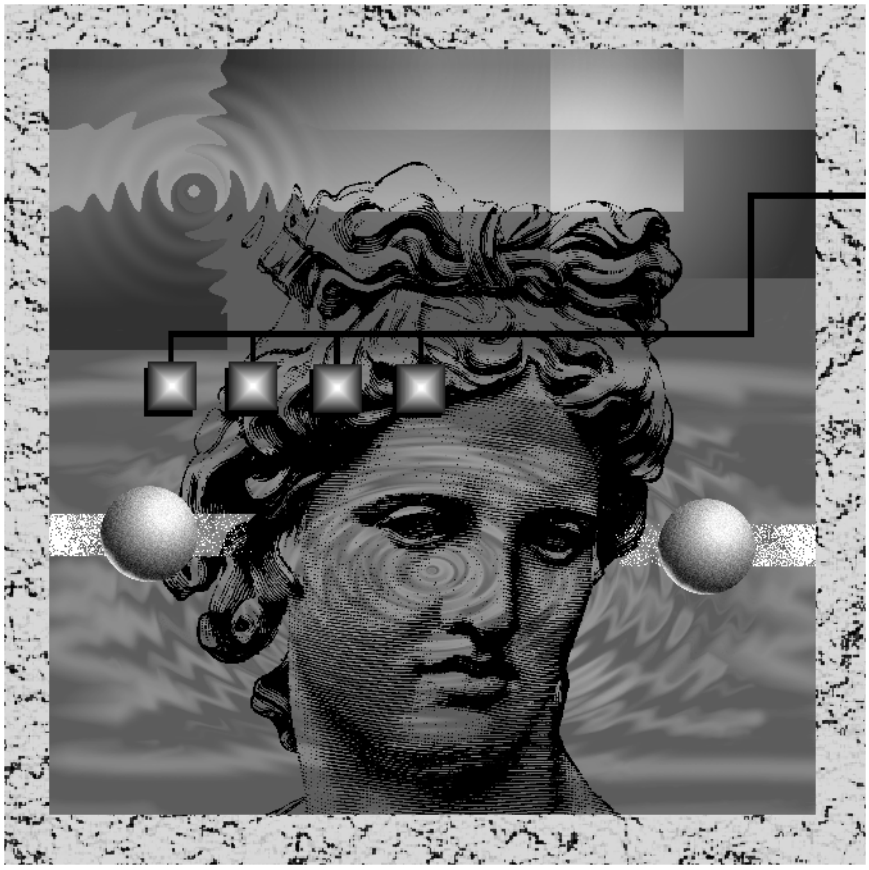
BioSigRP



User's Guide

BioSigRP User's Guide – Version 4.4

Contents

Preface

Software Philosophy

TDT's philosophy on software development is simple. We design comprehensive drivers that control all aspects of the hardware from circuits developed in a drag-and drop circuit design environment. With minimal programming, scientists can design customized experiments. This approach works quite well in most research environments. However, there has been an increasing demand for an interactive environment that allows the auditory researcher to design custom signals, present stimulus signals, and gather response data. In response to this need, TDT has raised its approach to software development to a higher level by designing two powerful and flexible software packages, *SigGenRP* and *BioSigRP*. SigGenRP offers a signal generation environment that is above the level of 'C' or Pascal programming. It is a complete stimulus design application that is the basis for a suite of TDT programs specifically developed for auditory research. BioSigRP provides the user with an easy-to-use, yet flexible, means for presenting stimulus signals and collecting response data.

Traditionally, systems designed to present stimulus signals and acquire response signals have been of two types: turn-key clinical systems and custom systems written from scratch. With turn-key systems, type and frequency of stimulus signals are restricted. Such systems are good for clinical settings, but are too restricted for research. Custom systems, while providing the ability to control all aspects of stimulus presentation and data acquisition, often require tedious hours spent programming and debugging software. Because BioSigRP utilizes custom signals generated in SigGenRP, it allows users to design and present complex stimulus signals without writing a line of code.

As with all software applications, SigGenRP and BioSigRP have their inherent limitations. For this reason, TDT still maintains as its highest priority continued support of its software drivers.

Organization of the Manual

The *BioSigRP User's Guide* is divided into three parts:

- Part 1 BioSig Fundamentals
- Part 2 Illustrative Examples
- Part 3 Appendix

BioSig Fundamentals

Part 1, BioSig Fundamentals, presents all the basic BioSig concepts necessary to present a stimulus signal and acquire data. It also serves as a general reference tool. Part 1 provides:

- General information about BioSigRP.
- Basic information about BioSigRP's features.
- A detailed explanation of data acquisition and processing.

General Information

General Information includes a description of the purpose and uses of BioSigRP, BioSigRP installation instructions, and basic BioSig concepts. General information is presented in the following chapter:

- *Chapter 1* Introduction

Basic Information

Basic information about BioSigRP's features is provided in the following section:

- *Chapter 2* Learning the Basics

Data Acquisition and Processing

The steps required to acquire and process data are listed below along with their associated chapter.

	Step	Chapter
1.	Configure the system	*Chapter 3* Configuration
2.	Present the stimulus and acquire response data	*Chapter 4* Data Acquisition
3.	Analyze data	*Chapter 5* Data Analysis

Illustrative Examples

Some typical examples of data acquisition and processing are presented in:

- *Chapter 6* Quick Start Examples
- *Chapter 7* Advanced Examples

Appendix

Information for System II users is presented in:

- *Appendix A* Using BioSigRP with System II

Part 1 BioSig Fundamentals

Chapter 1 Introduction

Welcome to BioSigRP, TDT's windows-based stimulus presentation and data acquisition package.

What Is BioSigRP?

BioSigRP is a powerful, yet easy-to-use, tool designed to automate the process of presenting stimulus signals and acquiring response signal data. BioSigRP is part of a suite of TDT applications designed to work with System 3 hardware and files generated by TDT's signal design software, SigGenRP.

BioSigRP for Windows

BioSigRP for Windows was created for today's preferred PC environment. It combines the advantages of Windows support with the advanced capabilities of TDT's System 3 hardware. BioSigRP uses standard Windows techniques for saving and loading files, selecting parameters, and printing.

BioSigRP Capabilities

BioSigRP is especially designed to meet the needs of auditory scientists. BioSigRP's capabilities include:

- SigGen file support
- System calibration
- Stimulus schedule customization
- Dual-channel stimulus
- Multi-channel response
- Artifact rejection
- Averaging
- Stimulus schedule override
- Historical data display
- Comparison data
- Calculator
- Displays
- Cursors
- Report generation

SigGen File Support

BioSigRP takes advantage of the powerful signal generation capabilities of TDT's SigGenRP. BioSigRP reads SigGen files (*.sig* files) and uses the signal parameters stored in these files to generate stimulus signals over successive SigGen Indices (SGIs).

System Calibration

BioSigRP's System Calibration window provides a means for calibrating your system through use of a pure tone or through use of the actual stimulus signal. Microphone effects may be removed to determine the true frequency characteristics of the system.

Stimulus Schedule Customization

The manner in which stimulus variables change as a function of the SGI is stored in the SigGen file. BioSigRP reads this information to determine the *stimulus schedule*. You may customize this schedule from within BioSigRP.

Dual-Channel Stimulus

BioSigRP allows you to present dual-channel stimuli. Each channel may be assigned its own SigGen file.

Multi-Channel Response

BioSigRP allows you to acquire up to four channels of response data.

Artifact Rejection

BioSigRP's *artifact rejection* provides a means for rejecting signals with anomalous amplitude values.

Averaging

BioSigRP maintains a running average as signals are acquired. BioSigRP allows you to view this running average. Averaging continues until the desired number of signals are acquired.

Stimulus Schedule Override

BioSigRP provides several command functions that allow you to manually override the stimulus schedule during stimulus presentation. These functions include: *Advance*, *Skip*, *Repeat*, and *ReDo*.

Historical Data Display

As averages are completed, resulting waveforms are displayed in an area of the screen known as the *History Plot* and are also appended to a file known as the *BioSig Record file* (*.arf* file).

Comparison Data

You may choose a record from the History Plot to serve as a comparison record.

Calculator

Through use of the *Calculator*, you may perform a variety of mathematical operations on acquired data.

Displays

You may view any record displayed in the History Plot in more detail. BioSigRP provides two detailed displays: a detailed *Time-Domain Plot* and a corresponding *Frequency-Domain Plot*. Additionally, you may *zoom-in* on any portion of either display.

Cursors

BioSigRP allows you to obtain information about instantaneous level at various points in time through the use of cursors.

Report Generation

You can generate custom reports consisting of historical signal data. The Worksheet area of the BioSigRP main window may be used to build these reports.

Hardware Support

BioSigRP supports TDT's System 3 instrumentation, including TDT's Real-time processors and programmable attenuators. BioSigRP also continues to support the System II hardware platform.

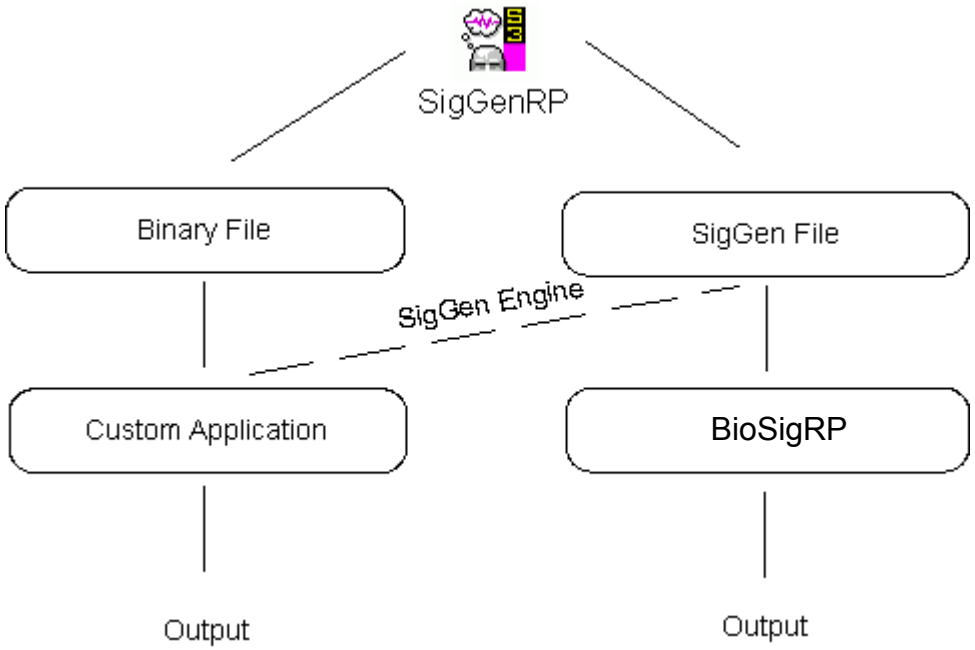
Who Can Use BioSigRP?

Anyone with a PC, Windows 2000 or higher, and TDT System II or System 3 instrumentation can use BioSigRP. BioSigRP was designed to meet the needs of auditory scientists requiring the use of complex stimuli without complex programming.

BioSigRP can be used to collect and analyze data such as auditory brainstem response (ABR) data and otoacoustic emission data.

How to Use BioSigRP

BioSigRP is used in conjunction with TDT's signal generation package, SigGenRP.



BioSigRP enables you to acquire and process bioelectric signal data in response to a customized stimulus signal. The process is as follows:

1. Design the stimulus signal using SigGenRP.

   TDT's signal generation package, SigGenRP, provides a simple, yet powerful, means for designing your stimulus signals. Signals generated with SigGenRP may be saved as SigGen files (*.sig* files) for use with other TDT signal processing applications, including BioSigRP.

2. Acquire and process response signal data using BioSigRP.

   BioSigRP is an easy-to-use tool for acquiring and processing response signal data. The process is relatively simple:

   a. Configure BioSigRP.

   b. Present the stimulus signal.

   c. Acquire response data.

   d. Analyze and process the response data.

Before You Begin

With a bit of preparation, processing signals with BioSigRP is quick and easy.

What You Need

See your Microsoft Windows documentation.

- Windows fundamentals

  You should be comfortable with Windows basics: starting Windows; using the mouse; manipulating windows; opening, closing, and saving files; and selecting items from a list.

See Digital Signal Processing Applications, Chapter 1.

- Signal processing

  A basic knowledge of signal processing is necessary. You should understand the parameters necessary for specification of a signal in the frequency and time domains.

See SigGenRP User's Guide, Chapter 2, "How to use SigGenRP."

- Basic SigGen concepts

  You should be comfortable with signal design using SigGenRP and should recognize the term SigGen Index.

Installing the Software

Requirements

In order to run BioSig, you must have the following:

- Computer running windows 2000 or higher
- TDT drivers (4.2 or higher)
- SigGenRP
- Super VGA (1024 x 768) resolution graphics (recommended)
- Two System 3 RPx devices (RP2, RP2.1, or Medusa amplifiers). RPx devices must be in the same caddie. (*See Appendix A for System II requirements.*)

Installation

To install BioSigPR

1. Make sure your TDT hardware is installed and functioning properly.

   Refer to the *System 3 Installation Guide*.

2. Insert the software CD in to your CD-ROM drive.
3. Click Install TDT drivers, click System 3, and click Install BioSigRP.

Hardware Configuration

BioSigRP uses System 3 hardware devices to acquire and average signals. System 3 hardware allows for increased flexibility in acquisition. Users and TDT can develop acquisition circuits for Oddball responses, MMN, P300, as well as generate Standard Deviations around the mean response. BioSigRP and SigGenRP allow users to view signal responses to complex stimulus patterns.

Note: To learn more about how to generate RCO files for acquisition in BioSig please contact TDT.

BioSigRP was designed to work with TDT's powerful and flexible System 3 hardware. All System 3 configurations must include two RPx devices:

- RPx device for acquisition (must have analog inputs)
- RPx device(s) for signal generation (must have analog outputs)

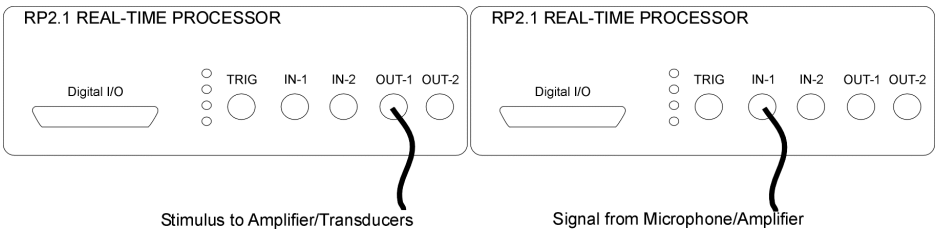
Note: all configurations must include separate devices for stimulus and acquisition.

The exception to the above minimum configuration requirements is a configuration for acquisition only, which may use an external trigger and does not require a separate RPx device for stimulation.

The minimum configuration may be expanded in a variety of ways. Below are examples of three configurations.

Minimum Configuration

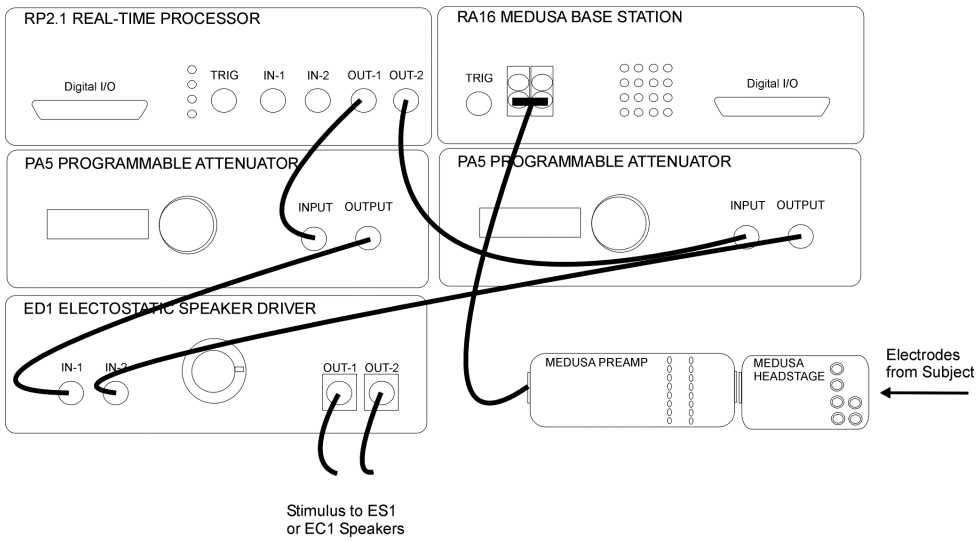
The minimum System 3 configuration is illustrated below. In this system two RP2.1s provide analog to digital and digital to analog conversion.



Typical ABR Configuration

Most systems require more functionality than that provided by the minimum configuration. A typical System 3 configuration for ABRs is illustrated below.

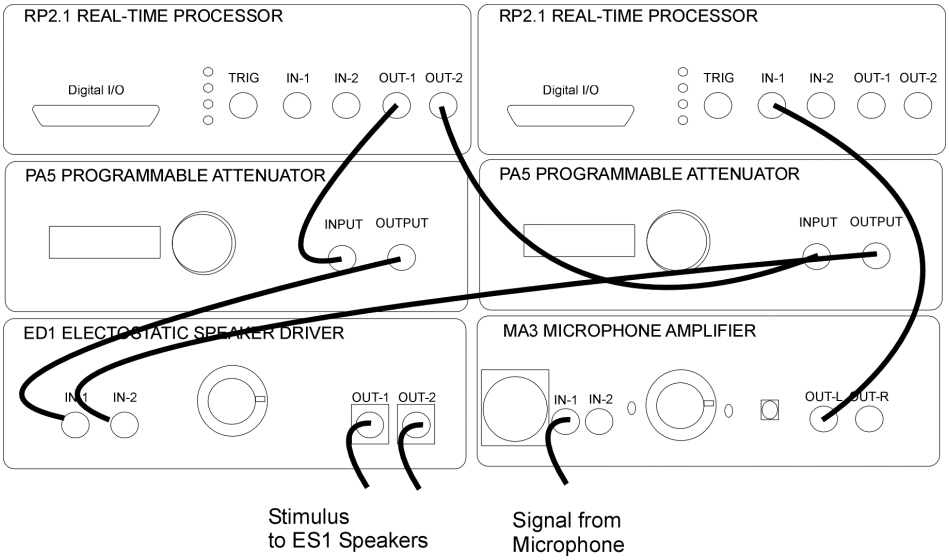
In this system an RP2.1 provides digital to analog conversion and an RA4Li or Medusa Base Station, Preamp, and Headstage provides data acquisition and analog to digital conversion. The two PA5s provide programmable attenuation for two stimulus channels. The ED1 drives TDT's ES1 or EC1 electrostatic speakers to present the stimulus. The HB7 Headphone Buffer or SA1 Speaker Amplifier can be substituted for the ED1 to support other transducers.



Typical DPOAE Configuration

A typical System 3 configuration for DPOAEs is illustrated below.

In this system one RP2.1 provides stimulus generation and another PR2.1 provides signal acquisistion. The two PA5s provide programmable attenuation for two stimulus channels. The ED1 drives TDT's ES1 electrostatic speakers to present the stimulus. The HB7 Headphone Buffer or SA1 Speaker Amplifier can be substituted for the ED1 to support other transducers, such as the ER2C. The MA3 provides amplification for the incoming signal.



Chapter 2 Learning the Basics

Getting Started

Starting BioSigRP

To start BioSigRP

- Double-click the BioSigRP icon.

  or

- Click the Start menu, point to Programs, point to TDT Sys3, and click BioSigRP.

  The BioSigRP main window opens.

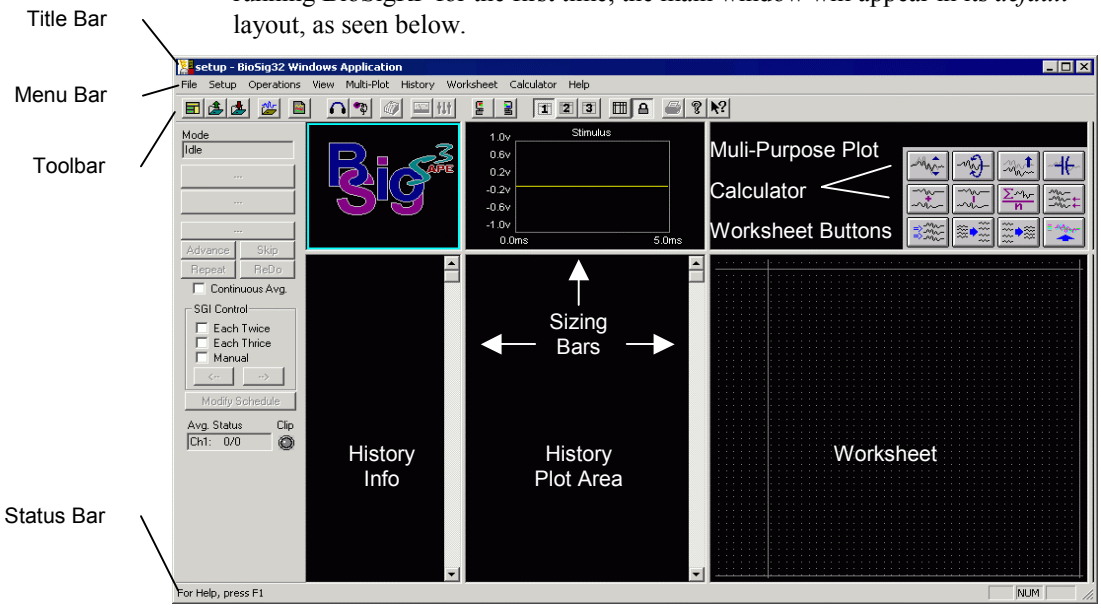
You are now ready to acquire data with BioSigRP.

Getting to Know the BioSigRP Main Window

BioSigRP's main window is designed to provide customizable visual displays of the stimulus signal, raw response signals, running averages, history data, and reports.

The Start-up Window

Upon starting BioSigRP, you will see the main BioSigRP window. If you are running BioSigRP for the first time, the main window will appear in its *default* layout, as seen below.



The window contains the following sections:

Title Bar Displays "BioSig32 Windows Application" and the name of the current BioSig file.

Menu Bar Contains a list of menus used for building, manipulating, and saving your BioSig file.

Toolbar Provides easy-to-use icons for the most common BioSig Menu commands.

Multi-Purpose Plot May be used to display a plot of the stimulus signal, the raw A/D signal, the FFT of the signal, the EEG signal, or the running average.

History Plot Area Is used to display historical, averaged signal data.

For a review of the SigGen Index (SGI) see the SigGenRP User's Guide.

Current Info Displays the current SigGen Index (SGI) plus variable names and their current values.

History Info Displays *Group* information. Responses obtained during the same data acquisition session are collectively referred to as a *Group*. Groups are automatically sequentially numbered. For each History Plot record, the names and values of variables are displayed.

Calculator Allows you to perform mathematical operations on one or more Worksheet record.

Worksheet May be used to store records for use in calculations and to build reports.

Sizing Bars Allow the user to resize each area of the screen.

Status Bar Provides information about the selected command.

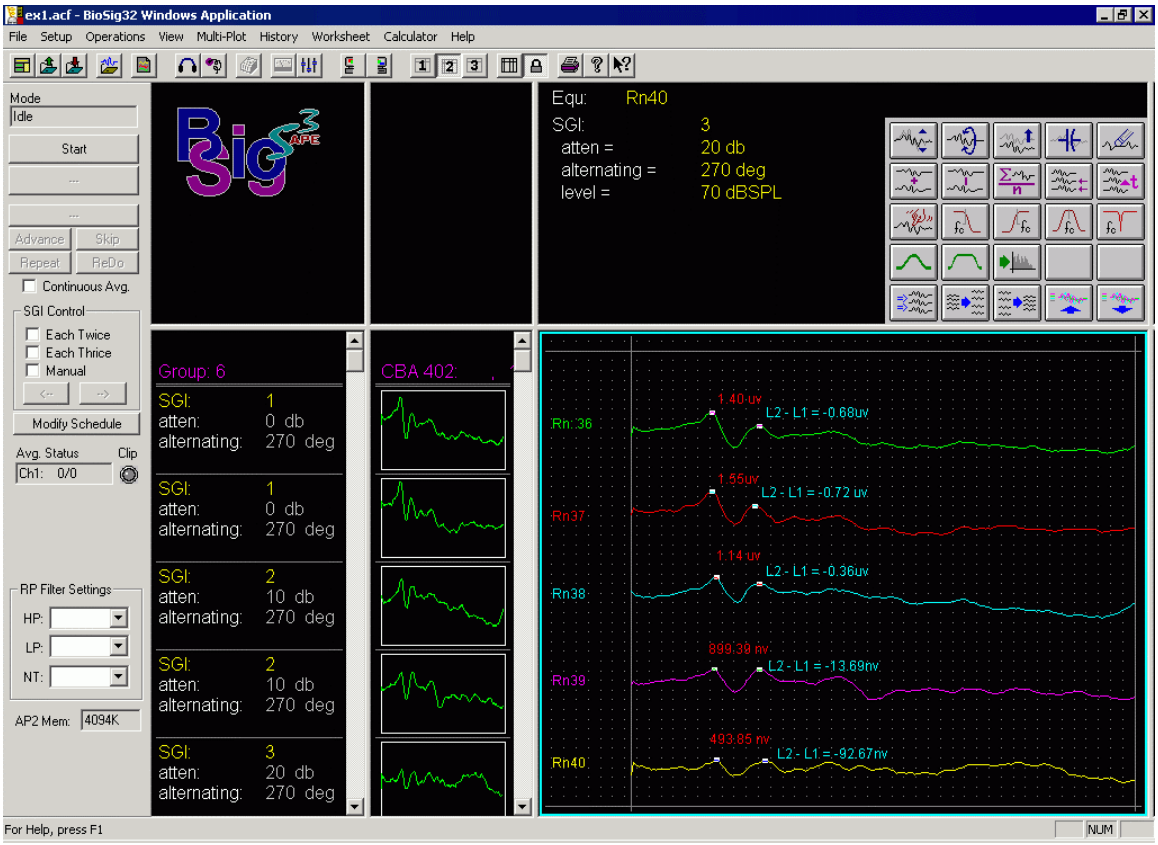
The Customized Window

BioSigRP provides numerous displays. Depending on your needs, you may wish to enlarge some displays and reduce others.

To enlarge/reduce a display area

➤ Drag the appropriate *Sizing Bar*.

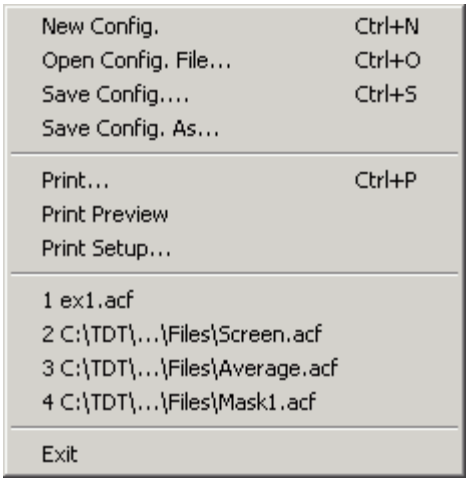
Below, the BioSigRP main window is configured to provide more room in the Worksheet area. The Calculator area has been expanded so that most calculator and worksheet buttons are visible.



Using the BioSigRP Menus

BioSigRP provides the user with a full set of menu commands. From these menu commands, you can create, open, and save files; customize screen displays; present stimulus signals; acquire response data; and analyze data.

The File Menu



The File Menu provides a standard Windows method for creating, saving, opening, closing, and printing files.

New Config. Resets all screen objects to their default states and clears all plots.

Open Config. File... Opens and displays an existing BioSig configuration file (*.acf* file).

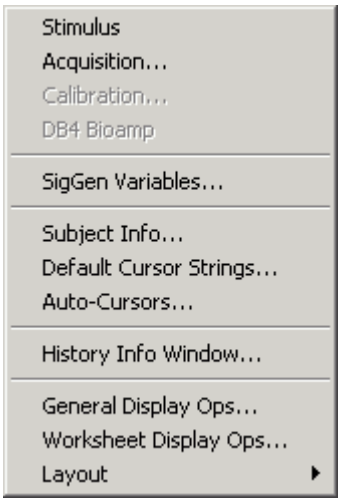
Save Config.... and **Save Config. As...** These menu options save BioSig configuration data in a BioSig configuration file. Files saved with this format use the default extension *.acf*.

Print... Prints the current Worksheet Area.

Print Preview Allows you to view the Worksheet Area as it will be printed.

Print Setup... Allows you to select a printer, define the paper size, and choose a page orientation.

The Setup Menu



From the Setup Menu, you can define stimulus and acquisition parameters, calibrate the system, schedule stimulus presentation, enter subject information, and customize the BioSigRP interface.

Stimulus... Opens the Stimulus Setup dialog box. From this box you can specify up to two SigGen stimulus signals and define presentation parameters.

Acquisition... Opens the Acquisition Setup dialog box, from which you can set timing parameters, define the default record file (*.arf* file), and configure up to four acquisition channels.

Calibration... Not currently supported.

DB4 Bioamp Not used for System 3.

SigGen Variables... Opens the SigGen Variable Control dialog box. From this dialog box, you can customize stimulus presentation.

Subject Info... Opens the Subject Information dialog box. This dialog box contains fields where you may enter identifying information for the subject.

Default Cursor Strings... Opens the Specify Default Cursor Text dialog box, from which you can customize cursor labels.

Auto-Cursors... Allows the user to specify the location of up to 10 cursors. These cursors will be automatically placed during data acquisition.

History Info Window... Opens the Info-Bar Setup dialog box, from which you can customize the History Info display area.

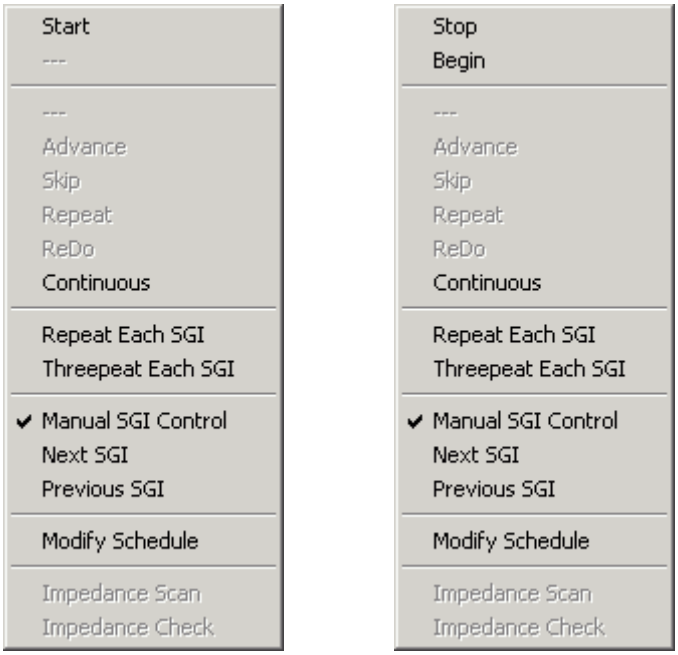
General Display Ops... Opens the General Display Options dialog box. From this dialog box, you may customize background colors, plot colors, text colors, and other display characteristics of the main window, Multi-Purpose Plot, and History Plot.

Worksheet Display Ops... Opens the Worksheet Display Options dialog box. From this dialog box, you may customize various display features of the Worksheet.

Layout Allows you to customize the screen layout.

> **Use #1, Use # 2, Use #3** Allow you to switch between three custom defined screen layouts.
>
> **To Default** Returns the screen layout to its initial, *default* layout.
>
> **Lock** Allows you to lock the current screen configuration.

The Operations Menu



Idle ***Running***

The Operations Menu provides a list of commands that control the presentation of the stimulus signal and the acquisition of response signals. Menu options vary, depending on the current operational mode. Operational modes consist of the following:

- ***Idle***
  No stimulus presentation or data acquisition.
- ***Running***
  Stimulus is being presented.
- ***Averaging***
  Response data is being acquired and averaged.
- ***Paused***
  Data averaging has been temporarily suspended.

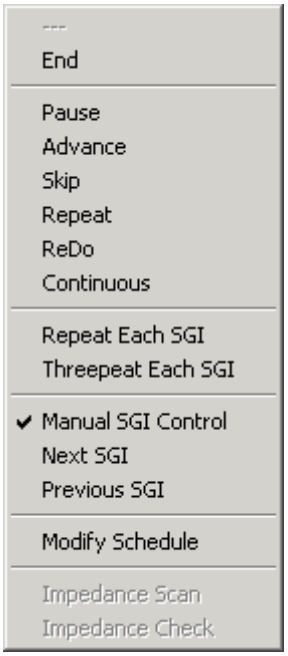
Start Begins the presentation of the stimulus signal. This menu option appears in Idle mode only.

Stop Discontinues the presentation of the stimulus signal. This menu option appears in Running mode only.

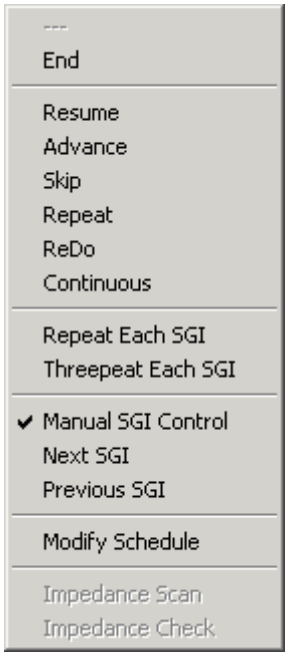
Begin Begins the process of data acquisition and signal averaging. This menu option appears in Running mode only.

End Discontinues data acquisition and signal averaging. This menu option appears in Averaging mode only.

Pause Temporarily halts data averaging. This menu option appears only in Averaging mode.



Averaging



Paused

Resume Resumes data averaging. This menu option appears only in Paused mode.

Advance Causes the stimulus to advance to the next SGI. This menu option is enabled in Averaging and Paused modes.

Skip Causes the stimulus to skip the current SGI. This menu option is enabled in Averaging and Paused modes.

Repeat Saves the current running average, re-presents the same stimulus, and saves the resulting averaged signal. This menu option is enabled in Averaging and Paused modes.

ReDo Discards the current running average, re-presents the same stimulus, and saves the resulting averaged signal. This menu option is enabled in Averaging and Paused modes.

Continuous Enables continuous data acquisition. BioSigRP will continue to acquire and average response data for the same stimulus until Continuous is disabled or the Advance, Stop, Repeat, ReDo, or End buttons are clicked.

Repeat Each SGI Acquires two averaged signals for each SGI specified in the stimulus schedule.

Threepeat Each SGI Acquires three averaged signals for each SGI specified in the stimulus schedule.

Manual SGI Control Enables the Next SGI and Previous SGI buttons and menu options. These buttons can be used to manually control the SGI.

Next SGI Advances the stimulus to the next SGI

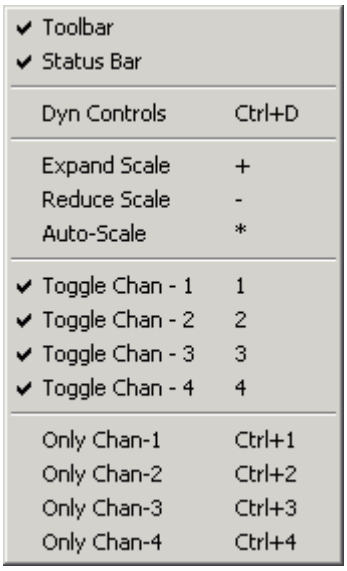
Previous SGI Moves the stimulus back to the previous SGI.

Modify Schedule Opens the SigGen Variable Control dialog box. From this dialog box, you can customize stimulus presentation.

Impedance Scan Not used with System 3.

Impedance Check Not used with System 3.

The View Menu



From the View Menu, you can turn various visual displays on or off.

Tool Bar Shows/hides the Tool Bar.

Status Bar Shows/hides the Status Bar.

Dyn Controls Displays all active Dynamic Control windows.

Expand Scale Expands the scale of the focus plot.

Reduce Scale Reduces the scale of the focus plot.

Auto-Scale Automatically scales the focus plot.

Toggle Chan - 1 Shows/hides Channel 1 on the *focus* plot.

Toggle Chan - 2 Shows/hides Channel 2 on the *focus* plot.

*Whenever you click in a plot area, that plot receives the **focus**. Focus is indicated by a thin frame of highlight surrounding the plot area. Plot commands affect the focus plot, only.*

Toggle Chan - 3 Shows/hides Channel 3 on the *focus* plot.

Toggle Chan - 4 Shows/hides Channel 4 on the *focus* plot.

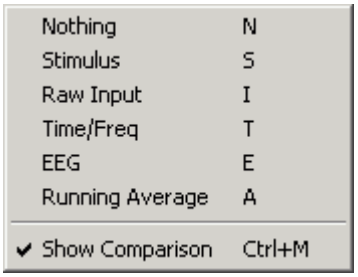
Only Chan-1 Shows only Channel 1 on the *focus* plot.

Only Chan-2 Shows only Channel 2 on the *focus* plot.

Only Chan-3 Shows only Channel 3 on the *focus* plot.

Only Chan-4 Shows only Channel 4 on the *focus* plot.

The Multi-Plot Menu



From the Multi-Plot menu, you can specify which signal you would like to display in the Multi-Purpose Plot.

Nothing Causes no plot to be displayed in the Multi-Purpose Plot.

Stimulus Causes the current stimulus to be displayed in the Multi-Purpose Plot.

Raw Input Causes one or more channels of raw (unprocessed) input signal to be displayed in the Multi-Purpose Plot.

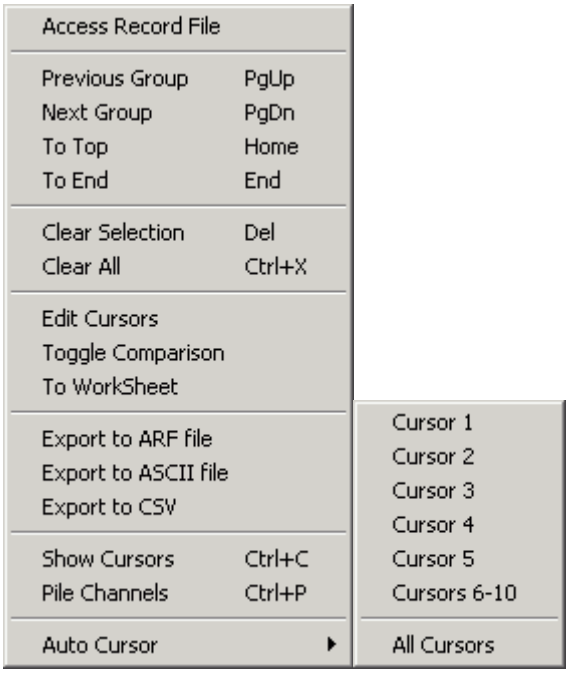
Time/Freq Performs an FFT on the incoming time-domain signal, producing frequency-domain response data.

EEG Causes one or more channels of EEG signal to be displayed in the Multi-Purpose Plot. EEG signals are created by applying the specified acquisition setup parameters to raw input signals.

Running Average Causes the running average to be displayed.

Show Comparison Causes the currently defined comparison plot to be displayed superimposed with the running average. Running Average must be selected in order to view the comparison plot.

The History Menu



From the History Menu, you can load history records and perform various operations on records displayed in the History Plot.

Access Record File Loads previously saved BioSig records from files known as BioSig record files. These files use the default extension, *.arf*. BioSig records are displayed in the History Plot Area.

Previous Group Scrolls the History Plot to the top of the previous group.

Next Group Scrolls the History Plot to the top of the next group.

To Top Scrolls the History Plot to the top.

To End Scrolls the History Plot to the bottom.

Clear Selection Clears all selected records from the History Plot.

Clear All Clears all records from the History Plot.

Edit Cursors Accesses the BioSig Cursor Edit dialog box. From this dialog box, you may place cursors and obtain signal information.

Toggle Cursor Marks the most recently selected history record for use as a comparison when viewing records details from the history area.

To Worksheet Allows you to place the most recently selected history record in the Worksheet.

Export to ARF File Saves the currently selected history records in a user-defined BioSig record file (*.arf* file).

Export to ASCII File Saves the currently selected history records in a user-defined ASCII file (*.txt* file).

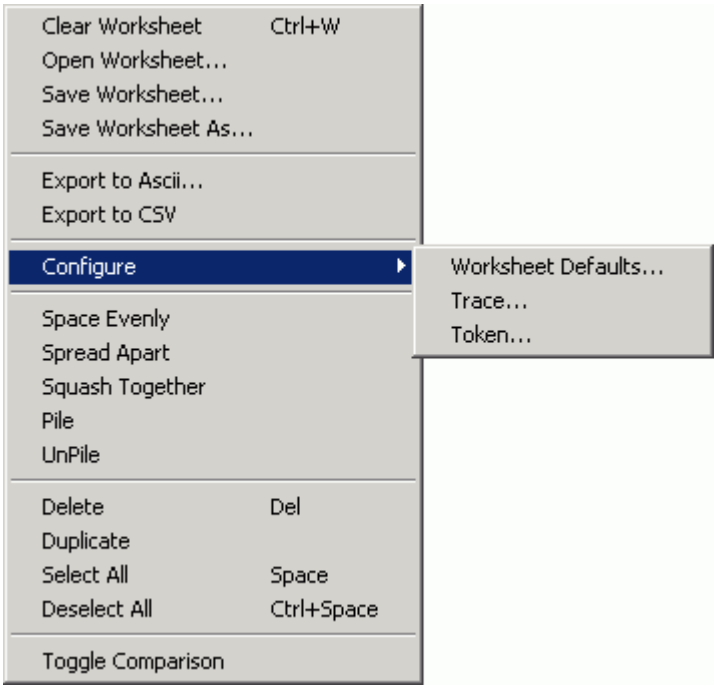
Export to CSV Saves the currently selected history records in a user-defined CSV file.

Show Cursors Displays any cursors placed in History Plot records.

Pile Channels Overlays multiple channel history data.

AutoCursor Applies the selected auto cursor to the selected history record.

The Worksheet Menu



Clear Worksheet Clears the entire Worksheet.

Open Worksheet... Opens a Worksheet file (*.awf* file).

Save Worksheet... Saves an existing Worksheet file.

Save Worksheet As... Save a new Worksheet file.

Export to Ascii… Saves the currently selected records in a user-defined ASCII file (*.txt* file).

Export to CSV Saves the currently selected records in a user-defined CSV file.

Configure

> **Worksheet Defaults...** Allows you to set Worksheet preferences such as colors, plot size, and grid resolution.
>
> **Trace...** Displays a message describing how to edit a trace.
>
> **Token...** Displays a message describing how to edit a token.

Space Evenly Spaces selected plots evenly throughout the Worksheet.

Spread Apart Spreads selected plots apart. Spread Apart may be used repeatedly. Each use continues to further spread apart all selected plots.

Squash Together Squashes selected plots together. Squash Together may be used repeatedly. Each use continues to further squash together all selected plots.

Pile Piles selected plots on top of one another.

UnPile Unpiles selected plots.

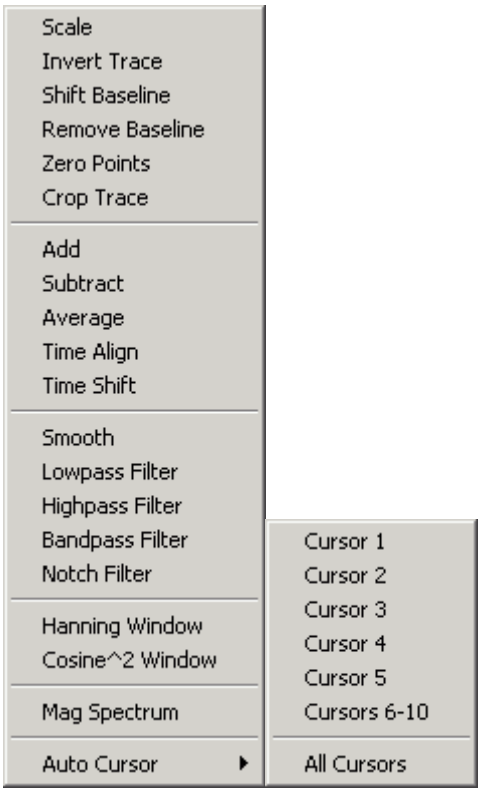
Delete Deletes the currently selected Worksheet records.

Select All Selects all Worksheet records.

Deselect All Deselects all Worksheet records.

Toggle Comparison Marks the most recently selected worksheet record for use as a comparison in the worksheet.

The Calculator Menu



The Calculator Menu provides mathematical operations that may be applied to one or more records displayed in the Worksheet.

Scale Multiplies each point in the selected Worksheet record(s) by a specified constant.

Invert Trace Multiplies each point in the selected Worksheet record(s) by -1.

Shift Baseline Creates a DC offset by adding a specified constant to each point in the selected Worksheet record(s).

Remove Baseline Removes the DC offset.

Zero Points Sets all points within a specified time range to zero.

Add Adds two or more Worksheet records.

Subtract Subtracts one Worksheet record from another.

Average Computes the average of two or more Worksheet records.

Time Align Aligns all selected records with the first record in the selected group.

Time Shift Shifts the selected Worksheet record(s) along the time axis.

Smooth Applies a smoothing algorithm to the selected Worksheet record(s).

Lowpass Filter Applies a low-pass filter to the selected Worksheet record(s).

Highpass Filter Applies a high-pass filter to the selected Worksheet record(s).

Bandpass Filter Applies a band-pass filter to the selected Worksheet record(s).

Notch Filter Applies a notch filter to the selected Worksheet record(s).

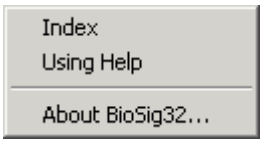
Hanning Window Generates a Hanning window for use with the magnitude spectrum.

Cosine^2 Window Generates a Cosine^2 window for use with the magnitude spectrum.

Mag Spectrum Does a FFT and generates a magnitude spectrum of the data.

AutoCursor Applies the selected auto cursor to the selected worksheet record.

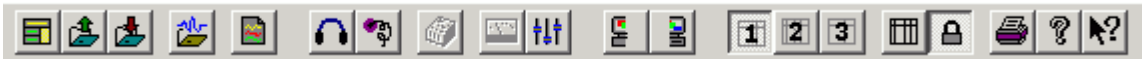
The Help Menu



From the Help Menu, you can access the About BioSigRP dialog box. On-line help is not available as of this version.

The Toolbar

On the BioSigRP Toolbar, you can find quick point-and-click access to the most common commands.



Click		To
	New	Clear all plots and reset BioSigRP to its default configuration
	Open	Open an existing BioSig file
	Save	Save a BioSig file
	BioSig Records	Load records stored in a *.arf* file
	Worksheet Records	Load an *.awf* file
	Setup Stimulus	Define stimulus parameters
	Setup Acquisition	Define acquisition parameters
	Setup Bioamp	Not used with System 3
	Calibrate	Not currently supported
	Modify Schedule	Modify the Stimulus Schedule

Click		To
	General Display	Configure general display fonts and colors
	Worksheet Display	Configure Worksheet display fonts and colors
	Setup #1	Switch the screen layout to #1
	Setup #2	Switch the screen layout to #2
	Setup #3	Switch the screen layout to #3
	Clear All	Clear all plots and screen areas
	Lock	Lock the screen layout
	Print	Print the current history plot
	Help	Access on-line help
	Context-Sensitive Help	Access context-sensitive help

*Whenever you click in a plot area, that plot receives the **focus**. Focus is indicated by a thin frame of highlight surrounding the plot area.*

The Plot Control Toolbar

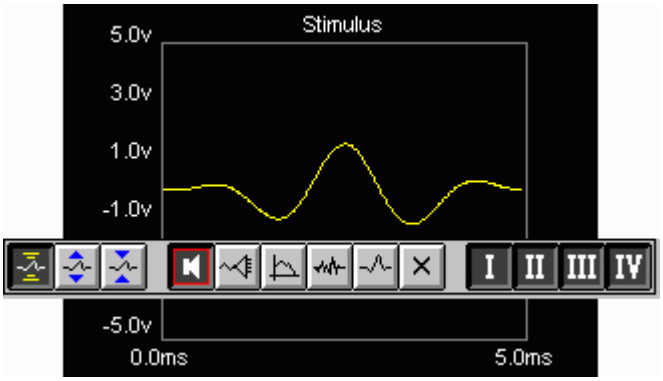
The various BioSigRP plot areas are controlled through the use of the *Plot Control Toolbar*. This toolbar is normally invisible.

The Plot Control Toolbar may be used to control the plot area that currently has the *focus*.

