FONIX® 6500-CX
HEARING AID TEST SYSTEM

COMPUTER CONTROLLED
REAL-TIME ANALYZER

OPERATOR'S MANUAL

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Software Versions 4.91 and higher

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Frye Electronics, Inc. conforms to ISO 13485, and the Medical Device Directive of the European Union of June 1993 (Annex II).

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Chapter 1: Introduction to the FONIX 6500-CX

1.1 A Little Boasting About the FONIX 6500-CX

The FONIX 6500-CX is the third major step in the development of the FONIX 6500 Hearing Aid Test System. The original model was the 6500, succeeded by the 6500-C, which in May of 1994 was replaced by the CX. Starting with serial number 2063, the 6500-CX has a new, fast printer and a new CPU board that can make up to 8 composite measurements a second.

In addition to the composite signal, the 6500-CX provides pure-tone signals for traditional tests. Options such as ANSI 87, ANSI 92, ANSI 96, Profiler, IEC, and JIS run entire sequences of tests automatically.

Provision is made for up to six individuals to set up the unit according to their own preferences. These settings can be saved in permanent memory and called up whenever you turn the unit on.

Here are some of the standard features of the FONIX 6500-CX:

- Interactive, real-time testing
- Color VGA video monitor
- Graphical and numerical displays
- Automatic saving of sound chamber leveling
- Composite and pure-tone testing
- Noise reduction by signal averaging
- Tests of harmonic distortion
- Built-in telecoil
- Built-in battery voltage supply
- Moveable cursor; and a relative feature that allows you to compare the data for any point on a curve to that of any other point
- Built-in thermal printer

In addition to the above, Frye Electronics has developed numerous other options for the FONIX 6500-CX. Most options are described in Chapter 7 of this manual.

A major option for the 6500-CX is QUIK-PROBE II, which makes real-ear measurement simple and fast. QUIK-PROBE II uses either pure-tones or our patented, real-time, speech-shaped composite signal found only on FONIX hearing aid analyzers. A remote module lets you operate from right next to the client. You can even have your real-ear measurement station in a separate room from the main electronics module. Chapter 8 of the manual has complete instructions for using the QUIK-PROBE II Option.

1.2 About This Manual

The FONIX 6500-CX is easy to use. You can't hurt the 6500-CX by pressing the wrong button, so go ahead...! You can begin testing right away by just following the help messages on the screen. But if you want detailed instructions, the manual contains all the information you need.

The FONIX 6500-CX Operator's Manual was designed to be read in a sequence progressing from front to back. When you come across something you already know or don't need at the moment, skip to the next section. There is also a separate "Quick Reference Guide" that gives abbreviated, step-by-step instructions for everyday tests.

Throughout this manual, as with the help messages you will see on the screen, specific punctuation is used to designate the buttons on the modules and the readings on the screen. Button names are in brackets: for example, [START], which indicates the Start Button. Words or messages on the screen are in caps: for example, AID GAIN 27.8 dB. Connectors and plugs are designated by the same words that are printed on the modules.

Frye Electronics has continued to develop new, upgradable hardware and software for the 6500-CX. This manual is based on software Version 4.70 (or higher) and on the 6050 Test Chamber. (Contact Frye Electronics for manuals for previous versions.) Any changes in operation made after the printing of this manual will be described in blue pages inserted into the manual. Your 6500-CX can always be upgraded as new software is introduced. To find out which version of software you have, turn the power off and then on again. The screen will show the software version number.

A glossary of terms appears at the end of the manual. Whenever you come across a term you don't understand, check the Glossary for the definition. If you have any other questions about operating your FONIX 6500-CX, please contact your sales representative or call us at (503) 620-2722 or (800) 547-8209.

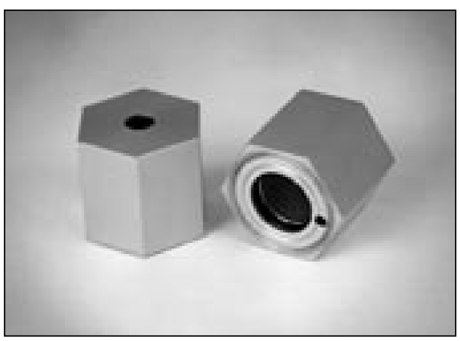
With the FONIX 6500-CX, you are equipped for the highest professional level of hearing aid testing. With the instructions in this manual and with the help messages on the video monitor, we are confident you will find it easy to operate the 6500-CX. In fact, it should be **fun!**

1.3 Accessories

Below are pictures and descriptions of the standard and optional accessories for the FONIX 6500-CX.

1.3.1 Standard Accessories

M1550E
14mm pressure-type electret instrumentation microphone.



HA-1 2-cc coupler
Dimensions per ANSI S3.7 for testing in-the-ear aids, canal aids, and aids fitted with earmolds.

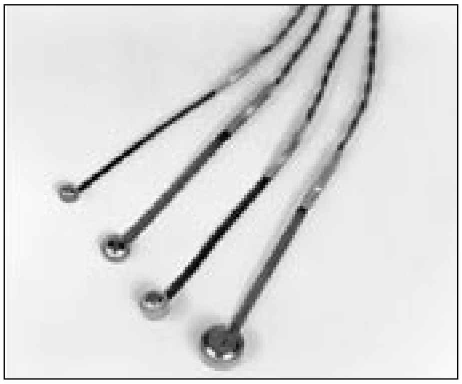
HA-2 2-cc coupler
Dimensions per ANSI S3.7 for testing behind-the-ear aids, eyeglass aids, and body aids.

Ear-Level Adapter (BTE)
Snaps into the 1/4" (6.35 mm) diameter cavity in the HA-2 coupler or the MZ-2 coupler. Equipped with a 0.6" (15 mm) length of 0.076" (1.93 mm) ID tubing, the adapter allows ANSI S3.22 specified connection of an ear-level aid to the coupler.

Microphone Adapter
14 mm to 1" (25.4 mm) adapter for coupling the M1550E and reference microphone to a 1-inch device such as a sound level calibrator.

Test Chamber Cable:
Connects the main module to the test chamber.

Phono Dummy Plug
For calibrating the built-in telecoil.



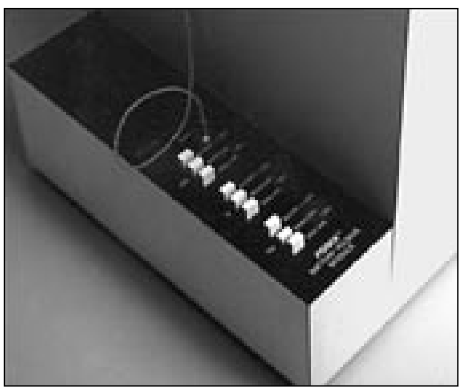
Battery Substitution Pills
Used with the built-in Battery Voltage Module to power hearing aids, measure battery drain, and estimate battery life. Sizes 675/76, 13, 312, and 10A/230 are standard; sizes; AA, 5, and 41 are also available.

Operator's Manual

Maintenance Manual (on request at time of purchase)

Quick Reference Guide

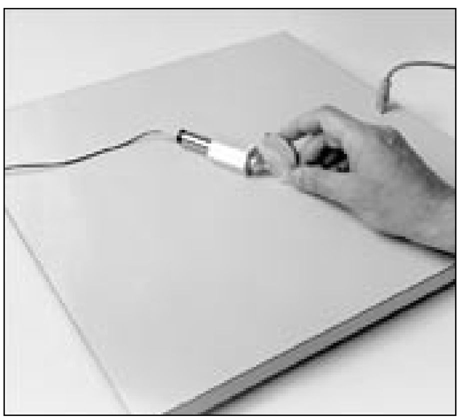
1.3.2 Optional Accessories



External Battery Voltage Module
(for units shipped before mid-December, 1988)
Simulates zinc-air, mercury, and silver batteries according to Appendix B of ANSI S3.22.

6-cc Coupler
Enables checking response of standard audiometer headphones. It is designed around the NBS 9A coupler specifications.

Test Chamber Stand
A secure, steel-tube stand that improves sound isolation and brings the testing area of the test chamber to convenient table height. Color matches the electronics module.

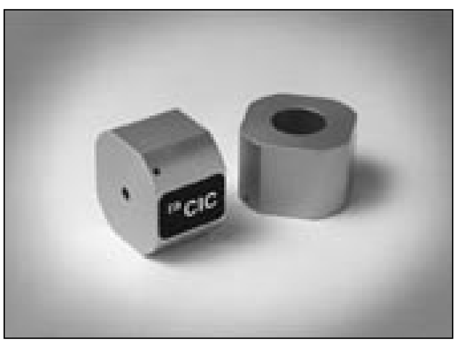


External Telecoil
Used for checking the response of aids in the "telephone" mode. Its color matches the test chamber. In some situations, a system is set up in such a way that the external board isolates the hearing aid from unwanted magnetic fields better than the built-in telecoil feature. The telecoil board is used in ANSI S3.22-1987.

Telewand
Provides a magnetic field that complies with the ANSI S3.22-1996 standard's requirements for shape and strength. The telewand is included with ANSI 96.

Quest QC-10 Sound Level Calibrator
A portable, self-contained, field-type calibrator for calibrating the microphone amplifier. It operates on one nine-volt transistor battery. Sound pressure level is 114 dB at 1000 Hz (±0.5 dB accuracy). Use with 14 mm-to-1" adapter. Calibration is traceable to the U.S. National Institute of Standards and Technology. Conforms to ANSI S1.40-1984 and IEC 942: 1988.

MZ Couplers
Left to right: the MZ-3, MZ-2, and MZ-1 couplers supplied with the OES, In-Situ, and JIS Options.



CIC Coupler
Non-standard coupler (0.4 cc) for testing CIC hearing aids; supplied with the CIC Option.

Quik-Probe II Option
Provides real-time, real-ear testing in speedy automatic, or flexible manual modes. A hand-held remote module controls all probe functions. Accessories include probe and reference microphones, monitor earphones, sound field speaker with choice of stands, wedge-style earhook, Velcro headband, ear hanger, foot switch, and cables. The color matches the 6500-CX electronics module.

Floor Stand Kit
One of the two ways you can mount the sound field speaker. (Specify when ordering.) The lightweight, but sturdy floor stand is adjustable in height and has a low-profile tri-pod base. The remote module shelf fits directly on the stand, providing a stable, convenient platform for operating and storing the remote module.

Swing Arm Kit
The second of two ways you can mount the sound field speaker. (Specify when ordering.) This convenient device can be mounted to a wall or a desk top. The four-piece arm swivels and extends to allow precise placement and aiming of the speaker. Spring tension and friction keep the speaker exactly where you put it.

Remote Operation Kits
For operating real-ear measurements from a separate room. Kits for the 6500-CX include a VGA video splitter (shown at left), a VGA video extension cable, a remote module extension cable, an audio/speaker cable and an extra VGA color monitor.

Wedge Style Ear Hooks
Hold probe and reference microphones in place at the ear during real-ear testing. Improved design eliminates need for Velcro headband.

Standard size (043-2043-00) included with the Quik-Probe II Option.

Children's size (043-0043-00) available as an optional accessory.

Infant/Child Headband Package
180-0017-00
With the infant headband, the weight of the probe and reference microphones is supported by the child's head rather than by the child's ear (via an ear hook). Includes infant, child, and adult headbands, six flexible earhooks, and two sets of "animal ears."

#5 Battery Pill
Provides battery current measurements for many CIC hearing aids that use the new, very small battery.

RECD Earphone Package
Consists of the Eartone 3S earphone, a 72" cable, Consists of one ER3A earphone with an 1/8 inch plug, a 72 inch cable, an assortment of ear tips, a calibration certificate, and a lapel clip. This package is suitable for performing an RECD measurement with the 6500-CX Test System.

External Printer Package
Enables the 6500-CX to print on inkjet or laser printers. See Chapter 9 for details. Consists of two connecting cables and a serial-to-parallel converter.

FM Kit
Facilitates coupler and real-ear tests of FM systems. The kit includes a telescoping floor stand with a test platform and plenty of extra Fun-Tak, a manual, and a 6 inch (15 cm) square foam pad for using the 2-cc coupler outside the test chamber.

1.4 Warranty

The FONIX 6500-CX and its accessories are guaranteed to be free of manufacturing defects which would prevent the products from meeting the specifications (given in Appendix C of this manual) for a period of one year from the date of purchase.

Chapter 2: Setup and Maintenance

2.1 Unpacking the FONIX 6500-CX

Remove the FONIX 6500-CX test system from the shipping cartons. Store the cartons in a dry place so that they can be used again in the event that the unit must be returned for updating or repair.

You should have received the following equipment and standard accessories:

- Main electronics module
- 6050 sound chamber
- Power cable for electronics module
- Sound chamber cable
- M1550E electret microphone
- Operator's manual
- Thermal paper
- Fun-Tak
- Dummy microphone
- 14 mm to 1 inch adapter
- HA-1 coupler
- HA-2 coupler
- Ear level adapter for use with HA-2 coupler
- Battery pills: #76, #13, #312, #10
- RCA male shielded plug
- Monitor stop package

Units purchased with Quik-Probe II for real-ear measurements:

- Remote Quik-Probe module with attached ten-foot cable
- Dual microphone cable with reference and probe microphones
- Package of probe tubes
- Wedge style adult earhook
- Child ear hook
- Velcro head band
- Monitor headset with 1/4" adapter plug

- Foot switch with cable
- 14-mm probe calibration adapter (Fig. 8.6.1-1)
- Probe calibration clip (Fig. 8.6.1-1)
- Sound field speaker
- Sound field speaker stand or wall/desk mount
- Sound field speaker cable with dual banana plug and mini-plug
- Red marker pen

Depending upon the options purchased, your unit may come with additional equipment and accessories.

2.2 Setup

Set up the instrument in a moderately quiet area, such as a private office or laboratory. Ambient noise, mechanical vibrations, electrical or magnetic fields must not affect the test results by more than 0.5 dB (ANSI S3.22-1987). Low-noise acoustic conditions, as found in sound treated rooms and booths, are ideal but not necessary.

Locate the electronics module near the sound chamber. A sound chamber stand (optional) brings the sound chamber to convenient table height. The video terminal may be placed on top of the electronics module, but if you are planning to use the built-in telecoil, some special consideration must be given to the relative placement of the test chamber and the video monitor.

The video monitor gives off its own magnetic field. This field is normal, but it may affect telecoil measurements if the monitor is too close to the test chamber. For accurate results across the entire frequency spectrum, it is best to separate the monitor from the test chamber as much as possible. (See Section 7.19.2 for details on setting up for telecoil operation. If necessary, you can use an external telecoil board, which is an available option.)

2.2.1 Basic Setup

Connect the electronics module to the other system components as follows (see Figure 2.2.1):

1. Connect the video monitor cable to the jack marked VIDEO MONITOR on the back of the 6500-CX. Tighten the screws on the cable plug to secure the connection. (Older, monochrome models, use the six foot patch cord with RCA phono plugs on each end to connect the video monitor to the 6500-CX.)

2. Plug the M1550E microphone into the connector marked INPUT, located in the upper right corner on the rear panel of the electronics module.

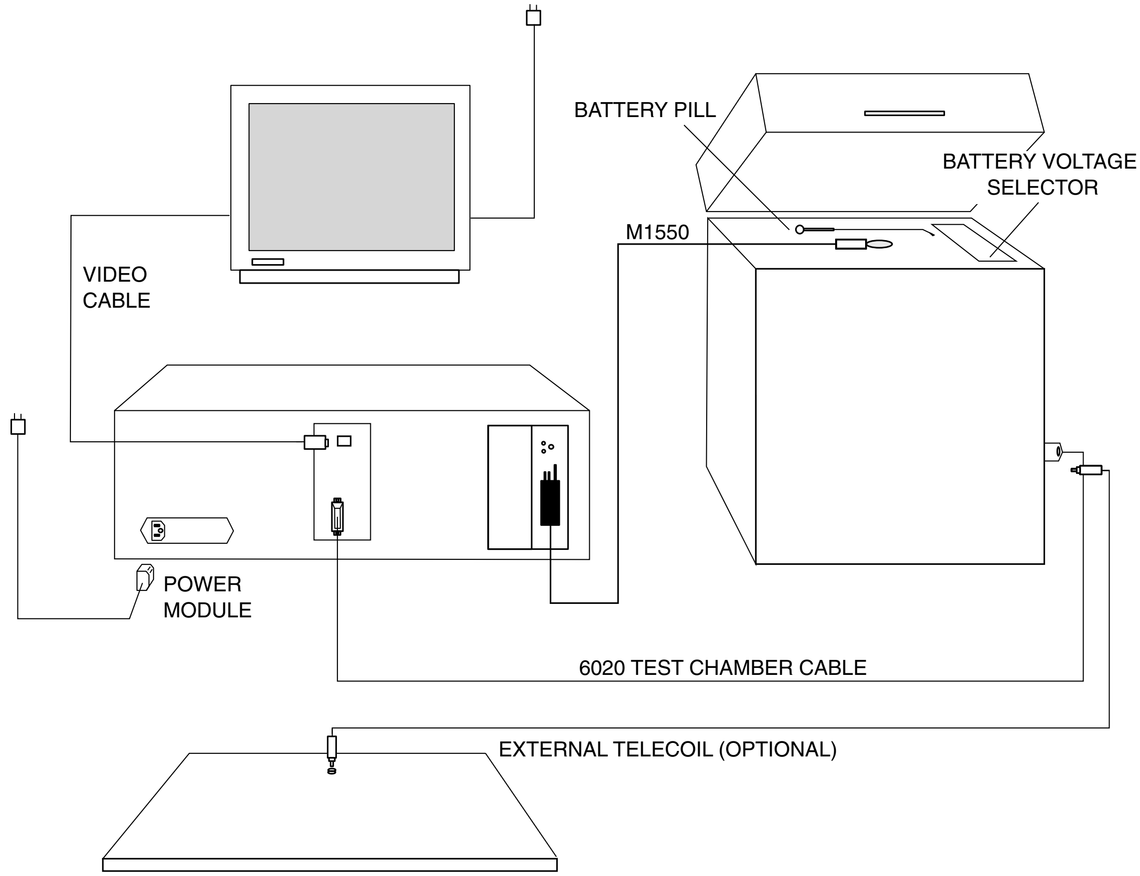


Figure 2.2.1—6500-CX system setup

3. Connect the electronics module to the sound chamber with the black, seven-foot (2.3 meter) cable. Tighten the screws on the plugs to secure the connections to the jacks at both ends of the cable.

4. Plug the power cord into the three pronged jack on the rear panel of the electronics module. Plug the power cord of both the electronics module and the video monitor into a 110 VAC, 50 to 60 Hz source. (Export units are set for 240 or 100 VAC, selectable on the rear panel. See the maintenance manual for instructions on changing the voltage.)

5. Since both the electronics module and the video monitor require power, it may be convenient for you to purchase a switchable multiple outlet strip for turning the whole system on or off with one switch. Plus, these outlet strips power both the modules from a common power source, which can help improve operation of the instrument.

2.2.2 Quik-Probe II Option Setup

If you have purchased the Quik-Probe II Option for real-ear measurements, follow these instructions.

Choose a measuring location that is as far as possible from walls or other large, hard, acoustically reflective surfaces. If necessary, remove unnecessary reflective items which could interfere with measurements. Refer to Figure 2.2.2 for a diagram of the setup.

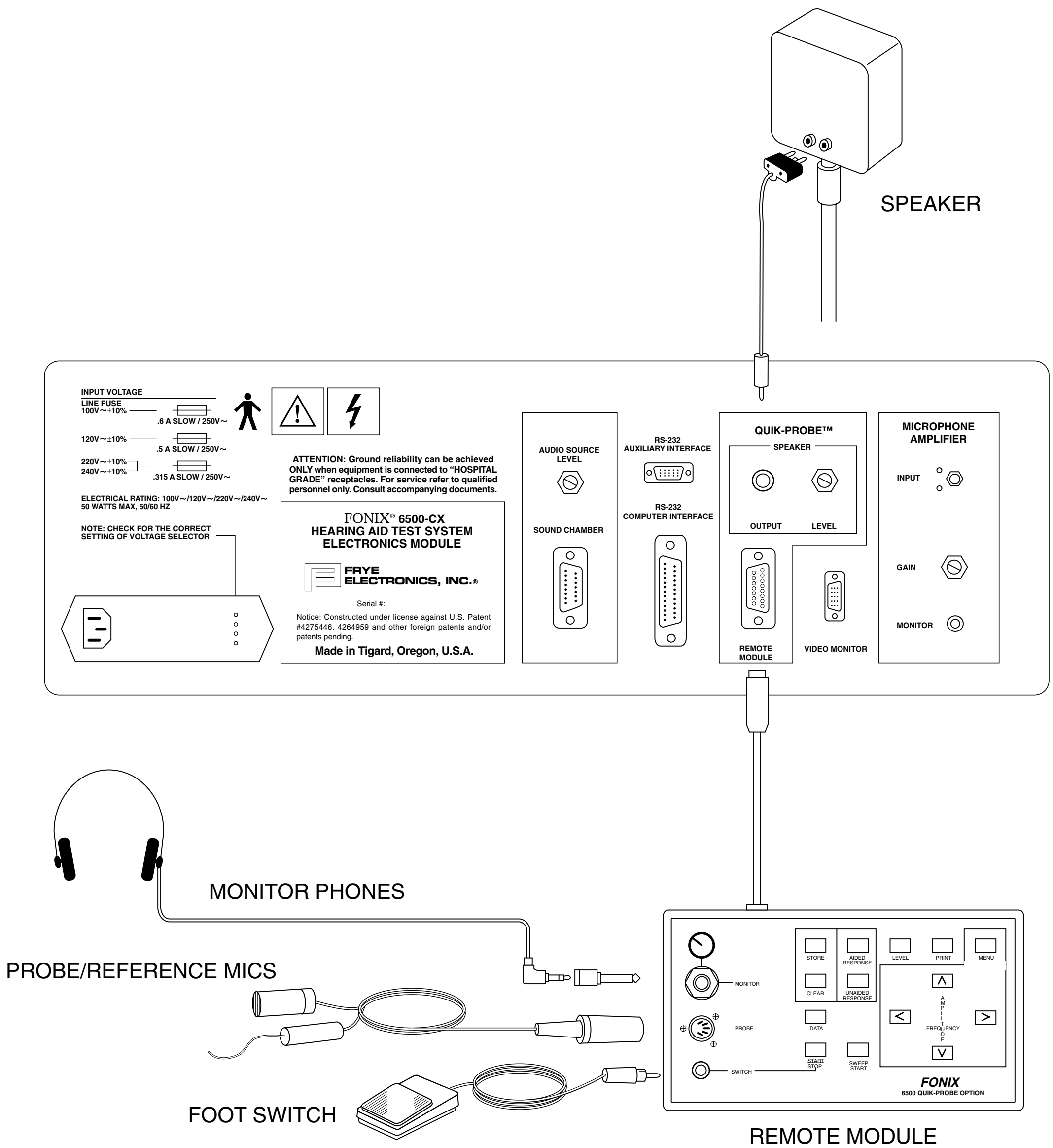


Figure 2.2.2—Quik-Probe II Option setup

Assembly:

1. Plug the remote module cable into the jack labeled REMOTE MODULE, in the back of the main electronics module. Tighten the connector screws to secure the connection.

2. Plug the round, 5-pin connector of the dual microphone cable into the top surface of the remote module, where it is marked PROBE.

3. If desired, plug the monitor headset into the remote module by attaching the 1/4" adapter and plugging it into the jack marked MONITOR.

4. Plug the foot switch cable into the jack on the remote module marked SWITCH. Locate the foot switch in a convenient position on the floor.

5. Depending on whether you have a floor stand or a swivel arm, either: 1] Unfold and extend the floor stand to the desired height, about the level of a seated client's ear; or 2] Mount the wall/desk bracket of the swivel arm in a convenient location. Attach the loudspeaker to the stand or arm, using the threaded connection.

6. Plug the dual banana plug into the rear jacks of the loudspeaker. Be careful to align the "ground" prong with the black-colored jack. Then plug the other end of the loudspeaker cable into the back of the main electronics module, where it is marked SPEAKER OUTPUT.

2.3 Power-Up

1. Turn on the electronics module by pressing the upper edge of the POWER switch, located on the lower right side of the front panel. The green LED under the power switch turns on when the instrument is powered up.

2. Turn on the video monitor by pressing the power switch at the lower right corner of the screen. The FONIX logo will appear on the screen along with the software version and option code numbers. These numbers are important in identifying your equipment when you communicate with the company about your FONIX 6500-CX.

2.4 Safety

The FONIX 6500 CX is designed to conform to the IEC 60601-1 safety standards. However, in order to be in conformity, everything that is attached to the FONIX 6500-CX must also meet these standards. Therefore, you must have a special medical grade monitor, and if you are connecting your instrument to a printer or computer, they must be medical grade, as well. You also must tell us at the time of purchase that you wish to conform to this standard. A special tag from the ETL safety firm is then attached to the back panel.

2.4.1 Rear Panel Safety Markings

Symbol **Meaning**

ISO 13485

(A) This symbol indicates that Frye Electronics, Inc. is a Registered Firm of British Standards Institution, and we conform to the ISO 13485 standard.

FM 77405

(B) "FOR CONTINUED PROTECTION AGAINST FIRE AND ELECTRICAL SHOCK, REPLACE ONLY WITH SAME TYPE AND RATING FUSE."

For the 6500-CX, the mains fuse(s) depend on the mains voltage in your area.

Mains Input Voltage	Qty	Type	Dimensions	Rating
100V	1	Slow (time delay)	1/4" x 1 1/4"	0.6A 250V
120V	1	Slow (time delay)	1/4" x 1 1/4"	0.5A 250V
230V	2	Time lag (type T)	5mm x 20mm	.315A 250V
240V	2	Time lag (type T)	5mm x 20mm	.315A 250V

Never replace a fuse with a fuse of rating higher than listed in the table above.

The fuse(s) must have at least one safety approval stamped on the fuse:

1/4" x 1 1/4" fuses: UL and/or CSA

5mm x 20mm fuses: Semco or British Electro Technical Committee

(NCB, or other agency appropriate for your country.

5mm x 20mm fuses must conform to IEC 127 sheet III

(C) 250V∼ The "∼" means AC, alternating current.

(D) NOTE: CHECK FOR THE CORRECT SETTING OF VOLTAGE SELECTOR (Please do this.)

(E) For purposes of safety classification under IEC 601-1, the 6500-CX is class 1 equipment, Type B.

"Type B" means the equipment is operated in the vicinity of a patient but there is no direct patient connection.

"Class 1 equipment" means that the 6500-CX chassis is connected directly to ground via the mains power cord. Safe operation of the 6500-CX absolutely depends on the integrity of the safety earth connection at your mains outlet. If you have any doubts concerning the adequacy of your mains outlet, contact a qualified electrician.

(F) "Read the accompanying documents "
(Read this manual before operating the 6500-CX.)

A separate maintenance manual exists for the 6500-CX. The 6500-CX maintenance manual normally is shipped with all 6500-CXs shipped outside the U.S. and Canada. If you wish to obtain a 6500-CX maintenance manual, please contact Frye Electronics or your Frye representative.

(G) "Hazardous voltages inside. Refer service to qualified personnel."

(H) This symbol is provided on 6500-CX with safety approval option. A sample 6500-CX has been examined and tested by ETL Testing Laboratories. The 6500-CX conforms to :

IEC 601-1	Safety for countries outside the USA
IEC 801-2	Electrostatic discharge susceptibility
IEC 801-3	Radiated susceptibility
IEC 801-4	Conducted susceptibility
EN 50082-1	European community generic immunity
EN 55011	Group 1, Class A European community emission limits for industrial, medical, and scientific equipment

ETL conducts routine site inspections of Frye Electronics.

Note that for the ETL listing to be valid, all mains connected electrical equipment attached to the 6500-CX must conform to IEC 60601-1. Display monitors and computer equipment attached to the 6500-CX must be "medical grade" or else used with a medical grade isolation transformer.

(I) CE 0086

This symbol indicates that Frye Electronics conforms to the Medical Device Directive 93/42/EEC. Any attached video monitor, external printer, or external computer should also have a CE mark in order for the 6500-CX Test System to remain compliant.

2.5 Cleaning

For your safety, disconnect the 6500-CX from mains power while cleaning.

Wipe the 6500-CX with a slightly moist but not dripping cloth. Use plain water or water with mild dishwashing detergent. Wipe away any detergent with a slightly moist cloth, then dry the 6500-CX.

Never allow fluid to enter:

- the 6500-CX enclosure
- the 6500-CX power switch
- the 6500-CX voltage selector/power connector
- the 6500-CX electrical connectors
- the 6500-CX front panel push buttons

The microphones should be wiped with a dry cloth. Excess moisture may damage the microphones. Solvents and abrasives will cause permanent damage to the 6500-CX.

2.6 Calibration

This section describes all the different calibration procedures for the 6500-CX. Some of these procedures pertain only to instruments with the Quik-Probe Option

2.6.1 Identifying Rear Panel Calibration Controls

There are three separate sections on the rear panel, with a control that can be adjusted. *It is normally not necessary to adjust these controls because they are set at the factory.*

Should an adjustment be needed, loosen the lock nut before turning the adjustment screw. Be certain to tighten the lock nut when the adjustment is complete.

1. Under MICROPHONE AMPLIFIER

   The GAIN control allows the microphone amplifier to be matched to the sensitivity of the particular M1550E microphone used. See Section 2.6.2.

2. Under AUDIO SOURCE

   The LEVEL control sets the output of the loudspeaker in the test chamber to the range required by the automatic leveling program. See Section 2.6.3.

3. Under QUIK-PROBE / SPEAKER

   On units having the QUIK-PROBE Option, the LEVEL control adjusts the output of the sound field loudspeaker. See Section 2.6.5.

NOTE: The AUDIO SOURCE must be properly adjusted before the QUIK-PROBE level control is adjusted. See Section 2.6.5.

2.6.2 Calibrating the M1550E Microphone

Although it is not necessary to check the calibration of the 6500-CX every time it is turned on, we recommend for the microphones to be checked at least once a year.

Equipment Needed:

- Sound field calibrator such as Quest QC-10
- 14-mm-to-1" adapter

NOTE: Allow at least 30 minutes at room temperature before checking the calibration of the test set, especially if it has been exposed to cold temperatures. Open the sound chamber lid during this warm up period.

1. Insert the M1550E microphone into the 14-mm-to-1" adapter. Insert the microphone/adapter assembly into the calibrator. See Figure 2.6.2A.

Figure 2.6.2A—Calibrating the M1550E microphone

2. Press [RESET].

3. Press [SINE / COMPOSITE]. The green LED will turn off indicating that the instrument is in SINE (Pure tone) mode.

4. IMPORTANT: Be sure Noise Reduction is off. If necessary, press the [NOISE REDUCTION] button repeatedly, until the LED next to the button is off and there is no NOISE REDUCTION designation on the screen.

5. Turn on the sound field calibrator.

6. Read the SPL from the M1550E on the video monitor (next to AID OUT). The displayed reading should agree with the stated output of the calibrator (in the case of the Quest QC-10, this is 114 dB). See Figure 2.6.2B.

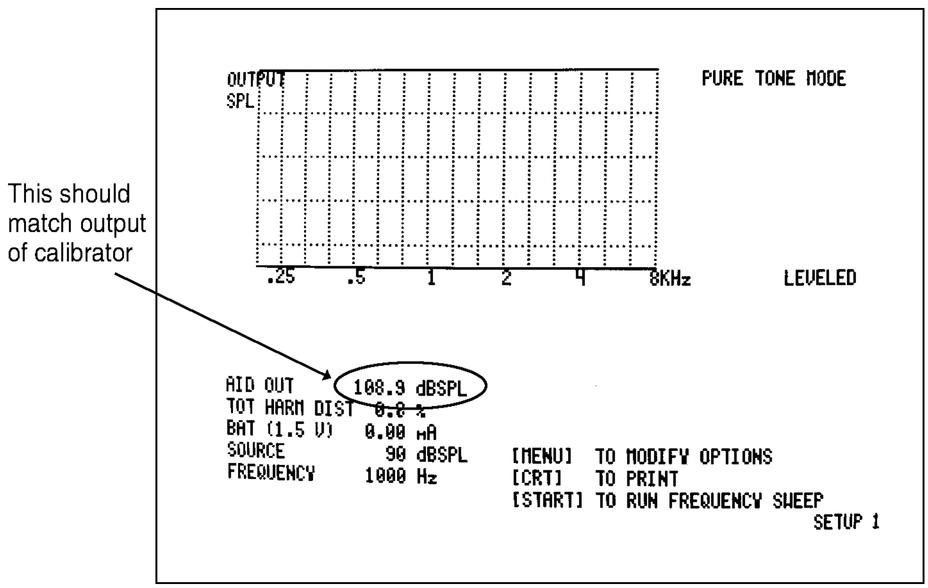


Figure 2.6.2B—Example of M1550E microphone out of calibration. The output of calibrator used in this test was 110 dB.

7. If the SPL reading next to AID OUT does not match the stated output level of the calibrator, adjust the test set amplifier with the GAIN adjustment control screw located on the rear panel, next to the M1550E input plug. Loosen the lock nut and turn the screw until the reading on the display matches the specifications of the calibrator. Tighten the lock nut without moving the position of the adjustment screw.

2.6.3 Calibrating the Sound Chamber Audio Source

No additional equipment needed for this measurement.

The Audio Source Level is pre-set at the factory and may never need adjusting. However, if there is a problem with LEVELING (Section 4.1), it could mean that the Audio Source Level is out of adjustment.

1. Follow the procedure for microphone calibration in Section 2.6.2, above.
2. Remove the microphone from the chamber. Press [LEVEL]. This will unlevel the analyzer.
3. Place the M1550E microphone at the reference position (circle) in the sound chamber.
4. Press the [WEIGHT] button twice, to get to Composite Mode (without speech weighting). See Figure 2.6.3.

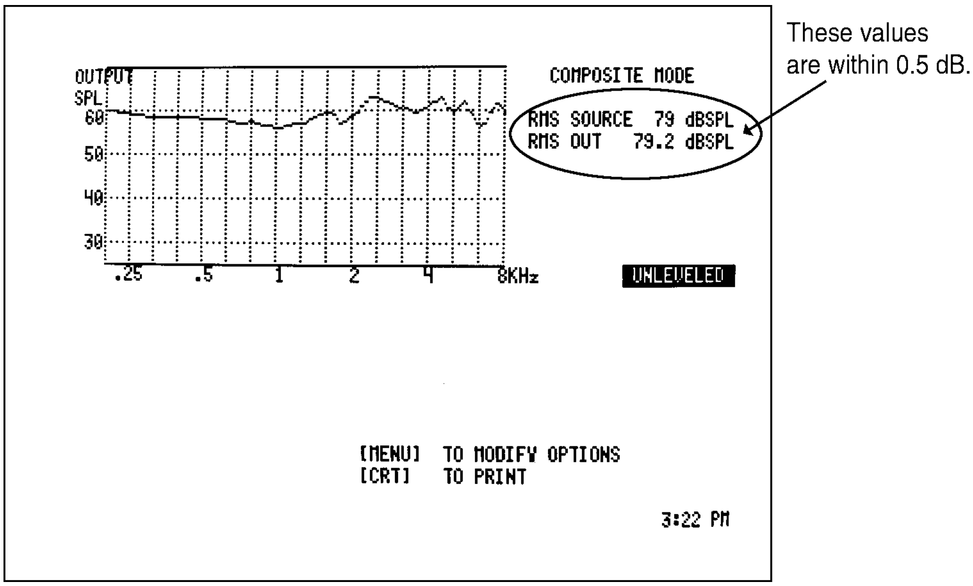


Figure 2.6.3—Sound chamber source in calibration

5. Checking the numbers in the upper right of the video monitor, verify that the RMS OUT level is within 0.5 dB of the RMS SOURCE level. If not, loosen the lock nut on the AUDIO SOURCE LEVEL control on the rear panel and adjust the control until the RMS OUT reading is within 0.5 dB of the RMS SOURCE.
6. Tighten the lock nut.

2.6.4 Calibrating the Reference and Probe Microphones (only for units with Quik-Probe II)

Equipment Needed:

- Sound field calibrator such as Quest QC-10
- 14-mm-to-1-in. adapter
- Probe adapter

1. Press [PROBE] to enter the Insertion Gain Screen.
2. Press [MENU] on the remote module.
3. Use [v] to highlight CALIBRATE PROBE.
4. Press [START/STOP] on the remote module to enter the calibration screen.
5. Put the 14-mm-to-1-inch adapter into the calibrator.
6. Turn on the calibrator with the switch on the bottom.
7. To calibrate the reference microphone:
    a. Insert the reference microphone into the calibrator.
    b. The box in the lower part of the screen will have the heading, MEASURED MIC. AMPLITUDE.
    c. If the number you see under REFERENCE is not within 1 dB of the calibration value (114 for the Quest QC-10), adjust the gain of the reference microphone with a small screwdriver using the control marked REFERENCE, on the bottom of the Quik-Probe module (see Figure 2.6.4A).
    d. Remove reference microphone from calibrator.

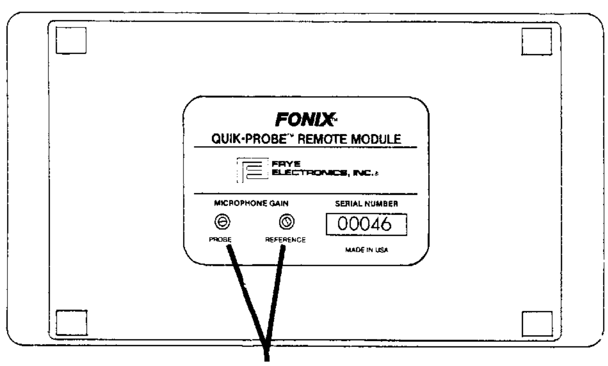


Figure 2.6.4A—Screw adjustments on bottom of remote module

8. To calibrate the probe microphone:
    a. Attach probe tube to probe microphone.
    b. Thread probe tube through probe adapter so that the tip of the tube extends several millimeters out the other side of the adapter.
    c. Secure probe tube to probe adapter with Fun-Tak.

d. Insert probe adapter into calibrator. See Figures 2.6.4B and 2.6.4C.

e. The number under PROBE should be within 1 dB of the calibration value. If necessary, adjust the gain of the probe microphone with a small screwdriver using the control marked PROBE, on the bottom of the remote module (see Figure 2.6.4A).

9. Press [MENU] to return to the Insertion Gain Screen.

Figure 2.6.4B
Probe microphone in calibrator

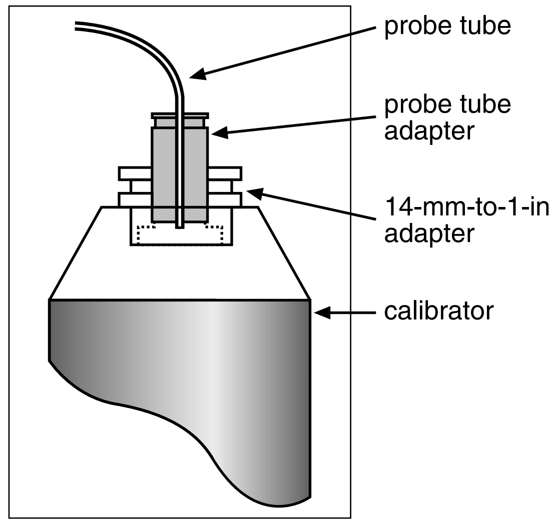


Figure 2.6.4C
Probe microphone in calibrator

2.6.5 Calibrating the Sound Field Speaker (Only for units with Quik-Probe II)

Equipment Needed:

- Calibration clip
- Velcro headband
- Human volunteer or KEMAR

1. Make sure the sound field speaker is UNLEVELED.

2. Prepare the room for real-ear testing, as described in Section 8.2. Situate a person, wearing the Velcro headband, in the proper position near the loudspeaker.

3. Combine the reference microphone and the probe microphone with the calibration clip as shown in Figure 2.6.5A. Be sure the tip of the probe tube is at the center of the grid of the reference microphone.

4. Position both microphones on the headband just above the ear nearest the loudspeaker. Re-adjust the position of probe, if necessary.

5. Push [START/STOP] to turn on the test signal. Observing the screen display, compare the RMS SOURCE SPL to the RMS OUT SPL. If the levels are within 3 dB of each other, the calibration is correct. See Figure 2.6.5B.

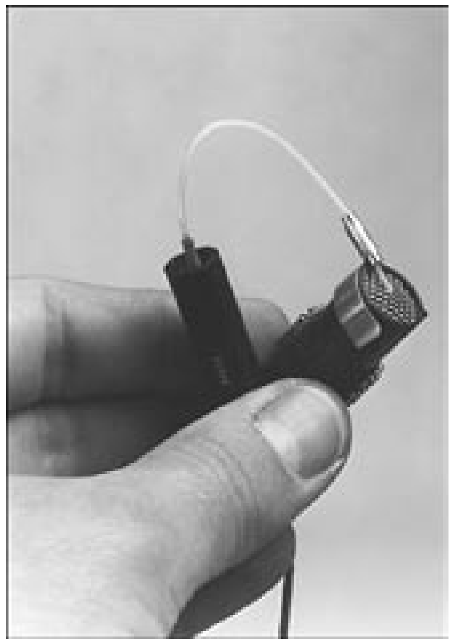


Figure 2.6.5A—Calibration clip holding probe tube in position

6. If the difference is greater than 3 dB, locate the adjustment for the loudspeaker on the back panel of the main electronics module. It is labeled LEVEL, below the words QUIK-PROBE and SPEAKER.

7. Loosen the lock nut and then turn the screw adjustment until the RMS SOURCE and RMS OUT levels are within 3 dB of each other. Re-tighten the lock nut.

8. Press [START/STOP] and then [CLEAR] to return to the normal operation.

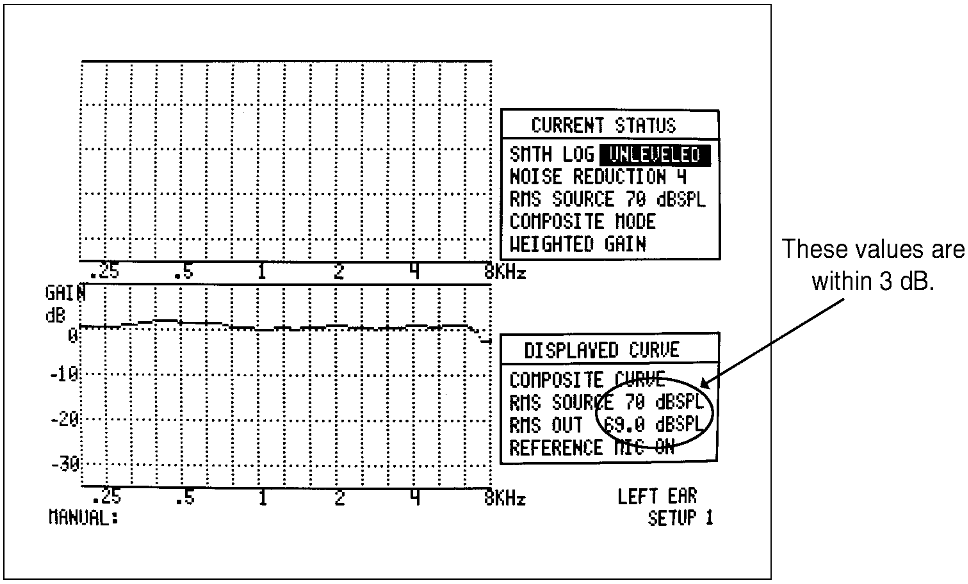


Figure 2.6.5B —Probe sound field calibration

2.6.6 Checking Probe and Reference Microphones Together (Only for units with Quik-Probe II)

Equipment Needed:

- Calibration clip

1. Combine the reference microphone and the probe microphone with the calibration clip as shown in Figure 2.6.5A. Be sure the tip of the probe tube is at the center of the grid of the reference microphone.

2. Hold the two connected microphones about 12 inches (30 cm) from the sound field loudspeaker. Push the [START/STOP] button.

3. Since the responses of the reference and probe microphones should be within 2 dB of each other, the GAIN curve (difference curve) on the screen should be very close to horizontal at the 0 dB line. If this is not the case, one or both microphones need re-calibration. See Figure 2.6.6.

4. Push [START/STOP] and then [CLEAR] to stop the test and return to the normal operation.

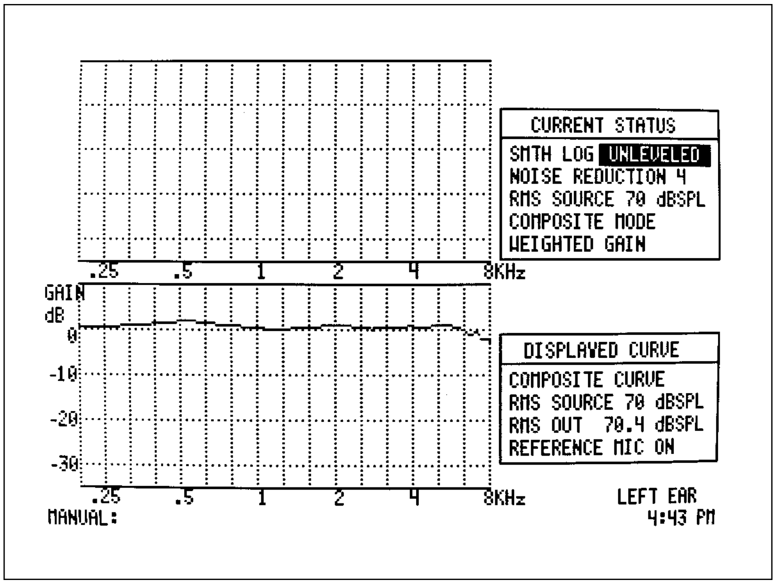


Figure 2.6.6—Holding probe and reference mics together

Chapter 3: General Operation

3.1 Hints

The software on the FONIX 6500-CX is designed so that the meanings of the panel buttons stay fairly consistent regardless of the function or option you are using. This consistency throughout makes the 6500-CX easy to learn to use. When you are exploring a new function or option, you can build on your past knowledge of the 6500-CX, rather than starting over each time. Listed below are a few points that you should notice as you are learning to use the 6500-CX.

- **Freedom to explore**. You cannot damage the 6500-CX by pressing any of its buttons. If you are exploring the use of the 6500-CX and you want to try pressing this button or that, please do so. That's part of the learning process. Pressing the [RESET] button will always set the instrument to Composite Weighted Gain Mode.

- **Flashy, but harmless**. If you press a button that is inactive or temporarily inactive, the display will flash. Don't worry! You haven't broken anything! Just try a different button and refer to this operator's manual for details on your current screen.

- **Magic buttons**. Some buttons take on different meanings depending on which feature you are using. For example, the arrow buttons [<], [>], [∧] and [∨] are used to adjust the frequency and amplitude of the source signal. (They are labeled FREQUENCY and AMPLITUDE on the front panel.) They are also used to move the cursor when you are in Cursor Mode, to select items when you are in a menu, and to cycle through a stack of measurements when you have frozen a measurement.

- **Settings du jour**. Menus are used for changing the settings of a feature. For example, pressing [MENU] before you press [CRT], displays a menu from which you can select how information on the screen is printed.

- **That special button**. There are two uses of the [CONTINUE] button:

    1. **Leaving a sub-program**: When you want to return to a normal measuring mode from one of the feature or option modes, press the [CONTINUE] button. This gets you out of the feature or option sub-program (once the sub-program has finished) and back to the normal measuring mode you were in before running the feature or option. For example: When you are in Composite Mode and press the [DATA] button, the display switches from a graphical curve to a table of numbers representing the individual readings used for the displayed curve. Pressing the [CONTINUE] button returns the display from the tabular to the graphical mode, and you will again see the curve.

    2. **Continuing a programmed sequence**: There are a few exceptions to [1], above. Some programmed sequences stop in the middle of a run to allow you to make adjustments. Pressing [CONTINUE] in the middle of such a sequence does not exit the function, but

tells the 6500-CX to proceed with the rest of the programmed sequence. (An example of this is the ANSI 87 sequence which often stops after the full-on measurements are made, to allow you to adjust the volume control to the reference test position before continuing with other measurements.) Once the programmed sequence is completed, pressing [CONTINUE] will get you out of the program and back to the normal measuring mode you were in before starting the programmed sequence.

Exceptions: With the Cursor, In-Situ, CIC, and OES functions, the [CONTINUE] button does not exit the function. Pressing the function's button the first time gets you into that function, while pressing the same button a second time gets you out of that function.

- No-fault defaults. When you first turn on the 6500-CX or press [RESET], the instrument is set to Composite Weighted Gain Mode with the output of the source set to 70 dB SPL RMS. Many other conditions are set to common default values that you will see as you work through the features and options described in the remaining chapters of the manual.

- Help! Many screens contain help messages that tell you which button to press for a particular function. Keep an eye out for these messages!

3.2 Menus

Each time you turn on the FONIX 6500-CX, the computer automatically selects the settings that control how each programmable function will run. You can easily modify the settings by using menus. To use a menu:

1. Be sure the 6500-CX is in a normal measurement state. No options may be in effect. If in doubt, press [RESET].

2. Press the [MENU] button. The help message SELECT OPTION TO MODIFY will appear on the screen.

3. Press the button that corresponds to the function or option you want to modify. The menu for that function will then appear in the lower half of the screen. (If you push a button for a function that cannot be modified, the screen will flash.)

4. When there is more than one feature that can be modified within a menu, a highlighted bar will appear across one of the listed features. The highlighted bar is the cursor. (Skip to Step 6 if there is only one feature listed, and no highlighted cursor.)

5. Move the cursor up or down using the [∧, ∨] buttons to highlight a particular feature.

6. Follow the help messages on the screen to make any modifications or to enter a submenu. Usually this involves pressing [<, >] to make a selection or [START] to enter a sub-menu.

7. Press [CONTINUE] to exit the menu or submenu. The function will run using the last menu settings, until the menu is modified again or the analyzer is turned off.

3.3 General Setup Menu

To enter the General Setup Menu:

1. Press [RESET].
2. Press [MENU] twice.

CRT COLOR SET: Choose from among 5 different color settings (Settings 0 through 4). Settings 5 and 6 are for monochrome monitors.

SET TIME & DATE: Push [START] and follow on-screen instructions.

CRT SAVER: Choose how long the unit should stay on before the screen saver is engaged. When the screen saver is engaged, the lights on the front panel will flash in a rotating pattern. No pattern will appear on the monitor.

REAL TIME BATTERY: Turn on/off the display of real time battery voltage drain. OFF increases the speed of composite display.

SAVE CURRENT SETUP: This selection allows you to change your default settings. Press [START] to enter sub-menu. See Section 3.4 for more details.

SELECT NEW SETUP: Select from 5 possible default setting combinations. See Section 3.4 for more details.

TIME/SETUP DISPLAY: Display either TIME, SETUP, or BOTH at the lower right side of the display. If BOTH is chosen, the display will alternate between the time and the current setup number.

3.4 Default Settings

The 6500-CX is loaded with an incredible number of settings and options that different people may want to use in different ways. For this reason, we have provided a way to create up to five different default setting combinations. For instance, one user may want to automatically perform I/O measurements at 250, 1000, and 4000 Hz when running an ANSI 96 test and have a default source setting of 65 dB for insertion gain measurements. Another user may want different I/O measurements to be made or have a different default insertion gain source. The 6500-CX allows multiple default settings for multiple users.

Step 1: Setting the 6500-CX the way you want it to run

Here are the selections you can modify to create new default settings. Go through the 6500-CX and set everything you want to include as part of your new default settings. Make sure you press [CONTINUE] to exit from any function. Pressing [RESET] could cause some settings to reset to their original values.

ANSI 87 MENU

Aid Type
Full On Gain
Telecoil
Average Frequencies

ANSI 92 MENU

Noise Reduction Setting
Display Response Curves
Settling Time Display

ANSI 96 MENU

Aid Type
Telecoil
Avg Frequencies
Hdist 12 dB
Ear

Options Menu (a submenu of ANSI 96)

Fog Source Ampl
Printout

AGC Menu (a submenu of ANSI 96)

250 Hz
500 Hz
1 kHz
2 kHz
4 kHz
Attack Window
Release Window

AVERAGING MENU

Frequencies
Start Delay
Sweep Delay

CIC—AUTO MENU

Aid Type
Full On Gain
Telecoil
Average Frequencies

DIGITAL SPEECH-IN-NOISE

Bias Signal
Speech Signal
Speech Source (on screen)
Bias Source (on screen)
Bias Frequency (on screen)
Noise Reduction

GENERAL SETUP MENU

CRT Color Set
CRT Saver Delay
Battery Current Test
Time/Setup Display
Microphone

IEC MENU

Reference Test Frequency
Full On Gain Source Level
Harmonic Distortion Frequency
Aid Type

IN-SITU MENU

Source Correction
Output Correction

I/O MENU

I/O Frequency
I/O Display
I/O Start Delay
I/O Meas Delay

JIS MENU

Gain Curve Ampl
Aid Type
Coupler Type
Ref Test Freq

PROFILER MENU

Noise Reduction
Speech Signal Type
Dig Sp Duration
EIN Method
EIN frequencies

PRINT MENU

- Type
- Speech
- Mode
- Show Menu Before Print
- Print Date & Time

QUIK-PROBE II MENU

- Ear Tested
- Create Target
- Mode
- Gain (G)/SPL

Operation Parameters Menu (sub-menu of Quik-Probe II)

- Signal Level
- Smoothing
- Output Limiting
- Noise Reduction
- Data Conversion

QUIK-PROBE II SPL SETUP MENU

- Ear Tested
- Formula
- Predict UCL
- Unaided Response

QUIK-PROBE II SPL MENU

- Aided Curve 1
- Aided Curve 2
- Aided Curve 3
- Noise Reduction

Digital Speech Menu (submenu of QPII SPL Menu)

- Bias Signal
- Bias Level
- Bias Freq

In some cases, an option will have more than one test to choose from in its menu. For example, the ANSI Option can have up to three different tests to choose from. You can save which test is highlighted when you open the menu.

ANSI

Choose ANSI S3.22-1987, ANSI S3.42-1992, or ANSI S3.22-1996 to be the default test.

CIC

Use the arrow keys to choose Manual or Auto to be the default test.

TELECOIL

Use the arrow keys to choose Composite, ANSI 87, IEC, or ANSI 96 as the default test.

"STAR"

Choose desired default test. You can also select the default frequency and amplitude for the Enhanced and Adaptive Attack and Release tests, respectively.

Step 2: Saving the settings

1. Press [CONTINUE] repeatedly until you arrive at the main composite measuring screen. Don't press [RESET] as this may cause some of your settings to revert to their original values.
2. Press [MENU] twice.
3. Use the [∧] to select SAVE CURRENT SETUP.
4. Press [START].
5. Select desired setup number using [∧, ∨].
6. Press [START].

Your settings have now been saved.

Step 3: Selecting the saved setup

Although the 6500-CX saves your settings to a particular setup when you follow the instructions in the Step 2, it doesn't automatically select that new saved setup as your current setup. To select the new setup:

1. Use [∨] to highlight SELECT NEW SETUP.
2. Press [START].
3. Use [∧, ∨] to select desired setup.
4. Press [START].
5. Press [CONTINUE] to exit the General Setup Menu.

The last selected setup is always the power-on default setup of the 6500-CX. So, if you save all your settings to SETUP 2 in Step 2 and select SETUP 2 in Step 3, those settings will be the new 6500-CX power-on default settings.

3.5 Common Functions

The functions described in this section work the same way for most or all of the measurement modes.

3.5.1 Using the Battery Voltage Supply

The battery voltage supply, used with the appropriate battery simulator pill, supplies power to the hearing aid being tested. When you follow the instructions below, the 6500-CX will display battery drain information with all normal screens, and with several option screens. If you do not use the battery voltage supply to power the test aid, no battery drain information will be available to the 6500-CX.

To use the battery voltage supply:

1. To the right of the test area in the 6050 test chamber is the battery voltage supply (see Figure 3.5.1).
2. Choose the appropriate size battery simulator pill and insert it into the aid as you would a battery. (The metal “ribbon” that attaches the pill to the cord, will fit between the battery door and the hearing aid case, once the battery door is closed.)
3. Insert the plug on the battery simulator pill into the jack near the battery voltage supply.
4. Press the button that corresponds to the size and type of battery to be simulated. The choices are:

   Sizes: 675 (76), 13, 312, and 10A/5 (also 230).

   Batteries: silver oxide (1.5 V) and zinc/air (1.3 V).

   For 41 and AA batteries, press the 675 button that gives the correct voltage.

   For 5 batteries, press the 10A/230 button.

NOTE: The aid will not be powered unless a button on the battery voltage supply is pressed.

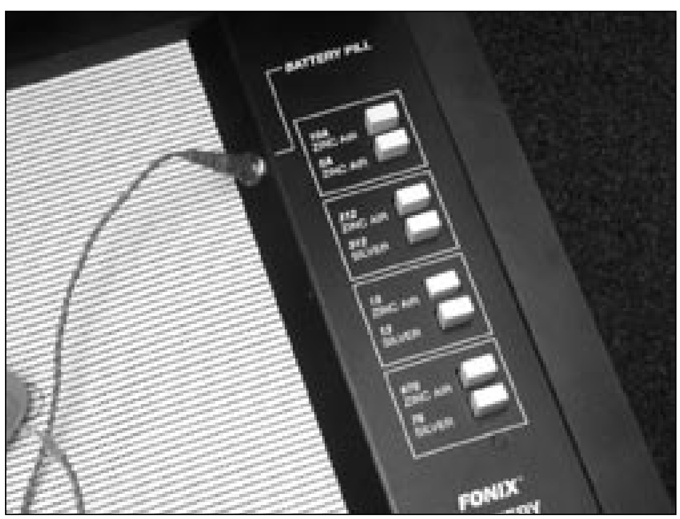


Figure 3.5.1—Battery voltage supply.
Select the appropriate battery to simulate

3.5.2 Printing a Screen

To print the information (graph or table) displayed on the screen, press the [CRT] button at the far right of the front panel. This button freezes the screen and starts the printer. Information is printed exactly as it is displayed, and testing resumes automatically when printing is finished.

With some screens, you can select FULL or HALF screen printing via the PRINT MENU (press [MENU] and then [CRT]). FULL screen printing is the default setting. To print an information label, press [LABEL] before [CRT] (see Section 3.5.3).

To abort a printout in progress, press [CRT] a second time.

For more information about printing, including printing to an external printer, see Chapter 9.

3.5.3 Labeling

To get an identification label printed just before the screen information, press the [LABEL] button (on the far right of the front panel) <u>before</u> pressing [CRT]. The green LED will light. All subsequent screen printouts will then be preceded by the printed label, until the LABEL LED is turned off by pressing [LABEL] a second time (or by pressing [RESET]).

