FONIX® FP35

Hearing Aid Analyzer

Operator's Manual

Ver. 5.01

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Contents

An Overview of the FP35

Welcome to the FONIX FP35 Analyzer! The FONIX FP35 provides quick, accurate information about how well a hearing aid works. It uses a graphical display or numerical table to show how much amplification the aid provides, which frequencies it amplifies, and how much distortion is creates.

The FP35 Hearing Aid Analyzer is a lightweight instrument notable for its ease of use. It has an intuitive interface to lead novice users through the process of hearing aid prescription and real-ear testing, but the interface is versatile enough for experts to use without feeling limited.

You can reach the menus from any screen. To make finding what you are looking for quick and easy, and to avoid confusion, the pop-up menu screens display only the choices relevant to the application currently in use. The FP35 also offers pop-up help windows that guide you through the possible steps available from the current screen.

The FP35 uses a backlit LCD with an adjustable contrast for its main display, and it has a thermal printer built in so that you can print hard copies of gathered data no matter where you are. The FP35 also has an external monitor option that allows the simultaneous display of the built-in LCD and an external monitor. Most computer monitors will work with this feature, although the FP35 display is only in two colors. There is also a parallel port on the back of all FP35 analyzers, allowing the use of an external printer.

The FP35 features three different pure-tone tests. The normal sweep covers a detailed range of frequencies; the fast sweep offers a continuous signal, updating as fast as once every three seconds; the short sweep is a quick test (under two seconds) covering standard audiometric frequencies. You can view the curves in either gain or sound pressure level.

Indications for use

The FONIX FP35 Hearing Aid Analyzer allows the user to test the characteristics of a hearing aid using coupler and optional real-ear measurements. These characteristics include: Frequency response, harmonic distortion, equivalent input noise, and compression. Coupler measurements are performed inside a sound chamber. Real-ear measurements are performed with a small probe microphone inside the patient's ear. This manual provides detailed instructions on the measurement capabilities and user interface of the FONIX FP35.

1.1 A Guide to Using this Manual

The FP35 is easy to use. You can begin testing right away, and, if you do happen to get stuck, the pop-up help menus will guide you through what to do next. In addition, this manual contains detailed instructions and information about all the different testing capabilities and options that the FP35 gives you.

The FP35 Operator's Manual follows a logical, sequential order and is meant to be read in order. If you come across a section that contains information you are already familiar with, skip to the next section.

Notations are consistent throughout the manual. Key names are contained in brackets, for instance [START/STOP]. Selections and settings are written in all capitals without brackets, such as PURETONE. Screen names are capitalized, such as Coupler screen.

The up-down arrow keys are represented by these symbols: [▲ ▼]. The right-left arrow keys are represented by these symbols: [◄ ►].

1.2 Layout, Controls, & Safety

The basic layout of the FP35 analyzer and special information pertaining to safety regulations are described in this section.

1.2 .1 Power LED and LCD display

The FP35 uses a 1/4 VGA LCD screen to display graphs and numerical data. An optional external monitor connection is also available. The FP35 analyzer is equipped with a screen saver that will turn off the display automatically if the FP35 is not used for a period of ten minutes or some other length of time specified by the user in the Default Settings Menu (see Section 2.3, The Default Settings Menu). To activate the screen after the screen saver has turned it off, press any key.

The FP35 has only one LED. It is above the [OPERATE] key (see Figure 1.2.1). The LED can indicate several different things by its color and by how quickly it flashes.

- **Green (not flashing)**—Normal operation
- **Green fast flash (every second)**—Screen saver mode
- **Green slow flash (every three seconds)**—Off, but the circuit continues to receive power
- **Red**—Error condition; unit should not be used
- **Red & Green alternating**—Software upload mode
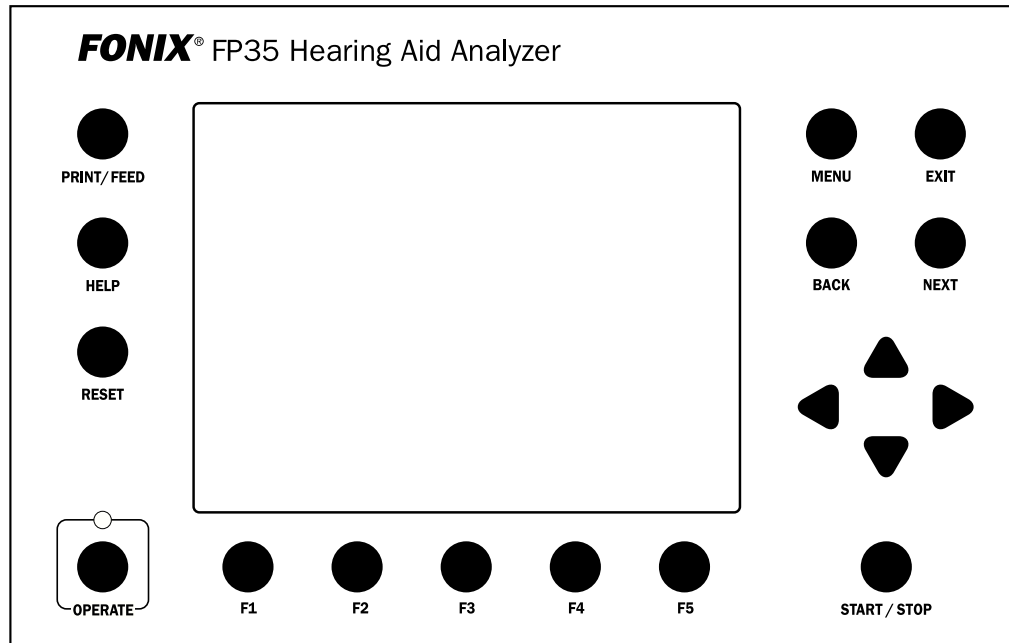
Figure 1.2.1—FP35 front panel

