

# **SigPlay User's Guide**

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*SigPlay32 User's Guide ? Version 3.4*

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# Preface

## ***Software Philosophy***

TDT's philosophy on software development is simple. We design comprehensive drivers that control all aspects of the hardware from common, high-level programming languages. With minimal programming, TDT's hardware drivers enable scientists to produce high-quality signals tailored to meet their specific needs. This approach works quite well in most research environments. With TDT's software, scientists no longer face the arduous task of programming each experiment in low-level machine code. Furthermore, they avoid the limitations imposed by "turn-key" software.

As with all software applications, SigPlay has its inherent limitations. Undoubtedly, some researchers find it necessary to design and generate highly sophisticated stimuli that are beyond the current capabilities of SigGen and SigPlay. For this reason, TDT still maintains as its highest priority continued support of its software drivers.









# Organization of the Manual


The *SigPlay User's Guide* is divided into two parts:

 Part 1      SigPlay Fundamentals


 Part 2      Illustrative Examples

## ***SigPlay Fundamentals***


Part 1, SigPlay Fundamentals, presents all the basic SigPlay concepts necessary to load and play a SigGen signal. Part 1 guides you through the process of building a SigGen signal and also serves as a general reference tool.

 Chapter 1 Introduction

Installation of SigPlay and hardware configuration.

 Chapter 2 Learning the Basics

Presents an overview of the menus and toolbar in SigPlay.

 Chapter 3 Loading and Playing SigGen Signals


Presents detailed information on how to load SigGen signals and configure SigPlay for playing.


 Chapter 4 Triggers and Timing

Presents detailed information on issues related to triggers produced by the TG6 and PI2 and timing issues.

## ***Illustrative Examples***

In Part 2, Illustrative Examples, various configurations of SigPlay are illustrated to show how to set up, calibrate and play stimuli and how to interconnect hardware systems.

 Chapter 5 Examples

 Chapter 6 Calibration



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*Part*

**1**

*SigPlay Fundamentals*



# Chapter 1 Introduction

## What Is SigPlay?

SigPlay was designed to allow you to play SigGen signals in an interactive environment. SigPlay supports interfacing with other scientific hardware systems by generating trigger signals and bit patterns when SigGen signals are played. It can also be controlled by other systems that can send bit patterns for specifying signals and trigger pulses to control playing.

## SigPlay Capabilities

SigPlay allows you to play SigGen files from up to four channels. SigPlay gives full access to SigGen variables and peripheral controls. Sound presentation can be controlled in several ways. The current SigGen index (SGI) can be specified from software or externally by signalling the Parallel Interface (PI2). Sound playback is controlled by triggering from the Timing Generator (TG6). External triggering of the TDT system can be achieved by triggering the TG6. The number of repeats for each SGI and the repetition rate can be set as a constant or set to a SigGen variable.

## Hardware Support

SigPlay supports TDT's System II instrumentation, including any combination of TDT's D/A converters, programmable attenuators, waveform generators, cosine switches and programmable filters. You can play simple, single channel stimuli or complex stimuli that can play up to four channels simultaneously.

## Before You Begin

### What You Need

See your Microsoft Windows documentation.

➤ Windows fundamentals

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

See the SigGen manual.

➤ Basic SigGen concepts

You should recognize the term *SigGen Index (SGI)* and understand how SigGen variables work.

## ***Installing the Software***

### **Requirements**

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

- ~~☒~~ Microsoft Windows 95, 98 or NT
- ~~☒~~ A monitor with at least VGA resolution graphics. Super VGA (1024 x 768) resolution graphics highly recommended
- ~~☒~~ TDT's AP2 Array Processor
- ~~☒~~ TDT's XBUS hardware including
  - ?? D/A converter
  - ?? TG6 timing generator
  - ?? PI2 Parallel Interface (optional; for external control of SGI's)
  - ?? A/D converter (optional; for calibration of signals)
- ~~☒~~ SigGen software for generating signal files

## Installation

### To install SigPlay

1. Make sure your TDT hardware (including AP2 Array Processor and XBUS devices) is installed and functioning properly.

Refer to the *System II Installation Guide*.

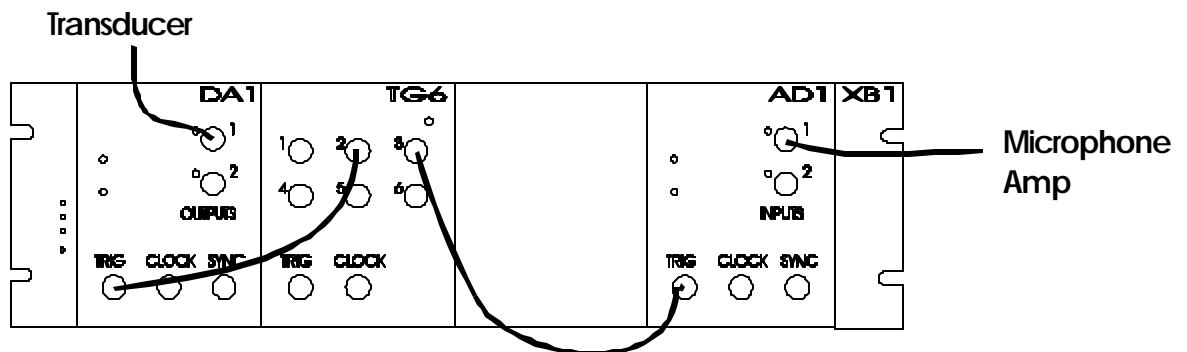
2. Insert the SigPlay diskette into drive A: or B:.
3. Run **setup.exe** to start the installation program.

## Hardware Configuration

In SigPlay the D/A is controlled by triggering from TG6 channel 2. For calibration, the A/D is controlled by triggering from TG6 channel 3.

External Triggering: Connect your trigger source to the TRIG connector on the TG6.

Triggering Peripherals: Channels 4 and 5 can be used to generate trigger signals using the SigGen peripheral setup dialog.





# Chapter 2 Learning the Basics

## ***Getting Started***

This chapter presents an overview of all of the menu choices and their specific functions. Chapter 3 shows how to load a SigGen signal and configure SigPlay for playing.

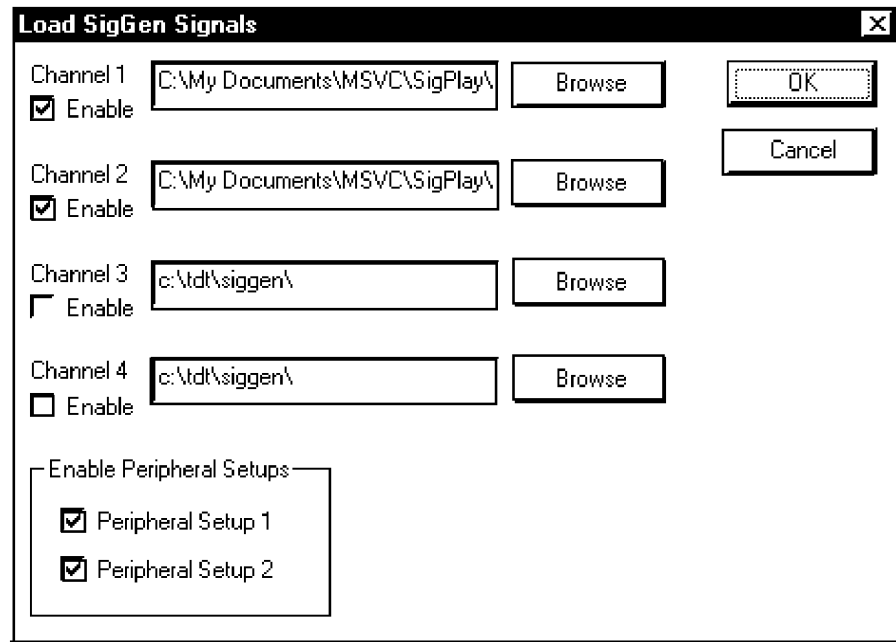
## ***File Menu***

### **Open/Save/Save As**

These commands will save the settings for which SigGen signals are loaded and all of the settings in SigPlay. These include SGI's selected for play, trigger rate, and number of repeats.

## SetUp Menu

### SigGen Signals



#### Overview

Use this dialog box to load SigGen signals on up to four channels.

#### Browse

Click on browse to open up the file open dialog box from which you can select a SigGen signal. Channels 3 and 4 will be grayed out if you are using a DA1 or DD1 that has only two channels of D/A.

#### Enable

The signal will be displayed and enabled for playing if the Enable box is checked.

#### Enable Peripheral Setups

The peripheral setups specified in SigGen will be used if the Enable Peripheral Setups boxes are checked. Peripheral Setup 1 for the TG6 will trigger TG6 channel 4, and Peripheral Setup 2 for the TG6 will trigger TG6 channel 5. Note that the SigPlay enable box does not disable the TG6 peripheral setups.

#### Tips on loading more than one signal

The signals should have the same sampling rate. If they have different sampling rates, the sampling rate of the last file loaded will be used for all signals.

If the signals have different durations, they will all be set to have the same duration as the longest signal.