To display the Plot Control Toolbar

➤ Place the mouse pointer within the plot area of interest and hold down the right mouse button.

The Plot Control Toolbar will remain displayed while the right mouse button remains depressed.



To click a Plot Control Toolbar button

1. With the right mouse button depressed, place the mouse pointer above the desired toolbar button.
2. Release the right mouse button.

The button will be clicked. With the release of the right mouse button, the Plot Control toolbar will disappear.

Common Plot Control Toolbar Features

Scaling *Customization* *Channels*

The Plot Control Toolbar is customized for each BioSigRP plot area. However, there are certain common features found in all Plot Control Toolbars. Each toolbar consists of the following sections.

- Scaling Section
- Customization Section
- Channels Section

Scaling Section

Located on the far left of the Plot Control Toolbar, the scaling section consists of three buttons that may be used to alter plot scaling. These scaling commands may also be accessed from the View Menu.

Scaling buttons are mutually exclusive. That is, clicking one scaling button turns that function "on" and turns all other scaling functions "off." "On" buttons appear depressed.

Auto-Scale

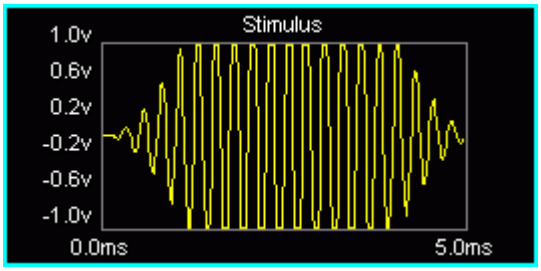
When Auto-Scale is chosen, BioSigRP will automatically scale the plot that currently has the focus.

To enable Auto-Scale

1. Access the Control Plot Toolbar.
2. Click  or press * on the numeric pad.

Expand Scale

Choosing Expand Scale causes the scale of the focus plot to expand. You may continue to expand the scale by repeatedly choosing Expand Scale.

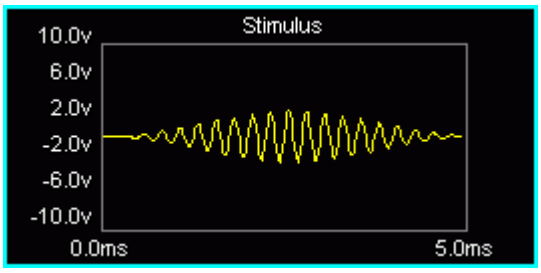


To expand the scale

1. Access the Control Plot Toolbar.
2. Click  or press + on the numeric pad.

Reduce Scale

Choosing Reduce Scale causes the scale of the focus plot to be reduced. You may continue to reduce the scale by repeatedly choosing Reduce Scale.



To reduce the scale

1. Access the Control Plot Toolbar.
2. Click  or press - on the numeric pad.

These functions are described in the sections "The Multi-Purpose Plot," "The History Plot," and "The Comparison Plot."

Customization

Each plot area has its own specialized plot control functions. Buttons controlling these functions are found in the center of the Plot Control Toolbar.

Channels

You may wish to display some or all channels in the current plot. Located on the far right of the Plot Control Toolbar, the channels section consists of four buttons that may be used to show/hide channels. These channel commands may also be accessed from the View Menu.

Channel buttons are independent. That is, more than one channel button may be "on" at one time. Channel buttons act like toggle switches. Clicking a button that is "on" turns it "off." Clicking a button that is "off" turns it "on." As with Scaling buttons, "on" buttons appear depressed.

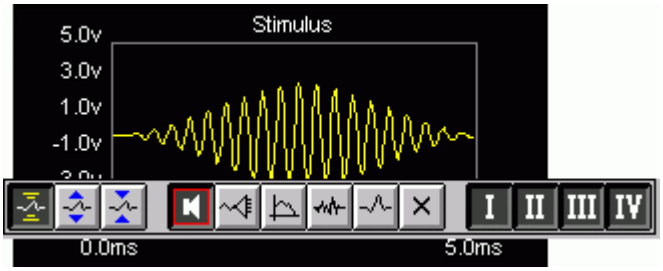
Channels are indicated in Roman numerals, I, II, III, and IV.

To show/hide a channel

1. Access the Control Plot Toolbar.
2. Turn the channel "on" or "off" by clicking its button.

Note: If none of the channel buttons are turned "on," no plot will be displayed. The plot area will appear blank.

Multi-Purpose Plot



The Multi-Purpose Plot may be used to display a variety of signals during stimulus presentation and data averaging. The plot is controlled through the use of the Plot Control Toolbar.

As with all other plots, you may control the scaling and channel display through use of the Plot Control Toolbar. Functions specific to the Multi-Purpose Plot are found in the center of the Plot Control Toolbar. These functions may also be accessed from the Multi-Plot menu.

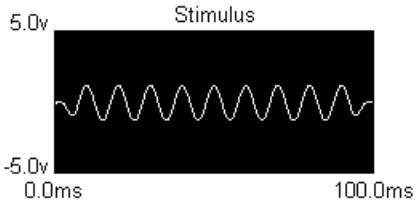
Types of Displays

The buttons located in the center of the Plot Control Toolbar control the Multi-purpose signal display. The Multi-purpose Plot may be used to display the following signals:

- ❑ ***Stimulus***
- ❑ ***Raw A/D***
- ❑ ***Frequency Domain***
- ❑ ***EEG***
- ❑ ***Running Average***
- ❑ ***None***

Plot display buttons are mutually exclusive. That is, clicking one display button turns that function "on" and turns all other display functions "off." "On" buttons appear depressed.

Stimulus

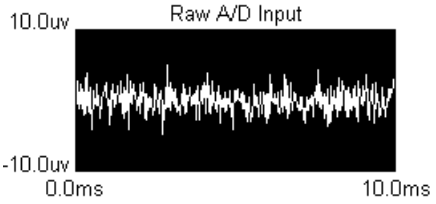


Choosing Stimulus causes the current stimulus signal to be displayed. BioSigRP allows up to two channels of stimulus output.

To display the Stimulus signal

1. Access the Control Plot Toolbar.
2. Click  or press 'S' on the keyboard.

Raw A/D

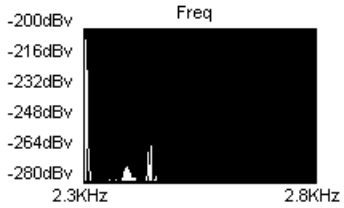


Choosing Raw A/D Input causes unprocessed A/D input to be display. Raw input is not affected by currently defined acquisition setup parameters such as gain (See *Chapter 3*).

To display the raw A/D signal

1. Access the Control Plot Toolbar.
2. Click  or press 'R' on the keyboard.

Frequency Domain

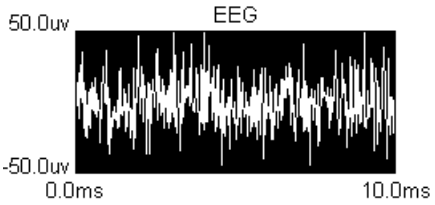


Choosing Frequency Domain causes the Multi-purpose Plot to display the A/D input in the frequency domain.

To display the frequency-domain A/D signal

1. Access the Control Plot Toolbar.
2. Click  or press 'T' on the keyboard.

EEG

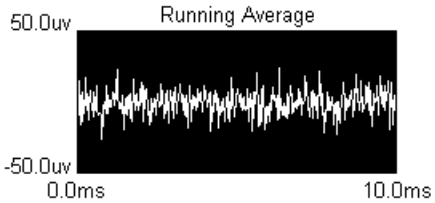


Choosing EEG causes processed input to be displayed. EEG data is affected by currently defined acquisition setup parameters such as gain (See *Chapter 3*).

To display the EEG signal

1. Access the Control Plot Toolbar.
2. Click  or press 'E' on the keyboard.

Running Average



Choosing Running Average causes the current averaged EEG signal to be displayed.

To display the running average

1. Access the Control Plot Toolbar.
2. Click  or press 'A' on the keyboard.

None

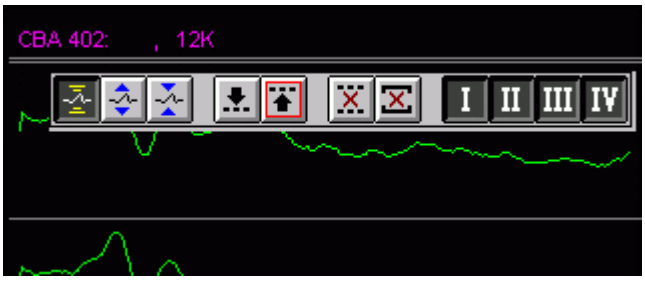
Choosing None causes no signal to be displayed.

Note: If None is chosen, the plot area will appear blank.

To display no signal

1. Access the Control Plot Toolbar.
2. Click  or press 'N' on the keyboard.

The History Plot



The History Plot is used to display historical averaged signal data. The plot is controlled through the use of the Plot Control Toolbar.

As with all other plots, you may control the scaling and channel display through use of the Plot Control Toolbar. Functions specific to the History Plot are found in the center of the Plot Control Toolbar. These functions may also be accessed from the History menu.

Scrolling Functions

History Plot data is organized into *groups*. Each time you tell BioSigRP to begin collecting data, it begins a new group. Data records are appended to the end of the group until you halt data collection. When data collection is resumed, a new group is appended to the end of the History Plot.

You may quickly scroll to the top or bottom of a group by using the scrolling buttons.

To scroll to the top of the previous group

1. Access the Control Plot Toolbar.
2. Click  or press Page Up on the keyboard.

To scroll to the top of the next group

1. Access the Control Plot Toolbar.
2. Click  or press Page Down on the keyboard.

Editing Functions

You may edit the History Plot through the use of the editing buttons. You may perform editing functions on all records or just those that are selected. Selected records appear surrounded by a frame of highlight.

Selecting Records

You may select one record, multiple contiguous records, or multiple non-contiguous records for editing.

To select a single record

- Click the desired record.

To select multiple, non-contiguous records

- Ctrl+Click the desired records.

To select a group of contiguous SGIs

1. Click the first record.
2. Shift+Click the last record.

To deselect a record

- Ctrl+Click the desired record.

Editing

To clear selected History Plot records

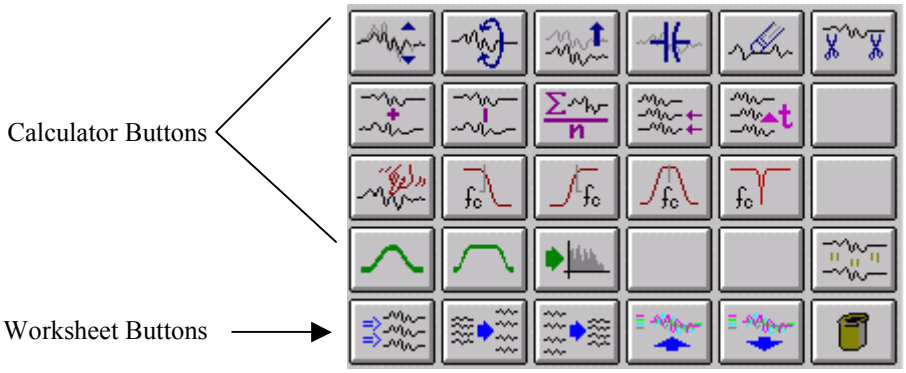
1. Access the Control Plot Toolbar.
2. Click 

To clear all History Plot records

1. Access the Control Plot Toolbar.
2. Click  or hit Ctrl-X.

Note: BioSigRP maintains a file of historical records knows as the BioSig record file (*.arf* file). As history records are acquired, they are appended to this file. Clearing a record from the History Plot **does not** remove the record from the BioSig record file. Records stored in the BioSig record file can be retrieved and viewed in the History Plot by choosing Access Record File from the History menu.

The Calculator and Worksheet Buttons



For more information about the Calculator, see Chapter 5, "Using the Calculator."

BioSigRP provides mathematical functions that may be applied to one or more Worksheet record. These functions may be accessed from the Calculator menu or from buttons displayed in the area of the main window known as the *Calculator*. Calculator functions are described in detail in a later section.

Calculator Functions

Button	Menu Option	Action
	Scale	Multiplies each point in the selected Worksheet record(s) by a specified constant.
	Invert Trace	Multiplies each point in the selected Worksheet record(s) by -1.
	Shift Baseline	Creates a DC offset by adding a specified constant to each point in the selected Worksheet record(s).
	Remove Baseline	Removes the DC offset.
	Zero Points	Sets all points within a specified time range to zero.
	Crop	Select a crop point for the selected record
	Add	Add two or more Worksheet records
	Subtract	Subtracts one Worksheet record from another.
	Average	Computes the average of two or more Worksheet records.
	Time Align	Lines up selected Worksheet records along the time axis.
	Time Shift	Shifts the selected Worksheet record(s) along the time axis.

Button	Menu Option	Action
	Smooth	Applies a smoothing algorithm to the selected Worksheet record(s).
	Lowpass Filter	Applies a low-pass filter to the selected Worksheet record(s).
	Highpass Filter	Applies a high-pass filter to the selected Worksheet record(s).
	Bandpass Filter	Applies a band-pass filter to the selected Worksheet record(s).
	Notch Filter	Apply a notch filter to the selected Worksheet record(s).
	Hanning Window	Applies a Hanning window to the selected worksheet record for use with the magnitude spectrum.
	Cosine^2 Window	Applies a Cos^2 window to the selected worksheet record (smoothes the start and end of the waveform). Used with magnitude spectrum.
	Mag Spectrum	Generates an FFT of the data using 1024-8192 points per FFT.
	Auto Cursor	Applies the selected auto cursor to the selected worksheet record.

Worksheet Functions

Located below the Calculator, the five Worksheet buttons can be used to format and organize the Worksheet (see Chapter 5). These functions may also be found in the Worksheet menu.

Button	Menu Option	Action
	Space Evenly	Spaces all selected plots evenly throughout the Worksheet.
	Spread Apart	Spreads all selected plots apart.
	Squash Together	Squashes all selected plots together.
	Pile	Piles all selected plots on top of one another.
	UnPile	Unpiles all selected plots.
	Delete	Deletes the currently selected Worksheet records.

The Worksheet

For more information about the Worksheet, see Chapter 5, "Using the Worksheet."

The Worksheet is an area of the main window where you can place records for reporting. Calculator functions may also be applied to records in the Worksheet.

Working with Files in BioSigRP

BioSigRP uses or writes to five types of files:

- SigGen files
- BioSig configuration files
- BioSig record files
- ASCII text files
- BioSig worksheet files
- CSV files

SigGen Files

Stimulus signals are designed with TDT's signal generation package, SigGenRP. The information necessary to reconstruct these signals may be saved in a SigGen file. All TDT signal processing applications, including BioSigRP, can reconstruct a SigGen signal by reading its SigGen file. The default extension for SigGen files is *.sig*.

Specifying a SigGen File

Prior to presenting a stimulus signal, it is necessary to specify the SigGen file from which the stimulus signal will be generated.

To specify a SigGen file

1. Choose Stimulus... from the Setup menu.
2. Type the file name in the SigGen File field of the desired stimulus channel.

   or

   Click the Find File button and select the desired file name.

Modifying SigGen Files

You may modify SigGen variables from within BioSigRP. These modifications are not saved in the original SigGen file, however. All modifications to original SigGen files must be made in SigGenRP.

BioSig Configuration Files

Prior to presenting a stimulus signal and acquiring response data, you must specify stimulus and data acquisition parameters. These parameters may be saved for future use in a BioSig configuration file. The default extension for BioSig configuration files is *.acf*.

Opening BioSig Configuration Files

To open an existing BioSig file

1. Choose Open Config. File... from the File menu.
2. Click on the desired file name.
3. Click the OK button.

The selected file must be in BioSig format. By default, BioSig configuration files have the extension, *.acf*.

To open a recently updated file

1. Choose the File menu.

   BioSigRP displays the names of the last 4 BioSig configuration files saved.
2. Click the desired file name.

Saving BioSig Configuration Files

To save a new file in BioSig format

- Choose Save Config. or Save Config. As... from the File menu.

The File Save As dialog box will be displayed. You may assign a name to your new signal. It is best to use the default **.***acf* file extension.

To save an existing file

- Choose Save Config. from the File menu.

The file will be saved with its current name.

BioSig Record Files

For every stimulus interval, or SigGen Index (SGI), BioSig acquires response signals and computes an average. The resulting averaged waveforms are collectively stored in a BioSig record file. These waveforms may be retrieved for analysis in later sessions. Waveforms retrieved from BioSig record files are displayed in the History Plot. The default extension for these files is *.arf*.

Specifying a BioSig Record File

Immediately prior to stimulus presentation, BioSigRP will ask you to supply the name of the BioSig record file. You may, however, optionally define a default BioSig record file ahead of time.

To specify a default BioSig record file

1. Choose Acquisition from the Setup menu.
2. Type the file name in the Response Record File Name field.

   or

   Click the Find File button and select the desired file name.

It is best to use the default file extension, *.arf*.

Loading a BioSig Record File

To load a BioSig record file

1. Choose Access Record File from the History menu.
2. Choose the *group*.
3. Choose the desired records.

The BioSig record(s) will be displayed in the History Plot.

For more information about exporting ASCII text files, see Chapter 5, "Using the History Plot and BioSig record files."

ASCII Text Files

You may wish to export BioSig record information to an ASCII text file for use by another application. BioSigRP allows you to export record information in ASCII text format. These files are saved with the default extension, *.txt*.

Information may be saved from both the History Plot and the Worksheet.

BioSig Worksheet Files

BioSigRP allows you to build custom reports. Custom reports are created by placing desired History Plot records in the Worksheet. These reports may be saved in BioSig Worksheet files. The default extension for these files is *.awf*.

Opening BioSig Worksheet Files

To open an BioSig worksheet file

1. Choose Open Worksheet... from the Worksheet menu.
2. Click on the desired file name.
3. Click the OK button.

Saving BioSig Worksheet Files

To save a new BioSig Worksheet file

- Choose Save Worksheet or Save Worksheet As... from the File menu.

The File Save As dialog box will be displayed. You may assign a name to your new signal. It is best to use the default **.***awf* file extension.

To save an existing file

- Choose Save Worksheet from the Worksheet menu.

The file will be saved with its current name.

CSV Files

BioSigRPallows you to export raw trace data along with descriptors into a standard spreadsheet file (CSV files). Each row in the spreadsheet file contains all of the data for one record.

Information may be saved from both the History Plot and the Worksheet. *(See Chapter 5 for more information.)*

Customizing Your Display

BioSigRP is designed to provide various types of visual data on one easy-to-use main window. Depending on your data display needs and your type of monitor, you may find it useful to alter the default BioSigRP screen configuration. Some common screen configuration problems and their solutions are listed below.

Problem	Solution
Plot text seems too big or too small.	Change the size of the font.
Plots cannot be seen clearly against the plot background.	Change the plot background color and/or the plot color.
One or more plot is not large enough.	Maximize the window and/or change one or more plot sizes.
Multi-purpose plots cannot be differentiated from one another.	Change one or more plot colors.

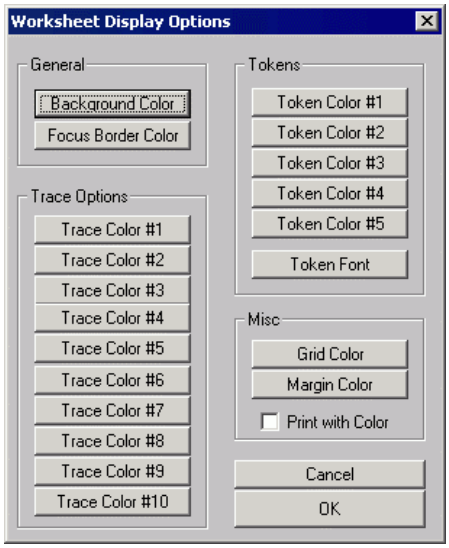
You may customize two areas of the main window:

- The Worksheet
- All other areas

To customize the Worksheet

➢ Choose Worksheet Displays Ops... from the Setup menu.

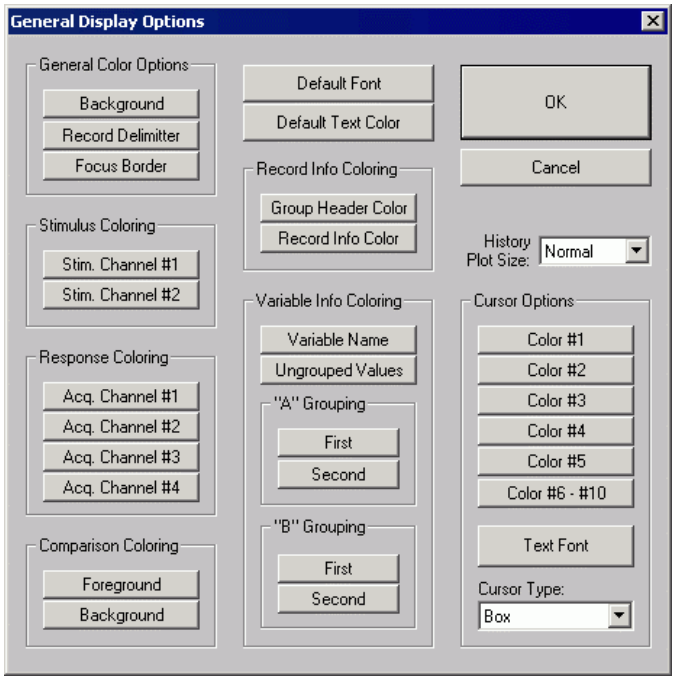
You will see the Worksheet Display Options dialog box.



To customize all other areas

➢ Choose General Displays Ops... from the Setup menu.

You will see the General Display Options dialog Box.



From either Display Options dialog box you may configure the following:

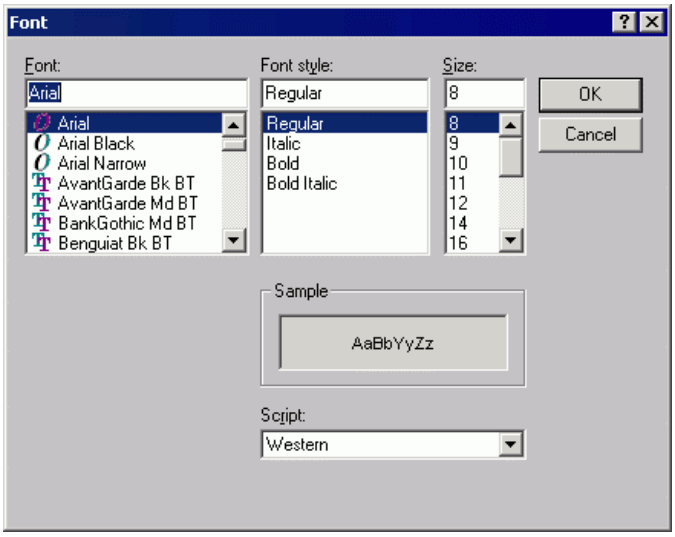
- Font types and sizes
- Colors

Customizing Fonts

You may customize the screen font used by BioSigRP components.

To access the Font dialog box

➢ Click the appropriate font button.



From the Font dialog box, you may select any screen font type, style, and size currently available in Windows.

Customizing Colors

You can customize the color of numerous screen and plot elements.

To access the Color dialog box

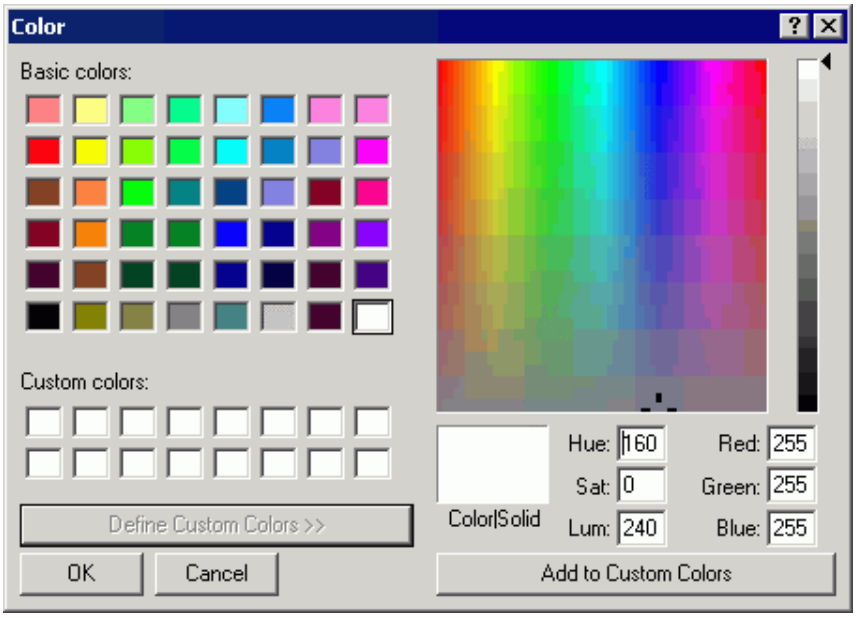
➢ Click the appropriate Color button.

You may wish to design your own Custom colors.

To design custom colors

➢ Click the Define Custom Colors button.

The Color dialog box will expand to provide a color palette from which you can design your custom colors.



Customizing the Layout

You may wish to re-size screen display areas. This can be accomplished in two ways:

- Manual customization
- Using setups

Manual Customization

To manually customize a screen area

Drag one or more Sizing Bars until the desired size is reached.

Using Setups

You may configure up to three layout setups.

To use a setup

➢ Choose the desired Setup # from the Layout sub-menu of the Setup menu.

To configure a setup

1. Choose the desired Setup # from the Layout sub-menu of the Setup menu.
2. Manually customize the layout.
3. Choose Lock from the Layout sub-menu of the Setup menu.

This layout is now associated with the chosen Setup #.

Returning to the Default Layout

To return to the default layout

➢ Choose To Default from the Layout sub-menu of the Setup menu.

Customizing Cursor Strings

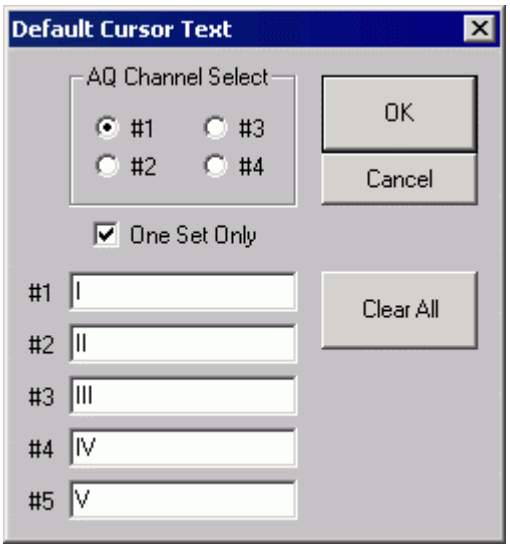
BioSigRP provides a means for placing cursors in history/worksheet records. This process is known as Cursor Editing.

When a history or worksheet record is selected for Editing, it is possible to place up to 10 cursors within the signal. Each cursor is associated with a text label. You may customize the first five labels. These labels are known as *cursor strings*.

To customize a default cursor string

➢ Choose Default Cursor Strings... from the Setup menu.

You will see the Default Cursor Text dialog box.



Cursor strings may be defined as follows:

- One set for all acquisition channels.
- One set for each acquisition channel.

To specify one set of cursor strings for all acquisition channels

1. Check the One Set Only check box.
2. Type in the desired cursor strings.
3. Click OK.

To specify one set of cursor strings for each acquisition

1. Make sure the One Set Only check box is not checked.
2. Choose the desired acquisition channel.
3. Type in the desired cursor strings.
4. Click OK.
5. Repeat for each acquisition channel.

How BioSigRP Works

BioSigRP enables you to acquire and process bioelectric signal data in response to a customized stimulus signal. The process is as follows:

1. Design the stimulus signal using SigGenRP.
2. Acquire and process response signal data using BioSigRP.

Designing the Stimulus Signal

TDT's signal generation package, SigGenRP, provides a simple, yet powerful, means for designing your stimulus signals. Signals generated with SigGenRP may be saved as SigGen files (*.sig* files) for use with other TDT signal processing applications, including BioSigRP.

Acquiring and Processing Response Signal Data

BioSigRP is an easy-to-use tool for acquiring and processing response signal data. The process is relatively simple:

1. Configure BioSigRP.
2. Present the stimulus signal.
3. Acquire response data.
4. Analyze and process the response data.

Configure BioSigRP

Configuration settings include:

- Specification of stimulus signal parameters.
- Specification of data acquisition parameters.
- Specification of the stimulus schedule.
- Configuration of the Multi-Purpose Plot.

Present the Stimulus Signal

BioSigRP will present the stimulus signal beginning at the SigGen Index (SGI) you specify. All signal parameters associated with variables will vary as a function of the SGI.

Begin Acquiring Response Data

During the configuration process, you will have specified the value of Number Averages, *n*. For each SGI, the stimulus signal is presented until *n* response signals have been acquired and averaged. The resulting averaged waveform will be displayed in the History Plot.

Analyze the response data

Signals displayed in the History Plot are known as *history records*. Any history record may be viewed in greater detail. You may:

- Place cursors and measure x and y coordinate values.
- Place a record in the Comparison Plot for future reference.
- Place a record in the Worksheet as part of a report.
- Perform calculations involving one or more record.

Chapter 3 Configuration

Prior to presenting a stimulus signal and acquiring response data, it is necessary to complete the following steps:

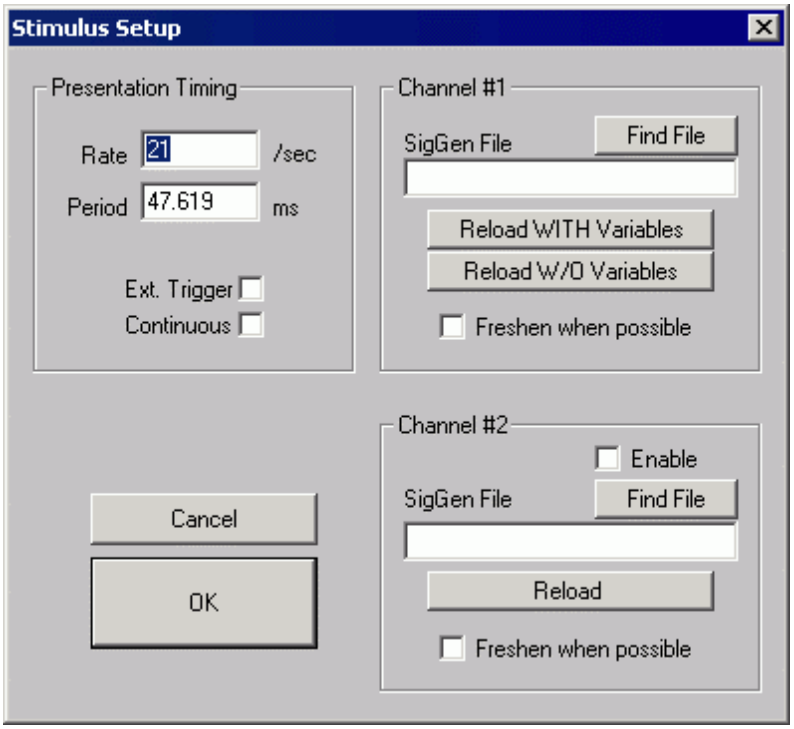
- Define stimulus signal parameters.
- Define data acquisition parameters.
- Calibrate the system (optional).
- Specify the stimulus schedule (optional).

Defining Stimulus Parameters

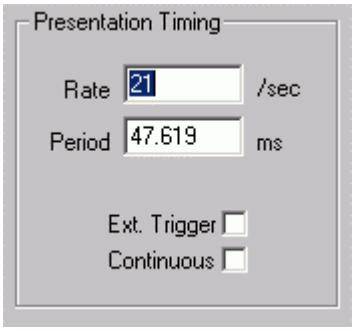
Stimulus parameters are defined from the Stimulus Setup dialog box.

To access the Stimulus Setup dialog box

- Choose Stimulus from the Setup menu.



Presentation



Temporal parameters associated with the presentation of the stimulus signal are defined in the Presentation section of the Setup Stimulus dialog box.

The Presentation parameters consist of the following:

- Presentation Rate (stimuli/second)
- Presentation Period (milliseconds) = 1000/Presentation Rate (sec)
- Ext. Trigger
- Continuous

Presentation Rate

You may define the Presentation Rate by entering a value in the Presentation Rate field. When you leave this field, the value of the Presentation Period field will be calculated automatically.

Presentation Period

You may define the Presentation Period by entering a value in the Presentation Period field. When you leave this field, the value of the Presentation Rate field will be calculated automatically.

When Continuous is enabled (see below), the presentation period is automatically defined as the length of the SigGen signal assigned to stimulus channel #1. When continuous is enabled, you may not edit the Presentation Rate or Presentation Period.

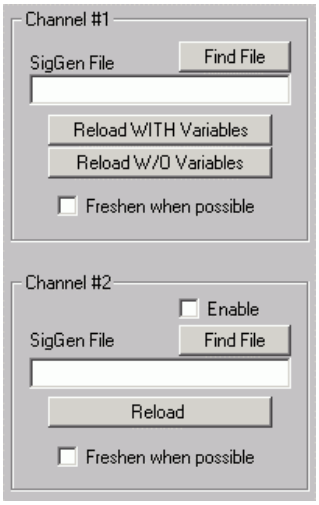
Note: When Continuous (see below) is not enabled, the Presentation Period must be 1.25 times longer than the stimulus and acquisition duration.

Ext. Trigger

An external trigger can be used with some modification of the RCO file. Contact TDT for assistance.

Continuous

When Continuous is checked, the stimulus will be played continuously. Upon reaching the end of the signal, BioSigRP will loop back to the beginning of the buffer and replay the signal. This cycle will continue throughout continuous signal play. **Note:** When selecting continuous record the SigGen file must be designed for continuous stimulus presentation.



Defining the Stimulus

You may define a single or dual channel stimulus. Defining the stimulus signal is the same for Channels 1 and 2, with a couple of exceptions.

Specifying the SigGen File

BioSigRP does not provide a means for designing stimulus signals. Instead, BioSigRP generates a stimulus signal based on signal parameters read from previously defined SigGenRP signal files (*.sig* files). To define a stimulus signal, you simply specify the appropriate SigGenRP file.

To specify the stimulus file

1. Click Find File.
2. Choose the desired file.

   -or-

   Type in the desired file name in the SigGen File field.

Stimulus Refresh

BioSigRP generates a stimulus signal based on the parameters specified in the SigGen file. The generated signal is stored in a buffer. This buffered signal is then presented as a stimulus. A stimulus refresh occurs whenever the signal currently stored in the buffer is replaced with a freshly generated stimulus signal.

In theory, a stimulus signal could be refreshed: (1) prior to each presentation or (2) prior to a new SGI.

In practice, however, the ability to perform a stimulus refresh is limited by processing considerations. The real time processing of incoming response data must take precedence over the refresh of the stimulus signal. BioSigRP performs a stimulus refresh as follows:

- The stimulus signal is always refreshed prior to a new SGI.

  This automatic refresh is necessary in order to reflect any changes in stimulus signal parameter values associated with the new SGI.

- The stimulus signal may be refreshed *when possible* within an SGI. This option is enabled by selecting Freshen when possible.

Refreshing Non-Noise Stimuli. Within an SGI, non-noise stimulus signals, such as clicks and periodic waveforms, remain constant. These signals need only be refreshed prior to a new SGI. For these signals, do not check Freshen when possible.

Refreshing Noise Stimuli. It may be desirable to refresh noise stimuli. While BioSigRP cannot guarantee that a noise signal will be refreshed for every presentation within an SGI, it will attempt to refresh the signal when possible. If the Freshen when possible option is chosen, the noise stimulus will be refreshed whenever there are no processing demands being made by incoming data. If you wish the noise stimulus to remain constant throughout all presentations in a given SGI, do not specify Refresh when possible.

To refresh the stimulus whenever possible

- Check the Freshen when possible check box.

Enabling the Channel

By default, BioSigRP assumes that Channel #1 will be active. No such assumption is made concerning Channel #2. Specifying a SigGen file is not sufficient to activate Channel #2. You must also enable the channel.

To enable Channel #2

- Check the Enable check box.

Note: The SigGen file specified for Channel 2 will use the variables defined in the SigGen file specified for Channel 1.

Reloading the SigGen Stimulus File

SigGen files are automatically loaded:

- When the file name is specified (see below).
- When an existing BioSig configuration file (*.acf* file) is loaded.

SigGen files may also be manually loaded in the following ways:

- Reload with variables
- Reload without variables

Included in the SigGen file is information defining how variables will change as a function of the SGI. Once a SigGen file has been loaded, this information is available to the BioSigRP application and will be saved in the BioSig configuration file (*.acf* file). In some cases, it may be necessary to modify these stimulus variables. BioSigRP allows you to make local changes to stimulus variables for Channel #1, only. (Note that with a two channel system, both SigGen files should have the same variables. BioSig only implements variables in the file for Channel.) The modified variable information will be saved in your BioSig file (*.acf* file). The original SigGen file, however, will not be modified. Modified variable information remains in the BioSig file until the SigGen file is reloaded by as defined above.

Reloading with Variables. When you reload a SigGen file with variables, the variable schedule currently defined in BioSigRP will be replaced with the schedule stored in the SigGen file.

Reloading without Variables. When you reload a SigGen file without variables, the variable schedule currently defined in BioSigRP will not be replaced with the schedule stored in the SigGen file.

To reload a SigGen file with variables

- Click the Reload WITH Variables button.

To reload a SigGen file without variables

- Click the Reload W/O Variables button.

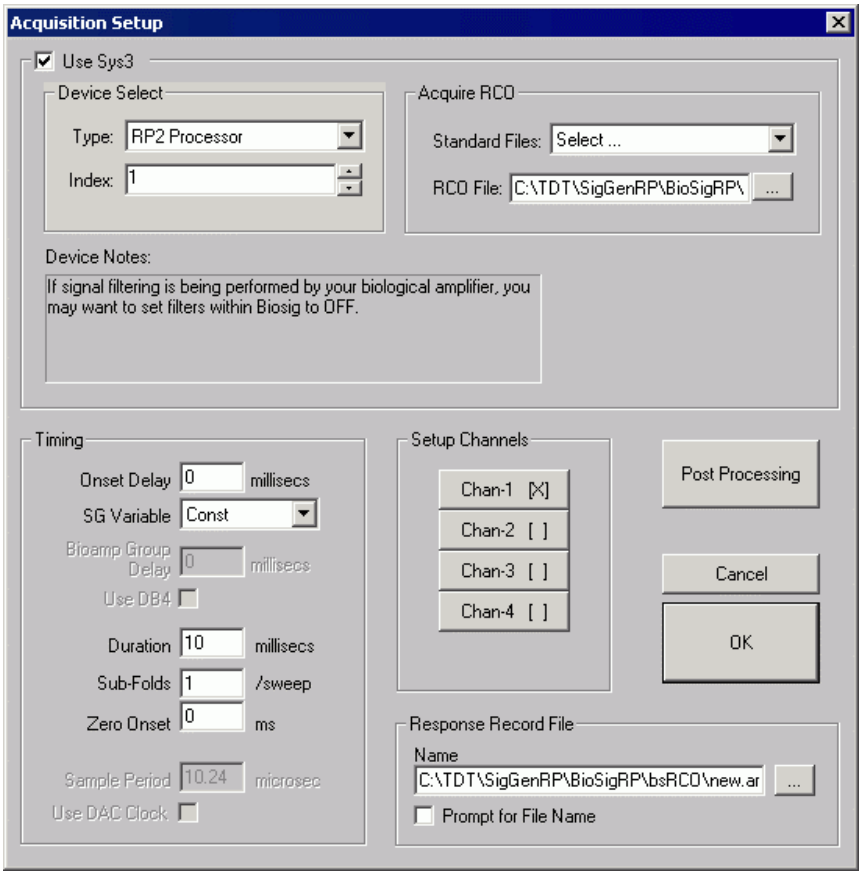
Defining Data Acquisition Parameters

Data Acquisition parameters are defined from the Acquisition Setup dialog box.

To access the Acquisition Setup dialog box

- Choose Acquisition from the Setup menu.

The Acquisition Setup dialog box opens.



In the Acquisition Setup dialog box the RPx device can be selected.

Use Sys3

The Use Sys 3 check box should be selected to allow users to access RCO files for acquisition on an RPx device. RCO circuits are included with the program for data acquisition and signal averaging.

If the Use Sys 3 check box is cleared users can access System II modules such as the DB4 and use the System II timing functions.

Device Select

Users must select the device type (RP2, Medusa, StingRay or Barracuda) and the module number. Not all modules have acquisition channels. For example, the RV8 module does not have acquisition channels.

Device type: All RPx modules are accessible from the Dialog box. RP2, RP2.1, and Stingray devices can have two acquisition channels and the Medusa can have up to four acquisition channels. The RCO files are device independent so the standard RCO files will work with most System 3 devices.

> **Note:** the Stingray runs at ½ the speed of the others RPx devices. Be sure to change the RCO sample period accordingly.

Index: Many systems have multiple RPx modules. To select the RPx module for acquisition use the device's index. Devices are numbered logically beginning with one. A device index of zero means that module type is not selected. The logical device numbers may not correspond to the physical device organization. When using TDT's USB interface make sure that devices are turned on in the same order each time the system is turned on to ensure that the devices are ordered consistently each time the system is used. To check that the devices have been properly selected use the zBUSmon software to check the order of the logical devices.

Acquire RCO

A standard RCO file can be selected or a custom RCO file can be used.

Standard Files: Four standard files come with the system. Not all RPx modules can use all standard files. The Sweep Rec, 2 at 25 kHz can be used by either an RP2.x module or a Medusa system. Sweep Rec, 4 at 25 only functions with the Medusa amplifier. Sweep Rec, 2 x 50 and Sweep Rec, 1 x 100 kHz only function with RP2.x modules. At 100 kHz artifact rejection is disabled. *Also see note under Device Type above.*

Timing

Onset Delay. The value in the Onset Delay field defines the time delay in milliseconds from the time of stimulus onset to the beginning of response signal acquisition. This field is set to zero and disabled when continuous signal presentation is enabled.

SG Variable. Onset delay may be defined as a constant or as a SigGen variable. This box is disabled when continuous signal presentation is enabled.

Bioamp Group Delay. Not available when using System 3.

UseDB4. Not available when using System 3.

Duration. The value in the Duration field specifies the length in milliseconds of the acquired response signal. When continuous signal presentation is enabled, this value will default to the duration of the SigGen signal. The field will be disabled.

Sub-Folds. You may divide the acquired signal into subunits that are folded onto each other. These sub-folds are added to one another. The resulting composite signal is averaged. For example, if an acquired signal of 50 milliseconds is assigned 2 sub-folds, the result is two 25 millisecond sub-folds. The first 25 millisecond sub-fold will be added to the second 25 millisecond sub-fold.

Sub-folds may be used with non-continuous and continuous signals.

Zero Onset. Zero Onset defines a duration beginning at 0 milliseconds during which the acquired signal will be set to zero. For example, if Zero Onset is defined as 20 milliseconds, the first 20 milliseconds of the acquired signal will be set to zero.

Sample Period. Not available when using System 3.

Use DAC Clock. Not available when using System 3.

Response Record File

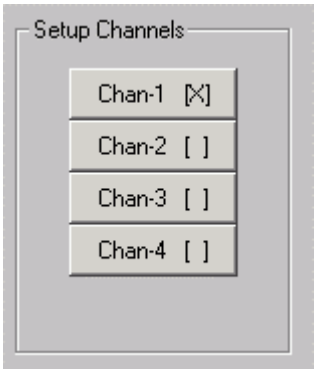
Response record files, or history record files, (*.arf* files) are continuously maintained during data acquisition. Each averaged record is appended to the history record file.

Name. This will be the default history record file name. It is recommend that you use the file extension, *arf*.

Prompt for File Name. When this box is checked, BioSigRP will always prompt you for a file name before stimulus presentation begins, allowing you to override the default file name.

Setting-up Acquisition Channels

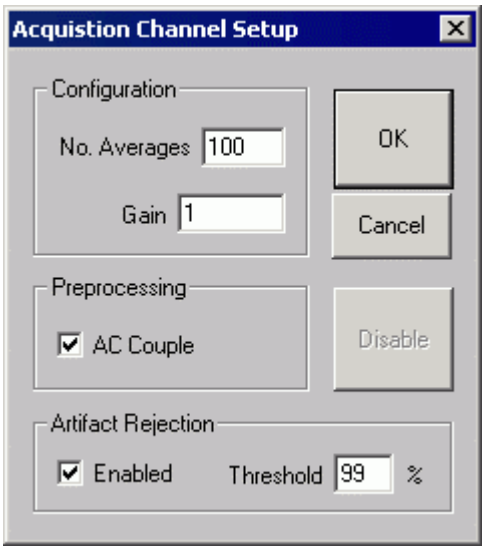
You must define configuration parameters for each acquisition channel.



To setup acquisition channels

➢ Click the appropriate acquisition channel button.

The Acquisition Channel Setup dialog box opens.



Configuration

No. Averages. The value of Number Averages determines the number of response signals acquired and averaged for every SGI. Number Averages must be at least 1 and cannot exceed 3000.

Gain. The value specified in the Gain field is used to adjust the voltage of the acquired data signal in the following manner:

- If you are using a Medusa amplifier with the low impedance headstage (serial number less than 2000) the Gain should be set to 10.
- If you are using a Medusa amplifier with the low impedance headstage (serial number greater than 2000) the Gain should be set to 20.
- If you are using the Medusa amplifier directly, the gain should be set to 1.
- Otherwise determine the gain based on the Gain of your amplifier.

BioSigRP voltage = acquired signal voltage/Gain

Gain may be used to remove the effects of signal amplification. For example, let's say you used a bio-amplifier to increase the level of an evoked potential by a gain of 50,000. Specifying a gain of 50,000 in the Gain field causes an evoked potential of the original level to be displayed.

Preprocessing

AC Couple. Checking this box enables AC Coupling. AC Coupling removes the DC component by subtracting the signal average.

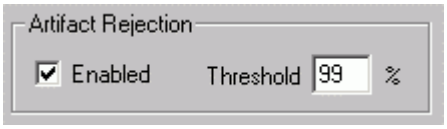
Artifact Rejection

In some cases, anomalous amplitude values may indicate an artifact in the acquired data signal. BioSigRP provides a means for detecting and rejecting signals with such artifacts, Artifact Rejection. By enabling Artifact Rejection, you can specify at which peak amplitude you wish to reject an acquired signal. This amplitude is specified as a percentage of the threshold relative to the maximum voltage input (10 Volts or input signal).

Signals rejected through Artifact Rejection are not included in the average for each SGI.

To enable Artifact Rejection

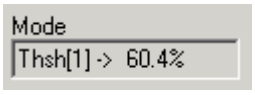
1. Check Enabled under Artifact Rejection.
2. Enter the percentage in the Threshold field.



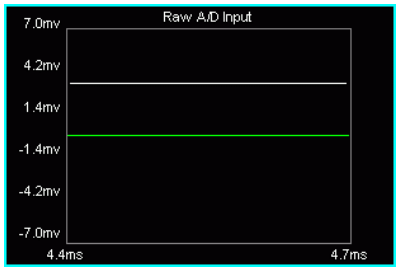
or

1. Display Raw A/D Input in the Multi-Purpose Plot.
2. Place the mouse pointer in the plot.
3. Hold down the left mouse button and CTRL.

   A threshold line appears.
4. Drag until the desired artifact rejection is reached.



The threshold percentage will be displayed in the Mode field.



Enabling/Disabling a Channel

Acquisition channels can be enabled or disabled.

By default, Channel #1 is always enabled. The other three channels can be defined as either enabled or disabled.

To enable a channel

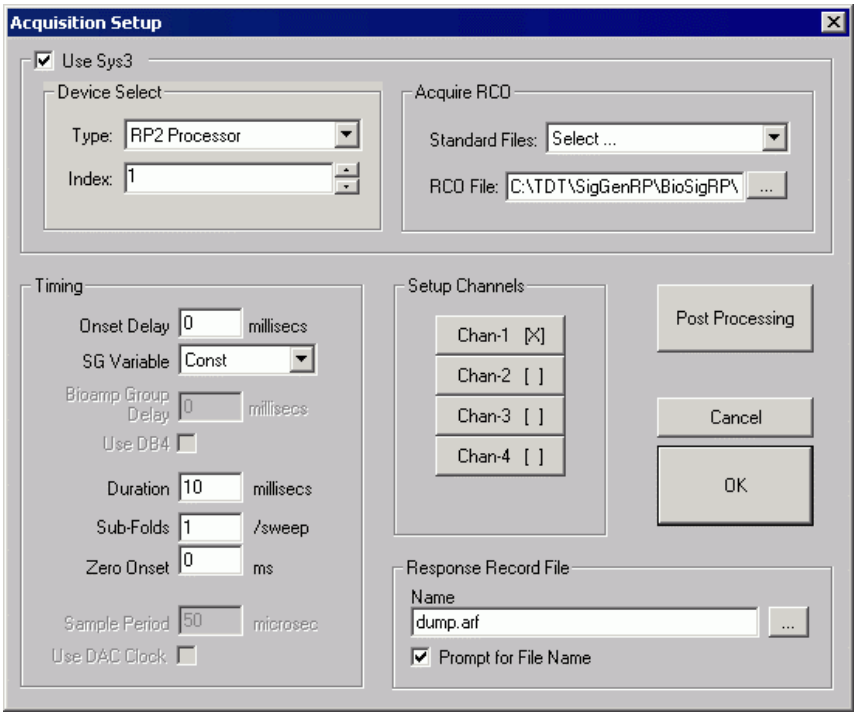
- Click OK.

