Audio/Visual Device

Technical Manual

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Technical Manual

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PREFACE

The Audio/Visual (AV) Device from Electrical Geodesics, Inc. (EGI) is a product for verifying the accuracy of stimulus-presentation timing for event-related potentials (ERPs). The AV Device can be used for two purposes:

- To verify that the system timing is correct.
- To verify that an experiment is programmed correctly.

Designed to work with EGI's Net Station electroencephalography (EEG) acquisition, analysis, and review software, the AV Device is an option to Geodesic EEG Systems (GES) that are configured for experiment control. These GES can operate in conjunction with either a PC-based experiment-control system that is available from EGI or with your own experiment setup. This manual describes EGI's experiment-control system, which uses E-Prime software from Psychology Software Tools (PST; www.pstnet.com).

Note: For more information about using the AV Device with other experiment-control software and setups, contact EGI Technical Support (Appendix A).

Related Manuals

This manual, the *Audio/Visual Device Technical Manual*, describes timing theory, the AV Device's features, visual-stimulus testing, auditory-stimulus testing, the Event Timing Tester, and troubleshooting tips. Because this manual describes only one component of the experiment-control process, it will be helpful to consult other documentation from EGI and PST when using the AV Device to conduct timing tests.

EGI Documentation

Descriptions related to experiment control are included in two other EGI manuals:

- *Net Station Acquisition Technical Manual*: describes the features of the Multi-Port Experimental Control Interface (ECI) device.
- *GES Hardware Technical Manual*: describes the ECI setup and experiment-control protocol.

These and other technical manuals from EGI are posted as PDF files at www.egi.com/documentation.html. Brief descriptions of EGI's products and documentation follow.

Hardware related

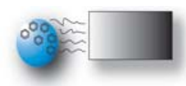
- The Geodesic Sensor Net (GSN) is EGI's patented device for acquiring electrical signals from the human scalp. The *Geodesic Sensor Net Technical Manual* provides comprehensive descriptions of all GSN features and functions.

- GES hardware is all the system hardware except for the GSN. GES hardware supports the acquisition and processing of EEG data and includes an amplifier, a data-acquisition computer, a monitor, and, in most cases, a cart or travel case. The *GES Hardware Technical Manual* provides comprehensive descriptions of all GES hardware components and features.

- The Geodesic Photogrammetry System (GPS) is EGI's photogrammetry-based sensor-registration system. The GPS consists of a geodesic dome structure containing 11 mounted cameras, a steel supporting structure, and the Photogrammetry software feature in Net Station. The *Geodesic Photogrammetry System Technical Manual* provides comprehensive descriptions of all GPS components and features.

Software related

- The Net Station Acquisition is the component of the Net Station software for acquiring EEG, in conjunction with the dense-array Geodesic Sensor Nets. The *Net Station Acquisition Technical Manual* provides comprehensive descriptions of all Acquisition features and functions.



- The Net Station Viewer is the component of Net Station for viewing and navigating EEG data. The *Net Station Viewer Technical Manual* provides comprehensive descriptions of all Viewer features and functions.

- The Net Station Waveform Tools is the component of Net Station for performing various operations on EEG data. The *Net Station Waveform Tools Technical Manual* provides comprehensive descriptions of all Waveform Tools features and functions.

- The *Net Station Viewer and Waveform Tools Tutorial* instructs you in the use of Net Station Viewer and Waveform Tools by guiding you through the analysis of a sample data set. It is not intended to be a comprehensive guide to these components, but it is a good place to start when learning about the software.

- The *Net Station File Formats Technical Manual* documents the objects contained in a native Net Station file, the formats of the export files, and other files associated with Net Station.

These publications contain a good deal of background information on the EEG/ERP field. However, they are not intended to represent a complete primer. To get the most out of these manuals, you should have some background in EEG/ERP methods.

Each manual assumes you are familiar with the Macintosh computer, the platform for Net Station.

PST Documentation

PST produces two technical manuals that describe how to use E-Prime with Net Station. These technical manuals are also available as PDF files at www.egi.com/documentation.html. Brief descriptions of each manual follow:

- E-Prime Extensions for Net Station (EENS) is a set of software extensions to E-Prime that allow Ethernet communication between Net Station and E-Prime during the run of an experiment. The *E-Prime Extensions for Net Station User Manual* describes EENS and single-clock timing, and EENS contains a set of sample experiments that can be run directly, or used as a basis from which to create new experiments.
- The E-Prime Biological Add-ons to Net Station (EBANS) is similar to EENS, except it is designed for serial communication between Net Station and E-Prime. The *E-Prime Biological Add-ons to Net Station User Manual* describes EBANS and how to compute clock-scaling factors, and EBANS contains a set of sample experiments that can be run directly, or used as a basis from which to create new experiments. EBANS has been superseded by EENS, but it is included in this manual for users who have not yet upgraded to EENS.

PST also produces a manual that describes how to use E-Prime to program experiments:

- E-Prime is a comprehensive suite of applications—E-Studio, E-Basic, E-Run, E-Merge, E-Data Aid, and E-Recovery—for generating experiments, collecting data, and handling and processing data. Though the *E-Prime User's Guide*, which describes how to use E-Prime to program experiments, should be read in its entirety, readers of the *Audio/Visual Device Technical Manual* will find Chapter 3, "Critical Timing in E-Prime," particularly useful. The *E-Prime User's Guide* is available from PST (www.pstnet.com).

About This Manual

This section describes this manual's features, organization, conventions and typography, and use of notes and cautions.

Features

This manual is supplied as a PDF file and in printed form. The hard-copy version has been printed from the PDF so the content of both will match.

Manual Organization

This manual features a table of contents, list of figures, list of tables, and index, which in the PDF are all hyperlinked to the topics they reference in the manual.

The chapters fall into four main categories:

- *Background*: Chapter 1, "Technical Overview," describes the AV Device and basic timing technology.
- *Testing*: Chapter 2, "Visual-Stimulus Testing," and Chapter 3, "Auditory-Stimulus Testing," describe how to use the AV Device to conduct timing tests of visual- and auditory-stimuli presentation.
- *Results and Solutions*: Chapter 4, "Event Timing Tester," describes the Event Timing Tester analysis software, which allows you to evaluate the results of the auditory or visual timing tests. The Event Timing Tester produces a file that compares the offsets between Net Amps digital input (DIN) and Net Station Experimental Control Interface (ECI) events, and allows you to determine the precision of the stimuli presentation. The chapter offers solutions to issues such as clock drift, time offsets, and other timing errors.
- *Troubleshooting*: Chapter 5, "Troubleshooting," describes common AV Device problems and solutions.

For further assistance with the AV Device, please contact EGI Technical Support (Appendix A).

Conventions and Typography

- In this manual, the following are treated as synonyms: *Audio/Visual Device* and *AV Device*.
- Older versions of the device may be labeled “AV Tester”; however, because of regulatory concerns, the manual refers to the device as the “AV Device.”
- In general, a minimal amount of special fonts are used in this manual—*italics* for definitions or newly introduced terms, ***boldface italics*** for important concepts, and **boldface** for command paths (such as, **File > Save**).

Additional Information

Two different methods are used to convey additional information: notes and cautions.

Note: This indicates information that is helpful in understanding AV Device operations.

Caution!: *This denotes important information that, if unheeded, could hinder use of the product or result in injury or equipment damage.*

Troubleshooting and Support

- Chapter 5, "Troubleshooting,” is a troubleshooting guide.
- For online updates to this book, check EGI’s Documentation page at www.egi.com/documentation.html.
- For AV Device technical support, see Appendix A, "Technical Support.”

The EGI Documentation page at www.egi.com/documentation.html

chapter 1

TECHNICAL OVERVIEW

The Audio/Visual (AV) Device from Electrical Geodesics, Inc. (EGI) is designed to work with EGI Geodesic EEG Systems (GES) that are configured to operate with experiment-control systems to conduct event-related potential (ERP) studies. The AV Device can be used for two purposes:

- To verify that the system timing is correct.
- To verify that an E-Prime experiment is programmed correctly.

The topics covered in this chapter include when to use the AV Device, an overview of AV Device operations, the AV Device package, AV Device features, basic event timing theory, and the effect of miscorrelation.

When to Use the AV Device

The AV Device is designed for use by both EGI personnel and customers in the following cases:

- *Before a GES is shipped with an experiment-control setup*: EGI uses the AV Device and an EGI E-Prime timing file to verify that the system timing is operating within specifications.
- *During system installation*: After installing the equipment, your EGI Support Engineer uses the AV Device and an EGI E-Prime timing file to verify that the system timing is operating within specifications.
- *Before running a study based on a new paradigm*: The customer should use the AV Device and his or her actual E-Prime experiment before acquiring study data to verify that the system timing is operating within specifications. Out-of-specification results often indicate that the experiment is programmed incorrectly.

- *After making major changes to the hardware and software*: The customer should use the AV Device and an EGI E-Prime timing file to verify that the system timing is operating within specifications. Differences in computers, operating systems, and so forth may affect the timing and require changes to the setup.
- *When troubleshooting timing problems*: The customer should use the AV Device and an EGI E-Prime timing file to help pinpoint suspected timing errors.

EGI provides two E-Prime timing files with your experiment control computer (ECC): *NSTimingTest.es* (for visual stimuli) and *SPTimingTest.es* (for auditory stimuli). You can use the Search function (**Start menu > Search > For Files or Folders**) to locate these files on your ECC or contact EGI Technical Support (Appendix A).

Overview of AV Device Operations

In conjunction with a GES (running Net Station acquisition, review, and analysis software) and an ECC system, the AV Device acquires timing data from ERP studies to measure the timing accuracy of the presentation of the stimuli.

Note: This manual describes how to use the AV Device with a GES and an EGI ECC running E-Prime. However, the device can be used with other experiment-control setups and software; for more information, contact EGI Technical Support (Appendix A).

The AV Device determines accuracy by providing a second, external measure of stimulus onset or offset, independent of the timing reported by the ECC. It does this by sensing an auditory or visual stimulus, thresholding the analog data, and passing the digital result to Net Station for storage and comparison with internal timing.

The Event Timing Tester drag-and-drop analysis software included with the Net Station package calculates the differences between the external and internal measures. Any discrepancy between the two is a timing error. A timing error may be the result of *clock drift* or *time offset* in the presentation of the stimuli. *Clock drift* occurs when a computer's internal clock drifts away from "real" time and from another computer's clock during the duration of an experiment. *Time offset* is the delay between the time a stimulus is reported to have occurred and when it actually occurs in an experiment. Both are described in more detail, on page 59 and page 62. A timing error may also be caused by incorrect programming of the experiment. For more information about programming errors, see Chapter 3, "Critical Timing in E-Prime," in the *E-Prime User's Guide* (www.pstnet.com).

AV Device Package

The AV Device is an option to the GES. The complete AV Device package includes:

- AV Device
- carrying case
- photocell
- photocell holder (supplied in two pieces: base and stem)
- digital input (DIN) patch cable
- power supply cable
- audio cable (1/4 miniplug to dual RCA)
- Event Timing Tester drag-and drop analysis software (described in Chapter 4) located in the Net Station Extras folder
- *Audio/Visual Device Technical Manual*

Table 1-1 shows the hardware components of the AV Device package.

Table 1-1. AV Device package hardware

Carrying case (containing all the hardware)	

Table 1-1. AV Device package hardware

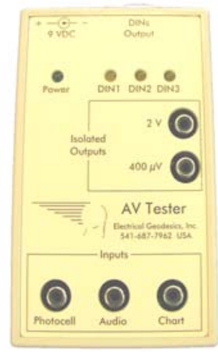
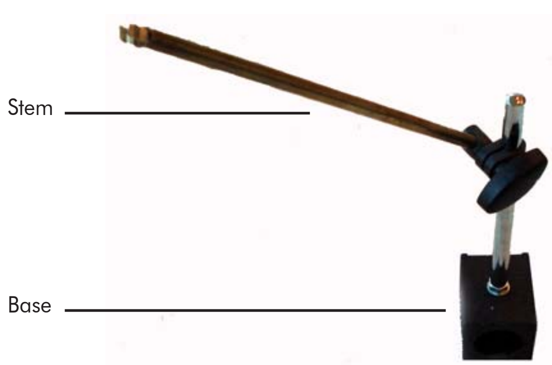
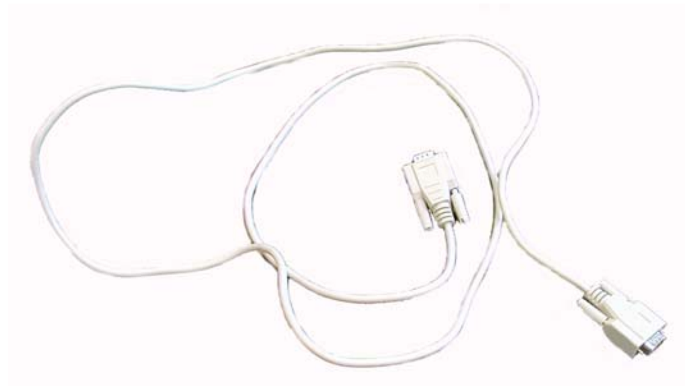
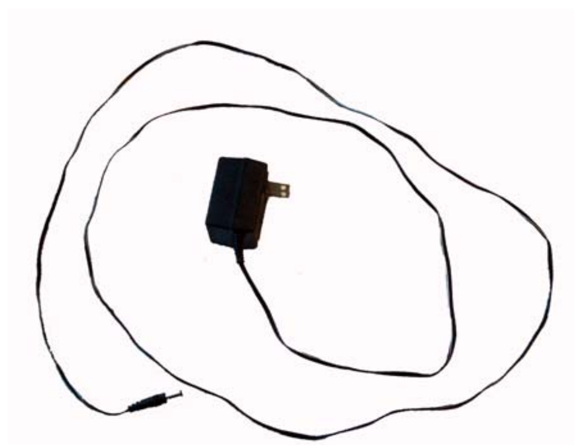
AV Device	
Photocell	
Photocell holder (assembled)	

Table 1-1. AV Device package hardware

DIN patch cable	
Power supply cable	
Audio cable (1/4 miniplug to dual RCA)	

AV Device Features

The AV Device contains a number of features that offer you considerable flexibility for measuring a variety of auditory and visual stimuli.

