Audiometer Calibration System Manual

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Larson Davis

Audiometer Calibration System

Manual

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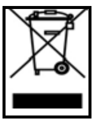

Warranty

For warranty information, refer to our *Terms and Conditions of Sale* on our website at www.larsondavis.com/TermsConditions.aspx.

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CHAPTER

1

Welcome to AUDit Audiometer Intelligent Testing

The Larson Davis audiometer calibration system has been designed for simplicity, portability, and durability. System weight, volume and component count have been carefully managed. Measurements for this system are made using the Larson Davis Model 824 precision sound level meter, which enables the user to perform complete Audiometer Calibrations per the requirements of ANSI S3.6-2004 and IEC 60645-2001 as well as testing Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms per ANSI S3.1-1999(R2008).

This system offers the following features:

- A whole range of transducers, their corrections and limits have been implemented, including: circumaural, supra-aural, insert earphones, bone vibrators, and speakers.
- A measurement database search allows quick reference to previously calibrated audiometers to speed up test configuration or compare the current test with historical data
- Extended frequencies can be tested using appropriate couplers such as the Larson Davis AEC201 coupler and plates.

Formatting Conventions

This manual uses the following format conventions:

- In step-by-step directions, the process (what you do) is shown in the right column, and the rationale (why you do it) with other cautions and comments are shown in the left column.
- **User Input:** this bold sans-serif typeface indicates values or selections entered in the software.
- ***Screen prompts***: this bold italic typeface denotes menu items, prompts, messages, and other textual information reported by the software.

Unpacking and Inspection

If you have received this manual as part of a complete Larson Davis audiometer calibration system, this section will acquaint you with its components. Your order has been shipped in protective packaging. As most audiometer calibration hardware must be recertified on an annual basis, please try to save these packing materials for future use.

Important*: If your packaging was damaged in transit, please contact your shipping provider for instructions on filing a claim.*

Please compare your system with the following table and note any discrepancies before contacting your Larson Davis representative.

SYS008

This system has the same components as the SYS009 with the exception of the AMC493B artificial mastoid.

Part	Description
2575	1 inch precision pressure response microphone, and case
824	Precision integrating sound level meter including
	PRM902 1/2 inch preamplifier with 7 pin LEMO® connector
	PSA027 90-264 Volt to 12 V Power supply.
	BAT010 nickel metal hydride AA rechargeable battery pack
	CBL006 serial communications cable (with 9 pin D connector)
	CBL042 stereo phone plug to dual BNC output cable
	I824.01 operator manual
	I824.02 training manual
	I824.03 firmware upgrade instruction sheet
	SWW 824 utility software CD
	WS001 - 3 1/2 inch foam windscreen
	AM814.06 Neg/Pos AA term Spring Assy for individual AA battery cell use
824-AUD	Audiometric test (internal 824 firmware option)
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	Audiometer earphone adaptor for electrical input to 824
AEC100	6cc coupler (NBS-9-A coupler) with base, coupler, retaining ring, microphone cap, mass and handle (weight), and pillow
ADP019	1/2 inch MIC TO 1 inch CAL adaptor
CAL250	Precision microphone calibrator with 1 inch opening I250.1 CAL250 operation manual
CCS007	Weather-tight hard carrying case
DVX011	USB to serial adaptor
EXA010	10 foot microphone extension cable
SWW-AUDIT	Audiometer calibration software including
	IAUDit.01 software operator manual and media

SYS009 with AMC493B

Part	Description
2575	1 inch precision pressure response microphone, and case
824	Precision integrating sound level meter including
	PRM902 1/2 inch preamplifier with 7 pin LEMO® connector
	PSA027 90-264 Volt to 12 V Power supply.
	BAT010 nickel metal hydride AA rechargeable battery pack
	CBL006 serial communications cable (with 9 pin D connector)
	CBL042 stereo phone plug to dual BNC output cable
	I824.01 operator manual
	I824.02 training manual
	I824.03 firmware upgrade instruction sheet
	SWW-824.F utility software CD
	WS001 - 3 1/2 inch foam windscreen
	AM814.06 Neg/Pos AA term Spring Assy for individual AA battery cell use
824-AUD	Audiometric test (internal) 824 firmware option
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	audiometer earphone adaptor for electrical input to 824
AEC100	'6cc coupler' (NBS-9-A coupler) with base, coupler, retaining ring, microphone cap, mass and handle (weight), and pillow
ADP019	1/2 inch MIC TO 1 inch CAL adaptor
AMC493B	Artificial mastoid coupler and case
	IAMC493B.01 AMC493B operator manual
	MAE100.55 additional weight ring
CAL250	Precision microphone calibrator with 1 inch opening
	I250.1 CAL250 operator manual
CCS007	Weather-tight hard carrying case
DVX011	USB to serial adaptor
EXA010	10 foot microphone extension cable
SWW-AUDIT	Audiometer calibration software including
	IAUDit.01 software operator manual and media

SYS010 with AEC201-A

Part	Description
824	Precision integrating sound level meter including
	PRM902 1/2 inch preamplifier with 7 pin LEMO® connector
	PSA027 90-264 Volt to 12 V Power supply.
	BAT010 nickel metal hydride AA rechargeable battery pack
	CBL006 serial communications cable (with 9 pin D connector)
	CBL042 stereo phone plug to dual BNC output cable
	I824.01 operator manual
	I824.02 training manual
	I824.03 firmware upgrade instruction sheet
	SWW-824.F utility software CD
	WS001 - 3 1/2 inch foam windscreen
	AM814.06 Neg/Pos AA term Spring Assy for individual AA battery cell use
824-AUD	Audiometric test (internal) 824 firmware option
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	audiometer earphone adaptor for electrical input to 824
ADP019	1/2 inch MIC TO 1 inch CAL adaptor
AEC201-A	IEC 60318-1:2009 Ear Simulator with 377A13 microphone
CAL250	Precision microphone calibrator with 1 inch opening
	I250.1 CAL250 operator manual
CCS007	Weather-tight hard carrying case
DVX011	USB to serial adaptor
EXA010	10 foot microphone extension cable
SWW-AUDIT	Audiometer calibration software including
	IAUDit.01 software operator manual and media

SYS011 with AMC493B and AEC201-A

Part	Description
824	Precision integrating sound level meter including
	PRM902 1/2 inch preamplifier with 7 pin LEMO® connector
	PSA027 90-264 Volt to 12 V Power supply.
	BAT010 nickel metal hydride AA rechargeable battery pack
	CBL006 serial communications cable (with 9 pin D connector)
	CBL042 stereo phone plug to dual BNC output cable
	I824.01 operator manual
	I824.02 training manual
	I824.03 firmware upgrade instruction sheet
	SWW-824.F utility software CD
	WS001 - 3 1/2 inch foam windscreen
	AM814.06 Neg/Pos AA term Spring Assy for individual AA battery cell use
824-AUD	Audiometric test (internal) 824 firmware option
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	audiometer earphone adaptor for electrical input to 824
ADP019	1/2 inch MIC TO 1 inch CAL adaptor
AEC201-A	IEC 60318-1:2009 Ear Simulator with 377A13 microphone
AMC493B	Artificial mastoid coupler and case
	IAMC493B.01 AMC493B operator manual
	MAE100.55 additional weight ring
CAL250	Precision microphone calibrator with 1 inch opening
	I250.1 CAL250 operator manual
CCS007	Weather-tight hard carrying case
DVX011	USB to serial adaptor
EXA010	10 foot microphone extension cable
SWW-AUDIT	Audiometer calibration software including
	IAUDit.01 software operator manual and media

Optional Components

- **AEC202** 2cc Artificial coupler for use with 1/2 inch microphone for insert earphone measurement. Microphone not included.
- **AEC203** 2cc Artificial coupler for 1 inch microphone, compliant to ANSI S3.7: Microphone not included.
- **AEC204** Ear simulator with 1/2 inch microphone.

Software Installation

Hardware and Software Requirements

The following table lists the requirements for the installation and use of the AUDit software for audiometer calibration.

- **Operating system**: Windows XP™ SP3 (32-bit), Windows Vista Professional™ SP1 (32-bit), Windows 7™ (32-bit and 64-bit), and Windows 8™ (32-bit and 64-bit). AUDit software must be installed using Administrator rights.
- **Network:** AUDit™ is not designed to work on a distributed network from a network drive. However, it may be operated from a local installation on a computer connected to a network.
- **Communications:** One available 9-pin serial communication port, 9600 baud or greater recommended or DVX011, USB Adapter to DBM9 interface (824) to USB port on PC.

Installing the Software

Place the AUDit CD in your PC and follow the onscreen instructions. You can accept the default settings on each screen for proper installation.

FIGURE 1-1 AUDit Icon on desktop

Look for new icon on the PC Desktop.

Getting Help

Contact PCB® Piezotronics Technical Support at 888-258-3222 (toll free) or +1 716 926-8243 if you encounter any problems with the installation or use of AUDit software.

Starting the Software

Step 1 On the PC desktop, double click the AUDit icon to run the software. If this is the first time you have used the AUDit software, you will be asked if you wish to create a new database.

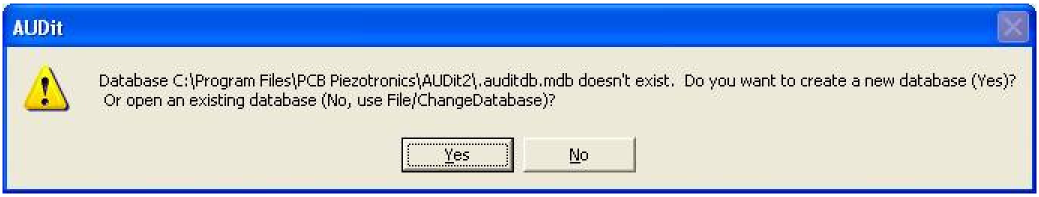


FIGURE 1-2 Create new database Dialog Box

Step 2 Selecting ***Yes*** will create a database named **Auditdb.mdb** in the default directory. To create a database later in another directory select ***No***.

FIGURE 1-3 Could not open database Dialog Window

Step 3 You will be able to enter a database name and directory in the ***File***, ***Change Database...*** menu item. Press ***OK*** to acknowledge the prompt and display the main menu.

CHAPTER

2

Initial Configuration

Before performing a measurement, a few items need to be configured in the AUDit software. This chapter covers setting up a database, configuring the system printer, entering calibration instrumentation information and other user preferences.

Creating a Database

The measurement database is a Microsoft Access® compatible file which contains information about calibration instruments, as well as audiometer and booth test results. During installation, you may have elected to create a blank database (by default Auditdb.mdb in the current directory). If so, you may skip this section.

To create a new database, click ***File, Change Database***... in the AUDit menu to open the Change Database dialog box then click ***Browse***.

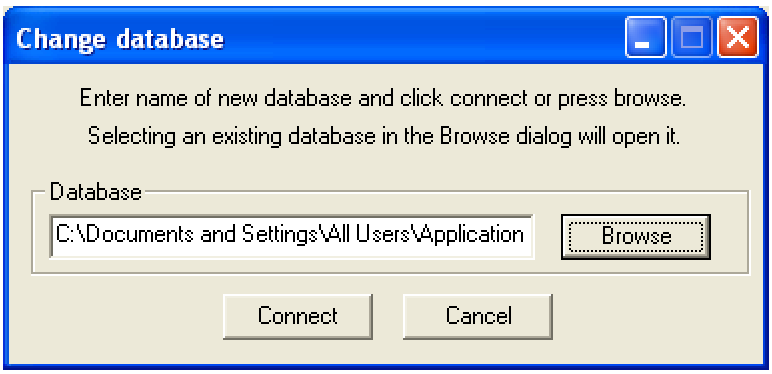


FIGURE 2-1 Change Database Dialog Box

The Open dialog box will appear, allowing you to select a database. To create a database enter a new database name and select open.

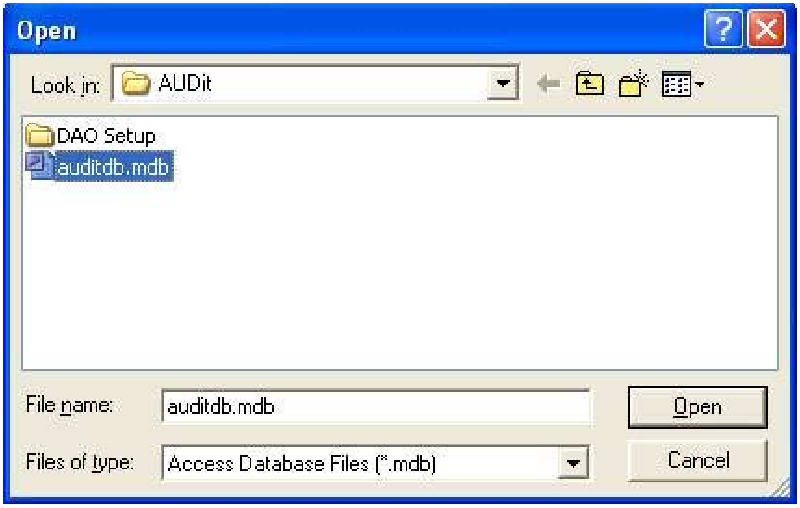


FIGURE 2-2 Open Dialog Box

Entering Instrumentation

NOTE: *When the desired instrumentation is selected for use with an audiometer measurement, a copy is stored with the measurement. If changes are later made to the instrumentation, those changes will not be reflected in the copy that is stored with the measurement.*

The AUDit audiometer calibration software maintains a list of the instruments used for calibration. These are normally certified traceable to NIST (National Institute of Standards and Technology) measurement standards at specified intervals. All this information is entered in the Instrumentation... Screen, shown in FIGURE 2-4.

Click ***Test, Instrumentation*** to display the Instrumentation screen.

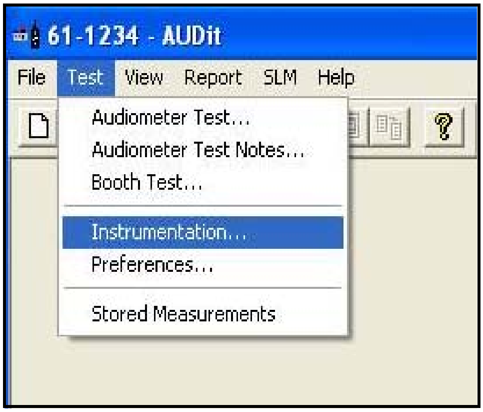


FIGURE 2-3 File, Instrumentation Menu

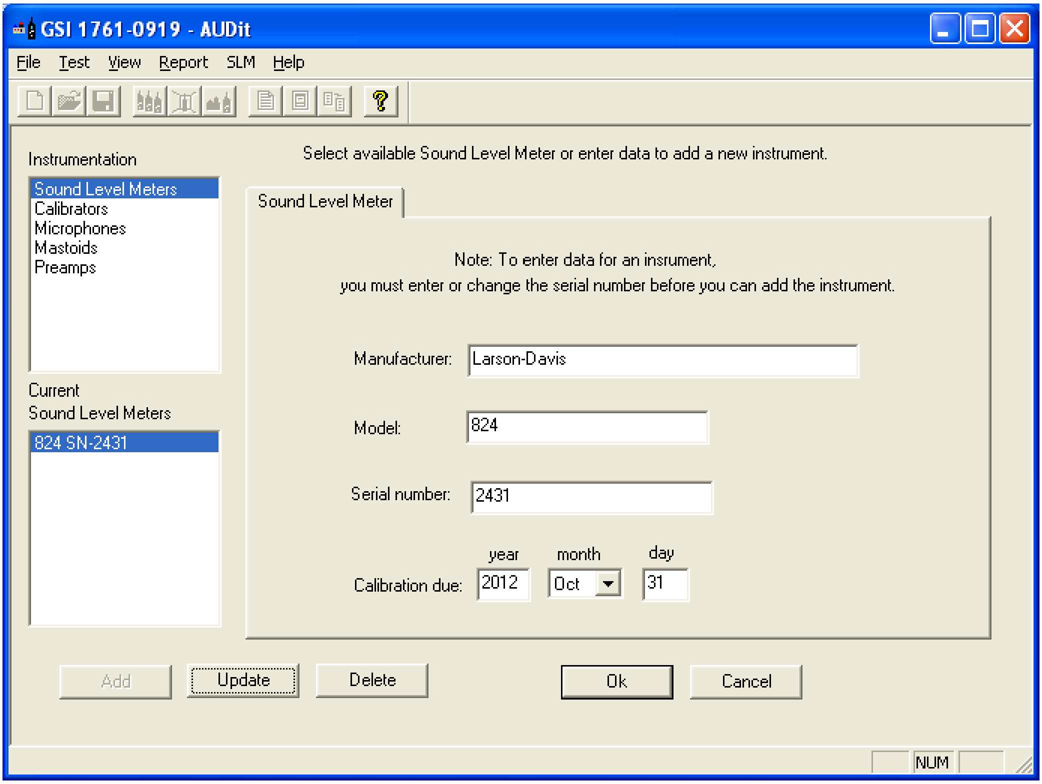


FIGURE 2-4 Instrumentation Screen

Types of instruments are listed in the upper left rectangle. Currently defined instruments (in this case, sound level meters) are listed in the rectangle at the lower left. The large area at the right has fields for model, serial number and other information for each type of instrument. If your instrumentation has already been defined for the current database, skip forward to the “Preferences” section.

If you modify data for an instrument and select ***Add***, then a new instrument will be created. U***pdate*** will change the information for the currently selected instrument. ***OK*** must be selected to commit any changes to the AUDit database. Selecting ***Cancel*** will discard all changes made using ***Add***, ***Update***, or ***Delete***.

Sound Level Meter

Currently, the Larson Davis System 824 precision sound level meter (SLM) is the only SLM instrument compatible with the AUDit software. To enter your SLM information, click **Test, Instrumentation**... and select **Sound Level Meters** in the upper left box of the screen.

Enter the serial number of your 824 and its calibration due date; both available on labels on the back of the instrument. The calibration year must have four digits. Once all fields are completed, click ***Add***. A new SLM entry will appear in the lower left box.

Calibrator

Calibrator information is entered by clicking ***Test, Instrumentation***... and selecting ***Calibrators*** in the upper left box of the screen.

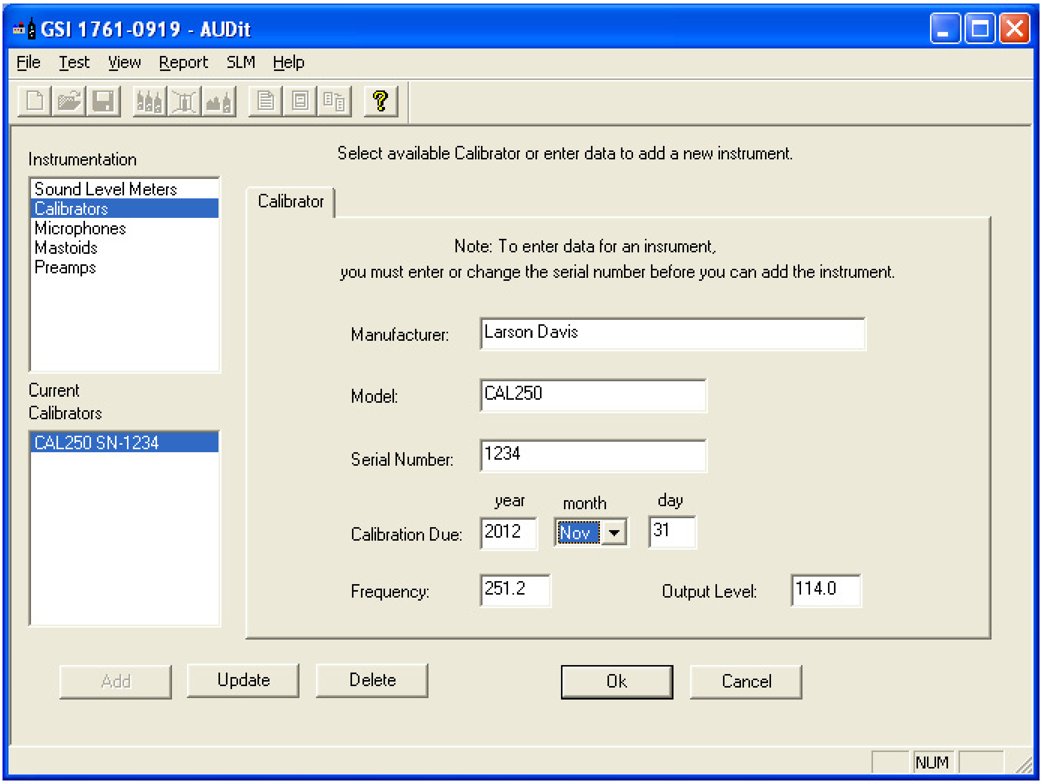


FIGURE 2-5 Calibrator Information Dialog Box

NOTE: *The Larson Davis CAL250 calibrator provided with your system has a frequency of 251.2 Hertz and a level of 114.0 dB re 20 micropascals. Output frequency and level are used by the AUDit the calibration procedure. Entering incorrect values could lead to measurement errors.*

Enter the serial number of your calibrator, its calibration due date, frequency and output level. The calibration year must have four digits. Once all fields are completed, click ***Add***.

Microphone

Microphone information is entered by clicking ***Test, Instrumentation***... and selecting ***Microphones*** in the upper left box of the screen.

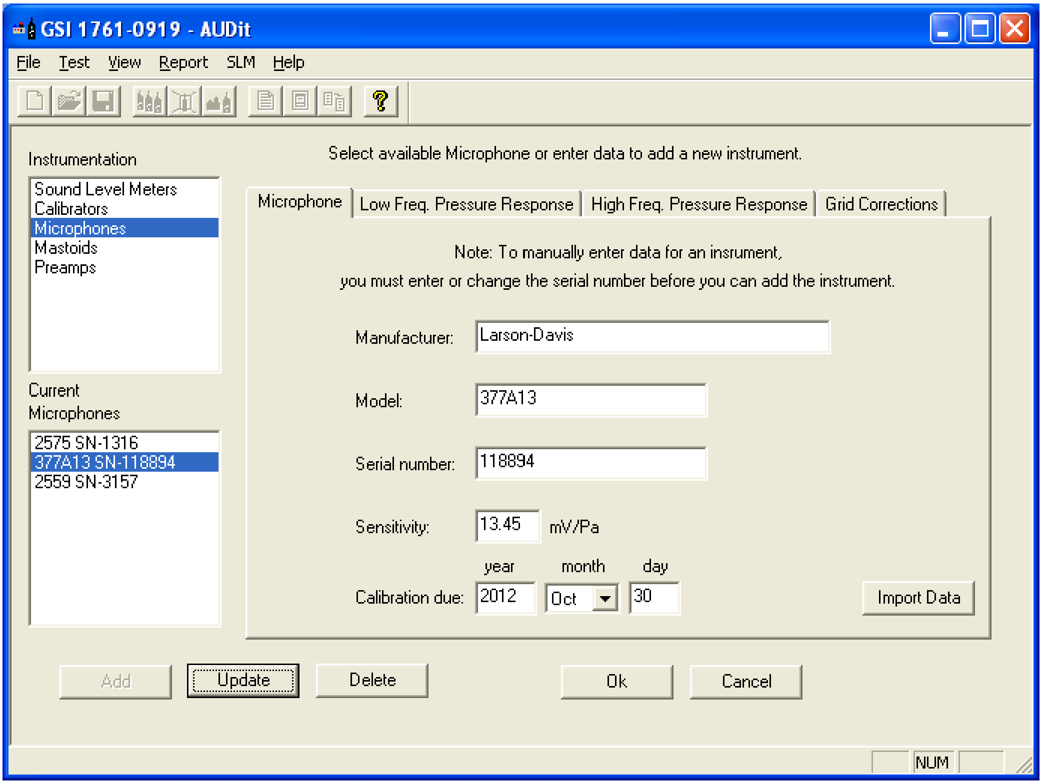


FIGURE 2-6 Microphone Information Dialog Box

Note: The 377A13 requires the polarization voltage set for Electret in the 824. In SETUP SLM Settings, set Transducer to Elctret.

For 2575, 377A13 and 2559 microphones, data can be imported directly from a .csv file using the import data button. After importing the .csv file, click **OK** to save the imported data to the AUDit database.

For other microphones, frequency response information is available on the provided calibration chart and can be entered manually. Some audiometric frequencies may not be listed exactly: e.g. 200 Hz is listed as 199.53 Hz. If the frequency labeled in the software is between two frequencies on the certificate, you may wish to enter an interpolated value.

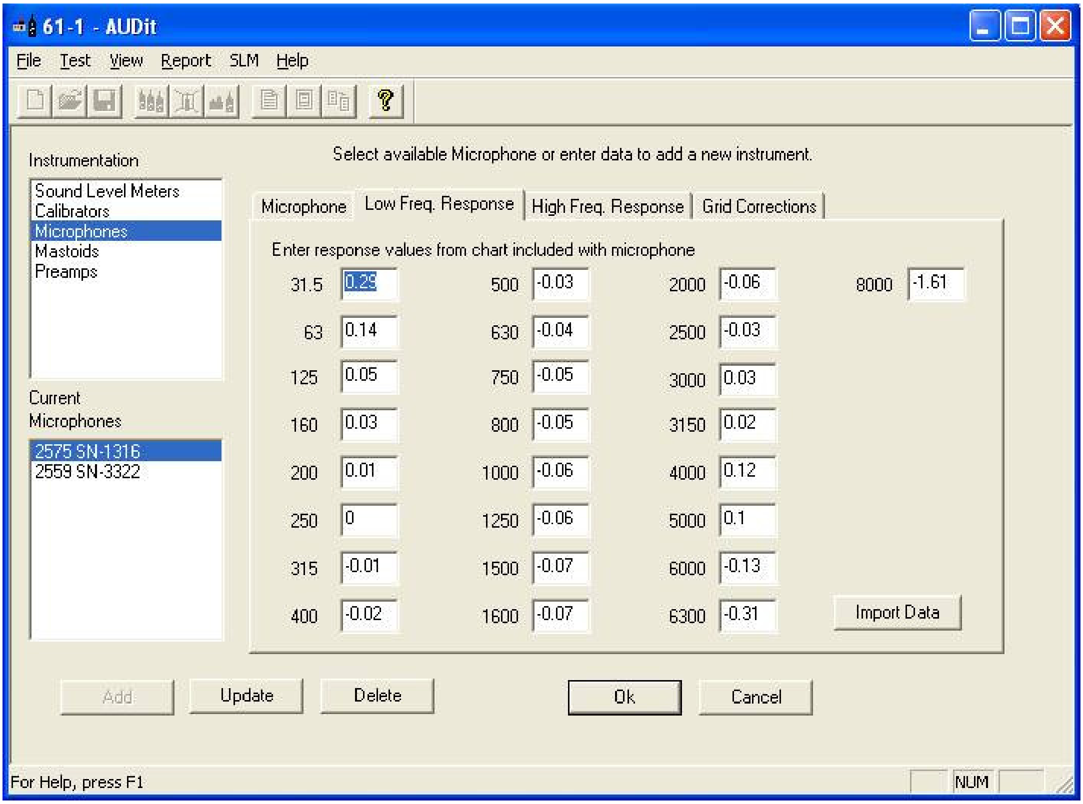


FIGURE 2-7 Microphone Frequency Response Information Dialog Box

High frequency and grid cap corrections may not be necessary if you are not performing the calibration of extended frequency audiometers.

Mic	Larson-Davis	2575	1316	40.96	4/13/2009
20	0.43				
25.1	0.36				
31.6	0.29				
39.8	0.23				
50.1	0.18				
63.1	0.14				
79.4	0.1				
100	0.07				
125.9	0.05				
158.5	0.03				
199.5	0.01				
251.2	0				
316.2	-0.01				
398.1	-0.02				
501.2	-0.03				
631	-0.04				
794.3	-0.05				
1000	-0.06				
1059.3	-0.06				
1122	-0.06				
1188.5	-0.06				
1258.9	-0.06				
1333.5	-0.07				
1412.5	-0.07				
1496.2	-0.07				
1584.9	-0.07				
1678.8	-0.07				
1778.3	-0.07				
1883.7	-0.06				
1995.3	-0.06				
2113.5	-0.06				
2238.7	-0.05				
2371.4	-0.04				
2511.9	-0.03				
2660.7	0				
2818.4	0				
2985.4	0.03				
3162.3	0.02				
3349.7	0.05				
3548.1	0.08				
3758.4	0.08				
3981.1	0.12				
4217	0.13				
4466.8	0.13				
4731.5	0.13				

FIGURE 2-8 Example of Imported .CSV File

AMC493 Artificial Mastoid

The artificial mastoid is used to calibrate the bone vibrator used for bone conduction audiometry. Information is entered by clicking ***Test***, ***Instrumentation***... And selecting ***Mastoids*** in the upper left box of the screen.

The sensitivity of a B&K® mastoid is found on its calibration chart, under the heading Force Sensitivity (including cable) and is in units of mV/N.

Only two types of mastoids are currently supported by AUDit software: the Larson Davis Model AMC493 and Bruel & Kjaer® 4930 artificial mastoids. Therefore, the Manufacturer entry is a pull down menu with those two choices. Enter the manufacturer, model and serial number of your mastoid and its calibration due date.

Field tests show the sensitivity offset for the AMC493 to be approximately 12.5 dB.

It is not necessary to enter a sensitivity with the Larson Davis artificial mastoid. AMC493B information can be imported directly from a .csv file using Import Data.

The Bruel & Kjaer calibration chart typically has three parts. Enter values read from Page 2: Frequency Response at constant dynamic force, using the 5.4 N (black) curve.

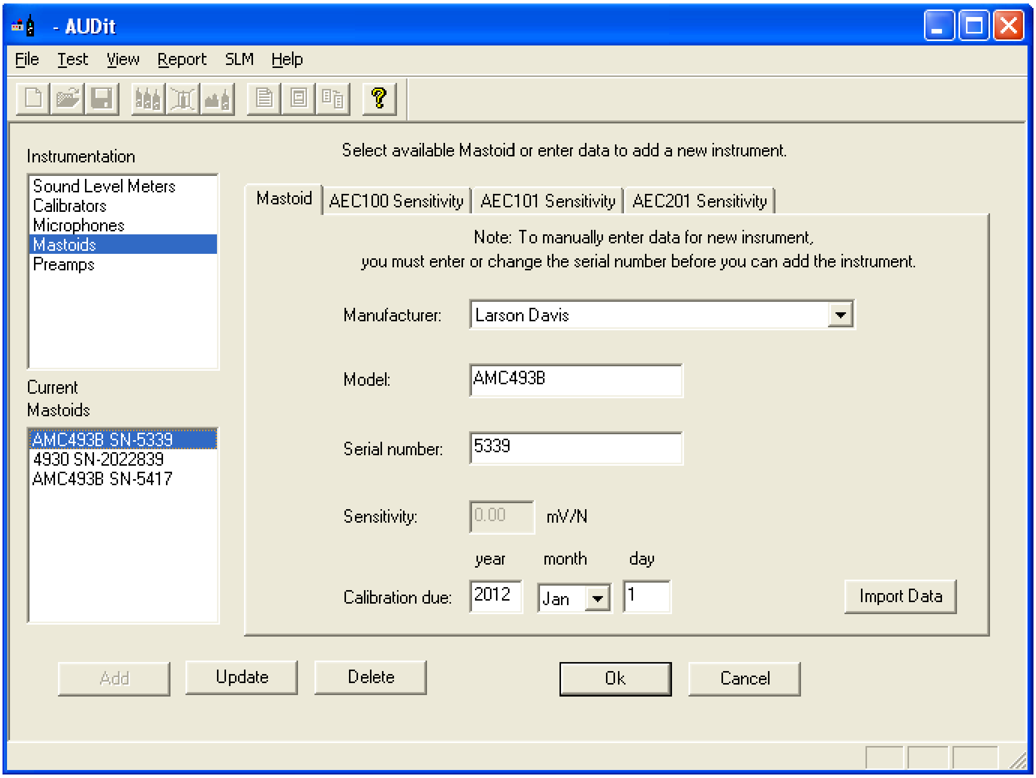
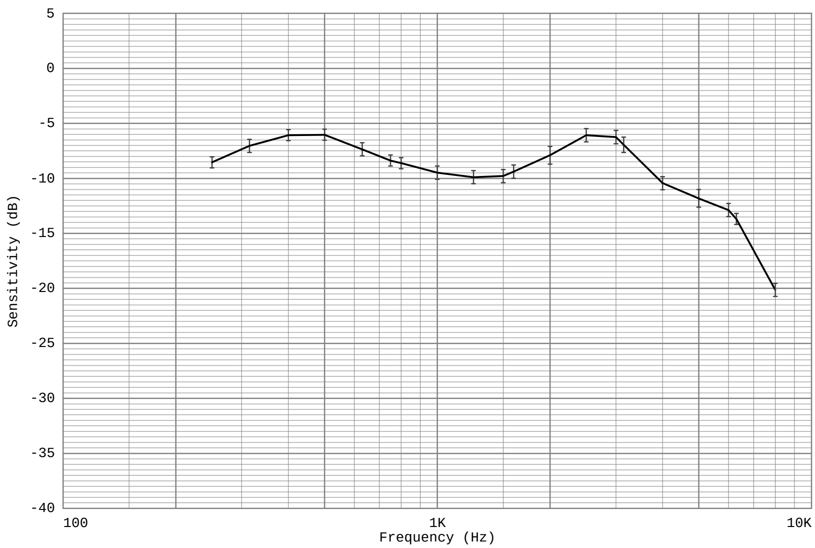


FIGURE 2-9 Mastoids Information Dialog Box

Sample Calibration Report

Artificial Mastoid Test Report: Sensitivity when used on an AEC201
Model: AMC493B Serial Number: 5021
AEC201 Serial Number: 0102

Tested without Black Conical Ring



Mastoid Sensitivity (reference: 20 μPa/μN)

Frequency (Hz)	Sensitivity (dB)	Uncertainty (dB)	Frequency (Hz)	Sensitivity (dB)	Uncertainty (dB)
250	-8.5	0.5	1600	-9.4	0.6
315	-7.0	0.6	2000	-7.9	0.8
400	-6.1	0.5	2500	-6.1	0.6
500	-6.0	0.5	3000	-6.2	0.6
630	-7.3	0.6	3150	-6.9	0.7
750	-8.4	0.5	4000	-10.4	0.6
800	-8.6	0.5	5000	-11.8	0.8
1000	-9.5	0.6	6000	-12.9	0.6
1250	-9.9	0.6	6300	-13.7	0.5
1500	-9.8	0.6	8000	-20.1	0.6

Temperature (°C): 23 ± 1
Relative Humdity (%): 49 ± 5
Static Pressure (kPa): 85.4 ± 2.0 (data corrected to 101.3 ± 3.0)

Uncertainty at ~95% confidence level (k=2)

Tested by Scott Montgomery on 2JUN2011

Test performed at: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

The results documented in this report relate only to the item(s) tested.
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FIGURE 2-10 Sample Artificial Mastoid Response chart

Preamplifier

The Larson Davis System 824 precision sound level meter (SLM) is supplied with a Model PRM902 preamplifier. To enter your preamplifier information, click ***Test***, ***Instrumentation***... And select ***Preamps*** in the upper left box of the screen.

