BioSigRZ Manual

ABR and DPOAE with RZ6 Processor

Updated 2025-02-27

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Notices

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Overview

Welcome to BioSigRZ, TDT's RZ6 compatible stimulus presentation and data acquisition package for ABR and DPOAE screening and research studies.

What Is BioSigRZ?

BioSigRZ is a powerful, yet easy-to-use, tool designed to automate the process of presenting stimulus signals and acquiring response signal data. BioSigRZ works with the RZ6 Multi I/O processor and supports stimulus customization using TDT's signal design software, SigGenRZ.

BioSigRZ Capabilities and Features

- Standard configurations for ABR and DPOAE
- Standard speaker and microphone profiles
- Stimulus schedule customization
- Stimulus variable customization
- Dual-channel stimulus
- Artifact rejection
- Averaging
- Stimulus schedule override
- Historical data display
- Comparison data display
- Calculator
- Detail display
- Cursors
- Report generation
- SigGenRZ file support

Standard Configurations for ABR and DPOAE

Standard configuration files enable you to run ABR and DPOAE screening protocols out-of-the box with little or no software configuration beyond basic installation.

Standard Speaker and Microphone Profiles

Standard speaker and microphone profiles are provided for TDT speakers and microphones typically used with the RZ6. In most cases a profile can be selected and no further calibration is required.

Stimulus Schedule Customization

Standard or custom stimulus files include a stimulus schedule that specifies how variables change during stimulus presentation. The stimulus can be presented over multiple intervals with signal parameters varied as a function of each interval.

The SigGen Index (SGI) is another name for the interval number. You may customize the SGI from within BioSigRZ.

Stimulus Variable Customization

BioSigRZ supports direct customization of stimulus variables such as frequency, level, and attenuation.

Dual-Channel Stimuli

BioSigRZ enables you to present dual-channel stimuli.

Artifact Rejection

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

Averaging

BioSigRZ maintains a running average that you can view as signals are acquired. Averaging continues until the desired number of signals is acquired.

Stimulus Schedule Override

BioSigRZ 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 a history plot and are appended to a file known as the BioSigRZ Record file (.arf file).

Comparison Data Display

You can compare historical data records with newly acquired records.

Calculator

Using a built-in calculator, you can perform a variety of mathematical operations on acquired data.

Detail Displays

You may view any record in more detail. BioSigRZ provides two detailed displays: a detailed Time-Domain Plot and a corresponding Frequency-Domain Plot. You can zoom-in on any portion of either display.

Cursors

BioSigRZ 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. A worksheet area of the BioSigRZ main window can be used to build these reports.

SigGenRZ File Support

BioSigRZ takes advantage of the powerful signal generation capabilities of TDT's signal design software, SigGenRZ. BioSigRZ reads SigGenRZ files (.sig files) and uses the signal parameters stored in these files to generate stimulus signals over successive SigGenRZ Indices (SGIs). Most users will not need to work directly with SigGenRZ, however, it provides a means of designing custom stimuli.

How to Use BioSigRZ

BioSigRZ is designed to collect and analyze data such as auditory brainstem response (ABR) data and distortion product otoacoustic emission (DPOAE) data. It enables you to acquire and process bioelectric signal data in response to a stimulus signal.

Workflow for Initial Experiment Set-Up

Most users will use BioSigRZ as follows:

1. Load a pre-existing Configuration file provided with BioSigRZ.

2. Select your transducers and microphones. This step ensures your system will be calibrated for your speakers and microphones. No manual calibration is required.

3. If needed, modify the pre-existing stimulus variables.

4. Save the BioSigRZ configuration with a new name.

   Saving the file, saves any modification you have made to the experiment configuration, stimulus, and variables. When you are ready to run the experiment it is as simple as loading the file, specifying a record file where data will be saved, and collecting the data.

BioSgRZ also supports complete customization of the configuration or stimuli for users who require it. For users who wish to design custom stimuli, see the SigGenRZ Manual.

Workflow for Daily Operation

Once your experiment hardware and software configuration is established, you can use BioSigRZ as follows:

1. Load your BioSigRZ configuration file (created above).

2. Prepare the subject.

3. In BioSigRZ, specify a Response Record File where data will be stored for the current trial or subject.

4. Begin averaging and data collection.

5. End data collection, then process and Analyze the response data.

Standard BioSigRZ Configuration Files

BioSigRZ provides standard configuration files in the C:TDT\BioSigRZ\Configs folder:

1. **ABR\Root_ClickAbr.acf** - A 0.1 millisecond, single-channel mono-phasic click will be presented. With each successive presentation, the click phase will alternate between a condensation and rarefaction click. Click level will vary from 90 dB SPL to 10 dB SPL in 10 dB decrements. A single channel acquires the response through the use of an RA4PA preamplifier via the RZ6 fiber optic port. A total of 512 responses will be averaged at each level.

2. **ABR\Root_ToneAbr.acf** - A five millisecond, single-channel tone with a 3 millisecond gate time will be presented at the following frequencies: 4000 Hz, 8000 Hz, and 16000 Hz. For each frequency, the tone level will vary from 90 dB SPL to 20 dB SPL in 10 dB decrements. With each successive presentation, the tone phase will alternate 180 degrees to reduce artifacts. A single channel acquires the response through the use of an RA4PA preamplifier via the RZ6 fiber optic port. A total of 512 responses will be averaged at each frequency and level combination.

3. **DPOAE\Root_DPOAE.acf** - Distortion-product otoacoustic emission (DPOAE) data will be collected in response to a combination tone presented continuously. The integrity of the cochlea will be measured at the following audiometric frequencies: 4000 Hz, 8000 Hz, 16000 Hz, and 32000 Hz. The frequencies of Channel A and Channel B will be geometrically centered about the audiometric frequency. That is, the frequency of Channel A (F1) will be the audiometric frequency multiplied by a factor of 0.909 and the frequency of Channel B (F2) will be the audiometric frequency multiplied by a factor of 1.09, so that F2/F1 = 1.2. The

level of the two primary tones will remain equal and will vary from 80 dB SPL to 20 dB SPL in 10 dB decrements. A single channel microphone response is acquired using the RZ6 In-A connector.

System Requirements

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

- Computer running Windows XP Service Pack 3, Windows 7, or Windows 10.

- TDT drivers (72 or higher)

- Super VGA (1024 x 768) resolution graphics (or higher)

- RZ6 Multi I/O processor

- Optibit Interface Card in your PC to communicate with RZ6

Hardware Configuration

BioSigRZ works with TDT's powerful RZ6 Multi I/O processor to acquire and average signals and to view signal responses to complex stimulus patterns. All acquisition and signal generation are performed using a single RZ6 processor. Typical configurations for ABR and DPOAE are shown in the diagrams below.
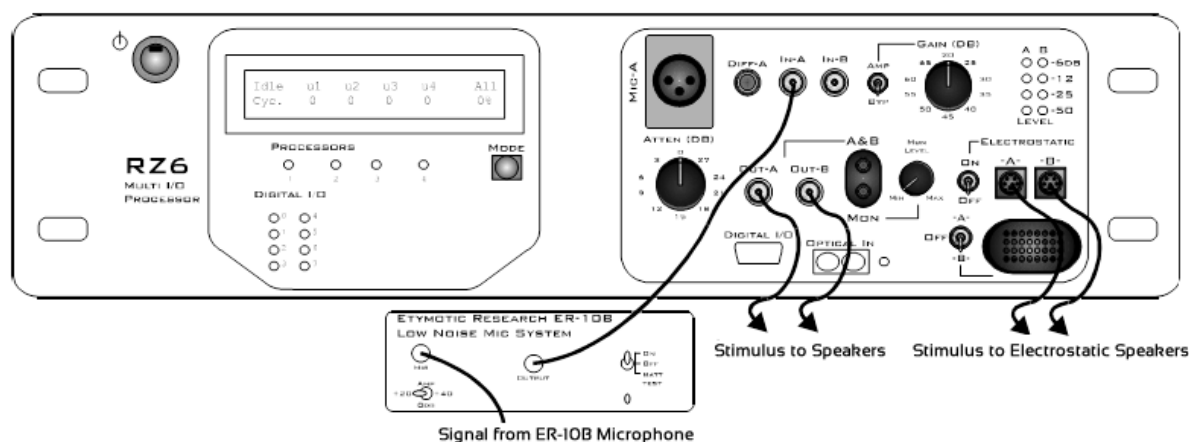
Typical ABR Configuration
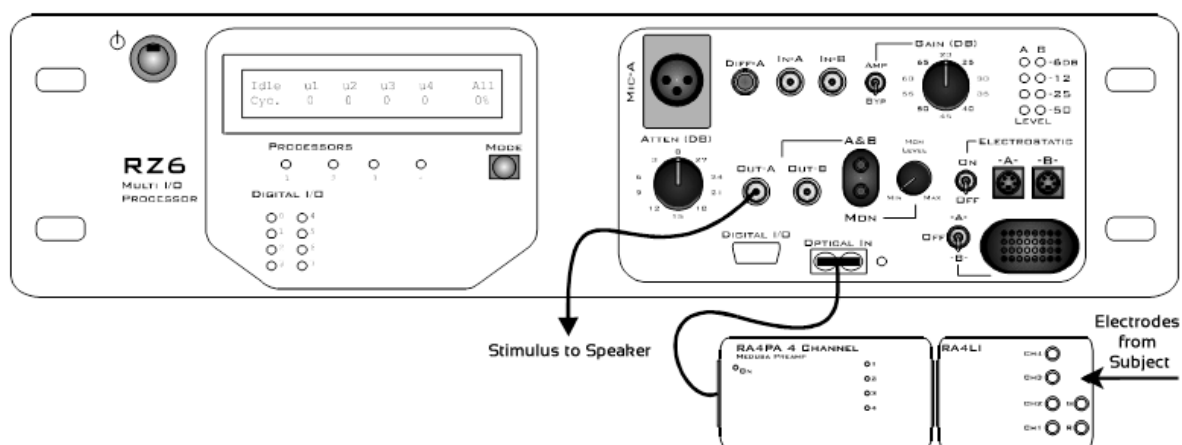
In a typical configuration for ABRs the RZ6 provides digital to analog conversion to drive the speaker stimulus, and an RA4PA preamp and RA4LI headstage acquire the subject data. In newer systems, the Medusa4Z replaces the RA4PA/RA4LI combination for electrode signal

acquisition. The RZ6 provides programmable and manual attenuation for stimulus channel A and drives a single speaker to present the stimulus. Other device outputs can be used to support alternative transducers.

Typical DPOAE Configuration

In a typical configuration for DPOAEs the RZ6 provides stimulus generation, programmable and manual attenuation for two stimulus channels and drives either two electrostatic speakers or other speakers to present the stimulus.

When not using the electrostatic speakers use Out-A and Out-B, these outputs and the stereo A&B headphone output can be used to support other transducers, such as the ER2C from Etymotic.

Response acquisition is handled by the ER-10B microphone system from Etymotic while analog to digital conversion is performed on the RZ6 through ADC channel In-A.

BioSigRZ File Types

BioSigRZ uses or writes to seven types of files:

- • BioSigRZ configuration files (*.acf)
- • SigGenRZ files (*.sig)
- • Calibration files (*.tcf)
- • BioSigRZ response record files (*.arf)
- • BioSigRZ worksheet files (*.awf)
- • ASCII text files (*.txt)

- CSV files (*.csv)

> 🔥 **Important**
>
> Some operating system configurations have file name and path character limitations. TDT recommends keeping file names, including path, short to avoid problems associated with long file names.

BioSigRZ Configuration Files

Stimulus and data acquisition parameters are saved as part of the BioSigRZ configuration file. The extension for BioSigRZ configuration files is .acf.

SigGenRZ Files

Standard stimulus files are provided with BioSigRZ and specification of the appropriate file is preconfigured in each of the standard configuration files. Stimulus signals are designed with TDT's signal generation package, SigGenRZ. BioSigRZ uses information saved in a SigGenRZ file to reconstruct the stimulus signal and vary it according to defined variables. The extension for SigGenRZ files is .sig.

Calibration Files

Standard calibration files for common speakers and microphones are provided with BioSigRZ. If a calibration file is not provided for your specific model, contact TDT for assistance. Prior to presenting a stimulus signal or acquiring data, you may specify calibration file(s) for your hardware. The extension for calibration files is .tcf.

BioSigRZ Record Files

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

BioSigRZ Worksheet Files

BioSigRZ allows you to build custom reports. Custom reports are created by placing desired historical plot records into a worksheet plot. These reports may be saved in BioSigRZ Worksheet files. The extension for these files is .awf.

ASCII Text Files

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

CSV Spreadsheet Files

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

ABR Using a Tone Stimulus Example

This example introduces BioSigRZ's streamlined interface and will illustrate the three types of workflows you're likely to use in your lab.

- **Initial Experiment Setup** - The first time you set up an experiment, you'll select one of the standard configurations provided, setup your system, update the configuration file to match your hardware, and save the project with a new name. The experiment and any other modifications you make will be saved as part of the configuration.

- **Daily Operation** - Once a configuration has been setup for your experiment, daily operation is as simple as loading a file, prepping your subject, and collecting data.

- **Modifying Stimulus Variables** - The standard configuration files provide the most common variable values, but you can easily modify them directly in BioSigRZ. Once changes are made they are saved in the configuration file for future trials.

Initial Experiment Setup

To setup the experiment for the first time, you will need to perform the following steps:

1. Connect the hardware.

2. Run BioSigRZ.

3. Load the standard configuration file.

4. Select your transducer and device input.

5. Specify a response record file.

6. Save the configuration with a new name.

Connect the Hardware

Before running an experiment, TDT hardware must be set-up and turned on. See the System 3 Installation Guide provided with your system for set-up instructions. The diagram below illustrates typical wiring connections for an ABR experiment.
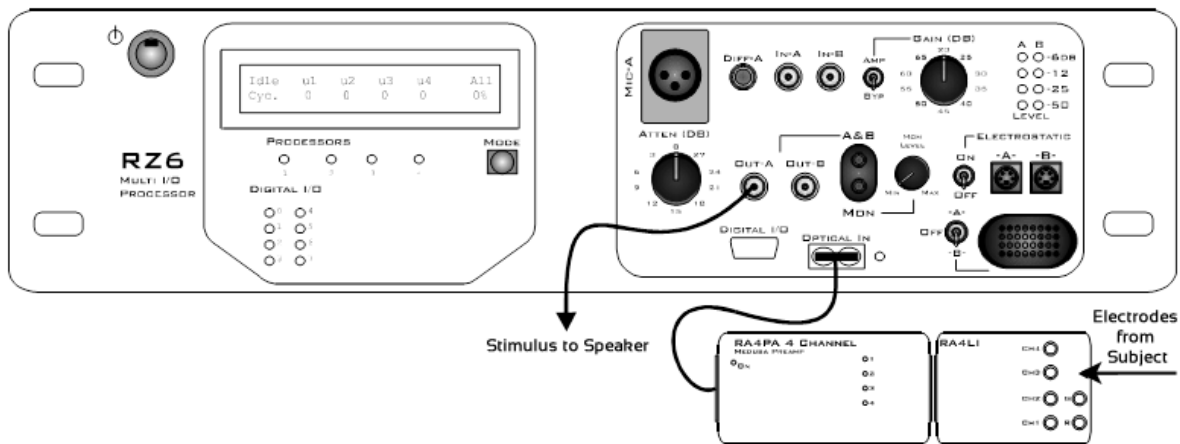
The stimulus is generated on Channel A. A single transducer is connected to this output channel. If a magnetic speaker is used (such as the MF1), connect it to Out-A and make sure the Electrostatic switch is in the 'OFF' position. If an EC1 or ES1 electrostatic speaker is used, connect it to Electrostatic -A- and turn the Electrostatic switch to 'ON'.

The RA4PA or Medusa4Z preamp is connected to the optical port on the front panel for data acquisition. If using an RA4PA, the RA4LI is connected directly to the RA4PA and the electrodes from the subject connect to the RA4LI touch-proof connectors. If using a Medusa4Z, the electrodes from the subject connect to the Medusa4Z touch-proof connectors.

Run the BioSigRZ Software

To run BioSigRZ:

- Double-click the BioSigRZ icon.

or

- Click the Start menu, point to Programs, point to TDT Sys3, point to the SigGen Solutions folder, and click BioSigRZ.

Load the Standard Configuration

In this example you'll begin with the standard configuration below for collecting auditory brainstem response (ABR) data in response to a pure tone stimulus:

C:\TDT\BioSigRZ\Configs\ABR\Root_ToneAbr.acf

Configuration files include information about how data will be acquired, such as number of averages, as well as information about the stimulus schedule and how it will be presented.

In this experiment, 5 ms tones with a gate time of 2 ms are presented at the following frequencies: 4000 Hz, 8000 Hz, and 16000 Hz. For each frequency, tone level varies from 90 dB SPL to 20 dB SPL in 10 dB decrements.

To load the configuration file:

1. Click the File menu and click Open Config. File.
2. Select the *C:\TDT\BioSigRZ\Configs\ABR\Root_ToneAbr.acf* file in the Open dialog box and click Open.

Before you can run the experiment you must specify a calibration file that corresponds to the transducer you will be using.
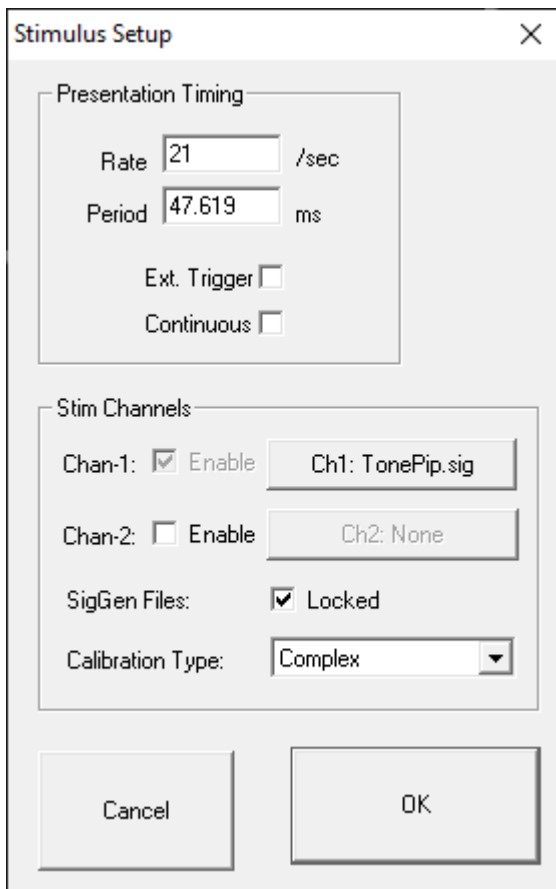
Select Your Transducer and Device Input

To simplify experiment setup and save you time, BioSigRZ is provided with calibration files for the most commonly used transducers and headstages/amplifiers. Additional calibration files may be available from TDT support.

To select your speaker calibration:

1. Click the Setup menu and click Stimulus.

Stimulus Setup ✕

Presentation Timing

Rate `21` /sec

Period `47.619` ms

Ext. Trigger ☐
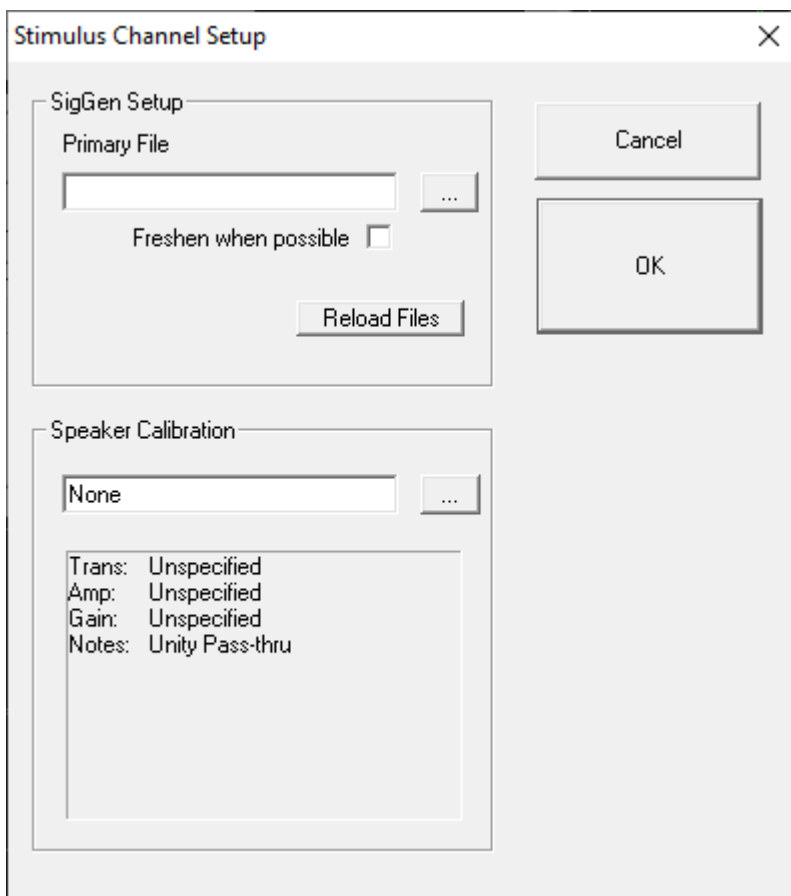
Continuous ☐

Stim Channels

Chan-1: ☑ Enable [Ch1: TonePip.sig]

Chan-2: ☐ Enable [Ch2: None]

SigGen Files: ☑ Locked

Calibration Type: [Complex ▼]

[Cancel]   [OK]

2. Click Ch1: TonePip.sig.

Stimulus Channel Setup ✕

SigGen Setup

Primary File

[   ] [...]
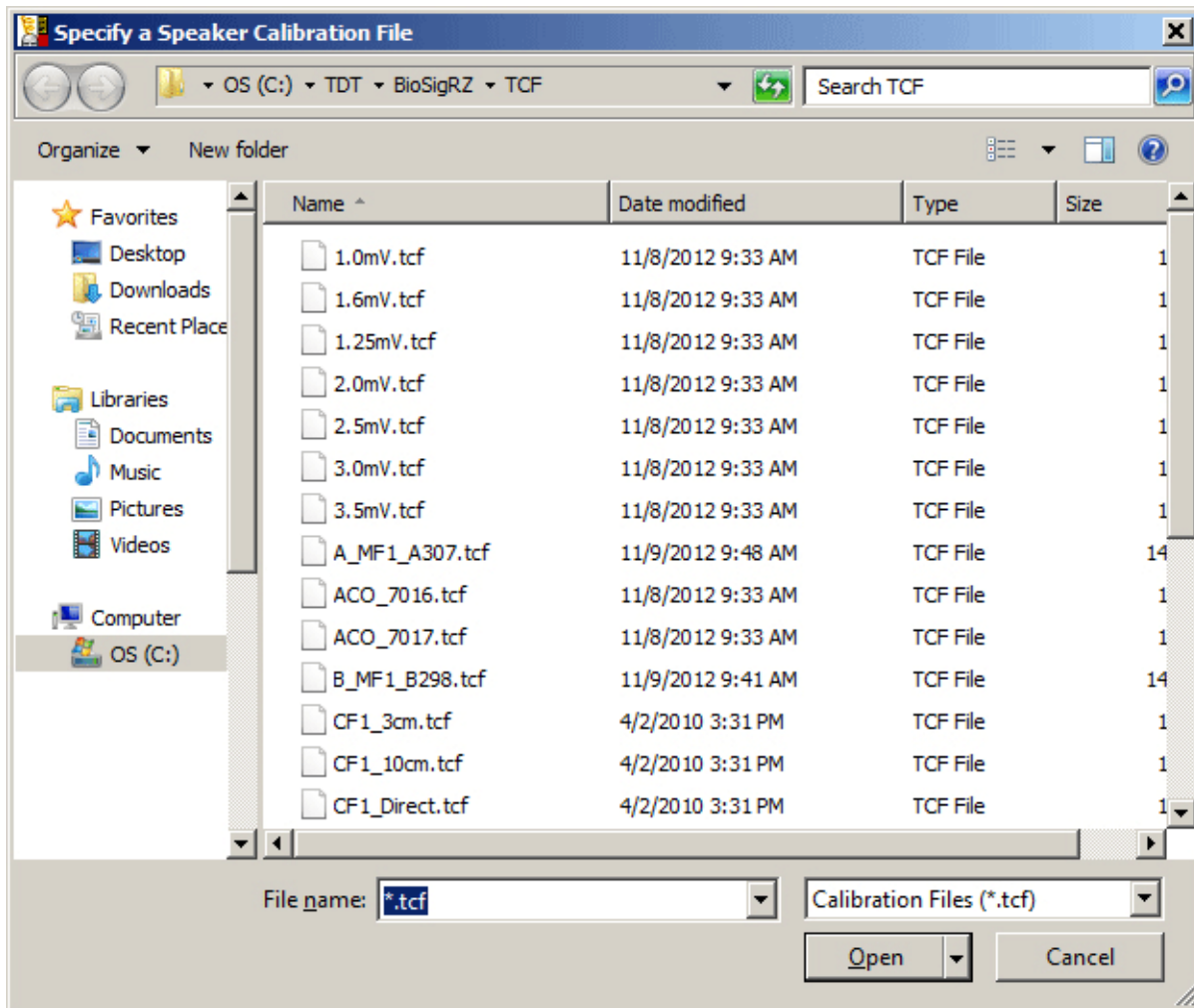
Freshen when possible ☐

[Reload Files]

[Cancel]

[OK]

Speaker Calibration

[None] [...]

