.

To reset the scale for all channels, click the RESET BASE SCALE button. This does not remove any zoom applied to a plot.

To return all channels of a single tetrode to their base scale, right-click in the wave window and select RESET SCALING - TETRODE from the menu.

To return a single channel to its base scale, right-click the desired pile plot and select RESET SCALING from the menu.

Scaling the Projection Plots

In addition to being scaled when all plots/channels are scaled, the projection plots can be scaled for each tetrode or as individual plots on the shortcut (right-click) menus.

The projection plots also have a base scale which is computed as a reasonable estimate based on the metric combinations and typical data sets.

Because the 2D clusters don't always fit into nice circles for sorting, the projection plot axes can be independently scaled in order to skew the visual data set so that it does fit into a circular boundary.

To independently scale each axis, hold down CTRL + ALT and click-and-drag the pointer to the left or right to scale the x-axis of the project plot, or drag up or down to scale the y-axis.

To reset the independent scaling for all projection plots in the current tetrode or all tetrodes, click the RESET 2D PLOT INDEPENDENT SCALING button.

Highlighting Traces

By default, the most recent trace acquired is highlighted in all plots throughout the tetrode display area. Alternatively, a group of traces that are of interest can be highlighted.

To highlight a group of traces, hold down the "A" key and drag the pointer across the desired traces in any pile plot. The selected pile plot traces and their corresponding dots in the projection plots will be highlighted.

This can be repeated to add more selected traces. To remove a group of traces from the highlighted selection, repeat this procedure with the "S" key.

To clear all custom highlighting from the pile and projection plots of the active tetrode, click the bottom display icon (to the right of the projection plots).

Settings Sidebar

Display Options

Show Channels	Select the number of channels to display in the multi-tetrode display.
Mon Level	Slide the indicator to adjust the level of the audio monitor output, when enabled.

Bypass Gate	A noise gate on the audio monitor removes background noises so only the spikes are heard. Select this check box to turn off the noise gate.
Both, Sort, or Hunt	Choose to apply the settings below in sort, hunt or both modes.
Pile Depth	Enter a number to set the maximum number of events displayed in pile plots. The oldest waveform traces are removed as new events are added.
Projection Depth	Enter a number to set the maximum number of events displayed in projection plots. The oldest waveform traces are removed as new events are added.
Clear on fill	Select the check box to refresh pile plots, clearing all traces for a given channel whenever the pile depth is reached on that channel. The same applies to projection plots when the projection depth is reached.
Wave Window Show	Select to show the wave window.
Snippet Plots Show	Select or show pile plots in the multi-tetrode display.

Prune Snippet Display

Threshold	Select to show only snippets that crossed the threshold for the channel on which they occurred.
Sort Code	Select to show only snippets from channels that are used as metrics for the projection plots that have sort circles in them.
Exclusive	Select to show traces only in the pile plot in which the corresponding sort code first appears. Note: this will always be the pile plot for the first channel of the tetrode, unless used in conjunction with the threshold or sort code pruning options.

Filtering

Set the highpass and lowpass digital filter settings.

Thresholding

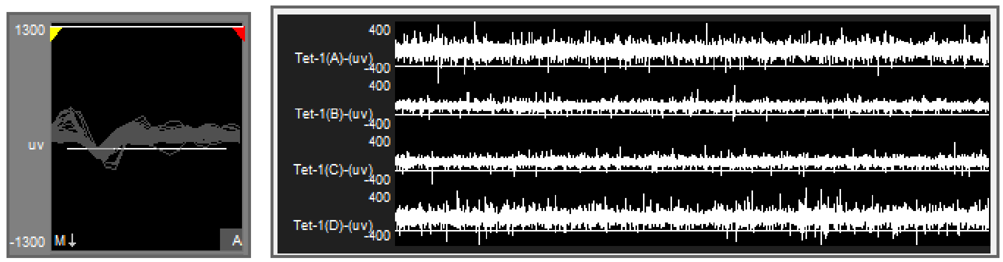
Level	Set the automatic threshold level for spike detection, in number of standard deviations from the baseline.
Polarity Negative	Set automatic threshold search polarity, either positive or negative.
Art Reject	When artifact rejection is enabled in the configuration options, sets the artifact rejection level in microvolts. If any sample of the candidate waveform is above this level, the waveform is ignored.

Threshold Control

Click the AUTO THRESHOLD  button to initiate automatic threshold tracking on all unlocked channels. If auto thresholding is enabled in the designtime interface, real-time tracking will begin on all channels, otherwise the channels will remain in manual threshold mode and the threshold will be set based on a one-time calculation using the current window data and the THRESHOLDING LEVEL and POLARITY settings.

Click the **Manual Threshold**  button to enable manual thresholding on all unlocked channels.

In manual threshold mode, the threshold bar can be adjusted by clicking and dragging the white bar in the threshold display or pile plot.



Pile Plot (left) and Wave Window (right), Manual Threshold Mode

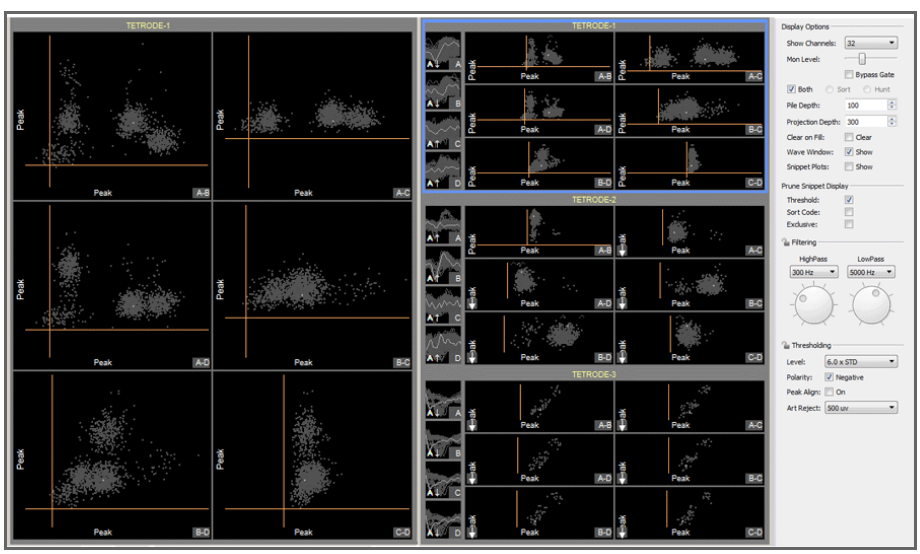
You can also right-click the pile plot at the desired threshold location and choose SET THRESHOLD HERE from the shortcut menu to move the threshold to that location on one channel. You have the option to apply this new location to all channels in manual thresholding mode.

Right-click the pile plot or threshold display and use the AUTO/MANUAL THRESHOLD options to change the threshold mode of an individual channel.

Hunt Mode

Hunt mode is designed for use during electrode placement. In this mode, the feature projections show peak vs peak for all electrode combinations to provide a general overall picture of activity.

By default, the runtime interface is in sort mode. To turn on hunt mode, click the HUNT  button. All sorting features are disabled in this mode, but scaling and other features are available.



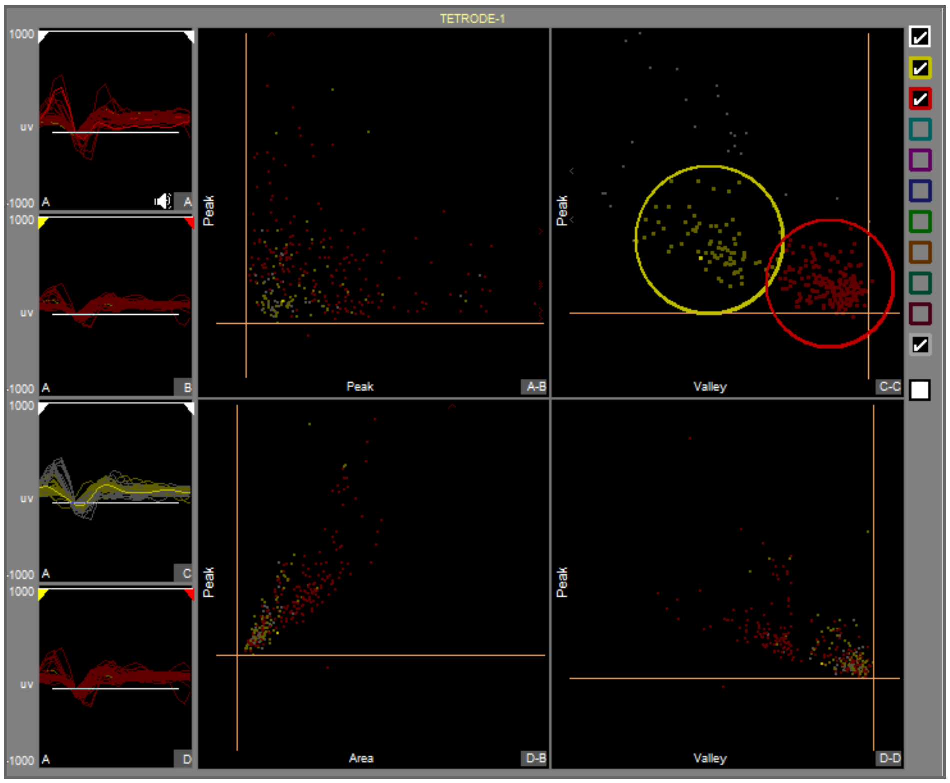
Hunt Mode

The number of events that are shown in the snippet plots (Pile Depth) and projection plots (Projection Depth) can be configured in the settings sidebar.

To clear all events from the display, press the **Spacebar**.

You can transfer projections from hunt mode to sort mode to speed up projection configuration. Press the Ctrl key and click the desired projection(s). You can select multiple projections across multiple tetrodes. Then click the Hunt button to turn hunt mode off. You'll be asked to confirm your selections. The display returns to sort mode with the selected projections.

Sorting in the Active Tetrode Plot Display



Active Tetrode Display

The active tetrode display provides an interactive space for online cluster-cutting. Once reasonable thresholds are set, snippets will appear in each of the four snippet plots. The projection plots are created by applying metrics to the waveforms in these pile plots and then plotting one metric versus another in an X-Y plane. When you are satisfied with the defined sorts, you can send the sorting parameters to the hardware by clicking the Hardware Sorts button and sort codes will be applied to new data as it is acquired in real-time. This toolbar button **must** be 'pressed' for online sorting to take place on the hardware. You can lock the plots by clicking the Lock button to protect them from modification.

Pile Plots

Restricting Metric Calculations to a Narrow Window

The marker at the top of the snippet plot indicates the window of snippet data that is used for metric calculations for the selected projection plot. This is called the min-max interval and can be adjusted on-the-fly.

This does not change the width of the window in data storage, which is defined in the configuration options.

Click-and-drag the yellow or red indicators to the desired position to adjust the min-max interval.

To reset the min-max interval for one channel, right-click in the pile plot and select RESET MIN-MAX INTERVAL. To reset the min-max interval for more channels, click the RESET SNIPPET PLOT MAX MIN INTERVALS  button.

Projection Plots

The main area of the active tetrode display is divided into four 2D projection plots for dynamic visual spike sorting. Each snippet appears as a single dot in 2D space of one metric plotted versus another. By default, the top left plot will display the peak of the first channel against the peak of the second channel.

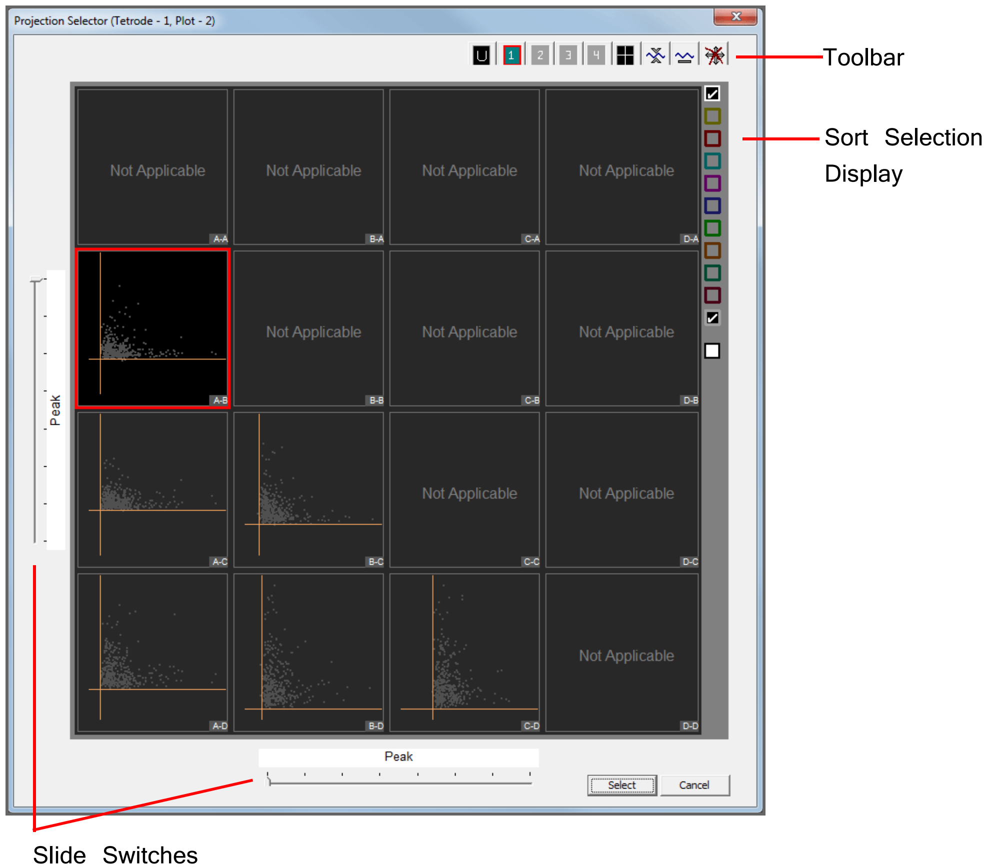
Up to four 2D projections can be used to visualize tetrode spike clustering. Each new projection can help to further refine a sort or identify new sorts. You can preview and choose projections using the active tetrode data.

Available Metrics

All metric calculations are performed on the segment of data within the min-max interval only.

Peak	The highest data point in the interval.
Valley	The lowest data point in the interval.
Height	The difference between peak and valley in the interval.
Energy	The arithmetic mean (average) of the squares of each point in the interval.
Non-linear Energy	sum(w(t)*w(t) - w(t-1)*w(t+1))/length(w), for all t in the interval, where w is the waveform array.
Average	The arithmetic mean of all values in the interval.
Area	The sum of the absolute values of all points in the interval.
Slope	The height divided by the difference between the peak timestamp and valley timestamp in the interval.

To open the Projection Selector, double-click a projection subplot. To add a projection, select a subplot that has not been configured.



Projection Selector Window

All possible combinations of metrics between channels are displayed. The letters in the lower-right corner of each plot indicate the x-axis and y-axis channels for that plot. Metric combinations that are already in use in other projection plots for this tetrode will have a solid border around them.

Use the slide switches on the left and bottom edges to chose the Y- and X-axis metrics, respectively.

The Sort Selection Display can be used to toggle the display of individual or all sort codes.

Toolbar Buttons

Shows all data as unsorted events

Switch to corresponding projection (only available in plots that are already configured)

Switch to selected cluster projection preview.

Auto scale projections

Reset base scale for projections

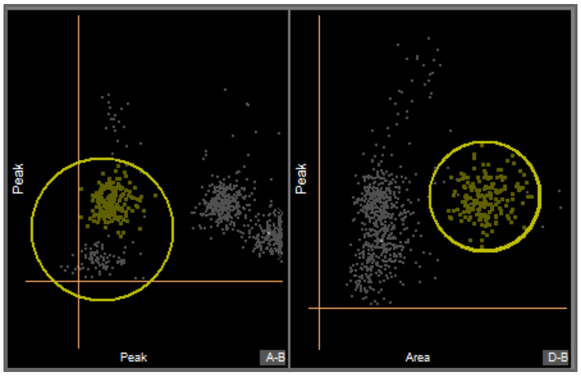
Reset independent plot scaling removes any x-axis or y-axis skew in all available projections.

Defining Sorts

You can assign sort codes to their associated snippets by drawing a circle around the desired cluster of points in the plot. Snippets falling inside a circle are given a sort code corresponding to that circle's color. The color of the dot representing that snippet will change to the color of the circle. More than one circle of the same color can be defined in each projection. A snippet falling in any of those same-colored circles will be classified with that sort code.

Because snippets can fall into more than one circle, the sort code assigned to candidate waveforms can be either (a) the largest value of all circles the dot fell inside or (b) a mask of all sort codes that the candidate snippet fell inside. For example, if a snippet falls into a yellow (sort code 1) and green (sort code 6) circle, then the snippet mask will be 33 (0b100001 = 33). This assignment option is selected by the user in the Sorting Options tab at designtime.

A snippet that doesn't fall inside any circles is considered unsorted and has sort code 0 (gray). If there are circles of the same color on more than one projection, a candidate snippet has to fall inside that type of circle in all projections to be given that color's sort code. The total number of circles that can be defined in any one projection plot is set in the configuration options (the default is 12).



Sorting Interface

Drawing Circles

The circles you draw in each projection plot determine a cluster's boundaries and shape. Sort codes are applied to snippets using the boundary calculated for each cluster. Hold down the CTRL key and click-and-drag to draw a sorting circle on the plot.

Sort circles can also be generated by drawing an arbitrary shape around points in a projection plot. Synapse will then attempt to draw circles that will efficiently represent the selected points. Hold down the ALT key and click-and-drag to draw an arbitrary shape that will be converted into sorting circles.

If necessary, the projection plot axes can be independently scaled so that the data points fit into circular clusters. To independently scale each axis, hold down CTRL + ALT and click-and-drag the mouse to the left or right to scale the x-axis of the project plot, or drag up or down to scale the y-axis.

Filtering the Display by Sort Code

A column of colored squares along the right edge of the active tetrode display serves to filter events by sort code. Check the white outlined box to display all sort codes. Check the gray outlined box to display unsorted events. Hold down the CTRL key and click a square, to show only that sort code.

Applying Sorts to New Data

Sort codes are not saved to the data tank until sorts are applied by the user. You can re-sort or make adjustments as needed to get the best results.

Click the HARDWARE SORT button to send the sorting parameters to the hardware and begin saving sort codes to the tank. Sort codes are applied as new data is acquired. While this button is down, changes in sorting parameters in the display will be applied automatically to new data.

Locking Channels

Click the LOCK ALL button to lock the sorting circles for all channels, or right-click individual channels and choose LOCK.

Click the UNLOCK button to unlock all channels, or right-click individual channel plots and choose UNLOCK.

Keyboard Shortcuts

Keyboard combos:

Click + Drag	Pan Projection Plot.
Shift + Click and Drag	Projection Plot: Zoom in and out.
	Snippet Plot: Y-axis zoom.
Ctrl + Alt + Click & Drag	Skew the Projection Plots up down or left right.
Alt + Click & Drag	Snippet Plot: Pan.
	Projection Plot: Draw arbitrary shape.

Keyboard Projection Plot hotkeys:

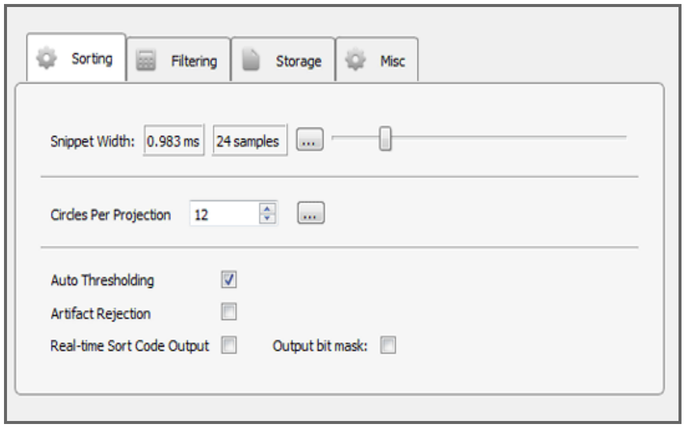
~	Show all sort codes.
1-9	Toggle sort code show/hide.
Ctrl + [1-9]	Show only the selected sort code.

Tetrode Spike Sorting Configuration Options

See “The Options Area” on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.

Sorting Tab

Settings on this tab apply to the runtime interface and snippet storage.



Sorting Options Tab

Snippet Width Slider

Drag slider to select the desired width (displayed in milliseconds and samples) of recorded snippets (per channel). The actual snippet output will be four times as long.

Circles Per Projection

Set the total number of circles that can be defined in any one projection plot. Lowering this value decreases the processing overhead.

Auto Thresholding

In automatic thresholding, the threshold used to record snippets is adjusted in real-time to changes in each channel waveform's RMS. The previous five seconds of data are used in the RMS calculation.

Artifact Rejection

When artifact rejection is enabled, snippets that contain at least one sample greater than the artifact rejection level set on the runtime interface are ignored.

Real-time Sort Code Output

Make the multi-channel integer stream of uncompressed sort codes available to other gizmos, such as Sort Binner or UDP output.

Note: The sort code output is delayed by (window width + 2) samples from when the threshold is crossed. When artifact rejection is enabled, the sort code output is delayed by an additional window width, so (2 * window width + 2) total samples.

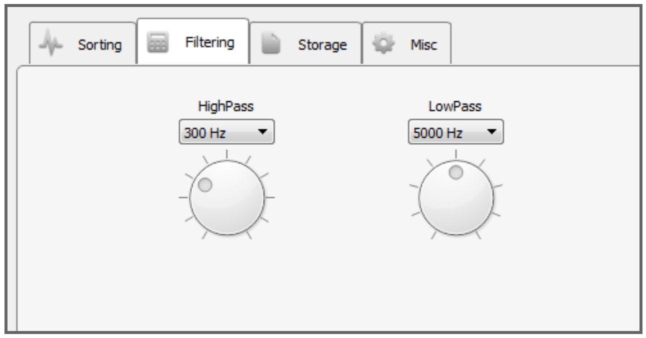
Output Bit Mask

Make the assigned sort code a mask of all sort codes that the candidate snippet fell inside. For example, if a snippet falls into a yellow (sort code 1) and green (sort code 6) circle, then the snippet mask will be 33 (0b100001 = 33).

The default behavior is to use the largest value of all circles the dot fell inside as the sort code. If using Sort Binner on the Sort Code output, leave this option unchecked.

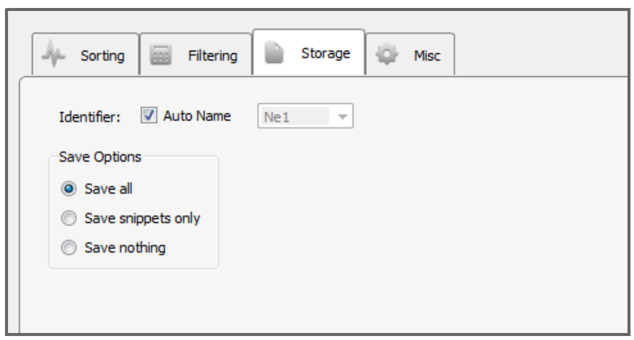
Filtering Tab

The gizmo applies a highpass and lowpass filter to all channels before spike detection. The runtime interface includes controls for dynamic adjustments to the filter settings. You also set default values in the Filtering tab.



Filtering Options Tab

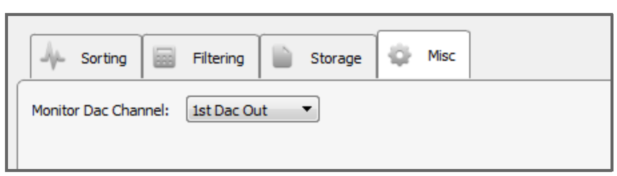
Storage Tab



Storage Options Tab

Select whether to save only snippet waveforms or to include the plot decimated waveforms used by the sorting gizmo, or to save nothing at all. The waveforms will still be displayed in the runtime interface and data plots but will not be saved to disk.

Misc Tab



Misc Options Tab

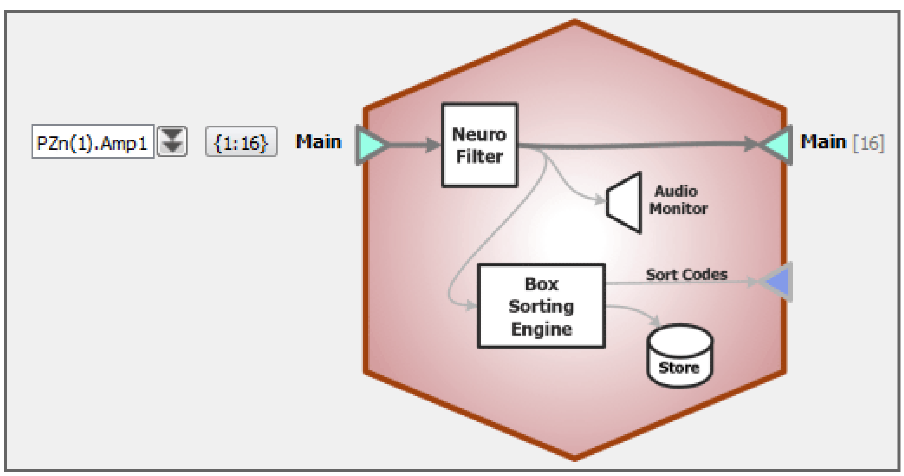
Monitor DAC Channel

Select an output channel to send the monitor signal to, or set to DISABLE to turn monitoring off.

Box Spike Sorting

The Box Spike Sorting gizmo performs filtering, thresholding and online time-voltage spike sorting and storage on multi-channel neural signals at sampling rates up to 50 kHz.

Data Stored:		
	Snippets (optional)	timestamped spike waveforms
	Stream (optional)	plot decimated waveforms
Outputs:		
	Main	filtered, multi-channel floating point signal
	Sort Codes	multi-channel integer signal
Key features:		
	Threshold detection	deviation from RMS
	Manual or auto threshold	available per channel
	Sorting	time voltage windows in waveform space
	Audio Monitor	single channel (selectable) analog signal



BoxSort Block Diagram

Data Storage

This gizmo generates two types of data for storage: snippet data (includes timestamp, short waveform, and sort code) and plot decimated data streams. The stream data generated by this gizmo is a highly decimated version of the waveforms that keeps local maximum and minimum values of the filtered signals, which makes it ideal for visualizing high frequency spike activity on a computer monitor with a fixed number of pixels.

In plots and in the data tank, each type of data is designated with a prefix: 'e' for snippets and 'p' for streams. You can opt to save only snippets or to disable storage in the gizmo's configuration settings. The sort codes can be configured as an output to be used in other gizmos.

Threshold Detection

At runtime, candidate spikes are detected based on a calculation of the deviation of a waveform from its RMS. By default, the timestamp and position of the waveform in the snippet is dependent on the time of the threshold crossing for the signal. An alternative setting allows waveform timestamp and positioning to be determined by the waveform's highest peak, aligning snippets to their respective peaks. By default, detection is automated and you can make adjustments in the threshold control plot in the runtime window.

Spike Sorting

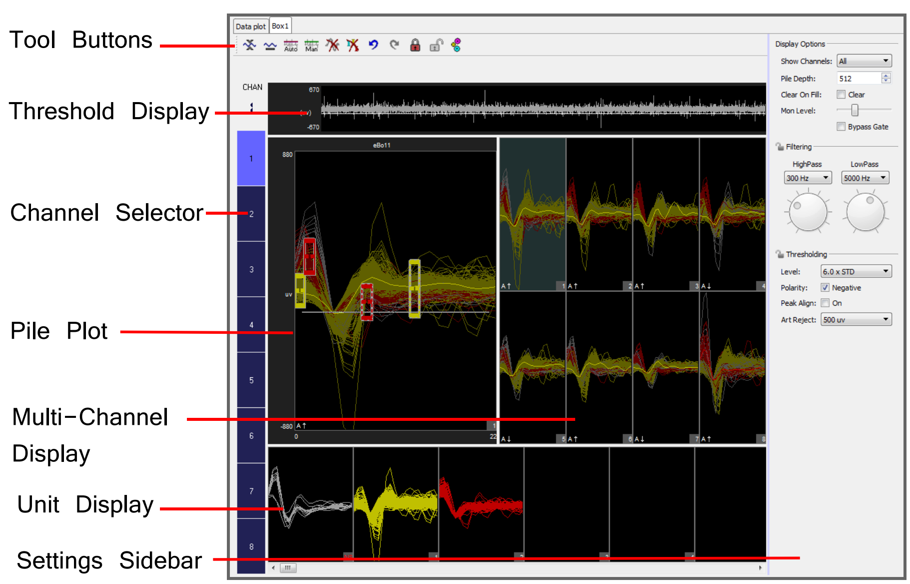
A runtime window tab offers manual sorting using time-voltage box pairs to classify potential units among candidate waveforms. When satisfied with the sorts for all channels, the user can choose to apply HARDWARE SORTS . The sorting parameters are sent to the hardware and sort codes will be applied to new data as it is acquired in real-time. This toolbar button **must** be 'pressed' for online sorting to take place on the hardware.

The Runtime Interface

Runtime Plot

Streamed waveform and Snippet plots are added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the plots.

Box Spike Sorting Tab



Box Spike Sorting Window

The runtime window includes:

Tool Buttons	Performs actions that are global to all channels.
Threshold Display	Displays the plot decimated waveform of the currently selected channel and the threshold marker. When automatic threshold tracking is active the threshold bar is locked.
Channel Selector	Selects the active channel and indicates channel status. Gray indicates the channel is locked and sorting parameters can't be changed.
Pile Plot	Displays candidate spikes for the active channel. Indicators in the bottom left corner denote scaling and threshold tracking states ('A' for automatic, 'M' for manual). Hold down the CTRL key and double-click to add time-voltage windows.
Multi-Channel Display	Displays a pile plot for each channel. The channel number is shown in the bottom right corner of each subplot and new waveforms are highlighted as they are added to the plot. Clicking a subplot makes that channel the active channel for other plots on the tab. Indicators in the bottom left corner denote scaling and threshold tracking states.
Unit Display	Displays a single channel of candidate waveforms by unit—each plot displays all waveforms classified with a single sort code.
Settings Sidebar	Includes settings for display options, filtering, and threshold settings.

Simple Zoom

You can zoom any plot to see more or less detail without affecting the actual data.

To change the zoom level, hold down the SHIFT key and click-and-drag the pointer up or down.

To reset the zoom level, hold down the SHIFT key and double-click within the display area.

Display Scale

To make it easier to see waveform shapes for channels with lower magnitude, you may scale individual channels manually or normalize all channels to fit to a similar scale, all without altering the data being stored.

To normalize all channels, click the AUTO SCALE  button in the toolbar and choose to normalize the display. Each channel is scaled individually to fit around 80% of the signal's vertical size in each plot. An up or down arrow is displayed in the bottom left corner of the plot or subplot to indicate whether the display has been scaled up or down. This does not change the scale of the feature space.

To adjust the scale of a single channel, press and hold down the CTRL key, and click-and-drag the mouse up or down in the multi-channel display. While adjusting the display scale, the numeric value in the lower right corner of the channel plot indicates the new scale value.

To reset the scale for all channels, click the RESET BASE SCALE button. This does not remove any zoom applied to a plot.

To return a single channel to its base scale, right-click the desired channel and select RESET SCALING from the menu.

Settings Sidebar

Display Options

Show Channels	Select the number of channels to display in the multi-channel display.
Pile Depth	Enter a number to set the maximum number of events displayed in pile plots. The oldest waveform traces are removed as new events are added.
Clear on fill	Select the check box to refresh plots, clearing all traces for a given channel whenever the pile depth is reached on that channel.
Mon Level	Slide the indicator to adjust the level of the audio monitor output, when enabled.
Bypass Gate	A noise gate on the audio monitor removes background noises so only the spikes are heard. Select this check box to turn off the noise gate.

Filtering

Set the highpass and lowpass digital filter settings.

Thresholding

Level	Set the automatic threshold level for spike detection, in number of standard deviations from the baseline.
Polarity	Set automatic threshold search polarity, either positive or negative.
Peak Align	If enabled, aligns spikes according to their peak values, altering the timestamp of the snippet.
Art Reject	When artifact rejection is enabled in the configuration options, sets the artifact rejection level in microvolts. If any sample of the candidate waveform is above this level, the waveform is ignored.

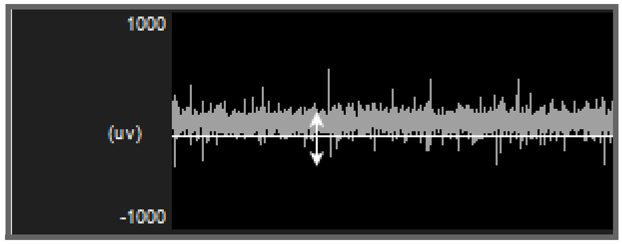
Threshold Control

Click the AUTO THRESHOLD button to initiate automatic threshold tracking on all unlocked channels. If Auto Thresholding is enabled in the designtime interface, real-time tracking will begin on all channels, otherwise the channels will remain in manual threshold mode and the threshold will be set based on a one-time calculation using the current window data and the THRESHOLDING LEVEL and POLARITY settings.

Click the MANUAL THRESHOLD 

to enable manual thresholding on all unlocked channels.

In manual threshold mode, the threshold bar may be adjusted by clicking and dragging the white bar in the threshold display window (shown below) or in the pile plot.



Threshold Display in Manual Mode

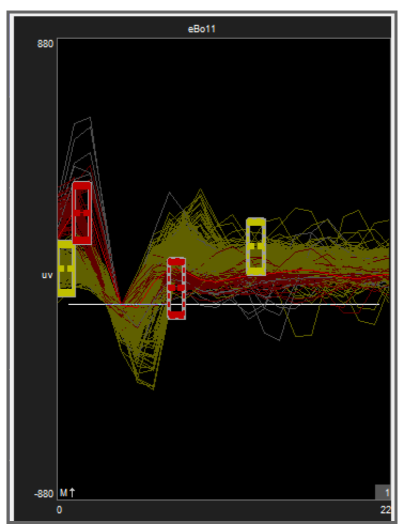
You can also right-click the plot at the desired threshold location and choose SET THRESHOLD HERE from the menu to move the threshold to that location on one channel. You have the option to apply this new location to all channels in manual thresholding mode.

Right-click the pile plot or threshold display and use the auto/manual threshold options to change the threshold mode of an individual channel.

Box Sorting Using the Pile Plot

Pair of color-coded boxes (one solid and one dotted) are used to classify each unit. In order to be classified as a particular unit, the following is required:

- Candidate waveforms must enter the solid box only one time.
- Candidate waveforms must contain data points that pass through both boxes in the pair.
- One digitized point of the candidate waveform must exist in each box.



Box Sort Waveform Space

To add a box pair:

- Press and hold the CTRL key and double-click to add a new box pair to the pile plot.

A sort code is automatically assigned to the newly added box pair. Click and drag the vertices to adjust the boundaries of the boxes or to move it. To remove a pair of boxes, drag one of the boxes outside of the vertical boundaries of the plot and release.

If a waveform passes through more than one box pair, sort code priority is assigned based on the sort code number. This means that the lower sort code will win in the event that a waveform passes through more than one box pair.

Applying Sorts to New Data

Sort codes are not saved to the data tank until you apply the sorting parameters. You can re-sort or make adjustments as needed to get the best results.

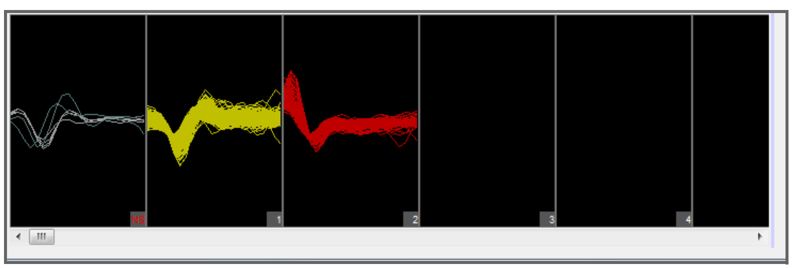
Click the HARDWARE SORT button to send the sorting parameters to the hardware and begin saving sort codes to the tank. Sort codes are applied as new data is acquired. While this button is down, changes in sorting parameters in the display will be applied automatically to new data.

Locking Channels

Click the LOCK ALL button to lock the boxes for all channels, or right-click individual channels and choose LOCK.

Click the UNLOCK button to unlock all channels, or right-click individual channel plots and choose UNLOCK.

The Unit Display



Unit Display

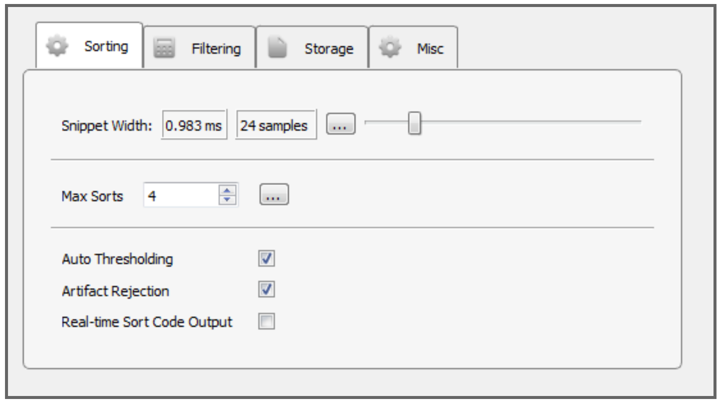
In the unit display, candidate waveforms from the currently selected channel are grouped by sort code. Unsorted (sort code 0) and outlier (sort code 31) waveforms are displayed to the left with the label NS.

The maximum number of sort codes (up to five) that can be sorted on the hardware is determined by the MAX SORTS configuration setting. Assigned sort codes larger than this value are displayed in red to indicate they are only visible in the software interface. These waveforms will be given a sort code of 31 (outlier) in the data tank.