To disable a channel

- Click Disable.

Once you have enabled or disabled a channel, you will be returned to the Acquisition Setup screen. By examining the Edit Acquisition Channels buttons, you can quickly determine which channels are enabled. Enable channels display [X] on their buttons.

Post Processing

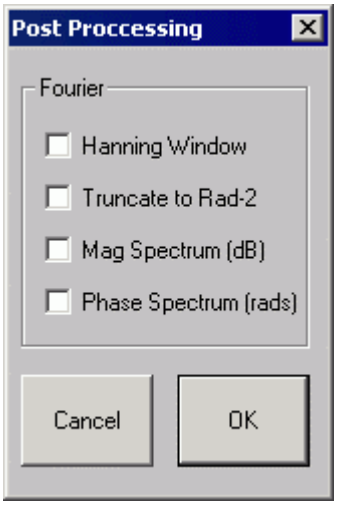


You may apply various types of post-processing to the acquired signal.

To apply post processing

➢ Click Post Processing.

You will see the Post Processing dialog box. From this box you may enable a variety of post processing options.



Hanning Window. Applies a hanning window to the acquired signal. The default is a Hamming window.

Truncate to Rad-2. Truncates the number of data points to radix 2.

Mag Spectrum (dB). Displays intensity in the logarithmic units of decibels.

Phase Spectrum (rads). Displays the phase spectrum in radians.

Specifying the Stimulus Schedule

TDT's signal generation package, SigGenRP, allows you to build signals that vary one or more signal parameter from one SGI to another. Such variation is accomplished through the definition and use of signal variables. Values of these variables change as a function of the SGI. This *stimulus schedule* information is stored within the SigGen file. BioSigRP and other TDT applications use the information stored in the SigGen file to generate stimulus signals and to control parameter variation across SGIs.

Viewing the Current Stimulus Schedule

To view the current stimulus schedule

From the main window,

- Choose SigGen Variables... from the Setup menu.

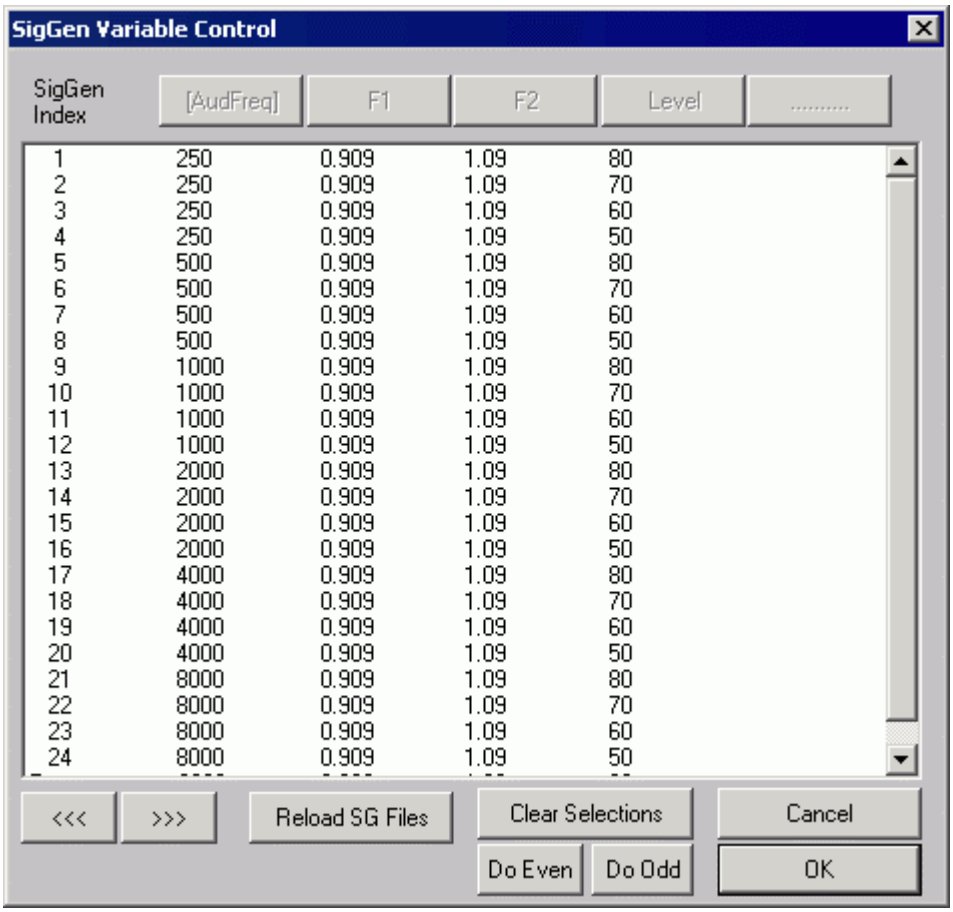
or

- Choose Modify Schedule from the Operations menu.

or

- Click the Modify Schedule button.

The SigGen Variable Control dialog box opens.



The SigGen Variable Control dialog box displays the current stimulus schedule. Variable values are shown for each SGI.

You may scroll through the stimulus schedule as follows:

To scroll up and down

- Use the vertical scroll bar.

To scroll to the right

- Hit the >>> button.

To scroll to the left

- Hit the <<< button.

Once you have viewed the stimulus schedule, you may:

- Accept the current stimulus schedule.
- Modify the current stimulus schedule.
- Modify variables.

To accept the current stimulus schedule

- Click OK.

Modifying the Stimulus Schedule

You may wish to present a subset of the current stimulus schedule. To do so, just select the SGIs to be included in the subset for presentation. When no SGIs are selected, BioSigRP will present the entire stimulus schedule. Otherwise, BioSigRP will present only the selected SGIs.

To select a single SGI

- Click the desired SGI.

To select multiple, non-contiguous SGIs

- Ctrl+Click the desired SGIs.

To select a group of contiguous SGIs

1. Place the mouse pointer over the first SGI.
2. Hold down the left mouse button.
3. Drag the mouse pointer to the last SGI.
4. Release the left mouse button.

or

1. Click the first SGI.
2. Shift+Click the last SGI.

To select all odd SGIs

- Click the Do Odd button.

To select all even SGIs

- Click the Do Even button.

To deselect a single SGI

- Ctrl+Click the desired SGI.

To deselect all SGIs

- Click the Clear Selections button.

Modifying Variables

Variables are defined within SigGenRP.

Chapter 4 Data Acquisition

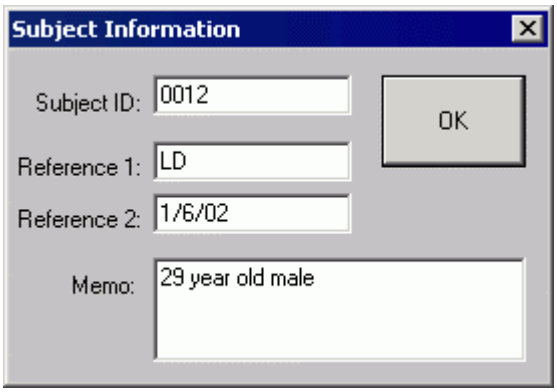
Once the configuration process has been completed, you are ready to present a stimulus and acquire data.

Subject Definition

You may wish to associate subject information with each group of signals added to the history plot. Such information may be defined in the Subject Information dialog box.

To access the Subject Information dialog box

- Choose Subject Info... from the Setup menu.



Subject ID. This subject identifier may be up to 15 characters in length. The Subject ID will be associated with all subsequently acquired data. The ID will be displayed in the history plot immediately above the history data. It will also be stored with the history data in the BioSig record file (*.arf* file).

Reference 1. This reference text may be up to 15 characters in length. The text of Reference 1 will be associated with all subsequently acquired data. The character string will be displayed in the history plot immediately above the history data. It will also be stored with the history data in the BioSig record file (*.arf* file).

Reference 2. This reference text may be up to 15 characters in length. The text of Reference 2 will be associated with all subsequently acquired data. The character string will be displayed in the history plot immediately above the history data. It will also be stored with the history data in the BioSig record file (*.arf* file).

See Chapter 5 for more information about viewing Memo text.

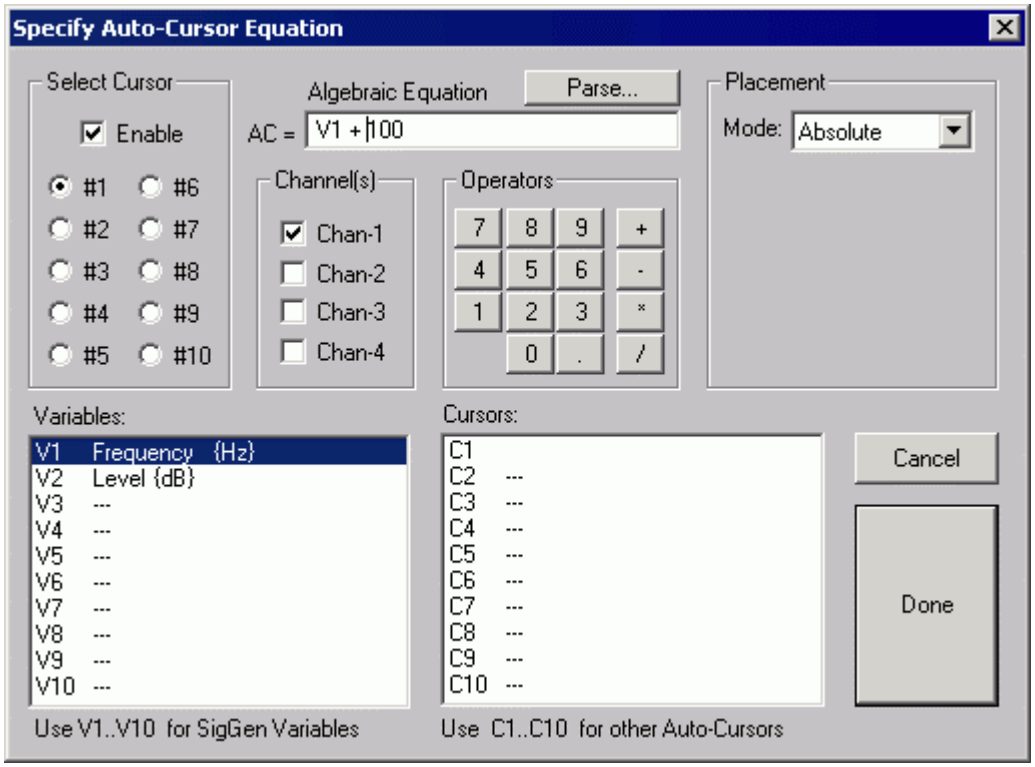
Memo. This character string may be up to 49 characters in length. This text will be associated with all subsequently acquired data. The text will not be displayed in the history plot, but will be stored with the history data in the BioSig record file (*.arf* file). Memo text can be viewed from BioSig Cursor Edit dialog box.

Auto-Cursors

You may specify up to 10 auto-cursors. Auto-cursors are cursors that are automatically placed at specific points in the signal as the signal is acquired. Auto-cursor position is determined through specification of an auto-cursor equation. You may specify an auto-cursor equation from the Specify Auto-Cursor Equation dialog box.

To access the Specify Auto-Cursor Equation dialog box

➢ Choose Auto-Cursors... from the Setup menu.



Select Cursor

From the Select Cursor group box, you may choose to specify an auto-cursor equation for any of the first 10 cursors.

To specify an auto-cursor

➢ Click the desired cursor number in the Select Cursor box.

Specifying the Algebraic Equation

Specifying the algebraic equation may be accomplished in three steps:

- ❑ Enabling auto-cursoring.
- ❑ Specifying the equation.

- Parsing the equation.

Enabling Auto-Cursoring

To enable auto-cursoring

- Check the Enable box.

Specifying the Equation

You may now enter an auto-cursor equation in the Algebraic Equation field.

Auto-Cursor equations may include one or more SigGen Variable. Instead of using the variable name, however, you must use a variable number. For example, if the variable you wish to use is second in the BioSig variable list, use V2.

V2 + 100

You may also use existing auto-cursors as variables in auto-cursor equations. Auto-cursor variables are specified by C*n*, where *n* is the number of the auto-cursors. For example, if you wish to use auto-cursor #3 in an equation, use variable C3.

C3 - V2 + 100

Auto-cursors are placed in the time axis in time-domain waveforms and in the frequency axis in frequency-domain waveforms. Thus, the unit of measurement for time-domain auto-cursors is milliseconds, while the unit of measurement for frequency-domain auto-cursors is Hz.

Parsing the Equation

Once you have specified the equation, it must be parsed. During parsing, the equation is evaluated. Any errors noted during parsing will be reported.

Note: All auto-cursor equations must be parsed. Failure to parse the equation will result in a failure to use the equation during data acquisition.

To parse the equation

- Hit Parse.

Accepting an Equation

Once an equation has been defined, it must be accepted.

To accept an equation

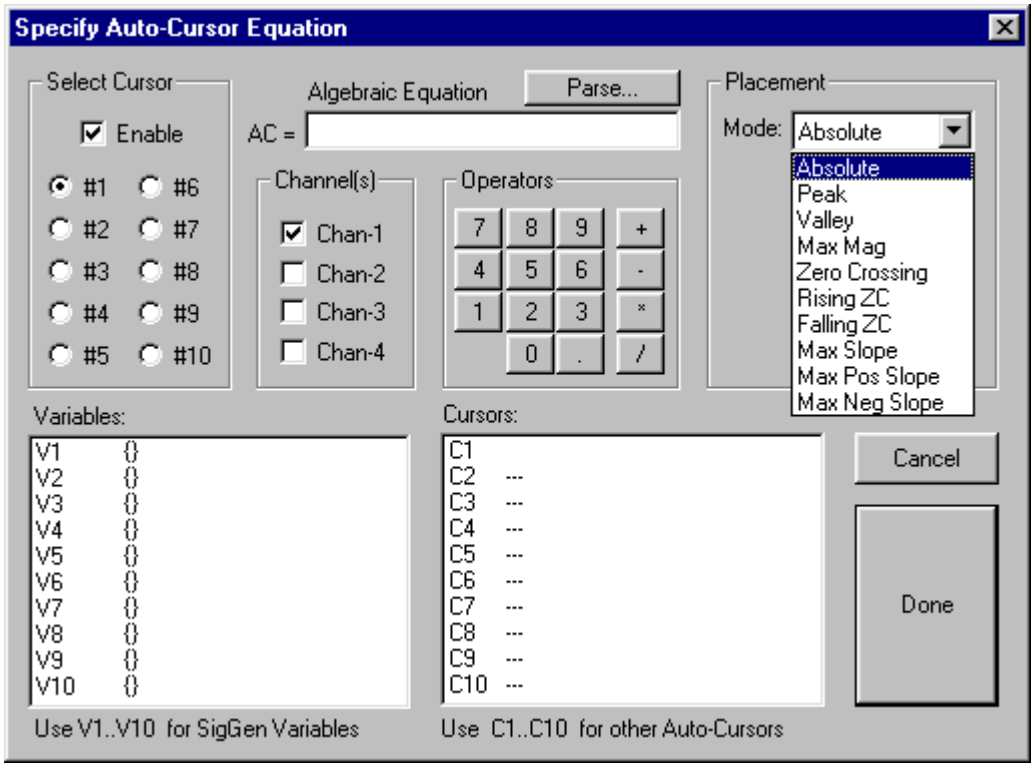
- Hit Done.

To reject an equation

- Hit Cancel.

Auto-Cursor Feature Finding

The auto-cursor feature will place up to 10 cursors on each acquired trace as a mathematical function of a variable or at a specific time or frequency. BioSigRP now supports automatic feature finding to minimize the amount of manual cursor manipulation that has to be performed after data acquisition.



Placement

The settings under Placement allow you to specify placement of the cursor on the feature selected from the drop-down menu. The Placement will search over the specified range around the value calculated by the algebraic equation.

Absolute

This corresponds to auto-cursoring by earlier versions of BioSig. The cursor will be placed at the position specified by the algebraic equation.

Peak

Will place the cursor at the highest peak in the specified range.

Valley

Will place the cursor at the lowest valley in the specified range.

Max Mag

Will place the cursor at the maximum + or – value in the specified range..

Zero Crossing

Will place the cursor at the nearest zero crossing in the specified range.

Rising ZC

Will place the cursor at the nearest rising (i.e. positive going) zero crossing in the specified range.

Falling ZC

Will place the cursor at the nearest falling (i.e. negative going) zero crossing in the specified range.

Max Slope

Will place the cursor on the maximum slope (either positive or negative) in the specified range.

Max Pos Slope

Will place the cursor on the maximum positive slope in the specified range.

Max Neg Slope

Will place the cursor on the maximum negative slope in the specified range.

Search From and To

This specifies the search range for the feature (e.g. peak, valley etc.). AC stands for AutoCursor.

For example, if the feature is set to peak and the result of the algebraic equation is 5 ms and the search range is From: AC –1.0 To: AC +1.0, the autocursor will be placed on the highest peak between 4.0 ms and 6.0 ms.

Multiplicative

By default, the range specified in the search box will be added to the result of the algebraic equation. If the multiplicative box is checked, the range will by multiplied by the result of the algebraic equation.

Flag Edge Placements

If the placement of the cursor occurs at the beginning or end of the search range, clicking Flag Edge Placements, will cause the cursor to be flagged as such. For example, if the cursor placement was set for a peak at 5 ms (as in the following example), but the peak actually occurred before the search window, the cursor would be placed at the Start of the search window and would be flagged. This will let you know that you might want to manually move the cursor to the true peak, which was outside the search window.

Cursors in the Auto-Cursor Equation

When an auto-cursor's value is calculated based on the value of another auto-cursor, the calculation is performed on the absolute value of the cursors.

For example if two cursors are placed on the signal and the first one (C1) uses peak finding over a 200 Hz range while the second cursor (C2) is calculated as C1 + 100 Hz, the second cursor will be placed as a function of the absolute value of C1, not the value actually found in the search over the 200 Hz range.

Understanding BioSigRP Operational Modes

Functions controlling the presentation of stimuli and the acquisition of data are controlled from the Operations Menu or from buttons displayed on the main window. The title and function of these menu options and buttons vary, depending on the current operational mode. Operational modes consist of the following:

For more information about modes, see Chapter 3, "Using the BioSig Menus," "The Operations Menu."

- ***Idle***

  No stimulus presentation or data averaging.

- ***Running***

  Stimulus is being presented.

- ***Averaging***

  Response data is being acquired and averaged.

- ***Paused***

  Data averaging has been temporarily suspended.

Idle Mode

When BioSigRP is in *idle mode*, no stimulus signals are presented and no data is acquired. It is during idle mode that you specify parameters and configure displays.

Start is the only operation available in idle mode. Clicking the Start button begins stimulus presentation and causes BioSigRP to enter *running mode*.

To present the stimulus

When in idle mode,

- Click the Start button.

or

- Choose Start from the Operations menu.

Running Mode

When in *running mode*, BioSigRP continuously presents the stimulus signal based on the variable values associated with the current SGI as defined in the stimulus schedule. No data is averaged in running mode.

Stimulus presentation will continues until:

- Stimulus presentation is manually halted.
- The stimulus schedule reaches its termination point.

During running mode, no data is being averaged. Consequently, the stimulus will continue to be presented at its initial SGI. The SGI will not be incremented until response data has been averaged.

Stop and Begin are the only operations available in running mode. Clicking the Stop button halts stimulus presentation and returns BioSigRP to idle mode. Clicking the Begin button begins data averaging, placing BioSigRP in *averaging mode*.

To view the stimulus

See Chapter 3, "The Plot Control Toolbar" for more information.

1. Display the Plot Control Toolbar of the Multi-purpose Plot.
2. Click the Stimulus button.

You may alter the scale of the display or change the number of displayed channels through use of the Plot Control Toolbar.

To manually halt stimulus presentation

While in running mode,

- Click the Stop button.

or

- Choose Stop from the Operations menu.

To begin averaging data

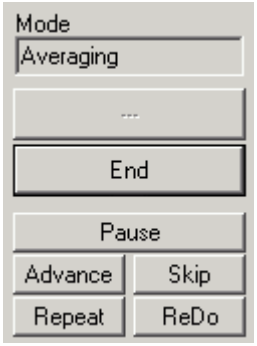
While in running mode,

- Click the Begin button.

or

- Choose Begin from the Operations menu.

Averaging Mode



During *averaging mode*, BioSigRP acquires data and calculates a running average. BioSigRP acquires data from up to four A/D channels according to setup specifications. Data will be acquired until enough records have been gathered to compute the final averaged signal. At that time, the averaged signal will be appended to the end of the History Plot, the SGI will be incremented, a new stimulus signal will be generated according to the current stimulus parameters, and a new average will be computed. This process continues until the termination of the stimulus schedule is reached or until you manually end data averaging.

During averaging mode, the operations End and Pause are available. In addition, you may access four manual control functions: Advance, Skip, Repeat, and ReDo. These functions are defined in the "Manual Control of Data Acquisition" section of this chapter.

During data acquisition, you may use the Multi-Purpose Plot to view:

- The stimulus signal
- The EEG signal
- The raw A/D input
- The running average

To choose a signal type for display in the Multi-Purpose Plot

See Chapter 3, "The Multi-Purpose Plot" for more information.

1. Display the Plot Control Toolbar of the Multi-purpose Plot.
2. Click the appropriate button.

You may alter the scale of the display or change the number of displayed channels through use of the Plot Control Toolbar.

To manually end data averaging

While in Averaging mode,

- Click the End button.

or

- Choose End from the Operations menu.

BioSigRP will return to running mode. The current stimulus signal will continue to be presented until manually halted as described previously.

To pause data averaging

While in Averaging mode,

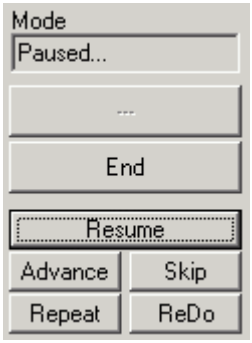
- Click the Pause button.

or

- Choose Pause from the Operations menu.

Data averaging will pause. The stimulus signal will continue to be presented.

Paused Mode



In paused mode, data averaging is temporarily halted. Stimulus presentation continues.

From paused mode, the operations End and Resume are available. The four manual control functions, Advance, Repeat, Skip, and ReDo are also available. These functions are defined in the "Control of Data Acquisition" section of this chapter.

To resume data averaging

- Click the Resume button.

or

- Choose Resume from the Operations menu.

To manually end data averaging

While in Averaging mode,

- Click the End button.

or

- Choose End from the Operations menu.

BioSigRP will return to running mode. The current stimulus signal will continue to be presented until manually halted as described previously.

Control of Data Acquisition

You may control data acquisition automatically or in real time.

Automatic Control

Automatic control begins with the specification of the stimulus schedule. Once the stimulus schedule has been specified, you may make further modifications to automatic stimulus presentation through use of some of the SGI Control features shown above.

Modifying the Stimulus Schedule

See Chapter 3, "Specifying the Stimulus Schedule" for more information.

The manner in which stimulus parameter values vary as a function of the SGI is initially defined during signal design in SigGenRP. You may make further modifications to the stimulus schedule from within BioSigRP.

Modify Schedule. The Modify Schedule button provides access to the SigGen Variable Control dialog box, from which you may alter the stimulus schedule.

Automatic Repetition of the SGI

You may wish to repeat an SGI automatically. BioSigRP allows you to automatically present an SGI once, twice, or three times.

To present an SGI once only

- Make sure that the Each Twice and Each Thrice boxes are not checked.

To present an SGI twice

- Check the Each Twice box.

To present an SGI three times

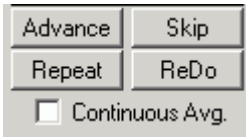
- Check the Each Thrice box.

Real-Time Control

You may wish to control data averaging in real time. BioSigRP provides several functions that allow you to override the current stimulus schedule. These functions include:

- Advance
- Skip
- Repeat
- ReDo
- Continuous
- Manual SGI Control
- Dynamic Variable Control

Note: In some cases, real-time control of data averaging will result in averaged signals based on some number < *n*, where *n* is the number of signals per average that you specified during setup. The actual number of signals used to compute the average is associated with the record and stored in the BioSig record file, (*.arf* file). It may be viewed from the BioSig Cursor Edit Screen (See "Chapter 5").



Advance

The Advance function causes the stimulus to advance to the next SGI specified in the stimulus schedule. This menu option is enabled in Averaging and Paused modes, only. When advance is chosen, the follow process occurs:

1. Stimulus presentation at the current SGI is halted.
2. The running average for the current SGI is saved to the BioSig record file (*.arf* file).
3. The averaged signal is appended to the history plot.
4. Stimulus presentation is advanced to the next SGI as defined in the stimulus schedule.
5. A new stimulus signal is generated based on the stimulus parameters for the new SGI.
6. Data averaging begins at the new SGI.

To advance data averaging to the next SGI

While in Averaging or Paused mode,

- Click the Advance button.

or

- Choose Advance from the Operations menu.

Skip

The Skip function causes the stimulus to skip the current SGI. This menu option is enabled in Averaging and Paused modes. The process is as follows:

1. The average for the current SGI is discarded.
2. Stimulus presentation is advanced to the next SGI specified in the stimulus schedule.
3. A new stimulus signal is generated based on the stimulus parameters for the new SGI.
4. Data averaging begins at the new SGI.

To skip the current SGI

While in Averaging or Paused mode,

- Click the Skip button.

or

- Choose Skip from the Operations menu.

Repeat

The Repeat function repeats the current SGI. This menu option is enabled in Averaging and Paused modes. The process is as follows:

1. The running average for the current SGI is saved to the BioSig record file (*.arf* file).
2. The averaged signal is appended to the history plot.
3. The stimulus is re-presented at the current SGI.
4. This second average is also saved to the BioSig record file (*.arf* file) and appended to the history plot.

To repeat the current SGI

While in Averaging or Paused mode,

- Click the Repeat button.

or

- Choose Repeat from the Operations menu.

ReDo

The ReDo function restarts the current SGI. This menu option is enabled in Averaging and Paused modes. The process is as follows:

1. The average for the current SGI is discarded.
2. The stimulus is re-presented at the current SGI.
3. This second average is saved to the BioSig record file (*.arf* file) and appended to the history plot.

To re-do the current SGI

While in Averaging or Paused mode,

- Click the ReDo button.

  or

- Choose ReDo from the Operations menu.

Continuous

Choosing Continuous causes BioSigRP to continuously average data. When Continuous is chosen, BioSigRP will continue to average response data indefinitely, regardless of *n*, the number of signals per average that you specified during setup.

To enable continuous data averaging

- Check the Continuous Avg. box.

  or

- Choose Continuous from the Operations menu.

To disable continuous data averaging

- Uncheck the Continuous box.

  or

- Choose Continuous from the Operations menu.

This will disable continuous data averaging. Data averaging will continue based on the acquisition parameters that you specified during setup.

To halt continuous data averaging

- Click the End button.

  or

- Choose End from the Operations menu.

This will end all data averaging.

Manual SGI Control

You may manually advance stimulus presentation through use of Manual SGI Control.

To enable manual control

- Check the Manual box.

To advance to the next SGI

- Click –>

To return to a previous SGI

- Click <–

Dynamic Variable Control

You may manually control stimulus presentation through the use of dynamic variables. A variable may be defined as dynamic during design in SigGenRP or during modification in BioSigRP. The value of a dynamic variable may be changed at any time during stimulus presentation.

To display all dynamic variables

1. Choose Dyn Controls from the View menu.

To change the current value of a dynamic variable

1. Hit the Current button.
2. Enter the desired value.
3. Click OK.

You may wish to dynamically specify a step value, or Delta value. A Delta value defines how the variable will be modified with each SGI. The Next button displays the projected value of the variable for the next SGI given the current Delta value.

To specify a Delta value

1. Click the Delta button.
2. Enter the desired Delta value.
3. Click OK.

You may wish to override the value of the variable for the next SGI.

To override the next value

1. Click the next button.
2. Enter the desired value.
3. Click OK.

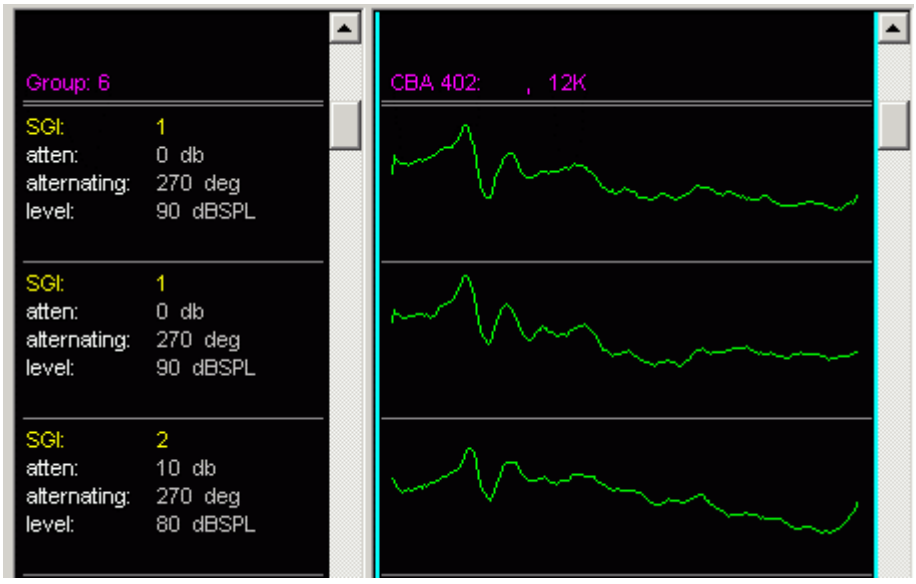
You may wish to decrement the variable by the specified Delta value. You may reverse the sign of the Delta value by clicking the +/1 Delta button.

Chapter 5 Data Analysis

BioSigRP provides numerous analysis functions. Using these functions you may:

- Obtain detailed information about specific records.
- Designate a history record for use as a comparison.
- Perform calculations involving one or more records.
- Build and print customized reports.

Using the History Plot and BioSig Record Files



BioSigRP's History Plot and BioSig record files are central to all BioSigRP data analysis capabilities.

The History Plot. From the History Plot, you may select records for further analysis. Signals are automatically appended to the History Plot as they are averaged.

BioSig Record Files. BioSig record files store averaged signals for later analysis. As signals are averaged they are appended to the currently defined BioSig record file (*.arf* file).

Through use of the History Plot and *.arf* files, you may easily average, organize, store, retrieve, and analyze signal records.

- Averaged data is automatically appended to the History Plot.
- Averaged data is automatically appended to the currently specified *.arf* file.
- Records may be retrieved from a specified *.arf* file for display in the History Plot at any time.
- Records may be saved to a separate *.arf* file.
- Records may be saved to an ASCII text file (*.txt* file) for use by other applications.
- Records may be deleted from an *.arf* file.

Specifying the Current BioSig Record File

See Chapter 3, "Defining Data Acquisition Parameters" for more information.

Prior to averaging data, you must specify the BioSig record file (*.arf* file) to which averaged data will be appended. You may specify the *.arf* file in one of two ways:

- You may specify a default *.arf* file during acquisition setup.
- You may define the current *.arf* file when prompted immediately prior to data acquisition.

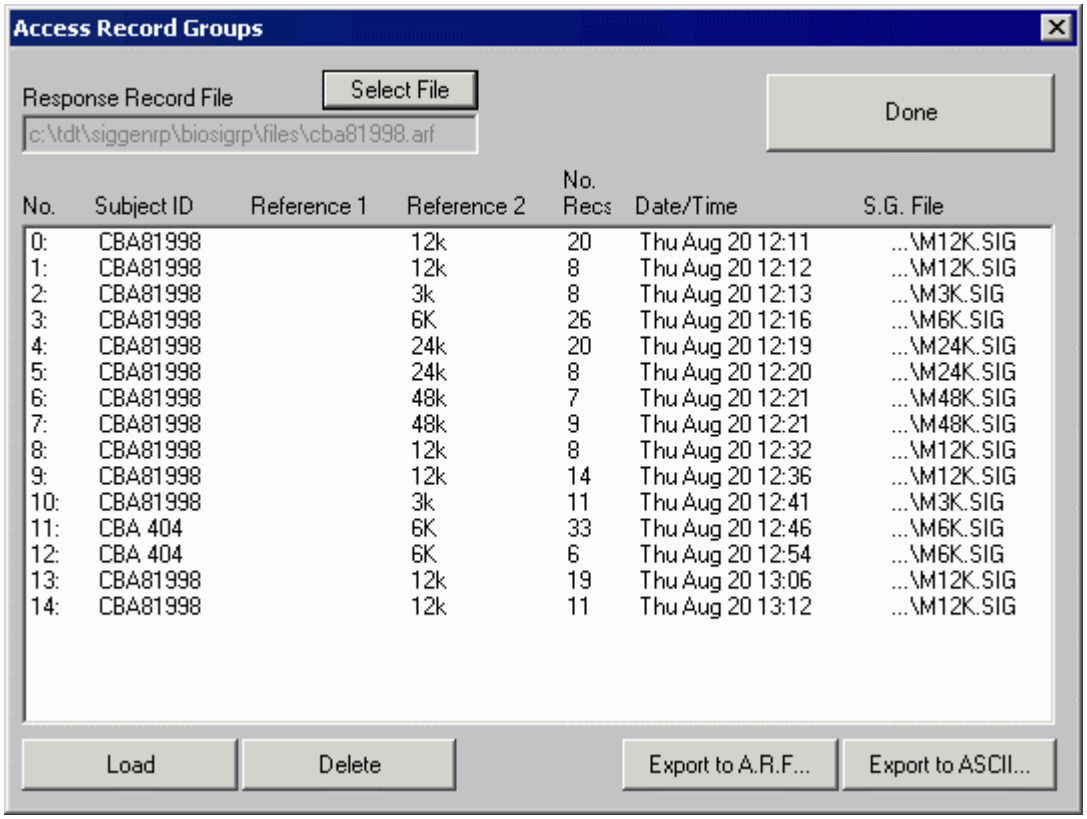
Loading Records

BioSigRP organizes averaged records into *groups*. A new group is begun each time you "Begin" data averaging and is ended each time you "End" data averaging. From the Access Record Groups dialog box, you may:

- Retrieve groups of averaged signals.
- Save specific groups to separate *.arf* files.
- Save specific groups to ASCII text files (*.txt* files).
- Delete groups of records from the *.arf* file.

To access the Access Record Groups dialog box

1. Choose Access Record File from the History menu.
2. Specify the desired file name and click OK.



The Access Record Groups dialog box displays the following information:

No. This column displays the group number.

Subject ID. The Subject ID associated with the group of records is displayed in this column.

Reference1. This column displays the Reference1 information assigned to the group.

Reference2. This column displays the Reference2 information assigned to the group.

No. Recs. The number of records in the group is displayed in this column.

Date/Time. This column displays the date and time the group of records was acquired.

S.G. File. The S. G. File column displays the name of the SigGen file used to generate the stimulus signal.

Selecting Groups

For a reminder on how to select items from a list in Windows, see Chapter 2.

Windows provides standard procedures for selecting/deselecting groups. You may use these procedures to select groups from the Access Record Groups dialog box.

To deselect all groups

➢ Click the Clear Selections button.

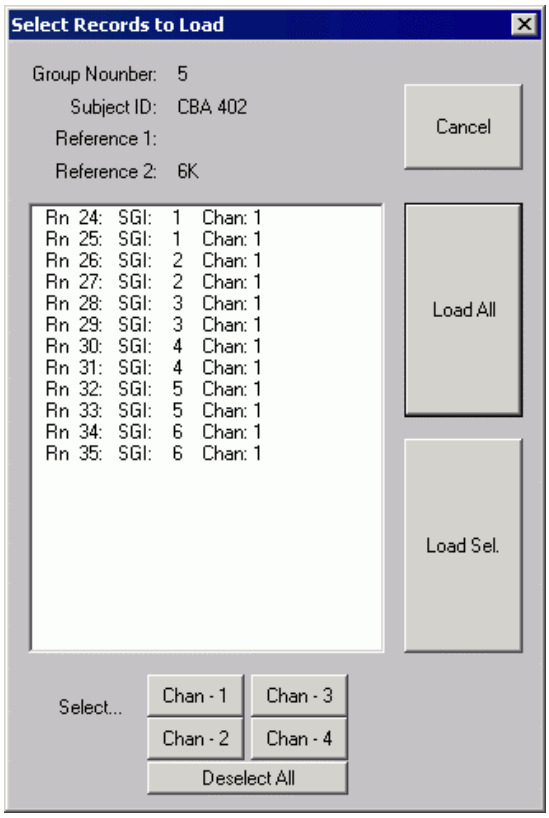
Performing Actions

Groups may be loaded into the History Plot, deleted from the *.arf* file, exported to another *.arf* file, or exported to an ASCII text file (*.txt* file).

To load, delete, or export a group of records

1. Select the desired groups.
2. Click the appropriate button.

Load. If the chosen action is Load, then you will see the Select Records to Load dialog box.



3. Select the record(s) you wish to load and hit Load Sel.

   or

   Load all the records by hitting Load All.

   You may manually select/deselect records for loading or you may use the Select... buttons to automatically select/deselect records.

Delete. If the chosen action is Delete, you will be prompted "Are you sure?" If you answer "yes," the selected groups will be deleted from the file. The Access Record Groups dialog box will remain open.

Export to ARF or **Export to ASCII**. If the chosen action is an export, you will be asked to supply the export file name. The selected groups will be saved to the designated file. The Access Record Groups dialog box will remain open.

Access Another BioSig Record File

To access another BioSig Record File

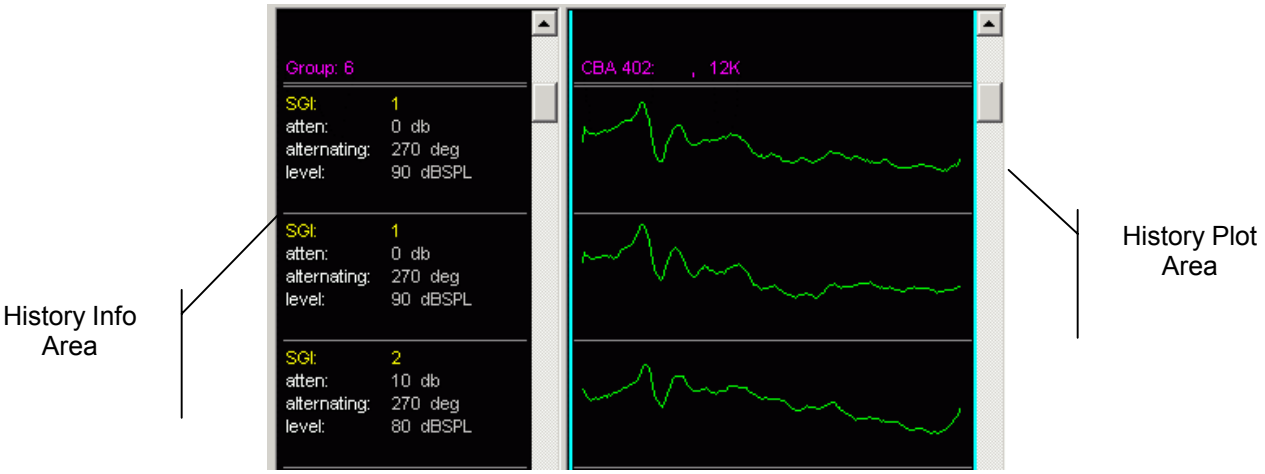
1. Click the Select File button.
2. Choose the desired file.

Closing the Load Record Group Dialog Box

To close the Load Record Group dialog box

➢ Click the Done button.

The History Plot



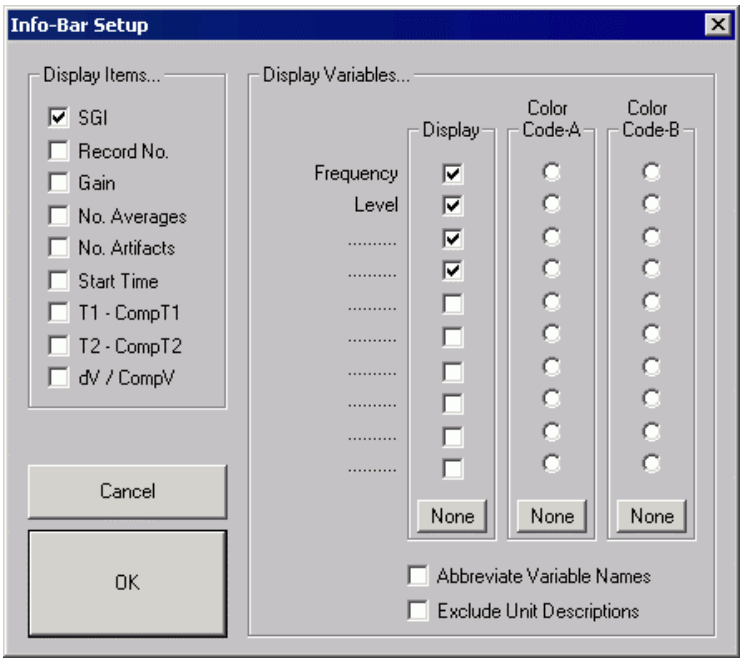
Customizing History Info

You may customize the information displayed in the History Info area.

To customize the History Info area

➢ Click the right mouse button in the History Info area.

You will see the Info-Bar Setup dialog box.



From this box you may specify items to be displayed in the History Info area. You may also associate a group color with a particular variable. Group colors are created from the General Display Options dialog box (See Chapter 2).

Display Items... From the Display Item group box, you may specify all information to be displayed in the History Info area. Display items consist of the following:

- SGI

  The current SigGen Index.

- Record No.

  The current record number.

- Gain

  The gain as currently defined in the Acquisition Setup dialog box.

- No. Averages

  The number of signals from which the average was calculated.

- No. Artifacts

  The total number of signals discarded due to artifact rejection.

- Start Time

  The start time of data acquisition.

- T1 - CompT1

The difference in milliseconds between Cursor 1 of the current record and Cursor 1 of the Comparison record.

- T2 - CompT2

  The difference in milliseconds between Cursor 2 of the current record and Cursor 2 of the Comparison record.

- dV/CompV

  Delta V percentage calculated as follows:

  *ΔV of the current record/ ΔV of the Comparison record * 100*

To select information for display in the History Info area

- Check the desired box.

  You may check multiple boxes.

Display Variables. You may specify which, if any, variables you wish to display. Chosen variable names and current variable values will be displayed for each record in the History Plot. You may also assign a color to a variable. Finally, you may customize the variable display by abbreviating the variable names or excluding the unit description (e.g., ms, Hz, dB).

To select variables for display in the History Info area

- Check the desired variable box.

  You may check multiple boxes.

To assign a color to a variable

1. Create the desired Group Color (A or B) from the General Display Options dialog box (See Chapter 2).
2. Check the desired color, Code-A or Code-B.

To abbreviate variable names

- Check the Abbreviate Variable Names check box.

All variable names will be abbreviated.

To exclude unit descriptions

- Check the Exclude Unit Descriptions check box.

All unit descriptions will be omitted from display.

Exporting History Plot Records

Groups of records can be reorganized through use of the Load Record Group dialog box. Individual records can be reorganized through use of the History Plot.

In Chapter 2, the procedure used to select History Plot records is described. Additional History Plot functionality is also presented.

Individual History Plot records may be exported to another *.arf* file or exported to an ASCII text file (*.txt* file).

To export History Plot records

1. Select the desired records.
2. Choose the appropriate action from the History menu.
3. Supply the file name.

The selected groups will be appended to the designated file.

Making a Comparison Record

BioSigRP allows you to choose a record for comparison with other data records. Any record currently displayed in the History Plot may be used as a comparison record.

The comparison record may be displayed in the Cursor Edit window. This window is explained in greater detail in the following section, "Viewing Records in Detail." The comparison record may also be displayed in the Multi-Purpose Plot during data acquisition.

To make a comparison record

1. Click the desired record.
2. Choose Toggle Comparison from the History menu.

or

- Ctrl+Double-click the desired record.

To display a comparison record in the Multi-Purpose Plot

1. Choose Show Comparison from the Multi-Plot menu.
2. Choose Running Average from the Multi-Plot menu.

The comparison record will be displayed along with the running average.

Viewing Records in Detail

You may wish to view individual history records in greater detail. From the Cursor Edit window, you may:

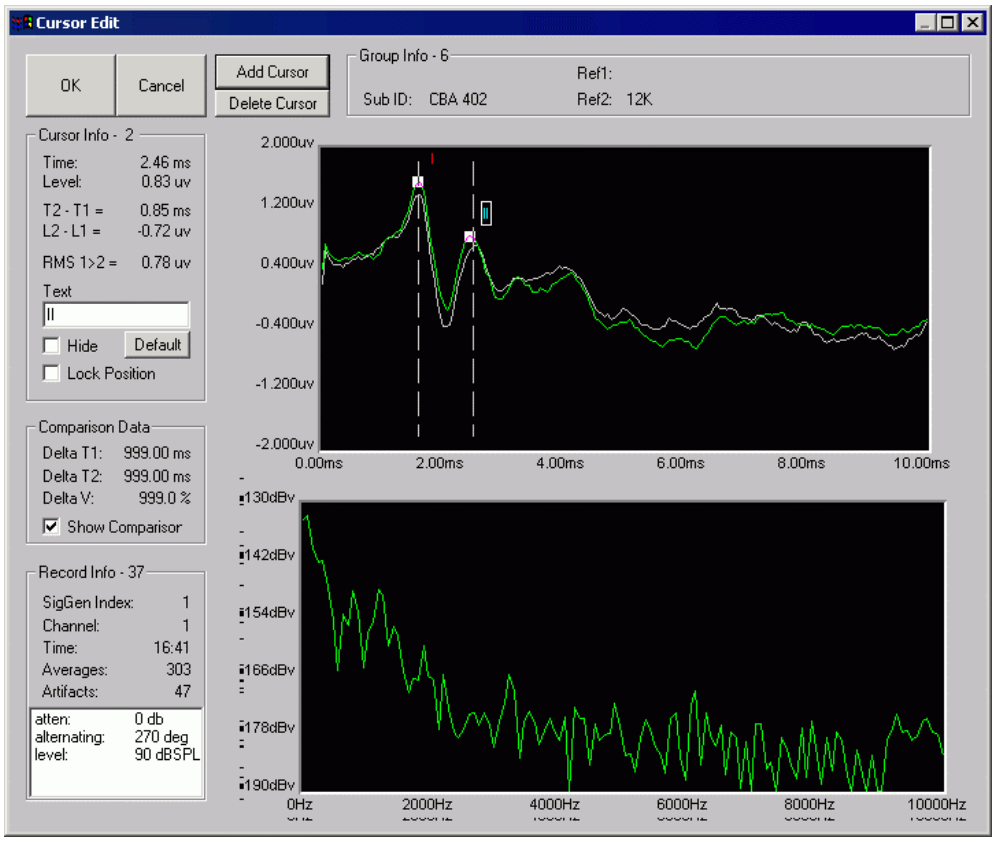
- View a more detailed plot of the time-domain waveform.
- View frequency-domain information.
- View subject information.
- Place cursors to obtain intensity and time information.
- View information pertaining to the SGI.

To access the Cursor Edit window

➢ Double-click the desired History Plot record.

or

1. Click the desired History Plot record.
2. Choose Edit Cursors from the History menu.



Time-Domain Plot

The Cursor Edit window contains two waveform plots. The upper plot displays the time-domain waveform. The x-axis is labeled in units of time. The y-axis is labeled in dB Volts.

Using Zoom

You may zoom-in on a portion of the time-domain waveform.

To zoom-in on a portion of the time-domain waveform

1. Place the mouse pointer at the beginning of the zoom area.
2. Hold down the left mouse button.
3. Drag the mouse pointer to the end of the zoom area.
4. Release the left mouse button.

To return to the original time-domain waveform

- Click the right mouse button anywhere in the Time-Domain Plot.