1.2.2 Front panel layout

The front panel of the FP35 analyzer consists of 5 function keys, 4 arrow keys, and 9 other keys with varying operations. Together, these keys are used to control all the operations of the FP35 analyzer.

Function Keys:

There are five "function keys" located just below the FP35's front panel, labeled [F1] through [F5]. The function of these keys change from screen to screen, according to the operation displayed. There are three basic uses of the function keys:

• To navigate from screen to screen
• To toggle a selection
• To pop-up up a selection menu

For example, in the Opening Screen, pressing [F3] will take you into the Coupler Multi-Curve screen where you can test an aid in the sound chamber.

Other Keys:

[MENU]   Enters and exits the menu relevant to the current screen.

[EXIT]   Exits the current screen, returning you to the a measurement screen or the Opening Screen. Unlike the [RESET] key, pressing [EXIT] does not erase any data.

[NEXT] [BACK]	Moves back and forth between screens that are in a sequences. Examples include menus and the real-ear measurement screens.
[▲ ▼]	Moves the cursor up and down in a menu screen and in the Audiogram Entry screen. Adjusts the level of the source amplitude in a measurement screen.
[◄ ►]	Cycles through available menu choices, adjusts the frequency selection in a single tone measurement, and adjusts the amplitude levels in an audiogram in the Audiogram Entry screen.
[START/STOP]	Starts or stops the current selected function.
[OPERATE]	Powers up and down the analyzer. When powered down, the LCD display is turned off and all data is cleared, but the main power is not turned off. The green LED will flash once every 3 seconds.
[RESET]	Interrupts any current running measurement and returns the FP35 to the Opening Screen. [RESET] will not clear leveling or calibration, but it will clear any data you have collected.
[HELP]	Pops up a help window containing instructions for the current screen.
[PRINT/FEED]	Prints the current screen when you press and release this key. Feeds the thermal paper when you press and hold this key.

Connector:

The FP35 main board was revised in late October 2008 (the "-09 revision"). This added a new microphone connector on the front of the analyzer labeled "Mic" for the integrated real-ear microphone. The coupler microphone (and the old style real-ear microphone) is connected inside the sound chamber.

1.2.3 Rear Panel Layout

The rear panel layout contains most of the external connections for the FP35 analyzer. There have been three major versions of the FP35 rear panel. For the sake of this manual, we will refer to them as the "original" rear panel, the "-08" rear panel, and the "-09" rear panel.
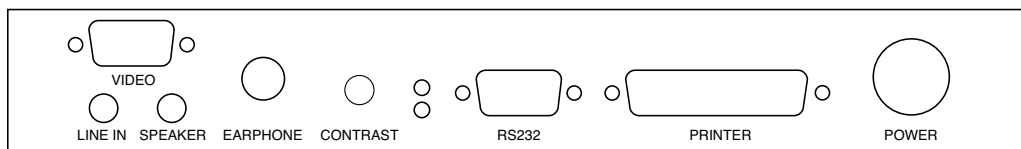
Figure 1.2.3A—The newest rear-panel, manufactured starting in November 2008. This revision added a "line-in" input as a 3.5mm jack.
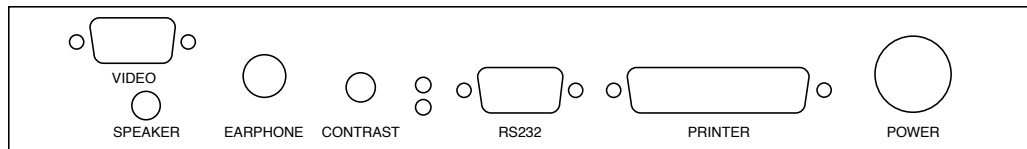
Figure 1.2.3B—The "08" rear-panel, manufactured between February 2007 and October 2008.
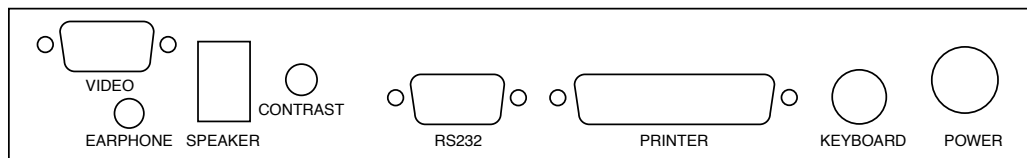
Figure 1.2.3C—The "original" rear-panel, manufactured before February 2007.