Trans: Unspecified
Amp: Unspecified
Gain: Unspecified
Notes: Unity Pass-thru

3. In the Stimulus Channel Setup dialog click the Browse button under Speaker Calibration.

In the Specify a Speaker Calibration File dialog, calibration file names provide information about the type of speaker and calibration. For example, MF1_FreeField is a calibration file for the MF1 speaker in free field configuration calibrated at 10 cm from the subject. Several files are also provided for closed-field speakers positioned at several different distances depending on the length of tubing in use.

4. Select the appropriate file for your setup and click Open.
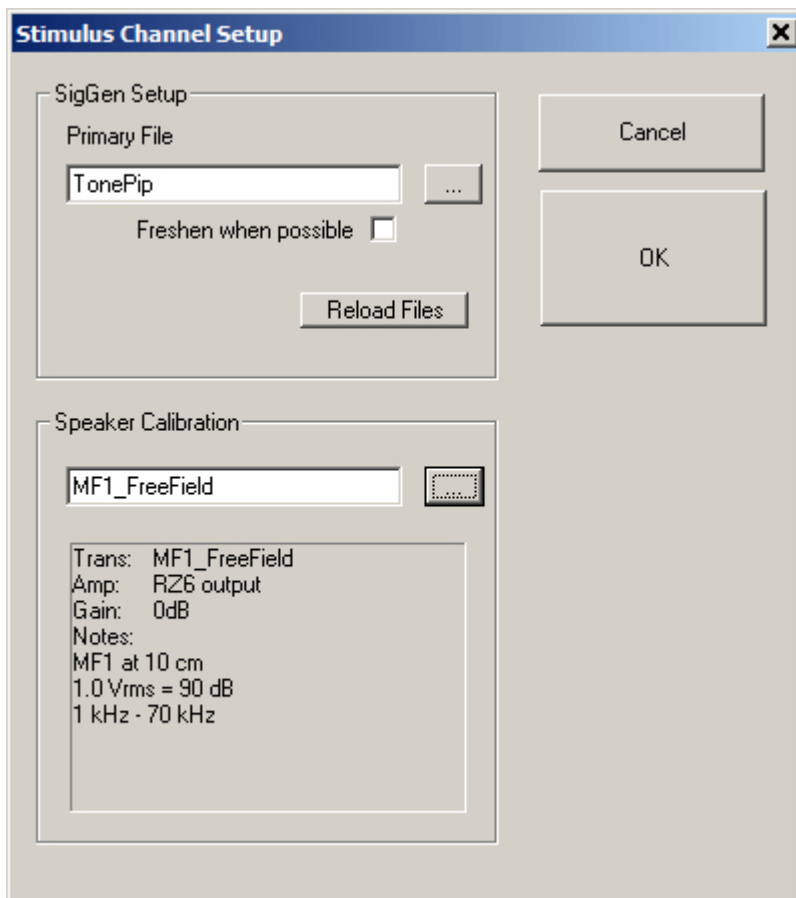
5. In the text area below Speaker Calibration, review the calibration information.

To ensure the accuracy of the calibration, set the manual attenuation on your RZ6 according to the gain value used in the calibration. For example: for the MF1_FreeField calibration shown above, you must set your manual attenuation on the RZ6 to 0 dB.

6. Click OK.

To specify your device input calibration:

1. Click the Setup menu and click Acquisition.

If using the RA4PA, select Bioamp. If using the Medusa4Z, select Medusa4Z and change the sampling rate to match the sampling rate on your Medusa4Z physical hardware. We recommend 12 kHz for ABR recording.

2. Click the Chan-1 button.

In the Configuration area, the Gain setting should match the gain of your preamplifier. If using the RA4PA/RA4LI combination, set this to 20, which is the gain TDT's RA4LI. If you are using a Medusa4Z, set this value to 1. If you are using a third party amplifier you might need to adjust this value.

3. Click OK.

Specify a Response Record File

Response record files (.arf) are continuously maintained during data acquisition. Each averaged record is appended to the history record file. You can specify where the data will be saved in the Acquisition Setup dialog box.

To specify a record file:

1. Select Acquisition from the Setup menu or click the Setup Acquisition button.

2. In the Name field, type a new file name or browse to a new location or file.

3. Ensure the Prompt for File Name check box is selected to be prompted for a new file name before stimulus presentation begins.

4. Click OK.

Save the .acf File

To save the configuration file:

1. Select Save Config. As from the File menu.

2. Enter a name in the File Name field.

3. Click Save.

> 🔥 **Important**
>
> Some operating system configurations have file name and path character limitations. TDT recommends keeping file names, including path, short to avoid problems associated with long file names.

Daily Operation

Once the initial experimental setup has been completed, the daily operation is as follows:

1. Load your saved configuration.

2. Prepare the subject.

3. Review the input/output settings.

4. Run the experiment.

Load your Saved Configuration

You may load your initial setup configuration to perform daily operations for BioSigRZ.

To load the configuration file:

1. Click the File menu and click Open Config. File.

2. Browse to the location of your saved configuration file (*.acf) and click Open.

Prepare the Subject

At this time prepare the subject for experimental trial(s).

Review the Input/Output Settings

When making changes to an existing configuration file it is useful to quickly review or verify that the input/output configuration matches the equipment and transducer you are using.

To view input/output settings of the loaded BioSigRZ configuration file:

1. Click the Review button. This prompts the Transducer Setup and Settings dialog.
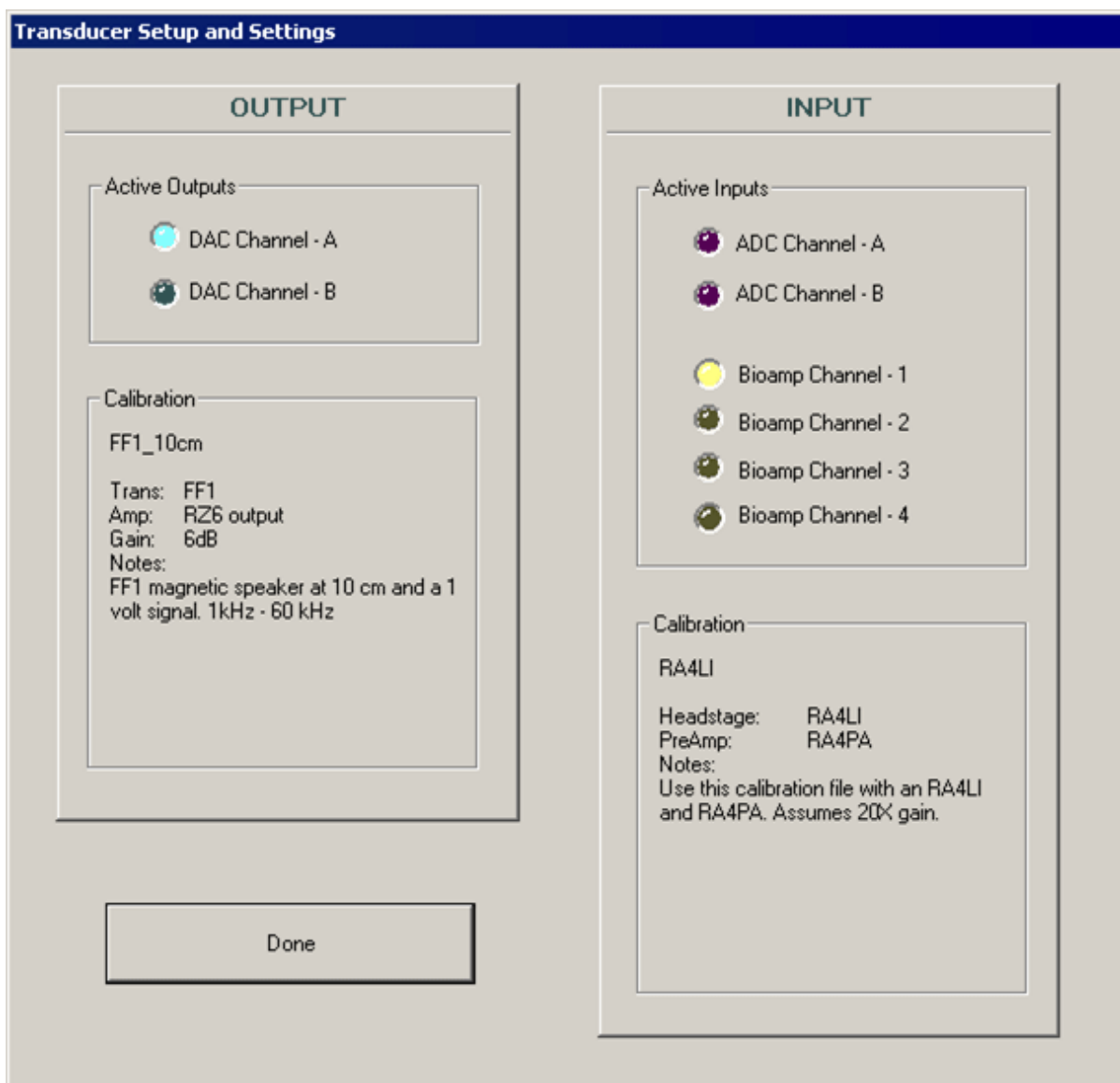
From the review dialog, the stimulus will be output on channel A, input will be acquired from Bioamp Channel 1, and the system is currently calibrated for a magnetic speaker at 10 cm

with device input coming from an RA4LI headstage and RA4PA preamp. RZ6 manual attenuation should be set to -6 dB.

2. After you have reviewed the dialog and verified that the setup is correct, click Done.

Run the Experiment

You can begin stimulus presentation or run the experiment using buttons on the left side of the BioSigRZ main window.

Running

To begin stimulus presentation:

1. Click the Start button. You will be prompted to specify a response record file where data will be stored.

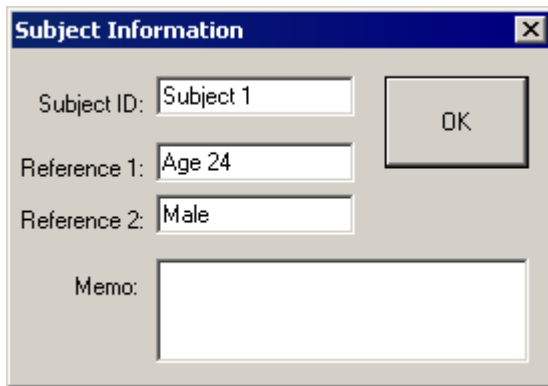2. Type a name in the File Name field and click Open.

You are now in *Running Mode*. The stimulus signal is presented using the first SigGen Index. No data is collected.

Averaging

To begin data averaging:

1. Click the Begin button.

2. A Subject Information window opens. Information entered here is stored with the data in the response record file.

3. Enter any subject information and click OK.

You are now in *Averaging Mode*. The first stimulus is repeatedly presented and the ABR response data is acquired and included in the running average until the desired number of responses has been collected at that level. In this experiment the number of responses averaged at each stimulus level is 512.

As averages are completed, the averaged ABR records will be appended to the History plot and the .arf file.

Termination

Once the boundary conditions have been met, BioSigRZ will automatically terminate data averaging. However, you may manually terminate data averaging at any time.

To manually terminate data acquisition:

• Click 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.

See Data Acquisition for more information on tools to control and streamline data acquisition and Data Analysis for more information on analyzing data during or after data collection.

Modifying a Stimulus Variable

As mentioned before, the standard ABR tone configuration probes the following frequencies: 4000 Hz, 8000 Hz, and 16000 Hz. Depending on the desired subject, you may wish to change the values of these probe frequencies. For example, for a mouse subject you might wish to probe 32000 Hz.

To modify a stimulus variable you will:

1. Load your saved configuration.

2. Review the stimulus variables.

3. Modify the frequency variable.

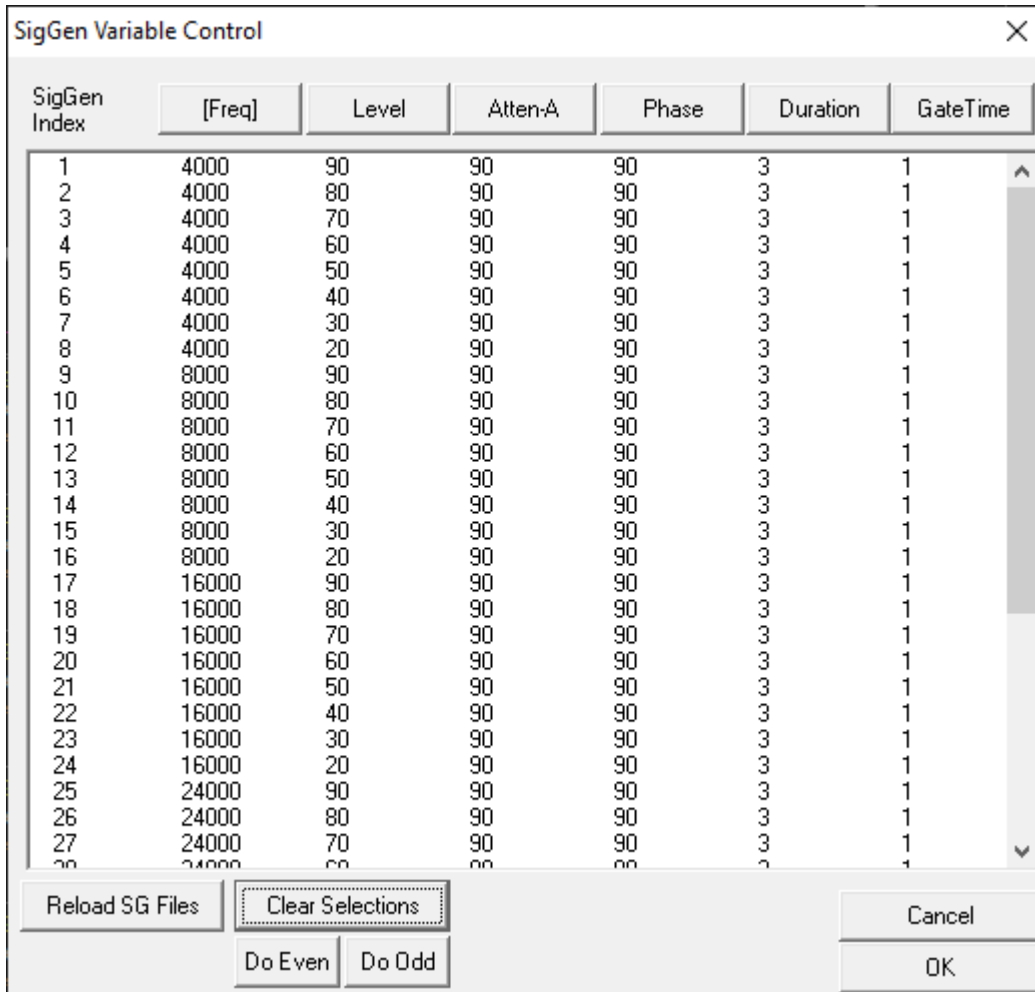4. Save the modified configuration.

Load the Saved Configuration

To load the configuration file:

1. Click the File menu and click Open Config. File

2. Browse to the location of your saved configuration file (*.acf) and click Open.

Review the Stimulus Variables

To review the stimulus variables and schedule:

1. Select SigGen Variables from the Setup menu or click the Modify SigGen Variables ⊞ icon. The SigGen Variable Control dialog opens.

SigGen Index	[Freq]	Level	Atten-A	Phase	Duration	GateTime
1	4000	90	90	90	3	1
2	4000	80	90	90	3	1
3	4000	70	90	90	3	1
4	4000	60	90	90	3	1
5	4000	50	90	90	3	1
6	4000	40	90	90	3	1
7	4000	30	90	90	3	1
8	4000	20	90	90	3	1
9	8000	90	90	90	3	1
10	8000	80	90	90	3	1
11	8000	70	90	90	3	1
12	8000	60	90	90	3	1
13	8000	50	90	90	3	1
14	8000	40	90	90	3	1
15	8000	30	90	90	3	1
16	8000	20	90	90	3	1
17	16000	90	90	90	3	1
18	16000	80	90	90	3	1
19	16000	70	90	90	3	1
20	16000	60	90	90	3	1
21	16000	50	90	90	3	1
22	16000	40	90	90	3	1
23	16000	30	90	90	3	1
24	16000	20	90	90	3	1
25	24000	90	90	90	3	1
26	24000	80	90	90	3	1
27	24000	70	90	90	3	1
28	24000	60	90	90	3	1

Reload SG Files   Clear Selections   Cancel

Do Even   Do Odd   OK

All of the variables which define the stimulus signal are displayed within this dialog. From here you can modify the stimulus schedule or modify the variables themselves.

The Stimulus Schedule

The SigGen Index (column 1) shows the order in which each variable condition, or SGI, will be presented. You can select a subset of conditions to run using standard Windows techniques. For more information, see Modifying the Stimulus Schedule.

Modifying Variables

Variables change the signal parameters as a function of the SigGen Index (SGI) and can be modified in BioSigRZ through the use of the Signal Variable dialog. See General Variable Parameters in the SigGenRZ Manual for more information on the variable parameters.

> ✏️ **Note**
>
> When modifying the frequencies to be probed, make sure you use only frequencies in the calibrated range (see the speaker calibration notes for more information).
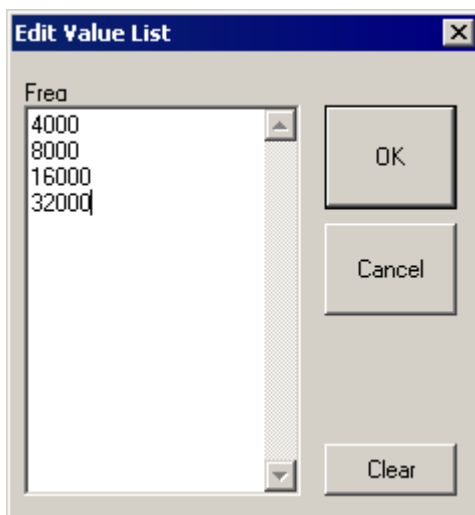
To modify the Freq variable:

1. In the SigGen Variable Control dialog, click the Freq button. The Signal Variable dialog opens.
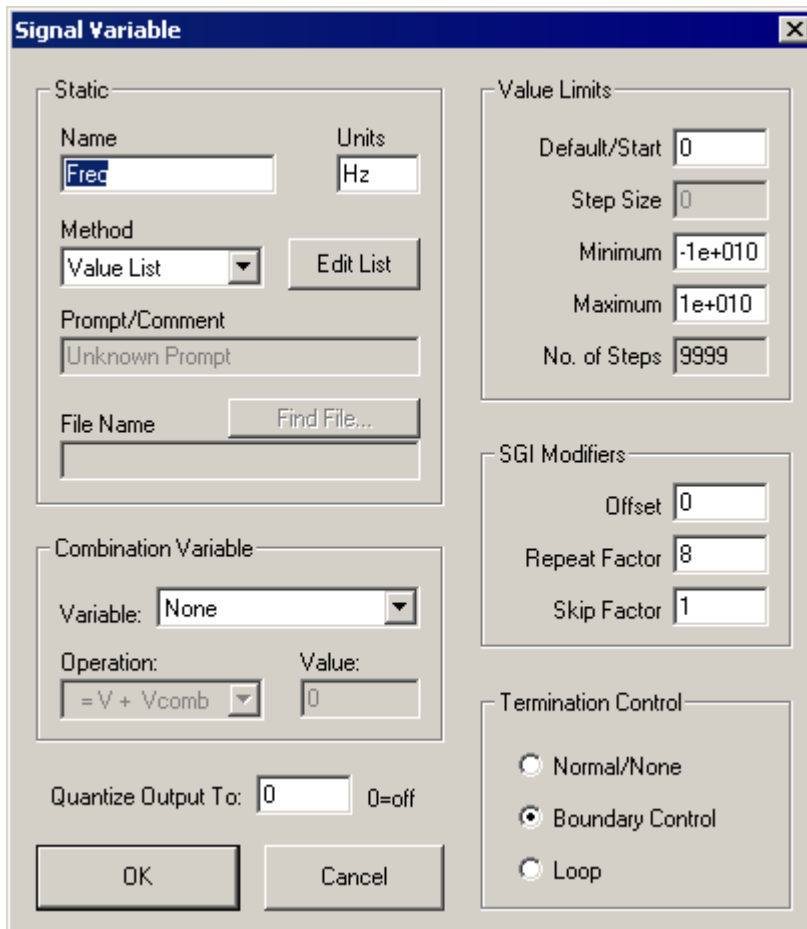
The variable Freq has been defined using the Value List method type.

2. To add the desired frequency to the list, click the Edit List button.

3. In the Edit Value List dialog, add the value 32000 to the bottom of the list.

4. Click OK.

5. Click OK.

SigGen Variable Control ✕

SigGen Index	[Freq]	Level	Atten-A	Phase	Duration	GateTime
1	4000	90	90	90	3	1
2	4000	80	90	90	3	1
3	4000	70	90	90	3	1
4	4000	60	90	90	3	1
5	4000	50	90	90	3	1
6	4000	40	90	90	3	1
7	4000	30	90	90	3	1
8	4000	20	90	90	3	1
9	8000	90	90	90	3	1
10	8000	80	90	90	3	1
11	8000	70	90	90	3	1
12	8000	60	90	90	3	1
13	8000	50	90	90	3	1
14	8000	40	90	90	3	1
15	8000	30	90	90	3	1
16	8000	20	90	90	3	1
17	16000	90	90	90	3	1
18	16000	80	90	90	3	1
19	16000	70	90	90	3	1
20	16000	60	90	90	3	1
21	16000	50	90	90	3	1
22	16000	40	90	90	3	1
23	16000	30	90	90	3	1
24	16000	20	90	90	3	1
25	24000	90	90	90	3	1
26	24000	80	90	90	3	1
27	24000	70	90	90	3	1
28	24000	60	90	90	3	1

Reload SG Files | Clear Selections | Cancel

Do Even | Do Odd | OK

The frequency 32000 has been added to the schedule.