Frequency-Domain Plot

BioSigRP performs a Fast Fourier Transform (FFT) on the waveform displayed in the Time-Domain Plot. The resulting frequency-domain waveform is displayed in the lower plot on the BioSig Cursor Edit window. The x-axis is labeled in Hz. The y-axis is labeled in dB Volts.

Using Zoom

You may zoom-in on a portion of the frequency-domain waveform.

To zoom-in on a portion of the frequency-domain waveform

1. Place the mouse pointer at the beginning of the zoom area.
2. Hold down the left mouse button.
3. Drag the mouse pointer to the end of the zoom area.
4. Release the left mouse button.

To return to the original frequency-domain waveform

- Click the right mouse button anywhere in the Frequency-Domain Plot.

Subject Information

Subject information is displayed in the Group Info group box. This box displays the following information:

Group Info. Each time you initiate Averaging mode by choosing Begin, a new data group is created and appended to the end of the BioSig record file (*.arf* file) and to the end of the History Plot. Groups are numbered sequentially. The Group Info title displays the group number of the current record.

Subject ID: This read-only field displays the subject ID that you assigned during the initiation of Averaging mode.

Ref1 and **Ref2**. These read-only fields display other subject data that you assigned during the initiation of Averaging mode.

Memo. This read-only field displays any additional text information that you assigned during the initiation of Averaging mode.

Cursors

You may place up to 10 cursors in the Time-Domain Plot. Cursors may be used to obtain specific information concerning:

- Level at a specific point
- Time at a specific point
- Change in time (ΔT) between two points
- Change in voltage (ΔV) between two points

Working with Cursors

Cursors may be manipulated in various ways:

To place a cursor in the Time-domain Plot

- Double-click the desired position.

or

1. Click the Add Cursor button.
2. Move the Cursor to the desired position.

Note: Placing a cursor is more precise if you first zoom-in on a portion of the signal.

To move a cursor

1. Place the mouse above the cursor.
2. Hold down the left mouse button.
3. Drag to the desired position.

Note: Moving a cursor to a new position is more precise if you first zoom-in on a portion of the signal.

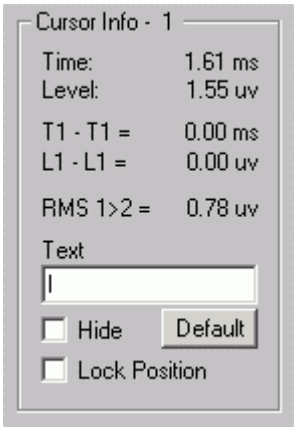
To select a cursor

1. Click the cursor.
2. The selected cursor text appears surrounded by a small box.

To delete a cursor

1. Select the desired cursor.
2. Click the Delete Cursor button.

Cursor Info



Information about the selected cursor is displayed in the Cursor Info group box.

Cursor Info. The title of the Cursor Info group box displays the number of the currently selected cursor.

Time. The Time field displays the time value associated with the currently selected cursor.

Level. The Level field displays the instantaneous intensity level associated with the currently selected cursor.

T*n* - T1. This field displays the difference in time (ΔT) between the selected cursor (Cursor *n*) and Cursor 1.

L*n* - L1. This field displays the difference in intensity (ΔL) between the selected cursor (Cursor *n*) and Cursor 1.

RMS 1>2. This field displays the RMS amplitude as calculated between cursors 1 and 2.

Text. The text field displays the label associated with the currently selected cursor. You may edit this label.

To edit the cursor label

1. Type the desired text in the Text field.
2. Click the cursor.

The cursor label will be updated.

To move the cursor label relative to the cursor

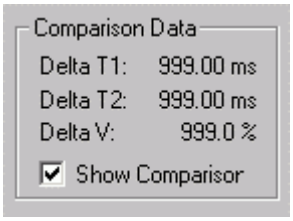
1. Place the mouse pointer over the desired label.
2. Hold down the left mouse button and drag the label to the desired position.
3. Release the left mouse button.

Default. Clicking the Default button causes the label of the currently selected cursor to return to its default setting.

Hide. Checking this box hides the label of the currently selected cursor.

Lock Position. You may lock the position of the currently selected cursor by checking the Lock Position box.

Comparison Data



Information about the relationship of the current record to the comparison record is displayed in the Comparison Data group box.

To display the comparison record

- Check the Show Comparison box.

The comparison record will be displayed in the Time-domain plot along with the current record. The location of cursors in the comparison plot will be displayed with vertical dashed lines.

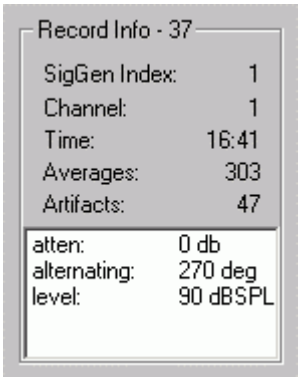
Delta T1. This field displays the difference in time between Cursor 1 of the current record and the comparison record.

Delta T2. This field displays the difference in time between Cursor 2 of the current record and the comparison record.

Delta V. This field displays a percentage value computed as follows:

*ΔV of the current record / ΔV of the Comparison record * 100*

Record Information



Information about the current record is displayed in the Record Info group box.

SigGen Index. The SGI associated with the current record is displayed in the SigGen Index field.

Channel. The current channel is displayed in the Channel field.

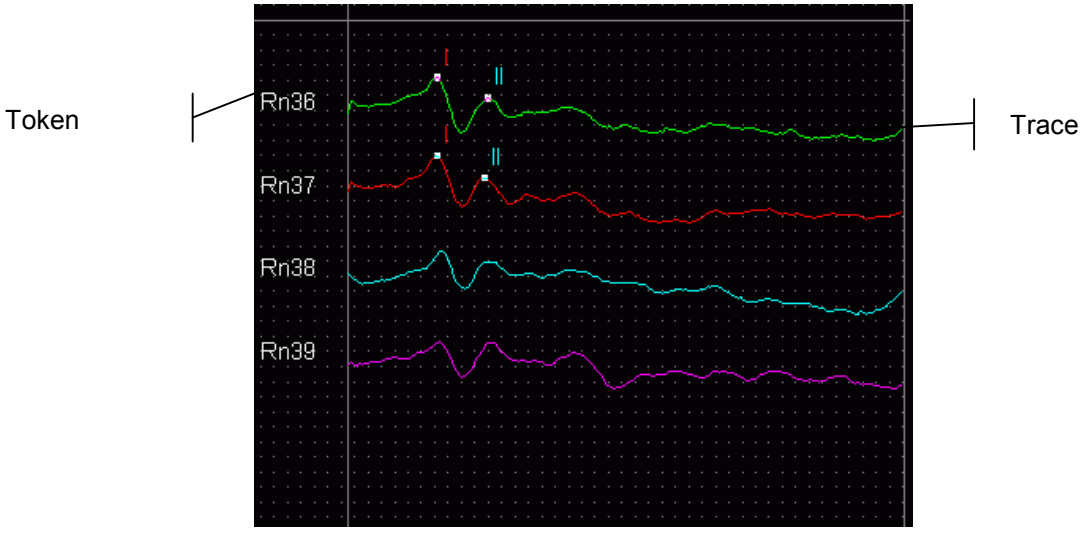
Time. The duration of the record is displayed in the Time field.

Averages. The number of sweeps included in the average is displayed in the Averages field.

Artifacts. The number of responses discarded due to artifact rejection is displayed in the Artifacts field.

Variables. The Variables box contains a list of all signal variables and their current values.

Using the Worksheet



You may use the Worksheet to set aside records for mathematical operation or to build and print reports. The process is simple and straightforward.

1. Place all desired History Plot records into the Worksheet.

2. Format tokens and traces.
3. Select records in the Worksheet for mathematical operations.
4. Perform mathematical operations using the Calculator.
5. View Worksheet records in detail.
5. Organize the report.
6. Print the report.

Placing Records

To place History Plot records into the Worksheet

1. Select the desired record(s).
2. Choose To Worksheet from the History menu.

   A box appears in the Worksheet.
3. Move the box to the desired location.
4. Click the left mouse button.

or

1. Select the desired record(s).
2. Drag the selected record(s) from the History Plot to the Worksheet.

The selected History Plot record(s) will be placed into the Worksheet.

Formatting Tokens and Traces

You may customize the following:

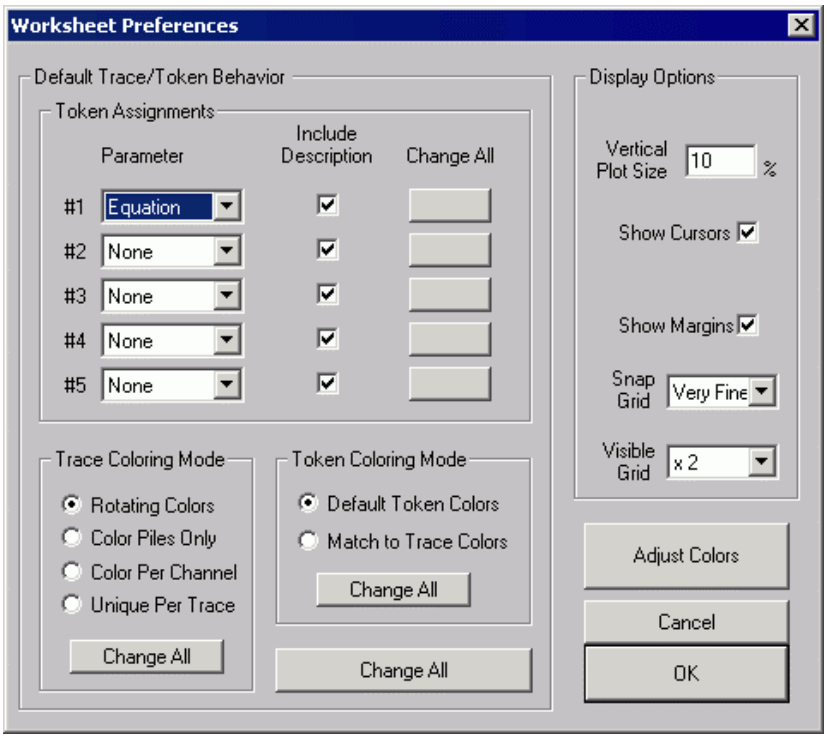
- The general worksheet area
- Specific tokens
- Specific traces

Customizing the General Worksheet

You may customize the Worksheet area from the Worksheet Preferences dialog box. This dialog box controls the *default* behavior of the Worksheet.

To access the Worksheet Preferences dialog box

➢ Click the right mouse button anywhere in the Worksheet, but not directly above a trace or a token.



The Worksheet Preferences dialog box is divided into two sections:

- Default Trace/Token Behavior
- Display Options

Preference settings located within the Default Trace/Token Behavior section affect trace or token parameters. These Worksheet preferences affect all records subsequently placed into the Worksheet. You can override these settings by specifically customizing tokens and traces as described in the following section, "Customizing Specific Tokens."

Parameter settings located in the Display Options section affect the Worksheet as a whole.

Token Assignments. You may assign up to five tokens for each Worksheet record. Tokens may consist of a variety of parameters.

Parameters. Token Assignment parameters may be selected from the Parameter list boxes found in the Token Assignments group box.

Include Description. Token Assignment parameters consist of a description and a number. For example, Channel and Record No. consist of a description ("Chan:" and "Rn:", respectively) followed by a number. By default, all token descriptions are displayed. You may choose to omit the description from the Worksheet display. To do so, simply uncheck the appropriate Include Description check box.

Trace Coloring Mode. You may wish to enhance the Worksheet display through the application of trace color. You may choose one of the following Trace Coloring Modes:

Rotating Colors. Causes trace colors to rotate. Rotating colors are assigned based on the Trace colors you defined in the Worksheet Display Options dialog box.

Color Piles Only. Assigns the same color to all records stacked in the same pile.

Color per Channel. Assigns unique trace colors for each channel.

Unique Per Trace. Assigns a unique color to each trace.

Token Coloring Mode. Token color may be assigned the following ways:

Default Token Colors. Assigns the token colors you defined in the Worksheet Display Options dialog box.

Match to Trace Color. Overrides the default token color and assigns the color of the associated trace.

Display Options. You may control the look of the overall Worksheet display by specifying the following:

Vertical Plot Size. Controls the vertical dimension of the plot.

Show Cursors. Displays any cursors placed in the record.

Show Margins. Shows/hides the margin lines used to separate Worksheet sections.

Snap Grid. Controls the fineness of the *Snap-to-Grid*. This is the invisible grid onto which all Worksheet objects snap into place.

Visible Grid. Controls the visible grid. You may choose no grid or control the resolution of the visible grid.

Adjust Colors. From the Adjust Colors button, you may modify color settings through the Worksheet Display Options dialog box.

Change All. Token and Trace preferences affect all records subsequently placed into the Worksheet. If you wish to change these preferences for records currently displayed in the Worksheet, you must click the appropriate Change All button.

Local Change All Buttons. You may modify existing Worksheet record parameters individually by clicking the appropriate "local" Change All button. Local Change All buttons are provided for the following:

- Token Assignment parameters
- Trace Coloring Mode settings
- Token Coloring Mode settings

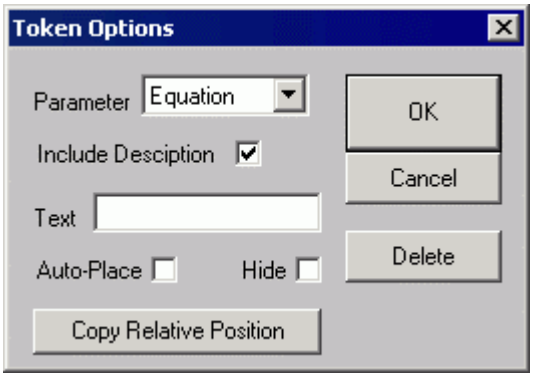
Global Change All You may modify existing Worksheet record parameters as a group by clicking the "global" Change All button. The Global Change All button simultaneously updates all parameters located in the Default Trace/Token Behavior section.

Customizing Specific Tokens

To customize a specific token

➢ Click the right mouse button on the desired token.

You will see the Token Options dialog box. From here you can modify the token, position the token, change its text, or cause it to be hidden.



Parameter and **Include Description**. You may change the Parameter and show/hide the token description. For more information, see the above section, "Customizing the General Worksheet."

Text. You may customize the token by entering the desired text in this field.

> **Note:** To change a token's text you must first choose User Text from the Parameter list.

Auto-Place. Realigns the token with its trace.

Hide. Hides the token.

Copy Relative Position. Copies the position of the token relative to its trace to all other traces and tokens.

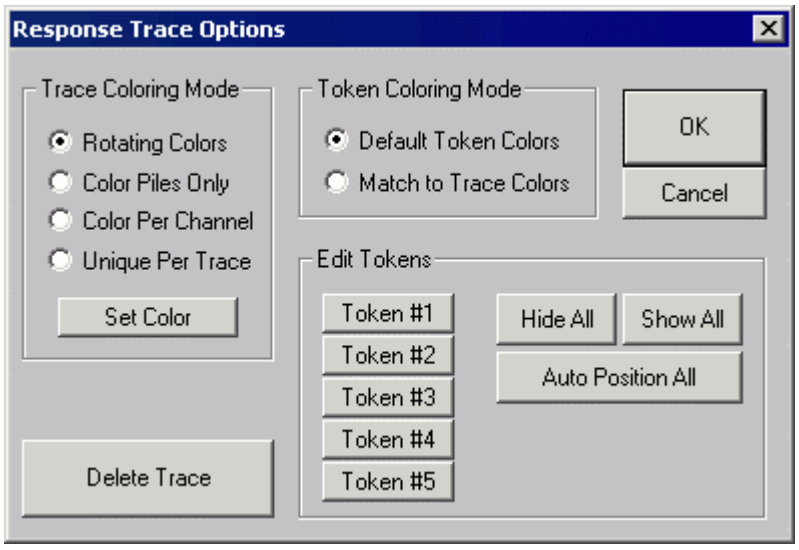
Delete. Deletes the token.

Customizing Specific Traces

To customize a specific trace

➢ Click the right mouse button on the desired trace.

You will see the Response Trace Options dialog box. From here you can modify the trace color, position the trace, edit its token, delete the trace, or cause its tokens to be hidden.



Trace Coloring Mode and **Token Coloring Mode**. You may set the Trace or Token coloring modes. For more information see the previous section, "Customizing the General Worksheet."

Set Color. This button accesses the Color dialog box, from which you may set custom colors.

Edit Tokens. You may edit the tokens associated with a specific trace. Clicking the desired token button opens the Token Options dialog box (see previous section).

Hide All. Hides all tokens associated with the current trace.

Show All. Shows all tokens associated with the current trace.

Auto Position All. Realigns all associated tokens with the current trace.

Delete Trace. Deletes the current trace.

Selecting Worksheet Records

Various Calculator and Worksheet formatting functions require the selection of one or more record.

To select specific records

- Ctrl+Click the desired trace(s).

The record's token will appear in reverse video.

Note: You must Ctrl+Click the trace. A Ctrl+Click on the token will not select the record.

To select all records

- Choose Select All from the Worksheet menu.

or

- Hit the Spacebar.

To select contiguous records

1. Hold down Ctrl and the left mouse button.
2. Drag until the box surrounds all desired records
3. Release the left mouse button and the Ctrl key.

To deselect specific records

- Ctrl+Click the desired selected trace(s).

Note: You must Ctrl+Click the trace. A Ctrl+Click on the token will not deselect the record.

To deselect all records

- Choose Deselect All from the Worksheet menu.

or

- Hit Ctrl+Space bar.

Performing Mathematical Operations

You may perform a variety of mathematical operations on Worksheet records. These operations are described in detail in the following section, "Using the Calculator."

To perform a mathematical operation

1. Select the desired Worksheet record(s).
2. Click the appropriate Calculator button.

   or

   Choose the appropriate Calculator menu option.

Viewing Worksheet Records in Detail

You may view a worksheet record in detail from the BioSig Cursor Edit dialog box.

To access the BioSig Cursor Edit dialog box

- Double click on the desired Worksheet record.

Organizing the Report

Moving a Record

You may move individual records. Moving a record moves both the trace and all associated tokens.

To move a record

1. Place the mouse pointer over the trace.
2. Hold down the left mouse button.
3. Drag the record to the desired position.
4. Release the mouse button.

Note: You must place the mouse pointer over the trace. Placing the mouse pointer over the token will move the token only.

To move a group of records

1. Select the desired records.
2. Place the mouse pointer over a selected trace.
3. Hold down the left mouse button.
4. Drag the records to the desired position.
5. Release the mouse button.

Note: Selected records always move as a block. If you wish to move only one record of a selected block, deselect the record, move it, and then re-select the record.

Moving a Token

You may wish to move a token relative to its associated trace.

To move a token

1. Place the mouse pointer over the token.
2. Hold down the left mouse button.
3. Drag the token to the desired position.
4. Release the mouse button.

Using the Worksheet Buttons

Located below the Calculator, the five Worksheet buttons can be used to format and organize the Worksheet. These functions may also be found in the Worksheet menu.

Button	Menu Option	Action
	Space Evenly	Spaces all selected plots evenly throughout the Worksheet.
	Spread Apart	Spreads all selected plots apart.
	Squash Together	Squashes all selected plots together.
	Pile	Piles all selected plots on top of one another.
	UnPile	Unpiles all selected plots.
	Delete	Deletes the currently selected Worksheet records.

Printing a Report

BioSigRP provides the standard Windows functions: Print Setup, Print Preview, and Print.

To setup the printer

- Choose Print Setup... from the File menu.

To preview the Worksheet

- Choose Print Preview from the File menu.

To print the Worksheet

- Choose Print... from the File menu.

Saving Data to an ASCII File

All Worksheet data may be saved to an ASCII file. Such data can be accessed by other applications.

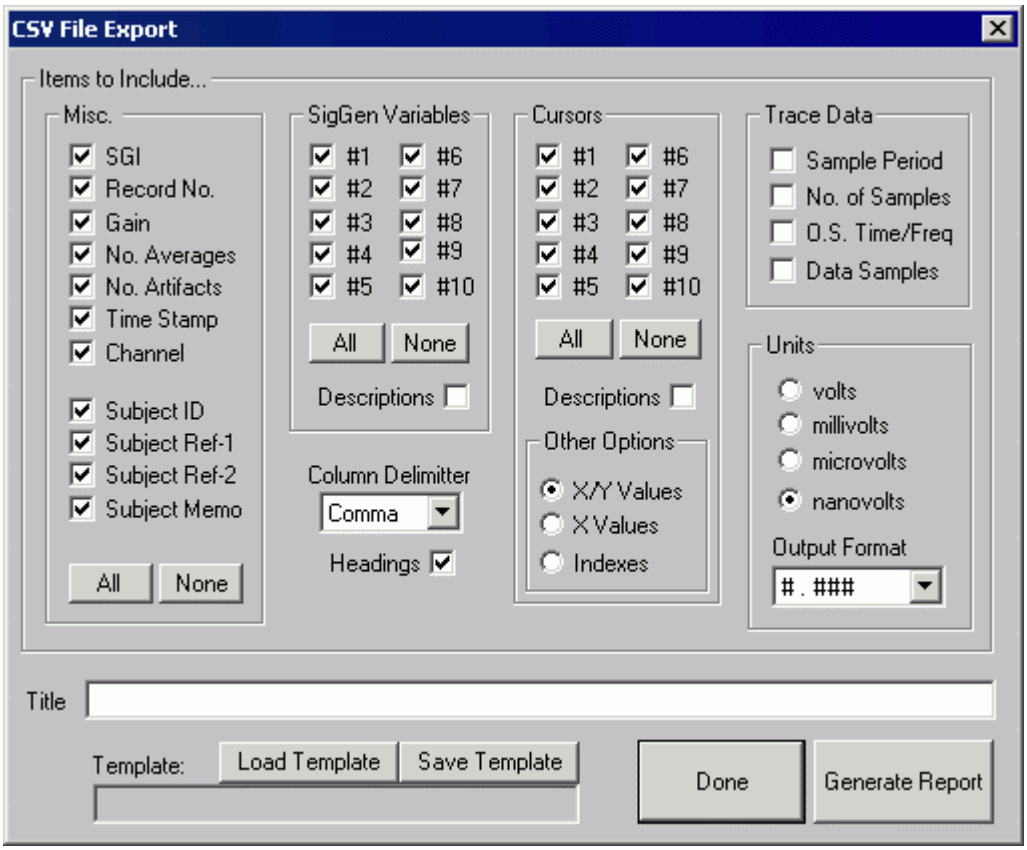
To save Worksheet data to an ASCII file

- Choose Export to Ascii... from the Worksheet menu.

  You will be prompted to name the file.

Worksheet Enhanced File Export

The Export to CSV option allows you to export raw trace data along with descriptors into a standard spreadsheet file. Each row in the spreadsheet file contains all of the data for one record.



Selecting Items

You may select one or more miscellaneous item, SigGen variable, or cursor.

To select individual items

- Check the appropriate box.

To select all items within a box

- Click All.

To deselect all items within a box

- Click None.

Misc. and SigGen Variables

Saves the selected fields to the spreadsheet file.

Cursors

X/Y Values

Exports both X and Y values for cursors.

X Values

Exports only X values for cursors. Does not export Y values.

Indexes

Exports the indices of the cursors. This indicates which sample in the waveform the cursor was located on.

Trace Data

Sample Period

Sampling period in microseconds of the acquired data.

No. Samples

Number of samples in the trace

O.S. Time/Freq

Offset of the first point in waveform in ms for Time or Hz for Frequency.

Data Samples

Saves the data for the waveform

Units

Scales the output to the units that are selected. For example, a cursor value that is .0001 V, will be output as 100.0 μV if microvolts is selected.

Output Format

Sets the output format of the data. For example #.### will export data to three significant digits.

Template

Saves the export settings from the CSV File Export dialog box to a file that can be reloaded later.

Report Name

You must specify how the report is to be formatted. Additionally, you may give the report a title.

To define a title

- Enter the title in the Title field.

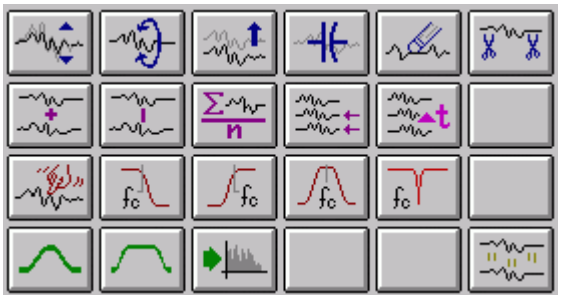
Generating the Report

To generate the report

➢ Press the Generate button.

Using the Calculator

The calculator provides numerous mathematical functions that may be applied to one or more Worksheet records.



Calculator Functions

- ❑ Scale
- ❑ Invert BioSig
- ❑ Shift Baseline
- ❑ Remove Baseline
- ❑ Zero Points
- ❑ Crop
- ❑ Add
- ❑ Subtract
- ❑ Average
- ❑ Time Align
- ❑ Time Shift
- ❑ Smooth
- ❑ Lowpass Filter
- ❑ Highpass Filter
- ❑ Bandpass Filter
- ❑ Notch Filter
- ❑ Hanning Window
- ❑ Cosine^2 Window
- ❑ Mag Spectrum
- ❑ Auto Cursor

Scale

The Scale function multiples each point in the selected Worksheet record(s) by a user-defined constant. This function may be used to increase or decrease the scale of a waveform displayed in the Worksheet. By specifying a negative scale factor, you may also invert the selected Worksheet record(s).

To scale a Worksheet record

1. Select the desired record(s).
2. Click 

   or

   Choose Scale from the Worksheet menu.

You will be prompted to enter the desired scale factor. This factor must be no less than $-(10^{10})$ and no greater than 10^{10}.

Invert BioSig

Invert BioSig multiplies each point in the selected Worksheet record(s) by -1, thereby inverting the waveform while maintaining its original scale.

To invert a Worksheet record

1. Select the desired record(s).
2. Click 

   or

   Choose Invert BioSig from the Worksheet menu.

Shift Baseline

The Shift Baseline function adds a user-defined constant, or DC offset, to each point in the selected records(s), effectively shifting the baseline.

To add a DC offset to a Worksheet record

1. Select the desired record(s).
2. Click 

   or

   Choose Shift Baseline from the Worksheet menu.

You will be prompted to enter the DC offset. This offset must be no less than -1000 microvolts and no greater than 1000 microvolts.

Remove Baseline

A DC offset may be removed through the use of Remove Baseline.

To remove a DC offset from a Worksheet record

1. Select the desired record(s).
2. Click 

   or

   Choose Remove Baseline from the Worksheet menu.

Zero Points

The Zero Points function allows you to "zero out" a specific portion of a Worksheet record. Zero Points will convert each point within the specified time range to a value of zero.

To zero a portion of the record

1. Select the desired record(s).
2. Click 

   or

   Choose Zero Points from the Worksheet menu.

You must specify the time interval within which you wish to convert all level values to zero. You will be prompted to enter a lower time boundary and an upper time boundary.

Add

The Add function adds two or more Worksheet records.

To add Worksheet records

1. Select two or more records.
2. Click 

   or

   Choose Add from the Worksheet menu.

   A box appears in the Worksheet.
3. Move the box to the desired location.
4. Click the left mouse button.

The resulting record will be added to the Worksheet.

Subtract

The Subtract function allows you to subtract one Worksheet record from another.

To subtract one Worksheet record from another

1. Select the record from which you wish to subtract.
2. Select the record you wish to subtract.
3. Click 

   or

   Choose Subtract from the Worksheet menu.

   A box appears in the Worksheet.
3. Move the box to the desired location.
4. Click the left mouse button.

The resulting record will be added to the Worksheet.

Average

The Average function calculates the average of two or more records.

To average Worksheet records

1. Select two or more records.
2. Click 

   or

   Choose Average from the Worksheet menu.

   A box appears in the Worksheet.
3. Move the box to the desired location.
4. Click the left mouse button.

The resulting record will be added to the Worksheet.

Time Align

The Time Align function lines up two or more records according to values on the time axis. Records will be aligned with the first selected record of the group.

To time align Worksheet records

1. Select two or more records.
2. Click 

   or

   Choose Time Align from the Worksheet menu.

The records will be aligned in time.

Time Shift

The Time Shift function shifts the selected record(s) along the time axis.

To time shift Worksheet records

1. Select the desired record(s).
2. Click 

   or

   Choose Time Shift from the Worksheet menu.

You will be prompted to enter the amount of time shift in milliseconds. This number can be no less than -100 ms and no greater than 100 ms.

Note: Once data points have been time-shifted off the Worksheet display, they cannot be retrieved. These points in effect no longer exist. All such points will appear as zero.

Smooth

The Smooth function smoothes a selected Worksheet through application of an averaging algorithm. The record is averaged with a shifted version of itself.

To smooth a Worksheet record

1. Select the desired record(s).
2. Click 

   or

   Choose Smooth from the Worksheet menu.

You will be prompted to enter the number of smooth points. This is the number of points to be included in the average. For example, specification of 2 smooth points will cause the record to be average with a second version of itself shifted by one point. Specification of 3 smooth points will result in an average based on the original record, a version of the record shifted by one point, and a version of the record shifted by two points.

The resulting record will be added to the Worksheet.

Filtering

BioSig provides functions allowing you to lowpass, highpass, bandpass filter, or notch filter Worksheet records. BioSig performs filtering through use of a Butterworth filter.

In order to specify a filter, you must define certain filter parameters. These parameters include:

- Corner frequency

  Frequency at which the level has decreased by 3 dB.

- Center frequency

  The center frequency of a bandpass filter.

- Filter Bandwidth

  The bandwidth between lower and upper corner frequencies of a bandpass filter. Filter bandwidth is defined in octaves. Filter bandwidth must be at least 0.01 octave and no greater than 10 octaves.

- Filter order

  The number of poles necessary to achieve a desired roll-off rate. Roll-off rate = 6 dB per octave per pole. Number of poles must be an even number. Number of poles must be at least 2 and no greater than 20.

Example: Specifying a Filter

You may wish to specify a lowpass filter with a -3 dB frequency of 4000 Hz and a roll-off of 120 dB per octave. You would define the following parameters:

Corner frequency = 4000 Hz

Filter order = 20 poles.

120 dB per octave/ 6 dB per octave = 20 poles

To filter a Worksheet record

1. Select the desired record(s).

Lowpass/Highpass Filter

2. Click  or 
3. Enter corner frequency.
4. Enter filter order.

Bandpass or Notch Filter

2. Click  or 
3. Enter center frequency.
4. Enter filter bandwidth.
5. Enter filter order.

Part 2 Illustrative Examples

Chapter 6 Quick Start Examples

The Quick Start examples presented in this section illustrate common procedures for collecting ABR audiogram data. Quick Start examples are designed to introduce important concepts. Ready-to-use application files are provided for each Quick Start example.

Learn New Concepts

Each example in this section provides step-by-step instructions you may use to build the Quick Start example from scratch. Along the way, you will be introduced to important concepts. These concepts are always indicated with the icon currently seen in the left margin.

The examples found in this section are listed below. Also listed are the concepts introduced in each example.

Example 1: Using a Tone Stimulus

- Value List
- Repeat Factor
- Boundary Control
- Loop
- Gate Type
- Gain

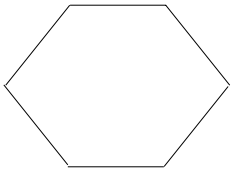
Example 2: Using a Click Stimulus

- Alternating Variable
- Combination Variable
- Uniphasic Click

Get a Quick Start

Completed SigGen and BioSig files are provided for all examples in this section. If you prefer, you may use these files, bypassing the step-by-step instructions. Quick Start file names are listed at the beginning of each example. Look for these files whenever you see the Quick Start icon currently displayed in the left margin. Instructions for accessing these files and running the applications appear in boxes and are always located next to a Quick Start icon.

Example 1: Using a Tone Stimulus



This experiment is designed to gather auditory brainstem response (ABR) data in response to a pure tone stimulus. Five millisecond tones will be presented at the following frequencies: 500 Hz, 1000 Hz, 2000 Hz, and 4000. For each frequency, tone level will vary from 80 dB SPL to 5 dB SPL in 5 dB decrements.

The Quick Start files necessary to run this experiment are as follows:

SigGen signal file
C:\TDT\SigGenRP\BioSigRP\Files\tnstRP.sig

BioSig configuration file
C:\TDT\SigGenRP\BioSigRP\Files\tnstRP.acf

To run the experiment, you will need to perform the following steps:

1. Build the SigGen Signal.
   a. Run SigGenRP.
   b. Define the signal parameters.
   c. Define frequency and level variables.
   d. Create the segment and component.
   e. Save the SigGenRP File.
2. Run the experiment with BioSigRP.
   a. Run BioSigRP.
   b. Setup the stimulus parameters.
   c. Setup the acquisition parameters.
   d. Save the *.acf* file.
   e. Run the experiment.
   f. Analyze the data.

- ✓ *Value List*
- ✓ *Repeat Factor*
- ✓ *Boundary Control*
- ✓ *Loop*
- ✓ *Gate Type*
- ✓ *Gain*

Note: Only those parameters to be entered or selected are given below. All other parameters will remain according to the default settings.

Building the SigGen Signal

In this example, you will use TDT's signal generation software, SigGenRP, to create the stimulus signal. The duration of the entire stimulus will be 5 milliseconds, the minimum allowed in SigGenRP. Tones will be presented at the following frequencies: 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. For each frequency, level will vary from 80 dB SPL to 5 dB SPL in 5 dB decrements.

Run SigGenRP

To run SigGenRP

- Double-click the SigGenRP icon.

To build the SigGenRP signal from scratch

- Choose New from the File menu.

BioSigRP\files\tnst.sig

To follow along using a Quick Start file

1. Choose Open from the File menu.
2. Select the file listed in the left margin.

To bypass the SigGenRP signal design process

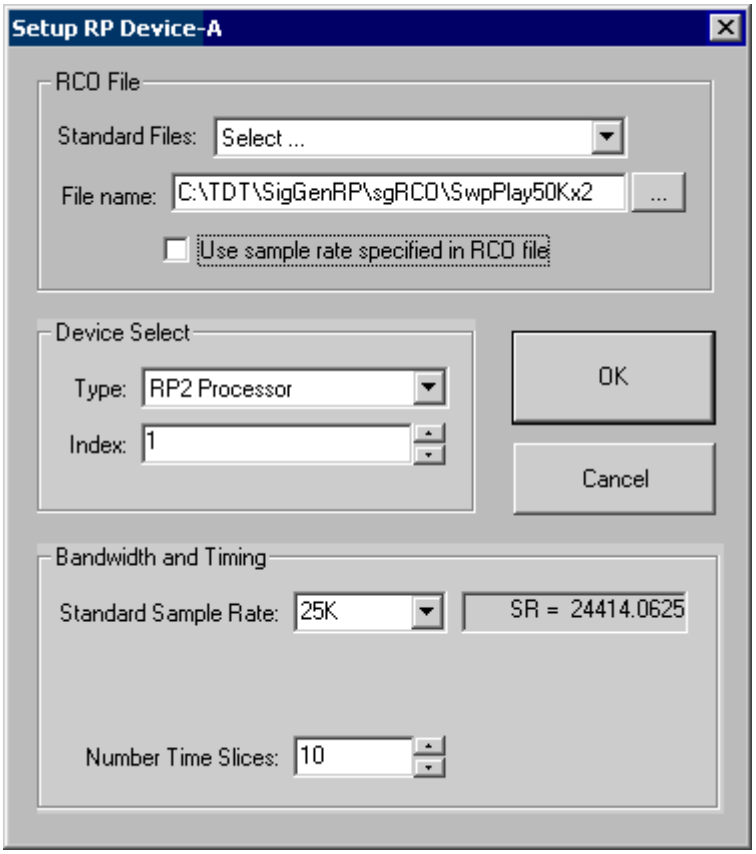
- Exit SigGenRP by choosing Exit from the file menu and skip to **Running the BioSigRP Experiment.** (Look for the Quick Start icon!).

Configure the RPx device and RCO file

For System 3 equipment SigGenRP uses the RPx device and RCO files (See RPvds help) to play out signals.

To configure the RPx device and select the RCO file

1. Select RP devices|Device A from the Modify menu or click on the "A" icon on the tool bar.
2. Select from the Standard file menu "Sweep Play, 2 Chan 50k (100k max).
3. Select RP2 Processor as device type.
4. Select Index 1.
5. Deselect "Use sample rate specified in RCO file."
6. Under Bandwidth and Timing change the Standard Sample Rate to 25kHz (ignore the number of time slices).



The RPx device selected determines what hardware device (RP2.1, RV8, RA16) is used to generate the stimulus, the number of channels, and the sample rate.

Define the Signal Parameters

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

Name:	*Tone*
Timing	
Duration:	5 milliseconds
Calibration	
Level:	90 dB = 9 volts

Note: This is a temporary calibration setting. You should set the calibration values according to the output of your system.

Define the Variables

This example will use two variables. The first, *Freq*, will vary the tone frequency as follows: 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. The second, *Level*, will cause the tone level to vary from 80 dB SPL to 5 dB SPL in 5 dB decrements for each frequency.

Controlling Frequency

Tone frequency will be controlled through use of the variable, *Frequency*. The values of this variable will be determined through a method known as *Value List. Value List* allows you to specify a sequential list of values.

Because each frequency will be presented at 16 output levels, a *Repeat Factor* of 16 must be defined for the variable *Frequency*.

Stimulus presentation will be controlled through the use of a feature called *Boundary Control*. When boundary control is enabled, data acquisition halts once the boundary conditions have been met.

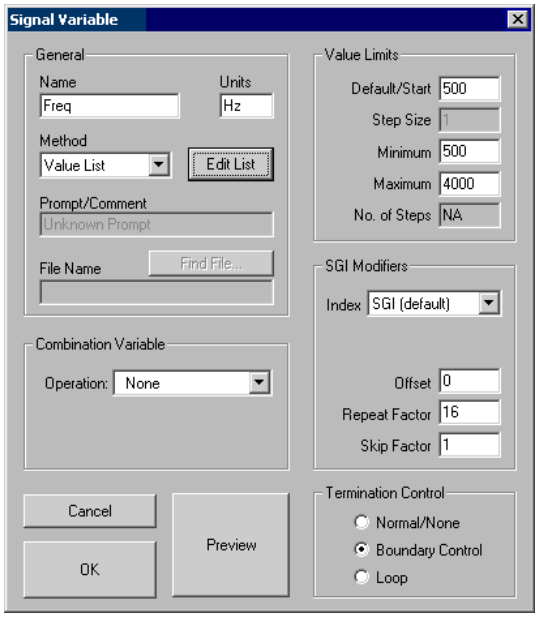
To define the variable, Freq

1. Select Signal from the Modify menu of the main window.
2. Click the Edit button in the Variables group box of the Signal Parameters dialog box.
3. Enter or select the following parameters in the Signal Variable dialog box:

   General
   Name: *Freq*
   Method: Value List

4. Click Edit List and enter the following:
   500
   1000
   2000
   4000
5. Set the remaining parameters as follows:

Value Limits		SGI Modifiers	
Default/Start:	500	Repeat Factor:	16
Minimum:	500	Termination Control	
Maximum:	4000	Boundary Control:	⊙



To accept the variable parameters and return to the Signal Parameters dialog box

➢ Click the OK button in the Signal Variable dialog box.

Controlling Output Level

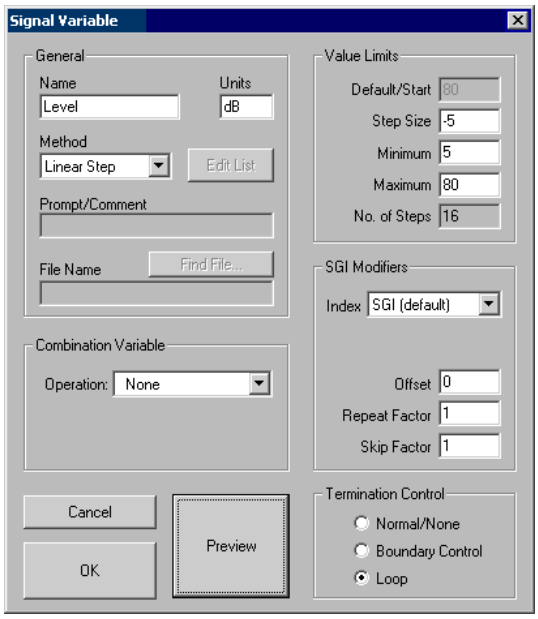
Output level can be controlled by employing one of two types of attenuation: digital attenuation or analog attenuation. When using digital attenuation, level is controlled by modifying the signal parameters through SigGenRP. When using an analog attenuator such as a PA5, level is controlled via the hardware device. In this example, digital attenuation is used. For an example of analog attenuation, see *Chapter 7*.

Tone level will be controlled digitally through the use of the variable, *Level*. For each tone frequency, *Level* will vary from 80 dB to 5 dB in 5 dB decrements. Because the values of *Level* must repeat for each value of *Frequency*, *Level* must be defined with a Termination Control of *Loop*.

To define the variable, Level

1. Click on 2. ..... in the Variables list box.
2. Enter or select the following parameters in the Signal Variable dialog box:

General		Value Limits	
Name:	*Level*	Default/Start:	80
Units:	dB	Step Size:	-5
Method:	Linear Step	Minimum:	5
		Maximum:	80
		Termination Control	
		Loop:	⊙



To accept the variable parameters and return to the Signal Parameter dialog box

➢ Click the OK button in the Signal Variable dialog box.

To accept the signal parameters and return to the SigGenRP main window

- Click the OK button in the Signal Parameters dialog box.

Create the Segments and Components

Each SigGen signal consists of at least one segment. Each segment in turn consists of one to three components. In this example, the tone consists of one segment which in turn consists of one component.

Creating the Segment

You will be creating a segment that consists of one component, a pure tone. SigGenRP provides a method for gating the pure tone segment, *Gate Type*. You will be defining a *Gate Type* of Cos2 and a *Gate Time* of 2 milliseconds.

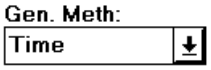
To create the segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

Select:	Seg[1]
Gate Type:	Cos2
Gate Time:	2 msec
Duration:	5 msec

Creating the Component

You may generate a tone in either the time domain or the frequency domain. Generation method is specified in the Gen. Meth field. *Time* is the default generation method. Time domain generation is employed in this example.



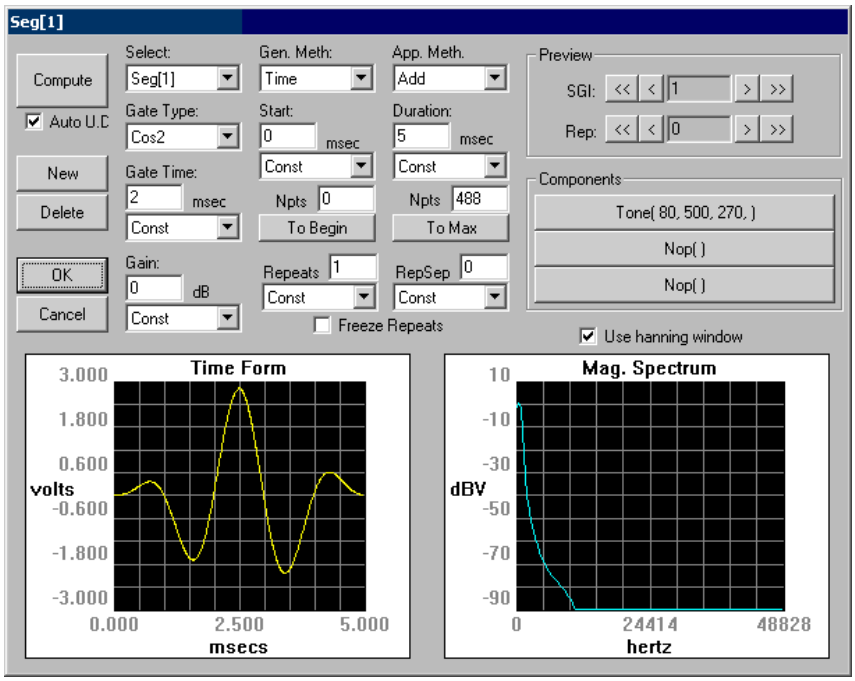
To create a component for the segment

1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

Call:	Tone
Level:	Choose the variable, *Level*
Frequency:	Choose the variable, *Freq*
Phase:	270

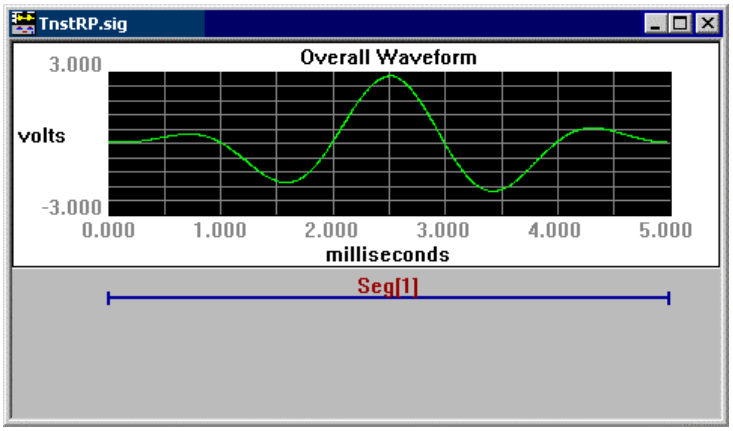
Note: Phase is specified in degrees Cosine. In order to generate a signal with a zero crossing onset, Phase must be defined as 270 degrees.

3. Click the OK button to accept the component parameters.



To return to SigGenRP's main window

- Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen file to generate a stimulus signal through BioSigRP.

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SigGenRP\BioSigRP\Files\tnst2.sig* in the File Name field.

Running the BioSigRP Experiment

Once you have designed the stimulus signal with SigGenRP and saved the SigGen file, you are ready to setup BioSigRP and begin collecting ABR data. In this example, you will present the single-channel stimulus signal via headphones and acquire single-channel response data. This example assumes that you will amplify and filter the ABR response data prior to digitization. BioSigRP will collect 10 milliseconds of ABR data for each stimulus presentation. Averaged ABR data will be computed using an *N* of 500.

Run BioSigRP

To run BioSigRP

- Double-click the BioSigRP icon.

Note: To run this experiment, you must either create the BioSig file by following along with the step-by-step instructions or open the existing Quick Start file.

BioSigRP\files\tnst.acf

To use a Quick Start file

1. Choose Open from the File menu.
2. Select the file listed in the left margin.

To bypass experiment setup and begin running the experiment

- Skip to **Run the Experiment**.

Setup the Stimulus Parameters

During stimulus setup, you will define the presentation rate, and specify the SigGen file.

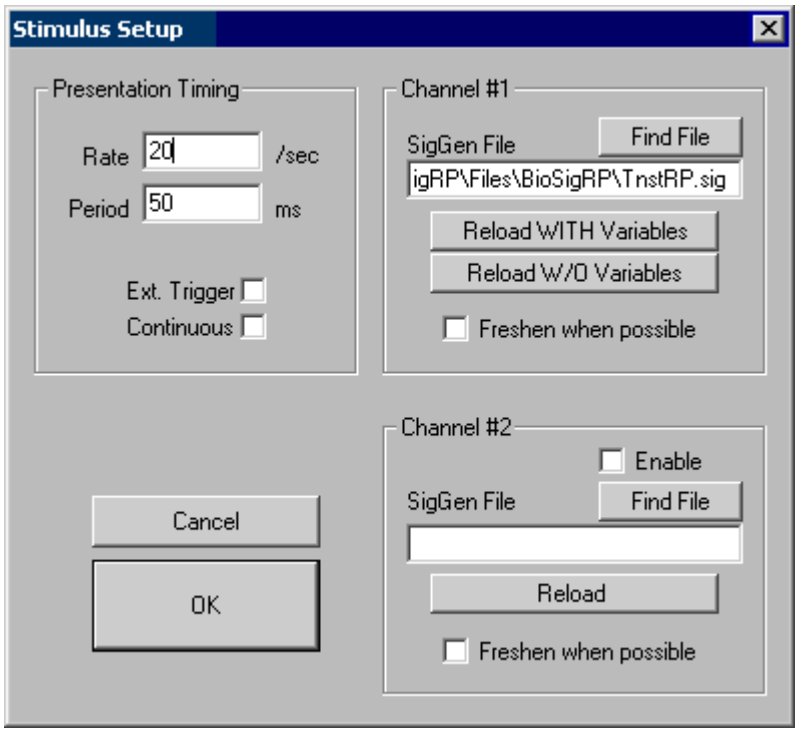
The *Presentation Rate* is the number of times the stimulus will be presented per second. The *Presentation Period*, measured in milliseconds, is the inverse of the Presentation Rate. The Presentation Period must be at least 1.25 times the total amount of time required to present the stimulus signal and acquire response data. For this example, a rate of 20 presentations per second, or a period of 50 milliseconds, will be sufficient.