The unit display can be used to reassign units to different sort codes by clicking-and-dragging the units.

Box Spike Sorting Configuration Options

Sorting Tab



Sorting Options Tab

Snippet Width

Drag slider to select the desired width (displayed in milliseconds and samples) of recorded snippets.

Max Sorts

Events that contain similar shapes are grouped into sorts and given the same sort code. The maximum number of sorts supported in hardware sorting is five. Allowing a larger number of sorts increases processing overhead, but accommodates greater variability in the data set.

Auto Thresholding

In automatic thresholding, the threshold used to record snippets is adjusted in real-time to changes in each channel waveform's RMS. The previous five seconds of data are used in the RMS calculation.

Artifact Rejection

When artifact rejection is enabled, snippets that contain at least one sample greater than the artifact rejection level set on the runtime interface are ignored.

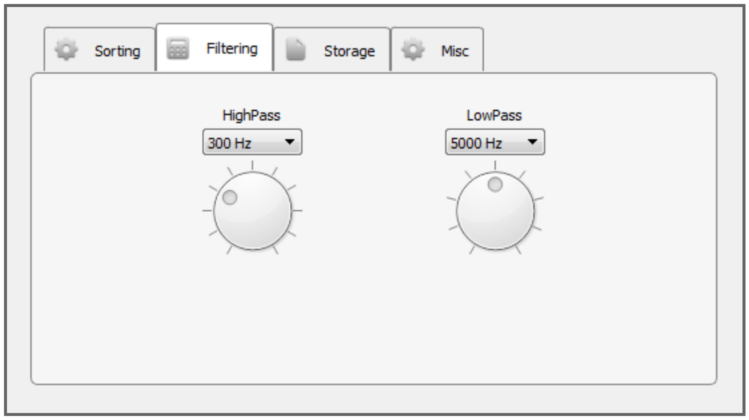
Real-time Sort Code Output

Make the multi-channel integer stream of compressed sort codes available to other gizmos, such as Sort Binner or UDP output.

Note: The sort code output is delayed by (window width + 2) samples from when the threshold is crossed. When artifact rejection is enabled, the sort code output is delayed by an additional window width, so (2 * window width + 2) total samples.

Filtering Tab

The gizmo applies a highpass and lowpass filter to all channels before spike detection. The runtime interface includes controls for dynamic adjustments to the filter settings. You also set default values in the Filtering tab.



Filtering Options Tab

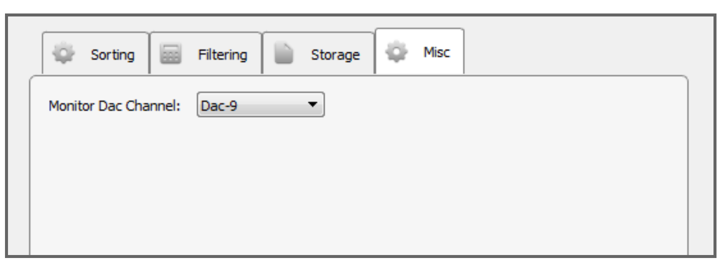
Storage Tab

Storage Tab Options

Save Options

Select whether to save only snippet waveforms or to include the plot decimated waveforms used by the sorting gizmo, or to save nothing at all. The waveforms will still be displayed in the runtime interface and data plots but will not be saved to disk.

Misc Tab



Misc Options Tab

Monitor DAC Channel

Select an output channel to send the monitor signal to, or set to DISABLE to turn monitoring off.

Sort Binner

Sort Binner primarily serves as a sort code processor that compresses sort code data. For greater versatility it can also accept any multi-channel data.

Data Stored:

Compressed sort code counts (optional)

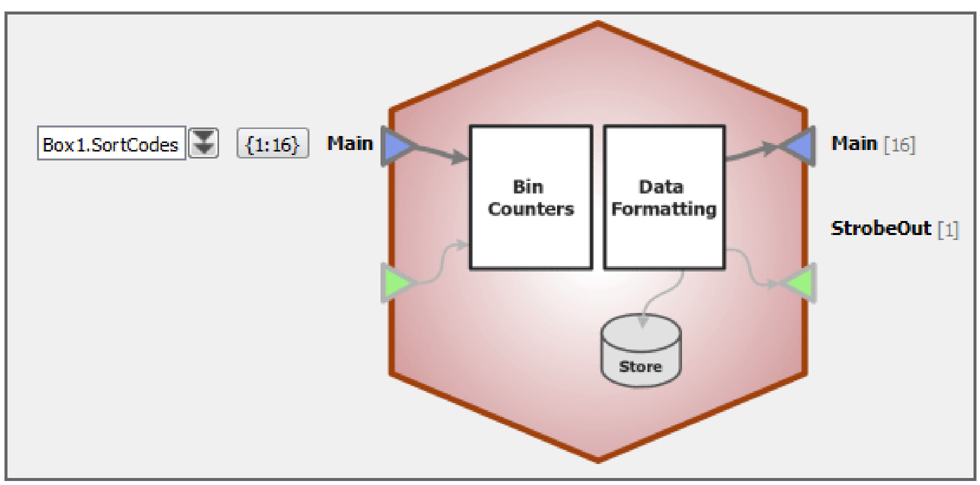
Key features:

User defined timing and formatting options

Outputs:

Compressed sort code counts	multi-channel integer
Multi-channel signals	floating point
Timing pulse	logic

Sort Binner is designed to work with multichannel data, and in particular, sort code outputs from spike sorting gizmos. When used with the real-time sort code output of a spike sorting gizmo, such as PCA Spike Sorting, Box Spike Sorting or Tetrode Spike Sorting—whose outputs contain sort code data that has been compressed four channels to one—it's a sort code processor that accepts compressed sort code data and then further compresses the data by counting sort code occurrences within user-set intervals.

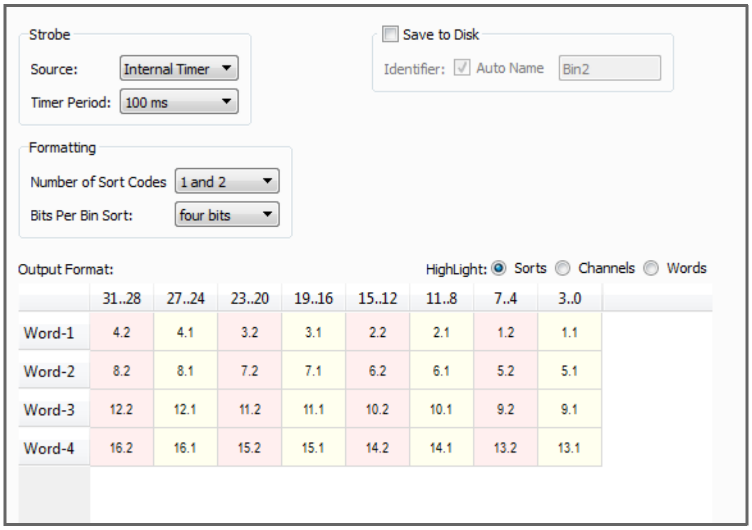


Sort Binner Block Diagram

The Main output can be sent to a UDP or other output device and can be used for closed loop control.

Sort Binner Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Sort Binner Configuration Options

Strobe

The strobe latches and resets the sort code counter on all channels. It can be a fixed timer (INTERNAL TIMER) or a logical trigger source from another gizmo or device (GIZMO INPUT).

If using the gizmo input, use the block diagram to choose the STROBEIN input after you have committed your selection.

Formatting

Select the number of sort codes to look for on each channel of the incoming data and the number of bits per sort codes you want to use for each counter. Use fewer bits and a shorter strobe period to quickly transfer firing/not-firing information. Use more bits and a longer strobe period to convey a more accurate count of sort codes in between strobes.

Output Format

The table provides a visual reference of how the data is compressed into 32-bit words (integers) and is useful when unpacking the data, for example on the other end of the UDP interface. Words are shown in rows with bits in columns. Each cell contains Channel#.SortCode. Highlight radio buttons are available for fast visual simplification of the format.

In the example above, the gizmo will output a four-channel stream of 32-bit integers (Word 1..4). The first four bits of channel 2 on the Main output will contain an integer count of how many spikes fired on channel 5, that were assigned a sort code value of 1, since the last strobe. Because four bits are used to represent this counter, the maximum count value is fifteen (2^4-1).

Neural Stream Processor

The Neural Stream Processor gizmo filters and stores single or multi-channel biopotential waveforms.

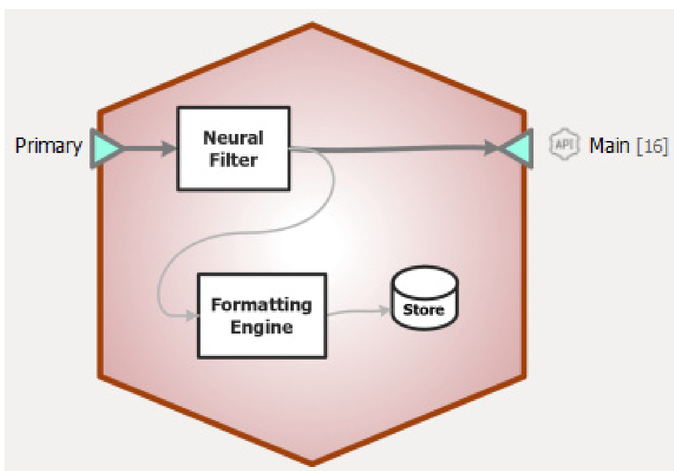
Data stored:

Stream	continuous filtered waveforms (optional)

Key features:

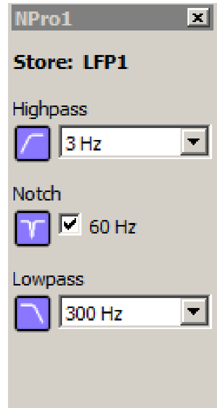
Runtime control	filter corner frequencies and notch (optional)

The Neural Processing gizmo takes single or multi-channel floating point signals, filters the signals and optionally formats and stores into the data tank. The filtered data can also be available as an output to other gizmos for further processing.



Neural Stream Processor Block Diagram

The Neural Stream Processor Runtime Interface



Runtime Window

Runtime Plot

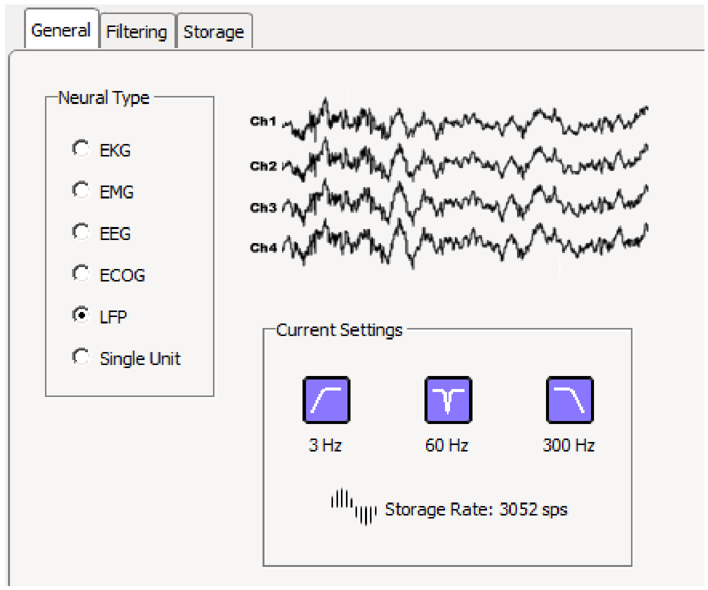
A multichannel streaming plot is included in the data plot tab when storage is enabled. See "Flow Plot" on page 66 for more information on using and customizing the plot.

NPro1 Tab

The NPro1 tab contains controls for runtime highpass, lowpass, and notch filter adjustments, if the RUNTIME CONTROLS option is selected at designtime.

Neural Stream Processor Configuration Options

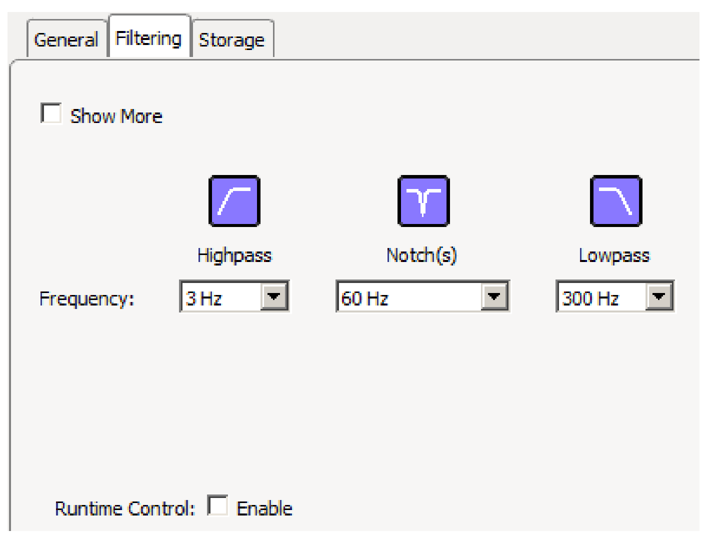
General Tab



General Options Tab

Select the signal type to automatically configure default highpass, lowpass, notch settings. A depiction of the signal type, along with the current filter and storage settings, is displayed.

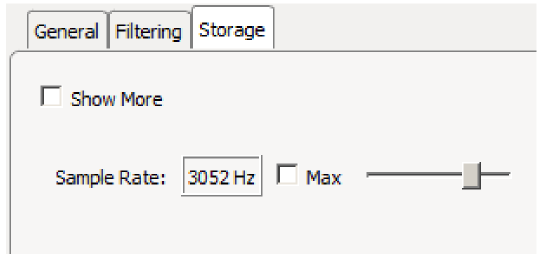
Filtering Tab



Filtering Options Tab

Select the initial highpass, lowpass, and notch filter values. To modify the highpass, lowpass, and notch settings during runtime, select the ENABLE RUNTIME CONTROL check box. Click SHOW MORE to adjust the highpass/lowpass filter rolloff in dB/Oct.

Storage Tab



Storage Options Tab

Set the desired sampling rate of the stored data using the slider.

Click SHOW MORE to change the store name, data format, and scaling factor of the stored data.

Use the DISCRETE FILES check box to save each channel of data as a discrete file (*.sev file) in the data tank.

Clear the SAVE TO DISK check box to view data in the runtime plots without storing data to the Tank.

Neural Signal Referencer

The Neural Signal Referencer gizmo removes common signals from a multi-channel stream of neural signals.

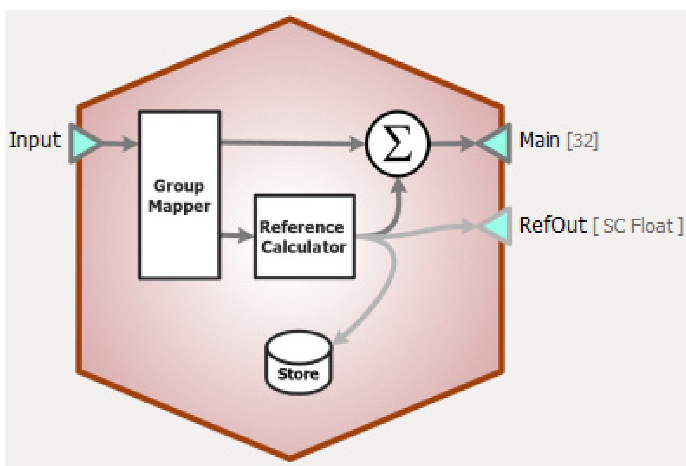
Data stored:

Stream	continuous reference waveforms (optional)

Key features:

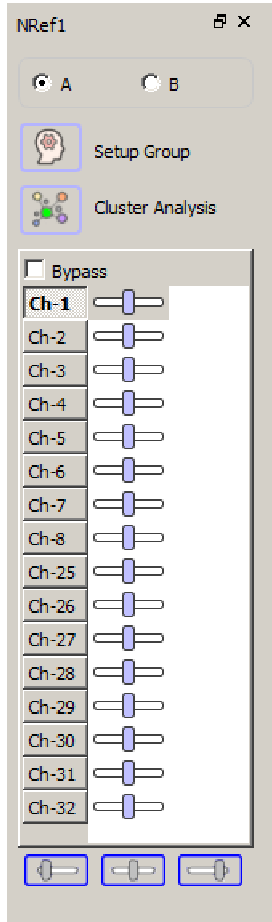
Runtime control	choose which channels to include in the reference

The Neural Signal Referencer gizmo takes multi-channel floating point signals, determines the common signal on all or independent sub-groups of channels, and removes it. The signals can optionally be normalized before the reference is calculated. The resulting signals (and optionally the reference signal used for the subtraction) is available as an output to other gizmos for further processing.



Neural Signal Referencer Block Diagram

The Neural Signal Referencer Runtime Interface



Runtime Window

Runtime Plot

A streaming plot of the reference signal used for each group is optionally included in the data plot. See "Flow Plot" on page 66 for more information on using and customizing the plot.

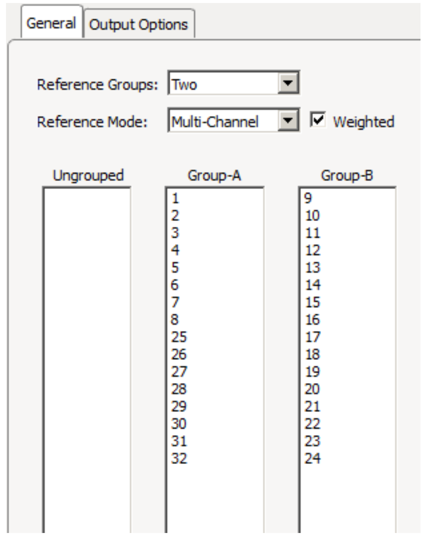
NRef1 Tab

The NRef1 tab contains controls for choosing the referencing channels for each group. In single-channel mode, simple sliders choose the reference channel for each group. In multi-channel mode, you can optionally compute the correlation between each channel and selectively remove them from the average. The Cluster Analysis mode will suggest referencing channels for you based on a minimum correlation threshold.

Neural Signal Referencer Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

General Tab



Neural Signal Referencer General Tab (Multi-Channel Mode Shown)

Choose up to four starting groups for your referencing. Each group will be referenced separately, and are then merged back together in the correct order.

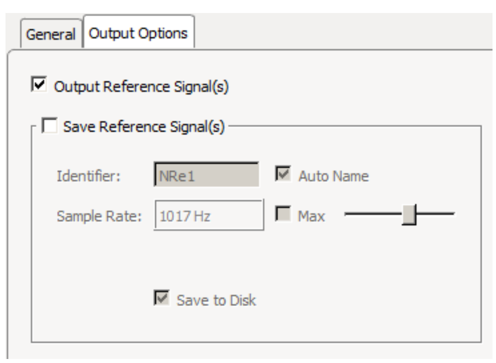
By default, in Single Simple mode all channels are treated as one group and you can pick a single channel as a digital reference that is subtracted from all channels.

In Signal Channel mode, each group can have a single channel from within the group act as a reference for that group.

In Multi-Channel mode, any number of channels can be added to the reference signal that is subtracted from the group.

In Weighted mode, the channels in each group are normalized before calculating the reference signal, and then each individual scaling factor that was used is removed when the reference signal is subtracted from each channel.

Output Options Tab



Output Options Tab

Select OUTPUT REFERENCE SIGNAL(S) to make the reference signal(s) available as gizmo output(s).

Select SAVE REFERENCE SIGNALS(S) to display and/or save the reference signal(s) to disk. The Identifier is used to name the data store that is saved in the tank. It must be four characters in length.

Choose a specific Sample Rate for the data store, or set it to Max and it will run at the master device rate.

Clear the SAVE TO DISK check box to view data in the runtime plots without storing data to the Tank.

Routing

Routing gizmos provide simple ways of working with single and multi-channel signals, including combining and separating signal paths, remapping channels, and controlling signal distribution to multiple gizmos.

The Routing gizmo group includes:

Mapper

Injector

Parameter Manifold

Selector

Merger

Delay

Mapper

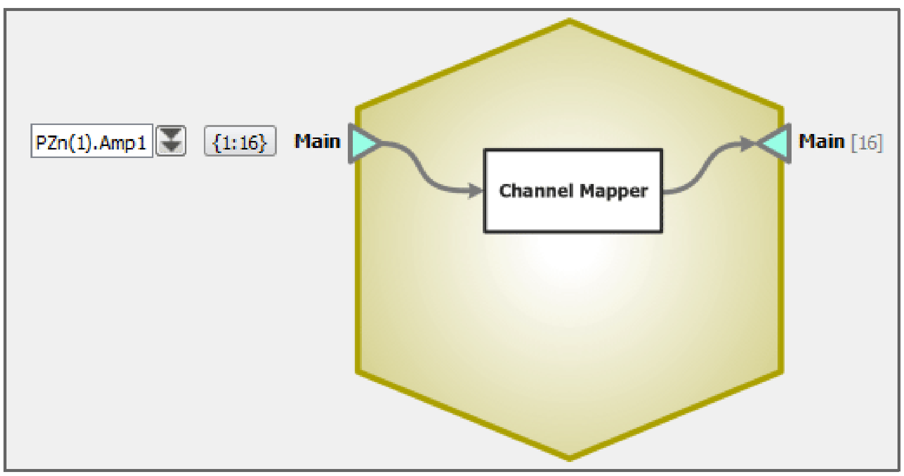
Mapper provides a simplified interface for remapping recording channels. It takes in multi-channel signals then remaps or reorganizes the channel order for your system. You select your electrodes, headstage, and adapters from lists or edit the map manually for custom system components.

Key features:

Selectable maps	common headstages, electrodes, and adapters

Outputs:

Stream	remapped multi-channel waveforms

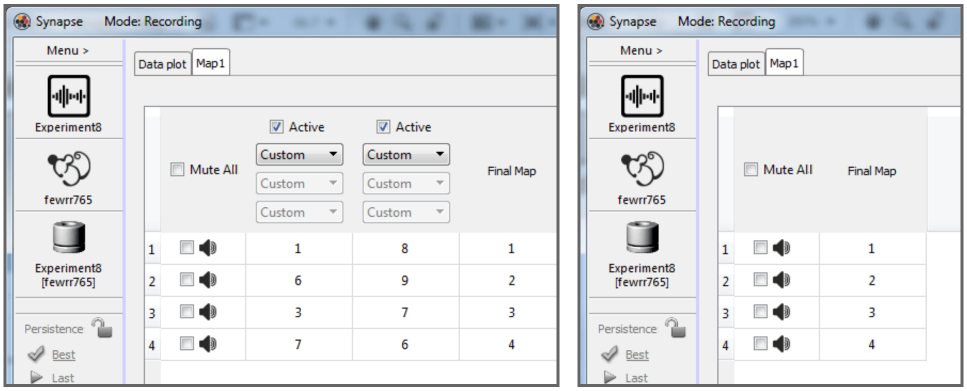


Mapper Block Diagram

The Mapper Runtime Interface

Map Tab

At runtime the channel maps table is displayed for runtime updates, primarily to enable muting noisy channels. The map columns can be hidden to avoid accidental changes to the map.

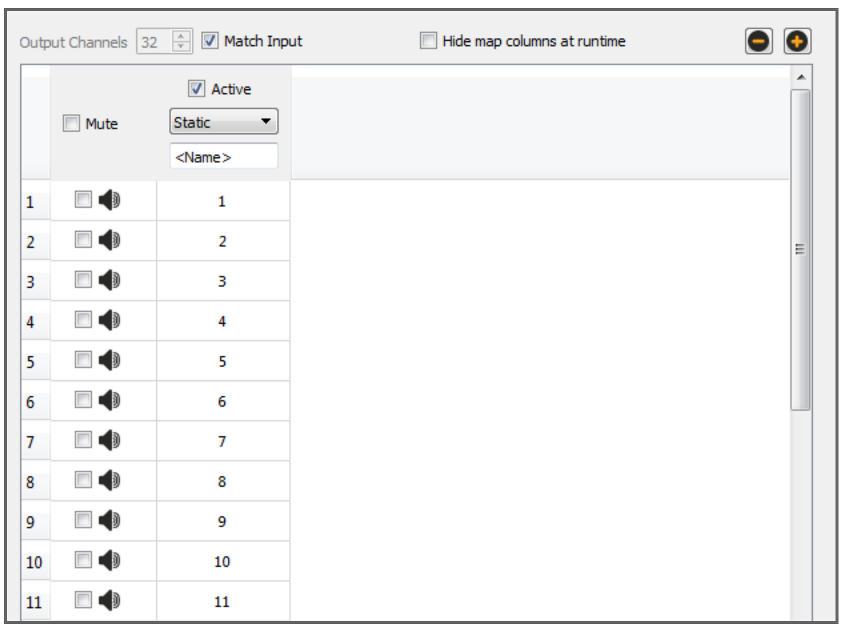


Runtime Tab Shown with Map Shown (left) and Hidden (right)

Mapper Configuration Options

Options Tab

See "The Options Area" on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.



Mapper Options

Use the drop-down menu to choose an existing map for your Headstage, Adapter, or Electrode, or create your own custom map (Static). The default maps are read from a CSV file that installs with Synapse (C:\Synapse\SupportFiles\EAHS.csv). You can add your own maps to this CSV file and they will appear in the drop-down list.

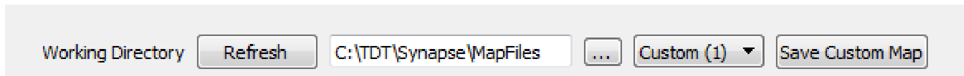
You can enter the channel map manually, or you can copy it from the clipboard by right-clicking on the starting channel that you want to paste the map into.

To only pass a subset of channels through the Mapper gizmo, clear MATCH INPUT and change the number of OUTPUT CHANNELS.

Click “-” to delete the selected column. Click “+” to add a column to the map. The new column is added to the right of existing columns. All active maps will be applied to the incoming data stream. The ACTIVE check box must be selected to allow editing.

Use the MUTE check boxes to set the default mute state of each channel.

Working Directory

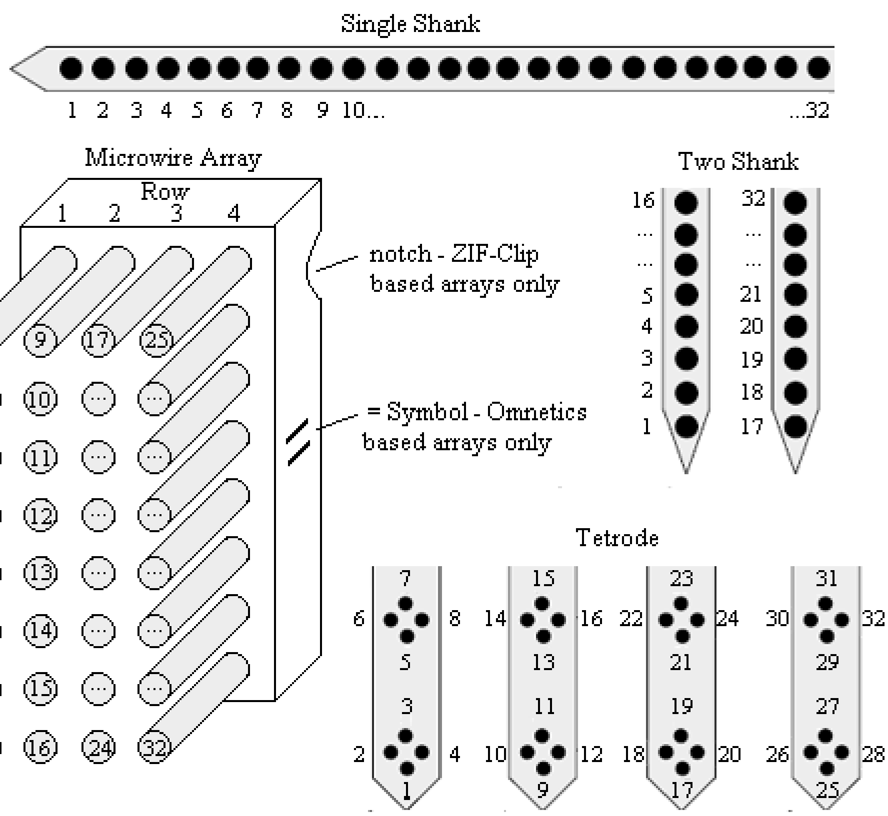


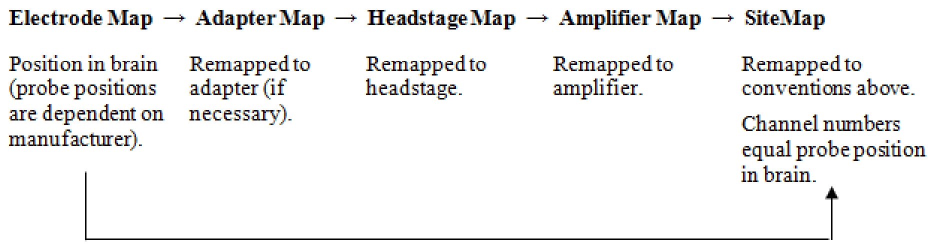
Working Directory Options

Directly above the mapping interface, you can save the map as a Custom Map or open an existing Custom Map.

Site Numbering Conventions

Probe sites for shanks and tetrodes are arranged clockwise and in ascending order from tip-to-shank. Omnetics and ZIF-based microwire arrays are arranged in descending order top-to-bottom from left-to-right with the array symbols shown in the diagram below.





Site Numbering Conventions

Mapper

Injector

The Injector inserts a single channel input into a multi-channel data stream at channels you specify. For example, use this to send a given stimulation pattern to one or more specific channels on a stimulator, with full dynamic control at runtime.

Data Stored:

User selected channels, when any channel changes (optional)

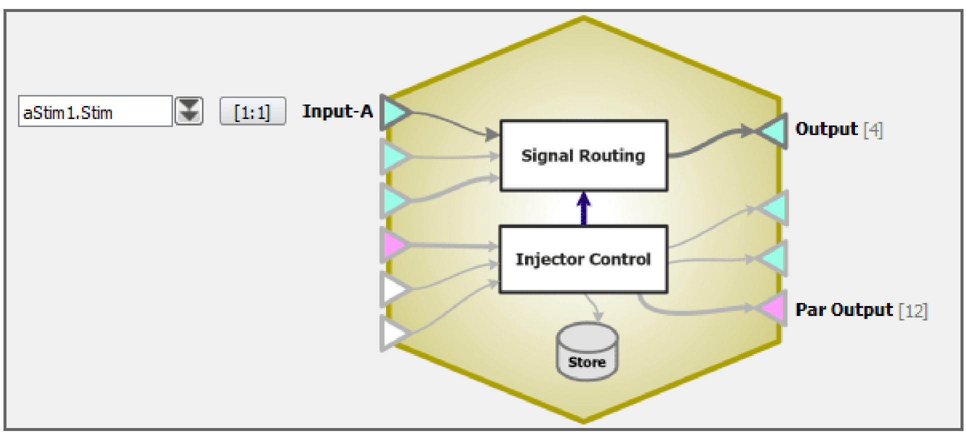
Key features:

Runtime manual channel control

Flexible parameter handler

Outputs:

Output	multi-channel floating point output
ChanSel-* (optional)	selected channel numbers
Par Output	parameter stream

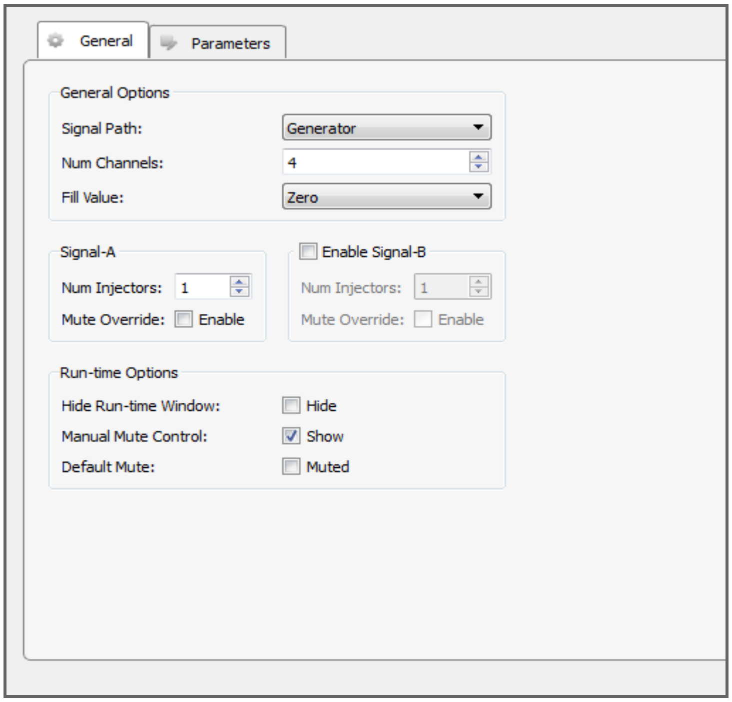


Signal Injector Block Diagram

Injector Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.

General Tab



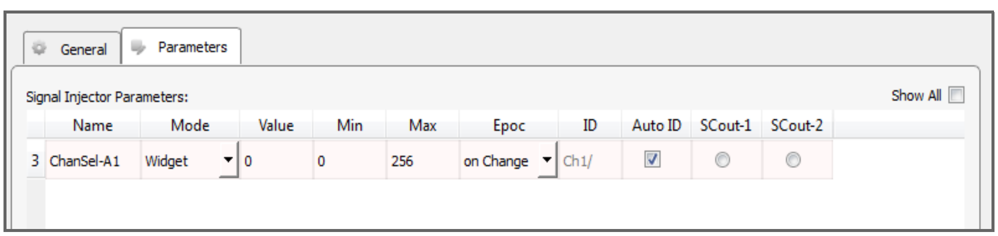
General Tab

General Options

The Injector can operate on an existing multi-channel stream (PASS THRU) or generate a multi-channel stream of constants (GENERATOR) with the given FILL VALUE.

Each single channel input (SIGNAL-A and SIGNAL-B) can be injected on up to four channels, chosen in the PARAMETERS tab.

Parameters Tab



Parameter Files Tab

See "Parameters Table" on page 233, for more information.

Parameter Manifold

Use the Parameter Manifold if you have multiple stimulation gizmos that require parameter inputs that you want controlled from the same parameter sequencer. Each stimulation gizmo brings its own parameter list into the manifold. Parameters used in multiple gizmos can retain individual values or use a common/shared value. For example, two stimulation gizmos might use a common PulsePeriod, but different WaveAmps.

You can also use the Parameter Manifold to create parameters for a User Gizmo.

Data Stored:

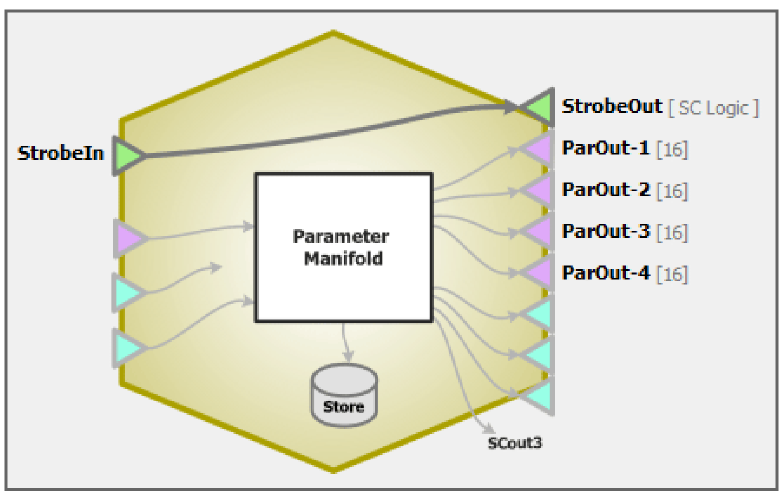
Parameter values when triggered (optional)

Key features:

Control of multiple stimulation gizmos from a single place.

Outputs:

Main	logic trigger
ParOut-1..4	parameter streams to connect to stimulation gizmos
SCout-1..4(optional)	single channel, floating point parameter values



Parameter Manifold Block Diagram

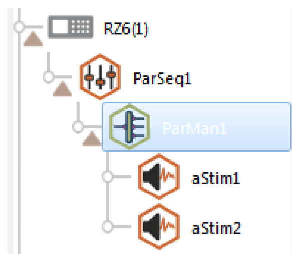
Adding a Parameter Manifold to Your Experiment

This gizmo links between the stimulation gizmos and the Parameter Sequencer gizmo in the signal/processing path. To establish the links, the gizmos rely on input/outputs that must be configured in other gizmos in this path. Because of this, you will need to follow the ordered steps below:

1. Add your stimulation gizmos to the Processing Tree.

   You can temporarily add them to the stimulation device. They will be moved later.
2. Set the parameters, choosing ParamIn for any parameters you want to automate/control using the manifold.
3. Add the **Parameter Manifold** to the Processing Tree.

   You can temporarily add the manifold to the stimulation device. It will be moved later.
4. Connect the stimulation gizmos to the manifold.
5. **Configure the Parameter Manifold (see below).**
6. Add the Parameter Sequencer to the stimulation device, such as an RZ6.
7. Connect the manifold to the sequencer.
8. Configure the Parameter Sequencer.



Parameter Manifold in the Processing Tree

Each gizmo linked to the manifold must be attached to a unique output (ParOut-1..4). The numbered outputs match the indexed columns in the routing/matching table (see below) and this information is used to populate the master parameter table.