## Trigger

**Trigger Setup**

TDT Triggering

External Triggering Setup

External  Trigger For Each SGI  
 Trigger For Each Repeat  
 Use 1 us TG6 base rate

Repeats per SGI: 100 (0=contin)  Repeat Rate (Hz): 4 = 250 ms  
 max=8.00

Inter-SGI Delay (ms): 100  Continuous Repeat Play

Oddball Setup

Oddball Presentation  
 Oddball Ratio (OddBall/Total): 0.1 = 10 # Oddballs  
 Oddball Window: 0

New Randomization Each SGI  
 Non-Random Presentation  
 Save Oddball Presentation Pattern to File

Oddball Trigger Dur (ms): 1

Neuroscan Vector Files

Save Neuroscan .vec Files  
 File Prefix (4 letters)   
 Notify When Vector File Saved

Multiple Oddball Setup

Max Sequential Playing of Same Oddball: 3

### Overview

Use this dialog to configure the triggering protocol. To use only software triggering, select TDT Triggering. To use an external trigger to trigger the TG6, check External under External Triggering Setup.

TG6 channel 1 sends a trigger at the beginning of each signal, and can be used to trigger other equipment to synchronize sound playback with other events.

### External Triggering

You can trigger either each SGI or each repeat in an SGI.

**Trigger for Each SGI**

All of the repeats for an SGI will be played according to the Repeat Rate setup when the TG6 is triggered externally.

**Trigger for Each Repeat**

SigGen signals will only be played when you send a trigger to the TG6 from an external system. The SGI will increment after all of the repeats for an SGI have been played. In this case the repeat rate setting is not used. The repeat rate is controlled by the external triggering rate.

**Use 1 ?s TG6 base rate**

This option is available only for external triggering for each repeat. When checked the TG6 baserate is changed from 1 ms to 1 ?s. This gives more accurate triggering from the TG6 when an external trigger pulse is received. Note that any offset delay in the SigGen signal or triggering of peripherals will not work properly when this box is checked (the timing will be 1000 times faster; thus an offset delay of 10 ms will become an offset delay of 10 ?s).

**Repeats per SGI**

This can be either a constant value entered into the edit box, or can be set to a SigGen variable. The default is 1 repeat per SGI. If you have more than one SigGen file loaded, the SigGen variables listed are those from the last file loaded. Enter 0 for an infinite number of repeats.

**Repeat Rate (Hz)**

This is the rate the signals for each SGI will be repeated. The repeat rate can also be specified by a SigGen variable. The default is 1 repeat per second.

Maximum repeat rate: The maximum repeat rate is limited to  $(1/\text{signal duration}) \times 8$ . If you load a signal with a longer duration than the current repeat rate will support, the repeat rate will automatically be changed to  $(1/\text{signal duration}) \times 8$ .

You may also enter the repeat period that you want and click on the Calculate button to calculate that repeat rate.

**Continuous Repeat Play**

When this box is checked the SigGen signals are repeated continuously, with no gap between the end of one repeat and the start of the next repeat. A trigger pulse is generated only at the start of each SGI. There is no trigger pulse for each repeat. This is useful for generating long stimuli, such as continuous tones.

**Inter-SGI Delay (ms)**

This is an added delay between the end of one SGI and the beginning of the next.

## OddBall Setup

### Oddball Presentation

When checked, this setup will present an OddBall paradigm using up to 7 different SigGen files.

The SigGen file listed as the **Channel 1** stimulus is the *base* stimulus.

The SigGen files listed as **Channel 2** is the first Oddball stimulus. Channels 3-8 can be used for other oddball stimuli.

The files must be loaded into Channel 1 and Channel 2 for the OddBall paradigm *before* selecting the Oddball Presentation check box. Both stimuli are played out of Channel 1 of the DA converter.

### Oddball Ratio

Percent of stimuli that will be the OddBall stimulus. It is a fraction of the number of Repeats per SGI (see above). You can also calculate this ratio by entering the desired number of oddball presentations and clicking the calculate button. The same number of each oddball will be presented.

### Oddball Window

This window is used to determine how close two oddballs can lie. A window of 1 would not allow oddballs to be within one presentation of each other. A window of 5 would not allow oddballs to be presented within 5 presentations of each other. A window of 0 would allow oddballs to be played twice in a row. The maximum window size is equal to  $((\text{Total \# repeats} - \text{\#Oddballs}) / \text{\#Oddballs}) - 1$ , which corresponds to almost equal spacing of oddballs.

### New Randomization Each SGI

When checked, the presentation sequence for each SGI will be randomized. If this box is not checked, the randomized sequence will be the same for each SGI.

### Non-Random Presentation

When checked, the presentation sequence is presented non-randomly, with base and OddBall signals evenly spaced according to the Oddball Ratio. The sequence will always start with the OddBall signal. For example, if the OddBall ratio was .5, the sequence would alternate between the OddBall signal and the base signal on every signal. This setting only works for setups with one oddball stimulus (i.e. it does not work when there is more than one oddball).

### Save Oddball Presentation Pattern to File

If checked, this will prompt for a filename to save the presentation pattern to a comma delimited text file. The first column in the file is the number of background stimuli (the signal loaded to Channel 1) played before an oddball was played. The second column is the ID number of the oddball that was played (the first oddball that was loaded will be number 1, the second oddball will be the number 2, etc.).

**Save Neuroscan .vec Files**

When checked, the presentation sequence for the base and OddBall sequences will be saved to separate Neuroscan (.vec) vector files. These text vector files are used by Neuroscan to average the OddBall and base stimuli separately.

**File Prefix**

Enter up to 4 letters for a file prefix for the Neuroscan .vec files. The filename will consist of [prefix][O or B][SGI].vec.

For example, on SGI 3 with a prefix of 'CAT', the filenames would be CATB3.vec for the base stimulus pattern and CATO3.vec for the Oddball stimulus pattern.

The files are saved to the same directory as the base and OddBall SigGen (.sig) files. Old .vec files of the same name will be overwritten without warning.

**Notify When .vec File Saved**

When checked, a notification box will appear after randomization. This will give you the opportunity to transfer the .vec files to the Neuroscan machine before starting signal presentation.

**Oddball Trigger Duration**

This is the duration of the TTL pulse that is played out of DA Channel 2 for oddball presentations.

## SigGen Indices

Setup SigGen Indices			
Sgi	SpecLevel	CompLevel	RoveAtt
1	50.000000	30.000000	2.100000
2	50.000000	29.000000	5.300000
3	50.000000	28.000000	4.900000
4	50.000000	27.000000	4.400000
5	50.000000	26.000000	1.000000
6	50.000000	25.000000	5.100000
7	50.000000	24.000000	4.200000
8	50.000000	23.000000	3.000000
9	50.000000	22.000000	1.800000
10	50.000000	21.000000	0.000000
11	50.000000	20.000000	0.500000
12	50.000000	19.000000	2.100000
13	50.000000	18.000000	0.800000
14	50.000000	17.000000	0.900000
15	50.000000	16.000000	5.900000
16	50.000000	15.000000	2.600000
17	50.000000	14.000000	0.700000
18	50.000000	13.000000	0.000000
19	50.000000	12.000000	0.000000
20	50.000000	11.000000	2.200000
21	50.000000	10.000000	3.100000
22	50.000000	9.000000	3.400000
23	50.000000	8.000000	3.600000
24	50.000000	7.000000	3.600000
25	50.000000	6.000000	0.900000
26	50.000000	5.000000	3.900000
27	50.000000	4.000000	2.700000

Clear Selections   Do Odd   Do Even   Do All   Save To File   OK   Cancel

### Overview

This dialog shows the SigGen variables and the values for all of the SigGen indices for a given channel.

If you have more than one SigGen signal loaded and select to play a subset of the SGI's, the same subset will be played for all signals. When playing multiple signals, it is best to have the same number of SGI's for each signal.

Settings in this dialog box will not be used if the PI2 is used to specify SGI's.

### SGI control

To control which SGI's are played, click on individual SGI's. To select multiple SGI's use CTRL-click.

#### Clear Selections

Clears all selections. No SGI's will be played.

#### Do Odd

Play all odd SGI's.

#### Do Even

Play all even SGI's.

#### Do All

Play all SGI's.

If the SigGen signal has no termination (i.e. boundary control in SigGen), you can play continuously by choosing Do All. Only the first 500 SGI's will be shown on this screen.

**Save To File**

Saves all of the variable values to an ASCII file.

## PI2

**SetUp PI2 Parallel Interface**

Use PI2 for SigGen Index Specification

Use Latch Bit 15

Use Smart Port Control of Play

Trigger Delay After New PI2 Bit Code (ms)

Testing

Bit 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

PORT B PORT A

Decimal  Bit Pattern

Bit 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

PORT B PORT A

### Overview

The SetUp PI2 Parallel Interface dialog is used to configure the PI2 to interface the TDT system to another hardware system.

#### Use PI2 for SigGen Index Specification

Check this box to specify SGI's from an external system through Ports A and B of the PI2. These ports allow you to send 16-bit numbers to the PI2. If you use this method of SGI specification, you will not be able to select individual SGI's through the SigGen Indices dialog box.

#### Use Latch Bit 15

If you use the PI2 for SGI specification, you have the option of using Bit 15 (Bit 8 of Port B) as a latch bit.

##### *No Latch Bit*

If Use Latch Bit 15 is not selected, bit 15 will be used in calculating the SGI. The program will wait until it detects a changing bit pattern on the PI2. Once it detects a new stable bit pattern, it will load the specified SGI and proceed with playing. To play the same SGI repeatedly, send all 0's before resending the bit pattern. Sending a bit pattern of all 0's will cause the PI2 to pause until a new non-zero bit pattern is sent.