Previously, you saved the stimulus signal parameters in a SigGen file called *tnst2.sig*. Now you must specify the stimulus channel in BioSigRP. You may use the file you created, *tnst2.sig*, or the one provided, *tnst.sig*. You must specify one of these two files in the Channel 1 SigGen File field. The stimulus parameters found in the SigGen file will be read by BioSigRP and used to generate the stimulus signal. Later, when you save the BioSig configuration file (*.acf* file), these parameters will be saved within that file.

To setup the stimulus parameters

1. Select Stimulus from the Setup menu of the main window.
2. Enter or select the following parameters in the Stimulus Setup dialog box:

Presentation	
Rate:	20 /sec
Period:	50 milliseconds
Channel #1	
SigGen File:	*C:\TDT\SigGenRP\BioSigRP\Files\tnst.sig (or tnst2.sig)*



To accept the stimulus setup parameters and return to the main window

- Click OK.

Setup the Acquisition Parameters

Prior to running the experiment, you must define the acquisition timing parameters and specify a record file (*.arf* file).

Acquisition timing parameters include: *Onset Delay*, the delay in onset of data acquisition from the beginning of stimulus presentation; *Duration*, the duration of the acquired signal; and *Sample Period*, the time between successive data points of the digital response signal.

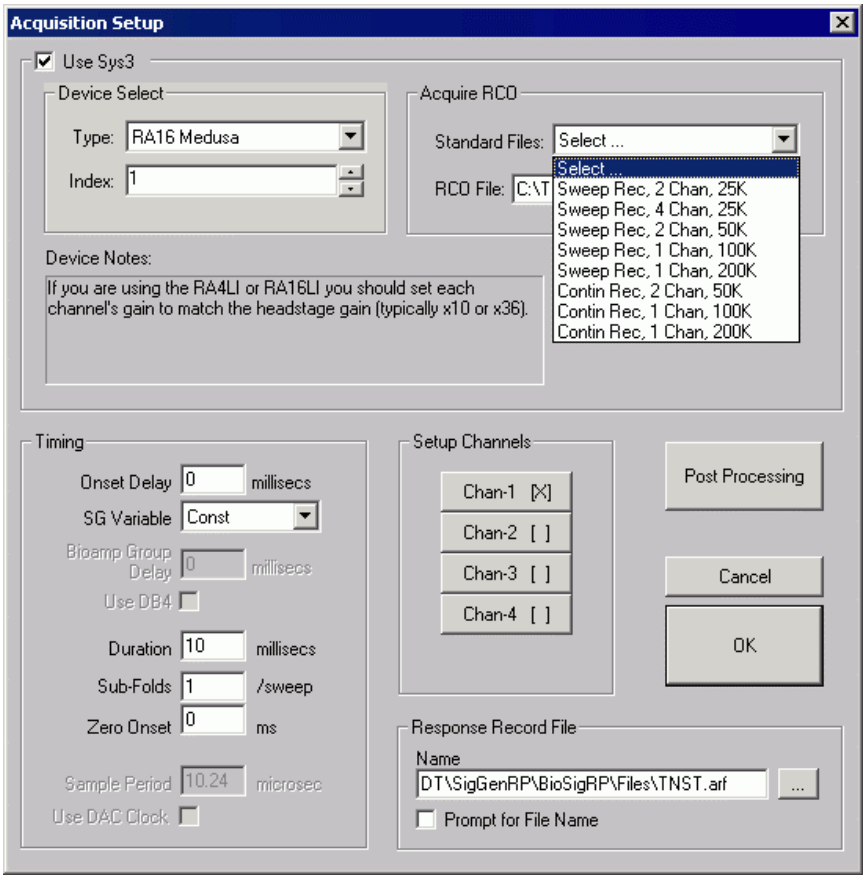
During data averaging, completed averages are appended to the end of a file know as the BioSig record file (*.arf* file). You specify the default *.arf* file in the Response Record File Name field. When *Prompt for File Name* is enabled, you will be automatically prompted to enter a file name prior to stimulus presentation. This is useful should you wish to use a file other than that specified as the default. You may disable automatic prompting by unchecking Prompt for File Name.

To setup the acquisition parameters

1. Select Acquisition... from the Setup menu of the main window.
2. Enter or select the following parameters in the Acquisition Setup dialog box:

Response Record File	
Name:	*C:\TDT\SigGenRP\BioSigRP\Files\TNST.ARF*
Prompt for File Name:	☐

The options that you have for the acquisition circuits are based on the number of acquisitions and maximum sample rate. ABR usually require a 25 kHz sample period. For DPOAE use the continuous record.



To setup acquisition Channel 1

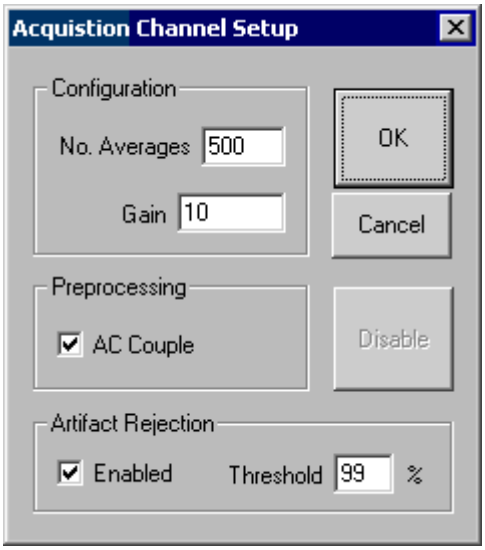
1. Click the Chan-1 button.
2. Enter or select the following parameters in the Acquisition Channel Setup dialog box:

Configuration	
Number of Averages:	500
Gain:	10

The *Gain* field is used to remove the effects of hardware amplification of the response signal. Thus, if you have used amplification hardware to apply a gain of 100,000 to the response signal, you would specify 100,000 in the Gain field. If you use the Medusa amplifier with a low impedance headstage BioSigRP will prompt you to set the gain to 10x (or 20 for devices with serial numbers greater than 2000) each time you open the acquisition window. While this can be a minor annoyance in the beginning once you have set up the system you will not have to modify this again.

Enabling *AC Couple* causes BioSigRP to remove any DC components from the signal by subtracting the signal average.

You may wish to reject anomalous signals. By enabling *Artifact Rejection*, you can specify at which peak amplitude you wish to reject an acquired signal. This amplitude is specified as a percentage of the A/D threshold of ± 10 volts.



To accept the Channel 1 acquisition parameters and return to the Acquisition Setup dialog box

- Click the OK button of the Acquisition Channel Setup dialog box.

To accept the acquisition setup parameters and return to the main window

- Click OK button of the Acquisition Setup dialog box.

Save the Configuration File

You will want to save the configuration file for future experiment sessions.

To save the configuration file

1. Choose Save from the File menu.
2. Enter *C:\TDT\SIGGENRP\BIOSIGRP\FILES\TNST2.ACF* in the File Name field.

Run the Experiment

See the "Hardware Configuration" section of Chapter 1.

Before running the experiment, you should check the hardware configuration.

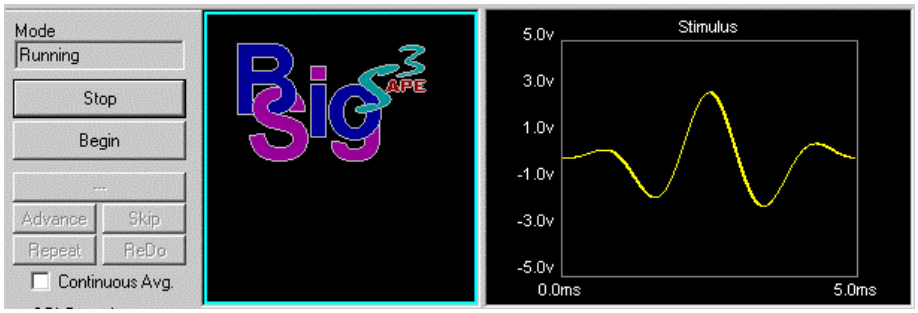
Running

To begin stimulus presentation

- Click the Start button.

  You are now in *Running Mode*. The stimulus signal is presented according to the parameters you specified during setup.

For more information about the Multi-Purpose Area, see Chapter 2.



Averaging

To begin data averaging

1. Click the Begin button.
2. Enter any subject information and click OK.

   You are now in *Averaging Mode*. Upon each trigger, the acquired ABR response data will be included in the running average until 500 response signals have been obtained and averaged. In the Multi-Purpose plot, you may view the current stimulus, the raw A/D signal, the EEG signal, or the running average. As averages are completed (when N=500), the averaged ABR records will be appended to the History plot and the *.arf* file.

Hint:
Use the Multi-Purpose plot to view acquired data in real time.

For more information about the Multi-Purpose Area, see Chapter 2.

Real-Time Comparison

You may view the running average in real-time in the Multi-Purpose Plot. You may choose to overlay the running average with a comparison record selected from the History Plot. For this example, the first ABR obtained will serve as a nice comparison, since it was obtained as a response to a tone of large amplitude.

To make the first ABR record a comparison record

1. Click on the first record displayed in the History Plot.

   Note: If several records have been obtained, you may have to scroll to the top of the History Plot.

2. Choose Make Comparison from the History menu.

To view the running average

1. Click the *right* mouse button in the Multi-Purpose Plot.
2. Drag the pointer until it is above  .
3. Release the *right* mouse button.

To superimpose the comparison record

- Check Show Comparison on the Multi Plot menu.

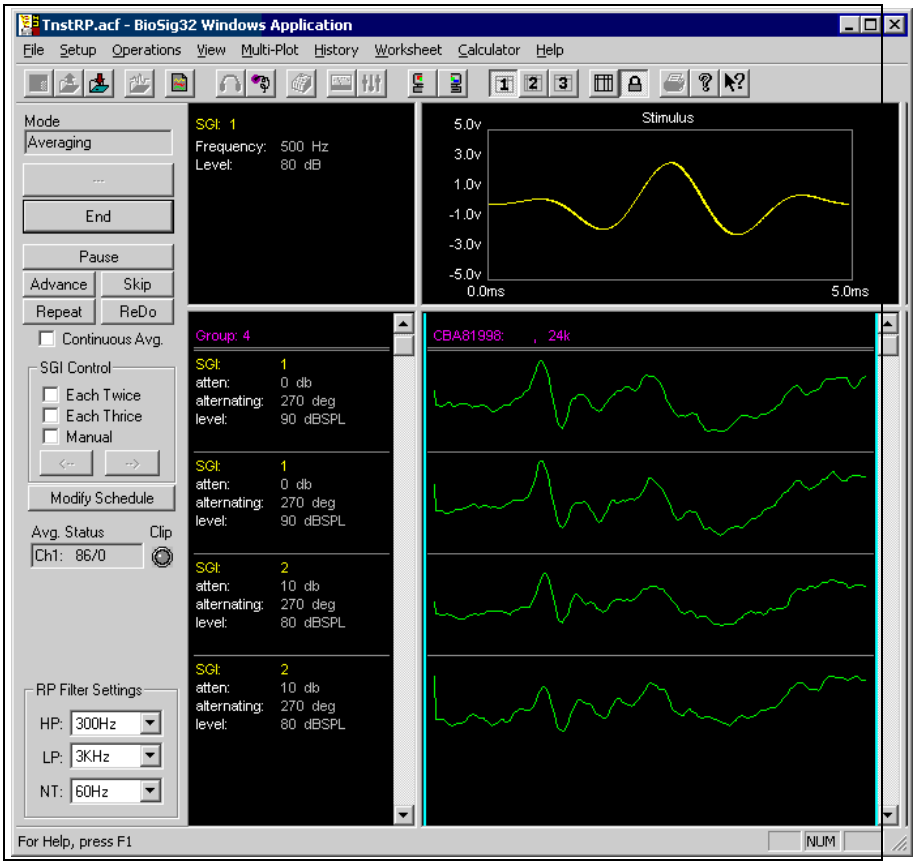
Termination

Because you enabled Boundary Control when creating the stimulus signal in SigGen, data averaging will automatically halt once the 4000 Hz tone has been presented at all 16 levels. Stimulus presentation, however, will continue.

As you monitor ABR acquisition, however, you may decide that data acquisition should be manually terminated.

To manually terminate data acquisition

➢ Hit the End button.



At this point, you may halt stimulus presentation or run the experiment again.

To halt stimulus presentation

➢ Click Stop.

To run the experiment again

1. Click Begin.
2. Enter in the new subject information.

Analyze the Data

BioSigRP does not automatically determine threshold levels. Instead, BioSigRP allows the user to place cursors on peaks in selected ABR records. Each cursor will provide the user with peak values and latencies. The experienced clinician/experimenter can use these values to determine when a threshold has been achieved.

Using Cursors

Once the experiment has been run and ABR data have been obtained, you will want to analyze the results. In this experiment, ABR peak levels and latencies are analyzed through the use of cursors.

To place a cursor

- Double click the desired record in the History Plot.

You will see the Cursor Edit dialog box.

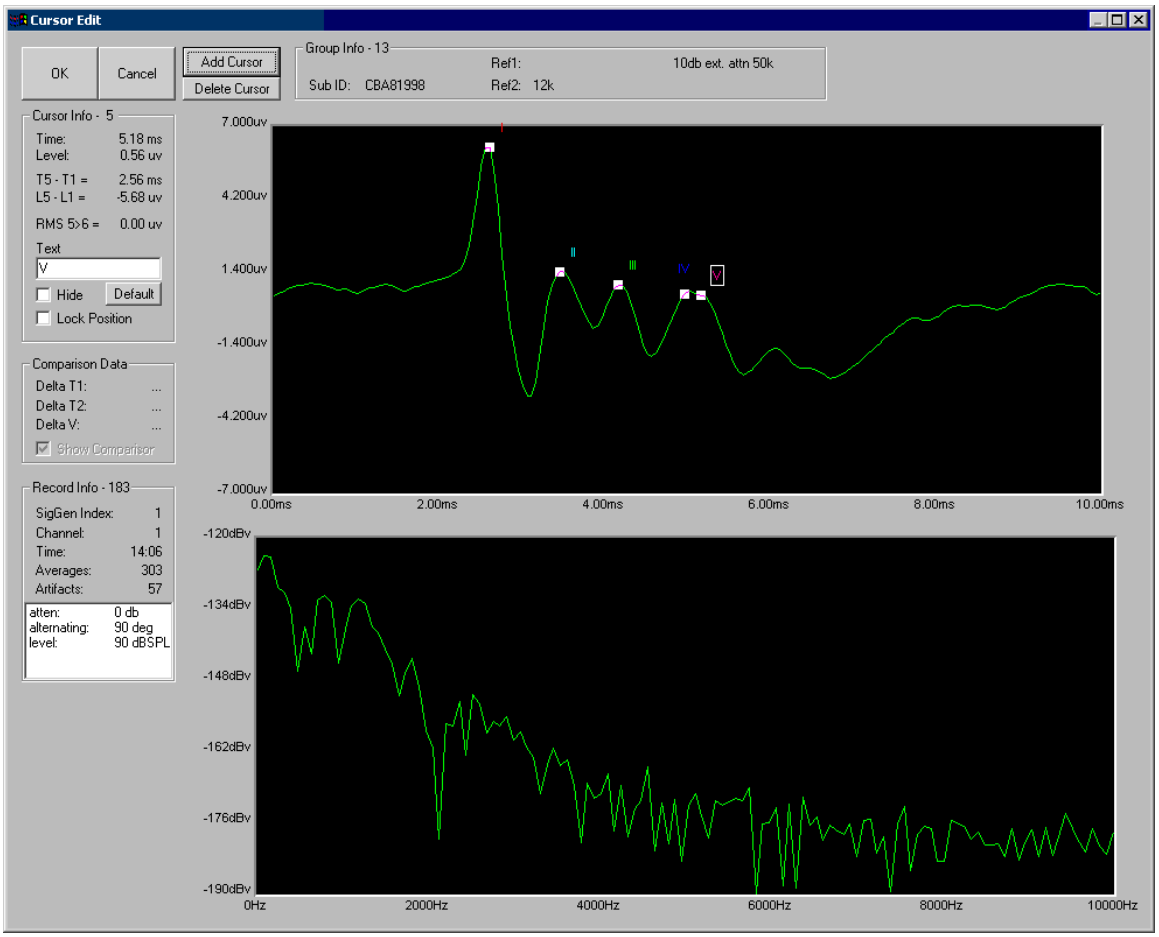
To place cursors on peaks

- Double click each peak.

Note: Cursors have a default number (e.g., 1, 2, 3...) and a default name (e.g., I, II, III...). Cursor numbers and default names are assigned in the order in which cursors are created. Therefore, you should create cursors in ascending order.

To customize a cursor label

1. Click the cursor.
2. Enter the customized text.
3. Hit TAB to leave the field and update the cursor label.



Note that after you click on a cursor, its label is surrounded by a box. This indicates that the cursor is currently *selected*. Once a cursor is selected, you can view its instantaneous time and level values. Additionally, you may view the time and level difference between the selected cursor and Cursor 1. In the illustration below, time and level differences are shown in the fields labeled T5 - T1 and L5 - L1 fields, respectively.

To view instantaneous time and level values

- Click on the desired cursor.

To return to the main BioSig window

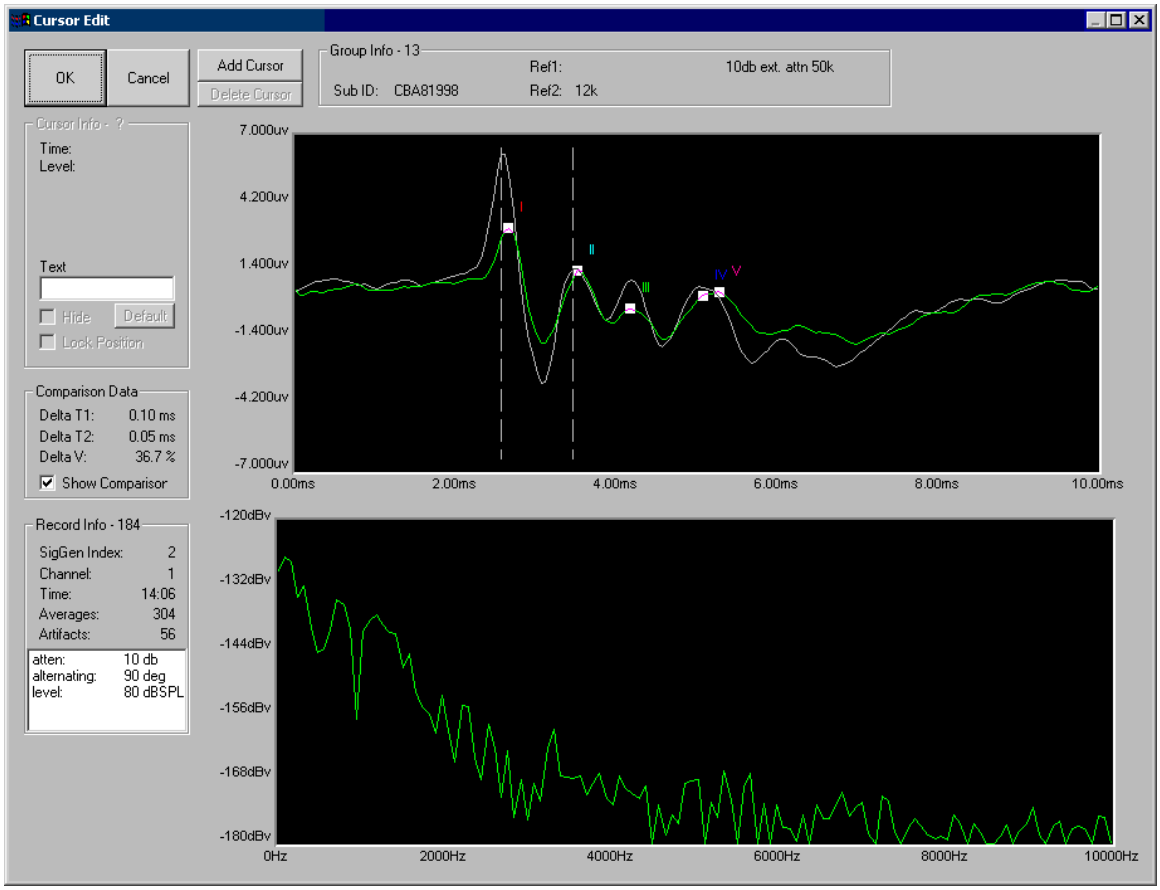
- Click OK.

Making Comparisons

Recall that you previously designated the first ABR record as a comparison record. Once you have placed cursors in the comparison record, it is possible to compare its cursor values to those of other records.

To compare cursor values

1. Double click the desired ABR record
2. Check the Show Comparison box found in the Comparison Data group box.



The comparison record will be simultaneously displayed with the current ABR record. The placement of comparison record cursors 1 and 2 are indicated by vertical dashed lines.

Note: In some instances, you will be more interested in comparing values associated with higher latency peaks, such as Peak V. In this case, the cursor marking Peak V should be the first or second cursor placed.

In the Comparison Data group box the following information is displayed:

Delta T1 The difference in time between current Cursor 1 and comparison Cursor 1.

Delta T2 The difference in time between current Cursor 2 and comparison Cursor 2.

Delta V This parameter is specifically designed for experiments that examine the degree of amplitude reduction.

To return to the main BioSigRP window

- Click OK.

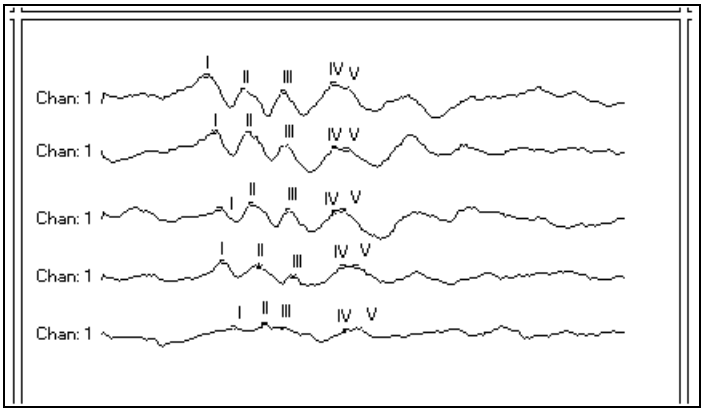
Building Reports and Manipulating Data

You may wish to view specific records in a report format. You may also wish to perform mathematical operations on one or more record. You may doing so by placing specific records in the Worksheet.

To place a record in the Worksheet

For more information about selecting History Plot records, see Chapter 2.

1. Select the desired record in the History Plot.
2. Drag the record into the Worksheet.



For more information about Worksheet formatting and calculator options, see Chapter 5.

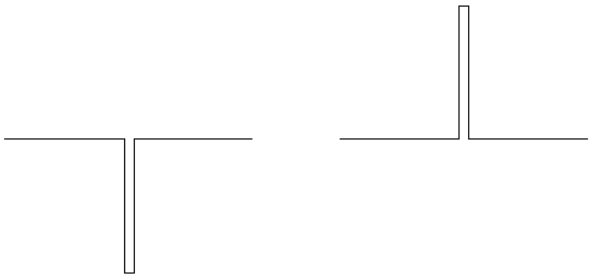
You may format the Worksheet in a variety of ways. You may also apply various calculator functions to Worksheet records. For our example, it may be useful to display the cursors placed in each record.

To display cursors

1. Click the *right* mouse button anywhere in the Worksheet except directly over a record or a record label.

   You will see the Worksheet Preferences dialog box.
2. Check the Show Cursors box.
3. Click OK.

Example 2: Using a Click Stimulus



This experiment is designed to gather auditory brainstem response (ABR) data in response to a rectangular-pulse click stimulus. During presentation, the stimulus will alternate between a condensation click and a rarefaction click, thereby canceling any artifacts such as electromagnetic stimulus effects and cochlear microphonic effects. Click level will vary from 80 dB SPL to 5 dB SPL in 5 dB decrements.

The Quick Start files necessary to run this experiment are as follows:

SigGen signal file
SigGenRP\BiosigRP\Files\clickRP.sig

BioSig configuration file
SigGenRP\BioSigRP\Files\clickRP.acf

To run the experiment, you will need to perform the following steps:

1. Build the SigGen Signal.
   a. Run SigGenRP.
   b. Define the signal parameters.
   c. Define polarity and level variables.
   d. Create the segment and component.
   e. Save the SigGen file.
2. Run the experiment with BioSigRP.
   a. Run BioSigRP.
   b. Setup the stimulus parameters.
   c. Setup the acquisition parameters.
   d. Calibrate the system.
   e. Save the *.acf* file.
   f. Run the experiment.
   g. Analyze the data.

- ✓ *Alternating Variable*
- ✓ *Combination Variable*
- ✓ *Uniphasic Click*

Note: Only those parameters to be entered or selected are given below. All other parameters will remain according to the default settings.

Building the SigGen Signal

In this example, you will use TDT's signal generation software, SigGenRP, to create the stimulus signal. The duration of the entire stimulus will be 5 milliseconds, the minimum allowed in SigGenRP. A 0.1 millisecond, single channel, rectangular-pulse click will be presented. With each successive presentation, click phase will alternate. Thus, the click will alternate between a condensation click and a rarefaction click. Click level will vary from 80 dB SPL to 5 dB SPL in 5 dB decrements.

Run SigGenRP

To run SigGenRP

- Double-click the SigGenRP icon.

To build the SigGen signal from scratch

- Choose New from the File menu.

BioSigRP\files\click.sig

To follow along using the Quick Start file

1. Choose Open from the File menu.
2. Select the file listed in the left margin.

To bypass the SigGen signal design process

- Exit SigGenRP by choosing Exit from the File menu and skip to **Running the BioSigRP Experiment**. (Look for the Quick Start icon!)

BioSigRP\files\tnst.sig

To follow along using a Quick Start file

1. Choose Open from the File menu.
2. Select the file listed in the left margin.

To bypass the SigGenRP signal design process

- Exit SigGenRP by choosing Exit from the file menu and skip to **Running the BioSigRP Experiment.** (Look for the Quick Start icon!).

Configure the RPx device and RCO file

For System 3 equipment SigGenRP uses the RPx device and RCO files (See RPvds help) to play out signals.

To configure the RPx device and select the RCO file

1. Select Rp devices|Device A from the Modify menu or click on the "A" icon on the tool bar.
2. Select from the Standard file menu "Sweep Play, 2 Chan 50k (100k max).
3. Select RP2 Processor as device type
4. Select Index 1.

5. Deselect "Use sample rate specified in RCO file
6. Under Bandwidth and Timing change the Standard Sample Rate to 25kHz. (Ignore the Number of Time Slicies).

Define the Signal Parameters

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

Name:	*Click*
Timing	
Duration:	5 milliseconds
Calibration	
Level:	90 dB = 9 volts

Note: This is a temporary calibration setting. You should set the calibration values according to the output of your system.

Define the Variables

This example will use two variables. The first, *Polarity*, will cause the stimulus to alternate between a condensation click and a rarefaction click. The second, *Level*, will cause click level to vary from 80 dB SPL to 5 dB SPL in 5 dB decrements.

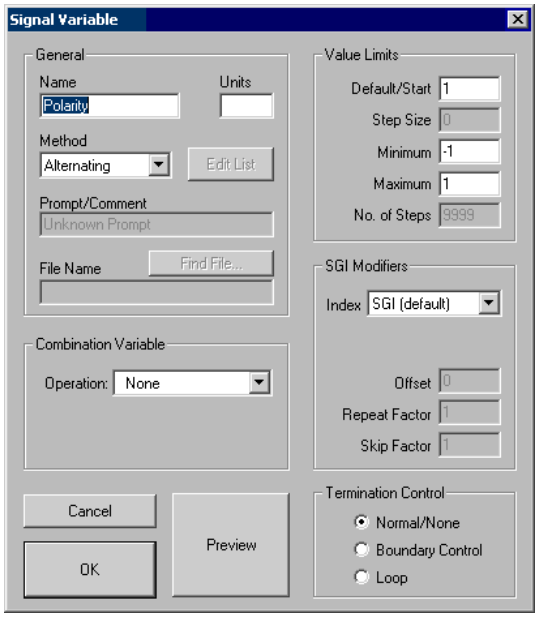
Controlling Polarity

You will alternate the variable *Polarity* through the use of the Variable Method: *Alternating*. Variables assigned the method Alternating switch between the values specified in the Minimum and Maximum fields with each presentation trigger.

To define the variable, Polarity

1. Select Signal from the Modify menu of the main window.
2. Click the Edit button in the Variables group box of the Signal Parameters dialog box.
3. Enter or select the following parameters in the Signal Variable dialog box:

General		Value Limits	
Name:	*Polarity*	Default/Start:	1
Method:	Alternating	Step Size:	0
		Minimum:	-1
		Maximum:	1



To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Controlling Output Level

In this example, click level will vary from 80 dB SPL to 5 dB SPL in 5 dB steps. In the previous example, you accomplished a similar variation digitally through SigGen variable manipulation. However, when digital attenuation is used, signal level is attenuated while noise remains constant, resulting in output signal-to-noise ratios that decrease as signal level decreases. On the other hand, when analog attenuation is employed, both noise and signal are attenuated at the same rate, holding signal-to-noise ratio constant as signal level decreases. Therefore, in this example analog attenuation is employed through use of a PA5 programmable attenuator.

The PA5 attenuation level is programmed as follows:

Attenuation level = click level - *Level*

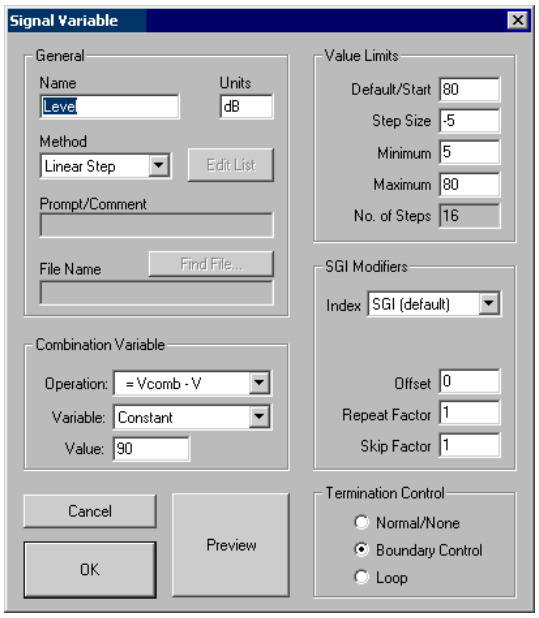
where click level equals 90 dB (or whatever output a 9 volt click produces on your system) and *Level* is a SigGen variable that varies from 80 dB SPL to 5 dB SPL in 5 dB decrements. The attenuation level will be calculated through the use of a *combination variable*.

To define the variable, Level

1. Click on 2. ..... in the Variables list box.
2. Enter or select the following parameters in the Signal Variable dialog box:

General		Value Limits	
Name:	*Level*	Default/Start:	80
Units:	dB	Step Size:	-5
Method:	Linear Step	Minimum:	5
Combination Variable		Maximum:	80
Variable:	Constant	Termination Control	
Operation:	= Vcomb - V	Boundary Control:	⊙
Value:	90		

When *Level* = 80 dB, the combination variable = Vcomb-V
= 90-*Level*
= 10 dB (which is the attenuation applied to the PA5).



To accept the variable parameters and return to the Signal Parameter dialog box

- Click the OK button in the Signal Variable dialog box.

To define the programmable attenuator and set it's level

1. Set Attenuator Device = PA5 - 1.
2. Set Attenuator Level = Level.

To accept the signal parameters and return to the SigGen main window

- Click the OK button in the Signal Parameters dialog box.

Create the Segments and Components

Each SigGen signal consists of at least one segment. Each segment in turn consists of one to three components. In this example, the click consists of one segment which in turn consists of one component.

Creating the Segment

To create the segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

Select:	Seg[1]
Duration:	1 msec

Creating the Component

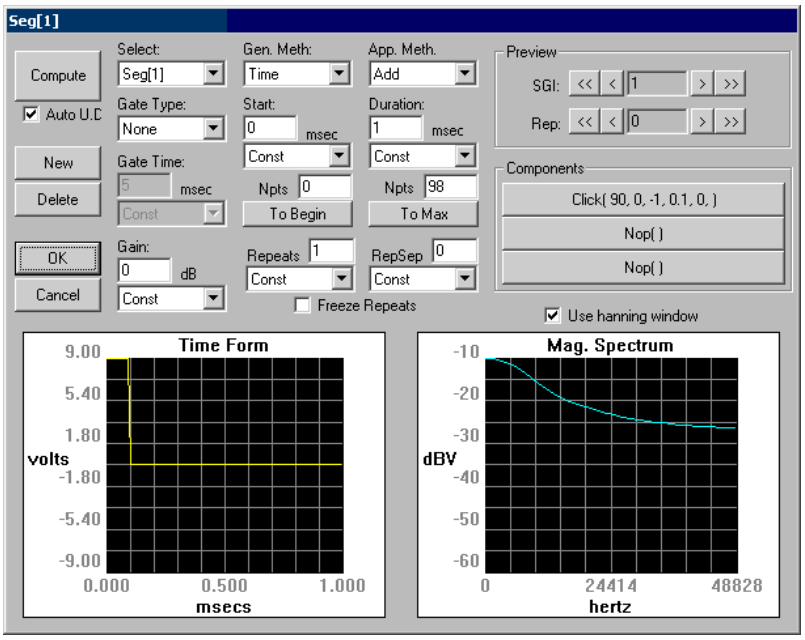
The call *Click* has been designed to create a bi-phasic click. To design a uniphasic click, simply leave null values in the fields Level Two and Dur Two. This will effectively remove the second portion of the bi-phasic click.

To create a component for the segment

1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

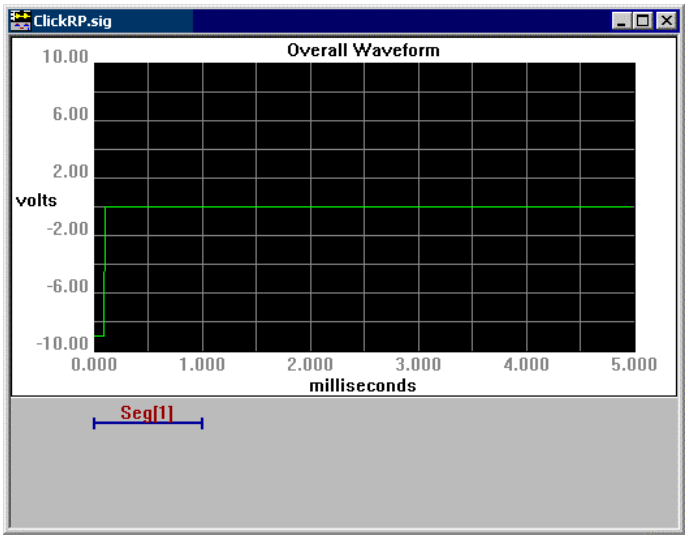
Call:	Click
Level One:	90 dB (or whatever output is produced by a 9 volt click)
Level Two:	0 dB
Polarity:	Choose the variable, *Polarity*
Dur. One:	.1 ms
Dur Two:	0 ms

3. Click the OK button to accept the component parameters.



To return to SigGenRP's main window

➢ Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen file to generate a stimulus signal through BioSigRP.

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SigGenRP\BioSigRP\Files\click2.sig* in the File Name field.

Running the BioSig Experiment

Once you have designed the stimulus signal with SigGenRP and saved the SigGen file, you are ready to setup BioSigRP and begin collecting ABR data. In this example, you will present the single-channel stimulus signal via headphones and acquire single-channel response data. This example assumes that you will amplify and filter the ABR response data prior to digitization. BioSigRP will collect 10 milliseconds of ABR data for each stimulus presentation. Averaged ABR data will be computed using an *N* of 500.

Run BioSigRP

To run BioSigRP

➢ Double-click the BioSigRP icon.

Note: To run this experiment, you must either create the BioSig file by following the step-by-step instructions or open the existing Quick Start file.

BioSigRP\Files\click.acf

To follow along using the Quick Start file

1. Choose Open from the File menu.
2. Select the file listed in the left margin.

To bypass experiment setup and begin running the experiment

- Skip to **Run the Experiment**

Setup the Stimulus Parameters

During stimulus setup, you will define the presentation rate, and specify the SigGen file.

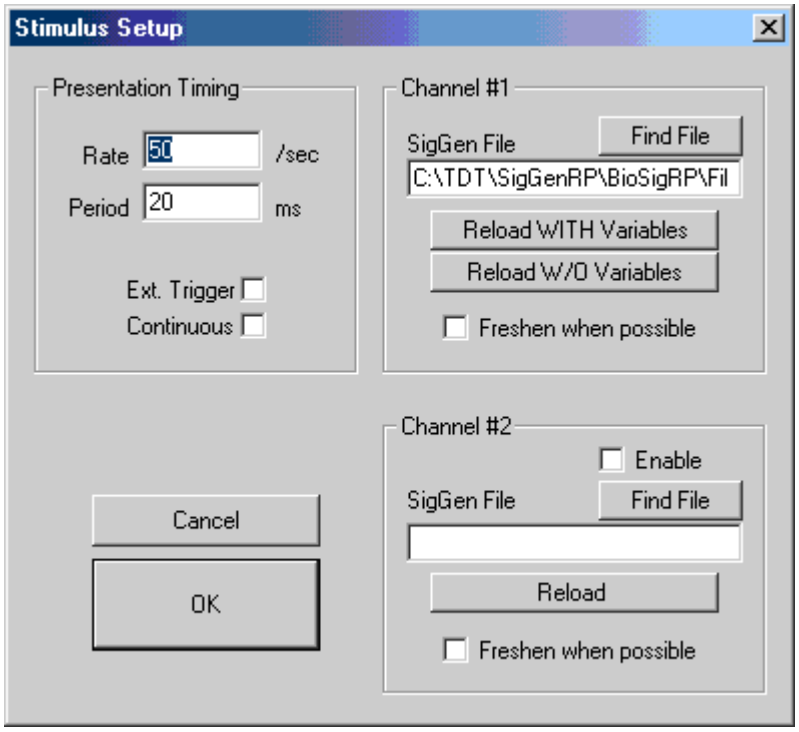
The *Presentation Rate* is the number of times the stimulus will be presented per second. The *Presentation Period*, measured in milliseconds, is the inverse of the Presentation Rate. The Presentation Period must be at least 1.25 times the total amount of time required to present the stimulus signal and acquire response data. For this example, a rate of 20 presentations per second, or a period of 50 milliseconds, will be sufficient.

You may have previously saved the stimulus signal parameters in a SigGen file called *click2.sig*. Now you need to specify either *click2.sig* or the file provided by TDT, *clickRP.sig,* in the Channel 1 SigGen File field. The stimulus parameters found in this SigGen file will be read by BioSigRP and used to generate the stimulus signal. Later, when you save the BioSig configuration file (*.acf* file), these parameters will be saved within that file.

To setup the stimulus parameters

1. Select Stimulus from the Setup menu of the main window.
2. Enter or select the following parameters in the Stimulus Setup dialog box:

Presentation	
Rate:	20 /sec
Period:	50 milliseconds
Channel #1	
SigGen File:	*C:\TDT\SigGenRP\BioSigRP\Files\clickRP.sig (or click2.sig)*



To accept the stimulus setup parameters and return to the main window

- Click OK.

Setup the Acquisition Parameters

Prior to running the experiment, you must define the acquisition timing parameters and specify a record file (*.arf* file).

Acquisition timing parameters include: *Onset Delay*, the delay in onset of data acquisition from the beginning of stimulus presentation; *Duration*, the duration of the acquired signal; and *Sample Period*, the time between successive data points of the digital response signal. This is greyed out and indicates the sample period of the RCO circuit.

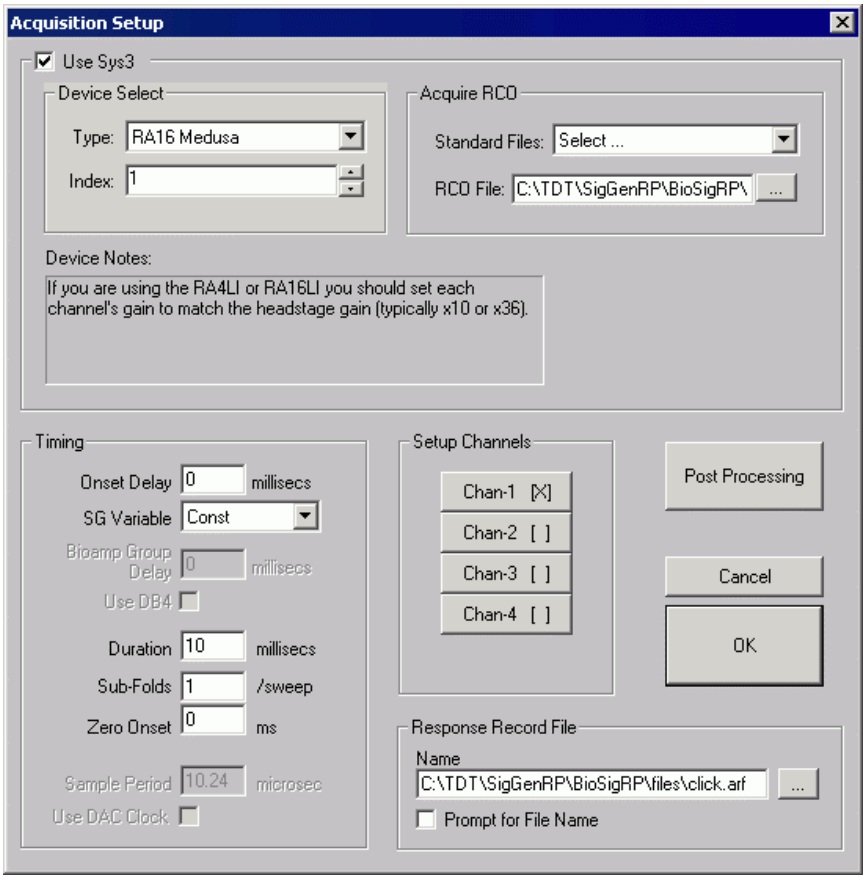
During data averaging, completed averages are appended to the end of a file know as the BioSig record file (*.arf* file). You specify the default *.arf* file in the Response Record File Name field. When *Prompt for File Name* is enabled, you will be automatically prompted to enter a file name prior to stimulus presentation. This is useful should you wish to use a file other than that specified as the default. You may disable automatic prompting by unchecking Prompt for File Name.

To setup the acquisition parameters

1. Select Acquisition... from the Setup menu of the main window.
2. Enter or select the following parameters in the Acquisition Setup dialog box:

Response Record File
Name: *C:\TDT\SIGGENRP\BIOSIGRP\FILES\CLICK.ARF*
Prompt for File Name: ☐

Use the proper RCO circuit for your required data acquisition. In general this would be 2-channel or 4-channel acquisition at 25 kHz.



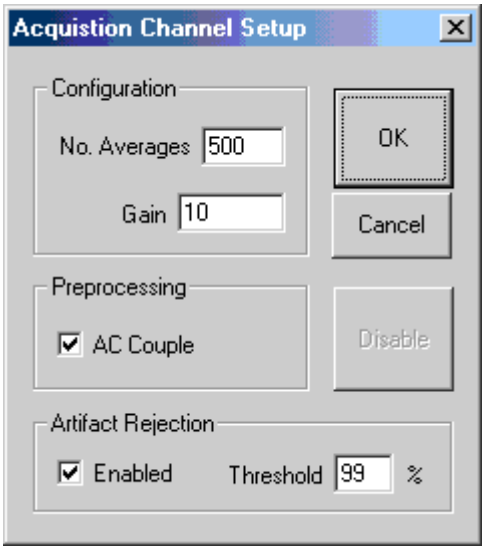
To setup acquisition Channel 1

1. Click the Chan-1 button.
2. Enter or select the following parameters in the Acquisition Channel Setup dialog box:

Configuration	
Number of Averages:	500
Gain:	100000

Enabling *AC Couple* causes BioSig to remove any DC components from the signal by subtracting the signal average.

You may wish to reject anomalous signals. By enabling *Artifact Rejection*, you can specify at which peak amplitude you wish to reject an acquired signal. This amplitude is specified as a percentage of the A/D threshold of $\pm$ 10 volts.



To accept the Channel 1 acquisition parameters and return to the Acquisition Setup dialog box

➢ Click the OK button of the Acquisition Channel Setup dialog box.

To accept the acquisition setup parameters and return to the main window

➢ Click OK button of the Acquisition Setup dialog box.

Save the Configuration File

You will want to save the configuration file for future experiment sessions.

To save the configuration file

1. Choose Save from the File menu.
2. Enter *C:\TDT\SigGenRP\BioSigRP\Files\CLICKRP.ACF* in the File Name field.

Run the Experiment

See the "Hardware Configuration" section of Chapter 1.

Before running the experiment, you should check the hardware configuration.

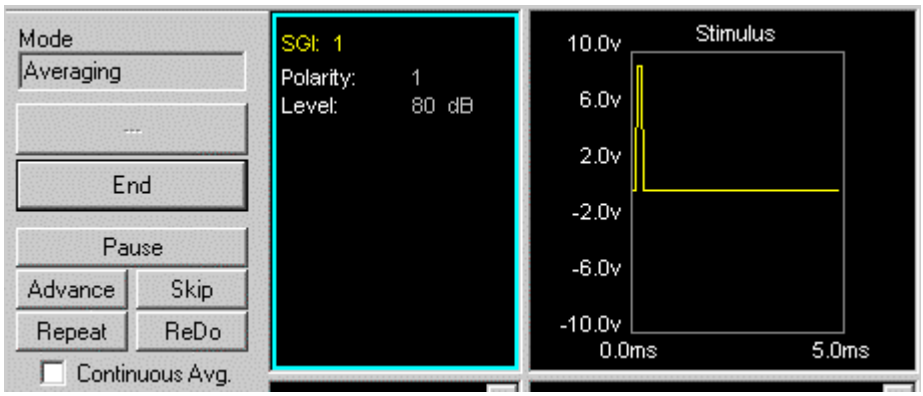
Running

To begin stimulus presentation

➢ Click the Start button.

For more information about the Multi-Purpose Area, see Chapter 2.

You are now in *Running Mode*. The stimulus signal is presented according to the parameters you specified during setup. You may view the stimulus signal in the Multi-Purpose area. Previously you defined the variable *Polarity* using the Variable Method: *Alternating*. Variables assigned the method Alternating, switch between the value specified in the Minimum field and the value specified in the Maximum field with each presentation trigger. In this example, the variable Polarity will alternate between 1 and -1 with each presentation trigger.



Averaging

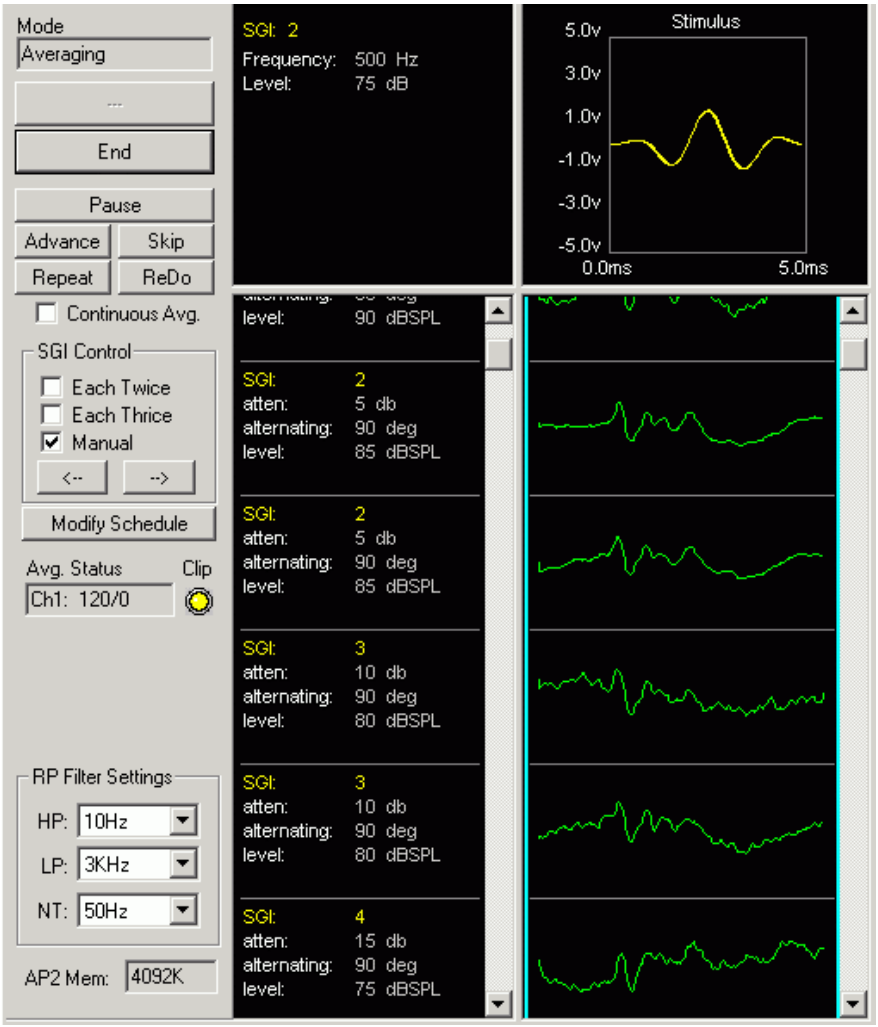
To begin data averaging

1. Click the Begin button.
2. Enter any subject information and click OK.

   You are now in *Averaging Mode*. Upon each trigger, the acquired ABR response data will be included in the running average until 500 response signals have been obtained and averaged. In the Multi-Purpose plot, you may view the current stimulus, the raw A/D signal, the EEG signal, or the running average. As averages are completed (when N=500), the averaged ABR records will be appended to the History plot and the *.arf* file.