3.5.4 Using Noise Reduction

Use noise reduction when the testing room or the hearing aid is noisy or when the curve on the screen is not steady. Noise reduction averages several successive measurements to present a more stable curve. You can choose to average 2, 4, 8, and 16 measurements by pressing the [NOISE REDUCTION] button repeatedly. Press the button once more after 16 to turn noise reduction off. Use the smallest number possible, because the larger the number, the longer it takes for the measurement to stabilize.

For all test-chamber applications, follow the procedure below for noise reduction. For real-ear measurements, however, use the procedure given in Sections 8.3.2.2.

To use noise reduction:

1. Push the [NOISE REDUCTION] button, under SIGNAL on the front panel. The green LED next to the button will light up, and the words NOISE REDUCTION 2 will appear on the screen to the right of the graph.

2. To change the amount of noise reduction, push the [NOISE REDUCTION] button repeatedly. As you push the button, the numbers on the screen will cycle through 2, 4, 8, and 16. After 16, the noise reduction message will disappear, indicating that the noise reduction has been turned off.

3. To turn noise reduction off, push [NOISE REDUCTION] repeatedly until the green LED goes out and the NOISE REDUCTION message on the screen disappears.

With SPECTRUM ANALYSIS tests: In Spectrum Analysis Mode (Composite Mode, source off), noise reduction works differently than for normal composite tests. In spectrum analysis mode, the spectra of several samples are averaged, to give a stable analysis of random or other external signals. See Section 10.3 for details.

3.5.5 Viewing Data (numerical tables)

The [DATA] button converts the displayed frequency response curve to a numerical table of values (as in Figure 3.5.5).

1. Once a curve is displayed on the screen, press [DATA] to convert the curve to a numerical table.

2. Print any displayed data table by pressing [CRT]. (NOTE: The top half of the screen will be printed first, followed by the bottom half. To re-create, with the printout, the arrangement seen on the video display, cut the printed tape in two and align the second half underneath the first.)

3. Press [CONTINUE], or press [DATA] a second time, to return to a curve display.

FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB
200	15.8	2000	28.7	3800	31.3	5600	9.4	7400	-13.7
300	19.5	2100	28.7	3900	31.5	5700	9.8	7500	-8.2
400	20.3	2200	29.0	4000	31.3	5800	9.8	7600	-13.7
500	21.1	2300	29.7	4100	29.6	5900	8.9	7700	-13.7
600	21.7	2400	30.4	4200	27.3	6000	2.3	7800	-13.7
700	22.0	2500	31.5	4300	24.7	6100	7.3	7900	-23.2
800	22.9	2600	33.2	4400	23.5	6200	3.3	8000	-23.2
900	24.0	2700	33.8	4500	20.6	6300	1.9	COMPOSITE	
1000	25.0	2800	33.8	4600	20.4	6400	4.6	SOURCE RMS	
1100	26.4	2900	32.9	4700	19.4	6500	2.3	70 dBSPL	
1200	27.8	3000	31.7	4800	18.0	6600	-0.1	OUTPUT RMS	
1300	29.2	3100	30.8	4900	17.0	6700	-1.5	95.5 dBSPL	
1400	30.4	3200	29.8	5000	16.8	6800	-6.8	N.R. OFF	
1500	30.4	3300	29.2	5100	17.3	6900	-4.7	WEIGHTED	
1600	29.3	3400	29.2	5200	15.0	7000	-8.2	GAIN	
1700	29.2	3500	29.4	5300	13.8	7100	-8.9	LEVELED	
1800	28.5	3600	29.4	5400	13.5	7200	-12.3		
1900	28.7	3700	30.6	5500	13.2	7300	-6.8		

Figure 3.5.5—Example of Data Screen

3.5.6 Using the Cursor

Use the cursor as an aid to making readings of frequency and amplitude or gain at specific positions on a curve. For example, use the cursor to get the frequency and amplitude of the tip of a peak (Figure 3.5.6). Readings can be either in absolute terms, or else relative to a selected reference position. (See Section 3.5.7.)

1. To use the cursor, press the [CURSOR] button. A vertical line (the cursor) will appear on the graph at 1000 Hz.

2. Move the cursor left and right with the [<, >] buttons to find the desired position on the curve. The frequency and amplitude or gain will be displayed under the CURSOR heading on the screen.

3. If desired, push [CRT] to print.

4. Push [CURSOR] to leave the cursor function.

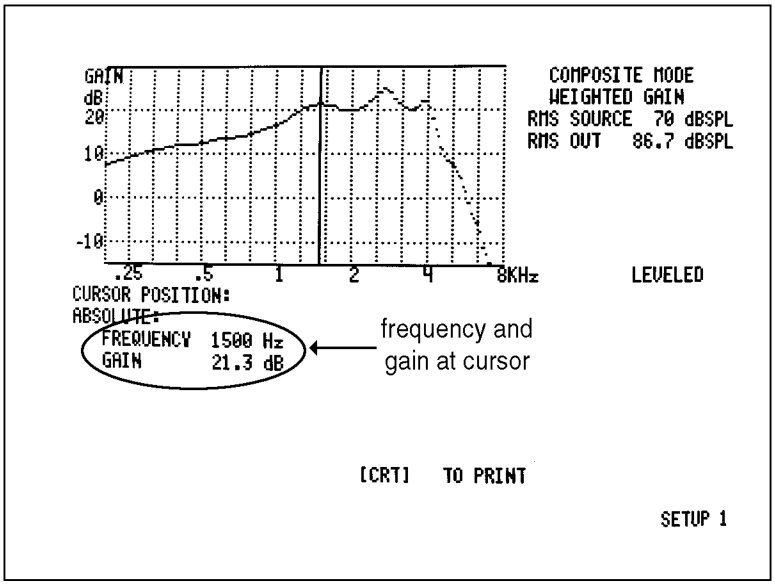


Figure 3.5.6—Example of cursor function

3.5.7 Using the Relative Mode

The Relative Mode tells you how one point on a curve relates to another.

1. Position the cursor on the displayed curve, as described above, to the point you want to use as a reference.

2. Press [RELATIVE]. You will see the word RELATIVE on the right side of the display, followed in parentheses by the absolute frequency and amplitude or gain values of the curve at the reference position. (See Figure 3.5.6.)

3. Now move the cursor to any other position. Under RELATIVE, you will see values of the frequency and amplitude or gain of the curve at the new cursor position, relative to the values at the reference position (Figure 3.5.7).

4. Press [CURSOR] to leave the Relative Mode. Press [CURSOR] again to return to normal testing.

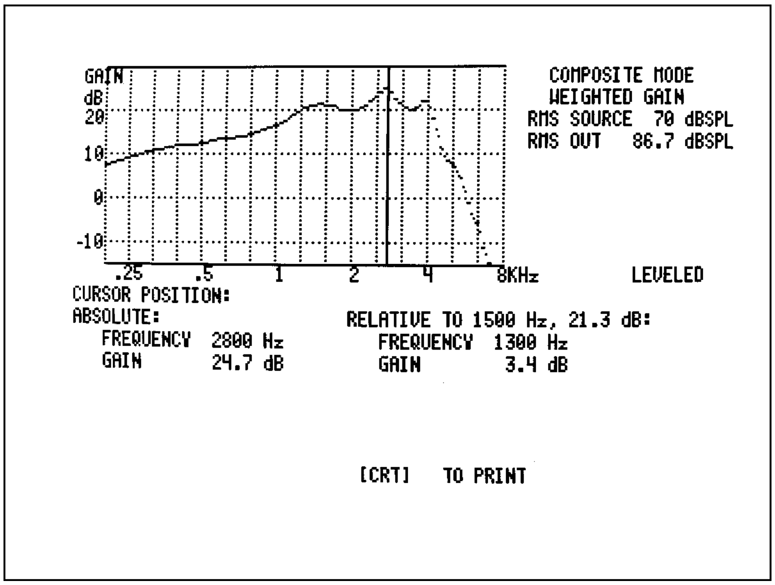


Figure 3.5.7—Relative function

Chapter 4: Preparing to Test

4.1 Leveling

All sound chambers have frequency response irregularities. Leveling is the process of adjusting for the irregularities, frequency by frequency.

The FONIX 6500-CX is leveled at the factory before shipping. However, microphone responses can shift during shipping, and sound environments can be different, so it's recommended that you re-level your instrument when you receive it and periodically afterwards.

When you re-level, the new leveling information is automatically stored in permanent memory until you re-level again. If, for some reason, no leveling information is stored, the help message DISCONNECT BATTERY PILL, THEN PRESS LEVEL will appear on the Opening Screen when you turn on the unit. The message 6500 IS LEVELED, PRESS RESET TO BEGIN MEASURING will appear when leveling is stored.

Use the following procedure to level the 6500-CX:

1. IMPORTANT: Be sure nothing is plugged into the battery voltage supply.

Figure 4.1A—Leveling setup

2. Place the microphone on the left side of the sound chamber, with the microphone grill over the reference point (Figure 4.1A). Close and latch the sound chamber lid.

   WARNING: Leveling is valid only when the microphone position is not changed after leveling. Each significant change in microphone location requires new leveling.

3. Press the [LEVEL] button (on the far right side of the front panel, just above the power switch) to start the leveling sequence. The system responds by presenting a complex composite signal consisting of tones from 100 to 8000 Hz. It measures the signal and stores correction factors, so that the sound field is flat for testing.

4. After a few seconds, the video monitor will display a graph (Fig. 4.1B) with a straight line across at 0 dB, indicating that the chamber has been leveled.

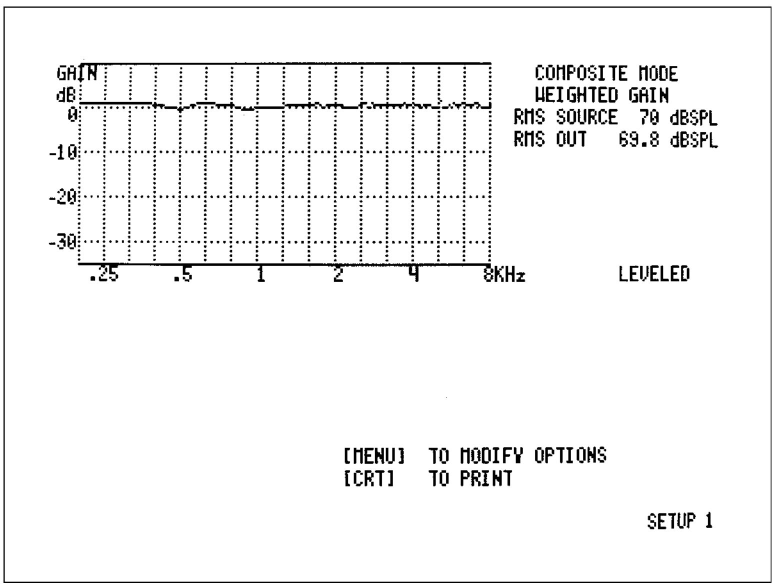


Figure 4.1B—Sound chamber leveled

5. Removing leveling:

   - To remove the leveling modifications from the analyzer's memory, disconnect the microphone or the sound chamber and then push the [LEVEL] button. This will unlevel the sound chamber.

   - To return all 6500-CX settings to their factory defaults, press [TITLE] and [LABEL] at the same time, and then turn the instrument off and on again.

NOTE: For instruments equipped with ANSI Option, see Section 6.1.2 for standardized leveling procedures.

4.2 Couplers and Adapters

The standard 2-cc coupler (HA-2) approximates the human ear with an earmold attached. A drawing of the HA-2 2-cc coupler is shown in Figure 4.2A. Note the tube that simulates the earmold. Button-type receivers connect directly to this coupler. Behind-the-ear hearing aids connect to this coupler by means of an ear-level adapter, as shown in Figure 4.2C and Figure 4.4.

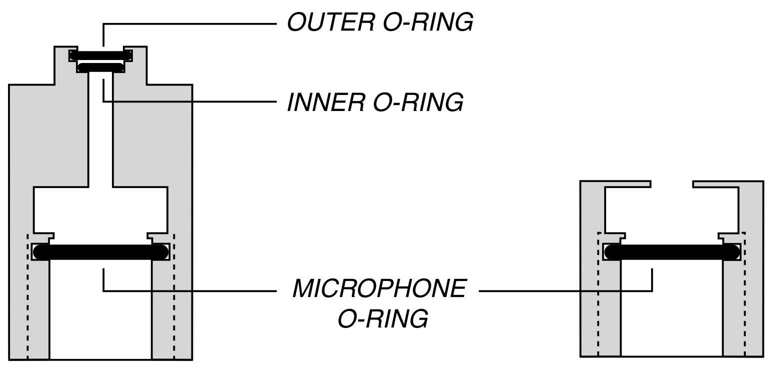


Figure 4.2A
Standard 2-cc coupler (HA-2)

Figure 4.2B
Direct access coupler (HA-1)

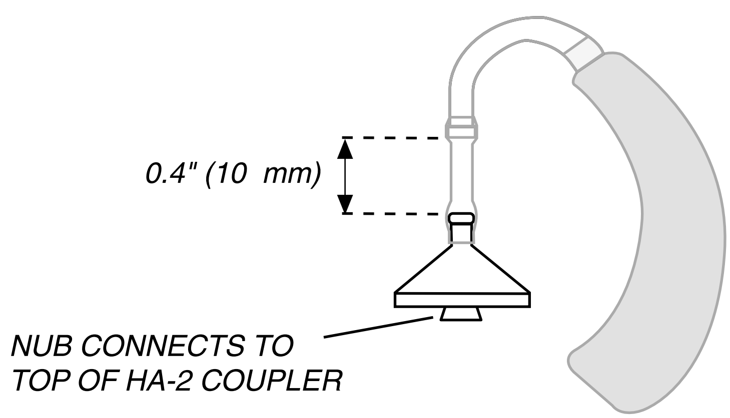


Figure 4.2C
Ear-level adapter (used with HA-2)

The direct access 2-cc coupler (HA-1) is used to test in-the-ear and canal aids, and aids with molds connected. Figure 4.2B shows the direct access coupler. The sound bore of the aid is sealed directly to the 2-cc cavity of this coupler with Fun-Tak putty, provided with the instrument.

On HA-1 and HA-2 couplers, the microphone O-ring is located deep within the coupler to reduce the pressure exerted on the diaphragm of the M1550E test microphone. When inserting the microphone into the coupler, you will feel a point of resistance when the microphone reaches the O-ring. You must continue to push the microphone into the coupler past that first resistance or incorrect data will be collected.

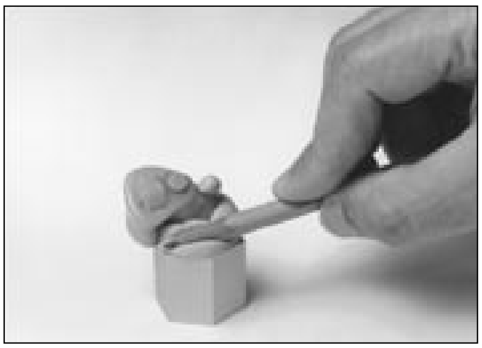
4.3 In-The-Ear (ITE) and Canal Aids

Follow the steps below:

1. Roll the Fun-Tak, provided with each instrument, into a rod long enough to go around the transmitting end of the aid (approximately 2 inches). (Modeling clay can also be used, but it doesn't work as well.)

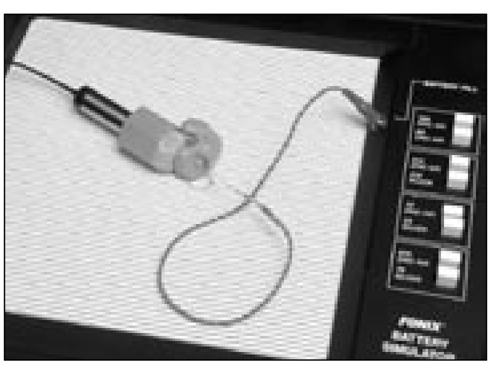
2. Bend the Fun-Tak rod around the canal of the aid, making the resulting "donut" flush with the end of the aid. (Some users choose to seal the vent opening at this end with a small amount of Fun-Tak.)

3. Align the sound opening of the aid to the hole at the conical end of the coupler. Look through the open end of the coupler to be sure the sound opening of the aid is clear of obstructions and correctly placed.



4. Seal any vent on the aid with a small kernel of Fun-Tak.

5. Complete the acoustical sealing of the aid to the coupler by using a pencil or finger. You may want to double-check the aid placement through the open end of the coupler at this point. Slowly reinsert the coupler microphone into its access opening.



6. Place the completed assembly at the reference position in the test chamber. With ITEs, the position of the aid can affect the frequency response. As a rule, point the faceplate of the aid toward the right, with the microphone opening as close as possible to the reference circle. It is best, when possible, to angle the faceplate upward instead of downward (see the photo at left).

For the sake of repeatability, you may elect to use a ninety degree angle of the faceplate to the reference circle, again with the microphone opening as close as possible to the reference circle. If you are using a battery pill, be sure the metal conductor strip does not obstruct the sound path.

4.4 Behind-The-Ear (BTE) Aids

1. Insert the coupler microphone into the HA-2 2-cc coupler.
2. Couple the aid to the HA-2 coupler using the ear-level adapter. There should be 0.4 inches (10 mm) of tubing between the nub of the ear-level adapter and the nub of the coupler adapter*. See Figure 4.2C.
3. Place the microphone of the hearing aid at the reference point in the chamber, as shown in Figure 4.4.
4. Close the lid and test as desired.

Figure 4.4 —Behind-the-ear aid with ear-level adapter

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* The length and thickness of the tubing can have a significant effect on the frequency response of an aid. If an aid is being compared against the manufacturer's specifications, the tubing should be carefully chosen to duplicate that used by the manufacturer to obtain the original data. For ANSI tests, use #13 thick-walled tubing, the length shown in figure 4.2-C. Note: When cutting tubing to length, leave extra at each end to go around the nubs of the ear-level adapter and the hearing aid hook.

4.5 Body Aids

1. Insert the coupler microphone into the HA-2 2-cc coupler. (The most consistent results for body aids can be obtained by locating the 2-cc coupler outside the test chamber, preferably on a foam pad to isolate it from vibration.)

2. Snap the earphone (receiver) of the Body aid onto the 1/4" recessed end of the coupler.

3. Place the aid in the test chamber with its microphone opening as close to the reference point as possible (See Figure 4.5).

4. Turn the gain (volume) control to the desired setting and set the switch for microphone operation (not telephone coil or "T").

5. Close the lid and test as desired. (The aid's cord will not be damaged by closing and latching the test chamber lid.)

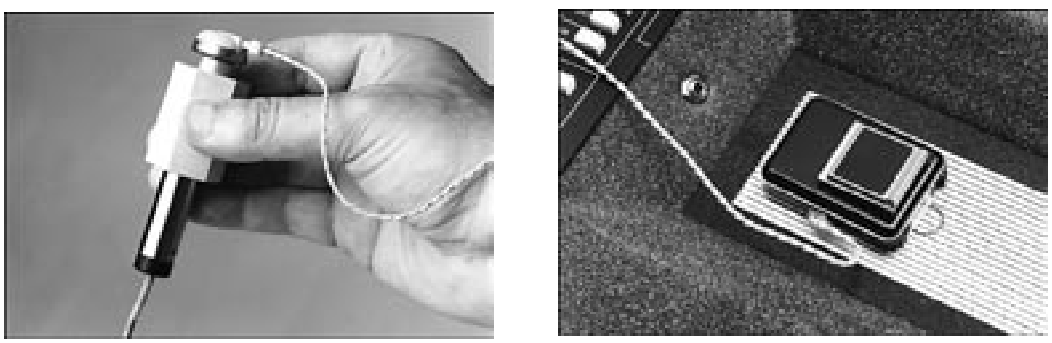

Figure 4.5—Body aid setup

4.6 Eyeglass Aids

1. If possible before testing, follow the manufacturer's instructions for removing the hearing aid assembly or the temple piece from the eyeglass frame. Should you be unable to remove the aid assembly or temple from the frame, it is possible to place the entire frame in the test chamber for testing. Be sure to fold the glasses first.

2. Insert the coupler microphone into the HA-2 2-cc coupler.

3. Couple the aid to the 2-cc coupler using the BTE aid adapter and the appropriate tubing,* as shown in Figure 4.6.

4. Position the microphone of the aid as close as possible to the reference point in the test chamber, as shown in Figure 4.6.

5. Close the lid, if possible, and then test as desired. If the lid can't be closed, measurements can be made with the lid open. But we recommend that you first re-level the chamber with the lid open, and use the quietest possible location.

Figure 4.6—Eyeglass aid set-up

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* The length and thickness of the tubing have a significant effect on the frequency response of an aid, especially in the 500 to 1000 Hz region. If an aid is being compared against the manufacturer's specifications, the tubing should be carefully chosen to duplicate that used by the manufacturer to obtain the original data. For ANSI tests, use 0.6" (15 mm) of #13 thick-walled tubing (exposed portion).

4.7 Wireless CROSand BICROS Aids

The key to testing CROS and BICROS aids is to get the proper amount of separation between the transmitter and the receiver. This separation may be vertical. The transmitter may be in the chamber while the receiver is on top of it.

It may be necessary to turn off the video monitor while testing these aids, because the monitor creates magnetic fields which may interfere with testing. Either turn the monitor back on to view results, or push [CRT] to print.

4.7.1 Wireless CROS

A CROS (Contralateral Routing of Signal) aid consists of a transmitter and a receiver so that sound received on one side of the head can be transmitted to the other side without a wire connection. You can test these units in the test chamber of the FONIX 6500-CX. (See text below and Figure 4.7.1.)

1. Place the microphone of the transmitter at the reference point in the test chamber. Turn on the transmitter.
2. Close the lid of the test chamber.
3. Check the specification sheet of the aid under test to determine how far apart to place the transmitter and the receiver. About 6 inches is usually sufficient.
4. You will be placing the receiver on top of the lid of the test chamber. The total depth of the lid of the test chamber and the recess of the test area is 5 $^{1}/2$ inches (14 cm). To increase the total separation, place foam on the top of the test chamber until the total separation equals that recommended by the aid manufacturer.
5. Attach the coupler to the receiver just as you would for an ordinary BTE or eyeglass aid.
6. Align the receiver and coupler assembly on the top of the test chamber so that the receiver is exactly parallel to the transmitter in the test chamber.
7. Test as you would any ordinary hearing aid.

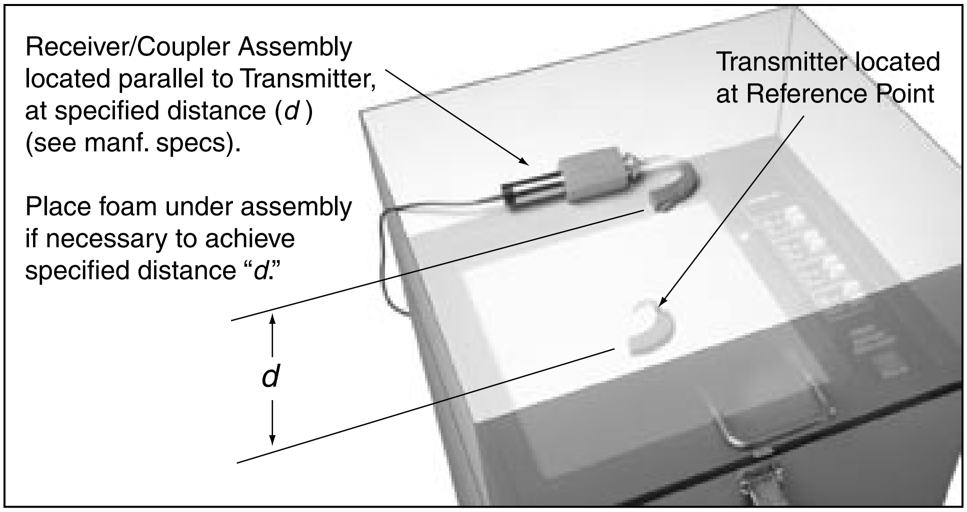

Figure 4.7.1—Testing Wireless CROS Hearing Aids

4.7.2 Wireless BICROS

BICROS systems have two microphones: one on the transmitter side and the other on the receiver side.

1. Test the receiver side as an ordinary hearing aid first.
2. Next, arrange the transmitter parallel to the receiver, but as far as possible from it while still in the chamber. You may have to unscrew the earhooks one-quarter turn to accomplish this. Fun-Tak may help to keep the units in position, but be careful not to obstruct the sound paths to the microphones.
3. Adding the transmitter should increase the gain by the amount specified by the manufacturer. It is not possible to get exact measurements by this measure because at least one of the microphones will not be at the reference point.
4. Telex, for one, does not recommend sealing the microphone of the receiver side because feedback could result, and the sealing material could get inside the case.

ADDITIONAL NOTES FOR TESTING WIRELESS INSTRUMENTS*

1. There must not be any metal objects between the transmitter and the receiver sides.
2. The two sides must be directly parallel as illustrated (See Figure 4.7.1).

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* Harry Teder, "Testing Telex Wireless CROS/BICROS /MultiCROS Hearing Aids," *Engineering Bulletin #3*, Telex Communications, Inc., Minneapolis, Minnesota.

3. The distance between the two sides should be as specified by the manufacturer.

   THE GAIN OF THE AID INCREASES AS THE TRANSMITTER AND RECEIVER MOVE CLOSER TO EACH OTHER. EVENTUALLY, THE RECEIVER WILL OVERLOAD.

4. No other wireless CROS/BICROS/MultiCROS transmitters are to be turned on near the test box.

5. Calculators should be kept at least a foot (300 mm) from the test box.

4.8 Wire-Type CROS and BICROS Aids

4.8.1 CROS

CROS aids are similar to ordinary hearing aids, except that the microphone and amplifier are separate units connected by a wire. Both units may be placed inside the test chamber during testing.

1. Place the orifice of the microphone unit at the reference position in the test chamber.

2. Connect the amplifier unit to the appropriate 2-cc coupler. (See earlier sections for details.)

3. Place the coupler with the amplifier unit at the left side of the test area.

4. Test as desired.

4.8.2 BICROS

Test wire-type BICROS aids just as you would wireless BICROS aids, except instead of separating the two units and keeping them parallel, place both units as close as possible to one another with the microphone openings as close as possible to the reference circle. (Otherwise, follow the steps given in Section 4.7.2.)

4.9 Directional Aids

For exact checks of directional hearing aids against published specifications, you must use an anechoic test chamber. The FONIX 6000 series test chambers (used with the 6500-CX) are not anechoic, so you cannot make exact comparisons of 6500-CX test results with published specifications for directional hearing aids. However, keeping in mind the possibility of errors in measurement owing to directional properties, you can use the 6500-CX to check whether directional hearing aids are functioning within “loosely defined” expected limits.

A simple test of directional aid function can be done with the 6500-CX by taking an analysis with the aid positioned to point toward the right (forward position) in the sound chamber and then taking another response with the aid pointing toward the left (reverse position). Since the speaker drives sound from right to left, and since sound reflections are controlled in the sound chamber, a comparison of these two measurements will let you know if the aid is directional or not. This is best demonstrated using the Multi-Curve Option.

1. Position the aid to point toward the right side of the sound chamber. See Figure 4.9A.

2. If you have Multi-Curve, press [FREEZE] and [START] **(not [CONTINUE]!)** to save the forward measurement to the Multi-Curve stack. Otherwise, print the curve using the [CRT] button.

3. Position the aid to point toward the left side of the sound chamber. See Figure 4.9B.

4. If you have Multi-Curve:

    a. Press [MULTI].

    b. Highlight MULTIPLE CURVES.

    c. Press [START].

    d. If necessary, use the arrow keys to select CRV 1 for slot 1 in the Multi-Curve display, and select CRV 2 for slot 2 in the Multi-Curve display.

If you don't have Multi-Curve, press [CRT] to print the current curve.

5. Compare the two curves to make sure that you're getting the desired directional responses. See Figure 4.9C for a comparison.

Figure 4.9A—Forward positioning of directional aid test

Figure 4.9B—Reverse positioning of directional aid test

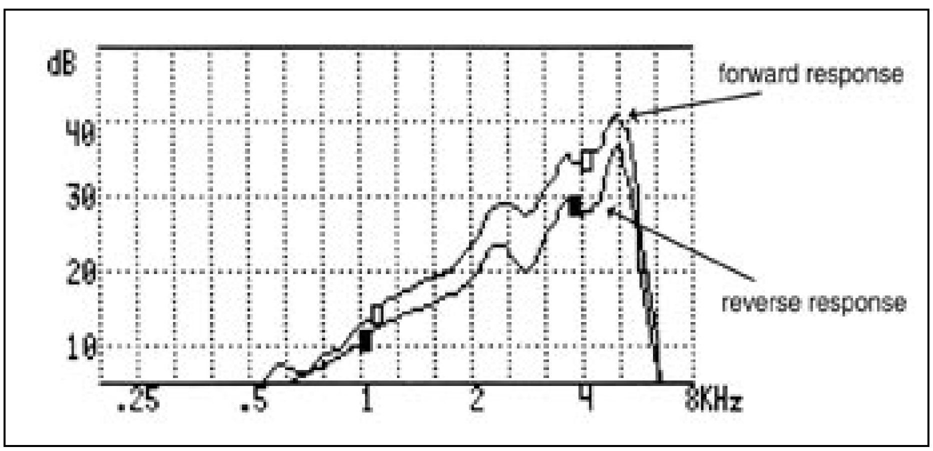


Figure 4.9C—Comparison of directional aid forward and reverse response

Chapter 5: Basic Sound Chamber Tests

In the Composite and Pure-Tone Modes of the 6500-CX, you can manually perform many useful coupler measurements. This chapter describes the composite and pure-tone signals and the tests you can perform.

5.1 Composite Mode

The Composite Mode is the default screen of the 6500-CX; whenever you press [RESET], you will return to this screen. The measurement uses a wide band composite test signal consisting of 80 frequencies presented all at once.

5.1.1 Composite Mode Sub-Modes

There are three different sub-modes available in the Composite Mode: WEIGHTED GAIN, WEIGHTED POWER, and flat-weighted power. Flip between these three sub-modes using [WEIGHT]. WEIGHTED GAIN is the default sub-mode that is displayed when you press [RESET].

WEIGHTED GAIN and WEIGHTED POWER use a speech-weighted composite signal with a spectrum that decreases at a rate of -6 dB per octave, starting with a 3-dB-down point of 900 Hz. When this signal is presented to a hearing aid, the response will give you information about how the aid responses to a speech-like input. WEIGHTED GAIN displays the response of the aid to this signal in dB GAIN (Output of the hearing aid minus the test signal.) WEIGHTED POWER displays the response of the aid to the signal in dB SPL (Output of the hearing aid including the test signal).

The third option available with the [WEIGHT] button gives you a flat-weighted signal and a blank line where WEIGHTED GAIN or WEIGHTED POWER is usually displayed. This composite signal contains no speech-weighting and is very difficult for many aids to handle. We suggest you use the flat-weighted COMPOSITE mode only when you want to see what happens to the response of a hearing aid in the presence of an unusually strong amount of high frequencies.

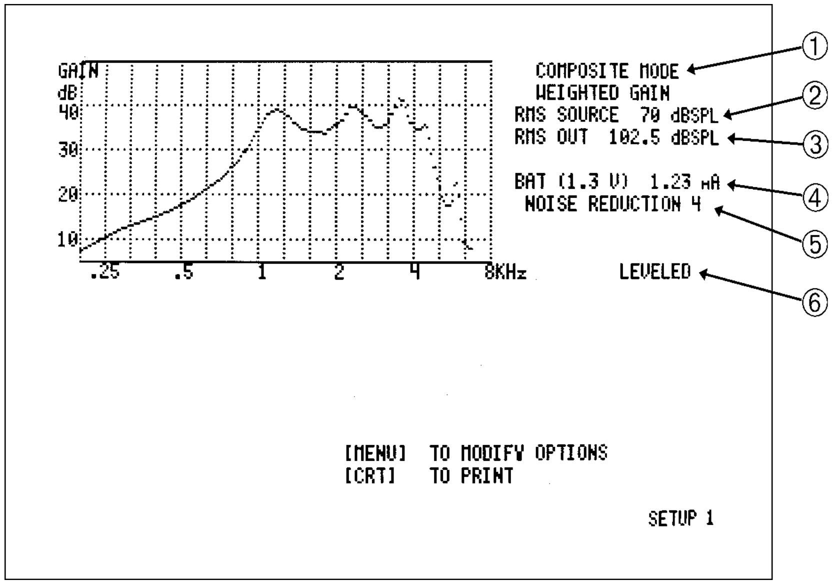


Figure 5.1.1—Composite Mode display

5.1.2 Composite Mode Display

1. COMPOSITE MODE Type: This will be WEIGHTED GAIN, WEIGHTED POWER, or have no label. No label means the analyzer is in flat-weighted mode. See above for more details.

2. RMS SOURCE: Root-Mean-Square, or "overall" amplitude of the test signal delivered by the loudspeaker to the reference position of the test chamber.

3. RMS OUT: Overall amplitude of the output of the hearing aid as measured by the coupler microphone.

4. BAT: Battery voltage drain. To get this reading, you will need to be using FONIX battery pills plugged into the battery voltage supply. See Section 3.5.1 for details. A reading of 0.00 mA or 0.01 mA implies no battery pills are being used for the test. If no battery drain reading appears on the screen, the battery current test is turned off in the General Setup Menu. See Section 3.3.

5. NOISE REDUCTION: Amount of averaging used in measurement. A higher noise reduction level leads to smoother curves but slower screen updates. Choose from 2, 4, 8, 16, or OFF. See Section 3.5.4.

6. Leveling status. See Section 4.1 for details.

5.1.3 Composite Mode Commands

The following describes the different commands you can do in the Composite Mode.

[∧, ∨]	Raises and lowers the source amplitude. The range is 40 to 90 dB SPL. The source turns OFF below 40 dB SPL. Turning the source OFF starts the Spectrum Analysis Mode (See Chapter 10).
[NOISE REDUCTION]	Changes the amount of noise reduction used in the response curve measurement. A higher number leads to smoother curves but slower screen updates.
[FREEZE]	Freezes a curve on the screen. This saves the last four measurements made. Scroll between these measurements with the [∧ and ∨] buttons. Push [FREEZE] again to resume measurements.
[CRT]	Prints the information displayed on the screen. See Chapter 9 for details. To get an identification label before the screen information, press the [LABEL] button before pressing [CRT].
[DATA]	Stops the measurement and shows you a numerical table of values from the last curve displayed.
[CURSOR]	Activates a cursor line that shows the exact response of a certain frequency. See Section 3.5.6 for details. Press [CURSOR] again to deactivate.
[RELATIVE]	After pressing [CURSOR], press [RELATIVE] to show how one point on the frequency response graph relates to another point. See Section 3.5.7 for details. Press [RELATIVE] or [CURSOR] to deactivate.

Optional Commands

[FREEZE] and [START]	Saves the frozen curve to the Multi-Curve stack. See Section 7.12.2 for details.
[MULTI]	Enters Multi-Curve mode which can display up to 4 different curves simultaneously. See Section 7.12.
[0/60]	Toggles between a 60 dB SPL source and turning the source off.
[CIC]	Turns on and off CIC software correction factors to be used with a CIC coupler. See Section 7.3 for details.
[OES]	Turns on and off OES software correction factors to be used with MZ couplers. See Section 7.14 for details.

5.1.4 Composite Maximum Output Tests – RMS vs. Spectrum Levels

The Root-Mean-Square (RMS) level of a signal is the overall power level of a signal. The RMS level is a summation of the effective power of each frequency component contained within a signal. Because the composite signal presents 80 frequencies all at once, the overall level of the signal (RMS level) will be several decibels higher than the level at any individual frequency (spectrum level). One might say that the overall power of the composite is the RMS-sum of the parts.

This concept is especially important when measuring the maximum output of a hearing aid. When using a composite signal to measure maximum output, **the effective power of the hearing aid is the RMS OUT level** (displayed to the right of the graph). Do not judge maximum output by spectrum levels (which are the values of the curve on the graph). Judging maximum output by spectrum levels could lead to an excessively high setting of the maximum output.

5.1.5 Intermodulation Distortion Test

The composite signal is ideal for testing a hearing aid for intermodulation (IM) distortion. IM distortion is very disruptive for the patient. With the composite signal, you can see immediately if IM distortion is present because the signal breaks apart when it is. Details of how to run this test are given in the Quick Reference Guide that accompanies this manual.

5.2 Pure-Tone Signals & Measurements

To enter Pure-Tone Mode, press the [SINE/COMPOSITE] button, in the SIGNAL section on the left of the front panel. When the green LED is out, you are testing with pure tones. (If in doubt, press [RESET] and then [SINE/COMPOSITE].)

Some hearing aids have a very long attack time. Therefore, a delay is necessary between each measurement so that there is no invalid measurement. The sweep delay may be set in the ANSI, the IEC, or the JIS menu. After that it will be effective in all pure-tone tests until the instrument is turned off or until you change it in these menus again.

5.2.1 Pure-Tone Mode Display

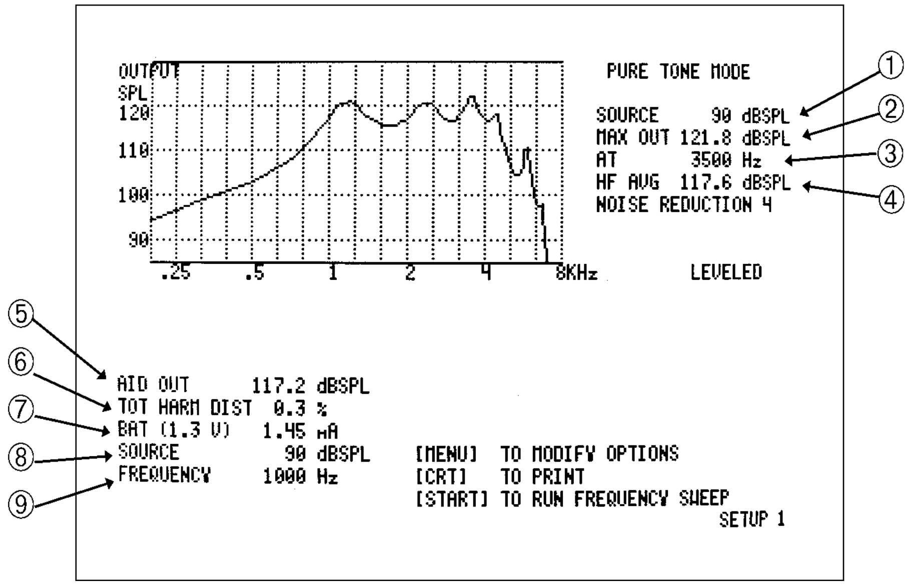


Figure 5.2.1—Pure-Tone Mode display

1. SOURCE: Source level of the displayed curve.
2. MAX OUT: Maximum output of the displayed curve.
3. AT: Frequency where maximum output occurred.
4. HF AVG: The average of the frequency responses at 1000, 1600, and 2500 Hz of the displayed curve. Known as the "high frequency average."
5. AID OUT: The sound pressure level as measured by the coupler microphone of the displayed frequency.
6. HARM DIST: The harmonic distortion as measured by the coupler microphone of the displayed frequency. The distortion type (2ND, 3RD, or TOTAL) is determined by the [HARMONIC DISTORTION] button. See Section 5.2.3 for details.
7. BAT: Battery voltage drain. To get this reading, you will need to be using FONIX battery pills plugged into the battery voltage supply. A reading of 0.00 mA or 0.01 mA implies no battery pills are being used for the test. If no battery drain reading appears on the screen, the battery current test is turned off in the General Setup Menu. See Section 3.5.1.
8. SOURCE: Current source level. This isn't necessarily the source level of the displayed curve.
9. FREQUENCY: Current frequency being generated and measured.

5.2.2 Pure-Tone Commands

The following describes the different commands you can do in Pure-Tone Mode.

[∧, ∨]	Raises and lowers the source amplitude. The range is 50 to 100 dB SPL. The source turns OFF below 50 dB SPL.
[<, >]	Changes the frequency of the current single tone measurement.
[START]	Run a pure-tone sweep at the selected amplitude.
[NOISE REDUCTION]	Changes the amount of noise reduction used in the response curve measurement. A higher number leads to smoother curves but slower screen updates.
[CRT]	Prints the information displayed on the screen. See Chapter 9 for details. To get an identification label before the screen information, press the [LABEL] button before pressing [CRT].
[DATA]	Gives you a numerical table of values from the last pure-tone sweep measured.
[CURSOR]	Activates a cursor line that shows the exact response of a certain frequency of a displayed curve. See Section 3.5.6 for details. Press [CURSOR] again to deactivate.
[RELATIVE]	After pressing [CURSOR], press [RELATIVE] to show how one point of the displayed curve relates to another point. See Section 3.5.7 for details. Press [RELATIVE] or [CURSOR] to deactivate.
[LINE]	Prints current AID OUT, HARM DIST, SOURCE, and FREQ.
[TITLE]	After [LINE], press [TITLE] to add a title for the printed information.

Optional Commands

[MULTI]	Enters Multi-Curve mode which can display up to 4 different curves simultaneously. See Section 7.12.
[0/60]	Toggles between a 60 dB SPL source and turning the source off. See Section 7.13.
[CIC]	Turns on and off CIC software correction factors to be used with a CIC coupler. See Section 7.3 for details.
[OES]	Turns on and off OES software correction factors to be used with MZ couplers. See Section 7.14 for details.
[AVG]	Run a three frequency average. See Section 7.2 for more details.

5.2.3 Harmonic Distortion Measurements

The harmonic distortion analyzer used in the FONIX 6500-CX measures the 2nd, the 3rd, or the total (2nd plus 3rd) harmonic distortion at every multiple of 100 Hz from 400 through 2500 Hz (2000 Hz with earlier software and with all automatic curves). Measurements are in percent, referred to the total signal at all frequencies combined.

(NOTE: In the ANSI, IEC, and JIS Options, harmonic distortion is measured only at the appropriate selected frequencies.)

5.2.3.1 Measurement precautions

To obtain accurate results from the distortion analyzer, observe the following precautions:

1. Operate the source amplitude at 60 to 70 dB SPL.
2. A hearing aid output of 80 dB SPL or more is recommended to get above noise levels.
3. Keep the sound chamber lid sealed.
4. Disregard distortion readings at frequencies where the response of the second harmonic is at least 12 dB greater than the fundamental (see Section 5.2.3.4). (This rule is automatically applied in ANSI, IEC, and JIS tests.)

5.2.3.2 Basic distortion test

1. Choose 2nd, 3rd, or TOTAL (2nd + 3rd) harmonic distortion by pushing the [HARMONIC DISTORTION] button repeatedly. The selection will be indicated by the LEDs next to the button and also by the display on the screen.
2. Push [START] to begin the frequency sweep. At the end of the sweep, a bar graph will appear showing the distortion readings at various frequencies. The scale at the right side of the graph gives the percentage. (If the source amplitude is 90 dB or more, the bar graph will not appear. However, the distortion percentage will still be displayed in numbers at the bottom of the screen.)
3. For a numerical list of the distortion readings at each frequency, push [DATA]. Numerical lists are not available for source amplitudes of 90 dB or greater. However, the numerical value of the distortion for the specified frequency is listed in the column of information at the bottom of the screen.
4. Push [CRT] to print.

5.2.3.3 Individual frequency distortion tests

Harmonic Distortion tests can be made and printed, for each multiple of 100 Hz from 400 to 2500 Hz (2000 Hz with earlier software), using the following procedure:

1. Choose 2nd, 3rd, or TOTAL (2nd + 3rd) harmonic distortion by pushing the [HARMONIC DISTORTION] button repeatedly. The selection will be indicated by the LEDs next to the button and also by the display on the screen. (For total harmonic distortion, both LEDs will be lit.)

2. Use the [<] or [>] button to select the test frequency.

3. Use the [∧] or [∨] button to select the source amplitude.

4. The harmonic distortion (in percent) will be displayed at the lower left of the screen.

5. Print the displayed numbers and headings by pushing [LINE] and then [TITLE].

6. By changing the amplitude and frequency of the source signal and by selecting different harmonic distortion settings, you can check and compare distortion with many different variables.

5.2.3.4 Distortion artifacts

At times, the distortion measurement may be the result of an artifact. Disregard distortion readings where the response curve rises 12 dB or more between the distortion frequency and its second harmonic.

For example, compare the output of the aid at 500 Hz and then at 1000 Hz (the second harmonic of 500 Hz). If the output at 1000 exceeds the output at 500 by more than 12 dB, ignore the distortion measurement for 500 Hz.

If the output of the aid is below 80 dB at a given frequency, the harmonic distortion measurement can be erroneous because of extraneous noise.

Chapter 6: ANSI Automated Test Sequences

The ANSI test sequence allows you to test hearing aids according to the ANSI S3.22 standard. You can use the ANSI test to control the quality of the hearing aids that you dispense. Compare the manufacturer's specifications with your own ANSI measurements of an aid. If they do not conform within expected tolerances, you can contact the manufacturer.

There are three versions of the ANSI S3.22 standard on the 6500-CX analyzer: ANSI 03, ANSI 96, and ANSI 87. As of the printing of this manual, ANSI 96 is the current standard to which the FDA requires hearing aid manufacturers to label their newly designed hearing aids. ANSI 03 will eventually replace this standard, but the date of the switchover is not yet known. Hearing aids designed before March 17, 2000 (and with no significant design changes after that date) can continue to be labeled to the older ANSI 87 standard.

Here are the major differences between ANSI 03 and ANSI 96:

- When you set up an AGC aid for an ANSI 03 test sequence, you will start with its compression controls set to minimum (with the compression knee point set as high as possible). Just before the input/output measurements, the test sequence will pause to allow you to set the compression controls of the aid to maximum (with the compression knee point set as low as possible). In ANSI 96, AGC aids are tested with their compression controls set to maximum for all measurements.

- When you adjust the gain control of the hearing aid midway through the ANSI 03 automated test sequence, the measured reference test gain value needs to be within 1.5 dB of the target value. In ANSI 96, the measured valued needs to be instead of within 1 dB of the target value.

- The EIN formula in ANSI 03 uses a 50 dB SPL input instead of the 60 dB SPL input used in ANSI 06. With ANSI 96, any aid with a compression knee point below 60 dB SPL showed artificially high EIN results. This means that ANSI 03 EIN test results should be better (lower) for AGC aids.

Here are the major differences between ANSI 96 and ANSI 87:

- ANSI 87 refered to the 90 dB pure-tone sweep as the "SSPL90" or "Saturation SPL with a 90 dB SPL input signal." ANSI 96 refers to the same curve as "OSPL90" or "Output SPL with a 90 dB SPL input signal."

- AGC aids are measured at full-on gain in ANSI 87, but at a reduced reference test gain in ANSI 96.

- The attack & release measurements use 55-85-55 levels in ANSI 87 and 55-90-55 levels in ANSI 96.

- Input/output curves and attack & release are measured only at 2000 Hz in ANSI 87, but are measured at a choice of 250, 500, 1000, 2000, and 4000 Hz in ANSI 96.

- The telecoil feature is only measured at 2000 Hz in ANSI 87, but an entire frequency sweep is made to measure the telecoil response in ANSI 96. Also, the device used to measure the telecoil was changed quite a bit in ANSI 96.

See the ANSI S3.22 standards for more details or check out our website at http://www.frye.com for articles and workbooks on the ANSI test sequences.

Also explained in this chapter is the ANSI 92 test sequence. ANSI 92 is based on the ANSI S3.42-1992 standard for non-linear hearing aids. It's a voluntary standard that is quite different than the ANSI S3.22 standard.

6.1 ANSI S3.22

The methods for setting up the hearing aid and leveling the sound chamber to ANSI specifications are described in this section.

6.1.1 Leveling

Before you run an ANSI test, you should make sure the sound chamber is leveled. Even if the screen says that the chamber is leveled, it is a good idea to periodically re-level it to account for any differences that might have entered into the testing environment.

For testing hearing aids precisely according to ANSI S3.22, the 6500-CX must be leveled to account for everything that is in the sound chamber at the time of testing. The equivalent substitution method (illustrated in Figure 6.1.1) is used to satisfy this requirement.

1. Place the dummy microphone (a black cylinder, provided with the ANSI option) into the coupler.

2. Attach the hearing aid to the coupler in the way appropriate for the type of aid under test. See Chapter 4. Insert the appropriate battery pill into the hearing aid, but **DO NOT** plug it into battery voltage supply.

3. Position the hearing aid/coupler assembly in the sound chamber with the microphone of the aid at the reference point.

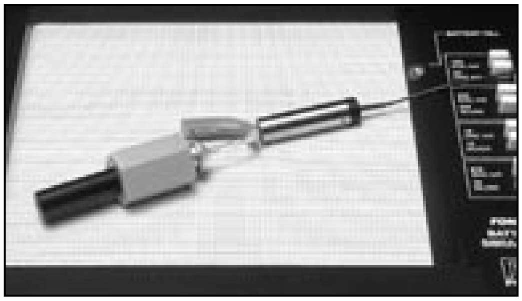
4. Place the test microphone as close to possible to the hearing aid microphone (5 ± 3 mm, about 1/5 inch), and close the lid. See Figure 6.1.1A.

5. Press [LEVEL].

6. When the leveling sequence is finished, exchange the posiitions of the dummy microphone and the test microphone and plug the battery pill into the battery voltage supply. See Figure 6.1.1B.

Whenever a significant change is made in the physical size and shape of the aid being tested, you should repeat this procedure and relevel the sound chamber.

Note: For most clinical purposes, the standard leveling procedure described in Section 4.1 is adequate.



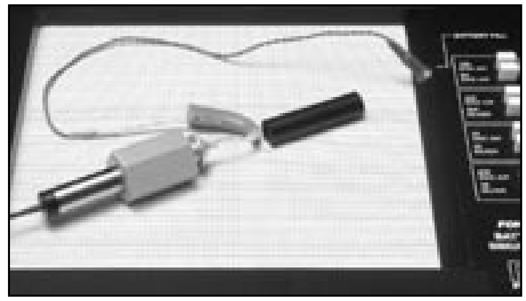


Figure 6.1.1A—Setup for leveling

Figure 6.1.1B—Setup for aid testing/ equivalent substitution method

6.1.2 ANSI Setup

The hearing aid controls must be set to conform with ANSI requirements for the test results to be valid.

1. Set the controls on the aid (except for the compression controls) to give the greatest possible output and gain.
2. Set the aid for the widest frequency response range.
3. For ANSI 96, set AGC aids to achieve the greatest possible compression or as other-wise specified by the manufacturer. For ANSI 03, set the compression controls to have minimum effect or as specified by the manufacturer.
4. If you are testing a digital hearing aid, put it in “test” mode if possible.
5. Set the gain control to full-on.
6. Make sure the sound chamber is leveled, as described in Section 6.1.1.

6.1.2.1 Setting up a Linear Aid

To test a linear hearing aid to ANSI 03, ANSI 96, or ANSI 87:

1. Press [RESET].
2. Press [ANSI].
3. Select the ANSI test you want to perform.
4. Press [MENU].
5. Use [∨, ∧] to select AID TYPE.
6. Use [>] to select LINEAR.

For ANSI 96 and ANSI 87, linear hearing aids can be tested at 60 dB or 50 dB SPL. Most linear hearing aids are tested at 60 dB SPL, but high gain, low output aids that may go into saturation at 60 dB are instead tested at 50 dB SPL. In ANSI 03, all aids are tested at 50 dB SPL.

If you are unsure which amplitude to use, check the manufacturer's specification or follow the instructions found in Section 6.3.4.

To switch between using a 50 dB input and a 60 dB input (this selection is not available in ANSI 03):

1. Highlight OPTIONS MENU using [v, ʌ] while in the ANSI menu.
2. Press [START].
3. Use the arrow keys to select the desired amplitude for FOG SOURCE AMPL.
4. Press [CONTINUE] twice to leave the ANSI menu.

For an explanation of other ANSI menu settings, see Sections 6.1.8 and 6.1.9.

6.1.2.2 Setting up an AGC Aid

There are two aid type settings for AGC aids: AGC and ADAPTIVE AGC. The only difference between these two settings is that ADAPTIVE AGC presents each tone in the test sequence for a longer period of time before taking the measurement, thus allowing the hearing aid to adjust to the signal. This was originally designed for hearing aids with adaptive release times, but it can also be used for digital hearing aids that may require more time to adjust to the signal during the test sequence.

To change the aid type to AGC or ADAPTIVE AGC:

1. Press [RESET].
2. Press [ANSI].
3. Select the ANSI test you want to perform by using [v, ʌ].
4. Press [MENU].
5. Use [v, ʌ] to select AID TYPE.
6. Use [>] to select AGC or ADAPTIVE AGC.

When you run the ANSI 03 or ANSI 96 sequence on an AGC aid, you may run up to five different input/output curves and attack & release measurements. The frequencies that you can choose from are 250, 500, 1000, 2000, and 4000 Hz. (ANSI 87 only runs AGC tests at 2000 Hz.)

To turn on and off AGC frequencies:

1. Highlight AGC MENU using [∨, ∧] while in the ANSI menu.
2. Press [START].
3. Use the arrow keys to turn ON and OFF I/O and attach & release measurements at the displayed frequencies.

In ANSI 03, you can choose whether or not you want to change the compression controls midway through the test. According to the ANSI standard, AGC aids should be set to have minimum compression at the beginning of the test and maximum compression for the AGC part of the test. However, if you don't want to adjust the compression controls during the test sequence, you can set the analyzer to skip the pause it usually makes in the test sequence to allow you to adjust the compression controls.

To do this, adjust the AGC SWITCH selection in the AGC menu. A choice of ON will include the pause in the test sequence that will allow you to adjust the compression controls. A choice of OFF will remove the pause from the test sequence.

For an explanation of other ANSI menu settings, see Sections 6.1.8 and 6.1.9.

6.1.3 Running an ANSI 03 or ANSI 96 Test

After making any necessary menu selections as described in Section 4.1.8, leveling the sound chamber as described in Section 6.1.1, and setting up the aid as described in Section 6.1.2, follow these instructions:

1. Press [RESET].
2. Press [ANSI]. This will open the ANSI selection menu.
3. Use [∨, ∧] to select the ANSI test of your choice: ANSI 03 or ANSI 96.
4. Press [MENU] to make any changes to the ANSI settings. See Section 6.1.8 for details. [CONTINUE] exits from the menu.
5. Press [START] to begin the test.
6. The 6500-CX will usually pause during the measurement process in order to let you adjust the gain of the hearing aid to the reference test position.
    a. Lift the sound chamber lid and adjust the gain control of the aid until the HF AVG MEASURED gain matches HF AVG TARGET gain. The MEASURED gain should be within 1 dB of the TARGET gain. (ANSI 03 only requires that you match the target within 1.5 dB.)
    b. Close the sound chamber lid when finished.

7. If you have selected TELECOIL: ON in the ANSI menu, do the following when the sequence stops for the telecoil measurement. Otherwise, skip to the next step.

   a. Open the lid of the sound chamber.

   b. Switch the aid to telecoil mode.

   c. Hold the aid in your hand where there is the least amount of magnetic noise. This doesn't necessarily have to be in the sound chamber because the magnetic field produced for the test is going to come from the telewand, not the chamber. To guide you, a continous readout of the output is on the screen.

   d. Plug the telewand into the side of the sound chamber, just below the cable that connects the sound chamber to the Frye box. (Older 6500 units may have a different setup.)

   e. Hold the telewand in position as if you were holding a telephone receiver against the aid. That is, the flat surface of the end of the wand should be against the faceplate of an ITE or parallel to the body of a BTE. The aid should be in a vertical positioning in order to get a good telecoil response. You may also want to turn off the 6500-CX monitor to avoid the magnetic noise it produces during the telecoil test.

   f. Press [CONTINUE] to measure the telecoil response. You will hear a pure-tone sweep from the chamber as an audio cue that the test is running.

   g. When the test sequence stops again, return the aid to normal microphone mode, reposition it in the sound chamber, close the lid of the chamber, and press [CONTINUE]. If you have turned off your video monitor, you can turn it on again at this time.

8. If you are measuring to ANSI 03, have set the aid type to AGC or ADAPTIVE, and have set AGC SWITCH to ON in the AGC menu, the analyzer will pause again after several measurements have been taken. Adjust the AGC controls of the aid to have maximum effect (or as specified by the manufacturer) and press [START] again to complete the test sequence.

9. Wait until the test sequence is complete.

10. Press [v] to view the telecoil curve, the input/output curves, and attack and release times.

11. Press [CRT] for a hard copy of the results.

6.1.4 Viewing ANSI 96 Results

This section describes the ANSI 96 test results. ANSI 03 results are similar.

Refer to Figure 6.1.4A and 6.1.4B for the following explanation of the graphical display:

1. OSPL 90 curve: full-on gain frequency sweep taken at 90 dB SPL.

2. RESP 50 curve: reference test gain frequency sweep taken at 50 dB SPL.

3. MAX OSPL90: Maximum output of the aid and the frequency at which it occurs.

4. HF AVG: Three-frequency average of the OSPL90 curve.

5. HF AVG FULL ON GAIN: Three-frequency average taken at full-on gain at the amplitude of the response curve.

6. REFERENCE TEST GAIN TARGET: Target reference test gain to aim for when lowering the gain of the hearing aid.

7. REFERENCE TEST GAIN MEASURED: Actual reference test gain achieved.

8. RESP LIM: The response limit level is determined by taking the three frequency average of the RESP 50 curve and subtracting 20 dB.

   F1 is where the RESP 50 curve crosses the response limit level on the way up.

   F2 is where the RESP 50 curve crosses the response limit level on the way down.

9. THD: Total harmonic distortion and the frequencies and amplitudes at which they are taken.

10. EQ INP NOISE: equivalent input noise measurement.

11. BAT: Battery current drain.

12. HFA-SPLITS: Three-frequency average of the telecoil response curve.

13. STS-SPLITS: Difference between the three-frequency average of the microphone curve and the HFA-SPLITS. (This is referred to as RSETS in ANSI 03.)