### ***Latch Bit 15***

Using bit 15 as a latch bit gives control over when signal play will proceed after a bit pattern is sent to the PI2. Typically, the next bit pattern is set with bit 15 off. To start play of the signal, resend the same bit pattern with bit 15 on. Avoid sending a new bit pattern with the latch bit on, because this may result in reading the bit pattern while it is in the process of being sent to the PI2, and result in incorrect SGI's being run. If you use bit 15 as a latch bit, this bit will not be used in calculating the SGI.

### **Use Smart Port Control of Play**

Channels 5-8 of the PI2 smart port may be used to control play. Send a trigger pulse to the appropriate PI2 channel to control play (see below). You must click on Play in SigPlay, to configure the PI2 to accept these control triggers.

**Channel 5: Play** This will start play (or restart play if paused).

**Channel 6: Pause** This will pause play in the middle of an SGI. When play is restarted, all of the repeats for that SGI will be run.

**Channel 7: Forward** Steps ahead one SGI if under software control of SGI's. If you are using PI2 SGI specification, this will stop play and wait for another bit pattern on the PI2.

**Channel 8: Stop** This will stop play and reset the SGI to 1 (if you are using software control of SGI's). If you are using PI2 SGI specification, this will stop play and wait for another bit pattern on the PI2.

### **Trigger Delay After New PI2 Bit Code (ms)**

This is a delay before triggering will start after a new bit code is received by the PI2.

## **Testing**

This section of the dialog box allows you to test your connections to the PI2.

### **Read**

Reads the current bit pattern on PI2 Ports A and B.

### **Continuous**

Will continuously read the PI2 ports, and is a good way to verify that protocols are set up properly on external systems.

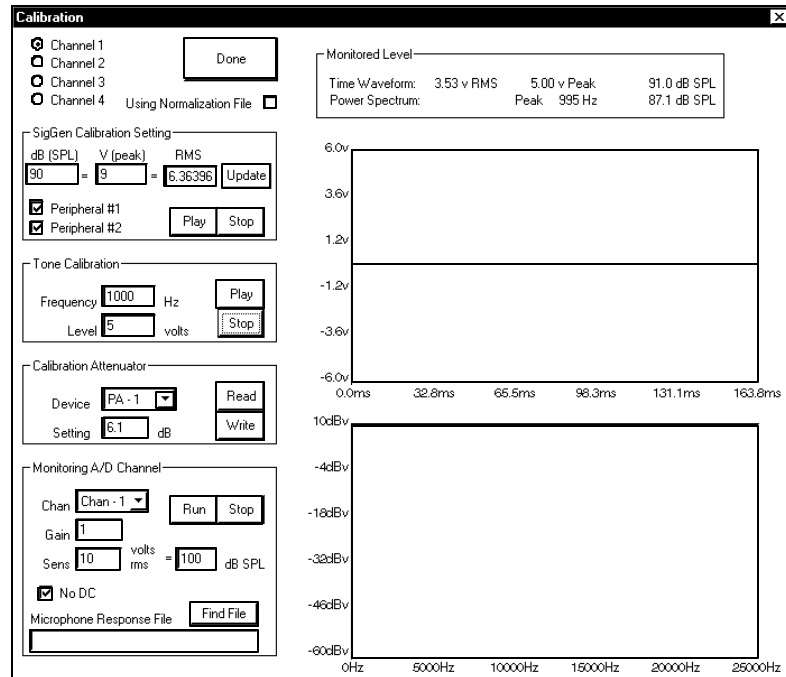
### **Stop**

Will stop continuous reading.

**Write**

Writes the specified bit pattern to PI2 Ports C and D. If decimal is checked, the value in the edit box is written. If bit pattern is checked, the bit pattern is written.

## Calibration



## Overview

The calibration dialog box allows you to play out test signals and record data from a calibrated microphone (if you have an AD converter) to calibrate your signals. Step by step instructions for calibration can be found in Chapter 6. Note also, that SigGen32 now ships with a program called SigCal that performs automatic calibrations.

There are three ways to calibrate your signals:

1. Change the SigGen file calibration settings.
2. Adjust the calibration specified under the Current SigGen Specification in the calibration dialog. This will not affect the SigGen file, but will be stored with your SigPlay file.
3. Adding attenuation to a PA4.

## Selecting Stimulus Channels

SigPlay allows up to four stimulus channels. You must calibrate each channel separately. If you don't have four channels in your DA, SigPlay doesn't like it if you try to calibrate channels 3 and 4.

- Channel 1
- Channel 2
- Channel 3
- Channel 4

## SigGen Calibration Setting

Stimulus signal calibration information is displayed in the SigGen Calibration Setting group box.

SigGen Calibration Setting

dB (SPL) = V (peak) = RMS

90 = 9 = 6.36396 Update

Peripheral #1

Peripheral #2

Play Stop

*For additional information, See the [SigGen User's Guide, Chapter 3, "Configuring Peripherals."](#)*

SigGen allows the specification of up to two peripheral device configurations. You may enable one or both of these peripheral configurations by checking the appropriate Peripheral check box. You may change the calibration setting to calibrate your signal in SigPlay. Change the values under dB SPL and/or Volts, and then click the Update button. Note that the calibration in the SigGen file will not be changed.

### Playing the Stimulus Signal

You may wish to play the stimulus signal for calibration purposes. Stimulus play is controlled through use of the Play and Stop buttons.

## Tone Calibration

SigPlay allows you to calibrate your system through the use of a calibration tone.

Tone Calibration

Frequency 1000. Hz

Level 1. volts

Play

Stop

SigPlay will output a sine wave based on the specified frequency and voltage level. Tone play is controlled through use of the Play and Stop buttons.

**Frequency.** The value of Frequency must be at least 10 Hz and no more than 100,000 Hz.

**Level.** Level must be at least .01 volts and no more than 10 volts.

## Calibration Attenuator

You may set or read the level of a programmable attenuator during calibration.

**Device.** Choose the specific programmable attenuator you wish use during calibration from the list presented in the Device box.

**Setting.** This field may be used to enter the desired attenuation level. Attenuation level must be no less than zero dB and no greater than 99 dB.

**Note:** You may specify the same programmable attenuator for calibration and for SigGen signal generation. During calibration of the SigGen signal, the two attenuation values will be summed.

## Monitoring the A/D Channel

SigPlay allows you to use an A/D channel for system calibration. By specifying gain, sensitivity, and the frequency response of the microphone, you may calibrate your system for use with a microphone of known response.

### Setting Parameters

**Chan.** Set the A/D Channel to monitor by choosing the appropriate channel from the Chan box.

**Gain.** Enter the gain that is applied to the microphone output. This gain value is on a linear scale (e.g. 100x gain), not a dB scale.

**Sens.** Monitor level sensitivity may be set by assigning a specific number of dB SPL per specific number of volts. These values are determined by the characteristics of your particular system.

**No DC.** This will remove any DC signal from the acquired signal through subtracting out the average of the entire waveform.

**Microphone Response File.** You may wish to subtract the frequency response of the microphone from the overall frequency response in order to determine the frequency characteristics of the system. By specifying an ASCII microphone response file (*.rsp* file), you can remove microphone effects from your calibration.

## The Monitor Display

The monitor display consists of three parts:

- The Monitored Level group box
- The time-domain display
- The frequency-domain display

**The Monitored Level Group Box.** Within this box, the RMS voltage, peak voltage, dB SPL, and peak frequency for the portion of the signal shown in the time-domain display is presented on the first line. The second line shows the peak frequency and the dB SPL corresponding to that frequency from the power spectrum. The dB SPL corrects for the decrease in SPL produced by the Hanning window.

Monitored Level			
Time Waveform:	3.53 v RMS	5.00 v Peak	91.0 dB SPL
Power Spectrum:		Peak 995 Hz	87.1 dB SPL

**The Time-Domain Display.** The upper plot contains a display of the time-domain waveform.

**The Frequency-Domain Display.** The time-domain waveform displayed in the Time-Domain Display is subjected to a Hanning Window and 8192 point Fast Fourier Transform (FFT). The resulting frequency-domain waveform is displayed in the lower plot.

## Monitoring A/D Channels

A/D channels may be monitored in three manners:

- Monitoring during stimulus play
- Monitoring during calibration tone play
- Manual monitoring

**Monitoring during stimulus play.** You may wish to monitor an A/D channel during stimulus play, only.

### *To monitor during stimulus play*

1. Define the Monitoring A/D Channel parameters.
2. Play the stimulus by clicking the Play button found in the Current SigGen Specification group box.

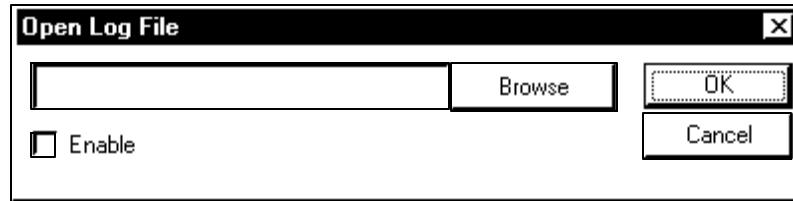
***To monitor during tone calibration***

1. Define the Monitoring A/D Channel parameters.
2. Define the Tone Calibration parameters.
3. Play the calibration tone by clicking the Play button found in the Tone Calibration group box.