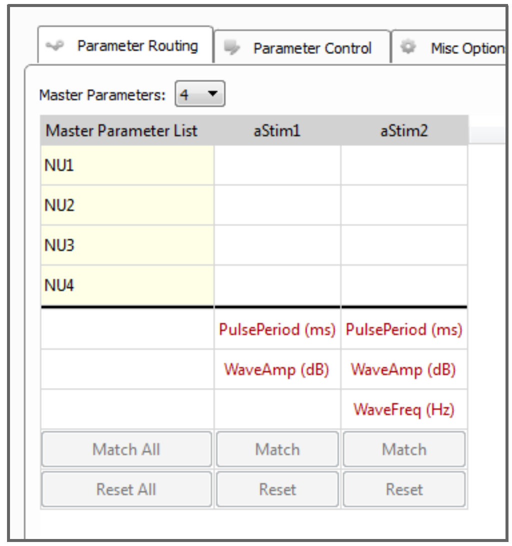
Parameter Manifold Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.

Parameter Routing Tab

The manifold pulls together the parameters used by each gizmo and generates a master parameter list. The master list and parameters are auto-filled in a table on the Parameter Routing tab. Before the parameters from each gizmo are matched to a master parameter, they are organized in columns, shown in red, and filled below the main table rows.

In this example, two Audio Stimulation gizmos are attached to the Parameter Manifold. The columns contain the gizmo names and the rows contain the parameter that the manifold is controlling. aStim1 is a noise stimulus and aStim2 is a tone stimulus. They have some, but not all, parameters in common. Initially, the parameters for each gizmo are unassigned and appear in red text at the end of the column.

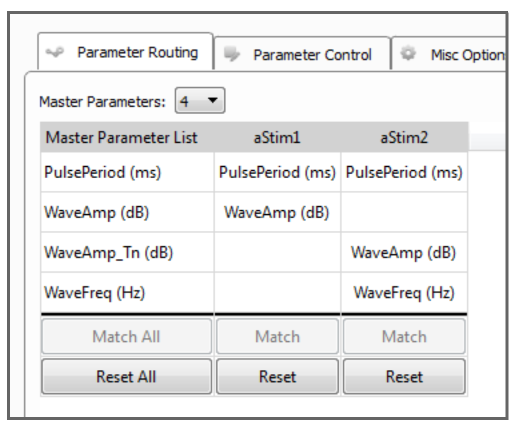


Master Parameters Matching Table with Unassigned Parameters

You can double-click, drag, or use the Match and Reset buttons to move the unassigned parameters into master parameter rows. As you do, Synapse auto fills the parameter names in the master column.

If a parameter is present in more than one gizmo, but will NOT share a common value, you might need extra rows. Use the Master Parameter drop down list to increase the number of rows (if needed). When you have enough rows, drag one of the duplicate parameters into an unused row. Double-click the first cell in the master row to give the master parameter a different name.

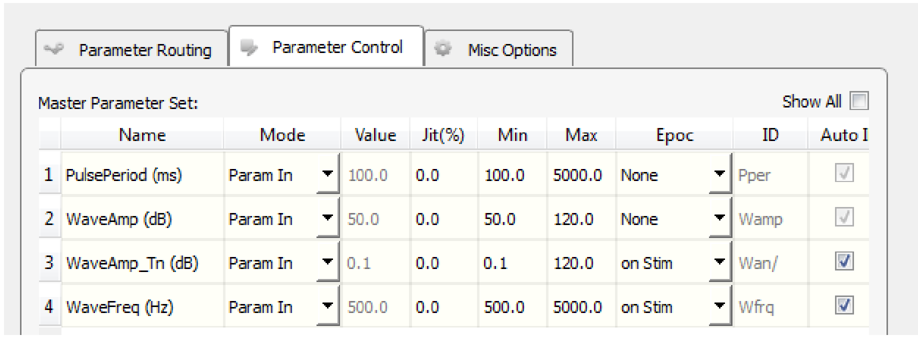
In the illustration below, the tone and noise stimuli share a common pulse period (PulsePeriod, shown in the first row). Frequency (WaveFreq) is used in the tone stimulus (aStim2) but not for noise (aStim1). Amplitude (WaveAmp) is used in both, but the value will not be shared. A new parameter, called WaveAmp_Tn, has been created to differentiate the tone amplitude from the noise amplitude.



Master Parameters Matching Table with Shared and Not-Shared Parameters

Parameter Control Tab

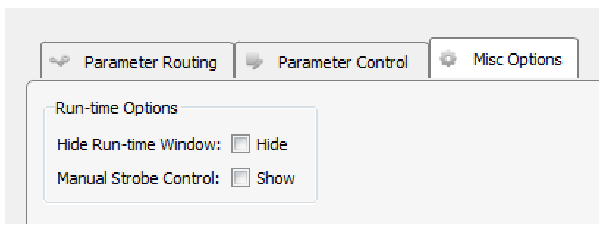
The Master Parameter Set table on the Parameter Control Tab functions like any other parameter table (see “Parameters Table” on page 233). We will control the parameters from a Parameter Sequencer gizmo, so the Mode for the parameters must be set to ParamIn.



Parameter Control Tab

Misc Options Tab

Use Run-time Options to show and hide run-time features.



Misc Options Tab

Selector

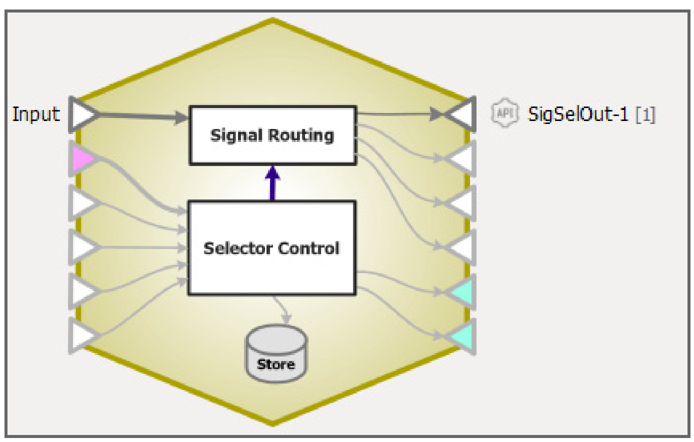
The Selector converts a multi-channel stream into individual channels that can then connect to other gizmos. Integer streams can be further sub-divided to access portions of compressed data, like sort codes from the spike sorting gizmos or the compressed sort code output from the Sort Binner gizmo. Selection can be controlled dynamically through a runtime slider or a gizmo input. Output channels and channel selections can optionally be saved.

Data Stored:
- Selected signals (optional)
- User selected channels (optional)

Key features:
- Runtime manual parameter control
- Flexible parameter handler

Outputs:

SigSelOut1-4	individual output channels



Channel Selector Block Diagram

Selector Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

General Tab

The Selector handles multi-channel streams of floating point or 32-bit integer values. By default, you choose individual channels from the multi-channel stream to send to the outputs, depending on the settings in the Parameters tab.

Selection Options

The Selection Options are only available if the Main input to Selector is a multi-channel integer stream. You tell Selector how the data is packed into the 32-bit integers and it will properly extract it, otherwise it will automatically set these values.

Bit Fields

If the incoming data has been compressed, use the BIT FIELDS option and indicate how many bits per channel you used in BITS PER FIELD.

For example, suppose you pack sixteen 8-bit integers into four 32-bit integer channels and send it to the RZ UDP interface, and connect the UDP component to Selector. The Main input into Selector will see a four channel stream of 32-bit integers. Set the BITS PER FIELD to Eight Bits and you can extract channels 1-16 on the output side.

You can also extract a particular channel of sort codes from any of the spike sorting gizmos with this.

Sort Codes

If you have multiple sub-fields for each channel, use the SORT CODES option to indicate how many sub-fields you have (NUMBER OF SORT CODES) and how many bits are in each sub-field (BITS PER SORT CODE). The most common use of this is to extract a particular channel/sort code count from the output of the Sort Binner gizmo to drive real-time decision making in other gizmos (e.g. State Maker).

When you connect a Sort Binner output to the Selector, Synapse automatically sets the BITS PER SORT CODE and NUMBER OF SORT CODES based on the settings in Sort Binner and updates them automatically for you if they are changed in the parent Sort Binner gizmo. If a different type of gizmo is generating the multi-channel integer data (e.g. UDP gizmo or user gizmo), these settings can be defined manually.

This option adds additional rows to the parameters table so you can define the channel and the sub-field you want to extract.

Logical Outputs

When selected in BIT FIELDS mode, output is a logic 1 if selected field's value equals selected sort code value.

When selected in SORT CODES mode, output is a logic 1 if selected field's value matches the target sort code.

Save Options

The four selected output signals can be stored continuously or not at all.

Parameters Tab

Use the parameters table to define how the channels are selected. See "Parameters Table" on page 233 for more information on working with parameters tables.

Merger

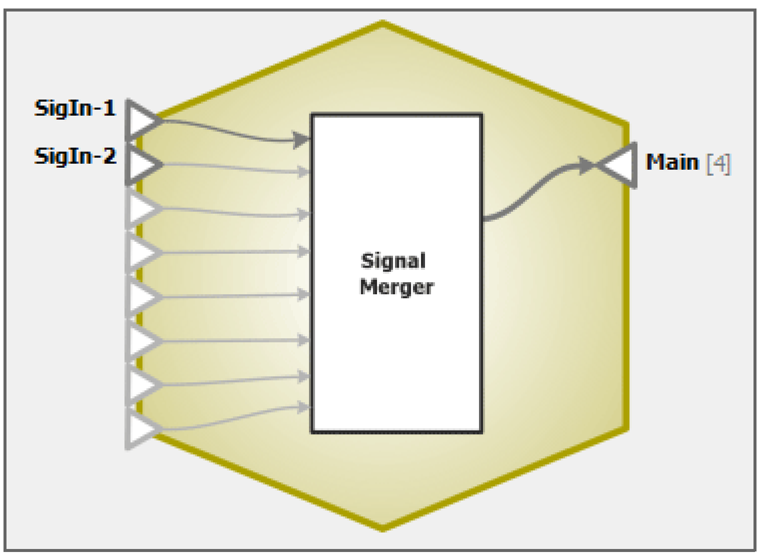
The Merger gizmo takes up to eight single-channel integer or floating point inputs, or up to eight multichannel inputs, from other gizmos or HALs and merges them into a single multichannel output.

Data Stored:

None

Outputs:

Main	multi-channel merged signal path

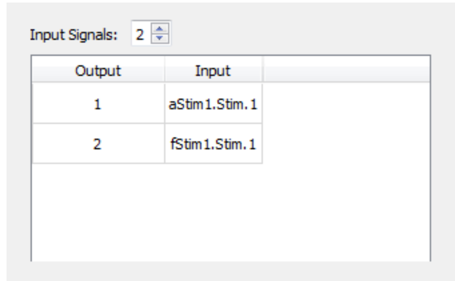


Merger Block Diagram

Merger Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Options Area



Merger Configuration Options

Each Merger gizmo can take either single channel or multi-channel inputs, but can't mix them. The source that is first assigned to the SigIn-1 input determines which signal type can be selected for subsequent sources. The type can't be changed without deleting the gizmo.

Input Signals value box	Select the number of input signals that you want to merge into one multi-channel output (between 2 and 8).

When increasing the number of signals, commit the change then display the block diagram to select the additional input sources. Commit again to see them updated in the matrix.

The output channel count is always a multiple of two, and is always greater than or equal to four.

Delay

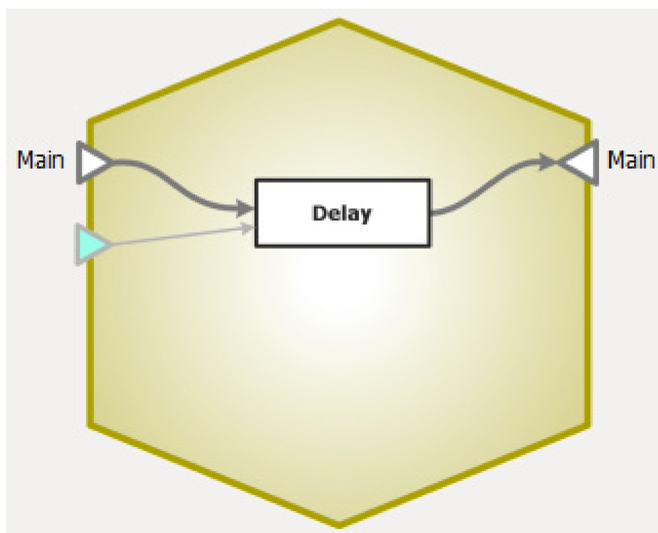
The Delay gizmo takes any single or multi-channel input and adds a fixed or dynamic delay to the signal.

Data Stored:

None

Outputs:

Main	single or multi-channel delayed signal

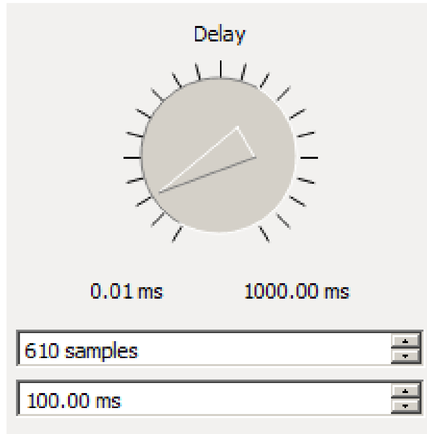


Delay Block Diagram

The Runtime Interface

Delay Tab

The runtime interface is available when DELAY MODE is Dynamic and CONTROL SOURCE is Widget. The value of the signal delay is then adjustable by the user at runtime and is also available through the Synapse API.



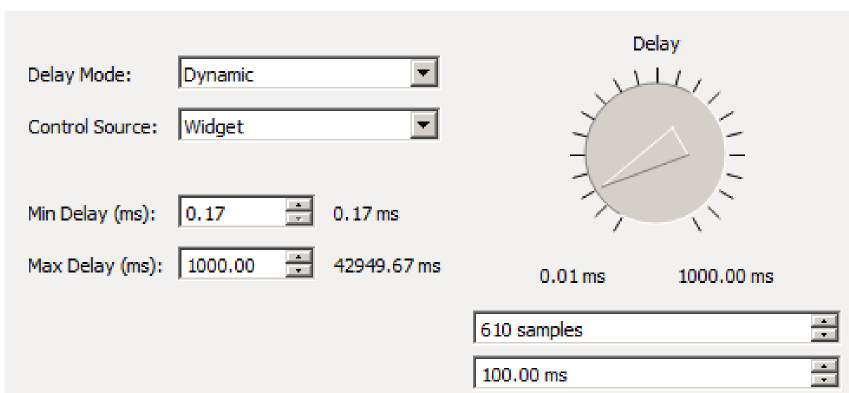
Delay Runtime UI

In the above example, the min and max delay values were set to 0.01ms and 1000ms at designtime and the current delay value is 100ms. Because the device sampling rate was ~6K, the actual number of real-time samples shows 610.

Delay Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Options Area



Delay Configuration Options

The Delay gizmo can take either a single channel or a multi-channel input. The signal type of the input determines the signal type of the output.

In STATIC Mode, the delay value set at designtime is the signal delay used at runtime. In DYNAMIC Mode, the delay value can either be controlled by a Widget at runtime or by a Gizmo Input by setting the CONTROL SOURCE.

The min and max delay bounds are set at designtime. In WIDGET mode, the bounds set the min and max values of the knob. Also, use WIDGET mode if controlling the delay value via the Synapse API. The absolute maximum delay available in any mode is displayed to the right of the Max Delay spin box. This is dependent on the type of input signal and the device sampling rate.

Signal Conditioning

Signal Conditioning gizmos are simple but powerful gizmos for common tasks that improve or refine input signals.

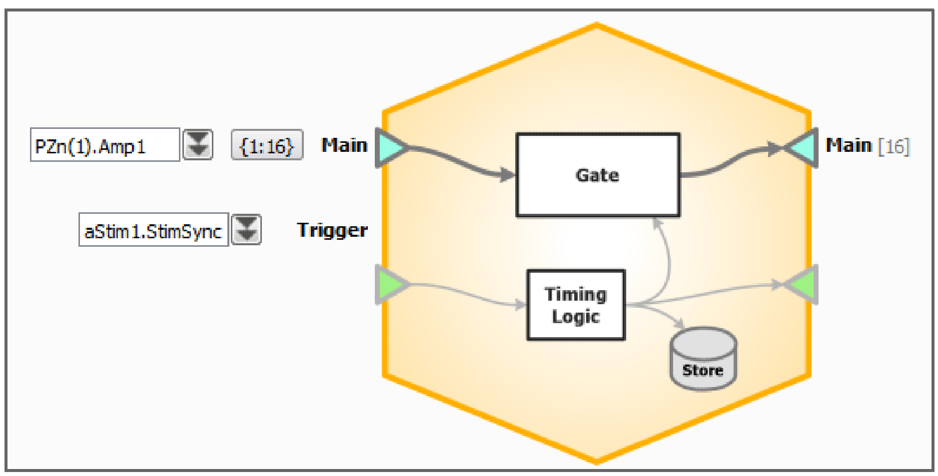
The Signal Conditioning gizmo group includes:

- Artifact Blocker
- General Purpose Filter
- Unary Signal Processor

Artifact Blocker

The Artifact Blocker gizmo zeros a signal relative to a trigger, blocking stimulus artifacts in recorded data associated with a triggered event. Timing logic can be stored and/or used as a source for other gizmos.

Data stored:	
Epoch (optional)	timestamps for each artifact
Key features:	
Trigger	selectable
Gate Control (optional)	timestamped logical trigger/gate values
Runtime Controls	onset and offset timing controls

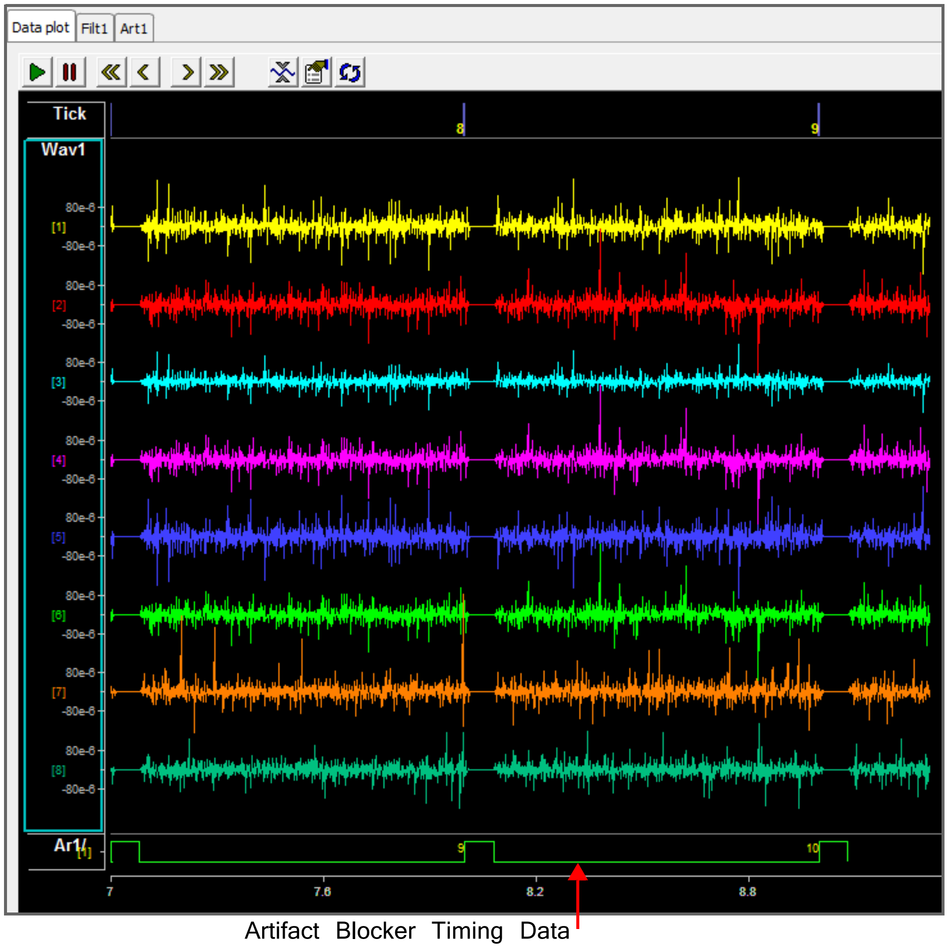


Artifact Blocker Block Diagram

The Artifact Blocker Runtime Interface

Runtime Plot

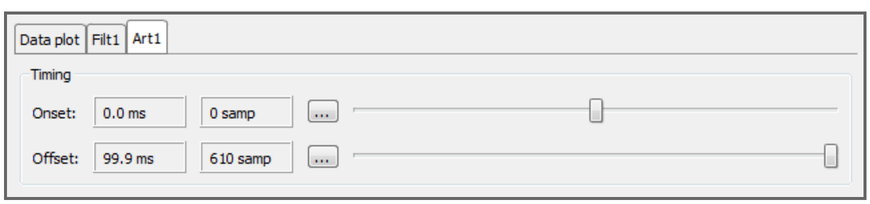
If you choose to save gate timing, a plot showing the timing of the gate is added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the main runtime data plots.



Runtime Plots include Artifact Timing Data

The main runtime plots show where artifact rejection has been applied to the neural signals.

Artifact Blocker Tab

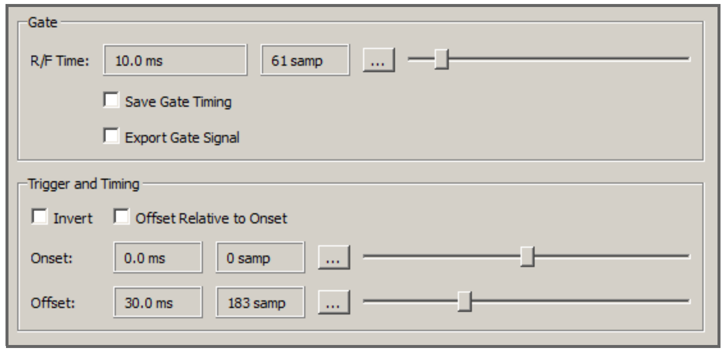


Artifact Blocker Runtime Tab

The Artifact Blocker tab has sliders to dynamically adjust the gate onset and offset timing at runtime. If the onset is less than zero, the incoming signal is delayed by that many samples in order to synchronize with the trigger.

Artifact Blocker Configuration Options

See “The Options Area” on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Trigger Options

Gate

The artifact blocker uses a cosine-squared gate. The rise/fall time (R/F TIME) represents the amount of time it takes to reduce the signal by 90%, and to increase it back to 90% of its final value.

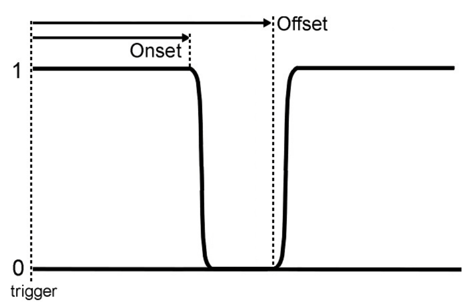
If the specified rise/fall time is less than four samples, a square edge is used which immediately scales the signals by 0 when the trigger onset occurs.

The SAVE GATE TIMING stores the timing signal in the data tank. The EXPORT GATE SIGNAL check box makes the gated timing signal available as an output.

Trigger and Timing

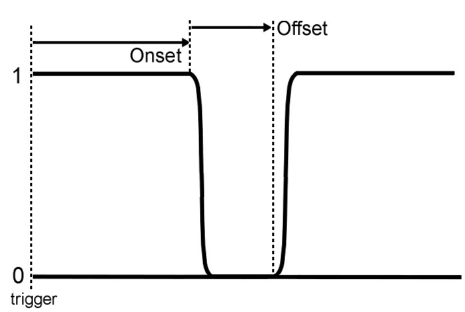
Check the INVERT box to reverse the polarity of the trigger input.

Set the default ONSET and OFFSET of the gate relative to the onset of the trigger input. By default the offset is also relative to the trigger, as shown in the gate depiction below.



Default Timing Diagram

If OFFSET RELATIVE TO ONSET is selected, the gate signal timing looks like this:



Offset Relative to Onset Timing Diagram

General Purpose Filter

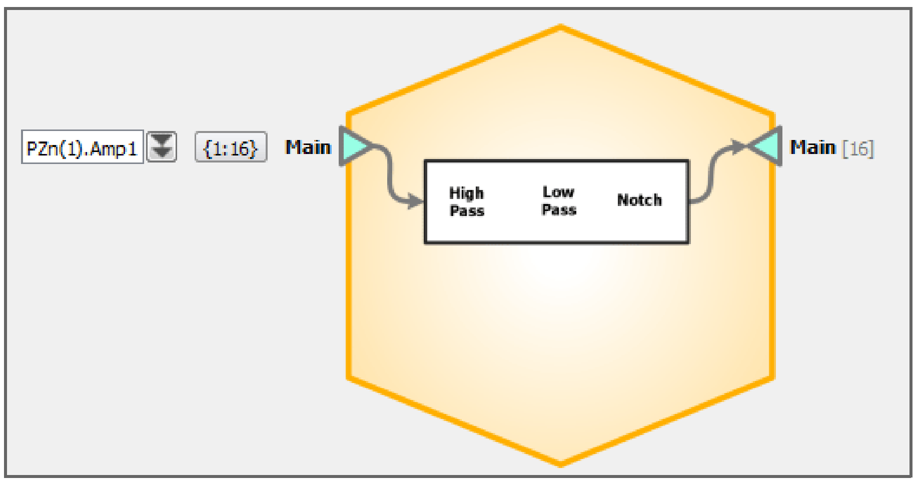
The General Purpose Filter gizmo implements highpass, lowpass, and notch filters and supports control of corner frequencies at runtime.

Data stored:

Stores	None

Key features:

Runtime Controls	Corner frequencies (optional)



General Purpose Filter Block Diagram

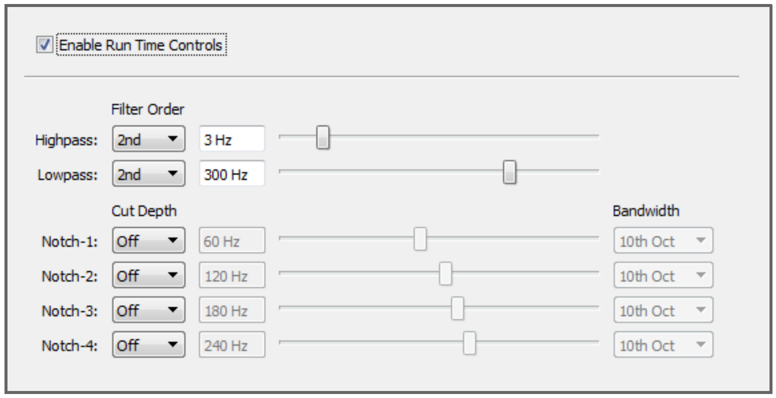
The filter gizmo applies user-defined filters to multi-channel data streams and makes this data available to other gizmos. No data is stored by this gizmo.

Configuration settings determine basic parameters, such as filter order, bandwidth, and default corner frequencies. When enabled, the corner frequency controls are added as a tabbed page in the runtime plot window.

Filter Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.

Options Tab



Filtering Options

Enable Run Time Controls Check Box

Select or clear the check box to enable or disable runtime filter controls.

Filter settings are arranged with columns for settings and a row for each filter.

Highpass/Lowpass Filter

Filter Order	Choose the number of biquad filters to use for each filter type.
Corner Frequency	Type the filter frequency or drag the slider to set the initial filter values.

Notch Filters (1 - 4)

Cut Depth	Select the notch depth (in dB) from the drop-down menu.
Center Frequency	Type the frequency or drag the slider to set the initial frequency value.
Bandwidth	Select the bandwidth of the notch in octaves.

Unary Signal Processor

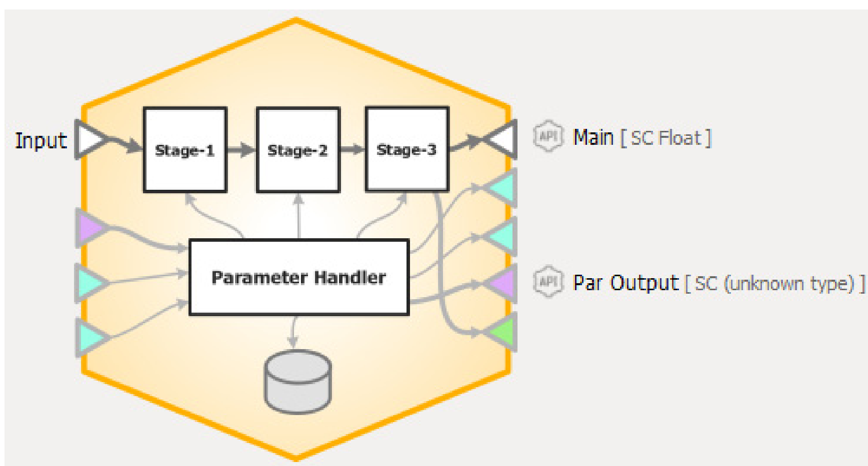
The Unary Signal Processor gizmo applies a series of mathematical operations to a single or multi-channel signal. Operations such as RMS and power band calculations are available as presets. Other available operations include adding custom FIR or IIR filters, calculating absolute value, converting data types, and many others, all in one gizmo. Example uses include triggering based on power in a frequency band, or processing/converting external sensor voltages.

Data stored:

Epoch (optional)	parameter values and timestamp

Outputs:

Main	single or multi-channel floating point signal
Parameters	varies



Unary Signal Processor Block Diagram

The Unary Signal Processor gizmo automatically detects if a single or multi-channel signal is connected. It applies the user-defined mathematical operations and makes this data available to other gizmos. The gizmo uses a bounded parameter table (see "Using Bounded Parameters" on page 233) to define values for some operations, such as filter settings and scale/shift parameters. Optionally, you can enable runtime control or storage of these gizmo parameters.

The Runtime Interface

Runtime Plot

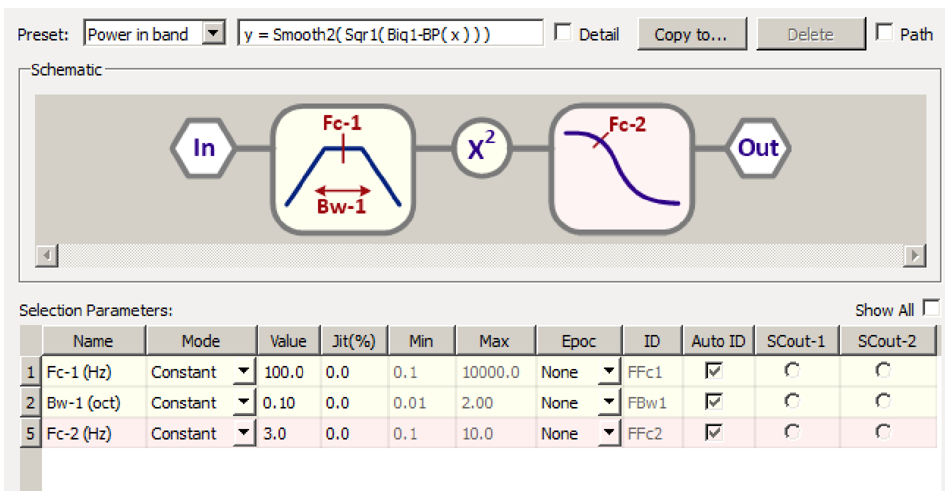
This gizmo is not specifically associated with any plotting. If you want to view the output data during an experiment, you can add data storage gizmo to the Unary Signal Processor gizmo's output. See "Flow Plot" on page 66 for more information on using and customizing the plot.

Runtime Parameter Controls

The gizmo parameters will be shown at runtime. You can enable runtime control of any parameter by selecting "Widget" in the parameter table. See "Using Bounded Parameters" on page 233, for more information.

Unary Signal Processor Configuration Options

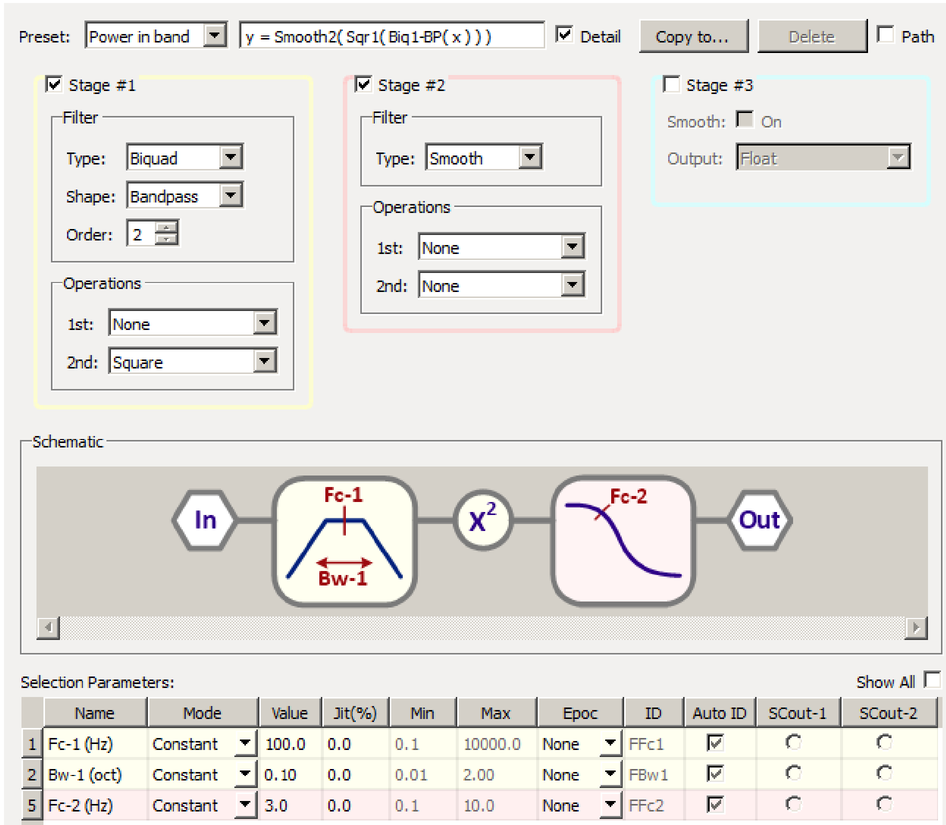
See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Options Area

The Unary Options area displays the mathematical formula, an image showing the operations and parameters used by each operations, and the corresponding editable parameters. You can choose a "Preset" formula, such as RMS or Power In Band, or create your own. By default, the formula is set to Bypass (output = input).

The gizmo unary formula consists of up to three stages. If you want to view or customize the stages, select the Detail check box. The stages are numbered to reflect the order of operations and you can click or clear the check box for each stage to enable or disable it.



Unary Options Area - Detail View

As stages are enabled or modified the parameter table is updated to show the updated parameters in use. See "Using Bounded Parameters" on page 233 for more information on using the table.

When you are happy with a modified formula you can use the COPY TO button to save it for later use. The name you choose will then appear in the Preset list. This also ensures the formula is included with all files, if you ever wish to export or share the experiment. To show the path where Presets are stored, click the PATH check box.

Stage 1 and 2

Each of these stages provide a filter and two operations.

Filter Types

Biquad: An IIR filter of a selectable shape (Lowpass, Highpass, Bandpass, Notch) and order. The 'Fc-{N}' parameter determines the center frequency. If shape is 'Bandpass' or 'Notch', the 'Bw-{N}' parameter determines the bandwidth in octaves. If shape is 'User', the filter coefficients are defined in a file generated by the user. This must be a CSV text file format with the coefficients in a single row separated by commas, or with a single coefficient in each row.

Parametric: A second order linear filter used to pass or suppress a particular frequency band. The 'Fc-{N}' parameter determines the center frequency. The 'Bw-{N}' parameter determines the bandwidth in octaves.

FIR: A finite impulse response filter defined by the coefficient file generated by the user. This must be a CSV text file format with the coefficients in a single row separated by commas, or with a single coefficient in each row.

Smooth: A simple exponential smoothing filter applied to the input. The 'Fc-{N}' parameter determines the effective low pass corner frequency.

Operations

Scale/shift: Multiplies by a scalar ('OpParA-{N}' parameter) and adds a shift value ('OpParB-{N}' parameter).

Bound: Output is bound to min ('OpParB-{N}' parameter) and max ('OpParA-{N}' parameter) values.

Square: Output is the square of the input.

Sqr Root: Output is the square root of the input.

AbsVal: Computes the absolute value of the signal.

Sign: Determines the sign of the input and outputs either -1 (signal with negative value), 0 (signal with no value), or 1 (signal with positive value).

Stage 3

This stage provides an exponential smoothing filter and a way to change the data type. The 'Fc-3' parameter determines the effective low pass corner frequency of the filter.

Integer

Scales the input by the 'OpParA-3' parameter and then converts to an integer.

Logic

The operations available use natural language labels and apply a truth test using editable values in the parameter table for comparison. The operation outputs a "1" if true or a "0" if false.

Select 'Logic Out to Alternate' if you wish to have both the logic output and the signal before the logic test available as outputs to the gizmo. For example, if making an RMS threshold detector, you can output both the threshold crossings and the RMS value used for the detection for visualization with other gizmos. In this case, the 'Main' output will be the RMS signal and the 'AltOut' output will be the logic signal.

Working with Single and Multi-Channel Signals

The gizmo can be used with single or multichannel signals and automatically detects the number of channels in the input signal. The formula is applied independently to each channel. The Unary Signal Processing gizmo can handle up to 96 channels. If more channels are required, you can use a second gizmo.

Tip: To pick one channel for processing from a multichannel signal, use the Selector gizmo. See "Selector" on page 201.

Specialized

Specialized gizmos encompass specific applications within a single gizmo.

The Specialized gizmo group includes:

Fiber Photometry

MRI Recording Processor

Fiber Photometry

The Fiber Photometry gizmo includes designtime and runtime control of up to four light drivers and stores and reports demodulation results using up to two sensor inputs.