14. I/O curves: Input/output curves

15. Attack and release measurements

16. SPLITS: telecoil response curve.

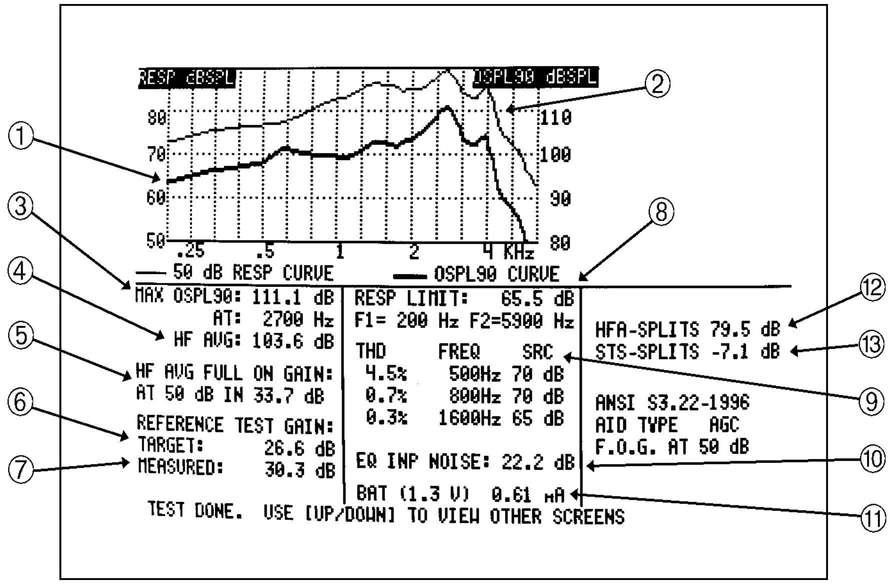


Figure 6.1.4A—ANSI 96 results, frst screen

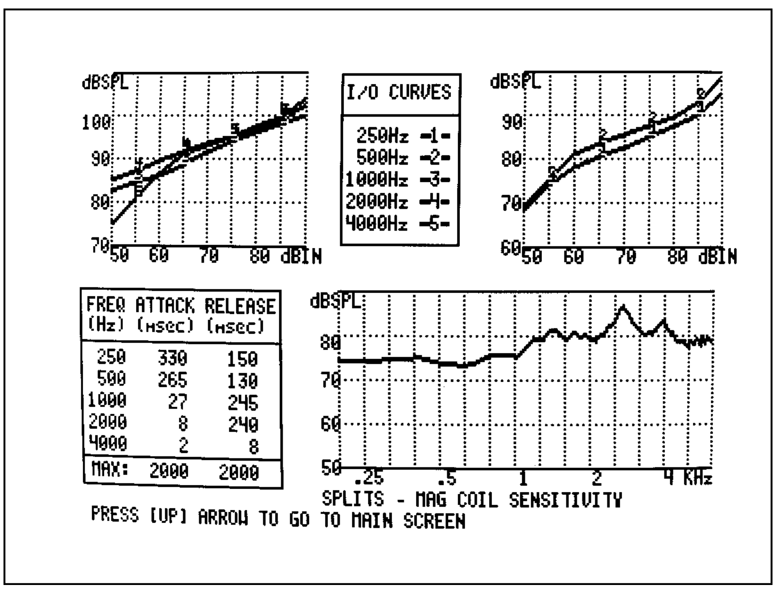


Figure 6.1.4B—ANSI 96 results, second screen

6.1.5 Running an ANSI 87 Test

After making any necessary menu selections as described in Section 4.1.8, leveling the sound chamber as described in Section 6.1.1, and setting up the aid as described in Section 6.1.2, follow these instructions:

1. Press [RESET].
2. Press [ANSI]. This will open the ANSI selection menu.
3. Use [∨, ∧] to select the ANSI 87.
4. Press [START] to begin the test.
5. If you have selected TELECOIL: ENABLED in the ANSI menu, do the following when the sequence stops for the telecoil measurement. Otherwise, skip to the next step.
   a. Open the lid of the sound chamber.
   b. Switch the aid to telecoil mode.
   c. While viewing TELECOIL OUTPUT in the lower center of the screen, position the hearing aid in the sound chamber until you find the spot that gives the highest output with the least variability. Usually the best position is with the hearing aid held in the vertical position. (Newer 6500-CX models have a build-in telecoil board inside the sound chamber, but if you are using an older 6500 model, you may have to do this over an external telecoil board.)
   d. Press [CONTINUE] to measure the telecoil response. The 6500-CX video monitor produces a fair amount of magnetic noise, so for most accurate results, turn it off before pressing [CONTINUE]. Turn it back on to resume testing.
   e. Switch the aid back to the normal microphone position, reposition it in the sound chamber, close the lid of the chamber, and press [CONTINUE] to resume the test sequence.
6. If you have set the AID TYPE to LINEAR (see Section 6.1.2), the ANSI sequence may pause during the measurement process in order to let you adjust the gain of the hearing aid to the reference test position.
   a. Lift the sound chamber lid and adjust the gain control of the aid until the HF AVG MEASURED gain matches HF AVG TARGET gain. The MEASURED gain should be within 1 dB of the TARGET gain.
   b. Close the sound chamber lid when finished.
7. Wait until the test sequence is complete.
8. Press [CRT] to print a hardcopy of the test results.

6.1.6 Viewing ANSI 87 Results

Refer to Figure 6.1.6.

1. **SSPL 90** curve: full-on output frequency sweep taken at 90 dB.

2. **RESP curve**: frequency sweep taken at 50 dB
3. **I/O curve**: input/output curve at 2000 Hz (AGC aids only).
4. **MAX SSPL90**: Maximum output of the aid at the frequency where it occurs.
5. **HF AVG**: High (or special) frequency average of 90 dB response curve.
6. **HF AVG FULL ON GAIN**: High (or special) frequency average gain.
7. **REFERENCE TEST GAIN**: Gain of aid when measuring RESP curve. Linear aids will usually include a second “target” value to aim for when turning down the gain of the aid.
8. **RESP LIMIT**: The response limit is determined by taking the three frequency average of the 50 dB response curve and subtracting 20 dB.

   F1 is where the RESP curve crosses the response limit level on the way up.

   F2 is where the RESP curve crosses the response limit level on the way down.
9. **THD**: total harmonic distortion and the frequencies and amplitudes at which they are taken.
10. **EQ INP NOISE**: equivalent input noise measurement. This will occur in AGC measurements only when specified in the Setup Menu.
11. **BAT**: Battery current drain
12. **ATTACK**: Measured attack time (AGC aids only)
13. **RELEASE**: Measured release time (AGC aids only)
14. **1 kHz COIL**: Telecoil measurement

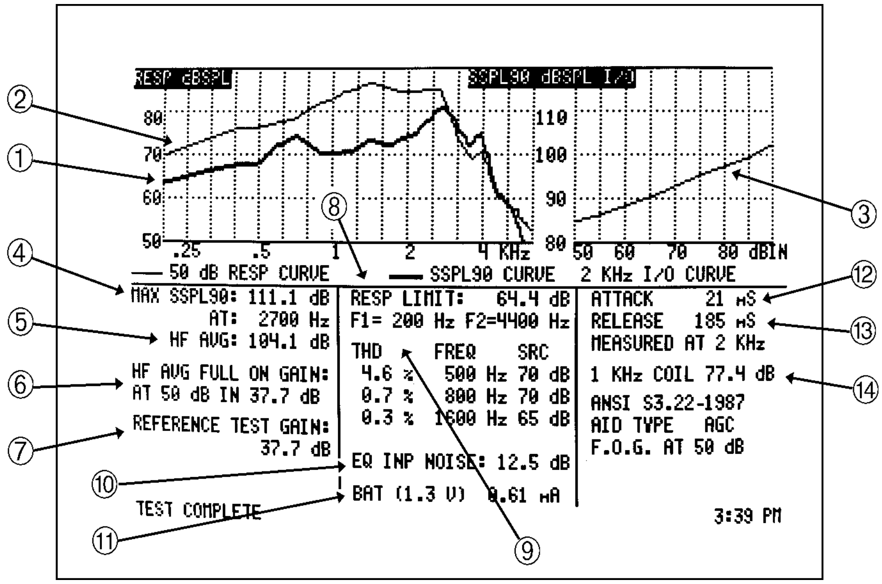


Figure 6.1.6—ANSI 87 results

6.1.7 Testing Digital Hearing Aids

The ANSI S3.22 "labeling" standard for hearing aids was not designed with digital hearing aids in mind. In fact, most of the testing methods employed by ANSI have been around since the 1970s. However, since ANSI is a standard, in order to conform to that standard, it must use only the testing techniques outlined in the standard. For this reason, **the 6500-CX has no provisions for incorporating composite or digital speech into the ANSI test sequences.**

In order to test digital hearing aids with "noise reduction" or "speech enhancement" features to the ANSI 96 or ANSI 03 standards, put the aid in "test" mode via its programming software and do the steps outlined in Section 6.1.2.

In order to get an accurate picture of the aid's actual performance when it goes home with your client, put the aid in the mode you will use for that client, and perform response curve measurements in the coupler and in the real-ear via the procedures described in Sections 7.4 and 8.4.6 using the digital speech signal source.

6.1.8 ANSI 03 and ANSI 96 Menu Settings

This section contains information on ANSI 96 and ANSI 03 settings.

6.1.8.1 Main Settings

Press [ANSI], select the ANSI test with the arrow keys, and press [MENU] to enter the ANSI 03 or ANSI 96 menu. Here are the selections:

AID TYPE: Choose LINEAR for linear aids, AGC for most AGC aids, and ADAPTIVE AGC for AGC aids with adaptive compression or digital aids that may need more time to adjust to the test signals.

TELECOIL: Select ON to include a telecoil measurement in the test sequence.

AVG FREQS: The three frequencies used in the ANSI three frequency averages. If the manufacturer doesn't specify the frequencies, use the HFA (1000, 1600, 2500). Otherwise, choose the SPA combination closest to the frequencies specified by the manufacturer.

HDIST 12 dB: Status of the harmonic distortion rule. The ANSI standard states that when measuring harmonic distortion, if the amplitude of the response curve at second harmonic of the distortion frequency is 12 dB greater than the response curve at the distortion frequency, the harmonic distortion measurement should be ignored. Choose ON to apply this rule. Choose OFF to ignore this rule.

EAR: Ear tested. Select LEFT, RIGHT, or NONE. When NONE is selected, the ear will not be labeled on the ANSI results.

6.1.8.2 Options Menu

Highlight OPTIONS MENU in the ANSI Menu with the arrow keys and press [START] to enter the Options Menu.

FOG SOURCE AMPL: Full-on gain source amplitude. For AGC and ADAPTIVE AGC aids, this is always 50 dB SPL. For LINEAR aids, use 60 dB SPL for most aids and 50 dB for aids with high gain and low output. See Section 6.1.2 for details. This setting is not available for ANSI 03.

PRINTOUT: Select how the ANSI test sequence results are printed. CURRENT SCREEN will print only the current displayed test results. ALL SCREENS will print all results when the [CRT] button is pressed.

To exit from the Options Menu, press [CONTINUE].

6.1.8.3 AGC Menu

Highlight AGC MENU in the ANSI Menu with the arrow keys and press [START] to enter the AGC Menu.

AGC SWITCHING: Choose whether or not to include a pause in the test sequence that will allow you to adjust the compression controls of the AGC aid from minimum to maximum. A selection of ON will include the pause. A selection of OFF will remove the pause. This setting is available only when ANSI TEST is set to S3.22-2003. (See Section 6.1.2.)

FREQUENCY SELECTIONS: Turn ON or OFF input/output and attack & release measurements at the displayed frequencies.

ATTACK WINDOW: The amount of time the analyzer measures the attack time of the hearing aid. Select a time that is at least twice as long as the attack time specified by the manufacturer.

RELEASE WINDOW: The amount of time the analyzer measures the release time of a hearing aid. Select a time that is at least twice as long as the release time specified by the manufacturer.

To exit from the AGC Menu, press [CONTINUE].

6.1.8.4 Delay Menu

Highlight DELAY MENU in the ANSI Menu with the arrow keys and press [START] to enter the Delay Menu.

SWEEP DELAY: The amount of time the analyzer presents each tone in a pure-tone sweep before measuring the response and proceeding to the next frequency.

START DELAY: The amount of time the analyzer presents the first tone of a pure-tone sweep before measuring the response. Thiis allows the analyzer time to adjust to the amplitude of the pure-tone sweep.

I/O START DELAY: The amount of time the analyzer presents the first tone of an input/output measurement.

I/O MEAS DELAY: The amount of time the analyzer presents each tone in an input/output measurement before measuring the response and proceedig to the next level.

To exit from the Delay Menu, press [CONTINUE].

6.1.9 ANSI 87 Settings

6.1.9.1 Main Settings

AID TYPE: Choose LINEAR for linear aids, AGC for automatic gain control aids, and ADAPTIVE AGC for AGC aids with adaptive release times. Select an AGC aid type WITH EIN to perform an equivalent input test with the test sequence.

FULL ON GAIN: Full-on gain source amplitude. For AGC and ADAPTIVE AGC aids, this is always 50 dB. For LINEAR aids, use 50 dB for aids that have high gain and relatively low output. See Section 6.3.4 for details.

TELECOIL: Select ENABLED to include a telecoil measurement.

AVERAGE FREQUENCIES: If the manufacturer does not specify the average frequencies, use the HFA frequencies (1000, 1600, 2500). Otherwise, choose the SPA combination closest to the frequencies specified by the manufacturer.

6.1.9.2 Delay Settings

To enter the DELAY sub-menu, highlight DELAY MENU and press [START]. To exit from a menu, press [CONTINUE]. **Any settings you make here will also reflect on all other pure-tone and I/O measurements made outside ANSI.**

SWEEP DELAY: The amount of time the analyzer presents each tone in a pure-tone sweep before measuring the response and proceeding to the next frequency.

START DELAY: The amount of time the analyzer presents the first tone of a pure-tone sweep before measuring the response. This allows the analyzer to adjust to a new pure-tone sweep level.

I/O START DELAY: The amount of time the analyzer presents the first tone of an input/**output measurement.**

I/O MEAS DELAY: The amount of time the analyzer presents each tone in an input/output measurement before measuring the response and proceeding to the next level.

To exit from the Delay Menu, press [CONTINUE].

6.2 VA-CORFIG Option

The Veteran's Administration has developed correction factors for the frequency response measured on a 2-cc coupler, so the measurement will be closer to that of an actual ear. The V.A. requires hearing aid manufacturers to supply corrected curves with every in-the-ear aid delivered under its contracts. The VA-CORFIG Option is available with ANSI 87 and ANSI 96 but must be ordered separately. To use the VA-CORFIG Option:

1. Run ANSI 87 or ANSI 96 test. If you wish the CORFIG graph added to the ANSI graph on a continuous strip of paper, press [CRT] to print the ANSI results, but do not tear the paper off when the printing is finished.

2. Once the ANSI test is completed, press the [∧] key. A new graph will appear in the top half of the screen, labeled: ESTIMATED INSERTION RESPONSE. See Figure 6.2.

3. Print this curve by pressing [CRT].

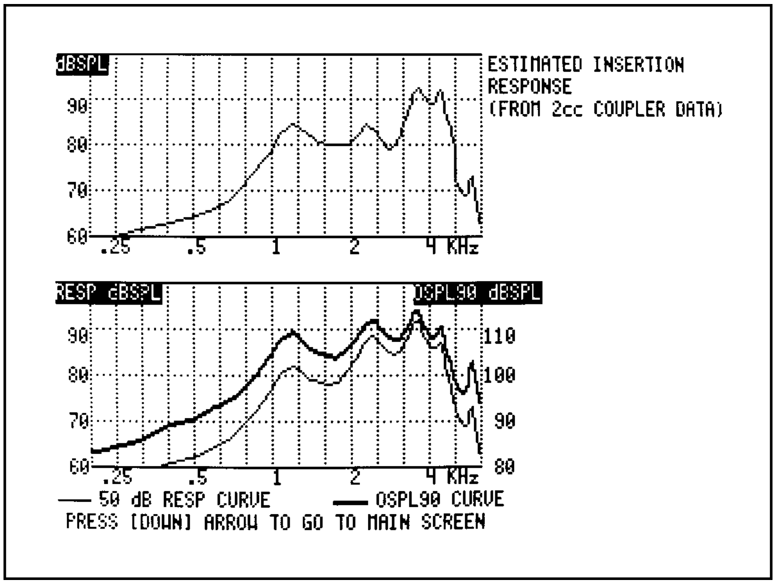


Figure 6.2—VA-CORFIG results

6.3 Manual ANSI Measurements

All the tests in the ANSI S3.22 standard, with the exception of attack and release times, can be done manually on the FONIX 6500-CX. It is desirable that students and others new to hearing aid testing understand how to run the standard tests manually before relying on the computer-controlled ANSI Option.

See Section 6.1 for instructions on how to level the sound chamber and set up the hearing aid according to ANSI specifications.

6.3.1 Pure Tone Mode

All ANSI S3.22 measurements are made in Pure Tone Mode. To enter Pure Tone Mode:

1. Press [RESET].
2. Press [SINE/COMPOSITE].

You are now ready to perform the manual ANSI measurements.

6.3.2 High Frequency Average (HFA) vs. Special Purpose Average

The High Frequency Average (HFA) is the average of the hearing aid output or gain at three frequencies. The standard "high-frequency-average" (HFA) frequencies are 1000, 1600, and

2500 Hz. Under specified conditions, however, the ANSI S3.22 standard allows manufacturers to designate different frequencies, called “special-purpose-average” (SPA) frequencies, for instruments that do not work maximally at the standard HFA frequencies (for example, with “high-frequency-emphasis” instruments). Check the manufacturer’s specifications. When SPA frequencies are designated, use the designated frequencies instead of the HFA frequencies.

To get the HFA without the AVG Option:

1. Using the [∨, ∧] keys to select the desired amplitude.
2. Press [START] to run a pure-tone sweep.
3. After the test has completed, the HF AVG will be displayed on the screen.
4. If you want an SPA instead:
    a. Press [DATA].
    b. Find the amplitudes of the three frequencies of your SPA.
    c. Find the average of those values.

If you have the AVG Option:

1. Press [MENU].
2. Press [AVG].
3. Select FREQUENCIES with [∨, ∧] if necessary.
4. Use [<, >] to select desired HFA/SPA values.
5. Press [START].

The selected three frequency average will be selected and displayed on the screen.

6.3.3 OSPL 90 Curve, Maximum SPL, and HFA-OSPL 90

Both ANSI 87 and ANSI 96 contain frequency response measurements at 90 dB SPL. ANSI 87 refers to this measurement as SSPL 90. ANSI 96 refers to this measurement as OSPL 90.

1. Use the [∨, ∧] keys to set the SOURCE amplitude to 90 dB SPL.
2. Push [START] to run the OSPL 90 curve.
3. Maximum Sound Pressure Level and High Frequency Average data are given to the right of the graph.

To calculate any SPA frequencies, see Section 6.3.2.

6.3.4 Determining the Source for Linear Hearing Aids

In ANSI 03, the source amplitude for the response curve of all hearing aids is always 60 dB SPL. In ANSI 96 and ANSI 87, most linear aids are tested at 60 dB SPL, but high gain aids are tested at 50 dB SPL when there is a danger of them going into saturation at 60 dB. Check the specification of the hearing aid to determine the appropriate signal. If specifications are unavailable, use the following procedure.

If you have the Multi-Curve Option:

1. Set the hearing aid to full-on gain.
2. Use the [∨, ∧] keys to set the SOURCE amplitude to 90 dB SPL.
3. Press [START/STOP] to run the pure-tone sweep measurement.
4. Use the [∨, ∧] keys to set the SOURCE amplitude to 60 dB SPL.
5. Press [START/STOP] to run the pure-tone sweep measurement.
6. Press [MULTI].
7. Select SUBTRACT CURVES with [∨, ∧] keys.
8. Press [START].
9. Using the arrow keys, select CRV 1 for SUBTRACT and CRV 2 for FROM.
10. Press [DATA].
11. If any value between 200 and 5000 Hz is less than 4 dB, use a 50 dB full-on gain source in the ANSI tests. Otherwise, a 60 dB source is appropriate.

If you don’t have the Multi-Curve Option:

1. Set the hearing aid to full-on gain.
2. Use the [∨, ∧] keys to set the SOURCE amplitude to 90 dB SPL.
3. Press [START/STOP] to run the pure-tone sweep measurement.
4. Press [CRT] to print the results.
5. Use the [∨, ∧] keys to set the SOURCE amplitude to 60 dB SPL.
6. Press [START/STOP] to run the pure-tone sweep measurement.
7. Press [CRT] to print the results.
8. Compare the two graphs. If the difference between the amplitude of these two graphs is more than 4 dB at any frequency between 200 and 5000 Hz, use a 50 dB source. Otherwise, use a 60 dB source.

6.3.5 HFA Full-on Gain

1. Press the [HARMONIC DISTORTION] button repeatedly until both LEDs are out (indicating the harmonic distortion measurement is turned off).

2. Use the [∨, ∧] buttons to set the SOURCE amplitude to either 50 or 60 dB SPL. See Section 6.3.4 to determine which source to use.

3. Set the hearing aid to full-on gain.

4. Follow the directions in Section 6.3.2 to find the HFA or SPA value.

5. Subtract the source amplitude (50 or 60) to get the gain or use the [GAIN] button.

6.3.6 Reference Test Gain

ANSI 03 & ANSI 96:

AGC & Linear aids: Subtract 77 dB from the HFA (or SPA) OSPL 90 found in Section 6.3.3. If this number is smaller than the HFA full-on gain found in Section 6.3.5, then the reference test gain is this value. Otherwise, the reference test gain is full-on gain.

ANSI 87:

Linear aids: Subtract 77 dB from the HFA (or SPA) SSPL 90 found in Section 6.3.3. If this number is smaller than the HFA full-on gain found in Section 6.3.5, then the reference test gain is this value. Otherwise, the reference test gain is full-on gain.

AGC aids: The reference test gain is always full-on gain.

6.3.7 Reference Test Position of the Gain Control

For many aids, the gain control must be turned down to the reference test position for most of the ANSI measurements. See Section 6.3.6 to determine if the hearing aid volume needs to be turned down. If it does, follow these instructions:

1. Set the source amplitude to the same level used for the full-on gain measurement: 50 or 60 dB SPL.

2. Set the source frequency to one of the HFA or SPA frequencies used for the full-on gain HFA/SPA.

3. After observing the aid output on the screen, turn the gain control on the hearing aid down until the output comes down the number of dB found in Step 1.

To you have the correct setting, measure the appropriate three-frequency average gain with a 60 dB SPL or 50 dB SPL source. (See Section 6.3.2.) If the result is within 1 dB of the target reference test gain from 6.3.6, the position is correct. If not, adjust the gain control and re-verify.

6.3.8 Frequency Response Curve

1. Use the [∨, ∧] buttons to set the SOURCE amplitude to either 50 or 60 dB SPL. See Section 6.3.4 to determine which source to use.

2. With the hearing aid gain control at the reference test position (see Sections 6.3.6 and 6.3.7), push [START] to run the frequency response curve.

3. Press [CRT] to print the results.

6.3.9 Frequency Range (and Response Limit)

1. Subtract 20 dB from the reference test gain (found in Section 6.3.6).

2. Add the result to the source amplitude used to run the frequency response curve (50 or 60 dB SPL). This level is called the "response limit".

3. Draw a horizontal line across the frequency response graph from Section 6.3.9 at the level of the response limit.

4. The two points at which the horizontal line intersects the frequency response curve are the low and high points ("f_1" and "f_2") of the frequency range. See Figure 6.3.9.

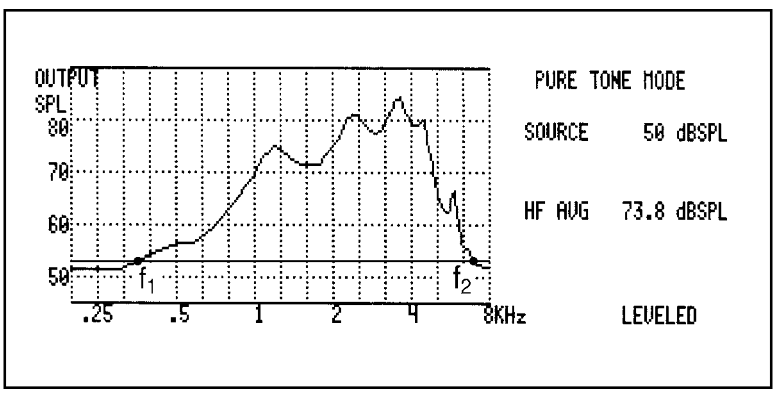


Figure 6.3.9—Frequency range

6.3.10 Harmonic Distortion Measurement

1. Set the harmonic distortion measurement for TOT (total) by pressing the [HARMONIC DISTORTION] button until both LEDs are lit.

2. Set the source amplitude to 70 dB SPL.

3. Observe the TOT HARM DIST readout at the lower left of the screen:

If you used HFA frequencies for averages earlier, measure the total harmonic distortion for 500 and 800 Hz.

If you used SPA frequencies for averages earlier, measure the total harmonic distortion for frequencies that are one-half the lower two SPA frequencies (or nearest multiples of 100 Hz).

4. Set the source amplitude for 65 dB SPL.

5. If you used HFA frequencies for averages earlier, measure the total harmonic distortion for 1600 Hz.

   If you used SPA frequencies for averages earlier, measure the total harmonic distortion for one-half the highest SPA frequency (or nearest multiple of 100 Hz).

   NOTE: Sometimes you should ignore a harmonic distortion reading, because the reading might be confounded by an artifact. When the frequency response curve rises 12 dB or more between any distortion frequency and its second harmonic, ignore the harmonic distortion reading. [The second harmonic is twice the original frequency. For example, if the level of the frequency response curve at 1000 Hz is 12 dB higher (or more) than the level at 500 Hz, ignore the harmonic distortion measurement for 500 Hz.]

6.3.11 Equivalent Input Noise (EIN) Measurement

The "equivalent input noise" is a measurement of the internal noise of the hearing aid. It is a very difficult measurement to make accurately because it requires the analyzer to have a very low noise floor. It also assumes that the aid is behaving linearly up to the source level where part of the EIN is taken.

To take the EIN measurement:

1. Set the hearing aid to the reference test gain (See Section 6.3.6) and place it in the chamber.

2. For ANSI 96: Select a source level of 60 dB with the [∧, ∨] keys.
   For ANSI 87 and ANSI 03: Select a source level of 50 dB with the [∧, ∨] keys.

3. Find the HFA/SPA value by following the instructions found in Section 6.3.2.

4. Use the source off by repeatedly pressing the [∨] key.

5. Find the RMS OUT value, as displayed on the screen to the right of the measurement graph.

6. For more accurate results, repeat Step 5 several times and take an average of the results.

7. Subtract the result found in Step 3 from the result found in Step 6. This is the equivalent input noise.

Possible problems with 6500-CX system noise

The 6500-CX has an equivalent input noise specification of less than 50 dB SPL. This means that, while it is able to perform an accurate EIN test of most hearing aids, it could have problems with some low-gain hearing aids.

To check if the analyzer is adequate to perform the EIN for a particular aid:

1. Place the hearing aid/coupler setup in the sound chamber, with the gain control of the aid set to user gain.
2. Press [RESET] to enter Composite Mode.
3. Press [∨] repeatedly until the source of the analyzer is off.
4. Note the RMS output.
5. Switch the hearing aid off.
6. Note the RMS output. If it hasn't dropped by at least 6 dB, the EIN is suspect.

Possible problems with compression hearing aids
One half of the EIN measurement is made at either 50 dB (for ANSI 87) or 60 dB (for ANSI 96). If the aid being tested has a compression kneepoint below this level, then the EIN results will be artificially high. This is particularly a problem for ANSI 96 because many modern hearing aids have kneepoints below 60 dB SPL.

Note: For some AGC hearing aids, the EIN measurement will be higher for ANSI 96 than it is for ANSI 87. This is because the input level of the test is at 60 dB for ANSI 96 and 50 dB for ANSI 87. If the aid has a compression kneepoint between 50 and 60 dB, then the ANSI 96 EIN results may be higher than the ANSI 87 EIN results.

6.3.12 Input/Output Curves

Input/Output curves are required measurements for AGC hearing aids. ANSI 87 requires only one I/O measurement at 2000 Hz. ANSI 96 gives you a choice of up to 5 different I/O measurements at 250, 500, 1000, 2000, 4000 Hz.

If you have the I/O Option:

1. Follow the instructions in Section 6.3.1 to put the analyzer in Pure Tone Mode.
2. Press [MENU].
3. Press [I/O].
4. Select I/O FREQUENCIES with the [∧, ∨] keys.
5. Select the desired I/O frequency with the [<, >] keys.
6. Press [START].

If you don't have the I/O Option:

1. Follow the instructions in Section 6.3.1 to put the analyzer in Pure Tone Mode.
2. Set the source frequency to the desired frequency using [<, >].
3. Set the source amplitude to 50 dB SPL using [∧, ∨].
4. Record the aid output by pressing [LINE].
5. Repeat steps 3 and 4 for source amplitudes of 55, 60, 65, 70, 75, 80, 85, and 90 dB SPL.
6. Print headings for the LINE data by pressing [TITLE].
7. On linear graph paper, draw equal dB-SPL scales for the inputs (source amplitudes) you used and the outputs you recorded; use the horizontal scale for input dB SPL and the vertical scale for output dB SPL.
8. Transfer the data collected in steps 1 through 4 to the graph.
9. Repeat steps 2 through 8 for subsequent frequencies.

6.3.13 Telecoil Measurements

See Section 7.19 for more details on making telecoil measurements.

6.3.13.1 ANSI 96

1. Press [MENU].
2. Press [COIL].
3. Select ANSI 96 using [<, >].
4. Set the hearing aid's gain control in the reference test position. See Section 6.3.6 and Section 6.3.7 for more details.
5. Switch the aid to telecoil mode.
6. a. If you are taking the telecoil measurement with the telewand, plug it into the side of the sound chamber and hold it next to the aid as if you would hold a phone receiver next to an aid.

   b. If you want to take the telecoil measurement using the internal telecoil board in the 6050 sound chamber, make sure that the telewand isn't plugged into the side of the chamber.
7. Press [START] to measure telecoil response (SPLITS) curve.
8. Find the HFA or SPA of the SPLITS curve. See Section 6.3.2 for more details.

9. Subtract the reference test gain plus 60 dB from the value found in Step 8. This is the STS-SPLITS value which is used as an indication of how much the user would have to turn up or down his hearing aid to get the same frequency response in telecoil mode as in normal microphone mode.

6.3.13.2 ANSI 87

1. Set the hearing aid to full-on gain and place in the test box or on an external telecoil board.
2. Press [MENU].
3. Press [COIL].
4. Select ANSI 87 using [<, >].
5. Press [START].
6. Record the telecoil output for a 1000 Hz tone, displayed at the bottom of the screen.

6.4 ANSI S3.42

The ANSI Option includes a test sequence based on the ANSI S3.42-1992 standard. This standard has been developed to test nonlinear hearing aids with a broad-band noise signal. The need for this standard stems from the importance of evaluating the performance of these circuits in a more real-world environment. ANSI 92 gives you: noise saturation sound pressure level, noise gain, a family of frequency responses, and a noise input/output curve.

6.4.1 Understanding ANSI 92

The original signal used in the 6500-CX is that of a speech weighted set of pure tones starting at 100 Hz and ending at 8000 Hz, with a gradual high frequency roll off of 6 dB per octave. The kneepoint of the roll off is placed at 900 Hz. This signal has been in place and used for about 10 years. The spectrum was developed from data supplied by the National Bureau of Standards, and is the signal used for the testing of hearing aids submitted for use in the Veterans Administration hearing aid program.

In 1992, the ANSI standards committee for hearing aid test standards published ANSI S3.42-1992. This standard describes a noise signal that is very similar to the one we use in the 6500-CX. There are some differences, mostly in the low frequencies and in the way that the signal spectral shape is specified. The committee wanted a system that could be built easily by anyone, and assumed that a manufacturer who would develop equipment to make tests for this standard would use a white noise signal and apply analog filters to remove the 100 Hz component and to produce the roll off above the 900 Hz kneepoint. The value for 200 Hz and 300 Hz are smaller than the values used in the 6500 composite signal. They are rolled off because of the high pass analog filter envisioned by the standards writers.

In order to produce a signal that met with the provisions of theANSI S3.42 standard, Frye Electronics decided to slightly modify the composite signal for use in this ANSI 92 option. The following steps were taken:

1. The 100 Hz component was removed.
2. The 200 Hz component was reduced in amplitude by 2 dB.
3. The 300 Hz component was not changed in amplitude.
4. The rest of the components (400 Hz through 8000 Hz) were adjusted upward in amplitude by a small amount to bring the RMS level of the composite signal to the value displayed on the CRT and set by the operator using the amplitude control on the front panel.

This modified signal is used to make the measurements in the ANSI 92 option and is not used in the normal composite operation of the 6500-CX.

Only the most critical operator will see any significant difference in the hearing aid performance between the two signals. The ANSI S3.42 signal may result in an increase in noise gain by about 1 dB.

6.4.2 Entering ANSI 92

1. Press [ANSI].
2. Highlight ANSI 92 using [∧, ∨].
3. Press [MENU] to adjust the settings.
4. Press [START] to begin the test sequence.

6.4.3 Changing the ANSI 92 Settings

NOISE REDUCTION SETTING: Amount of noise reduction used for test sequence. Choose from 4X, 8X, and 16X.

DISPLAYED RESPONSE CURVES: Family of curves measured in test sequence. Choose from 50-80 dB (50, 60, 70, 80 dB), 40-70 dB (40, 50, 60, 70), and 60-90 dB (60, 70, 80, 90 dB).

SETTLING DELAY TIME: Time delay between the response curves. Choices are 0.5 sec, 1 sec, 2 sec, 5 sec.

Note: The amount of settling time should be at least as long as the attack time specified for the hearing aid under test. If the settling time is lengthened beyond that, accuracy will improve.

6.4.4 Running ANSI 92

1. Set the hearing aid to full on gain as specified in Section 6.1.1.
2. Press [START] to begin the test sequence.
3. For some aids, the analyzer will pause the test and tell you to turn the aid down to reference test gain. Adjust the volume of the aid until it comes within 1 dB of the target gain.

Note: Take care not to move the aid from its position. If you must move it in order to adjust the gain control, replace as close as possible to its original position.

4. Push [CONTINUE] to complete the test.

6.4.5 Viewing ANSI 92 Results

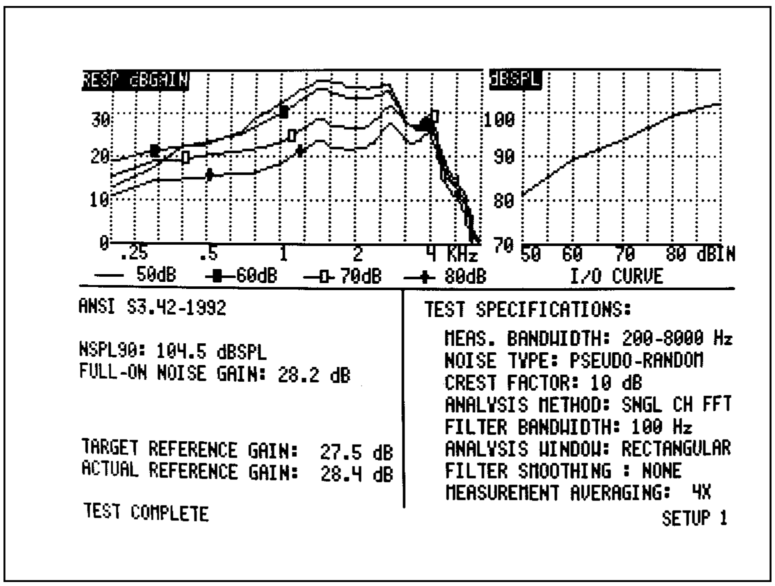


Figure 6.4.5—ANSI 92 Results

NSPL90:	Maximum RMS output sound pressure level (SPL) produced with a 90 dB RMS speech-weighted noise input SPL signal.
Full-On Noise Gain:	Maximum RMS gain with a 60 dB SPL noise input signal. (Note: This test may not elicit a true reading of maximum gain for hearing aids with an onset of nonlinear operation below 60 dB.)
Actual Reference Gain:	The measured amount of gain when the hearing aid is set to the reference test position.

Target Reference Gain: This information is only displayed when the actual gain is greater than the calculated desired setting of gain. This target is used to adjust the hearing aid's actual gain to a level of ±1 dB of the target. The figure is calculated by adding the 60 dB SPL input + 17dB and subtracting it from the NSPL90 RMS output. (NSPL90 –77 = desired setting of gain)

Family of Frequency These curves are developed by adjusting the noise input level in

Response Curves: 10-dB steps over a selected range. The preferred levels are 50, 60, 70, 80, and 90 dB SPL. Frye has added 40 dB SPL to the preferred levels.

Noise I/O Curve: This demonstrates the compression or limiting of the nonlinear circuit.

Test Specifications : Stated for information purposes only.

The Test Specifications (Brief Definitions)

Measured Bandwith: 200-8000 Hz
These are the frequency bands being tested.

Noise Type: Pseudo-Random
A modified speech weighted composite noise signal. Synchronous analysis with this signal, as compared to random noise, has the advantages of easier equalization of the input signal and fewer averages required to reduce variability in the spectral estimate.

Crest Factor: 10 dB
The ratio of the peak value of the signal to its root-mean-square (RMS) value.

Analysis Method: Single Channel FFT
Fast Fourier Transform (FFT) is a mathematical and electronic method of converting a signal from an amplitude-vs-time measurement to a amplitude-vs-frequency graph. Filter Band Width: 100 Hz. Analysis points at every 100 Hz.

Analysis Window: Rectangular
Rectangular filter window (or frame) is the type used to measure the test signal for the FFT analysis.

Filter Smoothing: None
An averaging method to smooth out point-to-point frequency response fluctuations.

Measurement Averaging: Selectable
A selectable amount of averaging (4X, 8X, or 16X) of the test signal to present a more stable curve.

For a more detailed explanation of these terms, consult the ANSI S3.42-1992 standard.

Chapter 7: Coupler Options

7.1 Adaptive Attack & Release

The Adaptive Attack & Release measurement is part of the Star Option.

7.1.1 Introduction

The adaptive attack & release test makes it possible to evaluate the performance of special compression circuits that change their release time, depending on the length of the input signal. This type of processing is designed to distinguish between ongoing speech and loud, abrupt noises that can often cause normal compression circuits to obscure parts of a conversation. Examples of this type of signal processing are Telex's Adaptive Compression®¨, Etymotic's K-Amp™, and Phonak's Super Compression™. (The FONIX adaptive attack & release test is based on information provided by Telex Communications, Inc.)

It performs a 2000 Hz attack test, followed by a special, two-signal release test consisting of a short signal (1/10 second) and a long signal (2 seconds). You can select whether the signal level varies between 55 and: 75, 80, 85, 90, or 95 dB SPL (80 is standard). The results are displayed numerically and graphically on the screen (Figure 7.1.2).

A numerical readout gives you the attack time and two release times, corresponding to the two release signal lengths. A special graph shows you how the output of the instrument varies over the course of the attack and release phases. Erratic performance during these critical phases could result in effects that are audible to a hearing-impaired listener. These effects could be annoying, or even could obscure parts of a conversation.

The "output-versus-time" graph can be viewed in any of four selectable time scales for ease of interpretation.

7.1.2 Procedure

Set up the hearing aid for testing in the sound chamber. Make sure the sound chamber is leveled.

1. Press [MENU].
2. Press [*].
3. Use the [∧] or [∨] buttons to select ADAPTIVE A&R.
4. Use the [<] or [>] buttons to choose 55 and: 75, 80, 85, 90, or 95 dB SPL for the signal levels used in the test. (55 and 80 are used for ANSI standard attack/release tests.)
5. Press [START] to run the test. It is important to be very quiet if you are near the test chamber.

6. Once the results are displayed (as in Figure 7.1.2), press [CURSOR] to select the graph time scale that gives the clearest viewing (50, to 100, 200, 25, and then back to 50 milliseconds per horizontal division on the graph).

7. Press [CRT] to print the results.

8. Press [START] to run another test, or press [CONTINUE] to exit.

NOTE: Whichever Star Option measurement you ran last will automatically be run the next time you press [*]. So, after running and exiting the Adaptive Attack & Release Screen, just press [*] to run the measurement again.

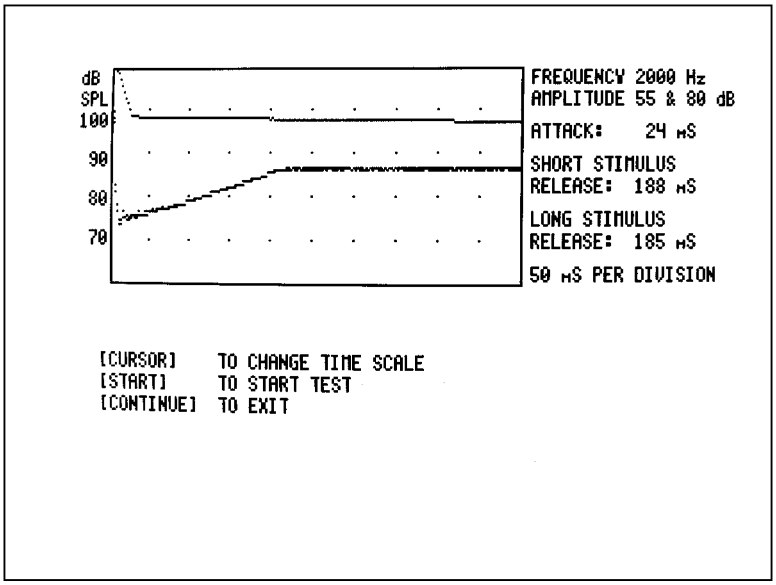


Figure 7.1.2—Adaptive attack and release test results

7.2 Averaging

The Averaging Option, known as AVG, is part of the Multiple Option Package.

7.2.1 Introduction

The Averaging Option is a pure-tone option that continuously displays the averaged output for three frequencies. This option gives you a choice of six sets of frequencies to average:

ANSI High Frequency Average (HFA):	1000, 1600, and 2500
ANSI Special Purpose Averages (SPA):	800, 1600, and 2500
	1250, 2000, and 3150
	1600, 2500, and 4000
	2000, 3150, and 5000
HAIC Average:	500, 1000, and 2000

The Averaging Option can also be used with the Gain Option to display average GAIN.

7.2.2 Procedure

1. Press [RESET].
2. Press [SINE/COMPOSITE] to enter Pure-Tone Mode.
3. Press [MENU].
4. Press [AVG].
5. Use [<, >] to select desired set of frequencies.
6. Press [START] to begin averaging measurement.
7. Use the [∧] and [v] buttons to choose the desired source level (50 to 100 dB SPL, in 5-dB steps).
8. Display average gain by pressing [GAIN].
9. Print displayed averaged data by pressing [LINE] and then [TITLE].
10. Exit the Averaging Option by pressing [CONTINUE].

NOTE: Once you have chosen your frequencies, you can start subsequent averaging measurements directly from Pure-Tone Mode by pressing [AVG]; you don’t need to go through the menu screen.

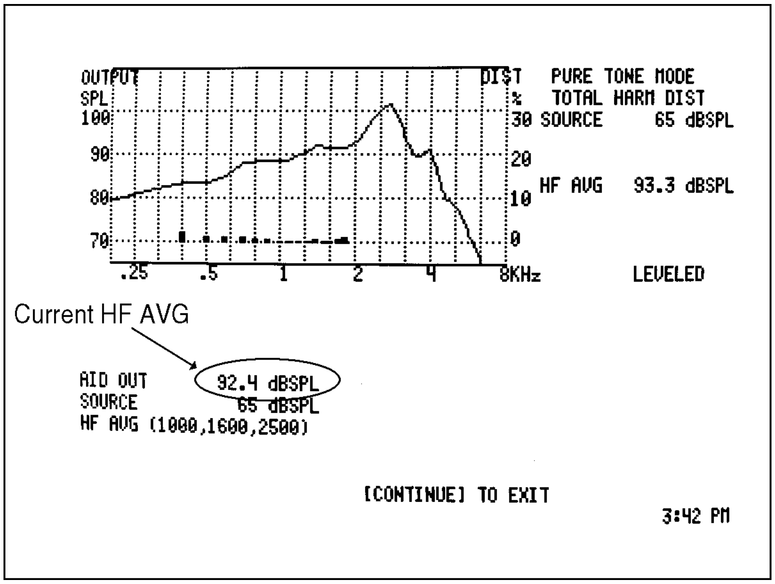


Figure 7.2.1—The AVG Option

7.3 CIC

The CIC Option is an accurate coupler measurement for CIC aids. It is part of the Multiple Option Package.

7.3.1 Introduction

The ANSI standard for testing hearing aids calls for a 2-cc coupler when taking sound chamber measurements. This standard was developed in the 1970s when most hearing aids consisted of body aids, BTEs, or ITEs. More recently, CIC hearing aids have become increasingly popular. ANSI treats CIC hearing aids as it treats ITE aids; it calls for the use of a HA-1 2-cc coupler However, CIC aids settle deeper into the ear than a standard ITE; they take up more space in the ear canal. This means that an ANSI measurement using a 2-cc coupler, while appropriate for comparing its characteristics to manufacturing specifications, won't tell you very much about how the aid will actually behave inside a person's ear.

The CIC Option was developed as a more accurate coupler test for CIC aids than is available with a standard HA-1 coupler. The CIC coupler, along with the corresponding correction factors, produce measurements that are much closer real-ear approximations than those obtained with the standard testing procedures.

CIC measurements may be made with a complete test sequence, based on the method used in the ANSI 87 standard. You can also use the CIC coupler and correction factors to make simple frequency responses in Composite, Pure-Tone, or DSIN Modes.

NOTE: Although it runs all the same tests, the CIC Automated Sequence does not comply with the ANSI standard. It is intended to provide additional information about the hearing aid, not substitute for the ANSI sequence.

7.3.2 Procedure to Make a Manual Measurement

1. Attach the CIC aid to the CIC coupler using the technique described in Section 4.3 and place the aid inside the sound chamber.
2. Press [MENU].
3. Press [CIC].
4. If MANUAL TEST isn't already selected, use the [<] button to select it.
5. Press [START]. This will add the CIC correction factors to the Composite Mode or Pure-Tone Mode Screens. See Figure 7.3.2A.

NOTE: Once MANUAL TEST has been selected (or if it is the default CIC selection), you can just press the [CIC] button to turn on the correction factors. A comparison of a CIC aid tested with an HA-1 coupler and a CIC coupler with correction factors is shown in Figure 7.3.2B.

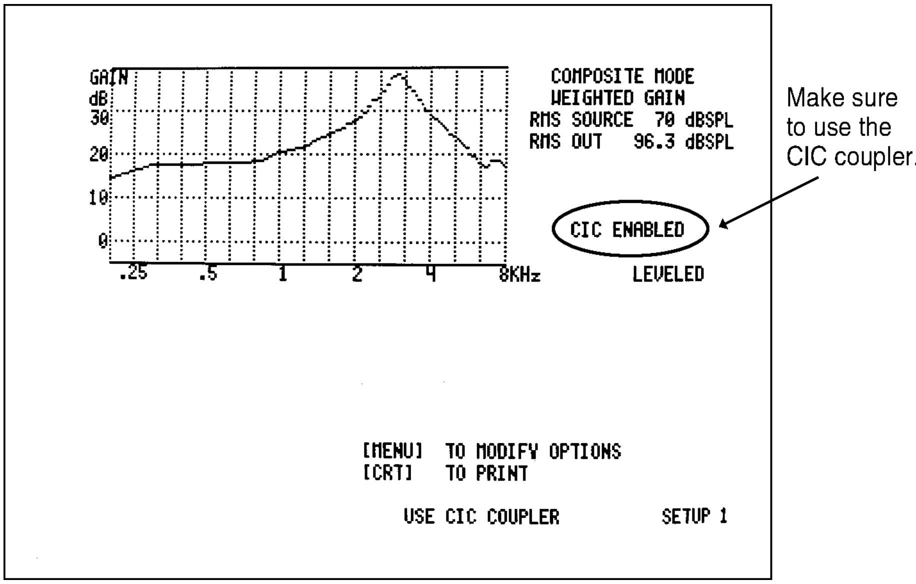


Figure 7.3.2A—CIC Option

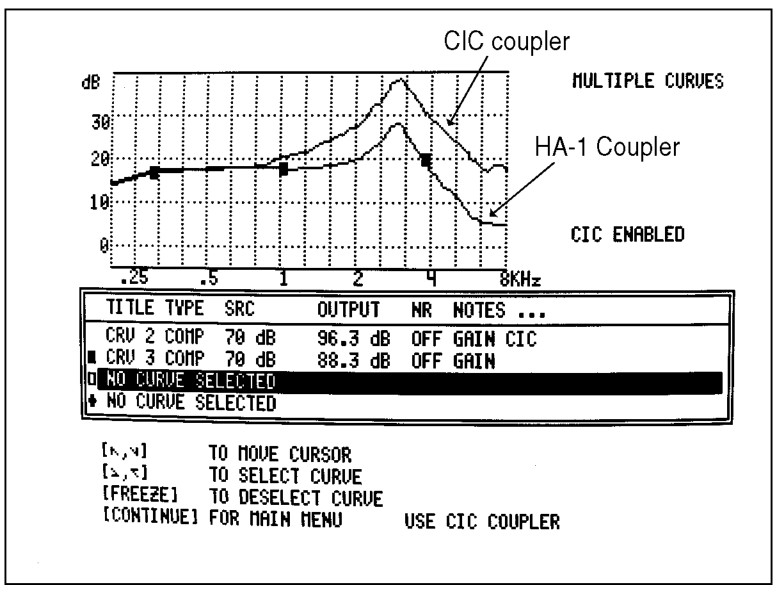


Figure 7.3.2B—A Comparison of an HA-2 measurement with a CIC measurement CRV2 is performed with a CIC coupler and correction factors. CRV3 is performed with an HA-2 coupler.

7.3.3 Procedure to Run a CIC ANSI Test Sequence

1. Press [MENU].
2. Press [CIC].
3. Select AUTO MODE with [<].
4. Press [MENU].
5. See Section 6.3.2 for a description of the available choices.
6. Press [START] to begin the test sequence.
7. Press [CONTINUE] to exit.

7.4 Digital Speech-in-Noise

The Digital-Speech-in-Noise test is an accurate test for digital hearing aids. The coupler measurements are described in this section. See Section 8.4.6 for real-ear DSIN instructions.

7.4.1 Introduction

The Digital Speech-in Noise Test is designed to provide an accurate way to test high end digital hearing aids with noise reduction circuits. When these aids are exposed to continuous sound, such as the composite signal or a pure-tone sweep, they treat that sound as noise and lower the gain at the offending frequencies. The Digital Speech signal is a randomly interrupted composite signal that the aid treats as speech instead of noise, thus avoiding the noise reduction problem.

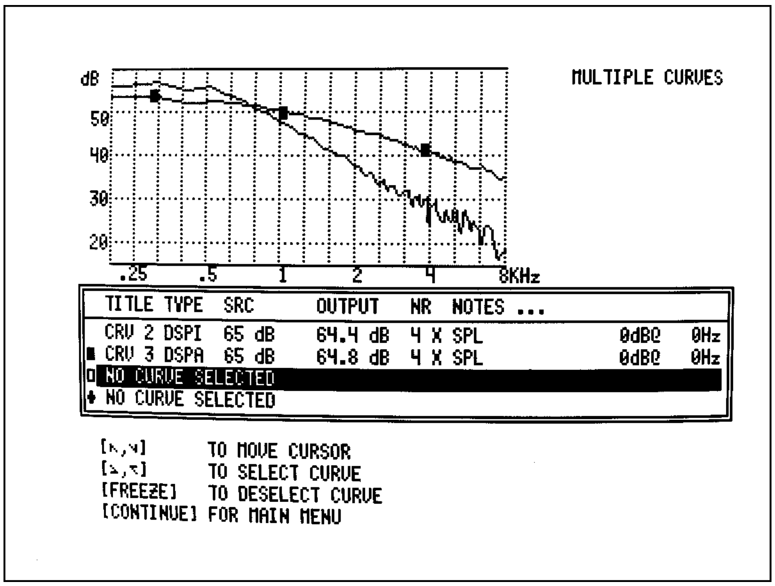


Figure 7.4.1—Comparison of ANSI and ICRA spectra

There are two speech spectra available with Digital Speech. The first comes from the ANSI S3.42 standard (see Section 6.6 for more details) and is almost exactly the same weighting as the signal we use in the normal Composite Mode. The other uses the ICRA speech weighting, developed by the International Colloquium of Rehabilitative Audiology. See Figure 7.4.1 to see a comparison of the spectra.

We also allow you to add a continuous pure-tone bias signal. This allows you to see how the aid responds to noise at different frequencies.

7.4.2 Procedure

1. Press [MENU].
2. Press [*].
3. Use the [∧] or [∨] button to select DIGITAL SPEECH-IN-NOISE.
4. Press [START]. See Figure 7.4.2.
5. Use [∧, ∨] to change the amplitude of the Digital Speech signal.
6. Press [CONTINUE] to exit from the DSIN Screen.

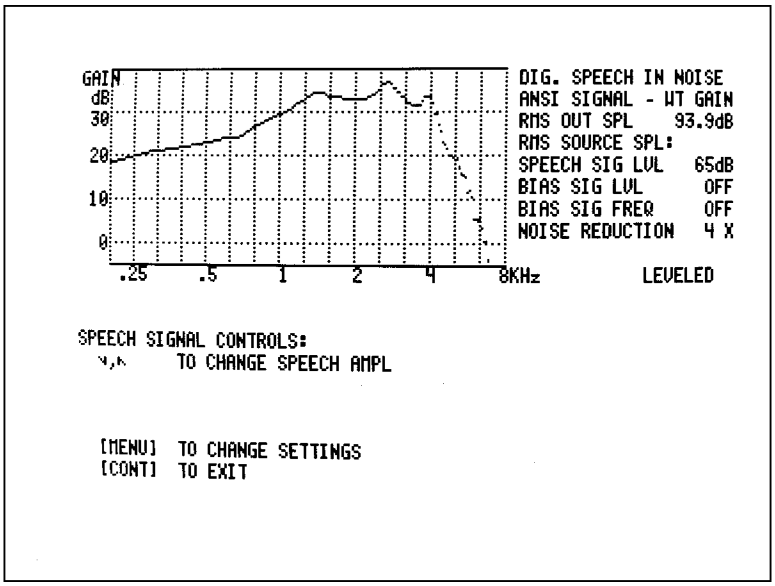


Figure 7.4.2—Digital Speech in Noise Screen

7.4.3 Changing the Speech Spectrum

1. From the DSIN Screen, press [MENU].
2. Select SPEECH SIGNAL with [∨].
3. Change the current selection with [<].
4. Press [CONTINUE] to exit. See Figure 7.4.3 for a comparison of the response of an aid to the ANSI and ICRA spectra.

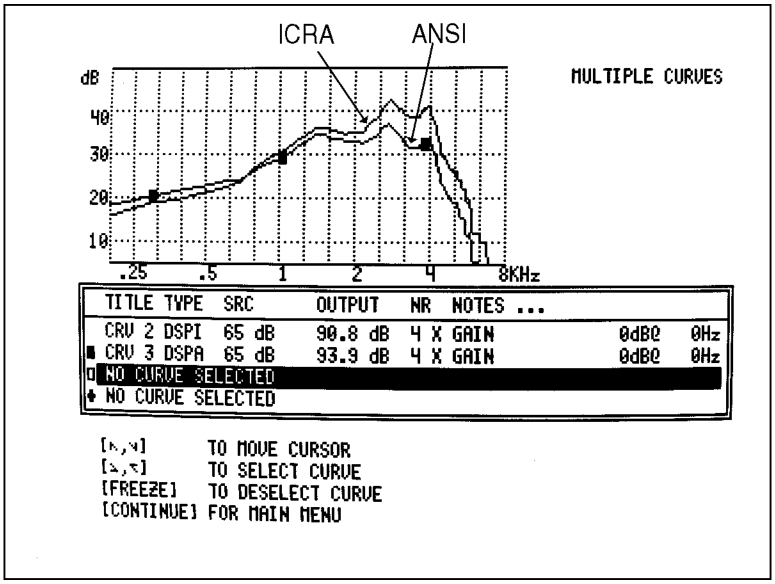


Figure 7.4.3—Comparison of response of an aid to ICRA (CRV2) with ANSI (CRV3)

7.4.4 Adding a Bias Tone

1. Press [MENU].
2. If necessary, use [∧] to select BIAS.
3. Use [<] to select PURETONE.
4. Press [CONTINUE] to exit.
5. Use the [<, >] keys to change the frequency of the bias signal.
6. To change the amplitude of the bias signal:
    a. Press [START].
    b. Press [∧, ∨] to change the amplitude of the bias.
    c. Press [START] again to change the amplitude of the Digital Speech signal again.

Figure 7.4.4 shows a comparison of bias signals at different frequencies.

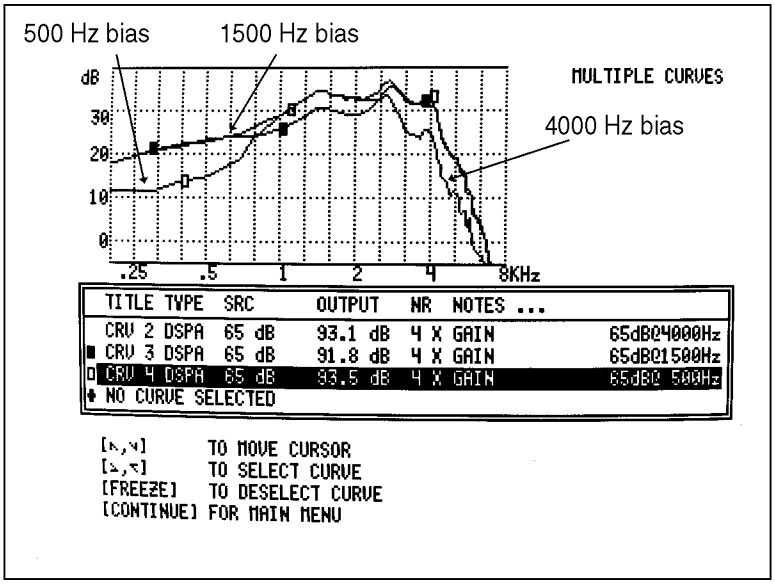


Figure 7.4.4—Comparison of aid reacting to different bias signals

7.5 Enhanced Attack & Release

The Enhanced Attack & Release measurement is part of the Star Option.

7.5.1 Introduction

This procedure displays numerical and graphical results of attack and release tests using any of 18 different pure-tone frequencies, or the speech-weighted composite signal. These tests are important for testing the performance of frequency-specific signal-processing circuits.

A choice of test frequencies lets you exercise the attack and release phases of the hearing aid in the specific frequency region for which a particular signal-processing circuit was designed to work. For example, "ASP-type" circuits are usually designed to reduce low-frequency background noise. So you would use a low frequency to test the circuit.

The speech-weighted composite signal lets you see how the circuit reacts to a broad-band, speech-like signal.

The numerical display gives you the attack and release times for the chosen test signal. Attack time is particularly critical for low-frequency-active circuits, such as "ASP," since a fast attack time will react to speech, whereas a slow attack time will react only to ongoing noise.

The graphical display of "output versus time" lets you see how the device performs over the attack and release phases. Erratic performance during these critical phases could result in effects that are audible to a hearing-impaired listener. These effects could be annoying, or even could obscure parts of a conversation.