Figure 1-1 shows the AV Device.

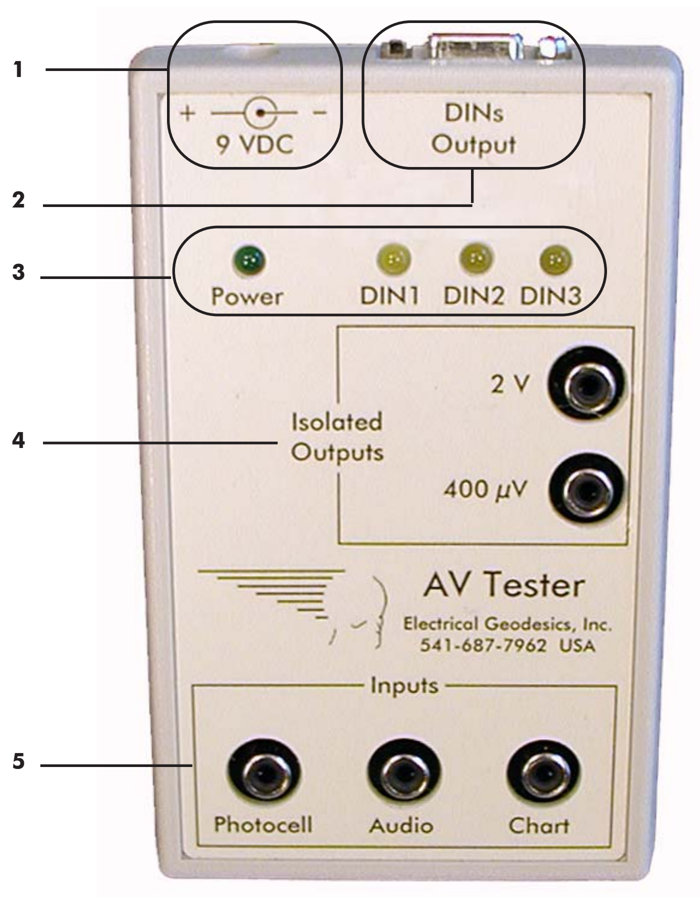


Figure 1-1. The AV Device

The following are brief descriptions of the numbered items from Figure 1-1.

1. 9 VDC port. Provides a receptacle for the plug of the power supply cable. The other end of the power supply cable connects to a surge-suppressed power socket in the experiment room.

2. ***DINs Output port***. Provides digital output with the choice of three duration values, which are described in the next section entitled"DIN Specifics." The DINs Output port is connected to a DIN port on the amplifier via the DIN patch cable.

3. ***Light-emitting diode (LED) lights***. Indicate power-on and DIN activity.

4. ***Isolated Outputs ports***. Provide receptacles for low-level (400 μV) and high-level (2 V) analog outputs. These ports allow the Inputs ports to be recorded as EEG input as well as DINs, so that the timing can be compared. These controls are ***not*** used by EGI and, consequently, are not discussed further in this manual.

5. ***Inputs ports***. Allow input from passive photocells, line-level audio, or strip chart recorders. The Photocell and Audio ports are used for testing visual and auditory stimuli, and are discussed in Chapter 2 and Chapter 3, respectively. The Chart port accepts output from any analog device that has at least 1 Vpp output (e.g., a strip chart recorder). The Chart port is ***not*** used by EGI and, consequently, is not discussed further in this manual.

DIN Specifics

DIN is an acronym for *digital inputs*. During testing with the AV Device, stimuli detected by a photocell or speaker are converted from analog to digital form and transmitted to the amplifier as DIN events by way of the DIN patch cable.

The three duration values of the AV Device digital output are:

- 20 milliseconds
- 100 milliseconds
- Actual

These duration values correspond to the following stimuli type, respectively:

- visual stimuli presented on cathode-ray tube (CRT) monitors
- auditory stimuli
- visual stimuli presented on liquid-crystal display (LCD) monitors

While setting up the testing configuration (described further in "Configuring Net Station" on page 34), you specify the stimuli type in Net Station's Setup Single Channel Input window by selecting the corresponding DIN:

- *DIN 1*: featuring a 20-millisecond duration, this is suitable for visual stimuli presented on CRT monitors
- *DIN 2*: featuring a 100-millisecond duration, this is suitable for auditory stimuli

- *DIN 3*: the actual signal, this is suitable for visual stimuli presented on LCD monitors

If the equipment is connected correctly, the corresponding DIN LED on the AV Device will illuminate accordingly during operation.

Basic Event Timing Theory

To understand how the AV Device works, some background on ERP system configuration and EEG/event miscorrelation is needed.

System Configuration

ERPs are averaged EEG waveforms elicited by external stimuli. Typical external stimuli might be sounds, shapes, or words, though the type of stimulus is limited only by the experimenter's resourcefulness.

EGI offers a two-system approach to ERP studies: the GES and the ECC system.

The GES generally consists of:

- the data-acquisition computer (DAC) running Net Station
- a monitor
- computer peripherals such as a keyboard and a mouse
- a Net Amps 200 or 300 amplifier
- a Geodesic Sensor Net (GSN)
- required cabling
- a subject response pad *(optional)*

The ECC system generally consists of:

- the ECC running the experiment-control software (E-Prime is the software used in the ECC systems offered by EGI)
- an experimenter's monitor
- a stimulation-presentation monitor (for the subject)
- computer peripherals such as a keyboard and a mouse
- external stimuli equipment such as speakers for auditory experiments
- a subject response pad
- required cabling

Figure 1-2 shows the two-system setup for ERP studies, with all the components included. During timing tests, the GSN typically is ***not*** connected to the amplifier.

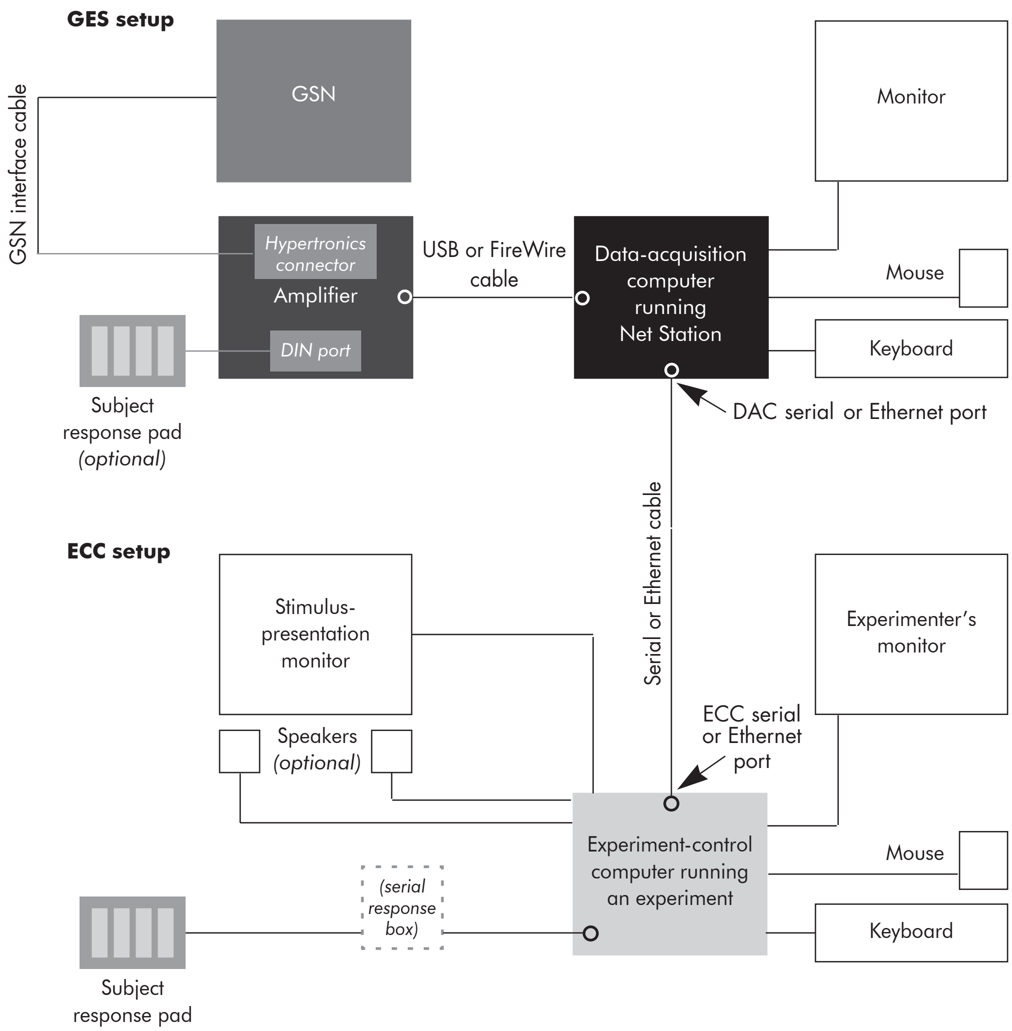


Figure 1-2. Experiment-control diagram

System Overview

The ECC is responsible for presenting auditory or visual stimuli via a screen or speakers, and for establishing or controlling stimulus timing. The ECC communicates timing information, by way of a serial or an Ethernet cable, to the DAC. Net Station registers the data as Experimental Control Interface (ECI) events.

A cable connects the AV Device and the Net Amps amplifier, which transmits the AV Device outputs to the DAC, which is responsible for recording the EEG data, along with the incoming event stream. Net Station registers the AV Device outputs as *DIN events* and the E-Prime event information as *ECI events* in the Events control strip (Figure 1-3).

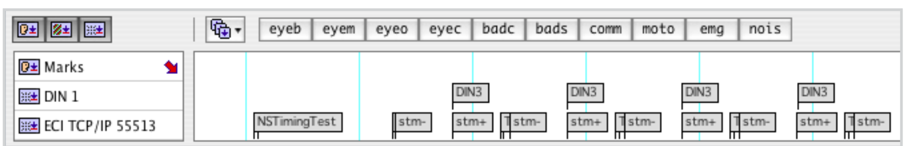


Figure 1-3. ECI and DIN events in Net Station's Events control strip

For more information about data acquisition and experiment control, see the *Net Station Acquisition Technical Manual*, *GES Hardware Technical Manual*, *E-Prime Extensions for Net Station User Manual*, or *E-Prime Biological Add-ons for Net Station User Manual.*

Miscorrelation

EEG data and ECI and DIN events are indexed with respect to time, an essential feature if the ERPs are to be correctly associated with their causal stimuli. Errors in the indexing of either the EEG or the event stream result in miscorrelation between stimulus and EEG.

Clock drift, time offsets, and programming errors are three causes of miscorrelation.

Effect on a Single Recording

For a single trial, miscorrelation has the result of skewing the EEG and the stimulus by some number of milliseconds, potentially confusing what is evoked and what is background EEG.

Effect on Averaged ERPs

For an averaged ERP, miscorrelation between event and EEG has a potentially more serious effect.

Averaged ERPs help determine the constant, cross-subject response to a given stimulus. One way researchers create averaged ERPs is by selecting regions of EEG around a given stimulus type (a process called *segmentation*), aligning all the EEG segments so that their causal events coincide, and averaging the pieces together. What's left is a smoothed ERP, with little of the "incidental" or "background" EEG (Figure 1-4).