Hint:
Use the Multi-Purpose plot to view acquired data in real time.

For more information about the Multi-Purpose Area, see Chapter 2.



Real-Time Filtering

During averaging you can adjust filter setting on the fly using the RP Filter Settings boxes in the lower right corner of the BioSigRP main window. To change the filter settings, select a value from the drop down list for the built-in highpass (HP), lowpass (LP), or notch (NT) filters.

Real-Time Comparison

You may view the running average in real-time in the Multi-Purpose Plot. You may choose to overlay the running average with a comparison record selected from the History Plot. For this example, the first ABR obtained will serve as a nice comparison, since it was obtained as a response to a click of large amplitude.

To make the first ABR record a comparison record

1. Click on the first record displayed in the History Plot.

   Note: If several records have been obtained, you may have to scroll to the top of the History Plot.

2. Choose Make Comparison from the History menu.

To view the running average

1. Click the *right* mouse button in the Multi-Purpose Plot.
2. Drag the pointer until it is above  .
3. Release the *right* mouse button.

To superimpose the comparison record

- Check Show Comparison on the Multi Plot menu.

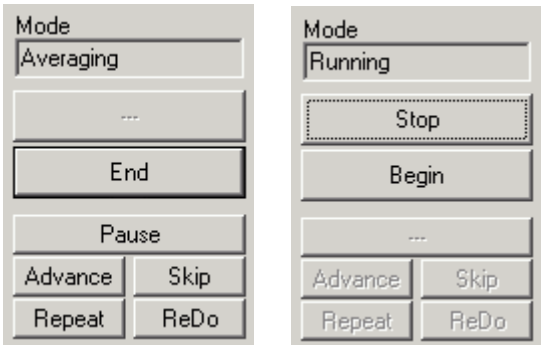
Termination

Because you enabled Boundary Control when creating the stimulus signal in SigGenRP, data averaging will automatically halt once the value of the variable *Level* reaches 30 dB SPL, the defined minimum value. Stimulus presentation, however, will continue.

As you monitor ABR acquisition, however, you may decide that data acquisition should be manually terminated.

To manually terminate data acquisition

- Hit the End button.



At this point, you may halt stimulus presentation or run the experiment again.

To halt stimulus presentation

- Click Stop.

To run the experiment again

1. Click Begin.
2. Enter in the new subject information.

Analyze the Data

BioSigRP does not automatically determine threshold levels. Instead, BioSigRP allows the user to place cursors on peaks in selected ABR records. Each cursor will provide the user with peak values and latencies. The experienced clinician/experimenter can use these values to determine when a threshold has been achieved.

Using Cursors

Once the experiment has been run and ABR data have been obtained, you will want to analyze the results. In this experiment, ABR peak levels and latencies are analyzed. This is accomplished through the placement of cursors.

To place a cursor

- Double click the desired record in the History Plot.

You will see the Cursor Edit dialog box.

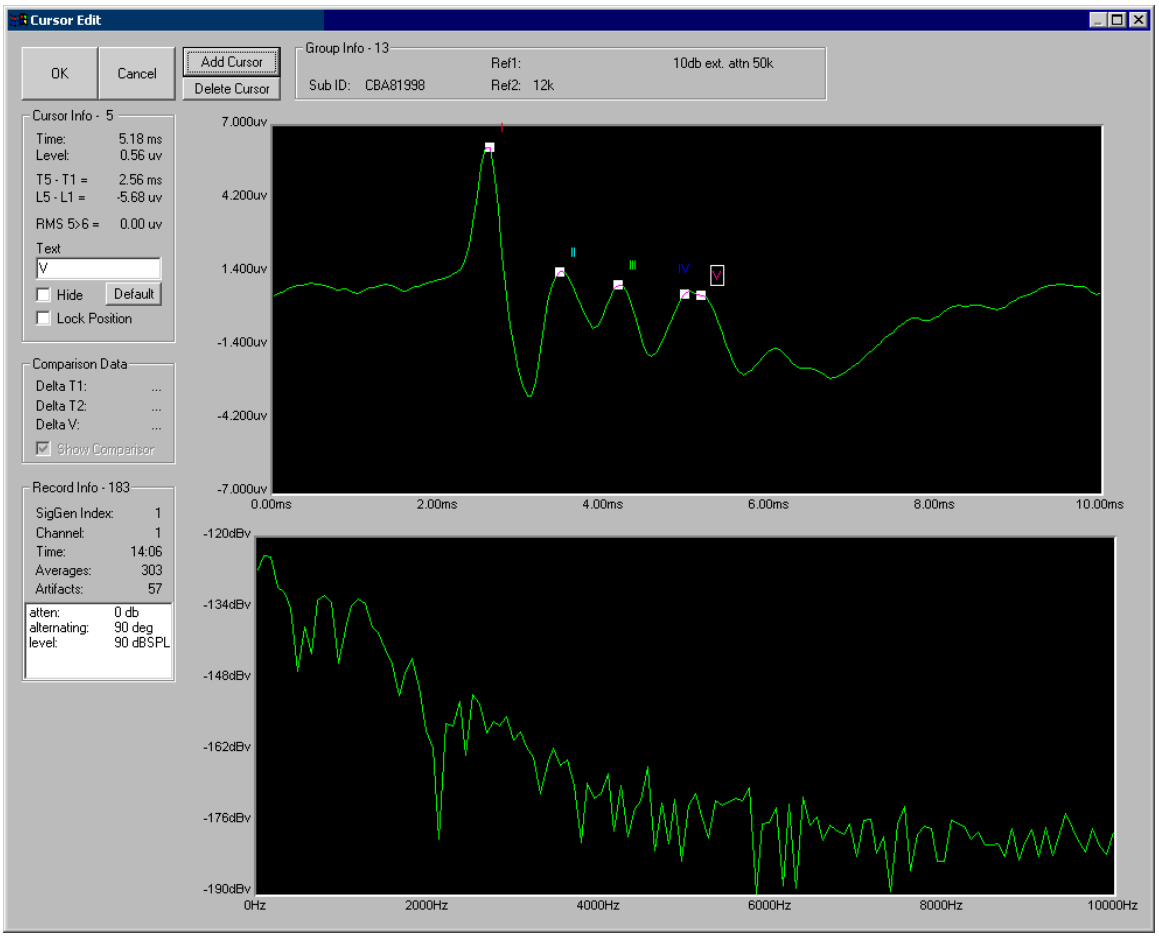
To place cursors on peaks

- Double click each peak.

Note: Cursors have a default number (e.g., 1, 2, 3...) and a customizable name. Numbers are assigned in the order in which cursors are created. It is a nice idea to synchronize the default numbers with peak numbers. Therefore, you should create them in ascending order.

To customize a cursor label

1. Click the cursor.
2. Enter the customized text.
3. Hit TAB to leave the field and update the cursor label.



Note that after you click on a cursor, its label is surrounded by a box. This indicates that the cursor is currently *selected*. Once a cursor is selected, you can view its instantaneous time and level values. Additionally, you may view the time and level difference between the selected cursor and Cursor 1. In the illustration below, time and level differences are shown in the fields labeled T5 - T1 and L5 - L1 fields, respectively.

To view instantaneous time and level values

➢ Click on the desired cursor.

To return to the main BioSigRP window

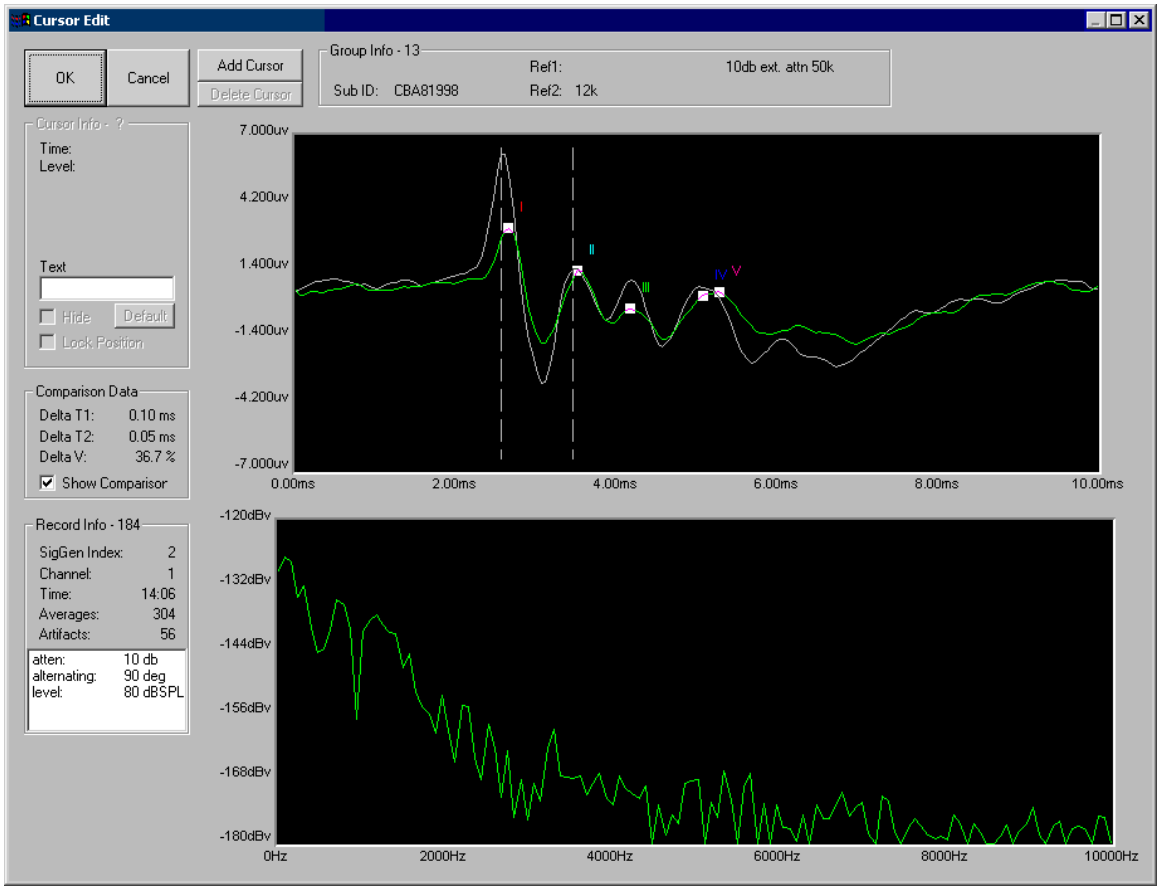
➢ Click OK.

Making Comparisons

Recall that you previously designated the first ABR record as a comparison record. Once you have placed cursors in the comparison record, it is possible to compare its cursor values to those of other records.

To compare cursor values

1. Double click the desired ABR record
2. Check the Show Comparison box found in the Comparison Data group box.



The comparison record will be simultaneously displayed with the current ABR record. The placement of comparison record cursors 1 and 2 are indicated by vertical dashed lines.

Note: In some instances, you will be more interested in comparing values associated with higher latency peaks, such as Peak V. In this case, the cursor marking Peak V should be the first or second cursor placed.

In the Comparison Data group box the following information is displayed:

Delta T1 The difference in time between current Cursor 1 and comparison Cursor 1.

Delta T2 The difference in time between current Cursor 2 and comparison Cursor 2.

Delta V This parameter is specifically designed for experiments that examine the degree of amplitude reduction. It is used for that purpose in the example presented in Chapter 7.

To return to the main BioSigRP window

- Click OK.

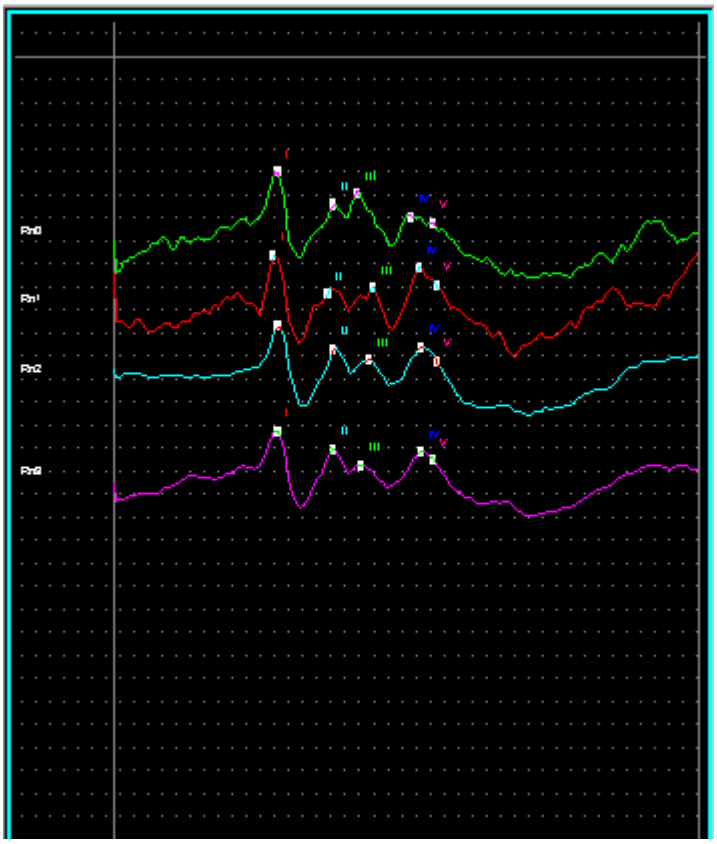
Building Reports and Manipulating Data

You may wish to view specific records in a report format. You may also wish to perform mathematical operations on one or more record. You may doing so by placing specific records in the Worksheet.

To place a record in the Worksheet

For more information about selecting History Plot records, see Chapter 2.

1. Select the desired record in the History Plot.
2. Drag the record into the Worksheet.



For more information about Worksheet formatting and calculator options, see Chapter 5.

You may format the Worksheet in a variety of ways. You may also apply various calculator functions to Worksheet records. For our example, it may be useful to display the cursors placed in each record.

To display cursors

1. Click the *right* mouse button anywhere in the Worksheet except directly over a record or a record label.

   You will see the Worksheet Preferences dialog box.

2. Check the Show Cursors box.

3. Click OK.

Chapter 7 Advanced Examples

The examples in this section use the powerful features of SigGenRP and BioSigRP to construct experiments using paradigms taken from the auditory sciences literature. They are not intended to support any particular paradigm, but to illustrate how SigGenRP and BioSigRP may be used to design complex experiments.

The examples found in this section are listed below. Also listed are the concepts introduced in each example.

Example 3: Tone in Continuous Notched Noise

- Continuous Noise
- Dual Channel Signals

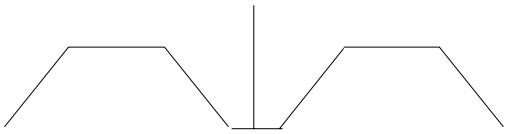
Example 4: Tone-on-Tone Forward Masking

- Constant Variables
- Repeat Factor
- Loop

Example 5: Distortion Product Otoacoustic Emission

- Radix-2
- Continuous Stimulus
- Post Processing
- Auto-Cursors

Example 3: Tone in Continuous Notched Noise



✓ *Continuous Noise*
✓ *Dual Channel Signals*

In this experiment, ABR data will be collected in response to a tone presented during continuous notched noise. The method used is similar to that described by Stapells, et al.[1] According to these authors, notched noise can be used to restrict the responsiveness of the cochlea to only those frequencies found within the notch.

Using SigGenRP and RPvds you can design a variety of short duration stimuli. You can also control the generation of continuous signals through SigGenRP. This example uses a tone presented in continuous notched noise to illustrate the process of designing and controlling an experiment utilizing both short duration and continuous signal components. Masking noise will also be presented to the non-test ear.

To run the experiment, you will need to perform the following steps:

1. Build the stimulus signal.
   a. Configure the hardware.
   b. Run SigGenRP.
   c. Define the signal parameters.
   d. Define the signal variables.
   e. Specify analog attenuation.
   f. Define the peripheral devices.
   g. Create the segment and component.
   h. Save the SigGen File.
2. Build the masking signal and continous notched signal using RPvds. Note this circuit is already designed for you.
3. Run the experiment with BioSigRP.
   a. Check the hardware configuration.
   b. Run BioSigRP.
   c. Setup the stimulus parameters.
   d. Setup the acquisition parameters.
   e. Save the .acf file.
   f. Run the experiment.
   g. Analyze the data to determine threshold levels.

Note: Throughout this example, only those parameters to be entered or selected are given below. Parameters not specifically mentioned will remain at their default settings.

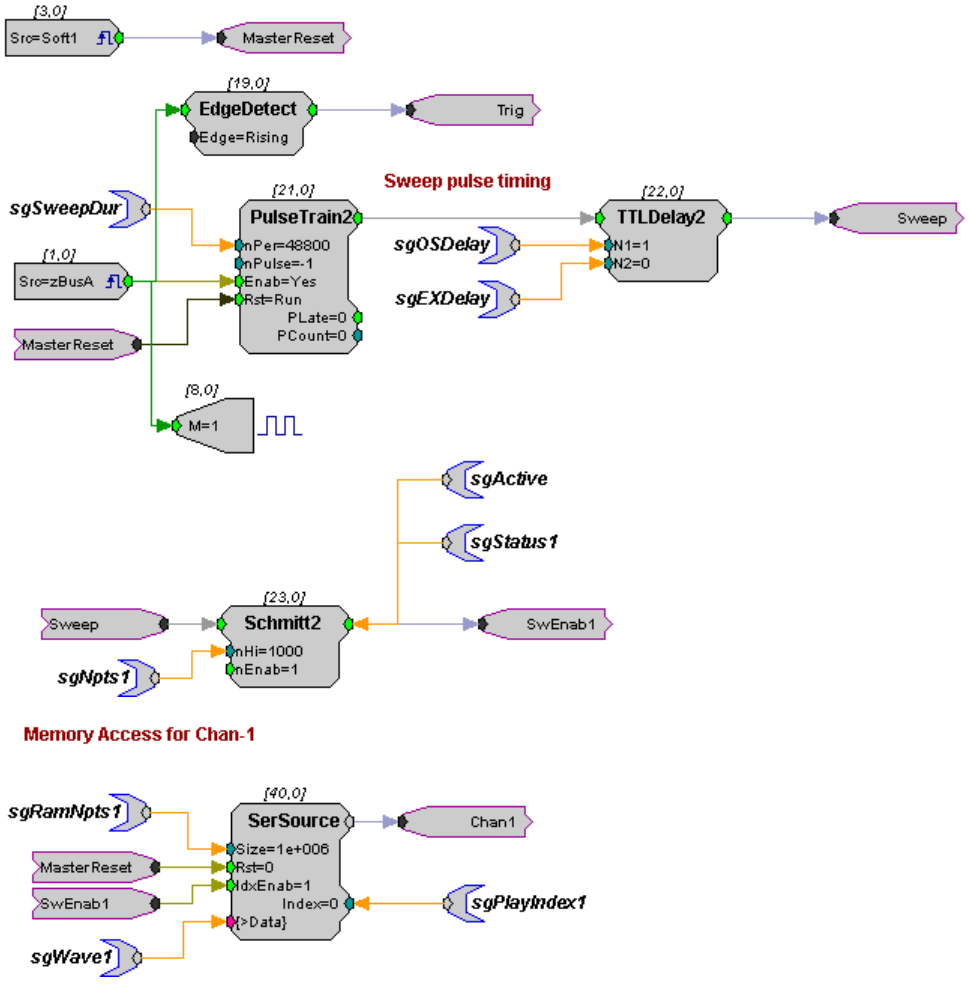
[1]Stapell, D. R., Picton, T. W., Durieux-Smith, A., Edwards, C. G., and Moran, L. M. (1990). Thresholds for short-latency auditory-evoked potentials to tones in notched noise in normal-hearing and hearing-impaired subjects. *Audiology*, *29*, 262-274.

Building the SigGen Signal

Configuring the RCO circuit

In this experiment, you will be generating a stimulus signal consisting of two components: a tone and continuous notched noise. Additionally, you will want to mask the non-test ear by presenting a second channel of continuous noise. To do this it is necessary to modify an Existing SigGenRP circuit. Each circuit has several constructs that are required by SigGenRP and BioSigRP in order to run. The first controls the stimulus presentation. The construct below is part of the TINN.rco file that comes with BioSigRP.

SigGenRP can use the parameter tags generated by an RCO file. This parameter tags are then maped to a SigGen variable. The variable can have all the functionality of a regular SigGen variable. It is even possible to use RPvds to generate a circuit that does not require a Signal to be generated in a segment window.



The first part includes several components that control stimulus presentation and duration. The bottom middle is used by other software to indicate that status of each Signal. The bottom section is used to load the signal waveform to the serial buffer. These parts of the file should NEVER be modified.

Run SigGenRP

To run SigGenRP

- Double-click the SigGenRP icon.

To open a new signal window

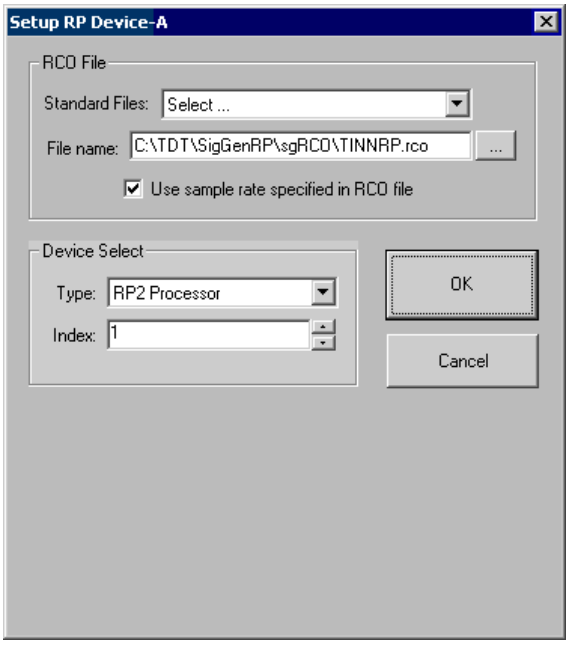
- Choose New from the File menu.

Configure the RPx device and RCO file

For System 3 equipment SigGenRP uses the RPx device and RCO files (See RPvds help) to play out signals.

To configure the RPx device and select the RCO file

1. Select RP devices|Device A from the Modify menu or click on the "A" icon on the tool bar.
2. Select the (…) and choose from the sgRCO folder TINNRP.rco
3. Select RP2 Processor as device type
4. Select Index 1.
5. Select "Use sample rate specified in RCO file."



Define the Signal Parameters

Prior to performing the experiment, you should calibrate the system. In this experiment, level will be measured in dB SPL. For illustration purposes, we will assume that a 9 volt 1000 Hz tone produces an output of 90 dB SPL. We will use this calibration throughout the example. You should determine the actual characteristics of your system.

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

Name:	*Tone*
Timing	
Duration:	15 milliseconds
Calibration	
Level:	90 dB = 9 volts

Define the Variables

In this example, you will be defining the parameters of a tone. You will also specify the characteristics of continuous notched noise, including: noise level, notch center frequency, and notch bandwidth. Finally, you will specify the output noise level of the non-test ear masker.

The parameters necessary to build the tone and to control the notched noise and non-test ear masker are presented below.

	Parameter	**Variable**	**Method**	**Combination**
Tone	Frequency	*CenterFreq*	Log Step (base 2)	None
	Level	*ToneLevel*	Linear Step	None
	Attenuation Level	*ToneAtten*	Constant = 90 dB	*ToneAtten* - *ToneLevel*
	Phase	*Phase*	Constant = 270	None
	Rise Time	*RiseTime*	Log Step (base 2)	None
	Duration	*Duration*	Log Step (base 2)	None
Notched Noise	Center Frequency	*CenterFreq*	see above	None
	Bandwidth	*Bandwidth*	Constant = 1 oct	None
	Level	*NoiseAtten*	Constant = 113	*NoiseAtten* - *ToneLevel*
Masker	Level	*MaskerLevel*	Value List	90 dB - *MaskerLevel*

Building the Tone

Frequency. Tone frequency will be controlled by the variable, *CenterFreq*. Thresholds will be obtained at the following frequencies: 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. Fortunately, these frequencies can be computed using a logarithmic (base 2) formula. Specifying a Minimum value of 500, a Maximum value of 4000, and a Step value of 1 will generate the following *CenterFreq* values: 500, 1000, 2000, and 4000. For each value of *CenterFreq*, the stimulus will be repeated while the level varies from 90 dB SPL to 10 dB SPL in 5 dB decrements. Thus, it will be necessary to repeat each frequency 17 times.

To define the variable, CenterFreq

1. Double-click 1. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*CenterFreq*
Units:	Hz
Method:	Log Step (base 2)
Value Limits	
Default/Start:	500
Minimum:	500
Maximum:	4000
SGI Modifiers	
Repeat:	17
Termination Control	
Boundary Control:	⊙

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Level. In order to provide maximum possible signal to noise ratios, Tone level will be controlled through analog attenuation. You will generate a SigGen tone with a peak amplitude of 90 dB SPL. Using a PA4 programmable attenuator, you will vary the peak amplitude from 90 dB SPL to 10 dB SPL in 5 dB decrements. To do so, you will use two variables, *ToneLevel* and *ToneAtten*.

To define the variable, ToneLevel

1. Double-click 2. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*ToneLevel*
Units:	dBSPL
Method:	Linear Step
Value Limits	
Default/Start:	90
Step Size:	-5
Minimum:	10
Maximum:	90
Termination Control	
Loop:	⊙

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To define the variable, ToneAtten

1. Double-click 3. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*ToneAtten*
Units:	dBSPL
Method:	Constant
Combination Variable	
Variable:	*ToneLevel*
Operation:	V - VComb
Value Limits	
Default/Start:	90

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Phase. Tone phase will remain constant at 270 degrees (cosine).

To define the variable, Phase

1. Double-click 4. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*Phase*
Units:	deg
Method:	Constant
Value Limits	
Default/Start:	270

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Rise Time and Duration. As described by Stapell, et al.,[2] rise time and duration will vary with frequency. For each frequency, a tone will have a 2 cycle rise, and 1 cycle peak, and a 2 cycle fall. Since frequency is being controlled through the use of a logarithmic (base 2) calculation, both rise time and duration may also be controlled through a logarithmic calculation. At 500 Hz, a 2-cycle rise/fall time will equal 4 milliseconds. A peak duration of 1 cycle will equal 1 millisecond. Total duration of the signal will equal 10 milliseconds. At 4000 Hz, the rise/fall time will equal .5 milliseconds. The peak duration will equal .25 millisecond. Total signal duration will equal 1.25 milliseconds. All values between these two extremes may be calculated through use of a logarithmic (base 2) function.

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[2]Stapell, D. R., Picton, T. W., Durieux-Smith, A., Edwards, C. G., and Moran, L. M. (1990). Thresholds for short-latency auditory-evoked potentials to tones in notched noise in normal-hearing and hearing-impaired subjects. *Audiology*, *29*, 262-274.

To define the variable, RiseTime

1. Double-click 5. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*RiseTime*
Units:	ms
Method:	Log Step (base 2)
Value Limits	
Default/Start:	4
Step:	-1
Minimum:	4
Maximum:	0.5
SGI Modifiers	
Repeat:	17

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To define the variable, Duration

1. Double-click 6. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*Duration*
Units:	ms
Method:	Log Step (base 2)
Value Limits	
Default/Start:	10
Step:	-1
Minimum:	10
Maximum:	1.25
SGI Modifiers	
Repeat:	17

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Controlling the Notched Noise

The notched noise will be generated through the RCO file. A gaussian noise with a base level of 90 dB SPL will be generated. Noise level will be controlled through variable, *NoiseAtten*. The center frequency of the notch will be controlled through use of the previously defined variable, *CenterFreq*. The bandwidth of the noise will be controlled through the variable, *Bandwidth*.

NoiseAtten. Programming the noise attenuation level is a simple process. The desired output noise level is as follows:

Output noise level = *ToneLevel* - 23 dB

The continuous noise will begin with a level of 90 dB SPL. The nois must be attenuated as follows:

Level of attenuation = 90 dB - Output noise level
= 90 dB - (*ToneLevel* - 23 dB)
= 113 dB - *ToneLevel*

To define the variable, NoiseAtten

1. Double-click 7. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*NoiseAtten*
Units:	dB
Method:	Constant
Value Limits	
Default/Start:	113
Combination Variable	
Variable:	*ToneLevel*
Operation:	V - Vcomb

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Bandwidth. Bandwidth will remain constant at 1 octave.

To define the variable, Bandwidth

1. Double-click 8. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*Bandwidth*
Units:	oct
Method:	Constant
Value Limits	
Default/Start:	1

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Controlling the Non-test Ear Masker

The non-test ear masker will be generated through the RCO file. A white noise with a base level of 90 dB SPL will be generated. Noise level will be controlled through use of the variable, *MaskerAtten*. The level of attenuation will be frequency specific.

NoiseAtten. Programming the noise attenuation level is a simple process. The desired output noise level is as follows:

Frequency in Hz	Level in dB SPL
500	Your choice
1000	Your choice
2000	Your choice
4000	Your choice

The continuous noise will be generated with a base level of 90 dB SPL. The noise must be attenuated as follows:

Level of attenuation = 90 dB - Output noise level

You can easily define a variable that perform this calculation using the correct output noise levels for each frequency. To do so, create a combination variable, *MaskerLevel*.

To define the variable, MaskerLevel

1. Double-click 9. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*MaskerLevel*
Units:	dBSPL
Method:	Value List
	Your choice
	Your choice
	Your choice
	Your choice
Combination Variable	
Variable:	Constant
Operation:	Vcomb - V
Value:	90
SGI Modifiers	
Repeat Factor:	17

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To accept the signal parameters and return to the SigGen main window

- Click the OK button in the Signal Parameters dialog box.

Create the Segment and Component

To create the tone, you must define the parameters for one segment.

To create the segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

Select:	Seg[1]
Gate Type:	Cos2
Gate Time:	*RiseTime*
Level:	0 dB
Gen. Meth.:	Time
App. Meth.:	Add
Start:	0
Duration:	*Duration*

To create a component for the segment

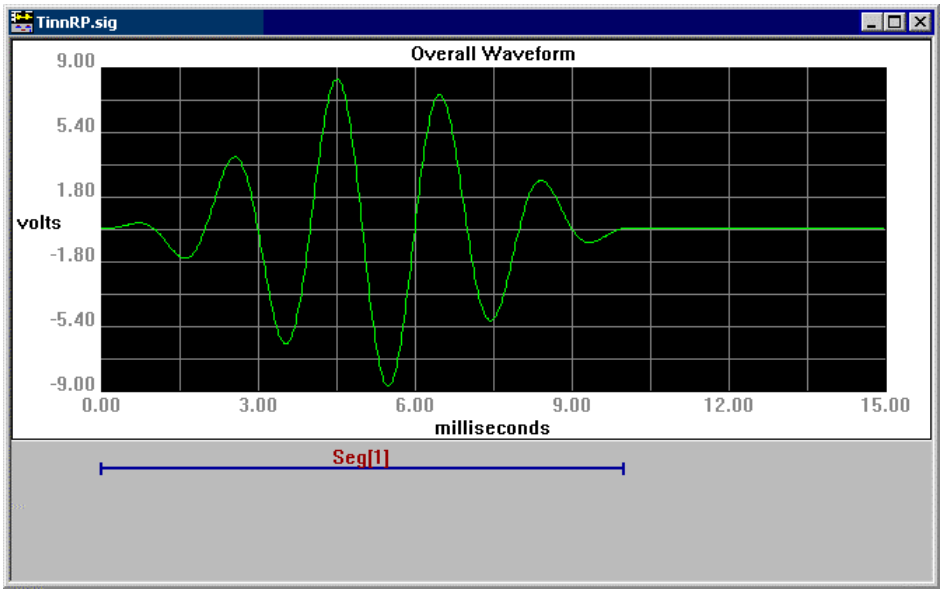
1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

Call:	Tone
Level:	90 dB
Frequency:	*CenterFreq*
Phase:	*Phase*

3. Click the OK button to accept the component parameters.

To return to SigGenRP's main window

➢ Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen File to generate a stimulus signal through BioSig. Save it with the name *tinn.sig* (*t*one *in n*oise).

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SigGenRP\BioSigRP\Files\tinn.sig* in the File Name field.

Running the BioSigRP Experiment

Now that you have created the SigGen file that will be used to generate the tone and control the continuous notched noise and non-test ear masker, you are ready to run the experiment.

Check the Hardware

Prior to running BioSigRP, make sure that all hardware is properly configured.

Run BioSig

To run BioSig

- Double-click the BioSigRP icon.

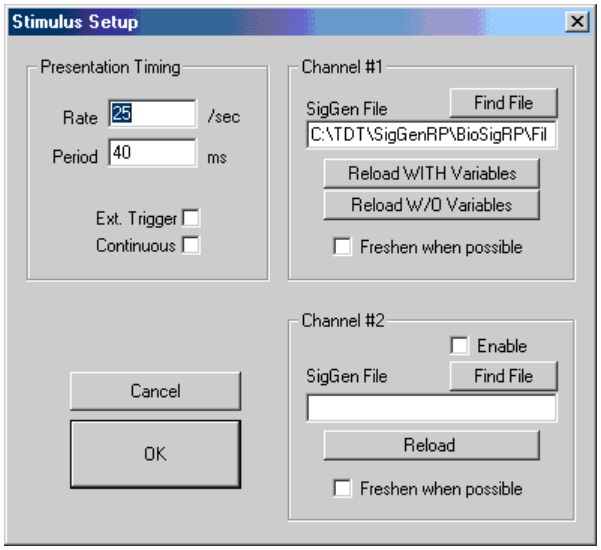
Setup the Stimulus Parameters

During stimulus setup, you will define the presentation rate and specify the SigGen file.

To setup the stimulus parameters

1. Select Stimulus from the Setup menu of the main window.
2. Enter or select the following parameters in the Stimulus Setup dialog box:

Presentation	
Rate:	40/sec
Period:	25 milliseconds
Lock SigGen Files	☒
Channel #1	
SigGen File:	*C:\TDT\SigGenRP\BioSigRP\Files\tinn.sig*



To accept the stimulus setup parameters and return to the main window

➢ Click OK.

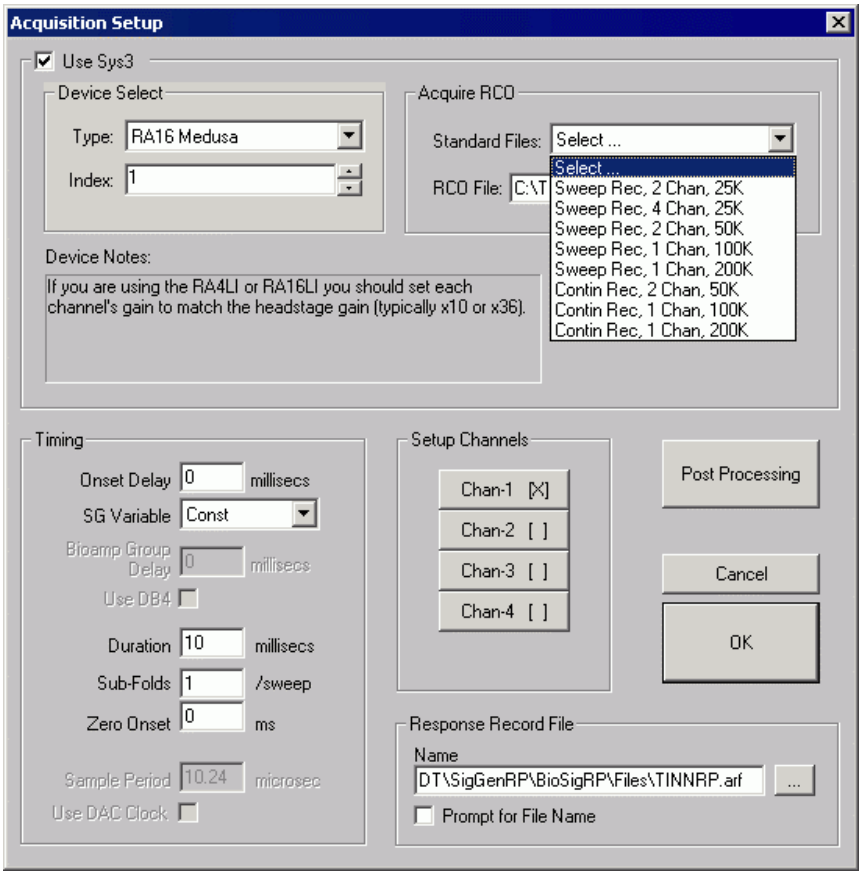
Setup the Acquisition Parameters

Prior to running the experiment, you must define the acquisition timing parameters and specify a record file (*.arf* file).

To setup the acquisition parameters

1. Select Acquisition... from the Setup menu of the main window.
2. Choose the correct RCO file (sweep Rec 4 channel acquisition) From the Acquisition setup menu.
2. Enter or select the following parameters in the Acquisition Setup dialog box:

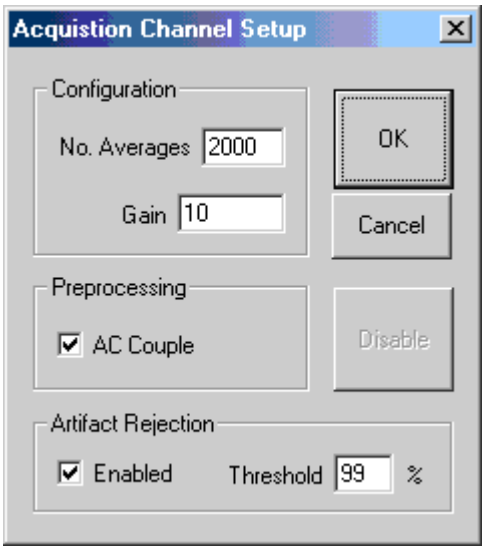
Timing
Duration: 20 milliseconds
Response Record File
Name:*C:\TDT\SigGenRP\BioSigRP\Files\TINNRP.ARF*
Prompt for File Name: ☐



To setup acquisition Channel 1

1. Click the Chan-1 button.
2. Enter or select the following parameters in the Acquisition Channel Setup dialog box:

Configuration	
Number of Averages:	2000
Gain:	10



To accept the Channel 1 acquisition parameters and return to the Acquisition Setup dialog box

➢ Click OK.

To accept the acquisition setup parameters and return to the main window

➢ Click OK.

Save the Configuration File

You will want to save the configuration file for future experiment sessions.

To save the configuration file

1. Choose Save from the File menu.
2. Enter C:\TDT\SIGGENRP\BIOSIGRP\FILES\TINN.ACF in the File Name field.

Run the Experiment

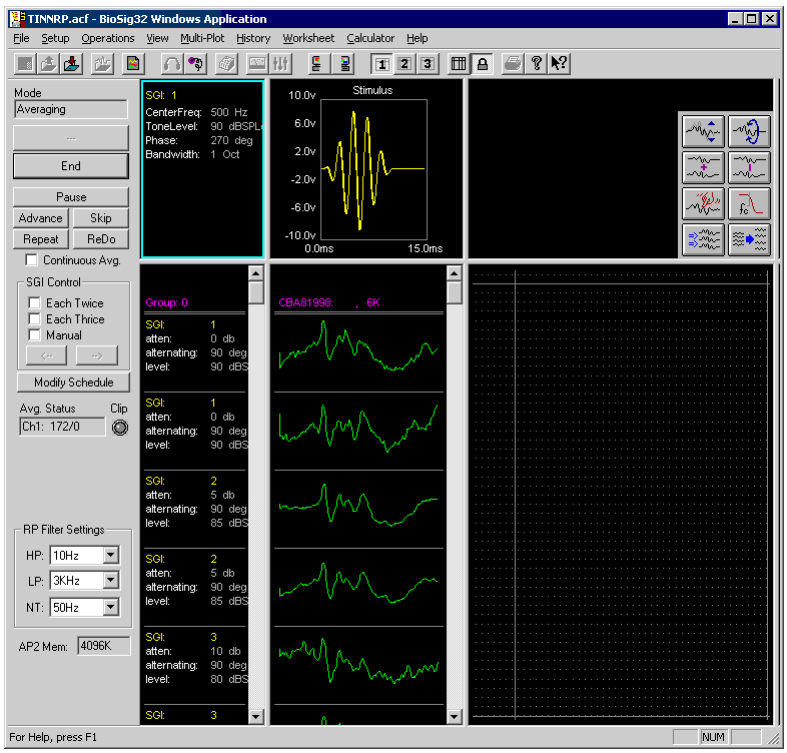
You are now ready to run the experiment.

Running

To begin stimulus presentation

➢ Click the Start button.

You are now in Running Mode. The tone in continuous notched noise and non-test ear masker will be generated according to the parameters you defined during SigGenRP and BioSigRP setup.

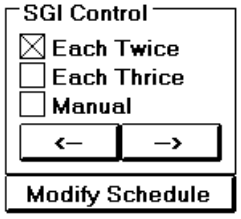


Averaging

BioSigRP provides several features that allow you to modify the stimulus schedule. For example, you may wish to obtain multiple averaged responses for each stimulus condition. Such modification may be accomplished through use of the SGI Control features displayed in the left portion of the SigGenRP main window.

To repeat each SGI twice

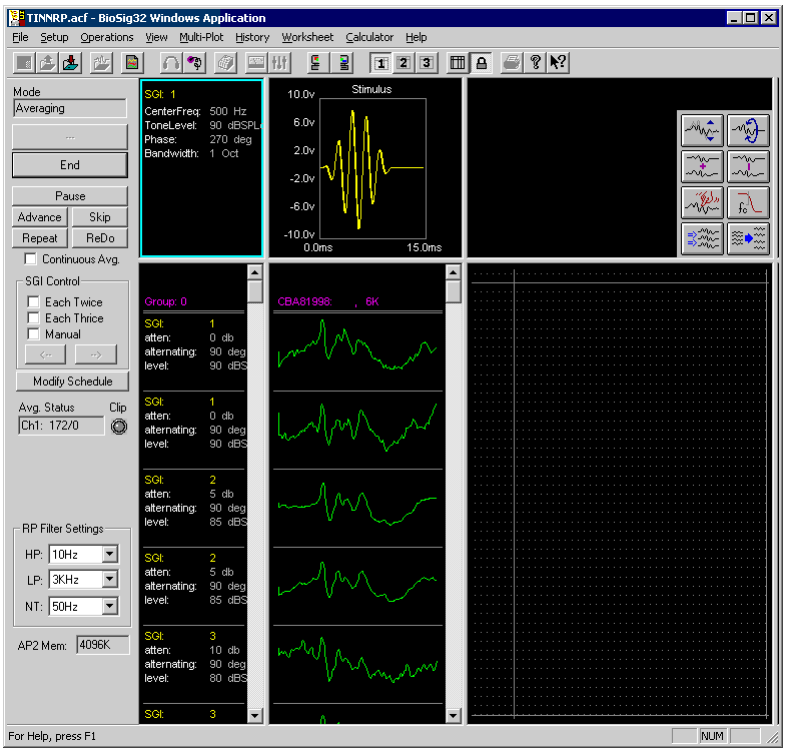
➢ Check Each Twice.



To begin data averaging

1. Click the Begin button.
2. Enter any pertinent subject information and click OK.

   You are now in Averaging Mode. Upon each trigger, the acquired auditory brainstem response data will be included in the running average until 2000 response signals have been obtained. If you checked Each Twice, two averaged responses will be collected for each stimulus condition.



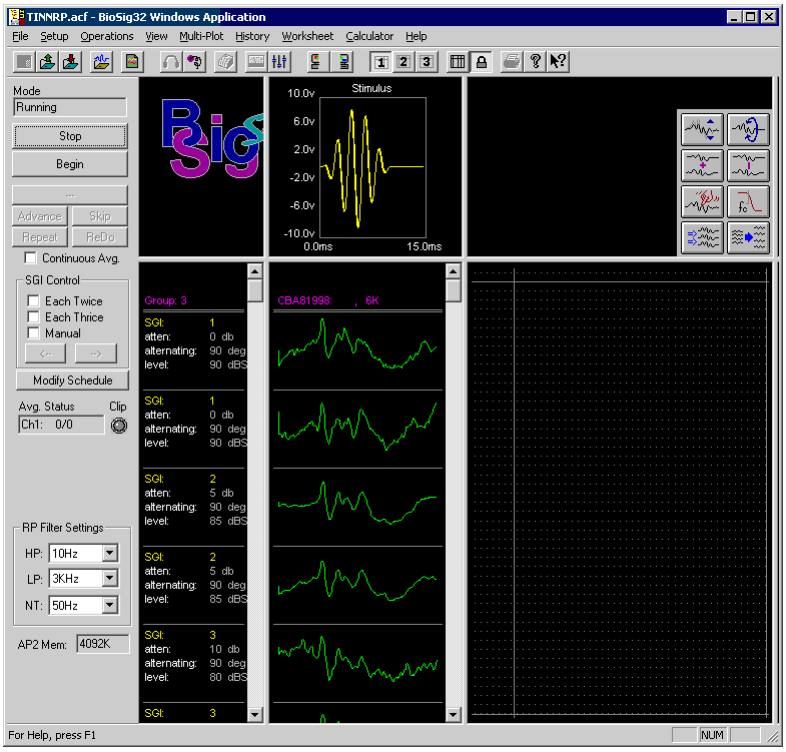
Termination

Once the boundary conditions have been met, BioSigRP will automatically terminate data averaging. However, you may manually terminate data averaging at any time.

To manually terminate data averaging

➢ Click the End button.

You will be returned to Running mode.



To halt stimulus presentation

➢ Click Stop.

Analyze the Data

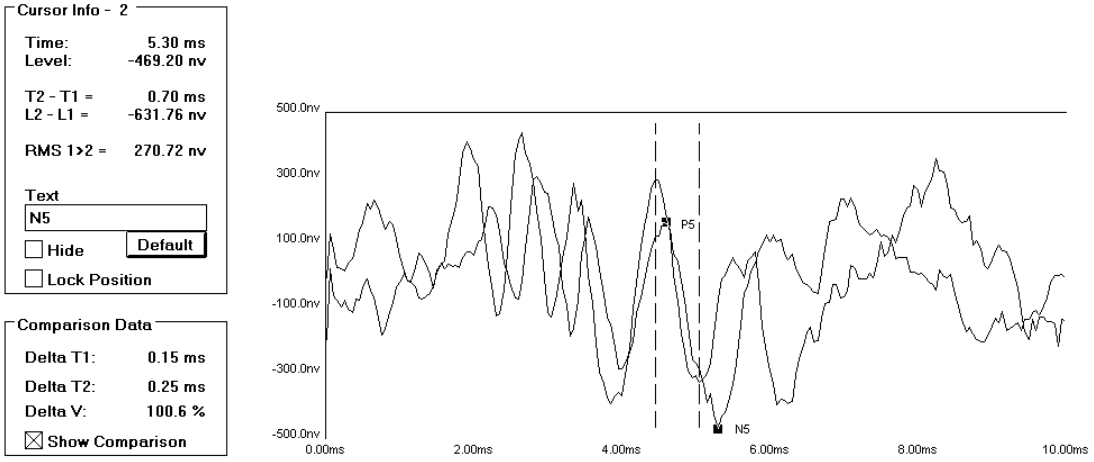
As mentioned in previous examples, BioSigRP does not automatically determine threshold levels. Instead, BioSigRP allows the user to place cursors on peaks in selected ABR records. Each cursor provides the user with peak values and latencies. The experience clinician\researcher may use these values to determine whether or not a threshold has been achieved.

To analyze the data

1. Create a comparison record, if desired.
   a. Select the desired record.
   b. Choose Make Comparison from the History menu.
2. Double-click in turn on each interesting experimental record in the History Plot.
3. Place cursors on the peaks or valleys of interest.
4. Enable Show Comparison.