7.5.2 Procedure

1. Press [MENU].
2. Press [*].
3. Select ENHANCED ATTACK & RELEASE.
4. Use the [<] or [>] buttons to set the desired test frequency, or press the [SINE/COMPOSITE] button to switch between pure-tone and composite signals.
5. Press [START] to run the test. It is important to be very quiet during the test.
6. Once the results are displayed (as in Figure 7.5.2), press [CURSOR] to select the time scale that gives the clearest viewing (50, to 100, 200 and then back to 50 milliseconds per horizontal division on the graph).
7. Press [CRT] to print the results.
8. Press [CONTINUE] to exit.

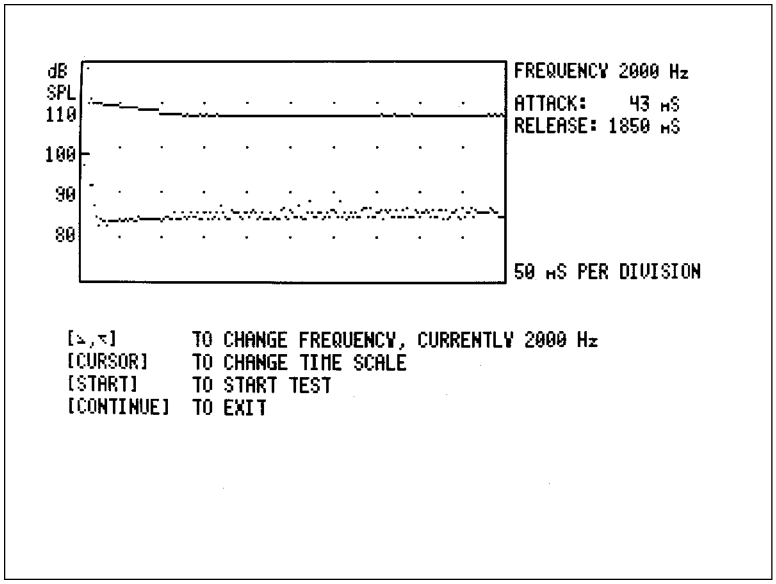


Figure 7.5.2—Enhanced attack & release

7.6 Enhanced DSP

Enhanced DSP is a unique test of the group delay and phase of hearing aids. It is part of the Star Option.

7.6.1 Introduction

The Enhanced DSP Screen was designed to give you more information about digital hearing aids. The new technology in digital hearing aids has added a great deal of capability such as increased clarity and flexible programming. However, the same technology can also have its pitfalls. This test will tell you the *digital processing delay* (also known as group delay) and the *signal phase* of the hearing aid.

The digital processing delay measurement will help you determine whether or not a hearing aid is suitable for a monaural fitting. The phase measurement will help you determine whether custom binaural hearing aids are working properly together as a team.

7.6.2 Digital Processing Delay

One of the properties of digital technology not normally mentioned in the literature is that it *always* takes time to process digital data. Imagine the digital hearing aid as a miniature computer: it takes an analog sound wave, turns it into digital information, performs some kind of algorithm to amplify the signal, and turns it back into an analog sound wave for the ear to hear. All of this calculating takes precious time; it's never instantaneous. The processing delay for some hearing aids is so slight that it is imperceptible to the human ear. The processing delay for other aids can extend to several milliseconds – longer than the calculating time for an analog hearing aid.

Why is this a problem? Well, if you fit a client monaurally with an aid with a significant digital processing delay, that person might experience some confusion because his unaided ear will be hearing sounds slightly faster than his aided ear, creating an echo effect. Problems can also be predicted for patients with open canal fittings. However, if you fit the same patient with an occluded binaural set, then both ears will be listening with the same delay, and the confusion will be alleviated.

What is a significant delay? At what magnitude does this delay start to affect speech intelligibility? These are very good questions. Unfortunately, we don't have an answer at this time; the field of digital hearing aids is still too young, and there has not yet been enough research done to establish necessary guidelines. A conservative approach would be to avoid monaural and open canal fittings with digital aids that have delays of more than 1 to 2 milliseconds.

For now, this measurement will give you more information about what's really going on in that digital hearing aid circuit, and, hopefully, it will help you troubleshoot why some aids work better than other aids with monaural or binaural fittings.

Technical details

The digital processing delay measurement is taken by sending a short impulse from the sound chamber speaker to the hearing aid. The 6500-CX microphone collects information from the hearing aid for 20 milliseconds from the time the impulse is delivered. This information is a series of numbers of varying amplitudes.

The 6500-CX finds the maximum peak amplitude of the resulting information. Since the impulse response of a hearing aid is not always simple, the analyzer also checks for any peaks occurring before this maximum peak. If a smaller peak exists, and it has an amplitude of at least 50% of the maximum peak, the time of the smaller peak will be considered the processing delay point. Otherwise, the time of the maximum peak will be considered the processing delay point. The 6500-CX system delay is subtracted from this delay point in order to form the actual aid processing delay time. (The 6500-CX system delay is determined during the sound chamber leveling process.)

The data collected in the digital processing delay measurement is displayed in graphical format as amplitude vs. time. A dotted vertical line is placed at the calculated delay point. The numerical value is also displayed. A second dotted vertical line shows the 6500-CX system delay for reference.

7.6.3 Signal Phase

The signal phase measurement is a test of the “pushing” and “pulling” of the amplified sound of the hearing aid. Sound is created by vibrations in the air. Those vibrations can be thought of as air pushing and pulling against the ear. If sound goes through a hearing aid, the hearing aid might cause a phase shift, turning a “push” of the sound wave into a “pull.” This isn’t necessarily a bad thing; there may be good reasons for a phase shift of the sound wave.

The components of a custom hearing aid are usually wired by hand. The receiver is typically wired into the amplifier in such a way that it may or may not cause a phase shift of the signal. If care is not taken, it’s entirely possible to wire one hearing aid of a custom binaural set one way, and wire the other aid in the opposite way. This could cause one of the hearing aids to be “pulling” while the other aid is “pushing,” resulting in strange sound quality for the hearing aid wearer.

We propose that it could be very important to check the signal phase of the hearing aids when fitting a client with a binaural set in order to ensure that the aids are working together as a team.

Technical details

The signal phase measurement works by generating a 1 kHz cosine wave, turning it into a test signal, and delivering it to the aid. The cosine wave signal is offset at the time of generation so that it starts at the baseline (the zero point). It then continues through a complete cycle and terminates when it reaches the baseline again. This signal, although consisting of only a single pulse, contains very few frequencies above 1 kHz and is one millisecond wide at its base.

The data collected from this measurement is displayed in a graphical format 20 milliseconds wide. The system delay as well as the digital processing delay are noted for reference on the phase graph in the form of vertical lines.

7.6.4 Procedure

1. Make sure the 6500-CX sound chamber is leveled. See Section 4.1 for more details.
2. Set up the first hearing aid for measurement in the sound chamber.
3. Press [MENU].
4. Press [*].
5. Use [v] to select “Binaural Enhanced DSP.”
6. Press [START]. This will enter the Binaural Enhanced DSP screen.
7. Press [START] again to measure the first hearing aid. The results will be displayed in the upper graph.
8. Remove the hearing aid from the sound chamber, and set up the second hearing aid for measurement.
9. Press [START] to perform the second measurement. The results will be displayed in the lower graph. See Figure 7.6.4A
10. Press [v] to view the results of the signal phase measurement of both aids. See Figure 7.6.4B. Return to the delay results by pressing [∧].

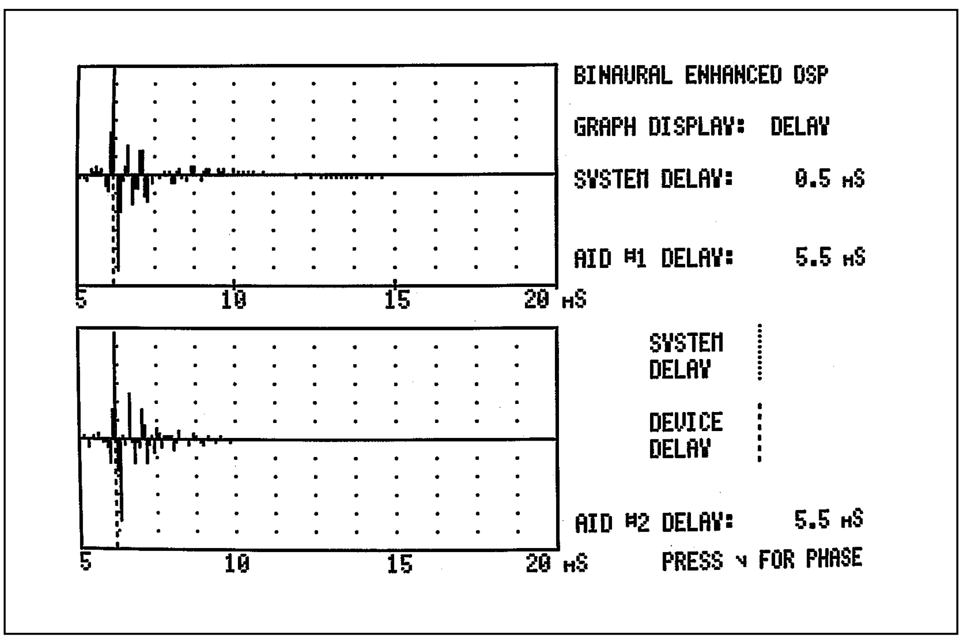


Figure 7.6.4A—Binaural Enhanced DSP delay graph

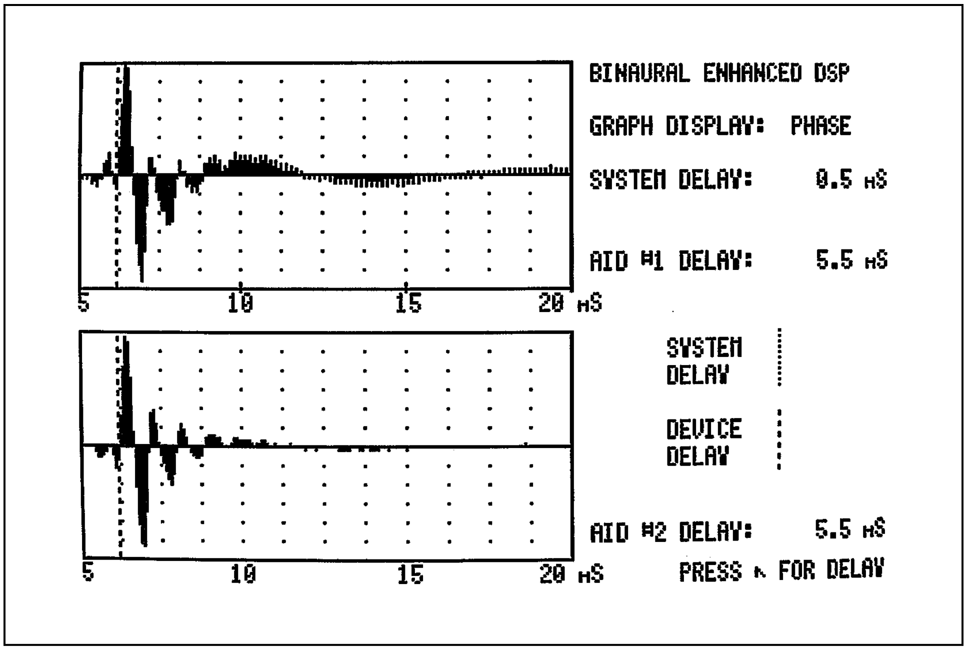


Figure 7.6.4B—Binaural Enhanced DSP phase graph

7.6.5 Printing

The Binaural Enhanced DSP test allows you to choose between printing only the current screen, or printing both screens of the test every time you press [CRT] while in the Binaural Enhanced DSP screen.

To make the selection:

1. Press [RESET] to return to the normal Composite testing screen.
2. Press [MENU].
3. Press [*].
4. Use [v] to select "Binaural Enhanced DSP."
5. Press [MENU] to open the Binaural Enhanced DSP menu.
6. Use [<] to switch between PRINT CURRENT SCREEN and PRINT ALL SCREENS.
7. Press [CONTINUE] to return to the Star menu.
8. Press [START] to enter the Enhanced DSP screen and proceed with the test.

7.7 Gain

The Gain Option comes with the Multiple Option Package when the 6500-CX is purchased.

7.7.1 Introduction

The Gain Option allows you to view pure-tone tests in terms of dB GAIN, rather than output dB SPL. When you press the [GAIN] button, the source SPL is subtracted from the output SPL to calculate the gain of the hearing aid. The gain is displayed next to the title AID GAIN, in the lower left corner of the display.

7.7.2 Procedure

1. Press [SINE/COMPOSITE] to enter Pure-Tone Mode.
2. Press [GAIN] to enter Pure-Tone Gain Mode.
3. Press [START] to run a pure-tone sweep.

You can also convert a pure-tone SPL curve to dB GAIN by pressing the [GAIN] button. If you have the Averaging Option, press [AVG] to activate a three frequency average in dB GAIN.

NOTE: The Gain Option is inactive in Composite Mode. If you press the GAIN button from Composite Mode, the screen will flash, indicating you have pressed an inactive button. A composite GAIN curve is displayed when the 6500-CX is in Weighted Gain Mode. Press [RESET] to get to the Composite Weighted Gain Mode.

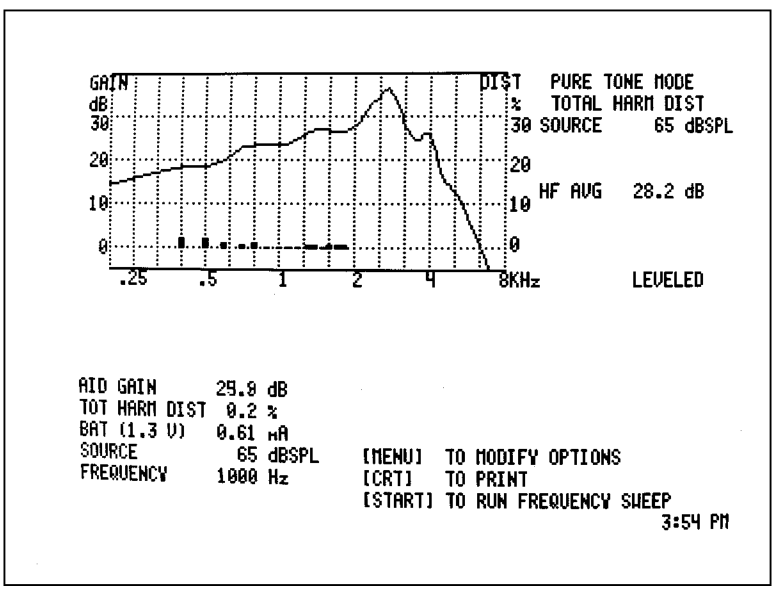


Figure 7.7.2—Pure-Tone gain display

7.8 I. D. Option

The ID Option comes with the Multiple Option Package. To change the ID, contact the factory.

7.7.1 Introduction

The I.D. Option personalizes your printouts of measurements made by the 6500-CX. When ordering the I.D. Option, you specify your desired identification – up to 27 characters, including spaces. Frye Electronics programs the instrument. The identification line is then automatically printed as the last line of every label. Labels consist of lines for entering DATE, MODEL, SERIAL #, OWNER, COMMENTS, and your I.D. line, when purchased.

7.8.2 Procedure

1. Press [LABEL].
2. Press [CRT]. The current screen will print with a label that will include your ID.

The label feature will remain activated until you press [LABEL] gain or [RESET].

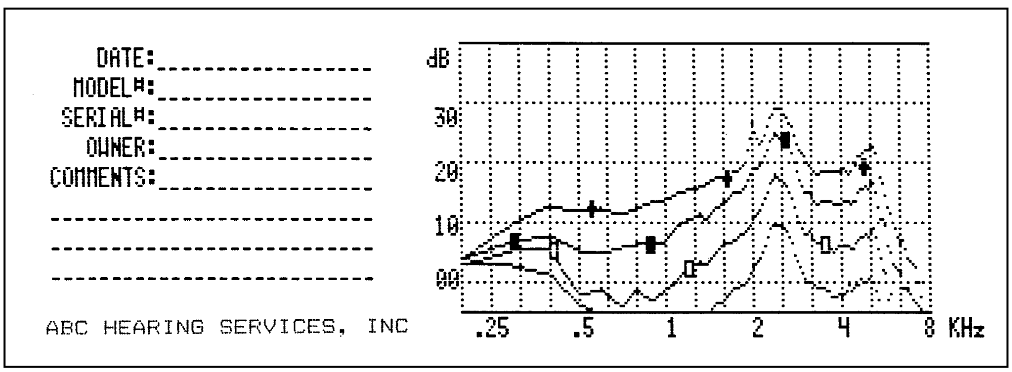


Figure 7.8.2 —Printout with custom I.D. label

7.9 IEC

The International Electro-Technical Commission (IEC) standard in the international community is analogous to the ANSI standard in the United States. With the IEC option installed in your 6500-CX, you can run the IEC test series automatically with one press of the [IEC] button. A menu is provided that allows you to select test conditions.

The IEC 118-7 standard was amended in 1994, and in July of 1995, the IEC Option was changed to conform to that amendment.

Note: The IEC standard is the equivalent of the Chinese National Standard.

7.9.1 Setting up the Aid for IEC Tests

1. Set the controls on the aid to give the maximum output and gain. For AGC aids, this is usually accomplished by setting for the minimum compression.

2. Set the aid for the widest frequency response range.

3. Insert the appropriate battery simulator pill, but do not yet plug it into the battery voltage supply.

4. Attach the aid to the appropriate coupler. See Section 4.2 for details. When testing a BTE aid, use the BTE adapter and a 0.6 inch (15 mm) length of #13 thick walled tubing. The combined length of the BTE adapter and the tubing is the right length to meet the specification (once you have inserted the earhook into the tubing).

5. Re-level the chamber, if necessary (see Section 6.1.2).

6. Plug the battery simulator into the jack near the battery voltage supply.

7.9.2 Leveling for IEC

The equivalent substitution method of leveling the test chamber is used for the IEC standard as well as the ANSI standard. Level the test chamber before IEC testing by following the leveling procedure described in Section 6.1.2.

7.9.3 Entering IEC

1. Press [MENU].

2. Press [IEC] from the main Composite Mode Coupler Screen.

3. Make any necessary adjustments. See Section 7.9.4.

4. Press [START] to perform the test sequence.

7.9.4 Changing IEC Settings

REFERENCE TEST FREQUENCY: Choose 2500 or 1600 Hz.

FULL ON GAIN LEVEL: 50 or 60 dB.

Linear Aids: See Section 6.5.4 to determine the correct source level to use.

AGC Aids: If the AGC hearing aid does not allow the AGC circuit to be disabled, use 50 dB. Otherwise, use 60 dB.

HARMONIC DISTORTION FREQUENCY: Choose one of seven values between 400 and 1600 Hz.

AID TYPE : Choose LINEAR, AGC, OR ADAPTIVE AGC.

Delay Menu

Highlight DELAY MENU from the Main IEC Menu and press [START] to enter the Delay Menu.

SWEEP DELAY: Delay between presenting a tone and measuring the response before proceeding to the next frequency in a pure-tone sweep.

I/O START DELAY: Delay before the first tone in an input/output test.

I/O MEASUREMENT DELAY: Delay between presenting a tone and measuring the response before proceeding to the next tone in an input/output measurement.

Note: If you choose LINEAR for an AGC or adaptive AGC hearing aid, the instrument may miscalculate the reference test gain. This artifact usually happens when the AGC aid has a slow response time.

7.9.5 Running the IEC Test Sequence

1. Press [START] from the IEC Menu to begin the test sequence. Otherwise, just press [IEC].
2. The instrument will always pause after the measurement of the OSPL 90 curve to allow you to turn the gain of the aid down to the reference test position. Match the target value within 1 dB. The target value is determined by the following method:
   a. The reference frequency is measured at 90 dB SPL.
   b. The reference frequency is measured at 60 dB SPL.
   c. If the value found in Step (b) is greater than the value of Step (a) minus 67, the reference test gain is the value of Step (a) minus 75. Otherwise, the reference test gain is the value of Step (b) minus 7 dB.

Note: If you prefer, you can set the Target Reference Gain to match the manufacturer's specifications as the IEC 118-7 standards instruct. In our experience, using the calculated value for the Target Reference Gain has never presented any difficulties.

4. Press [CONTINUE] to complete the test sequence.
5. Press [CRT] to print test results.
6. Press [START] to repeat the test or press [CONTINUE] to exit.

7.9.6 Viewing IEC Results

See Figure 7.9.6

1. OSPL 90 response curve
2. Full-on gain curve
3. Maximum output and its frequency
4. Output of 90 dB at reference test frequency
5. Reference test gain target
6. Reference test gain measured
7. Battery current drain
8. Response curve at 50 or 60 dB at reference test gain
9. Total harmonic distortion
10. Equivalent input noise measurement

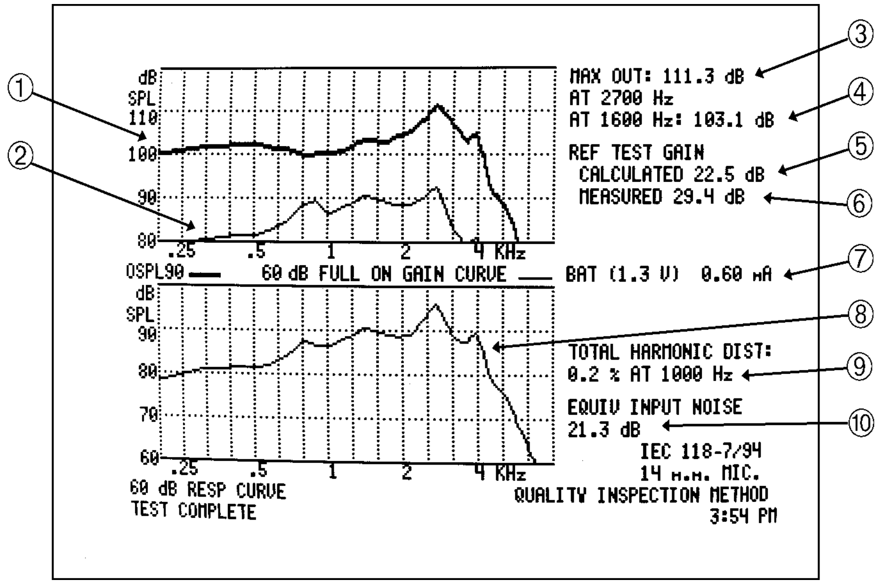


Figure 7.9.6—IEC results

7.10 In-Situ

The In-Situ Option can come in place of the CIC Option when the Multiple Option Package is purchased.

7.10.1 Introduction

"In situ" is Latin for "in position." The In-Situ Option predicts how a hearing aid will perform when it is "in position" on the user's ear. The option takes into account average values for the real-ear factors not accounted for by 2-cc coupler measurements: the position of the hearing aid microphone, the impedance of the occluded ear canal, and the effect of occluding the ear canal with an earmold. With these factors accounted for, measurements made in the test chamber of a FONIX 6500-CX can estimate the performance of a hearing aid as worn by the average user.

7.10.2 Explanation of Correction Factors

The 6500-CX organizes the real-ear factors into two groups of menu-selectable corrections:

— *Source Correction:* for the position of the hearing aid microphone.

— *Output Corrections:* including a *Coupler Correction*, for the impedance of the occluded ear canal, and an *Insertion Gain Correction*, for the effect of occluding the ear canal with an earmold.

7.10.2.1 Source correction

The head, the pinna, and the torso affect the spectrum of sound arriving at the microphone of a hearing aid. These spectral effects are different for different locations of the hearing aid microphone. The In-Situ Option Menu provides selectable corrections for ITE (in-the-ear), ITC (canal), and BTE (behind-the-ear) hearing aids. These corrections change the spectrum of the signal at the reference position in the test chamber, to simulate locating the hearing aid microphone at the appropriate spot on the head of the average adult. (ITE and BTE data are from Madaffari[1]; "BTE" refers to a behind-the-ear hearing aid with a front-facing microphone. ITC data are from Wiener and Ross.[2])

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[1] Peter L. Madaffari, "Pressure Response about the Ear," Industrial Research Products, Inc., Elk Grove Village, IL, 1974.
[2] Francis M. Wiener and Douglas A. Ross, "The Pressure Distribution in the Auditory Canal in a Progressive Sound Field," Journal of the Acoustical Society of America, Volume 18, Number 2, October 1946.
[3] The MZ couplers, when used with the OES coupler correction, meet the specifications of IEC Publication 711.

7.10.2.2 Output corrections

Coupler Correction (OES):

The standard 2-cc coupler is less than optimal as a model for the occluded human ear canal. A coupler better suited to this purpose, the Zwislocki ear simulator, is available, but it is very expensive and fragile. The In-Situ Option comes with three durable, "ear-simulator" couplers: the MZ-1, MZ-2, and MZ-3.[3] ("MZ" stands for "modified Zwislocki.") The MZ couplers alone, however, do not adequately simulate the performance of a real ear. To get results similar to those expected from the average occluded ear (or from a Zwislocki coupler), you must also use the built-in software coupler correction, called "OES" (for "occluded ear simulator"). Earmold vents must be plugged when using the MZ coupler and OES coupler correction. A true Zwislocki coupler (such as those made by Industrial Research Products or Bruel & Kjaer) may also be used, in which case the user disables the OES coupler correction.

Insertion Gain Correction:

The insertion gain correction subtracts the average adult unaided ear canal response from the "in-situ response" to get an estimate of the "insertion gain response." (The unaided ear canal data are from Shaw.[4])

7.10.3 Types of Measurements Available

Depending on which corrections you select, the In-Situ Option will estimate either the "in-situ response," the "insertion gain response," or the "occluded ear simulator (OES) response."

In-situ response: Measures the acoustic effect of a complete hearing aid system as it is worn, including the hearing aid, the earmold, the occluded ear canal, the head, the torso, and (as appropriate) the pinna of the wearer.

The "in-situ response" requires Source and Coupler Corrections.

Insertion gain response: Provides the benefit of the hearing aid system to the wearer.

The "insertion gain response" requires Source, Coupler, and Insertion Gain Corrections.

OES response: Isolates and measures the acoustic effects of the hearing aid and the occluded ear canal. An estimate of the "OES response" is no more than a regular coupler measurement that uses an ear simulator instead of a 2cc coupler.

The "OES response" requires the OES Coupler Correction only.

The "insertion gain response" measures the <u>net</u> acoustic effect, at the eardrum of the wearer, of inserting a hearing aid into the wearer's ear. A person's own (unaided) ear canal provides a degree of acoustic benefit that is lost when a hearing aid is inserted into the ear. Therefore, the "lost" unaided ear canal SPL is subtracted from the "in-situ response" to arrive at a measure of the <u>net</u> benefit of inserting the hearing aid.

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[4] E.A.G. Shaw, "Sound Pressure Transformation from the Free Field to the Eardrum," Journal of the Acoustical Society of America, Volume 53, p. 291(A), 1973.

7.10.4 In-Situ Option Settings

To change the selections of the In-situ Option:

1. Press [MENU].
2. Press [INSITU].

The settings you select will depend upon the type of measurement you want to make.

7.10.4.1 In-Situ response settings

SOURCE CORRECTION	ITE, ITC, or BTE
OUTPUT CORRECTION	OES ONLY

When using a true Zwislocki coupler, select:

OUTPUT CORRECTION	NONE

7.10.4.2 Insertion gain response settings

SOURCE CORRECTION	ITE., ITC, or BTE
OUTPUT CORRECTION	OES AND INSERTION GAIN

When using a true Zwislocki coupler, select:

OUTPUT CORRECTION	INSERTION GAIN ONLY

7.10.4.3 OES response settings

SOURCE CORRECTION	NONE
OUTPUT CORRECTION	OES ONLY

When using a true Zwislocki coupler, select:

OUTPUT CORRECTION	NONE

7.10.5 Instructions for Using the In-Situ Option

1. Connect the hearing aid to the proper coupler. If using the MZ-1 coupler, occlude any earmold vent. (See Table 7.10.5 for an explanation of which coupler to use, and Figure 7.10 for identification of the three MZ couplers.)
2. Place the hearing aid at the reference position in the test chamber and close the lid.
3. Make any necessary settings. See Section 7.10.4 for details.
4. Enter the In-Situ mode by pressing [START] from the In-Situ Menu or [INSITU] from the normal coupler mode.

5. Make any pure-tone or composite frequency response measurement in the usual way.
6. Exit the In-Situ Mode by pressing [INSITU].

Table 7.10.5 —Which is the correct MZ Coupler to use?

TYPE OF AID	COUPLER	COMMENT
ITE, ITC	MZ-1	
BTE, or EYEGLASS	MZ-1	With custom earmold attached. (NOTE: Vents must be plugged.)
	MZ-2	Without custom earmold attached, when a 3-mm horn earmold is planned, use with the Ear-Level Hearing Aid Adaptor that normally snaps onto the HA-2, 2cc coupler.
	MZ-3	Without custom earmold attached, when a conventional (#13 tubing) earmold is planned, attach a length of #13 tubing that corresponds to the length of the sound channel of the wearer's earmold.
BODY*	MZ-2	With snap-on receivers, use the MZ-2 without the Ear-Level Hearing Aid Adapter attached.

* NOTE: No source correction is available with the IN-SITU Option for the BODY microphone location. BODY instruments can be tested without a source correction, but the "OES response" is the only appropriate measure.

(NOTE: Figure 7.14.2A shows the three MZ Couplers)

7.10.6 The In-Situ Display

The In-Situ display is the same as the display in any of the normal measurement modes, except that the In-Situ settings are identified in two lines at the lower right of the graph grid. The first line says INSITU followed by the Source Correction in effect (if any). The second line gives the Output Correction in effect (if any). See Figure 7.10.6.

Pressing the [DATA] button converts the display from a graph to a numerical table. The label INSITU ON, found at the lower right, signifies that the data have been modified by the In-Situ Option, but there is no indication on the DATA Screen as to the selected Source and Output Corrections. Pressing the [DATA] button again, returns the display to the graphical mode, where information on the current settings is available.

Any of the In-Situ displays (except the menu) can be printed by pressing [CRT].

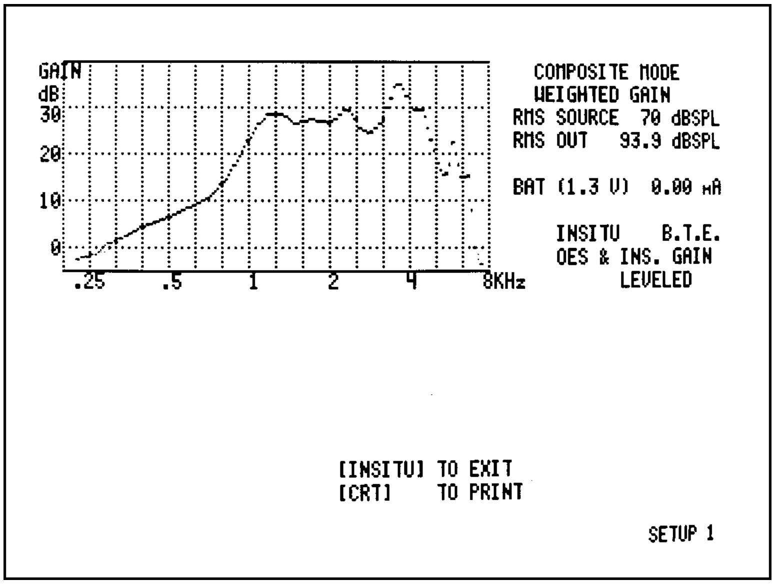


Figure 7.10.6 —Insitu Display

7.11 I/O Option

The I/O Option comes with the Multiple Option Package when the 6500-CX is purchased.

7.11.1 Introduction

With the Input/Output Option, you can test the Input/Output (I/O) and Input/Gain (I/G) characteristics of a hearing aid at any of the 80 frequencies tested by the FONIX 6500-CX, from 100 through 8000 Hz. You can also test with the wideband, speech-weighted composite signal used in real-time testing of frequency response. Input/output curves are reported as dB SPL RMS input and dB SPL RMS output. Input/gain curves are reported as dB SPL RMS input and relative dB gain. (Refer to Figure 7.11.3.)

7.11.2 I/O Settings

To enter the I/O Menu:

1. Press [MENU].
2. Press [I/O].

I/O FREQUENCY: Choose frequency used to measure I/O curve. COMPOSITE is also available.

I/O DISPLAY: Select AMPLITUDE or GAIN

I/O START DELAY: Time the analyzer waits between presenting the first tone in the test before taking a measurement.

I/O MEAS DELAY: Time the analyzer waits before presenting each input level before taking the measurement.

7.11.3 Procedure

1. Make any necessary selections. See Section 7.11.2.
2. Press [START] to begin test from I/O Menu. Otherwise, press [I/O]. The test will proceed.
3. Press [START] to perform a new test.
4. Press [CONTINUE] to exit.

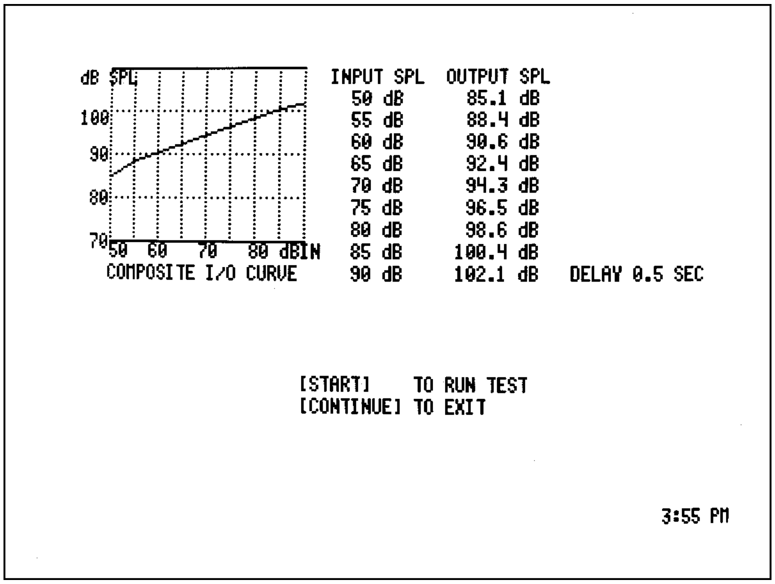


Figure 7.11.3—I/O display

7.11.4 Testing ASP (and Multi-Channel) Aids

One of the best ways to check proper functioning of an ASP circuit is to run an input/output (I/O) or input/gain (I/G) curve using a low-frequency, pure-tone signal. However, manufacturers of ASP and multi-channel instruments often use long attack times to avoid annoying “pumping” sounds. For example, you would want an ASP circuit to be triggered by the “drone” of a motor, but not by the “thud” of a door closing. For this reason, in order to get a proper measure of ASP action, longer stimulus times must be used. There must be a delay between the onset of the test signal and the measurement of the response. (You have to give the ASP circuit a chance to react before measuring it.)

To find the correct delay settings to use in an I/O measurement, check the manufacturer’s specifications for attack time. Use a delay of at least twice the specified attack time. If the manufacturer’s specifications are not available, use 0.5 seconds or less for AGC aids, and 1.5 or 2.0 seconds for ASP or other low-frequency circuits. Make these settings in the I/O Menu. See Section 7.11.2 for more details.

7.12 Multi-Curve

The Multi-Curve Option comes with the Multiple Option Package when the 6500-CX is purchased.

7.12.1 Introduction

Multi-Curve allows you to store up to thirteen coupler or real-ear curves and view up to four of those curves on a single graph. There is also a Dual Scale Screen that allows you to view two curves together that are usually too far apart in amplitude to be viewed together on the same graph.

There are two main storage places for curves: the Multi-Curve Stack and Reference Curves. The Multi-Curve Stack consists of four shifting curves that are eventually erased as more curves are added to the stack. See Section 7.12.2 for details. The Reference Curves are nine places to store curves temporarily. See Section 7.12.3 for details.

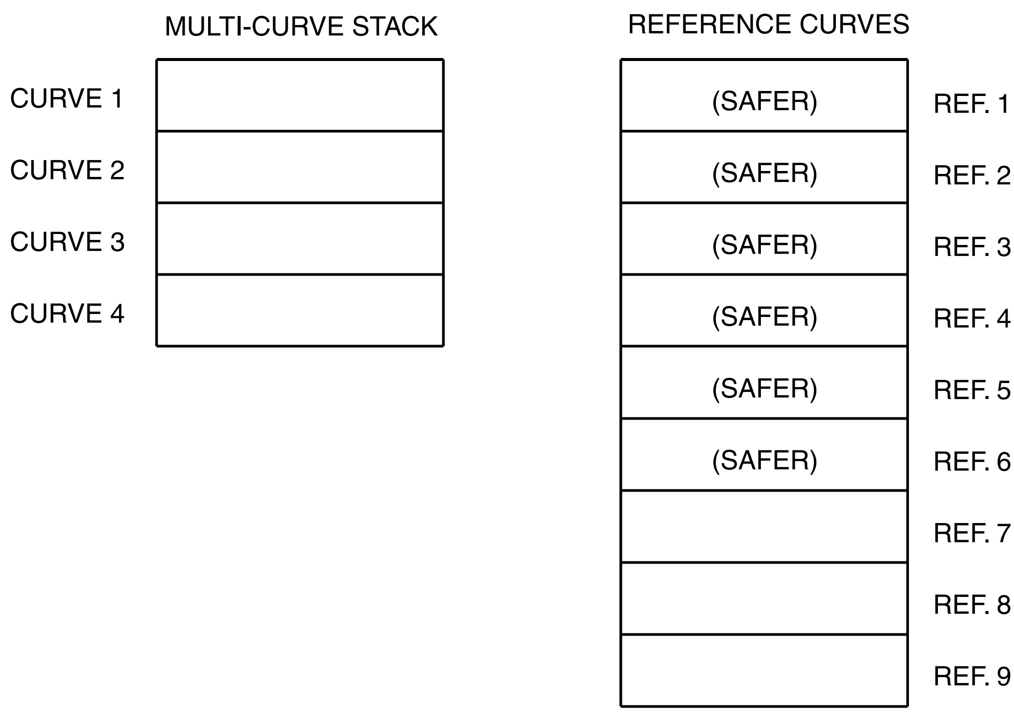


Figure 7.12.1—Diagram of Multi-Curve stack and reference curves

7.12.2 Understanding the Multi-Curve Stack

As illustrated in Figure 7.12.2, the Multi-Curve Stack is a collection of four curves that move from one location to another. Whenever a curve is stored to the stack, it enters at the top of the stack, CURVE 1. All other curves on the stack are pushed down one position. In other words, any curve previously stored in CURVE 1 is now stored in CURVE 2. Any curve previously stored in CURVE 2 is now stored in CURVE 3. Any curve previously stored in CURVE 3 is now stored in CURVE 4. Any curve previously stored in CURVE 4 is deleted.

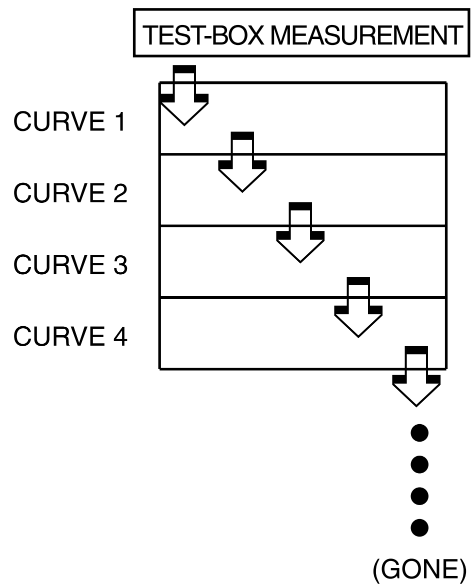


Figure 7.12.2 —How the Multi-Curve stack works

7.12.2.1 Storing pure-tone coupler curves

Whenever you run a coupler pure-tone frequency response, the resulting curve is automatically stored to CURVE 1 of the Multi-Curve Stack. This includes any pure-tone sweeps made in normal Pure-Tone Mode, ANSI 87, ANSI 96, IEC, JIS, ISI, In-Situ, DSIN coupler, and Telecoil.

7.12.2.2 Storing composite coupler curves

In Composite Mode, frequency response curves are updated several times a second, making it undesirable to push all the curves in the Multi-Curve Stack each time a new curve is generated. Instead, CURVE 1 is reserved to display each ongoing real-time measurement update, without pushing the other stored curves down the stack.

To push a specific composite curve into the Multi-Curve Stack:

1. Press [FREEZE].
2. Use the [∧] or [v] buttons to cycle through the last four real-time samples.
3. When the desired sample is displayed, press the [START] button, to store the frozen curve into CURVE 2.

NOTE: If you press [CONTINUE] instead of [START], the displayed curve will not be saved onto the Stack.

Whenever you switch from Composite Mode to Pure-Tone Mode, the last composite curve measured will automatically be stored into CURVE 1. It will be pushed to CURVE 2 the next time you take a measurement.

7.12.2.3 Storing Digital Speech-in-Noise coupler curves

When testing in the Digital Speech-in-Noise Mode, send curves to the Multi-Curve just as you would in Composite Mode, by pressing [FREEZE] and then [START]. Multi-Curve will record whether the curve used the ICRA or ANSI Digital Speech signal under TYPE. It will also record in the NOTES the frequency and amplitude of the bias signal if a bias signal was used.

Note: Whenever you exit the DSIN Screen, the last current measurement will be stored in CRV2, pushing the stack.

7.12.2.4 Storing Real-Ear Curves

In the Quik-Probe Option, the curves that you create, or measure and store, will always be placed in predetermined Multi-Curve locations, as follows:

Real-ear Unaided Response (REUR)	➻ CURVE 1
Real-ear Aided Response (REAR)	➻ CURVE 2
Real-ear Insertion-gain Response (REIR)	➻ CURVE 3
Target Insertion-gain Response	➻ CURVE 4
SPL Aided Curve #1	➻ REFERENCE 1
SPL Aided Curve #2	➻ REFERENCE 2
SPL Aided Curve #3	➻ REFERENCE 3
HTL Target	➻ REFERENCE 4
Target	➻ REFERENCE 5
UCL Target	➻ REFERENCE 6
Target 2cc SSPL-90	➻ REFERENCE 7
Target 2cc Full-on Gain	➻ REFERENCE 8

NOTE: There are special rules for using Multi-Curve with the Quik-Probe Option.
These Are:

1. Whenever you enter Quik-Probe II, CURVES 1 through 4 are automatically cleared.

2. In AUTOMATIC probe mode, the REUR, REAR, and REIR are entered automatically into CURVES 1, 2, and 3, thereby overwriting curves previously stored in those locations. In MANUAL probe mode, you must press either [UNAIDED RESPONSE] or [AIDED RESPONSE] to enter the curve last displayed as the REUR or REAR, respectively. Once both REUR and REAR have been entered, the insertion-gain response (REIR) is entered automatically.

3. Target curves are stored automatically.

4. In QUIK-PROBE II, the Multi-Curve Stack is never pushed, as with the general Multi-Curve Option. The old measurements are simply overwritten by the next stored measurement.

7.12.3 Using Reference Curves

There are a total of nine Reference Curve locations. If you do not have or use the Quik-Probe Option, then REF 1-8 are "safe" locations and will not be overwritten or erased until you choose to do so or the analyzer is turned off.

If you use the Quik-Probe Option, the Reference Curve locations are potentially volatile; they could be overwritten by saving curves in SPL Mode or using one of the Target 2cc modes. See Section 7.12.2.4 for more details.

7.12.4 Entering Multi-Curve

1. From the coupler Composite Mode or Pure-Tone Mode Screens, press [MULTI].

2. From the Insertion Gain Screen:

   a. Press [MENU].

   b. Highlight MULTICURVE.

   c. Press [START/STOP].

You will now be in the Main Selection Menu. See Figure 7.12.4.

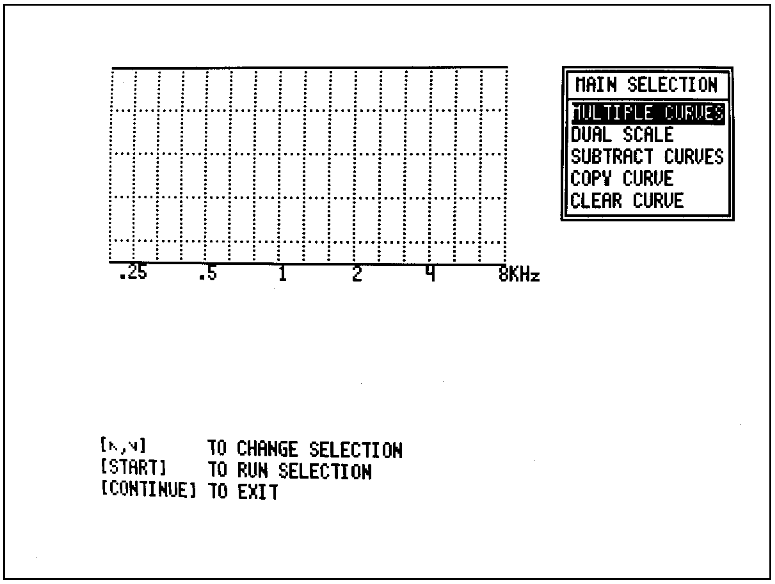


Figure 7.12.4—Multi-Curve Menu

7.12.5 Displaying Multiple Curves

To enter Multiple Curve Mode:

1. In the Main Selection Menu, highlight MULTIPLE CURVES.
2. Press [START] to run Multiple Curves. You will see the screen shown in Figure 7.12.5. By default, CURVES 1-4 are displayed.

To change selection of displayed curves:

1. Highlight desired position with the [∧, ∨] buttons.
2. Use the [<, >] buttons to select desired curve.

Note: The amplitude range of the Multi-Curve display is 45 dB. If the difference between the amplitudes of the displayed curves is more than 45 dB, only the curves with the highest amplitude will be displayed. De-select the curves of highest amplitude to display the other curves or use the Dual Scale Screen.

To de-select a curve:

1. Highlight desired position with the [∧, ∨] buttons.
2. Press [FREEZE].

Note: The first position can not be de-selected.

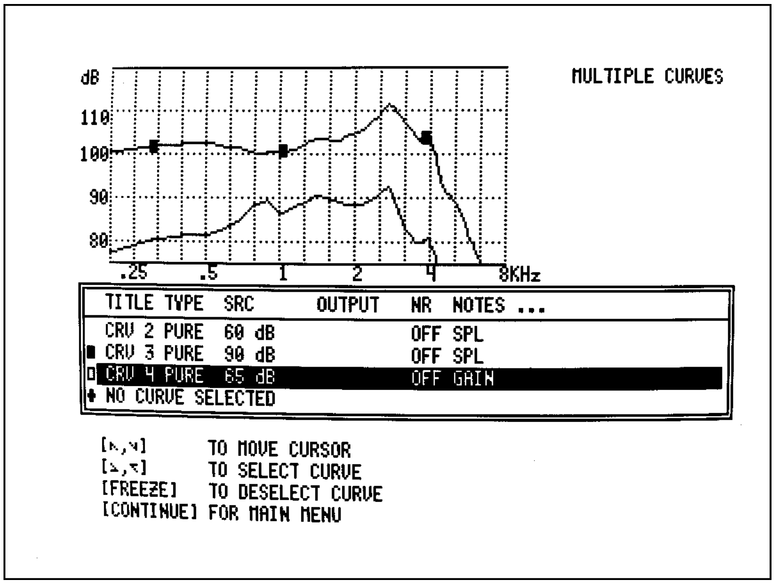


Figure 7.12.5—Multiple curve display

Explanation of Title Box Headings:

TITLE: Name of the curve (For example, CRV 1 or REF 1)

TYPE: Either PURE (PURETONE) or COMP (COMPOSITE), DSPI (Digital Speech in Noise ICRA), or DSPA (Digital Speech in Noise ANSI)
(If INVALID appears, no curve has been stored in that curve location.)

SRC: Source amplitude, dB SPL RMS

OUTPUT: Measured overall (RMS) output amplitude (COMPOSITE only)

NR : Noise reduction (either 2x, 4x, 8x, 16x, or OFF)

NOTES: Explanation of test conditions (GAIN, AMPL, INSITU, or OES)
(AMPL = Amplitude; OES = Occluded Ear Simulator) The frequency and amplitude of the bias tone used in Digital Speech-in-noise tests is also listed here.

7.12.6 Dual Scale

Use DUAL SCALE when you wish to display two curves that would not ordinarily fit on the same graph scale. For example, when you have one gain curve and one amplitude curve, it is likely that the values of the gain curve will be much lower than those of the amplitude curve. Since the graph scale is limited to a range of 45 dB, and since the 6500-CX automatically scales the graphs to the highest values, it is likely that the gain curve will be forced down and off the graph scale. DUAL SCALE allows you to shift the gain curve up and assign separate scales, left and right, to each curve.

1. In the Main Selection Menu, highlight DUAL SCALE.
2. Press [START] to run Dual Scale. See Figure 7.12.6.
3. Use the [<] or [>] buttons to select a curve for the currently highlighted title box.
4. Then use the [∧] or [∨] buttons to highlight the other title box and select another curve.

The curve selected in the upper title box is displayed with a thin line in the graph, and is assigned the left graph scale. The curve selected in the lower title box is displayed with a thick line in the graph, and is assigned the right graph scale.

NOTE: If you are using DUAL SCALE with ongoing real-time measurements, always use the left scale (thin line, upper title box) for CURVE 1.

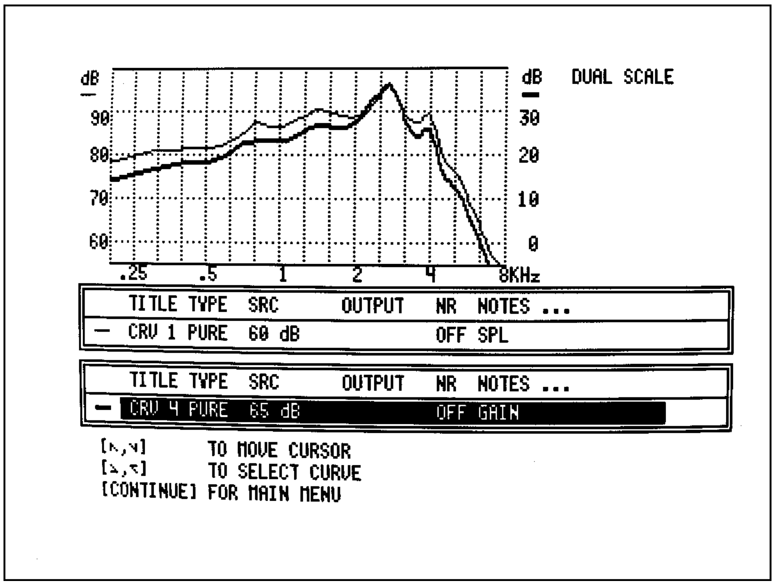


Figure 7.12.6—Dual scale display

7.12.7 Displaying the Difference Between Two Curves

1. In the Main Selection Menu, highlight SUBTRACT CURVES.
2. Press [START] to run Subtract Curves. See Figure 7.12.7.
3. Use the [<] or [>] buttons to select a curve for the currently highlighted title box. Then use the [∧] or [∨] buttons to highlight the other title box and select another curve.

The program will automatically subtract the curve identified in the upper title box from the curve identified in the lower title box. The difference curve will be displayed on the graph.

NOTES: Subtract Curves will overwrite REFERENCE 9. Whenever you subtract curves, the resulting difference curve is not only displayed on the screen, it is automatically copied into REFERENCE 9. This means that any curve previously stored in REFERENCE 9 will be overwritten and lost.

In composite test-chamber mode, if you select CURVE 1 as one of the two curves in the subtraction, the displayed difference of two curves will update as each real-time measurement is made.

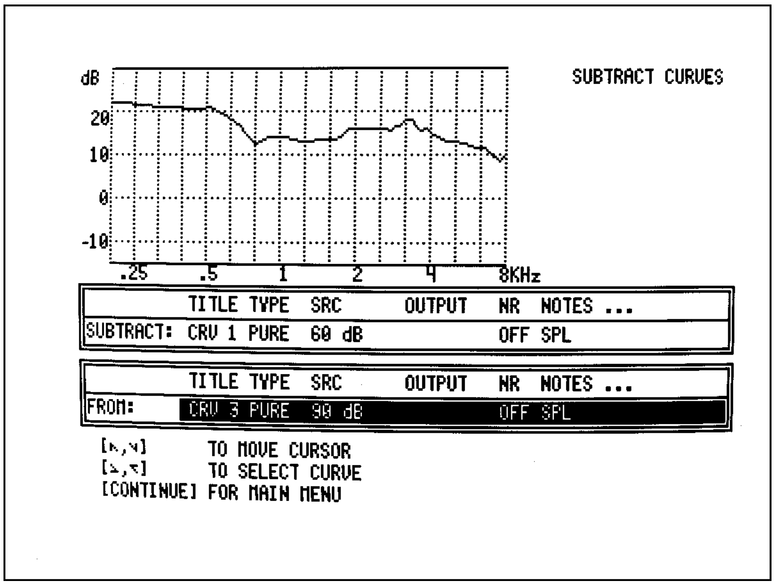


Figure 7.12.7—Subtract Curves display

7.12.7.1 Adding two curves

For special purposes, you may want to add two curves. To do this, you can use the Subtract Curves Mode in a special way.

1. In the top box, select the curve you want to add.
2. In the bottom box, select an empty or "invalid" curve. (Don't select REFERENCE 9.) This creates an "inverse" curve in REFERENCE 9.
3. Press [CONTINUE] to exit from Subtract Curves Mode.
4. Copy the inverse curve from REFERENCE 9 to an unused location. See Section 7.12.8.
5. Re-enter Subtract Curves Mode.
6. Subtract the inverse curve from the other curve to be added. The resulting curve, automatically stored in REFERENCE 9, is the sum of the original two curves.

7.12.8 Copying a Curve

Use Copy Curve to store a copy of a curve in a new memory location.

1. In the Main Selection Menu, highlight COPY CURVES.
2. Press [START] to enter Copy Curves Mode. See Figure 7.12.8.
3. Use the [<] or [>] buttons to select a curve for the currently highlighted title box. The selected curve will appear in the graph.
4. Use the [∧] or [∨] buttons to highlight the other title box.
5. Use the [<] or [>] buttons to select another curve.
6. Press [START] to make a copy of the curve identified in the upper title box and store it into the location identified in the lower title box.

A message in reverse video, CURVE COPIED, will appear under the Main Selection Menu, indicating the program has performed the copy and store operations. NOTE: The curve previously identified in the lower box, will be overwritten and lost. Copying an INVALID CURVE to a new location has the same effect as CLEARING the new location.

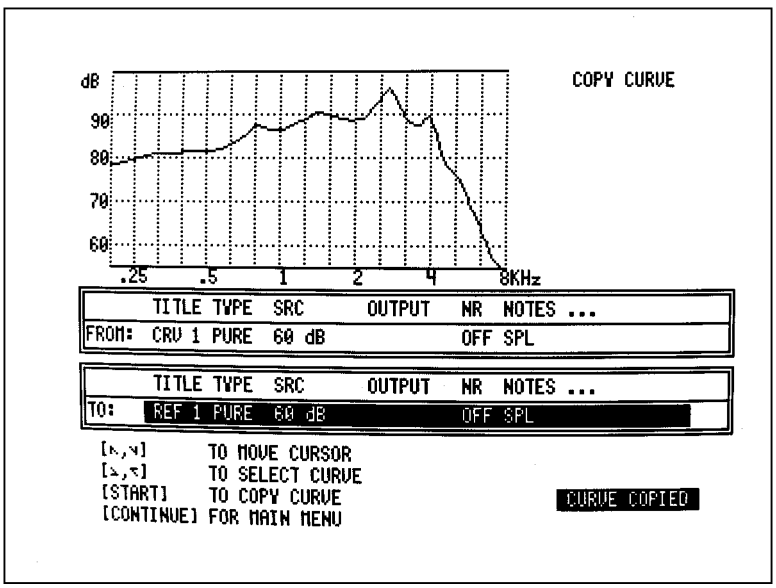


Figure 7.12.8—Copy Curve display

7.12.9 Clearing a Curve

This function erases the data stored in a selected curve location. The data are replaced with zeros.

1. In the Main Selection Menu, highlight CLEAR CURVE.
2. Press [START] to enter Clear Curve Mode. See Figure 7.12.9
3. Use the [<] or [>] buttons to select the curve you wish to clear. The selected curve will appear on the graph.
4. Push [START] to clear the curve. A reverse-video message, CURVE CLEARED, will confirm the action, and the curve-type description in the title box will change to INVALID CURVE.

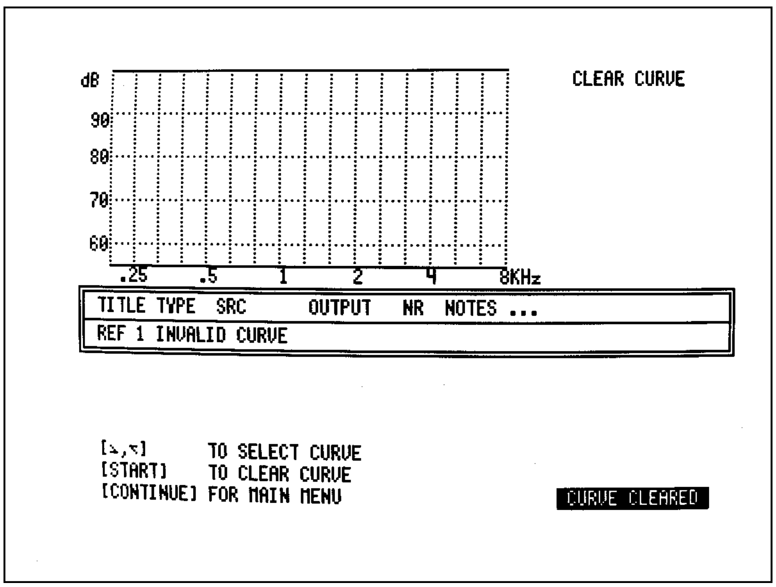


Figure 7.12.9—Clear Curve display

7.12.10 Saving Curves Permanently

When power to the 6500-CX is turned off, all curves are lost. Other than printing hard copies, for permanent storage you must interface your 6500-CX with an external computer using the RS232 Option. Frye Electronics also offers a computer hearing aid program, called WinCHAP, for communicating data between the FONIX 6500-CX and a Windows-based personal computer.

7.13 0/60

The 0/60 Option comes with the Multiple Option Package when the 6500-CX is purchased.

7.13.1 Introduction

This option gives the operator the convenience of being able to remove the signal instantly without turning off the instrument. It also gives instant access to the 60 dB SPL source level, which is frequently used in testing.

7.13.2 Procedure

Press the [O/60] button once to turn the signal source off. Press it again to set the source amplitude to 60 dB SPL. To go to any other sound pressure level, push the [∧]or [∨] button.