***To manually monitor***

1. Define the Monitoring A/D Channel parameters.
2. Click Run in the Monitoring A/D Channel group box.







## Log File



### Overview

A log file saves information about each SGI that is played to an ASCII text file. A log file is useful when using random or prompted variables from SigGen, since these variables can change each time the program is run. The values for random variables shown in the SigGen Indices dialog box are not the same as those calculated during the playing of the signal.

This ASCII file includes the following information for each SGI:

-  Start date and time of the SGI
-  SGI
-  Number of Repeats
-  Repeat Rate (Hz)
-  Inter-SGI Interval (ms)
-  SigGen Variable Values for each channel

### Browse

Click on browse to open a Save dialog box to select the directory and file name. If an existing file is chosen, the new data will be appended to the end of that file (despite what the program may tell you).

### Enable

When checked the log file is saved. When not checked, no log file is saved, even if there is a file name in the edit box.

### Notes

#### Back and Forward

If back or forward is used to change SGI's during play, the number of repeats in the log file does not represent the number that were actually played. Since playing is controlled by the TG6 hardware, the software does not have a way to determine the actual number of repeats played.

### External Triggering

If external triggering of each repeat is used, the repeat rate does not reflect that actual trigger rate.

#### Sample Log File Output

Date	Time	SGI	Repeats	RepeatRate	SGIinterval	Channel	Frequenc y	Octave
04/21/98	17:14:46	1	1	1.000000	100	1	500.000	1.000
04/21/98	17:14:47	2	1	1.000000	100	1	600.000	2.000
Date	Time	SGI	Repeats	RepeatRate	SGIinterval	Channel	Frequenc y	Octave
05/20/98	13:01:52	0	5	5.000000	500	1	500.000	1.000
05/20/98	13:01:56	1	5	5.000000	500	1	600.000	2.000
05/20/98	13:02:05	2	5	5.000000	500	1	700.000	3.000
05/20/98	13:02:11	3	5	5.000000	500	1	800.000	4.000
05/20/98	13:02:17	4	5	5.000000	500	1	900.000	5.000
05/20/98	13:02:36	0	5	5.000000	500	1	500.000	1.000

## ***Play Menu***

### **Play**

Starts playing of the SigGen signal. If using PI2 SmartPort control of play, a play trigger is required on PI2 channel 5 to initiate play, after Play is initiated from this menu.

### **Stop**

Stops playing of the SigGen signal, and resets the signal to SGI 1.

### **Pause**

Pauses playing of the SigGen signal. To resume playing, click on Play. All of the specified repeats will be played after pause is released.

### **Forward**

Step ahead one SGI or to the next selected SGI.

### **Back**

Go back one SGI or to the previously selected SGI.

## ***Screen Controls***

### **Zooming**

Zoom in on a plot by clicking on the left mouse button and dragging to the right. To zoom out, click on the right mouse button while it is in the plot area.

### **Stepping**

To step to the right in a zoomed in plot, left-click in the right-hand half of the plot. To step to the left on a zoomed plot, left-click in the left-hand half of the plot.

## ***Toolbar***

The toolbar has shortcuts to all of the menu items. Place the mouse cursor over a toolbar item for information on its function.







# Chapter 3 Loading and Playing SigGen Signals


## Loading and Playing SigGen Signals

SigGen allows you to build a variety of complex signals. SigPlay allows you to specify how these signals will be presented as stimuli. There are four ways that you might use SigPlay:

 Using the TDT System Alone to Present Stimuli

 Using the TDT System to Present Stimuli and Control Another System

 Controlling the TDT System from Another Hardware System

 Mixed Control: Controlling signal play from another system, and using the TDT system to control timing of data acquisition on the other system

## Using the TDT System Alone to Present Stimuli

Perform the following steps:


1. Connect TG6 channel 2 to the TRIG on the D/A converter.

In SigPlay under the SetUp Menu:

2. Load SigGen Files.

3. SetUp Triggering:

 Select TDT Triggering

 Set number of repeats for each SGI and repeat rate

4. Use Play controls to control playing.

## ***Using the TDT System to Present Stimuli and Control Another System***

To use the TDT System to control another hardware system, follow the same steps as above to play the signals (Using the TDT System Alone to Present Stimuli) and use the trigger from TG6 channel 1 or the PI2 signals to synchronize the other system.

### **Synchronizing the other system**

There are several ways this can be done.

**TG6 channel 1** sends out a trigger pulse every time a signal is triggered (except under continuous play where the trigger pulse is only produced once at the beginning of each SGI). This could be used to start data acquisition with another system. This is the most accurate timing pulse produced by the TDT system, and occurs exactly at the same time as the trigger pulse to the D/A (unless an offset delay for the D/A has been specified in the SigGen file).

**PI2 Smart Port Channels 1-4** send out signals about the SGI and playing status.

**Channel 1: Playing SGI.** This channel will remain high as long as an SGI is being played.

**Channel 2: Begin SGI.** A 1 ms pulse is played out of channel 2 at the beginning of each SGI.

**Channel 3: End SGI.** A 1 ms pulse is played out of channel 3 at the end of each SGI.

**Channel 4: SGI Termination.** A 1 ms pulse is played out of channel 4 when all SGI's have been played.

**PI2 Ports B and C** present a bit pattern for the SigGen signal currently being played.

---

# Controlling the TDT System from Another Hardware System

## Overview

To control the TDT system from another system, load the SigGen files as in the previous examples.

### Selecting SGI's

You have the option of either using the TDT system to control which SGI's are played, or having the external system control which SGI's are played.

### Triggering Signal Play

You have three choices for triggering signal play:

1. If using the external system to select SGI's, you can use the TDT system to control triggering for playing.
2. Trigger externally on each SGI, and let the TDT system control triggering for each repeat.
3. Trigger externally on each repeat.

### External Play Control

You also have the option of externally controlling play through the PI2 interface.

## Selecting SGI's

### SigPlay Control of SGI's

You can use SigPlay to control which SGI's are played as in the examples above. You would then use the external hardware system to send external triggers to the TG6.

### Controlling SGI's from an External System

To control which SGI is played from an external system, interface the other system to the PI2 Ports A/B. The external system will then send a bit pattern corresponding to the next SGI to play.

If you use the PI2 for SGI specification, you have the option of using Bit 15 (Bit 8 of Port B) as a latch bit.

*No Latch Bit:* Bit 15 will be used in calculating the SGI. The program will wait until it detects a changing bit pattern on the PI2. Once it detects a new stable bit pattern, it will load the specified SGI and proceed with playing. Sending a bit pattern of all 0's will cause it to loop and wait until a non-zero bit pattern arrives. To play the same SGI repeatedly, send all 0's before resending the bit pattern.

*Latch Bit 15:* Using bit 15 as a latch bit gives control over when signal play will proceed after a bit pattern is sent to the PI2. Typically, the next bit pattern is set with bit 15 off. To start play of the signal, resend the same bit pattern with bit 15 on. Avoid sending a new bit pattern with the latch bit on, because this may result in reading the bit pattern while it is in the process of being sent to the PI2, and result in incorrect SGI's being run. If you use bit 15 as a latch bit, this bit will not be used in calculating the SGI.

## Triggering Signal Play

These triggering methods are compatible with either method of SGI specification. While external SGI specification through the PI2 SmartPort will allow you to control play, combining this with an external trigger signal to the TG6 will give you more precise timing over the start of signal play (microsecond accuracy versus millisecond accuracy). Note that this trigger signal needs to be sent *after* the new bit pattern is sent.

### TDT Triggering

Clicking on play will start playing the signal if under SigPlay control of SGI's.

If the PI2 is being used to control SGI's, clicking on play will prepare the system for receiving bit patterns on the PI2.

### External Triggering

1. Setup external triggering either for each SGI or for each repeat.
2. Connect the other systems trigger line to the TRIG on the TG6.
3. In SigPlay, click on Play to start the TDT System and prepare it for receiving external triggers. The TDT system will begin playing as soon as it receives an external trigger to the TG6.

## External Play Control through the PI2

The PI2 SmartPort channels 5 through 8 may be used to control playing from an external system.

Send a 20 ms pulse to the channel to control play. If you are not using one of the channels on the PI2, connect a shorted BNC cable to that port. Otherwise, it will be interpreted as a command on that channel. External play control may be used with any of the SGI and trigger setups described above.

The timing for external play control is not as precise (ms variation) as TG6 timing of signal presentation. Therefore, if at all possible, use either external triggering or synchronize the onset of acquisition to the timing pulse on TG6 channel 1.

1. Setup your SigGen signals and Triggering Setup.
2. Click on Play in SigPlay.
3. When ready to start play, send a trigger pulse to Channel 5 on the PI2.
4. Control Play by sending trigger pulses to the appropriate channel listed below.

**Channel 5: Play** This will start play (or restart play if paused).

**Channel 6: Pause** This will pause play in the middle of an SGI. When play is restarted, all of the repeats for that SGI will be run.

**Channel 7: Forward** Steps ahead one SGI if under software control of SGI's. If you are using PI2 SGI specification, this will stop play and wait for another bit pattern on the PI2.