Video	Connects to an external monitor (optional).
Earphone	Connects an insert earphone to the FP35 in order to perform RECD or audiometric measurements. It can also be used to connect a Telewand or telecoil board for telecoil measurements.
Speaker	Connects an external sound field speaker or external sound chamber to the FP35 analyzer. Can also be used to connect an external telecoil board or Telewand (-08 or -09 rear panel only)
Contrast	Changes the contrast of the LCD display.
RS232	Connects to a computer in order to run a computer program or to upgrade your software.
Printer	Connects the FP35 to an external printer.
Keyboard	This connector has no function (original rear panel only)
Power	Connects the FP35 to its power supply. We recommend that you attach the power supply to the FP35 before plugging it into the wall.

The following symbols can be found on the back and on the bottom of the FP35:

Meaning of Symbols

Read the accompanying documents. Please read this manual before operating the FP35. A separate maintenance manual exists for the FP35. If you wish to obtain a maintenance manual please contact Frye Electronics, Inc., or your Frye representative.

For purposes of safety classification under IEC 60601-1, the FP35 is class 1 equipment, Type B.

C E
0086

This symbol indicates that Frye Electronics conforms to the Medical Device Directive 93/42/EEC.

1.2.4 Sound Chamber Connectors

There are two jacks in the bottom part of the sound chamber. The small 3.5mm jack is for the internal sound chamber. The larger multi-pronged jack is for the coupler microphone or the M300 microphone set.

1.3 Accessories

1.3.1 Standard Accessories

HA-1 2-cc Coupler
Dimensions per requirements of ANSI S3.7 for testing in-the-ear hearing aids

HA-2 2-cc Coupler
Dimensions per requirements of ANSI S3.7 for testing ear level, eyeglass and body aids

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

Coupler Microphone
For performing coupler measurements.

Microphone Adapter
14 mm to 1-inch diameter microphone size. Couples the coupler microphone to a calibrator.

Other Standard Accessories

- Standard External Power Supply
- Roll of Printer Paper
- Operator's Manual
- Fun-Tak
- RS232 Cable

1.3.2 Real-Ear Option Accessories

Probe Microphone
Integrated probe microphone with a 10 ft (3 m) cable for real-ear measurements.

Other Real-Ear Option Accessories:

- **Probe Calibration Adapter—**Provides a means of coupling the probe microphone to a calibrator.
- **Extension Pole**—This extra pole (6 1/2" long), lets you use two different speaker heights when testing in the Real-ear Mode.

- **Probe Tubes**—set of 25
- **Felt Pen**—Red, Dry-erase
- **Rectangular reference microphone adapter**—Couples the rectangular reference microphone to a calibrator.

1.3.3 Optional accessories

Mounting Sleeves
For securing microphones to the earhook. Only used for M300 style microphone set. The newer style probe microphone with the integrated earhook does not require these sleeves.

Wedge Style Earhook
Holds probe and reference microphones during real-ear testing. Only used for M300 style microphone set. The newer style probe microphone with integrated earhook does not require this part.

Soft Carrying Case
An attractive, sturdy, soft carrying case that holds the FP35 and accessories.

External Monitor Option
Used for the external display of the FP35 analyzer. Requires the external monitor option.

Quest QC-10 Sound Level Calibrator
For calibration of microphone amplifier; operates at 1000 Hz at a level of 114 dB SPL.

Swing Arm Speaker
Gives you a wide range of speaker-position angles and heights to work with when testing in real ear.

Medical Grade External Power Supply
For the FP35 to qualify as a medical grade unit, all connections must be with medical grade equipment. This power supply meets medical grade standards.

Child Size Wedge Style Earhook
Holds probe and reference microphones during real-ear testing. Only used for M300 style microphone set. The newer style probe microphone with integrated earhook does not require this part.

Infant Headband Package
Used for performing real-ear measurements on infants and small children. Includes infant, child, and adult headbands, six flexible ear hooks, and two sets of "animal ears."