6. Click OK.

Save the .acf File

To save the configuration file:

• Select Save Config from the File menu.

Saving the file, saves any modifications you have made to the experiment configuration or stimulus variables. When you are ready to run the experiment again it's as simple as loading the file, specifying a record file, adding subject information, and collecting the data.

Workspace Basics

Getting to Know the BioSigRZ Main Window

BioSigRZ'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 BioSigRZ, you will see the main BioSigRZ window. If you are running BioSigRZ for the first time, the main window will appear in its default layout, as seen below.
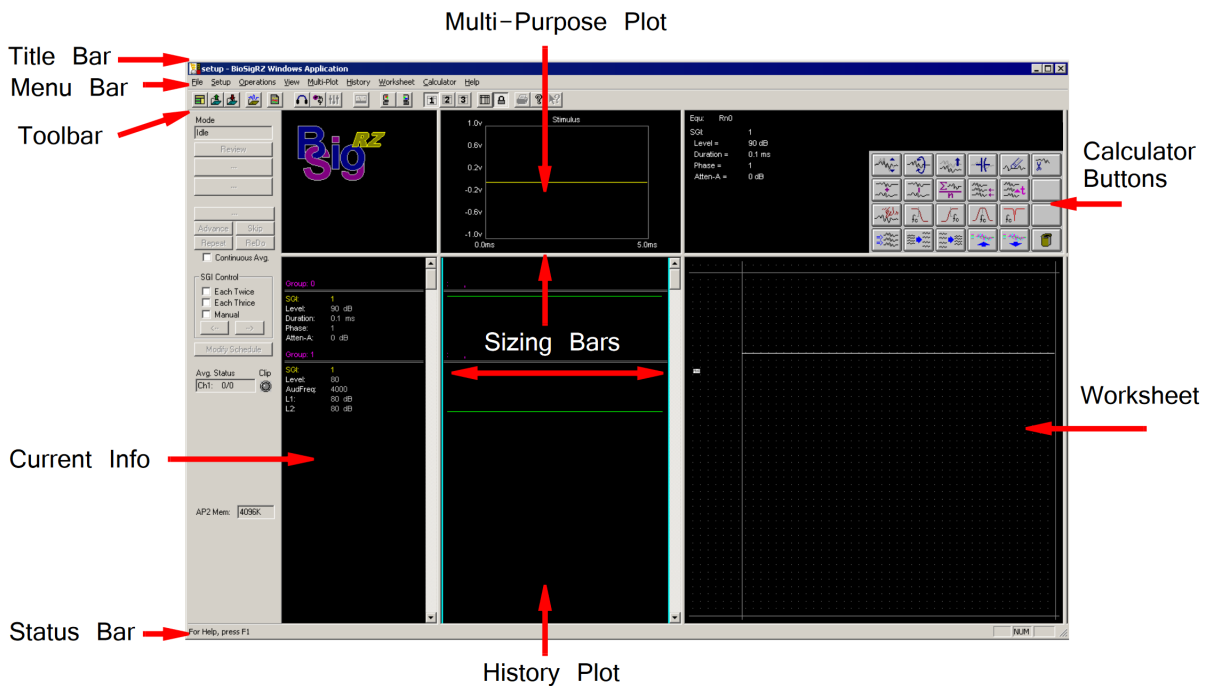
The window contains the following sections:

| Section	Description
Title Bar	Displays "BioSigRZ Windows Application" and the name of the current BioSigRZ file
Menu Bar	Contains a list of menus used for building, manipulating, and saving your BioSigRZ file
Toolbar	Provides easy-to-use icons for the most common BioSigRZ 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
Current Info	Displays the current SigGenRZ 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 records
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

BioSigRZ 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 BioSigRZ 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.
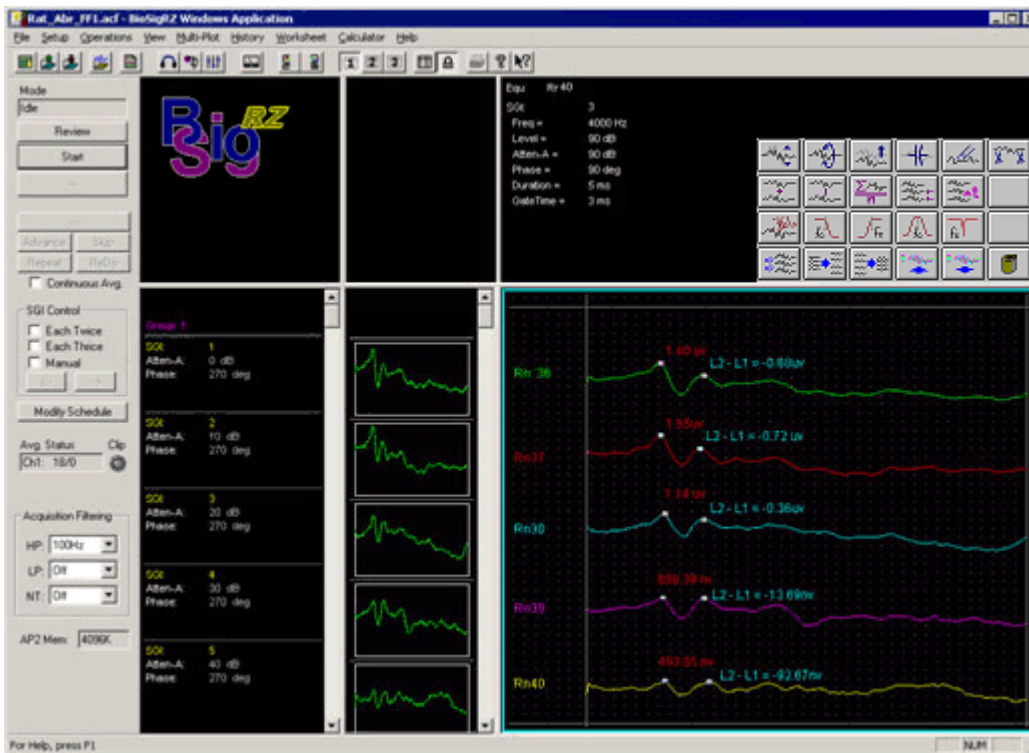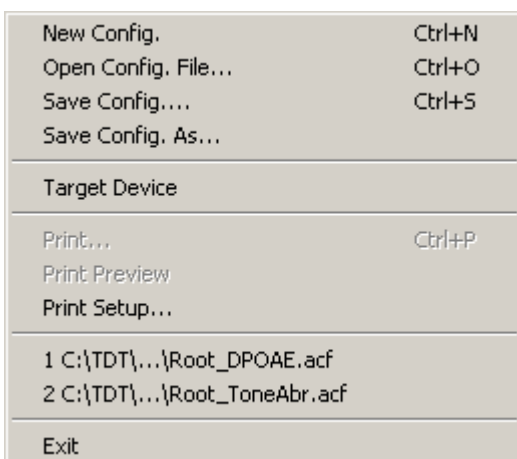
Using the BioSigRZ Menus

BioSigRZ 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.

Menu Option	Description
New Config	Resets all screen objects to their default states and clears all plots
Open Config. File	Opens and displays an existing BioSigRZ configuration file (.acf file)
Save Config / .As	These menu options save BioSigRZ configuration data in a BioSigRZ configuration file. Files saved with this format use the default extension .acf.
Target Device	Prompts the device selection window
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
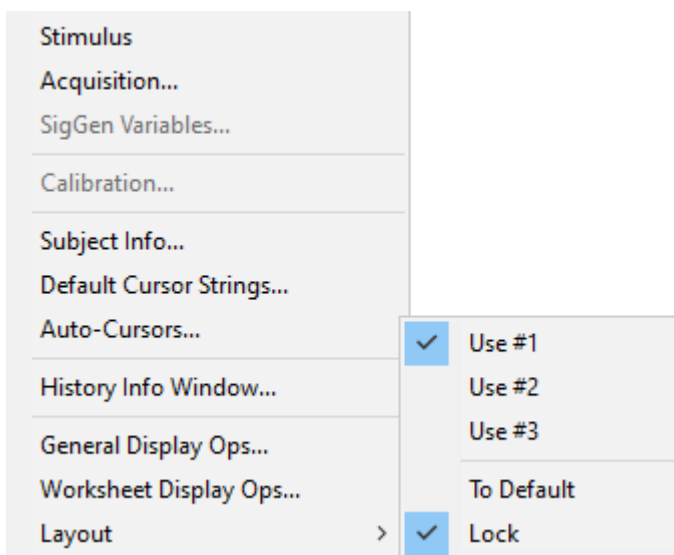
From the Setup Menu, you can define stimulus and acquisition parameters, adjust stimulus parameters, calibrate the system, enter subject information, and customize the BioSigRZ interface.

Menu Option	Description
Stimulus	Opens the Stimulus Setup dialog box. From this box you can specify up to two SigGenRZ 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.
SigGen Variables	Opens the SigGenRZ Variable Control dialog box. From this dialog box, you can customize stimulus presentation.
Calibration	Opens the calibration review dialog. See Reviewing Calibration for more information
Subject Info	Opens the Subject Information dialog box. This dialog box contains fields where you can 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	Opens the Specify Auto-Cursor Equations window, from which you can 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 can 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 can customize various display features of the Worksheet.
Layout	Displays a submenu, you can use to select a screen layout
Use #1, Use # 2, Use #3	Switch between three custom defined screen layouts
To Default	Returns the screen layout to its initial, default layout.
Lock	Locks/unlocks the current screen configuration.

The Operations Menu

Idle	Running
Start	Stop
---	Begin

---	Advance
Advance	Skip
Skip	Repeat
Repeat	ReDo
ReDo	Continuous
Continuous	
Repeat Each SGI	Repeat Each SGI
Threepeat Each SGI	Threepeat Each SGI
Manual SGI Control	Manual SGI Control
Next SGI	Next SGI
Previous SGI	Previous SGI
Modify Schedule	Modify Schedule

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

Menu Option	Description
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
--- End Pause Advance Skip Repeat ReDo Continuous Repeat Each SGI Threepeat Each SGI Manual SGI Control Next SGI Previous SGI Modify Schedule	--- End Resume Advance Skip Repeat ReDo Continuous Repeat Each SGI Threepeat Each SGI Manual SGI Control Next SGI Previous SGI Modify Schedule

Menu Option	Description
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 Pausedmodes.
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. BioSigRZ 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 SigGenRZ Variable Control dialog box. From this dialog box, you can customize stimulus presentation.

The View Menu

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

Menu Option	Description
Tool Bar	Shows/hides the Tool Bar
Status Bar	Shows/hides the Status Bar
Dyn Controls	Displays all active Dynamic Control windows. Dynamic controls can be enabled for the desired variable in the Signal Variable dialog.
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 - N	Shows/hides Channel N on the focus plot
Only Chan-N	Shows only Channel N on the focus plot

> ✏️ **Note**
>
> 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.

The Multi-Plot Menu

Nothing	N
Stimulus	S
Raw Input	I
Time/Freq	T
EEG	E
Running Average	A
✔ Show Comparison	Ctrl+M

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

Menu Option	Description
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 (such as gain) to raw input signals. See Defining Data Acquisition Parameters for more information.
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.

Menu Option	Description
Access Record File	Loads previously saved BioSigRZ records from files known as BioSigRZ record files. These files use the default extension, .arf. BioSigRZ 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 BioSigRZ Cursor Edit dialog box. From this dialog box, you may place cursors and obtain signal information.
Toggle Comparison	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 BioSigRZ 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
Auto Cursor	Applies the selected auto cursor to the selected history record. See Auto-Cursors for more information.

The Worksheet Menu

Clear Worksheet	Ctrl+W
Open Worksheet...	
Save Worksheet...	
Save Worksheet As...	
Export to Ascii...	
Export to CSV	
Configure ▶	
Space Evenly	
Spread Apart	
Squash Together	
Pile	
UnPile	
Delete	Del
Duplicate	
Select All	Space
Deselect All	Ctrl+Space
Toggle Comparison	

Submenu for Configure:

Worksheet Defaults...
Trace...
Token...
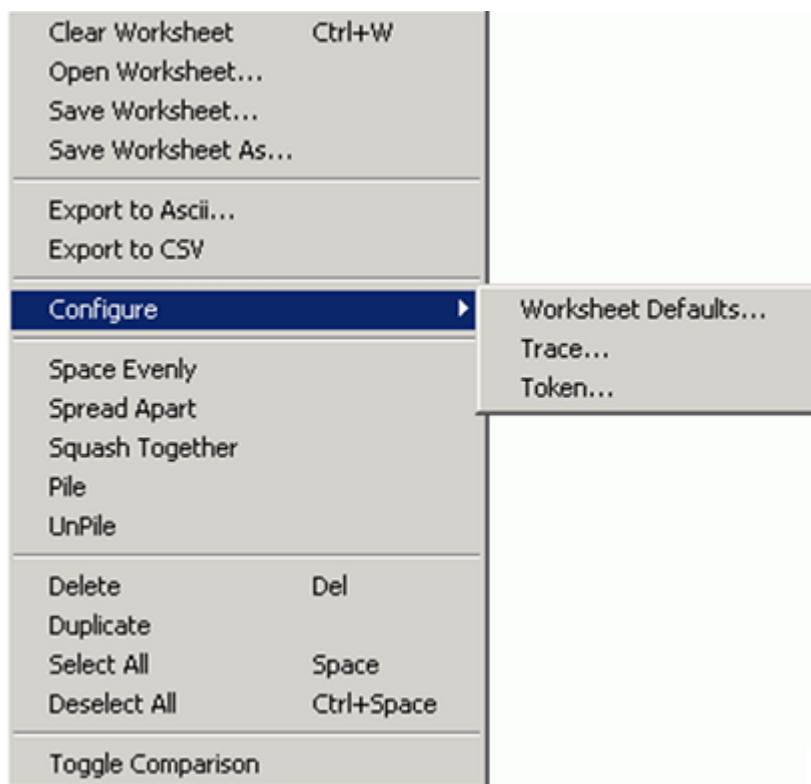
Menu Option	Description
Clear Worksheet	Clears the entire Worksheet
Open Worksheet	Opens a Worksheet file (.awf file)
Save Worksheet	Saves an existing Worksheet file
Save Worksheet As	Save a new Worksheet file
Export to Ascii	Saves the currently selected records in a user-defined ASCII file (.txt file)
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.
Configure Tract	Displays a message describing how to edit a trace
Configure 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

Scale	
Invert Trace	
Shift Baseline	
Remove Baseline	
Zero Points	
Crop Trace	
Add	
Subtract	
Average	
Time Align	
Time Shift	
Smooth	
Lowpass Filter	
Highpass Filter	
Bandpass Filter	Cursor 1
Notch Filter	Cursor 2
	Cursor 3
Hanning Window	Cursor 4
Cosine^2 Window	Cursor 5
	Cursors 6-10
Mag Spectrum	
Auto Cursor ▶	All Cursors

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

Menu Option	Description
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 Trace	Crops the selected trace from the specified starting point (ms) to the specified ending point (ms).
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 Cosine2 window for use with the magnitude spectrum
Mag Spectrum	Does a FFT and generates a magnitude spectrum of the data
Auto Cursor	Applies the selected auto cursor to the selected worksheet record

The Help Menu

```
About BioSigRZ...
BioSigRZ Help...  F1
```
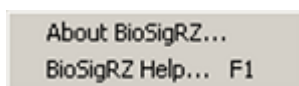
From the Help Menu, you can access the About BioSigRZ dialog box. Clicking the BioSigRZ Help option or pressing the F1 button at any time prompts the BioSigRZ Manual.

Using the Toolbars

The Toolbar

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

Click		To
	New	Clear all plots and reset BioSigRZ to its default configuration.
	Open	Open an existing BioSig file.
	Save	Save a BioSig file.
	BioSig Records	Load records stored in an .arf file.
	Worksheet Records	Load an .awf file.
	Setup Stimulus	Define stimulus parameters.
	Setup Acquisition	Define acquisition parameters.
	Modify SigGen Variables	Modify the Stimulus Schedule and variables.
	Calibrate	Open Calibration menu.

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.
	Default Layout	Auto adjusts the current layout to the default layout.
	Lock	Lock the screen layout.
	Print	Print the current history plot.
	About BioSigRZ	Access about BioSigRZ dialog.
	Context-Sensitive Help	Context-sensitive help is not currently supported. ### The Plot Control Toolbar

The multi-purpose and history plots 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.

> ✏️ **Note**
>
> 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.

To display the Plot Control Toolbar:

- Place the mouse pointer within the plot area and hold down the right mouse button.

  The Plot Control Toolbar will remain displayed while the right mouse button remains depressed.
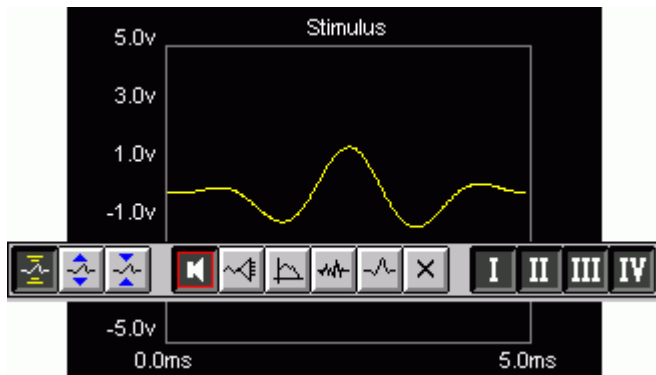
To click a Plot Control Toolbar button:

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 BioSigRZ plot. However, there are certain common features found in all Plot Control Toolbars. Each toolbar consists of the following sections.

- Scaling Section
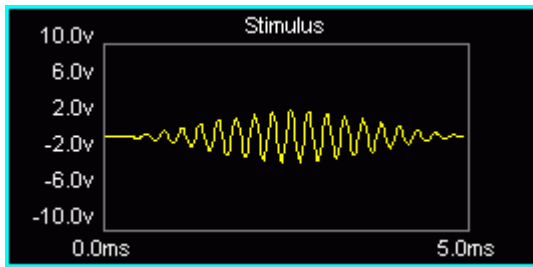- Customization Section
- Channels Section

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.

Click	Numpad Shortcut		To
	*	Auto-Scale	When Auto-Scale is chosen, BioSigRZ will automatically scale the plot that currently has the focus.
	+	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.
	-	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.
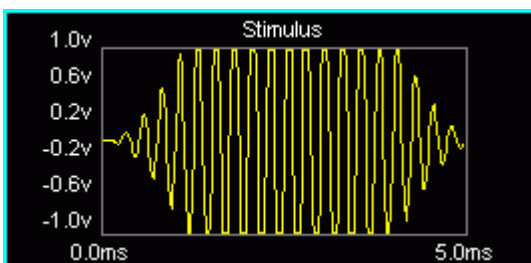
Expand Scale

Reduce Scale

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. See The Multi-Purpose Plot below and See The History Plot., for more information.

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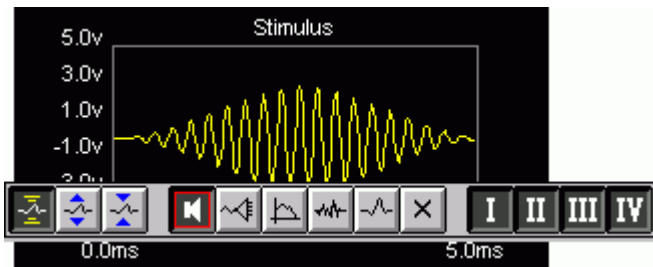
The Multi-Purpose Plot may be used to display a variety of signals during stimulus presentation and data averaging. The plot is controlled through the use of the Plot Control Toolbar.

As with all other plots, you can 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 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:

Click	for Display Type
	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.
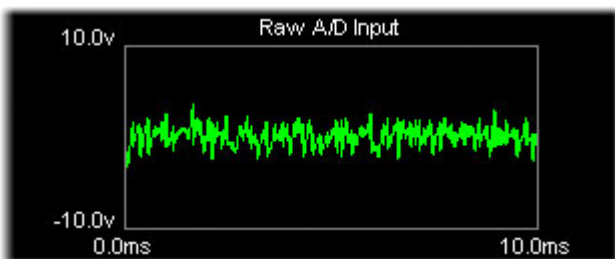
Stimulus
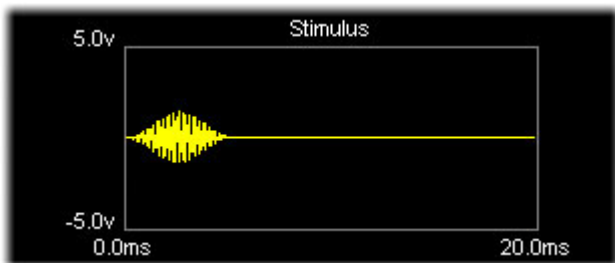
Choosing Stimulus causes the current stimulus signal to be displayed. BioSigRZ allows up to two channels of stimulus output.

To display the Stimulus signal:

1. Display the Control Plot Toolbar.

2. Click the Stimulus Signal button or press 'S' on the keyboard.
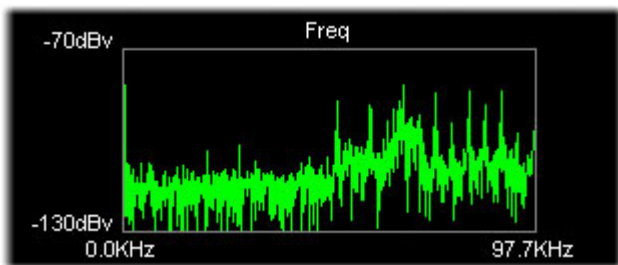
Raw A/D

Choosing Raw A/D Input causes unprocessed A/D input to be displayed. Raw input is not affected by currently defined acquisition setup parameters such as gain but will display the effects of acquisition filter settings.

To display the raw A/D signal:

1. Display the Control Plot Toolbar.

2. Click the Raw A/D Input button or press 'I' on the keyboard.
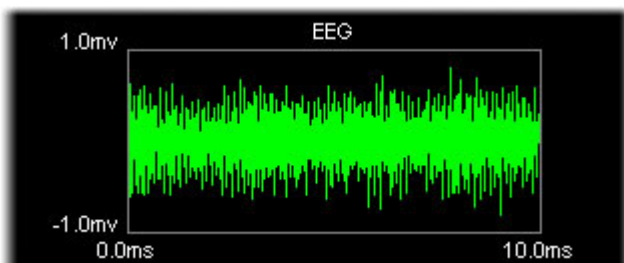
Frequency Domain

Choosing Frequency Domain causes the Raw A/D input to be displayed in the frequency domain.

To display the frequency-domain A/D signal:

1. Display the Control Plot Toolbar.

2. Click the Frequency Domain button 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 and any acquisition filter settings that are applied.