Data stored:

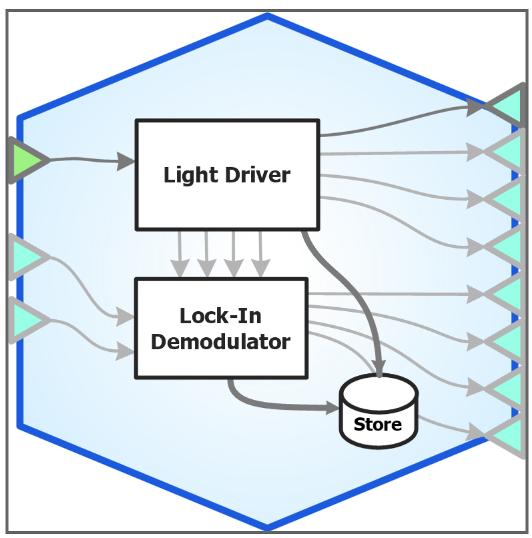
Stream	demodulated response signals
Stream (optional)	broadband raw signals
Scaler (optional)	driver parameters

Outputs:

Driver output voltage (optional)	up to 4 single-channel floats
Demodulated signals (optional)	up to 4 single-channel floats

Key Features:

runtime controls	driver parameters and lowpass filter setting
runtime display	clip indicators and response results
flexible demodulation	sensor x driver matrix



Fiber Photometry Block Diagram

The Runtime Interface

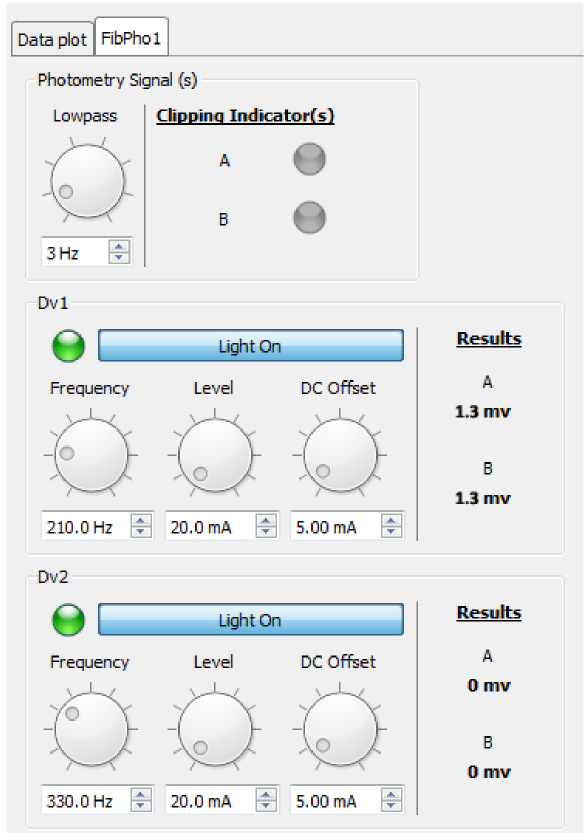
Runtime Plot

A plot is added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the plot.

Data Plot Showing Demodulated Responses

The subplots shown in a runtime plot represent data storage you chose in the designtime options. In the example above, the streamed data shows the resulting power output (such as Dv1A) at the frequency of interest when comparing the selected driver (such as Drv1) to the selected sensor input (such as sensor A). Simultaneous neural recordings from a different gizmo are integrated in the plot for a quick visual comparison. The Fiber Photometry gizmo also stores and displays broadband raw input signals and driver parameters, depending on selections made at designtime.

Runtime Controls



Runtime Interface

The runtime window includes:

Photometry Signal(s)

Lowpass Filter	A knob and value entry box allows runtime control of the lowpass filter applied to the sensor input.
Clipping Indicator(s)	Two indicators, one for each sensor, flash when the user-defined clipping threshold is approached. The clipping indicator LEDs will also light up if the input voltage is below 10uV to indicate a bad connection.

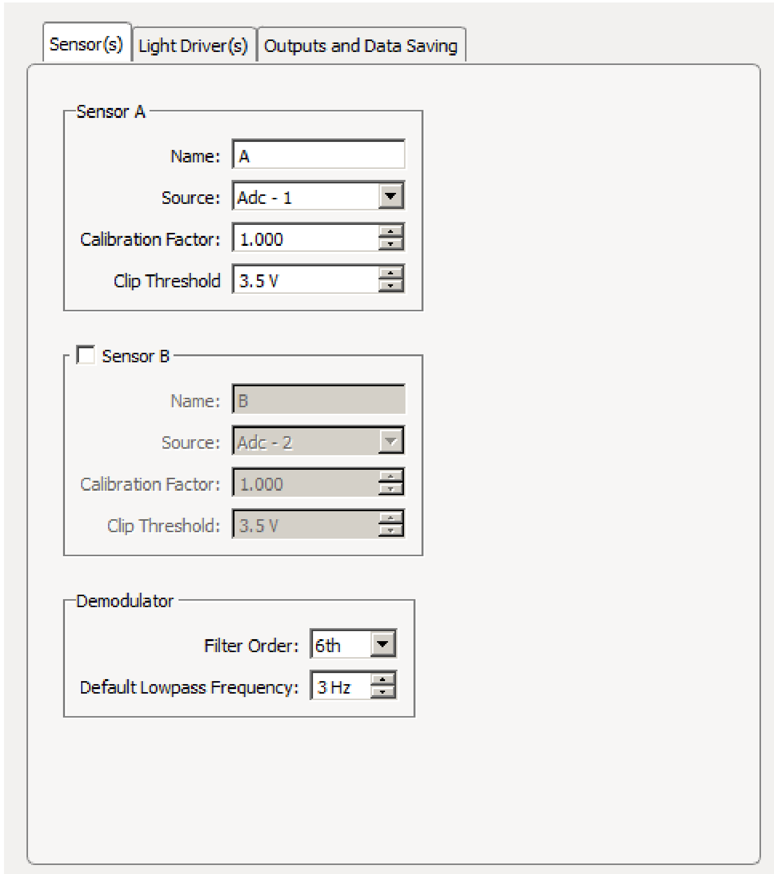
Drivers

Light On	A button enables the light driver and an indicator is lit green when the light is on.
Parameters	Knobs and value entry boxes allow runtime control of light driver Frequency, Level, and DC Offset parameter values.
Results	A result for each sensor is dynamically displayed as a single value in millivolts.

Fiber Photometry Configuration Options

See “The Options Area” on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Sensor(s) Tab



Sensor(s) Tab

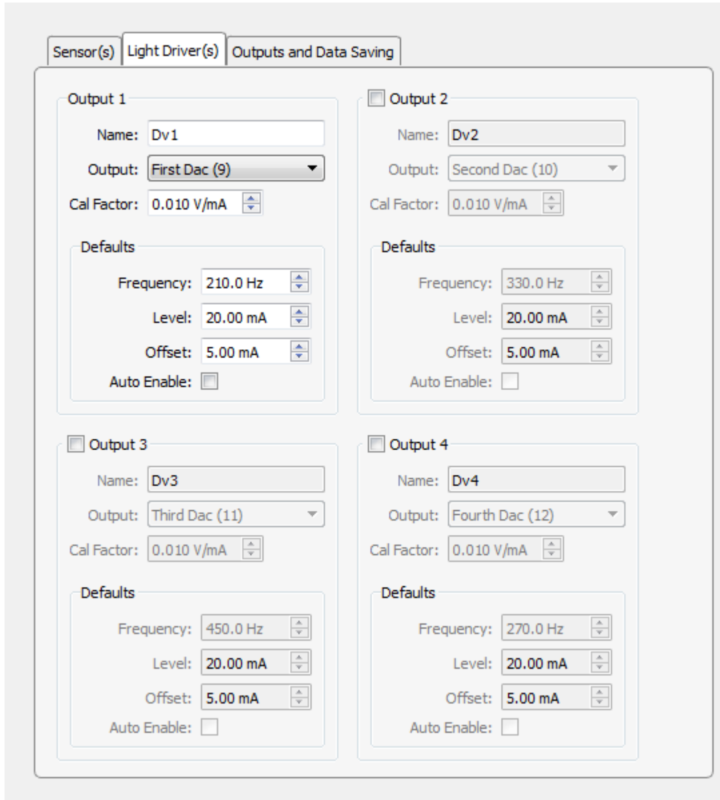
Sensor A / Sensor B

Sensor B check box	Enables a second sensor input.
Name	Give the sensor a name as it will appear in the runtime interface. The first letter of the sensor name is used as the last letter of the streaming data store name.
Source	The sensor input can be an analog input from the front panel of the hardware or a floating point signal output of another HAL or gizmo.
Calibration Factor	Scales the sensor data.
Clip Threshold	Raw A/D sensor input voltage value to light runtime indicator (no calibration factor applied).

Demodulator

Filter Order	Higher order filters tighten the band around the response frequency.
Default Lowpass Frequency	Determines the band around the frequency of interest to do the RMS calculation. This can be modified at runtime.

Light Driver(s) Tab



Light Driver(s) Tab

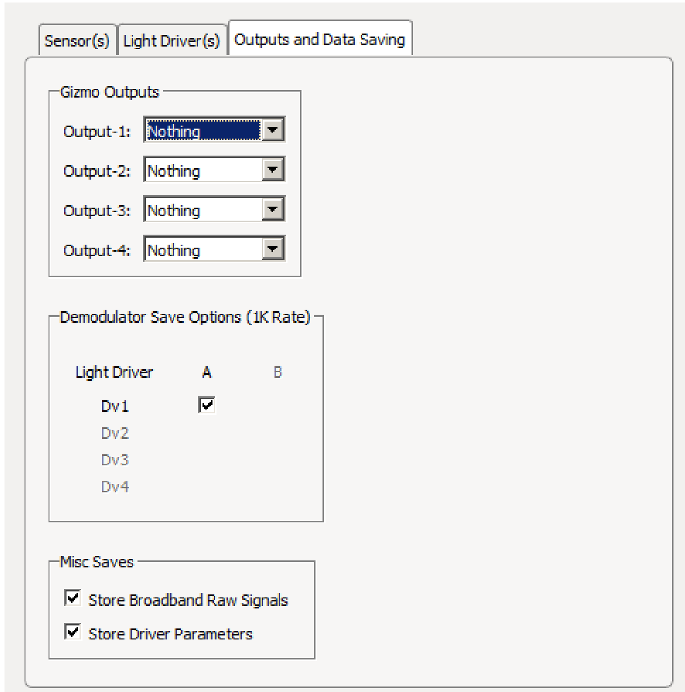
Output 1 through 4

Name	Three characters that serve as the first three characters in the store name.
Output	Specify the DAC number (channel number in parenthesis), or send this as a gizmo output.
Cal Factor	Scale factor used to convert desired milliamps into voltage.

Defaults

Frequency	Modulation frequency. Can be modified in runtime mode.
Level	Light amplitude. Can be modified in runtime mode.
Offset	The offset is tweaked to reach the linear range of the physical light driver output. Can be modified in runtime mode.
Auto Enable	When selected, lights are “on” when recording begins. Otherwise, light drivers must be turned on manually in the runtime interface.

Outputs and Data Saving Tab



Outputs and Data Saving Tab

Gizmo Outputs 1 through 4

Gizmo outputs are optional and may be chosen from a list of possible demodulation options (sensor x driver). Selecting an output makes the data stream available to other gizmos for further processing if desired.

Demodulator Save Options (1k Rate)

Use the matrix of check boxes to select the combinations of sensors and drivers that will be used for demodulation. All available sensor signals can be demodulated against all light driver signals if desired.

Misc Saves

Store Broadband Raw Signals

When enabled, a data store containing the raw signals is generated. The store name is the first two letters of the gizmo name, followed by the last letter of gizmo name, followed by 'r' (default 'Fi1r').

The first channels of the broadband store are the raw light driver voltages, followed by the raw sensor inputs. The order would be Dv1, Dv2, Dv3, Dv4, Sensor A, Sensor B, if they are enabled.

Store Driver Parameters

All light driver parameters and timestamped and stored to disk two second after a change has been made to any of the driver parameters in the runtime user interface.

MRI Recording Processor

The MRI Recording Processor gizmo removes MRI scanner artifacts from Single Unit and LFP data in real time. It can automatically detect/reject artifacts in the data stream or be synchronized with an external TTL. Timing logic can also be stored.

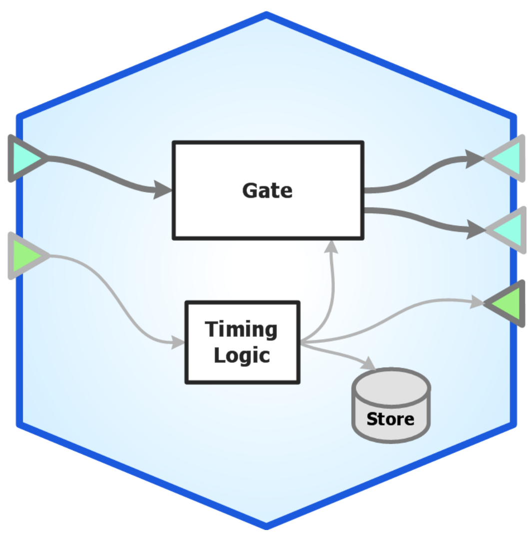
Typically the input is the raw amplifier signals and the output Single Unit data is ready for online spike sorting gizmos.

Data stored:

Epoch (optional)	timestamps for each artifact

Key features:

Trigger	selectable
Gate Control (optional)	timestamped logical trigger/gate values
Runtime Controls	onset and offset timing controls

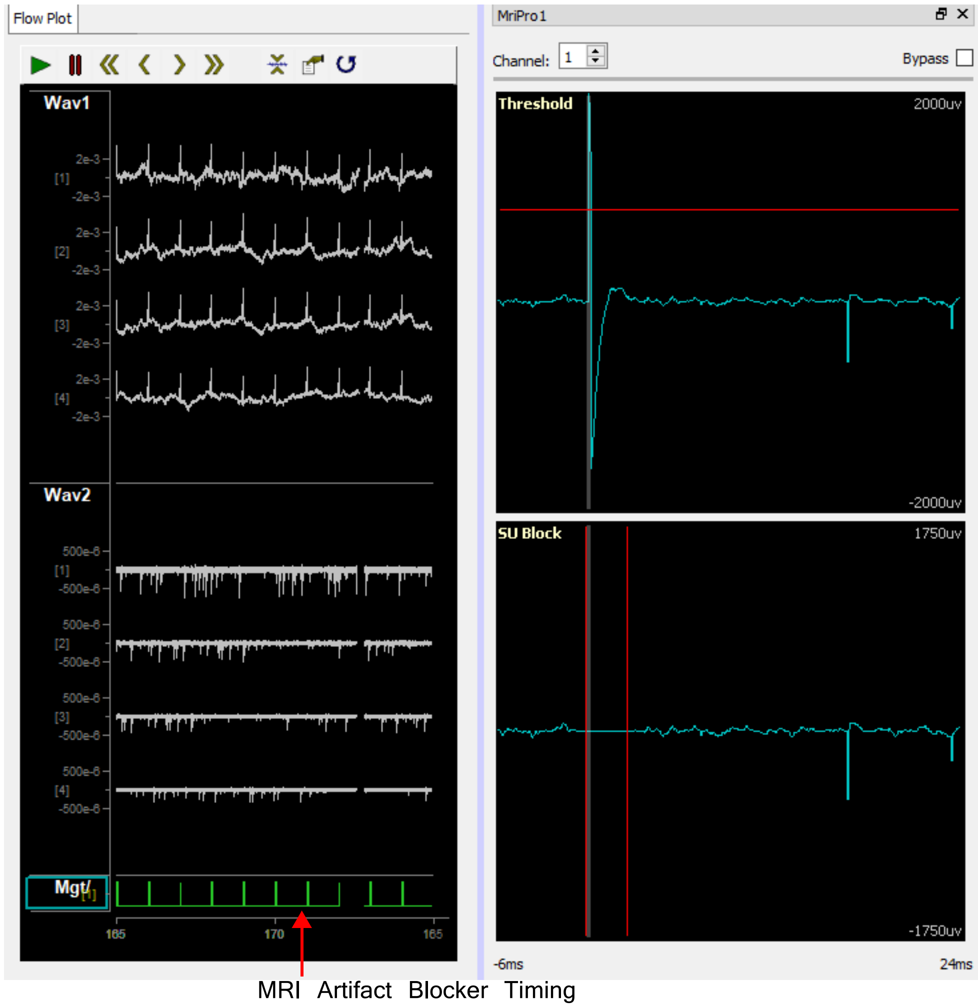


MRI Artifact Blocker Block Diagram

The MRI Recording Processor Runtime Interface

Runtime Plot

If you choose to save gate timing, a plot showing the timing of the gate is added to the runtime window for visualization. See "Flow Plot" on page 66 for more information on using and customizing the main runtime data plots.



Runtime Plots include MRI Artifact Timing

The threshold plot lets you choose a threshold for automatic artifact detection/ rejection. Use the mouse wheel or Shift + Left-click drag the mouse to adjust the y-scale. Right-click the choose “Find Threshold” to determine a reasonable threshold before fine tuning.

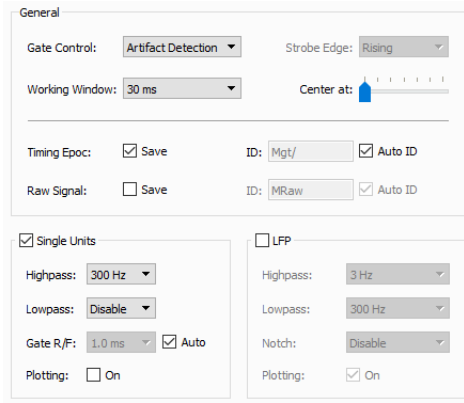
The lower plots (SU Block and LFP Block, if enabled) let you set a blanking window around the artifact onset. Adjust the left and right vertical bars to create as small a blanking window as possible while still removing the artifact. Click the ‘Bypass’ checkbox to see what the waveform looks like without the rejection applied.

In the Flow Plot above, Wav1 is the raw signal going into the blocker with a >2mV artifact, and Wav2 is the output of the single unit data with artifacts removed so you can see the spike waveforms are still present but without the large artifact.

The timing signal of the rejection window is also stored.

MRI Recording Processor Configuration Options

See “The Options Area” on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Trigger and Storage Options

General

The GATE CONTROL can trigger off a user-defined threshold crossing at runtime. If the artifact is timed to another gizmo or an external TTL event, those can be used as the gate trigger instead.

WORKING WINDOW determines what size of snippet to show in the runtime plots for gate control, and also determines the minimum time between consecutive artifact detections. If you find that multiple artifacts occur in the same window, consider reducing the working window size.

CENTER AT determines where to position the artifact onset in the runtime plots.

TIMING EPOC stores the rejection timing signal in the data tank.

RAW SIGNAL stores the raw streaming data before the rejection is applied.

Single Units

Set the filter characteristics for the Single Units signals before artifact rejection.

The Single Unit artifact blocker uses a cosine-squared gate. The rise/fall time (GATE R/F) represents the amount of time it takes to reduce the signal by 90%, and to increase it back to 90% of its final value. When set to AUTO it automatically adjusts based on the WORKING WINDOW size.

PLOTTING adds the resulting stream to the Flow Plot.

LFP

Set the filter characteristics for the LFP signals before artifact rejection.

The LFP artifact blocker uses a custom rejection method to reduce effects after gating.

PLOTTING adds the resulting stream to the Flow Plot.

Stimulation

Stimulation gizmos are special set of tasks related to signal generation and presentation control. The Audio, Electrical, and File stimulation gizmos share a common set of bound parameters that can be defined and controlled systematically using the Parameter Sequencer gizmo. This simplifies parameter management and makes it possible to combine and control multiple stimulation gizmos with a common set of parameter values. Parameters can be held constant, be controlled by inputting values from another gizmo, or they can be controlled at runtime using a runtime slider interface.

The Stimulation gizmo group includes:

Using Bounded Parameters

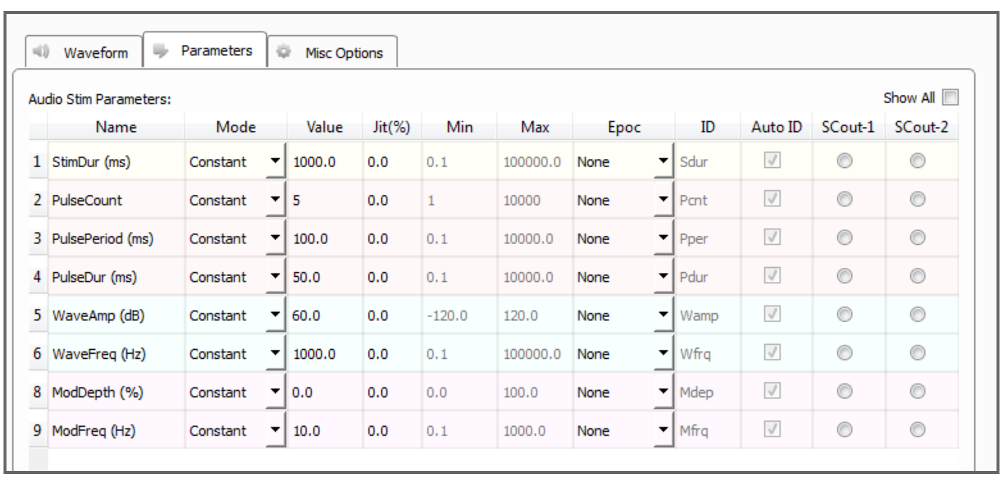
A bounded parameter is a named value that controls a parameter in the underlying real-time processing of the gizmo that contains it. The parameter's value can be modified at runtime by the user or by another gizmo. The user sets the allowed minimum and maximum values of each bounded parameter at designtime. These values are enforced whenever the parameter value is modified.

Gizmos that support bounded parameters share a common runtime interface which gives you manual, semi-automated or fully-automated control of the parameters at runtime.

The stimulation gizmos share a common set of bounded parameters with consistent names to define and organize information about the stimulus parameters so that you can easily switch between them. All of the stimulation gizmos and many of the routing gizmos use parameter tables.

Parameters Table

Gizmos that support bounded parameters have a Parameters tab in their designtime interface that contains the parameters table. The parameters table contains all of the possible bounded parameters for that gizmo. The Audio Stimulation gizmo parameter table is shown in the example below.



Parameters Tab

This table allows the user to set the parameter source and bounds at designtime, among other things that are discussed below.

Rows are shown or hidden depending on the stimulus type and in response to selections made during configuration, with only relevant parameters shown. Likewise, the columns contain values to further define the parameter and are enabled or disabled (gray) by choices you make during the design process.

Value and Min/Max

VALUE sets the default value for the parameter when you switch to runtime mode. All parameters are bounded by their MIN and MAX values. Whenever possible, narrow the bounds to the most reasonable values for the parameter. MIN and MAX set the bounds on any runtime slider widgets and inform any upstream gizmos, such as Parameter Sequencers, about the required values.

Right-click in the Value cell to open a pop-up dialog for easier value entry.

Epoc and ID

In the Epoc column, you can choose to save the individual parameter value on a strobe event or on value change. The options differ depending on the type of gizmo.

Synapse automatically generates a store name. TDT recommends using Auto ID to ensure no store names are duplicated. A "/" is appended to the name to indicate when the full epoc is stored (and is not when only saving the onset). To make your own store names, clear the AUTO ID check box.

Mode

In the Mode column, you can choose to make individual parameters constant, dynamically controlled by a runtime widget (slider), dynamically controlled by a parameter input (PARAM IN) from a Parameter Sequencer or Parameter Manifold gizmo, or dynamically controlled by one of two possible single channel gizmo inputs (Scalar In-1, Scalar In-2).

Constant

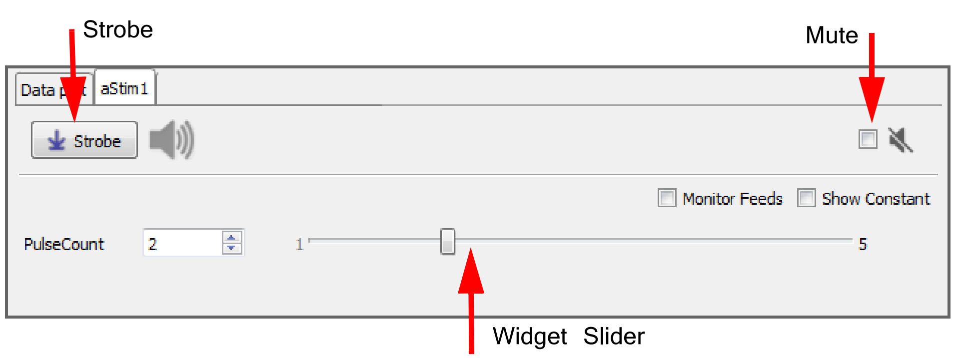
In constant mode, VALUE defines the value of the parameter. The value can be seen in the runtime interface, but cannot be changed.

If a value is entered in the Jit% column during designtime, Min and Max will be enabled. Jit%, or percentage jitter, acts as a randomizer for each presentation with Min and Max providing the bounds.

Widget

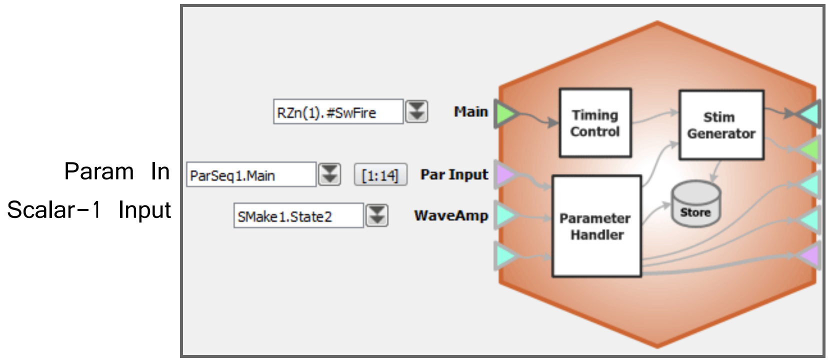
In Widget mode, Value and the group of adjacent parameters; Jit%, Min, and Max primarily define the reasonable limits for the parameter and set the initial value.

At runtime a interface is added as a tabbed window that includes a value box and slider for the parameter(s) set to WIDGET in the table. A manual STROBE button presents a single stimulus. A mute button zeros the signal when checked.



Scalar Inputs

Scalar Inputs 1 and 2 are similar to the PARAM IN line. They provide a line-in to control a parameter. The input line can come from anywhere, but must be a floating point value within the bounds defined for the parameter. You must set the parameter up in the table and commit the change, then update the source for the line-in in the block diagram.



Block Diagram with Several Stimulus Parameter Inputs

Param In

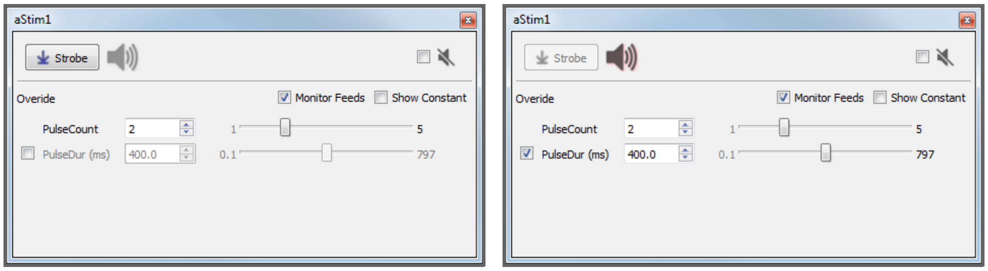
In PARAM IN mode, the parameter value is read in from another gizmo. Jit% (Jitter), Min, and Max primarily define the reasonable limits for the variable. PARAM IN is intended specifically for use with the Parameter Sequencer or Parameter Manifold gizmo. You will need to configure the stimulus, and choose the PARAM IN mode before adding the Parameter Sequencer or Parameter Manifold gizmo to the Processing Tree. Once attached to the parent gizmo, the parameters from the stimulus will be automatically added to the parent's parameter table.

Parameter Sequencer and Audio Stimulation Gizmos

In the example below, Pulse Count is controlled by a widget and PulseDur is controlled by in a parameter input. The MONITOR FEEDS check box shows the parameter controlled input.

Notice, on the left, only the widget controlled parameter is editable. On the right, The check box in the Override column next to the PulseDur (the PARAM IN controlled) parameter has been selected and is now editable.

This allows you to override the Parameter sequencer input line at any time.



Stimulation Runtime Tab Showing "Monitor Feeds" Enabled

Scalar Outputs

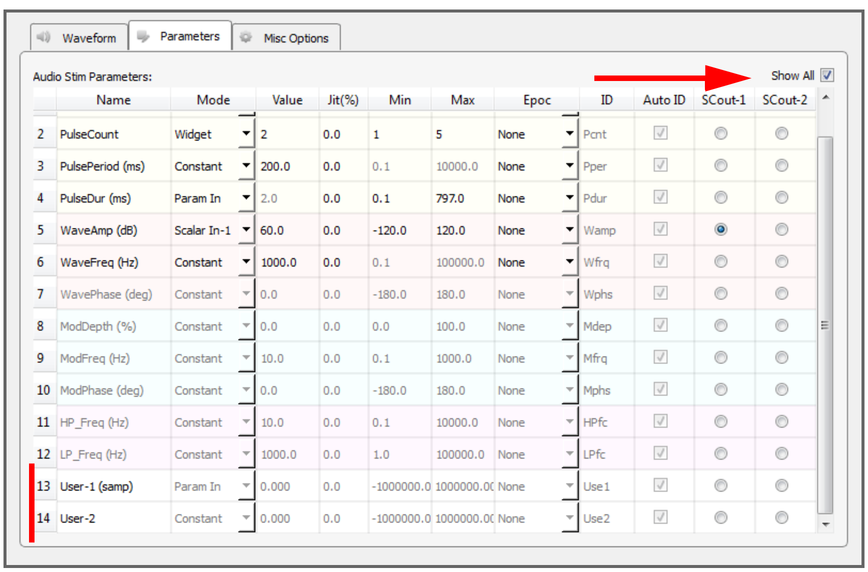
Use radio buttons in the SCout-1 or SCout-2 columns to select a parameter to output. The output can then feed an input on another gizmo. You must commit the change before the new output line will be enabled and labeled in the block diagram.

User Parameters

User-1 and User-2 are parameters meant for your custom needs. These parameters can be virtually anything you need them to be. For example, they can be useful for defining a stimulus presentation channel controlled by the Sequencer.

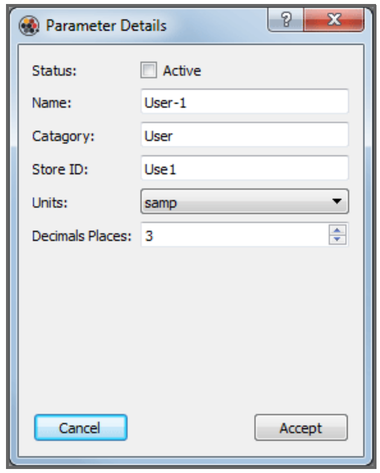
To locate these parameters:

- On the Parameters tab, select the SHOW ALL check box and scroll to the end of the list.



Parameter Table with Show All Selected

After you locate the User parameters, double-click the name cell to open the Parameter Details dialog box. You must select the ACTIVE check box to enable it.



Parameter Details Dialog Box

In the dialog, you can define some of the parameter's basic properties. Once the properties are accepted and the parameter is active, you can configure it much like you would any other parameter.

The Parameter Sequencer Gizmo

Stimulus gizmos uses uniform parameter tables to configure the stimulus parameters. Because the tables are structured using consistent parameter structure and naming, you can use a Parameter Sequencer or Parameter Manifold gizmo to feed values to one or more parameter tables in a systematic way.

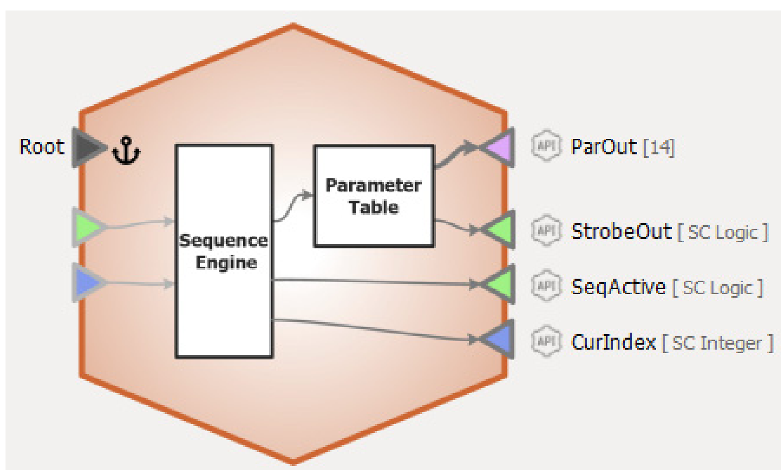
See "Parameter Sequencer" on page 239 and "Parameter Manifold" on page 197 for more information on using these gizmos.

Parameter Sequencer

The Parameter Sequencer gizmo is an interface for controlling stimulus parameters and presentation sequences. It is a highly flexible gizmo with many options for timing, triggering, and control to cover a wide variety of stimulus presentation needs. It is typically used with any of the stimulation gizmos. By selecting the PARAM IN mode in the stimulation gizmo's parameter table you tie that parameter to the parent Parameter Sequencer.

Outputs:

Main	any
StrobeOut	logic
SeqActive	logic
Current index	integer

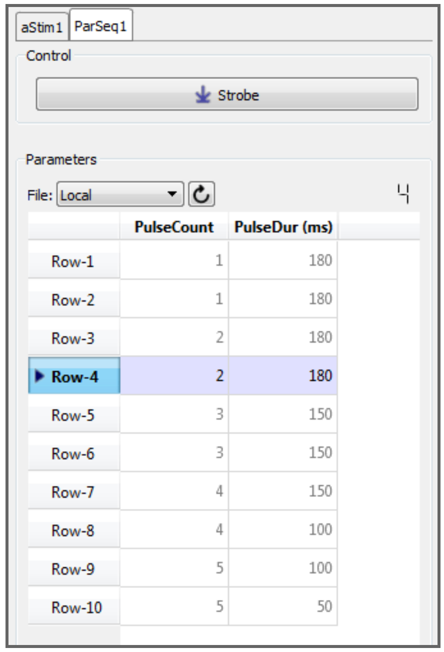


Parameter Sequencer Block Diagram

The Parameter Sequencer requires no inputs by default. Optional inputs for presentation timing and row selection are available depending on gizmo selections. Several different types of outputs are available for monitoring, storage, or to trigger other gizmos or devices.

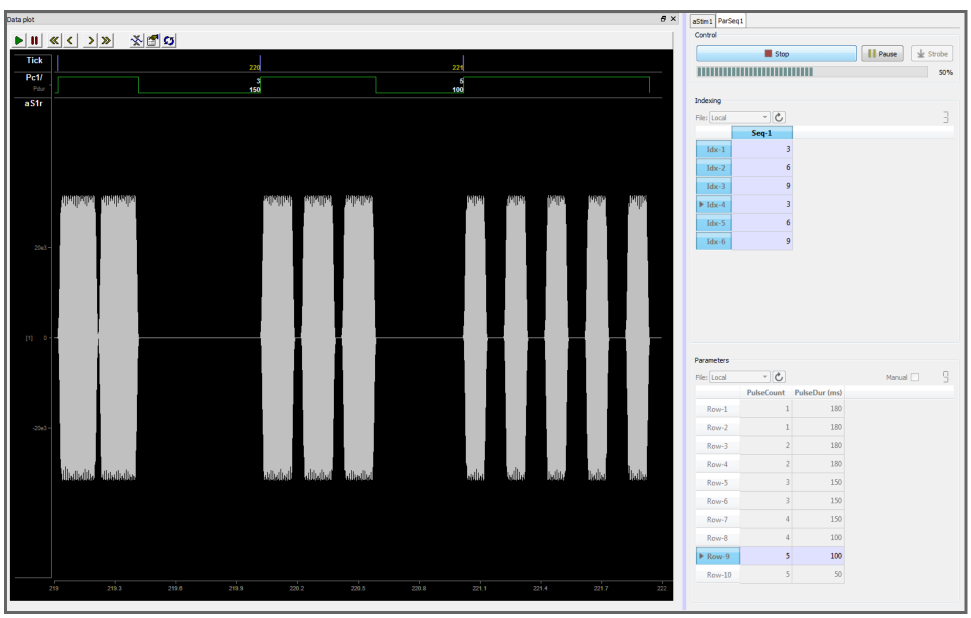
Parameter Sequencer Runtime Interface

At its most basic, the sequencer runtime interface is a table of stimulus parameter combinations that can be selected for use at runtime.



Parameter Sequencer Tab, Split Window

In the example above, combinations of values for Pulse Count and Pulse Duration are saved to the database and manual control was selected. Here you can trigger a presentation of the stimulus by clicking the STROBE button. The parameters in the highlighted row will be used to generate the stimulus. You can change rows by double-clicking a value cell in the desired row. Once the new row is selected, click STROBE again.