**Channel 8: Stop.** This will stop play and reset the SGI to 1 (if you are using software control of SGI's). If you are using PI2 SGI specification, this will stop play and wait for another bit pattern on the PI2.

## ***Mixed Control***

You may find that some level of mixed control works best for your system. For instance, you may send a bit pattern to the PI2 to specify what SigGen signal to play, and then trigger the external system to begin acquiring data when it receives a trigger from TG6 channel 1. If you do not use the triggers produced by the TDT system, the synchronization could vary by as much as 50 ms. SigPlay is flexible in the ways SGI's are specified and signals triggered, and you may generally use any combination of the features.

## ***PI2 Cabling***

See the PI2 tear sheet for pin assignments on PI2 Ports A-D. If you are using PI2 SGI specification, all pins on A and B should either be connected or shorted to one of the ground pins. Open pins will float high, and be interpreted as a signal.



# Chapter 4 Triggers and Timing

## Trigger Pulses

### TG6

The TG6 produces a trigger pulse from channel 1 for every signal that is triggered. This is the most accurate timing pulse produced by the TDT system, as it occurs at the same time as the trigger to the D/A (as long as no offset is specified in the SigGen file).

When continuous play is used, the trigger pulse occurs only once for each SGI (regardless of how many repeats there are).

TG6 Peripheral Setups 1 and 2 use TG6 channels 4 and 5, respectively.

### D/A

The D/A SYNC port will also produce a timing pulse every time the D/A begins conversion.

When an Oddball setup is run, the D/A channel 2 will play a timing pulse for each oddball that is played. This will allow one to configure a system to sort oddball from non-oddball stimuli.

### PI2

The PI2 trigger pulses discussed below are controlled from SigPlay, and so are not as precise as the TG6 pulses. The variation in the PI2 trigger pulses will depend on the speed of your computer. To determine the amount of variability compare the timing of the trigger pulse on TG6 channel 1 to the trigger pulse on PI2 Channel 2. On a Pentium 133 MHz machine, the timing pulse on PI2 Channel 2 occurred 0.1 - 1 ms before the TG6 timing pulse.

## Timing Jitter

When TDT devices are triggered externally, there are delays between when the trigger is received to when conversion begins up to one sample period in duration.

For example, if the D/A converter sampling rate is 50 kHz, there will be a 0-20  $\mu$ s jitter from when the trigger is received on its TRIG port until play begins.

### **D/A Timing Jitter**

To minimize the jitter on the D/A converter, you can choose a higher sampling rate in SigGen (i.e. a shorter sampling period). A 100 kHz sampling rate will have 10  $\mu$ s jitter.

### **TG6 Timing Jitter**

In SigPlay the TG6 Timing Generator runs by default with a time base of 1 ms. This slow sampling rate allows long timing sequences (up to 32 seconds) to be generated. However, when the TDT system is triggered externally by triggering the TG6, there will be a 1 ms jitter between when the trigger is received until the TG6 puts out its timing pulse to the D/A.

The TG6 time base can be set to 1  $\mu$ s when using external triggering on each repeat. If this option is selected, the jitter on the TG6 is reduced to 1  $\mu$ s. However, if the TG6 is also being used to trigger peripheral devices or an offset delay is specified for triggering the SigGen signal (this is set in SigGen), this timing will be increased 1000 times. Thus, a 100 ms offset delay, will actually only be 100  $\mu$ s.

## ***PI2 Polling Rate***

When using the PI2 for SGI specification of for external control of play, there will be a delay between when you send a signal and when it is detected by the PI2. The PI2 is polled 100 times per second, so there could be a 10 ms delay between sending an external command to the PI2 and the PI2 responding. This is why it is important to either trigger the TG6 to play signals, or use the trigger pulse produced by TG6 channel 1 to synchronize the other system.

Once an SGI is playing, the PI2 is ready to receive the next SGI. The signal is preloaded while the current signal is playing.

## ***PI2 Signal Information***

Any system that has a PI2, regardless of whether it is being used for SGI specification, will output information about the signal being played through PI2 Channels 1-4 and Ports C and D

### **PI2 Smart Port Channels 1-4**

**Channel 1: Playing SGI.** This channel will remain high as long as an SGI is being played.

**Channel 2: Begin SGI.** A 1 ms pulse is played out of channel 2 at the beginning of each SGI.

**Channel 3: End SGI.** A 1 ms pulse is played out of channel 3 at the end of each SGI.

**Channel 4: SGI Termination.** A 1 ms pulse is played out of channel 4 when all SGI's have been played.

## PI2 Ports C and D

A bit pattern corresponding to the current SGI is sent to Ports C and D as long as that SGI is being played.

### ***Inter-SGI Delay***

The inter-SGI delay that is specified in the trigger setup box should be taken as a minimum delay. The actual delay may be longer, especially for short delays. The next signal will be precalculated while the current signal is playing to minimize this delay.

SigPlay subtracts the time it took to get ready for the next SGI from the inter-SGI delay to try to keep the inter-SGI time constant.

However, if you enter an inter-SGI delay of 0, the actual inter-SGI delay will be more (probably at least 10 ms).

### ***Continuous Play***

The continuous play feature plays the current SigGen signal the number of times specified in the Repeats box. There is no delay between the end of playing of one repeat and the beginning of the next repeat.

The TG6 produces a trigger pulse on channel 1 only for the start of the first repeat.



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***Part***  
**2** ***Illustrative Examples***



# Chapter 5 Examples

The examples presented in this chapter illustrate the use of a variety of SigPlay features. Start with Example 1 to learn how to load a SigGen signal and configure it for playing. The first three examples show three different basic configurations with TDT control, external control of triggering, and external SGI specification. Examples 4-7 are shown with TDT control, but could be used with external control.

**Example 1: Playing a tone with TG6 Control**

**Example 2: Playing a tone with external triggering of the TG6**

**Example 3: Specify SGI's from an external system**

**Example 4: Oddball presentation**

**Example 5: Alternating phase**

**Example 6: Long duration tone using continuous play**

**Example 7: Variable repeat rate**

**Example 8: Single unit neurophysiology with external triggering**



## Example 1: Playing a tone with TG6 control



Example 1 shows how to load a simple SigGen signal, calibrate it in SigPlay, and configure playing. The triggering of signal play will be controlled by SigPlay through software triggering the TG6.

The files for this example can be found in `c:\tdt\siggen\sigplay\examples`

Exam_1.sig	Example 1 SigGen File
Exam_1.spl	Example 1 SigPlay File

### SigGen File

This SigGen file is similar to Example 1 in the SigGen manual. If you are not familiar with SigGen, work through SigGen Example 1 first.

This SigGen file will produce a 100 ms tone blip with 10 different frequencies and 5 different levels per frequency.

### Required Hardware

 D/A

 TG6

## Configuring SigPlay

### Quick Start

If you want to get an idea of how this example runs, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_1.spl

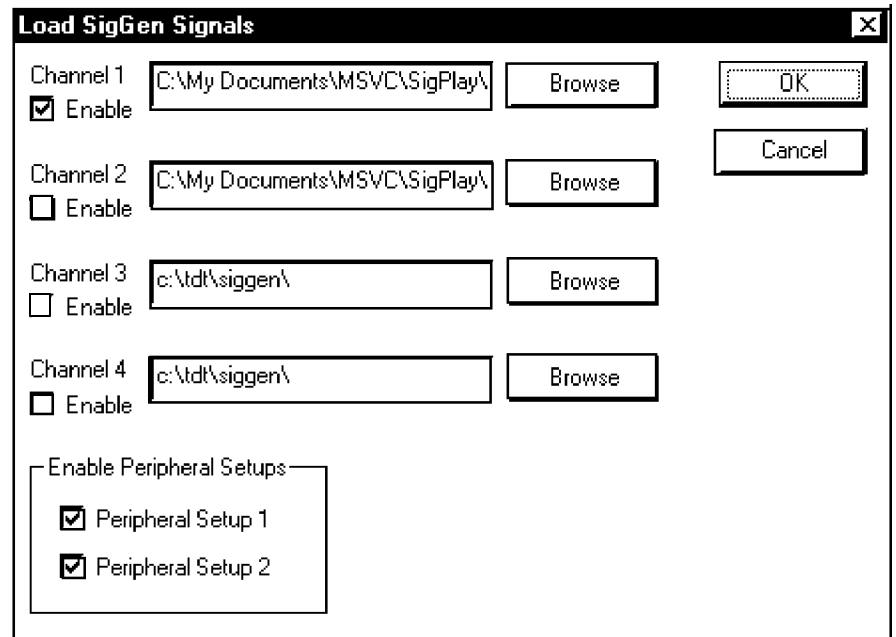
#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.

## Loading the SigGen Signal



1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_1.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

## Calibrate the System

To calibrate the system, a 9V 1000 Hz tone will be played out of the D/A. We want to measure how loud a tone is produced by our speaker when we play this 9V tone, and then adjust our calibration settings.

### Method 1: Using a sound level meter

Use this method if you do not have a TDT A/D converter.

1. Choose Calibrate from the SetUp menu.
2. In the Tone Calibration section enter 1000 Hz and 9 V into the appropriate boxes.
3. Click on Play to begin playing the calibration tone.
4. Measure the actual SPL produced by this tone with a Sound Level Meter.
5. If the measured SPL is different from the calibration shown in the Current SigGen Specification box, there are two options.