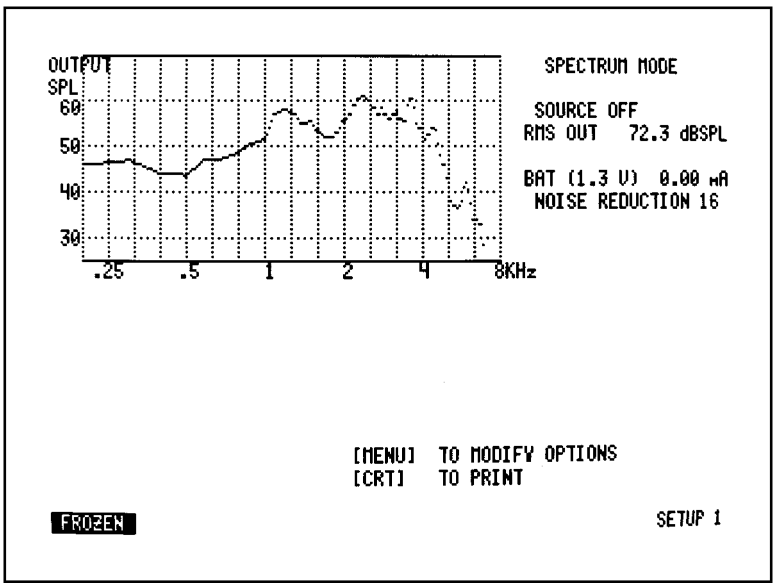


Figure 7.13.2—6500-CX in spectrum analysis mode (source off)

7.14 OES (Occluded Ear Simulator) Option

The OES Option gives you more accurate coupler measurements than can be obtained with HA-1 and HA-2 couplers.

7.14.1 Introduction

The OES Option consists of three special couplers (see Figure 7.14.2A) and software that allows you to obtain the same data you would get with a standard ear simulator (IEC 711, or Zwislocki coupler), provided the hearing aid or mold being tested is not vented.

Note: The OES couplers and software are also parts of the In-situ Option (see Section 7.10), which simulates manikin real-ear measurements.

Figure 7.14.2A—Modified Zwislocki couplers used with OES and with IN-SITU

7.14.2 Procedure

1. Select the proper MZ coupler and connect the aid as usual. See Figure 7.10.5 for details.
2. Push the [OES] button. A message will appear at the bottom of the screen reminding you that the special couplers are required. See Figure 7.14.2B.
3. Correction factors will now be included in all measurements. The reminder message OES ENABLED will appear on the display and in the print-outs.
4. Exit OES by pushing the [OES] button again. Don't forget to change back to the regular couplers when you leave OES.

Corrections will be made to all composite and pure-tone curves, data displays, and to individual measurements at one frequency. OES also works with the following options: Multi-curve, Averaging, Gain, and Telecoil.

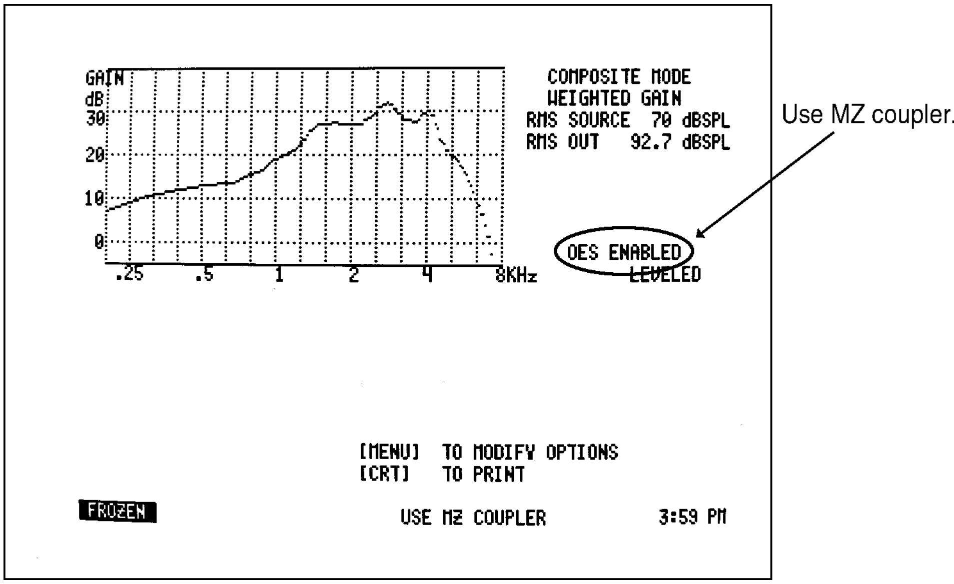


Figure 7.14.2B—OES cisplay

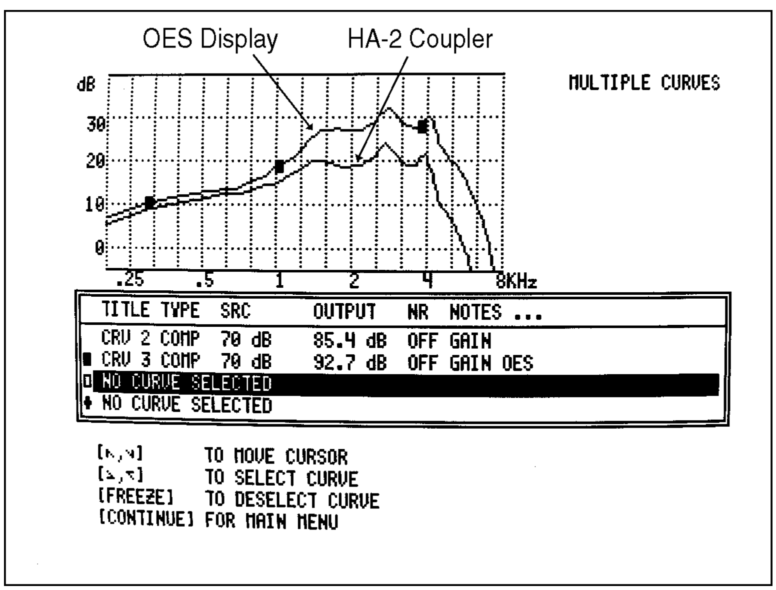


Figure 7.14.2C—Comparison of HA-2 and MZ measurements

7.15 Profiler

The Profiler can be purchased as an addition to the Star Option.

7.15.1 Introduction

The Profiler is a comprehensive, diagnostic tool. It includes ten tests, each selected because of its potential to identify common customer complaints. The tests included are an OSPL 90 test, a total harmonic distortion test, a maximum output reading, an equivalent input noise measurement, the RMS gain of the medium speech curve, a battery current drain measurement, three speech curves run at soft, medium, and loud levels, and a reserve gain test.

The entire sequence takes under forty-five seconds, and, with the exception of the reserve gain measurement, it is done with the hearing aid set at the user gain.

7.15.2 Profiler Settings

Set the hearing aid to the normal user-gain level. Attach the aid to the appropriate coupler, place the microphone in the coupler, and position the aid in the sound chamber as you normally would.

To enter the Profiler Menu from the Composite or Pure-Tone modes:

1. Press [MENU].
2. Press [*].
3. Use [v] to highlight HEARING AID PROFILE.
4. Press [MENU].

NOISE REDUCTION: Noise reduction used in the measurements.

SPEECH SIGNAL TYPE: Signal type used for speech curves. Choices are: Digital Speech ICRA (DSPI), Digital Speech ANSI (DSPA), or composite (COMP). For information on the Digital Speech signals, see Section 7.4.

DIGITAL SPEECH DURATION: Length of time the Digital Speech signal will be presented to the hearing aid for each speech curve measurement. Only used for DSPI or DSPA speech signal types.

EQUIVALENT INPUT NOISE METHOD: Method of measuring the equivalent input noise. Choose a three frequency average (HFA/SPA) or the overall noise (RMS).

EQUIVALENT INPUT NOISE FREQUENCIES: The frequencies used to measure the equivalent input noise when HFA/SPA is chosen as the equivalent input noise method.

7.15.3 Procedure

1. If you are in the Profiler Menu, press [CONTINUE] to return to the Star Menu. Otherwise, enter the Star Menu by pressing [MENU] and [*].
2. Make sure HEARING AID PROFILE is highlighted. Use [∧, ∨] if necessary.
3. Press [START] to begin the test.
4. When the test pauses, turn the aid's volume control to the full-on position.
5. Press [CONTINUE]. The test will be completed.
6. Press [CRT] to print the results.
7. Press [CONTINUE] to exit the Profiler.

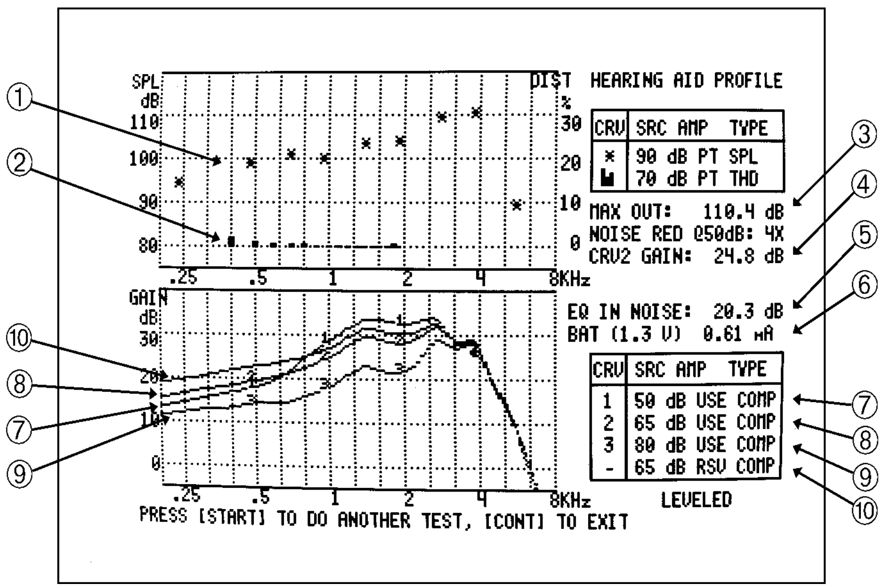


Figure 7.15.3—Profiler results

1. OSPL 90
2. Total Harmonic Distortion
3. Maximum Output
4. RMS Gain of Curve 2 (medium speech curve)
5. Equivalent Input Noise
6. Battery Current Drain
7. Soft Speech Curve
8. Medium Speech Curve
9. Loud Speech Curve
10. Reserve Gain

7.16 RBX

The RBX feature comes standard with every 6500-CX.

7.16.1 Introduction

RBX stands for "Release-Attack Battery Current." It gives you the following measurements:

- Attack and release times according to ANSI 87 and IEC standards
- Battery current according to ANSI S3.22 and IEC standards
- Battery current drain as a function of amplitude and as a function of frequency
- Estimated battery life

7.16.2 RBX Settings

To enter RBX Menu:

1. Press [MENU].
2. Press [RBX].

ATTACK & RELEASE MODE: Type of attack & release measurement made. Choose from ANSI AT 2000Hz, IEC at 1600 Hz, IEC at 2500 Hz, and NO ATTACK & REL.

Notes on attack & release:
The attack & release measurements in the RBX Option are always made with amplitudes switching from 55 dB to 80 dB SPL and back again. Attack and release times are defined as the times in milliseconds for the hearing aid to stabilize within 2 dB of the final values. A waiting time of 2 seconds is used for both attack and release time measurements. The complete attack & release test takes 9 seconds. When an aid has excessive noise or distortion, attack & release measurements may be inaccurate. In such cases, the readout may give an error message.

When the ANSI is selected, attack & release is measured at 2000 Hz.

Note on battery current measurement

When ANSI or NO ATTACK & RELEASE is selected, the battery current measurement is made at 1000 Hz using a 65 dB tone.

When IEC is selected, the battery current measurement is made at the selected frequency using a 60 dB tone.

7.16.3 Procedure

1. Insert the appropriate battery pill into the hearing aid.
2. Connect the hearing aid to the appropriate coupler.
3. Insert the microphone into the coupler.
4. Plug the battery pill cord into the battery voltage supply and select the battery type. If you are using a #5 battery pill, push the 10/230 button. The aid will not be powered unless a battery pill is used and a button on the Battery Voltage Supply is pushed.
5. Position the aid at the reference point in the sound chamber, and close and latch the lid.
6. Select the desired attack & release measurement as described in Section 7.16.2.
7. To begin the measurement, press [START] from the RBX Menu or [RBX] from the Composite or Pure-Tone Mode. See Figure 7.16.3.
8. If desired, adjust the frequency and amplitude of the test signal with the arrow keys; the battery current and estimated battery life will be updated with each selection.

Additional tests you can run while in the RBX Screen are noted in section 7.16.3.1 and 7.16.3.2. Press [CONTINUE] to exit the RBX Screen.

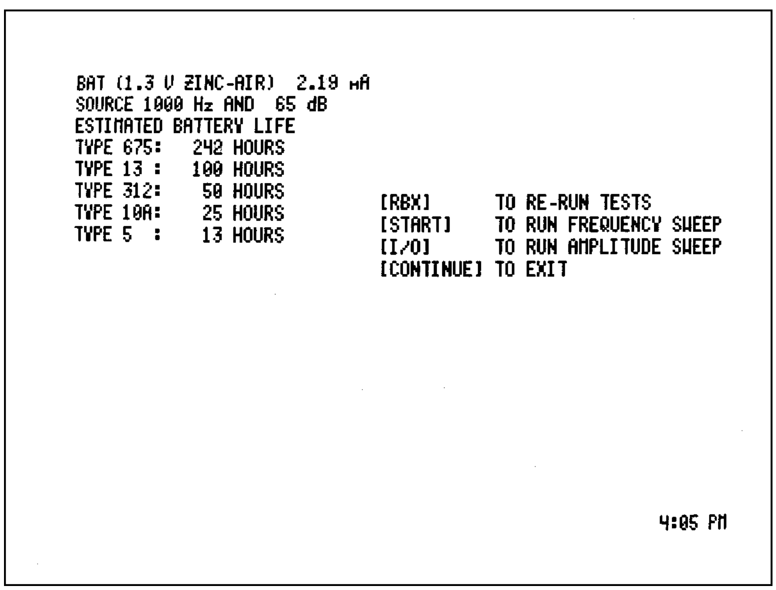


Figure 7.16.3—RBX Opening display

7.16.3.1 Battery current versus frequency

1. Using the [∧, ∨] buttons, select the desired amplitude.

2. Press [START] to run a frequency sweep.

3. See Figure 7.16.3.1. Each dot on the vertical scale is 0.5 mA.

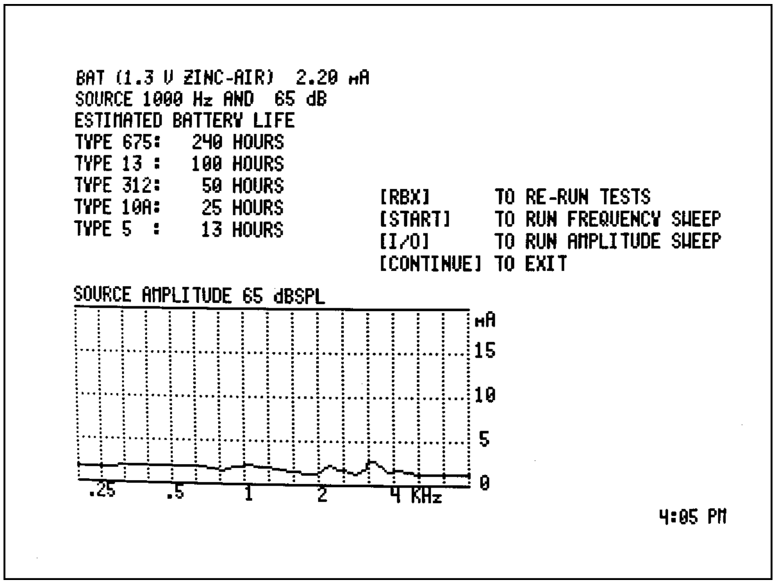


Figure 7.16.3.1—RBX amplitude sweep

7.16.3.2 Battery current versus amplitude

You can perform this automatic measurement only if you have the I/O Option.

1. Select the desired frequency with the [<, >] buttons, or use the composite signal by pressing [SINE/COMPOSITE].

2. Press [I/O].

3. See Figure 7.16.3.2.

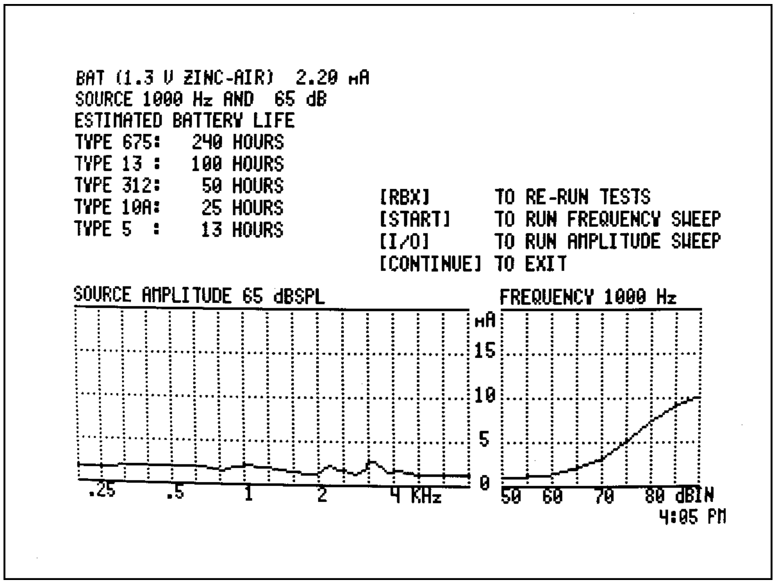


Figure 7.16.3.2—RBX amplitude and frequency sweep

7.16.4 RBX Specifications

The section includes the data used in RBX results and the specifications of the battery pills.

7.16.4.1 Estimated battery life

RBX estimates the hours of battery life by dividing a pre-stored milliampere-hour rating by the battery drain shown in the upper left of the screen. Milliampere-hour ratings vary, but the following numbers are used by RBX as indicative of present-day batteries.

BATTERY	ZINC/AIR	MERCURY	SILVER
675	530 mAh	250 mAh	180 mAh
13	220	95	75
312	110	50	37
10A/230	55	n/a	n/a
5	30	n/	n/a

7.16.4.2 Battery impedance

The impedance of the different battery simulator pills and their settings are as follows:

BATTERY	CHEMISTRY	VOLTS	IMPEDANCE
10A/230		1.3V	11.7 ohms
675	Mercury	1.3V	5 ohms
675	Zinc/air	1.3V	3.5 ohms
13	Silver	1.5V	8 ohms
13	Mercury	1.3V	8 ohms
13	Zinc/air	1.3V	6 ohms
312	Silver	1.5V	10 ohms
312	Mercury	1.3V	8 ohms
312	Zinc/air	1.3V	6 ohms

7.16.5 High Powered Batteries

The introduction of high-powered batteries has created new questions which need to be considered when fitting hearing aids. The 6500-CX can easily show you whether or not a high-powered battery will have a longer life in a specific hearing aid than would a regular battery.

1. In the RBX Screen, select an amplitude of 90 dB with the [∧] key.
2. Check the battery drain. If the drain is more than 10 mA for a #312 battery, 12 mA for #13, or more than 28 mA for a #675 battery, a high-powered battery might last longer than a regular sized battery in that aid.[1]

[1] Numbers quoted from John Oltman and Mead Killion as printed in "Nuts and Bolts" by Robert Martin in the October 1997, Vol. 50, No.10 Issue of *The Hearing Journal.*

7.17 RS232

The RS232 Option, often known as the “Computer Option,” is described in this section.

7.17.1 Introduction

The RS232 Option adds hardware and software to your 6500-CX that allows it to communicate with a personal computer. It is required for using programs such as WinCHAP which provide a computer interface for communicating with the 6500-CX analyzer.

- A large blue connector labeled “6500.” This is for attaching to the back of your 6500-CX.
- A small black connector labeled “computer.” This is for attaching to a communications port on your personal computer.

In addition to the hardware and software on the 6500-CX, you will receive:

- A large blue connector labeled “computer” and complete with a red and a green led. Some older computers have 25-pin communications port. This is an alternate connector for use with those computers. It is also a diagnostics tool
- A silver diagnostic plug. This is for troubleshooting RS232 connection problems.
- An RS232 cable. This is for plugging into the 6500-CX and the communications port plugs, connecting the 6500-CX to your personal computer.
- RS232 software disks. These are only used if you wish to program your own computer interface with the 6500-CX. If you are using a program such as WinCHAP, you can ignore these disks.

7.17.2 Troubleshooting

Since PC hardware and software varies so much, it is not unusual to have problems when first attempting to establish an RS232 connection with your 6500-CX. For this reason, we have included some tools that will help establish where the problem is. See Appendix D for a troubleshooting guide.

7.18 Star [*]

The Star Option consists of several different coupler tests that couldn't easily be incorporated into any existing option or button. They include:

- Digital Speech In Noise (See Section 7.4)
- Hearing Aid Profiler (See Section 7.15)
- Enhanced Attack & Release (See Section 7.5)
- Adaptive Attack & Release (See Section 7.1)
- Enhanced DSP (See Section 7.6)

Not all tests may be available with each analyzer; it depends on when you purchased your analyzer or upgrade and the options you decided to add to it.

Press [MENU] and [*] to find out which options are available on your analyzer.

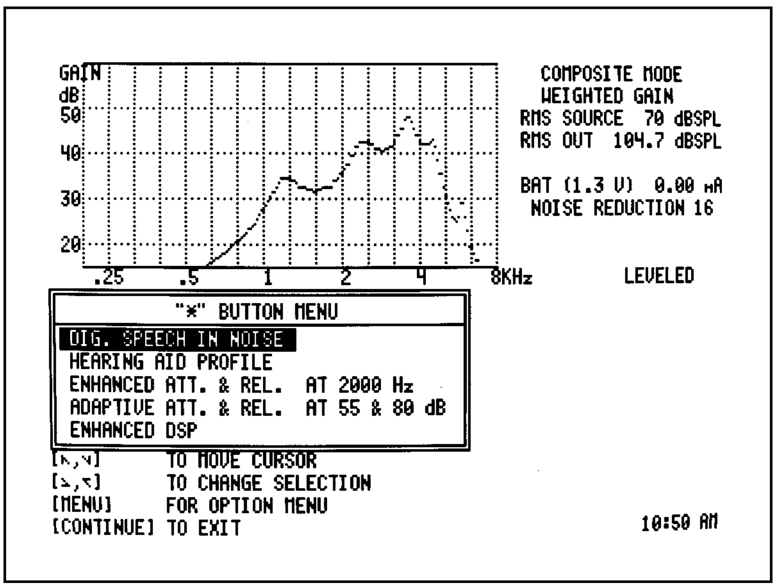


Figure 7.18—Star button menu

7.19 Telecoil

The Telecoil Feature, often referred to as the "coil" feature, comes standard with every 6500-CX.

7.19.1 Introduction

The Telecoil Option allows you to take telecoil measurements outside of an automated test sequence such as ANSI. All 6500-CX analyzers come with the ANSI 87, IEC, and composite method for testing the telecoil function of hearing aids. If you have purchased the ANSI 96 test sequence, you will also have use of the ANSI 96 method. Similarly, if you have purchased the JIS Option, you will have use of the JIS telecoil measurement.

There have been two different styles of sound chambers built during the 6500's history. The older style chamber, with the external battery box, requires an external telecoil board. The newer style chamber, with the internal battery box, has an internal telecoil board. For the most accurate telecoil measurements, it may be beneficial to purchase an external telecoil board for use with the new style chamber; it may help you to distance the measurement from the interference of the 6500-CX's VGA monitor.

7.19.2 Analyzer Setup

The VGA monitor used with the 6500-CX creates a magnetic field that interferes with the measurement of the telephone coil response of a hearing aid. All CRT monitors produce magnetic interference, but interference from the VGA monitors is worse than from the amber or green monochrome monitors used with earlier 6500s. Follow the procedures below for establishing the best possible test arrangement.

7.19.2.1 Picking a testing location

It's important to pick a testing location that is free of magnetic disturbances, especially those caused by fluorescent lights and power lines. To do this:

1. Locate a wide range linear hearing aid with good low frequency response.
2. Set the hearing aid to operate in the telecoil position and turn the gain control up to its full-on position.
3. Connect the hearing aid to a coupler. Don't attach the measurement microphone.
4. Walk around your possible testing location and listen for raspy humming sounds from the hearing aid. This will be the aid responding to magnetic fields in the room.
5. Pick a location that is as free of such sounds as possible. Rotate the aid in all directions when looking for a good site.

7.19.2.2 Setting up your analyzer

Place the 6500-CX hearing aid analyzer so that the sound box, the electronics module and the CRT monitor are all sitting on the same working surface. Place the electronics module in the center of the group, with the sound box on the left and the CRT on the right. It is not necessary to have large spaces between components, but better results can be obtained with a more spread out arrangement. When the measurement components are arranged properly, you will note that rotating and tilting the VGA monitor produces little if any change in the magnitude of the interference.

To minimize the interference of extraneous magnetic fields you can:

1. Turn off the video monitor of the 6500-CX as you take the telecoil measurement. Use [FREEZE] to freeze the measurement in place while the monitor is off.

2. Turn off any fluorescent lights in the room.

3. Position the test box or external telecoil board away from your video monitor.

4. Turn off nearby electrical devices.

7.19.2.3 Setting up an external telecoil board

With the 6050 Test Chamber, an optional external telecoil (standard with the 6010 chamber) may be used instead of the built-in telecoil, when extraneous magnetic fields in the test environment require moving the telecoil away from the test chamber.

1. Connect the external telecoil board to the test chamber using the supplied six-foot cable. The socket on the 6050 test chamber is located directly beneath where the multi-pin cable is plugged in, at the bottom right of the outside of the test box.

   Note: When the external telecoil board plug is connected to the jack on the test box, the internal telecoil is disabled.

2. The external telecoil board must be placed on a metal free surface. Steel desks are not satisfactory surfaces, even if they are covered by a layer of plastic or other non-metal materials.

7.19.3 Telecoil Settings

1. Press [MENU].

2. Press [COIL].

3. Select the desired test with the [<, >] buttons. Choose from ANSI 87, IEC, COMPOSITE, ANSI 96, and JIS 2000 (ANSI 96 & JIS 2000 only available with the ANSI 96 and JIS Options).

Note: The only difference between the ANSI 87 and IEC telecoil measurements is the default frequency. ANSI 87 uses 1000 Hz by default. IEC uses 1600 Hz or 2500 Hz.

7.19.4 Procedure for Using Telecoil Board

1. Enter the Telecoil Screen by pressing [START] from the Telecoil Menu or [COIL] from Composite or Pure-Tone Mode.

2. Orient the body of the aid for the maximum possible output. For BTEs this usually occurs when the body of the aid is in a vertical position. If necessary, use Fun Tak as shown in Figure 7.19.4, to help hold the aid in the desired position.

3. Press [<, >] to adjust the frequency of the telecoil test signal (except if you are using composite).

4. Press [START] to run a frequency sweep (except if you are using composite).

5. Press [CONTINUE] to exit from the Telecoil Screen.

Hint: For the most accuracy, you may have to temporarily turn off the video monitor while capturing the measurement.

Figure 7.19.4—Telecoil measurement setup using the sound chamber's internal telecoil board

7.19.5 Procedure for Using Telewand (ANSI 96)

The procedure ANSI 96 recommends for testing the telecoil function of hearing aids involves a device that looks like a flat telephone receiving – the telewand. The telewand is supposed to be a more realistic test than using a telecoil board because it more closely resembles the magnetic interference caused by a telephone receiver.

1. Plug the telewand into the jack on the side of the sound chamber, just below where the sound chamber connects with the instrument.

2. Bring the telewand up to the aid as if it were the ear piece of a telephone. Keep it parallel to the face plate of an ITE aid, parallel to the body of a BTE aid. See Figures 7.19.4.1A and 7.19.4.1B.

3. Press [START] to run a frequency sweep.

4. If you want to test an aid for loop sensitivity, position the telewand so that it is coming down on a BTE aid or so that it is perpendicular to and above the face plate of an ITE aid.

Figure 7.19.4.1A
Using the Telewand with a BTE

Figure 7.19.4.1B
Using the Telewand with an ITE

Chapter 8: Quik-Probe II Option

8.1 Introduction

The Quik-Probe II Option allows you to perform real-ear measurements accurately and efficiently. All measurements are performed using the remote module, allowing you to move freely while testing. And for extra convenience, or to solve space problems, you can operate Quik-Probe II as far as 50 feet from the main electronics module. For this purpose, Frye Electronics offers optional extension cables, a wall jack, and an extra monitor. Special instructions are available covering the installation of Quik-Probe II at an extended remote location.

There are two major real-ear measurement modes: the Insertion Gain Screen, and the SPL Testing Screen. Insertion Gain allows you to see the difference in ear canal sound pressure level between aided and unaided measurements – showing you the acoustic benefit delivered by the hearing aid. The remote module was specifically designed for this type of real-ear measurement, making it a very quick and easy measurement to perform.

The SPL Screen allows you to perform aided real-ear measurements and directly compare them to the patient's hearing threshold levels, uncomfortable levels, and the target, all converted to dB SPL. Since the SPL Testing Screen works quite differently than the Insertion Gain Screen, we had to do some creative reprogramming for some of the keys of the remote module. However, each screen, including the SPL Testing Screen, includes a short explanation of the function of each key; keep an eye out for these help messages.

Spectrum Analysis Mode, available in both the Insertion Gain and the SPL Testing Screen, is a great way of performing real-time, real-ear analysis with any sustained acoustic signal, such as live or recorded environmental sounds, or even the hearing-aid wearer's own voice. You can use it to measure the occlusion effect of the hearing aid or how much the aid is amplifying a loved-one's voice.

The Quik-Probe II Option also has two "Target 2-cc" Screens. These screens are for prescribing the 2-cc coupler response that is likely to give the desired Insertion Gain response in your client's ear.

The monitor headset lets the hearing-aid fitter or others listen to the sound of the hearing aid, via the probe microphone in the ear canal, while the hearing aid is worn by the user. Attach the 1/4" adapter, found in the headset package, to the headset plug, and then plug the adapter into the jack on the remote module marked MONITOR. The knob near the monitor jack controls the sound level of the headset. An undesirable feedback path can be created when using the monitor headset, especially with high gain hearing aids. If feedback occurs, reduce the headset sound level and/or move the headset further away from the hearing aid.

8.2 Real-Ear Setup

The placement of the sound field speakers, setup of the microphones, and leveling of the sound field are described in this section.

8.2.1 Placing the Sound Field Speaker

For the most accurate, repeatable measurements, we recommend a sound field speaker placement of approximately 12 inches from the client's head and pointing towards the ear to be tested. The speaker should be at an azimuth angle of 45 degrees (halfway between the client's nose and ear). The height of the loudspeaker should be level with, or a little above the ear. See Figure 8.2.1

NOTE: It is especially important, for accuracy, that the speaker be within 12" if you are using a 90-dB signal.

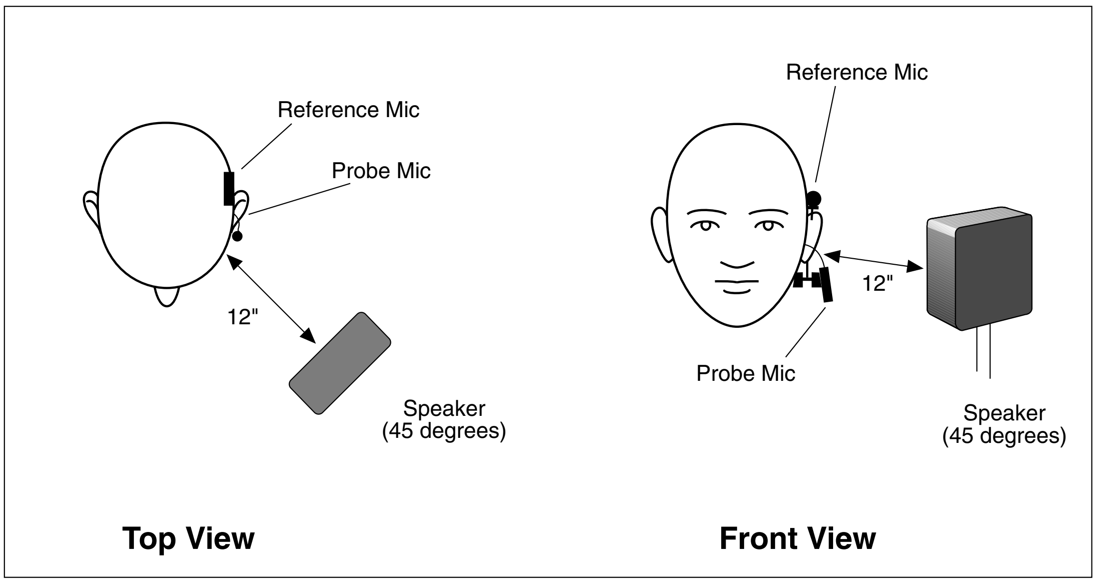


Figure 8.2.1—Sound field speaker setup

8.2.2 Placing the Probe and Reference Microphones

To ensure the proper insertion depth of the probe tube, the following marking procedure is necessary. After some practice, the procedure is easy.

1. Place an unattached probe tube on a flat surface along with the client's earmold or shell as shown in Figure 8.2.2A so that the tube rests along the bottom of the canal part of the earmold, with the tube extending at least 5 mm past the canal opening.

2. Mark the probe tube with a marking pen where it meets the outside surface of the earmold.

3. Place the wedge style earhook on the client's ear. Alternately, you may use the headband for the reference microphone.

4. Attach the reference microphone, facing forward, on the wedge of the earhook, directly above the ear to be tested.

5. Attach the probe tube to the body of the probe microphone and then attach the probe microphone to the round Velcro pad on the ear hanger.

6. Insert the probe tube into the client's ear so that the mark is at the location where the bottom of the outer surface of the earmold will be. See Figure 8.2.2B.

Hints: To help keep the probe tube in place, position the tube so that it runs through the tragal notch, resting against the lower edge of the tragus (Figure 8.2.2B). If necessary, reposition the body of the probe microphone lower on the Velcro button of the ear hanger. If desired, use surgical tape to hold the tube in position.

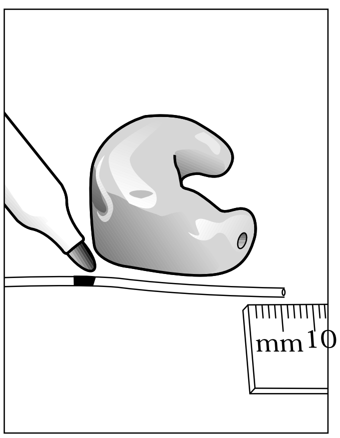


Figure 8.2.2A
Mark probe tube

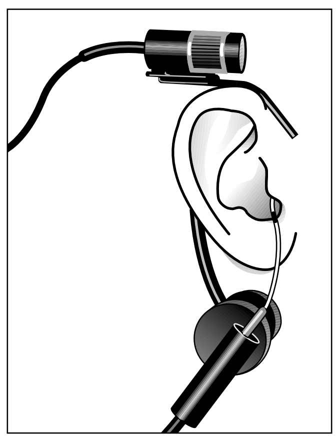


Figure 8.2.2B
Place probe microphone

Figure 8.2.2C
Place hearing aid

8.2.3 Leveling the Sound Field

The first step in making probe measurements with Quik-Probe II is to level the response of the sound field. The sound field includes the room and everything in it: the operator, the client, and any ambient noise that may penetrate the room. Leveling is important so that the input to the hearing aid is properly controlled across the frequency spectrum. See Figure 8.2.3. **You must re-level the sound field for every client and every ear.**

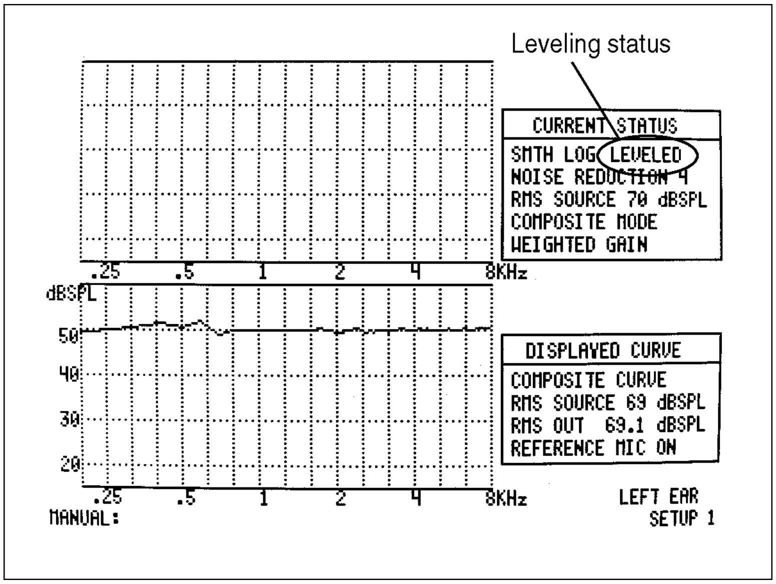


Figure 8.2.3—Sound field leveling

1. Follow the instructions found in Sections 8.2.1 and 8.2.2 to position the client, sound field speaker, and microphones for testing. Only the larger reference microphone is used for leveling. However, to speed things up and ensure the client is in the same position for leveling as he is for measuring, it is recommended that you insert the probe microphone tube in the client's ear for the leveling process.

2. Press [LEVEL] on the remote module.

3. The instrument will attempt to level the sound field speaker. There are three leveling statuses:

    a. LEVELED—This indicates the leveling process was correct within 2 dB.

    b. UNLEVELED—This indicates that the leveling process is incorrect at least 6 dB.

    c. <BLANK> — No leveling message indicates that the leveling process was correct somewhere between 2 dB and 6 dB.

If the instrument didn't successfully level, there are several things you can try.

- Check the position of the sound field speaker. It should be 12 to 15 inches from the client's head.

- Make sure the microphones are securely plugged into the remote module.

- Make sure the front of the reference microphone is as close to the client's head as possible.

- Check the calibration of the loudspeaker and microphones. See Section 2.6.4 and Section 2.6.5.
- Check the noise level in the room. It may be necessary to change or correct the sound field environment.

8.3 Insertion Gain Testing

Insertion gain testing, the default testing mode of Quik-Probe II, is a way of measuring the hearing aid's actual amplification inside the client's ear. There are two graphs on the screen because insertion gain testing actually involves two different dB scales.

The unaided and aided responses, displayed in the bottom graph are the actual gain or output inside the ear as measured by the probe microphone. The bottom graph has a scaling of dB GAIN (or dB SPL). The insertion gain, displayed in the top graph, is the *difference* between the unaided and the aided response – the amount the hearing aid is amplifying without the help of the unaided ear. The top graph always has a scaling of dB IG (Insertion Gain). When created, the insertion gain target will always be found in the top graph in dB IG.

8.3.1 Entering Insertion Gain

There are two ways to enter Insertion Gain Mode:

- Press [PROBE] on the 6500-CX main module
- Press [START/STOP] on the remote module

This will enter the Insertion Gain Screen.

8.3.2 Changing Insertion Gain Settings

The FONIX 6500-CX Quik-Probe II Option is flexible. You can change most of the test conditions using the menus described below. All of the settings have defaults, which are pre-programmed by the factory. If a previous user has changed the defaults, you might find settings other than the usual default settings.

8.3.2.1 Quik-Probe II Menu

The Quik-Probe II Menu serves as the main Insertion Gain Menu. To enter it, press [MENU] on the remote module. Use the [∧, ∨] buttons to highlight items in the menu. Use the [<, >] buttons to alter selections. Press [START/STOP] to enter a sub-menu.

EAR TESTED: This specifies the screen label. Choices are LEFT, RIGHT, or NONE. Important: Changing the ear will remove any sound field leveling and measurements from memory.

CREATE TARGET: Select the type of target you want to create. Choices are: INS. GAIN, 2 cc FOG, 2 cc SSPL90, SPL TARGET.

MODE: Testing mode used. COMP/AUTO automatically saves sequential measurements as "unaided" and "aided" responses, making testing quicker. COMP/MAN requires you to manually save measurements, but gives you more control. PURETONE also requires you to manually save measurements, but uses pure-tone signals instead of composite signals.

WARNING:

Choose OUTPUT LIMITING carefully (see procedure below). You don't want to damage your clients' hearing or to cause them discomfort during testing. To ensure safety and comfort, the Quik-Probe II system reacts automatically when the OUTPUT LIMITING level is exceeded at the Probe Microphone. When the level measured at the Probe Microphone exceeds the pre-set limit, the words "OUTPUT OVER LIMIT" appear on the screen, and the program automatically lowers the intensity of the sound source in 5-dB steps until the level drops below the limit.

Whenever the output limiting function has lowered the source, you have to reset the signal source using the Operation Parameters menu, before proceeding to the next measurement.

The default setting for OUTPUT LIMITING is 120 dB SPL. You can set the OUTPUT LIMITING to any level between 90 and 140 dB SPL in 5-dB increments (see procedure below). In special cases, when you select 130 or 140 dB SPL, be aware that extra care is necessary with any output that may exceed 132 dB SPL. KEEP IN MIND THAT THE SOUND PRESSURE LEVEL AT THE EARDRUM CAN BE HIGHER THAN THAT MEASURED AT THE MID-EAR CANAL POSITION, especially at high frequencies. For this reason, ***EXTREME CAUTION*** is advised when performing real-ear SSPL measurements.

When using pure tones, set NOISE REDUCTION to OFF in the OPERATION PARAMETERS menu to speed response.

To view or change the OUTPUT LIMITING setting:

1. Push [MENU] on the Remote Module to display the Quik-Probe II menu.
2. Use the [v] button to select "OPERATION PARAM." Then push [START /STOP].
3. In the Operation Parameters menu, move the cursor to highlight "OUTPUT LIMITING."
4. Use the [<] or [>] buttons to choose the desired limit.
5. Return to the normal Quik-Probe screen by pushing [MENU].

SANITATION NOTICE

DO NOT REUSE PROBE TUBES.

Use a new probe tube for each ear to prevent the possible spread of infection. Sterilization of probe tubes is not possible, and germicidal solutions can leave a residue inside the tubing which can result in errors. Do not cut off any portion of the tube.

OPERATION PARAM: Sub-menu for setting source selections. See Section 8.3.2.2 for details.

GAIN(G)/SPL: Select whether to use the reference microphone for testing and whether to display the bottom graph in dB GAIN or dB SPL.

AVERAGE UNAIDED: Press [START/STOP] to use the KEMAR unaided response for your insertion gain measurements.

CALIBRATE PROBE: Sub-screen used for calibrating the probe and reference microphones. See Sections 2.6.4 for details.

MULTICURVE: Multi-curve sub-menu. See Section 7.12 for details.

8.3.2.2 Operation Parameters Menu

Highlight OPERATION PARAM in the Quik-Probe II Menu and press [START/STOP] to enter the Operation Parameters Menu.

SIGNAL LEVEL: Select the source level for testing.

SMOOTHING: Select type of smoothing used in measurements. Smoothed curves may be less precise than unsmoothed curves, but they are often easier to read.

> 100 Hz: Measured data points from three consecutive frequencies, 100 Hz apart, are averaged to get the curve point plotted at the center frequency. This type of smoothing is more visible at low frequencies than at high frequencies.
>
> LOG: Below 2000 Hz, LOG smoothing works the same as 100 Hz smoothing. Between 2000 and 3000 Hz, measured data points from five consecutive frequencies are averaged to get the curve point plotted at the center frequency. Above 3000 Hz, measured data points from seven consecutive frequencies are averaged to get the curve point plotted at the center frequency. This leads to visible smoothing across all frequencies

OUTPUT LIMITING: Selects the maximum output the probe microphone will read at its tip before automatically turning the sound field signal off to prevent damage to the ear.

NOISE REDUCTION: Type of noise reduction used in measurements.

DATA CONVERSION: Selects the curve that is converted to numerical data points when [DATA] is pressed.

8.3.3 Entering the Audiogram

1. From the Insertion Gain Screen, press [MENU] on the remote module.
2. Highlight CREATE TARGET with [∧, ∨].
3. Select INS. GAIN with [>].

4. Press [START/STOP]. This will open the Audiogram Entry Screen. See Figure 8.3.3.
5. Enter threshold values with [∧, ∨] keys.
6. Go to the next frequency by pushing the [>] button.
7. Press [MENU] to change the ear tested and the fitting rule.
8. Press [CLEAR] to clear all displayed audiogram values.
9. Press [START.
ƒOP] to generate the insertion gain target and return to the Insertion Gain Screen.

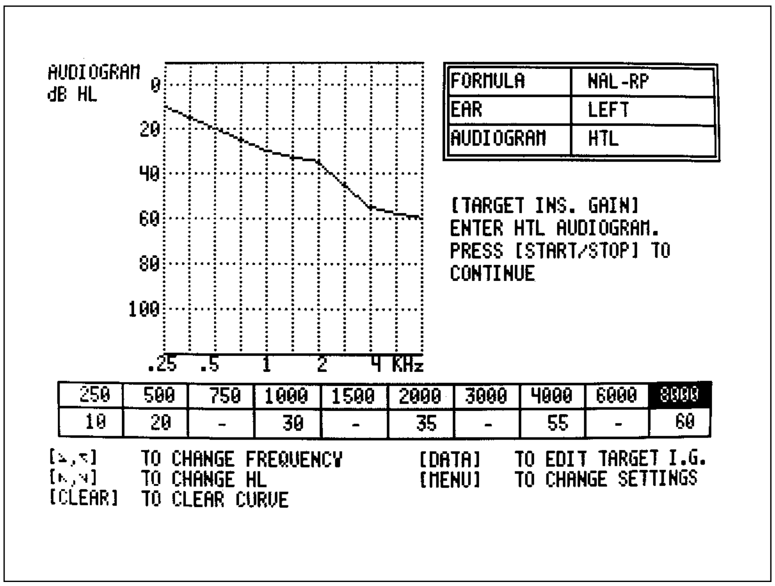


Figure 8.3.3—Audiogram Entry Screen

8.3.3.1 Insertion Gain Menu

To enter the Insertion Gain Menu, press [MENU] from the Insertion Gain Audiogram Entry Screen.

EAR TESTED: Select the ear to be labeled with the measurement.

FORMULA: Select the fitting rule used to create the insertion gain target.

CLEAR AFTER EAR CHANGE: Choose YES to clear all audiogram entries when ear is changed.

8.3.3.2 Target Insertion Gain Edit Screen

Press [DATA] to enter the Target Insertion Gain Edit Screen. See Figure 8.3.3.2.

Use [<, >] to select the desired frequency to edit. Use [∧, ∨] to modify the target in 2 dB steps. When you modify a target, the 6500-CX will add "/M" to the displayed fitting formula, indicating a modification has been made.

Note: These steps can also be used for the direct entry of the target curve.

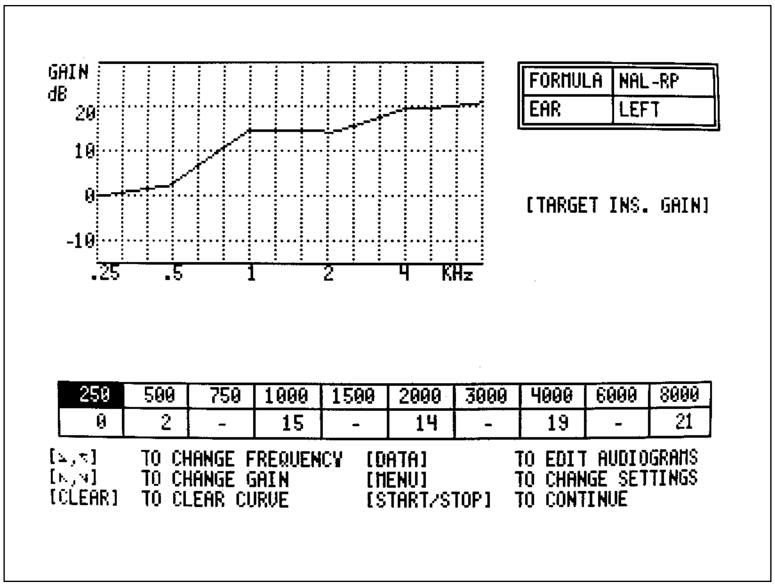


Figure 8.3.3.2—Target Insertion Gain Edit Screen

8.3.4 Measuring Insertion Gain

8.3.4.1 Introduction

There are two main modes for making Insertion Gain measurements: Manual and Automatic Mode. When you are in Manual Mode, you must manually save the unaided or aided measurement curves by pressing [AIDED] or [UNAIDED]. When you are in Automatic Mode, the curves are automatically saved for you, assuming a specific measurement order.

Look at the bottom left corner of the Insertion Gain Screen to see the current testing mode. Change the mode in the Quik-Probe II Menu. See Section 8.3.2.1.

All key presses are performed on the remote module.

8.3.4.2 Procedure

1. Instruct the client to remain very still every time the test signal is on, and also to be in exactly the same position each time. (Hint: Have the client look straight ahead and pick a spot on the wall to concentrate on during measurements. You may wish to place something of interest on the wall in front of where the client will be.)

2. Level the sound field speaker. See Section 8.2.3.

3. If necessary, insert the probe tube.

4. Press [START/STOP]. This will begin the unaided measurement.

5. Adjust the source level with [∧, ∨] if desired. We recommend 65 or 70 dB for taking an unaided response measurement.

6. When satisfied with the unaided response, press [START/STOP] to end the test.

7. Press [∧, ∨] to cycle through the last four curves measured.

8. If you are in Manual Mode, press [UNAIDED] to save the response.

9. Insert hearing aid, being careful not to move the probe tube.

10. Have the client adjust the aid for normal use gain setting.

11. Press the [START/STOP] to begin the aided measurement.

12. Adjust the source level with [∧, ∨] if desired.

13. When satisfied, press [START/STOP] to end the test.

14. Press [∧, ∨] to cycle through the last four curves measured.

15. If you are in Manual Mode, press [AIDED] to save the response.

16. If desired, adjust the hearing aid and press [START/STOP] again to take another measurement and [START/STOP] to stop the measurement. If you are in Manual Mode, this new curve will be displayed on top of the existing curves.

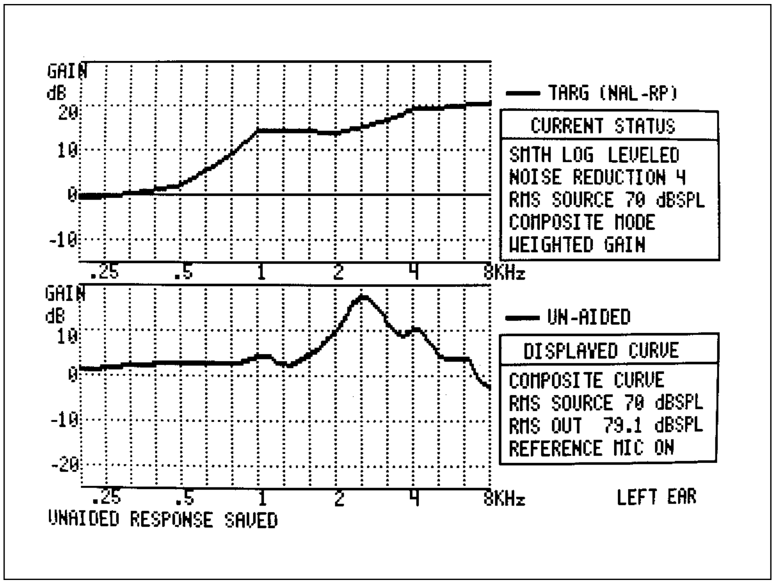


Figure 8.3.4.2A—Real-ear unaided response

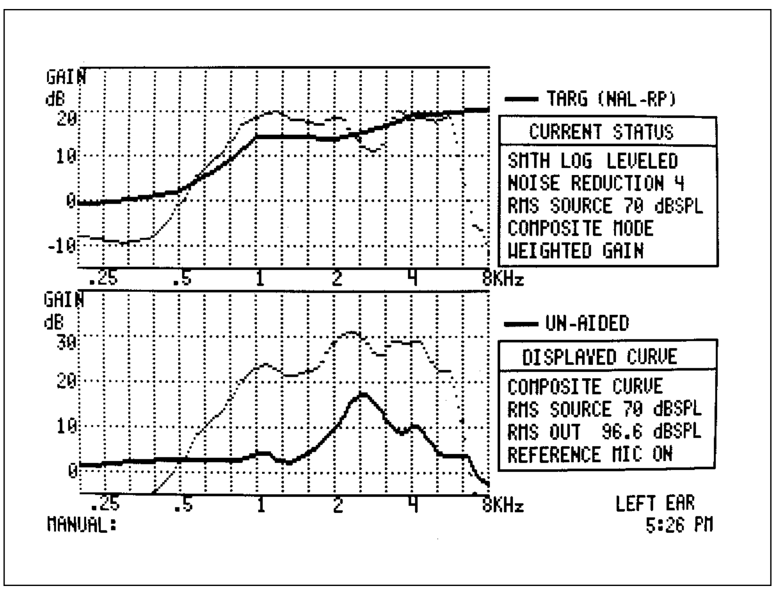


Figure 8.3.4.2B—Real-ear Insertion gain and aided gain response

8.3.4.3 Storing Measurements

You can copy measurement curves to the Reference Curves for later use.

1. Press [STORE] from the Insertion Gain Screen. This will bring up the Quik-Store Menu. See Figure 8.3.4.3.
2. Highlight the curve you want to copy in the COPY column using the [∧, ∨] keys.
3. Press [>] to highlight the TO column.
4. Highlight the reference curve you want to copy the curve to using the [∧, ∨] keys.
5. Press [START/STOP] to copy the curve.
6. Press [MENU] to resume testing.

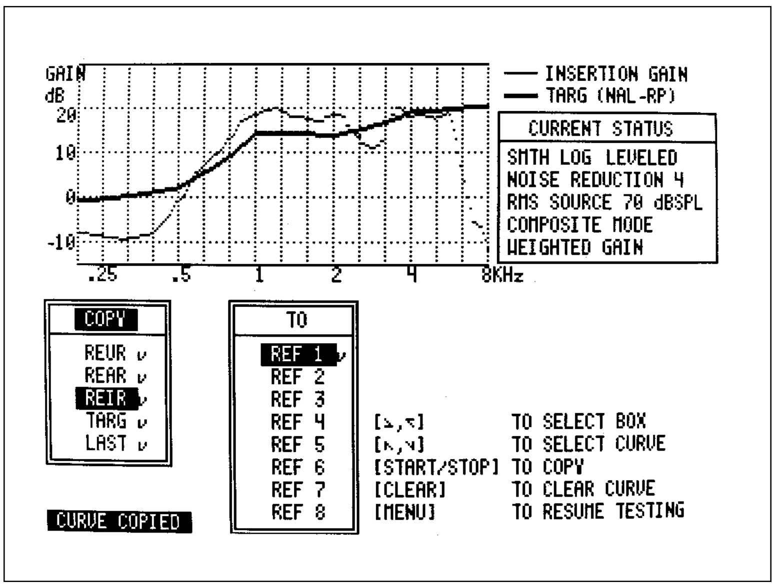


Figure 8.3.4.3—Quik-Store Menu

8.3.4.4 Clearing measurements

If you are in Automatic Mode:

- Press [CLEAR] to clear all measurements at once

If you are in Manual Mode:

- Press [CLEAR] and [UNAIDED] to clear unaided measurement.

- Press [CLEAR] and [AIDED] to clear the aided measurement. Although the insertion gain measurement will disappear, the aided response will remain on the screen until you take a new measurement.

8.3.4.5 Data values

The 6500-CX allows you to get the numerical values for your measurement curves by pressing [DATA]. Due to screen constraints, only one curve can be displayed this way at a time. To choose which curve is displayed in numerical format, go to the Operation Parameters Menu. See Section 8.3.2.2.

FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB
200	-8.0	2000	18.4	3800	19.0	5600	18.6	7400	-5.9
300	-9.6	2100	18.5	3900	18.3	5700	18.0	7500	-6.6
400	-7.8	2200	17.8	4000	18.1	5800	16.9	7600	-8.0
500	-1.1	2300	16.2	4100	18.2	5900	15.0	7700	-8.8
600	5.5	2400	14.6	4200	18.4	6000	12.8	7800	-9.5
700	9.6	2500	13.4	4300	18.6	6100	10.6	7900	-11.0
800	13.2	2600	12.0	4400	18.7	6200	8.7	8000	-11.3
900	16.9	2700	11.4	4500	18.5	6300	7.1		
1000	18.7	2800	11.2	4600	18.2	6400	5.3	SOURCE RMS	
1100	19.6	2900	10.9	4700	18.1	6500	3.6	70 dBSPL	
1200	19.9	3000	11.6	4800	17.9	6600	2.0		
1300	18.8	3100	12.6	4900	17.7	6700	0.0		
1400	18.2	3200	15.0	5000	17.8	6800	-1.8	DIFFERENCE OF	
1500	18.0	3300	16.9	5100	18.0	6900	-3.1	TWO CURVES	
1600	17.7	3400	18.7	5200	18.1	7000	-4.3	GAIN	
1700	16.9	3500	19.8	5300	18.3	7100	-5.3	LEVELED	
1800	16.8	3600	19.9	5400	18.7	7200	-5.7	PROBE REIR	
1900	17.8	3700	19.8	5500	18.8	7300	-6.1		

Figure 8.3.4.5—Data display

8.3.4.6 Pure-tone Measurements

By default, the 6500-CX uses composite signals to make its measurements. In some circumstances, however, you might want to use your 6500-CX to make a pure-tone sweep measurement or an individual frequency measurement. To do this, you must put the 6500-CX in real-ear pure-tone mode:

1. Press [MENU] from the Insertion Gain screen.
2. Use [∧, ∨] to highlight MODE.
3. Use [<, >] to select PURETONE.

4. Press [MENU] to return to the Insertion Gain screen.

5. Make sure you level the sound field speaker before taking a measurement. See Section 8.2.3.

When you have completed the steps above, the analyzer will be in real-ear pure-tone mode in the Insertion Gain screen. You can now perform the following actions:

- To run a single frequency measurement, press [START/STOP]. Use [∧, ∨] to change the amplitude of the signal and [<, >] to change the frequency of the signal.

- To run a pure-tone sweep, press [SWEEP/START]. This will run a pure-tone sweep at the selected amplitude. To select a different amplitude, run a single frequency measurement as described above and change the amplitude using the [∧, ∨] keys.

8.3.5 Testing of Digital Aids in Insertion Gain

Some high-end digital hearing aids have noise reduction features that cause them to lower the gain of the hearing aid when hearing a continuous sound. This will affect measurements made with both the composite signal as well as pure-tone sweeps.

Frye Electronics has developed a signal known as “Digital Speech” for testing these hearing aids. Digital Speech is an interrupted composite signal that causes the aid to respond to it as it would to speech instead of as it would to noise. Unfortunately, the Digital Speech signal in the Quik-Probe II Option is only available in the SPL Testing Screen of the 6500-CX at this time. (See Section 8.4.) To test digital hearing aids with noise reduction features in the Insertion Gain Mode, first put the aid into “test” mode with its programming software, turning off the noise reduction.