Parameter Sequencer Used to Manually Control Progression of Audio Stimulation Through a Sequence of Tone Bursts

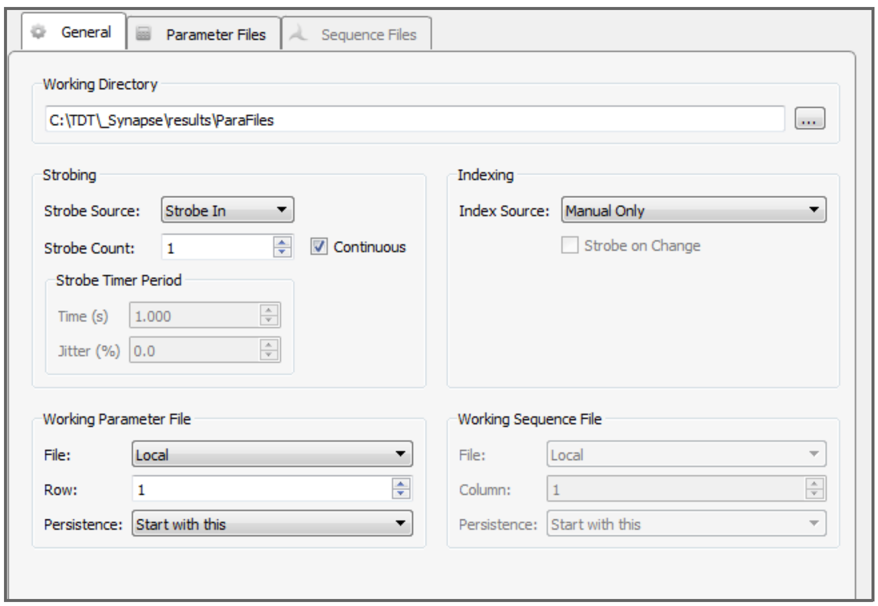
The stimuli can also be presented with the parameter combinations in the order listed in a sequence file. The example above shows the first three indexes (1 - 3), which correspond to rows 3, 6, then 9 in the parameters table. There is a visible difference as the pulse duration and count changes with each presentation. In this example, the interface is designed so you click play, then it runs through the sequence in response to a strobed input line. With many configurable options and the ability to combine the Parameter Sequencer with any of the stimulus gizmos and the Parameter Manifold gizmo, the possibilities will cover most any situation.

Parameter Sequencer Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

General Tab

The General tab pulls together information about where related files will be stored and how the sequencer will be timed/triggered.



General Tab

Working Directory

Sequencer related files are stored in the folder you designate as the Working Directory; by default, C:\TDT\Synapse\ParFiles. If the address entered does not exist, the field will be highlighted in red. You can use the BROWSE[...] button to navigate to the parent folder and create the desired folder.

Strobing

Strobing determines how parameters are fed to the stimulus gizmo. The strobe can be based on one of three possible sources.

Manual Only

If MANUAL ONLY is selected, you must generate the strobe manually using the runtime interface. A STROBE button is provided for this method and can also be used as an additional source when you use one of the other sources.

Strobe In

This option enable the strobe input in the gizmo's block diagram and requires that you select a source to be used for the strobe. Strobe Count and Continuous are also enabled to provide additional control of the strobe.

Timer

You can define an internal timer to control the strobe, using Time(s) and Jitter(%). Use jitter to introduce a random variability to the period for your timer.

Working Parameter File

In this area you must select the parameter file you will be using. Parameter files are created on the Parameter Files tab. There will be no selection available until you have created a parameter file and stored it in the Working Directory.

Using Row and Persistence you can determine where in the parameter file presentation will begin and if you want to start there or lock persistence to that row.

Indexing

The Indexing Source determines how you advance through the sequence of parameters. You can advance the index manually, using a gizmo input, or from a sequence file. The MANUAL ONLY and GIZMO INPUT options work similarly to the same options for the strobe source, described above. With a gizmo input, you have the option of sending a strobe out to indicate the change in the index. STROBE OUT can be stored or used to trigger other gizmos.

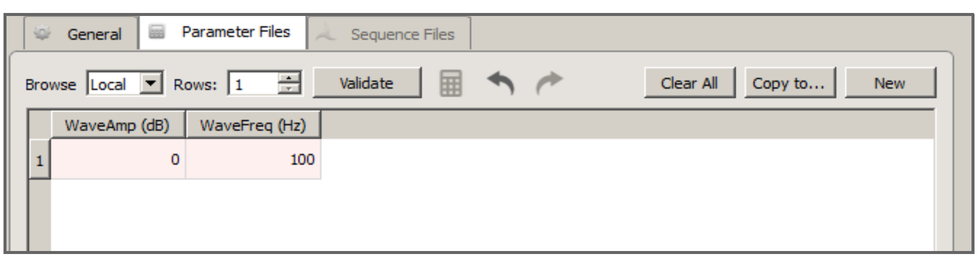
Sequence File

This option enables the WORKING SEQUENCE FILE selection where you can choose the file to control how signal presentation moves through the parameter index.

Sequence files are created on the Sequence Files tab. There will be no selection available until you have created a sequence file and stored it in the working directory.

You also get the option to automatically start the sequence presentation when the recording begins (START SEQ AT RUN-TIME), and an option to automatically stop the recording at the end of the sequence (IDLE WHEN DONE).

Parameter Files Tab



Parameter Files Tab

This tab is a visual interface for selecting or creating a list of all combinations of parameters that you want to use with the stimulation gizmo at runtime. When the gizmo is linked to a stimulation gizmo in the Processing Tree, the parameters are automatically added to the table as columns.

Values entered in the table are checked against the parameter's minimum and maximum, as defined in the stimulus gizmo parameter table. This check is made automatically when the gizmo options are committed and can also be made by clicking the VALIDATE button. The values you enter on the Parameter Files tab serve as the 'Local' file. These values are saved within the gizmo as part of the current experiment and are not saved in a separate file. Changes made to the current file overwrite any previous value.

Saving a Copy (Copy To, New)

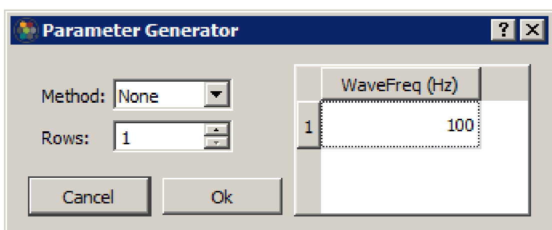
You can save a copy of the current parameter table as a CSV file (*.par.csv) in the working directory defined on the General tab. This ensures a permanent copy of the parameter set and allows you to have more than one file, reuse, and share files across experiments.

Use the COPY TO button to save parameter sets that have already been filled into the table. Once the CSV file is created any changes in the table are saved to the CSV file using the gizmo's COMMIT button.

Use the NEW button to create a new blank CSV file. The empty file is created immediately, but it will not be filled until parameters have been added and committed.

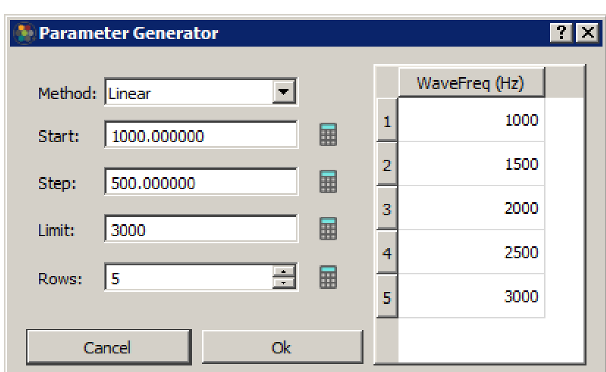
Parameter Generation

To make this whole process easier, Synapse can automatically build out a parameter list using common mathematical operations. Select a column in the table and click on the button to open the Parameter Generator dialog.



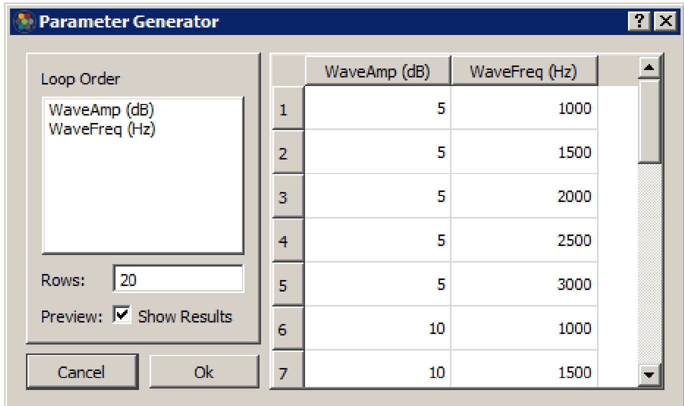
Generation Methods include CONSTANT, LINEAR, LOG2, LOGN, LOG10, RANDOM, GAUSSIAN.

For methods that use a mathematical equation (LINEAR, LOG2, LOGN, LOG10), set any of the three parameters and click the button next to the fourth parameter to automatically generate it.



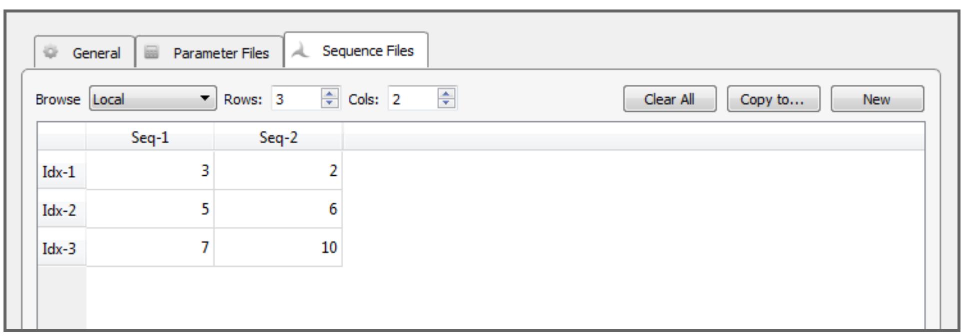
When you click OK those parameters are automatically added to the table.

If you want to generate all possible combinations of parameters in your table, select multiple parameter columns and click the  button to generate the combinations.



Sequence Files

This tab is enabled when the INDEX FILE option is selected on the General tab. The tab functionality is similar to the Parameter Files tab, described above. You can create a new sequence file or browse to an existing one and you will find the same COPY TO and NEW button options for working with multiple sequence files.



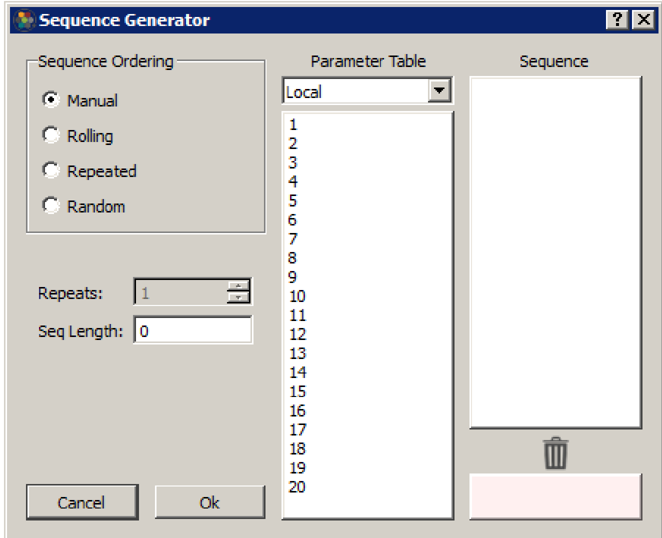
Sequence File Tab

In the sequence table, a column represents a sequence of stimulus presentations, with each index, or row, pointing to the desired set of parameters, or row of the parameters table, for that presentation. The illustration above shows a value of 3 for the first index of the first sequence. That means that the parameter values in the third row of the parameter file table will be used. When signal presentation advances to the second index in the first sequence, parameter values will be pulled from row 5 of the parameter file table.

When you have more than one sequence, you can choose which sequence to begin with or to lock to on the General Tab.

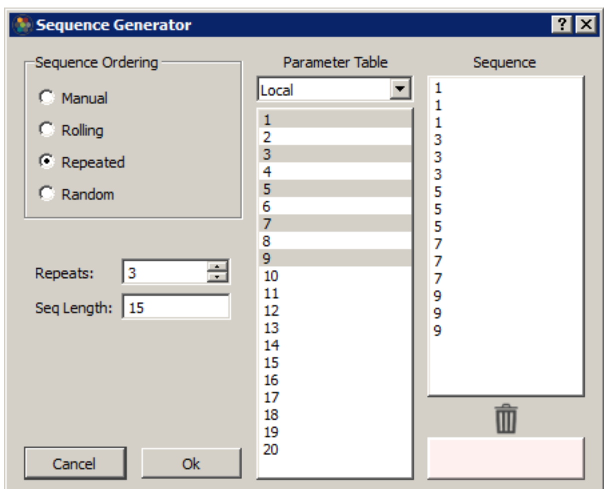
Sequence Generation

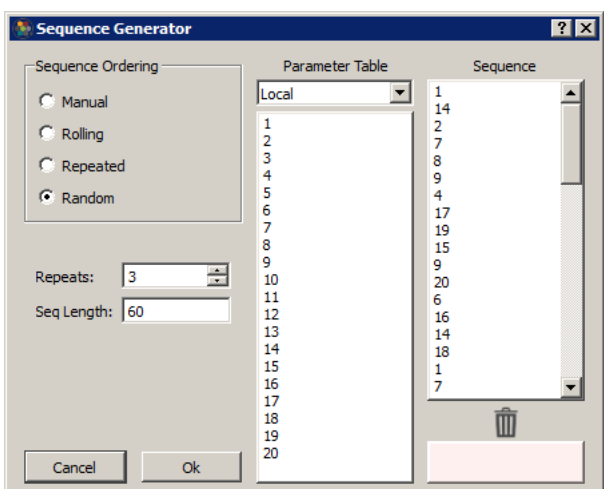
Synapse can automatically build out a sequence list using common ordering operations. Select a column in the table and click on the  button to open the Sequence Generator dialog.



In Manual mode, you can drag/drop rows into the Sequence column to order them. Drag/drop from the Sequence list to the trash list at the bottom to remove from the sequence.

In the other modes, select the number of Repeats and the Sequence list will automatically generate using the selected rows in the Parameter Table list (it will use all rows if no rows are selected). Some examples:





Audio Stimulation

The Audio Stimulation gizmo configures timing, parameter handling, and audio stimulation generation.

Data Stored:

- User selected parameters
- Parameter list (optional)
- Raw stimulus waveform (optional)

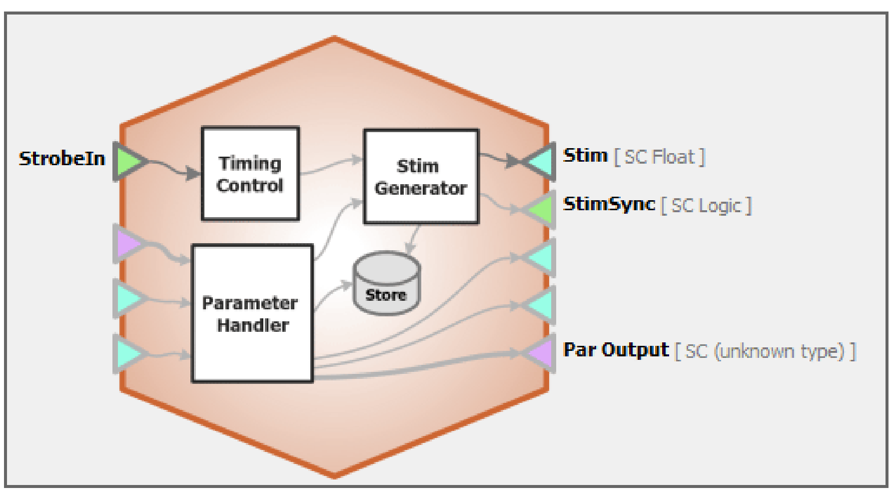
Key features:

- Runtime manual parameter control
- Flexible parameter handler
- Easy signal design and timing control

Outputs:

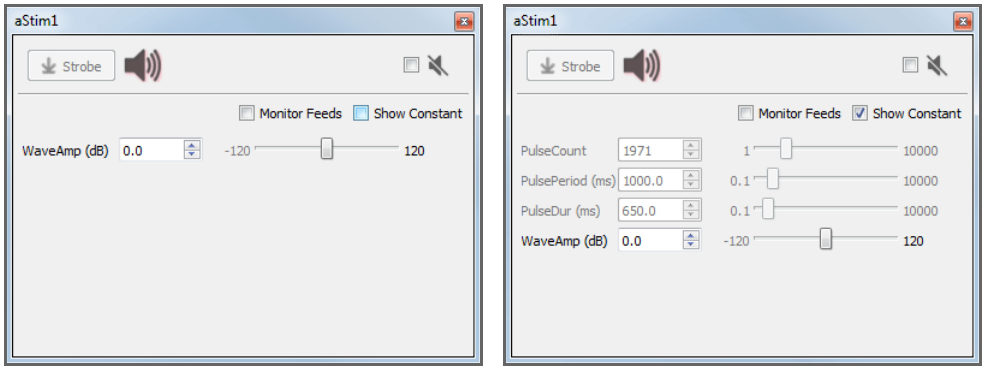
Stimulus waveform	floating point
Parameters	varies
Pulse sync	logic
Stim sync	logic

Audio stimulation waveforms may be comprised of tones, noise, sawtooth or square waves that can vary in duration, level, and more. The overall stimulation duration can be set by a fixed duration, based on a strobe or based on pulse count. The gizmo provides static or runtime control of stimulus parameters and can input parameters from a Parameter Sequencer gizmo. The audio stimulation gizmo includes options to store individual parameters, the parameter list, and raw waveform. A timing pulse can also be output to synchronize data collection.



Audio Stimulation Block Diagram

Audio Stimulation Runtime Interface



Two Versions of the Audio Stimulation Runtime Tab

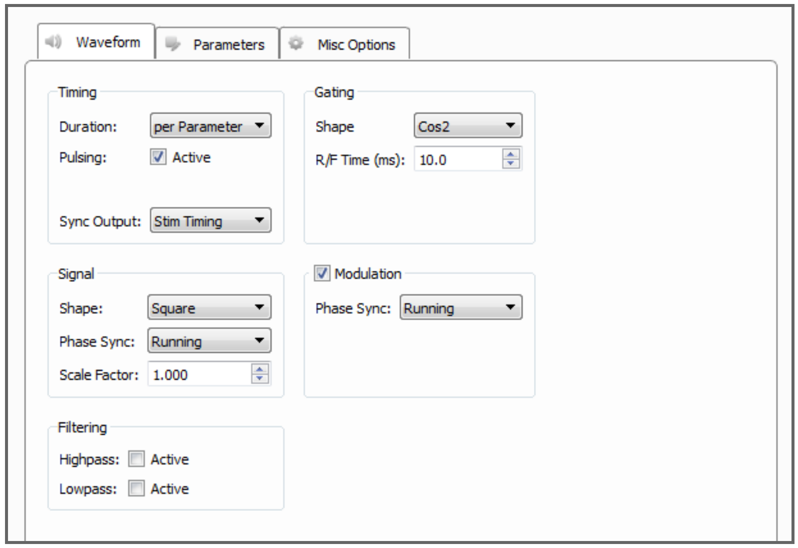
If enabled in the gizmo configuration, an eStim1 control tab is added at runtime. Parameters that can be controlled dynamically are shown in black (active). You can enter a value in the field, use up and down arrows, or drag a slider to modify to parameter value. You can show only the elements you need or hide the entire control. The illustrations above, show two version of the floated tab, one with only the runtime widget controlled parameter shown and one with all the parameters shown.

Strobe Button	Click and release to trigger a manual strobe pulse.
Mute Button	Select check box to zero stimulus signal.
Monitor Feeds	Select the check box to show stimulus parameters controlled by an input signal. Also adds an Override column and check box to the left. Select the OVERRIDE check box to adjust the parameter value manually instead of using the input signal.
Show Constant	Select the check box to display values for parameters set to Constant. They will appear gray.

Audio Stimulation Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Waveform Tab



Waveform Tab

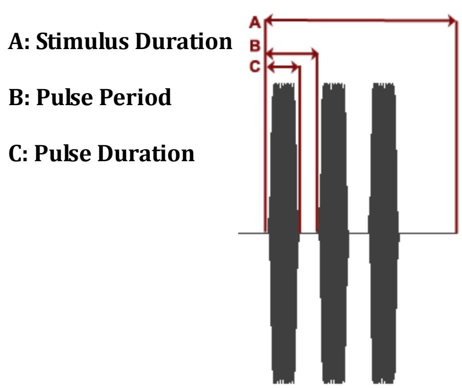
Timing

Duration

Choose to set the duration of the stimulus waveform: per Pulse, per Parameter, or per Strobe.

Pulse

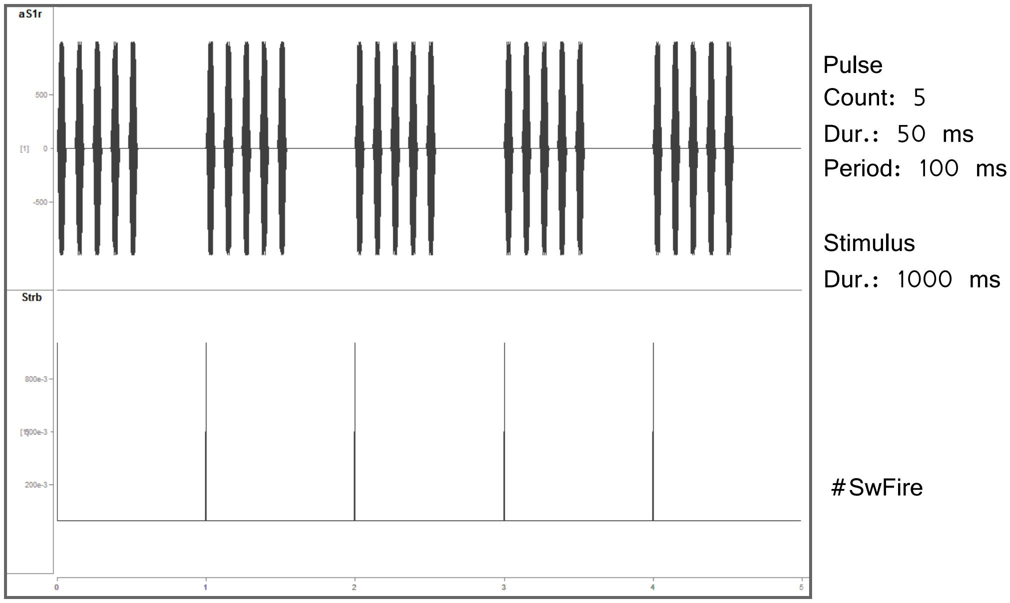
PER PULSE enables you to set a pulse count, duration, and period (in the parameter table) relative to a pulse input to the gizmo's Main input. Typically this is your #SwFire (stimulus sweep fire line) or similar repeating pulse. The diagram below provides a quick visual guide to the three parameters of the stimulus.



Stimulus Tone per Pulse

No matter which method is used to design the stimulus, the next trigger begins a new stimulus. This ends the previous stimulus whether or not the stimulus duration or pulse count has been reached. Before your experiment, be sure to preview your stimulus to ensure it is working as expected.

The plot below shows a tone pulse train, triggered by a sweep fire line (#SwFire)—a typical Synapse timing element available on RZ devices. It fires once every second.



Stimulus Waveform Shown Above with Timing Pulse Below

Parameter

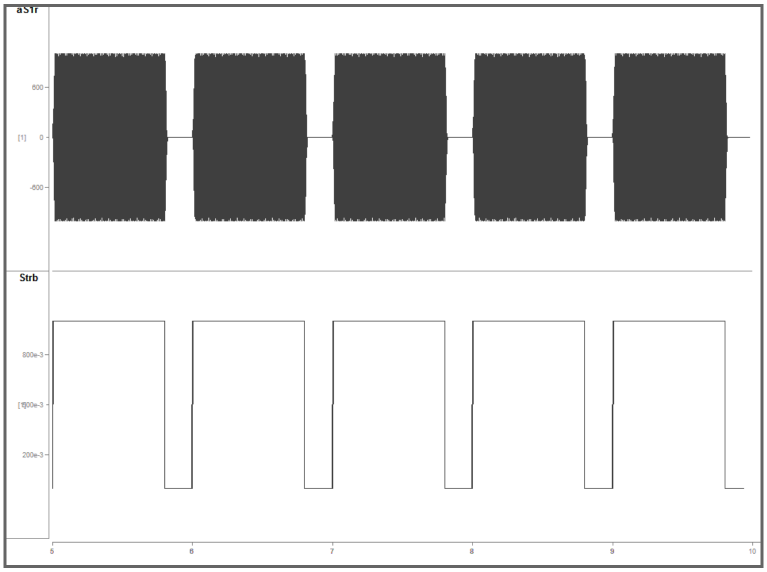
PER PARAMETER is similar to PER PULSE, in that it also enables the pulse count and period parameters (in the parameter table). However, the duration parameter is also enabled, so you can define the duration as a time period via the Parameters Table tab where you have the additional options to:

- set a constant value,
- use a runtime widget,
- use a parameter input from a parameter sequencer or
- use an input from a scalar input line.

See "Parameters Table" on page 233 for more on using the runtime widget or the parameter input option.

Strobe

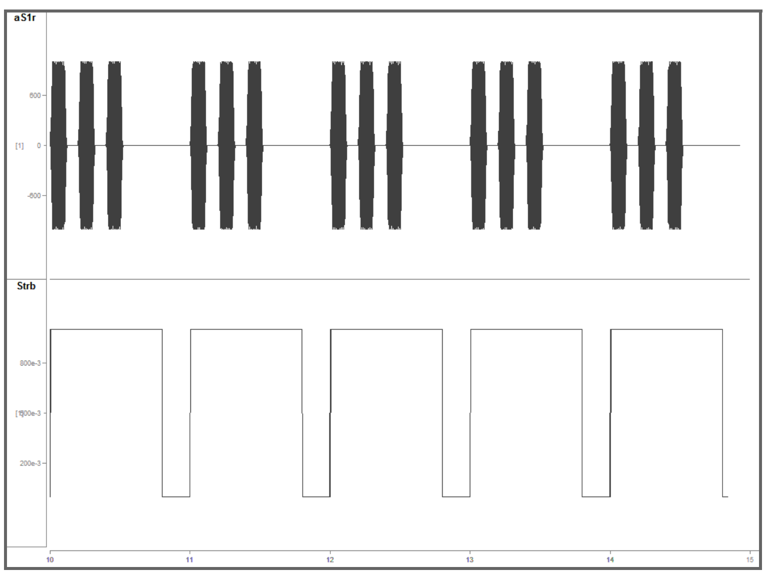
PER STROBE also uses the gizmo's Main input to trigger the signal, however, because no pulse parameters are applied the signal matches the duration of the Main input source, typically a strobe input.



Stimulus Timing Per Strobe

Pulsing Active check box

When selected, pulse duration and pulse count parameters are enabled in the parameter table and the stimulus is triggered when the strobe goes high, the pulse parameters are then followed and the stimulus ends with the pulse count is met or the strobe goes low. The next stimulus is triggered by the next strobe input.



Stimulus Timing Per Strobe with Pulsing Active

Gating

Shape

Choose the type of gate to apply to the signal. Gates serve to attenuate the signal during the onset and offset of the signal, increasing or decreasing in intensity, for the purpose of removing onset/offset related artifacts from this signal.

R/F Time (ms)

Defines the length of time over which the gate is applied, therefore, the length of time in which the signal goes from 0 to full signal strength or visa-versa.

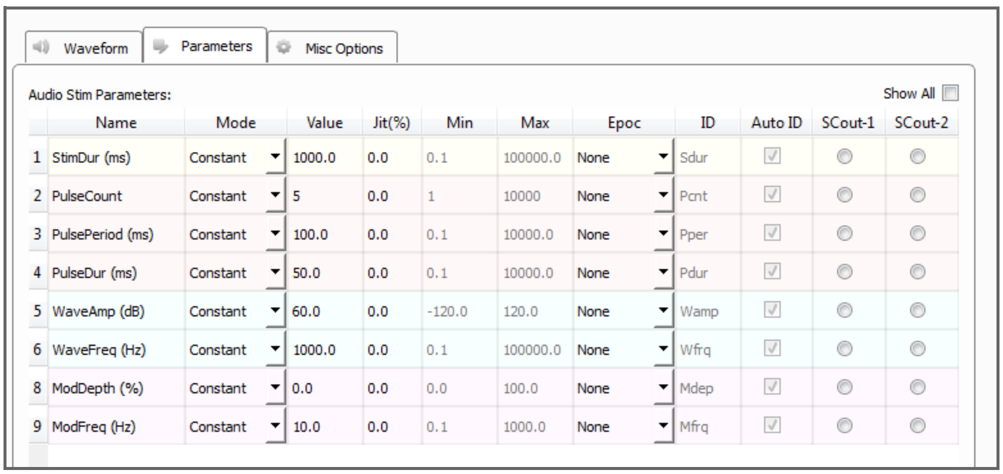
Signal

Select the desired waveform shape and related properties. Select the Modulation check box to add amplitude modulation and select whether to synchronize the phase of the modulation waveform.

Filtering

When a Highpass or Lowpass Active check box is selected a highpass or lowpass filter is applied. Can be used to frequency limit noise.

Parameters Tab



Audio Stimulation Parameters Tab

Audio Stimulation Parameters

The table lists signal parameters relevant to configuring a stimulus. Each row represents a parameter and rows are shown or hidden in response to selections made on the Waveform tab. Use the SHOW ALL check box to display hidden rows.

Mode

In the Mode column, you can choose to make individual variable Constant, controlled by a runtime Widget, fed by a parameter input line (from Parameter Sequencer gizmo) or controlled by a Scalar Input line.

Value Columns

Enter values in the Value, Jit% (Jitter), Min, and Max columns to set the Constant value or to set the initial value and limits when parameters are dynamically controlled. In Widget mode, the Min and Max set the Widget limits.

Epoc

In the Epoc column, you can choose to save the individual parameter value on stimulus or pulse onset.

ID and Auto ID check box

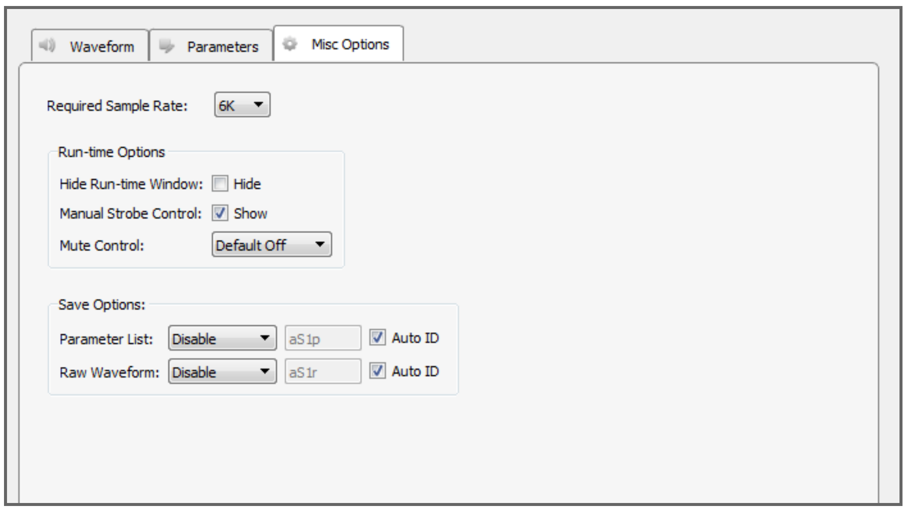
Synapse automatically generates a store name for each parameter. TDT recommends using Auto ID to ensure no store names are duplicated. A "/" is appended to the name to indicate that the full epoc (onset and offset timestamp) is stored.

SCout-1 and SCout-2

Select the radio button in the desired row to feed the parameter to an output signal on the gizmo.

See "Parameters Table" on page 233 for more information on using the parameters table.

Misc Options Tab



Misc Options Tab

Required Sample Rate

The minimum rate required. Synapse looks through the entire experiment and your Rig and sets the sample rate according to this and other limiting factors.

Run-Time Options

Hide Run-Time Windows

By default a runtime tab is added in Preview or Record mode. The contents of the tab are defined with configuration options on the General and Parameter options tab. Select the check box to hide the runtime tab.

Manual Strobe Control

When selected, a manual strobe control is added to the runtime UI.

Mute Control

Mute allows you to temporarily mute the stimulus during runtime. You can choose to hide or show the control and, if shown, set the default start state.

Save Options

The options in this area configure stores that can be generated natively within the gizmo.

Parameter List

Select whether to store the value of all parameters, at each stimulus or pulse onset. This generates a multi-channel list of scalar values. The channels map directly to the rows of the parameter table on the Parameters tab. By default, some parameters are hidden in the table, but values are stored for all parameters.

Auto ID field and check box

A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Raw Waveform

Select whether to store a copy of the raw stimulus waveform. You can choose to store continuously or only when the stimulus is active.

Auto ID field and check box

A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Electrical Stimulation

The Electrical Stimulation gizmo configures timing, parameter handling, and electrical stimulation generation.

Data Stored:

User selected parameters
Parameter list (optional)
Raw stimulus waveform (optional)

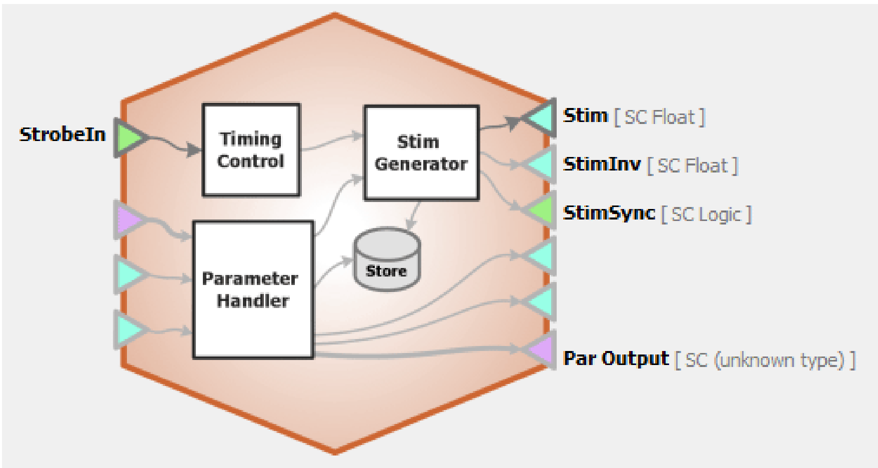
Key features:

Runtime manual parameter control
Flexible parameter handler
Easy signal design and timing control

Outputs:

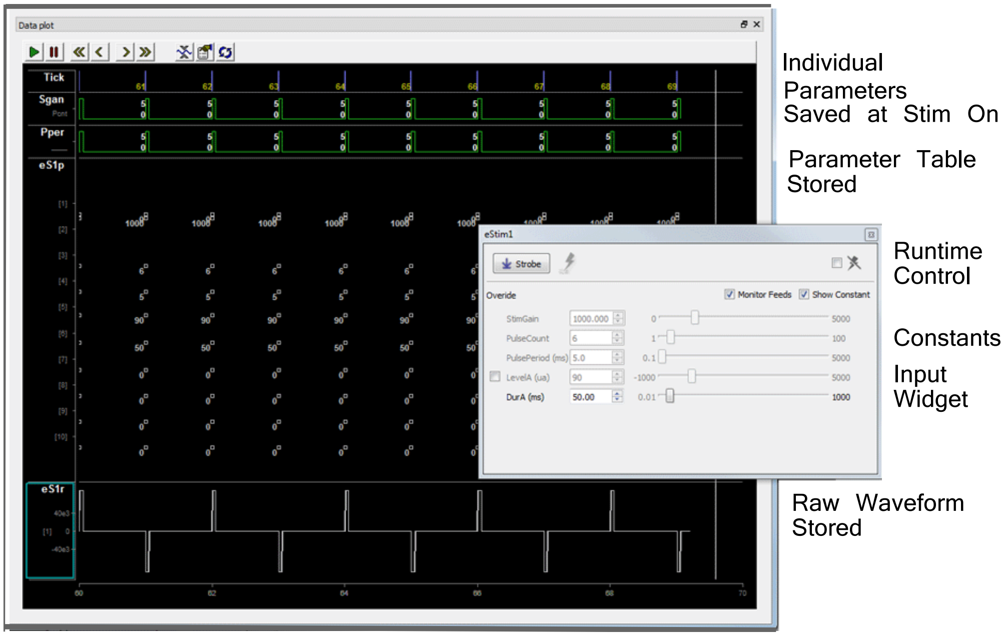
Stimulus waveform	floating point
Stimulus inverse	floating point
Parameters	varies
Pulse sync	logic
Stimulus sync	logic

Electrical stimulation waveforms are comprised of square waves that can vary in duration, level, and phase. The overall stimulation duration can be set by a fixed duration, based on a strobe or based on pulse count. The gizmo provides static or runtime control of stimulus parameters and options to store individual parameters, the parameter list, and raw waveform. Timing pulse can also be output for secondary control or storage. Both the Stimulus and the inverse of the stimulus are output.



Electrical Stimulation Block Diagram

Electrical Stimulation Runtime Interface

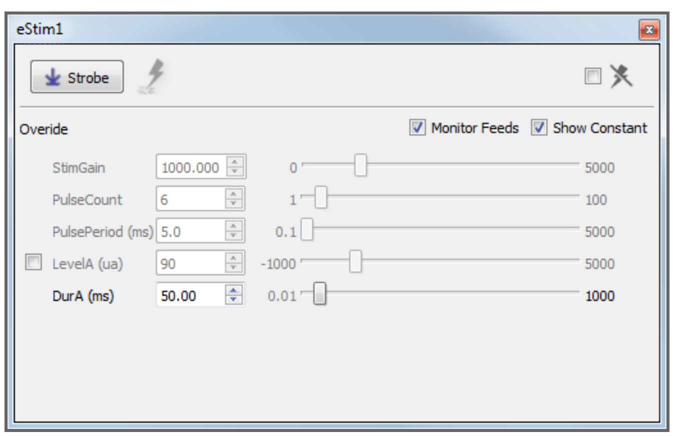


Runtime Tabs with Various Stimulus Stores Enabled for Illustration

The illustration above shows the different ways stimulus information can be stored with the Electrical Stimulation gizmo. Whichever stores you chose to include will be added to the runtime plot alongside the recording plots.

If enabled in the gizmo configuration, a control tab is added at runtime. Parameters that can be controlled dynamically are shown in black (active). You can enter a value in the field, use up and down arrows, or drag a slider to modify to parameter value.