- a) Calibrate the system by changing the SigGen Calibration: Enter the measured SPL and 9 V in the appropriate boxes in the Current SigGen Specification setting. Then click on the Update button to update these settings in SigPlay. Your SigGen signal will be recalculated based on these settings. However, the settings in the actual SigGen file will not be changed. There are two potential problems with this approach:
  - i. The signal could be clipped after changing the setting, because the signal exceeds the 10V maximum signal the D/A is capable of producing. This will look like squared off peaks on the signal plot.
  - ii. The signal voltage will be so low that the signal to noise ratio is very poor. If the newly calibrated signal is in the mV range you will not be taking full advantage of the dynamic range of the D/A converter. It is always best to try to produce signals in the 7-10 V range, without exceeding 10 V, and using an attenuator to control sound level.
- b) Calibrate the system by adjusting the attenuation on a PA4 Programmable Attenuator. If you expected say 90 dB SPL, but actually measured 96 dB SPL, you could add an additional 6 dB attenuation to a PA4 to calibrate the system. This value will be used by SigPlay for all of the signals that are played, and added to any attenuation specified by the SigGen file.

If you are unable to produce a signal in the 7-10 V range using the settings in the Calibration dialog box, you will have to go back to SigGen and adjust the level of the tone in the segment or component dialog boxes.

#### **Method 2: Using a microphone with a TDT A/D.**

If you are using a TDT A/D converter, connect channel 3 of the TG6 to the TRIG input on the A/D converter. This will synchronize data acquisition with sound presentation.

1. Connect the microphone to an appropriate microphone amplifier and then connect the output to the A/D converter. Remember that all TDT modules work with a 10 V peak maximum signal. Any signal voltage over this will be clipped by the A/D and could possibly damage the device. Check the output of the microphone amplifier on an oscilloscope before connecting it to the A/D converter.
2. Choose Calibrate from the SetUp menu.
3. In the Tone Calibration section enter 1000 Hz and 9 V into the appropriate boxes.
4. In the Monitoring A/D Channel section, select Chan-1 and enter the calibration of the microphone and the gain on the microphone amplifier (the gain is on a linear scale, not a dB scale).
5. Click on the Play button in the Tone Calibration section to start playing the tone and beginning acquisition on the A/D.

- The Monitored Level box on top of the plots displays the rms SPL of the time waveform, and the peak frequency and its SPL. Use these values to adjust either the SigGen Calibration or the attenuation on an attenuator as described above.

## Setup Triggering

**Trigger Setup**

TDT Triggering

External Triggering Setup

External  Trigger For Each SGI  
 Trigger For Each Repeat  
 Use 1 us TG6 base rate

Repeats per SGI: 50 (0=contin) Constant  
Repeat Rate (Hz): 5 max= 8.00 Constant

Inter-SGI Delay (ms): 100  Continuous Repeat Play

OddBall Setup

Oddball Presentation

Oddball Ratio (OddBall/Base): 0.1  
Oddball Window: 0

New Randomization Each SGI  
 Non-Random Presentation  
 Save Neuroscan .vec Files  
File Prefix (4 letters):  
 Notify When Vector File Saved

OK  
Cancel

In the Trigger Setup dialog box we will select TDT triggering and set the number of repeats and repeat rate for each SGI.

- Choose Trigger from the SetUp menu.
- Click on the TDT Triggering button to use SigPlay control of signal play.
- Enter the number of repeats for each SGI. In this case enter 50.
- Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 5.
- Click OK.

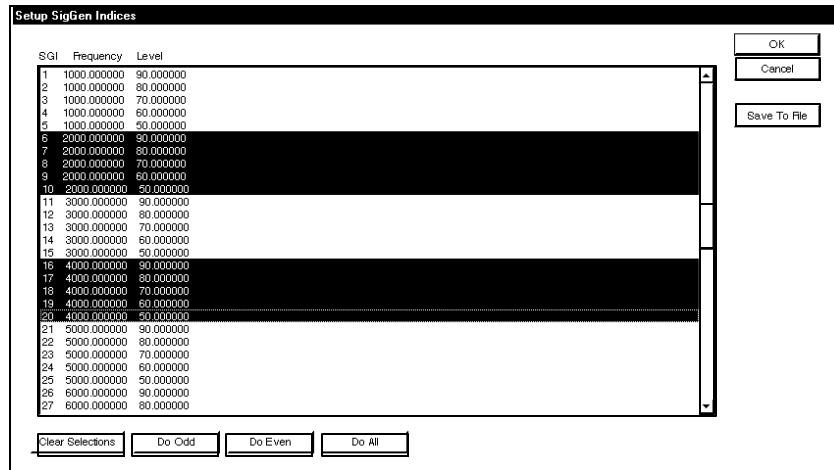
## Play

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.

Each SGI will be played 50 times with 5 repeats per second. At the end of each SGI, the SGI will be incremented and the next SGI will begin to play.

## Playing a subset of SGI's



If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play. In this example only the 2000 Hz and 4000 Hz presentations were selected.
4. Click OK, and restart Play.

## Example 2: *Playing a tone with external triggering of the TG6*



Example 2 uses the same SigGen signal as Example 1, but configures triggering so that sounds will only be played when the TG6 is externally triggered. The files for this example can be found in `c:\tdt\siggen\sigplay\examples`

Exam_1.sig	Example 1 SigGen File
Exam_2.spl	Example 2 SigPlay File


### SigGen File

This SigGen file is the same as the SigGen file used in Example 1.

### Required Hardware

 D/A

 TG6

 External system to produce trigger pulses

## Configuring SigPlay

### Quick Start

If you want to get an idea of how this example runs, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

3. Choose Open from the File menu.
4. Open Exam\_2.spl

#### Configure TDT Hardware

3. Connect TG6 channel 2 to D/A TRIG connector.
4. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.
5. Connect your external systems trigger to the TRIG input on the TG6

#### To Start Playing

3. Choose Play from the Play menu, or
4. Click on the Play icon on the toolbar.
5. Send a trigger to the TG6 from the external system.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_1.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

### Calibrate the System

Follow the directions for calibration later in this chapter.

## Setup Triggering

In the Trigger Setup dialog box we will select external triggering with a trigger for each SGI and set the number of repeats and repeat rate for each SGI. When the TG6 is triggered externally it will trigger all of the repeats for that SGI.

1. Choose Trigger from the SetUp menu.
2. Click on the External Triggering button to use SigPlay control of signal play.
3. Click on the Trigger for Each SGI button.
4. Enter the number of repeats for each SGI. In this case enter 50.
5. Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 5.
6. Click OK.

## Play

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.
3. Start the external trigger to trigger the TG6.

Each SGI will be played 50 times with 5 repeats per second for each external trigger to the TG6. At the end of each SGI, the SGI will be incremented and the next SGI will begin to play when a new trigger signal is received by the TG6.

### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

## Example 3: Specifying SGI's from an external system



Example 3 uses the same SigGen signal as Example 1, but configures triggering so that sounds will only be played when the TG6 is externally triggered and SGI's are specified by a bit pattern sent to the PI2 Parallel Interface. The files for this example can be found in `c:\tdt\siggen\sigplay\examples`

Exam_1.sig	Example 1 SigGen File
Exam_3.spl	Example 3 SigPlay File

### SigGen File

This SigGen file is the same as the SigGen file used in Example 1.

### Required Hardware

D/A

TG6

PI2

External system to produce trigger pulses

External system to produce bit patterns corresponding to each SGI

## Configuring SigPlay

### Quick Start

If you want to get an idea of how this example runs, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_3.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.
3. Connect your external systems trigger to the TRIG input on the TG6
4. Connect your external system to the PI2 Port A/B to specify the bit pattern.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.
3. Send a bit pattern to the PI2 from the external system.
4. Send a trigger to the TG6 TRIG from the external system.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_1.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

### Calibrate the System

Follow the directions for calibration later in this chapter.

## Setup Triggering

In the Trigger Setup dialog box we will select external triggering with a trigger for each SGI and set the number of repeats and repeat rate for each SGI. When the TG6 is triggered externally it will trigger all of the repeats for that SGI.

1. Choose Trigger from the SetUp menu.
2. Click on the External Triggering button to use SigPlay control of signal play.
3. Click on the Trigger for Each SGI button.
4. Enter the number of repeats for each SGI. In this case enter 50.
5. Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 5.
6. Click OK.

## Setup PI2

In the PI2 setup we will select PI2 SGI specification. This will allow the PI2 Parallel Interface to read bit patterns that specify individual SGI's, and allow the external system to not only control when signals play, but what signals play.

1. Choose PI2 from the SetUp menu.
2. Use the testing section of this dialog box to test for correct connection of the external system with the PI2. Click on the Read button to read the current pattern on the PI2, or the Continuous button to continuously read the pattern on the PI2.
3. Check the Use PI2 for SGI Specification box.

## Play

After configuring the TG6 and PI2 we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.
3. Start the external system so that a bit pattern is sent to the PI2.
4. Start the external trigger to trigger the TG6 to trigger play of that SGI.

Each SGI will be played 50 times with 5 repeats per second. At the end of each SGI, the system will wait for a new bit pattern on the PI2 before accepting another trigger to the TG6.