To display the EEG signal:

1. Display the Control Plot Toolbar.

2. Click the EEG button or press 'E on the keyboard.

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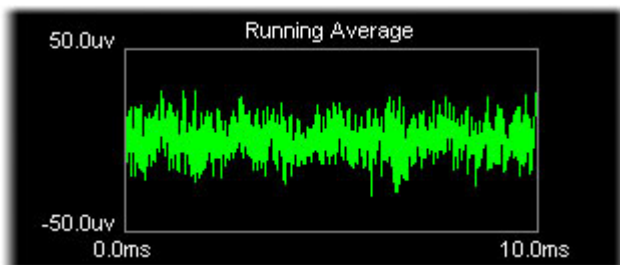
Choosing Running Average causes the current averaged EEG signal to be displayed.

To display the running average:

1. Display the Control Plot Toolbar.

2. Click the Running Average [icon] button or press 'A' on the keyboard.

None

Choosing None causes no signal to be displayed and the plot area will appear blank.

To display no signal:

1. Display the Control Plot Toolbar.

2. Click the Display None [icon] 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.

You can 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 toolbar. These functions may also be accessed from the History menu.

Scrolling Functions

History Plot data is organized into groups. Each time you tell BioSigRZ 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 using the scrolling buttons.

To scroll to the top of the previous group:

1. Display the Control Plot Toolbar.

2. Click the Scroll Up button or press 'Page Up' on the keyboard.

To scroll to the top of the next group:

1. Display the Control Plot Toolbar.

2. Click the Scroll Down button or press 'Page Down' on the keyboard.

Editing Functions

You may edit the History Plot using 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 using standard, Shift+click and Ctrl+click Windows methods.

Editing

To clear selected History Plot records:

1. Display the Control Plot Toolbar.

2. Click the Clear Selected Record button.

To clear all History Plot records:

1. Display the Control Plot Toolbar.

2. Click the Clear History button or press Ctrl + 'X' on the keyboard.

> ✏️ **Note**
>
> BioSigRZ maintains a file of historical records knows as the BioSigRZ 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 BioSigRZ record file. Records stored in the BioSigRZ 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
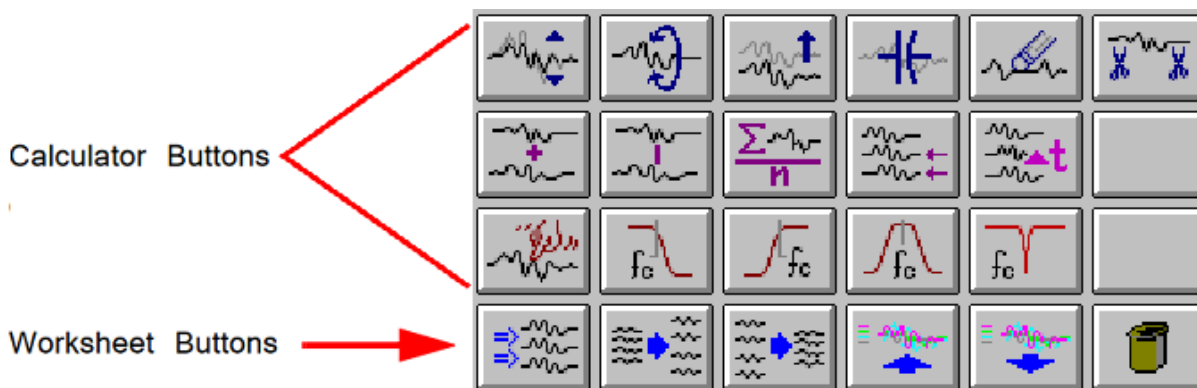
BioSigRZ provides mathematical functions that may be applied to one or more Worksheet record(s). These functions may be accessed from the Calculator menu or from buttons displayed in the area of the main window known as the Calculator.

Calculator functions are described in detail in a later section. For more information about the Calculator, see Using the Calculator.

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 Cos2 window to the selected worksheet record (smoothes the start and end). 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 recor

Worksheet Functions

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	Positions selected plots closer 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
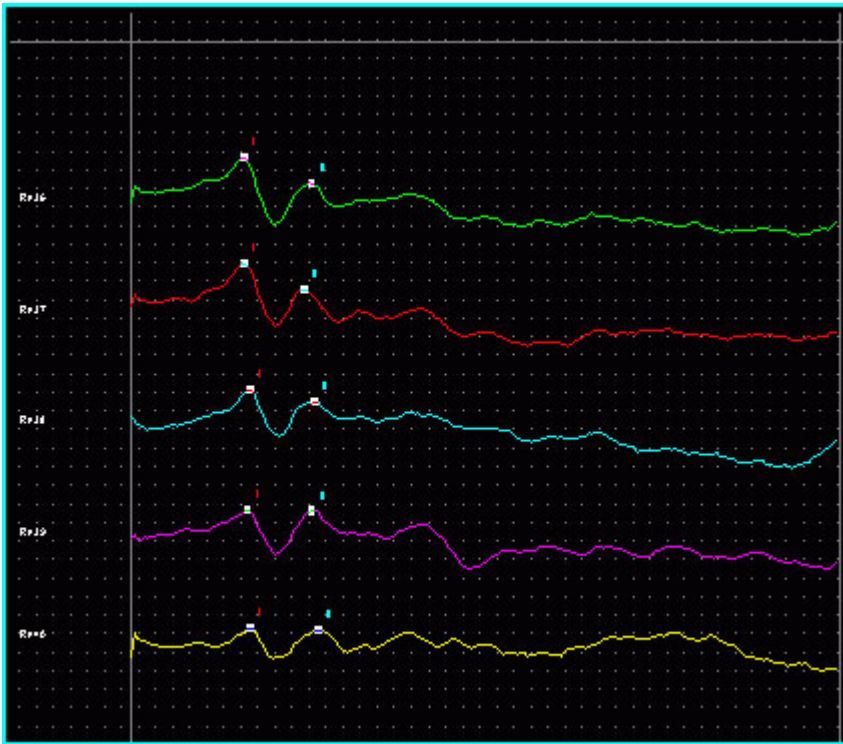
The Worksheet is an area of the main window where you can place records for reporting. Calculator functions may also be applied to records in the Worksheet. For more information about the Worksheet, See Using the Worksheet..

Customizing Your Display

BioSigRZ provides 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 BioSigRZ 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

To customize the Worksheeet:

- Select Worksheet Displays Ops from the Setup menu or click the Worksheet Display button. This prompts the Worksheet Display Options dialog box.

Worksheet Display Options

General
- Background Color
- Focus Border Color

Trace Options
- Trace Color #1
- Trace Color #2
- Trace Color #3
- Trace Color #4
- Trace Color #5
- Trace Color #6
- Trace Color #7
- Trace Color #8
- Trace Color #9
- Trace Color #10

Tokens
- Token Color #1
- Token Color #2
- Token Color #3
- Token Color #4
- Token Color #5
- Token Font

Misc
- Grid Color
- Margin Color
- ☐ Print with Color

- Cancel
- OK
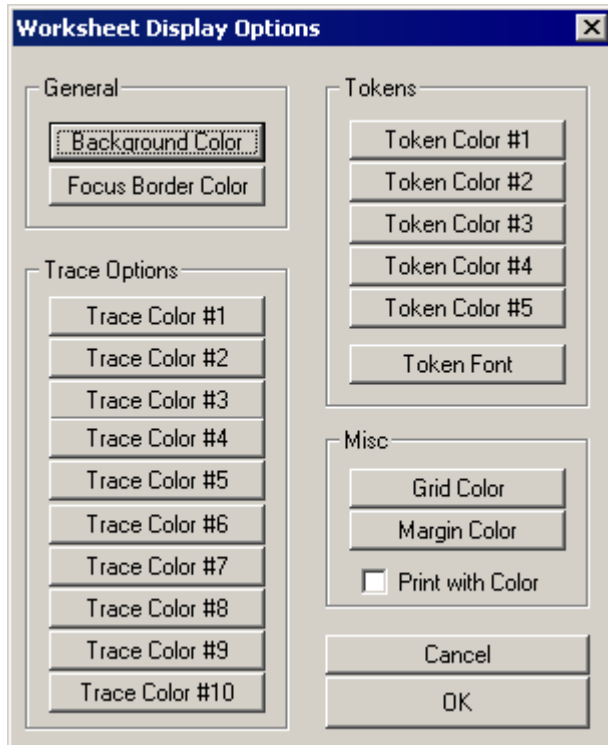
To customize all other areas:

- Select General Displays Ops from the Setup menu or click the General Display button. This prompts the General Display Options dialog box.
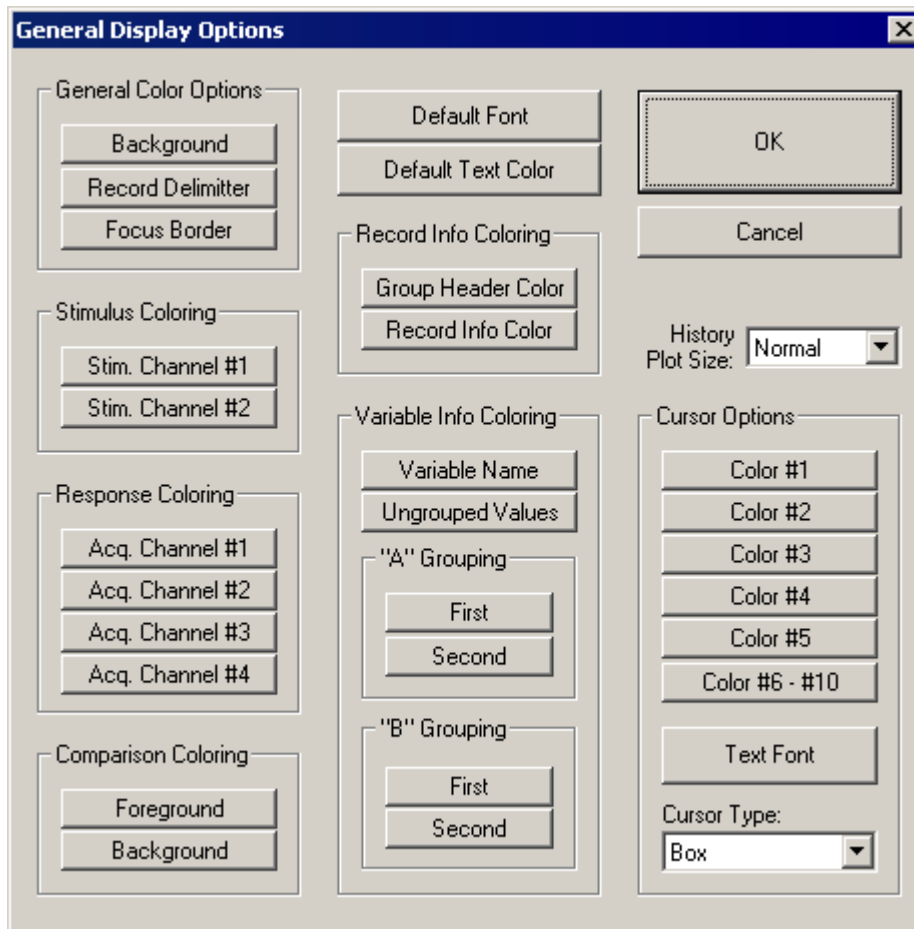
From either Display Options dialog box you may configure the font types and sizes and colors using standard Windows techniques.

Customizing the Layout

You may wish to re-size screen display areas.

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:

- Select the desired Setup # by hovering over the Layout option in the Setup menu.

To configure a setup:

1. Select the desired Setup # by hovering over the Layout option in the Setup menu or click the desired Setup # ![1] ![2] ![3] button.

2. Ensure that the desired Setup # is currently unlocked prior to any modifications. To do this, click the Lock ![lock] button if it is currently ![lock] enabled.

3. Manually customize the layout.

4. Select Lock by hovering over the Layout option in the Setup menu or click the Lock ![lock] button. This layout is now associated with the chosen Setup #.

Returning to the Default Layout

To return to the default layout:

1. Select To Default hovering over the Layout option in the Setup menu or click the Default Layout ![grid] button.

Customizing Cursor Strings

BioSigRZ 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:

• Select Default Cursor Strings from the Setup menu. You will see the Default Cursor Text dialog box.
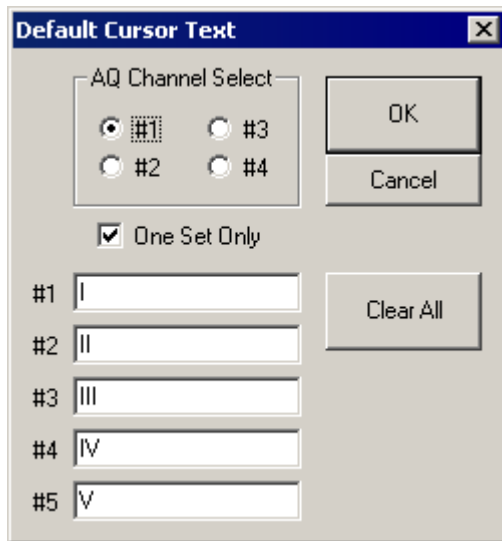
Cursor strings may be defined as follows:

- 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. Select the desired acquisition channel.

3. Type in the desired cursor strings.

4. Click OK.

5. Repeat for each acquisition channel.

Configuration

Prior to presenting a stimulus signal and acquiring response data, stimulus and data acquisition parameters must be configured. These parameters are saved as part of the BioSigRZ configuration file. The information in this section can be used to modify an existing configuration or to create a new configuration file.

Open existing BioSigRZ configuration files and save new ones from the File menu.

Creating Configurations

When creating a new configuration file, it is necessary to complete the steps below prior to presenting a stimulus signal and acquiring response data.

- Define stimulus signal parameters
- Define data acquisition parameters

Optionally the user might also wish to:

- Review the calibration
- Specify the stimulus schedule
- Modify the Target Device setup

Defining Stimulus Parameters

Stimulus parameters are defined from the Stimulus Setup dialog box.

To access the Stimulus Setup dialog box:

- Select Stimulus from the Setup menu or click the Setup Stimulus
   button.
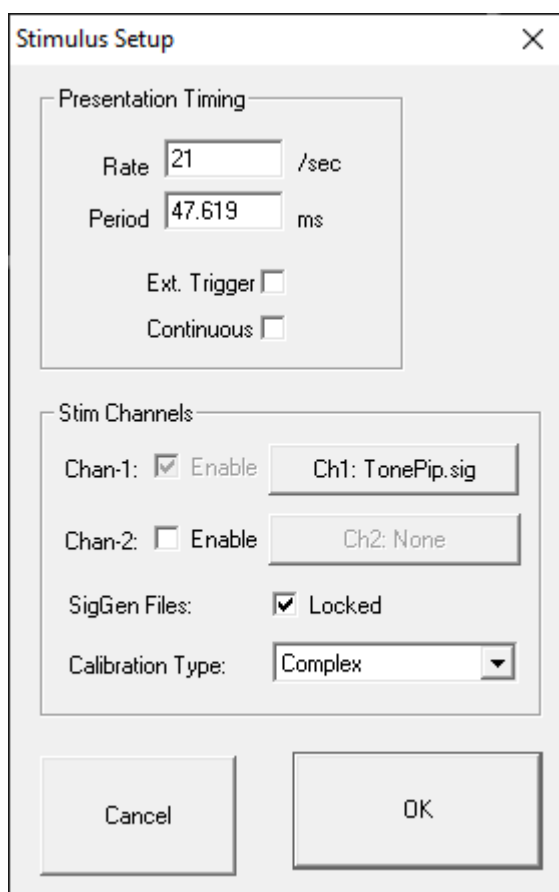
Defining the Stimulus

You may define a stimulus on one or two channels. Set the SIG file and calibration file for each channel by clicking the button for that channel. There is more information on that in the following sections.

Calibration Type

BiosigRZ takes the speaker calibration curve (*.TCF file) and generates an FIR filter to flatten the response. When the Calibration Type is set to Complex, all signals are passed through this filter before they are sent out the DACs/speakers.

In some instances, if the speaker response curve has large variance with sharp notches/peaks (this usually happens with closed-field speakers at higher frequencies), the FIR filter doesn't perfectly represent this and can affect the output signal quality, particularly for tone pip stimuli. In this case, set the Calibration Type to 'Tonal' and BioSigRZ will use a lookup table to scale the signal based on the primary frequency, instead of using the FIR filter.
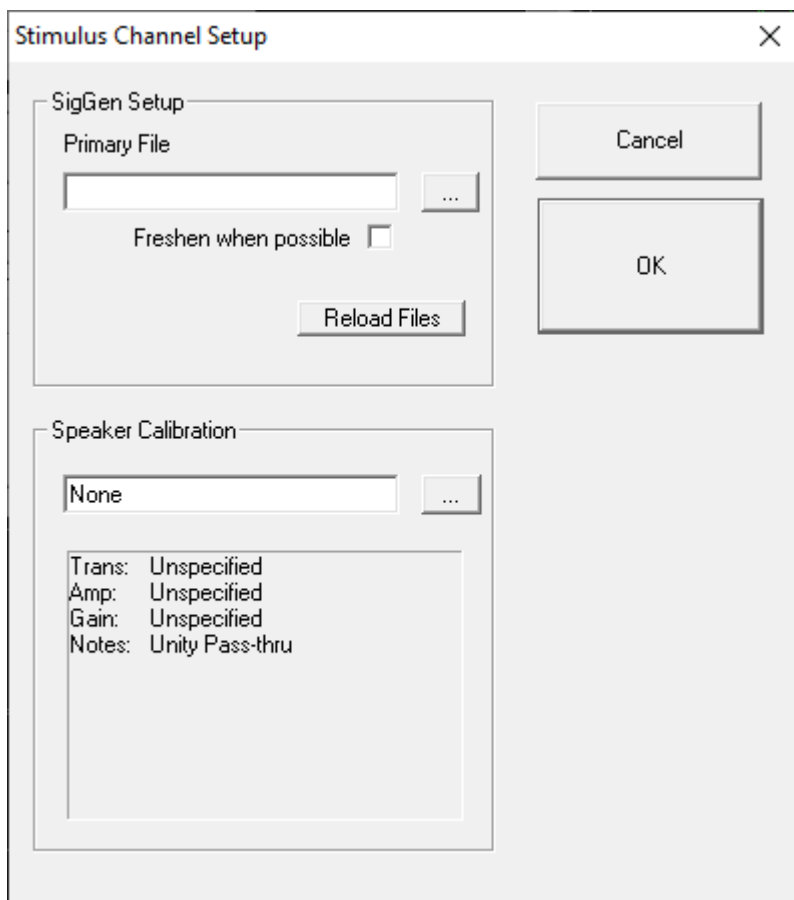
Specifying the SigGenRZ File

BioSigRZ generates a stimulus signal based on signal parameters read from previously defined SigGenRZ signal files (*.sig files). To define a stimulus signal, the user specifies the desired *.sig file.

To specify the stimulus file:

1. Click the Browse [...] button to the right of the Primary File field.

2. Select the desired file.

or

  • Type in the desired file name in the Primary File field.

Stimulus Refresh

BioSigRZ generates a stimulus signal based on the parameters specified in the SigGenRZ 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 set of stimulus variable conditions, called a SigGen Index or 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. BioSigRZ 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 checking the Freshen when possible checkbox.

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 BioSigRZ 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 Freshen when possible.

To refresh the stimulus whenever possible:

- Check the Freshen when possible check box

Locking SigGen Files

You may modify SigGenRZ variables from within BioSigRZ.

If the Lock SigGen Files checkbox is enabled, changes you make to the SigGenRZ variables within BioSigRZ will be saved with the *.acf file. Any changes to the *.sig file that are done outside of BioSigRZ will have no effect on the configuration, because BioSigRZ has 'locked' a copy of the SigGen file inside of the *.acf file.

If the Lock SigGen Files checkbox is unchecked, the SigGen file is reloaded from disk every time you open the *.acf file and your changes to the variables within BioSigRZ will be overwritten and lost.

To lock a SigGen File for the current *.acf:

- Check the Lock SigGen Files check box

Reloading the SigGenRZ Stimulus File

SigGenRZ files are automatically loaded:

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

SigGenRZ files may also be manually loaded by:

- Browsing to the desired SigGenRZ file.

Included in the SigGenRZ file is information defining how variables will change as a function of the SGI. Once a SigGenRZ file has been loaded, this information is available to the BioSigRZ application and will be saved in the BioSigRZ configuration file (*.acf file).

In some cases, it may be necessary to modify these stimulus variables. BioSigRZ allows you to make local changes to stimulus variables for Channel 1, only. (Note that with a two channel system, both SigGenRZ files should have the same variables. BioSigRZ only implements variables in the file for Channel 1.)
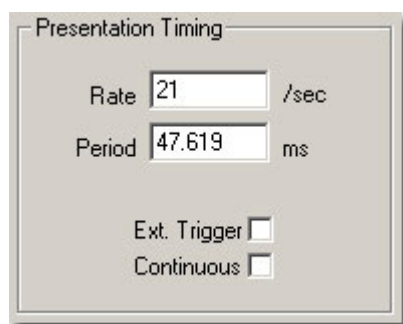
Reload File

When you reload a SigGenRZ file with variables, the variable schedule currently defined in BioSigRZ will be replaced with the schedule stored in the SigGenRZ file.

To reload a SigGenRZ file:

- Click the Reload File button.

Presentation Timing

Temporal parameters associated with the presentation of the stimulus signal are defined in the Presentation Timing 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 - Not supported at this time
- Continuous - Enable/disable continuous presentation.

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 SigGenRZ signal assigned to stimulus channel 1. When continuous is enabled, you may not edit the Presentation Rate or Presentation Period.

> ✏️ **Note**
>
> When Continuous is not enabled, the Presentation Period must be 1.25 times longer than the stimulus and acquisition duration.

Ext. Trigger

This feature is not currently supported at this time.

Continuous

When Continuous is checked, the stimulus will be played continuously. Upon reaching the end of the signal, BioSigRZ 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 assigned SigGenRZ file must be designed for continuous stimulus presentation.

Speaker Calibration
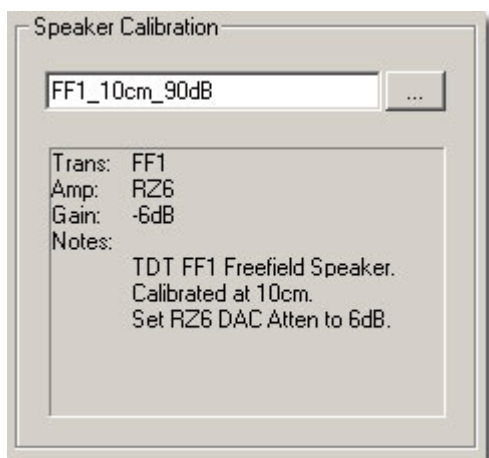
Calibration associated with the presentation of the stimulus signal can be loaded in the Speaker Calibration section of the Setup Stimulus dialog box.

To load a Calibration file:

1. Click the Browse [...] button.

2. Select the desired file or type in the desired file name in the text field.

A text area displays specific information regarding the currently selected calibration file including the transducer, amplifier, gain setting, and any additional notes.

The Gain value tells you what value to set the manual attenuator on the RZ6. For example, a gain value of -6 dB indicates that this calibration file was created with the manual attenuator knob set to 6 dB, so in order for this calibration to be accurate you must set the manual attenuator knob to 6 dB.

> ✏️ **Note**
>
> Calibration files are provided for common speakers and use the extension .tcf.

Defining Data Acquisition Parameters

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

To access the Acquisition Setup dialog box:

- Select Acquisition from the Setup menu or click the Setup Acquisition button.

Response Record File

Response record files, or history record files, (.arf) 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.