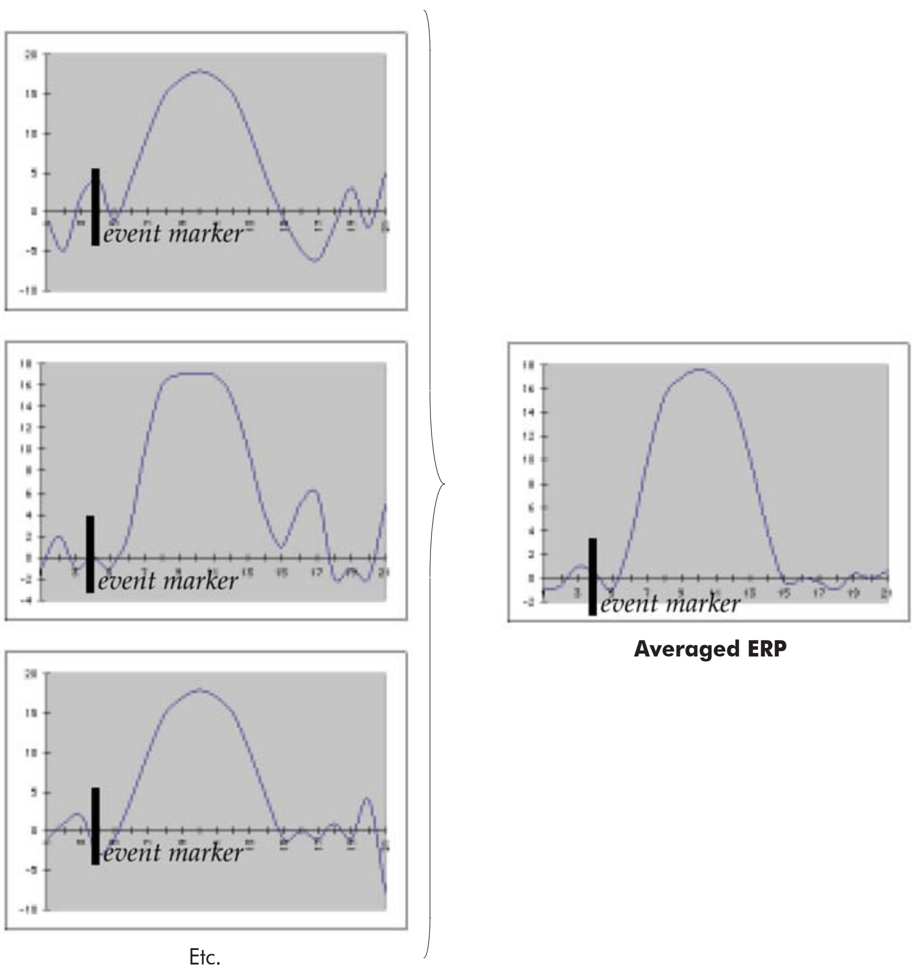


Figure 1-4. Averaged ERP

If offsets between event and EEG vary from segment to segment, the individual EEG segments are misaligned when indexed by causal event (Figure 1-5).

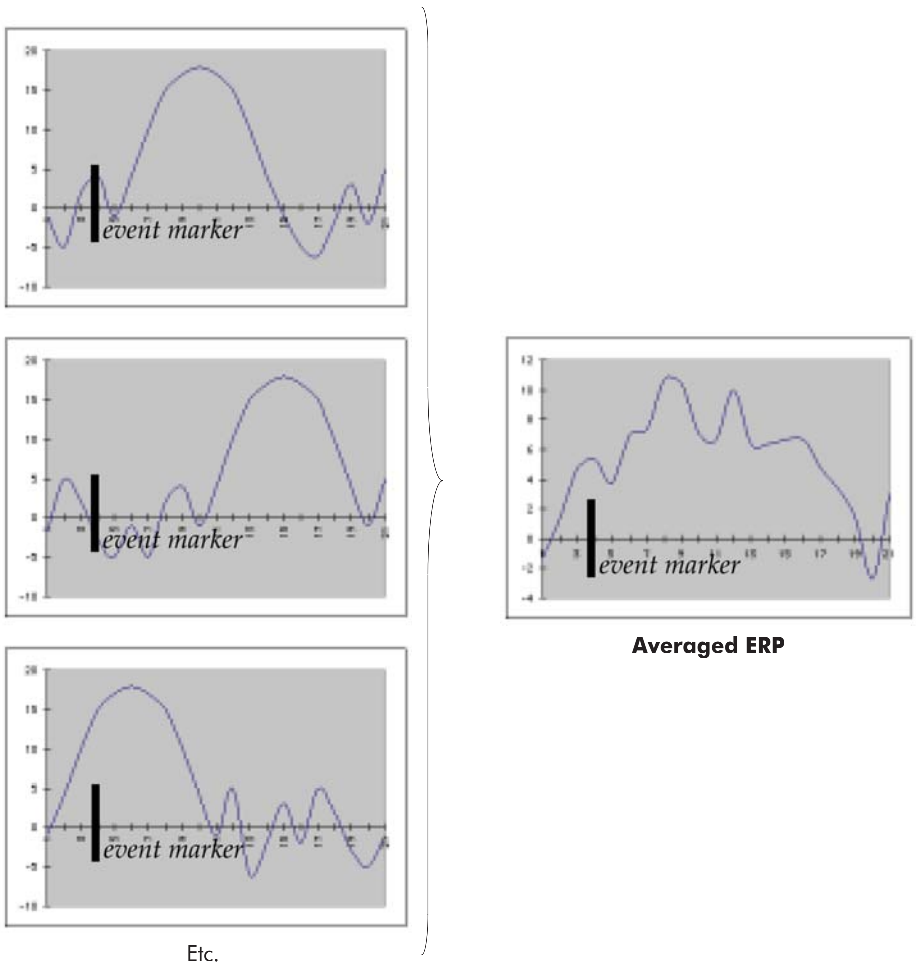


Figure 1-5. Averaged ERP with misalignment

The result is an averaged ERP that is blurred temporally and less distinct than it would be with proper indexing. In extreme cases, the averaged ERP may vanish entirely because of event/EEG miscorrelation.

chapter 2

VISUAL-STIMULUS TESTING

This chapter describes how to test the precision of visual-stimulus presentation, using the AV Device.

The topics covered in this chapter include general considerations (such as basic experiment requirements), hardware configuration, positioning the photocell holder (which involves configuring the software), verifying AV Device functionality, and test instructions.

General Considerations

The EGI E-Prime timing test meets all the testing requirements. If you are testing the timing of your own E-Prime visual-stimulus experiment, the experiment must have the following features:

- ***Identical setup***. If possible, we recommend using the actual experiment. If this is not possible, then the experiment should be as similar as possible to the actual experiment (in particular, stimulus type and size, GES and ECC configurations, and software versions should be identical).
- ***Full duration***. If possible, we recommend using the actual experiment. If this is not possible, then the duration (number of trials and blocks of trials) should be as the experiment will be used. Timing errors accumulate; testing a short version of an experiment does ***not*** certify a longer version.
- ***Same location***. The visual stimulus must always appear in the same location. (If they do not, you can run the test multiple times to account for the different locations.)

- ***Large stimuli***. The visual stimulus must be large enough (3 millimeters, or about 0.125 inch) to trigger the photocell. Wider stimuli make positioning the photocell easier.
- ***High contrast***. The visual stimulus should be high contrast (e.g., white stimuli on a black background). Low-contrast stimuli can fail to trigger the photocell at all, or, conversely, can trigger the photocell erroneously at all times.
- ***Bright stimuli***. White stimuli are recommended. Black stimuli are problematic and should be avoided for testing purposes (see Chapter 5, "Troubleshooting”).

If the experiment lacks some or all of these features, it may still be testable in a modified form. Contact EGI Technical Support for assistance (Appendix A).

Hardware Configuration

You will need the following:

- AV Device with power supply cord, DIN patch cable, photocell, and photocell holder
- a GES/ECC setup

The GES and ECC setup shown in Figure 1-2 on page 25 is the two-machine configuration that is normally used for stimulus presentation and data collection.

Note: During timing tests, the GSN typically is ***not*** *connected to the amplifier.*

GES Configuration

The GES, which represents the data-acquisition part of the ERP setup, consists of the GSN, a Net Amps 200 or 300 amplifier, a DAC running Net Station, a monitor, and cabling (e.g., connecting the amplifier to the DAC).

Before running an EGI E-Prime timing test or your own E-Prime experiment, you should test the GES for basic functionality (e.g., acquiring and recording data from the amplifier). During timing tests, the GSN typically is ***not*** connected to the amplifier.

For further information about Net Station and the amplifier, see the *Net Station Acquisition Technical Manual* and the *GES Hardware Technical Manual*.

ECC Configuration

The ECC, which represents the experiment-control part of the ERP setup, consists of an ECC running E-Prime, an experimenter's monitor, a stimulus-presentation monitor for the subject, a serial or TCP/IP cable connecting the ECC to the DAC, other cabling, and single-clock hardware, if TCP/IP is used. Computer peripherals such as the keyboard and mouse may be omitted, depending on the laboratory setup. For instructions on installing the single-clock hardware, see the *E-Prime Extensions for Net Station User Manual*.

Note: The E-Prime Extensions for Net Station User Manual *may not identify the timing port for the Net Amps 300. This port is located on the amplifier's back panel and is labeled "digital pins 9–16."*

Before running an EGI E-Prime timing test or your own E-Prime experiment, you should test the ECC setup for basic functionality (e.g., presenting stimuli in E-Prime, logging events in Net Station, and recording data).

For further information about E-Prime and experiment control, see the *E-Prime Extensions for Net Station User Manual*, *E-Prime Biological Add-ons for Net Station User Manual*, *Net Station Acquisition Technical Manual*, or *GES Hardware Technical Manual.*

Connecting the AV Device

To connect the AV Device, you will use the provided cabling to connect the device to the amplifier, a power socket, and the photocell.

See Table 1-1 on page 19 and Figure 1-1 on page 22 for photos and descriptions of the AV Device components mentioned in the following steps.

1 Verify that the GES and ECC setups are powered-on (particularly the amplifier).

2 Connect the DIN patch cable from the 9-pin DINs Output port on the top of the AV Device to the 9-pin DIN port on the amplifier.

   - For the Net Amps 200, the DIN port is located on the back panel and labeled "Digital Inputs." If using a 256-channel system, plug the DIN patch cable into the DIN port on the "master" amplifier.
   - For the Net Amps 300, the DIN port is located on the back panel and labeled "digital pins 1–8"; for the Net Amps 300, however, you will first need to plug the DIN patch cable into the provided adapter and then plug the adapter cable into the DIN port.

   Verify that the DIN patch cable is firmly seated at both ends.

3 Plug the power supply cord into a surge-suppressed power socket.

4 Plug the other end of the power supply cord into the port labeled "9 VDC" on the top of the AV Device.

5 Plug the photocell jack into the Photocell port on the front of the AV Device.

6 Fit the photocell into its receptacle in the assembled photocell holder.

Figure 2-1 shows the AV Device connected to a Net Amps 300.

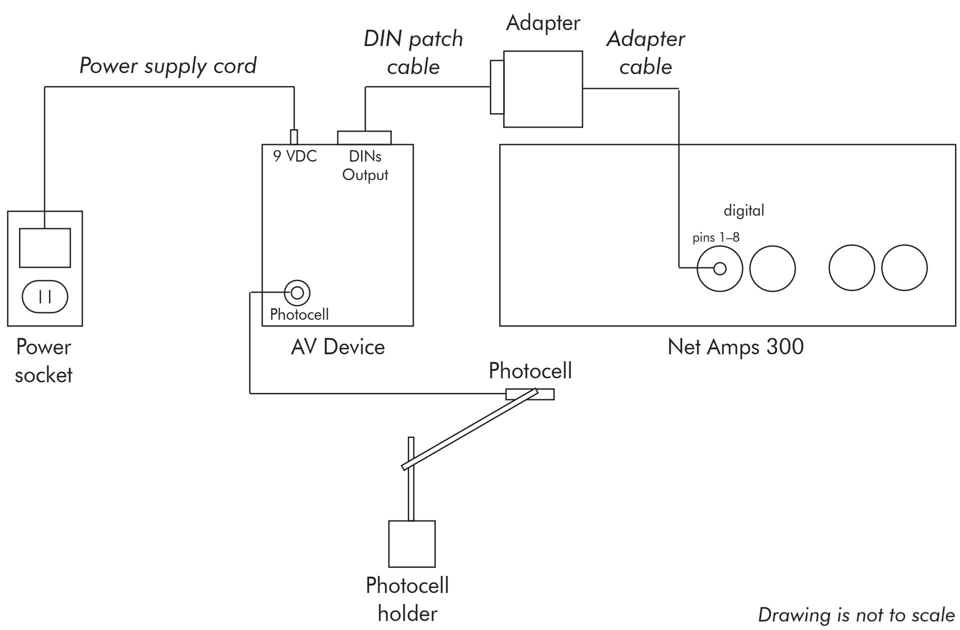


Figure 2-1. The AV Device connected properly for visual stimuli using the Net Amps 300

Positioning the Photocell Holder

The photocell holder must be placed flat against the stimulus-presentation monitor and positioned so that it is directly over the stimulus for which you wish to verify timing.

To do this, you must run both Net Station and E-Prime to display the stimulus on the stimulation-presentation monitor.

Configuring Net Station

For assistance in creating or modifying a Workbench setup, or in using Net Station, consult the *Net Station Acquisition Technical Manual*.

1 Open an existing Acquisition Setup, or create a new one.

2 With the Workbench off, configure it so that it includes the four devices connected as shown in Figure 2-2 (if your GES includes a Net Amps 200, use the Net Amps USB device as the Source device).