Single Insert Earphone (RECD)
Consists of one ER3A earphone with a phono 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 FP35 analyzer. It can also be used for performing audiometric measurements with the Audiometer option.

Dual Insert Earphones
Pair of insert earphones with special connector for performing audiometric measurements. Can also be used for RECD measurements.

Dual Insert Earphones Y Cable
3.5 mm stereo phone plug to 1/4" phone jack. Connects dual insert earphone to FP35. Included with the Dual Insert Earphone Option.

Two Microphone System
This two microphone setup can be ordered for sound chamber-only FP35 analyzers in order to enable testing with a reference microphone.

Earphone Calibration Adapter
Connects the Insert Earphone to the HA-2 coupler. Included with the Audiometer Option.

Open Fit Coupler
Non-standard coupler used for realistic testing of open fit hearing aids.

Telewand
Allows the measurement of telecoil per ANSI S3.22-1996 and ANSI S3.22-2003. Also allows real-ear telecoil measurements.
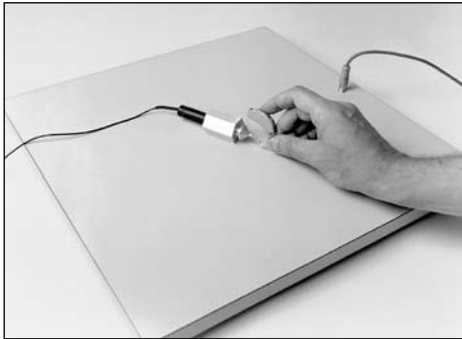
Telecoil Board
Allows the measurement of telecoil in sound chamber measurements.

External Sound Chamber
Connect the FP35 analyzer to an external sound chamber for better sound isolation and positioning. Sound chamber models 6040 and 6050 can be used.

Other Optional accessories

- **Calibration Clip**—Used to couple the old style probe and reference microphones together for calibration purposes.

1.4 Optional Features for the FP35

Real-Ear Option

You can order the FP35 with the Real-Ear Option so that you can do tests on the hearing aid while it is in the client's ear. It is then possible to individualize the fitting of a hearing aid—a necessary step since a coupler measurement can seldom tell the operator exactly what sound is received by the client. Many factors affect sound on its way to the eardrum. By measuring with a probe microphone, you will know what is really happening in your client's ear.

External Monitor Option

This hardware option allows the connection of the FP35 analyzer to an external monitor. When connected, the FP35 displays on both its internal LCD monitor and the connected external monitor. Although the display is always only in two colors, most standard flat screen and VGA computer monitors can be used.

IEC

You can add the IEC (International Electrotechnical Commission) test sequence to your FP35 analyzer. This automated sequence lets you test the performance of hearing aids in accordance with the IEC 118-7 standard as amended in 1994.

JIS

An automated test sequence that follows the JIS standard, widely used in Japan.

ANSI

The ANSI 96 and ANSI 03 automated test sequences are available as an option on your FP35. They provide you with the means to quickly and accurately test a hearing aid in accordance with the ANSI S3.22 standard.

CIC Option

This option consists of a 0.4 cc CIC coupler and software correction factors. The CIC correction factors are available in the Coupler Mode by selecting the CIC coupler in the Coupler Menu.

Audiometer Option

This adds pure-tone air audiometric measurements to your FP35 hearing aid analyzer. You can either take the measurements with insert earphones or with a sound field speaker. See Chapter 9 for more details.

ISI

An automated test sequence conforming to the Indian ISI IS-10775-1984 standard.

Note: The FP35 is fully upgradeable. These options can be added to an existing unit.

1.5 Setup

Unpack the instrument and all of the accessories, some of which can be found in a card box. If you ordered the soft carry case as an optional accessory, it will be shipped in a separate box.

Keep the shipping box for when you need to send the unit in to us for calibration, upgrade or repair.

Choose a location for your FP35 that is relatively free of ambient noise. Begin by plugging in the power supply to the back panel. See Figure 1.2.3 for an illustra-

tion of the back panel. Measurements can be considered reliable only when performed with the noise floor of the test environment 10 dB below the input level of the test signal.

If you have ordered the Real-ear Option on your FP35, remove the integrated probe microphone from its packing material and plug it into the front of the analyzer after removing the warning sticker covering the mic port. This connection can also be made when the analyzer is powered on, but make sure you press the [RESET] button after plugging in the probe mic cable.

The FP35 will power up as soon as you plug the power cord into the wall. To power it down again, either unplug it, or push the [OPERATE] key. Unplugging the FP35 turns it completely off; pushing the [OPERATE] key powers the unit down, but the internal circuit board continues to receive power.

Once you have power to the unit, you are ready to proceed.