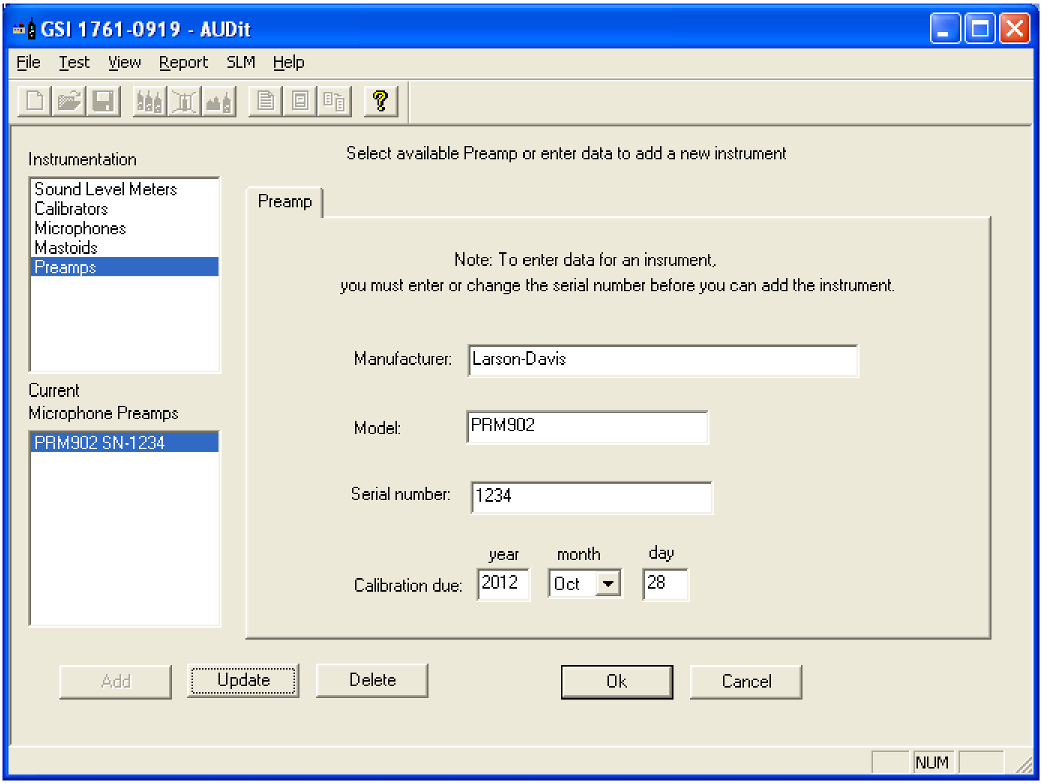


FIGURE 2-11 Preamplifier Information Dialog Box

Enter the serial number etched on the barrel of your preamplifier and its calibration due date, which is typically the same as that of the 824. Once all fields are completed, click ***Add***. A new Preamp entry will appear in the lower left box.

Preferences

This configuration item allows the entry of the calibrating organization and selection of communication parameters for the System 824 SLM.

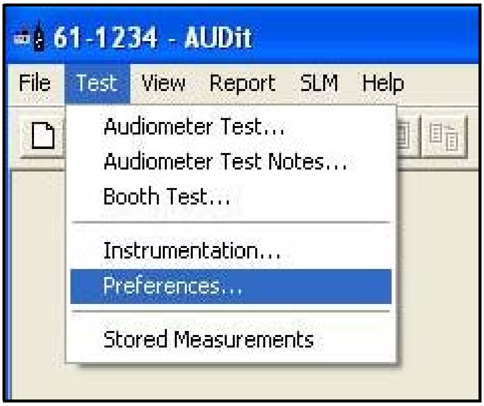


FIGURE 2-12 Test, Set Preferences Menu

Two system setup items are available in the rectangular area at the upper left of the screen as shown in FIGURE 2-13, Organization and RS232 Port.

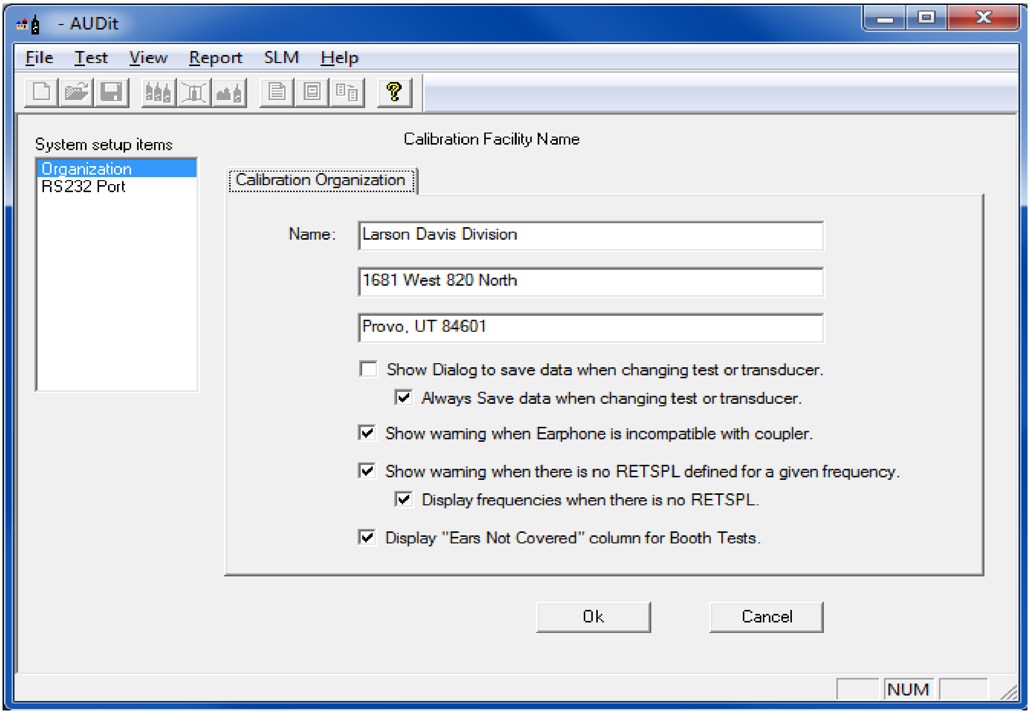


FIGURE 2-13 Preferences Dialog Box

Organization

- Click in the **Name** fields to enter information such as name and address.This information will appear on the report and calibration certificate.
- Checking the **Show Dialog to save data when changing test or transducer** option will cause the Save dialog box appear before each change.

*You can also click the **Save** button on the test panel when you wish to save data.*

- Checking the **Always Save data when changing test or transducer** option will cause the data to be saved automatically for each change without a **Save** dialog box prompt.
- Checking **Show warning when Earphone is incompatible with coupler** option will cause a warning message to appear when an incompatibility is detected.

- Checking the **Show warning when there is no RETSPL defined for a given frequency** option will cause a warning message to appear before running a test without RETSPL defined for the frequency to be tested., as shown in Figure 2-14.
- Checking the **Display frequencies when there is no RETSPL** will allow the frequencies in the Hearing Level tests to be displayed without RETSPL being associated with them.

When RETSPL is not defined for the frequencies to be tested, the message shown in Figure 2-14 appears:

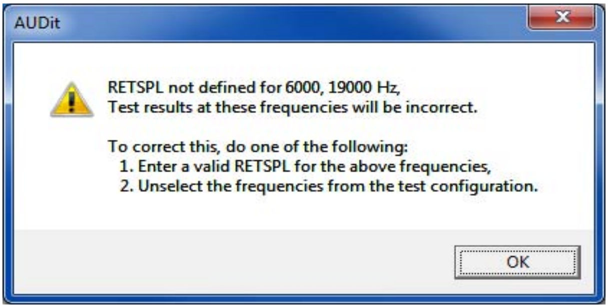


FIGURE 2-14 Frequencies without RETSPL

  - Click **Yes** to display all frequencies, including those with our without RETSPL.
  - Click **No** to close the dialog box to display only those frequencies with RETSPL.
  - Click **Cancel** to uncheck the option to show this warning message until it is re-checked on the **Preferences** dialog box.
- Checking the **Display "Ears Not Covered" column for Booth Tests** option will display columns in the 125 Hz to 8 kHz, 250 Hz to 8 kHz, and 500 Hz to 8 kHz booth tests and all of the reports.

Click ***RS232 Port*** to access the screen for RS232 communications port options. Here you may select port number (COM1 to COM8) and RS232 baud rate (300 to 115kBaud) from pull down menus.

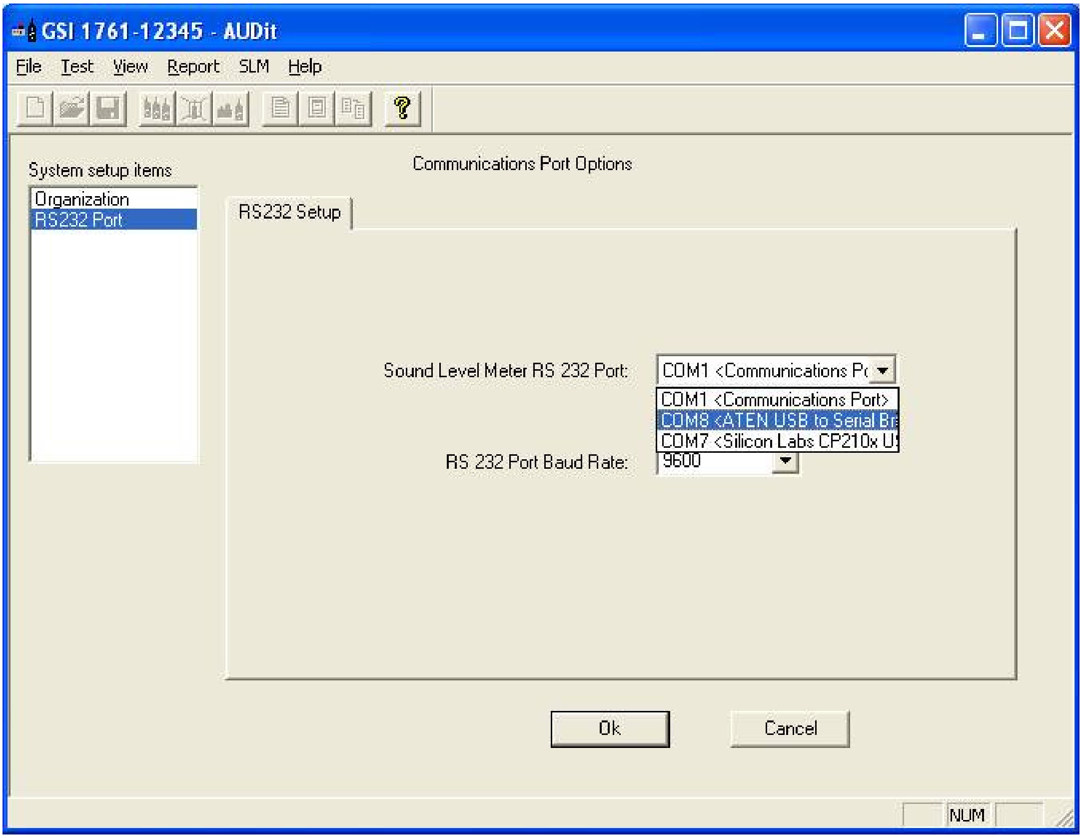


FIGURE 2-15 RS-232 Communications Dialog Box

You have now completed the initial configuration of the AUDit software. In the next chapter, the system will be assembled and calibrated to perform an audiometric booth ambient level test.

CHAPTER

3

Audiometer Test Setup

For every audiometer test, the AUDit software allows you to fully define the measurement as well as the components of the equipment under test. When a measurement is defined, all this information is recorded in the database. Therefore, an audiometer system only needs to be defined once, saving a lot of time in subsequent tests.

In this chapter, you will set up the audiometer test by performing this data entry. You will be able to refer to instruments which were entered previously in the Instrumentation screen. Audiometers and their many transducer types will also be entered.

To begin entering test information, click the ***Test, Audiometer Test***... drop down menu item. (FIGURE 3-1).

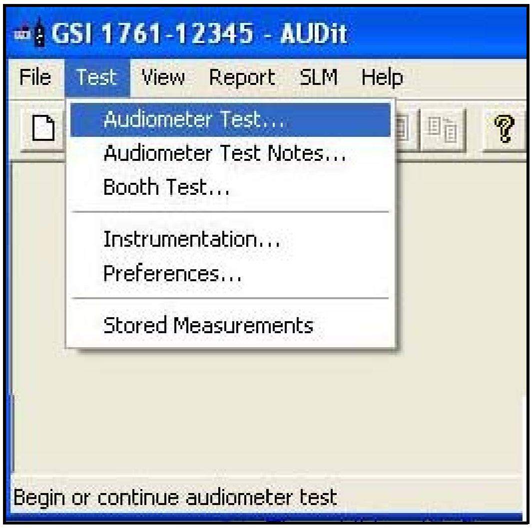


FIGURE 3-1 Test Menu

This will display the Enter Test Location screen (FIGURE 3-2). It is the first of a series of entry screens listed in a column on the left side of the screen.

Test Location

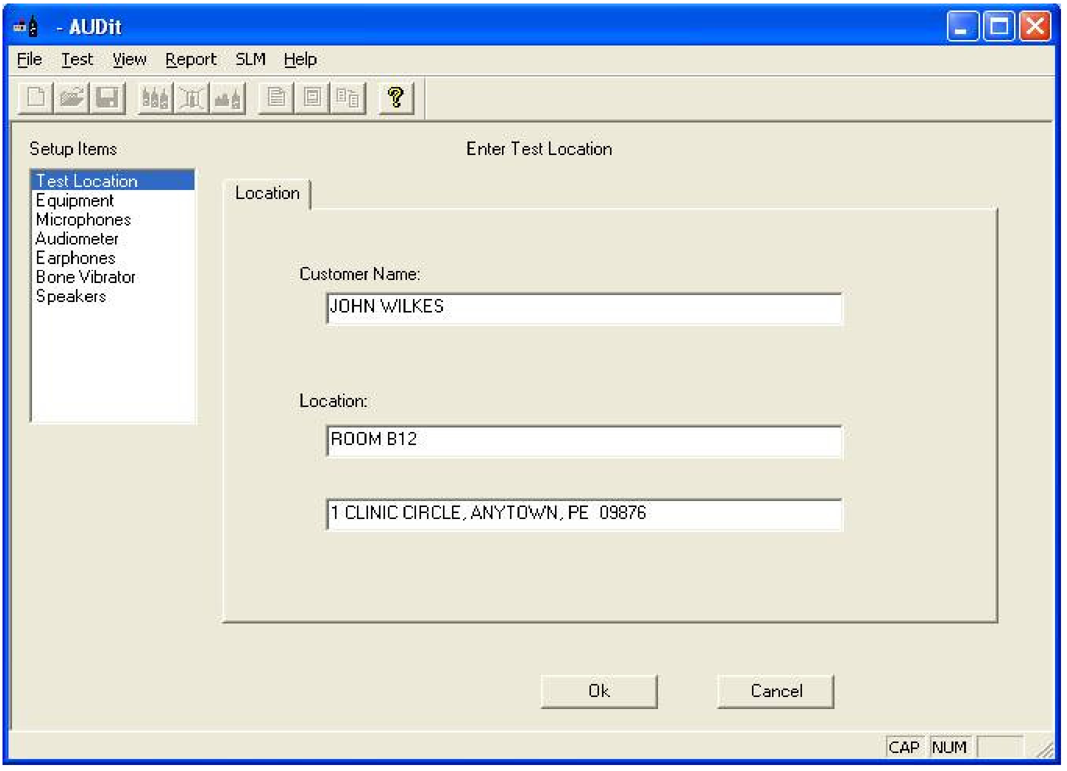


FIGURE 3-2 Test Location Dialog Box

This is where customer information is entered.

Test Location (FIGURE 3-2) contains the following fields:

- **Customer Name**: the customer or company name
- **Location**: the location of the audiometer, telephone number or other information

Equipment

NOTE: *When the desired instrumentation is selected for use with an audiometer measurement, a copy of the selected instrumentation is stored with the measurement. If changes are made to the instrumentation, those changes will not be reflected in the copy that is stored with the measurement.*

The equipment used to test the audiometer is selected here from the instrumentation which was entered earlier.

Equipment that has been previously entered into the instrumentation database is available for selection in these dialogs. To use a new piece of equipment in a test, first enter it into the instrumentation database then it can be selected here.

Mastoid Tab

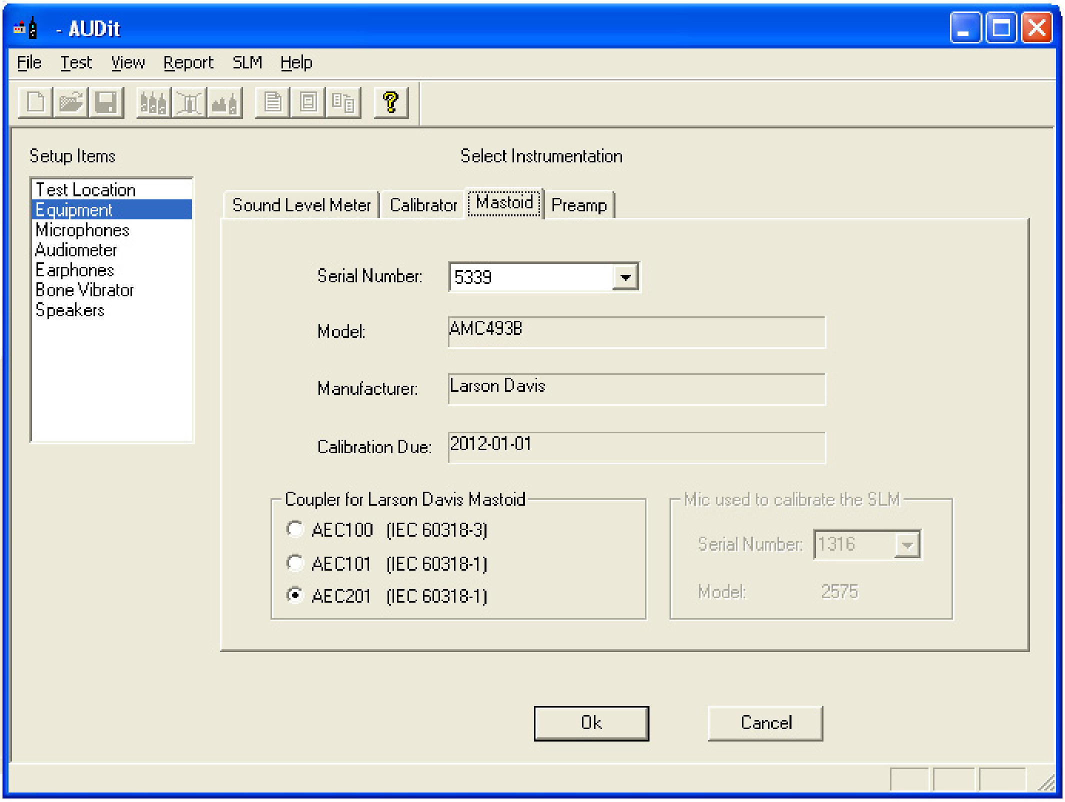


FIGURE 3-3 Mastoid Selection Tab

The serial number is selectable from a drop down list of the previously entered serial numbers, which determines the Model and Manufacturer. The Larson Davis AMC493B and B&K® 4930 artificial mastoids are supported by AUDit. The two boxes at the bottom of the screen are active only for the appropriate mastoid.

Coupler for Larson Davis Mastoid

Since the Larson Davis AMC493B artificial mastoid requires corrections based on the coupler with which it is used, these radio buttons selects either the Larson Davis Model AEC201 or AEC100 coupler.

Mic used to calibrate the SLM

This box is only enabled with the Bruel & Kjaer® artificial mastoid. It is used to specify which microphone will be used to calibrate the SLM before using the mastoid. Mastoid and microphone sensitivities are used to calculate the output level of the bone vibrator.

Microphones

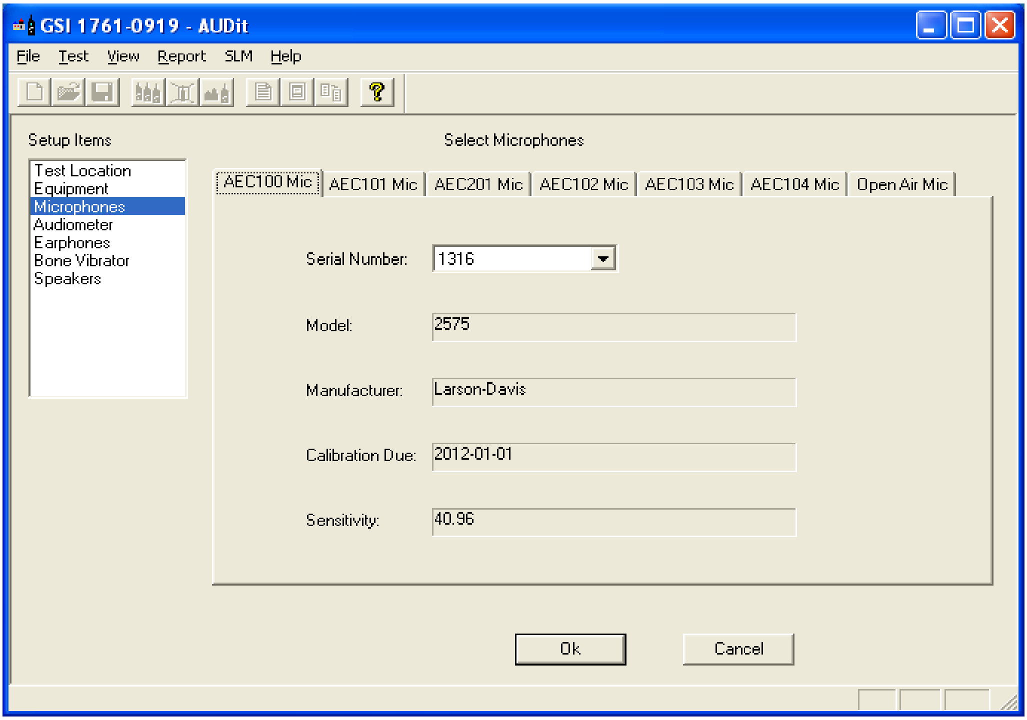


FIGURE 3-4 Select Microphone Dialog Box

Microphones (FIGURE 3-4) allow you to configure the microphone paired with each coupler.

If a specific coupler will not be used in the audiometer calibration, no data entry is required.

AEC100 Mic Tab

Select the microphone used with the NBS 9A coupler. This coupler was originally developed by the National Bureau of Standards, now called the National Institute of Standards and Technology (NIST). It is specified in American National Standard Institute *Specifications for Audiometers, S3.6-2004 for calibrating earphones used in audiometry.* The Larson Davis AEC100 artificial ear is designed to meet the requirements of this standard.

AEC201 Mic Tab

Select the microphone PCB 377A13 used with the AEC201. This coupler is designed to achieve the characteristics defined in International Electrotechnical Commission IEC 60318-1:2009 Simulators of Human Head and Ear - Part 1: Ear Simulator for the calibration of supra-aural and circumaural earphones. The AEC201 also meets the requirements of the American National Standard ANSI S3.7-1995 (R2008) Method for Coupler Calibration of Earphones (Section 5.4). With the help of a circumaural adapter plate as described in IEC60318-1:2009 Annex B and ANSI S3.6-2004 Annex C, the AEC201 may also serve to calibrate specific high acoustic damping earphones.

AEC202 or AEC203 Mic Tab

Select the microphone used with the HA-1 coupler. This coupler is described in *IEC 60126 (1973-01) IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts*. The coupler is designed to load the earphone with a specified acoustic impedance when determining the performance of air-conduction hearing aids using earphones coupled to the ear from 200 Hz to 5kHz.

AEC204 Mic Tab

Note: 126 and 711 have been replaced by IEC 60318-4 and -5. IEC60711 (1981) is canceled and replaced by IEC60318-4 (2010) and IEC 60126 (1973) is canceled and replaced by IEC 60318-5 (2006).

Select the microphone used with the IEC 60711 coupler. This coupler is described in *IEC 60711 (1981-01) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts*. The standard specifies an occluded-ear simulator for the calibration of insert earphones from 100 Hz to 10 kHz.

Open Air Mic Tab

Select the microphone used for open air measurements such as the ambient noise level measurement of the Booth Test, or speakers tests.

Audiometer

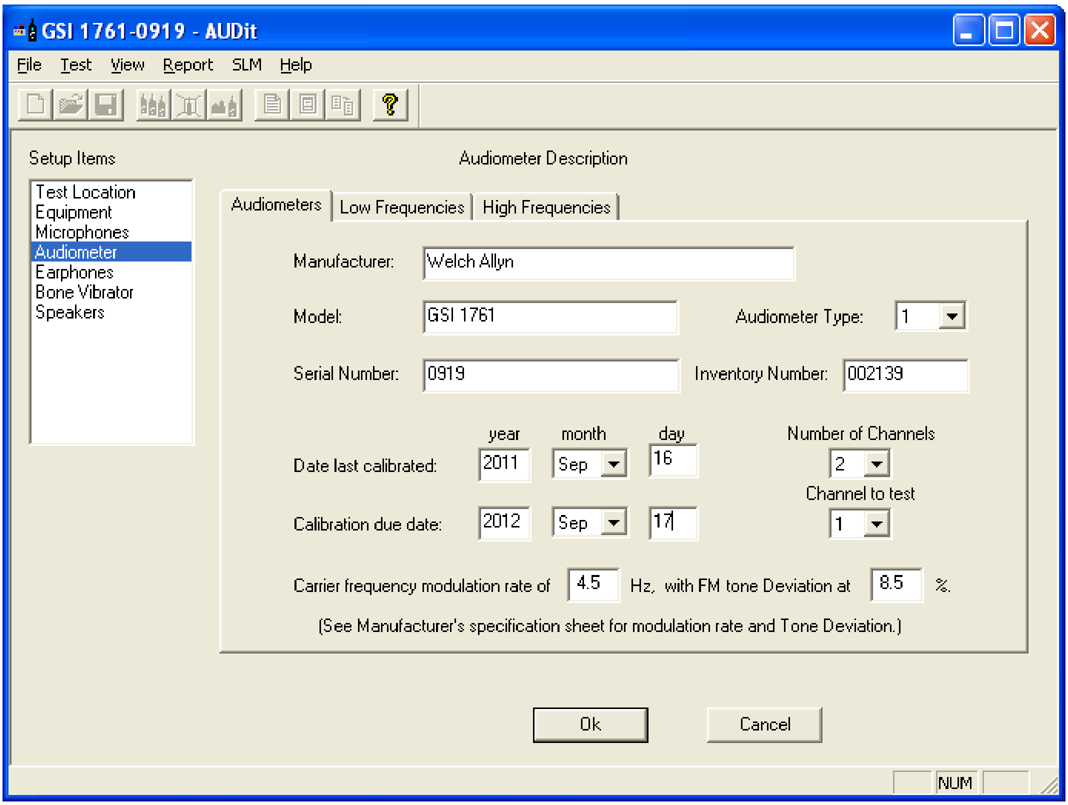


FIGURE 3-5 Audiometer Description Screen

The Audiometer Description screen contains information on the audiometer (or signal generator) under test, while its transducers are defined in the remaining screens of the setup items. The Audiometer Description screen is composed of three different tabs to describe the audiometer and the frequencies at which it is tested.

Audiometers Tab

NOTE: *American National Standard S3.6-2004 Specifications for Audiometers specifies the designation of audiometers (e.g. Type 3, Type 4) satisfying the standard. The minimum required facilities for each designation are listed in table 1 of the standard.*

NOTE: *ANSI S3.6-2004 pure tone Type 1 and 2 audiometers must have a facility for presenting a frequency modulated tone.*

- **Audiometer Type**: Enter the audiometer type number, which should be stated in the audiometer specifications or labeled on the instrument itself. Additional suffixes for high frequency, speech or free field equivalent are not available but may be entered in the **Audiometer Test Notes... comments**.
- **Carrier Frequency Modulation Rate Of**: Enter the audiometer's frequency modulation percentage and rate of modulation. These values will be verified in the appropriate test.

Low Frequencies Tab

The Low Frequencies tab allows you to specify which audiometer frequencies will be tested. It contains a list of audiometer frequencies from 125 to 8000 Hz.

High Frequencies Tab

The High Frequencies tab allows you to specify which high frequencies available on the audiometer will be tested. These frequencies are used by extended high frequency pure tone audiometers.

Earphones Screen

AUDit uses the supra-aural earphone reference equivalent threshold sound pressure levels (RETSPLs) in dB re 20 micropascals for common earphones as listed in Table 6 of ANSI S3.6-2004. The RETSPLs referred to the appropriate coupler are used in the calibration process. In the case of insert earphones, The RETSPLs listed in Table 7 of ANSI S3.6-2004 are used. Circumaural earphones interim RETSPLs listed in Table C1 are used by AUDit. Contact Larson Davis for information on enabling additional earphones with the manufacturer's valid RETSPL data.

Use the **Select Earphones** dialog box (FIGURE 3-6) to specify the audiometer earphones information and the respective artificial ear couplers used in the test setup.

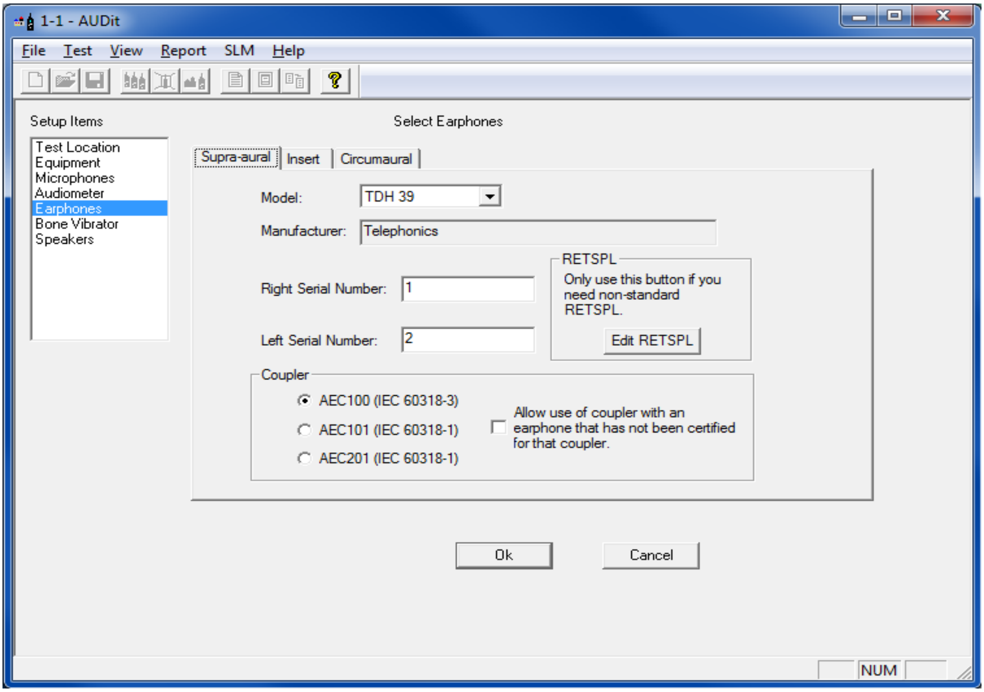


FIGURE 3-6 Select Earphones, Supra-aural Tab

On this tab, you can also modify RETSPL values. Click the E**dit RETSPL** button to display the **RETSPL** Editing dialog box.

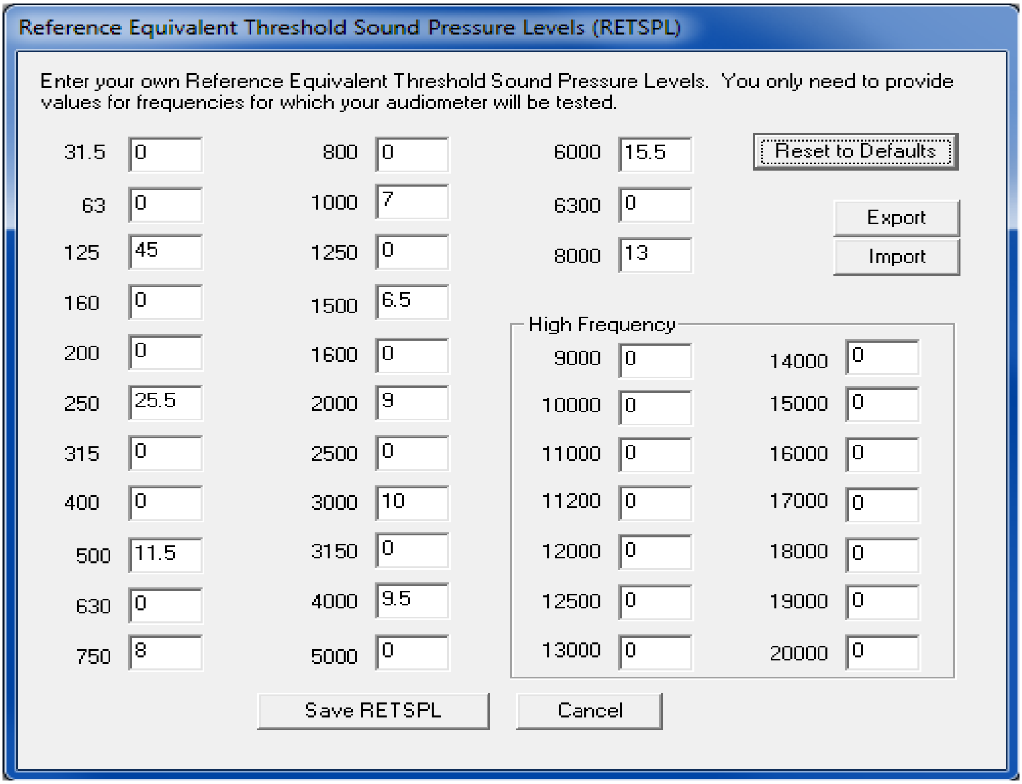


FIGURE 3-7 Editing RETSPL Values

*RETSPL levels are defined by US or international standards. Changing levels may result in tests that are no longer compliant. To restore RETSPL levels to those defined by these standards, click **Reset to Defaults**.*

- Clicking **Reset to Defaults** will undo any changes you made to RETSPL.
- Clicking **Export** will launch a Save dialog box to save modifications as a file for future use.
- Clicking **Import** will launch an Import dialog box import a file of RETSPL values.
- Clicking **Save RETSPL** will save your RETSPL changes and close the dialog box.
- Clicking **Cancel** will close the dialog box without saving any changes.