8.3.6 Viewing Multiple Curves

When fitting WDRC hearing aids, it’s often useful to view insertion gain measurements taken with inputs at varying levels. This allows you to verify that the compression characteristics of the hearing aid are working properly.

The following are “cookbook” instructions to using the Multi-Curve function of the 6500-CX while in the Insertion Gain screen:

8.3.6.1 Setup

1. Press [START/STOP] on the remote module to enter the real-ear Insertion Gain screen. (You can also press [PROBE] on the main module.) All further key presses will be done on the remote module.

2. Press [MENU].

3. Use the [∧, ∨] arrow keys to highlight CREATE TARGET.

4. Use the [<, >] arrow keys to select INS. GAIN.
5. Press [START/STOP] to enter the Audiogram Entry screen.
6. Use the arrow keys to input your patient's audiogram. Select the ear to be tested by using the [MENU] key. Exit the Audiogram Entry menu by pressing [MENU] again.
7. Press [START/STOP] to return to the Insertion Gain screen.
8. Set up your patient for real-ear testing. Use a speaker placement of 45 degrees with a distance of 12-15 inches from the patient's head. Place the larger reference microphone above the ear and insert the probe tube, if desired (probe tube insertion is not necessary for leveling.)
9. Press [LEVEL] to level the sound field speaker. Insert the probe tube if you haven't already done so.

8.3.6.2 Measurements

1. Press [START/STOP] to begin the unaided measurement. Use the up-down arrow keys to adjust the level of the signal, if desired. 65-70 dB is recommended for unaided measurements.
2. Press [START/STOP] when the measurement has stabilized. You should see the unaided measurement peak somewhere between 2-4 kHz. See Figure 8.3.4.2A. If the peak is before 2 kHz, the probe tube is probably not inserted deeply enough.
3. Press [UNAIDED] to save the unaided measurement if you are in MANUAL mode. (Look in the bottom left corner of the screen to determine if you are in MANUAL or AUTO mode.) Otherwise, go to the next step.
4. Insert the hearing aid of the patient, being careful not to move the probe tube.
5. Press [START/STOP] to start the aided measurement. Use the [∨] key to adjust the signal level to 50 dB (or the level that you desired for the "soft" measurement).
6. Press [START/STOP] once the measurement has stabilized. The top graph on the screen contains the insertion gain measurement. The bottom graph on the screen contains the unaided and aided measurements. See Figure 8.3.4.2B.
7. Press [AIDED] to save the aided measurement if you are in MANUAL mode. (This is not necessary if you are in AUTO mode.)
8. Press [STORE]. This will bring up two columns on the screen titled COPY and TO. See Figure 8.3.4.3.
9. Use the [>] key to highlight COPY, if it's not already highlighted.
10. Use the [∧, ∨] keys to highlight REIR in the FROM column.

11. Use the [>] key to highlight TO.
12. Use the [∧, ∨] key to highlight REF 1.
13. Press [START/STOP] to copy the REIR to REF 1.
14. Press [MENU] to remove the COPY and TO columns and return to the Insertion Gain screen.
15. Press [START/STOP] to start the second measurement. Use [∧, ∨] arrow keys to change the source level to 65 dB (or the level that you desired for the "medium" measurement).
16. Press [START/STOP] when the measurement has stabilized.
17. Press [AIDED] to save the aided measurement if you are in MANUAL mode. (This is not necessary if you are in AUTO mode.)
18. Press [STORE]. This will bring up the COPY and TO columns again. REIR should be automatically highlighted in the COPY column. REF 2 should automatically be highlighted in the TO column.
19. Press [START/STOP] to copy REIR to REF 2.
20. Press [MENU] to clear the COPY and TO columns and return to the Insertion Gain screen.
21. Press [START/STOP] to start the third measurement. Use [∧, ∨] keys to change the source level to 80 dB (or the level that you desired for the "loud" measurement)
22. Press [START/STOP] when the measurement has stabilized.
23. Press [AIDED] to save the aided measurement if you are in MANUAL mode.
24. Press [STORE]. This will bring up the COPY and TO columns. REIR should be automatically highlighted in the COPY column. REF 3 should automatically be highlighted in the TO column.
25. Press [START/STOP] to copy REIR to REF 3.
26. Use the [>] key to highlight TO, if necessary. Use the down arrow key to highlight REF 4 in the TO column.
27. Use the [<] key to highlight COPY, if necessary. Use the up-down arrow key to highlight TARG.
28. Press [START/STOP] to copy the target curve to REF 4.
29. Press [MENU] to clear the COPY and TO columns and return to the Insertion Gain screen.

8.3.6.3 Viewing all the curves

1. Press [MENU] to enter the Quik Probe menu.

2. Use the down arrow key to highlight MULTICURVE.

3. Press [START/STOP] to enter the Multi-curve menu. MULTIPLE CURVE should be highlighted.

4. Press [START/STOP] to enter the Multiple curves display. REF 1-REF 4 should automatically be displayed. REF 1 is the “soft” level curve made at 50 dB. REF 2 is the “medium” level curve made at 65 dB. REF 3 is the “loud” level curve made at 80 dB. REF 4 is the target curve. It should usually match up with REF 2, the “medium” level curve. See Figure 8.3.6.3.

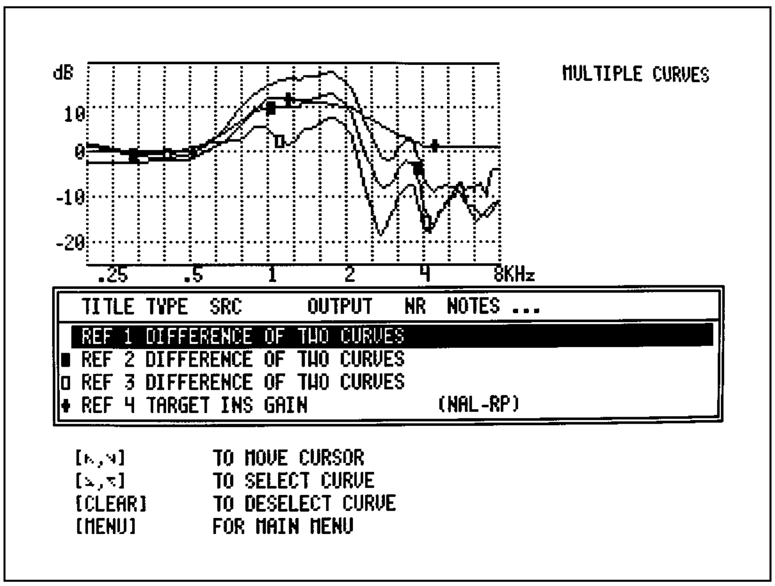


Figure 8.3.6.3—Multiple curves display

8.3.6.4 Measuring Output in the Insertion Gain screen

It’s also important to measure the real-ear output of the hearing aid with a 90 dB pure-tone swept input. This is used to make sure that the hearing aid doesn’t exceed the patient’s upper limit of comfort. You can do this in the Insertion Gain screen or the SPL screen. See the next section for instructions on using the SPL screen.

To measure output in the Insertion Gain screen:

1. Press [MENU] from the Insertion Gain screen to enter the Quick Probe menu.

2. Use the up-down arrow keys to highlight MODE.

3. Use the left-right arrow keys to select PURE TONE.
4. Use the down arrow key to select OPERATIONAL PARAM.
5. Press [START/STOP] to enter the Operational Parameters menu.
6. Use the arrow keys to change the SIGNAL LEVEL to 90 dB SPL.
7. Use [MENU] twice to return to the Insertion Gain screen.
8. Press [SWEEP/START] to run a pure-tone sweep at 90 dB SPL. Compare the output to the patient's UCL values measured (or converted) to dB SPL. See Figure 8.3.6.4.

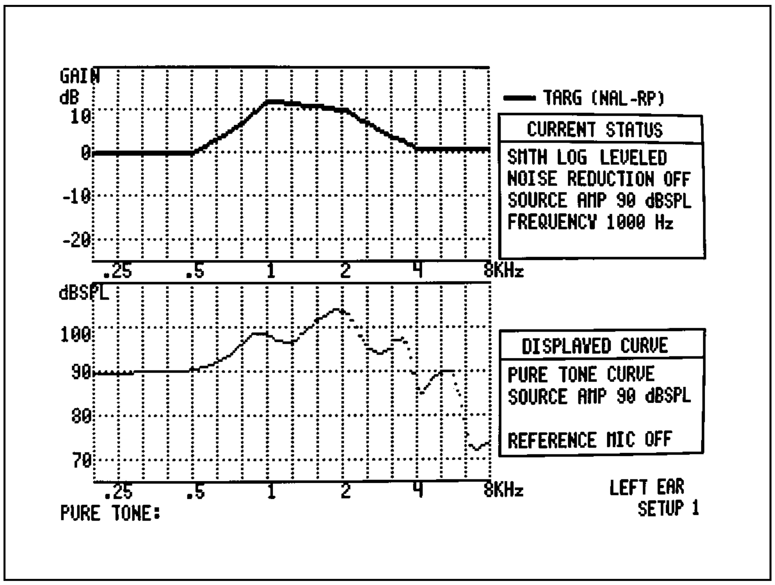


Figure 8.3.6.4—Output measurement in the insertion gain screen

8.3.6.5 Switching Ears

1. Move the sound field speaker (or rotate the patient) to set up for measuring the patient's other ear. Switch the microphones to the other ear as well.
2. Press [MENU] from the Insertion Gain screen to enter the Quick Probe menu.
3. Use [∧] to highlight CREATE TARGET.
4. Use [<, >] to select INS GAIN.
5. Press [START/STOP] to enter the Audiogram Entry screen.
6. Press [MENU] to enter the Audiogram Entry menu.

7. Change the EAR TESTED. If you would like to clear the existing audiogram, also choose YES for CLEAR AFTER EAR CHANGE. Press [MENU] to return to the Audiogram Entry screen.

8. Use the arrow keys to input the audiogram of the new ear.

9. Press [START/STOP] to return to the Insertion Gain screen. (All existing measurements are cleared from the screen when the ear is changed.)

10. Press [LEVEL] to re-level the sound field speaker.

11. Follow the instructions in Section 8.3.6.2 to perform the measurements for the new ear. The three new insertion gain curves can be saved over the existing REF 1-REF 4. Alternately, you can use REF 5-8 to save the curves for the new ear.

    If you use REF 5-8 for the new ear, when you reach Step 4 in Section 8.3.6.3, use the arrow keys to change the four slots of the display from REF 1-4 to REF 5-8. To do this:

    a. Use [∧] to select the first slot of the display, if needed. Use [>] to select REF 5 in the first slot.

    b. Use [∨] to select the second slot of the display, and use the right arrow key to select REF 6.

Repeat for slots 3 and 4 to select REF 7 and REF 8, respectively.

8.4 SPL Testing

A different perspective of the fitting process can be seen in the SPL Testing Screen, where all data is viewed in dB SPL.

8.4.1 Introduction

The SPL Testing Screen is a way to view three real-ear measurements, hearing threshold levels, uncomfortable levels, and the target all on one screen in dB SPL. Having all this information in a common format provides a convenient way to view the hearing loss and the amplification provided by the hearing aid without the confusion of different frames of reference.

Normally three measurements are made in the screen:

- soft speech curve to make sure that soft sounds reach the client's hearing threshold levels
- medium speech curve to make sure that normal speech reaches the target
- loud pure-tone sweep to make sure that loud sounds are below the client's uncomfortable levels.

The SPL Menu allows you to choose Digital Speech signals for testing, allowing you to perform real-ear measurements on even high-end digital hearing aids with noise reduction features.

The SPL Testing Screen involves two procedures: entering an audiogram and taking measurements. **Although you don't have to enter an audiogram in order to take measurements, you must go through the Audiogram Entry Screen to get to the SPL Testing Screen.**

8.4.2 Entering an Audiogram

1. From the Insertion Gain Screen, press [MENU] on the remote module.
2. Highlight CREATE TARGET using [∧, ∨].
3. Select SPL TARGET using [<, >].
4. Press [START/STOP] to enter the Audiogram Entry Screen.
5. Enter hearing threshold values with [∧, ∨] keys.
6. Go to the next frequency by pushing the [>] button.
7. Press [MENU] to enter the SPL Setup Menu and change the ear tested, the fitting rule, and other selections. See Section 8.4.3.
8. Press [CLEAR] to clear all displayed audiogram values.
9. To enter UCL values, press [SWEEP/START] and use the arrow keys.

10. To view or modify the insertion gain target, press [DATA] and use the arrow keys, if desired.

11. Press [START/STOP] to enter the SPL Testing Screen.

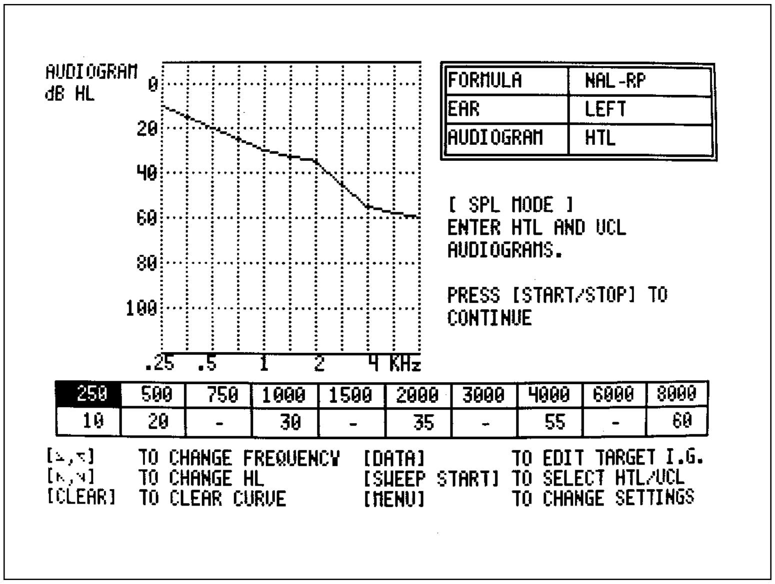


Figure 8.4.3—Audiogram Entry Screen

8.4.3 Changing the SPL Setup Menu

Enter the SPL Setup Menu by pressing [MENU] from the SPL Target's Audiogram Entry Screen.

EAR TESTED: Select desired ear. Changing ears will clear leveling and any previous measurements.

FORMULA: Select insertion gain fitting formula. Choices are: NAL-RP, POGO, BERGER, 1/3 GAIN, 1/2 GAIN, and 2/3 GAIN.

PREDICT UCL: Choose whether you want to predict UCL values in the SPL Testing Screen.

UNAIDED RESPONSE: When converting insertion gain targets to dB SPL, an unaided response is used. Choose whether to use the KERMAR average unaided response or the patient's own measured response measured in the Insertion Gain Screen.

CLEAR AFTER EAR CHANGE: Choose YES to clear the audiogram information when switching ears.

8.4.4 Measuring the SPL Testing Screen

The settings and measurements of the SPL Testing Screen are described in this section.

8.4.4.1 Introduction

From the Audiogram Entry Screen described in Section 8.4.2, press [START/STOP] to enter the SPL Testing Screen. If you entered HTL values and UCL values (or had the UCL values predicted), you should see a screen such as the one in Figure 8.4.4.1.

- T denotes the thresholds
- U denotes the uncomfortable levels
- The bold red line is the target

If you don't see a target on your screen as expected, or if you have questions about your target, see Section 8.4.5.

Like the Insertion Gain Screen, the SPL Testing Screen has a Manual and an Automatic testing mode. The current mode is identified in the bottom left corner of the SPL Testing Screen. Press [UNAIDED] to switch between modes.

In Manual Mode, you must manually select the measurement curve you want to run. However, you have the flexibility to change the source type and easily re-run measurements. In Automatic Mode, the measurement curves are automatically advanced for you, leaving you with fewer required key presses to make your measurements but less control.

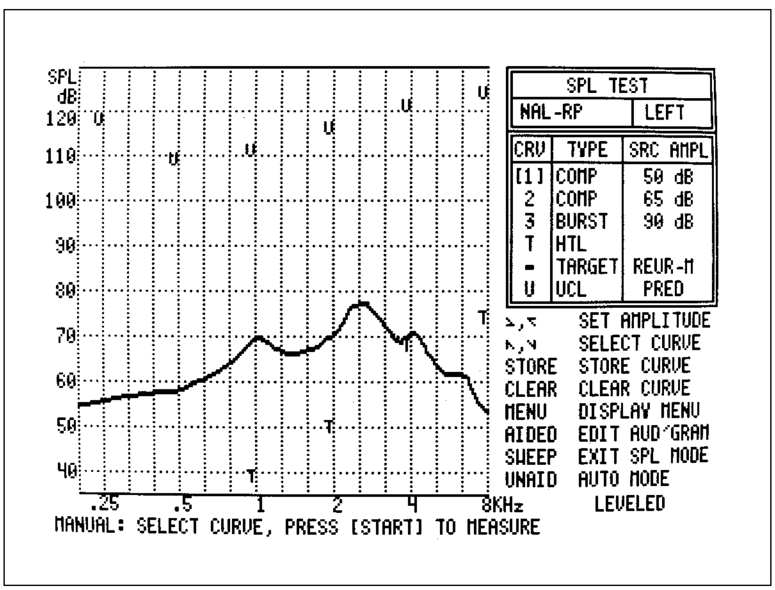


Figure 8.4.4.1—SPL Testing Screen

8.4.4.2 SPL Settings

Press [MENU] from the SPL Testing Screen to enter the SPL Menu. You must be Manual Mode. Press [UNAIDED] to enter Manual Mode if necessary.

AIDED CURVE 1, 2, 3: Select the source type for the three measurement curves. Choose from COMPOSITE, DSPIN-ANSI, DSPIN-ICRA, PT_BURST, and PURETONE. We recommend a speech curve such as composite or one of the Digital Speech curves for AIDED 1 & 2, and PT_BURST for CURVE 3.

NOISE REDUCTION: Select the amount of noise reduction used in measurement curves.

DIGITAL SPEECH MENU: Press [START/STOP] to enter this sub-menu for adding a bias tone to a Digital Speech signal type. See below.

AUTO SAVE AIDED CURVES: Select whether you want to automatically save the three measurement curves, HTLs, UCLs, and target to REFERENCE CURVES 1-6 without having to press [STORE].

Exit the SPL Menu by pressing [MENU].

Digital Speech Menu

Enter the Digital Speech Menu by highlighting it in the SPL Menu and pressing [START/STOP]. This menu allows you to add a pure-tone bias signal to a Digital Speech signal to test the aid's filters at specific frequencies.

BIAS SIGNAL: Turn on and off the bias signal.

BIAS LEVEL: Select the output of the bias signal.

BIAS FREQ: Select the frequency of the bias signal.

Press [MENU] to exit the Digital Speech Menu.

8.4.4.3 Procedure

1. Instruct the client to remain very still every time the test signal is on, and also to be in exactly the same position each time. (Hint: Have the client look straight ahead and pick a spot on the wall to concentrate on during measurements. You may wish to place something of interest on the wall in front of where the client will be.)
2. Level the sound field speaker. See Section 8.2.3. Leveling can be performed in either the Insertion Gain Screen or the SPL Testing Screen.
3. Insert the probe tube and hearing aid.
4. Follow the directions in Section 8.4.2 to input an audiogram and enter the SPL Testing Screen.

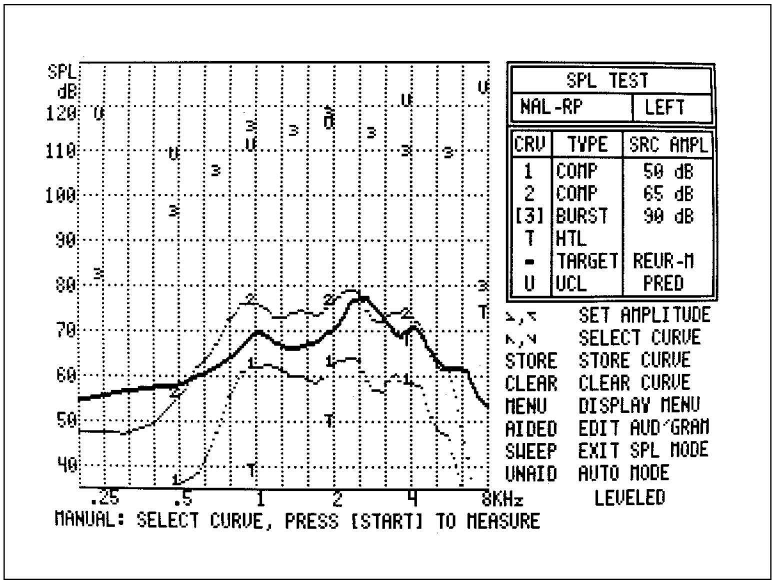


Figure 8.4.4.3—SPL Testing Screen with measurements

5. If you are in Manual Mode, press [∧] to select CRV 1 if it's not already selected.
6. If desired, press [<, >] to change the amplitude of CRV 1. We suggest 40-55 dB SPL as a soft sound measurement curve.
7. Press [START/STOP] to begin the measurement. For composite and Digital Speech curves, press [START/STOP] to end the measurement. The soft sound measurement curve should reach above the hearing threshold levels.
8. If you are in Manual Mode, press [v] to select CRV 2.
9. If desired, press [<, >] to change the amplitude of CRV 2. We suggest 65-75 dB SPL as a medium sound measurement curve.
10. Press [START/STOP] to begin the measurement. For composite and Digital Speech curves, press [START/STOP] to end the measurement. The medium sound measurement curve should meet the target.
11. If you are in Manual Mode, press [v] to select CRV 3.
12. If desired, press [<, >] to change the amplitude of CRV 3. We suggest 80-90 dB SPL as a loud sound measurement curve.
13. Press [START/STOP] to begin the measurement. For composite and Digital Speech curves, press [START/STOP] to end the measurement (we recommend using a pure-tone burst for this measurement). The loud sound measurement curve should fall below the uncomfortable levels.

14. If desired, press [AIDED] from the SPL Testing Screen to go to the Audiogram Entry Screen.

15. Press [SWEEP/START] from the SPL Testing Screen to return to the Insertion Gain Screen.

8.4.5 Understanding the SPL Target

- The SPL target is always set to the source level and type of CRV 2.
- If MEASURED is selected for UNAIDED RESPONSE in the SPL Setup Menu, a target will appear on the screen only if an unaided response is measured in the Insertion Gain Screen. See below.
- Sometimes target values will fall below the hearing threshold levels, especially for profound losses. This is an artifact of the fitting rule itself – not a bug in the 6500-CX. The fitting rule is indicating that the loss is too profound at those frequencies to be able to amplify successfully.

Unaided response in the SPL target

The SPL target curves are insertion gain targets converted to dB SPL. See Appendix H for details on the conversion formula. The conversion process uses either the KEMAR average unaided response or the patient's measured unaided response. The unaided response used is denoted on the SPL Testing Screen. See Figure 8.4.5.

REUR-A: average unaided response used

REUR-M: measured unaided response used

NO-REUR: measured unaided response selected but not measured.

The unaided response used is selected in the SPL Setup Menu. See Section 8.4.3.1. If you have entered threshold levels and no target is displayed in the SPL Testing Screen, it's probably because MEASURED unaided was selected in the SPL Setup Menu but no unaided measurements have been made in the Insertion Gain Screen.

To switch from MEASURED to AVERAGE unaided response:

1. From the SPL Testing Screen, press [AIDED]. This takes you to the Audiogram Entry Screen.
2. Press [MENU]. This takes you to the SPL Setup Menu.
3. Highlight UNAIDED RESPONSE with [∧, ∨].
4. Select AVERAGE with [>].
5. Press [MENU] to exit the SPL Setup Menu.

6. Press [START/STOP] to return to the SPL Testing Screen. The target should now be displayed.

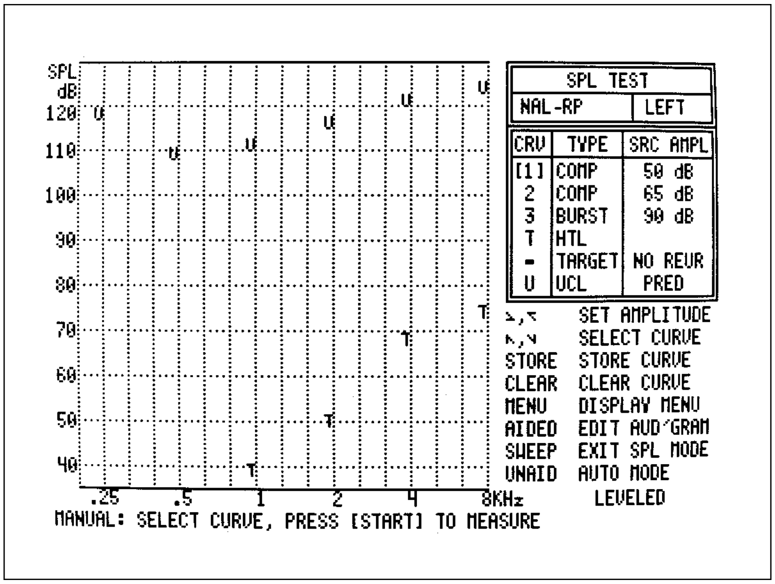


Figure 8.4.5.1—SPL Testing Screen with no target

8.4.6 Testing Digital Hearing Aids

Even the most advanced of digital hearing aids are easy to test with the 6500-CX. Many high-end digital hearing aids have a noise reduction feature on them that causes them to lower their gain when exposed to continuous sound. This has caused a problem for traditional testing techniques which used composite or pure-tone signals, both of which can trigger the noise reduction filters.

We developed a randomly interrupted composite signal that we call "Digital Speech" that makes the aid think it's hearing speech instead of hearing noise.

Digital Speech is available in two speech spectra: the ANSI S3.42 and the ICRA. The ANSI spectrum comes from the ANSI S3.42 standard for testing nonlinear hearing aids. It is almost identical to the speech spectrum we use in the standard composite signal, having a gentle roll-off of the high frequencies. The ICRA speech spectrum comes directly from the ICRA CD of sounds that was developed by the International Collegium of Rehabilitative Audiology. We took a spectrum analysis of that CD and used it as the speech spectrum of the ICRA Digital Speech signal. See Section 7.4 for more information on Digital Speech.

To use Digital Speech, just choose one of the Digital Speech signals in the SPL Menu for CRV 1 & 2. See Section 8.4.4.2. Then, just test as normal, using the Digital Speech signal selected as your measurement source. See Section 8.4.4.3 for the SPL Testing procedure.

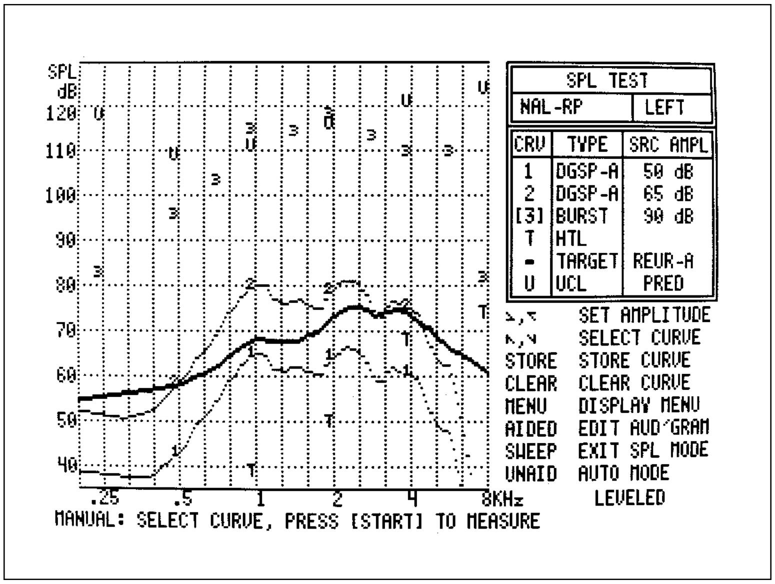


Figure 8.4.6—SPL Testing Screen using Digital Speech signals

8.4.7 Clearing Curves

If you are in Automatic Mode:

- Push [CLEAR] to clear all measurement curves

If you are in Manual Mode:

- Select the desired measurement curve to be cleared with the [∧, ∨] buttons
- Press [CLEAR] to delete selected curve
- Note: clearing thresholds will remove them from the SPL Testing screen but will not delete them from the Audiogram Entry Screen.

8.4.8 Saving Curves

There are six curves in the SPL Testing Screen: three measurement curves, the HTLs, the UCLs, and the target. When these curves are saved, they are stored in specific REFERENCE CURVE slots. These slots are:

REF 1	Aided Curve #1
REF 2	Aided Curve #2
REF 3	Aided Curve #3
REF 4	HTL Curve
REF 5	Target Curve
REF 6	UCL Curve

As each curve is saved, an asterisk will appear to the right of the curve label on the SPL Testing Screen.

If you have selected AUTO SAVE AIDED CURVES ON in the SPL Menu (See Section 8.4.4.2), then the measurement curves will automatically be saved the REF 1-3, regardless of whether you are in Automatic Mode or Manual Mode.

If you are in Automatic Mode:

- Press [STORE] will copy all six curves to their corresponding reference curve.

If you are in Manual Mode:

- Highlight the desired curve to be stored.
- Press [STORE] to save the selected curve to its corresponding reference curve.

8.4.9 Getting Data Values

All curves in the Manual SPL Test may be converted to numerical data. Select the desired curve and press [DATA] (Figure 8.4.9). Push [DATA] a second time to return to the main screen.

Data conversion is not available in Automatic SPL Test. Switch from Automatic Mode to Manual Mode by pressing [UNAIDED].

FREQ Hz	AMPL dBSPL	FREQ Hz	AMPL dBSPL	FREQ Hz	AMPL dBSPL	FREQ Hz	AMPL dBSPL	FREQ Hz	AMPL dBSPL
200	51.8	2000	79.0	3800	75.3	5600	62.3	7400	29.8
300	50.4	2100	80.3	3900	75.0	5700	61.5	7500	29.1
400	52.5	2200	80.9	4000	75.1	5800	60.3	7600	28.7
500	58.4	2300	81.2	4100	74.6	5900	58.6	7700	28.3
600	63.9	2400	80.9	4200	74.0	6000	56.5	7800	27.8
700	69.2	2500	80.5	4300	73.3	6100	54.4	7900	28.3
800	74.1	2600	79.1	4400	72.0	6200	52.5	8000	28.2
900	77.4	2700	77.9	4500	70.6	6300	50.8	DIG SP./ANSI	
1000	80.0	2800	76.4	4600	69.2	6400	48.8	SOURCE RMS	
1100	79.9	2900	74.8	4700	67.7	6500	46.9	65 dBSPL	
1200	77.0	3000	73.4	4800	66.4	6600	44.9	OUTPUT RMS	
1300	75.9	3100	73.3	4900	65.1	6700	42.7	93.8 dBSPL	
1400	76.7	3200	74.3	5000	64.2	6800	40.5	N.R. 4 X	
1500	77.1	3300	75.5	5100	63.7	6900	38.9	BIAS OFF	
1600	76.0	3400	76.6	5200	63.2	7000	36.8		
1700	74.8	3500	76.6	5300	62.8	7100	34.7	LEVELED	
1800	75.1	3600	76.1	5400	62.8	7200	33.2	SPL MODE	
1900	77.1	3700	75.7	5500	62.7	7300	31.8	AIDED CRV #2	

Figure 8.4.9—Data values

8.5 Target 2-cc Full-on Gain

The Target 2-cc FOG Screen gives you coupler targets based on your client's threshold measurements. It complements the Target 2-cc SSPL Screen.

8.5.1 Introduction

The Target 2-cc FOG feature was developed for ordering custom hearing aids from a hearing aid manufacturer. As programmable hearing aids have grown in popularity, this procedure has become less important. However, there may be some circumstances where this information could still be useful to you.

This feature uses your client's audiogram and the selected fitting rule to get the target insertion gain. A correction factor is applied to arrive at the Target 2-cc FOG information which can then be sent to the hearing aid manufacturer along with the Target 2-cc SSPL 90 information found in Section 8.6.

8.5.2 Entering an Audiogram

1. From the Insertion Gain Screen, press [MENU]. This takes you to the Quik-Probe II Menu.

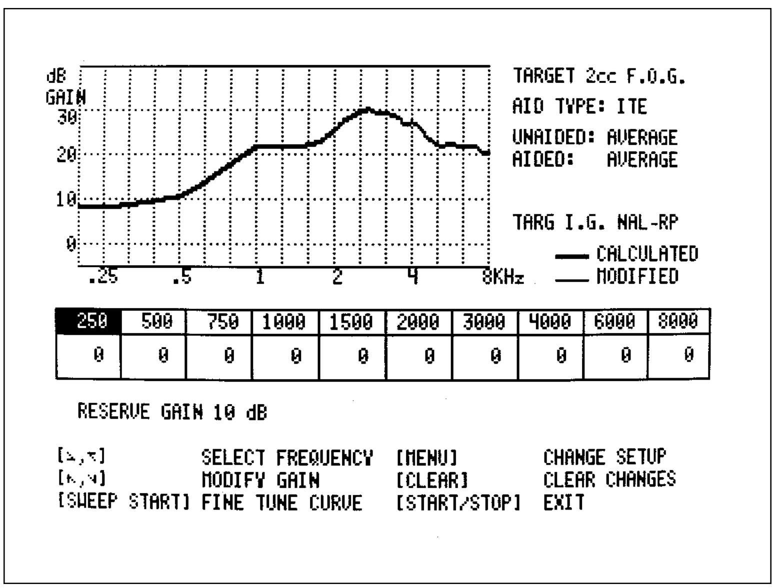


Figure 8.5.2—Target 2 cc FOG

2. Highlight CREATE TARGET using [∧, ∨].

3. Select 2-cc FOG with [<, >].

4. Press [START/STOP].

5. Enter the client's audiogram and select an insertion-gain formula just as if you were creating a normal insertion gain target. See Section 8.4.2 for more details.

6. Press [START/STOP] to get to the Target 2-cc FOG Screen. See Figure 8.5.2.

7. Use the arrow keys to make any desired modifications to the 2-cc target. See Section 8.5.6. Press [SWEEP/START] to fine tune the modifications.

8. Press [START/STOP] to return to the Insertion Gain Screen. The target 2-cc curve will automatically be saved in REFERENCE 8.

8.5.3 Changing the Target 2-cc FOG Settings

Enter the Target 2-cc FOG Menu by pressing [MENU] from the Target 2-cc FOG Screen.

AID TYPE: Select ITE, CANAL, or BTE. This changes the compensation for the microphone placement of the selected type of instrument.

UNAIDED EAR: Select Average or Custom. The average is based upon the KEMAR average ear. The Custom uses the patient's measured unaided response. See Section 8.5.4.

AIDED EAR – 2 cc: Select Average or Custom. This is also known as the real-ear –to-coupler difference (RECD). See Section 8.5.5.

RESERVE GAIN: Amount of extra gain you want available to the hearing aid user at the volume wheel, over the prescribed insertion gain. This is usually 10 dB for ITE and canal aids, but higher for BTE aids.

SCREEN PRINT: Select HALF to print only the Target 2-cc FOG graph. Select FULL to print both the calculated and the modified Target 2-cc FOG graphs and the modification table.

Press [MENU] to exit from the Target 2-cc FOG Menu.

8.5.4 Using the Unaided Response

To use the custom unaided response in the creation of the Target 2-cc FOG curve, you must measure it in the Insertion Gain Screen. See Section 8.3.4.2, Step 1-8 for instructions on how to take the unaided response.

8.5.5 Measuring the RECD

The real-ear to coupler difference (RECD) is the acoustical difference between a 2-cc coupler and the real-ear unaided response of an individual. It involves two measurements: a coupler measurement and a real-ear measurement. Both measurements are performed with an insert earphone. The method described here is specifically for use with the Target 2-cc program.

Use a 50 ohm ER-3A insert earphone for this measurement. You will probably need 1/4 inch male to 1/8 female adapter phone jack to allow you to plug the earphone into the external speaker jack on the back of the 6500-CX. You will also need the probe microphone adapter.

8.5.5.1 Coupler measurement

1. Attach the foam eartip of the ER-3A to an HA-1 coupler using putty, as illustrated in Figure 8.18.3.3(A).

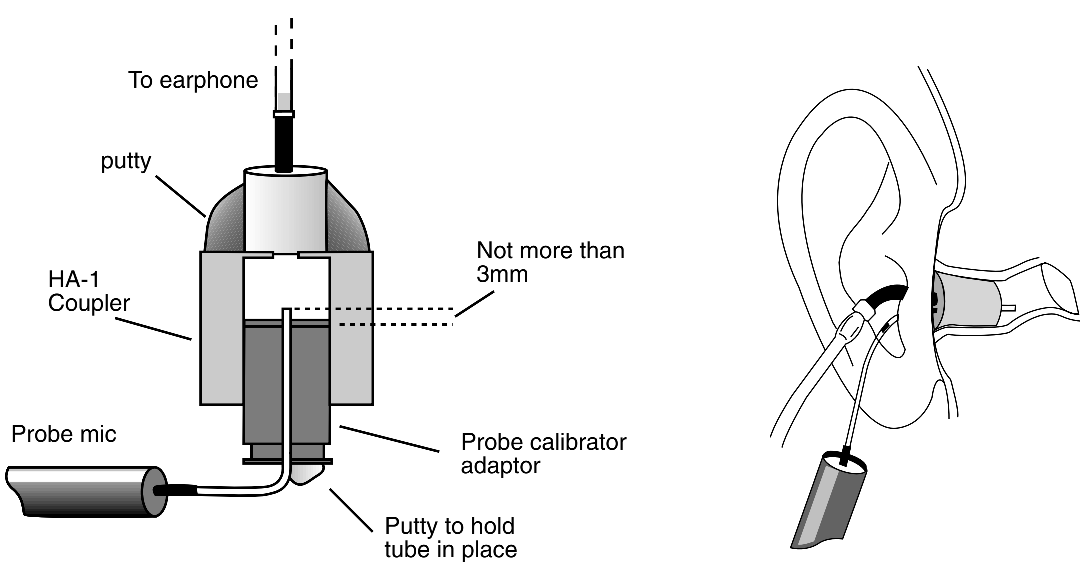
   Note: The DSL RECD procedure always uses an HA-2 coupler instead of an HA-1 coupler.

2. Thread a probe tube through the probe microphone adapter as shown in Figure 8.5.5.1A. Begin threading the tube from the notched end of the adapter. The tip of the probe tube should extend between 0 and 3 mm beyond the hole at the welled end of the adapter.

3. Secure the probe tube in position with a small piece of Fun-Tak at the notched end of the adapter, and insert the adapter fully into the HA-1 coupler. Then place the apparatus on a vibration-free surface, such as the test area of your test chamber.

4. Connect the eartip to the insert earphone and attach probe tube to probe microphone.

5. Unplug the sound field speaker from the back of the 6500-CX main module.



(Part A)

Eartip with probe on coupler

(Part B)

Eartip with probe in ear

Figure 8.5.5.1A

6. Plug the insert earphone, using the 1/4 inch to 1/8 inch adapter, into the external speaker jack.

7. Enter the Insertion Gain Screen from the normal coupler Composite Mode by pressing [START/STOP] on the remote module.

8. Press [MENU] to enter the Quik-Probe II Menu. Select:

MODE	COMP/MAN
GAIN(G)/SPL	G/REF OFF (very important!)
NOISE REDUCTION	16

9. Go to the Operation Parameters Menu, and set:

SIGNAL LEVEL	55
SMOOTHING	LOG

10. Return to the Insertion Gain Screen by pressing [MENU]. If you are in the Operation Parameters Menu, you will have to press [MENU] twice.

11. Press [START/STOP] once to turn the signal on, and again to freeze the measurement. This is the 2-cc coupler response of the insert earphone (Figure 8.5.51B).

12. Press [STORE] to get the Quik-Store screen.

13. Copy the LAST curve to REF 6. See Section 8.3.4.3 for more details.

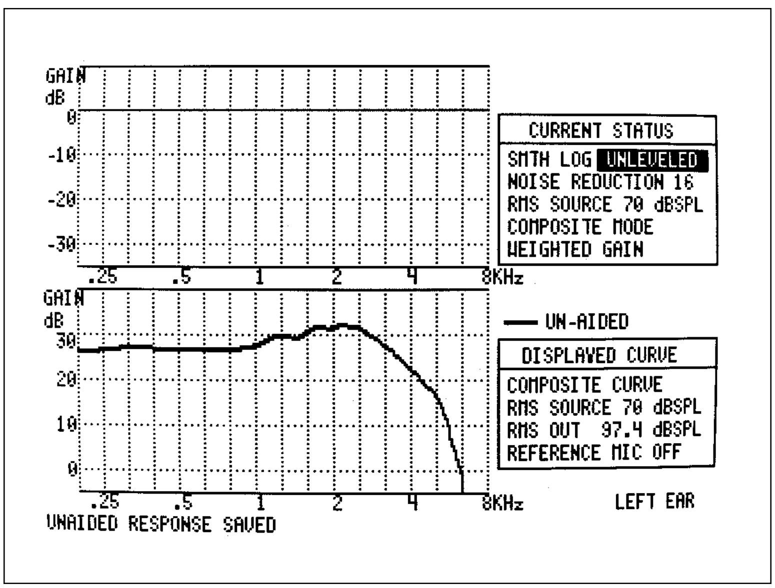


Figure 8.5.5.1B—RECD, coupler measurement

8.5.5.2 Real-ear measurement

1. Make sure the Insertion Gain Settings are identical to the ones described in Section 8.5.5.1, Steps 8-9 and that the sound field speaker is unleveled.

2. Make sure the insert earphone is plugged into the back of the 6500-CX main module, as described in Section 8.5.5.1, Step 6.

3. Carefully insert a probe tube attached to the probe microphone into the patient's ear, just as if you were doing a normal unaided measurement.

4. Insert the foam eartip connected to the insert earphone into the client's ear. See Figure 8.5.5.1.

5. Press [START/STOP] to start the measurement and press it again when satisfied with the measurement.

6. Press [AIDED] to save the measurement as the aided response (Figure 8.5.5.2A).

7. If desired, press [DATA] to get the numerical values of the RECD measurement (Figure 8.5.5.2B).

8. Follow the procedure from Section 8.5.2 to go to the Target 2-cc FOG Screen. When you select CUSTOM for AIDED EAR-2 CC in the Target 2-cc FOG Menu, the program will access the REAR (CRV 2) and the 2-cc response (REF 6) automatically, to be used in the target conversion.

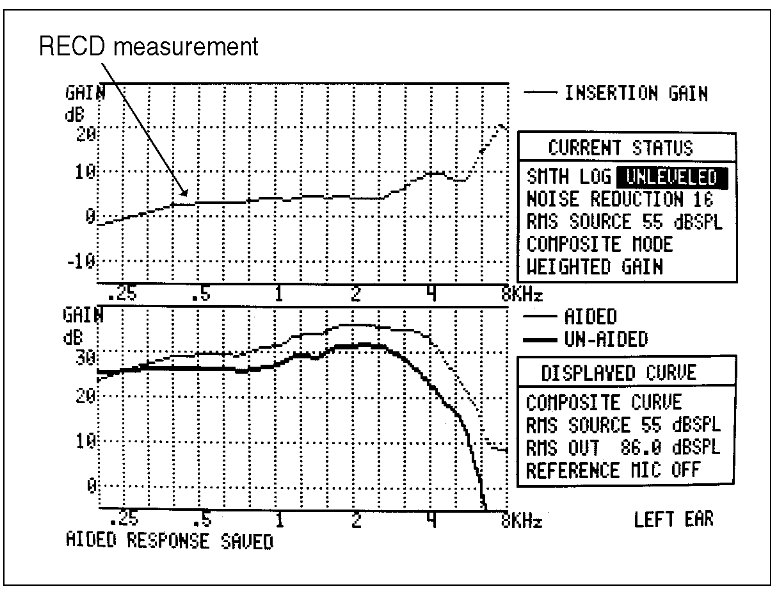


Figure 8.5.5.2A—RECD and real-ear measurement

FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB	FREQ Hz	GAIN dB
200	-2.0	2000	4.1	3800	9.0	5600	9.1	7400	20.6
300	0.4	2100	3.9	3900	9.4	5700	9.7	7500	20.7
400	2.4	2200	4.0	4000	9.3	5800	10.2	7600	20.7
500	3.1	2300	4.1	4100	9.4	5900	10.9	7700	20.0
600	3.1	2400	4.1	4200	9.5	6000	12.2	7800	18.3
700	3.1	2500	4.1	4300	9.5	6100	13.2	7900	19.1
800	3.5	2600	4.2	4400	9.5	6200	13.5	8000	19.2
900	3.9	2700	4.5	4500	9.3	6300	14.3		
1000	3.9	2800	4.9	4600	9.0	6400	14.4	SOURCE RMS	
1100	3.7	2900	5.3	4700	8.8	6500	14.9	55 dBSPL	
1200	3.9	3000	5.7	4800	8.4	6600	15.8		
1300	4.5	3100	6.1	4900	8.2	6700	16.1		
1400	4.7	3200	6.5	5000	8.0	6800	16.7	DIFFERENCE OF	
1500	4.5	3300	7.2	5100	7.8	6900	18.0	TWO CURVES	
1600	4.1	3400	7.8	5200	7.8	7000	18.1	GAIN	
1700	4.3	3500	8.2	5300	7.9	7100	17.9		
1800	4.7	3600	8.4	5400	8.2	7200	19.8	PROBE REIR	
1900	4.7	3700	8.6	5500	8.7	7300	21.3		

Figure 8.5.5.2B—RECD data

8.5.6 Modifying the Target for Venting Effects

The table below gives suggested modifications to the Target 2-cc FOG curve for the average effects of various vents. The correction values should be added to the prescribed values.

NOTE: Use the starred values only if prescribed insertion gain is greater than 0 dB at that frequency. Otherwise, use no correction. A blank indicates that no correction is needed. A slit leak is assumed for all vent conditions except "Tight Seal."

Target 2cc FOG Vent Corrections

Frequency (Hz)	250	500	750	1k	1.5k
Tight Seal	___	___	___	___	___
Slit Leak	2	2	1	___	___
1 mm	1*	2*	1	___	___
2 mm	7*	1*	___	___	___
Long Open	17*	10*	4*	1*	___
Short Open	26*	21*	14*	10*	5*

8.6 Target 2-cc SSPL 90

The Target 2-cc SSPL Screen gives you targets for 90 dB SPL input signals. It complements the Target 2-cc FOG screen.

8.6.1 Introduction

The Target 2-cc SSPL 90 feature was developed for ordering custom hearing aids from a hearing aid manufacturer. As programmable hearing aids have grown in popularity, this procedure has become less important. However, there may be some circumstances where this information could still be useful to you.

This feature uses your client's loudness discomfort levels in dB HL and converts them to dB SPL. The conversion formula used is from the ANSI audiometer standard. This information can be used to order a custom hearing aid along with the Target 2-cc FOG information found in Section 8.5.

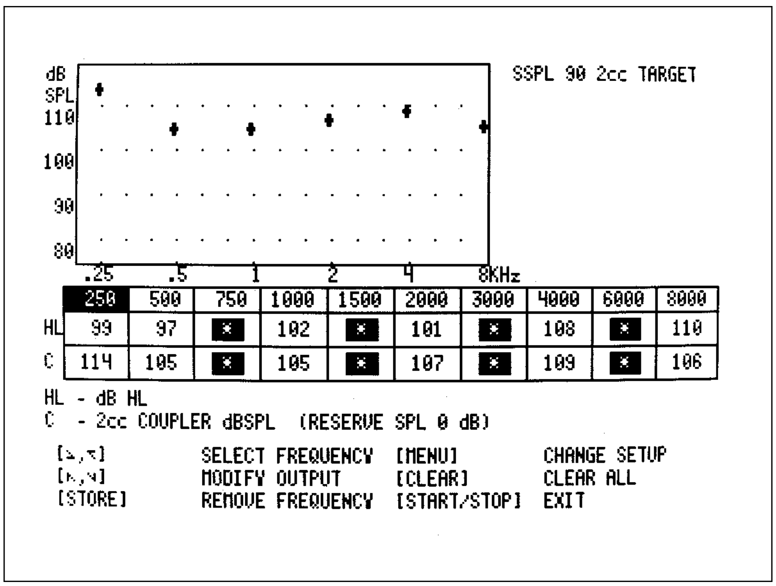


Figure 8.6.1 —Target 2 cc SSPL 90

8.6.2 Procedure:

1. From the Insertion Gain Screen, press [MENU].
2. Use the [∧, ∨] buttons to highlight CREATE TARGET.
3. Press the [>] button to select 2 cc SSPL 90.
4. Press [START/STOP] to run the Target 2 cc SSPL 90 program. See Figure 8.6.2.

5. Using the arrow keys, input the patient's uncomfortable levels (UCLs) or highest comfortable levels (HCLs), measured in dB HL.
6. Look at the numbers in the "C" row. These are the 2-cc coupler values in dB SPL corresponding to the entered dB HL values. They are also shown in the graph as + symbols.
7. To remove a particular frequency value, highlight the frequency and press [STORE]. To remove all entries, press [CLEAR].
8. Exit from the Target 2 cc SSPL 90 Screen by pressing [START/STOP]. This will copy the Target 2 cc SSPL 90 graph to REFERENCE 7.

8.6.3 Settings

Press [MENU] from the SSPL 90 2-cc Target Screen to enter the SSPL 90 2-cc Menu.

AMPL. INCREMENT: The amount by which the numbers in the HL and C boxes change when you press the [∧, ∨] buttons.

RESERVE SPL: The amount of output added or subtracted from the calculated 2-cc coupler values.

SCREEN PRINT: Choosing HALF will print the SSPL 90 2-cc graph only. FULL will print the graph plus the numerical table.

Press [MENU] to exit from the SSPL 90 2-cc Menu.

8.7 Custom Hearing Aids

The Target 2-cc FOG and SSPL screens are used to order custom hearing aids from the manufacturer.

8.7.1 Ordering a Custom Hearing Aid

After you have followed the procedures found in Section 8.5 and 8.6 and obtained Target 2-cc FOG and SSPL 90 curves, send copies of these curves, along with your choice of model, shell-type and venting, etc., to the manufacturer. Be sure the manufacturer knows you are sending 2-cc target curves. Do not send audiogram curves. Request the manufacturer to match your target 2-cc curves as closely as possilbe.

8.7.2 What to Do When the Hearing Aid Arrives

When the hearing aid arrives, follow a three-step process:

- Check the general performance of the instrument by running an ANSI S3.22 or an IEC automated test sequence.
- Compare measured 2-cc coupler curves to the target curves you used in the order, and make any necessary adjustments.
- Schedule an appointment with the patient to perform a real-ear verification of the fit.

8.8 Testing Body, CROS, BICROS

When using Quik-Probe II with a body, CROS, or BICROS aid, we suggest the following set-ups and procedures. But you certainly may experiment with different methods.

8.8.1 Body Aids

The following setup is recommended for body aids. Follow normal Insertion Gain measurement procedures, as given in Section 8.3.

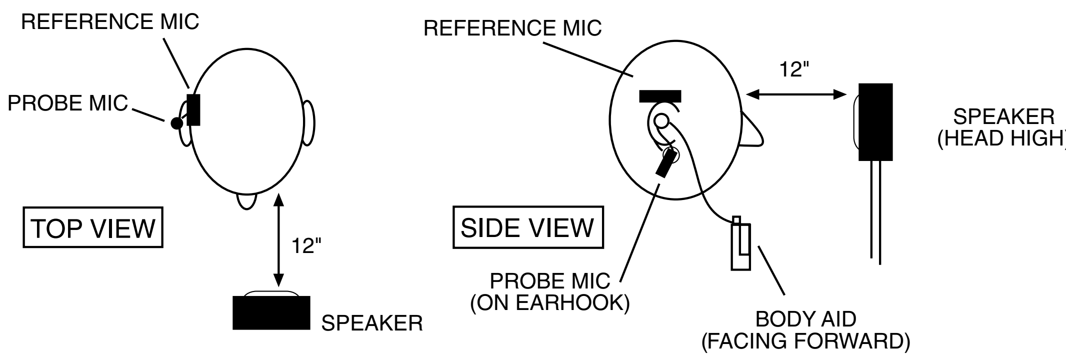


Figure 8.8.1—Body Aid

8.8.2 CROS and BICROS Aids

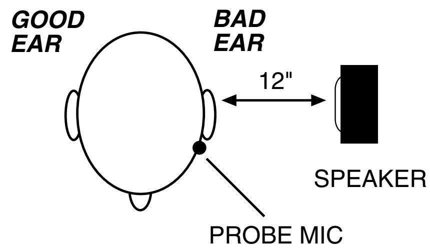
Four Goals:

8.8.2.1 Measure the Head Baffle Effect
8.8.2.2. Measure How Well the Aid Overcomes the Head Baffle Effect
8.8.2.3. Measure the Overall Insertion Gain
8.8.2.4. Measure the Insertion Loss to the "Good" Ear

8.8.2.1 Head-baffle effect

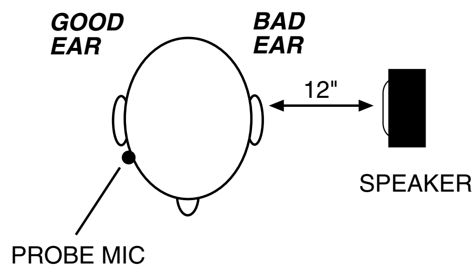
CROS or BICROS - Two Measurements

1. Probe response on "bad ear" side



- Sound field UNLEVELED.
- Probe microphone over "bad" ear, tube jutting just slightly forward of pinna.
- Sound field speaker at 90º, 12 inches from "bad" ear.
- Mode set to COMP/MAN in QP II Menu.
- Gain(G)/SPL set to G/REF OFF in QP II Menu
  - a. Press [START/STOP] from the Insertion Gain
    Screen to begin measurement.
  - b. Press [START/STOP] again when satisfied with measurement.
  - c. Press [UNAIDED] to save measurement.

2. Probe response on "good ear" side



- Same setup as (1), except probe microphone over "good" ear.
  - a. Press [START/STOP] to start measurement.
  - b. Press [START/STOP] again when satisfied with measurement.
  - c. Press [AIDED] to save measurement.

The difference curve, labeled INSERTION GAIN on the screen, shows the attenuation of sound arriving at the "good ear" from the "bad ear" side. Since this measurement excludes the external ear, differences across individuals should be minimal. A sample measurement made on KEMAR is shown in Figure 8.8.2.1.

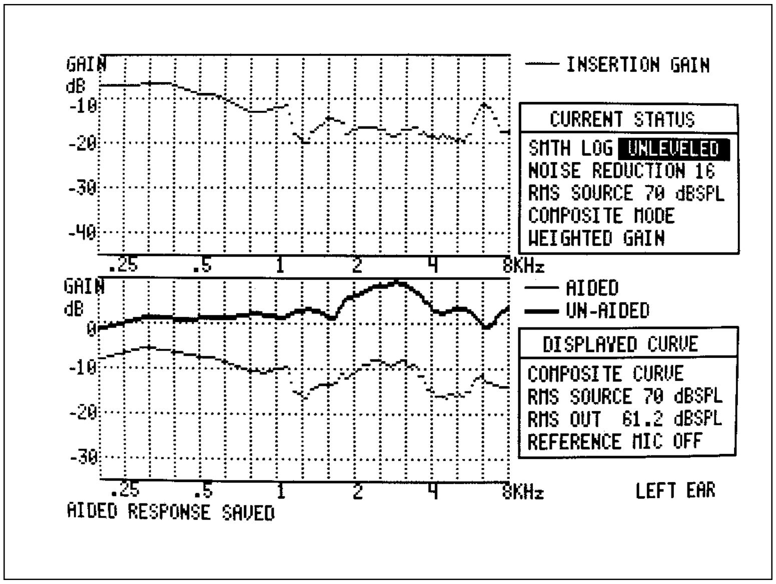
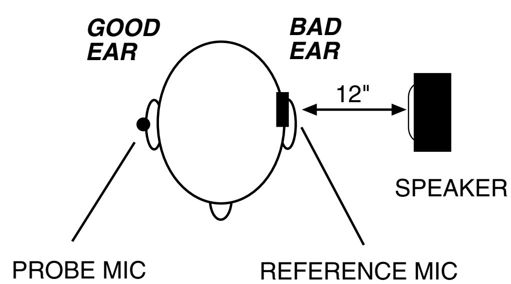


Figure 8.8.2.1—Head baffle effect

NOTE: Only for the above two measurements, the measuring system should be UNLEVELED with the reference microphone OFF. For all other CROS and BICROS measurements described below, the system should be LEVELED and the reference microphone ON.

8.8.2.2 How well the aid overcomes the head-baffle effect

CROS - Two Measurements



1. Unaided Response of "good" ear canal (baffled by head)
   - Reference microphone over pinna of "bad" ear.
   - Probe microphone inside unoccluded ear canal of "good" ear.
   - Sound field speaker at 90º, 12 inches from "bad" ear.

   a. Press [START/STOP] to begin measurement.
   b. Press [START/STOP] when satisfied with measurement.
   c. Press [UNAIDED] to save measurement.

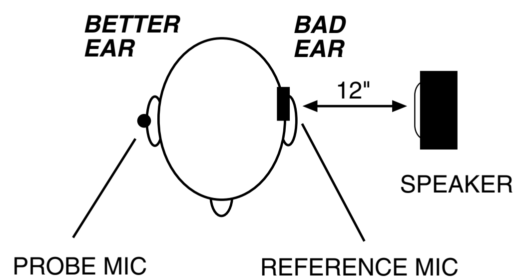
2. Aided Response of “good” ear canal (baffle overcome by aid)

- Same setup as (1), but aid in place, at use gain.
  a. Press [START/STOP] to begin measurement.
  b. Press [START/STOP] when satisfied with measurement.
  c. Press [AIDED] to save measurement.

The difference curve, labeled INSERTION GAIN on the screen, shows the benefit the aid gives, for sound arriving from the “bad” side.

BICROS - Two Measurements

1. Aided Response of “better” ear canal (baffled by head)
   - Reference microphone over pinna of “bad” ear.
   - Probe microphone inside ear canal of “better” ear.
   - Hearing aid in “better” ear, on, set at “use” gain.
   - Transmitter on “bad” side turned off.
   - Sound field speaker at 90º, 12 inches from “bad” ear.
     a. Press [START/STOP] to begin measurement.
     b. Press [START/STOP] when satisfied with measurement.
     c. Press [UNAIDED] to save measurement.



2. Aided Response of “better” ear canal (baffle overcome by aid)
   - Same setup as (1), but transmitter on “bad” side turned on.
     a. Press [START/STOP] to begin measurement.
     b. Press [START/STOP] when satisfied with measurement.
     c. Press [AIDED] to save measurement.