1.6 Safety

Shipping

The following symbols are included on the electronic module shipping box:

Keep dry. The FP35 Hearing Aid Analyzer should not be exposed to water or other fluids. Water or other fluids could cause damage to the equipment.
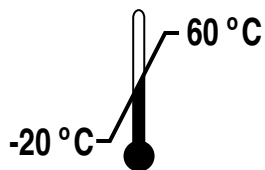
The shipping/storage temperature of the 7000 is -20 to 60 degrees Celsius (-4 to 140 degrees Fahrenheit)
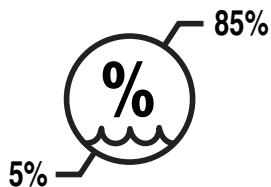
The shipping/storage Humidity of the FP35 is 5 to 85 percent relative humidity (non-condensing)

Probe Tubes

This symbol, included on the probe tube packaging, indicates that probe tubes should be discarded after use in order to prevent the possible spread of infection. They cannot be cleaned, sterilized, or reused. Cutting the probe tube to a shorter length will invalidate the probe microphone calibration.

Safety Classification for IEC 60601-1

Type of protection against electric shock: Class I

Degree of protection against electric shock: Type B

Protection against harmful ingress of water: Ordinary

Mode of operation: Continuous

The FP35 does not require sterilization or disinfection.

Warning: This equipment is not suitable for use in the presence of flammable anaesthetic mixture with air or with oxygen or nitrous oxide.

Warning: Connect only to the power supply packaged with the FP35. Using other power supplies could lead to electric shock or other safety hazards.

Connection of peripheral equipment to the FP35

Compliance with IEC 60601-1-1 Safety requirements for medical electrical systems must be determined on a case-by-case basis.

All electrical equipment attached to the FP35, such as video monitors, computer equipment, etc. must, at a minimum, meet one of the following conditions:

  a. The equipment complies with IEC 60601-1
  b. The equipment complies with relevant IEC and ISO safety standards and is supplied from a medical grade isolation transformer.
  c. The equipment complies with relevant IEC and ISO safety standards and is kept at least 1.5 meters from the patient.

The allowable leakage currents of IEC 60601-1-1 must not be exceeded. IEC 60601-1-1 should be consulted when assembling such a system. Failure to follow these instructions could cause interference with nearby medical equipment.

Electromagnetic compatibility

The FP35 complies with IEC 60601-1-2.

The FP35 generates and uses radio frequency energy. In some cases the FP35 could cause interference with radio or television reception. You can determine if the FP35 is the source of such interference by turning the unit off and on.

If you are experiencing interference caused by the FP35, you may be able to correct it by one or more of the following measures:

1. Relocate or reorient the receiving antenna.
2. Increase the distance between the FP35 and the receiver.
3. Connect the FP35 to a different outlet than the receiver.

In some cases radio transmitting devices, such as cellular telephones, may cause interference to the FP35. In this case try increasing the distance between the transmitter and the FP35. Failure to follow these instructions could lead to interference with nearby medical equipment.

Disposal of the FP35 and accessories

The FP35 and some of its accessories contain lead. At the end of its useful life, please recycle or dispose of the FP35 according to local regulations.

If you are located in the European Union, please report all safety-related concerns to our authorized representative:

> Siemens Hearing Instruments Ltd.
> Alexandra House
> Newton Road
> Manor Royal
> Crawley
> West Sussex RH109TT
> ENGLAND

Otherwise, please report all safety related concerns to the Frye factory:

> Frye Electronics, Inc.
> 9826 SW Tigard St.
> Tigard, OR 97223
> Ph: (503) 620-2722 or (800) 547-8209
> Fax: (503) 639-0128
> email: support @frye.com
>   sales@frye.com

Frye Electronics, Inc. is a Registered Firm of British Standards Institution, and we conform to the ISO 13485 standard.

1.7 Maintenance

We recommend checking the calibration of the FP35 analyzer once a year. See Appendix C for details. Because of the configuration of the FP35, the microphones should not go out of calibration. If you perform the checks described in Appendix C and find that the microphones are in need of calibration, contact your local service representative or Frye Electronics because this could be a sign that further repairs to your system are needed.

When used in a hospital environment, where such test equipment is commonly available, periodic current-leakage testing should be done on the power supply while the FP35 is connected. Testing on a yearly basis is sufficient.

1.7.1 Servicing the Instrument

Contact Frye Electronics, Inc., P.O. Box 23391, Tigard, Oregon 97281-3391 for service. Our toll-free number is 1-800-547-8209. Our regular number is (503) 620-2722, or you may contact your local Frye representative. We are also available on the internet. Our e-mail address is: service@frye.com, and our web site is www.frye.com.

Units may be returned to Frye Electronics, Inc., 9826 S.W. Tigard St., Tigard, Oregon 97223. Please contact the company or your local Frye representative first, since many problems can be fixed without returning the whole unit. If something must be returned, a return authorization number (RMA) will be issued to be attached to all returned materials.