Bone Vibrator and Speakers

Information on these two dialog boxes is used to document the measurement and does not affect results.

CHAPTER

4 Booth Test or Ambient Noise Level Test

You have now configured AUDit software in preparation for your first test. In this chapter, the system will be calibrated to perform a measurement of ambient levels in the audiometric test room. This is referred to as a Booth test in the AUDit software. In doing this test, we will also cover connecting to the SLM and calibrating it.

If ambient noise levels in an audiometric test room are excessively high, they can have a masking effect on the subject, effectively raising the measured hearing threshold. This is most likely to occur if very low hearing threshold levels are being measured.

AUDit allows simultaneous assessment of noise levels for audiometric measurements with ears covered or not covered, in the frequency ranges of 125, 250 and 500 Hz to 8000 Hz. This test and its pass/fail limits are based on the recommendations of American National Standard on *Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms, ANSI S3.1 - 1991 (R2008)*. It also allows assessment of ambient levels per OSHA 1915.95 Appendix D.

In order to consider the worst case conditions for an audiometric test, the ambient noise test should be performed with all possible noise sources present. If certain sources are operating at certain times but not at others, it may be necessary to schedule the measurement accordingly.

Assembling the system

The Larson Davis System 824 precision sound level meter meets all the requirements of the aforementioned standards and rules for the measurement of ambient noise level in the audiometric test room. Its low self-noise and internal fractional octave band measurement capability enable it to accurately measure octave and third octave levels much below the minimum required levels, when using a high sensitivity microphone such as the Larson Davis model 2575.

Equipment for Booth Test

The equipment listed below is suggested for ambient noise testing using AUDit.

- PC with serial port with AUDit
- CBL006 serial cable
- System 824 precision sound level meter

NOTE: *The microphone/preamp assembly may be suspended or supported with a suitable microphone clamp. If the dimensions or construction of the audiometric test room require a longer length of cable or the use of patch panels, care must be taken not to introduce ground loops or other problems which can lead to higher system self-noise levels.*

- EXA010 extension cable (optional)
- PRM902 preamplifier
- 2575 microphone
- ADP008 1/2 inch preamp to 1 inch microphone thread adaptor
- CAL250 precision Sound Pressure Level calibrator

Assembling the system

Step 1 Connect the CBL006 from the SERIAL connector on the butt plate of the 824 SLM to an active serial port on the computer.

FIGURE 4-1 Connecting CBL006 to 824

Step 2 Install the PRM902 microphone preamplifier directly on the SLM or use the EXA010 extension cable by matching red dots on opposite gender connectors

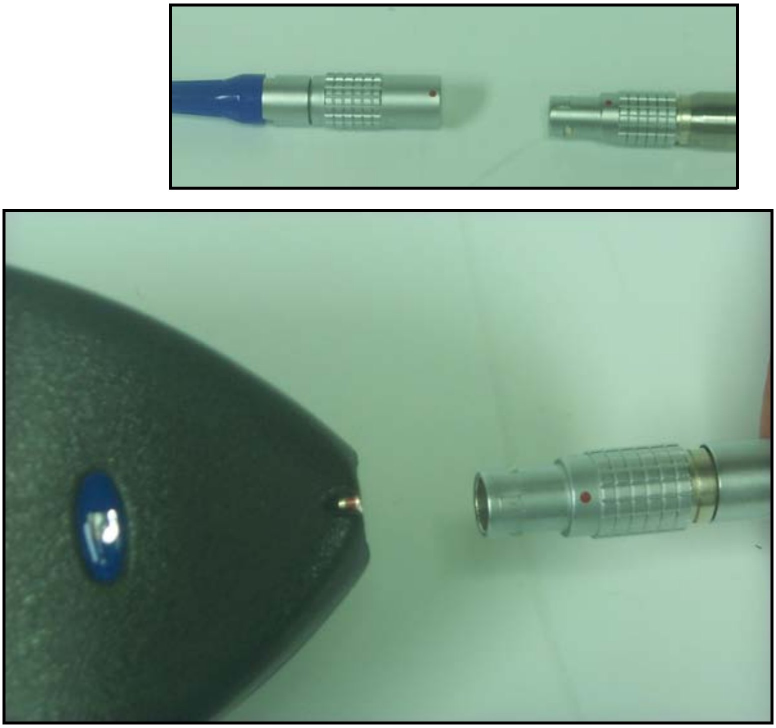


FIGURE 4-2 Connecting EXA010 extension cable to 824 and PRM902

Step 3 Thread the ADP008 onto the PRM902 preamplifier, being careful not to strip the threads

Step 4 Thread the 2575 or other microphone onto the PRM902 preamplifier, being careful not to strip the threads

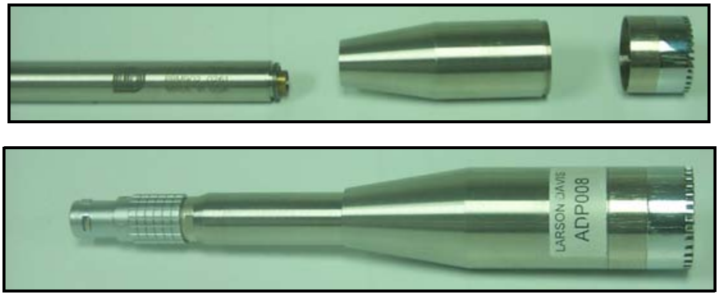


FIGURE 4-3 Connecting PRM902, ADP008 and 2575 Microphone

Connecting the SLM

If AUDit is not active, run the software by clicking on the desktop icon or PCB® Piezotronics AUDit (if AUDit was installed in the default folder). Verify communications port options in the Test, Preferences..., RS232 Port tab. The System 824, and Audit must be configured with the same baud rate.

NOTE: *The Communications settings on the System824 are accessed by pressing , scrolling to* **Communications***, and pressing the key. Please refer to the 824 reference manual (I824.01) for complete instructions.*

FIGURE 4-4 Connect Menu

Click **SLM**, **Connect** to establish connection with the SLM. You may verify battery level by clicking **SLM, Check Battery**... (Figure 4-4).

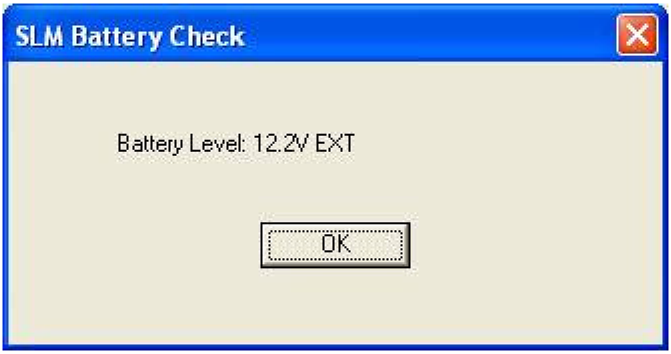


FIGURE 4-5 Battery Check Window

In this case the battery voltage is 12.2 Volts (Figure 4-5), with external power. Internal battery status is reported in percent. Measurements should not be attempted with internal battery readings lower than 10%.

System Acoustic Calibration

NOTE: *Calibrator and microphone must be selectecd as shown in the next section before calibration check or change*

The reference level of the sound level meter is calibrated using a CAL250 or other precision calibrator. This instrument generates a known sound pressure level (SPL) relative to 20 µPa To calibrate, click **SLM, Calibration**.

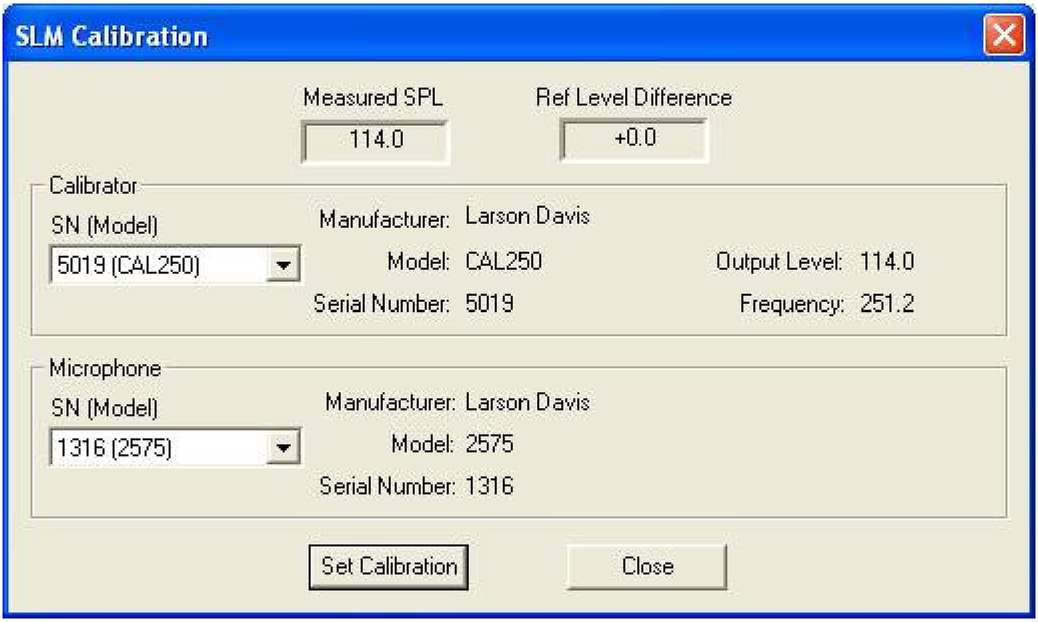


FIGURE 4-6 SLM Calibration Window

Hint: *Do not hold or bump the calibrator during calibration. Vibrations may affect readings. All measurement system components should have reached a stable temperature before calibrating. Your calibrator should remain on for the duration of the calibration (about 30 seconds). If its battery is low, replace it to extend the tone duration.*

AUDit will display the SLM Calibration dialog box. Select your calibrator and microphone in the pull down menus. Note that the current level and the difference between it and the calibrator output level are displayed at the top of the box.(Figure 4-6) You may use this display to check calibration without changing it, then click on Close to exit. To change calibration click **Set Calibration**.

Performing a Booth Test

Once the SLM has been calibrated, the ambient noise levels can be measured. Select the ***Test, Booth Test*** menu item to display the Booth Ambient Levels Measurement screen.

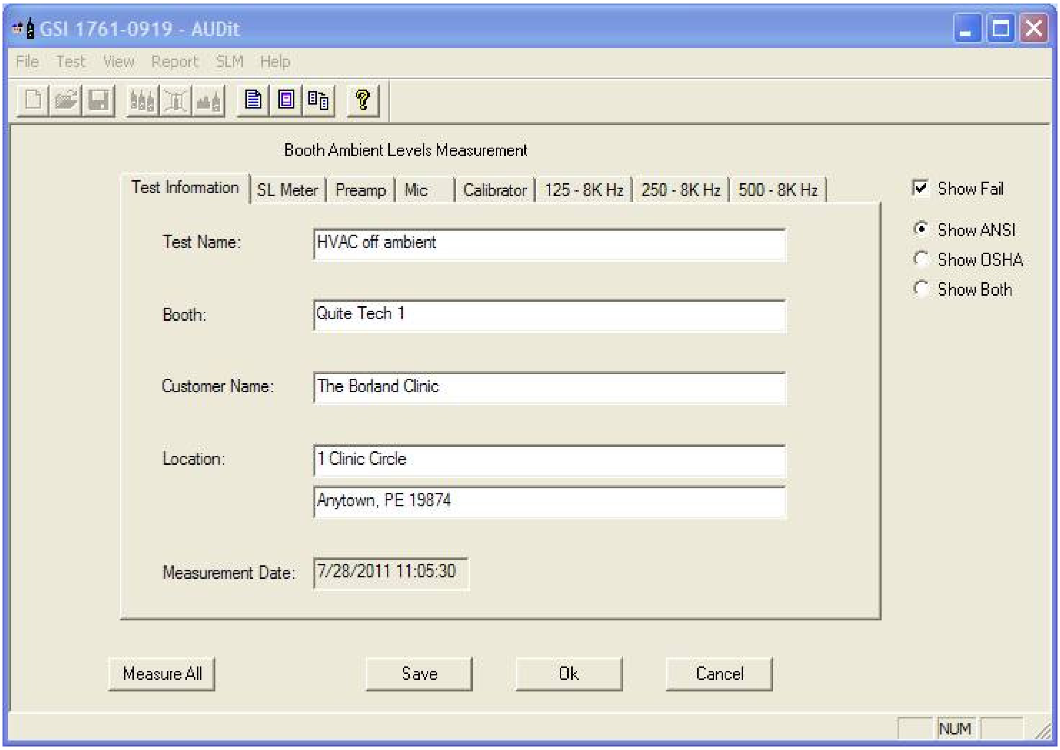


FIGURE 4-7 Both Ambient Levels Measurement Screen

The first five tabs; Test Information, SL Meter, Preamp, Mic and Calibrator are used to document the measurement. Choose the measurement instrumentation and enter the measurement descriptive text. The measurement instrumentation available for selection is defined in **Test, Instrumentation**.

The last three tabs are for displaying test results.

After selecting the equipment used for the ambient test, click **Measure All** to begin the test.

NOTE: *A message (Figure 4-10) will be displayed while the measurement is performed.*

FIGURE 4-8 Ambient Level Test Message Window

125 - 8K Hz, 250 - 8K Hz, and 500 - 8K Hz and OSHA Tabs

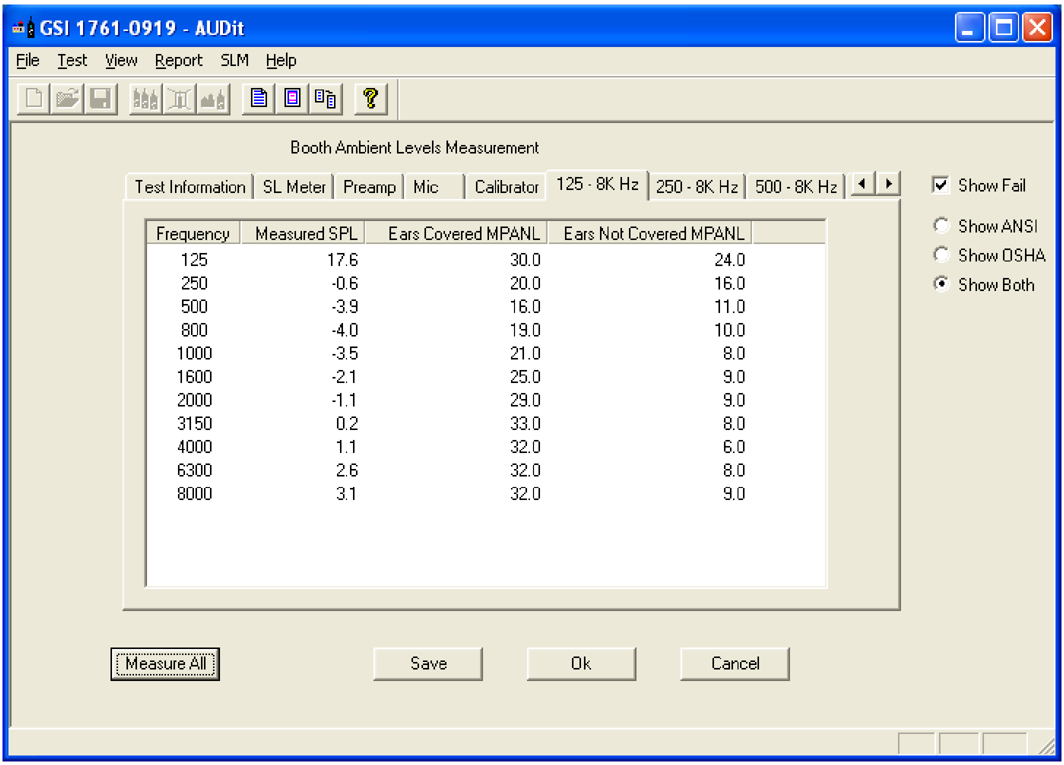


FIGURE 4-9 Ambient Level 125-8kHz Results Window

NOTE: *The limits used in these tabs are from Tables III and B2 of the* American National Standard on Maximum Permissible Ambient Noise Levels for Audiometric. *The OSHA limits are from OSHA 1910.95 Appendix D*

Once the measurement is completed, these three tabs show Booth Test results.(Figure 4-11) Failed frequencies are indicated with a red mark. In this case, the failed 125 Hz third octave measured SPL was 26.9 dB SPL, whereas the standard allows (at most) 30.0 for covered, and 24.0 for not covered ears. The exceeded limit values are displayed between parentheses.

Saving a Booth Test

Once the test is complete, you may save it by clicking **OK** at the bottom of the Booth Ambient Levels Measurement screen, which will display the dialog box shown in (Figure 4-12.

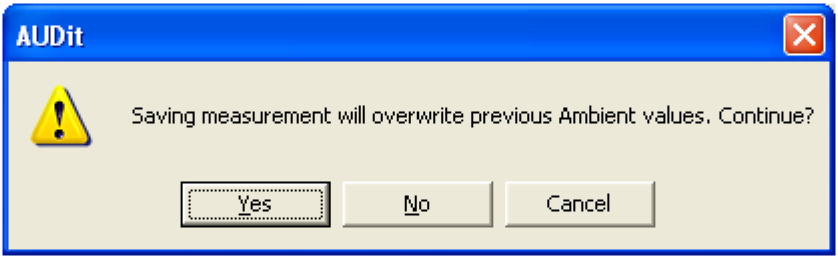


FIGURE 4-10 Ambient Level Test Save Window

Suspecting Instrument Noise?

Should the readings of the ambient test be questionable, you may want to check the measurement system noise. There are a few ways to do this. One simple alternative is to repeat the measurement with the non-activated calibrator left on top of the microphone. Another is to do the booth test without a bias voltage on the microphone. This has the effect of reducing its sensitivity and will show the electrical noise of the system. The results of this first method are shown in . FIGURE 4-11. The failed 125 Hz third octave measured SPL was 25.9 dB SPL.

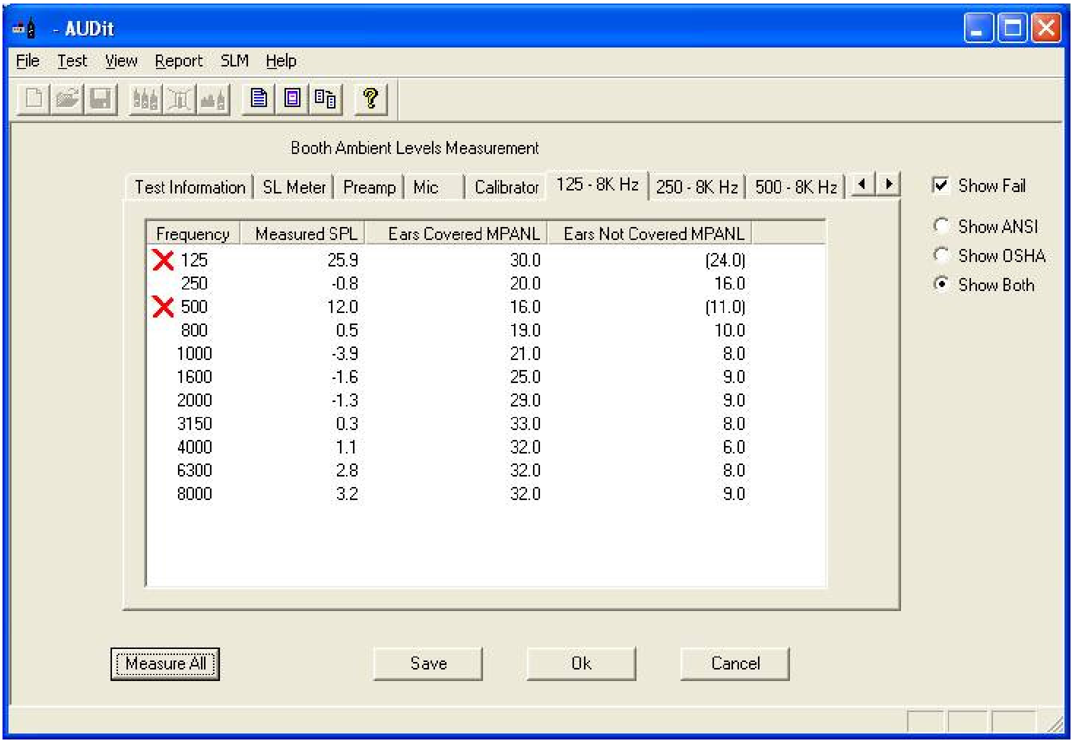


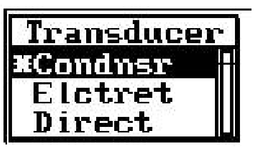
FIGURE 4-11 Booth Ambient Levels Window

As you can see, the noise level at the third octave centered at 125 Hz is 4.4 dB SPL, well below the failing ambient level.

This would indicate that the noise was not produced in the instrumentation.

Hint: *To remove the bias voltage from the microphone, stop the 824 and press* **(Setup)**, **(Right Arrow)** *to modify the Audtest.AUD settings. Scroll to SLM, press* **(Right Arrow)** *and scroll down to modify SLM parameter Transducer. Press the* **(Check key)** *and perform an Overall Reset to select Elctret. Remember to rest the transducer to condnser before making new measurements.*

This measurement has demonstrated the ease of use of the Larson Davis audiometer calibration system. In the remainder of this manual, a full audiometer calibration will be performed.



CHAPTER

5

Audiometer Test System Assembly

The setup defined for each transducer earlier in the AUDit software as described in the Audiometer Test Setup chapter. This will ensure the proper microphone corrections, RETS PL's etc. are applied to the measurement.

This chapter covers test configurations for the audiometer transducers which can be calibrated by the LD audiometer calibration systems. The recommended configurations for various earphones will be described first. Common elements such as the PC to System 824 SLM and PRM902 preamplifier connections, inspection and calibration procedures are explained next. Please contact Larson Davis if you have any system assembly questions not covered in this manual.

FIGURE 5-1 Audiometer Test System

Audiometer Transducer Test Configurations

The table below lists some typical audiometer transducers, many of which are covered in specifications such as *American National Standards Institute Specifications for Audiometers, S3.6-2004*. When configuring the audiometer transducer test, the AUDit software suggests or defaults to appropriate setups. These test setups are covered in greater detail in subsequent sections.

Transducer Type	Example	Suggested Setup	Comments
Supra-aural earphone	Telephonics TDH-39, 49, 50	AEC100 NBS 9-A coupler or AEC201 IEC 60318 Ear Simulator	Use 4-5 N weight. Test up to 8000 Hz.
Circumaural earphone	Sennheiser HDA200	AEC201 IEC 60318 Ear Simulator with MAEC101.06 Type 1 adaptor plate	Use 9-10N weight. Extended frequency tests up to 16000 Hz may be performed.
Circumaural earphone	Koss HV/1A	AEC201 IEC 60318 Ear Simulator with MAEC101.07 Type 2 adaptor plate	Use 9-10N weight. Extended frequency tests up to 16000 Hz may be performed.
Bone vibrator	Radio Ear B-71	AEC100 NBS 9-A coupler or AEC201 Ear Simulator and AMC493B Artificial mastoid	Use 9-10N weight
Speakers	Speakers	Use ambient noise level test setup from Chapter 4.	
Insert earphone	Insert Earphone	AEC202 or AEC203 2.0 cm^3 or Type 2 coupler AEC204 ear simulator	Refer to earphone and coupler manufacturer information.

Table 5-1: Audiometer Transducer Test Configurations

Connect the PC, 824 and PRM902 Preamplifier

WARNING! ***Before continuing, ensure that the 824 SLM is turned off. The 824 should remain off until the system is fully assembled.***

Step 1 Connect the CBL006 RS-232 cable from the SERIAL connector on the butt plate of the 824 to an active RS-232 port on the computer (FIGURE 5-2).

FIGURE 5-2 Connecting CBL006 to 824

Step 2 Connect the male end of the EXA010 extension cable to the nose cone of the 824 by matching the red dots on mating connectors (FIGURE 5-3).

FIGURE 5-3 EXA010 extension cable approaching System 824

Step 3 After the PRM902 microphone preamplifier has been inserted and treated in the appropriate coupler, (see below) connect it to the nose cone of the

824 with the EXA010 extension cable by matching the red dots on mating connectors (FIGURE 5-4).

FIGURE 5-4 Preamp connecting to extension cable and to AEC100

Step 4 The 824 SLM may now be turned on by parameters. Pressing the key on the 824.

Step 5 Press , scroll down with the to **Communication** and press to edit **Serial Comm**. parameters. Set the parameters as desired. 9600 Baud, serial address 000 and Hdwr flow control are suggested.

AEC100 Coupler Assembly and Calibration

For this you will need the following:

Part Number	Description
AUDit	AUDit software running on a PC
CBL006 serial cable	Serial cable 8 pin mini DIN to DB-9
824	System824 precision sound level meter (SLM)
EXA010	10 foot extension cable with 7 pin LEMO® connectors
2575	1" precision air condenser microphone
PRM902	1/2" diameter low noise microphone preamplifier
CAL250	Precision SPL calibrator with 114 dB SPL output at 250 Hz
The following are AEC100 components:	

Part Number	Description
MAE100.1	6 cc coupler
MAE100.3	1 inch coupler cap
SP-MAE100.40	Artificial ear base
MAE100.6	Earphone retainer ring
MAEC100.7	Mass handle screws into SAEC100.01
SAEC100.01	Weight assembly and rubber no handle
ACC001	Vibration isolation pad

AEC100 Initial Assembly

WARNING! ***Before continuing, ensure that the 824 SLM is turned off. The 824 should remain off until the system is fully assembled.***

The AEC100 artificial ear is an elegant, compact precision coupler built to provide a lifetime of dependable use with reasonable care. Read the following instructions to unpack, inspect and assemble the coupler for the first time.

Step 1 Place the cushioned vibration isolation pad on a table or other such stable surface near the audiometer system.

Step 2 Visually inspect the coupler (MAE100.1) for gouges, scratches and dents which may affect the measurement, especially around the lip which will be in contact with the test earphone. Verify that the small metallic wire in the capillary leak hole is present with no other obstructions (FIGURE 5-5).

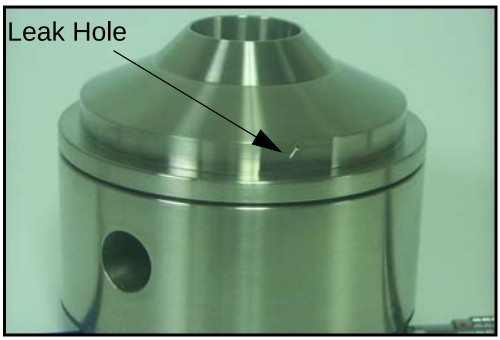


FIGURE 5-5 AEC100 with coupler, leak hole

Step 3 If installed, remove the coupler cap (MAE100.3) from the artificial ear base (SP-MAE100.40) by gently unscrewing it counterclockwise (FIGURE 5-6).

FIGURE 5-6 Protective ring being removed from AEC100

Step 4 Inspect a spring-loaded contact at the center of the base visually. It should extend approximately 5 mm above the threaded ridge. The insulator around it should be free of dust and other particles. Please do not handle the contact and protect it by keeping the coupler cap on whenever a microphone is not installed.

Step 5 Install the 1" microphone (LD Model 2575 or equivalent) on the center of the artificial ear base. The microphone should install easily: screw it finger tight (FIGURE 5-7).

FIGURE 5-7 2575 Microphone and AEC100

When removing the preamplifier, unscrew it by holding on its body, not the connector sleeve.

Step 6 Insert the 1/2" microphone preamplifier (LD Model PRM902 or equivalent) gently in the side port until its threads contact those of the base. The preamplifier should install easily: screw it finger tight (FIGURE 5-8). Connect the instrument cable to the preamplifier. The coupler is now ready for level calibration.

FIGURE 5-8 Preamp connecting to AEC100 and Extension Cable

AEC100 Acoustic Calibration

It is necessary to remove the calibrator 1/2 inch adaptor (ADP019) ring from the CAL250 to allow the one inch microphone to fit inside the calibrator one inch opening.

Level calibration is performed with the Larson Davis Model CAL250 precision calibrator. It offers a level of 114 dB with an accuracy of +/-0.2 dB at 251.2Hz. To calibrate the measurement system and artificial ear, follow the procedure below.

Step 1 Assemble the coupler as described in the AEC100 Acoustic Calibration on page 5-7 section above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Place the calibrator opening on the microphone and seat it fully (FIGURE 5-9). Note: Do not remove the microphone grid cap.

FIGURE 5-9 CAL250 being lowered onto 2575 microphone

Step 3 Activate the calibrator as prompted by the software and verify the stability of the indication on the measurement system (FIGURE 5-10). Do not hold the calibrator during calibration. Its tone will last about one minute (depending on the battery) and will turn off automatically.

FIGURE 5-10 Starting Calibration tone with on switch

In actual practice, for most testing, the grid cap does not need to be removed. This will help reduce the possibility of accidental damage to the delicate and expensive precision microphone diaphragm.

Step 4 AUDit requires a calibration in each of two measurement ranges. The calibrator tone may have to be reactivated for the second calibration as prompted by the software.

Step 5 See Note at left before proceeding. After the calibration, carefully remove the grid cap by holding the microphone body and unscrewing the grid counterclockwise (FIGURE 5-11). Store it in the microphone case.

FIGURE 5-11 Removing grid cap from 2575 Microphone

Step 6 Replace the grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm (FIGURE 5-12).

FIGURE 5-12 Installing Protective Ring on 2575 Microphone

AEC100 Final Assembly for Testing Supra-Aural Earphones

The following steps are suggested for audiometer calibration with the AEC100.

Step 1 Assemble the coupler as described in the AEC100 Coupler Assembly and Calibration on page 5-4. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Perform a calibration of the system as described in AEC100 Coupler Assembly and Calibration on page 5-4 and replace the microphone grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm.

.

FIGURE 5-13   Coupler being installed on AEC100

Step 3 Center the test earphone on the coupler. Lower the black retainer ring over the earphone, holding the earphone cable in line with the notch (FIGURE 5-14).

FIGURE 5-14 Retainer Ring being installed over headphone.

Step 4 Lower the mass by its handle to the top of the earphone (FIGURE 5-15).

FIGURE 5-15 Mass being installed on AEC100.

The coupler and earphone are now ready for measurement.

AEC201 Ear Simulator and Assembly and Calibration

For this you will need:

Part Number	Description
AUDit	AUDit software running on a PC
CBL006	Serial cable 8 pin mini DIN to DB-9
824	System824 precision sound level meter (SLM)
EXA010	10 foot extension cable with 7 pin LEMO® connectors
377A13	1/2" precision air condenser random incidence microphone
PRM902	1/2" diameter low noise microphone preamplifier
CAL250 or CAL200	Precision SPL calibrator with 114 dB SPL output at 250 Hz with 1" to 1/2" calibrator opening adaptor (ADP019)
The following are AEC201 components:	
	Artificial ear base including base, contacts, insulator and pad
AEC201.F	Coupler
AEC100.06	Type 1 adaptor (optional)
AEC201-2	Type 2 adaptor
MAEC100.08	Conical ring
MAE100.6	Earphone retainer ring
MAEC100.7	Mass handle screws into SAEC100.1
SAEC100.01	Weight assembly and rubber - no handle
ACC001	Vibration isolation pad

Part Number	Description
AMEC101.10	Bag Weight 9.5 Newton (946g)

AEC201 Initial Assembly

WARNING! ***Before continuing, ensure that the 824 SLM is turned off. The 824 should remain off until the system is fully assembled.***

The AEC201 artificial ear is a versatile coupler and allows measurement of a variety of earphones with its provided accessories. Read the following instructions to unpack, inspect and assemble the coupler for the first time.

Step 1 Place the cushioned vibration isolation pad on a table or other such stable surface near the audiometer system.

Step 2 Visually inspect the coupler for gouges, scratches and dents which may affect the measurement, especially around the sharp lip which will be in contact with the test earphone. Verify that the small tube in the capillary leak hole is present with no other obstructions (FIGURE 5-16).

FIGURE 5-16 AEC201 with coupler, leak hole

Step 3 If installed, remove the coupler from the artificial ear base by gently unscrewing it counterclockwise.

Step 4 Inspect the spring-loaded contact at the center of the base visually. It should extend approximately 5 mm above the threaded ridge. The insulator around it should be free of dust and other particles. Please do not handle the contact and protect it by keeping the coupler on whenever a microphone is not installed.

Step 5 Install the 1/2" microphone PCB® model 377A13 on the center of the artificial ear base. The microphone should install easily: screw it finger tight (FIGURE 5-17)

.

FIGURE 5-17 Microphone installed on AEC201

Step 6 Insert the 1/2" microphone preamplifier (LD Model PRM902 or equivalent) gently in the side port until its threads contact those of the base. The preamplifier should install easily: screw it finger tight (FIGURE 5-18).

When removing the preamplifier, unscrew it by holding on its body, not the connector sleeve

FIGURE 5-18 Preamp approaching AEC201

Step 7 Connect the instrument cable to the preamplifier. The coupler is now ready for level calibration.

AEC201 Acoustic Calibration

You will need to install the adapter (ADP019) into the CAL250 in order to calibrate 1/2 inch microphones.

Level calibration is performed with the Larson Davis Model CAL250 precision calibrator. It offers a level of 114 dB with an accuracy of +/-0.2 dB at 251.2 Hz. You will have to insert the provided 1" to 1/2" adaptor in the top of the calibrator. To calibrate the measurement system and artificial ear, follow the procedure below.

Step 1 Assemble the coupler as described in AEC201 Ear Simulator and Assembly and Calibration on page 5-12. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Do not remove the microphone grid cap.