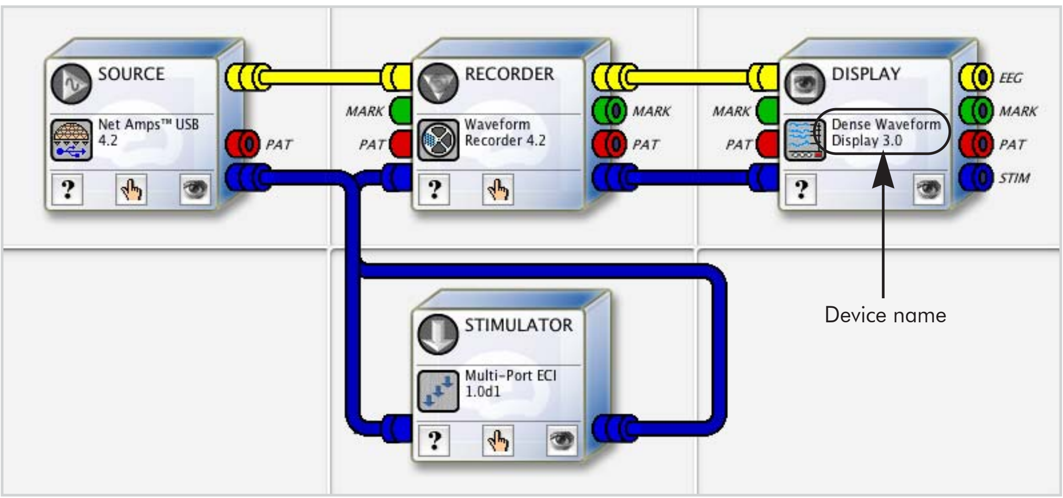


Figure 2-2. Net Station AV Device setup

3 From the Panels menu, choose the following:

- Digital Input Controls
- Dense Waveform Display
- Multi-Port ECI
- Waveform Recorder Controls

The digital input you should use is determined by the type of stimulus-presentation monitor and stimuli.

4 In the Digital Input Controls panel, click the disclosure toggle to open the window, and make sure that the EGI Response Pad button is selected (Figure 2-3).

Note: These instructions assume a white stimulus on a black background. For a black stimulus on a white background, select the TTL button. However, black stimuli can be problematic; for more information, see Chapter 5, "Troubleshooting."

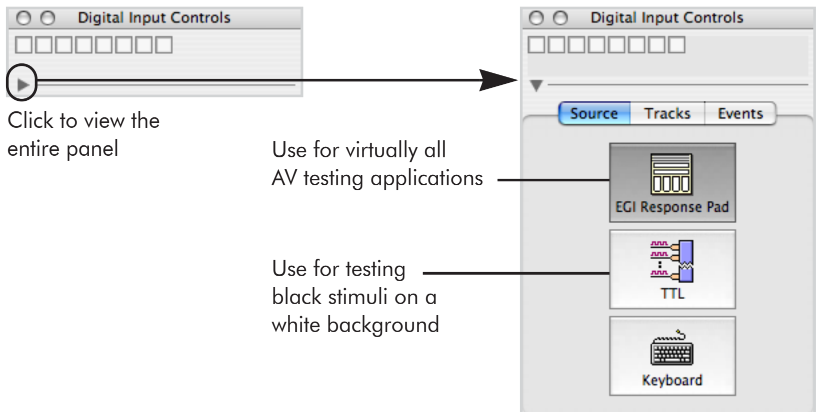


Figure 2-3. Opening the Digital Input Controls panel

5 Click the Events tab, and in the Events tabpanel, click the Single Channel button to open the Setup Single Channel Input window (Figure 2-4).

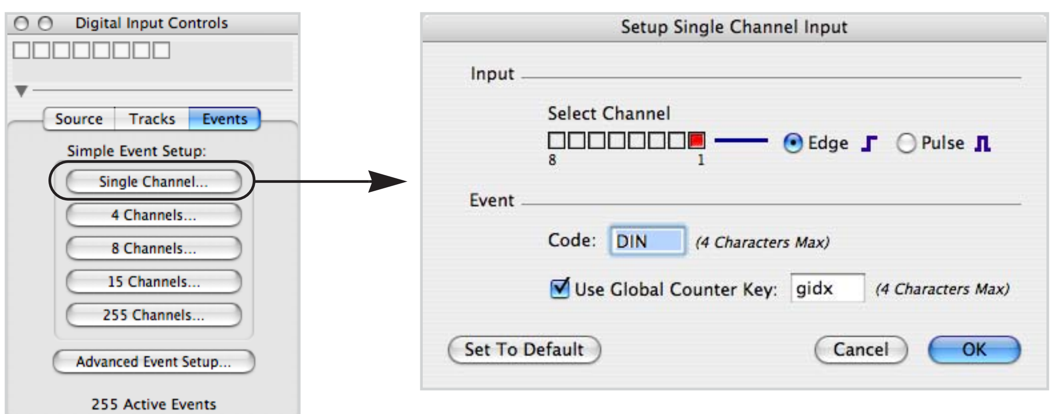


Figure 2-4. Opening the Setup Single Channel Input window

6 Configure the Setup Single Channel Input window as follows:

- If the stimulus-presentation monitor is a CRT, click on the box labeled "1" to turn on DIN 1.
- If the stimulus-presentation monitor is an LCD, click on the third box from the right to turn on DIN 3.

- In the Code box, type “DIN1” or “DIN3,” if desired (this is not required).
- Leave the Edge button and the Use Global Counter Key checkbox selected.
- Click the OK button (Figure 2-5).

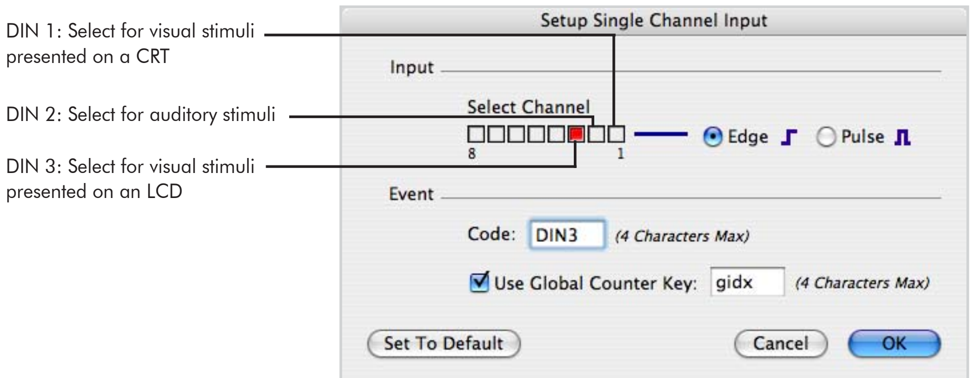


Figure 2-5. Selecting the correct digital input for a variety of stimuli

7 The Digital Input Control panel is now defined; drag it to the right side of the window.

8 You will use the Waveform Recorder Controls panel to view event information during acquisition. Because it requires no configuration, drag it to the right side of the window.

9 In the Multi-Port ECI panel, click the Log button to open the Session Log, which allows you to monitor ECI events during acquisition, and click the Long Form button; drag both the Multi-Port ECI panel and the Session Log to the right side of the window.

10 In the Dense Waveform Display panel, click the Events button near the top of the window to open the Events control strip, which allows you to view event markers during acquisition; drag the window to its maximum size.

11 Turn on the Workbench by clicking the On button in the upper-right corner of the Acquisition status panel.

12 Disregard any dialog that appears, notifying you that a Net must be plugged in before acquiring data or measuring impedances.

Figure 2-11 on page 42 shows the Workbench configured as described (disregard the event stream and waveforms for now). Net Station is now ready to communicate with the ECC, to record data and events, and to display ECI and DIN events in the Dense Waveform Display.

Presenting the Visual Stimuli

This section describes how to position the photocell based on the onscreen stimuli presented by the EGI E-Prime timing file or by your own E-Prime experiment.

Using the EGI E-Prime Timing File

If you are using NSTimingTest.es:

1. Use the Search function (**Start menu > Search > For Files or Folders**) to locate this file on your ECC; if necessary, contact EGI Technical Support (Appendix A).
2. Open the file, and click the Run button (Figure 2-6).

The Run button

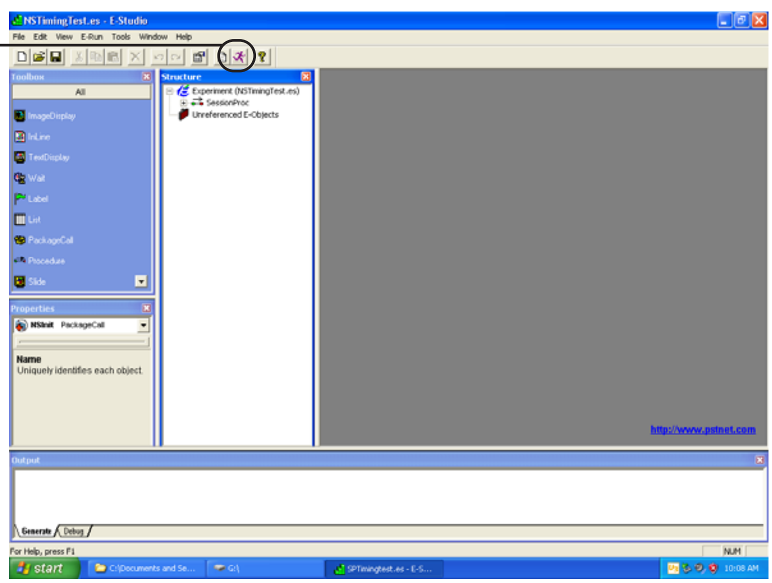


Figure 2-6. Click the Run button to begin onscreen instructions for the NSTimingTest.es file

3 Follow the onscreen instructions, which will guide you in the proper placement of the photocell holder (Figure 2-7).

Figure 2-7. The photocell holder positioned for the NSTimingTest.es file

Using Your Own E-Prime Experiment

If you are testing your own E-Prime experiment:

1 Open the NSInit object in your experiment file and set the second parameter to "off" to disable communication with Net Station (Figure 2-8).

Change the parameter to "off"

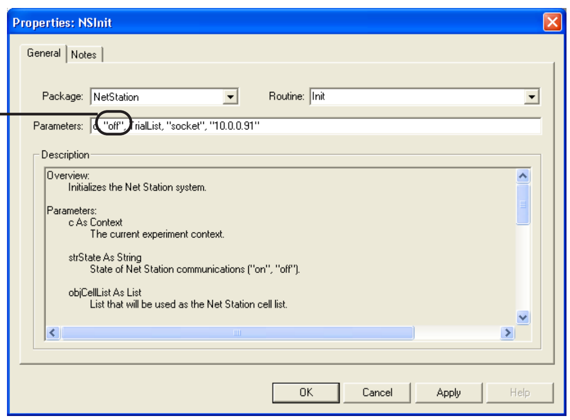


Figure 2-8. Change the NSInit object in your own E-Prime experiment file

2 Run the experiment and position the photocell holder aperture flat against the monitor so that the aperture is completely filled by the stimulus (Figure 2-9).

In this experiment, the photocell is placed such that the thick white circle of the stimulus completely fills the aperture of the photocell.

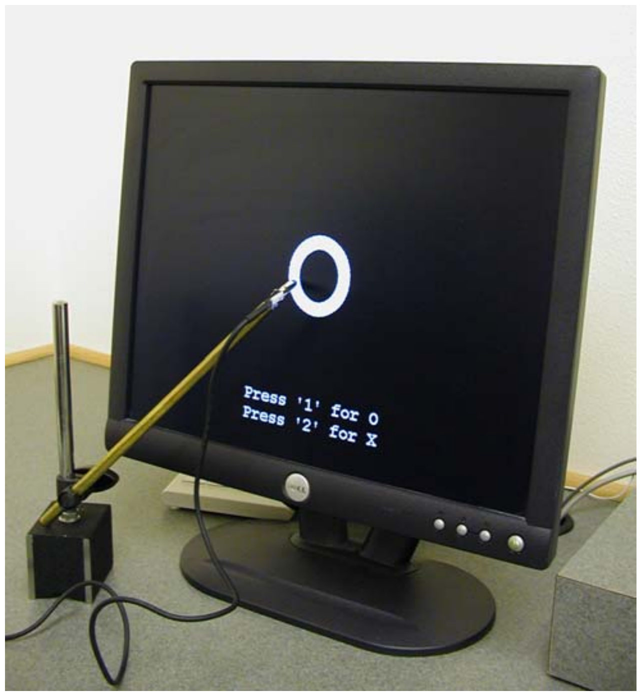


Figure 2-9. The photocell holder positioned for a visual-stimulus experiment

3 Check for proper positioning by confirming that the illumination of the LEDs on the AV Device matches the appearance of the stimuli onscreen.

4 Abort the experiment by pressing Control-Alt-Esc.

5 Open the NSInit object and set strState to "on".

6 If testing more than one stimulus type at once, make sure that the aperture location covers both or all of the desired stimuli (e.g., if the Visual Target Detection experiment features both an "o" and an "x" stimulus, the correct location for the photocell holder would allow both the "o" and the "x" pixels to fill the aperture). If this is impossible, you can run the test multiple times, making sure that the stimuli are covered in the other runs.