When contacting the factory, please have the serial number of your instrument on hand. Look for this number on the bottom of the instrument. It will also be helpful for you to be able to tell us the software version installed on your machine. Check the Opening Screen for this information.

1.7.2 Cleaning the Instrument

For your safety, disconnect the FP35 power supply from electric power while cleaning.

Wipe the FP35 case with a slightly moist soft cloth. Use plain water or water with mild dishwashing detergent. Wipe away any detergent with a clean, moist cloth, then dry the FP35.

The LCD surface can be easily damaged, so wipe lightly and use a soft, water-dampened cloth to clean it. Do not allow liquid to enter the LCD opening.

The microphones should be wiped with a dry cloth. Excess moisture may damage the microphone.

The external power supply may be cleaned with a cloth dampened with cleaning alcohol. Clean the outside of the enclosure only.

Warning: Do not immerse the power supply in water or a safety hazard could arise during use. This could cause an electric shock hazard.

Never allow fluid to enter:

- The Liquid Crystal Display (LCD)
- The electronics module
- The electrical connectors
- The external power supply

Solvents and abrasives will cause permanent damage to the FP35.

1.7.3 Warranty

The FONIX FP35 and its accessories are guaranteed to be free of manufacturing defects which would prevent the products from meeting the specifications (given in Appendix A of this manual) for a period of one year from the date of purchase.

General Operation

This chapter describes the general operation of the FP35 analyzer, including basic operation of the keys, screen navigation, default settings, source types, and printing.

2.1 Operation of Keys

The general operation of the various keys on the FP35 analyzer is described in this section. This includes a description of the function keys, the arrow keys, and the Menu, Help, Reset, Exit, Level, Feed, Print, Stop, and Start keys.

2.1.1 Using the Function Keys

There are four basic uses of the function keys:

- To navigate from screen to screen
- To toggle a selection
- To pop-up up a selection menu
- To perform an action

A short description of the function of a key is always displayed above the key on the bottom of the FP35 display.

Navigation

In the Opening screen, the function keys are used to navigate the various measurement screens. See Figure 2.1.1A for a flowchart of the available screens on the FP35 analyzer.

[F2] takes you to one of the real-ear screens: Audiogram Entry, Insertion Gain, Unaided and Aided, or Real-Ear SPL. Once you are in one of these screens, you can move to one of the other screens by using the [NEXT] and [BACK] keys. Audiogram Entry is the default screen, but [F2] will always take you to the last real-ear screen you entered. These screens are only available when the Real-Ear Option is ordered.

[F3] takes you to one of the coupler multicurve screens: Coupler Multicurve, Coupler Target, or Coupler EarSim. You can navigate between these screens using the [NEXT] and [BACK] keys. Coupler Multicurve is the default screen, but [F3] will always take you to the last coupler multicruve screen you entered. Coupler Target and Coupler EarSim are only available with the Real-Ear Option.

[F4] and [F5] are used to take you to an automated test sequence screen. The four available automated test sequences on the FP35 analyzer are: ANSI 96, ACIC, IEC, JIS, and ISI. Only the automated test sequences that you have ordered will be available.

Note: To exit from any screen, press the [EXIT] key.
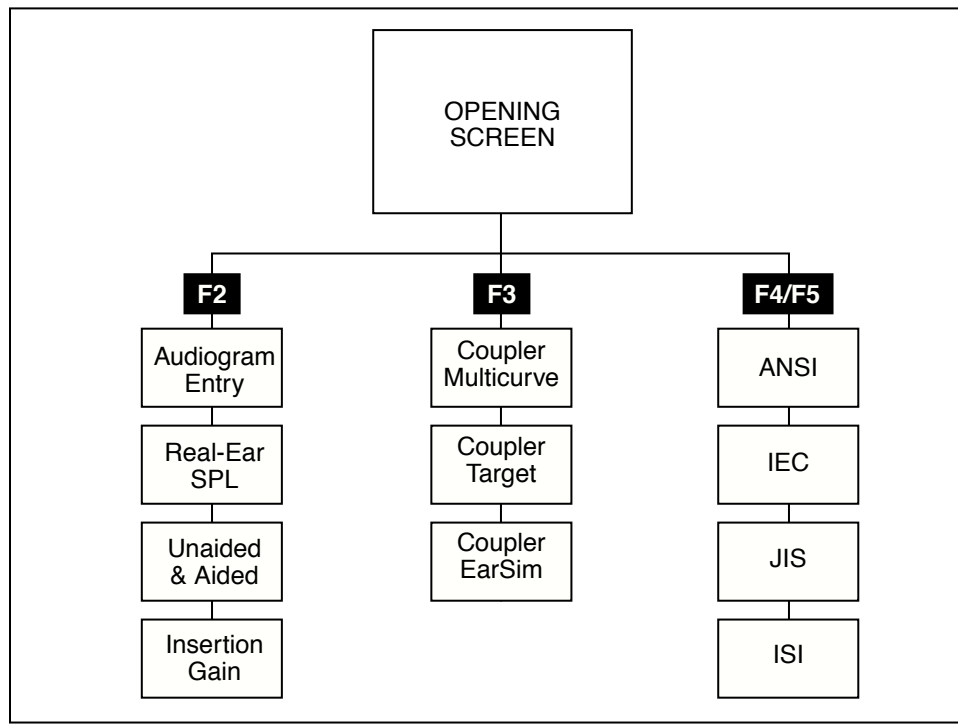
Figure 2.1.1A—Flowchart of the FP35 screens