Step 2 Place the calibrator opening on the microphone and seat it fully (FIGURE 5-18).

FIGURE 5-19 Installing the CAL250 on AEC201

Step 3 Activate the calibrator as prompted by the software and verify the stability of the indication on the measurement system (FIGURE 5-19). Do not hold the calibrator during calibration. Its tone will last about one minute (depending on the battery) and will turn off automatically.

FIGURE 5-20 CAL250 being activated on AEC201

Step 4 AUDit requires a calibration in each of two measurement ranges. The calibrator tone may have to be reactivated for the second calibration as prompted by the software.

AEC201 Final Assembly for Testing Supra-Aural Earphones

The following steps are suggested for audiometer calibration with the AEC201.

Step 1 Assemble the coupler as described in AEC201 Ear Simulator and Assembly and Calibration on page 5-12. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Perform a calibration of the system as described in AEC201 Acoustic Calibration on page 5-15.

Step 3 Screw the coupler over the base (FIGURE 5-21) until finger tight.

FIGURE 5-21 Coupler being installed on AEC201

Step 4 Place the black conical ring (FIGURE 5-22) on the top of the coupler.

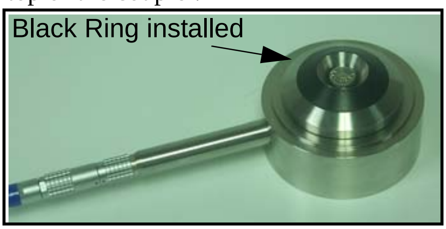


FIGURE 5-22 Black Conical ring installed on AEC201

Step 5 Center the test earphone on the coupler. Lower the black retainer ring over the earphone, holding the earphone cable in line with the notch (FIGURE 5-23).

FIGURE 5-23 Retainer ring being installed on AEC201

Step 6 Lower the mass by its handle to the top of the earphone (FIGURE 5-24).

FIGURE 5-24 Mass being lowered onto headphone

The coupler and earphone are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

AEC201 Final Assembly for Testing Circumaural Earphones

Circumaural earphones are available for audiometers using extended high-frequencies, from 8000 to 16000 Hz. These earphones typically rest against the head with little or no contact with the pinna (external ear). Their speaker (or driver) is coupled to the ear with a relatively large volume of air under the ear cap.

RETSPLs for two circumaural earphones are listed in *Annex C of ANSI S3.6-2010*. These two types of cirumaural earphones are available in AUDit: the Sennheiser HDA200 and Koss HV/1A.

Environmental conditions

It is stated in various standards that the extended high-frequency calibration of circumaural earphones be performed only when the following environmental conditions are met.

Condition	Range in ANSI S3.6-2010 (Annex C)	Range in IEC 60318-1:2009 Clause 6 Calibration
Ambient Pressure	98 to 104 kPa	98.325 to 104.325 kPa
Temperature	18 to 26 degrees C	20 to 26 degrees C
Relative Humidity	30 to 80% RH	30 to 70% RH
Any condition not met	Calibration is not allowed	State actual values

AEC201 Configuration

The following steps are suggested for circumaural earphone audiometer calibration with the AEC201.

Step 1 Assemble the coupler as described in theAEC201 Ear Simulator and Assembly and Calibration on page 5-12. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Perform a calibration of the system as described in AEC201 Acoustic Calibration on page 5-15.

Step 3 Screw the coupler over the base (FIGURE 5-25).

FIGURE 5-25 Coupler being installed on AEC201

Step 4 For earphones designed to be calibrated with a Type 1 adapter such as the Sennheiser HDA200, install the Type 1 adapter on the coupler, with the cylindrical rim facing down. Place the black conical ring on the top of the coupler and plate, with its flat base on the bottom (FIGURE 5-26).

FIGURE 5-26 AEC201 with Type 1 Adapter installed

Step 5 For earphones designed to be calibrated with a Type 2 adapter such as the Koss HV/1A, use the Type 2 adapter, which has crenellated distance clamps around its circumference. Do not use the black conical ring (FIGURE 5-27).

FIGURE 5-27 Type 2 adapter installed on AEC201

Step 6 Center the test earphone on the coupler or place it as recommended if the cushion is asymmetrical.

Step 7 ANSI S3.6-2010 requires a static force of 9 to 10 N on the earphone during calibration. Use the large weight bag (FIGURE 5-28).

FIGURE 5-28 Sennheiser earphone and weight bag being installed on AEC201

The coupler and earphone are now ready for measurement.

AMC493B Assembly for Testing Bone Vibrators

Bone vibrators are used to test sound conduction through the head. Their use is limited to a restricted frequency range. The LD AMC493B artificial mastoid uses an innovative design to allow bone vibrator calibration using an AEC100 or AEC201. The AMC493B converts the force applied by the bone vibrator to an acoustic signal which can then be measured acoustically by the calibration system. The following steps are suggested for bone vibrator transducer calibration.

In addition to the components of the AEC100 or AEC201, you will need the following equipment:

Part Number	Description
AMC493B	Artificial mastoid
MAE100.55	Additional ring mass

Environmental conditions

Bone vibrator calibration measurements are extremely sensitive to temperature and humidity. One important advantage of the AMC493B is its very low thermal mass, which allows it to stabilize to the temperature of the test area very quickly, typically within a few tens of minutes. The sensitivity and mechanical impedance data supplied for the AMC493B were measured at 23 °C and 50% RH.

The basis for ANSI Standard S3.13-1987 (Reaffirmed 1993) Mechanical Coupler for Measurement of Bone Vibrators is IEC 60373:1990-01 of the same name. This standard states that in general, temperature corrections can not be used directly to correct data not taken at the reference temperature of 23 degrees C, as the effect of temperature on the bone vibrator is unknown. See also IEC60318-6:2007 5.5

Although AUDit performs a temperature correction, it is recommended to make measurements as close as possible to the temperature at which the AMC493B mastoid was calibrated.

Except during use, the AMC493B is kept in a case with temperature and humidity meter. Place these temperature and humidity number corrections in the AUDit software, along with the local pressure, to enhance the mastoid accuracy.

Test Configuration

Step 1 Assemble the AEC100 or AEC201. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Perform a calibration of the system as described in.

Step 3 Place the coupler over the base (FIGURE 5-13).

Step 4 Lightly place the AMC493B artificial mastoid on the top of the coupler (FIGURE 5-29) with ring-shaped polymer.There must not be any metal to metal contact. Press down slightly on the AMC493B to secure its position.

FIGURE 5-29 Mastoid placed on AEC100

Step 5 Center the test vibrator contact surface on the circular resilient surface of the AMC493B. Ensure that there is no contact between the vibrator body and the AMC493B metallic rim (FIGURE 5-30).

FIGURE 5-30 Vibrator being placed and centered on mastoid

Step 6 Assemble the additional mass ring over the handle of the AEC100 mass (FIGURE 5-31)

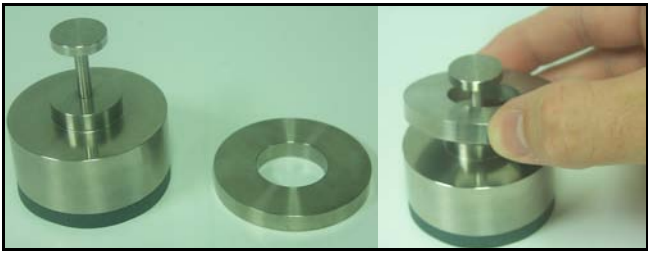


FIGURE 5-31 Additional mass being placed on AEC100 weight

When removing the AMC493B artificial mastoid from the coupler, gently twist it off to break the seal. For more information, refer to the AMC493B manual.

Step 7 Lower the black retainer ring over the vibrator, holding the vibrator cable in line with the notch (FIGURE 5-32).

FIGURE 5-32 Retainer Ring being placed over vibrator

Step 8 Lower the mass on top of the vibrator by its handle (FIGURE 5-33).

FIGURE 5-33 Artificial ear with vibrator and mass installed

The coupler and vibrator are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

B&K® 4930 Assembly for Testing Bone Vibrators

Unlike the LD AMC493B, the Brüel & Kjær artificial mastoid uses an accelerometer to measure the bone vibrator output. The LD audiometer calibration system can interface with the B&K mastoid by using the high input impedance PRM902 preamplifier and a suitable adapter.

If the cable from the B&K 4930 has a 10-32 microdot connector (small threaded coaxial connector), use the optional ADP007. On the other hand, if your artificial mastoid has a BNC coaxial connector, use the ADP006 provided with the LD system. You will also need the following:

Part Number	Description
AUDit	AUDit software running on a PC
CBL006	Serial cable 8 pin mini DIN to DB-9

Part Number	Description
824	System824 precision sound level meter (SLM)
PRM902	1/2" diameter low noise microphone preamplifier
ADP008	1" microphone to 1/2" preamp adapter
2575	1" precision air condenser microphone
CAL250	Precision SPL calibrator with 114 dB SPL output at 250 Hz
B&K 4930	Artificial Mastoid and accessories
ADP007 or ADP006	Microdot to 1/2" preamp adapter for charge-coupled accelerometer or BNC to 1/2" microphone thread adapter, 47 if with shorting cap

Larson Davis recommends making measurements as close as possible to the temperature at which the artificial mastoid was calibrated.

Test Configuration

Step 1 Assemble the measurement system as in the section on: Connecting the PC, 824 and PRM902 Preamplifier.

Step 2 Thread the ADP008 onto the preamplifier and then thread the 2575 microphone on the preamplifier (FIGURE 5-34).

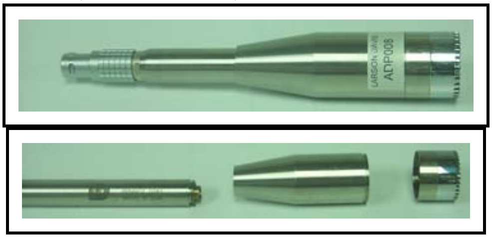


FIGURE 5-34 ADP008 being installed on PRM902

Step 3 Perform a system SPL calibration using the CAL250.

Step 4 Remove the ADP008 adaptor and 2575 microphone, and replace them with the appropriate adaptor to connect to the artificial mastoid (FIGURE 5-35).

FIGURE 5-35 Adapters to connect to B & K® mastoid

Step 5 Install the bone vibrator on the B&K 4930 as described in the B&K user manual.

The coupler and vibrator are now ready for measurement.

CHAPTER

6

Hearing Level Test

Once AUDit has been configured with the test instrumentation and audiometer information, an actual audiometer calibration may be performed. The main measurement screen is accessed from the Audiometer Test Setup screen by pressing the **OK** button.

Calibration Main Measurement Screen

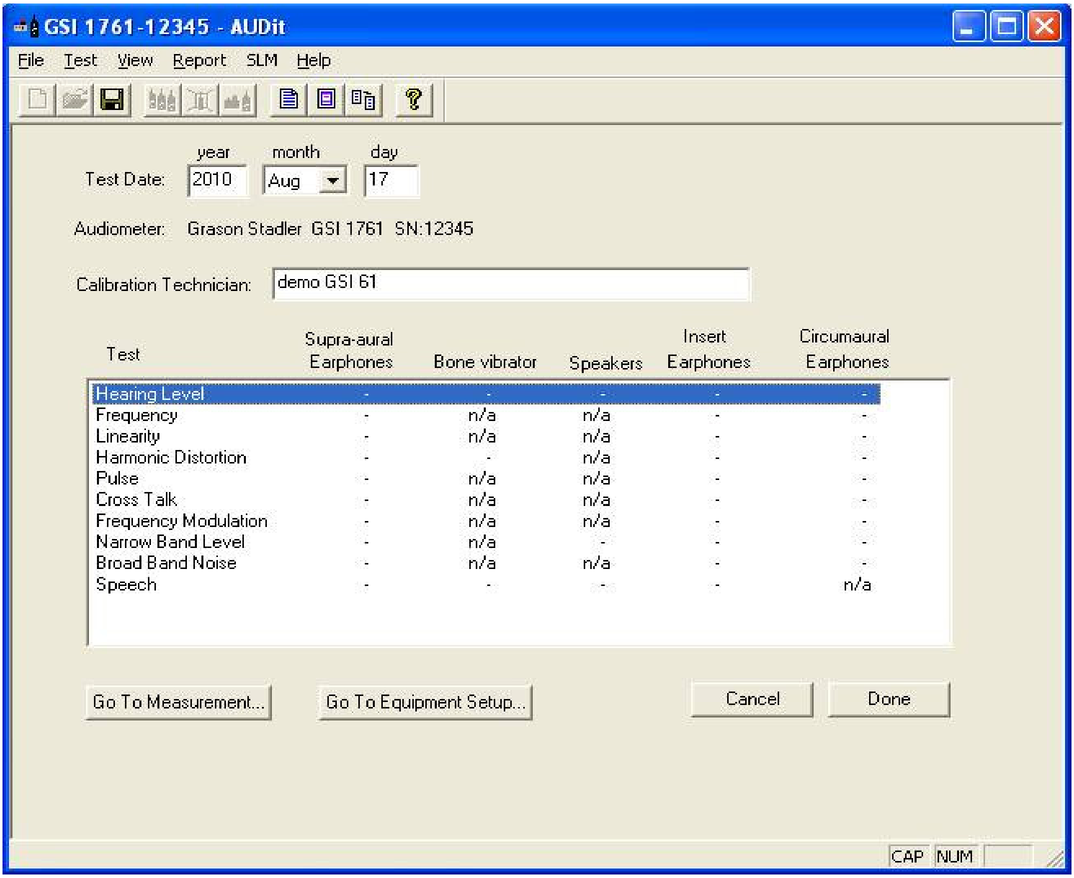


FIGURE 6-1 Main Measurement Screen

The main measurement screen allows one to enter the test date and technician name. The tested audiometer manufacturer, model and serial number are displayed as entered in the previous setup. A table of tests and transducers shows the available tests for the particular audiometer. For example, the Hearing Level test may be performed with supra-aural, insert or circumaural earphones, as well as with the bone vibrator and speakers. Appropriate corrections are applied within each test using microphone, coupler and standard adjustments.

The SLM should be calibrated before a measurement is performed.

To begin the audiometer calibration process, highlight the ***Hearing Level test*** with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window at the upper left.

Hearing Level Test with Earphone Transducers

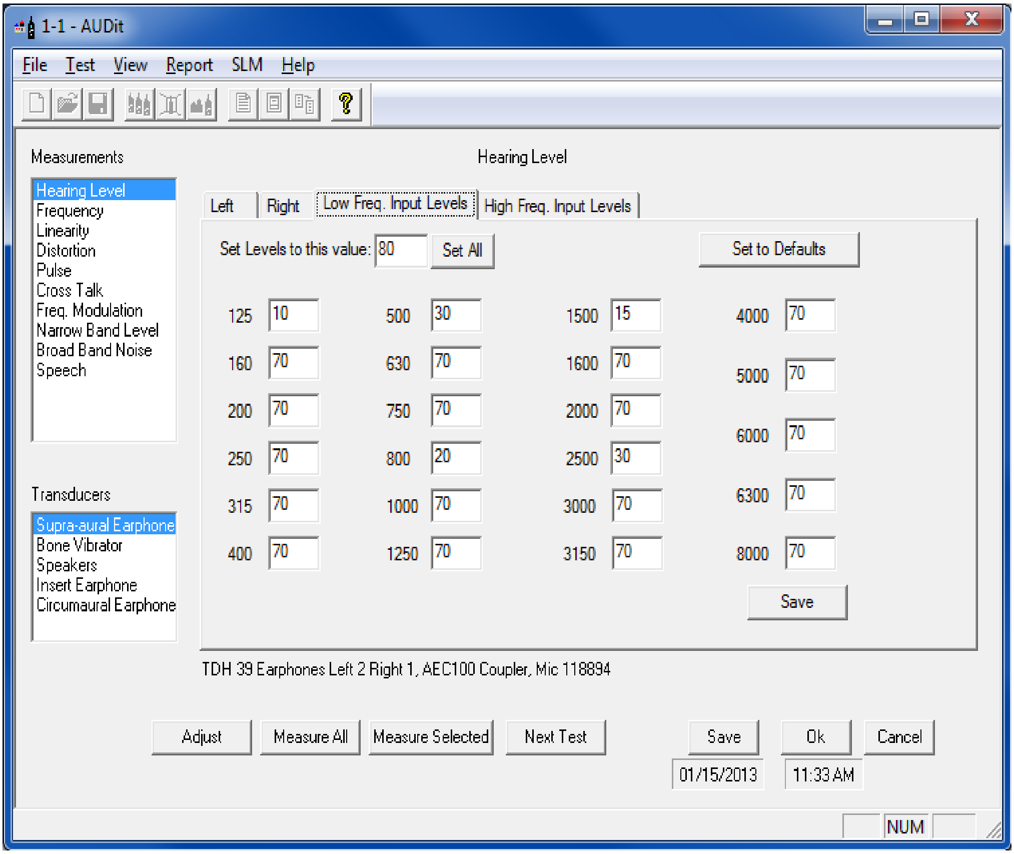


FIGURE 6-2 Hearing Level Screen

The Hearing Level screen is typical of the measurement screens. On the left, below the measurement table, you will find the list of transducers for which the audiometer hearing level may be tested. The large box at the right has multiple tabs and varies according to the transducer being tested. For example, all earphones types have four tabs: Low and High Freq. Input levels, Left and Right. On the other hand, the bone vibrator has only two tabs: Input levels and Bone Vibrator Levels. In this section, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

To perform a test of the supra-aural earphones, highlight the Supra-aural Earphone transducer list item. The four Supra-aural Earphone Hearing Level tabs will appear on the right part of the screen. Default low and high frequency input levels are typically set to 70 dB HL on each tab. Each value may be changed by highlighting it and entering a new value. Use the pointer or the TAB key to move to another frequency.

Once the input levels have been verified, one may select which earphone to test by pressing on the Left or Right tab.

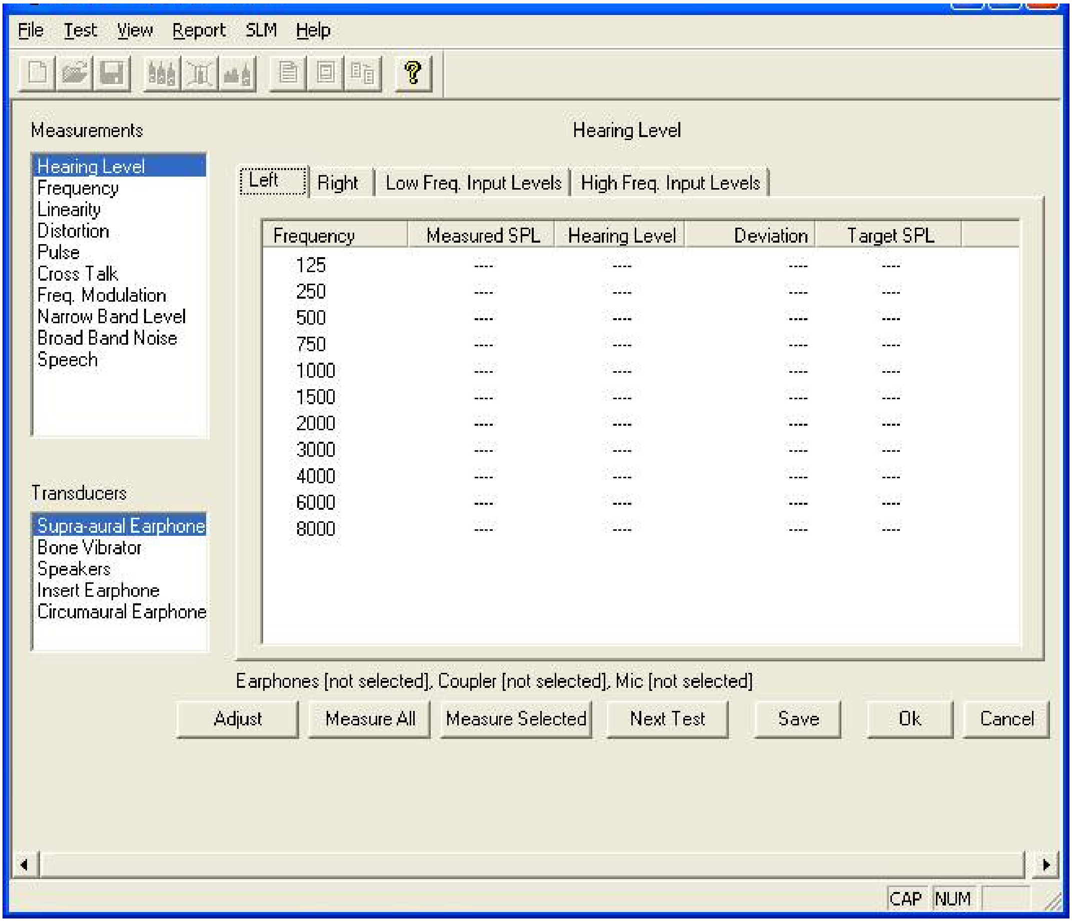


FIGURE 6-3 Active Frequencies List

The list of the active frequencies selected earlier in the audiometer setup appears in the right window. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

The row of buttons at the bottom of the screen allows the technician to:

- **Adjust - adjust the audiometer in real-time if a precision output level adjustment is available**
- **Measure All - measure all frequencies sequentially with software prompts**
- **Measure Selected - measure only the currently highlighted frequency with software prompts**
- **Next Test - move to the next measurement in the Measurements list in the upper left window**

Press **Measure All** to perform a hearing level test on the left earphone. AUDit then displays the prompt shown in Figure 6-4 for the first frequency:

FIGURE 6-4 Prompt for First Frequency Setting

Set the appropriate level and frequency on the audiometer then press **OK**. Each frequency will be tested until all have been measured. This can be done in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer. In the example, all frequencies passed except for the last 8000 Hz. This is indicated by a large red X next to the frequency.

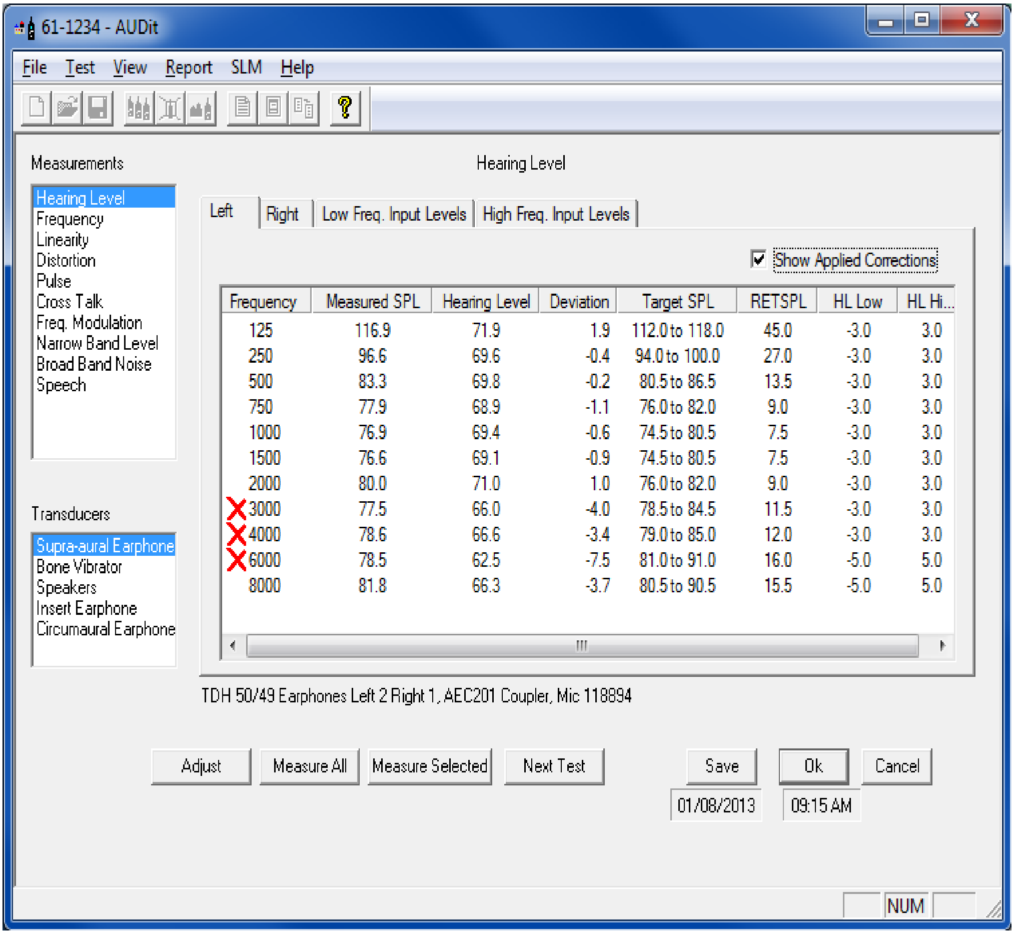


FIGURE 6-5 Hearing Level Test

It may be desired to adjust this level by pressing the **Adjust** button. A small dialog box is then displayed where the technician may select the current frequency and adjust the level potentiometer of the audiometer to fall within the listed target SPL range.

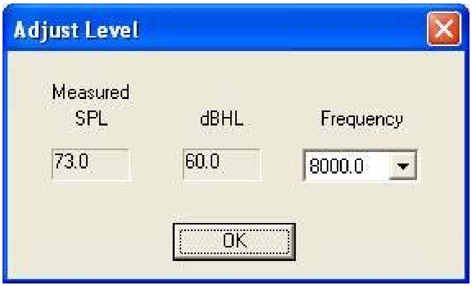


FIGURE 6-6 Adjust Level Dialog Box

Once this is done, the failed frequency may be retested with the Measure Selected button.

Hearing Level Test with Bone Vibrator

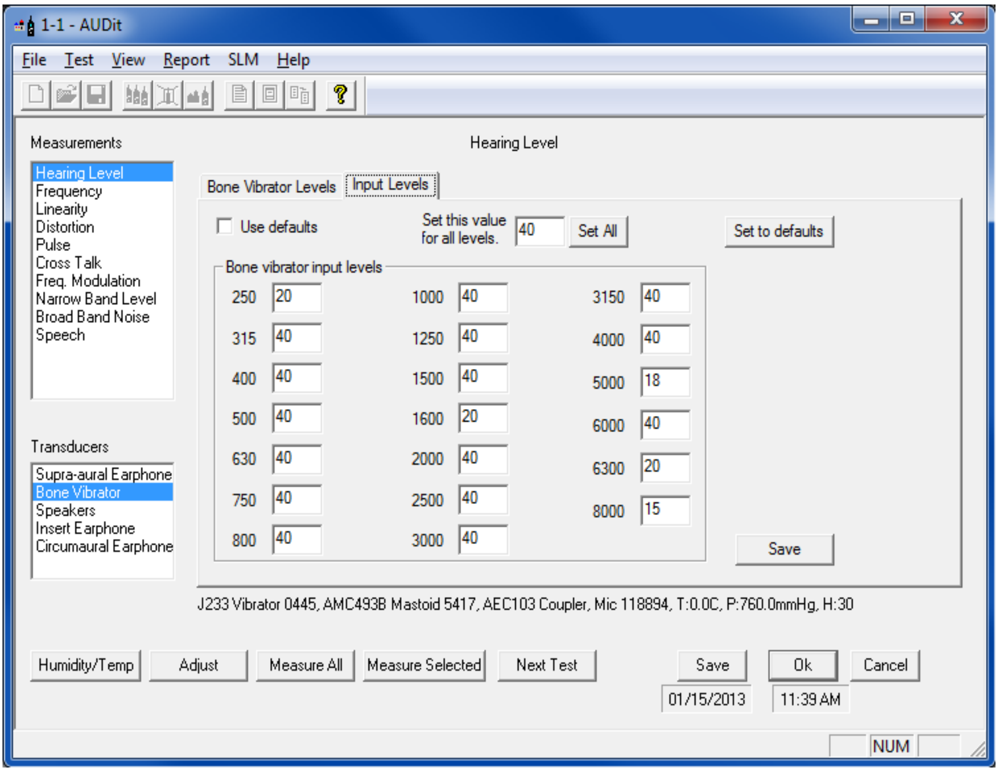


FIGURE 6-7 Hearing Level Test with Bone Vibrator Screen

To perform a test of the bone vibrator transducer, highlight the Bone Vibrator transducer list item. The Hearing Level screen for the bone vibrator transducer has two tabs: Input Levels and Bone Vibrator Levels. In the first tab, the test bone vibrator levels can be specified or set to default values. Use the pointer or TAB key to move from one frequency to another. The Bone Vibrator Levels tab displays calibration results.

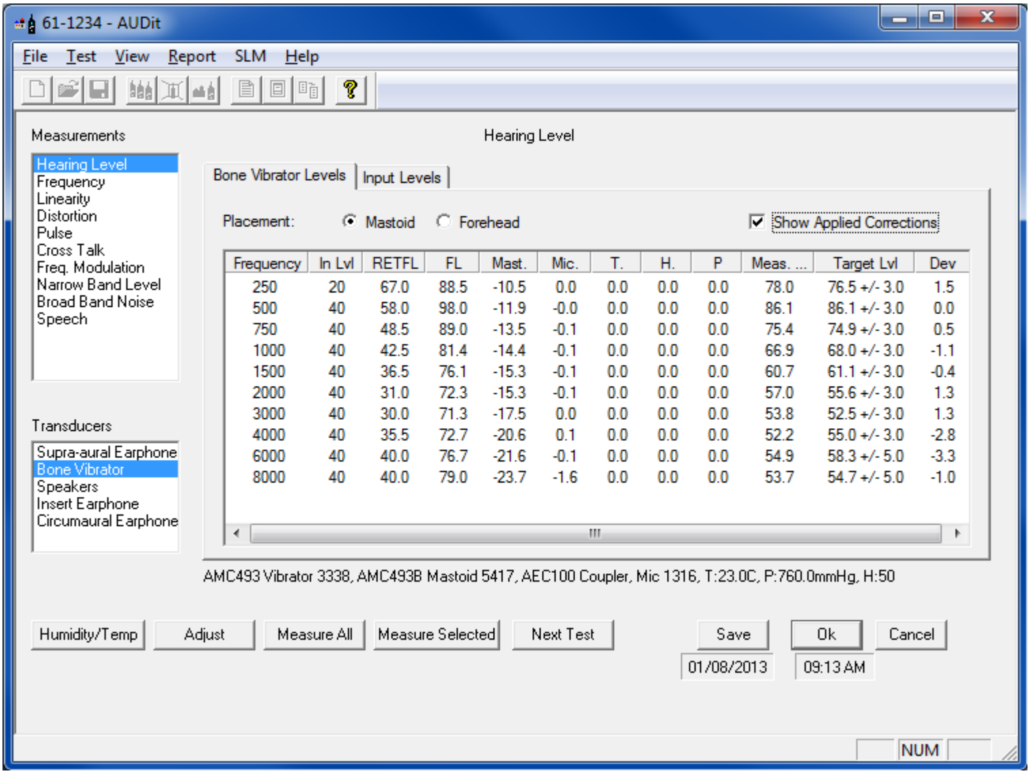


FIGURE 6-8 Bone Vibrator Levels Tab

Checking the ***Show Applied Corrections*** *option displays the following columns:* ***In Lvl***, ***RETFL***, ***FL***, ***Mast***, ***Mic***, ***T***, ***H***, *and* ***P***.

The list of the active frequencies selected earlier in the audiometer setup appears in the right window. Placement of the bone vibrator affects output. Select the proper option: Mastoid or Forehead. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

Not all frequencies have a valid RETSPL, i.e., 160 Hz.

The row of buttons at the bottom of the screen allows the technician to:

- **Adjust - adjust the audiometer in real-time if a precision output level adjustment is available**
- **Measure All - measure all frequencies sequentially with software prompts**
- **Measure Selected - measure only the currently highlighted frequency with software prompts**
- **Next Test - move to the next measurement in the Measurements list in the upper left window**
- **OK - end the current test**
- **Cancel - cancel the current test**

Press **Measure All** to perform a hearing level test on the bone vibrator. If you are using a Larson Davis mastoid, you will be prompted to enter temperature and humidity values (Figure 6-9) used within the software for artificial mastoid corrections.

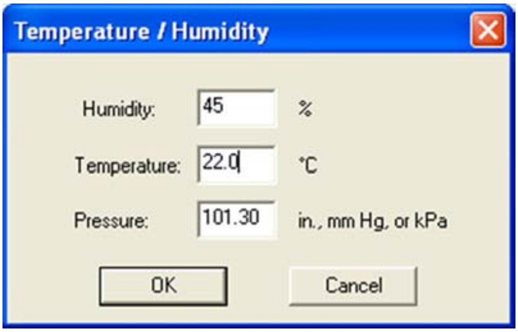


FIGURE 6-9 Temperature/Humidity Entry Screen

Enter the humidity value, as well as the temperature in degrees centigrade as indicated on the meter inside the AMC493B storage case.

AUDit then displays the prompt shown in Figure 6-9 for the first frequency:

FIGURE 6-10 Hearing Level Set Screen

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. This can be done in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer.