The illustrations above and below, show the tab floated and with all the options shown. You can show only the elements you need or hide the entire control.



eStim Runtime Tab - Floated

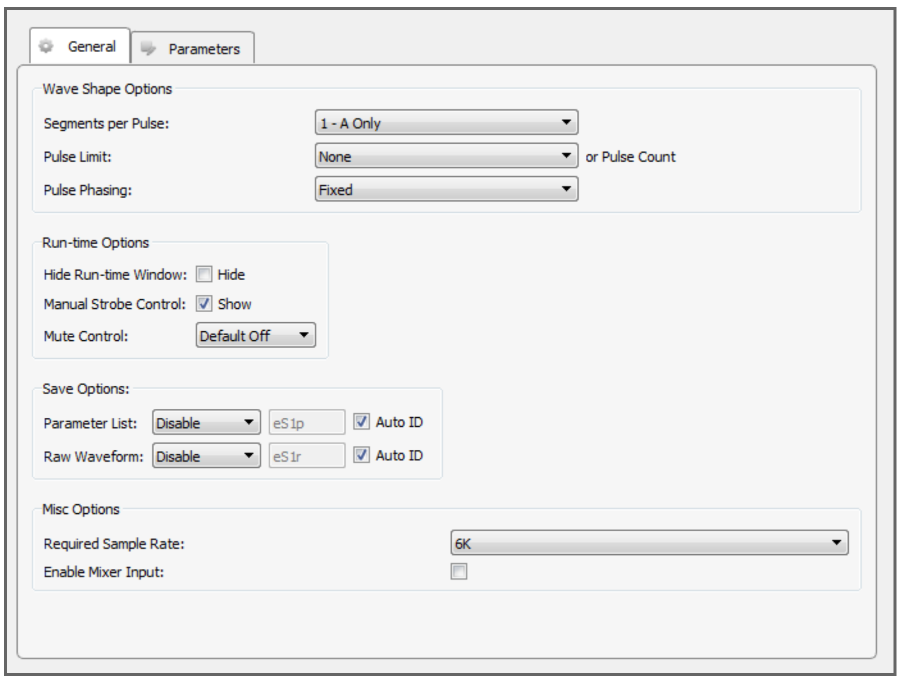
Strobe Button	Click and release to trigger a manual strobe pulse.
Mute Button	Select check box to zero stimulus signal.
Monitor Feeds	Select the check box to show and stimuli controlled by an Input line. Also adds an Override column and check

	box to the left. Select the OVERRIDE check box to adjust the parameter value manually instead of using the input line.
Show Constant	Select the check box to display values for parameters set to constant. They will appear gray.

Electrical Stimulation Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

General Tab

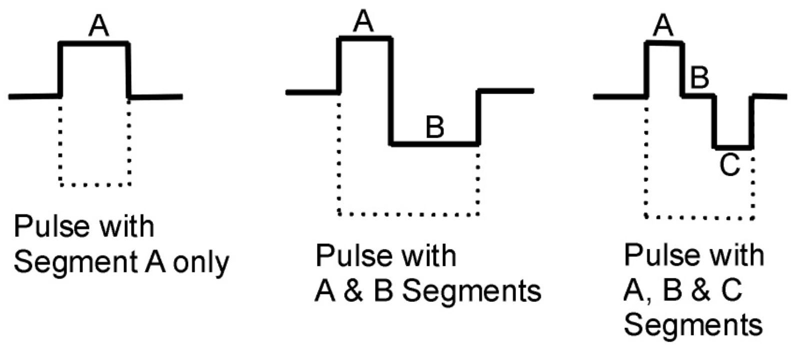


General Tab

Wave Shape Options

Segments per Pulse

Choose the number of segments that make up each pulse. Each pulse can have up to three segments, designated A, B, or C. Level and duration for each segment are configured on the Parameters tab. Examples below illustrate how segments can be used to build various waveform shapes.



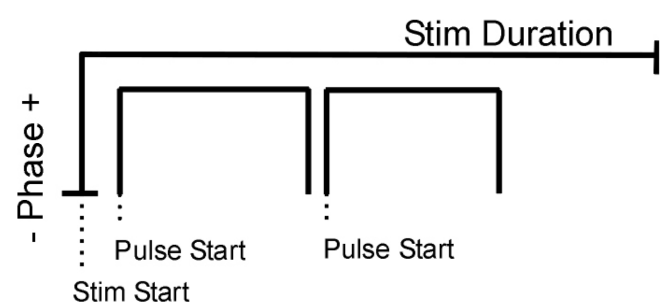
Pulse Examples

Pulse Limit (or Pulse Count)

Select how the stimulus comes to an end, that is, pulses stop. If none is selected, any pulse count value or method will be applied.

Pulse Phasing

By default, the level value of the pulse defines the phase of the stimulus. Pulse phasing can apply an alternating phase (* -1) by pulse or stimulus. If used, it will be applied at the start of a stimulation presentation or the start of each pulse.



Stimulus/Pulse Phase Diagram

Run-Time Options

Hide Run-Time Windows check box

By default a runtime tab is added in preview or record mode. The contents of the tab are defined with configuration options on the General and Parameter options tab. Select the check box to hide the runtime tab.

Manual Strobe Control check box

When selected a manual strobe control is added to the runtime eStim tab.

Mute Control

Select the default behavior of the runtime mute control. Mute allows you to mute or temporarily zero the stimulus during runtime. You can choose to hide or show the control and, if show, set the default start state.

Save Options

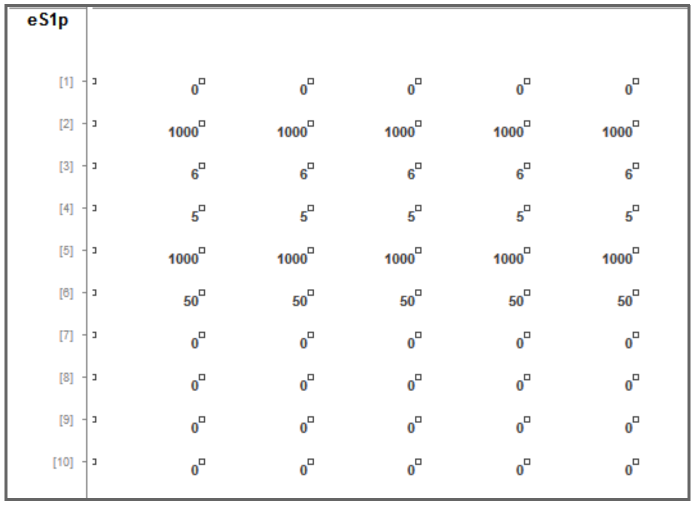
The options in this area configure stores that can be generated natively within the gizmo.

Parameter List

Select whether to store the value of all parameters, at each stimulus or pulse onset. This generates a multi-channel list of scalar values. The channels map directly to the rows of the parameters table on the Parameters tab. By default, some parameters are hidden in the table, but values are stored for all parameters.

Auto ID field and check box

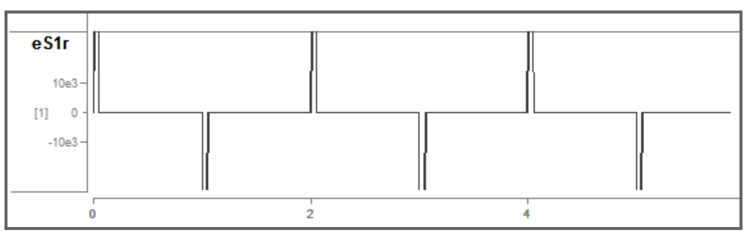
A store name is generated automatically. A "/" is appended to the name to indicate when the full epoc is stored (and is not when only saving the onset). To use your own store name, clear the AUTO ID check box.



Parameter List Store in the Runtime Plot

Raw Waveform

Select whether to store a copy of the raw stimulus waveform. You can choose to store continuously or only when the stimulus is active.



Raw Stimulus Waveform Store in the Runtime Plot

Auto ID field and check box

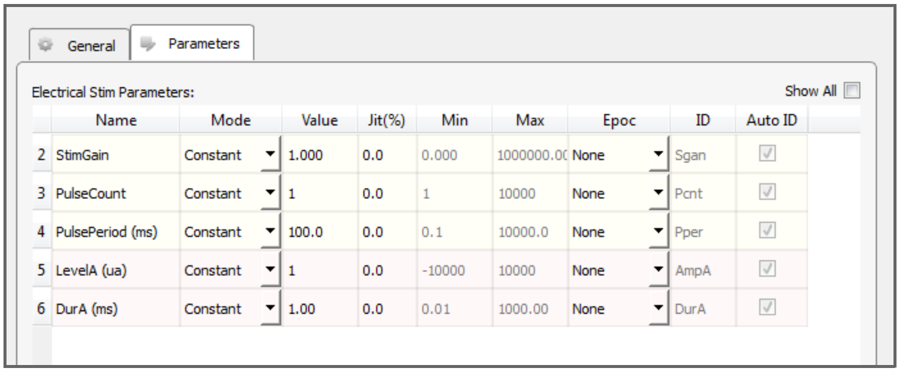
A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Misc Options

Required Sample Rate

The minimum rate required. Synapse looks through the entire experiment and your rig and sets the sample rate according to this and other limiting factors.

Parameters Tab



Parameters Tab

Electrical Stim Parameters

The table lists parameters relevant to configuring a stimulus. Each row represents a parameter and rows are shown or hidden in response to selections you make on the General tab. Use the SHOW ALL check box to display hidden rows.

Mode

In the Mode column, you can choose to make an individual parameter Constant, controlled by a runtime Widget, or controlled by a Parameter Input (PARAM IN) or one of two possible Scalar Input lines (Scalar In-1, Scalar In-2).

Value Columns

Enter values in the Value, Jit% (Jitter), Min, and Max columns to set the constant value or to set the initial value when a widget control will be used.

Epoc

In the Epoc column, you can choose to save the individual parameter value on stimulus or pulse onset. See the "Stimulus/Pulse Phase Diagram" on page 258 for an illustration.

ID and Auto ID check box

Synapse automatically generates a store name. TDT recommends using Auto ID to ensure no store names are duplicated. To make your own store names, clear the AUTO ID check box.

SCout-1 and SCout-2

Select the radio button in the desired row to feed the parameter to an output line.

See "Parameters Table" on page 233 for more information on using the parameters table.

Electrical Stim Driver

The Electrical Stim Driver gizmo configures timing, parameter handling, and electrical stimulation generation with up to four independent stim patterns (voices). It allows dynamic control of stim timings, amplitudes, delays relative to trigger onset, and presentation channels. Output can directly control external IZ2 or IZV stimulator device. For electrical stimulation design with the IZ2, this gizmo replaces the Electrical Stimulation gizmo and Injector gizmos.

Data Stored:

User selected parameters
Parameter list (optional)
Raw stimulus waveform (optional)

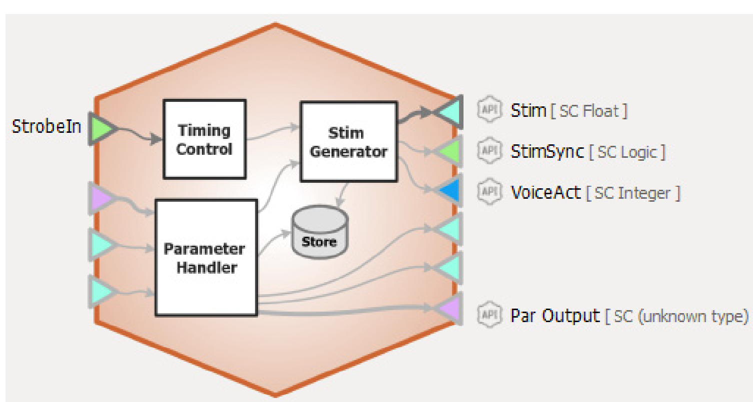
Key features:

Runtime manual parameter control
Flexible parameter handler
Easy signal design and timing control

Outputs:

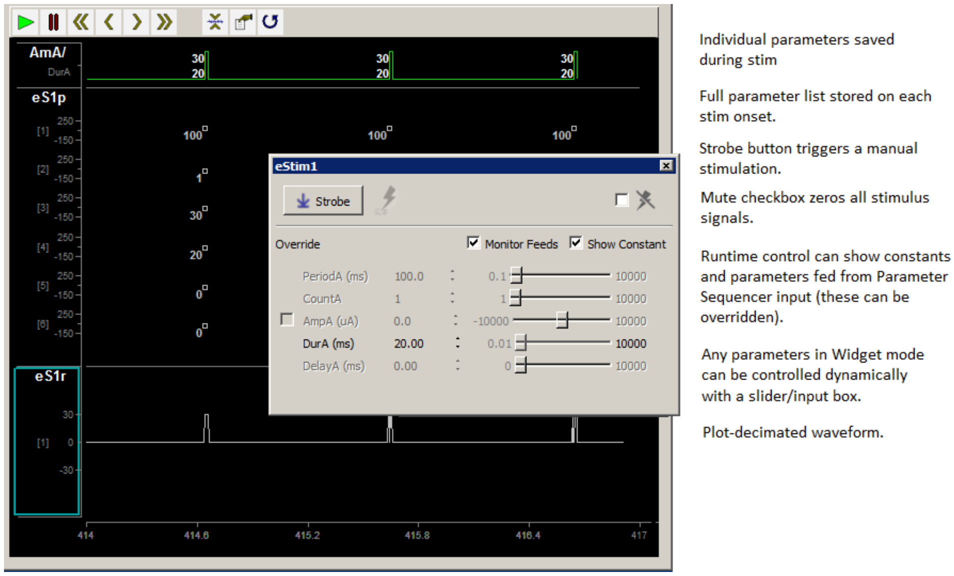
Stimulus waveform	floating point
Stimulus sync	logic
Active Voice	integer
Parameters	varies

Electrical stimulation waveforms are comprised of square waves that can vary in duration, level, phase, delay, and stim channel. The gizmo provides static or runtime control of stimulus parameters and options to store individual parameters, the parameter list, and raw waveform. Timing pulse can also be output for secondary control or storage.



Electrical Stim Driver Block Diagram

Electrical Stim Driver Runtime Interface



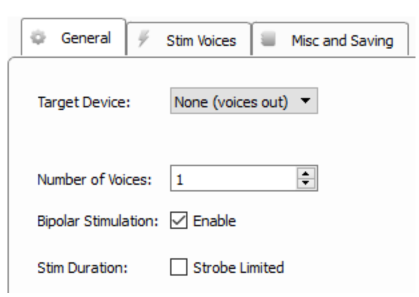
Runtime Tabs with Various Stimulus Stores Enabled for Illustration

The illustration above shows the different ways stimulus information can be stored with the Electrical Stim Driver gizmo. Whichever stores you chose to include will be added to the runtime plot alongside the recording plots. If enabled in the gizmo configuration, a control tab is added at runtime.

Electrical Stim Driver Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

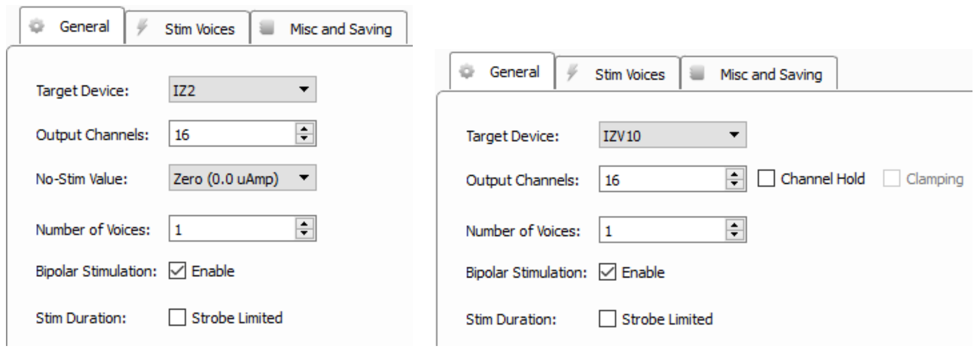
General Tab



General Tab (Target Device is None)

Target Device

When set to 'None', the Stim output link from the gizmo will contain the voices only. The Electrical Stim Driver will typically be used to control an IZ2 or IZV stimulator.



General Tab (Target Device is IZ2/IZV)

When set to 'IZ2' or 'IZV10', choose the total number of stim channels on your IZ.

Choose the number of unique stim patterns (VOICES) to present (up to 4). If BIPOLAR STIMULATION is enabled, you can have up to 2 independent patterns and their inverted waveform on the paired channel.

If STIM DURATION is set to Strobe Limited, then the StrobeIn input to the gizmo controls the number of presentations. When triggered, stim presentations continue until the Count* parameter is reached or the StrobeIn input goes low, whichever happens first.

IZ2 specific

The NO-STIM VALUE option tells the IZ2 channels that aren't actively stimulating how to behave. Either output zero current, open circuit them (recommended), or short them to ground as part of the current return path (the ground option is not compatible with IZ2M or IZ2MH devices).

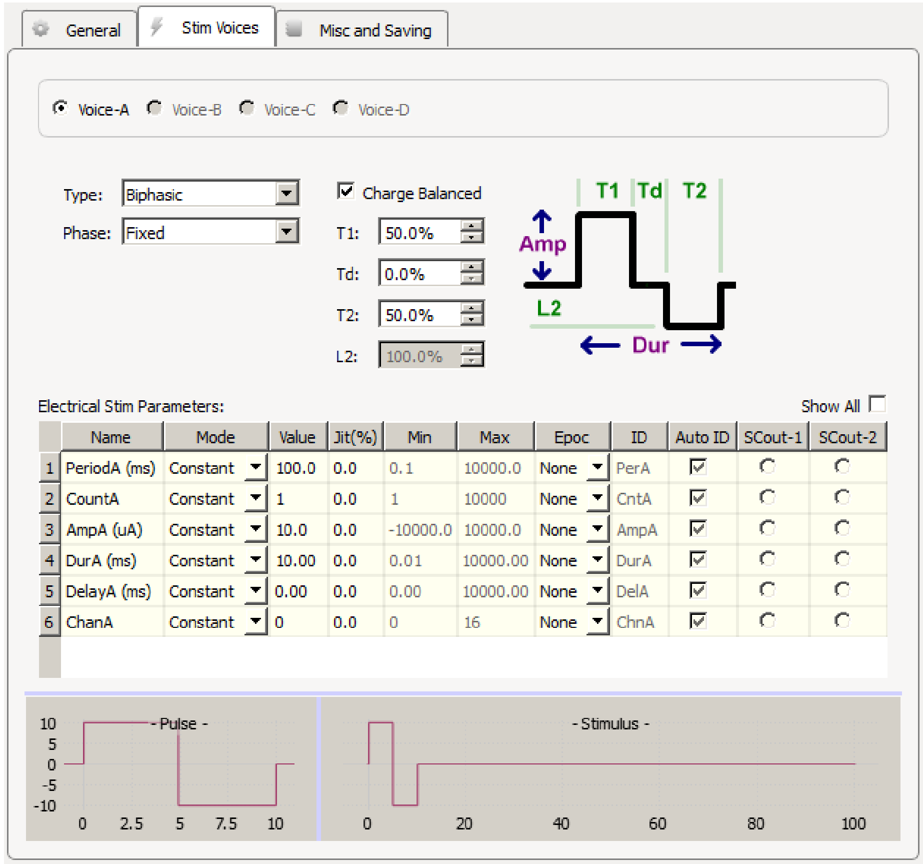
IZV specific

By default, the IZV channels will be open circuit when not stimulating.

Enable the CHANNEL HOLD option to keep the stim voice connected to the output channel (and set to zero current) between presentations.

Enable the CLAMPING option to activate a ground clamp (499 Ohm resistor to ground) on the stim voice between presentations.

Stim Voices Tab



Stim Voices Tab

Design the waveform shape of each voice. For Monophasic waveforms, the amplitude and duration are controlled by the Amp and Dur parameters.

Biphasic waveform parameters are based on percentage calculations of the Amp and Dur parameters. T1 and T2 are the durations of the phases, with Td the time in between the phases. L2 is the inverted level of the second phase as a percentage of Amp. Check the CHARGE BALANCED box to automatically compute L2 so the total current delivered is zero. This minimizes tissue damage and electrode corrosion for electrical stimulation applications.

The percentages are fixed at design time and can't be changed, however the amplitude and duration parameters can be dynamically controlled at run time.

Phase

By default, the level value of the pulse defines the phase of the stimulus. The PHASE setting can control whether to keep the phase Fixed, or to apply an alternating phase (multiply by -1) per Pulse in the train, or for the entire stimulus train (per Stim).

Electrical Stim Driver Parameters

The table lists parameters relevant to configuring the currently selected voice. Use the SHOW ALL check box to display hidden rows.

Mode

In the Mode column, you can choose to make an individual parameter Constant, controlled by a runtime Widget, or controlled by a Parameter Input (PARAM IN) or one of two possible Scalar Input lines (Scalar In-1, Scalar In-2).

Value Columns

Enter values in the Value, Jit% (Jitter), Min, and Max columns to set the constant value or to set the initial value when a widget control will be used.

Epoc

In the Epoc column, you can choose to save the individual parameter value on stimulus onset/offset.

ID and Auto ID check box

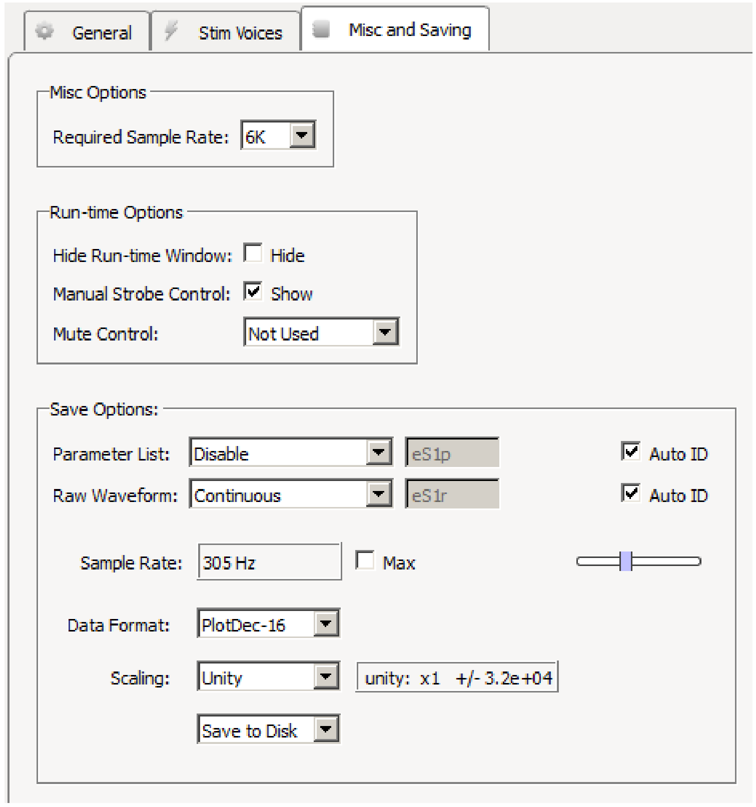
Synapse automatically generates a store name. TDT recommends using Auto ID to ensure no store names are duplicated. To make your own store names, clear the AUTO ID check box.

SCout-1 and SCout-2

Select the radio button in the desired row to feed the parameter to an output line.

See “Parameters Table” on page 233 for more information on using the parameters table.

Misc and Saving Tab



Misc and Saving Tab

Misc Options

Required Sample Rate

The minimum rate required. Synapse looks through the entire experiment and your rig and sets the sample rate according to this and other limiting factors.

Run-time Options

Hide Run-Time Windows check box

By default a runtime tab is added in preview or record mode. The contents of the tab are defined with configuration options on the General and Parameter options tab. Select the check box to hide the runtime tab.

Manual Strobe Control check box

When selected a manual strobe control is added to the runtime eStim tab.

Mute Control

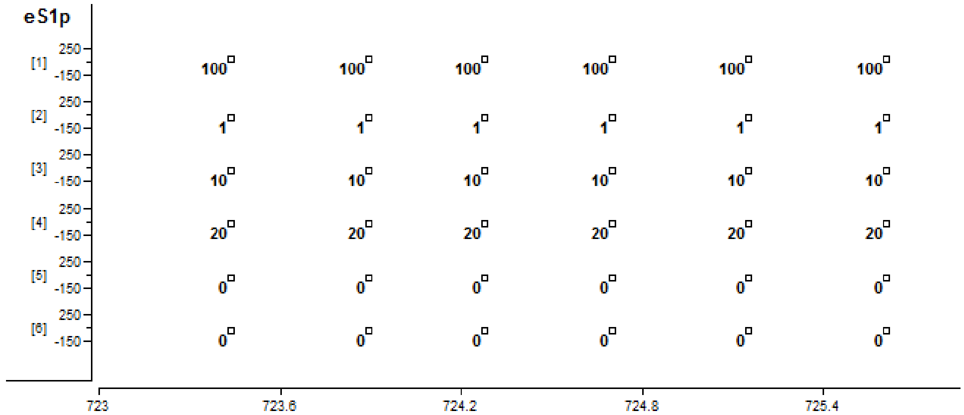
Select the default behavior of the runtime mute control. Mute allows you to temporarily zero all stimulus output during runtime. You can choose to hide or show the control and, if show, set the default start state.

Save Options

The options in this area configure stores that can be generated natively within the gizmo.

Parameter List

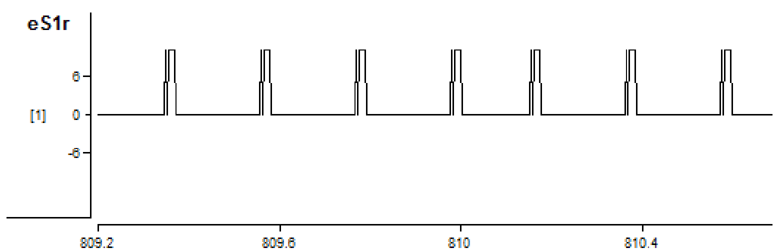
Select whether to store the value of all parameters, at each stimulus onset. This generates a multi-channel list of scalar values. The channels map directly to the rows of the parameters table on the Stim Voices tab. By default, some parameters are hidden in the table, but values are stored for all parameters.



Parameter List Store in the Runtime Plot

Raw Waveform

Select whether to store a copy of the raw stimulus waveform(s). You can choose to store continuously or only when the stimulus is active. By default the Data Format is set to plot-decimated, which is highly decimated for viewing on your computer monitor. It takes short chunks of points, finds the max and min values, and only keeps those. You can see this effect in the image below. The actual output is a square wave, but during the rising edge it plots the max and min for that chunk of time in the plot decimated view.



Raw Stimulus Waveform Store in the Runtime Plot

This is fine for monitoring the peak signal output and requires very low bandwidth. The plot will not contain all of the signal information but will capture the maximum/minimum signal amplitudes. Change the Data Format to Float-32 and increase the Sample Rate if you need a better resolution view.

Output Links

VoiceAct

The VoiceAct output is a bit mask where the first bit is the stim trigger, and the next four bits represent whether voices A, B, C, or D respectively are currently stimulating.

File Stimulation

The File Stimulation gizmo plays stimulus waveforms from a list of files. It supports timing control and dynamic parameters.

Data Stored:

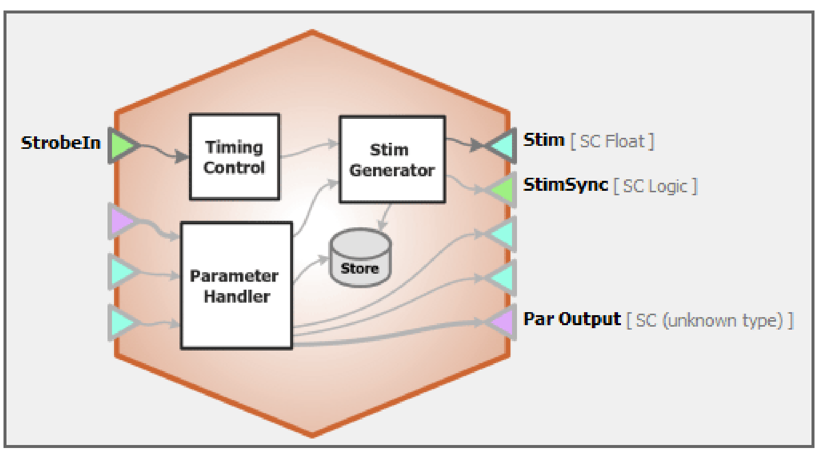
User selected parameters
Parameter list (optional)
Raw stimulus waveform (optional)

Key features:

Runtime manual parameter control
Flexible parameter handler
Easy signal design and timing control

Outputs:

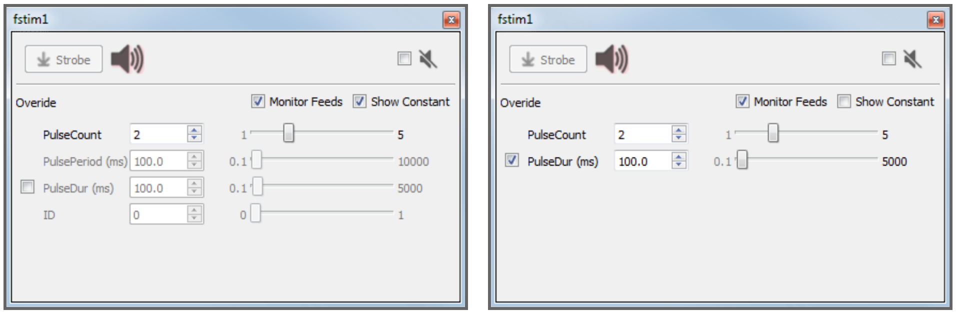
Stimulus waveform	floating point
Parameters	varies
Pulse sync	logic
Stim sync	logic



File Stimulation Block Diagram

File Stimulation Runtime Interface

If enabled in the gizmo configuration, a control tab is added at runtime. Parameters that can be controlled dynamically are shown in black (active). You can enter a value in the field, use up and down arrows, or drag a slider to modify to parameter value. You can show only the elements you need or hide the entire control.



Two Versions of the File Stimulation Runtime Tab

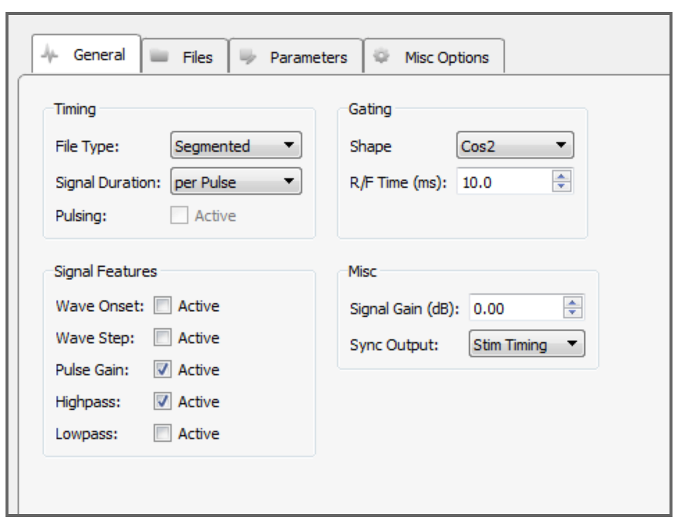
The illustrations above, show two version of the floated tab, one with all the parameters shown and one with only the runtime widget controlled parameter and the PARAM IN line (with override selected) shown.

Strobe Button	Click and release to trigger a manual strobe pulse.
Mute Button	Select check box to zero stimulus signal.
Monitor Feeds	Select the check box to show any stimuli controlled by an input line. Also adds an Override column and check box to the left. Select the OVERRIDE check box to adjust the parameter value manually instead of using the input line.
Show Constant	Select the check box to display values for parameters set to constant. They will appear gray.

File Stimulation Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See "The Options Area" on page 26 and page 59 for more information on the Gizmo name, source, global options, and displaying the block diagram.

General Tab



General Tab

Timing

You can choose to use the whole file or segments of the file. When using file segments, you can choose to set the duration of the stimulus waveform per Pulse, per Parameter, or per Strobe. You may also have to define the onset, or starting point of the segment, and step size in the parameter table. The step size allows you to use every nth sample in the signal.

When the PULSING ACTIVE check box is selected, pulse duration and pulse count parameters are enabled in the parameter table and the stimulus is triggered when the strobe goes high, the pulse parameters are then followed and the stimulus ends with the pulse count is met or the strobe goes low. The next stimulus is triggered by the next strobe input.

Gating

Gates serve to attenuate the signal during the onset and offset of the signal, gaining or decreasing in intensity, for the purpose of removing onset/offset related artifacts from this signal. You can choose one of several common gate shapes to apply to the signal. The R/F Time defines the length of time over which the gate is applied, therefore, the length of time in which the signal goes from 0 to full signal strength or visa-versa.

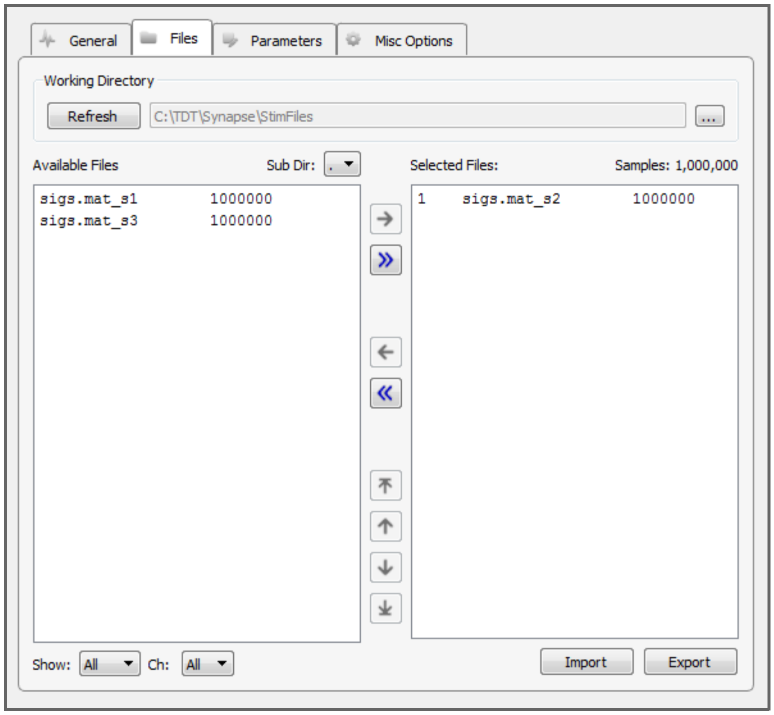
Signal Features

Features available here depend on the file type. When the check box is selected, the corresponding parameter is enabled in the parameter table.

Misc

In this section you can apply a signal gain factor and choose to output either a stimulus or pulse timing Sync Output signal.

Files Tab



Files Tab

Working Directory

The default working directory is C:\TDT\Synapse|StimFiles\. You can select a different directory or stick with the default. If you add files to the directory or choose a new directory, you can click REFRESH to update the displayed list of available files below.

The lower portion of the window serves as a simple graphical interface for displaying, filtering, and selecting stimulus files for play out.

Available Files

In the list on the left, all stimulus files found in the working directory are displayed. Stimulus files can be any of the following types:

- continuous 32-bit floating points (*.F32)
- continuous 32-bit integers (*.I32)
- continuous 16-bit integers (*.I16)
- Wave (*.wav)
- MATLAB arrays (*.mat)

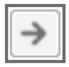
A Show Types drop-down filter, below the Available Files area, narrows the displayed files to the selected file type. The Sub Directory drop-down menu allows you to drill down to subdirectories within the working directory.

Selected Files

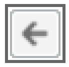
The area to the right, serves as a list of files to be loaded as the stimuli.

File Buttons

Use the file buttons, located between the two lists, to move files.

 move a file from available to selected

 move all files to selected

 move a file from selected to available

 move all files to available

 move file to top of list

 move file up in list

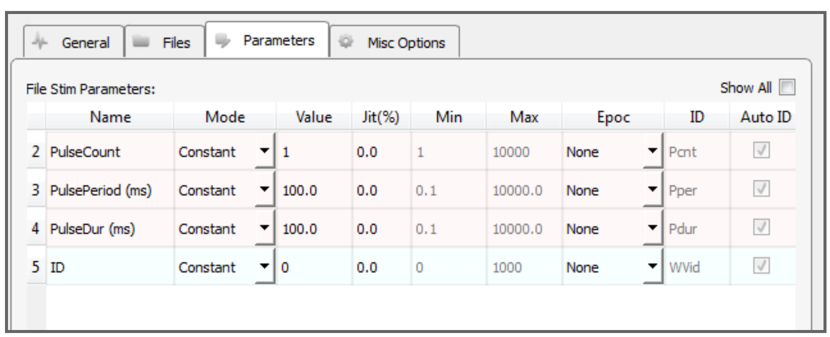
 move file down in list

 move file to the bottom of the list

Import /Export

These buttons can be used to import or export stimulus files.

Parameters Tab



Parameter Tab

File Stim Parameters

The table lists parameters relevant to configuring the stimulus. Each row represents a parameter and rows are shown or hidden in response to selections made on the General tab. Use the SHOW ALL check box to display hidden rows.

Mode

In the Mode column, you can choose to make individual parameter Constant, controlled by a runtime Widget, or controlled by an Input line.

Value Columns

Enter values in the Value, Jit% (Jitter), Min, and Max columns to set the Constant value or to set the initial value when a Widget control will be used.