The finished setup is shown in Figure 2-10.

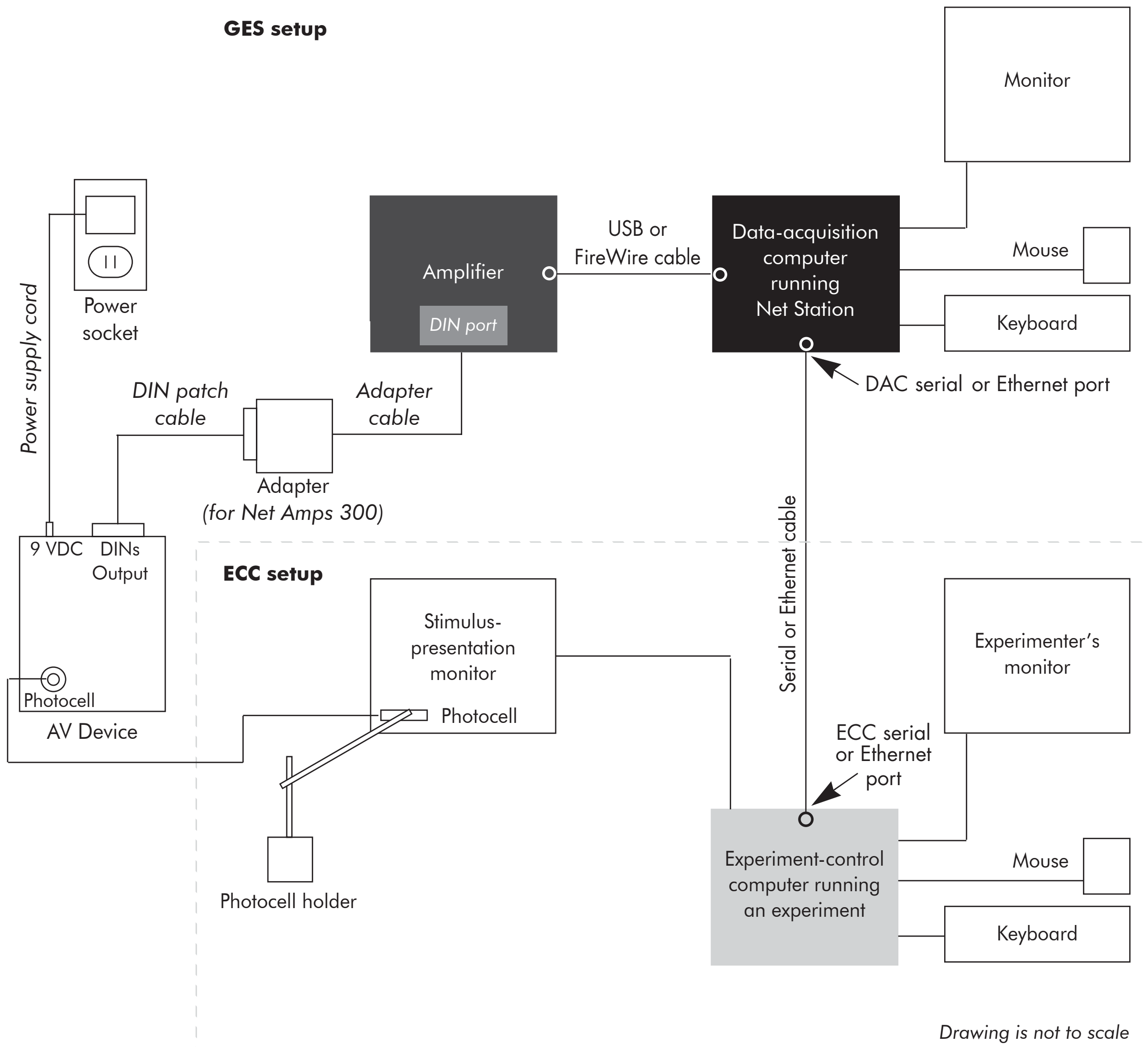


Figure 2-10. AV Device setup for visual stimuli

Verifying AV Device Functionality

Before acquiring timing data, check that the AV Device functions properly.

1 Run your own E-Prime experiment or NSTimingTest.es.

2 All the LEDs on the AV Device may light up. In addition to the other LEDs, verify that the correct DIN LED is definitely illuminated:

   - *DIN1*: visual stimuli on CRT monitors
   - *DIN3*: visual stimuli on LCD monitors

3 If the correct LED fails to illuminate, see Chapter 5, "Troubleshooting," for solutions.

4 Repeat Steps 1–3 until the correct LED illuminates.

5 Abort the experiment by pressing Control-Alt-Esc.

Test Instructions

ECI events are those received by Net Station via the Multi-Port ECI interface. In our case, these are the events sent by E-Prime.

Don't worry if events seem to appear late in the Net Station display. If Net Station is busy, the display may lag a bit, in the interests of preserving other, more vital, actions (e.g., writing to disk).

The important thing is to confirm that both DINs and ECI events are being transmitted by noting them in the Events control strip.

Running the Test

1 Start your own E-Prime experiment or NSTimingTest.es.

2 Verify that E-Prime is successfully transmitting events to Net Station (as evident in the Events control strip of Net Station's Dense Waveform Display)

and that Net Station is recording data to disk (as evident in Net Station's Waveform Recorder Controls panel).

3 When a stimulus is presented onscreen, both the ECI event and the corresponding DIN should be visible in the Events control strip of the Dense Waveform Display (Figure 2-11).

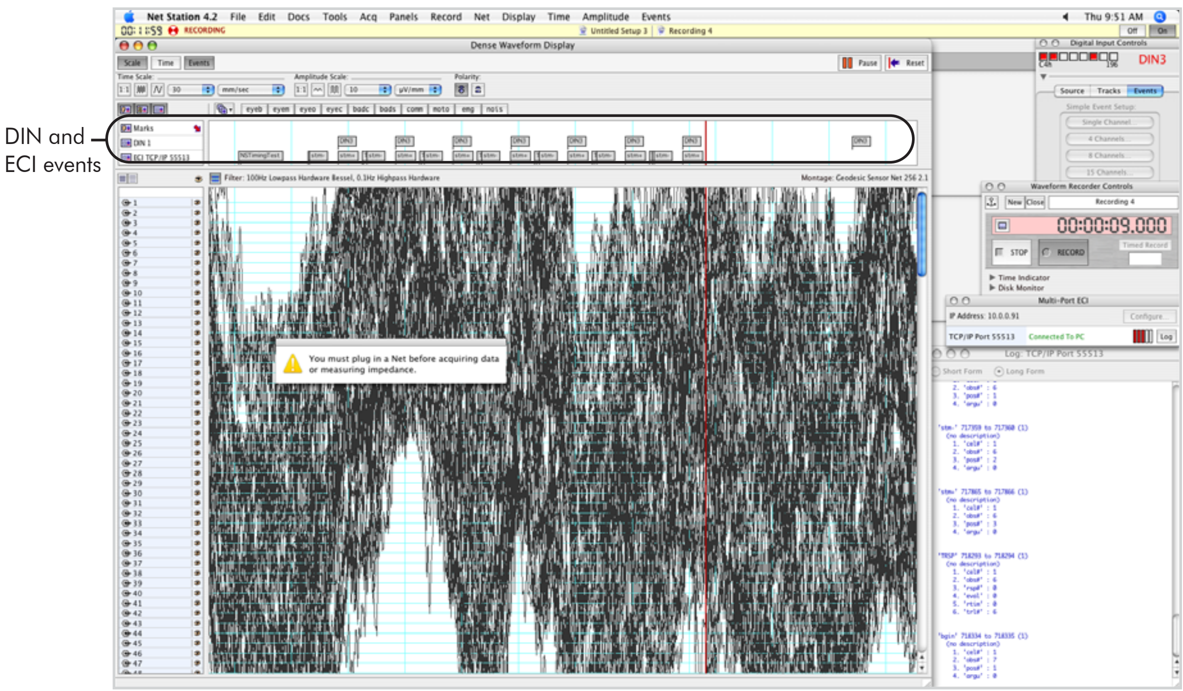


Figure 2-11. Visual ECI and DIN events in the Events control strip of the Dense Waveform Display

4 If DINs appear when the stimulus is off, make sure you have the correct DIN selected for the stimulus duration in the Setup Single Channel Input window (see page 35).

5 Complete the experiment and press Return to exit, when prompted to do so.

6 Exit Net Station, which will automatically save the timing results file as a Net Station Recording.

Viewing the Results

To view the results, launch the Event Timing Tester program and open the Net Station timing results file.

For information about how to use the Event Timing Tester, see Chapter 4.

AUDITORY-STIMULUS TESTING

This chapter describes how to test the precision of auditory-stimulus presentation, using the AV Device.

The topics covered in this chapter include general considerations (such as basic experiment requirements), hardware configuration, software configuration, verifying AV Device functionality, and test instructions.

General Considerations

The EGI E-Prime timing test meets all the testing requirements. If you are testing the timing of your own E-Prime auditory-stimulus experiment, the experiment must have the following features:

- ***Identical setup***. If possible, we recommend using the actual experiment. If this is not possible, then the experiment should be as similar as possible to the actual experiment (in particular, stimulus type and loudness, GES and ECC configurations, and software versions should be identical).
- ***Full duration***. If possible, we recommend using the actual experiment. If this is not possible, then the duration (number of trials and blocks of trials) should be as the experiment will be used. Timing errors accumulate; testing a short version of an experiment does ***not*** certify a longer version.
- ***Audible stimuli***. The auditory stimulus must be loud enough to trigger the AV Device.
- ***Rapid ramp-up***. The auditory stimulus should have a reasonably abrupt volume increase at the beginning of the sound. Very slow volume ramp-ups may not trigger the AV Device at stimulus onset.

- ***Compatible audio source***. The audio source must be compatible with RCA, miniplug, or 1-inch headphone connections.

If the experiment lacks some or all of these features, it may still be testable in a modified form. Contact EGI Technical Support for assistance (Appendix A).

Hardware Configuration

You will need the following:

- AV Device with power supply cord, DIN patch cable, and audio cable (1/4 miniplug to dual RCA)
- a GES/ECC setup

Note: It is important to use the provided audio cable because it includes a built-in attenuator for compatibility with the AV Device.

The GES and ECC setup shown in Figure 1-2 on page 25 is the two-machine configuration that is normally used for stimulus presentation and data collection.

*Note: During timing tests, the GSN typically is **not** connected to the amplifier.*

The GES and ECC setups for an auditory-stimulus test are similar to those for a visual-stimulus test, except the ECC setup contains speakers or other audio source. For details, see "GES Configuration" and "ECC Configuration" on page 30.

Connecting the AV Device

To connect the AV Device, you will use the provided cabling to connect the device to the amplifier, a power socket, and the audio output.

See Table 1-1 on page 19 and Figure 1-1 on page 22 for photos and descriptions of the AV Device components mentioned in the following steps.

1. Connect the DIN patch cable from the 9-pin DINs Output port on the top of the AV Device to the 9-pin DIN port on the amplifier.

  - For the Net Amps 200, the DIN port is located on the back panel and labeled "Digital Inputs." If using a 256-channel system, plug the DIN patch cable into the DIN port on the "master" amplifier.
  - For the Net Amps 300, the DIN port is located on the back panel and labeled "digital pins 1–8"; for the Net Amps 300, however, you will first need to plug the DIN patch cable into the provided adapter and then plug the adapter cable into the DIN port.

  Verify that the DIN patch cable is firmly seated at both ends.

2. Plug the power supply cord into a surge-suppressed power socket.

3. Plug the other end of the power supply cord into the port labeled "9 VDC" on the top of the AV Device.

4. Plug either of the audio cable's RCA plugs into the Audio port on the front of the AV Device.

Figure 3-1 shows the AV Device connected to a Net Amps 300.

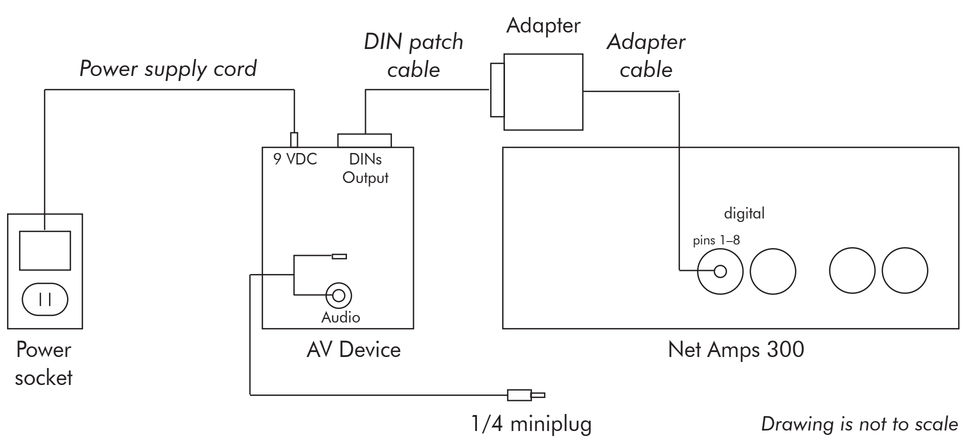


Figure 3-1. The AV Device connected properly for auditory stimuli using the Net Amps 300

Connecting the Audio Cable

The audio cable must be connected to a high-level audio output, because low-level signals will not trigger the AV Device reliably.