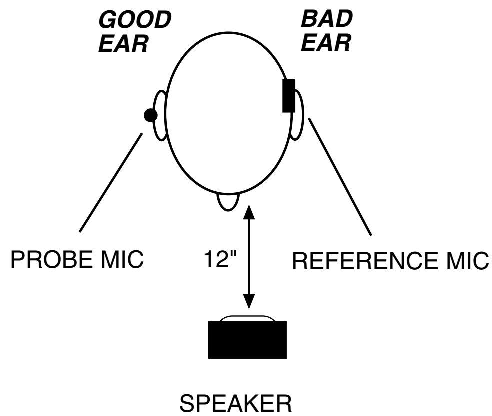
The difference curve, labeled INSERTION GAIN on screen, shows the benefit of adding the second microphone, for sound arriving from the “bad” side.

8.8.2.3 Overall insertion gain

NOTE: Since it has not been shown for CROS and BICROS instruments that a 45º position of the loudspeaker improves the reliability of insertion-gain measurements, we recommend a 45º position of the loudspeaker only for monaural instruments, and a 0º position for CROS and BICROS instruments.

CROS **—Two Measurements**

1. Unaided Response of "good" ear



- Reference microphone over pinna of "bad" ear.
- Probe microphone inside unoccluded ear canal of "good" ear.
- Sound field speaker at 0º, 12 inches from bridge of nose.
  a. Press [START/STOP] to begin measurement.
  b. Press [START/STOP] when satisfied with measurement.
  c. Press [UNAIDED] to save measurement.

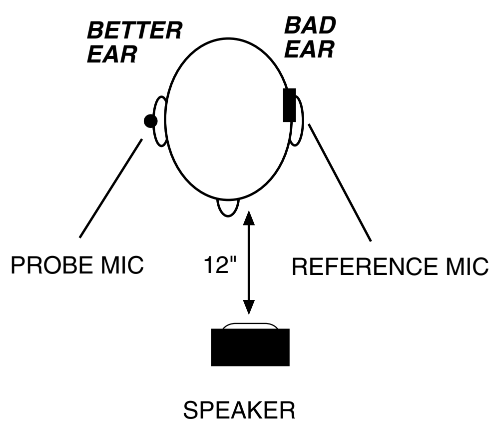
2. Aided Response of "good" ear

- Same setup as (1), except aid in place, set at "use" gain
  a. Press [START/STOP] to begin measurement.
  b. Press [START/STOP] when satisfied with measurement.
  c. Press [AIDED] to save measurement.

The difference curve, labeled INSERTION GAIN on the screen, shows the overall benefit of inserting the hearing aid.

BICROS —Two Measurements

1. Unaided Response of "better" ear



- Reference microphone over pinna of "bad" ear.
- Probe microphone inside unoccluded ear canal of "better" ear.
- Sound field speaker at 0º, 12 inches from bridge of nose.
  a. Press [START/STOP] to begin measurement.
  b. Press [START/STOP] when satisfied with measurement.
  c. Press [UNAIDED] to save measurement.

2. Aided Response of "better" ear

   - Same setup as (1), except complete aid in place, set at "use" gain.
   - Both microphones on..
     a. Press [START/STOP] to begin measurement.
     b. Press [START/STOP] when satisfied with measurement.
     c. Press [AIDED] to save measurement.

The difference curve, labeled INSERTION GAIN on the screen, shows the overall benefit of inserting the hearing aid.

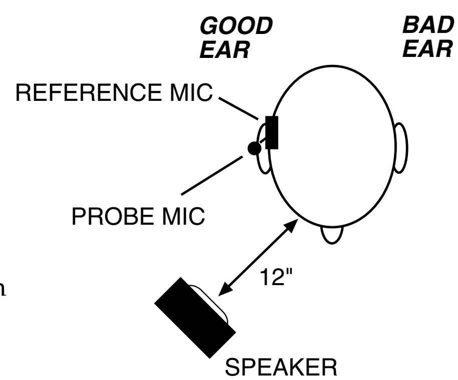
8.8.2.4 Insertion loss to the "good" ear (CROS)

When a CROS aid has been prescribed to overcome a severe unilateral high-frequency loss, you may want to ensure that inserting an "open" earmold into the "good" ear has not significantly attenuated the acoustic transmission to the "good" ear.

NOTE: Since this is a monaural measurement, a 45º position of the loudspeaker is recommended.

1. Unoccluded Ear canal Response of "good" ear

   - Reference microphone over pinna of "good" ear.
   - Probe microphone inside unoccluded ear canal of "good" ear.
   - Sound field speaker at 45º toward "good" ear, 12 inches from surface of head.
     a. Press [START/STOP] to begin measurement.
     b. Press [START/STOP] when satisfied with measurement.
     c. Press [UNAIDED] to save measurement.



2. Occluded Response of "good" ear.

   - Same setup as (1), except earmold in place in "good" ear
   - Hearing aid is turned off
     a. Press [START/STOP] to begin measurement.
     b. Press [START/STOP] when satisfied with measurement.
     c. Press [AIDED] to save measurement.

The difference curve, labeled INSERTION GAIN on screen, shows insertion loss, if any, caused by inserting earmold into "good" ear.

8.9 Spectrum Analysis Mode

As with Composite-mode test-chamber measurements, when you set the signal level to OFF by turning the source all the way down, the 6500-CX invokes the "Spectrum Analysis" feature. In this mode of operation, special windowing of the signal goes into effect, and "noise reduction" switches from time-domain signal averaging to frequency-domain spectrum averaging. See Chapter 10 of this manual for details. All other functions of Quik-Probe II remain in effect during spectrum analysis.

8.10 REDD Measurements

The real-ear to dial different (REDD) measurement is taken using both an audiometer and an analyzer. The audiometer is used to input a signal to the client's ear. The analyzer is used to take a real-ear measurement of that signal. The REDD measurement is often used to create more accurate dB HL to dB SPL conversions.

8.10.1 Setting up the analyzer

1. Press [START/STOP] on the remote module (or [PROBE] on the main module) to enter the Insertion Gain Screen of the 6500-CX analyzer. All key presses described after this are meant to be performed on the remote module.
2. Press [MENU] to enter the Quik Probe II Menu.
3. Select OPERATIONAL PARAM using the [∧, ∨] keys.
4. Press [START/STOP] to enter the Operational Parameters Menu.
5. Set SMOOTHING to OFF using the arrow keys.
6. Set SIGNAL LEVEL to OFF using the arrow keys.
7. Press [MENU] to return to the Quik Probe II Menu.
8. Set GAIN(G)/SPL to G/REF OFF using the arrow keys.
9. Press [MENU] to return to the Insertion Gain Screen.

8.10.2 Setting up the client

1. Put the earhook on the client's ear.
2. Attach the probe microphone to the Velcro button of the earhook. The reference microphone is not used for this measurement.
3. Insert the probe tube attached to the probe microphone as you would for a real-ear measurement. You may want to use medical tape to secure the probe microphone.

4. Carefully put the insert earphone, attached to your audiometer, into your client's ear. Alternately, place the TDH earphones on the client's head, being careful not to dislodge the probe microphone.

8.10.3 Taking the measurement

1. Set your audiometer to emit a continuous signal at 70 dB HL at the frequency of your choice.
2. Press [START/STOP] on your 6500-CX remote module to start the real-ear measurement.
3. Read the "RMS OUT" on your 6500-CX screen. This value will be in dB SPL.
4. Subtract 70 from the value found in step 3. This resulting value is the REDD for the frequency chosen in step 1.
5. Repeat steps 1-4 for each desired frequency of the REDD measurement.

Chapter 9: Printing

To print a graph or digital data, push [CRT] on the main module or, if you are performing a real-ear measurement, push [PRINT] on the remote module. To stop printing, push [CRT] or [PRINT] a second time.

For nicer printouts on regular paper, the user may connect an external printer to the FONIX 6500-CX. The internal printer remains completely functional. The choice of printers is made with a menu selection.

9.1 Settings

Push the [MENU] button and then [CRT] to access the Print Menu. The Print Menu is only available from Composite Mode or Pure-Tone Mode, so make sure to make your printing selections before entering a different screen such as ANSI 96.

Type: Internal, HPCL Mono (black & white), and HPCL Color. Note that there are two choices for an external printer. Be sure to select the one that is appropriate for your printer.

Speed: 38400, 9600, or 19200. We recommend the default setting, 38400, for best results.

Screen: When the CRT display has more than one graph displayed, or a digital data display, choose FULL. If it has only a single curve, choose HALF.

Show Menu Before Print: This selection allows you to choose to have the Print Menu open each time you print. Pressing [CRT] will open the menu, then pressing [START] begins printing. If you switch between an external and the internal printer fairly often, this could be a good choice for you. **If you do not enable this feature, you can only enter the Print Menu from Composite or Pure-Tone Mode.**

Print Date & Time: YES includes the date and time on your external printouts. Date and time is *always* displayed on internal printouts that include the label.

> Note: In rare cases, some printers fail to change over to text mode when it comes to printing the date. This difficulty can cause the print cycle to fail or it can cause the 6500-CX to lock up, requiring you to restart the instrument. If you experience difficulties printing, choosing NO may correct the problem.

Restore Factory Label: This line is of interest if you have customized the label with a computer through the RS232 port. Push [START] with this message highlighted and the label will return to the factory default.

All of these printer choices can be stored as part of a custom setting. See Section 3.4.

9.2 Internal Printer

The printer in the FONIX 6500-CX does not require cleaning. Here is an illustration of how to load the paper. Notice that the lever must be up when the paper is loaded and down when the printer is operated. Keeping the lever up when the analyzer is not in use will prolong the life of the print roller.

To order paper tape from Frye Electronics ask for part number 026-0009-00.

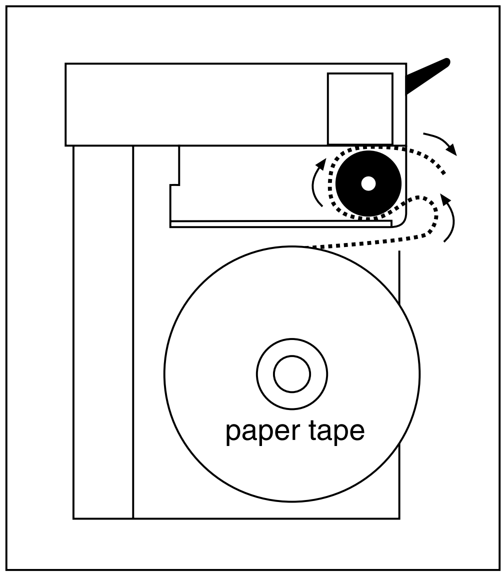


Figure 9.2—Paper tape path

Notes:

1. FONIX 6500 models prior to the introduction of the CX have a different printer that requires different paper. The part number for paper tape for these earlier printers is 026-0011-01.

2. Although the paper used in the FONIX 6500-CX is a good quality thermal paper, any thermal printing will eventually fade over time. To minimize fading, store away from light in a cool, dry place. Don't store the strips in plastic, or put cellophane tape on them, and avoid fingerprints. If you want to be absolutely certain that you will have data for many years, use a regular copier to duplicate the printed results.

9.3 External Printer

It is often convenient to hook up an external printer to your 6500-CX to provide quality printouts on normal paper.

9.3.1 Description

The FONIX 6500-CX can print to an external printer, provided the printer uses HP PCL (Hewlett Packard Printer Computer Language) version 3.0 or higher. Currently this includes all HP LaserJet printers, and several Deskjet printers. Also select Canon printers are compatible. If the printer uses PPA (Printer Performance Architecture), then it is incompatible with FONIX instruments. The Deskjet printers from the 720, 820, and 1000 series use PPA and are therefore incompatible.

A current list of compatible printers will be maintained on our web site. This page can be found at www.frye.com/products/analyzers/exprinter.html.

A complete external printer package, available from Frye Electronics, is required for use with an external printer. See details in section 9.4.

To use the external printer, it must be selected in the Print Menu as described in section 9.3. When you have chosen the external printer in the Print Menu, and pushed the [CRT] button or the [PRINT] button, the words PRINTING ON EXTERNAL PRINTER will appear on the screen. While these words are on the screen, no controls on the instrument will work. When the words disappear, control of the unit will be returned to you.

If you have made a mistake, and the printer is not ready to use, or if you have made a wrong choice in the menu (e.g. choosing mono or color inappropriately), you will have to make changes in the printer or on the Print Menu before you can print.

9.3.2 External Printer Kit

The external printer package includes a custom cable, a converter and another cable that attaches to the 6500 CX. Here is a drawing of how to connect the pieces of this package to your instrument. Make sure that the power is off both units before connecting.

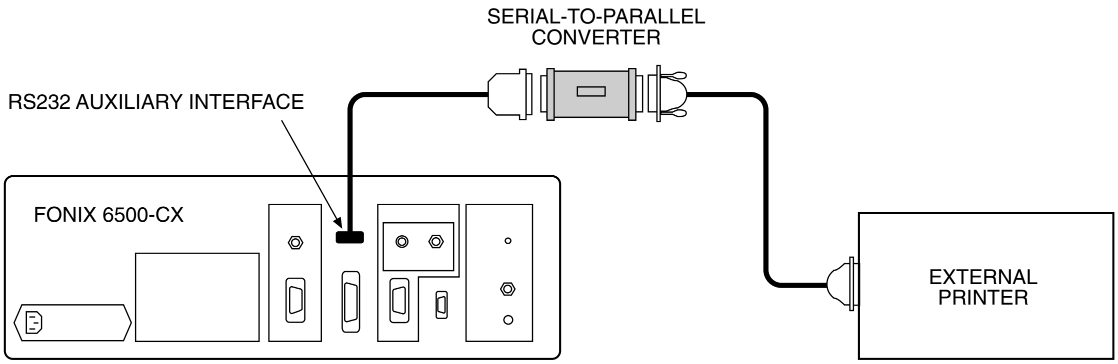


Figure 9.3.2—Connecting the 6500-CX to an external printer, using the External Printer Package

Earlier 6500s

If you have a 6500-C and would like the ability to print to an external printer, you have two options. You can either use the original RS232 port on your unit, or if you want to be able to use a computer as well as a printer, a new port can be added. Adding a new port requires the unit be shipped to the factory. In either case, you will have to upgrade your unit's software to at least version 4.20. It is possible to upgrade 6500 units manufactured prior to the C-series to accommodate external printers. All such upgrade will require the unit be shipped to the factory.

Chapter 10: Sound Spectrum Analyzer

The FONIX 6500-CX can be used as a sound spectrum analyzer, taking in external sounds through the microphone, or through a direct electrical connection, and displaying an amplitude-vs-frequency analysis curve.

10.1 The Fast Fourier Transform

The Fast Fourier Transform (FFT) is the key to this spectrum analysis. The FFT, briefly, is a mathematical (and electronic) method of taking a signal that can be represented as a graph of amplitude-vs-time and converting it into an amplitude-vs-frequency representation. Every sound is made up of a series of frequency components, each at a particular amplitude. The Fast Fourier Transform is a method of breaking any sound into its frequency components so that the amplitude at each frequency can be determined.

10.2 Spectrum Analysis Procedure

In general, when using a composite signal for testing, you can enter Spectrum Mode by setting the signal source level to "off." The steps below apply to test-chamber operation; for Probe operation, use the Operation Parameters Menu to set similar conditions. **Some useful examples are described, step-by-step, in Section 10.5.2.**

1. Be sure the 6500-CX is in a COMPOSITE mode. If in doubt, press [RESET].
2. Turn the signal off by pressing [∨] repeatedly until the RMS SOURCE (the signal level) is OFF. The label COMPOSITE MODE will change to SPECTRUM MODE.
3. Set the degree of spectral averaging desired by setting the NOISE REDUCTION level (see Section 10.4).
4. **To exit Spectrum Mode**, press the [∧] key to turn the COMPOSITE signal source (signal level) back on.

When you turn off the source, the microphone picks up any sound that it is being exposed to, and a spectrum analysis of that signal is shown on the display. If the sound chamber is open and the microphone is being exposed to the room noise, the graph on the display is an analysis of the noise in the room (the buzzing of lights, conversation, etc.). If you sustain a whistle for more than a fifth of a second, the microphone will pick that up, and a peak will show up on the analysis graph at the frequency of your whistle. By raising and lowering the pitch of your whistle, you can change the frequency position of the peak.

If you expose the microphone to a sound that you know is made up of one or two pure tones, those tones will show up as tall peaks on the displayed graph. Any sound that is sustained for more than a fifth of a second will be broken into its frequency components and displayed as an amplitude-vs-frequency graph. The [FREEZE], [DATA], and [CURSOR] keys work the same way with these graphs as they do with tests using the internal composite signal (see Section 5.1). After freezing, spectral analysis curves can be moved from the Freeze Stack to the Multi-Curve Stack as described in Section 7.12.2.2. From there, they can be stored as Reference Curves and treated as any other stored curves.

The microphone can be coupled to a hearing aid so that the aid modifies the sound before the 6500-CX does an analysis. Or, the microphone can be exposed directly to the sound. Or, the microphone can be bypassed altogether by unplugging it; an appropriate electrical signal can be plugged into the microphone amplifier input [where the longer prong of the three-prong microphone plug was connected].

10.3 More About the FFT

The procedure for performing spectral analysis as described in the previous section is simple and is similar to running composite mode tests. But a few important differences need to be mentioned. They have to do with the windowing that takes place during the FFT. If you have no interest in exploring this any further, just remember that the FONIX 6500-CX serves as a sound spectrum analyzer only when the source is turned off.

Windowing
In the composite mode, the FONIX 6500-CX cycles through a new test of the sound signal about five times every second. The first step in the test cycle is to sample the signal at the microphone input. This sample of the input signal must have a starting point and an ending point, meaning the sample is chopped off at both ends. So, the sample is a finite picture of the input signal, a "snapshot" that accurately represents the sound signal, but only between two definite points in time. As an example, assume the signal at the microphone input is a pure sine wave. A sampling of this signal may be represented by the following picture:

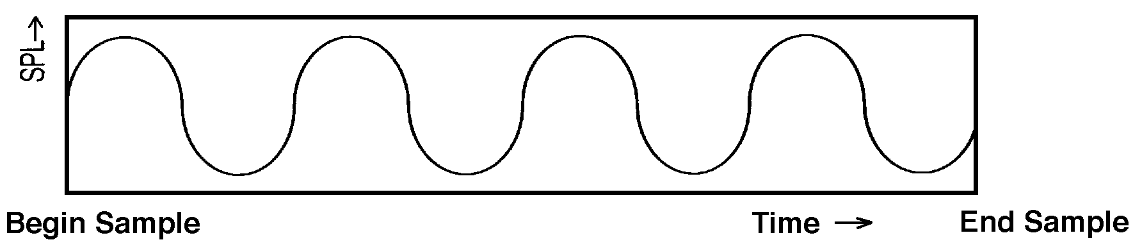


Figure 10.3A—Sample of a Puretone Signal

This sample of the signal approximates the actual signal by enclosing it in a frame or window. The actual signal extends well beyond the window in both directions. Because of the abrupt beginning and ending of the windowed sample, caution must be exercised when taking the Fast Fourier Transform, to avoid introducing frequency components that are not part of the actual test signal. In fact, such frequency artifacts can be introduced whenever the signal amplitude at one end of the window is different than the amplitude at the other end, as in the above diagram.

Two features in the design of the 6500-CX minimize the introduction of frequency artifacts during the Fast Fourier Transform.

First, when the composite source is turned on, the phase and frequency components of the signal being analyzed are assumed to be the same as the source. This assumption allows the 6500-CX to control the windowing of the signal sample to prevent the introduction of frequency artifacts.

But second, when the source is turned off, the 6500-CX has no control over the beginning and ending points of the sample because it has no previous information about the phase or frequency components of the incoming signal. So, in the case when the source is turned off, the 6500-CX introduces a multiplier to the sample that reduces to near zero the amplitude of the beginning and ending points of the sample. This process is called "Hanning windowing."

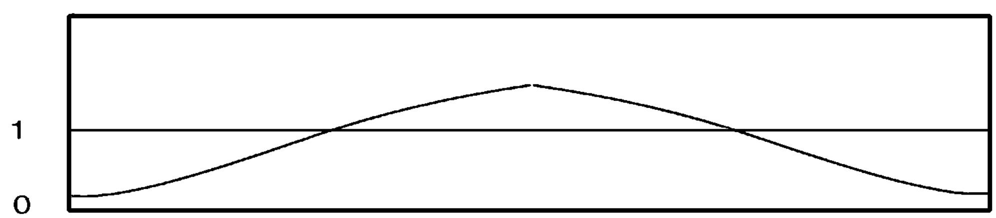


Figure 10.3B—Multiplier for Hanning Windowing

The multiplier is a sine wave with an amplitude value just over "one" at its peak. The multiplier retains the total energy of the incoming sample, even though it reduces the amplitude at the two ends of the sample to near zero. The Fast Fourier Transform of the resulting product (the above multiplier times the sample) is an accurate frequency representation of the actual signal without the introduction of frequency artifacts.

The important thing to remember from this section is that the 6500-CX uses Hanning windowing only when the source is turned off, allowing accurate analysis of externally generated signals. When the source is on, the 6500-CX uses information about the incoming signal, and no special windowing takes place. Accurate analysis of external signals, therefore, requires that the source be turned off, to invoke the Hanning windowing.

10.4 Spectrum Analysis and Noise Reduction

NOISE REDUCTION on the 6500-CX is an averaging process. The user selects whether to use 2, 4, 8, or 16 samples in each successive average. But as with the windowing of signal samples, the averaging feature works differently in the spectrum analysis mode than it does in the other analysis modes.

When the source is on (as with normal composite tests), the time-waveforms of the input samples are averaged, and then an FFT is performed, giving the frequency spectrum of the averaged waveform. Such "time-domain" averaging serves to reduce the effects of extraneous noise while maintaining the effects of the composite test signal. Although this method is effective with normal composite frequency-response analysis, time-domain averaging is not appropriate for spectrum analysis of externally generated signals, because externally generated signals will be treated as extraneous noise and thus will be rejected by the analysis.

When the source is off (spectrum analysis mode), an FFT is done on each time-waveform sample separately. Then the resulting spectra are averaged, giving the average spectrum of the samples. In summary, when the source is on, NOISE REDUCTION gives you the *spectrum of the average* of several waveform samples; when the source is off, you get the *average of the spectra* of several waveform samples.

How to Select the Amount of Averaging
As mentioned above, the "noise reduction" setting will determine the number of samples used in each spectral average. But the higher the setting, the slower the screen will respond to changes in the input spectrum. So when you want to capture the effects of a rapidly changing spectrum, such as the spectral changes over the course of a word, keep the setting low: either "off" or at 2. When you want to display the average spectrum of a long-term series of samples, such as the overall spectrum of cafeteria noise, keep the setting high: at 8 or 16. When you are analyzing the spectrum of a single sustained harmonic sound, such as a sung vowel, or the spectrum of a sustained random sound, such as a spoken "sss" or "sh" sound, keep the setting at 8 or 16 for the cleanest picture.

10.5 Some Examples of How to Use Spectrum Analysis

The following are examples of how you can use the spectrum analysis feature on your 6500-CX.

10.5.1 Calibration Procedure

This procedure is applicable only when using the test chamber microphone to make spectrum recordings of relatively quiet sounds (such as a spoken "sss" or "fff") that are near the ambient noise level of the recording environment. Examples are APPLICATION D and APPLICATION E, below. The calibration procedure is not necessary when the sound to be recorded has energy well above the ambient noise level at all frequencies (such as with vowel sounds). The effect of the calibration procedure is somewhat analogous to that of "leveling," in that it eliminates the response of the test system from the displayed measurement.

1. Press [RESET], and then hold the [v] key until the screen flashes. This gets you into the spectrum analysis mode (COMPOSITE MODE, SOURCE OFF).
2. Press the [NOISE REDUCTION] key repeatedly (four times) until the message NOISE REDUCTION 16 appears to the right of the graph.
3. Hold the analyzer microphone at chin level or lower, about two or three inches forward of the chin. Hold the microphone in that position, but do not make any other sound. Once the curve on the screen has stabilized, press [FREEZE] and then [START] to push the calibration curve into CURVE 2 of the Multi-curve stack.
4. Press [MULTI] and then use the [v] key to highlight COPY CURVES. Press [START] to invoke COPY CURVES.
5. Use the arrow keys to set up the title boxes under the graph to copy FROM CRV 2, TO REF 1. Then press [START] to complete the copy. You now have your calibration curve stored in REFERENCE 1.
6. Press [CONTINUE] to go back to the Multi-curve Main Selection Menu. Press [∧] to highlight SUBTRACT CURVES and then press [START].
7. Use the arrow keys to set up to SUBTRACT REF 1, FROM CRV 1. You should now see a waving line around the 0 dB level on the graph.

You are now ready to record a spectrum using your microphone, as calibrated to the ambient noise in your environment.

10.5.2 Examples

Below are a few suggested applications of the spectrum analysis feature used in conjunction with other Fonix 6500-CX options.

<u>**Application A**</u>**: Insertion-Gain Measurements Using an External Sound Source.** With signal-processing hearing instruments, the gain and frequency response varies when the input signal varies. Although the internal signals of the Fonix 6500-CX are among the most valid and versatile signals available for testing signal-processing instruments, you are no longer restricted to the internal composite and pure-tone sources for making real-ear measurements. You can now use Quik-Probe II with any <u>sustained</u> acoustic source, live or pre-recorded, to measure the real-ear unaided response (REUR), the real-ear aided response (REAR), and the real-ear insertion-gain response (REIR). You can use AUTOMATIC or MANUAL probe mode, although the instructions given below are for MANUAL mode.

<u>Suggested procedure</u>:

1. Prepare the sound source. For this procedure, the choice of sound source is yours. You may, for example, want to use a tape or CD of environmental noise played through a loudspeaker. But any <u>sustained</u> acoustic source will work. Placement of the loudspeaker is up to the tester, but as for other real-ear measurements, repeatability will be best when a 45° angle and a close distance is used (see Section 8.5).

2. Press [RESET] (if necessary) and then press [START/STOP] on the remote module to activate probe operation. All subsequent keystrokes are on the remote module.

3. Set to MANUAL mode by pressing [MENU] to get the Quik-Probe II Menu, then [v] to highlight OPERATION MODE, and then [>] to switch from AUTO to MANUAL. Also, while you are in the Quik-Probe II Menu, set GAIN(G)/SPL to G/REF ON.

4. Use the [v] key to highlight OPERATION PARAMETERS and then press [START/STOP] to get the Operation Parameters Menu.

5. Use the arrow keys to set SIGNAL LEVEL to OFF and set NOISE REDUCTION to 8X or 16X.

6. Press [MENU] twice to return to the main probe screen.

7. Follow the instructions in Section 8.2.2 for placing the probe and reference microphones in and about the ear.

8. Turn on the external sound source.

9. Press [START/STOP] to begin spectrum analysis. After the curve in the lower graph has stabilized, press [START/STOP] once more to freeze the measurement. Turn off the external sound source.

10. Press [UNAIDED RESPONSE] to save the REUR.

11. Holding the probe tube in position, place the aid in the ear. The aid should be turned on and set to "use gain."

12. Turn on the external sound source.

13. Press [START/STOP] to begin spectrum analysis. After the curve in the lower graph has stabilized, press [START/STOP] once more to freeze the measurement. Turn off the external sound source.

14. Press [AIDED RESPONSE] to save the REAR. The REIR will appear in the top graph.

Application B: **Real-Ear Environmental Sounds.** This application is similar to the REAR part of APPLICATION A, except instead of measuring real-ear gain (versus the reference microphone), you will measure without the reference microphone, to record the SPL spectrum of environmental sounds directly as reproduced by the hearing aid *in the client's ear*: Based on threshold and comfortable loudness measures, you can judge whether the environmental sounds can be expected to be comfortably audible; uncomfortably loud; or, perhaps just loud enough to be annoying after a long period of time.

Suggested procedure:

1. Prepare the sound source. For this procedure, the choice of sound source is yours. You may, for example, want to use a tape or CD of environmental noise played through a loudspeaker. But any sustained acoustic source will work. Placement of the loudspeaker is up to the tester, but as for other real-ear measurements, repeatability will be best when a 45° angle and a close distance is used (see Section 8.2.1).
2. Press [RESET] (if necessary) and then press [START/STOP] on the remote module to activate probe operation. All subsequent keystrokes are at the remote module.
3. Set to MANUAL mode by pressing [MENU] to get the Quik-Probe II Menu, then [v] to highlight OPERATION MODE, and then [>] to switch from AUTO to MANUAL. Also, while you are in the Quik-Probe II Menu, set GAIN(G)/SPL to SPL (the reference microphone will be automatically disabled.
4. Use the [v] key to highlight OPERATION PARAMETERS and then press [START/STOP] to get to the Operation Parameters Menu.
5. Use the arrow keys to set SIGNAL LEVEL to OFF, and set NOISE REDUCTION to 8X or 16X.
6. Press [MENU] twice to return to the main probe screen.
7. Mark the probe tube so that it will extend at least 5 mm beyond the earmold tip (see Figure 8.2.2A for details), but it is best for accuracy in the high frequencies for the probe tip to be as close as possible to the eardrum.
8. Referring to Figure 8.2.2B, insert the tube in the ear. (The reference microphone is not used for this procedure, and thus can be draped over the client's shoulder.)
9. Place the aid in the ear. The aid should be turned on and set to "use gain."
10. Turn on the external sound source, as applicable.
11. Press [START/STOP] to begin spectrum analysis. Press [START/STOP] once more to freeze the measurement. See Figure 10.5.2.
12. Turn off the external sound source.
13. Repeat steps 10 through 12 as necessary.

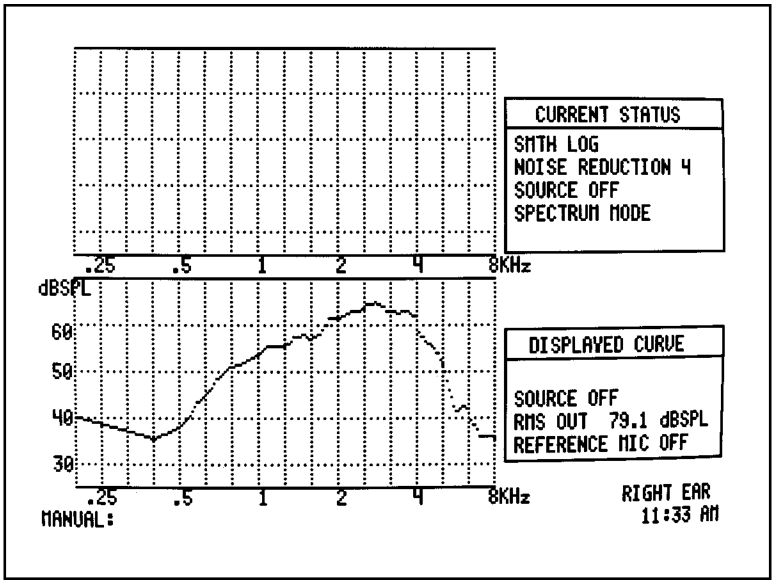


Figure 10.5.2—Real-ear spectrum analysis mode

Application C: Occlusion Effect. Use the Quik-Probe II Option to measure the "occlusion effect" of a hearing aid. By analyzing the spectrum of the hearing-aid-wearer's own voice, you can judge whether the occlusion effect will make the hearing aid uncomfortable, and you can measure an improvement (lessening) of the occlusion effect after adjusting the vent opening.

Suggested procedure:

This procedure can be done in either the AUTOMATIC or the MANUAL probe mode. The following procedure uses the MANUAL probe mode. The hearing aid must be in place, but can be either on or off.

1. Press [RESET] (if necessary) and then press [START/STOP] on the remote module to activate probe operation. All subsequent keystrokes are from the remote module.
2. Press [MENU] and set to COMPOSITE/MANUAL mode.
3. Set GAIN/SPL to GAIN/REF MIC ON, and set NOISE REDUCTION to 8X.
4. In the Operation Parameters Menu, set SIGNAL LEVEL to OFF.
5. Press [MENU] to return to the Insertion Gain Screen.
6. Mark the probe tube so that it will extend beyond the earmold tip (see Figure 8.2.2A for details) and insert the tube in the ear. Place the reference microphone above the ear (see fig. 8.2.2B).

7. Place the aid in the ear. The aid can be left off or turned on (see examples below).

8. Instruct the client to sustain the vowel sound "ee."

9. Press [START/STOP] to begin spectrum analysis.

10. While the "ee" is still sounding, and once the curve on the screen has stabilized, press [START/STOP] to freeze the measurement. (The client can now stop vocalizing.)

11. Press [UNAIDED RESPONSE] to store this measurement as the "unaided response." An example of the "ee" spectrum in an earcanal (referred to the reference mic) using a pin-hole vented earmold with the hearing aid turned off is shown in Figure 10.5.2A, below.

12. Press [CRT] if a printout is desired.

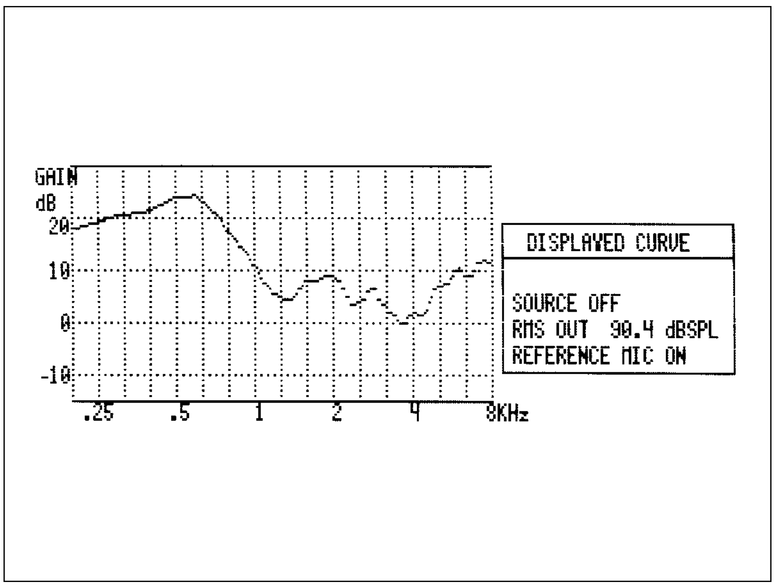


Figure 10.5.2A — Occlusion Effect. Example spectrum (referred to the reference mic) of hearing-aid-wearer's own voice, sustained "ee" sound, in the earcanal, with a pin-hole vented earmold in place, with the hearing aid turned off.

13. If the gain in the low frequencies seems high, for not even having the hearing aid turned on, you might consider adjusting the vent to a more open condition, to prevent occlusion-effect discomfort. Once the vent adjustment is made, again ask the client to sustain an "ee" sound and press [START/STOP].

14. While the “ee” is still sounding, and after the curve on the screen has stabilized, press [START/STOP] again to freeze the measurement. (Refer to Figure 10.5.2B, on the next page.) In the bottom graph, you will now have a thick curve showing the baseline condition and a thin curve showing the adjusted condition. The curve in the upper graph is the difference between the two lower curves.

    Figure 10.5.2B shows an example of a pin-hole vent as the baseline condition and a wide open vent as the adjusted condition. Note the 20 dB improvement (lessening) of the occlusion effect in the low frequencies. The wide open vent, however, could result in feedback when the hearing aid is turned on. Figure 10.5.2C shows a similar measurement set, but with the hearing aid turned on. The maximum possible improvement before feedback with this fitting was 10 dB.

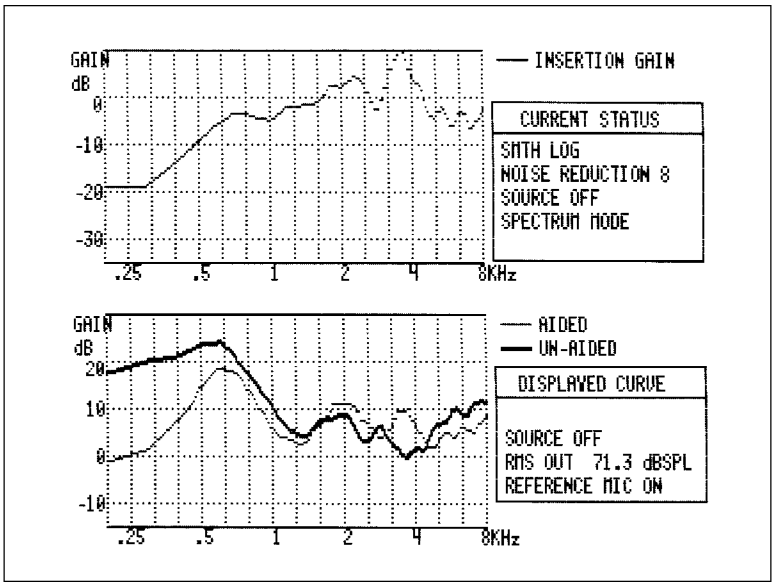


Figure 10.5.2B — Example spectrum (referred to the reference mic) of hearing-aid-wearer’s own voice, sustained “ee” sound, in the earcanal. Thick curve in lower graph is with a pin-hole vented earmold; thin curve in lower graph is with a wide-open earmold, both with the hearing aid turned off. Upper graph shows the difference between the two lower curves.

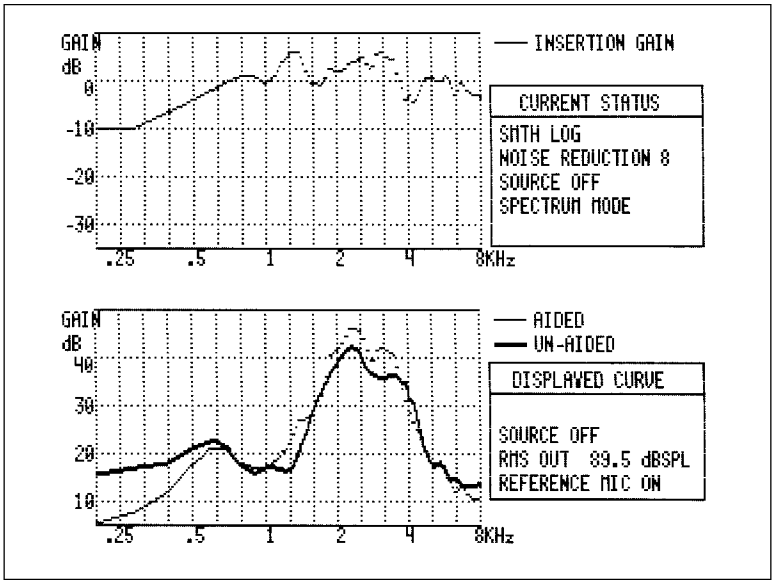


Figure 10.5.2C— ***Example spectrum (referred to the reference mic) of hearing-aid-wearer's own voice, sustained "ee" sound, in the earcanal. Thick curve in lower graph is with a pin-hole vented earmold; thin curve in lower graph is with a medium vented earmold, both with the hearing aid turned on. Upper graph shows the difference between the two lower curves.***

Application D: Speech Sounds. Use the Multi-curve and In-situ Options to compare the spectrum of a spoken sound with the estimated insertion-gain response of a hearing aid: Based on the comparison, you can demonstrate whether the aid can be expected to reproduce and amplify the important frequencies of the spoken sound. This test is especially useful with an "sss" sound, to demonstrate to a client whether or not one's present aid is giving enough of the high frequencies.

Suggested procedure:

1. Follow the calibration procedure given in Section 10.5.1. This puts you into the SUBTRACT CURVES mode of Multi-curve, so that the ambient soundfield spectrum will be subtracted from subsequent spectrum measurements.

2. Holding the analyzer microphone at the same position used for calibration, and utter the sound "sss" for a few seconds, until a consistent curve is visible on the graph. You should get a spectrum like the one in Figure 10.5.2D.

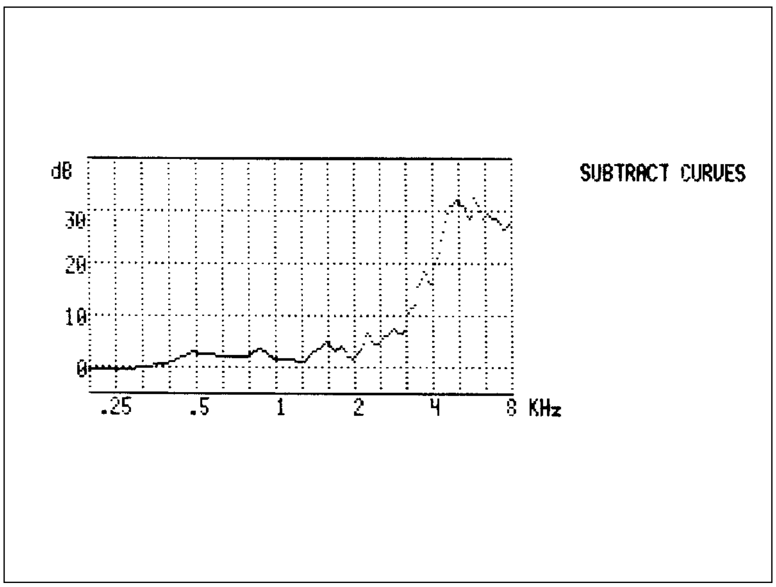


Figure 10.5.2D — Example spectrum of "SSS" sound through test mic Only

3. Before stopping the "sss" sound, press [CONTINUE]. The spectrum curve will disappear, but it will automatically have been stored in REFERENCE 9. The screen will now have the Multi-curve Main Selection Menu on the upper right.

4. Highlight COPY CURVE and press [START]. Set up to copy FROM REF 9, TO REF 2, and then press [START] again to store the calibrated "sss" spectrum for later use.

5. Press [CONTINUE] twice to exit Multi-curve.

6. Now attach a hearing aid (and earmold, if applicable) to the MZ-1 coupler; occlude any vent with Fun-Tak; set the volume control at a "use gain" setting; and insert the test microphone into the coupler.

7. Place the apparatus in the test chamber and close the lid.

8. Press [MENU] and then [INSITU] to get the In-situ Option Menu. Use the arrow keys to set the SOURCE CORRECTION for the appropriate type of aid and set the OUTPUT CORRECTION for OES AND INSERTION GAIN. Press [START] to invoke the In-situ Option.

9. Use the [∧] key to set the signal level to 50 dB SPL or less, to simulate a low-level speech input. (NOISE REDUCTION should still be at 16).

10. Press [MULTI] to invoke the Multi-curve Option, move the higlighting cursor to DUAL SCALE, and then press [START].

11. Use the arrow keys and the title boxes under the graph to display REF 2 and CRV 1. REF 2 is the "sss" spectrum, and CRV 1 is the estimated insertion-gain response. Does the aid have enough gain in the important high frequencies? (See the examples below.)

    An alternative procedure would be to substitute a real-ear insertion-gain response measurement (using Quik-Probe II) for the estimated insertion-response measurement using the In-situ Option.

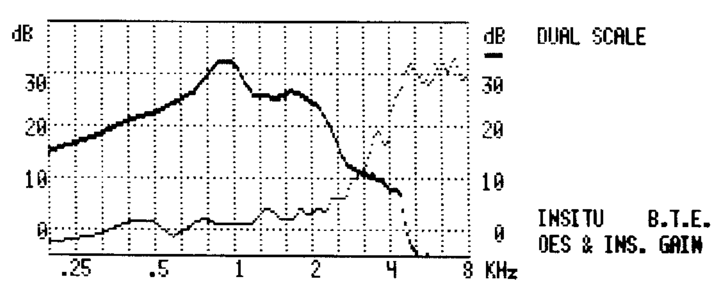


Figure 10.5.2E — Estimated insertion-gain response of a hearing aid, as compared to the spectrum of an "SSS" sound. (This hearing aid has little or no gain in the frequencies above 4 kHz, which are the important frequencies for the "sss" sound.)

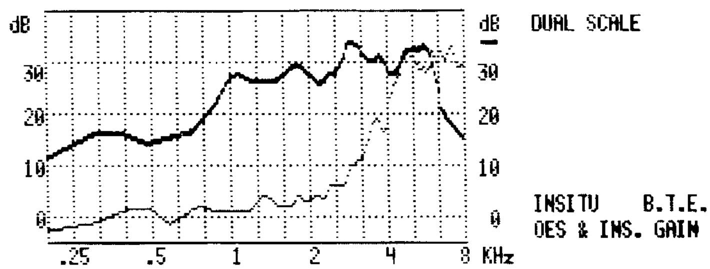


Figure 10.5.2F — Estimated insertion-gain response of a hearing aid, as compared to the spectrum of an "SSS" sound. (This hearing aid has usable gain in the frequencies above 4 kHz, which are the important frequencies for the "sss" sound.)

Application E: The Difference Between Two Speech Sounds. Use the Multi-curve Option to compare the spectra of two high-frequency speech sounds (for example, "sss" and "fff") to the response of a hearing aid. This is similar to APPLICATION D, except now you will demonstrate to what extent a hearing aid can reproduce the *difference between two* speech sounds.

Suggested procedure:

1. Follow steps 1 through 4 of the procedure for APPLICATION D, above (for the "sss" sound).

2. Repeat the same steps again, except for an "fff" sound instead of the "sss" sound, and copy the results into REF 3 instead of REF 2.

3. Press [CONTINUE] once to go to the Multi-curve Main Selection Menu.

4. Highlight MULTIPLE CURVES and press [START].

5. Use the arrow keys to select REF 2 and REF 3 in the upper two lines of the title box under the graph. Then, while highlighting each of the two lower lines in the title box one by one, press [FREEZE] to "de-select" the display for those two curve selection lines. Now you should see only the "sss" and "fff" spectra displayed on the graph, as in Fig. 10.5.2G, below.

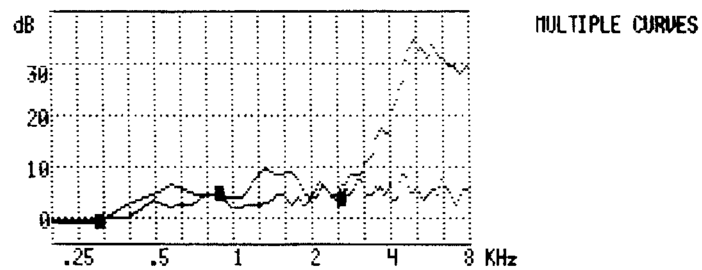


Figure 10.5.2G — Spectra of "SSS" and "FFF" displayed together (There is little difference between the spectra of the two sounds below 4 kHz. Therefore, a hearing aid having little gain above 4 kHz would obscure most of the information for distinguishing between the two sounds.)

6. Press [CRT] to print.

7. Now attach a hearing aid (and earmold, if applicable) to the MZ-1 coupler; occlude any vent with Fun-Tak; set the volume control at a "use gain" setting; and insert the test microphone into the coupler.

8. Place the apparatus in the test chamber and close the lid.

9. Press [MENU] and then [INSITU] to get the In-situ Option Menu. Use the arrow keys to set the SOURCE CORRECTION for the appropriate type of aid and set the OUTPUT CORRECTION for OES AND INSERTION GAIN. Press [START] to invoke the In-situ Option.

10. Use the [∧] key to set the signal level to 50 dB SPL or less, to simulate a low-level speech input. (NOISE REDUCTION should still be at 16).

11. After the curve stabilizes on the screen, press [CRT] to print.

12. Compare the hearing-aid gain curve to the "sss" and "fff" spectra. Does the hearing aid have sufficient gain in the frequency ranges necessary for distinguishing the two speech sounds? Refer to Figures 10.5.2E and -6, above, as examples.

Application F: Internal Noise of a Hearing Aid. Use the In-situ Option to estimate the *real-ear* spectrum of the internal noise of the hearing aid. Based on the audiogram, should the internal noise be audible? At what frequencies?

Suggested procedure:

1. Attach a hearing aid (and earmold, if applicable) to the appropriate MZ coupler; occlude any vent with Fun-Tak; set the volume control at a "use gain" setting; and insert the test microphone into the coupler.

2. Place the apparatus in the test chamber and close the lid.

3. Press [MENU] and then [INSITU] to get the In-situ Option Menu.

4. Use the arrow keys to set the SOURCE CORRECTION for the appropriate type of aid and set the OUTPUT CORRECTION for OES ONLY.

5. Press [START] to invoke the In-situ Option.

6. Press the [v] and hold it until the screen flashes. This turns the signal source off.

7. Press [NOISE REDUCTION] repeatedly until the reading on the screen indicates a setting of 16.

8. After the curve stabilizes on the screen, press [FREEZE] and then [START] to save the curve into CRV 2 of Multi-curve, or press [CRT] to print.

   This curve of the estimated *in-situ* hearing aid output with no input signal is a spectrum of the noise generated by the electronics of the hearing aid. The validity of the measurement, however, requires that the noise output of the hearing aid is significantly higher than that of the measuring system. Check this by turning off the hearing aid while the curve is not frozen. If the spectrum falls bellow that measured with the hearing aid on, then the original noise spectrum was valid.

The conversions used by the FONIX 6500-CX to convert audiograms to target gain curves are the following:

NAL-RP FITTING FORMULA CALCULATION

The insertion gains at each frequency are calculated according to the following formulas:

Freq (Hz)	Insertion Gain (dB)
250	X + .31 HTL - 17dB + S
500	X + .31 HTL - 8dB + S
750	X + .31 HTL - 3dB + S
1000	X + .31 HTL + 1dB + S
1500	X + .31 HTL + 1dB + S
2000	X + .31 HTL - 1dB + S
3000	X + .31 HTL - 2dB + S
4000	X + .31 HTL - 2dB + S
6000	X + .31 HTL - 2dB + S
8000	X + .31 HTL - 2dB + S

Where you calculate X and S (Slope correction values) as follows:

a. T = (HTL @ 500Hz) + (HTL @ 1000Hz) + (HTL @ 2000Hz)

b. If T is less than or equal to 180dB, then
X = .05 x T
If T is greater than 180dB, then
X = (.05 x 180dB) + (.116 x (T - 180dB)

c. If the HTL at 2000 Hz is less than 95dB, S = 0
If the HTL at 2000 Hz is greater than or equal to 95dB, then apply the following slope correction factors at each frequency based on the 2000Hz measurement:

2000Hz HTL (dB)	250	500	750	1000	1500	2k	3k	4k	6k	8k
95	4	3	1	0	-1	-2	-2	-2	-2	-2
100	6	4	2	0	-2	-3	-3	-3	-3	-3
105	8	5	2	0	-3	-5	-5	-5	-5	-5
110	11	7	3	0	-3	-6	-6	-6	-6	-6
115	13	8	4	0	-4	-8	-8	-8	-8	-8
120	15	9	4	0	-5	-9	-9	-9	-9	-9

Beginning with software ver. 4.01 (serial no. 2079 and above), the above correction factors for profound hearing loss are included in the NAL formula.

POGO

Prescription of Gain/Output (POGO) for Hearing Aids
by: Geary A. McCandless, PhD,
& Poul Erik Lyregaard, MSc
Hearing Instruments vol 34 #1, 1983

Required insertion gain is calculated as follows:

Frequency (Hz)	Insertion Gain (dB)
250	1/2 HTL - 10 dB
500	1/2 HTL - 5 dB
* 750	1/2 HTL - 2.5 dB
1000	1/2 HTL
* 1500	1/2 HTL
2000	1/2 HTL
3000	1/2 HTL
4000	1/2 HTL
* 6000	1/2 HTL
* 8000	1/2 HTL

Note: Frequencies preceded by an asterisk (*) are interpolated because the article does not reference them.

BERGER

A Method of Hearing Aid Prescription
by: Kenneth W. Berger, PhD, Eric N. Hagberg, M.A.,
& Robert L. Rane, PhD
Hearing Instruments July 1978

Required insertion gain is calculated as follows:

Frequency (Hz)	Insertion Gain (dB)
* 250	1/2 HTL
500	1/2 HTL
* 750	1/2 HTL
1000	1/1.6 HTL
* 1500	1/1.5 HTL
2000	1/1.5 HTL
3000	1/1.7 HTL
4000	1/2 HTL
* 6000	1/2 HTL
* 8000	1/2 HTL

Note: Frequencies preceded by an asterisk (*) are interpolated because the article does not reference them.

1/3, 1/2, 2/3 Gain

The 1/3-2/3 Insertion Gain Hearing Aid Selection Guide
by: Robert Libby
Hearing Instruments vol 37 #3, 1986

Required insertion gain is calculated as follows:

FREQ. (Hz)	INS GAIN (dB) (2/3 rule)	INS GAIN (dB) (1/3 rule)	INS GAIN (dB) (1/2 rule)
250	2/3 HTL - 5 dB	1/3 HTL - 5 dB	1/2 HTL -5 dB
500	2/3 HTL - 3 dB	1/3 HTL - 3 dB	1/2 HTL -3 dB
750*	2/3 HTL	1/3 HTL	1/2 HTL
1000	2/3 HTL	1/3 HTL	1/2 HTL
1500*	2/3 HTL	1/3 HTL	1/2 HTL
2000	2/3 HTL	1/3 HTL	1/2 HTL
3000	2/3 HTL	1/3 HTL	1/2 HTL
4000	2/3 HTL	1/3 HTL	1/2 HTL
6000	2/3 HTL - 5 dB	1/3 HTL - 5 dB	1/2 HTL -5 dB
8000*	2/3 HTL - 5 dB	1/3 HTL - 5 dB	1/2 HTL -5 dB

Note: Frequencies marked by an asterisk (*) are interpolated because the article does not reference them.

Parallel Button Operations with the Quik-Probe Remote Module and the 6500-CX Electonics Module

This table will help you perform Quik-Probe operations from the 6500-CX front panel instead of from the remote module, when it is conveinent.

IN THIS MODE................................THESE BUTTONS............DO THE SAME AS.........THESE BUTTONS

QUIK-PROBE OPERATION /DISPLAY	REMOTE MODULE BUTTONS	6500-CX ELECTRONICS MODULE BUTTONS
QUIK-PROBE II MENU	All arrow buttons	All arrow buttons
	[MENU]	[MENU] or [CONTINUE]
	[START / STOP]	[START]
MULTI-CURVE	All arrow buttons	All arrow buttons
	[START / STOP]	[START]
	[MENU]	[MENU]
OPERATION PARAMETERS MENU	All arrow buttons	All arrow buttons
	[MENU]	[MENU] or [CONTINUE]
CREATE TARGET: Audiogram Insertion Gain 2 cc FOG 2 cc SSPL 90	All arrow buttons	All arrow buttons
	[SWEEP START]	[START]
	[START / STOP]	[CONTINUE]
	[STORE]	[FREEZE]
	[CLEAR]	[CURSOR]
CALIBRATE PROBE	[MENU]	[MENU] or [CONTINUE]

Appendix C: Specifications

ACOUSTIC DRIVE SIGNAL

Frequencies:	100 Hz through 8000 Hz in 100-Hz intervals. Accuracy within 1 percent. Frequencies used in sweep presentation are from 200 to 8000 Hz only.

COMPOSITE MODE AMPLITUDES:

Flat or White Noise Weighting:	Each frequency component, 30 through 80 dB SPL; (total signal, 49 through 99 dB SPL RMS) in 5-dB steps.
Speech Weighting:	Response has flat amplitude for low frequency components; a slope of –6 dB/octave starts at 900 Hz, which is 3 dB down. Amplitude from 40 through 90 dB SPL RMS, in 5-dB steps.

SINE MODE AMPLITUDES:

Amplitude Accuracy:	50 through 100 dB SPL in 5-dB steps. After leveling, all amplitudes accurate to within 1 dB from 300 to 5000 Hz; all others within 3 dB.

CREST FACTOR

Composite Mode Signal:	Less than 12 dB (4 to 1 ratio of peak to RMS value).

TELECOIL DRIVE

10 and 31.6 mA/meter, or telewand in Coil modes.

DIGITAL READOUT OF SOUND PRESSURE LEVEL

Frequency Range:	100 through 8000 Hz.
Amplitude Range:	From 0 through 149 dB
Resolution:	0.1 dB.
Type:	True RMS.
Accuracy:	Within 1 dB plus or minus 1 digit from 300 to 5000 Hz; within 2 dB plus or minus 1 digit for all other frequencies.
Noise Immunity:	2.5 dB.
SPL Equivalent Input Noise:	Less than 50 dB RMS
Noise Reduction:	Averages the measured signal in synchronism with the signal generator by the factor chosen. Factors of 2, 4, 8, and16 available. Random noise will be reduced by an amount equal to the inverse of the square root of the factor chosen.

SPECTRUM MODE AVERAGING

Uses the Noise Reduction button to control the Spectral averaging in Spectrum Mode from 2 to 16.

BATTERY CURRENT MEASUREMENT

Range:	0 to 20 mA.
Accuracy:	Within ± 5% of reading plus or minus 0.01 mA.
Resolution:	0.01 mA.
Voltages supplied:	1.5 (silver), 1.3 (zinc air). See Appendix B, ANSI S3.22-1987.

Note: The above accuracy applies only if the battery pill is disconnected during the leveling operation.

HARMONIC DISTORTION ANALYZER

Type:	Selectable for 2nd, 3rd, Total (2nd plus 3rd), or none.
Resolution:	0.1 percent.
Reading:	Percent (%) with respect to total signal. Pure tone readings made at 100-Hz intervals from 400 through 2500 Hz.

ATTACK/RELEASE TIME

Range:	2 to 5000 mSec.
Accuracy:	± 10% or 2 mSec + Resolution, whichever is larger.
Signal Durations:	All modes: 2000 mSec Adaptive: 2 Sec, 0.1 Sec (Attack) ANSI 96: variable (500 to 5000 mSec)

PRIMARY POWER

Selectable for 100, 120 or 240 VAC (within 10 percent), 50/60 Hz. Power requirement is 50 watts.

ELECTRONICS MODULE

Color:	Light gray module case with dark grey front panel. Black trim and buttons.
Size:	17.5"W x 6.5"H x 14.75"D (44.5 x 16.5 x 37.5 cm).
Weight:	20.5 lbs.(9.5 kg).

VGA VIDEO MONITOR

Display Format:	320 pixels wide x 210 lines high.
Display Refresh Rate:	60 Hz.
Display Color:	Red, Green & Blue or Monochrome (Black & White)
Power:	115 VAC, 50 or 60 Hz. (230 VAC optional).
Color:	Light gray
Size:	14" diagonal (35.5 cm)
Weight:	27 lbs. (13.2 kg).

TEST CHAMBER

Type:	FONIX FC 6050.
Test Area:	Greater than 6" x 6" x 1.5" deep (15.5 x 7.5 x 4 cm).
Internal Acoustic Reflections:	SPL at test point will change less than 3 dB above 1 kHz, when lid is raised (without feedback compensation).
Ambient Noise Isolation:	45 dB at 1 kHz (allows THD measurement to within 3% at 60 dB source level and a 60 dB ambient).
Color:	Light gray with black trim. Black and white test area.
Size:	13.5"W x 18"H x 11.5"D (934.3 x 45.7 x 29.2cm).
Weight:	33 lbs. (15 kg).