Epoc

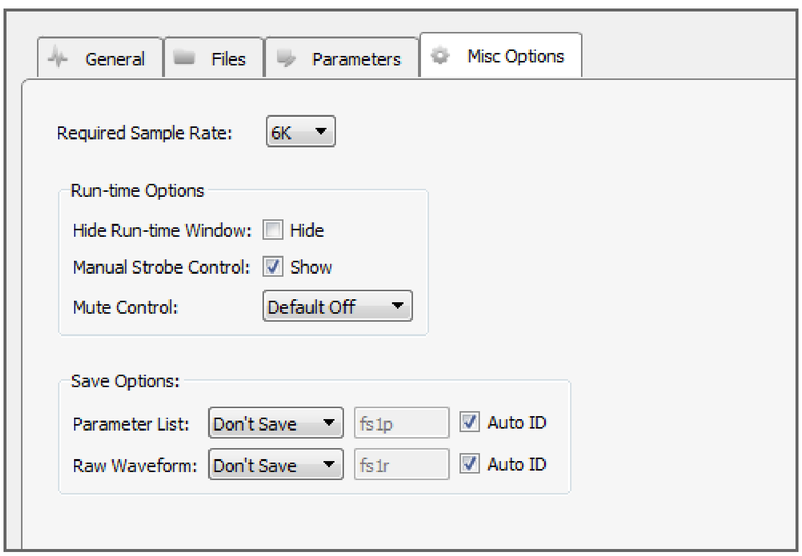
In the Epoc column, you can choose to save the individual parameter value on stimulus or pulse onset.

ID and Auto ID check box

Synapse automatically generates a store name. TDT recommends using Auto ID to ensure no store names are duplicated. A "/" is appended to the name to indicate when the full epoc is stored (and is not when only saving the onset). To make your own store names, clear the AUTO ID check box.

See "Parameters Table" on page 233 for more information on using the parameters table.

Misc Options Tab



Misc Options Tab

Required Sample Rate

The minimum rate required. Synapse looks through the entire system and sets the sample rate according to this and other limiting factors.

Run-time Options

Hide Run-Time Windows check box

By default a runtime tab is added in preview or record mode. The contents of the tab are defined with configuration options on the General and Parameter options tab. Select the check box to hide the runtime tab.

Manual Strobe Control check box

When selected a manual strobe control is added to the runtime eStim tab. Clear the check box to hide the manual strobe control at runtime.

Mute Control

Select the default behavior of the runtime mute control. Mute allows you to mute or temporarily zero the stimulus during runtime. You can choose to hide or show the control and, if show, set the default start state.

Save Options

The options in this area configure stores that can be generated natively within the gizmo.

Parameter List

Select whether to store the value of all parameters, at each stimulus or pulse onset. This generates a multi-channel list of scalar values. The channels map directly to the rows of the parameter table on the parameters tab. By default, some parameters are hidden in the table, but values for are stored for all parameters.

Auto ID field and check box

A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Raw Waveform

Select whether to store a copy of the raw stimulus waveform. You can choose to store continuously or only when the stimulus is active.

Auto ID field and check box

A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Ultrasonic Stimulation

The Ultrasonic Stimulation gizmo configures timing, parameter handling, and audio stimulation generation. It is a simplified version of the Audio Stimulation gizmo that is capable of stimulating up to 85 kHz pure tones and Gaussian noise on the RZ6 processor.

Data Stored:

- User selected parameters
- Raw stimulus waveform (optional)

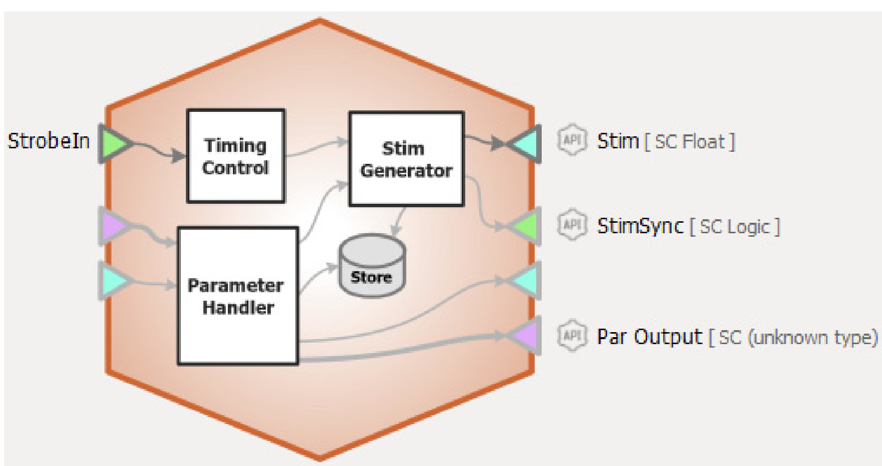
Key features:

- Runtime manual parameter control
- Flexible parameter handler
- Easy signal design and timing control

Outputs:

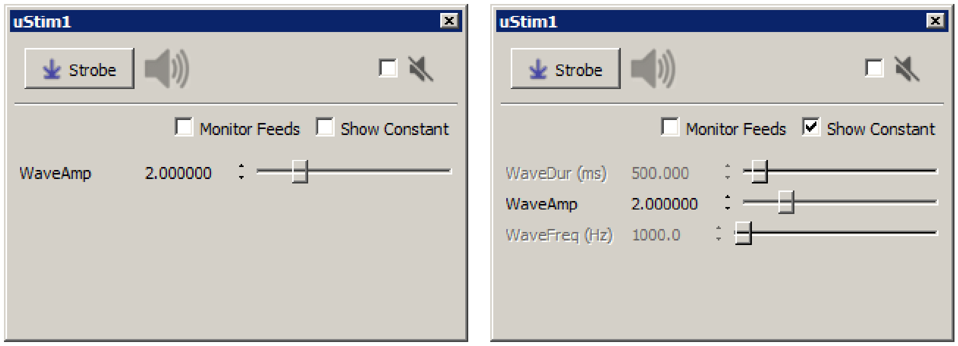
Stimulus waveform	floating point
Parameters	varies
Stim sync	logic

Ultrasonic stimulation waveforms may be comprised of tones or Gaussian noise that can vary in duration, level, and frequency. The gizmo provides static or runtime control of stimulus parameters and can input parameters from a Parameter Sequencer gizmo. The audio stimulation gizmo includes options to store individual parameters and raw waveform. A timing pulse can also be output to synchronize data collection.



Ultrasonic Stimulation Block Diagram

Ultrasonic Stimulation Runtime Interface



Two Versions of the Ultrasonic Stimulation Runtime Tab

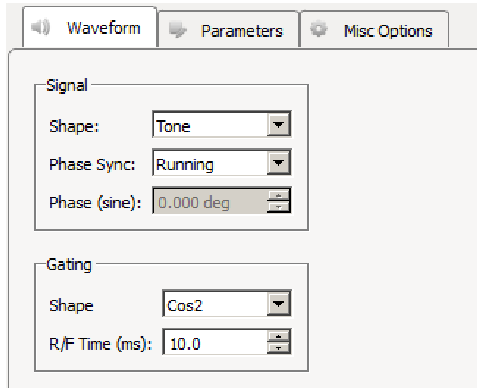
If enabled in the gizmo configuration, a uStim1 control tab is added at runtime. Parameters that can be controlled dynamically are shown in black (active). You can enter a value in the field, use up and down arrows, or drag a slider to modify to parameter value. You can show only the elements you need or hide the entire control. The illustrations above, show two version of the floated tab, one with only the runtime widget controlled parameter shown and one with all the parameters shown.

Strobe Button	Click and release to trigger a manual presentation.
Mute Button	Select check box to zero stimulus signal.
Monitor Feeds	Select the check box to show stimuli parameters controlled by an input signal. Also adds an Override column and check box to the left. Select the OVERRIDE check box to adjust the parameter value manually instead of using the input signal.
Show Constant	Select the check box to display values for parameters set to Constant. They will appear gray.

Ultrasonic Stimulation Configuration Options

Use the options tabs to enable/disable optional features and set parameters that will be used to configure the gizmo operation and interface. Changes are not applied until you commit all settings. See “The Options Area” on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

Waveform Tab



Waveform Tab

Signal

Select the desired waveform shape and whether to synchronize the phase of the waveform. For frozen noise, select the GAUSS NOISE Shape and set SYNC TO STIM as the Phase Sync.

Gating

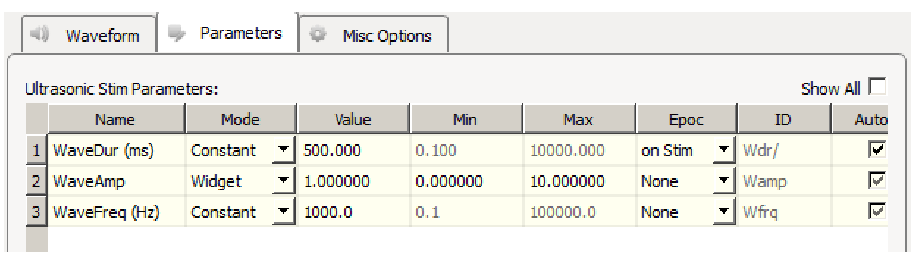
Shape

Choose the type of gate to apply to the signal. Gates serve to attenuate the signal during the onset and offset of the signal, increasing or decreasing in intensity, for the purpose of removing onset/offset related artifacts from this signal.

R/F Time (ms)

Defines the length of time over which the gate is applied, therefore, the length of time in which the signal goes from 0 to full signal strength or visa-versa.

Parameters Tab



Ultrasonic Stimulation Parameters Tab

Ultrasonic Stimulation Parameters

The table lists signal parameters relevant to configuring a stimulus. Each row represents a parameter and rows are shown or hidden in response to selections made on the Waveform tab. Use the SHOW ALL check box to display hidden rows.

Mode

In the Mode column, you can choose to make individual variable Constant, controlled by a runtime Widget, fed by a parameter input line (from Parameter Sequencer gizmo) or controlled by a Scalar Input line.

Value Columns

Enter values in the Value, Min, and Max columns to set the Constant value or to set the initial value and limits when parameters are dynamically controlled. In Widget mode, the Min and Max set the Widget limits.

Epoc

In the Epoc column, you can choose to save the individual parameter value on stimulus onset.

ID and Auto ID check box

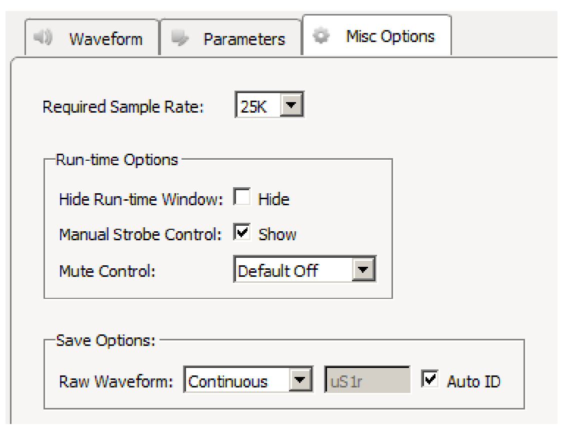
Synapse automatically generates a store name for each parameter. TDT recommends using Auto ID to ensure no store names are duplicated. A "/" is appended to the name to indicate that the full epoc (onset and offset timestamp) is stored.

SCout-1

Select the radio button in the desired row to feed the parameter to an output signal on the gizmo.

See "Parameters Table" on page 233 for more information on using the parameters table.

Misc Options Tab



Misc Options Tab

Required Sample Rate

The minimum sampling rate required. Synapse looks through the entire experiment and your Rig and sets the sample rate according to this and other limiting factors.

Run-Time Options

Hide Run-Time Windows

By default a runtime tab is added in Preview or Record mode. The contents of the tab are defined with configuration options on the General and Parameter options tab. Select the check box to hide the runtime tab.

Manual Strobe Control

When selected, a manual strobe control is added to the runtime UI.

Mute Control

Mute allows you to temporarily mute the stimulus during runtime. You can choose to hide or show the control and, if shown, set the default start state.

Save Options

The options in this area configure stores that can be generated natively within the gizmo.

Raw Waveform

Select whether to store a copy of the raw stimulus waveform. You can choose to store continuously or only when the stimulus is active.

Auto ID field and check box

A store name is generated automatically. To use your own store name, clear the AUTO ID check box.

Ultrasonic Stimulation

Storage

Timestamp and store any type of real-time data; continuously streamed data or periodic data samples, single channel or multi-channel. All are supported.

The Storage gizmo group includes:

Epoch Event Storage

Stream Data Storage

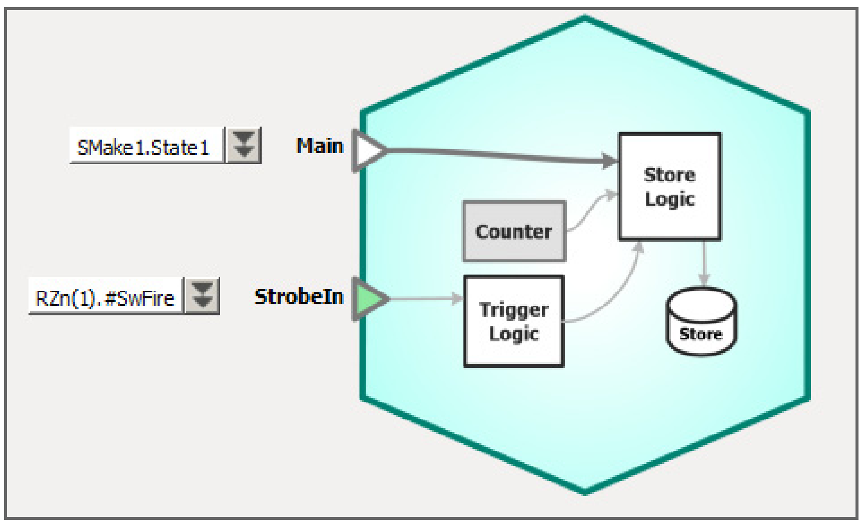
Strobed Data Storage

Epoch Event Storage

The Epoch Event Storage gizmo stores timestamps and values when triggered. Supports single channel or multiple channel input.

Data stored:

Epoch	event value (optional) and timestamp



Epoch Event Storage Block Diagram

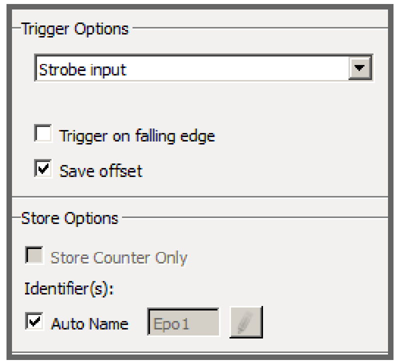
The Runtime Interface

Runtime Plot

An epoch plot is added to the runtime window for visualization that shows the timestamps and values of the stored events. See “Flow Plot” on page 66 for more information on using and customizing the plot.

Epoch Event Configuration Options

See “The Options Area” on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Storage Options

Trigger Options

By default, an internal timer stores timestamps at a regular interval. To use a gizmo input, select STROBE INPUT, then commit the change; this will enable the StrobeIn gizmo input so you can provide an external trigger source.

The VALUE CHANGE option stores a timestamp and value whenever the input value changes. If the input signal is multi-channel, then all channels will be stored whenever any channel values changes.

To invert the gizmo input trigger, select TRIGGER ON FALLING EDGE.

To save timestamps of the onset and offset of the trigger, select SAVE OFFSET.

Store Options

Check STORE COUNTER ONLY to ignore the Main input and store an incrementing counter value when the gizmo is triggered. This option is only available if the Main input is single channel.

If the Main input contains more than one channel, the additional channels are stored on the same timestamp and given unique identifiers in the data tank.

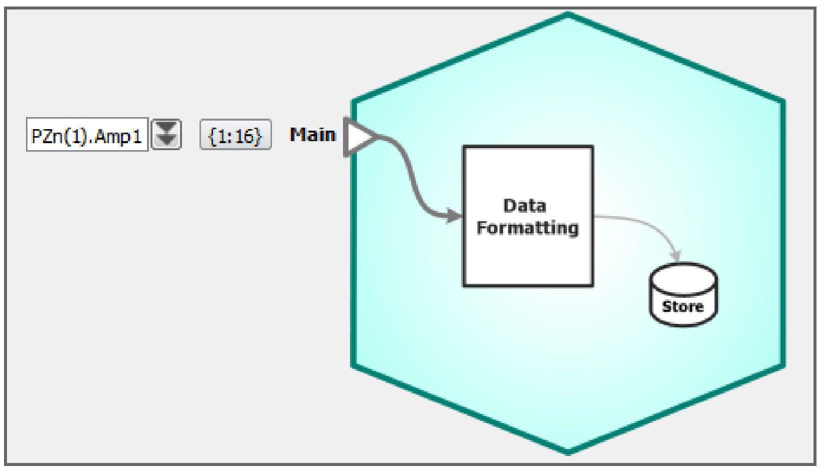
When using Auto Name, a "/" is appended to the name to indicate when the full epoc is stored (and is not when only saving the onset).

Stream Data Storage

The Stream Data Storage gizmo is a general purpose data streaming tool that includes options for data format and scaling.

Data stored:

Stream	raw or plot decimated continuous waveforms



Stream Store Block Diagram

This gizmo stores streamed data in the data tank. Raw waveforms can be saved as 16- or 32-bit floating point values or as integers. The plot decimated waveforms format (PlotDec-16) is a 16-bit representation of the waveform using maximum and minimum values and is used to visualize spike activity. This is not recommended for storing data streams.

A multichannel streamed plot is included in the runtime plot. There are no runtime controls for this gizmo, and it has no outputs available to other gizmos.

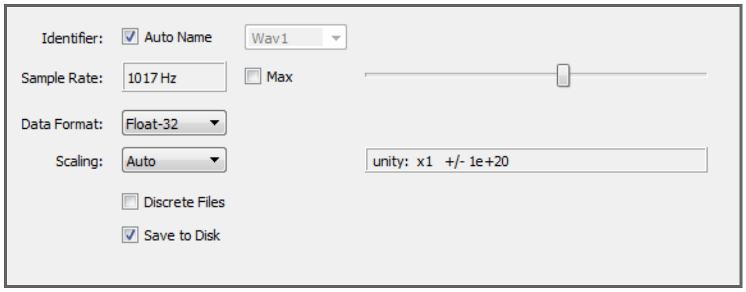
The Runtime Interface

Runtime Plot

See "Flow Plot" on page 66 for more information on using and customizing the plot.

Stream Storage Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



Storage Options

The Identifier is used to name the data store that is saved in the tank. It must be four characters in length.

Choose a specific Sample Rate for the data store, or set it to Max and it will run at the master device rate.

Choose the desired units to apply the appropriate scaling factor to the data.

Select DISCRETE FILES to save each channel of data as a discrete file (*.sev format) in the data tank.

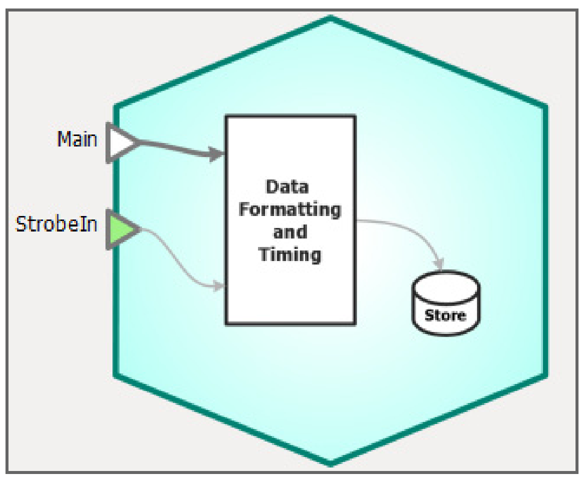
Clear the SAVE TO DISK check box to view data in the runtime plots without storing data to the Tank.

Strobed Data Storage

The Strobed Data Storage gizmo stores timestamps and associated event values when triggered. This can be a single value or a short segment of values stored at a specific sampling rate. This gizmo includes advanced runtime visualizations.

Data stored:

Scaler	scalar
Continuous	block waveforms



Strobed Data Storage Block Diagram

The Runtime Interface

Flow Plot

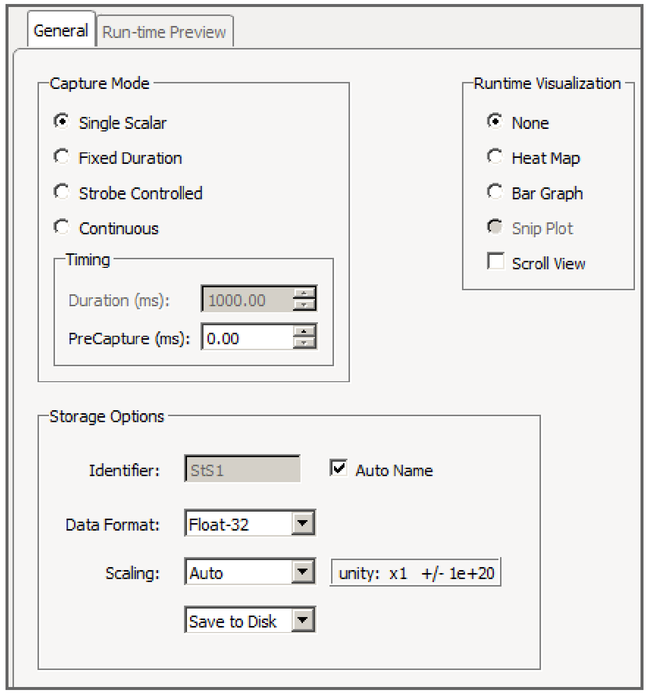
A strobe plot can be added to the Flow Plot for visualization. See “Flow Plot” on page 66 for more information on using and customizing the plot.

Runtime Visualization

Additional visualizations are available depending on the Capture Mode. See “Runtime Visualization” on page 293 for more information on using and customizing these plots.

Strobed Storage Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.



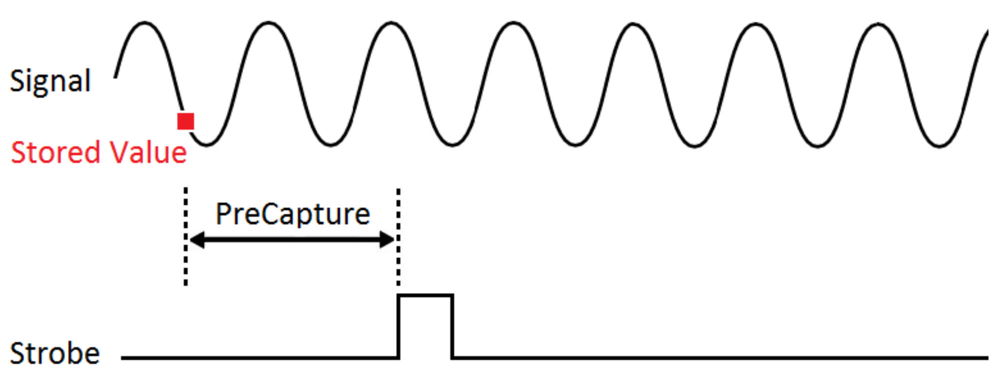
Storage Options

Capture Mode

The Timing and Storage Options have different meaning depending on which capture mode is selected.

Single Scalar

Single Scalar stores a single data point on the rising edge of the Strobe input. If you want to record the value at some fixed time before the trigger occurs, set PRECAPTURE (MS). The timestamp stored in the data tank will also be delayed by this amount.

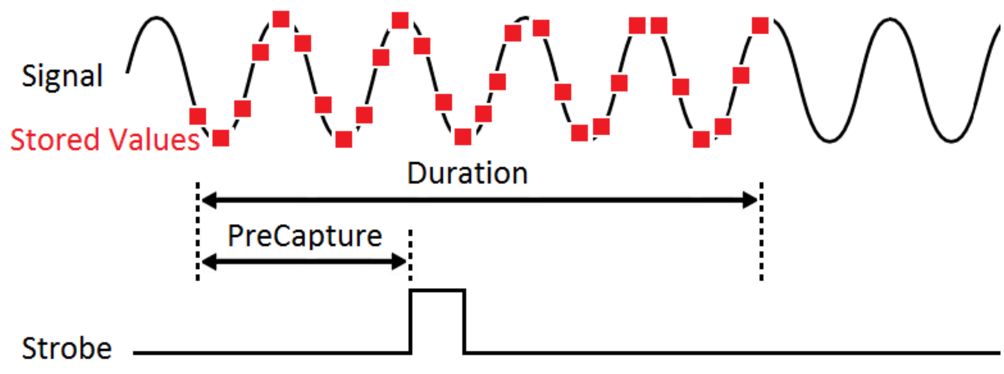


Single Scalar Timing Diagram

Fixed Duration

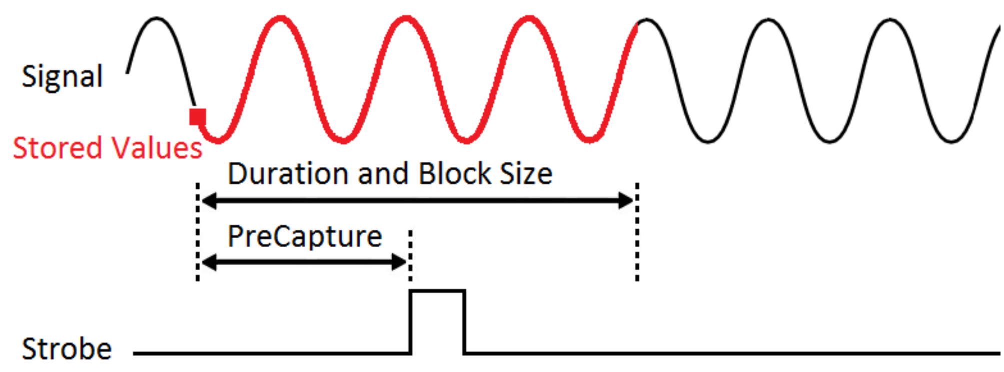
Fixed Duration stores a fixed number of points on the rising edge of the Strobe input. Set the desired sampling rate of the acquired data. The format of the data stored into the tank is optimized automatically for you depending on the sampling rate.

If the rate is below 10 Hz, each stored data point will have a timestamp and value (Record Type Scalar).



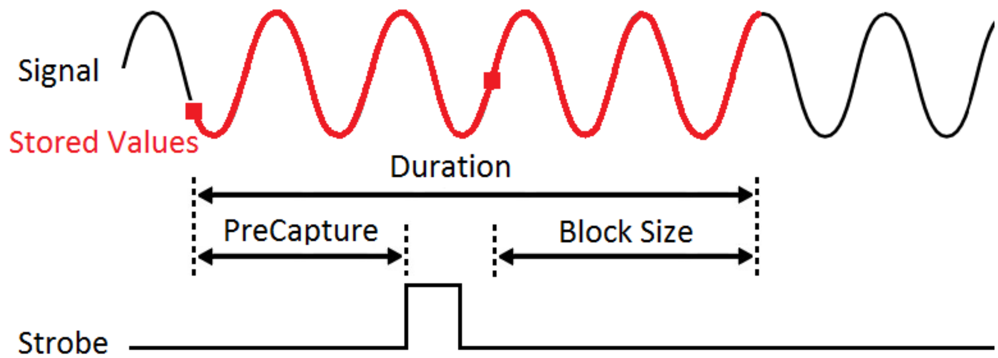
Fixed Duration Scalar Timing Diagram

If the rate is 10Hz or above, the data is recorded in short blocks (Record Type Block) that include a single timestamp and chunk of points, determined by the BLOCK SIZE setting.



Fixed Duration Block Timing Diagram

If the duration is longer than the optimized maximum block size, the recordings are broken up into smaller blocks, determined by the BLOCKS PER CAPTURE setting. The diagram below shows two sub-blocks.

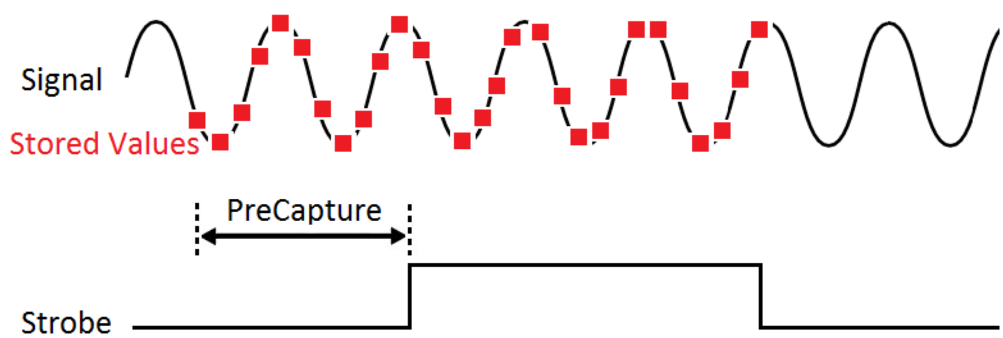


Fixed Duration Sub-Block Timing Diagram

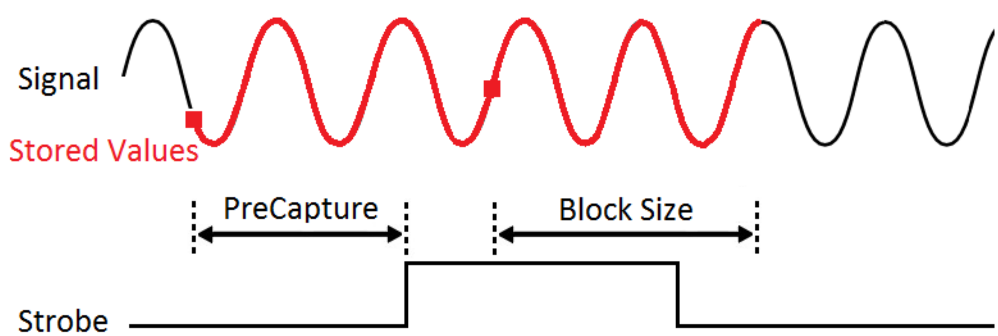
All of the automated settings in the STORAGE DETAILS options are designed to optimize data transfer from the hardware back to the PC. You can override these defaults by checking the STORAGE DETAILS box, though this is not typically recommended.

Strobe Controlled

Strobe Controlled stores values only when the Strobe input is high. The sampling rate determines the record type (Scalar or Block).



Strobe Controlled Scalar Timing Diagram



Strobe Controlled Block Timing Diagram

When the record type is Block, the last recorded sample will typically be beyond the end of the strobe because the Block Size is always fixed while the Strobe input duration can be variable.

Continuous

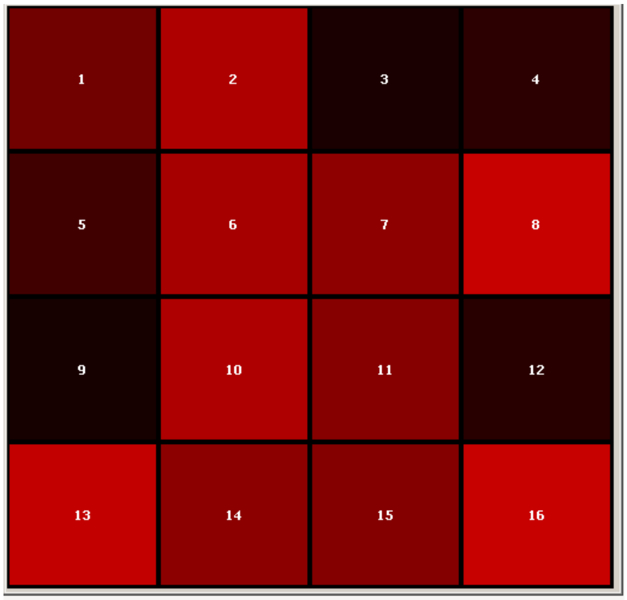
In Continuous mode, the Strobe input is ignored and data is continuously recorded into the tank at the specified sampling rate. For high sampling rates of continuous data above 30Hz, the Stream Data Storage gizmo is recommended instead.

Runtime Visualization

Choose what type of plot(s) to see at run time.

Heat Map

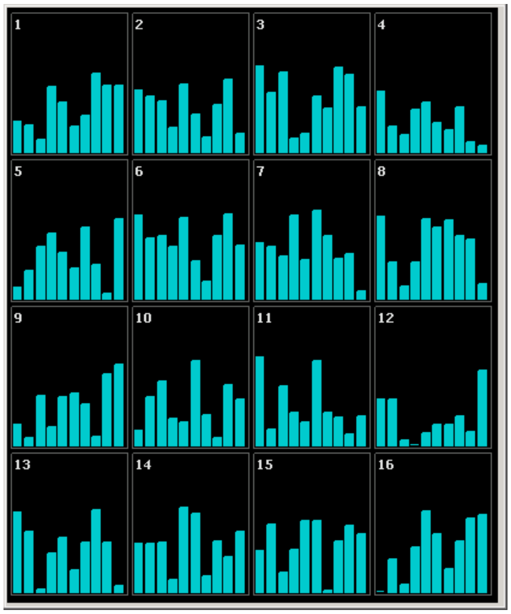
For Single Scalar values, display a grid with value mapped to color intensity.



Heat Map

Bar Graph

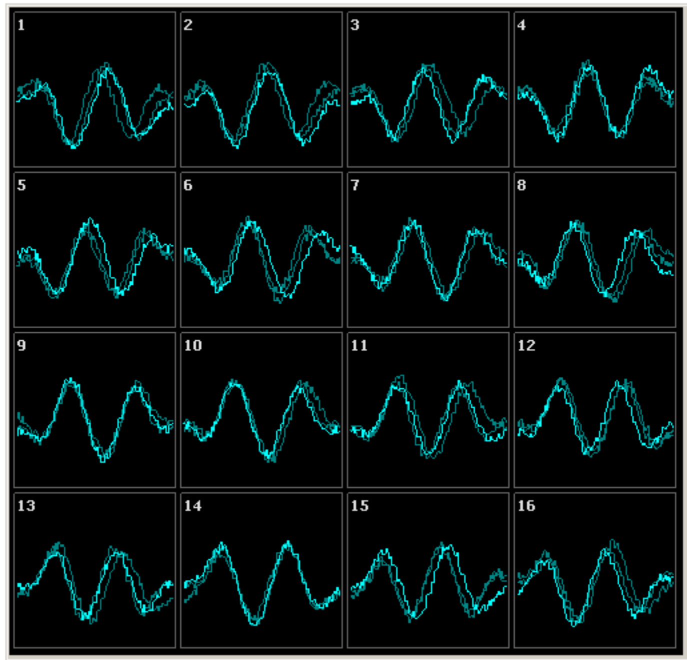
For Single Scalar values, display a bar graph of the previous N values.



Bar Graph

Snip Plot

For Fixed Duration storage, plot the previous N waveforms and highlight the current waveform.



Snip Plot

Flow Plot View

Select this to also show the corresponding data store in the Flow Plot window.

Visualization

View real-time data.

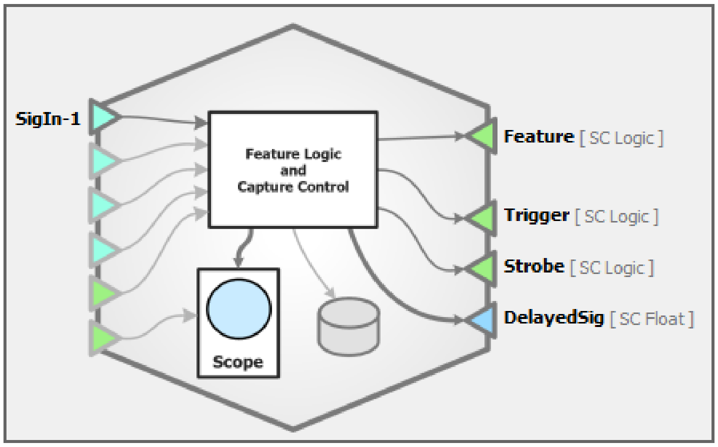
The Visualization gizmo group includes:

Oscilloscope

Oscilloscope

The virtual oscilloscope gizmo has all the functions of an oscilloscope plus flexible trigger design tools for triggering, using more complex waveforms. Triggering is implemented on the hardware and in real-time. The gizmo's user interface provides a view into what's happening and includes controls for adjusting the signal feature threshold(s). The oscilloscope works well for simple threshold and store tasks and is an excellent tool for closed loop triggering.

Data stored:	
Epoch (optional)	feature state
Epoch (optional)	on all conditions met
Strobe waveform (optional)	on all conditions met
Key Features:	
Runtime control	timing and threshold
Threshold detection	manual and auto
Outputs:	
Feature state	logic
Trigger (on all conditions met)	logic
Strobe (on all conditions met)	logic
DelayedSig	float



Oscilloscope Block Diagram

The gizmo supports up to four channels of input and includes several outbound logic signals, a waveform output, and an internal data store as shown above.

The Runtime Interface

Runtime Plot

At runtime, the standard Synapse data plot is available to display any stored data. The gizmo can save epoch events when the selected feature is true and/or when the required condition passes. A snippet waveform capturing the oscilloscope plot window to disk can also be saved when triggered. These stores are selected in the oscilloscope configuration options. See "Flow Plot" on page 66 for more information on using and customizing the plot.

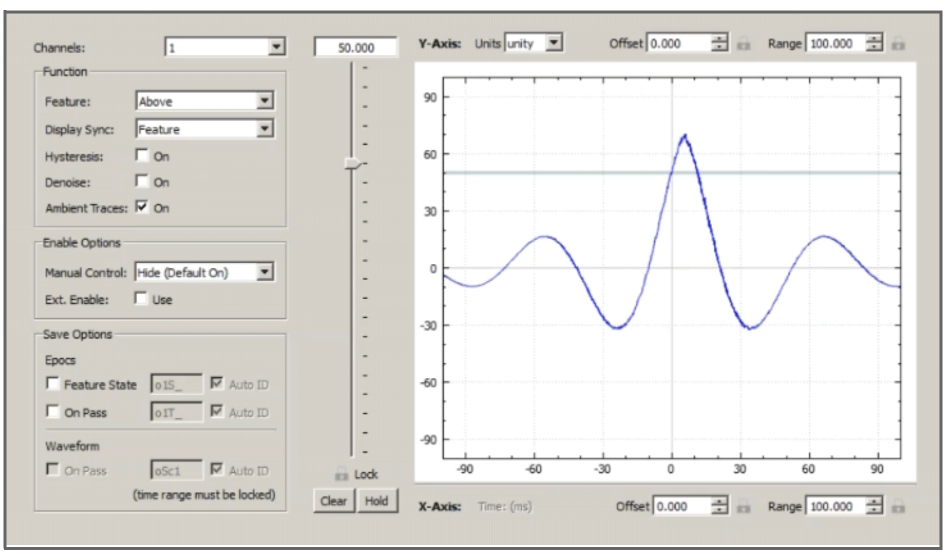
Oscilloscope Plot

The runtime oscilloscope plot must be configured in the Edit mode options before it can be used. Its use and features are nearly identical to the preview plot available in Edit mode. It allows you to modify or lock threshold, range, and offset at runtime. **Important!:** Oscilloscope is unique in that the runtime changes modify the experiment setup. Any changes you make to the plot configuration at runtime are available at designtime and vice versa.