The best method is to connect the miniplug end of the audio cable to the headphone (miniplug) port on the back of the ECC (Figure 3-2). Depending on the laboratory setup, you may need to use a 1/4 miniplug extension cord (male-to-female) to connect the audio cable and the ECC.

Note: Because computer upgrades may change the location of the audio port, contact EGI Technical Support (Appendix A) if you have difficulty locating this port.

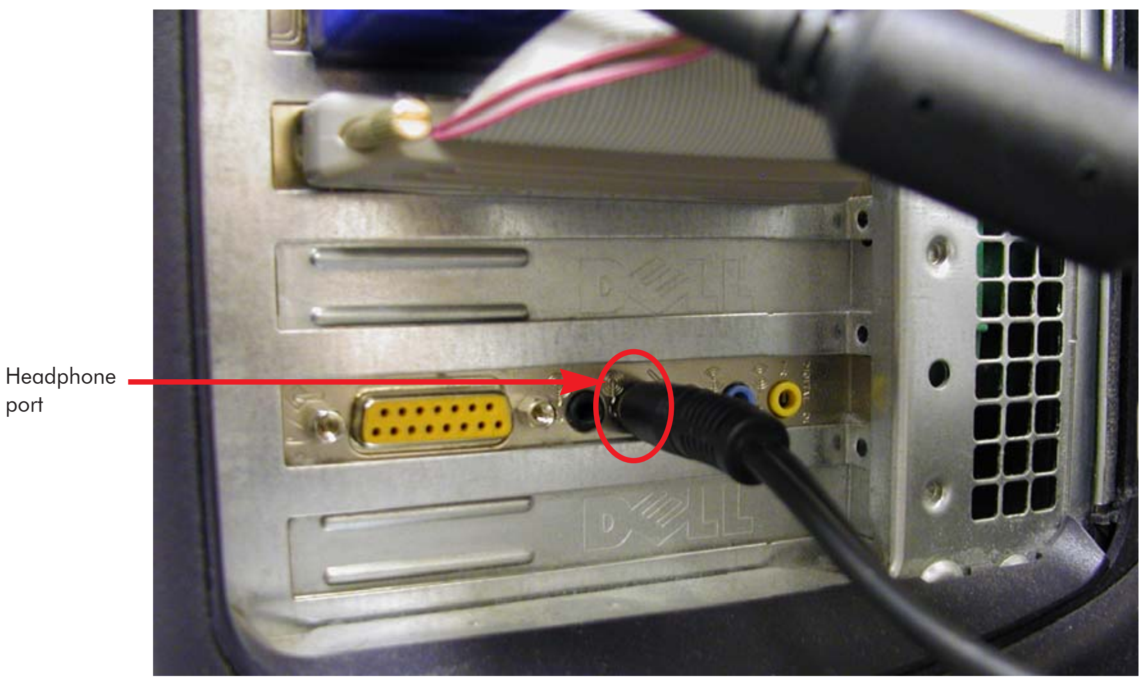


Figure 3-2. The audio cable plugged into the miniplug port on the back of the ECC

The finished setup is shown in Figure 3-3.

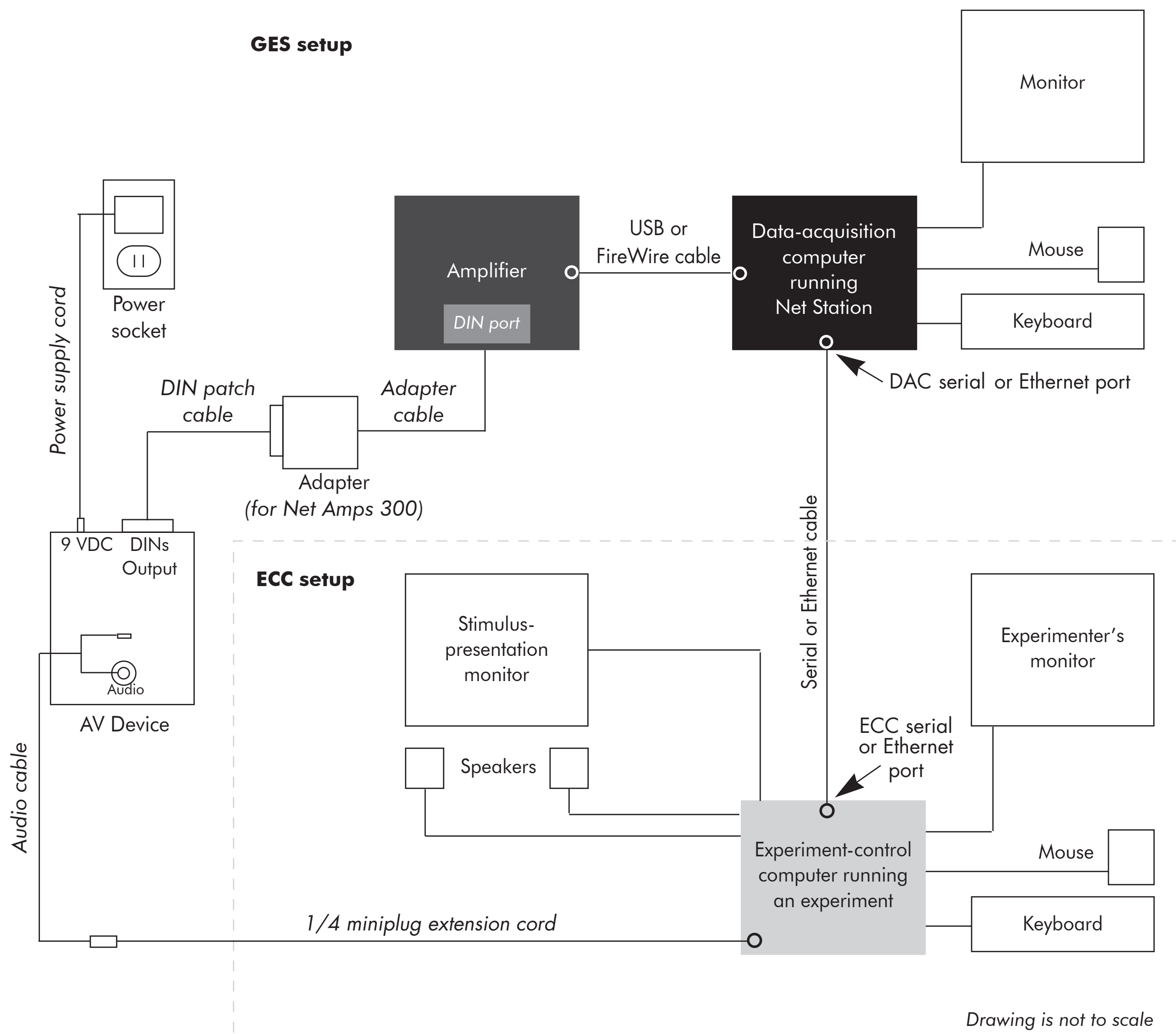


Figure 3-3. AV Device setup for auditory stimuli

Software Configuration

Setting up the software for experiment control involves configuring Net Station to record and display auditory stimuli.

Configuring Net Station

The instructions for configuring Net Station for auditory stimuli are nearly identical to those for visual stimuli. Therefore:

1 Follow Steps 1–12, beginning on page 34 of Chapter 2, "Visual-Stimulus Testing."

One exception: In Step 6 on page 35, click on the second box from the right to turn on DIN 2, and in the Code box type "DIN2," if desired (this is not required).

2 To confirm that Net Station is receiving and displaying DINs in the Events control panel of the Dense Waveform Display:

- On the ECC, choose **Start menu > Settings > Control Panel > Sounds and Audio Devices** to open the Sounds and Audio Devices Properties window (Figure 3-4).

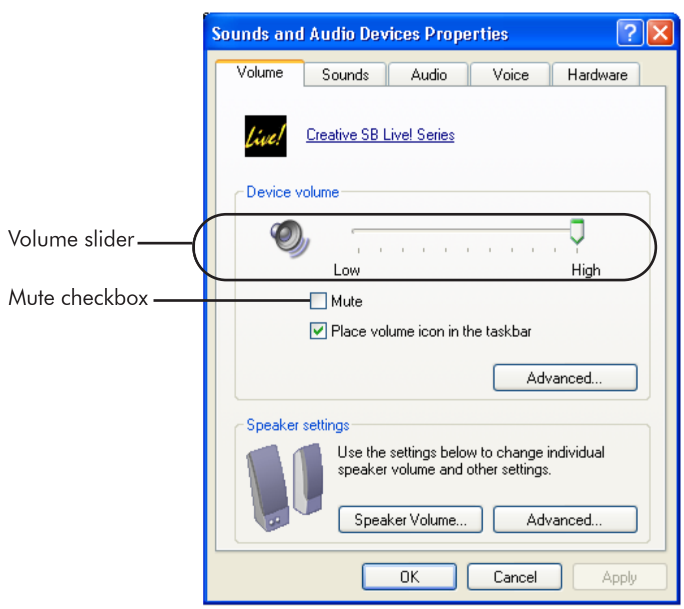


Figure 3-4. The Sounds and Audio Devices Properties window

◦ In the Sounds and Audio Devices Properties window, adjust the volume slider. As you do so, you should see a DIN event in the Events control panel of the Dense Waveform Display (Figure 3-5).

Figure 3-5. The DIN events for an auditory-stimulus experiment

Net Station is now ready to communicate with the ECC, to record data and events, and to display ECI and DIN events in the Dense Waveform Display.

Verifying AV Device Functionality

1. On the ECC, open the Sounds and Audio Devices Properties window by choosing **Start menu > Settings > Control Panel > Sounds and Audio Devices**.

2. In the Sounds and Audio Devices Properties window, make sure that the Mute checkbox is unselected (see Figure 3-4 on page 50).

3. Watch the DIN2 LED on the AV Device while adjusting the volume slider in the Sounds and Audio Devices Properties window.

4. The DIN2 LED should illuminate. If it fails to light up, check the cable connections.

5. If the LED still fails to illuminate, see Chapter 5, "Troubleshooting," for solutions.

Note: If the LED still remains unlit, contact EGI Technical Support (Appendix A).

Test Instructions

For information about testing, read the three paragraphs following the section title "Test Instructions" on page 41.

Running the Test

1 Start your own E-Prime experiment or SPTimingTest.es.

2 Verify that E-Prime is successfully transmitting events to Net Station (as evident in the Events control strip in Net Station’s Dense Waveform Display) and that Net Station is recording data to disk (as evident in Net Station’s Waveform Recorder Controls panel).

3 When a stimulus is presented via the audio source, both the ECI event and the corresponding DIN should be visible in the Events control strip of the Dense Waveform Display (Figure 3-6).

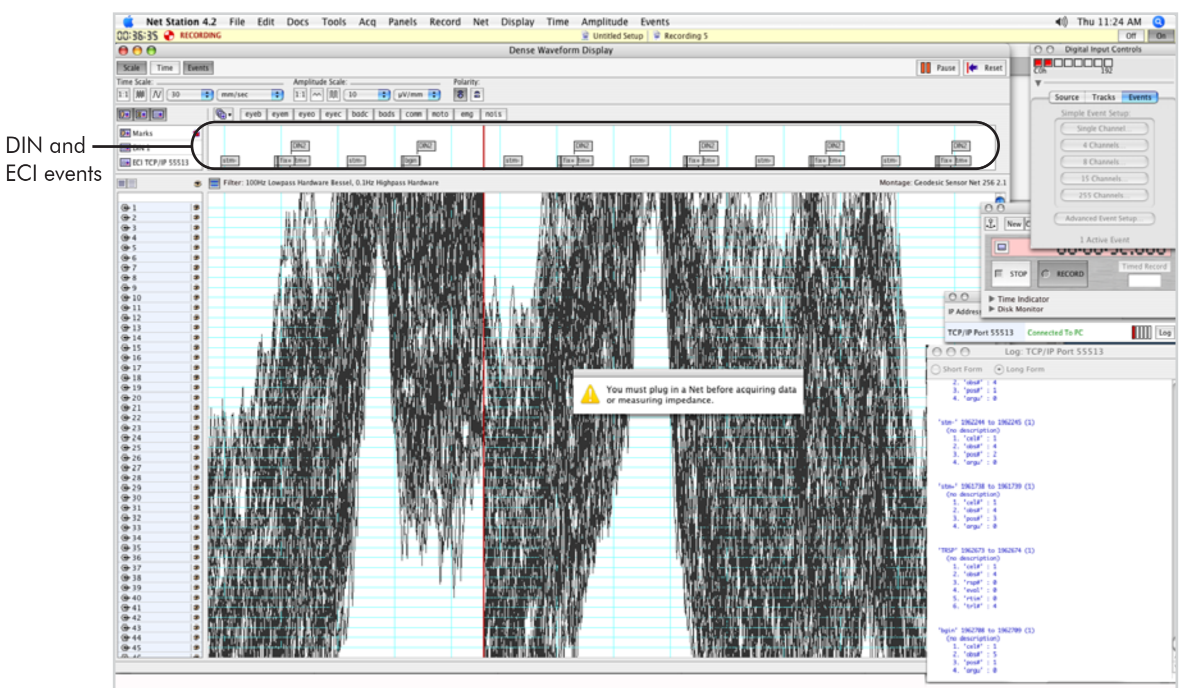


Figure 3-6. Auditory ECI and DIN events in the Events control strip of the Dense Waveform Display

4 If you see more than one DIN per auditory stimulus, make sure that you have selected DIN 2 for the stimulus duration in the Setup Single Channel Input window (see Figure 2-5 on page 36). If DIN 2 is selected but multiple DINs persist, contact EGI Technical Support (Appendix A).