Appendix D: RS232 Troubleshooting Guidelines

You should use these guidelines if you are having problems getting your FONIX hearing aid analyzer to communicate with your host computer. If you are trying to install an RS232 option upgrade, refer to the document titled “RS232 Installation Instructions.”

The most common problems encountered by Frye support personnel are listed below. It is always best to troubleshoot the most common causes first, before moving on to more complicated causes. For example, if you had the RS232 option installed at the factory, you should start out with the assumption that it has been installed correctly and troubleshoot problems external to the analyzer first.

Most common RS232 problems encountered:

- Customer didn’t purchase RS232 but thought he had the option.
- Bad RS232 cable
- Customer had RS232 cable connected to computer COM port 2 and was trying to communicate with software which was using COM port 1 (or vice versa).
- Customer had multiple COM ports in computer, but they were not configured properly on the serial card (e.g. COM ports were not enabled, interrupts conflicted, etc.).
- Customer installed RS232 option upgrade and didn’t connect cables properly inside the analyzer, or didn’t install jumper correctly.

To help you troubleshoot the RS232 operation of your FONIX instrument and RS232 software, Frye now supplies the following items with all analyzers which have the RS232 option and with all RS232 option upgrades:

- Diagnostic plug for your analyzer’s serial port.
- Special RS232 cable with red/green diagnostic LEDs.
- Diagnostic software to check the computer’s COM port.

If you purchased your RS232 option before these items became available and you are having trouble with your RS232 operation, you should contact Frye to obtain these troubleshooting tools.

1. Check the analyzer’s RS232 option

When you turn on your analyzer, it checks for RS232 software on the system software EPROM. If it detects the software, it performs a limited self-test of its RS232 hardware. A status message is displayed below the Frye Electronics copyright notice on the opening display screen. This message can be any of the following:

<no message> — No RS232 software was detected. This could also indicate bad system software EPROMs, but this is unlikely if the instrument is operating normally in all other functions. Contact Frye to verify that you have the RS232 option or to get replacement EPROMs. Have your serial number handy.

RS-232 AVAILABLE — RS232 software was detected and limited RS232 diagnostics were passed.

RS-232 BAD UART — RS232 software was detected, but the UART chip is bad, or is the wrong type, or is installed incorrectly. If your RS232 option was factory installed, contact Frye. Check that none of the pins on the UART chip are bent under or sticking out of the socket on the I/O board. Check that the notch on the UART chip is toward the top of the I/O board. Refer to the RS232 installation instructions for more information. If the UART looks like it is installed correctly and you still get this message, contact Frye for a replacement UART or additional help.

In addition to the limited self-test described above, you may perform a more detailed check of your RS232 option using the diagnostic plug shipped with your analyzer. If you did not receive one of these plugs with your instrument, contact Frye to obtain one.

To perform the detailed RS232 self-test, turn the analyzer off and insert the 25-pin plug labeled "RS232 Diagnostic Plug" into the 25-pin connector labeled "RS232 Computer Interface" on the back of your analyzer. Turn the instrument power on. The analyzer will automatically perform a detailed check of RS232 functions. One of the following status messages will be displayed under the Frye copyright notice:

DIAGNOSTICS PASSED — Indicates that no problems were detected in your analyzer's RS232 operation.

!!! If you get any of the following messages and your RS232 option was factory installed or installed by a distributor, please contact Frye or the distributor. Be sure to have your instrument serial number handy when you call.

RS-232 AVAILABLE — RS232 software was detected and the limited self-test passed, but no diagnostic plug was detected, so no detailed self-test was performed. If you get this message with the diagnostic plug installed, then the 7-pin RS232 connector on the I/O board inside your instrument is probably misaligned. Check to make sure that this connector is covering all the connector pins on the I/O board. Refer to the RS232 installation instructions for more information. If the connector is correctly installed and you are still getting this message, contact Frye.

RS-232 BAD UART — Same as described for the limited self-test.

RS-232 BAD CABLE — Indicates that the 7-pin connector on the I/O board is installed upside down. When this connector is correctly installed, the white dot on the connector is toward the bottom of the I/O board and the gray wire on the ribbon cable is toward the top. If the connector is installed correctly and you still get this message, contact Frye.

RS232 NO INTERRUPT — Indicates that the jumper next to the UART on the I/O board is connected incorrectly or that the run you should have cut during installation has not been cut. (Note: This applies only to some upgrades.) You should refer to the RS232 installation instructions for correct jumper installation.

2. Check that the analyzer is sending polls

When the analyzer is ready to accept commands from the computer it sends a stream of special data packets, called “polls”, to the computer, usually about 5 times per second. To determine if the analyzer is sending polls, connect the Frye RS232 cable with the red and green LEDs between the analyzer and the computer (the LEDs go on the computer end) and reset the analyzer. The analyzer will come up with the opening logo screen and begin sending polls. You should see a flickering red LED on the RS232 cable to indicate that polls are being sent down the cable. If you do not see the red LED flickering, there is a problem with your analyzer (or your test cable is bad).

Note: If you do not have the Frye cable, but you have an oscilloscope handy, you can use the scope to look for pulses on pin 3 of the 25-pin connector or pin 2 of the 9-pin connector.

If your analyzer is sending polls and you are not communicating, you can assume the analyzer is functioning properly and look for problems in the cable or computer.

3. Check the RS232 cabling

A bad RS232 cable is often the cause of communication problems between an analyzer and computer, particularly if the problem seems to be intermittent. The quickest way to check for a bad cable is to try a known good cable. If you don’t have a cable that you are sure is good, you may want to purchase a new one. The odds of the new cable being bad are slight, so if you still have the problem after trying a new cable, you can assume that the problems is in the computer or application software.

The FONIX RS232 option expects a standard ‘straight-thru’ RS232 cable. These cables are available from most stores that carry computer supplies. If you want to use a longer cable, the RS232 standard supports cable lengths up to 50' at the communication rate used by FONIX instruments, but you can probably go up to 100' without having any problems. Do not use RS232 cables which are designated as “Null Modem” cables. Your computer’s serial port connector may be either 9-pin or 25-pin connector (or you may have both types). You may connect your analyzer to either of these ports. You may use a standard 25-pin-to-9-pin adapter to adapt the Frye RS232 cable (or any other standard 25-pin RS232 cable) to use the 9-pin port.

4. Check the computer’s serial port

Most computers have one 25-pin female parallel port and one or two male 25-pin or 9-pin serial ports. With few exceptions you can identify the serial ports by looking for 25-pin or 9-pin connectors on the back of your computer which are male (they have pins sticking out). The serial card(s) in your machine usually have jumpers which disable or enable these ports and jumpers to determine which connector gets assigned to which communications port: COM1, COM2, COM3, or COM4. If you have two COM ports, they are almost always configured as COM1 and COM2 at the factory or at the computer store. It is important for you to determine which COM port has been assigned to each connector so that you are not trying to communicate with COM1 when you are connected to COM2. Some computers have these ports labeled, but most don't. You can usually look at your computer documentation or the documentation that came with your serial cards to determine this information, but often it is easier to just use some program which uses the serial ports and figure out which port works when you have the software configured for that port. This is the approach we have taken with the RS232 diagnostic program.

Your RS232 disk contains a program called FCHECK32.EXE which checks several functions of your RS232 communication from the computer side. To use FCHECK32, you should have your computer and analyzer connected with an RS232 cable. Reset your analyzer so it is in the opening screen sending polls. If you have the Frye RS232 cable, you should check the red LED to make sure you are receiving polls as described above. The Status box in the upper right hand corner will display the message "— Testing —." Eventually this status box will display either the message "No Poll" or the message "Test Completed."

A "No Poll message indicates that the computer is not receiving polls from the analyzer on COM1. If you see pulses on the red LED, you know you are getting polls, so you can assume that the port you are connected to on the back of the computer is not COM1, or that COM1 is disabled or malfunctioning. The Help window describes error conditions that might be causing the problem.

A "Test Completed" status message should be accompanied by a message in the Help window saying that RS232 communication on COM1 is functioning successfully. If you get this message, then you have a functioning communications link via the FRYERS protocol between the analyzer and the computer. If your application still isn't working, you probably have an error in your application. If your application can be configured to use COM1 or COM2, such as the Frye CHAP program, you should check to make sure that the program is configured for the correct port.

If you receive a 'No Poll' on COM1, press '2' to begin testing COM2. Do not change the connection on the back of your computer. If you get a successful connection, you know that the connector you are currently connected to on the back of the computer is COM2. If you get a 'No Poll' on COM2 as well, you know that the port is disabled, or malfunctioning, or is configured as COM3 or COM4. If you cannot get a successful communication using FCHECK, then you most likely have a malfunctioning or incorrectly configured serial card.

5. If comunication problems persist…

If you have performed all the checks in steps 1 through 4 and still cannot get the computer to communicate with your analyzer, call Frye for additional help.

Appendix E: Glossary of Terms for the FONIX 6500-CX

AGC — Automatic Gain Control (or Automatic Volume Control). A feature on a hearing aid that automatically adjusts the gain, depending either on the input level (AGC-I) or the output level (AGC-O). Also known as "Compression."

AIDED RESPONSE — The response of a hearing aid in place on the ear. (Also called "In-situ Response.") Subtract the "Unaided Response" from the "Aided Response" to get the Insertion Gain Response. When the Aided Response is measured in a real ear (as opposed to a manikin), it is called the "Real Ear Aided Response" (or "REAR").

AMBIENT NOISE — The environmental sounds in a testing area.

ANECHOIC CHAMBER — A room with little sound reverberation; a room constructed to be acoustically absorptive.

AMPLITUDE — A measure of the magnitude of a signal.

ANSI — American National Standards Institute. A national organization that determines standards for testing equipment. A section number and date (year) following the initials "ANSI," designate the standard referred to.

ARTIFACT — A false reading.

ASP — Automatic Signal Processing. A feature on a hearing aid intended to overcome the effects of background noise, making it easier to understand speech when noise is present. The term ASP is not standardized, and may refer to various forms of signal processing. Usually, however, ASP refers to a reduction in low-frequency gain in the presence of ongoing background noise.

AVG — Short for Averaging. An option on the 6500-CX that uses three puretones and averages them for the screen display.

BATTERY SUBSTITUTION PILL — A battery simulator that conforms to the size and shape of a battery used in a hearing aid. It connects to the Battery Voltage Supply, providing the proper voltage to the hearing aid.

BERGER — A prescription formula developed by Kenneth W. Berger (see Appendix A).

BIAS FREQUENCY — The background frequency, acting as noise, when using the Digital-Speech-in-Noise test.

BIAS AMPL	The amplitude of the background frequency used in the Digital-Speech–in-Noise test.
BICROS	A CROS aid that has two microphones, one at each ear, sending both signals to one ear.
BLOOMING EFFECT	A characteristic of puretone testing at high levels, that typically shows low frequencies being amplified more than they are under normal use conditions.
BUFFER	A memory location in a computer system. In the 6500-CX, it stores a curve for later use.
CALIBRATOR	A sound generator that produces a tone at a precisely controlled frequency and amplitude.
CHAP	Computer Hearing Aid Program. A program designed to interface with Fonix instruments in order to make the storage of information in computer files quick and easy. The current version is known as WinCHAP.
CIC COUPLER	Completely-in-the-Canal Coupler. A coupler designed to better handle the unique acoustic qualities of completely-in-the-canal aids. Included with the CIC Coupler is internal software which provides corrections to increase the accuracy of CIC measurements even further.
CONCHA RESONANCE	The major part of the acoustic effect of the pinna, contributing significant energy to the External Ear Effect in the region of 5000 Hz.
COIL	Abbreviation for telephone pickup coil.
COMPOSITE	The patented FONIX test signal consisting of 80 puretones presented simultaneously.
CONVERSION FORMULA	A hearing aid prescription formula, used to convert an audiogram to a target curve. Common formulas are the NAL, Berger, POGO, and the 1/2, 1/3, or 2/3 Gain rules (see Appendix A).
CORFIG	Coupler Response for Flat Insertion Gain (or “correction figure”). This is the transformation that, when added to a target insertion-gain response, will give the target coupler response. The inverse of “CORFIG” is “GIFROC.”
COUPLER	A device that connects a test microphone to a hearing aid to provide an accurate testing situation.
CROS	Contralateral Routing of Signal. A type of hearing aid that uses a wired or wireless system to send a signal to the opposite ear.
CRT	Cathode Ray Tube. The device in a computer system that projects information onto a display screen.

CURSOR	A marker on a computer screen. On the 6500-CX, it is either a solid vertical line on graphs, that marks a selected frequency, or it is a high-lighter bar that marks a choice on a menu.
CURVE	A visual diagram of a measurement using two variables. In testing hearing aids, one variable may be frequency, shown on the horizontal axis of the curve, and the other variable amplitude, shown on the vertical axis of the curve.
DATA	In FONIX analyzers, the word "data" refers to displaying curve information as a table of numbers.
DEFAULT	A choice automatically made by a computer program.
DIN CONNECTOR	A European-standard connector with pins surrounded by a round metal shell.
DISTORTION	Elements of a reproduced sound that deviate from the original.
DSIN	Digital speech-in noise. The source signal used for testing digital aids. The ANSI and ICRA speech weightings are available.
DUAL SCALING	In the Multi-Curve Option, a display of two selected curves with different scales (numbering) on the left and right sides of the graph. One of the curves refers to the scale on the left, and the other curve refers to the scale on the right.
EAR CANAL RESONANCE	An acoustic property of the earcanal, often characterized by a peak at or near 3000 Hz. Along with the acoustic properties of the head, torso, and pinna, the Earcanal Resonance contributes significantly to the External Ear Effect.
EIN	Equivalent Input Noise. The amplitude of internal noise created by a hearing aid.
ERROR	The latitude of inaccuracy in a testing system. It usually is expressed in +/- units and/or percent.
EXTERNAL EAR EFFECT	See Unaided Response.
FAST FOURIER ANALYSIS	A computer "short-cut" of the FOURIER TRANSFORM method for determining the frequency content of a signal.
FLAT WEIGHTED	Same as UNWEIGHTED, refering to a signal that has equal amplitude at every frequency.
FOURIER TRANSFORM	A mathematical procedure that changes "time" information into "frequency" information.
FREQUENCY	The number of vibrations, or cycles, per second, of a periodic wave. The unit of measurement is Hertz (Hz).

FREQUENCY RESPONSE A measure of the output or gain of a device across a range of frequencies of the input signal.

FUNDAMENTAL FREQUENCY The lowest frequency in a harmonic complex tone, such as the FONIX Composite signal. The fundamental frequency determines the "pitch" of a tone.

FUN-TAK A brand name for a modeling clay-like substance used to attach and seal hearing aids to couplers.

GAIN The amplification or increase in sound power in a hearing aid. In testing, it results from subtracting the level of the input from the level of the output of the aid.

GIFROC The inverse of "CORFIG." GIFROC is the transformation that, when added to a coupler response, will give the estimated insertion-gain response.

GRAPH A grid of lines, with the vertical lines representing one set of information and the horizontal lines representing another. A "Curve" superimposed on a graph grid, gives information about test results.

HAIC Hearing Aid Industry Conference.

HARMONICS Integral multiples of a puretone. The tone itself is the 1st harmonic, or fundamental frequency; twice the frequency of the tone is the 2nd harmonic; three times the frequency of the tone is the 3rd harmonic; etc.

HARMONIC DISTORTION The presence of harmonics in a reproduced signal that are not present in the original signal.

HFA High frequency average: according ANSI S3.22-1987, the averaged response at 1000, 1600, and 2500 Hz.

HEAD BAFFLE EFFECT Refers to the comparative augmentation of high-frequency sound caused by the acoustic diffraction of low-frequency sound by the head and pinna blending to produce a baffle.

HL Hearing Level. The amount of decibels above audiometric zero at which a measured ear barely hears a sound.

Hz Hertz. Unit of frequency, refering to cycles per second.

ICRA International Colloquium of Rehabilitative Audiology.

IEC International Electrotechnical Commission. An international organization that sets standards for measurements.

INSERT EARPHONE Earphone whose transducer is joined to the ear by means of a tube attached to a foam eartip that is placed into the outer ear canal; used in finding Real Ear to Coupler Difference (RECD) measurements.

INSERTION GAIN RESPONSE	A measure of the acoustic benefit of a hearing aid, measured in a patient's ear. The insertion gain is the difference, at any particular frequency, between the Aided Response and the Unaided Response. When considered across a range of frequencies, the measure is called the "Insertion-gain Response." When measured in a real ear (as opposed to a manikin), the insertion-gain response is called the "Real Ear Insertion-gain Response" (or "REIR).
IN-SITU	Latin for "in position." In audiometry, it designates measurements taken with the hearing aid "in place" in the ear.
INTER-MODULATION DISTORTION	Distortion generated by the faulty mixture of different input frequencies. This is a primary cause of harshness and lack of intelligibility in a hearing aid.
INVALID	In the Multi-Curve Option, this word appears when there is no curve stored in a selected memory location.
JIS	Japanese Industrial Standard. The organization which sets standards for measurements in Japan.
KEMAR	Knowles Electronics Manikin for Acoustic Research. Model, which nearly reproduces the acoustic qualities of an average adult head and torso, that is utilized in the assessment of hearing aid performance.
LED	Light Emitting Diode. A small pilot light on an instrument panel.
LEVELING	An automatic calibration procedure, establishing a "zero line" for measurements, taking into account all the acoustic properties of the test chamber or the testing room.
MENU	A list of choices offered by a computer.
MULTI-CROS	A hearing aid system that has a switch to select either a CROS, a BI-CROS, or a Monaural arrangement.
MULTI-CURVE	An option for the 6500-CX that allows for storing and comparing curves from several tests.
MULTI-CURVE STACK	A collection of curves stored by the Multi-Curve Option of the 6500-CX.
MZ COUPLERS	Modified Zwislocki Couplers. Three couplers based on the Zwislocki design, but sturdier; provided with In-Situ and OES options.
NAL	National Acoustic Laboratories of Australia (see Appendix A).
NBS	National Bureau of Standards (U.S.), now known as National Institute of Standards and Technology.

NOISE REDUCTION The 6500-CX's way of producing a more stable stable reading by averaging many samples.

OCCLUDED RESPONSE A frequency response measured inside the earcanal with the hearing aid earpiece in place, but with the hearing aid turned off. This is a measure of how much unamplified sound leaks into the ear through the earpiece (such as with an open fitting). When measured in a real ear (as opposed to a manikin), it is called the "Real Ear Occluded Response" (or "REOR").

OCCLUSION EFFECT Low-frequency intensification in the loudness level of bone-conducted signals resulting from the blocking of the ear canal.

OES Occluded Ear Simulator. An option on the 6500-CX, using three special couplers, that provides the same data obtained with a standard ear simulator. The OES hardware and software are also used with the In-Situ Option.

OPERATION PARAMETERS A collection of settings within a computer program. In the FONIX QUIK-PROBE Option, these are various ways one can set up the tests.

POGO Prescription Of Gain and Output. A hearing aid prescription formula (see Appendix A).

POWER In the 6500-CX, the label "POWER" refers to the output of an aid, in dB SPL.

PROBE MICROPHONE A miniature microphone with a thin, flexible tube that is inserted into an earcanal to measure sound.

PT BURST A burst of ten pure tones corresponding to standard audometric frequencies. The entire signal lasts for less than two seconds.

PURETONE A testing tone consisting of only one frequency. Same as SINE TONE.

REAL EAR MEASUREMENT A special test procedure using a probe microphone and a special instrument capable of measuring sound levels inside an earcanal.

REAL-TIME TESTING The ability to view instantly the results of hearing aid tests.

RECD Real Ear to Coupler Difference. Measurement of the difference in decibels between the output of a hearing aid found with a probe microphone in the ear canal and the output of the aid found in a 2 cc coupler.

REFERENCE CURVE Generally, a curve that can be used to compare a test with a curve from another test. In the 6500-CX, a stored curve to be used for comparison.

REFERENCE MICROPHONE	With the QUIK-PROBE Option, the microphone, placed above the ear, which provides a reference measurement that is compared to that of the probe microphone placed in the earcanal.
REFERENCE POINT	The location in a test chamber where the microphone of a hearing aid must be placed for accurate testing. In the 6500-CX, it is the small circle in the center of the test chamber.
REAR	Real Ear Aided Response. See "Aided Response."
REDD	Real-Ear to Dial Difference. This is the difference of the output of an audiometer, in dB HL, and the measured dB SPL value measured with a probe microphone in the ear.
REIR	Real Ear Insertion-gain Response. See "Insertion Gain."
RESONANCE	The tendency of an acoustic system to reinforce sounds of a certain frequency, the frequency determined by the shapes and sizes of the components of the system.
REOR	Real Ear Occluded Response. See "Occluded Response."
RESPONSE LIMIT	The high and low points of the frequency range found in the ANSI test sequence conditions.
RESR	Real Ear Saturation Response. A special case of the REAR for which the hearing aid is operated at its saturation level. This is akin to the coupler measurement known as the "SSPL-90."
REUR	Real Ear Unaided Response. See "Unaided Response."
RMS	Root Mean Square. An overall measurement of the signal going in or coming out of a hearing aid. When measuring with Puretones, the RMS level at each individual frequency will be the same as the level shown at each frequency on a response curve. When measuring with a Composite Tone, the (overall) RMS level will be several dB higher than the level at each frequency on a response curve, since all the frequencies are presented at once.
SATURATION	The condition where any further increase in input level will yield no further increase in output level.
SINE TONE	A testing tone consisting of only one frequency. Same as Puretone.
SMOOTHING	A "rounding-off" of a curve, removing minor peaks and valleys, to create a more readable curve, using a method that is equivalent to warbling the input signal.
SOFTWARE	The programming part of a computer system.

SPA	Special purpose average: according to ANSI S3.22-1987, the averaged response at specially designated frequencies (see Section 6.4.4).
SPL	Sound Pressure Level. Expressed in decibels (dB), a logarithmic measure of the energy (amplitude) of a particular sound as compared to the energy of a specified reference sound.
SSPL (OSPL)	Saturation Sound Pressure Level. The greatest SPL that a given amplifier can produce.
SSPL-90 (OSPL-90)	Saturated Sound Pressure Level for an input of 90 dB SPL.
SWEEP	A sequence of puretone frequencies, which generates a frequency response curve.
TARGET	A curve, based on an audiogram and a prescription strategy, presenting the theoretically optimum response that a hearing aid should have for a particular hearing loss.
TELECOIL	Same as COIL. In the 6500-CX, it is an accessory and option that generates a magnetic field for testing the telephone pickup of a hearing aid. The telecoil is a standard feature with the 6020 sound chamber.
UNAIDED RESPONSE	A frequency response measured inside the earcanal without a hearing aid in place. Also known as "External Ear Effect," the Unaided Response consists of the combined acoustic affects of the head, torso, pinna, and earcanal. When measured in a real ear (as opposed to a manikin), it is called the "Real Ear Unaided Response" (or "REUR").
UNWEIGHTED GAIN	A measurement of the amplification (gain) of an aid using an input signal (source) that has equal power across all test frequencies.
WARBLE TONE	A puretone with slight, but rapid, frequency variations.
WEIGHTED GAIN	A measure of the amplification (gain) of an aid, using an input signal (source) that has a spectral shape similar to that of the long term average of speech.
WEIGHTED POWER	The measurement of amplitude, in SPL, of the output of an aid, using an input signal (source) that has a spectral shape similar to that of the long term average of speech.
WHITE NOISE	A signal composed of all frequencies, which vary randomly in phase, each frequency having equal long-term energy levels.
WinCHAP	Windows® Computer Hearing Aid Program used for storing hearing aid tests and client information on a personal computer.

Appendix F: The FONIX CIC Option

Background

Zwislocki built an ear simulator coupler years ago to better approximate the real ear's impedance variation with frequency. The ear's volume appears to get larger at lower frequencies. Mahlon Burkhard at Industrial Research Products agreed with this approach, especially when they built the KEMAR, and designed an ear simulator that had impedance changes that matched the Zwislocki figures. This ear simulator was later standardized by the publication of American National Standards Association standard, S3.25. Another ear simulator that has similar characteristics was introduced in Europe a few years later by Bruel and Kjaer, and is characterized in the standard IEC 711.

Frye Electronics introduced a slightly different approach in the 1980's when it came out with the INSITU option (and later, the OES option) for its 5500-Z hearing aid Analyzer. Realizing that ear simulators which contain frequency sensitive elements are somewhat fragile and can be damaged as they are handled in every day use, Frye made a coupler which it labeled the MZ (for Modified Zwislocki). This coupler had a central volume very similar to the standardized Zwislocki, but had no frequency sensitive elements. Instead, an analyzer program was used with the coupler to apply correction factors to the measured curves from the hearing aid so that the output was very similar to that which would be obtained if the aid were tested on a standardized ear simulator as built by Knowles or B&K.

These software corrections work well for most regions in the frequency response of the aid. In low frequency areas up to about 1500 Hz, if the aid has a response peak that is influenced by the volume of the cavity, the peak will be slightly higher in amplitude and slightly higher in frequency than that peak would be if the aid were measured in a standardized ear simulator. The CIC hearing aid is not usually affected by this problem.

The Need for a CIC Coupler

The introduction of the CIC hearing aids has made it desirable to be able to test them with a coupler that more closely approximates the actual volume and frequency response characteristics of the real ear. The CIC aid fits so close to the tympanic membrane (TM) of the ear that the volume of the cavity is reduced greatly and the aid produces a significant amount more gain. Further, its response can be expected to be substantially influenced by the frequency dependent impedance variations of the TM.

Frye Electronics felt that the use of a CIC coupler with a proper response correction would give better data to a hearing professional than the use of the standard 2 cc coupler or even a Zwislocki ear simulator when attempting to produce a good hearing aid fitting. It also felt that the approach taken in the use of the MZ coupler has been well accepted by professionals throughout the world and that the new CIC coupler should use a similar approach, with response corrections modified to take the smaller CIC volume into account.

The Basic Problem

The ear is not a simple structure. It is a biological coupling device that converts sound energy to nerve impulses. It also has a pinna that helps to direct higher frequency sounds into the external canal. The part of the structure we are concerned with is the external ear canal or cavity which is terminated by the TM. The ear canal can be considered to be fairly rigid when it is compared to the TM. In the lower frequencies below 2000 to 3000 Hz, the frequency related changes in impedance that we see in an ear can be thought to be mostly caused by the TM.

When we reduce the volume of the cavity between the hearing aid and the TM by moving the aid closer to it, we should expect to see the TM play a more important part in determining the response of the aid.

For more shallow standard earmolds, the volume of the central cavity of the ear reduces the effect of the TM's frequency impedance changes. This is because the volume of the cavity is added to the equivalent volume of the TM. If the cavity volume is large and does not change with frequency, then the large changes in impedance of the TM are swamped by the large volume of the ear canal. If, on the other hand, the TM is working into a very small volume, then it would affect a large change in impedance across the frequency range.

CIC Hearing Aid—Gain and Frequency Response Changes

From the above discussion we see that we can expect that the frequency response of the CIC hearing aid will be greatly influenced by the frequency dependent impedance changes of the TM. What is the magnitude of these changes? A fairly typical ear fitted with a standard hearing aid and earmold should have characteristics that would normally be predicted by a KEMAR manikin and standardized ear simulator. When that ear is fitted with a CIC aid, what is the volume between the hearing aid and the TM? Because of the tilt of the TM, most professionals probably don't fit the aid right next to the TM. A reasonable figure may be 0.25 cubic centimeters. It should be realized that this number could be higher or lower, depending on circumstances. 0.2 to 0.4 cc may be a reasonable range.

Now, how much response variation will be introduced because of the smaller volume of 0.25 cc? This variation is that which is used in the frequency response correction table used with the CIC coupler. One assumption that we make in calculations of volumes is that the simulator is small as compared to the wavelength of sound at the frequency we are examining. In the case of the standard ear simulator, the length of the cavity begins to affect its response to sound at frequencies above about 3000 Hz.

Knowing the physical volume of the occluded ear canal and its frequency response variations, it is possible to calculate the equivalent volume of the TM itself at each frequency and to apply this figure to the response of the 0.25 cc cavity between the hearing aid and the TM.

When the calculated volume variation of the TM is applied to the smaller volume of the CIC coupler, the total response variation comes out to be from -8.6 dB at 200 Hz to +5.5 dB at 8000 Hz for a total variation of 14.1dB.

Summary

Using the CIC coupler with its software option gives the dispenser an immediate idea of how much gain that this new type of hearing instrument is going to give the hearing impaired individual. It is nice to see that the CIC hearing aid can really produce significant amounts of gain in spite of its apparently poor performance in the 2cc world of the ANSI standard test.

The user must remember that an actual ear may produce differences from the predicted values.

Acknowledgment

Mead Killion, Mahlon Burkhard and Elmer Carlson are to be thanked for helping assemble the data from which the CIC corrections were derived.

CIC CORRECTION FACTORS

dB	Hz	dB	Hz	dB	Hz	dB	Hz
-8.7	200	-0.95	2200	3.2	4200	4.54	6200
-8.6	300	-0.5	2300	3.3	4300	4.55	6300
-8.7	400	-0.2	2400	3.5	4400	4.6	6400
-8.75	500	0	2500	3.6	4500	4.65	6500
-9	600	0.3	2600	3.7	4600	4.7	6600
-8.9	700	0.5	2700	3.8	4700	4.75	6700
-8.8	800	0.7	2800	3.85	4800	4.8	6800
-8.2	900	1	2900	3.95	4900	4.85	6900
-6.55	1000	1.2	3000	4	5000	4.9	7000
-6	1100	1.4	3100	4.07	5100	4.95	7100
-5.4	1200	1.65	3200	4.12	5200	5	7200
-4.95	1300	1.9	3300	4.18	5300	5.05	7300
-4.2	1400	2.1	3400	4.2	5400	5.1	7400
-3.6	1500	2.2	3500	4.25	5500	5.15	7500
-3.3	1600	2.4	3600	4.3	5600	5.2	7600
-2.8	1700	2.5	3700	4.35	5700	5.25	7700
-2.3	1800	2.7	3800	4.4	5800	5.3	7800
-2	1900	2.85	3900	4.45	5900	5.4	7900
-1.7	2000	2.91	4000	4.5	6000	5.5	8000
-1.2	2100	3	4100	4.52	6100		

Appendix G: Troubleshooting Guide

These are the most common problems that typically cause instrument failure. Please check these troubleshooting suggestions and follow the procedures outlined in this manual before contacting your local service representative or Frye Electronics.

GENERAL PROBLEMS:

1. No power

a. Check ON switch(s).
b. Make sure the the power cable is plugged into a working wall outlet.
c. Check the fuse in the power entry module.

2. CRT/VGA/LCD display monitor is not working

a. Check the ON switch. (CRT/VGA monitors only)
b. Make sure the power cable is plugged into working wall outlet.
c. Check the monitor brightness and contrast controls.
d. Check the cable between the monitor and instrument.
e. Check the Screen Saver—push any front panel button to activate the screen.
f. If the video monitor is flashing, there may be a stuck test button.

3. 6500-CX "beeps" when the power first turned on

a. You may be out of printing paper.
b. The print lever may be in the up position.
c. Your paper may be threaded wrong.

TEST CHAMBER PROBLEMS:

1. Test Chamber Microphone does not Level

a. Check your mic calibration. (See Operator's Manual)
b. Is the mic properly plugged into the instrument?
c. Are all connections clean and tight?
d. Is the mic head (element) screwed on tightly?
e. Is the mic cable loose, broken, cut, worn or frayed?
f. Make sure everything is out of the test chamber (except the mic) when trying to Level. (See Operator's Manual)
g. Open the test chamber and listen for the leveling signal.
h. Check the test chamber cable connections.
i. Is there an unusal amount of background noise in the test area? (air conditioning/heating fans, street noise, people talking, computer fans, etc.)

COUPLER PROBLEMS:

1. HA-2 Coupler (BTE) adapter tubing is missing, loose or cracked

Replace with #13 thickwall tubing. Length: 0.6" (15mm).

2. Test microphone is difficult to get into coupler or the ear level adapter does not easily seal to the other end of the coupler

Lubricate the black "O" ring with light petroleum type lubricant.

3. A bump or peak in the low frequency response curve

a. There may be a hearing aid vent leak. Be sure to Fun-Tak the vent.
b. There may be a coupler vent leak.
c. The #13 coupler tubing could be cracked or broken.

PROBE PROBLEMS:

1. Probe Reference Mic does not Level.

a. Check the reference mic calibration. (See Operator's Manual)
b. Be sure the reference mic is properly plugged into the instrument.
c. Are all connections clean and tight?
d. Are the mic cables loose, broken, cut, worn or frayed?
e. Is the Leveling signal coming out of the speaker? If not, check cable and connections.
f. Make sure the distance from the speaker to the ref. mic during leveling is about 12" (max. 18").

2. Cleaning probe tubes

DO NOT REUSE probe tubes. There is NO recommended cleaning procedure. Germicidal solutions can leave a residue inside the tubing which can cause test result errors. DO NOT cut off any portion of the tube.

PRINTER PROBLEMS:

1. Printer does not work

a. Check for a paper jam.
b. Press the FEED Button.
c. Make sure the print head lock-down lever is released.

2. Test results do not print on paper

Make sure you are using thermal paper. To check it, take a hard object, e.g. a car key, and scratch the surface of the paper on both sides. If a black mark appears it's thermal paper. If not, it's plain paper and will not work.

Appendix H: Probe SPL Mode Description

The Target IG is converted to the Target SPL in the following steps:
(Conversion tables appear on the following pages.)

1. Add the source level for Aided curve 2.
2. Interpolate from 10 frequency to 80 frequency curve frame.
3. Add the AVG Unaided ear response REUR in Table 1.
4. If Aided 2 is composite, subtract 10.7 dB from each frequency. If Aided 2 is Speech Weighted tone, add 2.1 dB to each frequency.
5. If Aided 2 is Speech Weighted, subtract the Speech Weighting in Table 2.

The complete formula is then:

Target SPL = Target IG + CRV2 source + AVG REUR
(If Aided2 is composite) - 10.7 dB - Speech Weighting.
(If Aided2 is speech tone) + 2.1 dB - Speech Weighting.

- To convert the HTL and UCL from HL to SPL:
  Add the corrections in Table 3.
- To predict UCL's (HL) given the HTL (HL):
  Use Table 4 to convert from HTL to UCL.

TABLE 1
Average Real-Ear Unaided Response (REUR)

FREQ (Hz)	GAIN dB	FREQ (Hz)	GAIN dB	FREQ (Hz)	GAIN dB	FREQ (Hz)	GAIN dB
		2100	13.9	4100	12.7	6100	7.7
200	1.6	2200	14.7	4200	12.4	6200	7.5
300	2.1	2300	15.1	4300	12.2	6300	7.3
400	2.7	2400	15.0	4400	12.0	6400	7.2
500	2.9	2500	15.1	4500	11.9	6500	7.1
600	2.9	2600	15.0	4600	11.7	6600	6.9
700	3.1	2700	14.6	4700	11.6	6700	6.8
800	3.3	2800	14.1	4800	11.2	6800	6.6
900	3.6	2900	13.6	4900	10.7	6900	6.5
1000	3.4	3000	13.7	5000	10.3	7000	6.4
1100	3.1	3100	13.8	5100	9.9	7100	6.2
1200	3.6	3200	14.1	5200	9.5	7200	6.1
1300	4.2	3300	14.5	5300	9.2	7300	6.0
1400	4.4	3400	14.8	5400	8.9	7400	5.7
1500	5.6	3500	14.9	5500	8.7	7500	5.4
1600	7.0	3600	14.7	5600	8.5	7600	5.1
1700	8.1	3700	14.3	5700	8.3	7700	4.8
1800	9.3	3800	13.9	5800	8.2	7800	4.6
1900	10.9	3900	13.5	5900	8.0	7900	4.4
2000	12.6	4000	13.1	6000	7.8	8000	4.2

TABLE 2
Speech Weighting

FREQ (Hz)	dB	FREQ (Hz)	dB	FREQ (Hz)	dB	FREQ (Hz)	dB
		2100	8.1	4100	13.4	6100	16.7
200	0.2	2200	8.4	4200	13.6	6200	16.9
300	0.5	2300	8.8	4300	13.8	6300	17.0
400	0.8	2400	9.1	4400	14.0	6400	17.1
500	1.2	2500	9.4	4500	14.1	6500	17.3
600	1.6	2600	9.7	4600	14.3	6600	17.4
700	2.1	2700	10.0	4700	14.5	6700	17.5
800	2.5	2800	10.3	4800	14.7	6800	17.6
900	3.0	2900	10.6	4900	14.9	6900	17.8
1000	3.5	3000	10.8	5000	15.0	7000	17.9
1100	4.0	3100	11.1	5100	15.2	7100	18.0
1200	4.4	3200	11.3	5200	15.4	7200	18.1
1300	4.9	3300	11.6	5300	15.5	7300	18.2
1400	5.3	3400	11.8	5400	15.7	7400	18.4
1500	5.8	3500	12.1	5500	15.8	7500	18.5
1600	6.2	3600	12.3	5600	16.0	7600	18.6
1700	6.6	3700	12.5	5700	16.1	7700	18.7
1800	7.0	3800	12.7	5800	16.3	7800	18.8
1900	7.4	3900	13.0	5900	16.4	7900	18.9
2000	7.7	4000	13.2	6000	16.6	8000	19.0

TABLE 3
HL to SPL (or SPL to HL) conversion table
from ANSI S3.6-1989 Table G.1

FREQ (Hz)	dB
250	19.0
500	12.0
750	10.5
1000	9.0
1500	12.0
2000	15.0
3000	15.5
4000	13.0
6000	13.0
8000	14.0

TABLE 4
HTL(HL) to UCL(HL)
prediction table from Pascoe(1988) Table 4

HTL dBHL	UCL HL	HTL dBHL	UCL HL
0	97	65	114
5	99	70	115
10	99	75	117
15	98	80	120
20	97	85	120
25	101	90	124
30	102	95	130
35	101	100	127
40	103	105	133
45	105	110	134
50	107	115	137
55	108	120	140
60	110		

Appendix I: Quick Reference Pages

TARGET 2 CC F.O.G.

NOTE: Use the remote module for these procedures.

GENERAL PROCEDURE — using all AVERAGE EAR data:

1. In probe menu, highlight CREATE TARGET and select 2CC FOG.
2. Press [START], then enter audiogram.
3. Press [SWEEP/START] to select an insertion-gain formula.
4. Press [START/STOP] to continue
5. Set menu, if necessary (AVERAGE UNAIDED and AIDED).
6. Modify target curve, if desired.
7. Print; exit. (Result gets stored in REF 8).

CUSTOMizing for the UNAIDED EAR resonance:

1. Measure real-ear unaided response (REUR).
2. Do general procedure, but set UNAIDED EAR to CUSTOM in menu.

CUSTOMizing for the AIDED EAR (RECD) impedance:

1. Measure 2-cc-coupler response of insert earphone or BTE aid.
2. Copy 2-cc-coupler response to REF 6.
3. Measure aided response (REAR) of same earphone or aid.
4. Do general procedure, but set AIDED EAR-2cc to CUSTOM in menu.

CUSTOMizing for both UNAIDED EAR and AIDED EAR (RECD) values:

1. Measure 2-cc-coupler response of insert earphone or BTE aid.
2. Copy 2-cc-coupler response to REF 6.
3. Measure unaided response (REUR).
4. Measure aided response (REAR) of earphone or aid.
5. Do general procedure, but set both UNAIDED and AIDED EAR-2cc to CUSTOM in menu.

TARGET 2 CC SSPL 90

NOTE: Use the remote module for this procedure.

1. In the probe menu highlight CREATE TARGET and select 2 cc SSPL90. Press [START/STOP].
2. Use [∧ ∨, < >] buttons to enter comfort/discomfort levels in dB HL.
3. (Optional) Press [MENU] to change the settings.
4. Press [PRINT] to print.
5. Press [START/STOP] to exit.

Result is stored in REF 7 of Multi-Curve.

QUIK-PROBE (AUTOMATIC) INSERTION GAIN (IG) TEST

1. Enter probe menu by pressing [PROBE] (or [START/STOP] on remote) and then pressing [MENU].

   NOTE: From here on use only the remote module to enter and test.

2. Use [∧ ∨] buttons to highlight MODE. Select COMP/AUTO
3. Use [∧ ∨, < >] buttons to highlight CREATE TARGET and select INS. GAIN. Then press [START/STOP].
4. Use [∧ ∨, < >] buttons to enter HTL audiogram info.
5. If desired, press [MENU] to change settings.
6. Press [START/STOP] to continue.
7. Mark probe tube (5 mm/1/4")
8. Place wedge ear hook on subject.
9. Place Ref. Mic on Velcro platform above ear, and probe tube in ear.
10. Position subject 12" from speaker at 45º angle.
11. Press [LEVEL].
12. Press [START/STOP] to run Unaided (REUR).
13. Hold probe tube in place, put hearing aid in ear, set to user gain level.
14. Press [START/STOP] to run Aided (REAR).
15. Insertion Gain (REIR) & Target appear on upper graph.
16. Press [PRINT] to print.

QUIK-PROBE (AUTOMATIC) SPL TARGET TEST

1. Enter probe menu by pressing [PROBE] or [START/STOP] on remote) and then pressing [MENU].

   NOTE: From here on use only the remote module to enter and test.

2. Use [∧ ∨, < >] buttons to highlight CREATE TARGET and select SPL TARGET. Then press [START/STOP].
3. Press [MENU] to select and change settings.
4. Use [∧ ∨, < >] buttons to enter HTL audiogram info.
5. If desired, press [SWEEP START] to enter UCL levels.
6. Press [START/STOP] to continue.
7. Mark probe tube (5 mm/1/4")
8. Place wedge ear hook on subject.
9. Place reference mic on Velcro platform above ear, and probe tube in ear.
10. Position subject 12" from speaker at 45º angle.
11. Press [LEVEL].
12. Hold probe tube in place, put hearing aid in ear, set to user gain + output levels.
13. Press [UNAIDED] until AUTO appears at the bottom of the screen.
14. Press [START/STOP] to run CRV 1 (50 dB COMP), then CRV 2 (65 dB COMP) and finally CRV 3 (90 dB BURST)
15. The graph will display T (threshold), U (UCL), MCL Target (thick line), and CRV 1, 2, and 3.
16. Press [PRINT] to print.

AGC/ADAPTIVE AGC ANSI S3.22-1987 TEST

1. LEVEL (only if UNLEVELED).
2. Attach hearing aid & coupler to microphone, set full on gain, place in test box.
3. Press [MENU], then [ANSI]. Select ANSI S3.22-1987
4. Press [MENU]. Use [∧ ∨, < >] buttons to select:
   - AID TYPE: AGC with EIN
AGC without EIN
ADAPTIVE AGC with EIN
ADAPTIVE AGC without EIN
   - FULL ON GAIN: 50 dB will be selected automatically
   - TELECOIL: DISABLED or ENABLED
   - AVERAGE FREQUENCIES: HFA 1000, 1600, 2500 or SPA (specified by manufacturer)
   - SWEEP DELAY: 50 mS (default)
5. Press [START] to run test.
6. Press [CRT] to print.

LINEAR ANSI S3.22–1987 TEST

1. LEVEL (only if UNLEVELED)
2. Attach hearing aid & coupler to microphone, set full on gain, place in test box.
3. Press [MENU], then [ANSI]. Select ANSI S3.22-1987
4. Press [MENU]. Use [∧ ∨, < >] buttons to select:
   - AID TYPE: LINEAR
   - FULL ON GAIN: 60 dB (or 50 dB for high gain aids).
   - TELECOIL: DISABLED or ENABLED
   - AVERAGE FREQUENCIES: HFA 1000, 1600, 2500 or SPA (specified by manufacturer).
   - SWEEP DELAY: 50 mS (default)
5. Press [START] to run test.
6. The test may stop to turn down VC for Reference Test Gain. Follow instructions on screen.
7. Press [CRT] to print.
8. Press [CONTINUE] to return to ANSI Test Menu choice and [CONTINUE] again to exit.

MULTI-CURVE—PURE TONE

(Software version 2.50 and up)

Procedure: Using Multi-Curve to test four different hearing aids. All these test examples can be run as either SPL or Gain.

1. Press [SINE/COMPOSITE] to enter SINE/Pure Tone mode.
2. Select SPL or Gain, then select source input level.
3. Test hearing aid "A" in the test box.
4. Test hearing aid "B" in the test box.
5. Test hearing aid "C" in the test box.
6. Test hearing aid "D" in the test box.
7. Press [MULTI] button to enter the option.
8. Use arrow buttons [∧ ∨] to select (highlight) "Multiple Curves."
9. Press the [START] button to display CURVES 1, 2, 3 and 4.

IMPORTANT: Because the curves are STACKED one on top of another in Multi-Curve, they are now in reverse order of how you tested them.

Example:

	STACK		
4th TEST	Hearing Aid "D"	=	CURVE 1
3rd TEST	Hearing Aid "C"	=	CURVE 2
2nd TEST	Hearing Aid "B"	=	CURVE 3
1st TEST	Hearing Aid "A"	=	CURVE 4

CLEARING OLD TEST CURVES: Re-test directly over old curves, or enter Multi-Curve Menu and select "Clear Curve" menu choice, or use [FREEZE] to "Deselect" a curve.

VARIATIONS:

1. Use one hearing aid and test at four (4) different volume control settings.
2. Use one hearing aid and test at four (4) different amplitude levels, i.e. 50dB, 60dB, 70dB and 80dB.

MULTI-CURVE—COMPOSITE

(Software Version 2.50 and up)

Procedure: Using Multi-Curve to test four different hearing aids.

The key to understanding COMPOSITE MULTI-CURVE is that the first test stored always goes into CURVE 2, and CURVE 1 is always in Real-Time.

1. Place hearing aid "A" in the test box at full-on gain, set 6500 Amplitude [∧ ∨] at 60 dB RMS, when the real time curve is stable, press [FREEZE] and then the [START] button to store this test into the Multi-Curve Stack.
2. To test hearing aids "B" and "C", repeat Step 1.
3. To test hearing aid "D", DO NOT PRESS [FREEZE] and [START] buttons; just place the coupled aid in the test box.
4. Press [MULTI] button.
5. Use arrow buttons [∧ ∨] to select (highlight) "Multiple Curves."
6. Press [START] to display Curves 1, 2, 3, and 4.

Note*: Curve 1 will be in Real-Time on the display—this is the test currently being run in the test box. When you press [CRT] to print it will freeze and print out.*

IMPORTANT: Because curves are STACKED one on top of the other in Multi-Curve, they are now in reverse order of how you tested them.

Example:

	STACK		
4th TEST	Hearing Aid "D"	=	CURVE 1
3rd TEST	Hearing Aid "C"	=	CURVE 2
2nd TEST	Hearing Aid "B"	=	CURVE 3
1st TEST	Hearing Aid "A"	=	CURVE 4

CLEARING OLD CURVES; 1) Re-test over the old curves; 2) Enter Multi-Curve Menu and select "Clear Curves"; 3) Use [FREEZE] to "Deselect a curve.

VARIATIONS:

1. Use one hearing aid and test at four (4) different volume control settings.
2. Use one hearing aid and test at four (4) different amplitude levels, i.e. 50dB, 60dB, 70dB and 80dB.

IEC TEST

1. LEVEL (only if UNLEVELED)
2. Attach the hearing aid and appropriate coupler to microphone.
3. Linear aids—set to full-on gain
   Compression aids—set to maximum output (usually minimum compression).
4. Place in test box.
5. Press [MENU], then [IEC].
   Use the [< >, ∧ ∨] buttons to select parameters:

   • AID TYPE: LINEAR, AGC, or ADAPTIVE AGC
   • FULL ON GAIN: 50 dB or 60 dB
   • REFERENCE TEST FREQUENCY: 2500 Hz or 1600 Hz
   • HARMONIC DISTORTION FREQUENCY: 400 Hz–1600 Hz (200-Hz increments)
   • SWEEP DELAY: .02–1.0 seconds
6. Press [START] to run the test.
7. When the test stops, turn down aid to match Reference Test Gain. Follow instructions on screen.
8. Press [CRT] to print.
9. Press [START] run another test, or press [CONTINUE] or [IEC] to exit.

LINEAR ANSI S3.22-1996 TEST

1. LEVEL (only if UNLEVELED).
2. Attach hearing aid and coupler to microphone, set full on gain, place in sound chamber.
3. Press [MENU] then [ANSI]. Select ANSI 3.22-1996.
4. Press [MENU]. Use [∧ ∨, < >] buttons to select:
   - AID TYPE: LINEAR
   - TELECOIL: ON or OFF
   - AVG FREQUENCIES: 1000, 1600, 2500, or SPA closest to manufacturer’s specs.
   - HDIST 12DB: ON or OFF
   - EAR: RIGHT, LEFT, or NONE to be designated on SPLITS curve.

     The next three selections are sub-menus. Press [START] to enter submenu and [CONTINUE] to exit sub-menu.
   - FOG MENU: 60db (50dB for high gain aids; print CURRENT screen, or ALL the screens.
   - AGC MENU: Not applicable for linear aid test.
   - DELAY MENU: default settings will work for most aids. See manual for details.
5. Press [START] to run test.
6. The test may stop for you to turn down volume on aid to match reference test gain. Press [CONTINUE] when completed.
7. After the test is completed, press [∧] and [∨] to view different screens for test. [CRT] prints screen.
8. Press [CONTINUE] to return to ANSI test menu choice and [CONTINUE] again to exit.

AGC/ADAPTIVE AGC ANSI S3.22-1996 TEST

1. LEVEL (only if UNLEVELED)
2. Attach hearing aid and coupler to microphone, set full on gain, place in sound chamber.
3. Press [MENU] then [ANSI]. Select ANSI 3.22-1996.
4. Press [MENU]. Use [∧ ∨, < >] buttons to select:
   - AID TYPE: AGC WITH EIN or ADAPTIVE AGC
   - TELECOIL: ON or OFF
   - AVG FREQUENCIES: 1000, 1600, 2500, or SPA closest to manufacturer's specs.
   - HDIST 12DB: ON on OFF
   - AR: RIGHT, LEFT, or NONE to be designated on SPLITS curve.

     The next three selections are sub-menus. Press [START] to enter submenu and [CONTINUE] to exit sub-menu.
   - FOG MENU: 50 dB only option for AGC aids; print CURRENT screen, or ALL the screens.
   - AGC MENU: Attack and release times will be measured for frequencies turned on. Choose appropriate ATTACK WINDOW and RELEASE WINDOW.
   - DELAY MENU: default settings will work for most aids. See manual for details.
5. Press [START] to run test.
6. The test may stop for you to turn down volume on aid to match reference test gain. Press [CONTINUE] when completed.
7. After the test is completed, press [∧] and [∨] to view different screens for test. [CRT] prints screen.
8. Press [CONTINUE] to return to ANSI test menu choice and [CONTINUE] again to exit.

TELEWAND—ANSI '96 TELECOIL

Determining a proper position, one with little magnetic noise, is vital to effective telecoil testing.

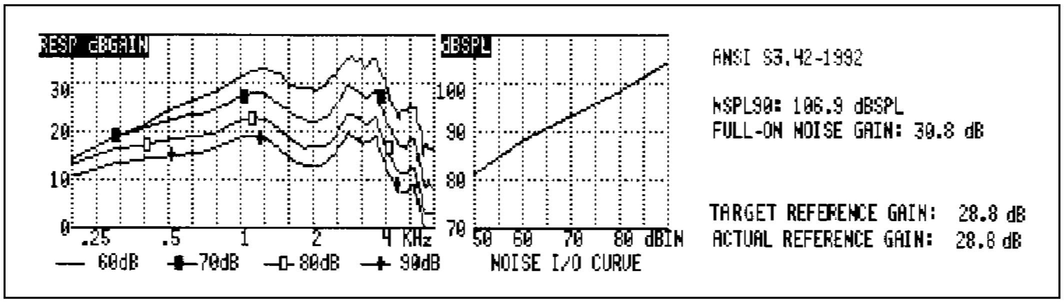
Test the area where the telecoil measurement is to be made for magnetic fields before beginning the ANSI '96 test sequence.

1. Connect the hearing aid to a 2-cc coupler and set the aid for "T" with the gain full on. Do not place the measurement microphone into the coupler. Rather, use the coupler as a megaphone so that you can hear its output.
2. Place the aid in the physical location where the test is to occur.
3. Listen to the output from the aid. Do you hear a buzz, indicating that the area has magnetic noise? Does the analyzer's CRT monitor cause the noise? This can be determined by shutting the monitor off for a brief period of time.
4. When the area has been tested and found to be free of undesirable levels of unwanted magnetic fields, then the aid can be tested for magnetic pickup sensitivity using the ANSI '96 sequence. If monitor noise is found to be unacceptable, then it may be necessary switch off the monitor during the telephone coil test.

If you have selected "TELECOIL: ON," do the following when the ANSI '96 sequence stops for the telecoil measurement.

1. Open the lid of the sound chamber.
2. Switch the aid to telecoil mode. Do not alter the gain control.
3. Position the aid where there is the least magnetic noise*. To guide you, a continuous reading of the output is on the screen.
4. Once you have determined the best position, plug the telewand into the side of the sound chamber, just below where the sound chamber connects to the Frye box.
5. Now relative to the aid, bring the telewand into position as if it were the earpiece on a phone. Keeping the telewand as parallel as possible to the faceplate of an ITE aid or as flat as possible against the body of a BTE aid, move it around until you find the position that returns the most gain. Again, use the continuous reading on the screen to guide you.
6. If it is necessary, turn the monitor off to reduce the magnetic noise.
7. Press [CONTINUE] to measure the SPLITS curve and STS. Turn the monitor back on when the signal stops.
8. Return the aid to the normal mode, and press [CONTINUE].

ANSI S3.42–1992
TESTING HEARING AIDS WITH A BROAD-BAND NOISE SIGNAL



DEFINITIONS (Tolerances are unavailable)

NSPL90: Maximum RMS output sound pressure level (SPL) produced with a 90dB RMS speech-weighted noise input SPL signal.

Full-On Noise Gain: Maximum gain with a 60dB SPL noise input signal. (Note: This test may not elicit a true reading of maximum gain for hearing aids with an onset of non-linear operation below 60dB.)

Actual Reference Gain: The measured amount of gain when the hearing aid is set to full on or the gain after the volume control has been adjusted to ±1 dB of the Target Reference Gain.

Target Reference Gain: This information is only displayed when the measured gain is greater than the calculated Actual Reference Gain. This target is used to adjust the hearing aid's actual gain to a level of ±1 dB of the target. The figure is calculated by adding the 60dB SPL input + 17dB and subtracting it from the NSPL90 RMS output. (NSPL90 – 77 = Target Reference Gain)

Family of Frequency Response Curves: These curves are developed by adjusting the noise input level in 10-dB steps over a selected range. The preferred levels are 50, 60, 70, 80, and 90dB SPL. Frye has added 40dB SPL to the preferred levels.

Noise I/O Curve: This demonstrates the compression or limiting of the non-linear circuit.

Test Specifications: Stated for information purposes only. Please refer to the operator's manual for a complete description of each test specification.

ANSI S3.22–1987
RECOMMENDED MEASUREMENTS, SPECIFICATIONS AND TOLERANCES

SSPL9O Curve:	Max. shall not exceed that spec. mfgr + 3dB
HFA-SSPL9O or SPA-SSPL9O:	Shall be within ±4 dB of mfgr. spec.
Full-on Gain:	50 or 60 dB inputs
HFA/FOG or SPA/FOG:	Within ±5 dB of mfgr. spec.
Reference Test Gain:	Shall be stated for info only
Frequency Response Curve:	60 db input
Frequency Range:	(f1 - f2): f1 ± 4 dB, f2 ± 6 dB
Harmonic Distortion:	(Total Harmonic Distortion), gain in ref. test postion, 70 dB at 500, 800, and 65dB at 1600 Hz or frequencies corresponding to 1/2 the freq. of each SPA frequency. Shall not exceed specs plus 3%. Note: If a rise of 12 dB or more occurs between the test freq. and its second harmonic, the test at that freq. may be omitted.
Equivalent Input Noise level:	1000, 1600, and 2500 Hz or the 3 SPA freq., shall not exceed spec plus 3%
Battery Current:	1000 Hz, 65 dB, Ref Test Pos., shall not exceed spec plus 20% *To calculate estimated battery life:* $\frac{\text{Capacity Rating (MAH)}}{\text{Current drain (MA)}} = \text{Hours}$
Induction Coil:	(Telecoil): l0mA/m at 1000 Hz, full-on, within ± 6 dB of spec
AGC Hearing Aids:	Input-Output Characteristics, not more than ± 5 dB. Attack & Release Times, shall be within ±5 ms or 50%, whichever is larger

ANSI S3.22-1996 SPECIFICATIONS AND TOLERANCES

OSPL90 Curve:	Max SPL shall not exceed the mfgr. spec. by +3 dB
HFA-OSPL90 or SPA-OSPL90:	Shall be within ± 4 dB of mfgr. spec.
Full-on Gain (FOG):	50 or 60 dB inputs
HFA-FOG or SPA-FOG:	within ± 5 dB of mfgr. spec.
Reference Test Gain:	information only
Freq. Response Curve:	50 dB input AGC, 60 dB input all others
Freq. Range:	low band ± 4 dB, high band ± 6 dB
Harmonic Ditortion:	Shall not exceed mfgr. specified percentage by +3%
Equivalent Input Noise:	Shall not exceed mfgr. spec. by + 3 dB.
Battery Current:	Shall not exceed mfgr. spec + 20%
HFA-SPLITS:	within ± 6 dB of mfgr. spec.
AGC Aids:	I/O—within ± 5 dB; Attack and Release— within ± 5 ms or ± 50 % whichever is larger

DIGITAL SPEECH IN NOISE—PROBE

1. Follow the instructions to do SPL testing, except once in the SPL screen, press [UNAIDED] until MANUAL appears at the bottom of the screen.
2. Next press [MENU].
3. Select DIGSP ICRA or ANSI as the test signal for AIDED CURVES 1 and 2. Leave AIDED CURVE 3 as PT BURST.
4. Select DIG SP MENU. Press [START/STOP].
5. Activate the bias tone and set its frequency and amplitude. It will be presented whenever a digital signal is used. The bias signal can only be turned on and off in this menu.
6. Press [MENU] twice to return to the main test screen.
7. Continue to follow the SPL testing instructions, but use the [v] button to select each curve as you want to run it.

DIGITAL SPEECH IN NOISE—SOUND CHAMBER

1. Level (only if unleveled)
2. Set up the hearing aid and coupler with the microphone. Place in the sound chamber.
3. Press [MENU] and then [*].
4. Select DIGITAL SPEECH IN NOISE. Press [START].
5. Press [MENU] to change the signal type (choices: ICRA or ANSI) and to activate the bias tone.
6. Use the [< >] buttons to adjust the bias tone frequency.
7. Press [START] to switch control of the [∧,v] buttons from the source amplitude to the bias tone amplitude.
8. Use the [∧,v] buttons to set the amplitude.

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