Below, a comparison record is displayed superimposed upon an experimental record. The comparison record was obtained in response to a tone of large amplitude. The experimental record is being compared to the comparison record to determined whether or not threshold has been reached. The researcher may use any standard technique for determining threshold. In this case, the amplitude difference between P5 and N5 is being examined.. The dashed vertical lines indicate the placement of P5 and N5 in the comparison sample.

Amplitude and latency values may be compared between the two signals. In this illustration, cursor 2, located at N5, is selected. It's latency and amplitude values are presented in the Time and Level fields. The difference in amplitude and time between the second cursor, N5, and the first cursor, P5, are reported in the fields, T2-T1 and L2-L1, respectively. The RMS amplitude between P5 and N5 is reported in the RMS 1>2 field. The difference in latency between P5 of the comparison signal and P5 of the experimental signal is reported in the Delta T1 field. The difference in latency between N5 of the comparison signal and N5 of the experimental signal is reported in the Delta T2 field. The percentage computed by dividing the difference in amplitude between P5 and N5 of the experimental signal by the difference in amplitude between P5 and N5 of the comparison record is provided in the Delta V field.



Building a Report

You might want to build a report showing the comparison record and experimental records.

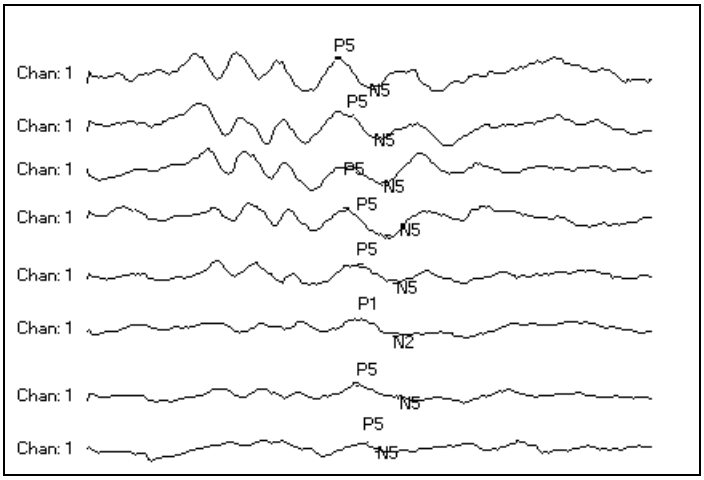
To build the report

1. Drag the desired History Plot records into the Worksheet.
2. Drag individual records to the desired location within the Worksheet.

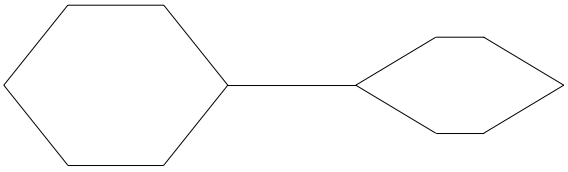
To display cursors

1. Click the *right* mouse button anywhere in the Worksheet except directly over a record or a record label.

   You will see the Worksheet Preferences dialog box.
2. Check the Show Cursors box.
3. Click OK.



Example 4: Tone-on-Tone Forward Masking



- ✓ *Constant Variables*
- ✓ *Repeat Factor*
- ✓ *Loop*

This experiment has been designed to obtaine an ABR masking recovery function using tone-on-tone forward masking. It is assumed that an ABR audiogram has already been obtained and that the system has been calibrated.

Prior to collecting the experimental data, you will obtain an averaged ABR waveform in response to an non-masked, 12 kHz tone presented at 20 dB SL for 5 msec with a 1 msec cosine-shaped rise-fall time. The P5 amplitude (P5 - N5) of this waveform will be used as a reference in the experiment. You will then conduct a tone-on-tone masking experiment. The probe will consist of a 5 msec 12 kHz tone burst presented with a level of 20 dB SL and a 1 msec cosine-shaped rise-fall time. The masker will consist of a 5 msec 12 kHz tone burst with a 1 msec cosine-shaped rise-fall time. The masker will precede the probe by ΔTs of 2, 4, 8, 16, 32, 64, and 100 msec. For each ΔT, masker level will be varied in 3 dB increments until the P5 amplitude, P5 - N5, is reduced from the non-masked P5 amplitude by 50%.

To run the experiment, you will need to perform the following steps:

1. Build the non-masked and masked SigGen Signals.
   a. Run SigGenRP.
   b. Define the signal parameters.
   c. Define the variables, *DeltaT*, *MaskerLevel*, *AltPhase*, and *ToneDuration*.
   d. Create the segment and components.
   e. Save the SigGen files.
2. Run the experiment with BioSigRP.
   a. Run BioSigRP.
   b. Setup the stimulus parameters.
   c. Setup the acquisition parameters.
   d. Save the *.acf* file.
   e. Obtain the reference ABR waveform and save it as a comparison record.
   f. Mark P5 and N5 on the comparison record.
   g. Redefine the SigGen signal.
   h. Run the experiment.
   i. Compare experimental ABR records to the comparison waveform.

Note: Only those parameters to be entered or selected are given below. All other parameters will remain according to the default settings.

Building the Non-masked Signal

For reference purposes, you will need to obtained an averaged ABR waveform in response to a non-masked signal. The signal will consist of a 5 msec 12 kHz tone presented at 20 dB SL with a 1 msec cosine-shaped rise-fall time.

Run SigGenRP

To run SigGenRP

➤ Double-click the SigGenRP icon.

To open a new signal window

➢ Choose New from the File menu.

Define the Signal Parameters

Prior to performing the experiment, you should calibrate the system. In this case, it would be best to calibrate the system in dB SL. For illustration purposes, we have assumed that presenting a 9 volt 12 kHz SigGen pure tone results in a 90 dB SL output. We will use this calibration throughout the example.

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

Name:	*Comparison*
Timing	
Duration:	10 milliseconds
Calibration	
Level:	90 dB = 9 volts

Configure the RPx device and RCO file

For System 3 equipment SigGenRP uses the RPx device and RCO files (See RPvds help) to play out signals.

To configure the RPx device and select the RCO file

1. Select Rp devices|Device A from the Modify menu or click on the "A" icon on the tool bar.
2. Select the (…) and choose from the sgRCO sweep 50 kHz Tone
3. Select RP2 Processor as device type
4. Select Index 1.
5. Select "Use sample rate specified in RCO file."

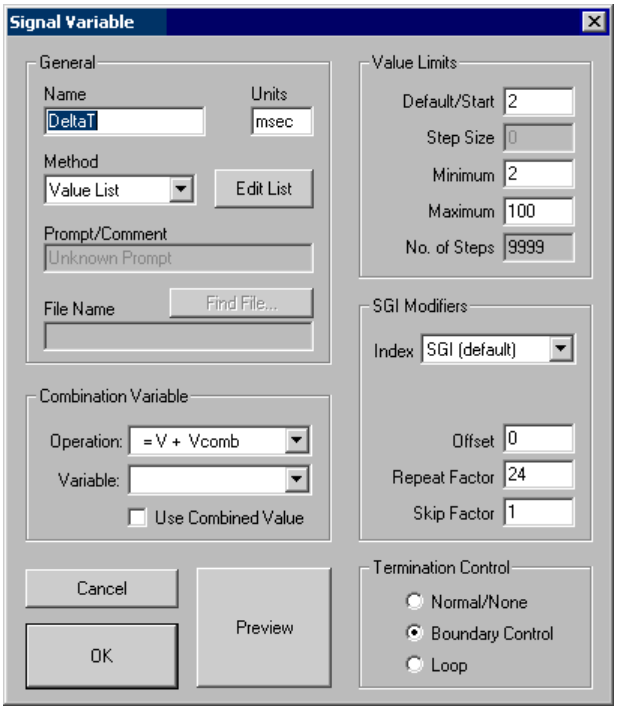
Define the Variables

It is necessary to use onset variables to synchronize stimulus play and ABR acquisition. Thus, you should create the onset variable, *DeltaT*. For the non-masked probe, *DeltaT* will be a constant value of 2 msec. Additionally, it is necessary to alter signal phase so that artifactual data such as cochlear microphonic effects may be canceled during averaging. You should create an alternating phase variable, *AltPhase*.

To define the variable, DeltaT

1. Select Signal from the Modify menu of the main window.
2. Click the Edit button in the Variables group box of the Signal Parameters dialog box.
3. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*DeltaT*
Units:	msec
Method:	Constant
Value Limits	
Default/Start:	2



To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To define the variable, AltPhase

1. Double-click 2. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*AltPhase*
Units:	deg
Method:	Alternating
Value Limits	
Default/Start:	90
Minimum:	90
Maximum:	270

Note: Use of an alternating variable will cause the variable value to alternate between the minimum and maximum value with each presentation.

Note: Phase is calculated using a cosine function. Thus, zero crossings occur at 90 degrees and 270 degrees.

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To accept the signal parameters and return to the SigGenRP main window

- Click the OK button in the Signal Parameters dialog box.

Create the Segment and Component

Our non-masked reference tone will consist of just one segment. This segment in turn will consist of just one component.

To create the segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

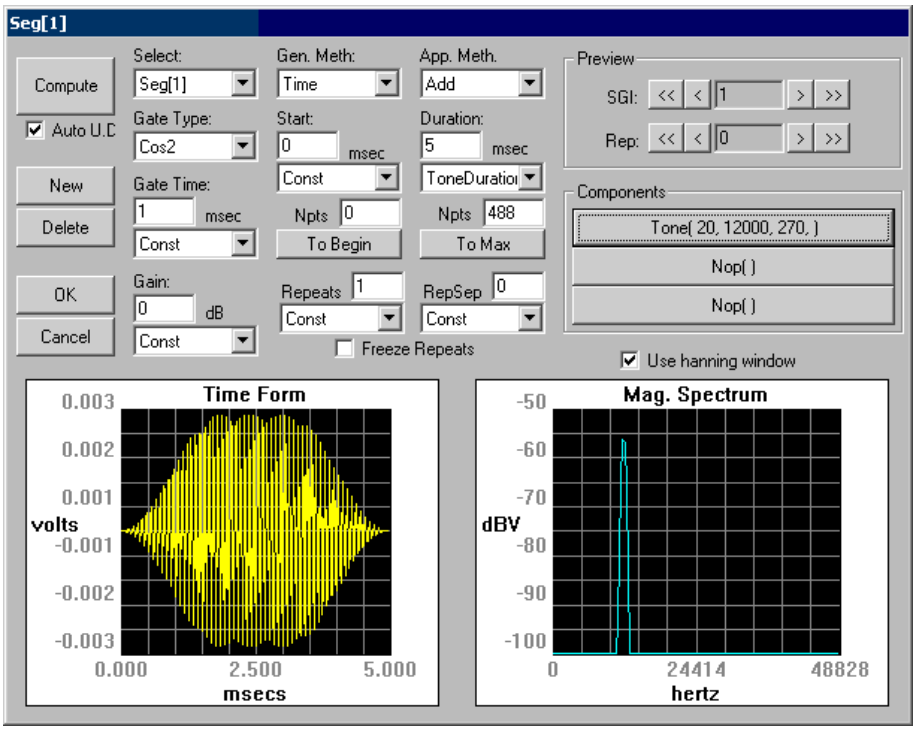
Select:	Seg[1]
Gate Type:	Cos2
Gate Time:	1 msec
Level:	0 dB
Gen. Meth.:	Time
App. Meth.:	Add
Start:	*DeltaT*
Duration:	5 msec

To create a component for the segment

1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

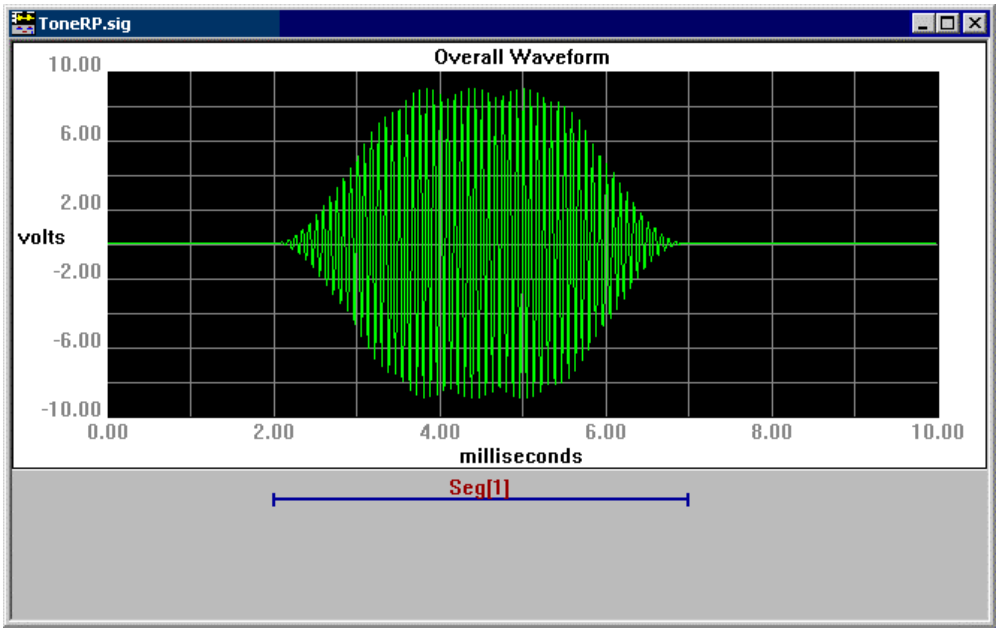
Call:	Tone
Level:	20 dB
Frequency:	12,000 Hz
Phase:	*AltPhase*

3. Click the OK button to accept the component parameters.



To return to SigGenRP's main window

➢ Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen file to generate a stimulus signal through BioSigRP.

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SIGGENRP\BIOSIGRP\FILES\tone.sig* in the File Name field.

Building the Masked Signal

The masked signal will be comprised of two segments, a masker and a probe. Each segment will consist of a 5 msec 12 kHz tone burst with a 1 msec cosine-shaped rise-fall time. The ΔT between the masker and the probe will vary as follows: 2, 4, 8, 16, 32, 64, and 100 msec. For each ΔT, the probe level will increase from 20 dB SL in 3 dB increments until a P5 amplitude (P5-N5) of 50% that seen in the comparison record is achieved.

Create a New SigGen Signal

To create a new SigGen signal

➢ Choose New from the File menu.

This will open a new window from which you may design the second SigGen signal.

Define the Signal Parameters

You should use the shortest sampling period, 5 microseconds. As in the previous signal, a calibration of 90 dB = 9 volts is being assumed for illustrative purposes.

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

Name:	*ToneOnTone*
Sample Period:	5 μseconds
Timing	
Duration:	125 milliseconds
Calibration	
Level:	90 dB = 9 volts

Define the Variables

The tone-on-tone masked signal will require the use of four variables, *ToneDuration, DeltaT*, *MaskerLevel* and *AltPhase*.

Defining Component Durations

The duration of both the masker and the probe will remain at a constant 5 msec. You will later be using this duration in a mathematical operation, however. For that reason, you should use a variable, *ToneDuration*, with a constant value of 5 msec to define the duration of each component.

To define the variable, ToneDuration

1. Select Signal from the Modify menu of the main window.
2. Click the Edit button in the Variables group box of the Signal Parameters dialog box.
3. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*ToneDuration*
Units:	msec
Method:	Constant
Value Limits	
Default/Start:	5

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Defining ΔT

The variable *DeltaT* will be used to control the variation of the ΔT between the masker and the probe. For each ΔT, the masker level will vary from 20 dB SL to 90 dB SL in 3 dB increments, resulting in 24 presentations for each value of *DeltaT*. You will thus define *DeltaT* as a Value List variable with values of 2, 4, 8, 16, 32, 64, and 100 msec. You will set the *Repeat Factor* field equal to 24. Because you will want averaging to terminate automatically, you will want to enable Boundary Control.

For more information about combination variables, see the SigGenRP User's Guide.

Note: In SigGenRP, the temporal placement of a segment is specified in terms of onset rather than in terms of its distance in time from the end of a previous segment (ΔT). Thus, probe onset must be defined as follows: *Masker duration + ΔT*. This may be accomplished through use of a combination variable.

To define the variable, DeltaT

1. Click on 2. ..... in the Variables list box.
2. Enter or select the following parameters in the Signal Variable dialog box

General	
Name:	*DeltaT*
Method:	Value List

3. Click the Edit List button.
4. Enter the following:

2
4
8
16
32
64
100

5. Click OK to accept the list
6. Enter the following parameters:

Combination Variable	
Variable:	*ToneDuration*
Operation:	V + Vcomb
SGI Modifiers	
Repeat Factor:	24
Termination Control	
Boundary Control:	⊙

Defining the Masker Level

The variable *MaskerLevel* will control the variation of the masker level. Since the level of the masker will be varied linearly in steps of 3 dB, *MaskerLevel* may be defined as a linear variable. Because *MaskerLevel* will vary for each value of the variable *DeltaT*, it must be assigned a termination control of *Loop*.

To define the variable, MaskerLevel

1. Click on 3. ..... in the Variables list box.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*MaskerLevel*
Method:	Linear Step
Value Limits	
Default/Start:	20
Step Size:	3
Minimum:	20
Maximum:	90
Termination Control	
Loop:	⊙

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Defining Alternating Phase

To eliminate the effects of artifact such as cochlear microphonic effects, you will want to alternate phase through use of the alternating variable, *AltPhase*.

Note: Use of an alternating variable with cause the variable value to alternate between the minimum and maximum value with each presentation.

Note: Phase is calculated using a cosine function. Thus, zero crossings occur at 90 degrees and 270 degrees.

To define the variable, AltPhase

1. Double-click 4. ..... in the Variables list
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*AltPhase*
Unit:	deg
Method:	Alternating
Value Limits	
Default/Start:	90
Minimum:	90
Maximum:	270

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

To accept the signal parameters and return to the SigGenRP main window

- Click the OK button in the Signal Parameters dialog box.

Create the Segments and Components

Our SigGen signal will consist of two components, the masker and the probe.

To create the masker segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

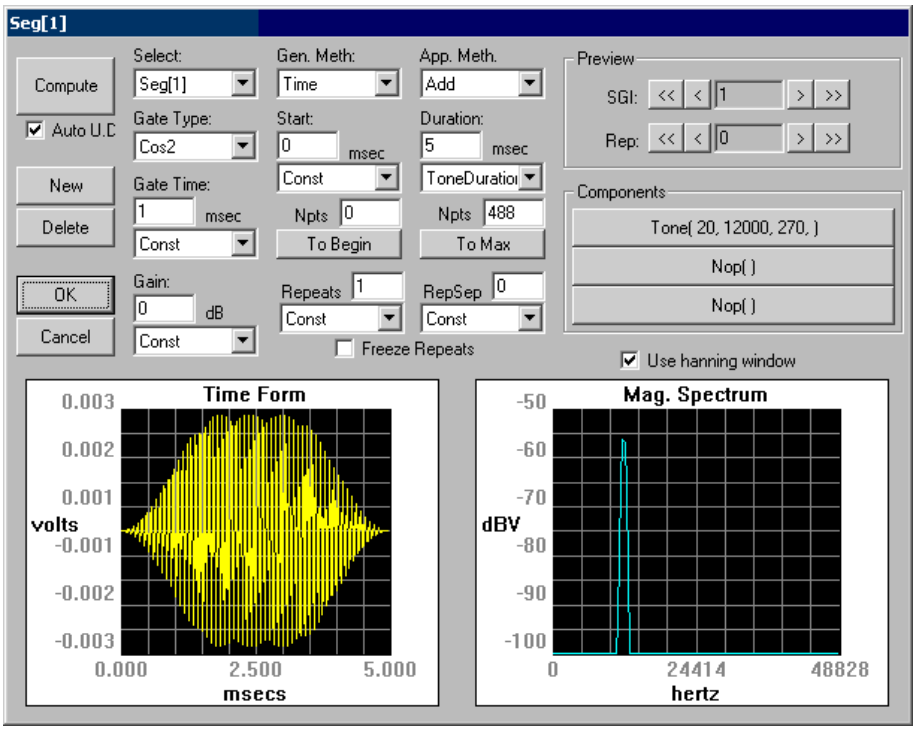
Select:	Seg[1]
Gate Type:	Cos2
Gate Time:	1 msec
Level:	0 dB
Gen. Meth.:	Time
App. Meth.:	Add
Start:	0 msec
Duration:	ToneDuration

To create a component for the masker segment

1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

Call:	Tone
Level:	*MaskerLevel*
Frequency:	12,000 Hz
Phase:	*AltPhase*

3. Click the OK button to accept the component parameters.



To create the probe segment

1. Click the New button.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

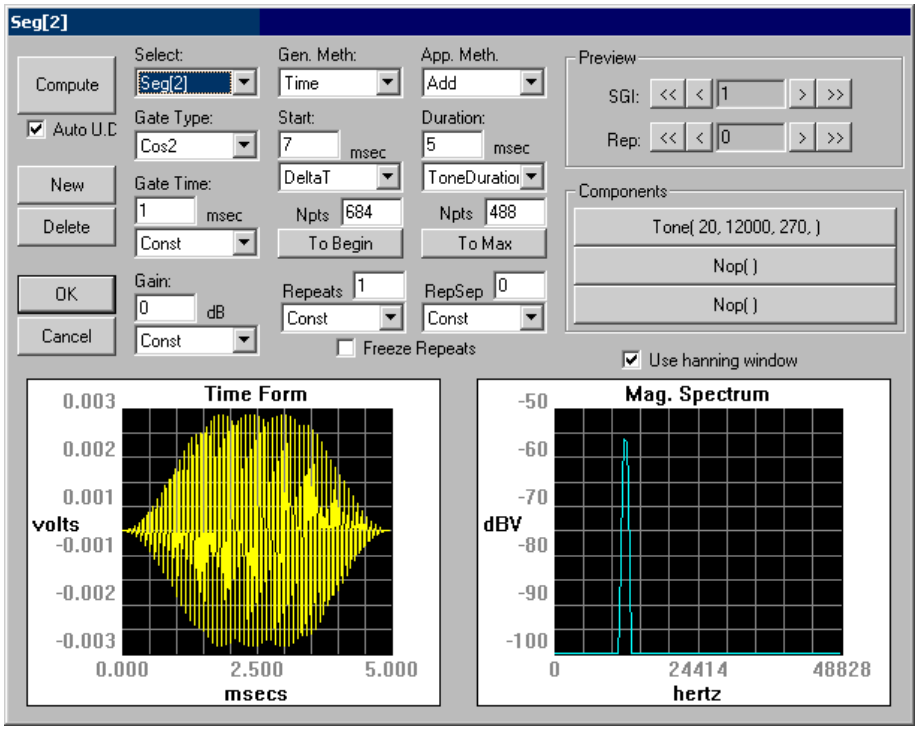
Select:	Seg[2]
Gate Type:	Cos2
Gate Time:	1 msec
Level:	0 dB
Gen. Meth.:	Time
App. Meth.:	Add
Start:	*DeltaT*
Duration:	*ToneDuration*

To create a component for the probe segment

1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

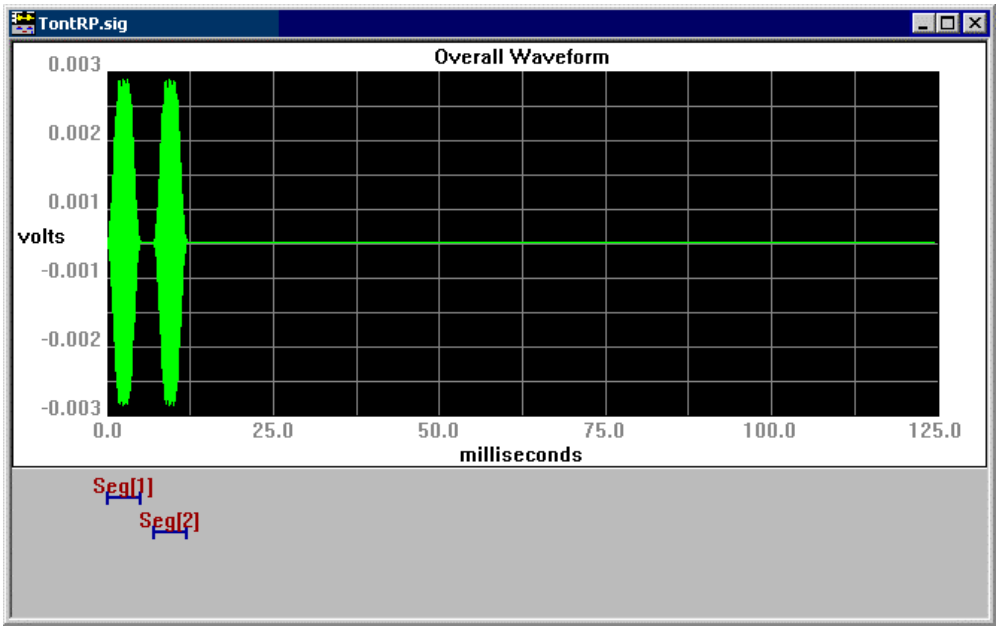
Call:	Tone
Level:	20 dB
Frequency:	12,000 Hz
Phase:	*AltPhase*

3. Click the OK button to accept the component parameters.



To return to SigGenRP's main window

- Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen File to generate a stimulus signal through BioSigRP.

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SIGGENRP\BIOSIGRP\FILES\tont.sig* in the File Name field.

Running the BioSigRP Experiment

Now that you have created both the non-masked and masked probe signal, you are ready to setup BioSigRP, collect a reference ABR, and collect ABR data in response to the masked probe. This example assumes that you will use some hardware amplification and filtering prior to digitization. You will collect 10 milliseconds of ABR data for each stimulus presentation. Averaged ABR data will be computed using an *N* of 500.

Run BioSigRP

To run BioSigRP

➢ Double-click the BioSigRP icon.

Setup the Stimulus Parameters

During stimulus setup, you will define the presentation rate and specify the SigGen file.

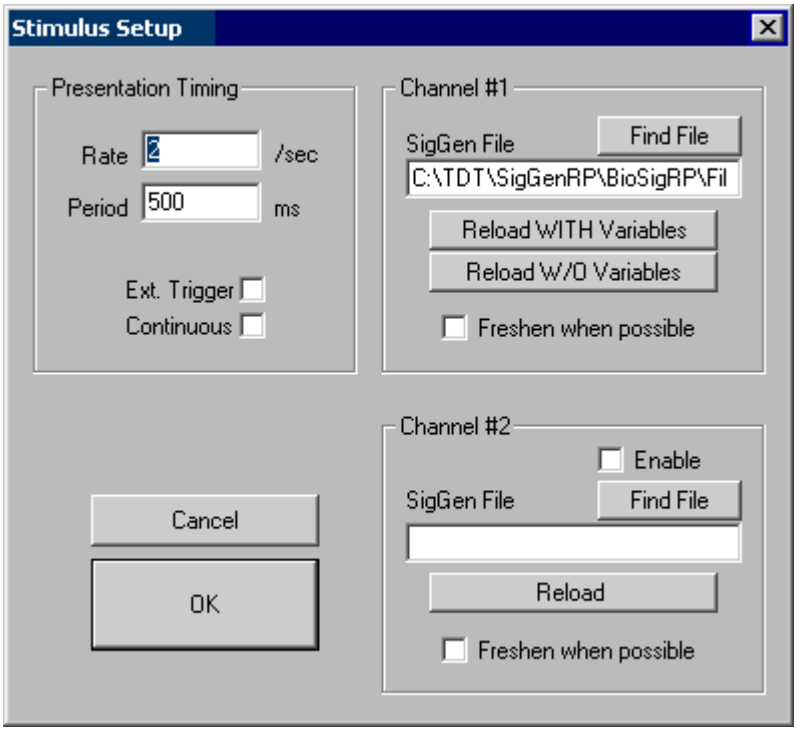
You will be presenting the entire stimulus two times per second. Thus the Presentation Rate will equal 2/sec and its inverse, Presentation Period, will equal 500 milliseconds.

You must first obtain a reference averaged ABR waveform in response to the non-masked tone. Previously, you saved the non-masked probe stimulus parameters in a SigGen file called *tone.sig*. Now you must specify this file in the Channel 1 SigGen File field. The stimulus parameters found in this SigGen file will be read by BioSigRP and used to generate the stimulus signal. Later, when you save the BioSig configuration file (*.acf* file), the signal generation parameters will be saved within that file.

To setup the stimulus parameters

1. Select Stimulus from the Setup menu of the main window.
2. Enter or select the following parameters in the Stimulus Setup dialog box:

Presentation	
Rate:	2/sec
Period:	500 milliseconds
Lock SigGen Files	☒
Channel #1	
SigGen File:	*C:\TDT\SIGGENRP\BIOSIGRP\FILES\TONE.sig*



To accept the stimulus setup parameters and return to the main window

➢ Click OK.

Setup the Acquisition Parameters

Prior to running the experiment, you must define the acquisition timing parameters and specify a record file (*.arf* file).

Acquisition timing parameters include the following: (1) *Onset Delay*, the delay in onset of data acquisition from stimulus presentation; (2) *Duration*, the duration of the acquired signal; and (3) *Sample Period*, the time in microseconds between successive data points of the digital response signal.

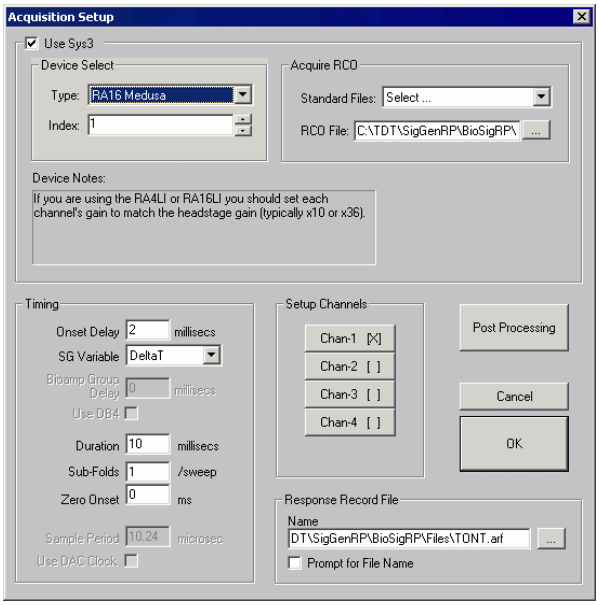
For both the non-masked and masked SigGen signals, you used a variable, *DeltaT*, to indicate probe onset time. To ensure that you begin ABR data acquisition upon presentation of the probe, you should use this same variable to specify the onset of data acquisition.

During data averaging, completed averages are appended to the end of a file know as the BioSig record file (*.arf* file). The default *.arf* file is specified in the Response Record File Name field. When *Prompt for File Name* is enabled, you will be automatically prompted to enter a file name prior to stimulus presentation. This is useful should you wish to use a file other than that specified as the default. You may disable automatic prompting by unchecking Prompt for File Name.

To setup the acquisition parameters

1. Select Acquisition... from the Setup menu of the main window.
2. Select the correct RCO file sweep acquisition 4-channels 25kHz.
2. Enter or select the following parameters in the Acquisition Setup dialog box:

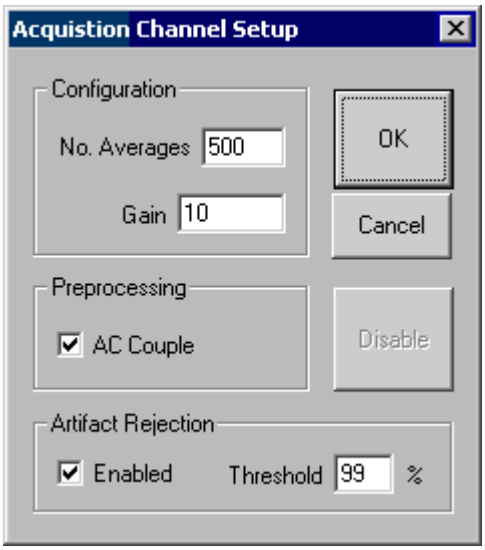
Timing
Onset Delay: *DeltaT*
Response Record File
Name:*C:\TDT\SIGGENRP\BIOSIGRP\FILES\TONT.ARF*
Prompt for File Name: ☐



To setup acquisition Channel 1

1. Click the Chan-1 button.
2. Enter or select the following parameters in the Acquisition Channel Setup dialog box:

Configuration	
Number of Averages:	500
Gain:	50000



To accept the Channel 1 acquisition parameters and return to the Acquisition Setup dialog box

- Click OK.

To accept the acquisition setup parameters and return to the main window

- Click OK.

Save the Configuration File

You will want to save the configuration file for future experiment sessions.

To save the configuration file

1. Choose Save from the File menu.
2. Enter C:\TDT\SIGGENRP\BIOSIGRP\FILES\TONT.ACF in the File Name field.

Obtain a Control Record

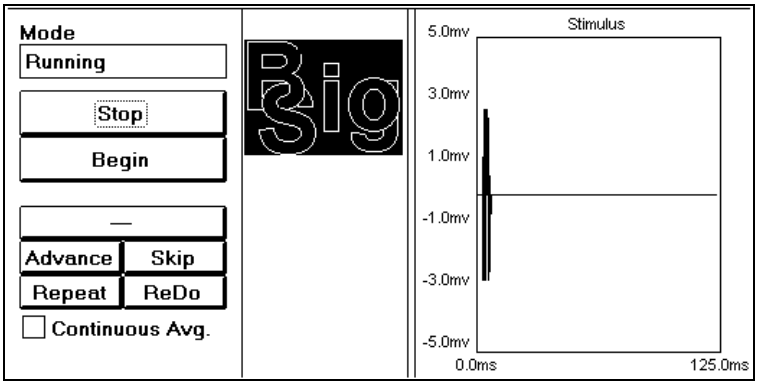
You must present the non-masked probe and obtain a response ABR for use as a comparison.

Running

To begin stimulus presentation

- Click the Start button.

You are now in running mode. The non-masked 12 kHz probe tone will be presented according to the parameters you defined during the setup procedure.

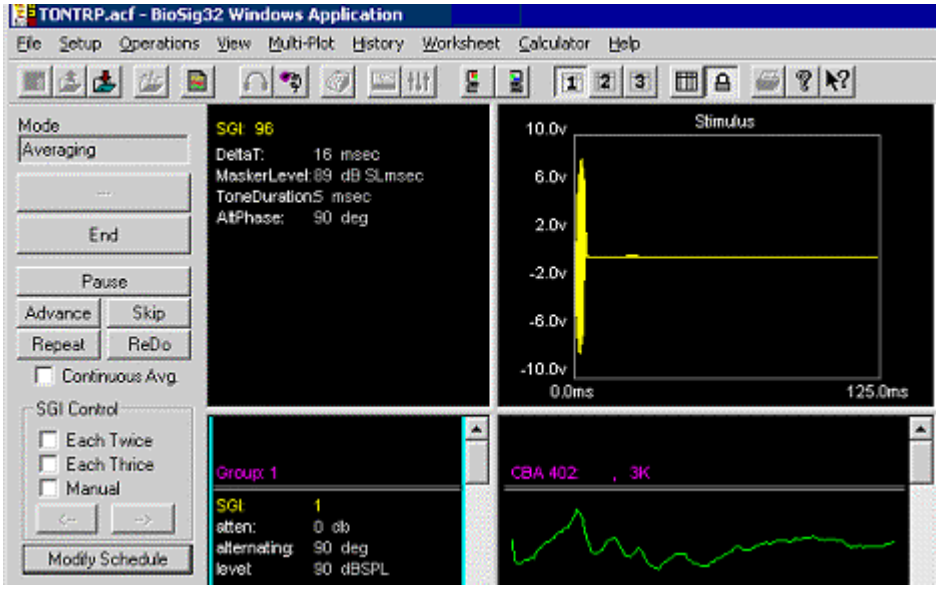


Averaging

To begin data averaging

1. Click the Begin button.
2. Enter any pertinent subject information and click OK.

   You are now in Averaging Mode. Upon each trigger, the acquired auditory brainstem response data will be included in the running average until 500 averaged response signals have been obtained. In the Multi-Purpose plot, you may view the current stimulus, the raw A/D signal, the EEG signal, or the running average. As averages are completed (when N=500), the averaged ABR records will be appended to the History plot and to the *.arf* file.



Termination

Once BioSig has averaged 500 ABR records, the resulting average will be displayed in the History Plot. You may then terminate data averaging and stimulus presentation. Or, if you would like additional reference records, you may continue to obtain ABR data.

To terminate data averaging

- Click the End button.

You will be returned to Running mode.

To halt stimulus presentation

- Click Stop.

Make a Comparison Record

You now should have one or more reference ABR records. Choose one to use as a comparison. For this experiment, you will want to place two cursors in the comparison record, one at P5 and another at N5.

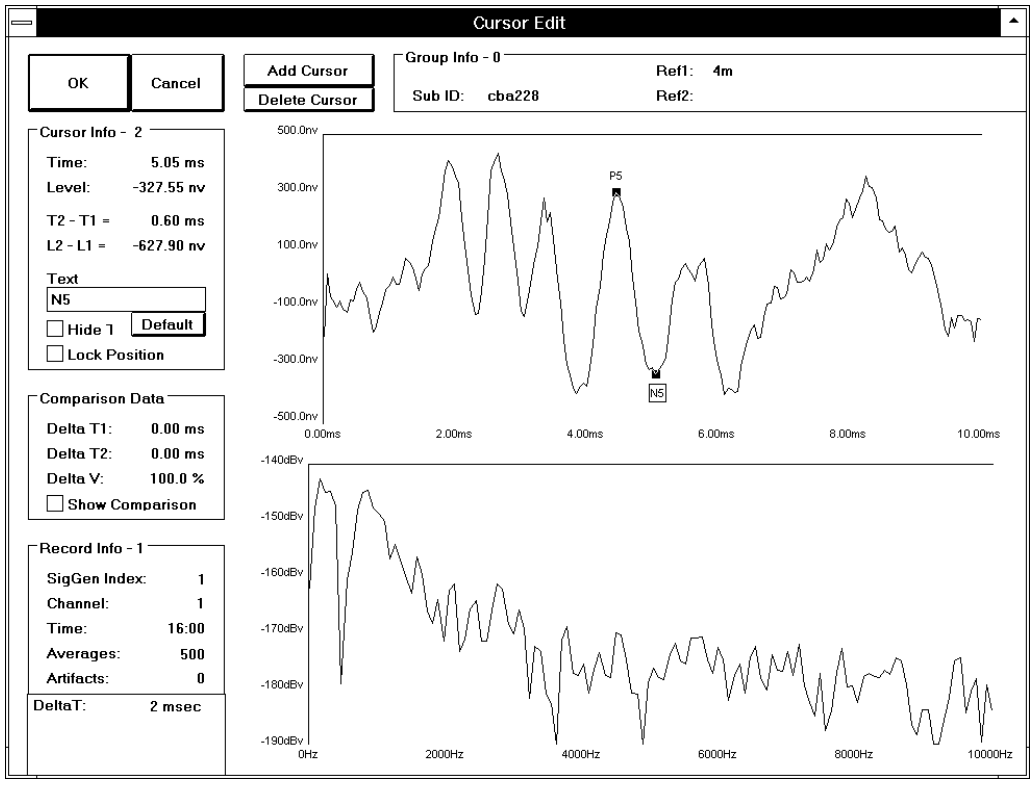
To make a comparison record

For more information about selecting History Plot records, see Chapter 2.

1. Select the desired record.
2. Choose Make Comparison from the History menu.

To place cursors

1. Double click the comparison record.
2. Double click the left mouse button on P5.
3. Type P5 in the Text field.
4. Double-click the left mouse button on N5.
5. Type N5 in the Text field.
6. Click OK to return to the BioSig main window.


Cursor Edit
OK
Cancel
Add Cursor
Delete Cursor
Group Info - 0
Sub ID: cba228
Ref1: 4m
Ref2:
Cursor Info - 2
Time: 5.05 ms
Level: -327.55 nv
T2 - T1 = 0.60 ms
L2 - L1 = -627.90 nv
Text
N5
Hide T
Default
Lock Position
Comparison Data
Delta T1: 0.00 ms
Delta T2: 0.00 ms
Delta V: 100.0 %
Show Comparison
Record Info - 1
SigGen Index: 1
Channel: 1
Time: 16:00
Averages: 500
Artifacts: 0
DeltaT: 2 msec
500.0nv
300.0nv
100.0nv
-100.0nv
-300.0nv
-500.0nv
P5
N5
0.00ms
2.00ms
4.00ms
6.00ms
8.00ms
10.00ms
-140dBv
-150dBv
-160dBv
-170dBv
-180dBv
-190dBv
0Hz
2000Hz
4000Hz
6000Hz
8000Hz
10000Hz

Run the Experiment

You are now ready to run the experiment, with the exception of one small detail. Currently, the SigGen file is defined as *tone.sig*, the file containing the parameters necessary to create the non-masked tone stimulus. You must define the SigGen file as *tont.sig*, the file containing the parameters necessary to create the probe and masker stimulus.

To change the SigGen file

1. Choose Stimulus from the Setup menu.
2. Enter *C:\TDT\SIGGENRP\BIOSIGRP\FILES\tont.sig* in the SigGen File field.
3. Click OK to return to the BioSigRP main window.

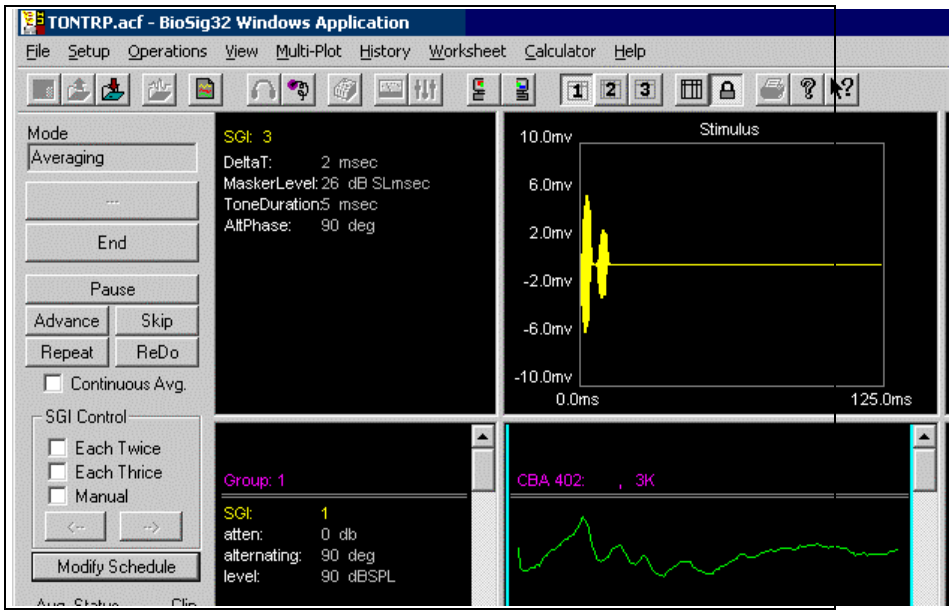
Running

You are now ready to run the experiment.

To begin stimulus presentation

➢ Click the Start button.

You are now in Running Mode. The 12 kHz probe and masker will be presented according to the parameters you defined during setup.

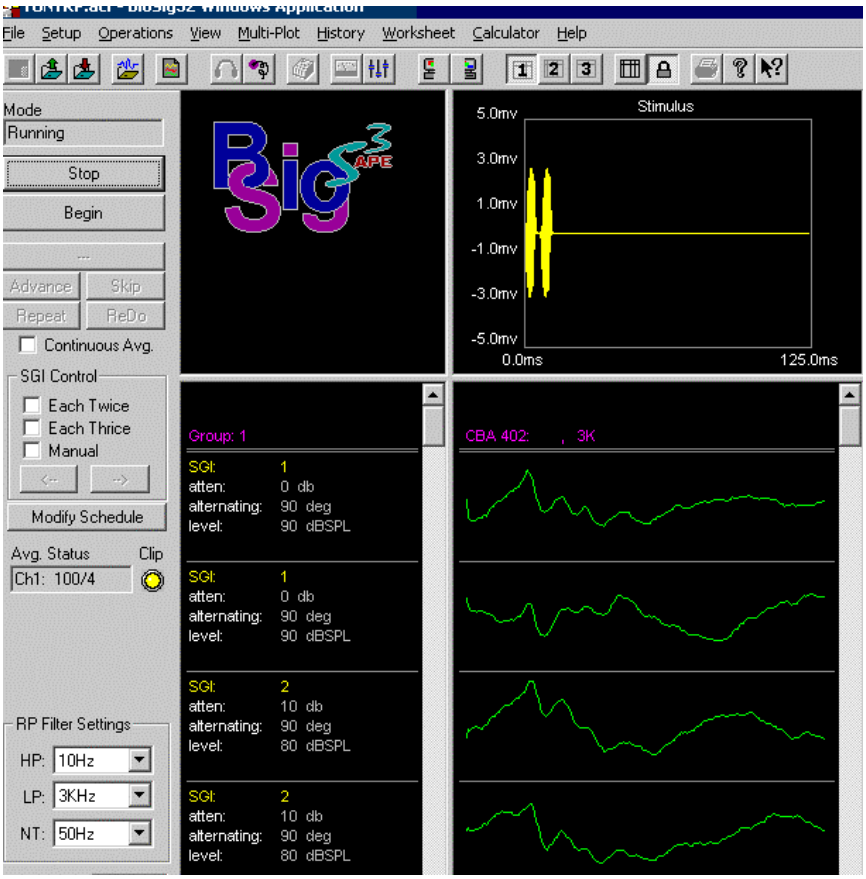


Averaging

To begin data averaging

1. Click the Begin button.
2. Enter any pertinent subject information and click OK.

   You are now in Averaging Mode. Upon each trigger, the acquired auditory brainstem response data will be included in the running average until 500 response signals have been obtained. In the Multi-Purpose plot, you may view the current stimulus, the raw A/D signal, the EEG signal, or the running average. As averages are completed (when N=500), the averaged ABR records will be appended to the History plot and the *.arf* file.



Real-Time Comparison

You have already defined a comparison record. You may wish to view the running averaged superimposed upon the comparison record.

To view the running average

1. Click the *right* mouse button in the Multi-Purpose Plot.
2. Drag the pointer until it is above  .
3. Release the *right* mouse button.

To superimpose the comparison record

- Check Show Comparison on the Multi Plot menu.

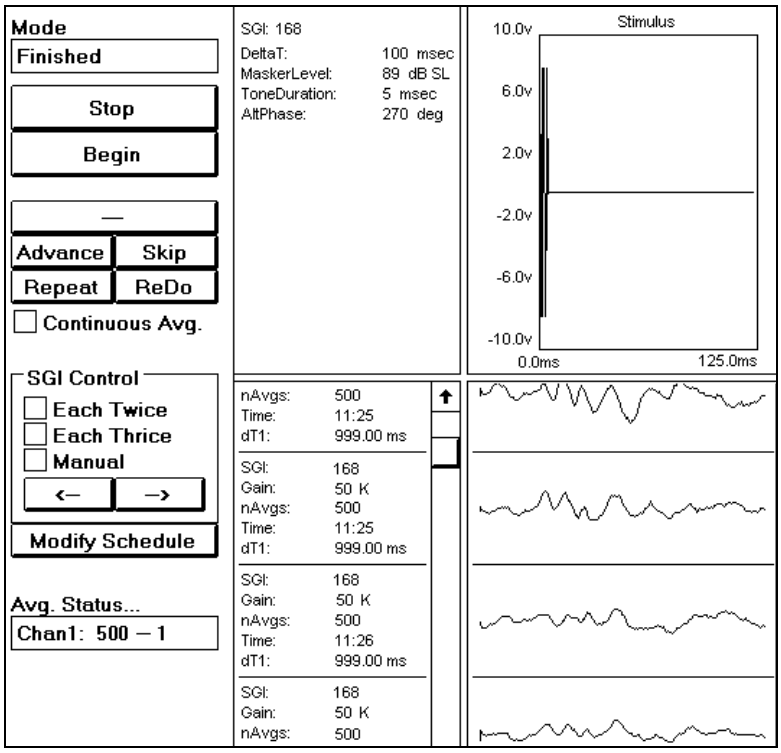
Termination

Once the boundary conditions have been met, BioSigRP will automatically terminate data averaging. However, you may manually terminate data averaging at any time.

To manually terminate data averaging

- Click the End button.

You will be returned to Running mode.



To halt stimulus presentation

- Click Stop.

Analyze the Data

In this example, the probe is considered to be masked when the value of P5 - N5 is reduced to 50% of that seen in the comparison ABR record. Recall that the comparison record was an averaged ABR record obtained in response to a non-masked probe.