5 Complete the experiment and press Return to exit, when prompted to do so.

6 Exit Net Station, which will automatically save the timing results file as a Net Station Recording.

Viewing the Results

To view the results, launch the Event Timing Tester program and open the Net Station timing results file.

For information about how to use the Event Timing Tester, see Chapter 4.

chapter 4

EVENT TIMING TESTER

The Event Timing Tester is a drag-and-drop application that extracts event timing information from a Net Station file.

Specifically, the Event Timing Tester compares offsets between the Net Amps DIN and the Net Station ECI events.

For more information about the Net Amps' digital inputs, see the *GES Hardware Technical Manual*. For more information about Net Station ECI events, see the *Net Station Acquisition Technical Manual*. For more information about using the AV Tester, see either Chapter 2, "Visual-Stimulus Testing," or Chapter 3, "Auditory-Stimulus Testing."

The Event Timing Tester is installed as part of the Net Station package, in the Extras folder (Figure 4-1).

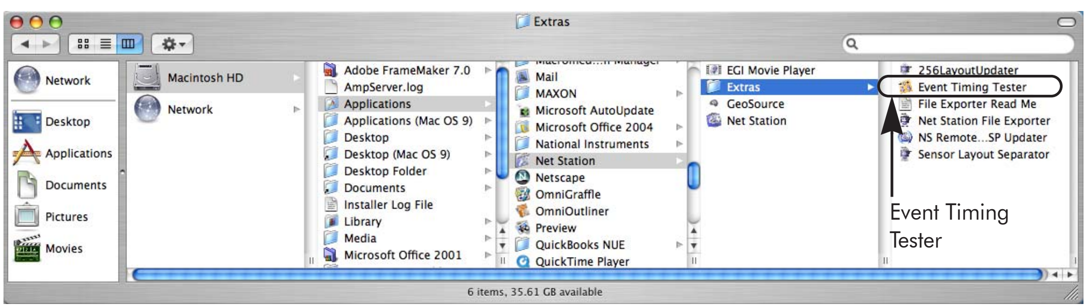


Figure 4-1. Event Timing Tester application

The topics covered in this chapter include interface features, using the interface, analyzing the results of the Event Timing Tester, and correcting for clock drift, time offsets, and other timing errors.

Event Timing Tester Interface

The Event Timing Tester coordinates viewing of DIN and ECI events in a single, simple interface. Figure 4-2 shows the Event Timing Tester interface.

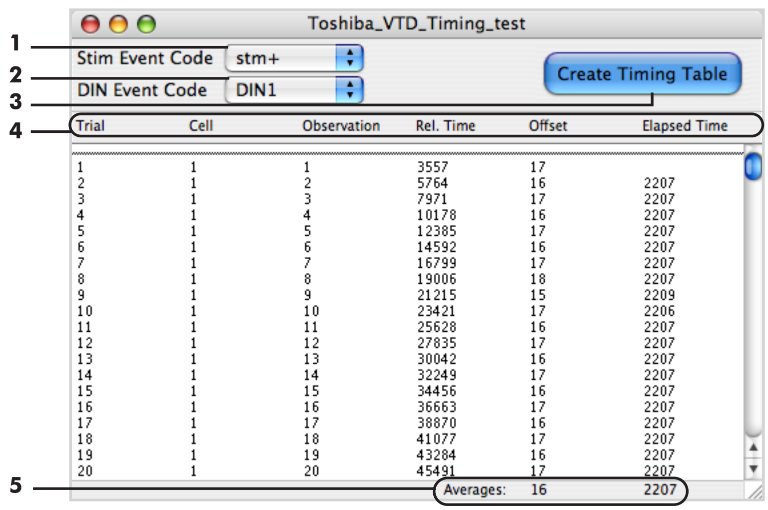


Figure 4-2. Event Timing Tester

The following are brief descriptions of the numbered items from Figure 4-2.

1. ***Stim Event Code pop-up menu***. Displays all the event codes extracted from the selected timing results file. You must choose the Stim event that corresponds to your ECI event.

2. ***DIN Event Code pop-up menu***. Displays all the event codes extracted from the selected timing results file. You must choose the DIN event that corresponds to your DIN event.

3. ***Create Timing Table button***. When clicked, calculates the Trial, Cell, Observation, Relative Time, Offset, and Elapsed Time information for the selected timing results file, given the Stim (ECI) and DIN event codes chosen.

4. Timing information. Displays the information extracted from the selected timing results file.

- *Trial column*: displays the number of the trial in the file. A *trial* is a single observation in an E-Prime file. A trial is usually defined as one cycle of a stimulus presentation in E-Prime; thus, during normal operation it usually consists of a beginning event, a stimulus event, a response event, and trial specifications. Virtually all ERP experiments consist of a sequence of trials.
- *Cell column*: Displays the number of the cell in the file. A *cell* is defined as a unique instance of the experiment condition being manipulated and provides a means of logically grouping the trials of an experiment into sets. Trials are grouped into cells on the basis of stimulus characteristics, not responses (e.g., for an "oddball" task, the standards are one cell, and the targets or "oddballs" are another). In Figure 4-2, all the trials visible (1–20) belong to Cell 1.
- *Observation column*: Displays the number of the observation in the file. An *observation* is a single trial of a particular cell. In Figure 4-2, trials 1–20 belong to Cell 1 and are Observations 1–20 for that cell.
- *Rel. Time column*: Displays the time, in milliseconds, of the stimulus onset, relative to the start of the file (e.g., in Figure 4-2, Trial 1 begins 3557 milliseconds after the start of the file).
- *Offset column*: Displays the time, in milliseconds, between the trial's Stim (ECI) event code (e.g., stm+) and the nearest DIN event code (e.g., DIN1). Following are some keys to interpreting offsets:
    - Positive values mean that the DIN appears after the Stim (ECI) event, or that the actual stimulus appeared later than E-Prime asserts.
    - Negative values mean that the DIN appears before the Stim (ECI) event, or that the actual stimulus appeared earlier than E-Prime asserts.
    - A question mark ("?") means that no DIN event code occurs ±1 second of the Stim (ECI) event.

- *Elapsed Time column*: Displays the time, in milliseconds, from the last trial's Stim (ECI) event to the current trial's Stim (ECI) event. This is also sometime referred to as the *interstimulus interval*, or *ISI*.

  In Figure 4-2, the Elapsed Time between trial 1's stm+ and trial 2's stm+ is 2207 milliseconds. Similarly, the time between the stm+s of trials 4 and 5 is 2207 milliseconds.

  Note: There can be no Elapsed Time for the first trial in a block.

5. Averages. Displays the average values calculated for Offset and Elapsed Time. These are simply the means of the values in the Offset and Elapsed Time columns.

Running the Event Timing Tester

The Event Timing Tester is an easy-to-use application:

1. Find the Event Timing Tester, which is located in the Extras folder of the Net Station folder on your hard drive (see Figure 4-1 on page 55).

2. To launch the Event Timing Tester, drag a Net Station Recording file (saved from a timing test; see Step 6 on page 42 or Step 6 on page 53, if needed) onto the Event Timing Tester icon to highlight the application, and release.

3. In the Event Timing Tester window, select the desired Stim (ECI) and DIN event codes from the pop-up menus. For example, if the data file in question resulted from using the AV Device to measure a visual stimulus onset presented on a CRT monitor, and if DIN1 was recorded by Net Station, in Figure 4-2 you would select stm+ and DIN1 for the Stim (ECI) and DIN event codes, respectively.

4. Click the Create Timing Table button to update the table.

For each trial, the corresponding Cell, Observation, Relative Time, Offset, and Elapsed Time is displayed.

If the ECC did not follow E-Prime conventions, the fields for Trial, Cell, and Observation will display a question mark ("?").

Analysis of Results

The values calculated by the Event Timing Tester allow you to determine if the system timing is operating within specifications or if the E-Prime experiment is programmed correctly.

Following are some guidelines to interpreting the Event Timing Tester results:

- *If the Offset values steadily increase or decrease*: this is a sign of clock drift. You can correct this by using the "clock synch" approach, a clock-scaling factor, or EGI's single-clock solution (for more information, see "Clock Drift" on page 59).
- *If the Offset values are constant*: this is a sign of time offsets. Time offsets are to be expected because of hardware delay and other factors. You can correct this by entering the average offset value into the Offset textbox when creating a Segmentation specification for segmenting your data (for more information, see "Time Offset" on page 62).
- *If the Offset values are variable*: sometimes referred to as *jitter*, this is a sign of a hardware error (e.g., a poorly functioning sound card), testing error, or more likely a programming error in E-Prime:
  - For information about likely hardware errors, contact EGI Technical Support (Appendix A).
  - For information about testing errors, see Chapter 5, "Troubleshooting."
  - For information about programming errors, see Chapter 3, "Critical Timing in E-Prime," in the *E-Prime User's Guide*, which is available from PST (www.pstnet.com).

Clock Drift

Any clock is an approximation of "real" time and continuously drifts away from synchronization with that "real" time.

This limitation can apply to the interaction between the DAC and the ECC. Each computer's internal clock may drift away from "real" time and from each other during the duration of any experiment (Figure 4-3).

Real Time **DAC Clock** **ECC Clock**

Before the experiment, "real" time, the DAC clock, and the ECC clock are all synchronized, each pointing to 1:00.

Real Time
After nine hours, the real-time clock points to 10:00.

DAC Clock
However, the DAC clock runs fast and points to 10:05, having drifted 5 minutes ahead of"real" time and 10 minutes ahead of the ECC clock during the nine hours.

ECC Clock
In contrast, the ECC clock runs slow and points to 9:55, having drifted 5 minutes behind "real" time and 10 minutes behind the DAC clock during that same time period.

Figure 4-3. The DAC and ECC clocks can drift away from "real" time and from each other

Such drift can introduce an error into the experiment data that causes events to be skewed with respect to the corresponding EEG.

Clock-Drift Solutions

To correct for clock drift, use one of the following:

- the "clock synch" approach,
- a clock-scaling factor, or
- EGI's single clock.

Clock Synch

Accumulated drift is corrected every time the DAC and ECC synchronize their clocks. Because clock accuracy is partly machine-dependent, the actual frequency with which clock synchronization should be performed is best determined empirically by running a test without clock synching and determining the clock-drift rate.

For instructions on how synchronize your clocks, see page 216, Command T, of Appendix G, “Experimental Control Protocol,” in the *GES Hardware Technical Manual*. The “Note” at the bottom of page 216 provides additional information.

Clock-Scaling Factor

The ECC clock and the DAC clock each has a small fraction of error in its designated frequency. If left unchecked, a linear cumulative clock drift will occur between the two clocks.

You can adjust the ECC event times using a scaling factor calculated with the AV Device. A clock-scaling factor determines the difference between the two clocks and provides a conversion factor that corrects for the difference.

For full instructions, see the *E-Prime Biological Add-ons for Net Station User Manual*.

EGI’s Single Clock

Clock drift primarily occurs because of the difference between the ECC and DAC clocks. You can eliminate clock drift completely by using EGI’s single-clock solution, which allows the ECC to read the DAC clock and use that as its time base. The single clock is available for use only with E-Prime.

For full instructions, see the E-*Prime Extensions for Net Station User Manual* or contact EGI Technical Support (Appendix A).

Note: Single clock eliminates only clock drift; it is still necessary to use the AV Device to correct for time offsets.

Time Offset

With both the single-clock and the two-clock GES, small offsets have been measured between the times reported for stimulus onset by E-Prime and those detected by the AV Device.

Time-Offset Solution

One simple way to correct for time offsets is to account for them when segmenting the data. You can do this by following these steps:

1. Run the timing tests described in Chapter 2, "Visual-Stimulus Testing," or Chapter 3, "Auditory-Stimulus Testing."
2. Calculate the average offset using the Event Timing Tester (see "Running the Event Timing Tester" on page 58).
3. Enter the average offset value into the Offset text box in your Segmentation specification (see the "Segmentation" chapter in the *Net Station Waveform Tools Technical Manual*).

Text Output

To save a copy of the Event Timing Tester results, choose **File > Save As Text File**.

The resulting file is a tab-delimited text file of the data shown in the Event Timing Tester interface. A blank line separates blocks.

For best results, view the file in a text editor that allows control over tab spacing (e.g., StatView or Microsoft's Word or Excel). Spacing should be about 15 characters, or 1 inch per tab, for best readability.

chapter 5

TROUBLESHOOTING

This chapter provides solutions to problems you may experience while operating or configuring the AV Device.