Toggle

Pressing a function key in a measurement screen will usually toggle a selection. For instance, pressing [F2] in the Coupler Multicurve screen will toggle through the various curves.

Pop-up Menu

In some cases, a particular function key will have several different available settings. For example, in the Coupler Multicurve screen, [F4] selects the source type for a frequency measurement. You can either push the function key repeatedly until the desired setting appears, or you can push and hold the key down for half a second to pop up a function key balloon menu.

A function key balloon menu is a listing of all available selections for that key. Choose the desired selection with [▼ ▲]. When satisfied, press [START/STOP] or push and hold the function key for half a second again. Figure 2.1.1B shows an example of a Function Key Balloon Menu.

Action

Sometimes function keys perform an action. For instance, in most measurement screens, [F5] levels the sound chamber. By looking at the label of the function key, you should be able to determine the action of the function key.
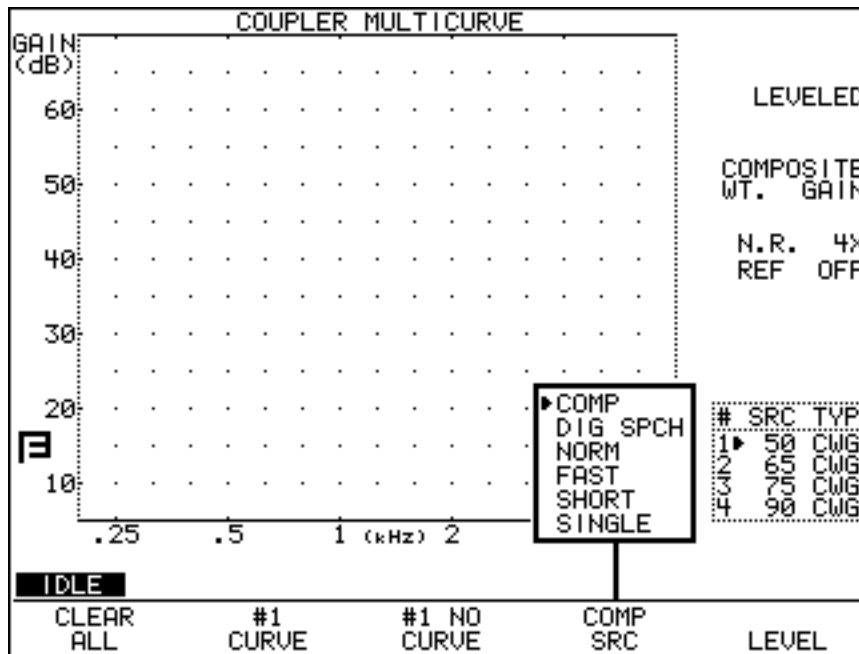
Figure 2.1.1B—Function key balloon menu

2.1.2 Using the Local Menus

Each screen contains a local menu that is displayed when you press the [MENU] key. The local menu, overlaid on the current screen, contains only settings that pertain to that screen. See Figure 2.1.2. For example, the local menu of a real-ear measurement screen will contain a selection for OUTPUT LIMIT. This setting does not pertain to coupler measurements, so you won't find that particular item in the local menu of a coupler screen.

In order for the FP35 to be highly configurable for the advanced user, yet easy to operate for the user, we divided the local menus into several different sections. In most cases these are: the menu, the advanced menu, and the custom menu.

When the [MENU] key is first pressed (in a screen other than the Opening screen), the basic local menu is displayed. This basic menu contains the selections most important to the displayed screen. Advanced users can open the advanced and custom menus by using the [NEXT] and [BACK] keys.

There are three different types of menu items: *local* variables that are only active within the current screen, *global* variables that are available in all screens that use it, and *resetable* variables that change to a default value when [RESET] is pressed or the unit is first turned on. *Resetable* variables can be local or global. Most *global* and *resetable* variables are available in the Default Settings menu. *Local* variables are **not** available in the Default Settings screen.