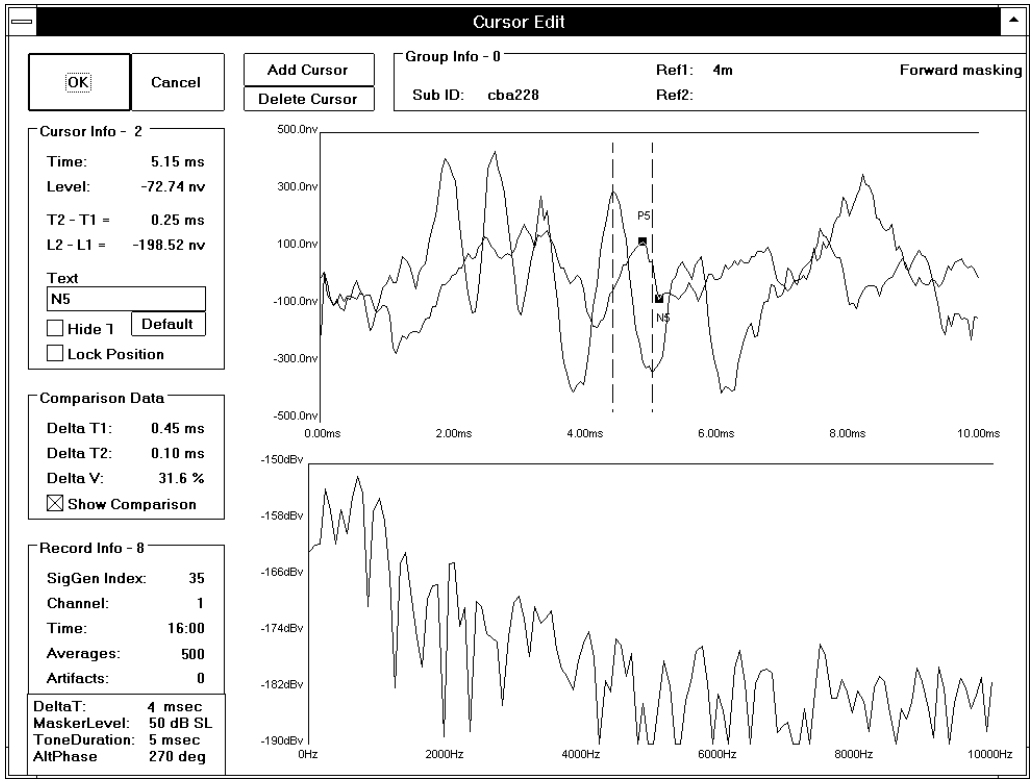
You have already placed cursors at P5 and N5 of the comparison record. Now to analyze the data, you must compare the Peak V amplitude (P5 - N5) of the comparison record to that of the experimental data. To do so, you must place cursors at P5 and N5 of the experimental data. It should not be necessary to place cursors in all of the experimental records. A quick visual scan of the History Plot should help you determine which records are most likely to exhibit a 50% reduction in Peak V amplitude.

To analyze the data

1. Double-click in turn on each interesting experimental record in the History Plot.
2. Double-click on P5.
3. Enter P5 in the Text field.
4. Double-click on N5.
5. Enter N5 in the Text field.
6. Check the Show Comparison box.
7. Examine the value of Delta V.

   When this value is 50% or less, masking has been achieved.

   Note: Delta V displays a percentage calculated as follows: *ΔV of the current record / ΔV of the Comparison record * 100*, where *ΔV* equals the level of Cursor 2 minus the level of Cursor 1. Since you have defined Cursor 2 to be N5 and Cursor 1 to be P5, Delta V will display the percent of P5 - N5 reduction.



Building a Report

You might want to build a report showing the comparison record and experimental records.

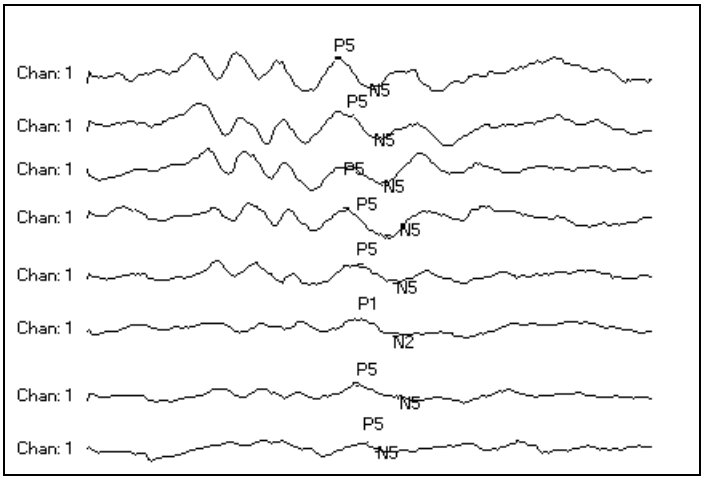
To build the report

1. Drag the desired History Plot records into the Worksheet.
2. Drag individual records to the desired location within the Worksheet.

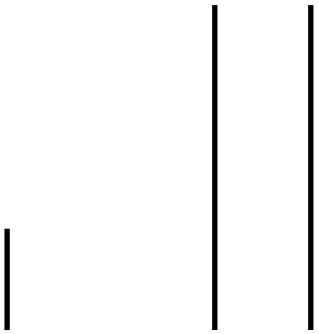
To display cursors

1. Click the *right* mouse button anywhere in the Worksheet except directly over a record or a record label.

   You will see the Worksheet Preferences dialog box.
2. Check the Show Cursors box.
3. Click OK.



Example 5: Distortion Product Otoacoustic Emission



- ✓ *Radix-2*
- ✓ *Continuous Stimulus*
- ✓ *Post Processing*
- ✓ *Auto-cursors*

In this experiment, distortion-product otoacoustic emission (DPOAE) data will be collected in response to a combination tone presented continuously. Distortion-product data will be collected every 163.84 milliseconds. In this experiment, it is assumed that the distortion product reflects the integrity of the cochlea at a frequency located at the geometric mean between F1 and F2 where F1 is the frequency of primary 1 and F2 is the frequency of primary 2.[3] Throughout this example the measurement frequency of the cochlea will be referred to as the audiometric frequency. The integrity of the cochlea will be measured at the following audiometric frequencies: 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz. The frequencies of both primary 1, named Tone 1, and primary 2, named Tone 2, will be geometrically centered about the audiometric frequency. The frequency of Tone 2 will be determined as follows: F2 = 1.2 * F1. Level of the two primary tones will remain equal and will vary with each frequency from 80 dB SPL to 50 dB SPL in 10 dB decrements.

To run the experiment, you will need to perform the following steps:

1. Build the primary tones.
   a. Configure the hardware.
   b. Run SigGenRP.
   c. Define the signal parameters.
   d. Define the signal variables.
   e. Create the segment and component.
   f. Save the SigGen file.
2. Run the experiment with BioSigRP.
   a. Check the hardware configuration.
   b. Run BioSigRP.
   c. Setup the stimulus parameters.
   d. Setup the acquisition parameters.
   e. Define auto-cursors.
   f. Save the .acf file.
   g. Run the experiment.
   h. Analyze the data to determine threshold levels.

[3] Osterhammel, P. A. and Rasmussen, A. N. (1992). Distortion product otoacoustic emissions: Basic properties and clinical aspects. *The Hearing Journal*, *45*(11), 38-41.

Configuring the Hardware

In this experiment, you will be using SigGenRP to generate two signals, one for each primary tone. The dual channel stimuli will be presented via a probe. Single channel emission data will be collected.

Configure the RPx device and RCO file

For System 3 equipment SigGenRP uses the RPx device and RCO files (See RPvds help) to play out signals.

To configure the RPx device and select the RCO file

1. Select RP devices|Device A from the Modify menu or click on the "A" icon on the tool bar.
2. Select the continous acquire at 50kHz
3. Select RP2 Processor as device type
4. Select Index 1.
5. Select "Use sample rate specified in RCO file."

Building Tone 1

Run SigGenRP

To run SigGenRP

- Double-click the SigGenRP icon.

To open a new signal window

- Choose New from the File menu.

Define the Signal Parameters

Prior to performing the experiment, you should calibrate the system. In this experiment, level will be measured in dB SPL. For illustration purposes, we will assume that a 1 volt 1000 Hz tone produces an output of 80 dB SPL. We will use this calibration throughout the example. You should determine the actual characteristics of your system.

It is often useful to define signal length so that the number of data points in the digital signal is specified in terms of *radix-2*. This is particularly important if the signal is to be played continuously by looping through the signal buffer. SigGenRP provides a function that truncates an original length and returns a radix-2 length. In this example, let's assume that you want a signal length of approximately 200 milliseconds. By using the radix-2 function, SigGenRP will calculate the next longest duration so that the signal consists of a number of data points specified in terms of radix-2. Use of radix-2 is illustrated below.

To define the signal parameters

1. Select Signal from the Modify menu of the main window.
2. Enter or select the following parameters in the Signal Parameters dialog box:

   Name: *Tone 1*
   Timing
   Duration: 200 milliseconds
3. Click the Rad-2 button.

   The duration will be recalculated as 163.84 milliseconds. Using the sampling period of 20 microseconds, the number of data points in the signal will be 8191.
4. Enter the remaining signal parameter information:

   Calibration
   Level: 80 dB = 1 volts

Define the Variables

In this example, you will be creating two separate signals, Tone 1 and Tone 2. These signals will be created with two separate SigGen files. In cases where stimuli are generated from two separate files, one file must be chosen as dominant, and must contain definitions for all variables used in the generation of both signals.

You should create the following variables for Tone 1:

	Parameter	Variable	Method	Combination
Tone 1	Audiometric frequency	*AudFreq*	Log Step (base 2)	None
	Tone 1 frequency	*F1*	.909	*.909 * AudFreq*
	Tone 2 frequency	*F2*	1.09	*1.09 * AudFreq*
	Level	*Level*	Linear Step	*80 - Level*

Note: Previously, it was stated that the frequencies of Tone 1 and Tone 2 would be geometrically centered about the audiometric frequency. Also, it was stated that the frequency of Tone 2 would equal 1.2 times the frequency of Tone 1. Multiplying the audiometric frequency by .909 and 1.09 calculates the desired frequencies for Tone 1 and Tone 2, respectively. These frequencies meet both conditions stated above.

Audiometric frequency. The audiometric frequency will be controlled by the variable, *AudFreq*. Thresholds will be obtained at the following frequencies: 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz. These values are computed through the application of a logarithmic (base 2) step. Specifying a Minimum value of 250, a Maximum value of 8000, and a Step value of 1 will generate the desired frequencies. For each value of *AudFreq*, the stimulus will be repeated while the level varies from 80 dB SPL to 50 dB SPL in 10 dB decrements. Thus, it will be necessary to repeat each frequency 4 times.

To define the variable, AudFreq

1. Double-click 1. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*AudFreq*
Units:	Hz
Method:	Log Step (base 2)
Value Limits	
Default/Start:	250
Step Size:	1
Minimum:	250
Maximum:	8000
SGI Modifiers	
Repeat:	4
Termination Control	
Boundary Control:	⊙

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Tone 1 frequency. The frequency of Tone 1 will be controlled by the variable, *F1*. The value of *F1* will be computed as a function of the audiometric frequency such that *F1 = .909AudFreq*.

To define the variable, F1

1. Double-click 2. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*F1*
Units:	Hz
Method:	Constant
Combination Variable:	
Variable:	*AudFreq*
Operation:	V*Vcomb
Value Limits	
Default/Start:	.909

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Tone 2 frequency. The frequency of Tone 2 will be controlled by the variable, *F2*. The value of *F2* will be computed as a function of the audiometric frequency such that *F2 = 1.09AudFreq*.

To define the variable, F1

1. Double-click 3. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*F2*
Units:	Hz
Method:	Constant
Combination Variable:	
Variable:	*AudFreq*
Operation:	V*Vcomb
Value Limits	
Default/Start:	1.09

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Level. In this example, analog attenuation is used. Analog attenuation ensures that signal-to-noise ratio remains constant as the signal level decreases. The PA4 programmable attenuator will be controlled through the use of the combination variable *Level*.

To define the variable, Level

1. Double-click 4. ..... in the Variables list.
2. Enter or select the following parameters in the Signal Variable dialog box:

General	
Name:	*Level*
Units:	dBSPL
Method:	Linear Step
Combination Variable	
Variable:	Constant
Value:	80
Operation:	Vcomb - V
Value Limits	
Default/Start:	80
Step Size:	-10
Minimum:	50
Maximum:	80
Termination Control	
Loop:	⊙

To accept the variable parameters and return to the Signal Parameters dialog box

- Click the OK button in the Signal Variable dialog box.

Now that the variable *Level* has been defined, it must be assigned to the appropriate programmable attenuator.

To enable analog attenuation

- Enter the following:

Attenuation	
Device:	PA5-1
Level:	*Level*

To accept the signal parameters and return to the main SigGenRP window

- Click OK.

Create the Segment and Component

To create Tone 1, you must define the parameters for one segment consisting of one component.

Because the tone will be played continuously by looping through the signal buffer, it must be generated in the frequency domain. Generation of the signal in the time domain will result in a discontinuity upon looping. Such a discontinuity typically introduces a click into the signal.

To create the segment

1. Choose Segment... from the Modify menu.
2. Enter or select the following parameters in the Edit Signal Segments dialog box:

Select:	Seg[1]
Gate Type:	None
Level:	0 dB
Gen. Meth.:	Freq: (4096)
App. Meth.:	Add
Start:	0
Duration:	163.84

To create a component for Tone 1

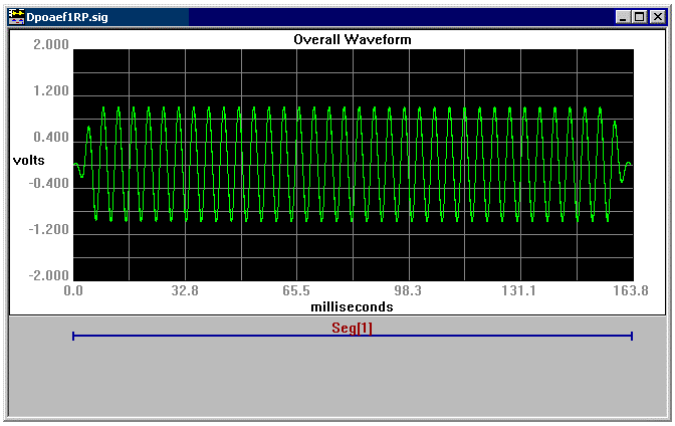
1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

Call:	Tone
Level:	80
Frequency:	*F1*
Phase:	0

3. Click the OK button to accept the component parameters.

To return to SigGenRP's main window

➢ Click OK in the Edit Signal Segments dialog box.



Save the SigGen File

You will be using this SigGen file to generate a stimulus signal through BioSigRP. Save it with the name *dpoaef1.sig*.

To save the SigGen file

1. Chose Save from the File menu.
2. Enter in *C:\TDT\SIGGENRP\BOISIGRP\FILES\dpoaef1.sig* in the File Name field.

Building Tone 2

Tone 2 will differ from Tone 1 only in frequency and the definition of a programmable filter. The file for Tone 2 may be created by copying the information from Tone 1.

Copy Tone 1

If you have not already saved *C:\TDT\SIGGENRP\BIOSIGRP\FILES\dpoaef1.sig*, do so now following the instructions above.

To copy the information from Tone 1 to Tone 2

1. Chose Save As from the File menu.
2. Enter in *C:\TDT\SIGGENRP\BIOSIGRP\FILES\dpoaef2.sig* in the File Name field.

Modify the Attenuation Information

You must specify a programmable attenuator for Tone 2.

To specify the programmable attenuator

1. Choose Signal from the Modify Menu.
2. Enter the following information:

Attenuation:	
Device:	PA5-2
Level:	*Level*

Modify the Segment and Component

You must modify the frequency so that it is appropriate for Tone 2.

To modify the component

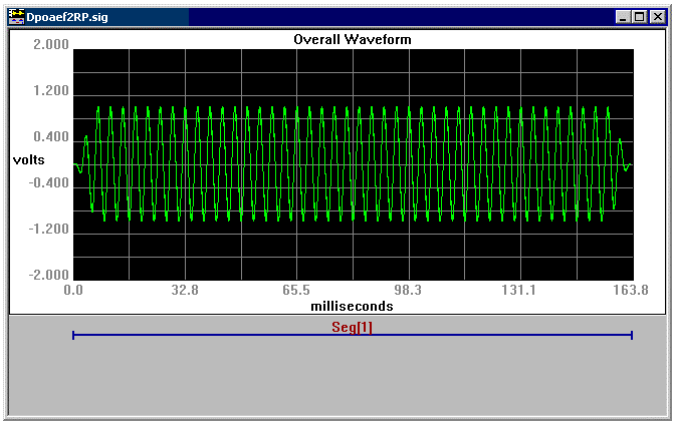
1. Choose Segment... from the Modify menu.
1. Click the first button in the Components group box.
2. Enter or select the following parameters in the Component Parameters dialog box:

Call:	Tone
Level:	80
Frequency:	*F2*
Phase:	0

3. Click the OK button to accept the component parameters.

To return to SigGenRP's main window

➢ Click OK in the Edit Signal Segments dialog box.



Save the modified SigGen File

Now that you have made changes to *dpoaef2.sig*, you must save these changes.

To save the SigGen file

- Chose Save from the File menu.

Running the BioSigRP Experiment

Now that you have created the SigGen files that will be used to generate the primary and secondary tones, you are ready to run the experiment.

To run BioSigRP

- Double-click the BioSigRP icon.

Setup the Stimulus Parameters

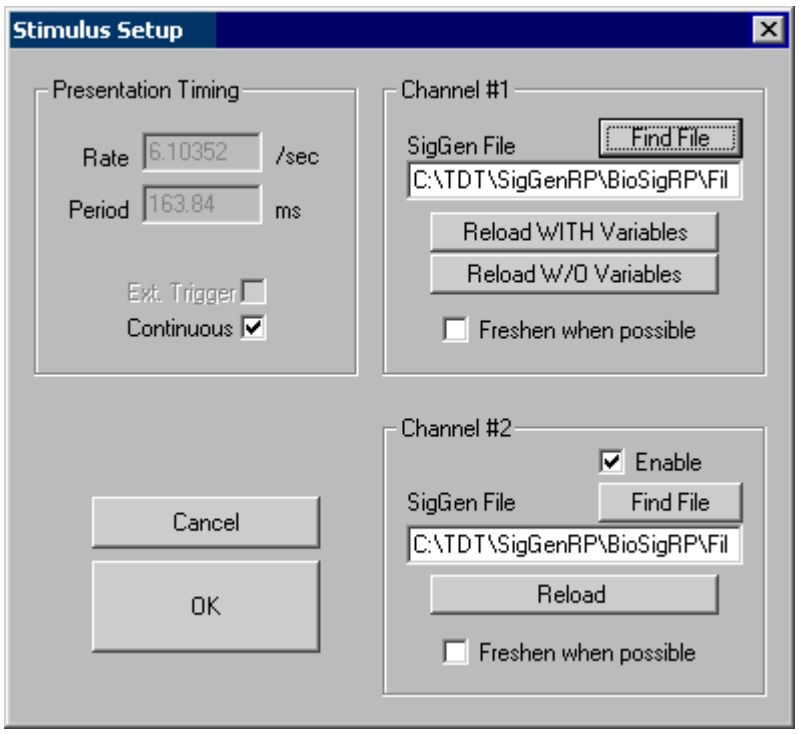
During stimulus setup you will define the presentation as continuous and specify the SigGen file.

Continuous presentation provides a means for presenting a continuous SigGen stimulus. When presenting a stimulus in continuous mode, BioSigRP repeatedly loops through the signal buffer, playing the signal continuously.

To setup the stimulus parameters

1. Select Stimulus from the Setup menu of the main window.
2. Enter or select the following parameters in the Stimulus Setup dialog box:

Presentation	
Continuous	☒
Lock SigGen Files	☒
Channel #1	
SigGen File:	*C:\TDT\SigGenRP\BioSigRP\Files\dpoaef1.sig*
Channel #2	
SigGen File:	*C:\TDT\SigGenRP\BioSigRP\Files\dpoaef2.sig*



To accept the stimulus setup parameters and return to the main window

- Click OK.

Setup the Acquisition Parameters

Prior to running the experiment, you must define the acquisition timing parameters and specify a record file (*.arf* file).

To setup the acquisition parameters

1. Select Acquisition... from the Setup menu of the main window.
2. Enter or select the following parameters in the Acquisition Setup dialog box:

Response Record File
Name:*C:\TDT\SIGGENRP\BIOSIGRP\FILES\DPOAE.ARF*
Prompt for File Name: ☐

To setup acquisition Channel 1

1. Click the Chan-1 button.
2. Select Continous Acquire 50 kHz two channels from the RCO file
3. Select RP2 device and select Index 2
2. Enter or select the following parameters in the Acquisition Channel Setup dialog box:

Configuration	
Number of Averages:	100
Gain:	1

Note: In this example, we are assuming that a unity gain has been applied. You should enter the appropriate gain based on your system.

To accept the Channel 1 acquisition parameters and return to the Acquisition Setup dialog box

- Click OK.

To apply post processing

1. Click Post Processing.
2. Enter or select the following parameters in the Post Processing window:

   Fourier
   Fourier Transform ☒
   Log dB ☒

A fast fourier transform (FFT) will be applied to the response signal as it is acquired. As frequency domain signals are acquired, they will be placed in the History Plot.

To accept the acquisition setup parameters and return to the main window

➢ Click OK.

Define Auto-Cursors

BioSigRP's auto-cursor capability is specifically designed to meet the needs of researchers collecting distortion product otoacoustic emission data. Through specification of a simple equation, the researcher may direct BioSigRP to automatically place cursors in all acquired data, whether such data is in the time or frequency domains.

In this example, a cursor will be placed automatically at the anticipated frequency of the distortion product, 2F1 - F2, where F1 is the frequency of Tone 1 and F2 is the frequency of Tone 2. This is accomplished by the specification of an auto-cursor equation.

Variable names are not used in auto-cursor equations. Instead, auto-cursor equations use a variable numbering system where *Vn* defines the variable that appears in the *nth* position in the SigGen variable list. In this example, F1 was the second variable defined, and thus will be denoted by the auto-cursor variable, *V2*. Because F2 was the third variable defined it will be denoted by the auto-cursor variable, *V3*.

To define the auto-cursor equation

1. Choose Auto-Cursors... from the Setup menu.
2. Click ⊙ #1 to select auto-cursor one.
3. Check ☒ Enable to enable the Algebraic Equation field.
4. Enter the equation 2*V2-V3 in the Algebraic Equation field.
5. Click the Parse button to parse the equation.
6. Click Done.

Save the Configuration File

You will want to save the configuration file for future experiment sessions.

To save the configuration file

1. Choose Save from the File menu.
2. Enter *C:\TDT\SIGGENRP\BIOSIGRP\FILES\DPOAE.ACF* in the File Name field.

Run the Experiment

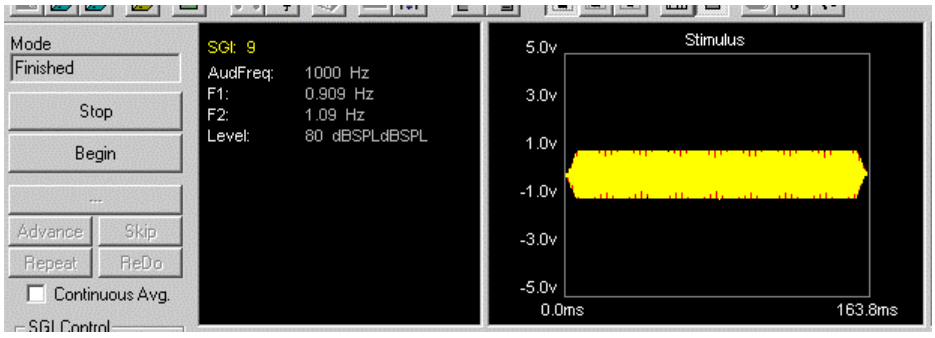
You are now ready to run the experiment.

Running

To begin stimulus presentation

➢ Click the Start button.

You are now in Running Mode. The two primary tones will be generated according to the parameters you defined during SigGenRP and BioSigRP setup.

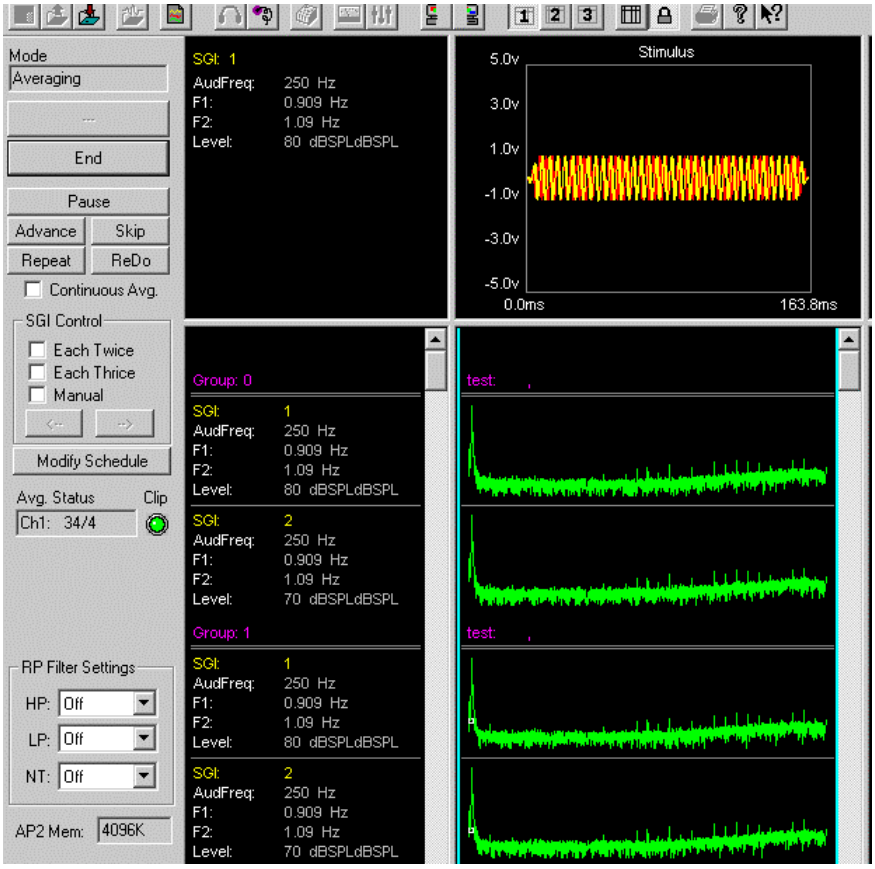


Averaging

To begin data averaging

1. Click the Begin button.
2. Enter any pertinent subject information and click OK.

   You are now in Averaging Mode. Upon each trigger, the acquired distortion product signal will be included in the running average until 100 response signals have been obtained.



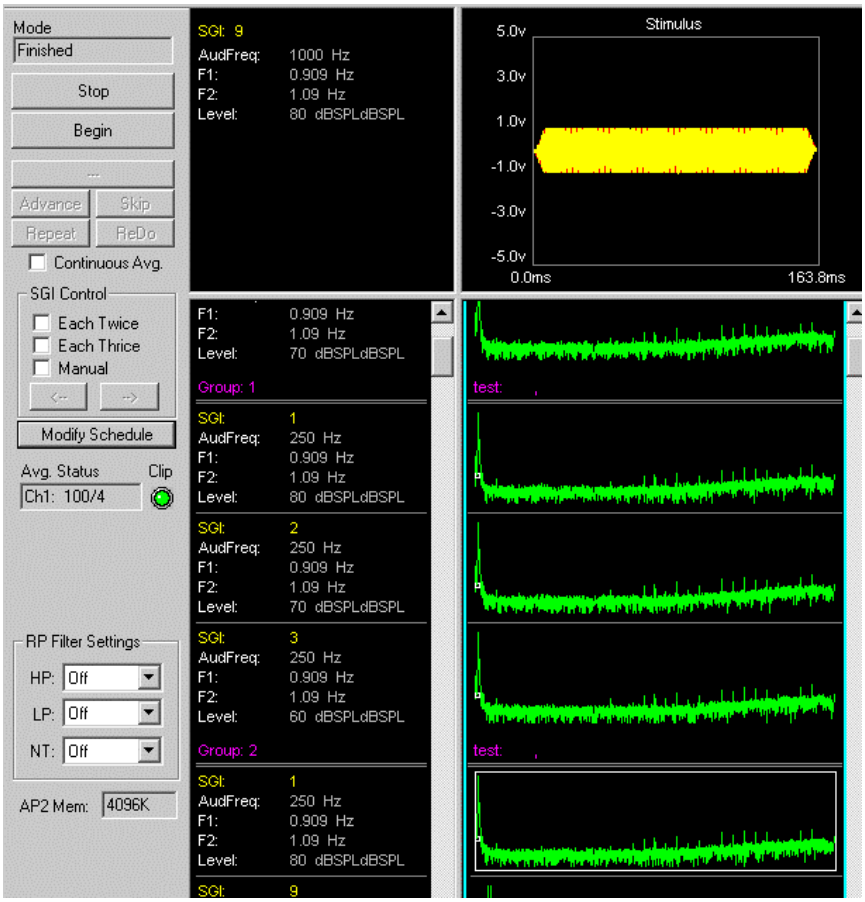
Termination

Once the boundary conditions have been met, BioSigRP will automatically terminate data averaging. However, you may manually terminate data averaging at any time.

To manually terminate data averaging

➢ Click the End button.

You will be returned to Running mode.



To halt stimulus presentation

➢ Click Stop.

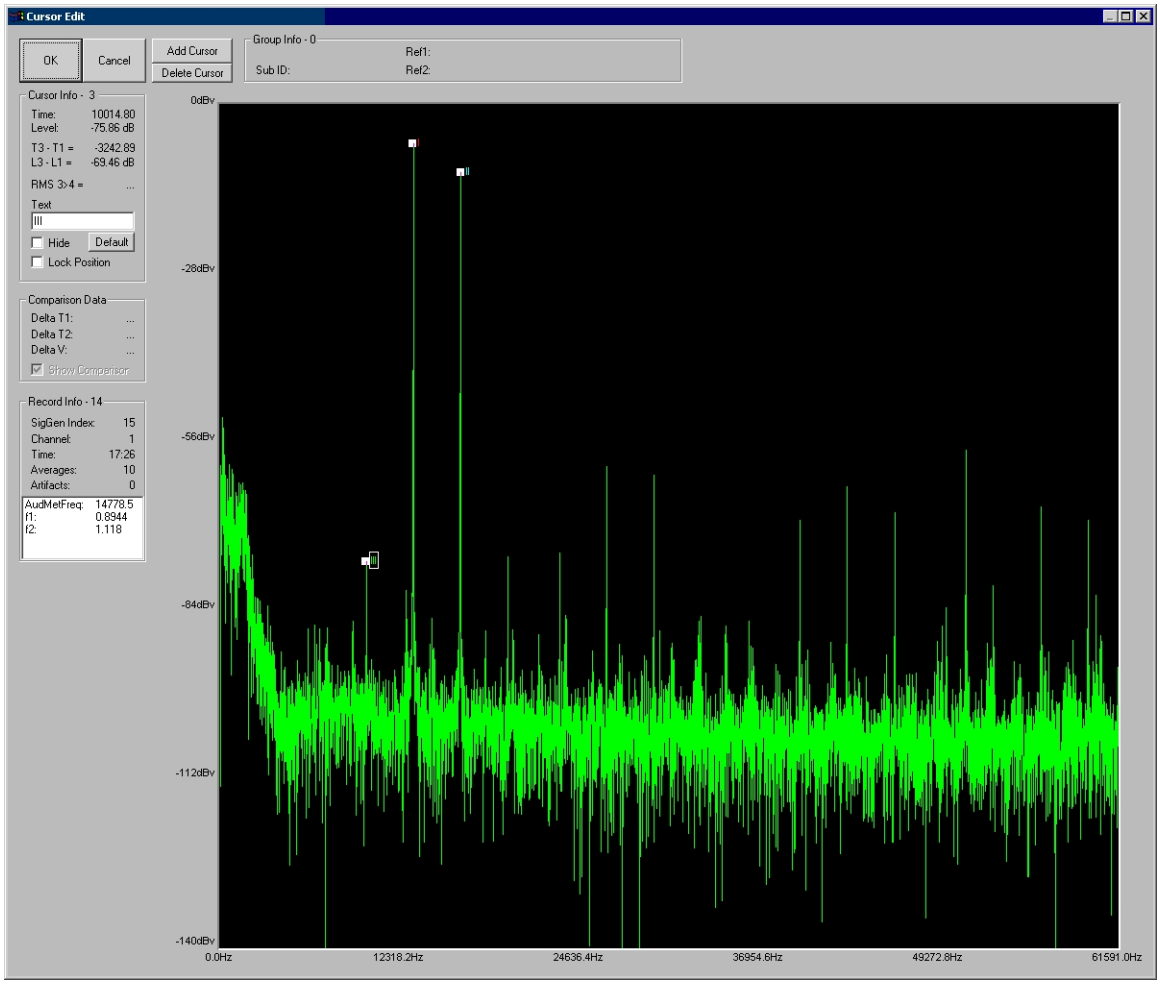
Analyze the Data

As mentioned in previous examples, BioSigRP does not automatically determine threshold levels. Instead, BioSig allows the user to place cursors on peaks in selected data records. Each cursor provides the user with peak values and latencies. The experienced clinician/researcher may use these values to determine whether or not a threshold has been achieved. In this example, a cursor has been automatically placed at the suspected distortion product frequency.

To analyze the data

1. Create a comparison record, if desired.
   a. Select the desired record.
   b. Choose Make Comparison from the History menu.
2. Double-click in turn on each interesting experimental record in the History Plot.
3. Enable Show Comparison if you wish to overlay a comparison plot.

In the below example, the auto-cursor function has placed a cursor at 799.76 Hz. The peak has an amplitude that is reduced from the primary tone's amplitude by approximately 60 dB.



Building a Report

The worksheet provides you with three basic functions. First, it allows you to graphically organize acquired data. Second, it allows you to perform mathematical manipulations of the acquired data. Third, by choosing to generate a report, you may output data for use by other applications.

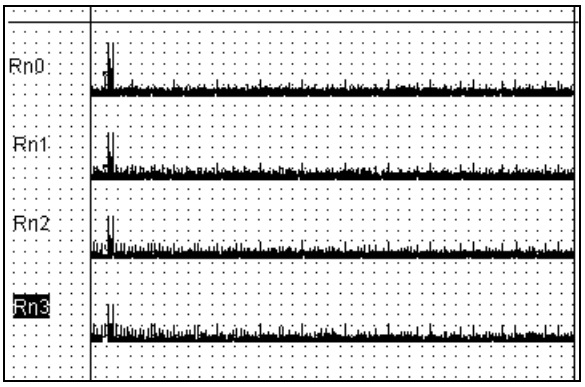
To build the report

1. Drag the desired History Plot records into the Worksheet.
2. Drag individual records to the desired location within the Worksheet.

To display cursors

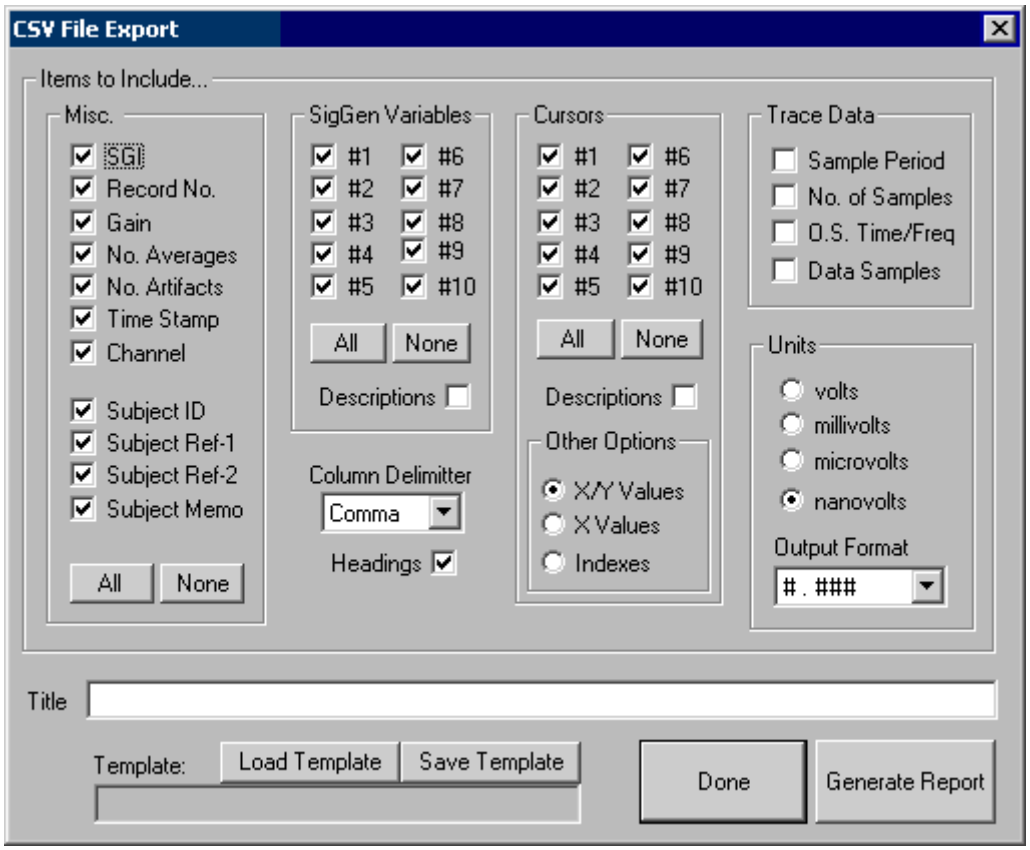
1. Click the *right* mouse button anywhere in the Worksheet except directly over a record or a record label.

   You will see the Worksheet Preferences dialog box.
2. Check the Show Cursors box.
3. Click OK.



To save worksheet data to a report file

1. Choose Export toCSV file ... from the Worksheet menu.
2. Select and enter all desired information.
3. Choose generate.



Part 3 Appendix

Appendix A Using BioSigRP with System II

This appendix provides the information needed to use BioSigRP with System II Hardware.

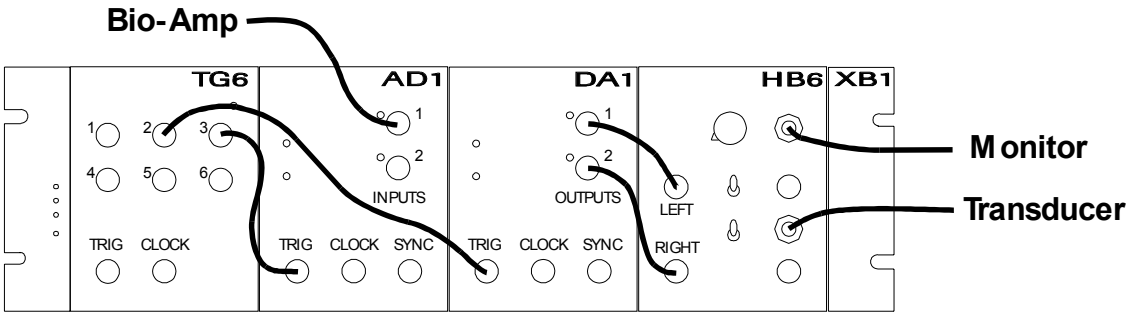
While SigGenRP and BioSig continue to support System II hardware we recommend continuing to use the version of SigGen and BioSig that was purchased with System II hardware whenever possible. SigGenRP and BioSigRP are configured for System 3 by default. If you decide to use them with System II contact TDT for assistance with reconfiguring the software.

Requirements

In order to run BioSigRP with System II hardware, you must have the following:

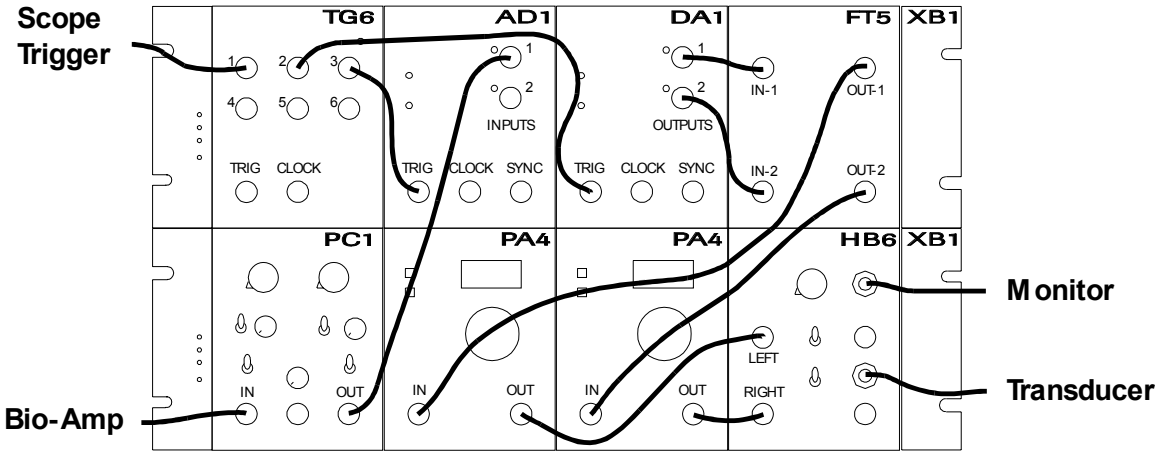
- TDT's AP2 Array Processor
- APOS ONBOARD software (latest version available)
- TDT's XBUS hardware

Minimum



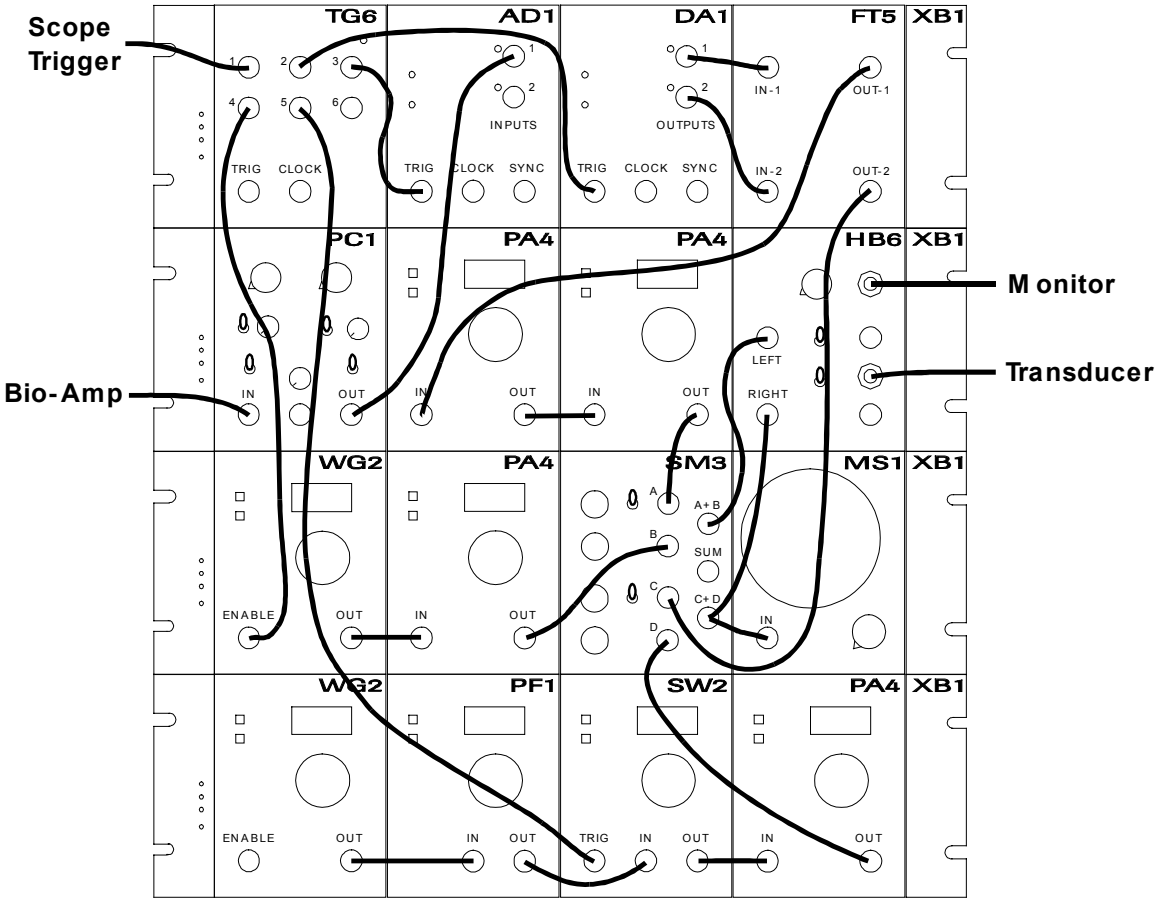
The minimum System II configuration is illustrated above. This system consists of analog to digital conversion (AD1), digital to analog conversion (DA1), and a transducer (HB6). Please note that a TG6 is also included in the illustration. A TG6 is required to run BioSig and must be connected as shown.

Basic



Most BioSig systems require more functionality than that provided by the minimum configuration. A typical System II configuration is illustrated above. With this system, the TG6 can be used to trigger the following: an optional scope, single or dual channel stimulus presentation through the DA1, and data acquisition through the AD1. The FT5 is used as an anti-aliasing filter for the stimulus output. The two PA4s provide programmable attenuation for both stimulus channels. If the stimulus is to be single channel only, the second PA4 may be used as a calibration attenuator. The PC1 is used to provide any additional gain and/or filtering to the acquired signal.

Complete



Some applications will require a more complete System II configuration. Such a configuration is illustrated above. This system is similar to that presented in the previous section with the addition of several components. The two waveform generators (WG2s) may be used to generate masking noise. The PF1 and two additional PA4s may be used to filter and/or attenuate the masking signals. The SW2 programmable cosine switch is used to apply a gate to the masker. The SM3 may be used to mix the masker and stimulus signals. Finally, the MS1 may be used to monitor the final output signal.

Setting up Acquisition

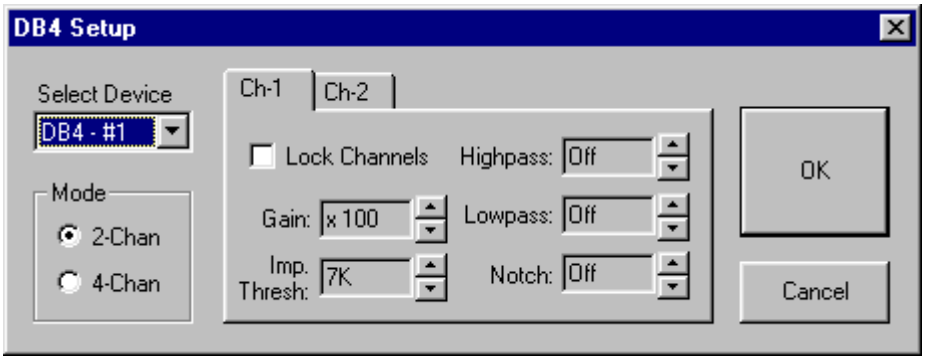
Sample Period. The value defined in the Sample Period field of the Acquisition Setup dialog box specifies the sample period, the distance in microseconds between successive data points, of the digital response signal. When continuous signal play is enabled, the value of Sample Period defaults to 20 microseconds and the field is disabled.

Use DAC Clock. When Use DAC Clock is checked, BioSig will time stimulus presentation and data acquisition using the DAC clock instead of the computer's clock. This option is disabled when continuous play is enabled.

TDT Digital Biological Amplifier

The operation of the TDT Digital Biolocal Amplfier (DB4 and HS4) has been fully integrated into BioSigRP.

To access the DB4 Setup dialog, choose DB4 BioAmp from the Setup Menu. Refer to the DB4 manual for an explanation of the DB4 settings. Note that settings made in this dialog box will not appear in the display on the DB4. The Lock Channels box will set the same values for all channels.



The DB4 has a 1.0 ms group delay when it is operated in 2-channel mode, and a 2.0 ms group delay when it is operated in 4-channel mode. To account for the group delay, BioSig will delay acquisition by the appropriate duration when Use DB4 is checked in the Acquisition Setup.

Impedance Scan/Impedance Check

Impedance scanning and checking can be performed from the Operations menu.

Impedance scanning measures the impedance on each of the channels and compares it to the impedance threshold value. The light next to the average status box will turn red if the impedance is higher than the threshold. The light will be green if it is less than the threshold. Impedance scan measures the impedance once.

Impedance check continuously measures the impedance of the electrodes and reports the values to the screen. To turn off impedance checking, select Impedance Check from the Operations menu.