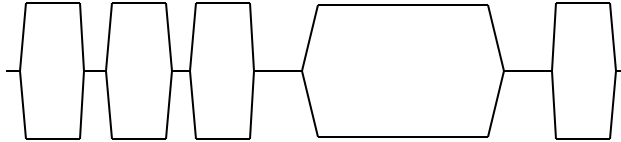
### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.



## Example 4: Oddball Presentation



In the OddBall paradigm, one signal known as the base stimulus is repeated many times, while a signal known as the OddBall is presented randomly and rarely. SigPlay implements the Oddball Paradigm using the signal loaded into channel 1 as the base stimulus and the signal loaded into channel 2 as the OddBall stimulus. Both stimuli are played out of channel 1 of the D/A.

The files for this example can be found in `c:\tdt\sigen\sigplay\examples`

Exam_41.sig	SigGen File for Base Stimulus
Exam_42.sig	SigGen File for Oddball Stimulus
Exam_4.spl	Example 4 SigPlay File

### SigGen File

The SigGen file for the base stimulus is the same as the SigGen file used in example 1. The SigGen file used for the OddBall stimulus is simply a 500 Hz tone.

### Required Hardware

D/A

TG6

### Other Configurations

This example could also be run with:

External triggering of signal play

External SGI specification

## Configuring SigPlay

### Quick Start

If you want to get an idea of what SigPlay will do, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_4.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.

SigPlay is configured in the same way as example 1, with the addition of loading a second SigGen file and specifying Oddball Presentation in the trigger setup.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal that will be the base stimulus. Select Exam\_41.sig.
4. Click on the browse button next to the Channel 2 line. This will load the SigGen stimulus that will be the Oddball stimulus. Select Exam\_42.sig.
5. Click OK to exit the dialog box.

You should now see the SigGen signals displayed in the main window.

## Calibrate the System

Calibrate the system as described in the Calibration section later in this chapter. Remember only channel 1 will be used to play both the base and OddBall stimuli. However, you could specify a separate SigGen calibration for the Oddball stimulus by calibrating Channel 2 in the Calibration dialog.

## Setup Triggering and Oddball Presentation

In the Trigger Setup dialog box we will select TDT triggering and set the number of repeats and repeat rate for each SGI. We will also choose Oddball presentation.

1. Choose Trigger from the SetUp menu.
2. Click on the TDT Triggering Radio Button to use SigPlay control of signal play.
3. Enter the number of repeats for each SGI. In this case enter 100.
4. Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 8.
5. In the Oddball Setup Section:
  - a) Check Oddball Presentation

- b) Select an OddBall ratio. For this example enter 0.1. This means 10 out of every 100 repeats played will be the OddBall stimulus.
  - c) Select an OddBall Window. A truly random presentation would have an OddBall window of 0. If you do not want to allow two OddBall presentations to be presented in a row, Enter 1 for the OddBall window.
  - d) Check New Randomization for Each SGI: This will give a new order of presenting the OddBall stimulus for each SGI.
  - e) Check Save Neuroscan .vec file and enter the file prefix test. This will save a text file of the order of presentation that can be used by the Neuroscan system to sort base and OddBall acquisitions.
  - f) Check Notify When Vector File Saved. This will give a notification before each SGI when a new vector file is saved.
6. Click OK.

## **Play**

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.

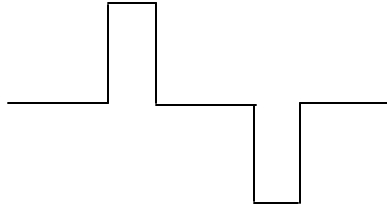
Each SGI will be played 100 times with 8 repeats per second. 90 of these presentations will be the base stimulus, and 10 will be the OddBall stimulus. At the end of each SGI, the pattern of presentation will be randomized and the SGI will be incremented and the next SGI will begin to play.

## **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

## Example 5: Alternating Phase



This example takes advantage of the OddBall presentation to present clicks with alternating polarity. If OddBall presentation were not used, and the polarity was defined as an alternating variable, then the variable would only alternate for each new SGI.

The files for this example can be found in `c:\tdt\sigen\sigplay\examples`

Exam_51.sig	SigGen File for positive click
Exam_52.sig	SigGen File for negative click
Exam_5.spl	Example 5 SigPlay File

### SigGen Files

In this example two SigGen files are used, with clicks of opposite polarity. One will be used as a 'base' stimulus and one as an 'OddBall' but each will be presented with equal frequency in a non-random fashion.

### Required Hardware

 D/A

 TG6

### Other Configurations

This example could also be run with:

 External triggering of signal play

 External SGI specification

## Configuring SigPlay

### Quick Start

If you want to get an idea of what SigPlay will do, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_5.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.

SigPlay is configured in the same way as example 1, with the addition of loading a second SigGen file and specifying Oddball Presentation in the trigger setup.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal that will be the base stimulus. Select Exam\_41.sig.
4. Click on the browse button next to the Channel 2 line. This will load the SigGen stimulus that will be the Oddball stimulus. Select Exam\_42.sig.
5. Click OK to exit the dialog box.

You should now see the SigGen signals displayed in the main window.

## Calibrate the System

Calibrate the system as described in the Calibration section later in this chapter. Remember only channel 1 will be used to play both the base and OddBall stimuli. However, you could specify a separate SigGen calibration for the Oddball stimulus by calibrating Channel 2 in the Calibration dialog.

## Setup Triggering and Oddball Presentation

**Trigger Setup**

TDT Triggering

External Triggering Setup

External  Trigger For Each SGI

Trigger For Each Repeat

Use 1 us TG6 base rate

Repeats per SGI: 50 (0=contin)

Repeat Rate (Hz): 8 max= 80.0

Inter-SGI Delay (ms): 100  Continuous Repeat Play

OddBall Setup

Oddball Presentation

Oddball Ratio (OddBall/Base): 0.1

Oddball Window: 0

New Randomization Each SGI

Non-Random Presentation

Save Neuroscan .vec Files

File Prefix (4 letters): test

Notify When Vector File Saved

OK Cancel

In the Trigger Setup dialog box we will select TDT triggering and set the number of repeats and repeat rate for each SGI. We will also choose Oddball presentation.

1. Choose Trigger from the SetUp menu.
2. Click on the TDT Triggering Radio Button to use SigPlay control of signal play.
3. Enter the number of repeats for each SGI. In this case enter 100.
4. Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 8.
5. In the Oddball Setup Section:

- a) Check Oddball Presentation
  - b) Select an OddBall ratio. For this example enter 0.5. This means each stimulus will be presented 50 times per SGI.
  - c) The OddBall Window value is not used because Non-Random Presentation is used.
  - d) Uncheck New Randomization for Each SGI and check Non-Random Presentation. Non-random presentation will equally distribute the base and OddBall stimuli. The first repeat will be the OddBall stimulus.
  - e) Uncheck Save Neuroscan .vec file and Notify when .vec file saved.
6. Click OK.

### **Play**

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.

Each SGI will be played 100 times with 8 repeats per second. The base and OddBall stimuli will alternate. At the end of each SGI, the SGI will be incremented and the next SGI will begin to play.

### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

## Example 6: Long duration tone using continuous play



This example uses the Continuous Play feature of SigPlay to generate a 10 second tone. An 81 ms SigGen signal is repeated 123 times to produce the 10 second continuous tone.

The files for this example can be found in c:\tdt\siggen\sigplay\examples

Exam_6.sig	Example 6 SigGen File
Exam_6.spl	Example 6 SigPlay File

### SigGen File

*See the SigGen manual for more information on generating signals in the frequency domain.*

This SigGen file generates a tone in the frequency domain, which is a radix-2 number of points. This ensures that the beginning and ending voltages of the signals are the same, so there is no click when the signal is repeated. This was accomplished in SigGen by clicking on the Rad-2 button in the Modify Signal dialog box, and making the segment equal to the signal duration.

### Required Hardware

 D/A

 TG6

### Other Configurations

This example could also be run with:

 External triggering of signal play

 External SGI specification

## Configuring SigPlay

### Quick Start

If you want to get an idea of what SigPlay will do, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_6.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_6.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

### Calibrate the System

Calibrate the system by following the directions at the end of this chapter.

## Setup Triggering

In the Trigger Setup dialog box we will select TDT triggering and set the number of repeats and repeat rate for each SGI.

1. Choose Trigger from the SetUp menu.
2. Click on the TDT Triggering Radio Button to use SigPlay control of signal play.
3. Enter the number of repeats for each SGI. In this case enter 123.
4. Click on the Continuous Repeat Play button. The repeat rate edit box will be grayed out.
5. Click OK.

## Play

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.

Each SGI will be played for 123 repeats, which corresponds to 10 seconds. Note that only one trigger signal is produced per SGI by the TG6 when using continuous play. Essentially the D/A loops back on the signal in the play buffer repeatedly until the number of repeats have been played.

### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

## Example 7: Variable Repeat Rate



Example 7 shows how to use a SigGen variable to play repeats with a variable repeat rate for different SGI's. This example is the same as example 1, but with an additional variable for Repeat Rate in the SigGen signal that is used in the Trigger SetUp. Note that the repeat rate is not variable within each SGI, but between SGI's.

The files for this example can be found in c:\tdt\siggen\sigplay\examples

Exam_7.sig	Example 7 SigGen File
Exam_7.spl	Example 7 SigPlay File

### SigGen File

This SigGen file is similar to Example 1 in the SigGen manual. If you are not familiar with SigGen, work through SigGen Example 1 first.