Prompt for File Name

When this box is checked, BioSigRZ will always prompt you for a file name before stimulus presentation begins, allowing the option to specify separate *.arf files.

Save Individual Traces

When this box is checked, a CSV file containing all individual trace data is saved next to the ARF file for each average saved into the ARF file. The file name format is {ARFNAME}-{GROUP}-{SGI}-{CHANNEL}-{NREPEAT}.csv

Within the CSV file the first row is headers for group, sgi, channel, subject, ref1, ref2, memo, and all variable names. The second row is the values for those headers. Each row after that contains an individual sweep.

During averaging, BioSigRZ requires two additional sweep triggers to move the internal buffer on the RZ6 to get it ready to read. Because of this, there will be two more traces at the end of this file than the specified number of desired averages.

The CSV files that are produced will be large (typically 14-15 MB per SGI) but because they are text files they compress well and typically take up 4-5 MB when zipped.

Individual Traces and the Acquisition Channel Setup dialog settings

The Gain setting in the Acquisition Channel Setup dialog is already divided out of this data.

The DC component is not removed from these traces, even if "AC Couple" is selected in the "Preprocessing" settings of the Acquisition Channel Setup dialog (which is the default).

Any "Post Processing" is also not applied, which means the DPOAE individual traces will be the time domain signals.

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 SigGenRZ variable. This box is disabled when continuous signal presentation is enabled.

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 SigGenRZ signal and 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 both 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

This field displays the current sample period in microseconds associated with the acquisition sampling rate (this rate is defined in the assigned .sig file and cannot be edited).

Setup Inputs

Select an input source (the RZ6 device analog A/D, RA4PA Bioamp, or Medusa4Z). If choosing Medusa4Z, also set the sample rate of the Medusa4Z device. Next, define configuration parameters for the acquisition channel.
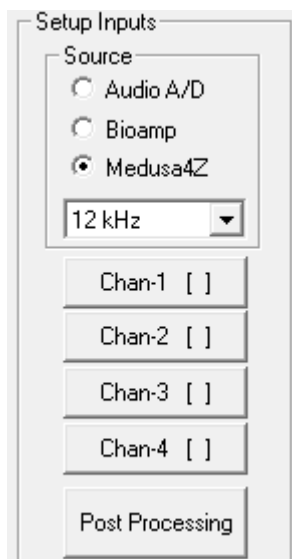
To setup an acquisition channel:

- Click the desired acquisition channel button. The Acquisition Channel Setup dialog box opens.
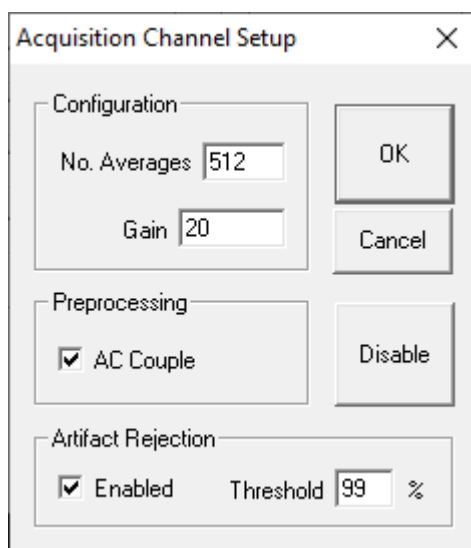
Configuration

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. Enter the gain applied by the preamplifier you are using. The TDT RA4LI applies 20X gain. The Medusa4Z gain is 1X. If using the A/D inputs you may have a different gain setting.

Preprocessing

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

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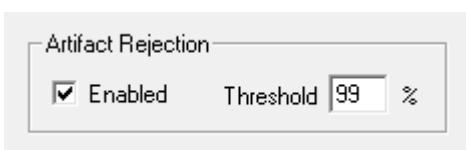
In some cases, anomalous amplitude values may indicate an artifact in the acquired data signal. BioSigRZ provides a means for detecting and rejecting signals with such artifacts, Artifact Rejection. By enabling Artifact Rejection, you can specify at which peak amplitude you wish to reject an acquired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

> ✏ **Note**
>
> Signals rejected through Artifact Rejection are not included in the average for each SGI.

To enable Artifact Rejection:

1. Check Enabled in the Artifact Rejection area

2. Enter the desired percentage in the Threshold field

or

1. Select the 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 the Ctrl key. A threshold line appears.
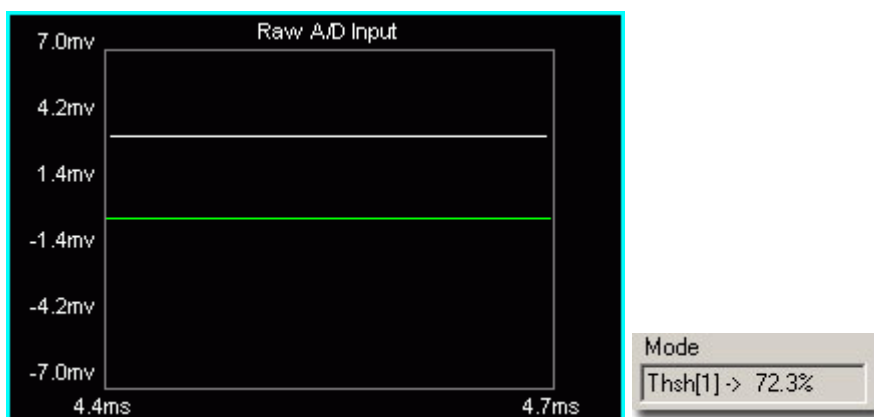
4. Drag until the desired artifact rejection is reached. The threshold percentage will be displayed in the Mode field.

Enabling/Disabling a Channel

Acquisition Channel 1 is always enabled. Channel 2 is disabled by default and is not supported by BioSigRZ at this time. However, if the system has been modified to use two channels, Channel 2 can be enabled or disabled. Contact TDT for more information if two channels are required.

> 🔥 **Important**
>
> Enabling channel 2 in BioSigRZ will not enable acquisition on a second channel unless the circuit file has been modified. Contact TDT for assistance.

For systems running custom circuit files:

To enable Acquisition channel 2:

1. Click the Chan-2 [ ] button

2. Click OK

To disable Acquisition channel 2:

1. Click the Chan-2 [X] button

2. 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 the Post Processing button.

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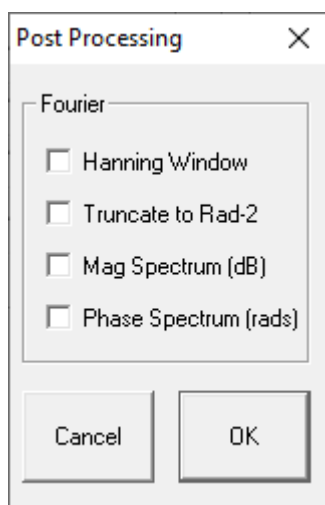
Hanning Window

Applies a Hanning window to the acquired signal.

Truncate to Rad-2

Truncates the number of data points to radix 2.

Mag Spectrum (dB)

Displays intensity in the logarithmic units of decibels. Uses an N-point FFT where N is half of the acquisition window. The default DPOAE acquisition window is 4096 samples, so the default FFT is 2048 points.

Phase Spectrum (rads)

Displays the phase spectrum in radians.

Reviewing Calibration

In most cases calibration is not required; however, calibration can be reviewed using the calibration dialog.

To view the current calibration:

- Select Calibration from the Setup menu or click the Calibration
   button.
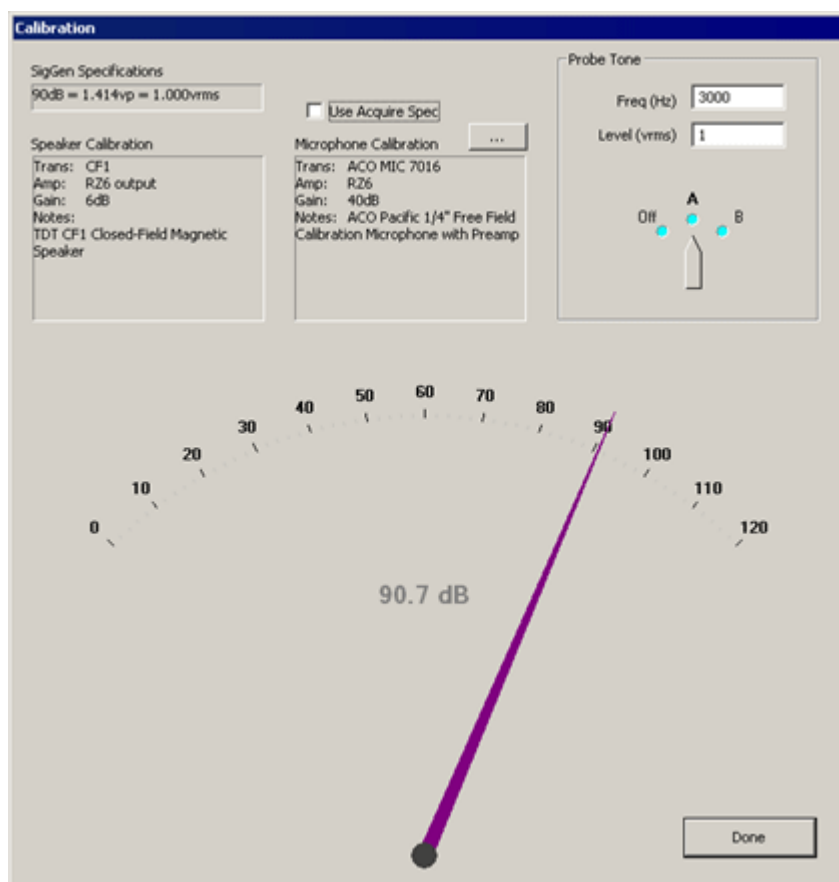
SigGen Specifications

Specifies the calibration defined in the currently loaded .sig file.

Speaker Calibration

Lists the details of the currently configured calibration file (.tcf) loaded in the Stimulus Setup dialog. See Defining Stimulus Parameters. for more information.

Use Acquire Spec

When checked, the details of the calibration file (.tcf) currently specified in the Acquisition Setup dialog will be displayed in the Microphone Calibration text area below. If unchecked you may specify a different microphone calibration file to be used with the Probe Tone test. This does not change the Acquisition Setup for your experiment configuration.

Microphone Calibration

Lists the details of the currently configured calibration file (.tcf) loaded in the Acquisition Setup dialog. See Defining Data Acquisition Parameters for more information.

Probe Tone

Present a probe tone to test connected equipment.

Freq (Hz): Specify the frequency for the probe tone.

Level (vrms): Specify the level of the probe tone. Typically 1 V is used (all examples are calibrated to 1 Vrms = 90 dB).

Probe Tone Dial

Click and drag to the desired output channel to enable the probe tone presentation. The large dial at the bottom of the dialog will display the measured sound level in dB SPL recorded by the microphone.
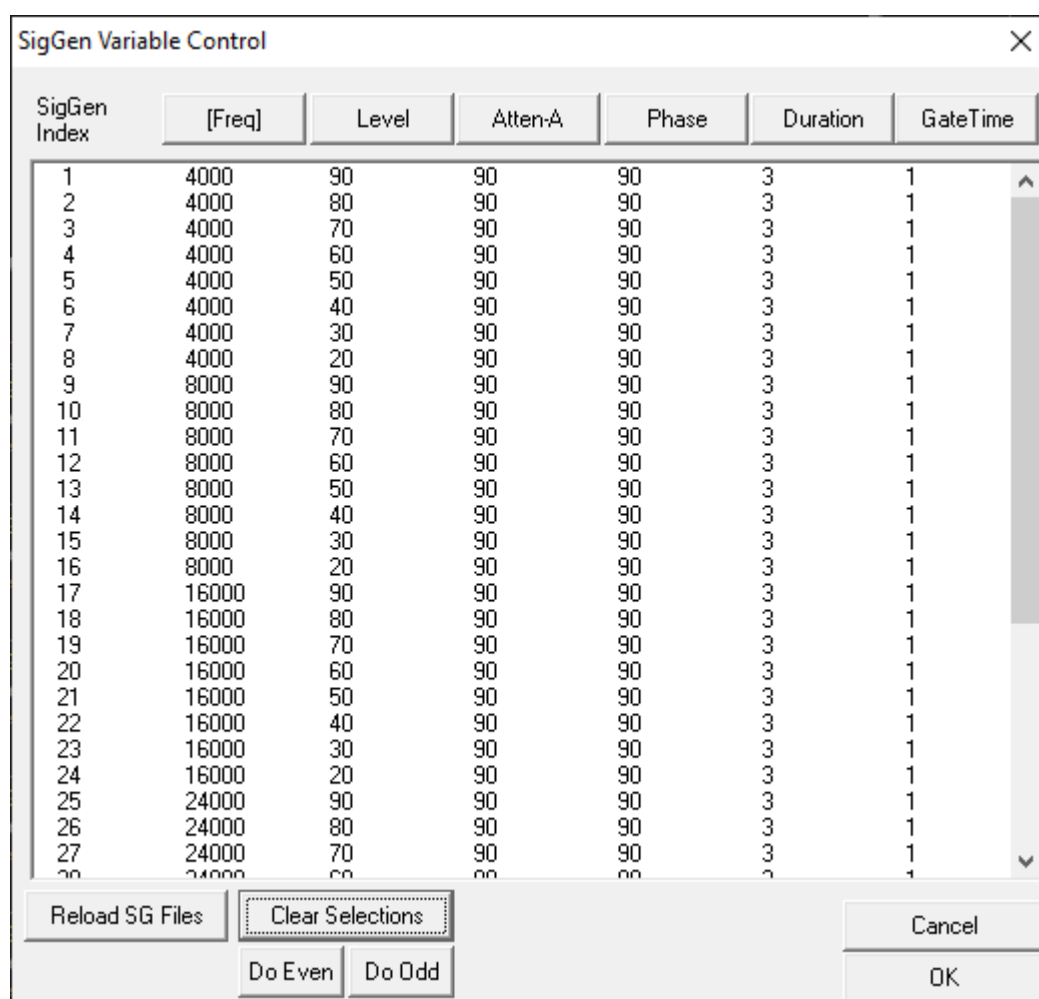
Specifying the Stimulus Schedule

When the stimulus is defined, either by loading a standard configuration file or by specifying a stimulus file in the Stimulus Setup dialog, a complete list of signal parameters and variables are added to the BioSigRZ file. During stimulus presentation, the values of the variables change as a function of the SGI (a set of variable conditions). This is called the stimulus schedule. Both the stimulus schedule and the variable definitions can be modified in BioSigRZ.

Viewing the Current Stimulus Schedule

To view the current stimulus schedule:

- Select Modify Schedule from the Operations menu. In addition, you can also select SigGen Variables from the Setup menu or click the Modify SigGen Variables [icon] button. This prompts the SigGen Variable Control dialog.

The SigGenRZ 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

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, BioSigRZ will present the entire stimulus schedule. Otherwise, BioSigRZ 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 change the signal parameters as a function of the SigGen Index (SGI) and are defined within SigGenRZ and can be modified in BioSigRZ through the use of the Signal Variable dialog.

> ✏️ **Note**
>
> When using dual channel stimuli such as in the standard DPOAE configuration, changes to signal variables will affect channels 1and 2. Variables may also be altered in SigGenRZ.

To access the Signal Variable dialog box:

> • Click the name of the variable you wish to change in the SigGen Variable dialog.

The Signal Variable dialog box available in BioSigRZ is much the same as the dialog used to define variable in SigGenRZ. This section provides information about the settings most pertinent to modifying variables from within SigGenRZ. For more information on all settings, see the SigGenRZ Manual.

Name and Units

In general, the variable name and units should not be changed in BioSigRZ.

Commonly used Variable Methods

Method defines the mechanism (function) of altering variable values as a function of the SigGen Index (SGI).
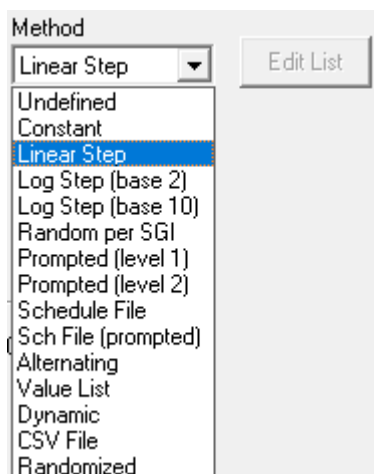
See the SigGenRZ Manual for more information on the available variable methods.

Some of the more commonly used Variable methods include:

Constant

This method sets the variable equal to a constant value. This method is most useful when more than one parameter will be set to the same value. Constant defines a variable that will always have the same value as given in the Default/Start field of the Value Limits box. This value will be a floating-point constant between 1.2E-38 to 3.4E+38.

Linear Step

For each SigGen Index (SGI) increment, Linear Step defines a variable that will increment by the Step value specified in the Value Limits box.

Alternating

The value of the variable alternates between the values defined in the Minimum and Maximum fields. The variable value does not depend on SGI value, but on the number of the continuous presentation of the current signal interval. In the Variables group box, an alternating variable must be defined next to another predefined variable, or as the first variable.

Value List

Variable values are specified in SigGenRZ during the signal design process. A maximum of 80 variable values can be specified for the variable.

To enter or modify a variable list:

1. Select Value List from the Method drop-down box

2. Click the Edit List button

3. Enter values to define the variable.
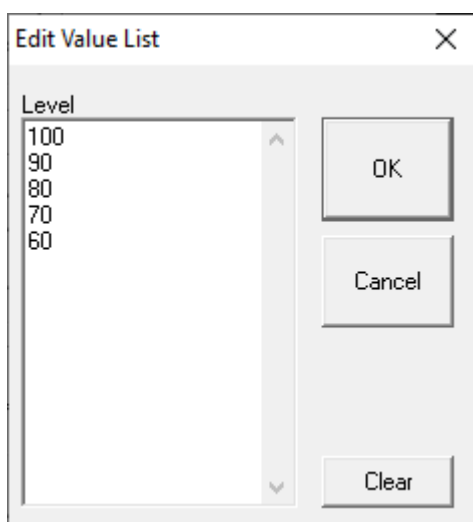
4. Click OK

Combination Variables

In some cases, a simple variable is not sufficient to define a signal. A combination variable is a variable whose value is calculated by performing a mathematical operation on another variable or a constant.
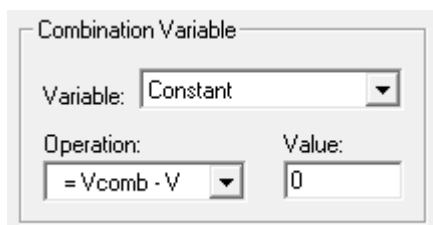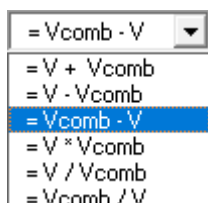
To Define a Combination Variable:

1. Open the Signal Variable dialog, either by selecting SigGen Variables from the Setup menu, or by clicking the SigGen Variables button.

2. Name and define the combination variable in the General box

3. In the Combination Variable box select an Operation to apply to this variable (V in the Operation formula). Combination variables can be defined using addition, subtraction, multiplication, and division.

Operation:

The Variable drop down menu in the Combination Variable box is used to define `Vcomb` in the operation. `Vcomb` can be defined as either a constant, and its value entered in the Value box, or it can be defined as another variable.

When the stimulus signals that contain combination variables are used in BioSigRZ, the combination variable value is calculated and used in generating the signal and controlling the peripherals.

Value Limits

From the Value Limits group box you can define the manner in which a variable value changes as a function of the SigGen Index (SGI) value. You can also define the range of allowable values for the variable. For combination variables, these values will only apply to primary variable(s), and will not limit the combination variable result. However, a zero will be used when the combination variable result becomes a divide-by-zero.

Default/Start

Default/Start defines the value of the variable when the SigGen Index = 1. This is also the value for a constant variable. When prompt variables (Prompt Level 1, Prompt Level 2, Prompted File) and Dynamic variables are defined, this value is also the default variable value before the value is specified.

Step Size

Step determines how much the variable will be systematically varied as a function of the SigGen Index value. A zero Step Size for other functions will define a constant variable (except when the method is Randomized).

Minimum

In the Minimum field, you define the minimum allowable value for the variable.

Maximum

In the Maximum field, you define the maximum value allowed for the variable.

> ✏ **Note**
>
> Minimum value must be smaller than Maximum, and Default/Start must be within Minimum and Maximum range.

No. of Steps

This field displays the total number of steps between the minimum and maximum variable values, when appropriate. This field is not editable.
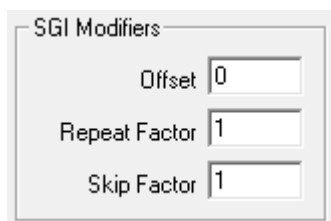
SGI Modifiers

SigGen Index (SGI) is a unique number which starts at 1 and increments by 1 when an interval is presented. This SGI applies to every variable by means of SGI Modifiers. These SGI Modifiers become important when SigGenRZ is used to design signals with complicated variables or nested variables.

By default, a stimulus presentation begins with the SGI = 1. Often, the stimulus signal generated at SGI = 1 is presented until a desired number of response signals have been attained. The SGI is incremented by 1 then all variables and the entire signal are updated. This

process continues until all SGIs have been presented.Through use of SGI Modifiers, it is possible to customize the process of SGI incrementation for individual variables. You may:

- Start variable calculation with an offset to SGI

- Repeat SGI

- Skip a specified number of SGIs

- Create nested variables

Offset

The initial SGI is always 1. When SGI is used to calculate variables, any deviations from this default value are termed offsets. If you wish to start stimulus presentation with a variable calculated based on a modified SGI = n, then enter n in the Offset field. If the variable's values are 0, 1, 2, 3, 4, 5, ..., corresponding to SGI = 0, 1, 2, 3, 4, 5, ..., an Offset = 2 will result in modified SGI = 2, 3, 4, 5, 6, ..., and so the variable's values 2, 3, 4, 5, 6, ..., correspond to SGI = 0, 1, 2, 3, 4, 5, ...

The default value of Offset is 0, that is, the modified SGI equals to SGI. The value of Offset must be no less than 10,000 and no greater than 10,000.

Repeat Factor

The Repeat Factor field specifies the number of times, r, an SGI will be used as modified SGI. For example, when r = 2, modified SGI will be 1, 1, 2, 2, 3, 3, ..., corresponding to SGI = 1, 2, 3, 4, 5, 6, ...

By default, Repeat Factor is set to 1 (use each SGI once). Repeat Factor may be no less than 1 and no greater than 100.

By using a Repeat Factor in tandem with a Termination Control specification of Loop (see next section), you can create nested variables.

Skip Factor

The Skip Factor field specifies the number of the SGIs is to be ignored in the modified SGI. For example, if Skip Factor is 2, modified SGI will be 1, 3, 5, 7, 9, ..., corresponding to SGI= 1, 2, 3, 4, 5, 6, ...

By default, Skip Factor is set to 1. Skip factor may be no less than 1 and no greater than 100.

Termination Control

You can control the termination of the SGI by choosing one of three types of termination control.
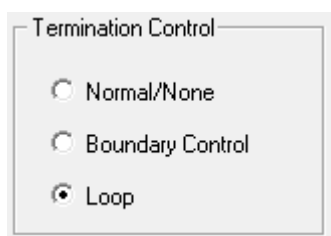
Normal/None

When Normal/None is chosen, the variable will not be considered in termination control. Thus, if a minimum or maximum variable value is reached, signal play will not terminate, nor will the variable value loop. The variable will instead remain at the minimum or maximum value. Continuous signal generation will be based on the final variable value. In this case, signal play will be terminated by other variables or manually.