Hearing Level Test with Speakers

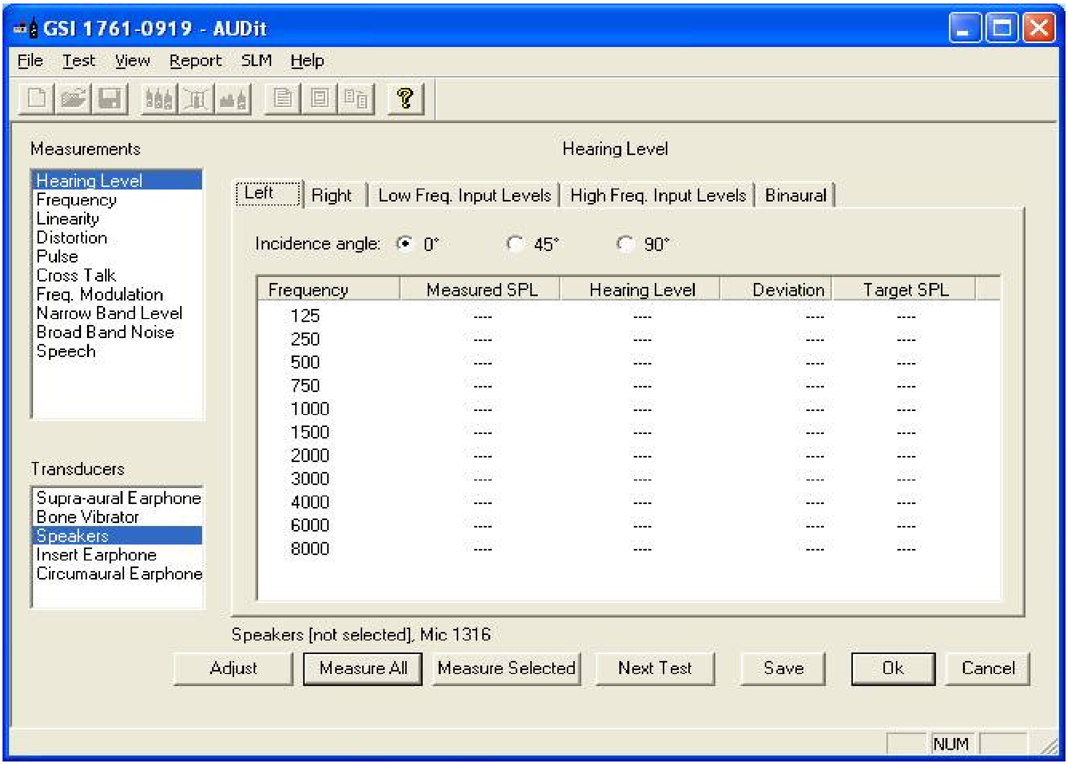


FIGURE 6-11 Hearing Level Test with Speakers Screen

Sound field audiometric testing using speakers may be performed in a variety of ways. Table 9 of ANSI S3.6-2004 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit to translate the measured sound pressure levels to hearing levels. Note that the prescriptions in section 9.5.1 of the standard for sound field characteristics should be followed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise Booth test in AUDit is helpful in making this determination.

To perform a test using speakers, highlight the ***Speakers*** transducer list item. The Hearing Level screen for the speakers transducers has five tabs, as shown previously in F:FIGURE 6-<n=1>:

- **Left**
- **Right**
- **Low Freq. Input Levels**
- **High Freq. Input Levels**
- **Binaural**

If the **Left** tab is selected, as shown, an incidence angle of 0, 45 or 90 degrees must be chosen so that the appropriate RETSPL correction is applied. Note the headers at the top of the table. Measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The **Right** tab operates in exactly the same manner. The **Binaural** tab has only one incidence angle selection, zero degrees.

For **Low Freq. Input Level** or **High Freq. Input Level** tabs, the speaker test levels can be specified for audiometric frequencies from 125 to 20000 Hertz. Use the pointer or TAB key to move from one frequency to another and enter the desired test level.

The row of buttons at the bottom of the screen allows the technician to do the following:

- **Adjust - adjust the audiometer in real-time if a precision output level adjustment is available**
- **Measure All - measure all frequencies sequentially with software prompts**
- **Measure Selected - measure only the currently highlighted frequency with software prompts**
- **Next Test - move to the next measurement in the Measurements list in the upper left window**
- **OK - end the current test**
- **Cancel - cancel the current test**

Press **Measure All** to perform a hearing level test using the speakers. Since frequency modulation is required for this test, you will also be prompted to select a FM test signal.

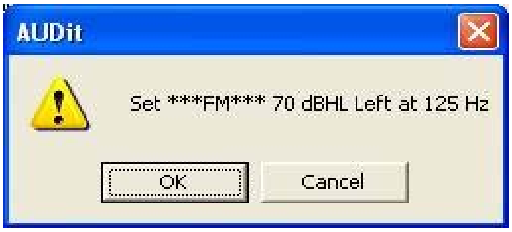


FIGURE 6-12 Level and Frequency Set Dialog

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. This test can be performed in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter key (**OK**) on the computer.

C H A P T E R

7

Frequency Test

Once AUDit has been configured with the test instrumentation and audiometer information, an actual audiometer calibration may be performed. The main measurement screen is accessed from the Setup screen by pressing the **OK** button.

Calibration Main Measurement Screen

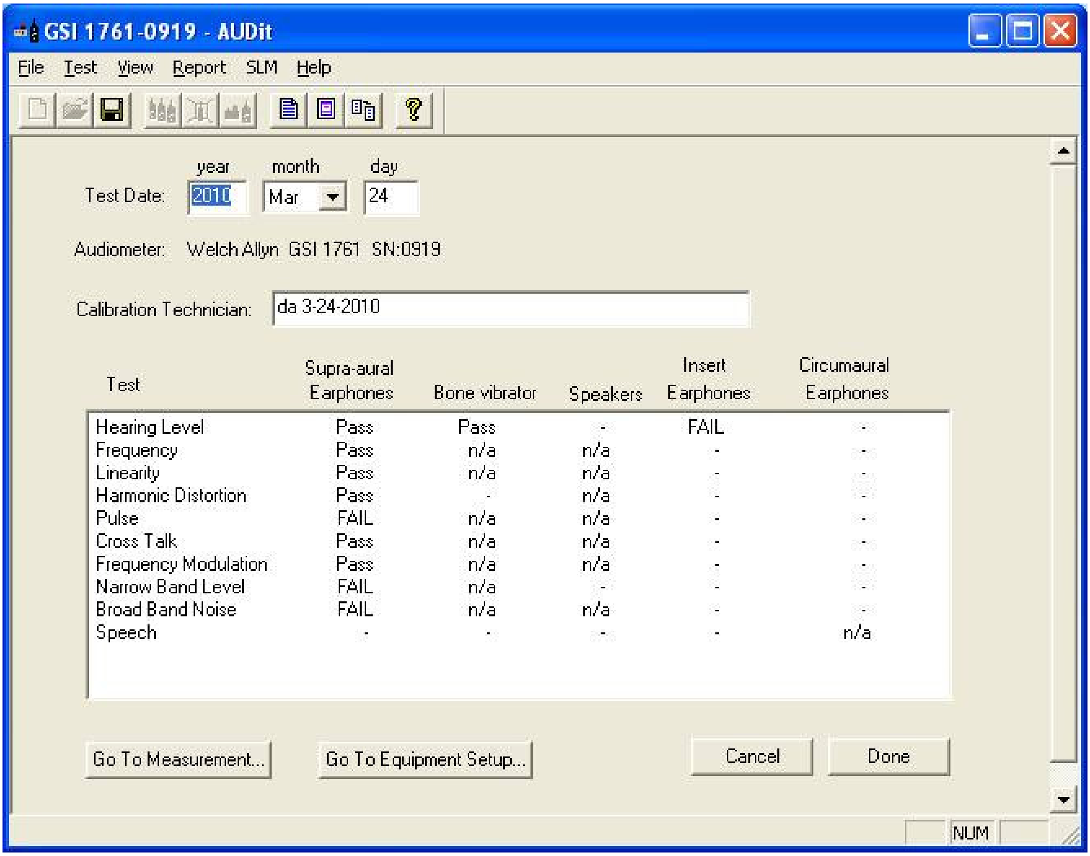


FIGURE 7-1 Main Measurement Screen

The main measurement screen (FIGURE 7-1) allows you to enter the test date and technician name. The tested audiometer manufacturer, model and serial number are displayed as entered in the previous setup. A table of tests and transducers shows the available tests for the particular audiometer. For example, the Frequency test may be performed with supra-aural, insert or circumaural earphones. Appropriate corrections are applied within each test using appropriate microphone, coupler and standard adjustments.

To continue the audiometer calibration process, highlight the ***Frequency*** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed.

Frequency Test with Earphone Transducers

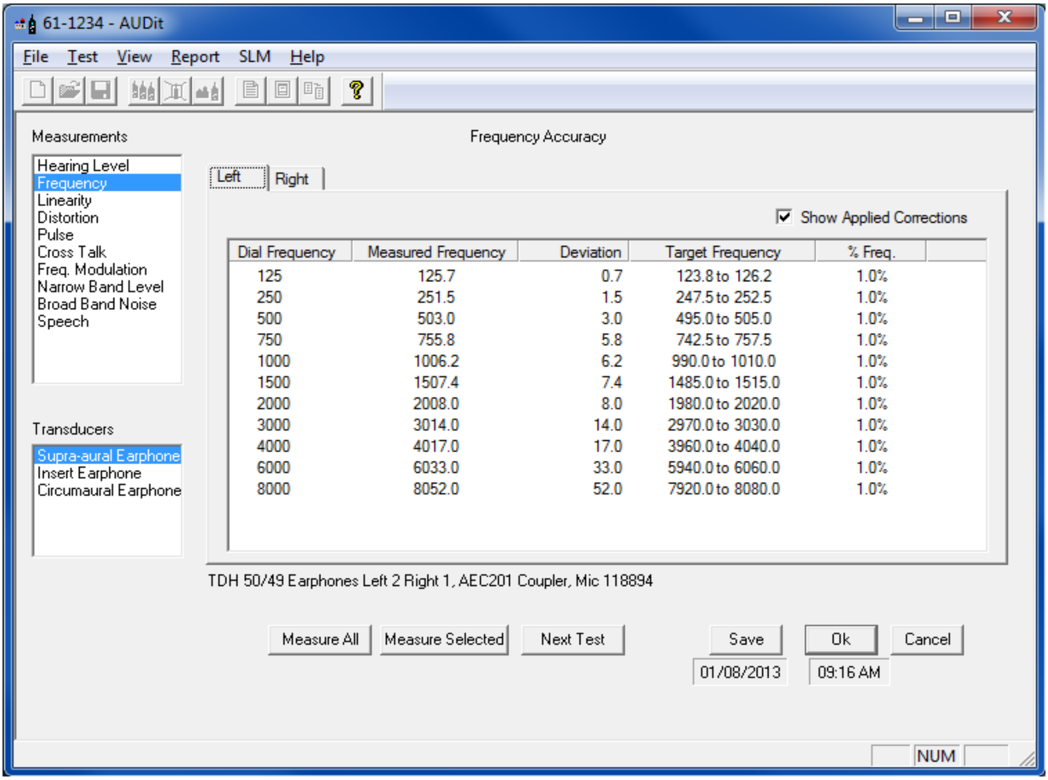


FIGURE 7-2 Frequency Test Screen

Checking the ***Show Applied Corrections*** *on this tab displays the* ***%Freq*** *column, which shows the percentage difference allowed for the associated frequency to pass the test.*

The Frequency test screen (FIGURE 7-2) is the same for all earphone types. On the left, below the measurement table, the transducers list contains supra-aural, insert and circumaural earphones. All earphones types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

To perform a test of the supra-aural earphones, highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone Frequency Accuracy tabs will appear on the right part of the screen. One may select the test earphone by pressing on the **Left** or **Right** tab.

The list of the active frequencies selected earlier in the audiometer setup process appears in the right window. Note the headers at the top of the table. The dial and measured frequency value from the sound level meter are displayed, and the deviation from the target frequency is displayed for each frequency.

The row of buttons at the bottom of the screen allows the technician to:

- **Measure All** - measure all frequencies sequentially with software prompts
- **Measure Selected** - measure only the currently highlighted frequency with software prompts
- **Next Tes**t - move to the next measurement in the Measurements list in the upper left window
- **OK** - end the current test
- **Cancel** - cancel the current test

Press **Measure All** to perform a frequency test on the left earphone. AUDit then displays the prompt shown in FIGURE 7-3 for the first frequency:

FIGURE 7-3 Set Level and Frequency Dialog Box

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. Frequency measurement is performed accurately by a dedicated counter in the Model 824 sound level meter. A number of counter values are compared to ensure an accurate reading. This process may take a few seconds. In this example, all frequencies higher than 750 Hz are out of tolerance.(FIGURE 7-4) This is indicated by a large red X next to each frequency.

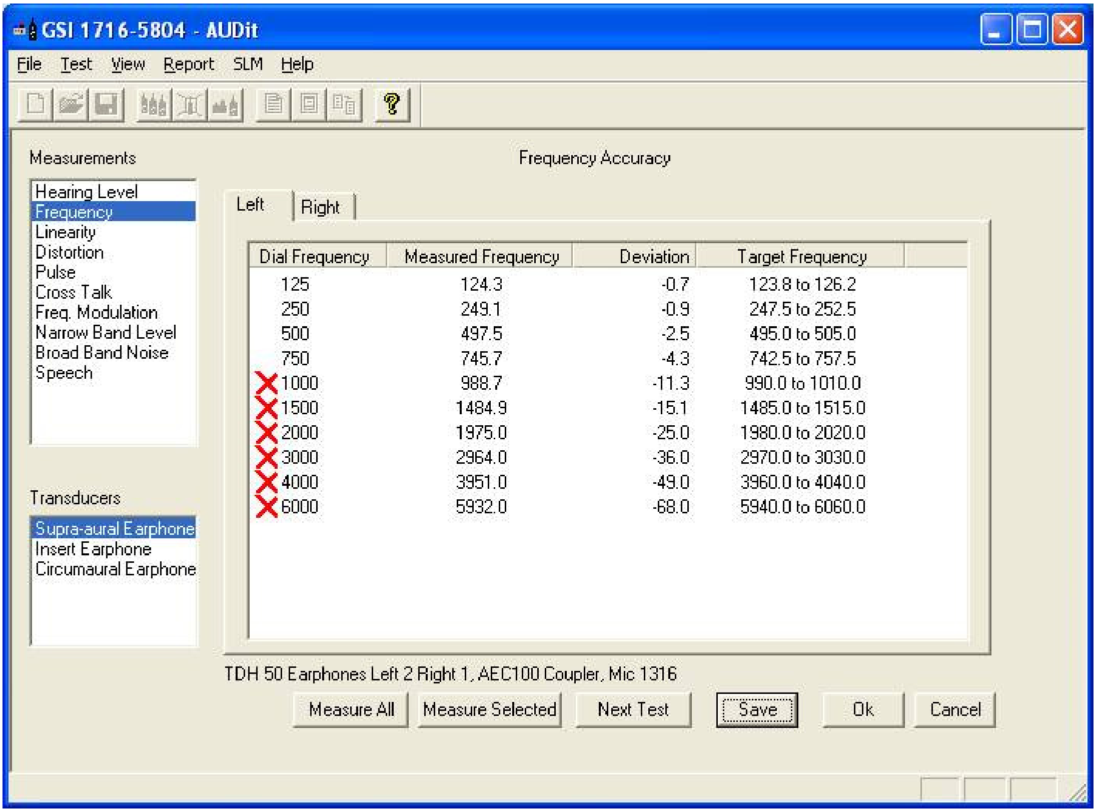


FIGURE 7-4 Frequency Test Results Box

NOTE: *If the frequency reading is not stable, it could be due to noise that is coupled into the artificial ear. Possible sources are HVAC, abient noise, (room noise) or vibration. Make sure to use the pad and test on a solid surface. Verify that the ambient noise levels are satisfactorily low.*

A failed frequency may be retested after adjustment by highlighting it and pressing the **Measure Selected** button. The **Adjust** button is inactive in this screen because frequency measurements are slightly longer and the display is not effective for adjustment in real time.

Follow the same procedure to test the right earphone.

CHAPTER

8 Linearity Test

Various requirements regarding signal level controls appear in Section 7 of ANSI S3.6-2004.

AUDit allows the measurement of linearity from the maximum hearing level down to the noise floor of the measurement system. The test frequency, maximum dBHL and dial step may be selected by the technician. Defaults are 1000 Hz 110 dBHL maximum level and 5 dBHL steps.

Linearity Measurement Screen

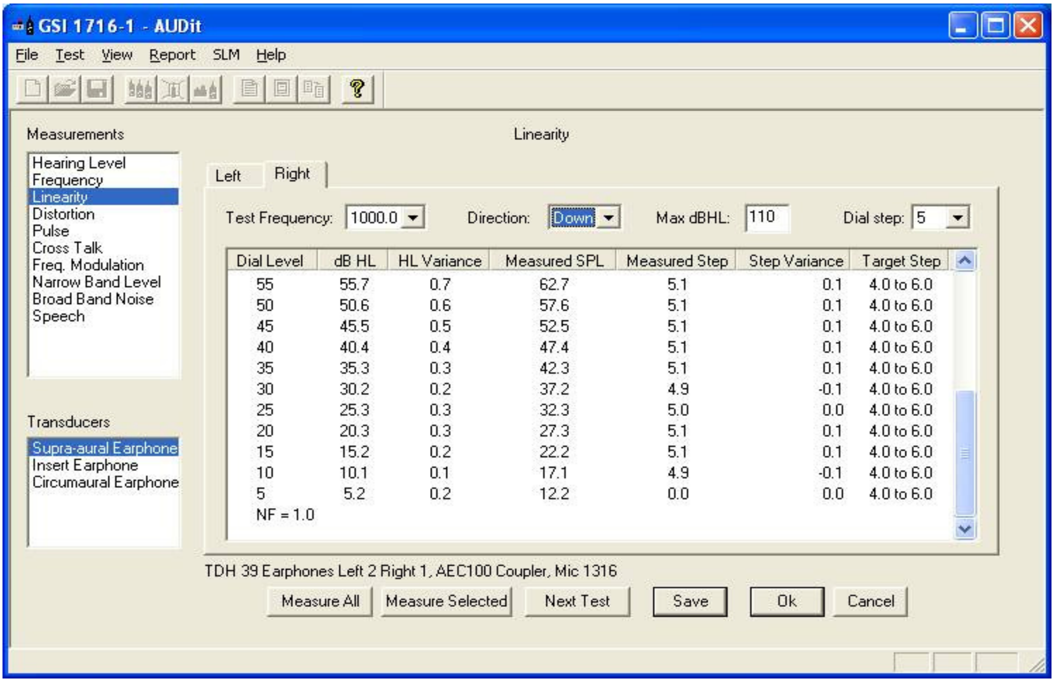


FIGURE 8-1 Linearity Measurement Screen

To perform a linearity test from the main audiometer test status screen, follow these steps:

The SLM should be calibrated before a measurement is performed. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

Step 1 Highlight the ***Linearity*** test with the pointer and click the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window.

Step 2 Highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone Linearity tabs will appear on the right part of the screen. One may select which earphone to test by clicking on the **Left** or **Right** tab.

Step 3 Select the desired frequency and dial step (**10**, **5**, **2** or **1** dB) from the drop down lists and enter the appropriate maximum output level of the audiometer.

Step 4 Click the **Measure All** button to perform a linearity test on the right earphone. AUDit then displays the prompt shown in Figure 8-2 to measure the lower end of the test range:

FIGURE 8-2 Level and Frequency Set Dialog Box

Hint: *To test only a certain part of the hearing level control linearity; First set the upper level in the* ***Max dBHL*** *entry field. Then present the lower level on the audiometer during the noise floor test.*

Step 5 Set the audiometer to the prompted level and frequency and then click **OK**. There may be a delay while the measurement system gain is adjusted. Once the noise floor has been measured (e.g. 1.0 dB), it will appear on the Linearity screen (FIGURE 8-1.

All level steps from the maximum level to the noise floor will be tested consecutively with AUDit prompts to change the level. Steps which are out of tolerance will be indicated by a large red X on the results screen, as shown in FIGURE 8-3.

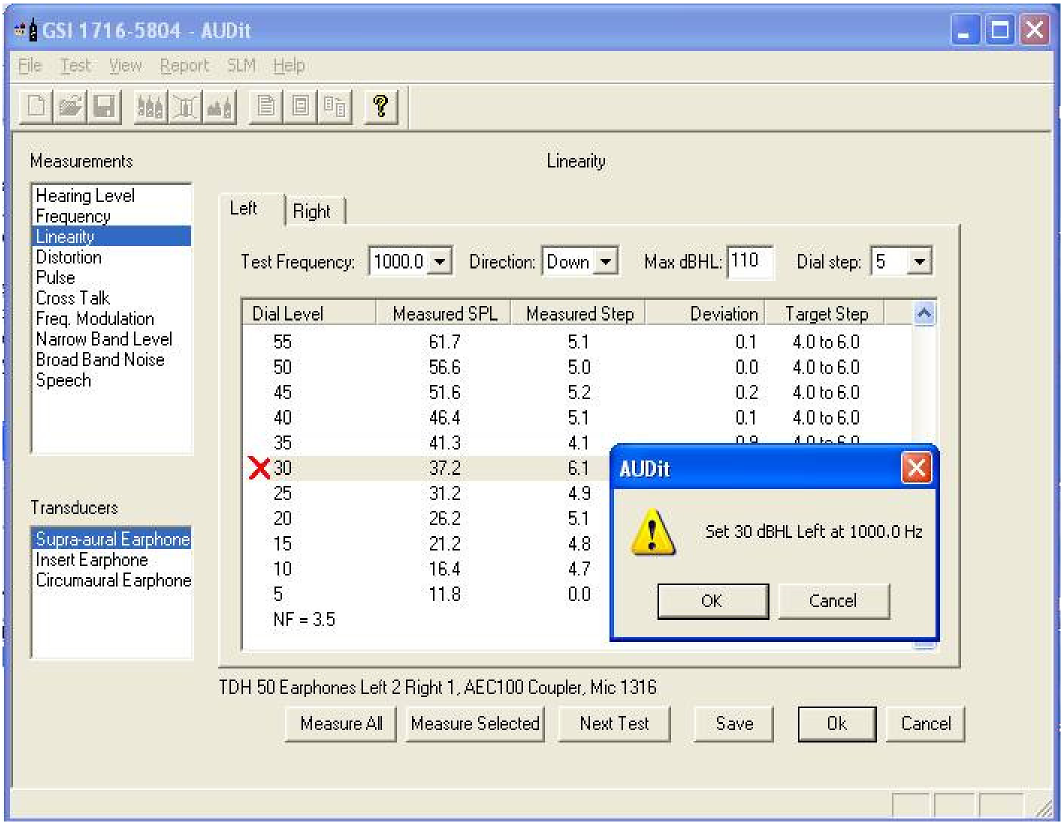


FIGURE 8-3 Noise Floor Test Results Screen

A failed level may be retested after adjustment by highlighting it and clicking the **Measure Selected** button.

Step 6 Follow the same procedure to test the other earphone.

CHAPTER

9 Distortion Test

Accurate distortion measurements of the pure tone signal source are performed by using narrow band fast Fourier transform (FFT) analysis. Distortion can affect audiometric evaluations and may indicate hardware problems. The maximum permissible levels in percent are listed in Table 3 of ANSI S3.6-2010. In general, total harmonics should be less than 2.5% for air conduction and less than 5.5% for bone conduction.

Harmonic distortion is measured at the level listed in ANSI S3.6: Table 4 or the maximum hearing level of the audiometer, whichever is lower. Limitations in the frequency response of the measurement system dictate that distortion measurements above 5000 Hz should be made across the electrical terminals of the transducer. The ADP010 Audiometer Earphone Testing Adaptor is ideal for this purpose. Insert it in the connection to the transducer, and then connect its BNC to the ADP006 BNC to 1/2" preamplifier adaptor on the PRM902.

Total harmonic distortion is defined as follows:

$$THD(percent) = 100\sqrt{\left(\frac{Lf2}{Lf1}\right)^2 + \left(L\frac{f3}{f1}\right)^2 \ldots}$$

where f_1 is the fundamental frequency, f_2 the first harmonic, etc. Levels must be expressed in linear units in this formula.

Harmonic Distortion Measurement Screen

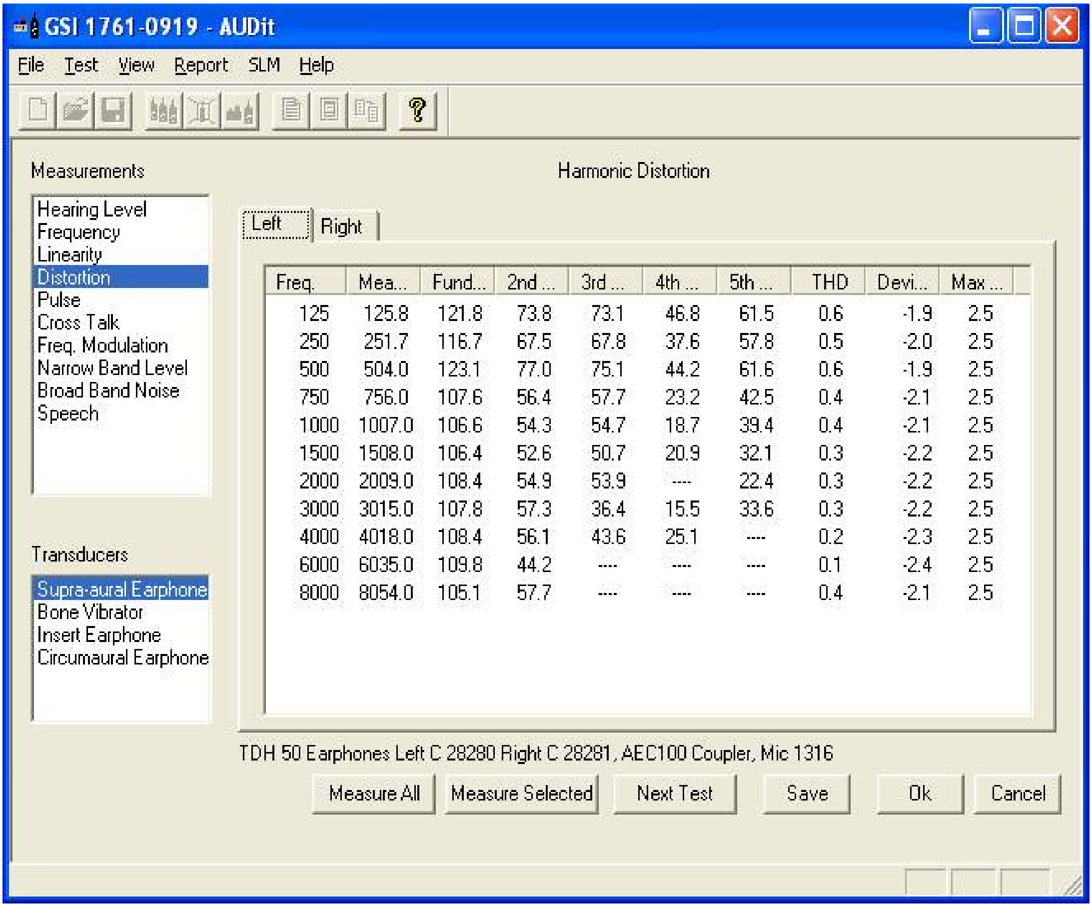


FIGURE 9-1 Harmonic Distortion Test Screen

To perform a distortion test from the main audiometer test status screen, highlight the ***Harmonic Distortion*** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen (FIGURE 9-1), press the same test in the Measurements window.

The SLM should be calibrated before a measurement is performed. On the left, below the Measurement table, the Transducers list contains supra-aural earphone, bone vibrator, insert and circumaural earphones. All types of earphones have two tabs: Left and Right. The bone vibrator has only one tab. In this example, the supra-aural earphone transducers will be calibrated. The procedure is nearly the same for all transducers. Remember to use the electrical terminal adaptor, ADP010 for frequencies above 5000 Hz.

Highlight the Supra-aural Earphone transducer list item. The Supra-aural Earphone tabs will appear on the right part of the screen (FIGURE 9-1).

Click the **Measure All** button to perform a distortion test on the left earphone. AUDit then displays the prompt shown in Figure 9-2 to measure the first frequency:

FIGURE 9-2 Level and Frequency Set Dialog Box

Set the audiometer to the prompted level and frequency then press **OK**. There may be a delay while the measurement system gain is adjusted. When test frequencies greater than 5000 Hz, it will be necessary to use the ADP010 and ADP006 combination to measure distortion on the electrical signal.

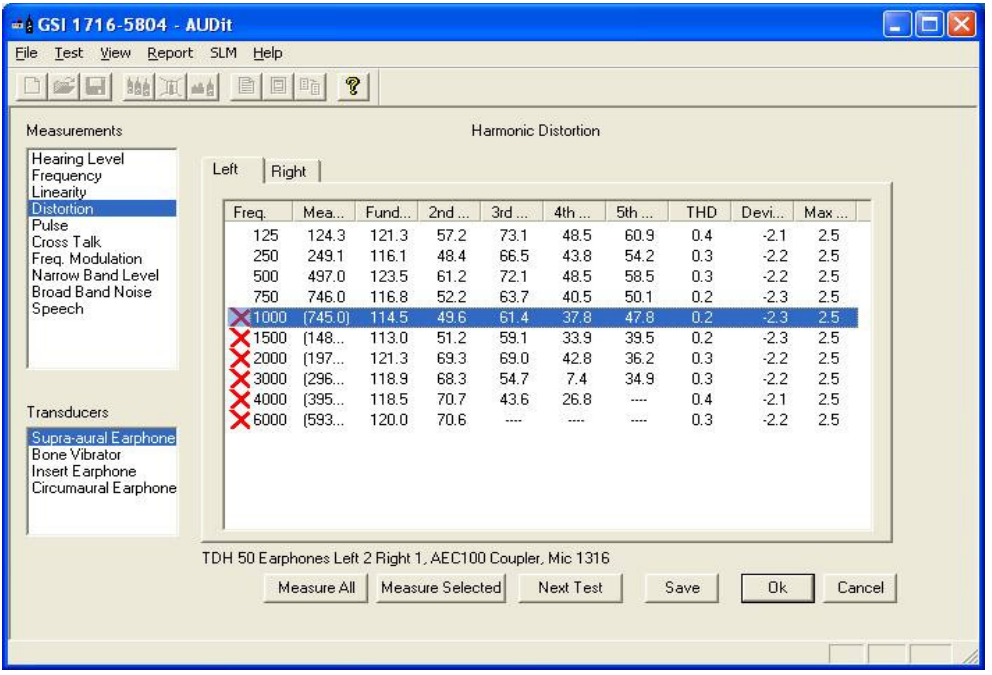


FIGURE 9-3 THD Test Results Screen

The results of the distortion measurement are listed in the tab (FIGURE 9-3), with each harmonic's level in dB and the total harmonic distortion in percent. Frequencies which are out of tolerance will be indicated by a large red X.

A failed frequency may be retested after adjustment by highlighting it, and pressing the Measure Selected button.

CHAPTER

10 Pulse Test

In some audiometry cases, the presentation of pulsed tones is preferred. The Larson Davis audiometer calibration system performs accurate pulse measurements of the pure tone signal source by using digital signal processing techniques. Requirements for the envelope of pulsed pure tone signals are listed in Section 7.5.4 of ANSI S3.6-2010. The relevant parameters for the automatically pulsed tones are defined below:

- **Frequency**: fundamental rate of change of the pure tone signal in Hertz
- **Rise Time**: time in milliseconds between the -20 dB point (referenced to the maximum level) and -1 dB point on the rising edge of the pulsed signal envelope, nominally between 20 and 50 ms
- **Fall Time**: time in milliseconds between the -1 dB point and -20 dB point on the falling edge of the pulsed signal envelope, nominally between 20 and 50 ms
- **On Time**: time in milliseconds between successive -5 dB points of the envelope of the pulsed signal during which the signal is present, nominally between 190 and 260 ms
- **Off Time**: time in milliseconds between successive -5 dB points of the envelope of the pulsed signal during which the signal is absent, nominally between 190 and 260 ms
- **Width**: duration in milliseconds of the plateau during which the signal is within -1 dB of its nominal value
- **On/Off Ratio**: ratio of the maximum level during the "OFF" portion of the pulse between the -20 dB point of the falling and rising edge of the envelope to the maximum level in the "ON" portion, nominally greater than 20 dB

Pulse signal envelope characteristics are measured at a nominal frequency of 1000 Hz by AUDit. However, the measurement may be made with another available pure tone frequency.

Pulse Measurement Screen

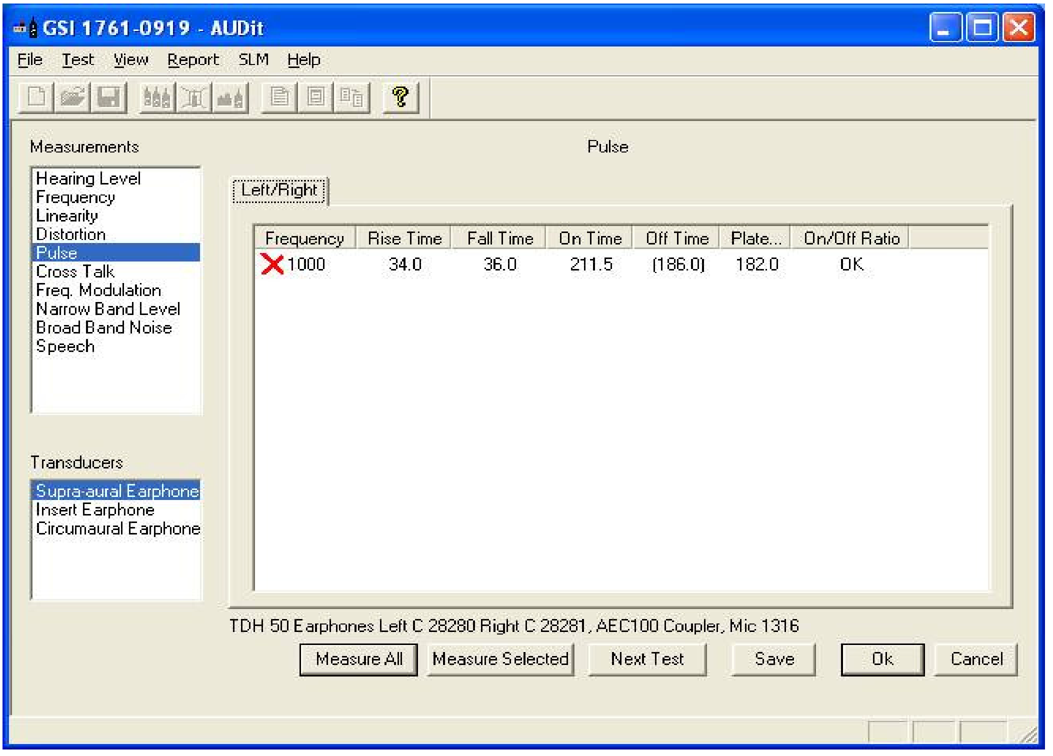


FIGURE 10-1 Pulse Test measurement Screen

To perform a pulse test from the main audiometer test status screen, highlight the ***Pulse*** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone tab will appear on the right part of the screen. The test is nominally performed on the left earphone.

Click **Measure All** or highlight the first line and press Measure Selected to perform a pulse test on the left earphone. AUDit then displays the prompt shown in Figure 10-2:

FIGURE 10-2 Level and Frequency Set Dialog Box

NOTE: *The On/Off Time limits in section 7.5.4 of ANSI S3.6-2004 are based on a 2 Hz pulse rate. If the audiometer being tested is using a different pulse rate, then the pulse on/off time measurements will likely fail. If the on/off time is the only part of the pulse test that fails, a note can be added to the certification paragraph stating that the audiometer is in compliance, with the exception of the on/off times.*

Set the audiometer to the prompted pulsed level and frequency then press **OK**. You may observe an overload on the sound level meter, in which case the level should be reduced until the overload disappears.