This SigGen file will produce a 100 ms tone blip with 10 different frequencies and 5 different repeat rates per frequency.

### Required Hardware

 D/A

 TG6

### Other Configurations

This example could also be run with:

 External triggering of signal play

 External SGI specification

## Configuring SigPlay

### Quick Start

If you want to get an idea of what SigPlay will do, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_7.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.

## Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_7.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

## Calibrate the System

Follow the directions under Calibration later in this chapter.

## Setup Triggering

The screenshot shows the 'Trigger Setup' dialog box with the following settings:

- TDT Triggering:** Selected (radio button).
- External Triggering Setup:**
  - External: Unselected (radio button).
  - Trigger For Each SGI: Selected (radio button).
  - Trigger For Each Repeat: Unselected (radio button).
  - Use 1 us TG6 base rate: Unselected (checkbox).
- Repeats per SGI:** 50 (text box).
- Repeat Rate (Hz):** 1 (text box), max= 8.00.
- Inter-SGI Delay (ms):** 100 (text box).
- Continuous Repeat Play:** Unselected (checkbox).
- Oddball Setup:**
  - Oddball Presentation: Unselected (checkbox).
  - Oddball Ratio (OddBall/Base): 0.1 (text box).
  - Oddball Window: 0 (text box).
  - New Randomization Each SGI: Selected (checkbox).
  - Non-Random Presentation: Unselected (checkbox).
  - Save Neuroscan .vec Files: Unselected (checkbox).
  - File Prefix (4 letters): (empty text box).
  - Notify When Vector File Saved: Selected (checkbox).

In the Trigger Setup dialog box we will select TDT triggering and set the number of repeats and repeat rate for each SGI.

1. Choose Trigger from the SetUp menu.
2. Click on the TDT Triggering Radio Button to use SigPlay control of signal play.
3. Enter the number of repeats for each SGI. In this case enter 50.
4. Set the repeat rate for the repeated signals by selecting the variable *RepeatRate* from the drop down box.
5. Click OK.

### **Play**

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.

Each SGI will be played 50 times with the repeat rate specified by the variable *RepeatRate*. At the end of each SGI, the SGI will be incremented and the next SGI will begin to play.

### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

## **Example 8: Single unit neurophysiology with external triggering.**



This example demonstrates the use of external triggering to trigger signal presentation in the situation where the timing of signal presentation has to be very precise (microsecond accuracy).

Example 8 uses the same SigGen signal as Example 2, but configures triggering so that sounds will only be played when the TG6 is externally triggered for each repeat and uses a 1 ?s base rate on the TG6. The files for this example can be found in c:\tdt\siggen\sigplay\examples

Exam\_8.sig            Example 8 SigGen File

Exam\_8.spl            Example 8 SigPlay File


### **SigGen File**

This SigGen file is the same as the SigGen file used in Example 1.

### **Required Hardware**

 D/A

 TG6

 External system to trigger TG6

### **Other Configurations**

This example could also be run with:

 External SGI specification

## Configuring SigPlay

### Quick Start

If you want to get an idea of what SigPlay will do, follow these steps to load and play this example in SigPlay. Then work through the detailed steps below to learn how to set up this example.

**Start SigPlay.** Remember to quit SigGen before running SigPlay.

#### To use the SigPlay file:

1. Choose Open from the File menu.
2. Open Exam\_8.spl

#### Configure TDT Hardware

1. Connect TG6 channel 2 to D/A TRIG connector.
2. Connect output of D/A channel 1 to HB6, MS1, or some other amplifier or speaker.
3. Connect your external systems trigger to the TRIG input on the TG6

#### To Start Playing

1. Choose Play from the Play menu, or
2. Click on the Play icon on the toolbar.
3. Send a trigger to the TG6 from the external system.

### Loading the SigGen Signal

1. Start SigPlay. Remember to quit SigGen before running SigPlay.
2. Choose Setup SigGen signals from the SetUp menu.
3. Click on the browse button next to the Channel 1 line. This will open up a dialog to let you open the SigGen signal for playing out of D/A channel 1. Select Exam\_1.sig.
4. Click OK to exit the dialog box.

You should now see the SigGen signal displayed in the main window.

### Calibrate the System

Follow the directions for calibration later in this chapter.

## Setup Triggering

**Trigger Setup**

TDT Triggering

External Triggering Setup

External  Trigger For Each SGI

Trigger For Each Repeat

Use 1 us TG6 base rate

Repeats per SGI (0=contin):

Repeat Rate (Hz):  max= 8.00

Inter-SGI Delay (ms):   Continuous Repeat Play

**OddBall Setup**

Oddball Presentation

Oddball Ratio (OddBall/Base):

Oddball Window:

New Randomization Each SGI

Non-Random Presentation

Save Neuroscan .vec Files

File Prefix (4 letters):

Notify When Vector File Saved

OK Cancel

In the Trigger Setup dialog box we will select external triggering with a trigger for each repeat and set the number of repeats and repeat rate for each SGI.

1. Choose Trigger from the SetUp menu.
2. Click on the External Triggering button to use SigPlay control of signal play.
3. Click on the Trigger for Each Repeat button.
4. Check Use 1 ?s TG6 base rate. This check box will only work for external triggering on each repeat.
5. Enter the number of repeats for each SGI. In this case enter 50.
6. Enter the repeat rate for the repeated signals. The maximum repeat rate that SigPlay will accept is shown next to this box. Enter 5.
7. Click OK.

## Play

After configuring the trigger setup we are ready to play the signal.

1. Make sure TG6 channel 2 is connected to the TRIG input on the D/A.
2. Choose Play from the Play menu.
3. Start the external trigger to trigger the TG6.

Each SGI will be played once for every trigger sent to the TG6. After 50 repeats, the SGI will be incremented and the next SGI will begin to play.

### **Playing a subset of SGI's**

If you do not want to play all of the SGI's, you can select a subset to play.

1. Choose Channel 1 under SigGen Indices in the SetUp menu.
2. A list of the SGI's and the variable values for those SGI's will be displayed.
3. Use the mouse or the buttons on the bottom of the dialog to select which SGI's you want to play.
4. Click OK, and restart Play.

# Chapter 6 Calibration

To calibrate the system, a 9V 1000 Hz tone will be played out of the D/A. We want to measure how loud a tone is produced by our speaker when we play this 9V tone, and then adjust our calibration settings.

## Method 1: Using a sound level meter

Use this method if you do not have a TDT A/D converter.

1. Choose Calibrate from the SetUp menu.
2. In the Tone Calibration section enter 1000 Hz and 9 V into the appropriate boxes.
3. Click on Play to begin playing the calibration tone.
4. Measure the actual SPL produced by this tone with a Sound Level Meter.
5. If the measured SPL is different from the calibration shown in the Current SigGen Specification box, there are two options.
  - a) Calibrate the system by changing the SigGen Calibration Setting: Enter the measured SPL and 9 V in the appropriate boxes in the SigGen Calibration Setting. Then click on the Update button to update these settings in SigPlay. Your SigGen signal will be recalculated based on these settings. However, the settings in the actual SigGen file will not be changed. There are two potential problems with this approach:
    - i. The signal could be clipped after changing the setting, because the signal exceeds the 10V maximum signal the D/A is capable of producing. This will look like squared off peaks on the signal plot.
    - ii. The signal voltage will be so low that the signal to noise ratio is very poor. If the newly calibrated signal is in the mV range you will not be taking full advantage of the dynamic range of the D/A converter. It is always best to try to produce signals in the 7-10 V range, without exceeding 10 V, and using an attenuator to control sound level.
  - b) Calibrate the system by adjusting the attenuation on a PA4 Programmable Attenuator. If you expected say 90 dB SPL, but actually measured 96 dB SPL, you could add an additional 6 dB attenuation to a PA4 to calibrate the system. This value will be used by SigPlay for all of the signals that are played, and added to any attenuation specified by the SigGen file.

If you are unable to produce a signal in the 7-10 V range using the settings in the Calibration dialog box, you will have to go back to SigGen and adjust the level of the tone in the segment or component dialog boxes.

**Method 2: Using a microphone with a TDT A/D.**

If you are using a TDT A/D converter, connect channel 3 of the TG6 to the TRIG input on the A/D converter. This will synchronize data acquisition with sound presentation.

1. Connect the microphone to an appropriate microphone amplifier and then connect the output to the A/D converter. Remember that all TDT modules work with a 10 V peak maximum signal. Any signal voltage over this will be clipped by the A/D and could possibly damage the device. Check the output of the microphone amplifier on an oscilloscope before connecting it to the A/D converter.
2. Choose Calibrate from the SetUp menu.
3. In the Tone Calibration section enter 1000 Hz and 9 V into the appropriate boxes.
4. In the Monitoring A/D Channel section, select Chan-1 and enter the calibration of the microphone and the gain on the microphone amplifier (the gain is on a linear scale, not a dB scale).
5. Click on the Play button in the Tone Calibration section to start playing the tone and beginning acquisition on the A/D.
6. The Monitored Level box on top of the plots displays the rms SPL of the time waveform, and the peak frequency and its SPL. Use these values to adjust either the SigGen Calibration or the attenuation on an attenuator as described above.