Boundary Control

Boundary Control provides a method of experiment termination. When Boundary Control is chosen, the SigGen Index (SGI) will not be incremented if such an action would cause the value of the variable to be:

- Less than the Minimum value
- Greater than the Maximum value

Such failure to increment the SGI produces differing results, depending on the application.

When a boundary is reached and the SGI ceases to be incremented, signal generation will continue for the current SGI, but no more response data will be collected.

> ✏️ **Note**
>
> Specification of Minimum and Maximum does not provide boundary control. Minimum and Maximum simply define the limits of parameter variation. The variable will not be allowed to go beyond either of these limits.

Loop

When Loop is chosen, parameters continuously loop through the series of variable values as SGI increments.

See the SigGenRZ Manual for more information on the variable parameters contained in this dialog.

Modifying the Target Device Setup

BioSigRZ is designed to run exclusively with the RZ6 Multi I/O processor. A standard RPvdsEx circuit file running at ~200 kHz is implemented by default and is suitable for most users.

In those rare cases where a custom circuit file is required, the circuit file may be overridden in the Target Device Setup. Contact TDT for assistance if you wish to use custom circuit files.

To access the Setup Target Hardware dialog box:

- Select Target Device from the File menu.
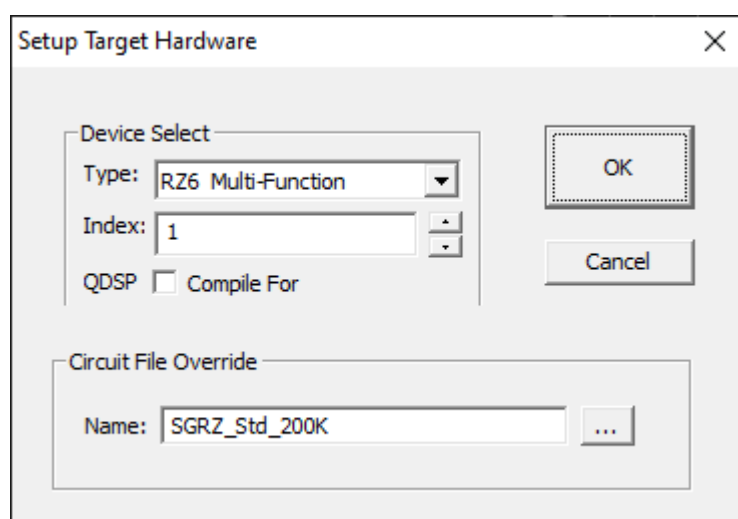
Device Select

Type

BioSigRZ supports the RZ6 only.

Index

If a system comprises more than one RZ6 the index number can be used to specify which RZ6 to use.

QDSP

This option can be ignored.

Circuit File Override

Name

If a custom circuit file (designed in RPvdsEx) is required. Type or browse to select the file name.

Data Acquisition

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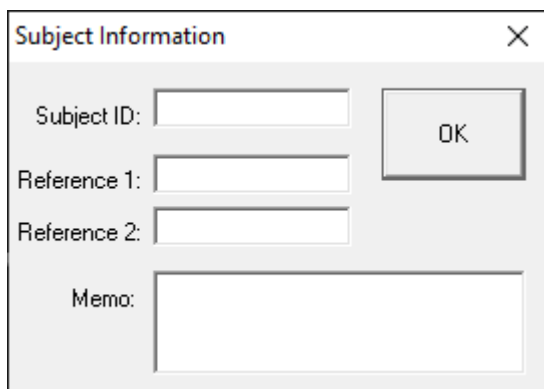
Subject Definition

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:

- Select 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 BioSigRZ 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 BioSigRZ 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 BioSigRZ record file (.arf file).

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 BioSigRZ record file (.arf file). Memo text can be viewed from BioSigRZ 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:

•	Select Auto-Cursors from the Setup menu.

Specify Auto-Cursor Equation   ✕

Select Cursor | Algebraic Equation   Parse... | Placement

☑ Enable   AC = | V5 | Mode: Absolute ▼

○ #1   ○ #6   Channel(s)   Operators

○ #2   ○ #7   ☑ Chan-1   7   8   9   +

○ #3   ○ #8   ☐ Chan-2   4   5   6   -

○ #4   ○ #9   ☐ Chan-3   1   2   3   ×

○ #5   ○ #10   ☐ Chan-4   0   .   /

Variables: Cursors:

V1   Level {}   C1   V5
V2   AudFreq {}   C2   V6
V3   L1 {dB}   C3   2*V5-V6
V4   L2 {dB}   C4   ---
V5   F1 {Hz}   C5   ---
V6   F2 {Hz}   C6   ---
V7   Atten-A {dB}   C7   ---
V8   Atten-B {dB}   C8   ---
V9   ---   C9   ---
V10 ---   C10   ---

Cancel

Done

Use V1..V10 for SigGen Variables   Use C1..C10 for other Auto-Cursors

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-cursors

• Specifying the equation

• Parsing the equation

Enabling Auto-Cursoring

To enable auto-cursoring:

- Check the Enable checkbox

Specifying the Equation

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

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

```
V2 + 100
```

You may also use existing auto-cursors as variables in auto-cursor equations. Auto-cursor variables are specified by Cn, 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:

- Click the Parse button

Accepting an Equation

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

To accept an equation:

   • Click Done

To reject an equation:

   • Click 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. BioSigRZ supports automatic feature finding to minimize the amount of manual cursor manipulation that has to be performed after data acquisition.
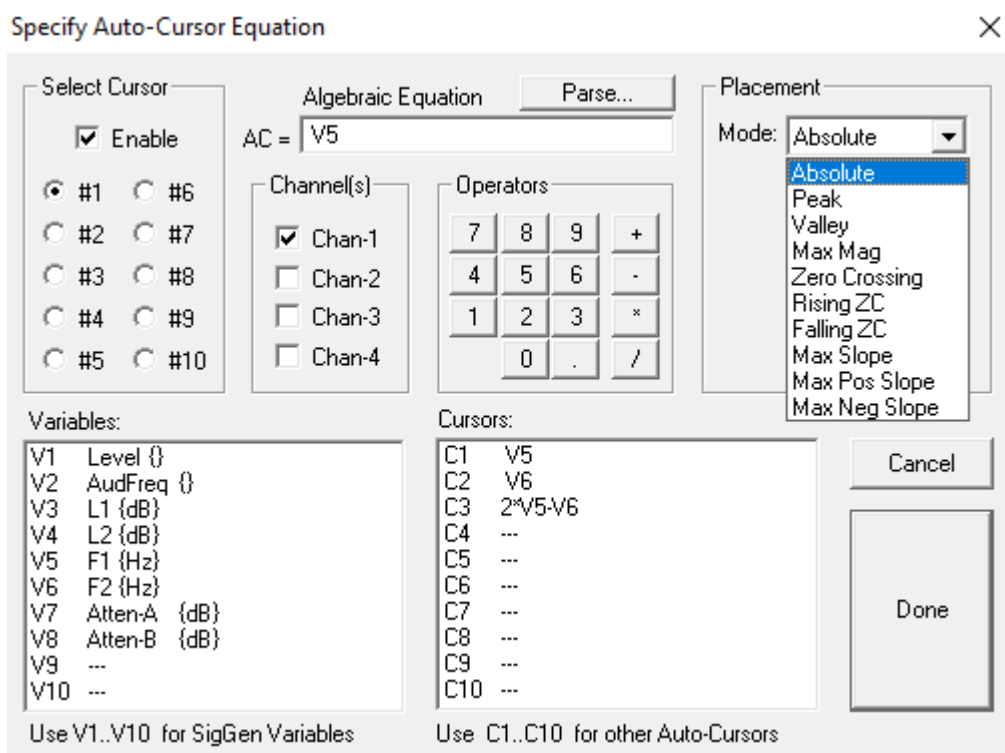
Placement

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

The cursor will be placed at the position specified by the algebraic equation.

Peak

Cursor will be placed at the highest peak in the specified range.

Valley

Cursor will be placed at the lowest valley in the specified range.

Max Mag

Cursor will be placed at the maximum ± value in the specified range.

Zero Crossing

Cursor will be placed at the nearest zero crossing in the specified range.

Rising ZC

Cursor will be placed at the nearest rising (i.e. positive going) zero crossing in the specified range.

Falling ZC

Cursor will be placed at the nearest falling (i.e. negative going) zero crossing in the specified range.

Max Slope

Cursor will be placed on the maximum slope (either positive or negative) in the specified range.

Max Pos Slope

Cursor will be placed on the maximum positive slope in the specified range.

Max Neg Slope

Cursor will be placed 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 auto cursor 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 be 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 BioSigRZ 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. For more information about modes, see The Operations Menu.

Operational modes consist of the following:

- 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 BioSigRZ is in idle mode, no stimulus signals are presented and no data is acquired. It is during idle mode that you specify parameters, configure displays, and review hardware configurations.

To check the hardware configuration:

1. Click the Review button.

This prompts the Transducer Setup and Settings.
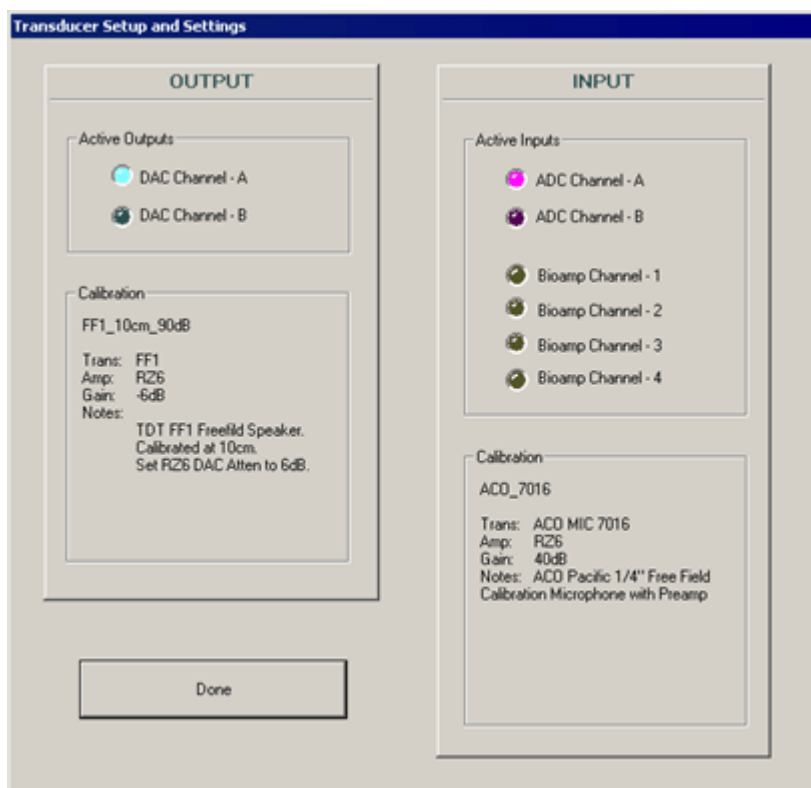
2. After you have reviewed the dialog and verified that the setup is correct, click Done.

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

To present the stimulus:

• When in idle mode, click the Start button or select Start from the Operations menu.

Running Mode

When in running mode, BioSigRZ 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.

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

To view the stimulus:

1. Access the Control Plot Toolbar of the Multi-purpose Plot

2. Click the Stimulus Signal button or press 'S' on the keyboard

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 select Stop from the Operations menu.

To begin averaging data:

   • While in Running mode, click the Begin button or select Begin from the Operations menu.

Averaging Mode
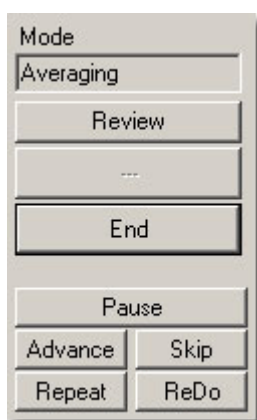
During averaging mode, BioSigRZ acquires data and calculates a running average. Data will be acquired until enough records have been gathered to compute the final averaged signal. At that time, the averaged signal will be appended to the end of the History Plot, the SGI will be incremented, a new stimulus 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 Real-Time Control section.

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

- The stimulus signal
- The raw A/D input
- The frequency domain
- The EEG signal
- The running average
- Nothing

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

1. Access 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. See Multi-Purpose Plot., for more information.

To manually end data averaging:

> • While in Averaging mode, click the End button or select End from the Operations menu.

BioSigRZ 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 select Pause from the Operations menu.

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

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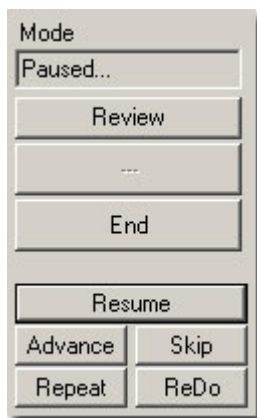
In paused mode, data averaging is temporarily halted. Stimulus presentation continues.

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 Real-Time Control section of this chapter on page 80.

To resume data averaging:

> • Click the Resume button or select Resume from the Operations menu.

To manually end data averaging:

> • While in Averaging mode, click the End button or select End from the Operations menu.

BioSigRZ 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

The manner in which stimulus parameter values vary as a function of the SGI is initially defined during signal design in SigGenRZ. You may make further modifications to the stimulus schedule from within BioSigRZ. See Specifying the Stimulus Schedule for more information.

> ✏️ **Note**
>
> The Modify Schedule option in the Operations menu provides access to the SigGenRZ 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. BioSigRZ 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 checkboxes 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. BioSigRZ provides several functions that allow you to override the current stimulus schedule. These functions include:

- Advance
- Skip
- Repeat
- ReDo
- Continuous Avg.
- 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 BioSigRZ record file, (.arf file). It may be viewed from the BioSigRZ Cursor Edit Screen. See Viewing Records in Detail for more information.

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 following 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 select 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 select 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 select 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 select ReDo from the menu.

Continuous

Choosing Continuous causes BioSigRZ to continuously average data. When Continuous is chosen, BioSigRZ 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. checkbox or select Continuous from the Operations menu.

To disable continuous data averaging:

> • Uncheck the Continuous Avg. checkbox or select 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 select 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 checkbox.

To advance to the next SGI:

   • Click the [-->] button.

To return to a previous SGI:

   • Click the [<--] button.

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 SigGenRZ or during modification in BioSigRZ. The value of a dynamic variable may be changed at any time during stimulus presentation.

To display all dynamic variables:

   • Select Dyn Controls from the View menu.

A dynamic variable settings prompt will be displayed for each dynamic variable.

To change the current value of a dynamic variable:

1. Click 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 ± Delta button.

Acquisition Filter Controls
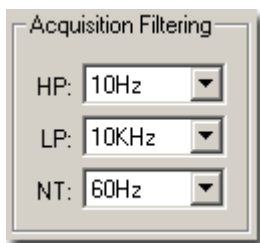
BioSigRZ provides three dynamic filter controls for adjusting acquisition corner frequencies and filter characteristics. Highpass, lowpass, and notch filters provide a comprehensive selection of filter configurations. The Acquisition Filtering control applies the selected filter settings during Running and Averaging modes.

To configure acquisition filters:

• Select the filter characteristics using the drop-down menu for the desired filter type(s).

The filter effects can be observed in the EEG and RAW A/D plots during Running Mode for fine tuning prior to averaging and recording. See Multi-Purpose Plot., for more information on these plot display.

Data Analysis

BioSigRZ 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 BioSigRZ Record Files
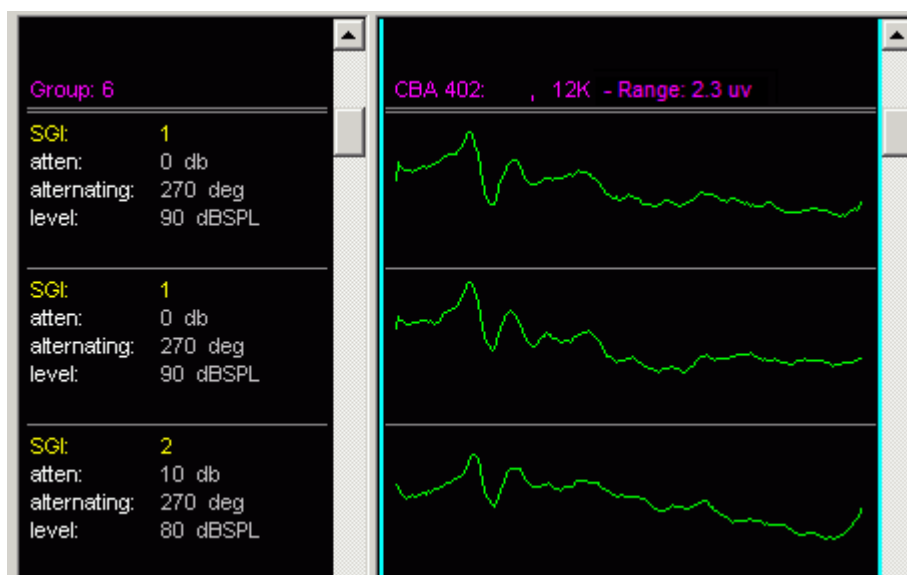
BioSigRZ's History Plot and BioSigRZ record files are central to all BioSigRZ data analysis capabilities.

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. The plot can contain up to 100 records at a time.

BioSigRZ Record Files

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

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

- Averaged data is automatically appended to the History Plot. When the number of records exceeds 100 the earliest record is removed from the display as each new record is added.

- Averaged data is automatically appended to the currently specified .arf file.

- Up to 100 records may be retrieved from a specified .arf file for display in the History Plot.

- Records may be saved to a separate .arf file.

- Records may be saved to an ASCII text file (.txt file) or CSV (spreadsheet) file for use by other applications.

- Records may be deleted from an .arf file.

Specifying the Current BioSigRZ Record File

Prior to averaging data, you must specify the BioSigRZ 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.

See Defining Data Acquisition Parameters for more information.

Loading Records

BioSigRZ 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.

- Export specific groups to separate .arf files.

- Export specific groups to ASCII text files (.txt files).

• Delete groups of records from the .arf file.

> ✏️ **Note**
>
> The History plot can display a maximum of 100 records at a time. Records must be displayed before they can be exported. If you need to export all records from an arf file containing more than 100 records, you must load and export it in subsets no more than 100 records long.

To prompt the Access Record Groups dialog box:

1. Select Access Record File from the History menu.

2. Specify the desired file name and click Done.
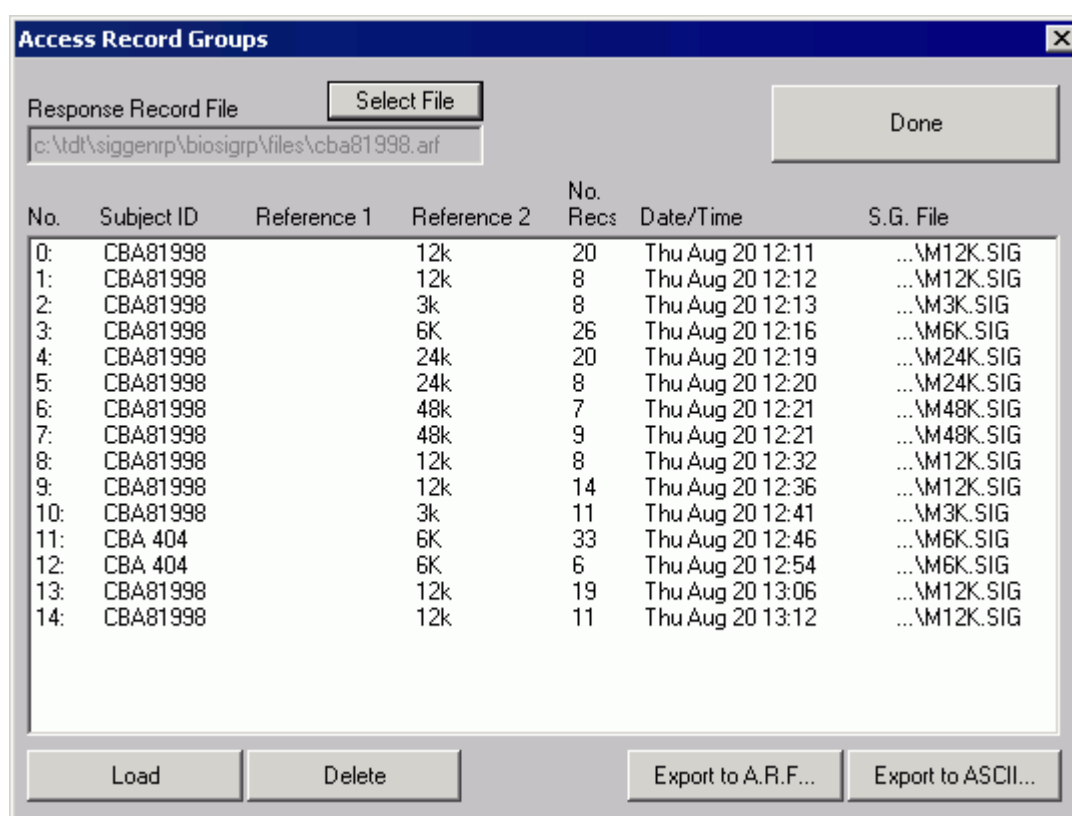
The Access Record Groups dialog box displays the following information:

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 Reference 1 information assigned to the group.

Reference2

This column displays the Reference 2 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 SigGenRZ file used to generate the stimulus signal.

Selecting Groups

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 Deselect All 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) or CSV (spreadsheet) file.

To load, delete, or export a group of records:

1. Select the desired groups.

2. Click the appropriate button.

If the chosen action is Load, then you will see the Select Records to Load dialog box.
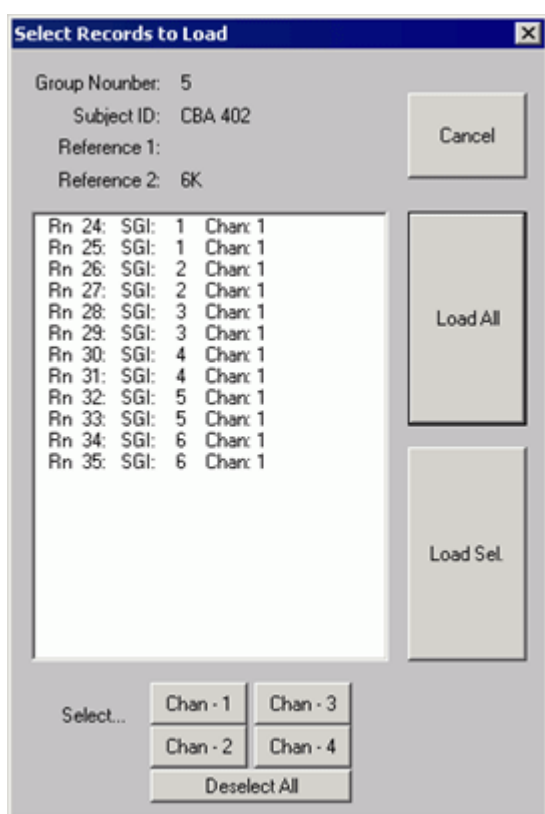
- Select the record(s) you wish to load and click Load Sel. Or load all the records by clicking Load All. You may manually select/deselect records for loading or you may use the Select buttons to automatically select/deselect records.

If the chosen action is Delete, you will be prompted "Are you sure?"

- Answer Yes to delete the selected groups from the file. The Access Record Groups dialog box will remain open.