The topics covered in this chapter include general troubleshooting, visual stimuli, and subject auditory response.

General Troubleshooting

The section discusses problems that may occur while configuring the AV Device for operation with the GES/ECC setup.

DINs Fail to Illuminate

If the DIN LEDs on the AV Device do not illuminate during a stimulus:

- Make sure the photocell or audio source is plugged in, and that the AV Device is powered-on.
- Test the photocell by exposing it to overhead lights.
- Test the audio input by connecting any suitable (line-level) audio source.

If these tests succeed, and the DIN LEDs still do not illuminate, contact EGI Technical Support (Appendix A).

DINs Always Lit

When testing a black stimulus on a white background, you may notice the DIN LEDs on the AV Device not turning off when the stimulus is presented.

1. First, turn both the brightness and contrast down on the stimulus-presentation monitor's controls.

2. If the DIN still does not turn off when the stimulus is visible, try increasing the size of the stimulus; also, check that the photocell sleeve has not fallen off or become dislodged.

DINs Not Visible in Net Station

If the DIN events fail to appear in Net Station's Events control strip, check the following:

- Check that the Net Amps is on.
  - If using a Net Amps 200, check that the power indicator on the front panel is brightly lit. (Some Net Amps 200 models have a "two-stage" indicator. The light is dim if the amplifier is plugged in, and bright if the Net Amps 200 is on.)
- Check that the AV Device's LEDs illuminate properly according to the stimulus you are using (e.g., for an auditory stimulus, the DIN 2 LED should illuminate).
- Check that the AV Device is connected to the Net Amps via the DIN patch cable.
- Check that the Events button is selected in the Net Station Viewer, and that the Events control strip is visible.
- Check that the desired DIN is selected as an event in the Setup Single Channel Input window of the Digital Input Controls panel.
- If you are testing black stimuli on a white background, make sure you have selected the TTL button in the Source tabpanel of the Digital Input Controls panel.

If these tests succeed, and the DIN events are still not visible in Net Station, contact EGI Technical Support (Appendix A).

Visual Stimuli

This section discusses the effects of monitor refresh rates and phosphor decay on the presentation of visual stimuli.

Refresh Rates of CRT and LCD Monitors

The *refresh rate* is the number of times per second a monitor is illuminated.

CRT monitors are inconstant displays. By repeatedly and rapidly flashing updates in sequence, they give the illusion of constant illumination, much like a fluorescent light, flickering at 60 Hz, seems to constantly be emitting light.

CRT monitor refresh rates vary, both with the monitor and with the particular monitor setting. Commonly, though, monitors update each pixel 60, 75, or 120 times a second.

Choosing DIN 1 in the Setup Single Channel Input window of the Digital Input Controls panel allows Net Station to automatically compensate for typical CRT monitor refresh rates of 16–18 milliseconds by integrating over 20 milliseconds. This digital output consequently has a single digital output state per monitor stimulus, instead of the periodic 16-millisecond spikes typical of unintegrated photocell detectors.

LCD monitors, on the other hand, pass a continuous stream of light to each pixel and dim a pixel only when instructed to do so. Choosing DIN 3 in the Setup Single Channel Input window allows the actual signal to trigger the digital output to Net Station.

Stimuli Positioning on CRT Monitors

Because monitor refreshes begin at the top of CRT monitors, there can be discrepancies related to the position of the stimulus on the screen. E-Prime sends the signal marking stimulus onset as the refresh begins at the top of the CRT monitor. If your stimulus is positioned at the top of the monitor, there should be no offset related to positioning. A stimulus positioned at the bottom of the monitor, however, can have an offset of as much as 10 milliseconds.

You should account for the time offset when you segment the data. For instructions, see "Time Offset" on page 62.

Phosphor Decay on CRT Monitors

Unlike LCD monitors, CRTs are also subject to *phosphor decay*. Phosphor decay is the time it takes for the intensity of the light emitted from the phosphor to fall off to 10% of its original value.

Suppose that you could view a single, white pixel under magnification, and very precisely in time. You'd notice that the pixel is brightly lit, then fades out a bit (while other pixels are being updated), then is brightly lit again, then fades a bit again, over and over again, 60 (or 75 or 120) times a second.

At each refresh, energy is rapidly sent to the pixel to keep it at the brightly lit state and to compensate for the partial dimming that occurs between refreshes. The pixel does not blacken entirely between refreshes, because it takes several cycles without energy for it to dim entirely to black.

Now consider a black pixel. No energy is being routed to it, and it consequently is not emitting photons. When the command is given to make it turn white, the monitor pours energy into that pixel on the next refresh cycle, and it glows brightly, almost immediately.

Pixels are thus faster changing from black to white than from white to black.

White on Black on CRT and LCD Monitors

White stimuli that appear on a black background are not a problem for either CRT or LCD monitors in the timing sense; they appear onscreen almost instantaneously and phosphor decay is not an issue. A black background is therefore the preferred visual stimulus testing mode.

Black on White on CRT and LCD Monitors

Black stimuli that appear on a white background are a problem for most CRT monitors, precisely because of phosphor decay (i.e., the fact that pixels are slow to turn off from full brightness).

In testing at EGI, we've discovered that, as a consequence of this battery effect, black-on-white stimuli can be delayed by as much as 80 milliseconds.

The photocell still reports the actual time at which the monitor dims beyond threshold, but the ECC reports when the event begins to happen. As far as the ECC is concerned, the event does happen earlier; it's the built-up energy in the pixel that causes an unexpected delay.

However, because there is no clock drift involved in the white-to-black error, only a constant time offset, ERPs can still be cleanly averaged, in spite of the CRT monitor error (see "Time Offset" on page 62). Researchers should note, however, that their EEG may lag the supposed causal event by as much as 80 milliseconds or more for black-on-white stimuli. (Subject responses may lag as well, which raises the question of how to determine when the subject is actually *perceiving* the stimuli.)

Black stimuli on white background can pose problems for LCD monitors, as well. If the stimulus is too small and the white background is detected by the photocell, it can erroneously trigger the photocell. In this case, you should increase the size of the stimuli so that no part of the background is detected by the photocell.

In general, black stimuli on a white background are not a preferred test mode, for either CRT or LCD monitors.

appendix A

Technical Support

Before Contacting EGI

Please check the Contents on page v and the Index on page 145 for coverage of your issue or question. You can also perform an electronic search using Find or Search in the PDF version of this manual posted on the Documents page of the EGI website (www.egi.com/documentation.html).

In addition, the Support page of the EGI website (www.egi.com/support.html) may have the information you need.

If you need more help, EGI recommends the following:

• ***Try to isolate the problem***. Is your problem well defined and repeatable?

• ***Document the problem.*** Carefully record and organize the details gleaned from the above step and report the problem to EGI.

Contacting EGI

EGI Support webpage	www.egi.com/support.html
Email support	support@egi.com
Sales information	info@egi.com
Telephone	+1-541-687-7962
Fax	+1-541-687-7963
Address	Electrical Geodesics, Inc. 1600 Millrace Drive Suite 307 Eugene, OR 97403 USA

Contacting PST

This manual describes using the AV Device in conjunction with EGI's GES/ECC systems and PST's E-Prime software. PST produces two manuals devoted to the interaction between E-Prime and Net Station (the *E-Prime Extensions for Net Station User Manual* and the *E-Prime Biological Add-ons to Net Station User Manual*) as well as a manual about programming E-Prime experiments (*E-Prime User's Guide)*. For questions about E-Prime, contact PST.

PST Support webpage	www.pstnet.com/ e-prime/support
Email support	support@pstnet.com
Sales information	info@pstnet.com
Telephone	+412-271-5040
Fax	+412-271-7077
Address	Psychology Software Tools 2050 Ardmore Boulevard Suite 200 Pittsburgh, PA 15221-4610 USA

GLOSSARY

A

Acquisition Setup file A saved Workbench configuration that preserves the control and display settings that were in effect at the time the file was saved. A setup can be multipurpose or specialized for specific acquisition needs, depending on the devices included.

aliasing Distortion of the EEG signal, which occurs when the signal is digitized at a rate less than half the highest frequency present. See *Nyquist frequency*.

amplifier A circuit that increases the voltage, current, or power of a signal.

antialiasing Filtering a signal prior to digitization so that high-frequency components do not appear as false lower-frequency components. See also *Nyquist frequency*.

C

cable A group of two or more insulated wires.

causal (event) An event that is responsible for, or associated with, EEG. This is usually a stimulus intended to elicit an *event-related potential (ERP)*.

cell A category of data in an E-Prime file that stores a single experimental condition. For example, one cell might contain all standards trials, another all target trials.

connector Any plug and socket that links two devices together.

contact Current carrying part of a switch, relay or connector.

correlation See *miscorrelation*

D

DAC See *data-acquisition computer.*

data-acquisition computer The computer running the EEG acquisition and review software.

dense (sensor) array Any (sensor) system that supports a sufficient number of sensors to adequately spatially sample a phenomenon. For

EEG recording, this generally means 32 channels or more.

digital input See *DIN*.

DIN A Net Amps digital input, or an event caused by a Net Amps digital input state change. Further details can be found in the *Net Station Acquisition Technical Manual* and the *GES Hardware Technical Manual*.

drift The change in a signal's offset over time, or the amount by which a signal's offset changes with time.

E

ECI See *Experimental Control Interface*.

EEG electroencephalography. The science of graphically recording the electrical activity of the brain as recorded by an electroencephalograph.

electroencephalography The science of recording and analyzing the electrical activity of the brain.

ERP See *event-related potential*.

event A discrete occurrence that coincides with EEG. An event could be a DIN or ECI event, or some other Net Station occurrence. Further details can be found in the *Net Station Acquisition Technical Manual*.

event-related potential An EEG waveform elicited by a stimulus such as an auditory or visual event.

Experimental Control Interface Built into Net Station is a protocol for experimental control technology that uses the Multi-Port ECI device along with a messaging system.

G

geodesic The shortest distance between two points on the surface of a sphere. The Geodesic Sensor Net is a structure of elastomer lines in the approximation of a geodesic.

Geodesic Sensor Net EGI's dense sensor array.

GSN See *Geodesic Sensor Net*.

H

Hertz Cycles per second. Something that occurs with a frequency of 10 Hertz happens 10 times each second.

J

jack Socket or connector into which a plug may be inserted.

M

miscorrelation A misalignment between EEG and ECI events in a data file. Miscorrelation causes errors in the average ERP.

N

Net Amps 200 and 300 EGI's dense-array amplifiers.

Net Station EGI's Mac-based data-acquisition software.

Nyquist frequency The maximum frequency able to be characterized for a given sampling rate. The Nyquist frequency is typically taken to be 2/5 of the sampling rate, for engineering purposes. See also *antialiasing*.

O

observation The unit of analysis. In a session file, an observation is a single trial. In an average file, an observation is a single subject (whose data have been averaged across trials).

offset A discrepancy between a DIN event and an ECI event (in timing testing), or between an ECI event and the corresponding EEG (in a study). See also *miscorrelation*.

P

phosphor decay The time it takes for the intensity of the light emitted from the phosphor to fall off to10% of its original value.

pixel A single picture element. A pixel is a point in 2D with a single color value. The number of pixels visible on a monitor is controlled by the monitor's resolution setting.

plug A fitting used to make electrical connections.

port A site for passing data in and out of a computer.

R

receptacle A fitting connected to a power supply and equipped to receive a plug.

reference An electrical point that is treated as zero for purposes of amplifying electrical signals. The Geodesic Sensor Net has a reference electrode located at the vertex.

refresh rate The frequency with which each pixel on a particular monitor is updated with new information. This is expressed in Hertz.

S

sample When a continuous signal is measured by examining it at discrete moments in time, each measurement corresponds to a sample.

sampling rate The number of times per second that data are temporally sampled.

segment (of EEG) A discrete portion of EEG, and the product of segmentation.

segmentation The process of breaking a continuous recording of EEG into discrete sections of equal length, usually centered around one or more causal events.

signal A detectable, measurable quantity that can be expected to display periodicity or other forms of variation in time.

socket An opening or cavity into which something fits.

spatial sampling The process of sampling a 3D space at regular location intervals in a given instant of time. Compare with *temporal sampling*.

stimulus An event presented to a subject, usually to elicit an ERP.

T

temporal sampling The process of sampling a given location at regular intervals in time. Compare with *spatial sampling*.

trial A single observation in an E-Prime file, or a single segment of EEG, with correlated ECI events.

V

vertex The point on an EEG subject's scalp that is closest to the top of the head. In the International 10-20 system, Cz is the vertex electrode. In the Adult 128 GSN, electrode #129 is the vertex. The point on the scalp or skull located midway between the nasion and inion and centered between the preauricular points. Also the name of the Geodesic Sensor Net sensor that corresponds to this location and that contains the reference electrode.

volt/voltage A measure of electrical force, or the tendency for electrons to move from one location to another. Voltages are measured with respect to a *reference*.

W

Workbench The Net Station equivalent of an electronics laboratory. On the Workbench, modular device are connected by data cables into Workbench configurations of differing functionality. See *Acquisition Setup file*.

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