The results of the pulse measurement are listed in the tab (Figure 10-1), in milliseconds. Values which are out of tolerance will be in parentheses, and the failed test is indicated by a large red X.

CHAPTER

11

Cross Talk Test

Cross talk measurements performed by the AUDit audiometer calibration system are implemented at a chosen frequency for both earphones. Crosstalk is defined as an unwanted acoustic signal present on the channel which is not active. AUDit evaluates the difference between the level of the driven test earphone and the non-driven earphone (see ANSI S3.6-2004 Section 5.4.2.1 item (2)).

Another test performed in this portion of the software is the audiometer on/off ratio. This test verifies the output from the left earphone, when the tone switch is in the "OFF" position, is no more than 10 dB above the Reference Equivalent Threshold.

In this case the hearing level control is set at 80 dBHL and the frequency to 1000Hz. (see ANSI S3.6-2004 Section 7.5.2).

Crosstalk Measurement Screen

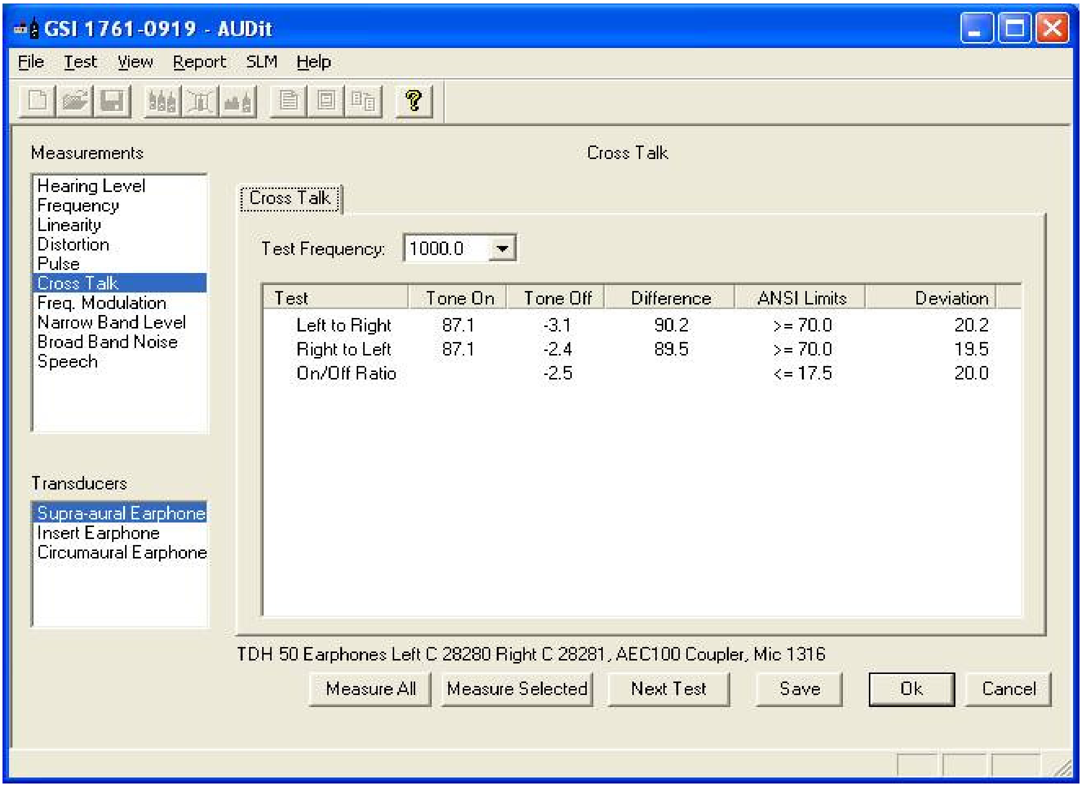


FIGURE 11-1 Cross Talk Measurement Screen

To perform a cross talk test from the main audiometer test status screen, highlight the ***Cross Talk*** test with the pointer and press the **Go To Measurement** button. In this example, the supra-aural earphone transducers will be tested.

Highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone Cross Talk tab will appear on the right part of the screen.

As with all measurements performed with the tone "OFF", external vibration or noise may affect the reading. The coupler and sound level meter must be on stable surfaces, preferably cushioned from room vibration. You may observe the display on the sound level meter to verify that the level is near the noise floor. Press **Measure All** to begin the cross talk test. AUDit displays the prompt shown in Figure 11-2:

FIGURE 11-2 Set Level and Frequency Set Dialog Box

Set the audiometer to the prompted level and frequency, making sure the left earphone is on the coupler and the tone is "OFF", then press **OK**. There may be a delay while the measurement system acquires a stable reading. AUDit should then display the prompt in FIGURE 11-3.

FIGURE 11-3 Earphone on Coupler Dialog Box

Present the appropriate tone on the left earphone. Once the measurement has been performed, the prompt in FIGURE 11-4 will appear.

FIGURE 11-4 Earphones Cross Talk Test Dialog Box

Leave the left earphone on the coupler but present the tone on the right earphone, ensuring that it is occluded and far enough away from the coupler to prevent acoustic pickup. FIGURE 11-5 contains the next prompt.

FIGURE 11-5 Right Earphone on Coupler Dialog Box

Replace the left earphone on the coupler with the right earphone. The right earphone should still be driven with the tone. The level will once again be measured. Once this is done, the last prompt, FIGURE 11-6, is displayed.

FIGURE 11-6 Cross Talk Test, Right Earphone on Coupler Dialog Box

Leave the right earphone on the coupler but present the tone on the left earphone, again ensuring that it is occluded and far enough away from the coupler to prevent acoustic cross talk.

This ends the Cross Talk test. The measurements and results are displayed in the tab (FIGURE 11-1). For example, the first line indicates that the level, with presentation in the test Left earphone, is 87.1dB SPL while the level measured at the Right earphone (with presentation on the non-test earphone) is -3.1 dB SPL. The difference of 90.2dB is 20.2 dB greater than the specification of equal or better than 70dB.

A subtest which is out of tolerance will be indicated by a large red X. A failed subtest may be repeated by highlighting it and pressing the Measure Selected button. Follow the same procedure to test any remaining transducers.

CHAPTER

12 Frequency Modulation Test

This chapter describes the Frequency Modulation Test which verifies various parameters of the frequency modulated signals available on some audiometers. The Larson Davis audiometer calibration system performs accurate FM measurements of the pure tone signal source by using accurate period measurement techniques. The permissible values for this test are listed in Section 6.1.3 of ANSI S3.6-2010. Frequency modulation parameters are measured for the available audiometer frequencies.

Frequency Modulation Measurement Screen

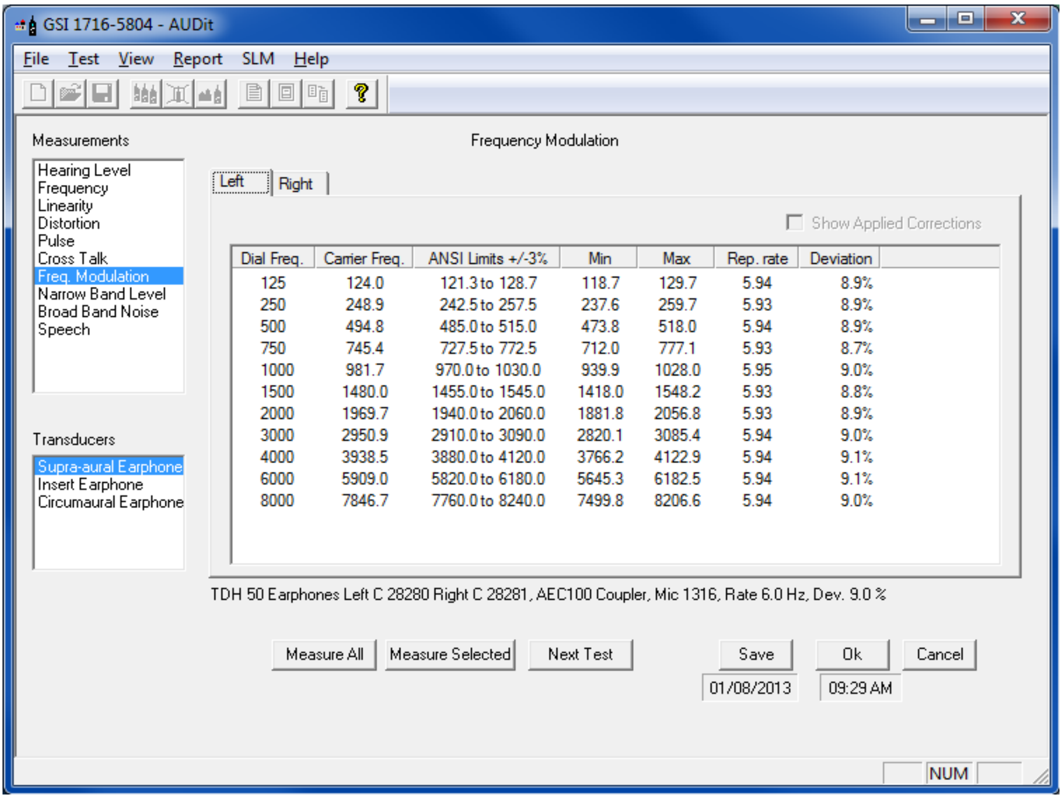


FIGURE 12-1 Frequency Modulation Test Screen

On this screen, all values come directly from the meters.

To perform a frequency modulation test from the main audiometer test status screen, highlight the ***Freq. Modulation*** test with the pointer and press the **Go To Measurement** button. In this example, the supra-aural earphone transducers will be calibrated.

Highlight the ***Supra-aural Earphone*** transducer list item. The Frequency Modulation tabs will appear on the right part of the screen. You may select which earphone to test by pressing on the Left or Right tab.

Press **Measure All** to perform a frequency modulation test on the left earphone. AUDit then displays the prompt shown in FIGURE 12-2 to measure the first frequency.

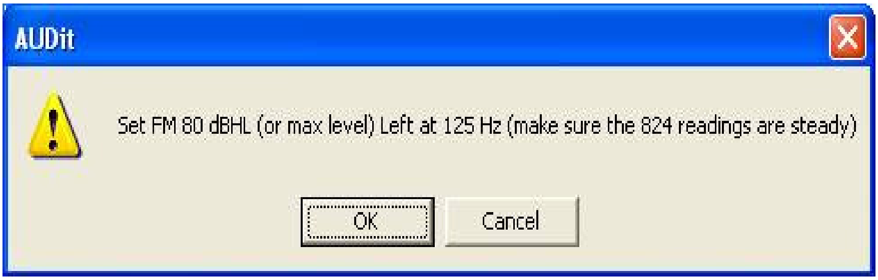


FIGURE 12-2 Set Level and Frequency Dialog Box

Set the audiometer to the prompted FM stimulus level and frequency then press **OK**. There may be a delay while the measurement system acquires an average reading (FIGURE 12-3).

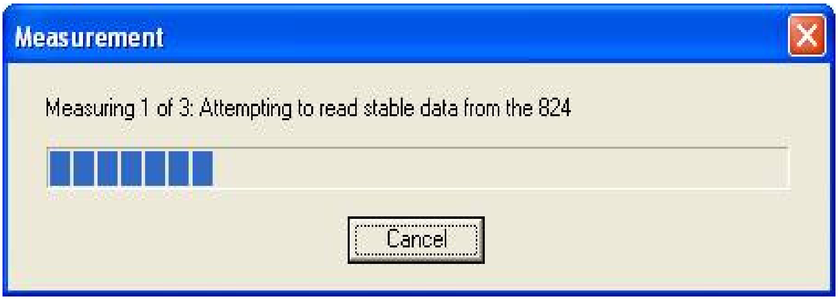


FIGURE 12-3 Noise or Variation Message Window

The presence of noise, variations in the readings or other problems may prompt the display shown in FIGURE 12-4.

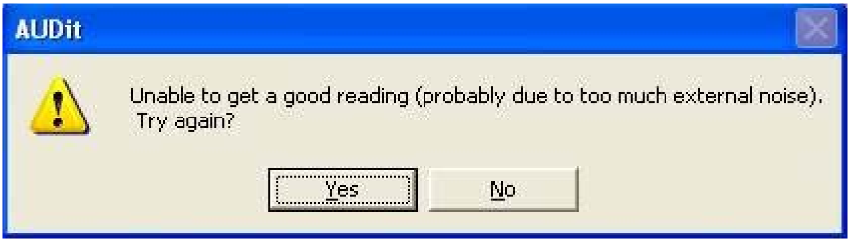
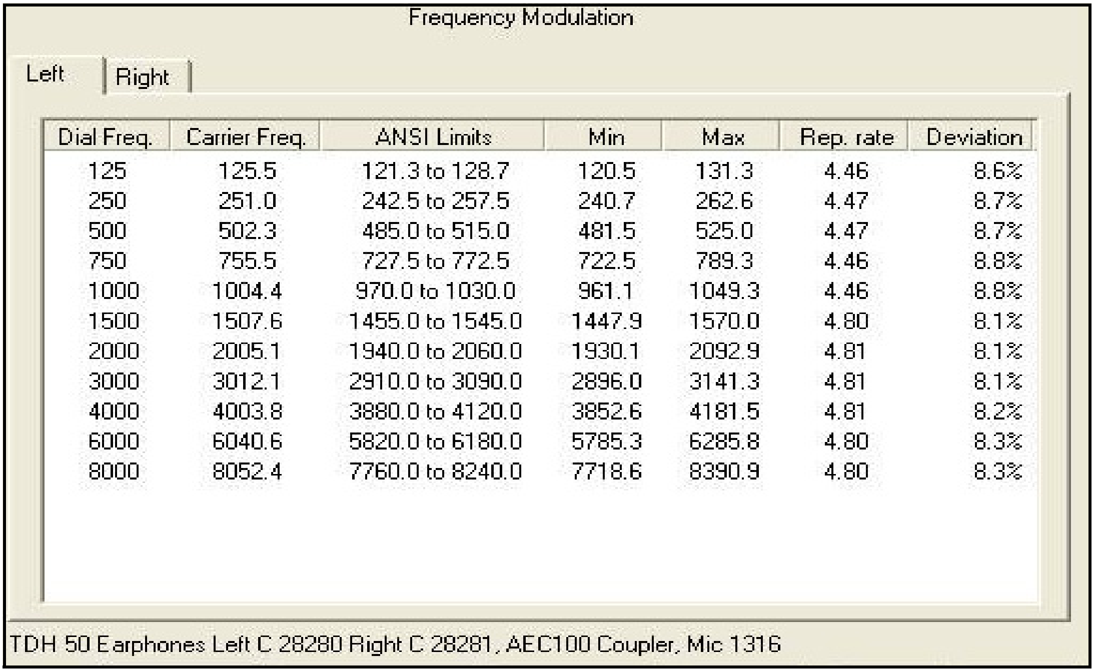


FIGURE 12-4 Unable to get Reading Message Window

It may be useful to observe the sound level meter display and change output level as needed. If the software is unable to retrieve an acceptable measurement, the frequency will be skipped. Each frequency is tested consecutively in the same manner.



Frequency Modulation

Left | Right

Dial Freq.	Carrier Freq.	ANSI Limits	Min	Max	Rep. rate	Deviation
125	125.5	121.3 to 128.7	120.5	131.3	4.46	8.6%
250	251.0	242.5 to 257.5	240.7	262.6	4.47	8.7%
500	502.3	485.0 to 515.0	481.5	525.0	4.47	8.7%
750	755.5	727.5 to 772.5	722.5	789.3	4.46	8.8%
1000	1004.4	970.0 to 1030.0	961.1	1049.3	4.46	8.8%
1500	1507.6	1455.0 to 1545.0	1447.9	1570.0	4.80	8.1%
2000	2005.1	1940.0 to 2060.0	1930.1	2092.9	4.81	8.1%
3000	3012.1	2910.0 to 3090.0	2896.0	3141.3	4.81	8.1%
4000	4003.8	3880.0 to 4120.0	3852.6	4181.5	4.81	8.2%
6000	6040.6	5820.0 to 6180.0	5785.3	6285.8	4.80	8.3%
8000	8052.4	7760.0 to 8240.0	7718.6	8390.9	4.80	8.3%

TDH 50 Earphones Left C 28280 Right C 28281, AEC100 Coupler, Mic 1316

FIGURE 12-5 Frequency Modulation Results Screen

The results of the frequency modulation measurement are listed for each frequency in the tab (Figure 12-5). The values are, in order:

- **Dial Freq**.: selected audiometric presentation frequency
- **Carrier Freq**.: measured carrier frequency of the modulated signal
- **ANSI Limits**: allowed range within 3% of the nominal frequency
- **Min**: minimum frequency of the FM signal
- **Max**: maximum frequency of the FM signal
- **Rep. Rate**: rate at which the FM signal is modulated in hertz (must be within 4 to 20 Hz and within 10% of the value stated in the audiometer setup screen)
- **Deviation**: It must be within 10% of the value stated in the audiometer setup screen

Any value which is out of tolerance is displayed within parentheses. Frequencies out of tolerance are indicated by a large red X.

A failed frequency may be retested after adjustment by highlighting it and pressing the **Measure Selected** button. Follow the same procedure to test the remaining transducers.

CHAPTER

13 Narrow Band Level Test

The Narrow Band Level Test is very similar to the Hearing Level test covered earlier. Narrow band noise is available in certain audiometers for masking and stimulus purposes. The Larson Davis audiometer calibration system performs the narrow band level measurements using real-time third octave filter analysis. Specifications regarding the masking sound level controls are enumerated in Section 7 of ANSI S3.6-2004. Various requirements include the accuracy of the masking sound level, which we test here. Maximum permissible deviation from the indicated value is 3 dB below to 5 dB above the indicated level (see Section 7.4.2 of the standard).

Narrow Band Level Test with Earphone Transducers

All earphone transducer types have four tabs in the large test window (FIGURE 13-1) at the right: **Left**, **Right**, **Low** and **High Freq. Input Levels**. In this section, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

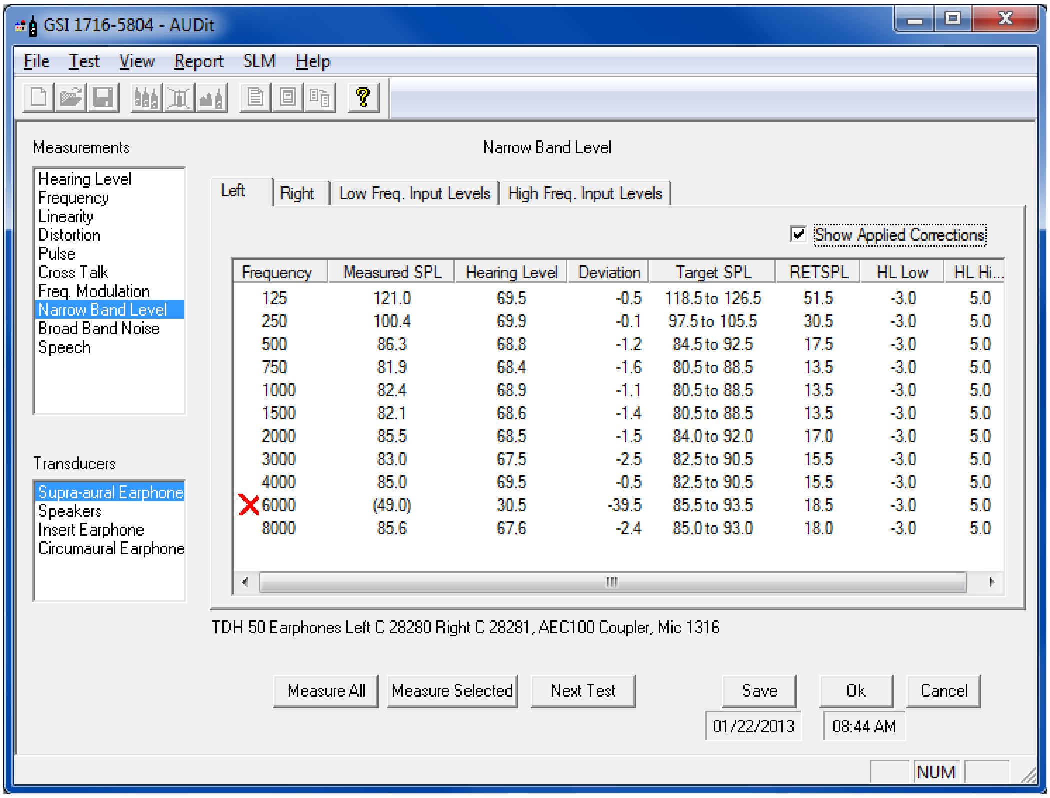


FIGURE 13-1 Narrow Band Level Measurement Screen

To perform a test of the supra-aural earphones, highlight the ***Supra-aural Earphone*** transducer list item. Default low and high frequency input levels are typically set to 70 dB HL on each tab.

Once the input levels have been verified, you may select which earphone to test by pressing on the Left or Right tab.

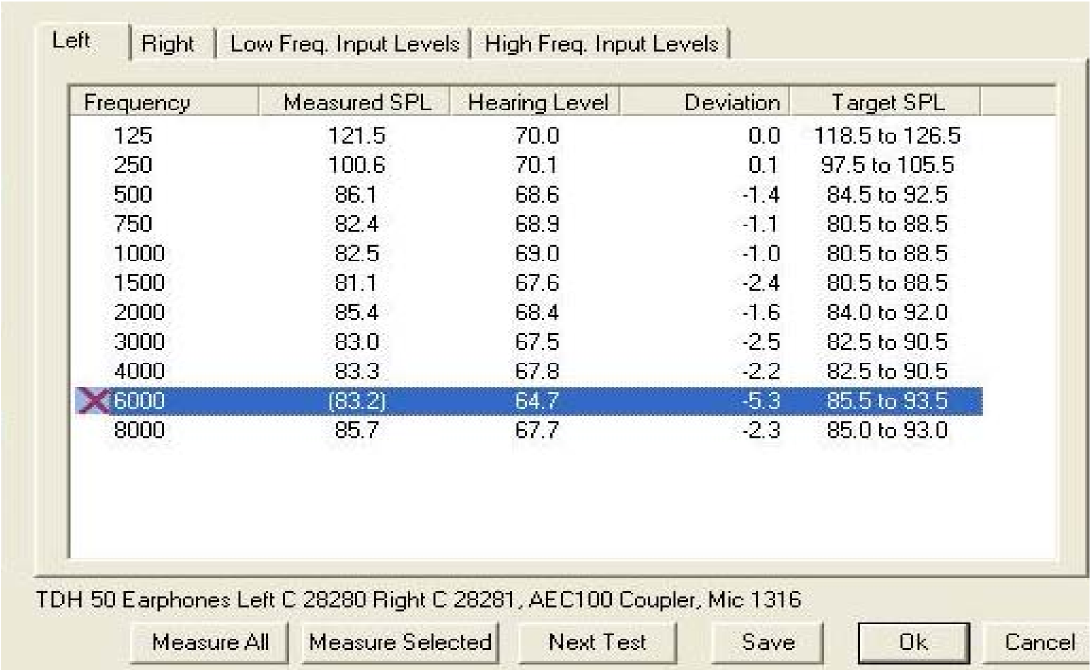


FIGURE 13-2 Active Frequencies List

*If the **Show Applied Correction** option is checked, the **RETSPL**, **HL High,** and **HL Low** columns are also displayed.*

The list of the active frequencies selected earlier in the audiometer setup appears in the right window (FIGURE 13-2). The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed along with the permissible target SPL range.

Click **Measure All** to perform a narrow band level test on the current earphone. AUDit then displays the prompt shown in Figure 13-3 for the first frequency.

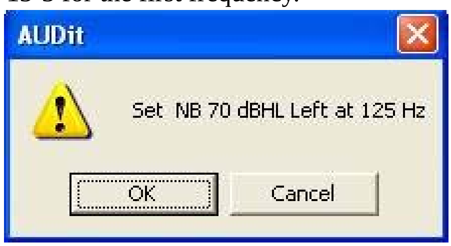
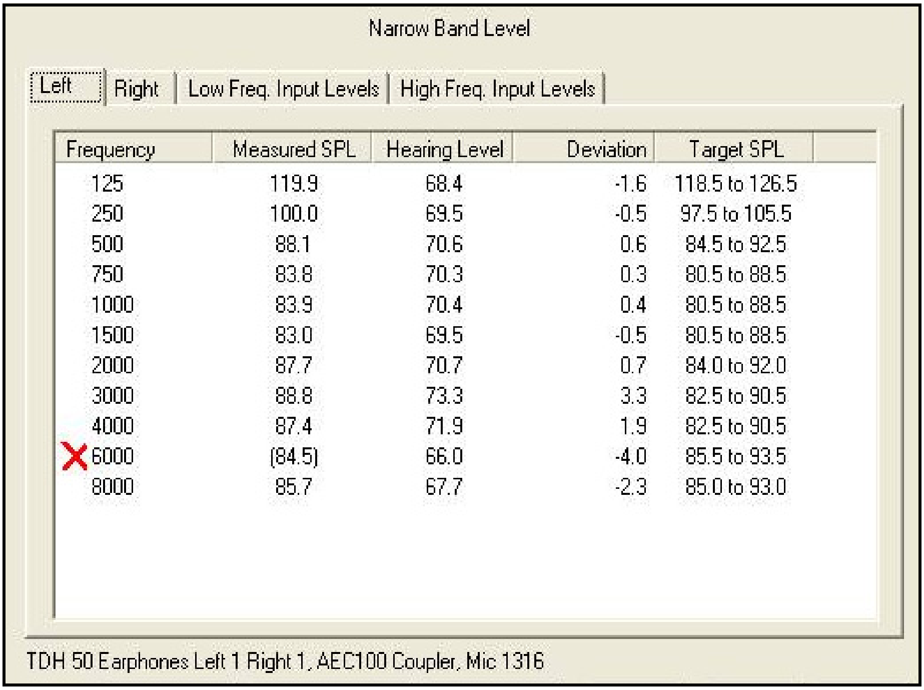


FIGURE 13-3 Level and Frequency Set Dialog Box

Set the appropriate narrow band level and frequency then press **OK**. Each frequency will be tested consecutively until all have been measured. This can be done very quickly by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer.


Narrow Band Level

Left | Right | Low Freq. Input Levels | High Freq. Input Levels

Frequency	Measured SPL	Hearing Level	Deviation	Target SPL
125	119.9	68.4	-1.6	118.5 to 126.5
250	100.0	69.5	-0.5	97.5 to 105.5
500	88.1	70.6	0.6	84.5 to 92.5
750	83.8	70.3	0.3	80.5 to 88.5
1000	83.9	70.4	0.4	80.5 to 88.5
1500	83.0	69.5	-0.5	80.5 to 88.5
2000	87.7	70.7	0.7	84.0 to 92.0
3000	88.8	73.3	3.3	82.5 to 90.5
4000	87.4	71.9	1.9	82.5 to 90.5
6000	(84.5)	66.0	-4.0	85.5 to 93.5
8000	85.7	67.7	-2.3	85.0 to 93.0

TDH 50 Earphones Left 1 Right 1, AEC100 Coupler, Mic 1316

FIGURE 13-4 Narrow Band Level Test Results Screen

Tests that are out of tolerance limits will be indicated by a red X. After adjustment, any failed frequency may be retested with the Measure Selected button.

Narrow Band Level Test with Speakers

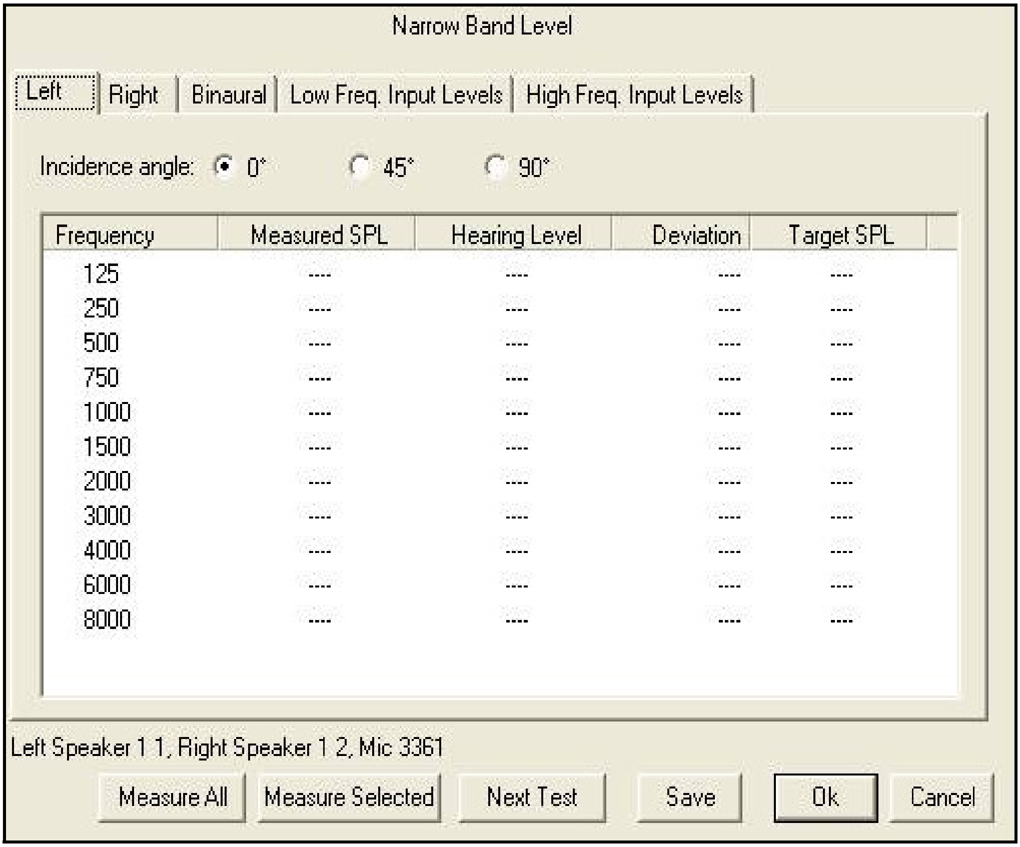


FIGURE 13-5 Narrow Band Test With Speakers Screen

Sound field audiometric testing using speakers may be performed in a variety of ways. Table 9, ANSI S3.6-2004 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening in sound field for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit to translate the measured sound pressure levels to hearing level. Note that the prescriptions in Section 9.5.1 of the standard for sound field characteristics should be followed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise Booth test in AUDit is helpful in making this determination.

To perform a test using speakers, highlight the ***Speakers*** transducer list item. The Narrow Band Level screen (Figure 13-5) for the speakers transducers has five tabs: Low and High Freq. Input Levels, Left, Right and Binaural. For the right two tabs, the speaker test levels can be specified for audiometric frequencies from 125 to 20000 Hertz.

The remaining tabs select the speaker(s) to be tested: left, right or both (binaural). In this example, the Left tab is selected. The incidence angle of 0, 45 or 90 degrees must be selected so that the appropriate RETSPL correction is applied. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The Right tab operates in the same manner. The Binaural tab has only one incidence angle selection, zero degrees.

Click the **Measure All** button to perform a narrow band (NB) level test using the speakers. Since narrow band modulation is required for this test, you will also be prompted to select a NB test signal (FIGURE 13-6).

FIGURE 13-6 Set Level and Frequency Dialog Box

Set the appropriate level and frequency then press **OK**. Each frequency will be tested consecutively until all have been measured. This test can also be performed rapidly by pressing the audiometer frequency increment button and then immediately pressing the **Enter** (OK) key on the computer.

CHAPTER

14 Broad Band Noise Masking Test

The Larson Davis audiometer calibration system performs accurate broad band ("white") noise masking measurement using narrow band fast Fourier transform (FFT) analysis. The requirements of ANSI S3.6-2004 are listed in Section 6.3.2. A minimum sound pressure spectrum flatness of within 5 dB of the level at 1000 Hz is required. The measurement is performed with an appropriate coupler.

Broad Band Masking Measurement Screen

To perform a broad band noise test from the main audiometer test status screen, highlight the ***Broad Band Noise*** test with the pointer and click the **Go To Measurement** button (FIGURE 14-1).

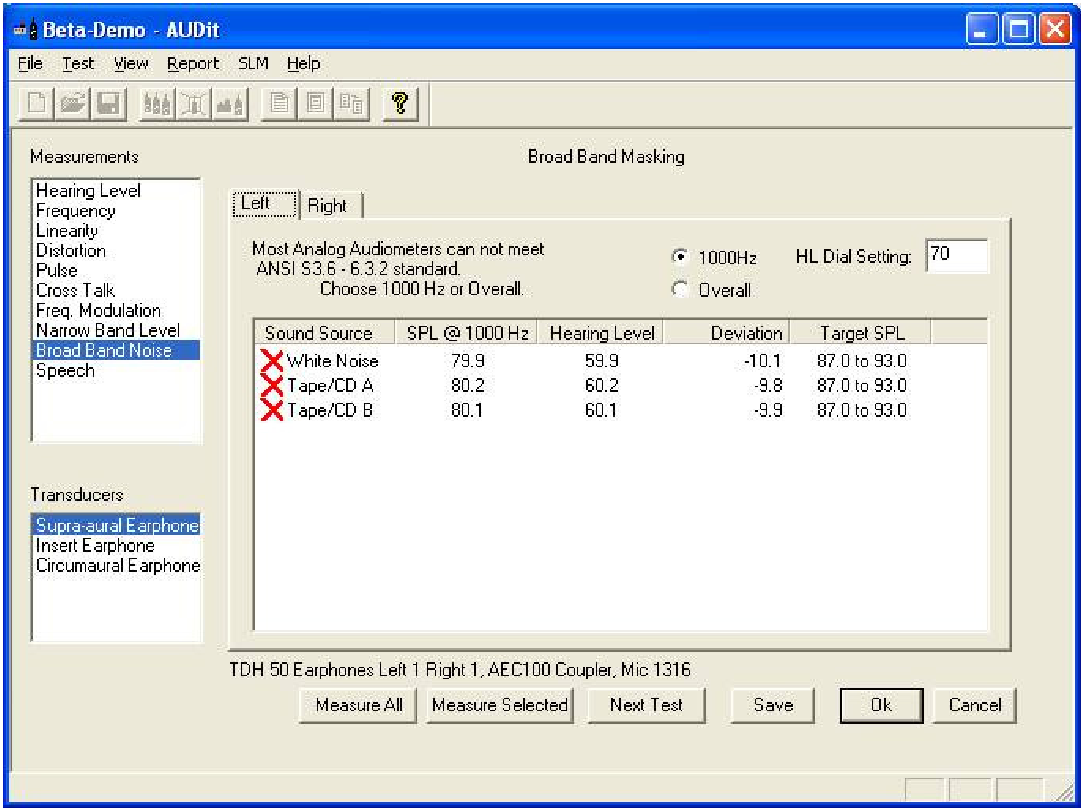


FIGURE 14-1 Broad Band Masking Measurement Screen

All earphones types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for all listed transducers.

Highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone tabs will appear on the right part of the screen. One may select which earphone to test by pressing on the Left or Right tab.

In the **HL Dial Setting** enter the Hearing Level Dial Setting that you will use for the measurement. Press **Measure All** to perform a broad band masking test on the left earphone. AUDit then displays the prompt shown in FIGURE 14-2

FIGURE 14-2 Set Level and Frequency Dialog Box

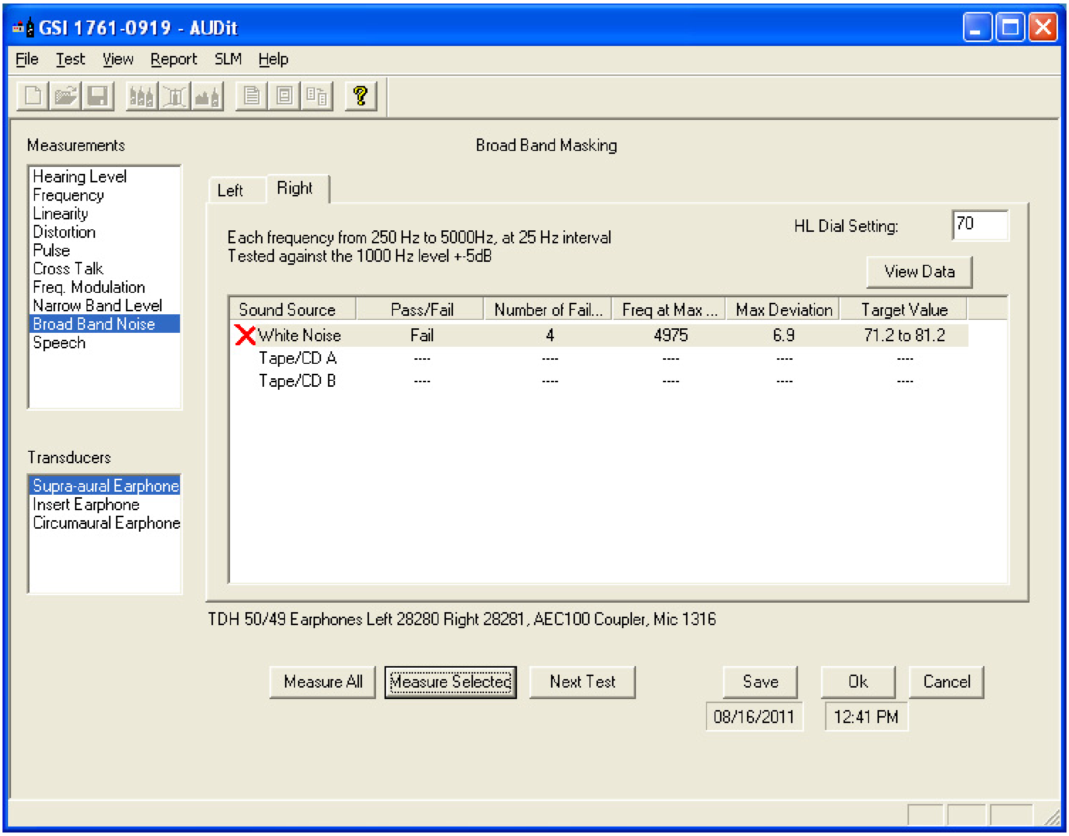


FIGURE 14-3 Broad Band Noise Results Screen

The results of the broad band noise measurement are listed in the tabs for each earphone (FIGURE 14-3). Tests which are out of tolerance limits will be indicated by a large red X.

A failed earphone may be retested after replacement/ audiometer adjustment by selecting it and clicking the **Measure All** button. Follow the same procedure to test the remaining transducers.

CHAPTER

15 Speech Test

This test verifies the calibration of audiometers which offer the facility for playback of standardized prepared speech signals. Speech signals may be provided from a microphone, tape or compact disc recording input electrically to the audiometer. AUDit performs level tests on microphone, tape/CD inputs A and B, as well as internally generated speech noise signals.

Speech Measurement Screen

To perform a speech test from the main audiometer test summary screen, highlight ***Speech*** Test with the pointer and click the **Go To Measurement** button. Appropriate corrections are applied by AUDit within each test using microphone, coupler and transducer data sheets and tables.

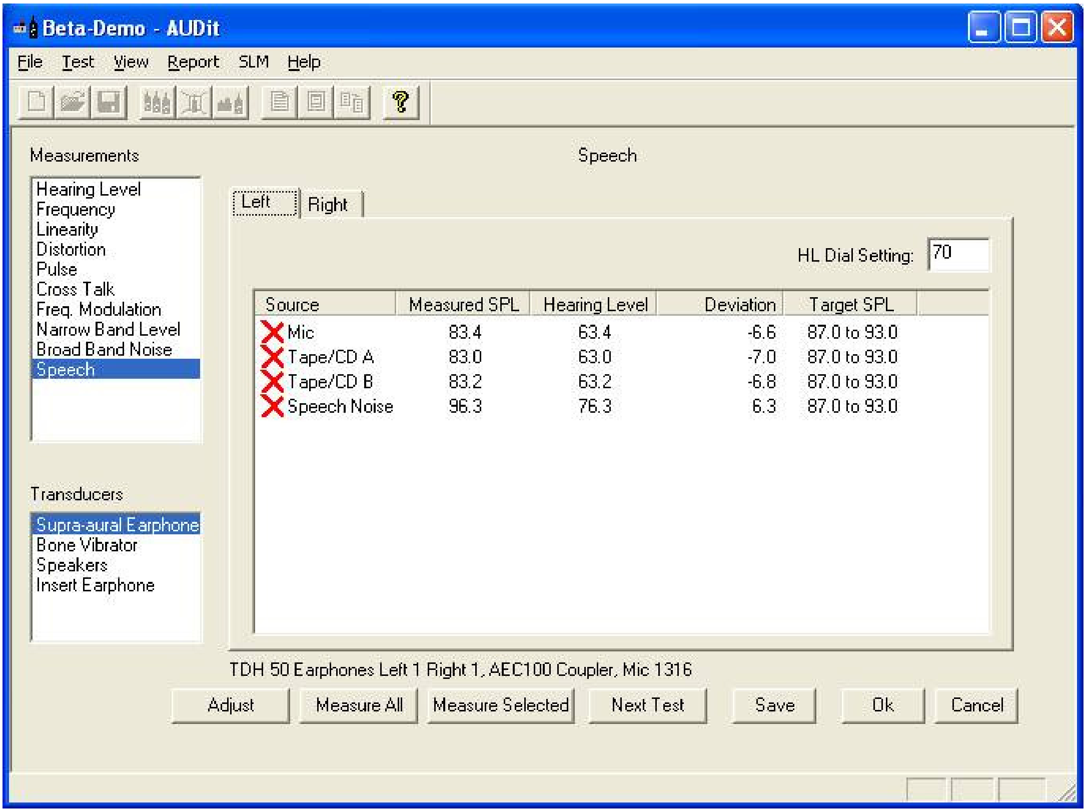


FIGURE 15-1 Speech Test Transducers Screen

Speech Test with Earphone Transducers

In this section, a supra-aural earphone transducer will be calibrated. The procedure is the same for insert earphones and is very similar for the other transducers.

To perform a test of the supra-aural earphones, highlight the ***Supra-aural Earphone*** transducer list item. One may select which earphone to test by pressing on the Left or Right tab.

The headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

The desired test hearing level is selected at the upper right of the tab, in the HL Dial Setting field.

Mic Test

Press **Measure All** to perform a complete speech level test on the left earphone, or highlight the Mic line and press **Measure Selected**. AUDit then displays the prompt shown in Figure 15-3.

FIGURE 15-2 Set Level and Frequency Dialog Box

The speech material calibration signal should be provided at the microphone input. Set the appropriate level, input and presentation on the audiometer then press OK. The measured SPL is corrected for coupler, microphone and other responses and should be 12.5 dB above the 1000 Hz RETSPL for the transducer in use (See ANSI S3.6-2004 section 6.2.12.). Target SPL is determined from ANSI S3.6 section 7.2 on the accuracy of sound pressure levels. An unsatisfactory reading is indicated by a large red X.

It may be necessary to adjust the level by pressing the Adjust button.

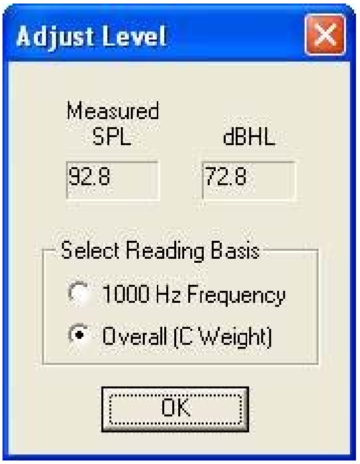


FIGURE 15-3 Current Level Readings Screen

A small dialog box appears (FIGURE 15-3) which shows the current SPL and HL readings which the technician may adjust to bring the level within the listed target SPL range. The adjustment does not affect the test result performed before.

To verify the adjustment, the input may be retested with the **Measure Selected** button.

Tape/CD A and Tape/CD B Test

To perform a speech level test on the left earphone Tape/CD A or B inputs, highlight the appropriate subtest and press **Measure Selected**. AUDit then displays the prompt shown in FIGURE 15-4.

FIGURE 15-4 Set Tape Level and Frequency Dialog Box

The speech material calibration signal should be provided to the appropriate input. Set the listed level, input and presentation on the audiometer then press OK. The measured SPL is corrected for coupler, microphone and other responses and should be 12.5 dB above the 1000 Hz RETSPL for the transducer in use. (See ANSI S3.6-2004 Section 6.2.12.) Target SPL is determined from ANSI S3.6 Section 7.2 on the accuracy of sound pressure levels. An unsatisfactory reading is indicated by a large red X.

It may be necessary to adjust the level by pressing the Adjust button. Once this is done, the input may be retested with the **Measure Selected** button.

Speech Noise Test

To perform a speech noise level test on the left earphone, highlight the last subtest and click **Measure Selected**. AUDit then displays the prompt shown in FIGURE 15-5.

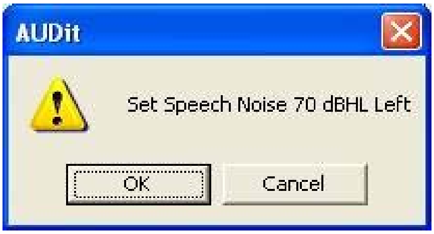


FIGURE 15-5 Speech Noise Level Set Dialog Box

The speech material calibration signal should be provided to the appropriate input. Set the listed level, input and presentation on the audiometer and click **OK**. The measured SPL is corrected for coupler, microphone and other responses.

It may be necessary to adjust the level by pressing the Adjust button.

Once this is done, the input may be retested with the **Measure Selected** button.

Speech Test with Bone Vibrator

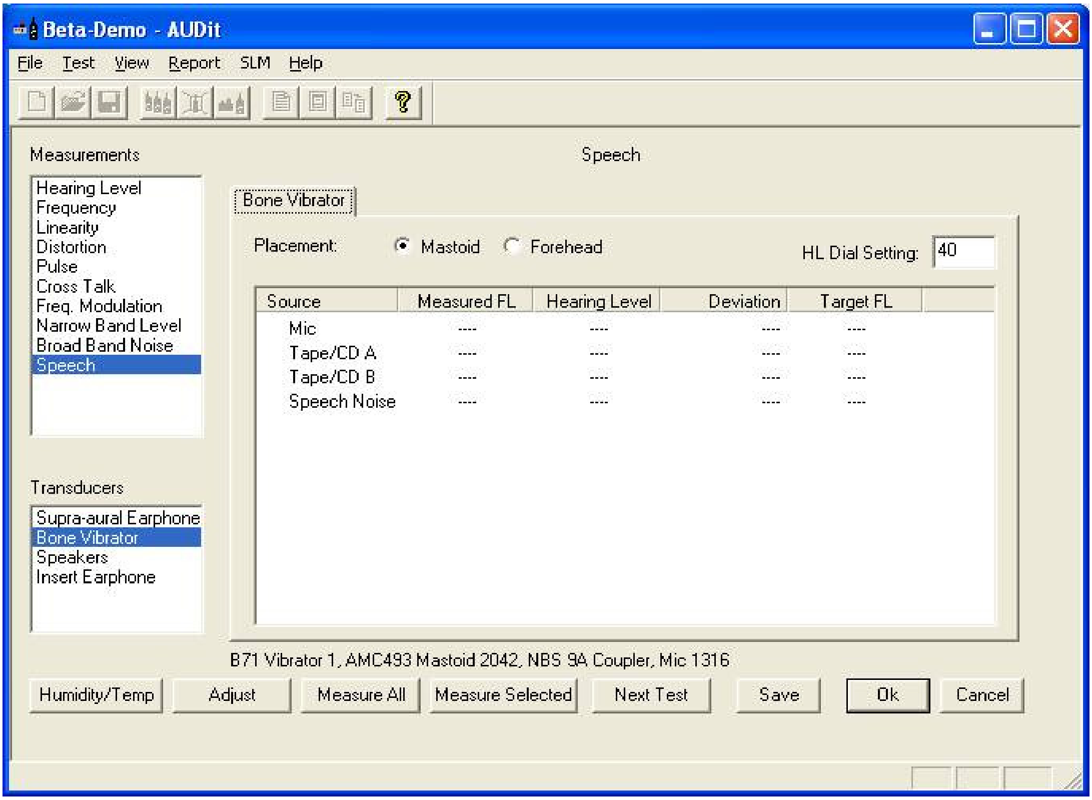


FIGURE 15-6 Bone Vibrator Test Screen

To perform a test of the bone vibrator transducer, highlight the ***Bone Vibrator*** transducer list item. The default output level is present at the upper right hand side. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

Press **Measure All** to perform all speech tests on the bone vibrator. If you are using a Larson Davis Mastoid, you will be prompted to enter temperature and humidity values used within the software for artificial mastoid corrections (FIGURE 15-7).

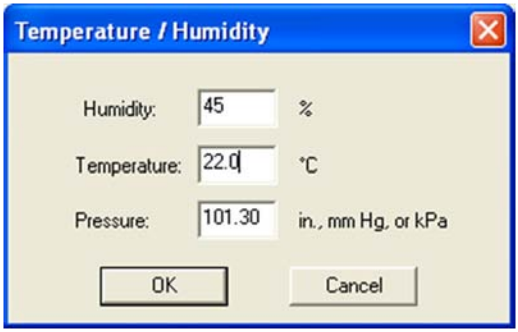


FIGURE 15-7 Temperature and Humidity Entry Box

Hint: *(degrees C = (degrees F - 32) x 5 / 9).*

Speech Test with Speakers

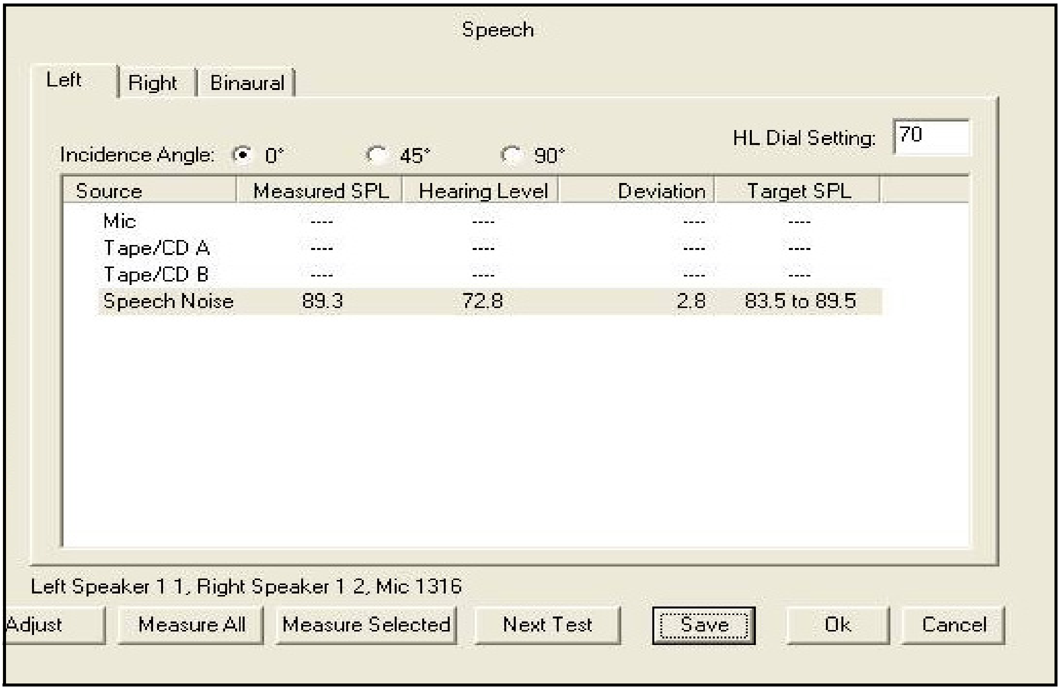


FIGURE 15-8 Speaker Test Screen

Sound field audiometric testing using speakers may be performed in a variety of ways. In table 9, ANSI S3.6-2004 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening in sound field for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit to translate the measured sound pressure levels to hearing level. Note that the prescriptions in Section 9.5.1 of the standard for sound field characteristics should be followed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise booth test in AUDit is helpful in making this determination.

To perform a test using speakers, highlight the ***Speakers*** transducer list item. left, right or both (binaural). In this example, the Left tab is selected. An incidence angle of 0, 45 or 90 degrees must be chosen so that the appropriate RETSPL correction is applied. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The Right tab operates in exactly the same manner. The Binaural tab has only one incidence angle selection, zero degrees.

Click **Measure All** to perform all speech tests on the selected speaker(s). They are similar to the earphone speech tests. An unsatisfactory reading is indicated by a large red X, with values within parentheses.

CHAPTER

16

Audiometer Test Notes

Before and during the calibration of an audiometer, a visual inspection of its components and control is necessary. AUDit's Audiometer Test Notes screen (FIGURE 16-1) affords a simple way to annotate the test report with comments and the condition of components or controls.

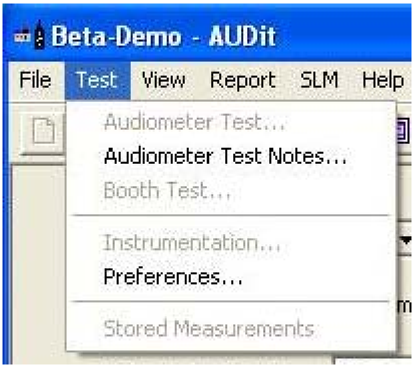


FIGURE 16-1 Audiometer Test Notes Menu Item

The Audiometer Test Notes screen is accessed from the main menu by pressing the Test, ***Audiometer Test Notes...*** selection.

Audiometer Test Notes Screen

This screen has two tabs, ***Visual Check*** and ***Comments***. A thorough visual and functional inspection of the audiometer and its accessories can be conducted with the help of the checklist in the first tab (FIGURE 16-2).

Visual Check Tab

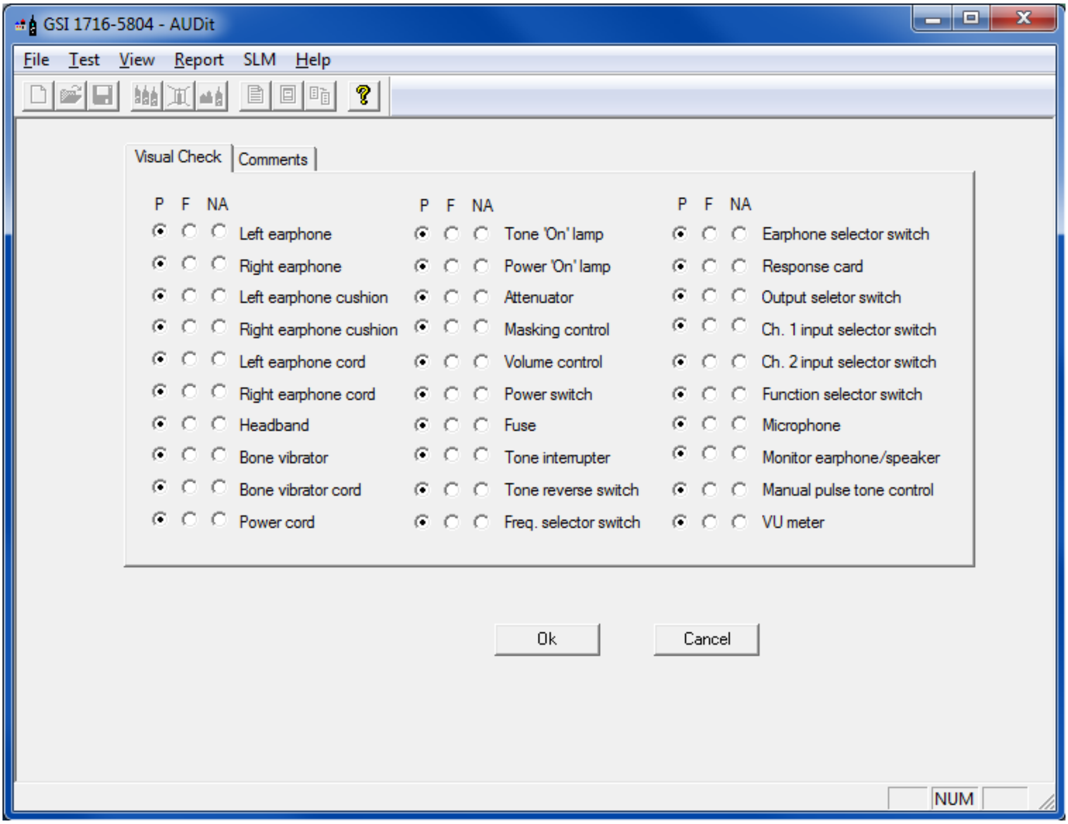


FIGURE 16-2 Audiometer Test Notes Visual Check Tab

This tab enumerates many components, accessories and controls of the audiometer. Some list items have properties which are governed by specifications in the ANSI S3.6-2004 standard. Any non-conforming or defective item should be checked by clicking the applicable radio button to the left of the item. These items will appear in the test report and will be stored in the database.

Comments Tab

The second tab allows the calibration technician to note any particularities of the tested system. These comments also will appear in the test report and will be stored in the database.

CHAPTER

17

Reports and Data Base Functions

AUDit incorporates a number of features which help maintain a record of audiometer calibrations. Tests performed can be printed immediately or stored for future hard copy. Results may be kept in an indexed database with comprehensive search capabilities, or exported to your external application in formatted output. This chapter will further describe these functions of the AUDit software.

Printing Reports

The Report menu can only be accessed from the ***Measurement Summary*** *page.*

Both audiometer calibrations and Booth measurements can be printed. An audiometer test can be printed in its entirety or only a subset of the measurements can be output.

To begin printing, a recent or recalled test must be active on the AUDit main screen. To recall a previous test, follow the procedures outlined later in this chapter. Once an AUDit test is active, click on ***Report, Report...*** on the main menu (FIGURE 17-1).

FIGURE 17-1 Main Menu Report Pull Down Menu

If the active measurement is an audiometer measurement, the dialog box shown in FIGURE 17-2 will appear.

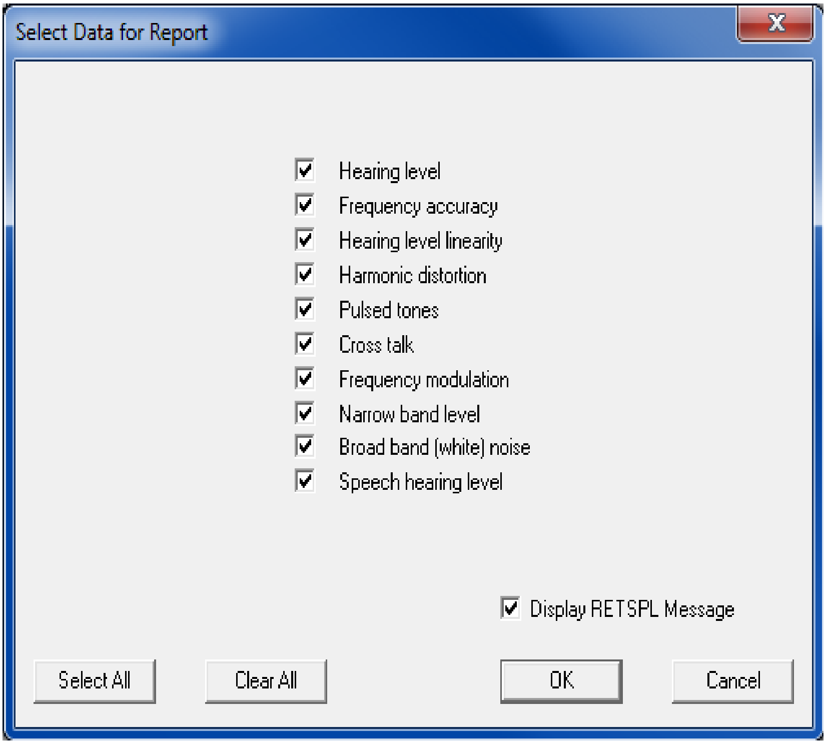


FIGURE 17-2 Measurement Report Select Box

*The **Display RETSPL Message** option does not display the message if only standard RETSPL is being used. Otherwise, if the option is checked the message "Includes non-standard RETSPL" will appear on the first page of the report.*

Click on the desired subset of measurements. Cl;ick the **Select All** button to enable printout of all test data, or the **Clear All** button to disable all tests. Clicking **OK** accepts the currently enabled selections and clicking **Cancel** aborts the report.

Once you have selected **OK**, the report preview screen displays the selected data approximately as it will appear on the printed page (FIGURE 17-3). The paper size and orientation are those selected in ***File, Printer Setup...***

Audiometer Calibration: Welch Allyn GSI 1761 (S/N 0919)

PCB Piezotronics, Larson Davis Division
1681 West 820 North
Provo, UT 84601

Calibration Date: 2011-09-08
Technician: AEC201 AMC493B 5417 Electret
Customer: Larson Davis
Bench
Provo, UT

Audiometer					
	Manufacturer:	Welch Allyn			
	Model Number:	GSI 1761		**Type:**	1
	Serial Number:	0919		**Inventory #:**	002139
	Number of Channels:	1		**Channel Tested:**	1
Earphones		**Supra-aural**	**Insert**		**Circumaural**
	Manufacturer:	Telephonics	EARtone		Sennheiser
	Model Number:	TDH 50/49	3A		HDA200
	Right S/N:	1	1		1
	Left S/N:	2	2		2
Bone Vibrator					
	Manufacturer:	Radio Ear			
	Model Number:	B71			
	Serial Number:	9999			
Speakers		**Left**	**Right**		
	Manufacturer:	Bose	Bose		
	Model Number:	1	1		
	Serial Number:	23	34		

Instrumentation	**Manufacturer**	**Model**	**Serial Number**	**Cal Due**
Sound Level Meter	Larson-Davis	824	2431	2012-10-31
Preamp	Larson-Davis	PRM902	1234	2012-10-28
Calibrator	Larson Davis	CAL250	1234	2012-11-31
Mastoid	Larson Davis	AMC493B	5417	2012-10-29
Open Air Mic	Larson-Davis	2575	1316	2009-04-13
AEC101 Mic	Larson-Davis	2559	3157	2012-01-01
AEC100 Mic	Larson-Davis	2575	1316	2012-01-01
AEC104 Mic	Larson-Davis	377A13	118894	2010-11-18
AEC102 Mic	Larson-Davis	2559	3157	2012-01-01
AEC103 Mic	Larson-Davis	2559	3157	2012-01-01

Test Name	Supra-aural Earphones	Bone Vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	Pass	Pass	-	-	-
Frequency	Pass	NA	NA	-	-
Linearity	Pass	NA	NA	-	-
Harmonic Distortion	Pass	-	NA	-	-
Pulse	**FAIL**	NA	NA	-	-
Cross Talk	Pass	NA	NA	-	-
Frequency Modulation	Pass	NA	NA	-	-
Narrow Band Level	Pass	NA	-	-	-
Broad Band Noise	**FAIL**	NA	NA	-	-
Speech	Pass	-	-	-	NA

FIGURE 17-3 Print Preview Screen

Note that the cursor now has the shape of a small magnifying glass, and may be used to zoom in on portions of the page.

Printing a Certificate

It is often desirable to provide a customer with a single page certificate after performing an audiometer calibration or booth test service. AUDit features certificate printing, including a custom header and a paragraph which can be used for standard or test specific text. The certificate includes the date on which the test was performed as well as the **Issued Date**.

FIGURE 17-4 shows the buttons for viewing and printing certificates.

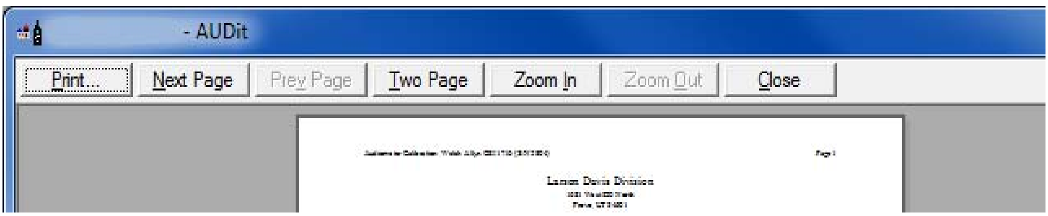


FIGURE 17-4 Print Certificate

To print a certificate, ensure a new or recalled test is active, then select **Report, Certificate...** on the main menu bar (FIGURE 17-6).

FIGURE 17-5 Main Menu, Certificate Pull Down Menu item

Certification Paragraph

The certification paragraph is a small unformatted text file which may contain any text you wish to have appear on the certificate. The Certification Paragraph dialog box allows the retrieval and modification of a previously saved paragraph as well as the creation of a new paragraph. In the example in FIGURE 17-6, the paragraph includes the calibration entity name and text referring to the standard. Other comments may be included, such as calibration status of the equipment used to calibrate the audiometer.

FIGURE 17-6 shows the **Certificate Paragraph** dialog box, with options for including borders, including the date of signature, and displaying the message "Includes non-standard RETSPL" when not using standard RETSPL.

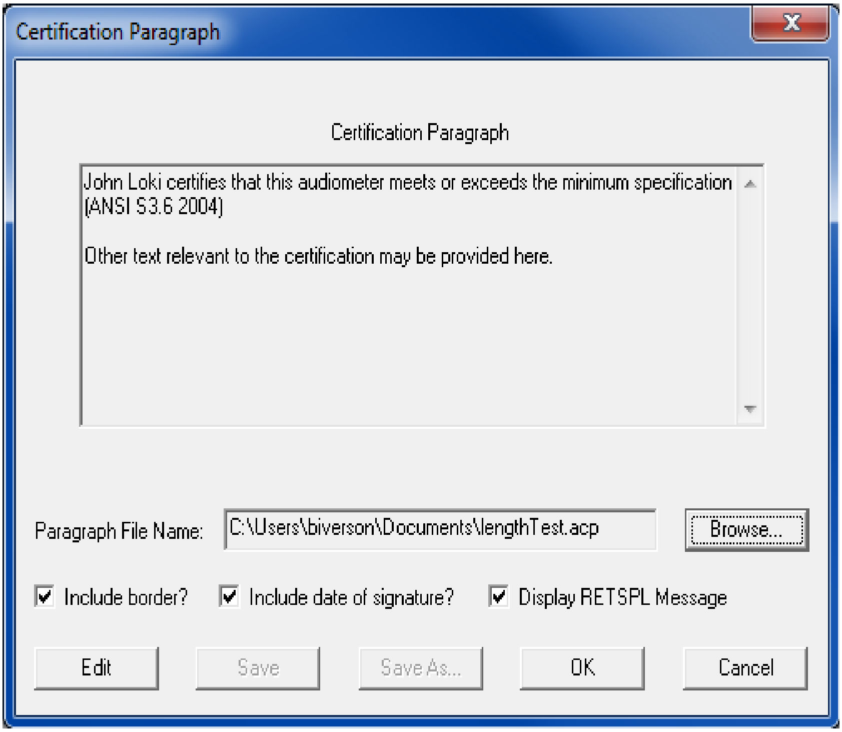


FIGURE 17-6 Certification Paragraph Dialog Box

Creating or Editing a Certification Paragraph

To create a new certification paragraph or edit the current paragraph, click on Edit.

Once you are done editing, save the paragraph under the same name by clicking on **Save**, or change the file name or location by clicking on **Save As....** Certification paragraphs can only be stored with the.acp extension. Press **OK** to accept and exit to the Certificate Preview Screen.

Browsing for a Certification Paragraph

To find a previously saved paragraph, click on the **Browse...** key.

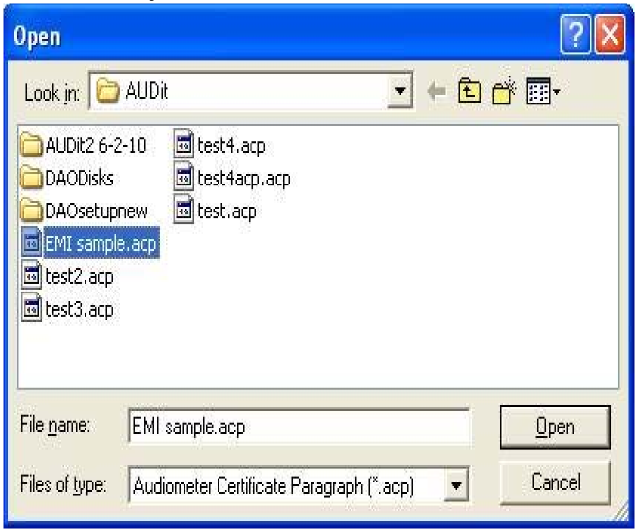


FIGURE 17-7 Search for Certification Dialog Browse Box

The selected paragraph will now be displayed in the Edit rectangle.