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 BioSigRZ Record File
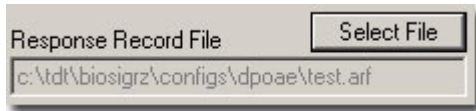
To access another BioSigRZ Record File:

1. Click the Select File button.

2. Select 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
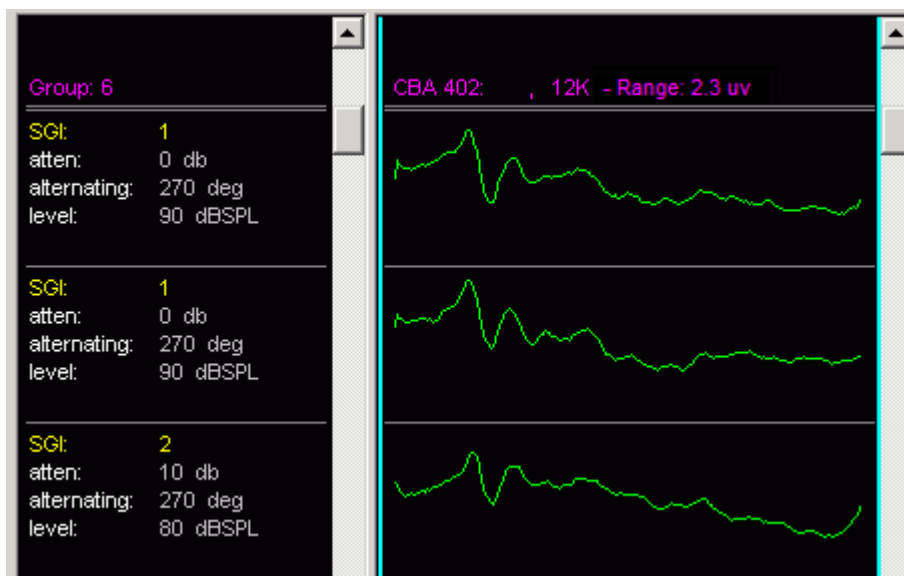
Customizing History Info

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.
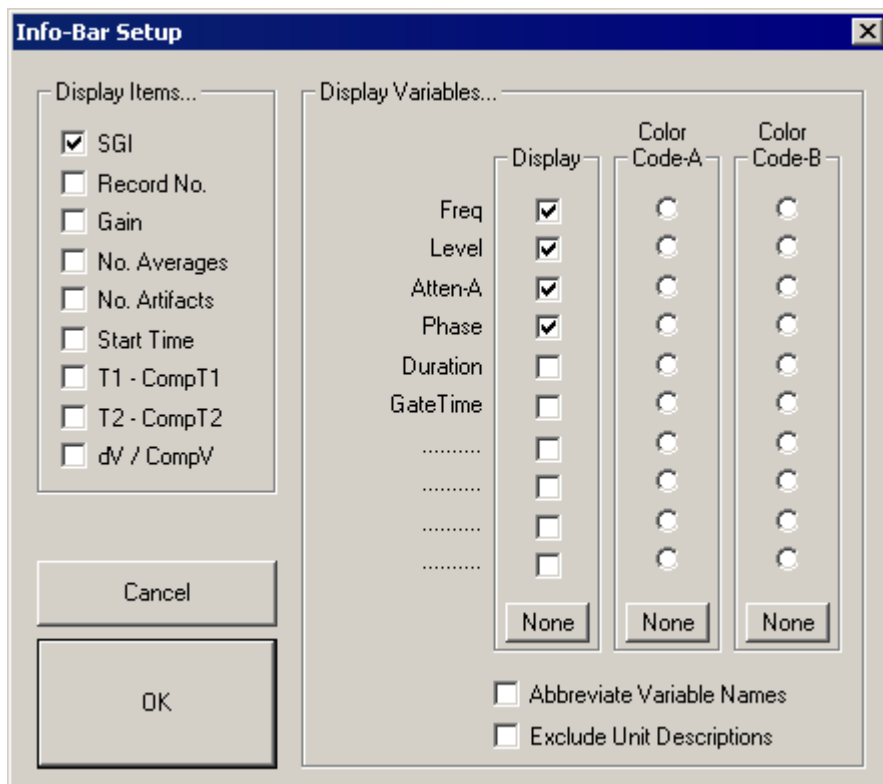
From this box you may specify items to be displayed in the History Info area. You may also associate a group color with a particular variable. Group colors are created from the General Display Options dialog box. See Customizing Your Display for more information.

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:

  *V of the current record / *V 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 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.
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 excluded.

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.

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

To export History Plot records:

1. Select the desired records.

2. Select the desired export action from the History menu.

    a. If Export to ARF file is selected supply the file name and click Open to save the file.

    b. If Export to ASCII file is selected supply the file name and click Open to save the file.

    c. If Export to CSV is selected, the CSV File Export dialog is prompted.

CSV File Export Dialog

The Export to CSV option allows you to export raw trace data along with descriptions 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 the All button.

To deselect all items within a box:

- Click the None button.

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. of 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 uV if microvolts are selected.

Output Format

Sets the output format of the data. For example #.### will export data to three decimal places.

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:

- Click the Generate Report button.

Making a Comparison Record

BioSigRZ 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. Select Toggle Comparison from the History menu or Ctrl+Double-click the desired record.

To display a comparison record in the Multi-Purpose Plot:

1. Select Show Comparison from the Multi-Plot menu.

2. Select 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 can:

- 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

> • Click the desired history plot record and select Edit Cursors from the History menu.
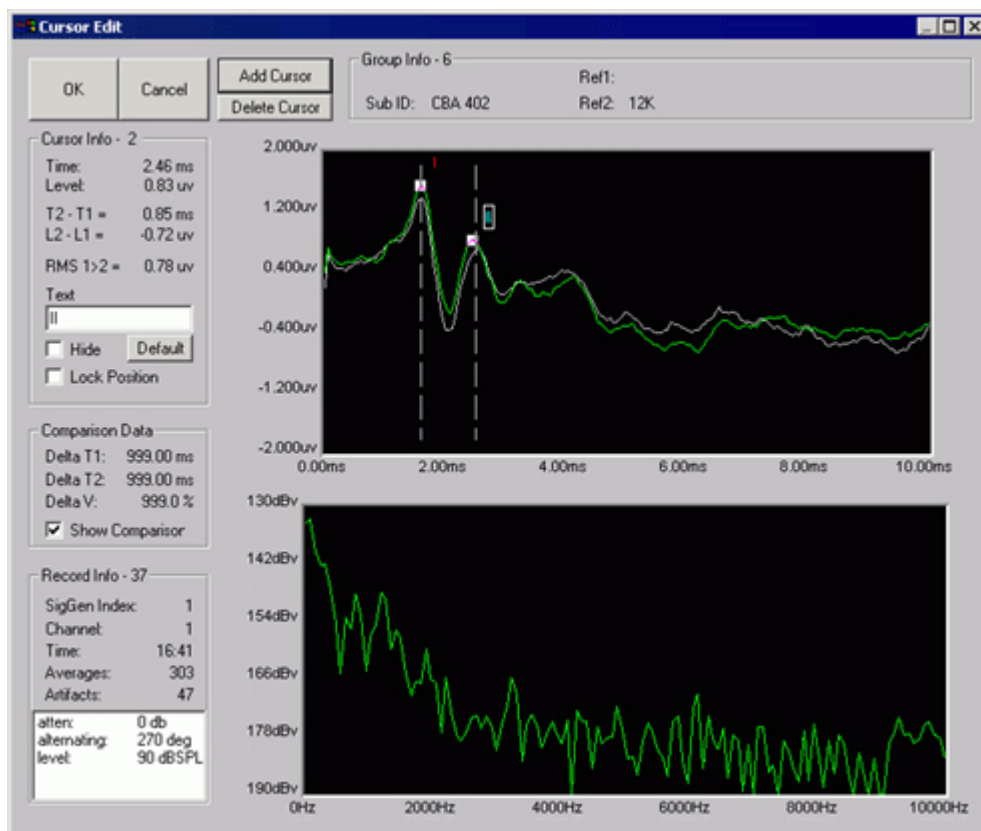
Time-Domain Plot

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 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.

5. Repeat for additional zoom.

To return to the original time-domain waveform:

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

Frequency-Domain Plot

BioSigRZ 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.

5. Repeat for additional zoom.

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 (T) between two points
- Change in voltage (V) 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.
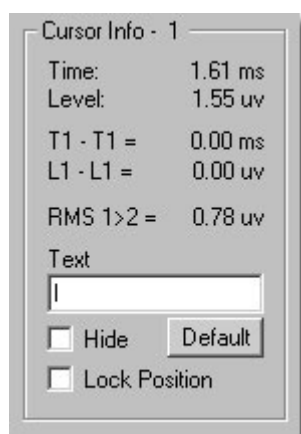
To select a cursor:

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 - 1 ──────────┐
│  Time:          1.61 ms    │
│  Level:         1.55 uv    │
│                            │
│  T1 - T1 =      0.00 ms    │
│  L1 - L1 =      0.00 uv    │
│                            │
│  RMS 1>2 =      0.78 uv    │
│  Text                      │
│  ┌──────────────────────┐  │
│  │I                     │  │
│  └──────────────────────┘  │
│  ☐ Hide     [ Default ]    │
│  ☐ Lock Position           │
└────────────────────────────┘
```

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.

Tn - T1

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

Ln - L1

This field displays the difference in intensity (L) 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.
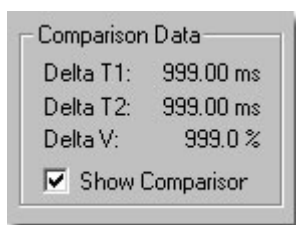
Hide

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 checkbox.

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.
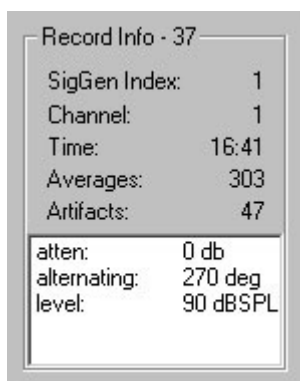
Delta V

This field displays a percentage value computed as follows:

*V of the current record / *V 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

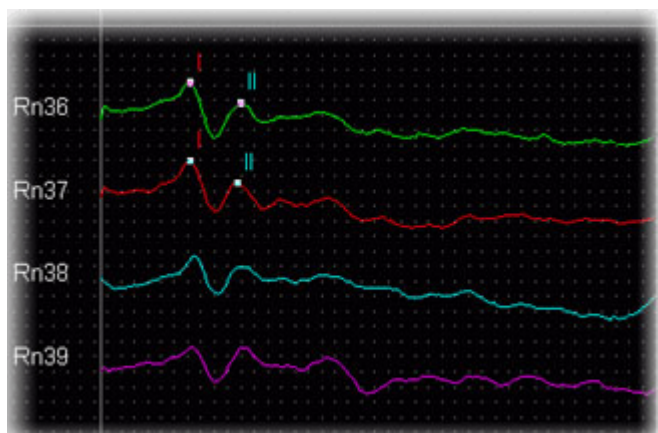The number of sweeps included in the average is displayed in the Averages field.

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.

6. Organize the report.

7. Print the report.

Placing Records

To place History Plot records into the Worksheet:

1. Select the desired record(s).

2. Select 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.
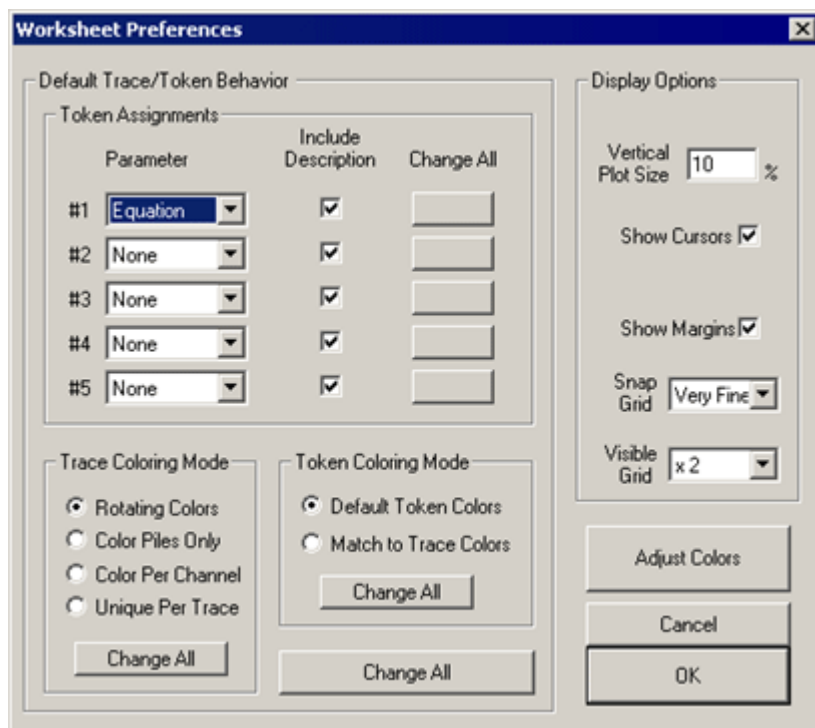
The Worksheet Preferences dialog box is divided into two sections:

- 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 Customizing Specific Tokens section below.

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.

Parameter: 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.
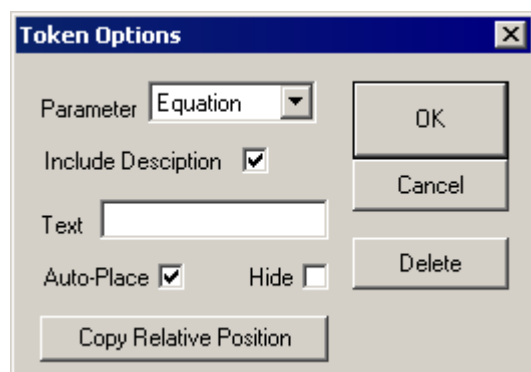
Parameter and Include Description

You may change the Parameter and show/hide the token description. For more information, see 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.
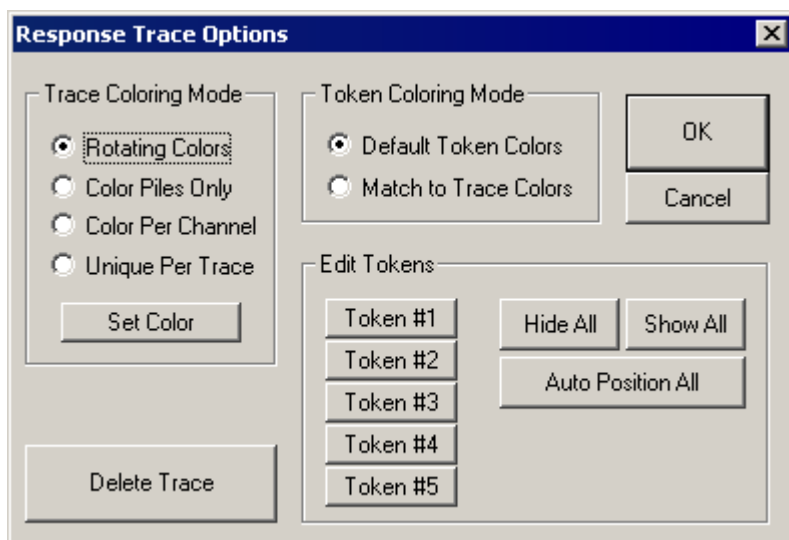
Delete

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 color.

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

To select all records:

- Select Select All from the Worksheet menu or press 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:

- Select Deselect All from the Worksheet menu or press Ctrl+Space bar.

Performing Mathematical Operations

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

To perform a mathematical operation:

1. Select the desired Worksheet record(s).

2. Click the appropriate Calculator button.

or

- Select 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 BioSigRZ Cursor Edit dialog box:

- Double-click 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	Positions selected plots closer together
	Pile	Piles all selected plots on top of one another
	UnPile	Unpiles all selected plots
	Delete	Deletes the currently selected Worksheet records

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

To setup the printer:

• Select Print Setup from the File menu.

To preview the Worksheet:

• Select Print Preview from the File menu.

To print the Worksheet:

• Select Print from the File menu.

Exporting Worksheet Records

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

To export Worksheet records:

1. Select the desired records.

2. Select the desired export action from the Worksheet menu.

    a. If Export to Ascii is selected you will be asked if you wish to include detailed group information (additional information such as the .sig file names, number of records, subject ID, reference and memos).

    Supply the file name and click Open to save the file.

b. If Export to CSV is selected, the CSV File Export dialog is prompted. See CSV File Export Dialog for more information.

Saving and Opening Worksheet Files

Reports may be saved in BioSigRZ Worksheet files. The extension for these files is .awf.

Saving BioSigRZ Worksheet Files

To save a new BioSigRZ Worksheet file:

• Select Save Worksheet As from the Worksheet menu.

The Save As dialog box will be displayed. You may assign a name to your new signal.

To save an existing file:

• Select Save Worksheet from the Worksheet menu.

The file will be saved with its current name.

Opening BioSigRZ Worksheet Files

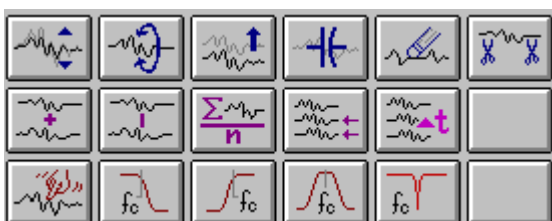To open a BioSigRZ worksheet file:

1. Select Open Worksheet from the Worksheet menu or click the Worksheet Records

    button

2. Click on the desired file

3. Click Open

Using the Calculator

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

Calculator Functions

- Scale

- Invert Trace

- 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

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

> • Select Scale from the Calculator menu.

You will be prompted to enter the desired scale factor. This factor must be no less than -(1010) and no greater than 1010.

Invert Trace

Invert Trace 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

> • Select Invert Trace from the Calculator 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

> • Select Shift Baseline from the Calculator 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

• Select Remove Baseline from the Calculator 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

• Select Zero Points from the Calculator 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

1. Select Add from the Calculator menu. A box appears in the Worksheet.

2. Move the box to the desired location.

3. 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

1. Select Subtract from the Calculator menu. A box appears in the Worksheet.

2. Move the box to the desired location.

3. 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

1. Select Average from the Calculator menu. A box appears in the Worksheet.

2. Move the box to the desired location.

3. 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

   • Select Time Align from the Calculator 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

   • Select Time Shift from the Calculator 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

  • Select Smooth from the Calculator 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	Bandpass or Notch Filter
2. Click or	2. Click or
3. Enter corner frequency.	3. Enter center frequency.
4. Enter filter order.	4. Enter filter bandwidth.
	5. Enter filter order.

Hanning Window

Applies a Hanning window to the selected worksheet record for use with the magnitude spectrum.

To impose a Hanning Window to a Worksheet record:

1. Select the desired record(s).

2. Select Hanning Window from the Calculator menu.

Cosine^2 Window

Applies a Cos2 window to the selected worksheet record (smooths the start and end of the waveform). Used with magnitude spectrum.

To impose a Cosine2 Window to a Worksheet record:

1. Select the desired record(s).

2. Select Cos^2 Window from the Calculator menu.

Mag Spectrum

Generates an FFT of the data using 1024-8192 points per FFT.

To impose a Mag Spectrum to a Worksheet record:

1. Select the desired record(s).

2. Select Mag Spectrum from the Calculator menu.

You will be prompted to enter the number of frequency points. This is the number of points to be included in the FFT used to compute the Mag Spectrum.

Calibration

Standard calibration files for common speakers and microphones are provided with BioSigRZ and a speaker-specific custom calibration file might also have been provided with your speaker. If a calibration file is not provided for your specific speaker model or the distance (free-field experiments) or length of tube (closed-field experiments) is different, you can create a custom file using BioSigRZ's Calibration tools. You will need a calibration microphone with a flat response in the band of interest.

The extension for calibration files is .tcf. All TCF files should be stored at: `C:\TDT\BioSigRZ\TCF`

During calibration, BioSigRZ performs a sweep over the frequency range of interest and generates a speaker response curve along with a correction curve that would be required to flatten the response. An FIR filter is calculated from the correction curve and stored in the contents of the TCF file. When you load the TCF file, that filter is loaded onto the RZ6 so that any sound stimulus you present through the RZ6 is calibrated to a flat response across all frequencies.

How often you calibrate is up to you. Some prefer to calibrate every day, others prefer once a week, month or longer. BioSigRZ offers two tools to verify your .tcf file to see if it needs to be replaced or if the file is working as needed.

Creating a Custom Calibration (.tcf) File

BioSigRZ's calibration generation tools are only available when using a Calibration configuration file (.acf).

To open the calibration configuration file:

1. Click the File menu and click Open Config. File

2. In the Open dialog box, select the `C:\TDT\BioSigRZ\Configs\Calibration\CAL200k.acf` file then click Open.

To create a custom calibration file:

1. Select Calibration from the Setup menu or click the Calibration ▦ button. The Calibration Profile window is displayed.
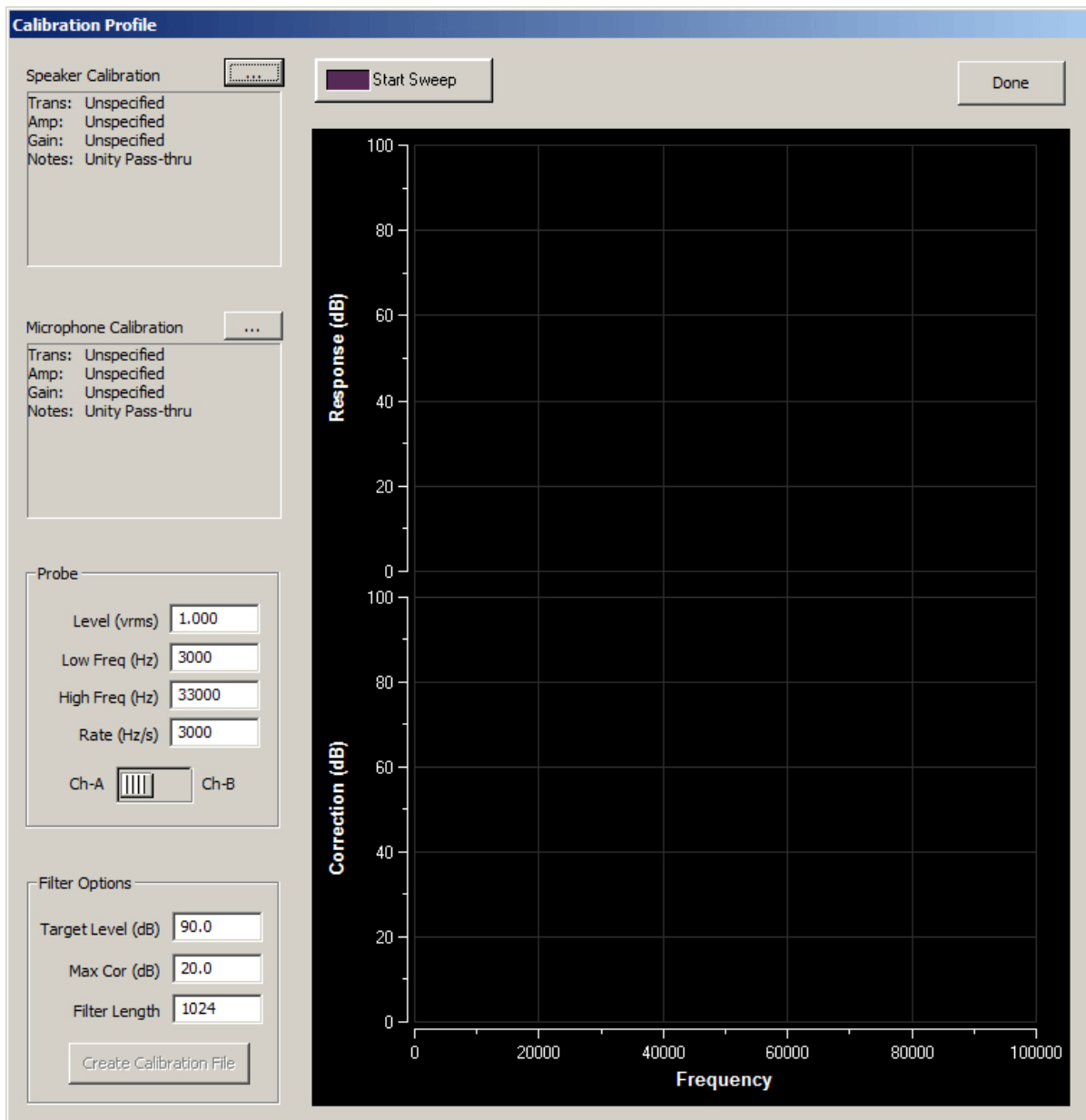
2. Click the Microphone Calibration Browse (...).

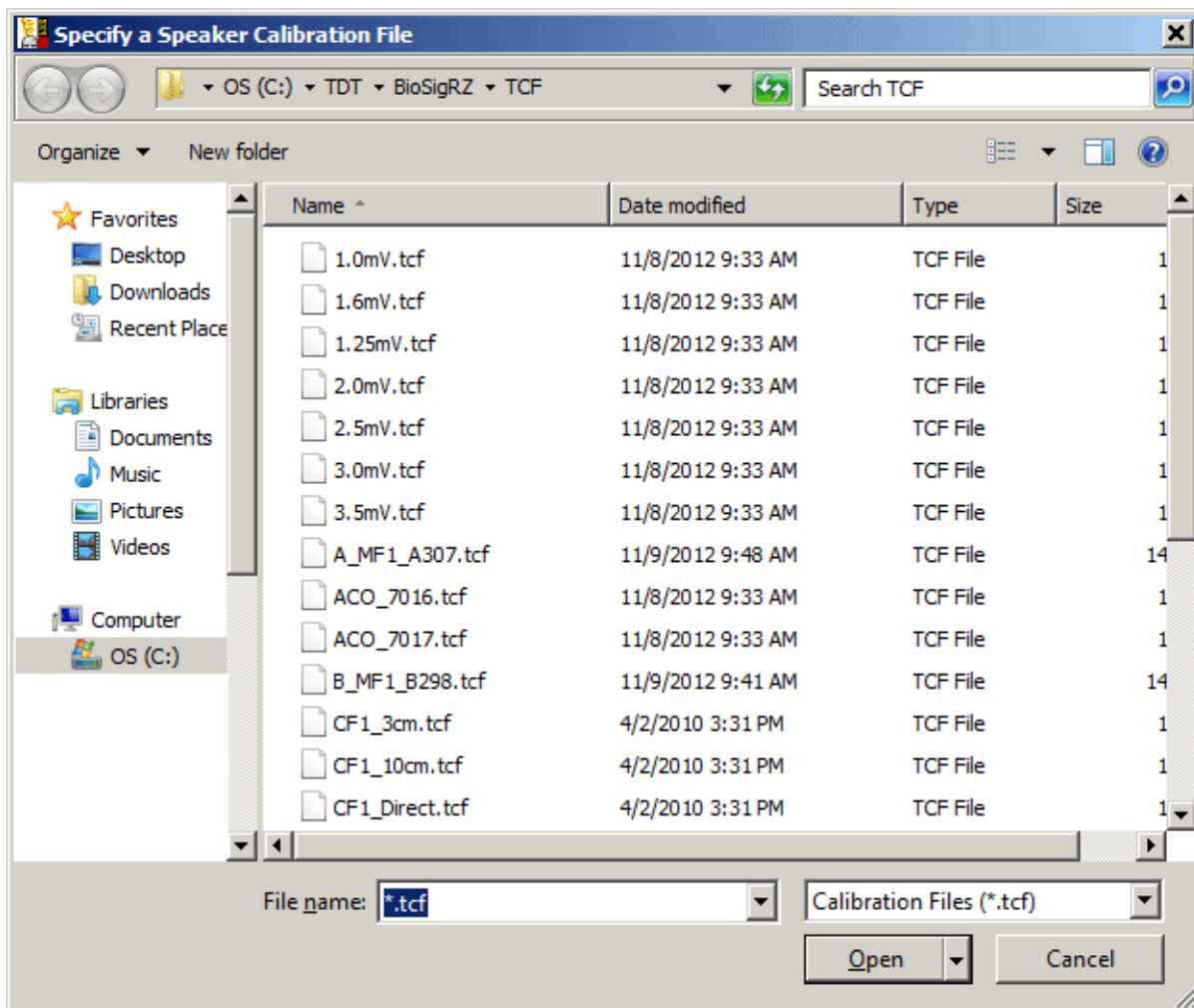TDT provides a set of microphone TCF files in your BioSigRZ installation. You will need to know the sensitivity (in mV per Pascal) of the microphone to pair it with the correct file. The generic microphone calibration files are named according to their sensitivity (such as 1.0mV.tcf).

In addition, TDT provides calibrations files for two ACO microphones. The files for these microphones are named according the microphone part number: ACO_7016.tcf (which is assumed to be 3 mV/Pa) and ACO_7017.tcf (assumed to be 1.1 mV/Pa). By choosing the sensitivity closest to your microphone's actual sensitivity you guarantee accuracy of no worse than 1 dB. Note: if your microphone sensitivity is far outside of this range of the provided microphone TCF files, contact TDT.

Select the file that is closest to your microphone sensitivity and click Open.

3. In the Probe group box:

   a. The default Level (vrms) value of 1.000 should be suitable in most cases. If you need to change the value, enter the desired voltage. However, note that the standard SIG files are programmed with a 1 Vrms stimulus and must be changed if this value is modified.

b. Enter a Low Freq (Hz) and High Freq (Hz) that includes the frequency range used in your experiment. The calibration curve has some smoothing applied so the range must be wider than the experimental paradigm requires to avoid edge effects during filter generation.

c. The Rate (Hz/s) value determines how quickly the frequency range is swept. The default value of 3000 should be suitable in most cases. Sweeping too slowly creates a very irregular correction curve that is difficult to model accurately with an FIR filter.
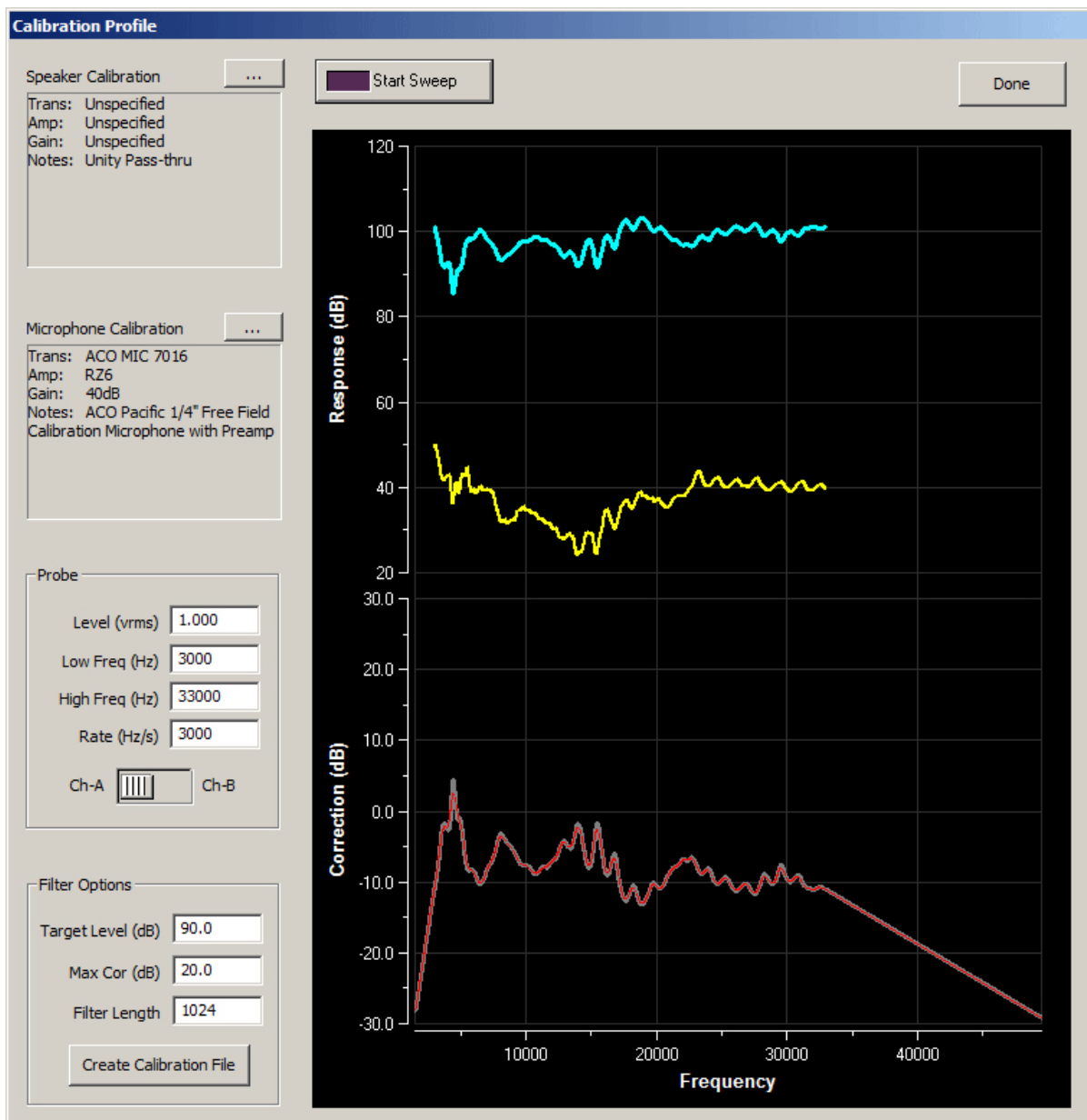
4. In the Filter Options group box:

a. Enter your Target Level (dB). This should be set to highest level you will use in your experiment. However, note that the standard SIG files are programmed to 90 dB and must be changed if this value is modified.

b. Do NOT change the Max Cor (dB) value without specific instructions from TDT. The default value of 20 dB (with a 1 Vrms level) limits the DAC output to 0.1-10 V. The upper limit ensures your signal does not exceed the system's 10 V DAC limit and avoids clipping. The lower limit keeps your signal to noise ratio high.

c. Enter the appropriate Filer Length:

   i. For free field speakers, enter 1024.

   ii. For closed field speakers enter 256.

5. If using TDT electrostatic speakers (ES1, EC1), connect the speaker to the RZ6 Electrostatic A connector and ensure the Electrostatic switch is set to ON. Otherwise turn the Electrostatic switch to OFF and attach your speaker to the RZ6 Out-A connector.

6. Attach your microphone to the RZ6 In-A connector and set the AMP/BYP switch to the AMP position.

7. Set the Gain (DB) knob to the position indicated in your calibration microphone .tcf file. This is listed in the 'Gain:' field of the Microphone Calibration panel.

   Best Practices: If using a closed field system be sure the tubing connecting the microphone and the speaker is as straight as possible and there are no connections where air can leak out. If using an open field system, place the speaker where it will be positioned during the experiment, and place the microphone where the animal's ear will be positioned.

8. Click the Start Sweep button.

Calibration Profile

Speaker Calibration   [...]
Trans: Unspecified
Amp: Unspecified
Gain: Unspecified
Notes: Unity Pass-thru

Microphone Calibration   [...]
Trans: ACO MIC 7016
Amp: RZ6
Gain: 40dB
Notes: ACO Pacific 1/4" Free Field
Calibration Microphone with Preamp

Probe
Level (vrms)   1.000
Low Freq (Hz)   3000
High Freq (Hz)   33000
Rate (Hz/s)   3000
Ch-A [||||] Ch-B

Filter Options
Target Level (dB)   90.0
Max Cor (dB)   20.0
Filter Length   1024
[Create Calibration File]

[Start Sweep]   [Done]

The blue trace shows the frequency response of the speaker and the yellow trace shows the harmonic distortion (THD). If there is less than 20 dB of separation between these traces there may be a problem with your speaker or recording setup.

If the red Correction curve reaches the -20 dB correction limit, adjust the Atten knob on the RZ6 to lower the output level of the speaker and click 'Start Sweep' again to perform another frequency sweep.

If the red Correction curve reaches the 20 dB maximum correction factor:

a. Ensure your speaker and microphone are connected to the RZ6 correctly.

b. If you are using a closed field speaker, ensure the tubing is straight and there are no leaks.

If all connections and tubing have been checked and the curve continues to exceed the 20 dB maximum, try one or more of the following:

    i. Lower the Target Level

    ii. If in closed field configuration, shorten your tubing

    iii. If in free field configuration, move your microphone closer to your speaker

9. Once you have a satisfactory calibration, click the Create Calibration File to save your calibration file.

10. In the TCF Specs dialog, enter a File Name and any additional information about your speaker set-up. Note: Gain Setting should be set to the value of the Atten knob.
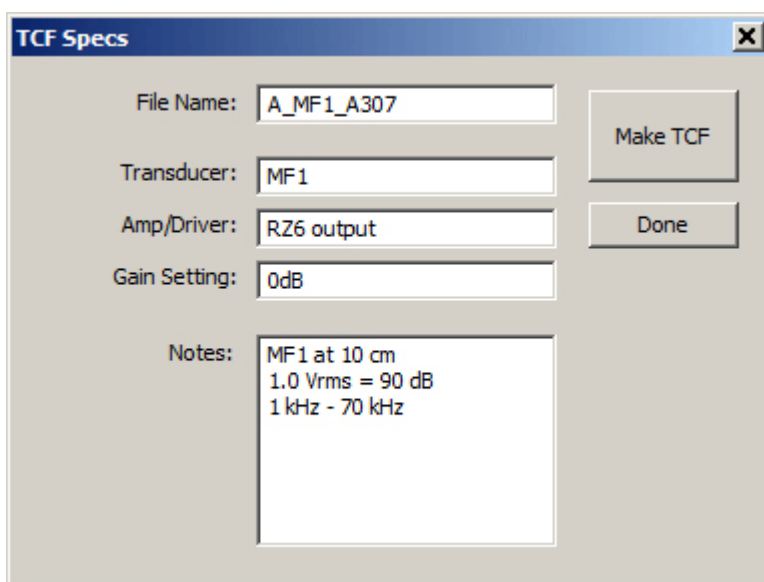

11. Click the Make TCF button.

12. A message is displayed to confirm the file has been created. Click OK

13. To return to the Calibration profile window, click Done

Testing the Calibration (TCF) File

1. To test your newly created calibration file, click the Speaker Calibration Browse (...) button

2. In the Specify a Speaker Calibration File dialog box, select the file name you specified earlier, and click Open

3. In the Calibration Profile window, click Start Sweep
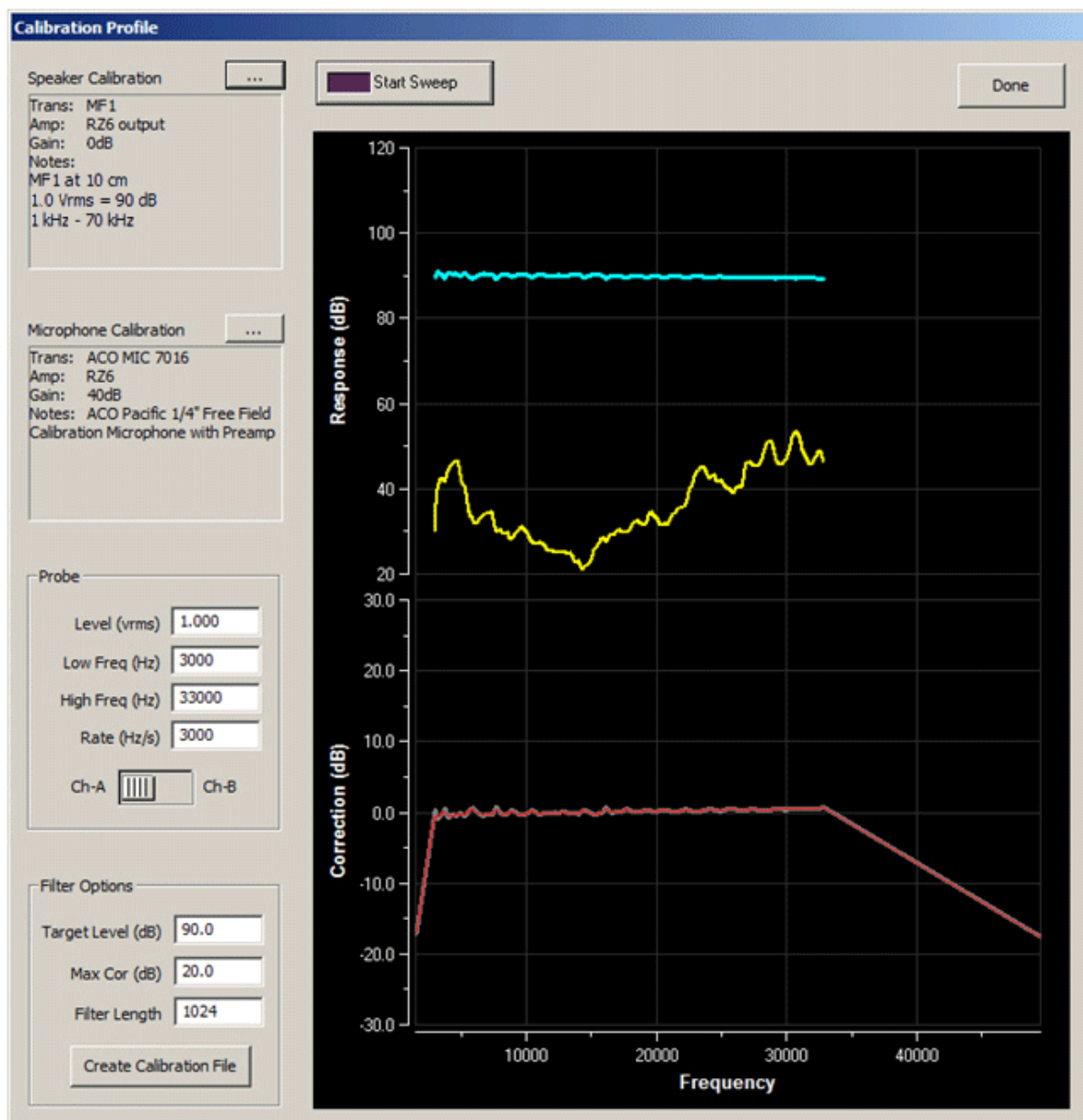
If the speaker is calibrated correctly the blue response curve should be flat and at your target level.

You can also test calibration files in your ABR or DPOAE configuration.
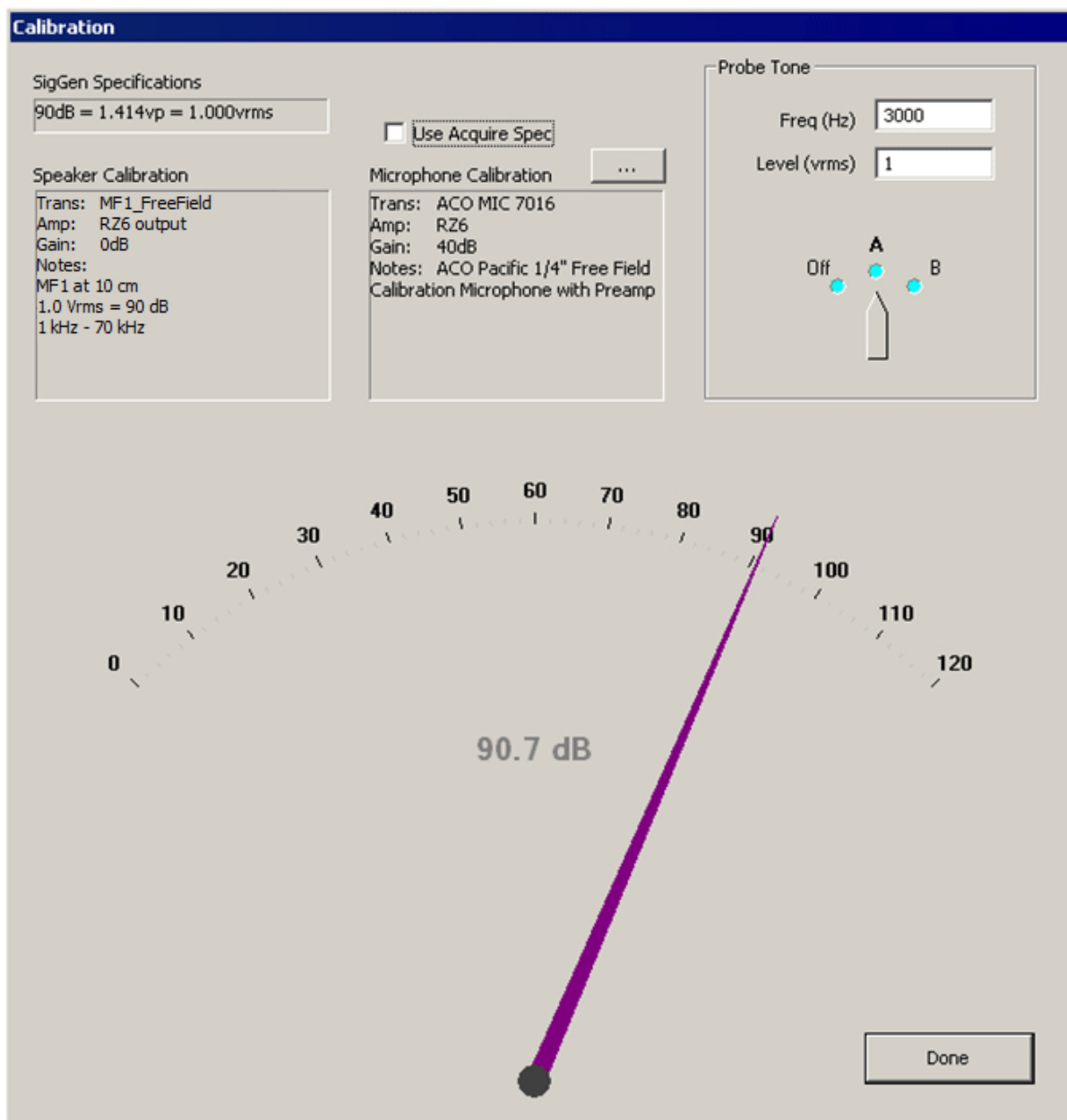
After loading your configuration:

> • Click Calibration on the Setup menu.

or

> • Click the Calibration [icon] button

The Calibration window shown below is opened.

The Speaker Calibration will be populated with the speaker calibration data specified in your Setup > Stimulus > Channel dialog.

The Microphone calibration file should be the file you used to make the .tcf file.

By adjusting the Freq field and then selecting "A" or "B" you can test the calibration at the specific frequencies used in your paradigm.

The Speaker Calibration will change to match the currently selected speaker (A or B).

The dB value shown should match your target level with only a slight deviation.