Oscilloscope Configuration Options

See "The Options Area" on page 26 and page 59 for more information on the gizmo name, source, global options, and displaying the block diagram.

In edit mode, the oscilloscope gizmo displays a simulated waveform alongside the gizmo options. This interface expedites setting the feature and triggering options.



oScope Options Area

Channels

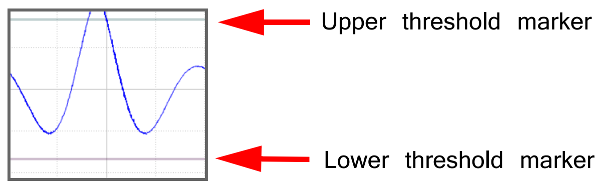
Up to four channels can be input. Only one channel can be used for feature detection at a time, but when conditions are met, all channels get stored (when WAVEFORM is selected).

Function

Feature

A standard threshold detection method is used to determine when a signal of interest is present. By default, the FEATURE is ABOVE, and the image is synced to the feature state, just like an oscilloscope. That is, the threshold crossing is set as X=0 and the X and Y axes are set to the defined range.

Feature Type	Description
Above	signal is above the threshold
Below	signal is below the threshold
Between	signal is between an upper and lower threshold (when selected a second threshold marker is added to the plot)
Outside	signal is outside an upper and lower threshold (when selected a second threshold marker is added to the plot)
Rising	signal is rising
Falling	signal is falling



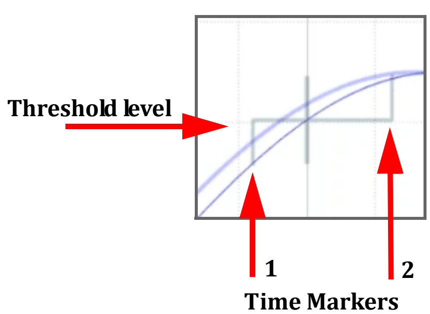
Display Sync

The Display Sync determines how to align the waveform at X=0.

Feature	when selected feature is true
Ext Input	external input from another gizmo or digital input (defined in the block diagram)
None	not set, shows the free running traces (ambient traces)

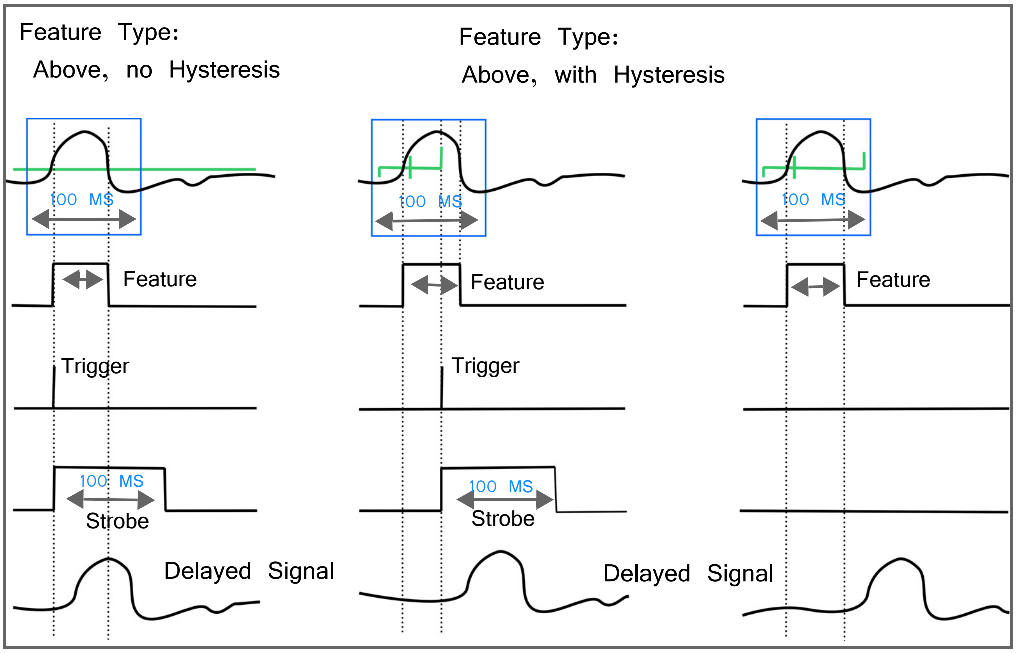
Hysteresis

To add temporal characteristics to feature detection, enable Hysteresis. The hysteresis marker replaces the default threshold marker. Two time markers are added on the x-axis and are controlled by sliders.



Hysteresis Marker

In the illustration above, the feature condition must be false for the time period between TIME MARKER 1 and the threshold crossing, and must be true between the threshold crossing and TIME MARKER 2 to pass all conditions. If it passes, the Trigger output pulses high for one sample. If it does not pass, the candidate waveform is displayed as a thick light blue line.



Feature and Triggering Diagram

As shown in the diagram above, when a Hysteresis is used, the signal must meet all conditions or no trigger is fired.

The Delayed Signal output is shown at the bottom. When there is no Hysteresis, this signal is delayed by range + offset, so you are always looking at the waveform window when the Strobe is high. When you do use a hysteresis, the delay is the range + offset + time marker 2.

Denoise

DENOISE adds a fixed three sample debounce to prevent spurious feature detections in a noisy signal. The feature must be true for 3 samples to register as a valid event.

Ambient Traces

the AMBIENT TRACES option show all traces even the ones that don't meet feature conditions. They are shown as thinner lines. If you don't have any signals meeting the feature conditions, viewing ambient traces can show where you need to set the threshold.

Enable Options

The Enable Options determine the state of the manual controls at runtime. When the controls are on an ENABLE button is added to the runtime window. When present, it must be selected to enable the Trigger and Strobe outputs.

When the option is set to hide (default on), the Trigger and Strobe outputs are enabled (On), but the button is hidden. For more on the Strobe and Delayed Signal outputs see "Storing Outputs" below.

Save Options

Epocs

Feature State	store the Feature state on/off timestamps. Feature state remains true/high (1) as long as the Feature condition is met.
On Pass	store the Trigger timestamp. Trigger fires once when all conditions are met, including any hysteresis.

Waveform

On Pass	store the plot snippet when feature conditions are met.

Storing Outputs

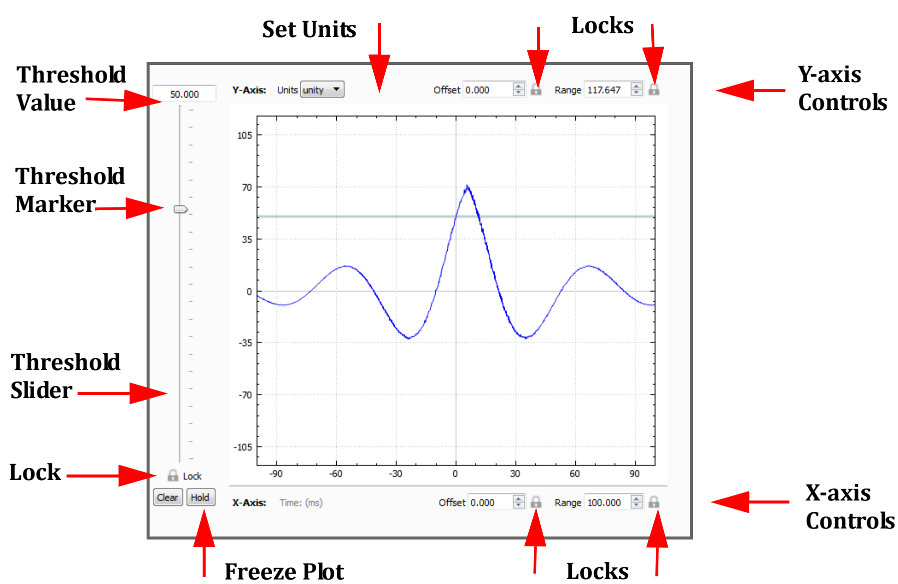
You can also pass the oscilloscope outputs (seen in the block diagram) to storage gizmos.

If you wanted to save the waveform on pass, but didn't want to use a fixed x-axis window (range), you can send the Strobe and DelayedSig output to a Strobe store gizmo.

Strobe	Strobe starts when Trigger fires (all conditions are met) and remains high for the duration of the X-axis window (range).
DelayedSig	The DelayedSig output is a continuous waveform delayed by the X-axis range and offset, such that you can always store what you are seeing in the plot.

Preview Plot Options

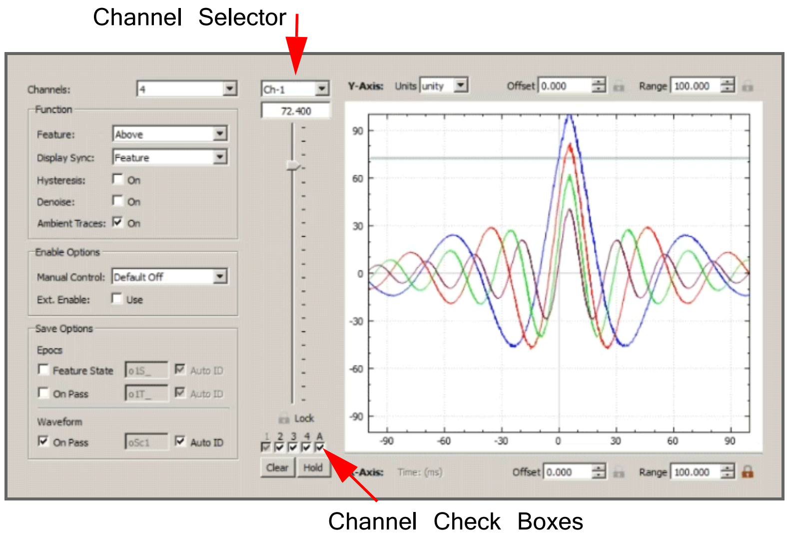
The plot area includes intuitive controls and provides immediate visualization of your changes. Drag the threshold marker along the slider to set a threshold.



Single Channel Preview Plot

Using Multiple Channels

When you use multiple channels, you can select which channel is used for detection by selecting from the drop-down menu located above the threshold slider. You can also choose which channels to display in the plot, using the channel number check boxes below the threshold slider.



MultiChannel Preview Plot

Check boxes for each channel are shown below the threshold slider. The grayed check box is the currently selected channel. Select additional numbered check boxes to show those channels in the plot.

Plot Controls

Move Offsets	click-and-drag
Y-axis Zoom	mouse-wheel
X-axis Zoom	Ctrl + mouse-wheel

Part Five: User Gizmos

Creating User Gizmos

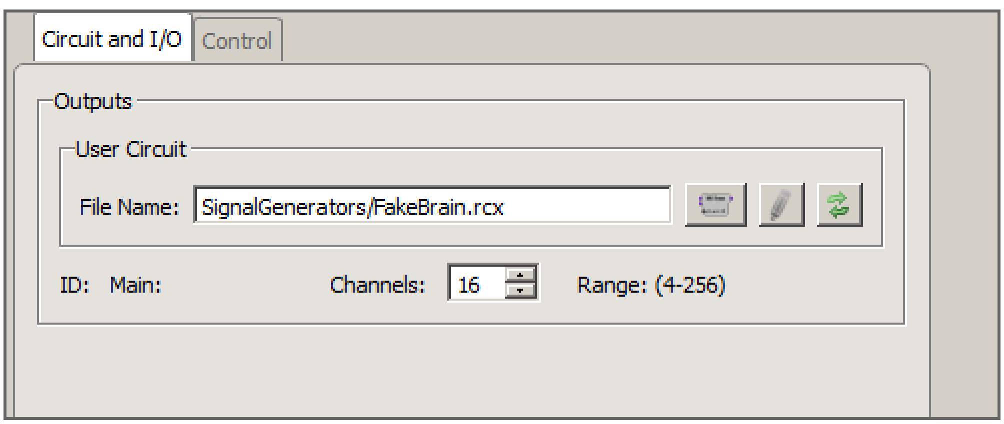
User gizmos are a class of gizmos which can bring customized processing tasks and user interfaces into Synapse. Any desired processing task that is not already defined in a provided gizmo can be created using user gizmos and then linked into the processing tree, just like any other gizmo.

User gizmo functionality is defined by 'circuits' that are designed in RPvdsEx software. The circuit defines what kind of inputs and outputs the user gizmo accepts and what type of user interface controls will display at designtime and/or runtime to dynamically modify parameters within that gizmo processing task.

Getting Started

Intro

User gizmos are *.rcx files created in RPvdsEx software. To add a user gizmo, add the NEW USER GIZMO in the Processing Tree. The user gizmo interface has two tabs, Circuit and I/O and Control.



Circuit and I/O Tab

On the Circuit and I/O tab, you can use the first button to the right of the File Name field to browse to an RCX file. Once selected, Synapse parses that file and updates the user interface with any available options, such as user selectable channel counts. If there are any designtime controls specified in the RCX file, they will appear on the Control tab.

The other two buttons on the right allow you to edit the currently selected RCX file in RPvdsEx, and reload the selected RCX file. If you make changes to the RCX file and save it, you must reload it so Synapse can parse it again.

For user gizmos that you want to make readily available in any experiment, place the RCX files in the UserCircuits folder of the Synapse installation directory (typically C:\TDT\Synapse\UserCircuits). Synapse reads this folder and displays the RCX files as gizmos in the Custom category in the Gizmos list so they are always available.

Creating Your Own User Gizmos

User gizmos are designed in RPvdsEx by adding components or macros (pre-made groups of components), linking them together in a logical order, and compiling them as an RCX file.

Prerequisites

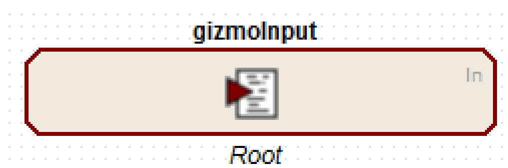
This tutorial assumes basic RPvdsEx knowledge of creating processing chains, working with macros and using parameter tags to read/write values dynamically.

Circuit Requirements

The user gizmo macros are available in the Components > Circuit Macros menu in RPvdsEx, or by clicking the  icon in RPvdsEx. There are three macros specific to Synapse user gizmo circuit design that are available in C:\TDT\RPvdsEx\Macros\Synapse\: **gizmoInput**, **gizmoOutput**, **gizmoControl**.

Inputs

Every user gizmo circuit must have at least one **gizmoInput** macro. If the user gizmo does not require a data source, for example: if you are designing a signal generator to be used as a data source for other gizmos, set the **gizmoInput** macro **Input Role** to 'Root'.



GizmoInput Macro

Each user gizmo can receive data from up to four data sources. For each data input into the user gizmo circuit you must add an additional **gizmoInput** macro and set the INPUT ROLE to one of 'Input-1' to 'Input-4'. The inputs must be sequential with no gaps in numbering. If the user gizmo requires at least one data source, you do not need a 'Root' **gizmoInput** macro in your circuit, 'Input-1' takes its place.

For each input data source you specify the allowed data type and channel count range so the Synapse compiler can properly connect it to other gizmos.

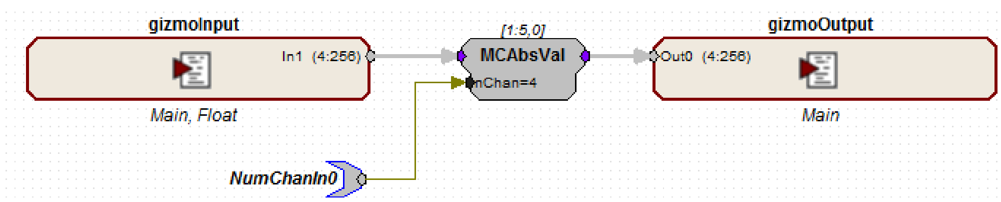
Outputs

A **gizmoOutput** macro is required if the user gizmo will be a data source for other gizmos. Up to four outputs are allowed in each user gizmo, named 'Output-1' to 'Output-4'. Each output requires its own **gizmoOutput** macro, where you specify the name, data format and allowed channel count range. The outputs must be sequential with no gaps in numbering.

You also set the output channel dependency. This can be 'Prompt' if the user gizmo is acting as a signal generator, which means the user will select the channel count at designtime, or you can link the channel count to one of the **gizmoInput** channel counts. For example, a user gizmo that does some custom filtering on a multi-channel signal would likely have an output channel count that matches the input channel count.

If you need to use the channel counts for the inputs/outputs in the processing chain, use specially named parameter tags. These parameter tags must be named **NumChanIn{n}** and **NumChanOut{n}** where n is 0, 1, 2, or 3, one for each of the four possible inputs and four possible outputs. Anything connected to one of these special parameter tags is given the value of the specified channel at compile time.

In the example below, the user gizmo is performing an absolute value operation on a multi-channel floating point data source and making the resulting signal available to other gizmos. It accepts between 4 and 256 floating point channels on the input. Here, the 'nChan' parameter of the MCAbsVal component will be replaced by the number of channels on the input data source when Synapse compiles this circuit into the processing tree. This ensures the MCAbsVal component will always have the correct number of channels.



Custom Absolute Value Gizmo Circuit

User Interface Widgets

If there are parameters in the processing chain that you want to control at designtime or runtime, or that you want to display to the user at runtime, you can specify a user interface widget and attach it to a specific parameter tag in your circuit.

Add a **gizmoControl** macro for any parameter tag that you want to display a user interface widget for. The **gizmoControl** macro determines whether this tag is read or write, what type of widget to display, when to display the widget (designtime or runtime), and other configuration options.

The parameter tag name must always be prefixed with "ID_". When Synapse compiles the processing tree, "ID" is replaced by the gizmo name. This allows you to use multiple instances of the user gizmo and prevents naming conflicts.

If any user interface widgets are specified to show at designtime, they will appear on the Control tab in Synapse. Any that show at runtime will have their own tab in the runtime interface. The controls will be organized alphabetically by parameter tag name on the runtime screen based on window size.

Removing Unused Components

It is important to keep circuit design in your user gizmos as efficient as possible. If you're unable to us multi-channel components and must instead use an iterate box in your circuit, you can dynamically remove unused components inside iterate loops by naming them "KILL~(x)".

Two-Sample Delays

Like all gizmos, user gizmos add a two sample delay to the processing path. This is particularly important to keep in mind for tasks where timing is critical. In cases where you have more than one signal or processing path, RPvdsEx delay components (such as: SampDelay, MCDelay) can be placed in a user gizmo to synchronize the paths.

Matlab Access

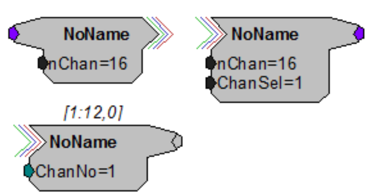
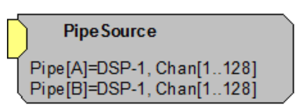
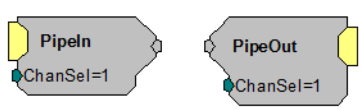
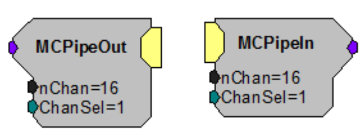
SynapseAPI can also be used to read and write parameter tags in the user gizmo circuit. The parameter tag name must always be prefixed with "ID_" to avoid naming collisions when multiple instances of the same user gizmo are used on the same device.

See the Synapse API Manual for more information.

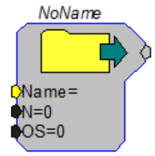
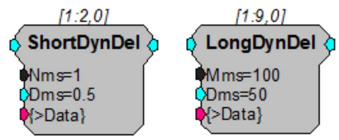
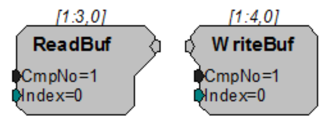
User Gizmo Do's and Don'ts

The following list of RPvdsEx components are not available in user gizmo circuits. Some may have alternatives.

Unsupported RPvdsEx Components

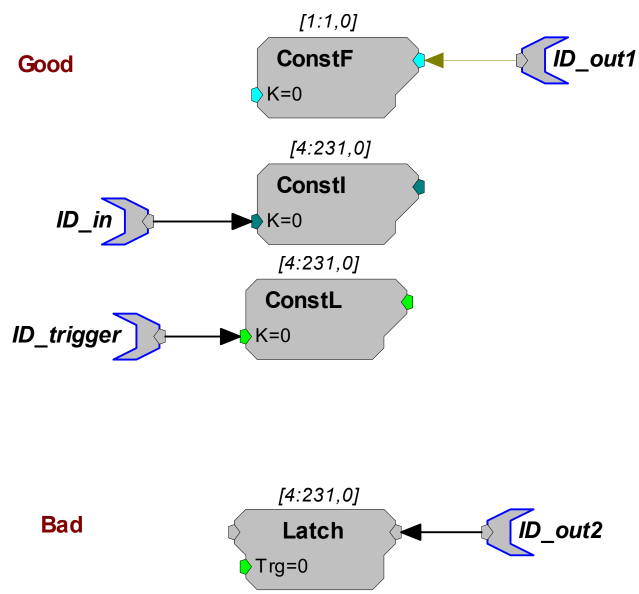
Component Name	Graphical Representation	Synapse Alternative
zHop Components		Use the gizmoInput / gizmoOutput macros to share signals between gizmos. The standard timing zHopIns from OpenEx (iTime, Reset and Enable) can be used in the circuit
MCzHopOut, MCzHopIn		
Pipe Components PipeSource		Use the gizmoInput macros to share signals between gizmos.
PipeOut, PipeIn		
MCPipeOut, MCPipeIn		
DSP Assign		Use DSP assignment option in gizmoInput macro to force a user gizmo to run on a specific DSP.

Unsupported RPvdsEx Components

Component Name	Graphical Representation	Synapse Alternative
SourceFile		Use Synapse API to load a buffer instead.
ShortDynDelay, LongDynDelay		None
ReadBuf, WriteBuf		None

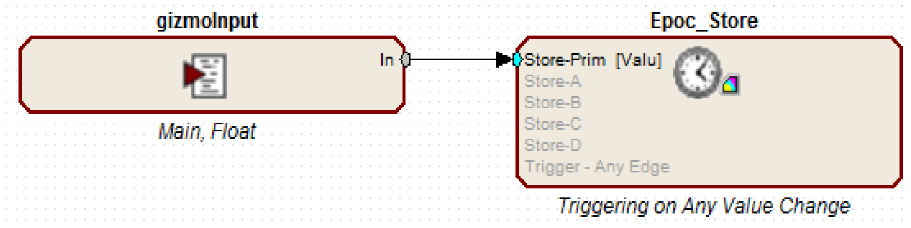
Parameter Tags

Parameter tags must be attached to a port that is typed (float, integer, logic). Do not connect a control tag to a gray non-typed port.



Legacy OpenEx macro support

The standard OpenEx macros can be used in user gizmos. All of the timing structures you need are included in the **gizmoInput** macro. The SpikePac macros are NOT supported in user gizmo - use their corresponding TDT Gizmo replacements instead.


gizmoInput
In
Main, Float
Epoc_Store
Store-Prim [Valu]
Store-A
Store-B
Store-C
Store-D
Trigger - Any Edge
Triggering on Any Value Change

Part Six: Cluster Processing

Cluster Processing with Synapse

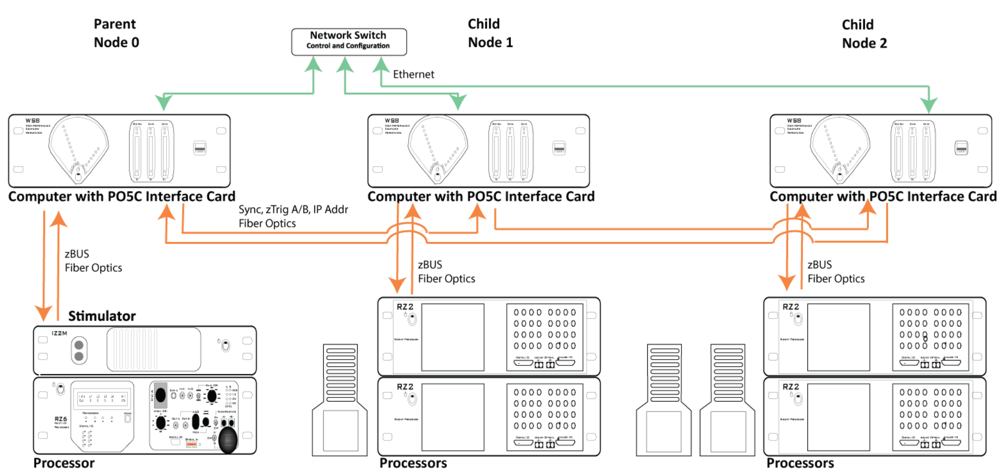
Overview

Cluster Processing is Synapse's solution for research that demands higher channel-count recordings or more processing power. Cluster Processing:

- Eliminates data bottlenecks
- Delivers more PC processing power for data visualization
- Overcomes zBUS bandwidth limitations
- Enables separation of stimulation and recording components, while remaining synchronized

Multiple complete systems, including System 3 hardware and computer, are networked and synched to a single system clock from which acquisition is triggered. This allows a single experiment to be distributed across multiple systems with one system serving as a "parent" node and the other systems as "child" nodes. This is accomplished using PO5C interface cards installed in each system PC. A switch on the card sets the parent/child role for the PC and its related hardware.

The parent node is always node 0. Synapse must be installed and running on all nodes. The PO5C includes a standard zBUS fiber Optic port and a second port that connects the cluster PCs in a "daisy-chain" fashion, delivering clock and trigger signals as well as system IP Address. Once in Cluster mode, The Rig Editor and Processing Tree on the parent computer become tabbed objects. Each tab configures a different node. The operational mode, such as Record or Preview, is controlled on parent node 0 during an experiment.



Cluster Processing Overview Diagram

The network connection is used to send experiments to the child nodes and report status to the parent node.

Setting Up Cluster Computing

Installation

Synapse with Cluster Computing must be installed on each computer that will be used as a node in the cluster.

To launch in Cluster mode, add "/cluster" to the command line path. For example: C:\TDT\Synapse\Synapse.exe /cluster.

PC Requirements

All PCs must have an Ethernet, network connection and a PO5C System 3 interface card installed.

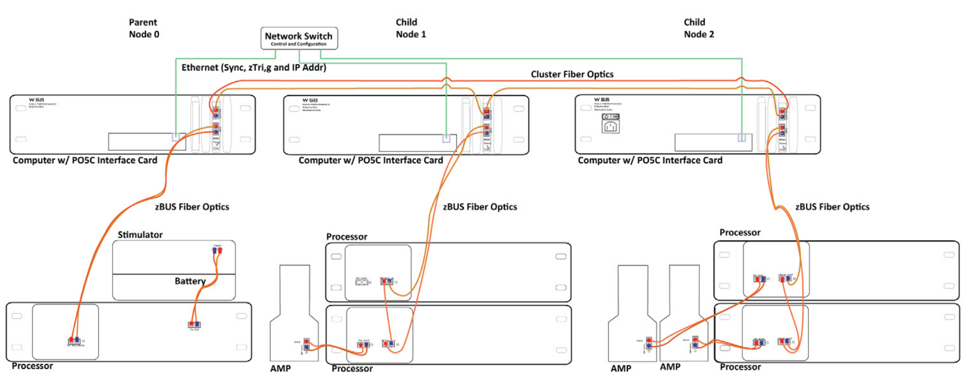
TDT Hardware Requirements

Each node in the system must be a complete system with computer, interface card, and connected RZ processor.

Hardware Configuration

When configuring your hardware, begin by connecting each individual node as you normally would for a single system. See the System 3 Installation Guide for detailed instructions. When the connections within the node are complete, you will connect the nodes together using the CLUSTER fiber optic ports on the PO5C cards as shown in the diagram below.

Connect Node 0 output to Node 1 input and Node 1 output to Node 2 input and so forth and then connect the final node output back to Node 0 input. After all fiber optic connections are complete, connect each node's Ethernet port to a shared network.



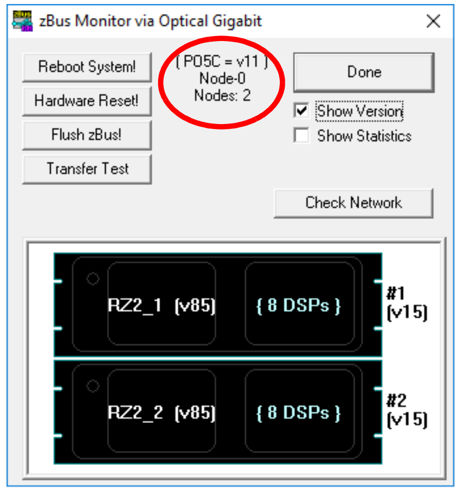
Cluster Computing Hardware Connection Diagram

Each node's role is determined by the parent/child switch on the PO5C card. The switch settings must match the node's position in the chain with Node 0 being the only Parent.

You can confirm that the cluster is correctly configured using the zBUSmon utility.

To launch the utility:

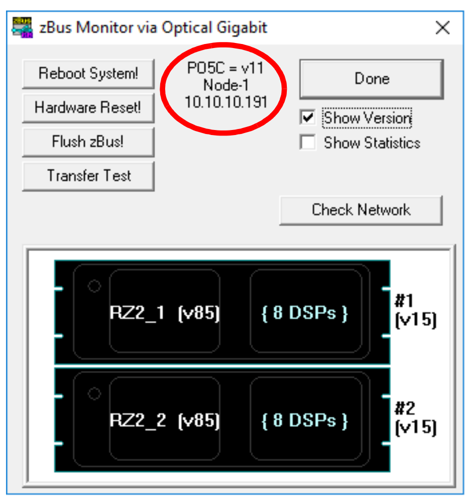
1. Click the zBUSmon shortcut on the parent desktop.
2. Repeat for each child computer.



zBUSmon on Parent Node

Parent Node Interface Display

Interface Card and Version
Node number
Number of nodes



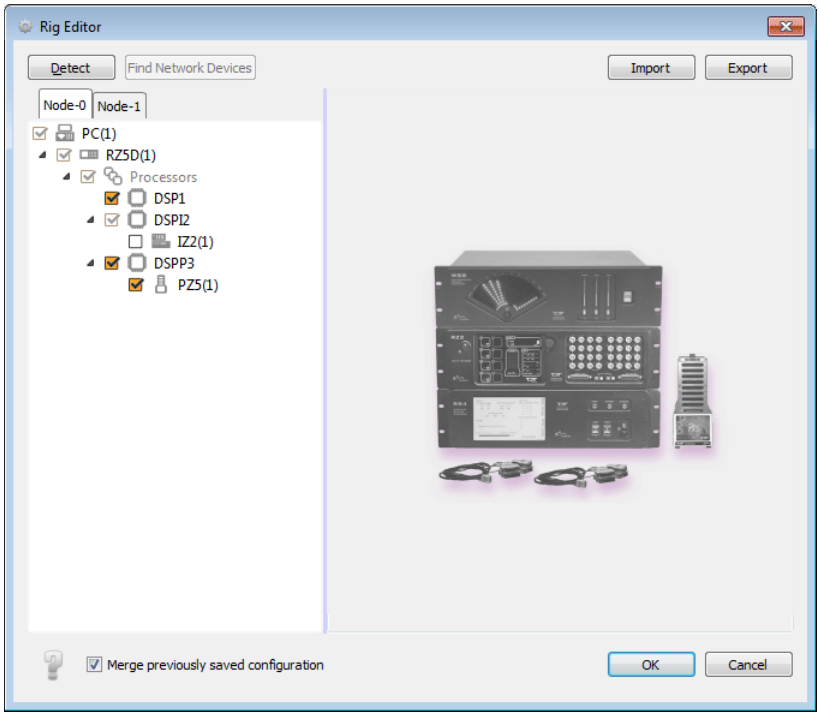
zBUSmon on Child Node

Child Node Interface Display

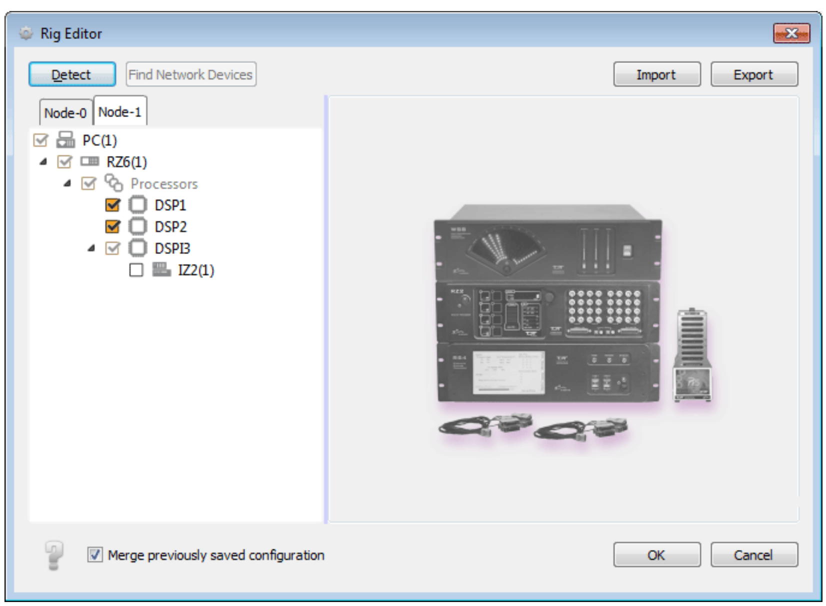
Interface Cord and Version
Node number
IP address of Parent (Synapse running on parent node)

The Rig

The Rig Editor is accessed and used much the same in Cluster Mode. If multiple nodes are connected, a tab will be added to the Rig Tree for each node.

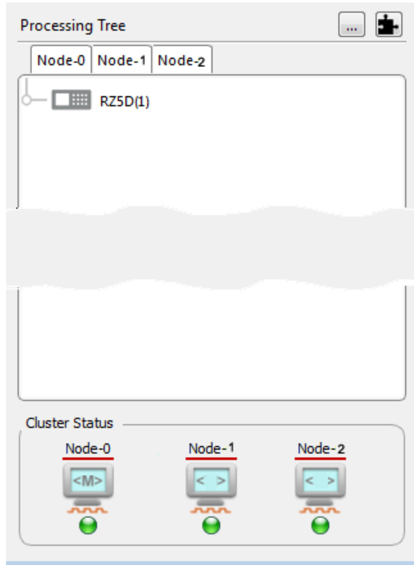


Rig Editor: Cluster Mode, Node 0



Rig Editor: Cluster Mode, Node 0

Processing Tree



Processing Tree in Cluster Mode

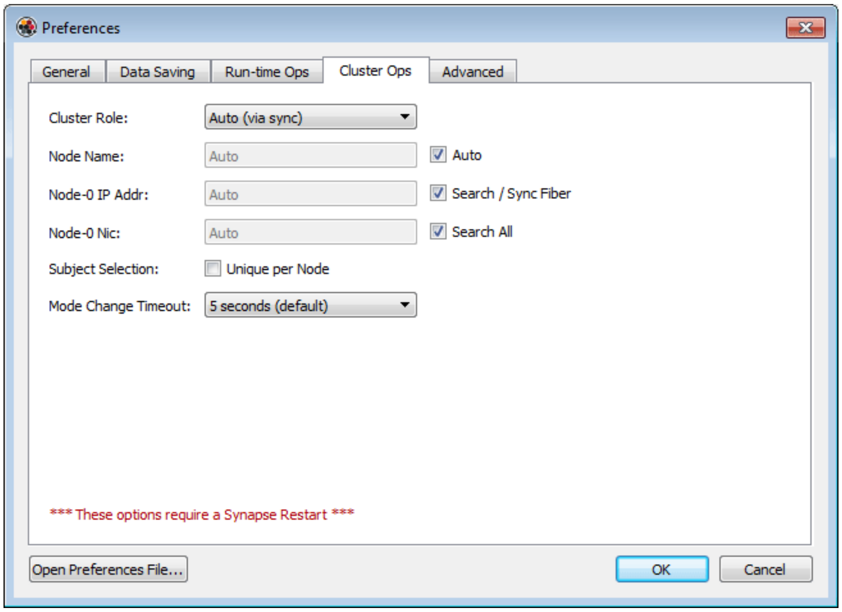
In Cluster mode, the Processing Tree is comprised of a tab for each node—the computer and connected System 3 devices. The experiment is designed using the node 0 computer. Here, you can see the hardware available in each node and use gizmos to create a processing tree for each node.

At the bottom of the Processing Tree pain, icons are displayed for each node. If a node has been previously defined and is not currently connected, the missing asset is shown in gray and the corresponding tab is disabled. The icon also includes indicators for synchronization and connection status. (orange squiggly)

Every COMMIT compiles not only the parent experiment but also the child experiments. If that is successful, the child experiments are pushed to the child nodes and imported. The import status from all children is returned to the parent.

Preferences

In Cluster Mode a Cluster Ops tab is added to the Preferences dialog box. On this tab, you can chose to manually set the parent/child roles and the name, IP Addr, and Nic for node 0. You can also set the length of the Mode Change Timeout.



Preferences Dialog, Cluster Ops Tab

By default, the user, experiment and subject are common across all nodes. The Subject Selection check box allows you to make the subject different for each node. This is particularly useful when running multiple subjects in a single recording session.

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