Certificate Preview Screen

After creating, recalling or editing a certification paragraph, selecting **OK** will display the certificate preview.

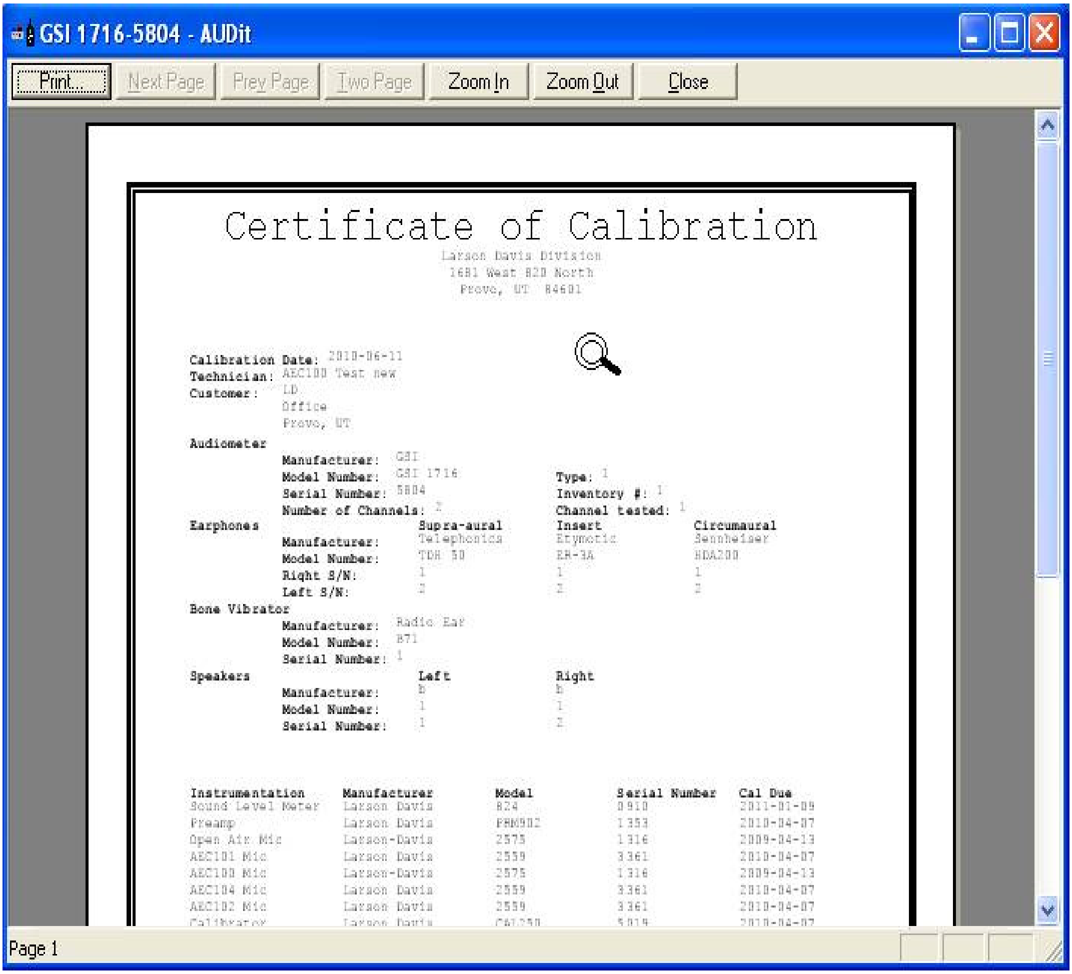


FIGURE 17-8 Certificate Paragraph Print Preview

Exporting Data

Audiometer and booth test data are maintained in a database by AUDit. You may wish to export the results of a certain test to another application for further manipulation. This is possible with the Export function. To export test data, ensure a new or recalled test is active, then select ***Report, Export...*** on the main menu bar (FIGURE 17-9).

FIGURE 17-9 Export Data Main Menu Pull Down Menu

As an example, an audiometer test file may be exported to .csv format and then formatted with Microsoft Excel® to add graphs and tables for greater impact.

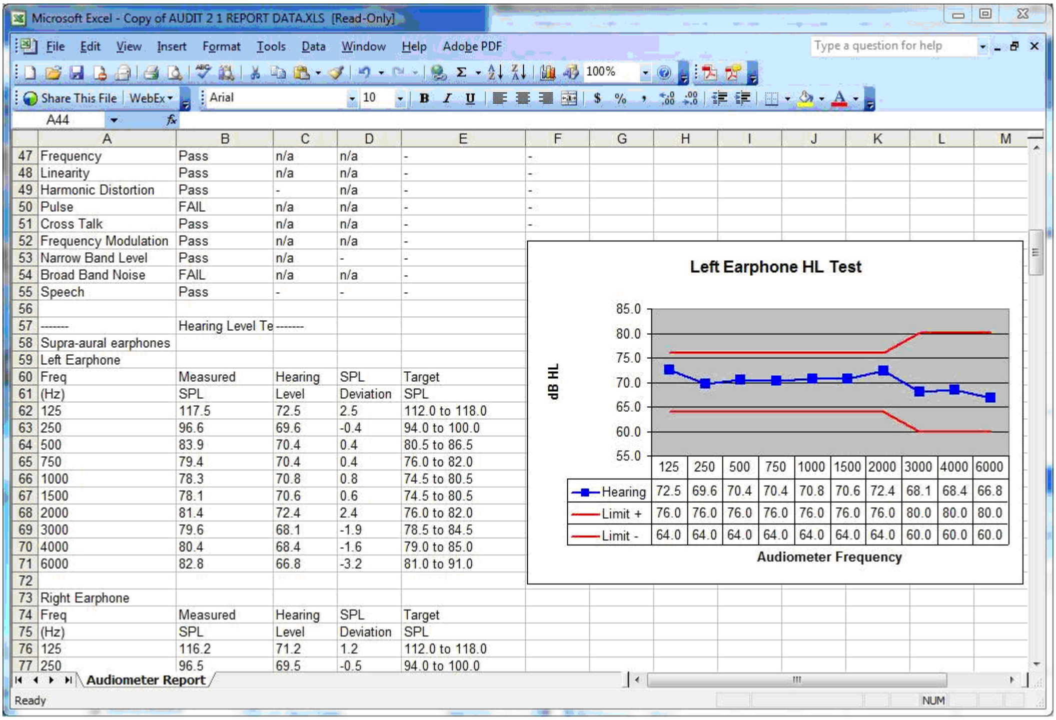


FIGURE 17-10 Data File Exported into Microsoft Excel™

Stored Measurements Database Functions

The Larson Davis audiometer calibration system software maintains all tests, audiometer and booth, in a database which is compatible with database software. This section will illustrate the use of the database to retrieve booth and audiometer measurements.

To recall a stored measurement, click on the ***Test, Stored Measurements*** item on the main menu bar (FIGURE 17-11).

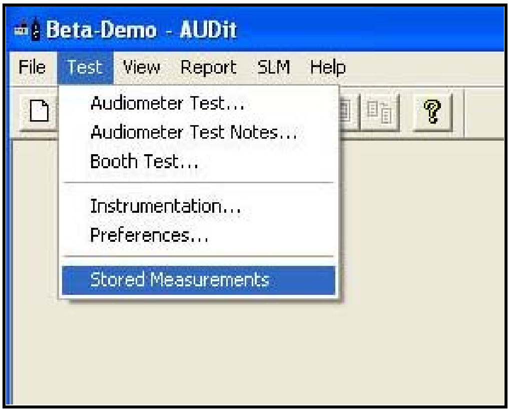


FIGURE 17-11 Test Pull Down Menu, Stored Measurements items

Audiometer Measurements

The audiometer measurements available in the current AUDit database can be searched with the dialog box shown in FIGURE 17-12.

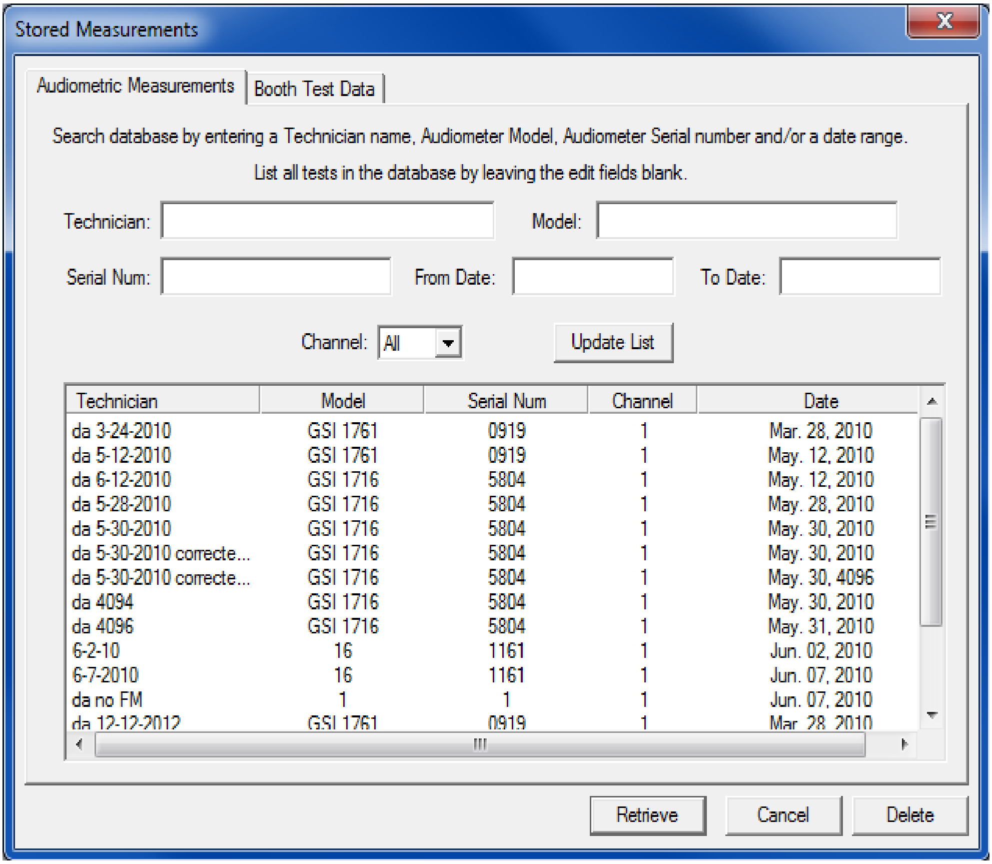


FIGURE 17-12 Search Database Dialog Box

Entry fields for technician, audiometer model, serial number, calibration from/to date and channel number can be used to search for the proper test. When all fields are left blank, all tests in the current database are displayed. To find a certain test, enter a search criterion in a field. Alphabetical characters are not case sensitive in the search, but otherwise search entries must be spelled exactly as they appear in the test. Spaces before or after an entry are disregarded. Dates may be entered in the following formats: "Apr. 20, 2010" or "04/20/10". The ***To Date*** must be equal to or later than the ***From Date***.

Click on **Update List** to display the search results. In the example above, entering da 5-28-2010 into the Technician field will display the fourth test on the list. Retrieve the test by highlighting it and then clicking on **Retrieve** at the bottom of the dialog box. Delete the highlighted test by clicking on **Delete**. Deleted tests cannot be recalled.

Booth Test Data

The booth measurements available in the current AUDit database can be searched with the dialog box shown in FIGURE 17-13.

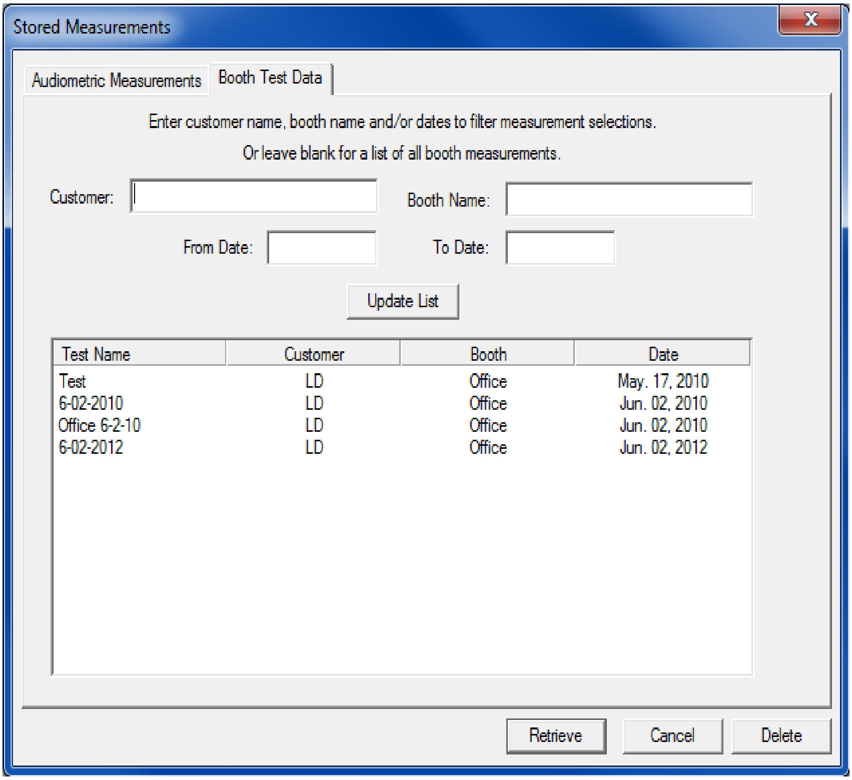


FIGURE 17-13 Search Booth Measurements Dialog Box

Entry fields for customer, booth name, calibration from/to date and channel number can be used to search for the proper test. When all fields are left blank, all tests in the current database are displayed. To find a certain test, enter a search criterion in a field. Alphabetical characters are not case sensitive in the search, but otherwise search entries must be spelled exactly as they appear in the test. Spaces before or after an entry are disregarded. Dates may be entered in the following formats: "Apr. 20, 2010" or "04/20/10". The ***To Date*** must be equal to or later than the ***From Date***.

Click on **Update List** to display the search results. Retrieve the test by highlighting it and then clicking on **Retrieve** at the bottom of the dialog box. Delete the highlighted test by clicking on **Delete**. Deleted tests cannot be recalled.

APPENDIX

A Glossary

This appendix contains technical definitions of key acoustical and vibration terms commonly used with Larson Davis instruments. The reader is referred to American National Standards Institute document S1.1-1994 for additional definitions. Specific use of the terms defined are in the main body of the text.

Average Sound Level (L_{avg})

It is the logarithmic average of the sound during a Measurement Duration (specific time period), using the chosen Exchange Rate Factor. Exposure to this sound level over the period would result in the same noise dose and the actual (unsteady) sound levels. If the Measurement Duration is the same as the Criterion Duration, then $L_{avg}=L_{TWA(LC)}$

$$L_{avg} = qLog_{10}\left(\frac{1}{T}\int_{T_1}^{T_2} 10^{(L_p(t))/q}dt\right)$$

where the Measurement Duration (specified time period) is $T=T_2-T_1$ and q is the Exchange Rate Factor. Only sound levels above the Threshold Level are included in the integral. *Standard*: ANSI S12.19

Calibration

Adjustment of a sound or vibration measurement system so that it agrees with a reference sound or vibration source. It should be done before each set of measurements.

Decibel (dB)

A logarithmic form of any measured physical quantity, typically used in sound and vibration measurements. Whenever the word *level* is used it implies this logarithmic form. The relationship is relatively simple, but the mathematics can become complex. It is widely used and was developed so that the very wide range of any quantity could be represented more simply. It is not possible to directly add or subtract physical quantities when expressed in decibel form. The word level is always attached to a physical quantity when it is expressed in decibels; for example L_p represents the sound pressure level. The table below shows the actual value of a specific item, such as sound pressure, for which the level is to be determined. First the value is put into exponential form in powers of ten; the exponent is the Bel. The exponent is then multiplied by ten to yield the decibel. This procedure converts multiplication into addition; every time 10 is *added* to the level, the value is *multiplied* by 10. When the value is not a even multiple of ten the exponent is more complicated as shown in the table. Every time the level increases by 3 dB, the value is multiplied approximately by 2 (doubled). These two rules are worth remembering.

Linear form		Level form
Ration of Value to Reference	Exponential Form of Ratio	10•Exponent
1	10^0	0
10	10^1	10
100	10^2	20
200	$10^{2.3}$	23
1000	10^3	30
10000	10^4	40
100000	10^5	50
1000000	10^6	60

The definition of decibel is intended for power-like quantities (W). Sometimes power is represented by the square of a measured quantity and this results in a different form of the equation (See Sound Pressure Level).

$$L = 10Log_{10}\left[\frac{W}{W_0}\right] \qquad W = W_0 10^{L/10}$$

The value of the item in the table is not the value of the quantity itself but the ratio of that quantity to a reference quantity. So for every level in decibels there must be a reference quantity. When the quantity equals the reference quantity the level is zero. To keep the values above zero, the reference is generally set to be the lowest value of the quantity.

Detector

The part of a sound level meter that converts the actual fluctuating sound or vibration signal from the microphone to one that indicates its amplitude. It first squares the signal, then averages it in accordance with the time-weighting characteristic, and then takes the square root. This results in an amplitude described as rms (root-mean-square).

Energy Equivalent Sound Level (L_{eq})

The level of a constant sound over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period.

$$L_{eq} = 10Log_{10}\left[\frac{\int_{T_1}^{T_2} p^2(t)dt}{p_o^2 T}\right]$$

where p is the sound pressure and the Measurement Duration (specific time period) $T = T_2 - T_1$. See Sound Exposure Level.

Far Field

There are two types of far fields: the *acoustic* far field and the *geometric* far field.

Acoustic Far Field: The distance from a source of sound is greater than an acoustic wavelength. In the far field, the effect of the type of sound source is negligible. Since the wavelength varies with frequency (See the definition of Wavelength), the distance will vary with frequency. To be in the far field for all frequencies measured, the lowest frequency should be chosen for determining the distance. For example, if the lowest frequency is 20 Hz, the wavelength at normal temperatures is near 56 ft. (17 m); at 1000 Hz, the wavelength is near 1.1 ft. (1/3 m). See the definition of Acoustic Near Field for the advantages of being in the acoustic far field.

Geometric Far Field: The distance from a source of sound is greater than the largest dimension of the sound source. In the far field, the effect of source geometry is negligible. Sound sources often have a variety of specific sources within them, such as exhaust and intake noise. When in the far field, the sources have all merged into one, so that measurements made even further away will be no different. See the definition of Geometric Near Field for the advantages of being in the geometric far field.

Free Field

A sound field that is *free* of reflections. This does not mean that the sound is all coming from one direction as is often assumed, since the source of sound may be spatially extensive. See the definitions of near and far fields for more detail. This definition is often used in conjunction with reverberant field.

Frequency (Hz, rad/sec)

The rate at which an oscillating signal completes a complete cycle by returning to the original value. It can be expressed in cycles per second and the value has the unit symbol Hz (Hertz) added and the letter f is used for a universal descriptor. It can also be expressed in radians per second, which has no symbol, and the greek letter ω is used for a universal descriptor. The two expressions are related through the expression $\omega=2*\pi*f$.

Frequency Band Pass Filter

The part of certain sound level meters that divides the frequency spectrum on the sound or vibration into a part that is unchanged and a part that is filtered out. It can be composed of one or more of the following types:

Low Pass: A frequency filter that permits signals to pass through that have frequencies below a certain fixed frequency, called a *cutoff frequency.* It is used to discriminate against higher frequencies.

High Pass: A frequency filter that permits signals to pass through that have frequencies above a certain fixed frequency, called a *cutoff frequency.* It is used to discriminate against lower frequencies.

Bandpass: A frequency filter that permits signals to pass through that have frequencies above a certain fixed frequency, called a lower cutoff frequency, and below a certain fixed frequency, called an *upper cutoff frequency.* The difference between the two cutoff frequencies is called the *bandwidth*. It is used to discriminate against both lower and higher frequencies so it passes only a band of frequencies.

Octave band: A bandpass frequency filter that permits signals to pass through that have a bandwidth based on octaves. An *octave* is a doubling of frequency so the upper cutoff frequency is twice the lower cutoff frequency. This filter is often further subdivided in 1/3 and 1/12 octaves (3 and 12 bands per octave) for finer frequency resolution. Instruments with these filters have a sufficient number of them to cover the usual range of frequencies encountered in sound and vibration measurements.The frequency chosen to describe the band is that of the center frequency. Note table in Frequency Filter - Frequency Weighting.

Frequency Filter - Weighted

A special frequency filter that adjusts the amplitude of all parts of the frequency spectrum of the sound or vibration unlike band pass filters. It can be composed of one or more of the following types:

A-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to low levels of sound. This weighting is most often used for evaluation of environmental sounds. See table below.
B-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to higher levels of sound. This weighting is seldom used. See table below.
C-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to high levels of sound. This weighting is most often used for evaluation of equipment sounds. See table below.
Flat-Weighting: A filter that does not adjust the levels of a

frequency spectrum. It is usually an alternative selection for the frequency-weighting selection.

Center Frequencies, Hz		Weighting Network Frequency Response		
1/3 Octave	1 Octave	A	B	C
20		-50.4	-24.2	-6.2
25		-44.7	-20.4	-4.4
31.5	31.5	-39.4	-17.1	-3.0
40		-34.6	-14.2	-2.0
50		-30.2	-11.6	-1.3
63	63	-26.2	-9.3	-0.8
80		-22.5	-7.4	-0.5
100		-19.1	-5.6	-0.3
125	125	-16.1	-4.2	-0.2
160		-13.4	-3.0	-0.1
200		-10.9	-2.0	0
250	250	-8.6	-1.3	0
315		-6.6	-0.8	0
400		-4.8	-0.5	0
500	500	-3.2	-0.3	0
630		-1.9	-0.1	0
800		-0.8	0	0
1000	1000	0	0	0
1250		0.6	0	0
1600		1.0	0	-0.1
2000	2000	1.2	-0.1	-0.2
2500		1.3	-0.2	-0.3
3150		1.2	-0.4	-0.5
4000	4000	1.0	-0.7	-0.8
5000		0.5	-1.2	-1.3
6300		-0.1	-1.9	-2.0
8000	8000	-1.1	-2.9	-3.0
10000		-2.5	-4.3	-4.4
12500		-4.3	-6.1	-6.2
16000	16000	-6.6	-8.4	-8.5
20000		-9.3	-11.1	-11.2

L_{eq}

See “Energy Equivalent Sound Level”, “Sound Level”, Energy Average”, and “Time Weighted Average”

Level (dB)

A descriptor of a measured physical quantity, typically used in sound and vibration measurements. It is attached to the name of the physical quantity to denote that it is a logarithmic measure of the quantity and not the quantity itself. The word *decibel* is often added after the number to express the same thing. When frequency weighting is used the annotation is often expressed as dB(A) or dB(B).

Measurement Duration (T)

The time period of measurement. It applies to hearing damage risk and is generally expressed in hours.
Standard: ANSI S12.19

Microphone Guidelines

Microphone - Types: A device for detecting the presence of sound. Most often it converts the changing pressure associated with sound into an electrical voltage that duplicates the changes. It can be composed of one of the following types:

Capacitor (Condenser): A microphone that uses the motion of a thin diaphragm caused by the sound to change the capacitance of an electrical circuit and thereby to create a signal. For high sensitivity, this device has a voltage applied across the diaphragm from an internal source.
Electret: A microphone that uses the motion of a thin diaphragm caused by the sound to change the capacitance of an electrical circuit and thereby to create a signal. The voltage across the diaphragm is caused by the charge embedded in the electret material so no internal source is needed.

Microphone - Uses: The frequency response of microphones can be adjusted to be used in specific applications. Among those used are:

Frontal incidence (Free Field): The microphone has been adjusted to have an essentially flat frequency response when in a space relatively free of reflections and when pointed at the source of the sound.
Random incidence: The microphone has been adjusted to have an essentially flat frequency response for sound waves impinging on the microphone from all directions.
Pressure: The microphone has not been adjusted to have an essentially flat frequency response for sound waves impinging on the microphone from all directions.

What a microphone measures: *A microphone detects more than just sound*. The motion of a microphone diaphragm is in response to a force acting on it. The force can be caused by a number of sources only one of which are we interested: sound. Non-sound forces are: (1) direct physical contact such as that with a finger or a raindrop; (2) those caused by the movement of air over the diaphragm such as environmental wind or blowing; (3) those caused by vibration of the microphone housing; and (4) those caused by strong electrostatic fields.

Rules:

1. Do not permit any solid or liquid to touch the microphone diaphragm. Keep a protective grid over the diaphragm.
2. Do not blow on a microphone and use a wind screen over the microphone to reduce the effect of wind noise.
3. Mount microphones so their body is not subject to vibration, particularly in direction at right angles to the plane of the diaphragm.
4. Keep microphones away from strong electrical fields.

A microphone measures forces not pressures. We would like the microphone to measure sound pressure (force per unit area) instead of sound force. If the pressure is applied uniformly over the microphone diaphragm a simple constant (the diaphragm area) relates the two, but if the pressure varies across the diaphragm the relationship is more complex. For example, if a negative pressure is applied on one-half the diaphragm and an equal positive pressure is applied to the other half, the net force is zero and essentially no motion of the diaphragm occurs. This occurs at high frequencies and for specific orientations of the microphone.

Rules:

1. Do not use a microphone at frequencies higher than specified by the manufacturer; to increase the frequency response choose smaller microphones.
2. Choose a microphone for *free field* or *random incidence* to minimize the influence of orientation.

A microphone influences the sound being measured. The microphone measures very small forces, low level sound can run about one-billionth of a PSI! Every measurement instrument changes the thing being measured, and for very small forces that effect can be significant. When sound impinges directly on a microphone the incident wave must be reflected since it cannot pass through the microphone. This results in the extra force required to reflect the sound and a microphone output that is higher than would exist if the microphone were not there. This is more important at high frequencies and when the microphone is facing the sound source.

Rules:

1. Do not use a microphone at frequencies higher than specified by the manufacturer; to increase the frequency response choose smaller microphones.

2. Choose a microphone for *free field* or *random incidence* to minimize the influence of orientation.

A microphone measures what is there from any direction: Most measurements are intended to measure the sound level of a specific source, but most microphones are not directional so they measure whatever is there, regardless of source.

Rules:

1. When making hand-held measurements, keep your body at right angles to the direction of the sound you are interested in and hold the meter as far from your body as possible. Use a tripod whenever possible.

2. Measure the influence of other sources by measuring the background sound level without the source of interest. You may have to correct for the background.

Near Field

There are two types of near fields: the *acoustic near field* and the *geometric near field*.

Acoustic Near Field: The distance from a source of sound is less than an acoustic wavelength. In the near field, the effect of the type of sound source is significant. Since the wavelength varies with frequency (See the definition of Wavelength), the distance will vary with frequency. The most common example of a near field is driving an automobile with an open window. As you move your ear to the plane of the window, the sound pressure level builds up rapidly (wind noise) since most of the pressure changes are to move the air and very little of it compresses the air to create sound. Persons not far way, can hardly hear what you hear. The acoustic near field is characterized by pressures that do not create sound that can be measured in the far field. Therefore measurements made here are not useful in predicting the sound levels far way or the sound power of the source.

Geometric Near Field: The distance from a source of sound is less than the largest dimension of the sound source. In the near field, effect of source geometry is significant. Sound sources often have a variety of specific sources within them, such as exhaust and intake noise. When in the near field, the sound of a weaker, but close, source can be louder than that of a more distant, but stronger, source. Therefore measurements made here can be used to separate the various sources of sound, but are not useful in predicting the sound levels and sound spectrum far from the source.

Noise

Typically it is *unwanted* sound. This word adds the response of humans to the physical phenomenon of sound. The descriptor should be used only when negative effects on people are known to occur. Unfortunately, this word is used also to describe sounds with no tonal content (random):

Ambient: The all encompassing sound at a given location caused by all sources of sound. It is generally random, but need not be.
Background: The all encompassing sound at a given location caused by all sources of sound, but excluding the source to be measured. It is essentially the sound that interferes with a measurement.
Pink: It is a random sound that maintains constant energy per octave. Pink light is similar to pink noise in that it has a higher level at the lower frequencies (red end of the spectrum).
White: It is a random sound that contains equal energy at each frequency. In this respect, it is similar to white light.

Sound

The rapid oscillatory compressional changes in a medium (solid, liquid or gas) that propagate to distant points. It is characterized by changes in density, pressure, motion, and temperature as well as other physical quantities. Not all rapid changes in the medium are sound (wind noise) since they do not propagate.
The auditory sensation evoked by the oscillatory changes.

Difference between sound and noise: Sound is the physical phenomenon associated with acoustic (small) pressure waves. Use of the word *sound* provides a neutral description of some acoustic event. Generally, noise is defined as unwanted sound. It can also be defined as sound that causes adverse effects on people such as hearing loss or annoyance. It can also be defined as the sound made by other people. In every case, noise involves the judgment of someone and puts noise in the realm of psychology not physics.
Rules:
1. Use word *sound* to describe measurements to remove the emotional overtones associated with the word *noise*. Some sound metrics use noise in their name and it is proper to use the name as it is.

Sound Pressure

The physical characteristic of sound that can be detected by microphones. Not all pressure signals detected by a microphone are sound (e.g., wind noise). It is the amplitude of the oscillating sound pressure and is measured in Pascals (Pa), Newtons per square meter, which is a metric equivalent of pounds per square inch. To measure sound, the oscillating pressure must be separated from the steady (barometric) pressure with a detector. The detector takes out the steady pressure so only the oscillating pressure remains. It then squares the pressure, takes the time average, and then takes the square root (this is called rms for root-mean square). There are several ways this can be done.

Moving Average: The averaging process is continually accepting new data so it is similar to an exponential moving average. The equation for it is

$$p_{rms} = \sqrt{\frac{1}{T}\int_{t_s}^{t} p^2(\xi)e^{-(t-\xi)/T}d\xi}$$

The sound pressure is squared and multiplied by a exponential decay factor so that when the time of integration is near the current time (t) it is essentially undiminished. For times older (less) than the current time, the value is diminished and so becomes less important. The rate at which older data are made less influential is expressed by the constant T. The larger is it the slower the decay factor reduces and the slower the response of the system to rapid changes. These are standardized into three values called Time Weighting. See the values below.

Fixed Average: The averaging process is over a fixed time period. The equation for it is

$$p_{rms} = \sqrt{\frac{1}{(T_2 - T_1)}\int_{T_1}^{T_2} p^2(t)dt}$$

The sound pressure is squared and averaged over a fixed time period. Unlike the moving average, the sound pressures in all time intervals are equally weighted.

Sound Pressure Level (SPL, L_p)

The logarithmic form of sound pressure. It is also expressed by attachment of the word decibel to the number. The logarithm is taken of the ratio of the actual sound pressure to a reference sound pressure which is 20 MicroPascals (μ Pa). There are various descriptors attached to this level depending on how the actual sound pressure is processed in the meter:

Instantaneous: The time varying reading on a meter face on in a meter output due to changes in the sound pressure. The reading will depend on the time-weighting applied.

The fundamental relationship between the two is logarithmic

$$L_p = 20\log_{10}\left[\frac{p_{rms}}{p_0}\right] \qquad p_{rms} = p_0 10^{L_p/20}$$

where p_0 is the reference sound pressure of 20 μPa. The square of the sound pressure is a power-like quantity that can be expressed in the original form of the level definition

$$L_p = 10\log_{10}\left[\frac{p_{rms}^2}{p_0^2}\right] \qquad p_{rms}^2 = p_0^2 10^{L_p/10}$$

Sound Pressure Level can be converted to sound pressure as follows. If the sound pressure is 1 Pascal, then the sound pressure level is

$$L_p = 20\log_{10}\left[\frac{1}{20 \bullet 10^{-6}}\right] = 20\log_{10}[50000] = 20[4.699] = 94.0dB$$

Calibrators often use a level of 94 dB so they generate a sound pressure of 1 Pascal.

If the sound pressure level = 76.3 dB, then the sound pressure is

$$Pa = 20 \bullet 10^{-6} \bullet 10^{76.3/20} = 20 \bullet 10^{3.815 - 6} = 20 \bullet 10^{-2.185} = 20[0.0065] = 0.13$$

Energy Average (L_{eq}): The value of a steady sound measured over a fixed time period that has the same sound energy as the actual time varying sound over the same period. This descriptor is widely used. It is a fixed average (See Sound Pressure).

Impulse: The value of an impulsive sound. The reading will depend on the time-weighting applied.

Unweighted Peak: The peak value of a sound with a meter that has flat frequency weighting and a peak detector.

Weighted Peak: The peak value of a sound with a meter that has a frequency weighting other than flat and a peak detector.

Sound Speed, (c,)

The speed at which sound waves propagate. It is measured in meters per second. It should not be confused with sound or particle velocity which relates to the physical motion of the medium itself.

$$c = 20.05\sqrt{\text{degC} + 273} \qquad \text{m/s}$$

$$c = 49.03\sqrt{\text{degF} + 460} \qquad \text{ft/sec}$$

Spectrum (Frequency Spectrum)

The amplitude of sound or vibration at various frequencies. It is given by a set of numbers that describe the amplitude at each frequency or band of frequencies. It is often prefixed with a descriptor that identifies it such as sound pressure spectrum. It is generally expressed as a spectrum level.

Time Weighting

The response speed of the detector in a sound level meter. There are several speeds used.

Slow: The time constant is 1 second (1000 ms). This is the slowest and is commonly used in environmental noise measurements.
Fast: The time constant is 1/8 second (125 ms). This is a less commonly used weighting but will detect changes in sound level more rapidly.
Impulse: The time constant is 35ms for the rise and 1.5 seconds (1500 ms) for the decay. The reason for the double constant is to allow the very short signal to be captured and displayed.

Vibration

The oscillatory movement of a mechanical system (generally taken to be solid). It is used as a broad descriptor of oscillations.

Wavelength (l)

The distance between peaks of a propagating wave with a well defined frequency. It is related to the frequency through the following equation

$$\lambda = \frac{c}{f}$$

where c is the sound speed and f is the frequency in Hz. It has the dimensions of length.

Wavenumber (k)

A number that is related to the wavelength of sound and is used to compare the size of objects relative to the wavelength or the time delay in sound propagation. It is related to wavelength through the following equation

$$k = \frac{2\pi}{\lambda} = \frac{2\pi f}{c} = \frac{\omega}{c}$$

where λ is the wavelength, c is the sound speed, f is the frequency in Hz, and ω is the radian frequency. It has the dimensions of inverse length.