You can always tell what type a variable is by looking at the dash sequence next to it in one of the menus. *Local* variables use a series of small dots. *Global* variables use a series of large dots. *Resetable* variables use a series of short dashes. See Figure 2.1.2.
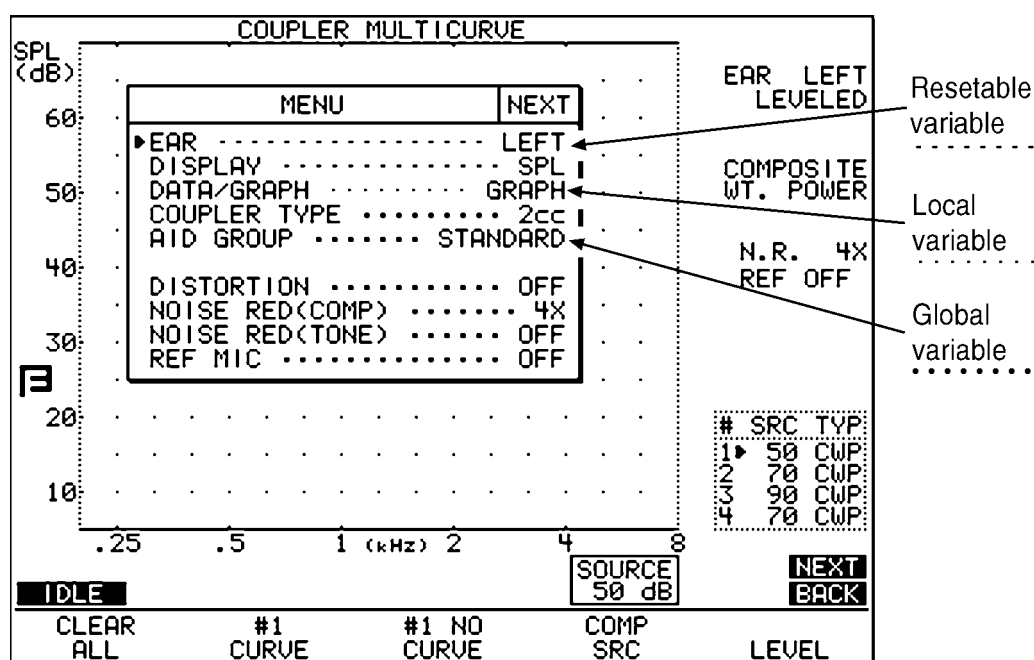
Figure 2.1.2—Local menu of the Coupler Multicurve screen

Details on the behavior of menu items:

Local variables are not available in the Default Settings menu. When the analyzer is first powered on, *local* variables are set to a factory defined default setting, but they are not normally changed back to the default setting when [RESET] is pressed. (There are some exceptions.)

When you change a *resetable* variable in the Default Settings menu, it will impact that variable in all local menus where it is available. However, changing a *resetable* variable in a local menu will not change its value in the Default Settings menu. When [RESET] is pressed, the local menu variable will revert back to the value defined in the Default Settings menu.

Changing a *global* variable will change its value in all screens where it is available, including the Default Settings menu.

2.1.3 Using the Help Menus

Each screen of the FP35 analyzer contains a pop-up help feature to aid you if you ever get stuck. If you find yourself uncertain of your next step, press the [HELP] key. A pop-up window (Figure 2.1.3) will appear that lists the active keys and explains what they will do from your current screen.

```
                    COUPLER MULTICURVE
GAIN
(dB)      .   .   .   .   .   .   .   .   .   .   .   .
                                                    LEVELED
┌──────────────────────────────────────────────────┐
│                       HELP                         │
├──────────────────────────────────────────────────┤
│  Press F1 to clear all curves                      │
│  Press F2 to select measurement curve             │
│  Press F3 to turn curve display On or Off         │
│  Press F4 to select source type                   │
│  Press F5 to level the chamber                    │
│  Press ▲ or ▼ to select source level              │
│  Press ◄ or ► to select static frequency          │
│  Press START to measure curve                     │
│  Press EXIT to return to the Opening screen       │
│                                                    │
│  Abbreviations          : Gain   Power            │
│     Pure Tone Normal    : PNG    PNP              │
│     Pure Tone Fast      : PFG    PFP              │
│     Pure Tone Short     : PSG    PSP              │
│     Composite Weighted  : CWG    CWP             │
│     Composite Spectrum  : CSG    CSP             │
│                                                    │
├──────────────────────────────────────────────────┤
│                >>> Press any key <<<               │
└──────────────────────────────────────────────────┘
──────────────────────────────────────────────────────
   CLEAR        #1        #1 OFF        COMP
  CURVES       CURVE       CURVE         SRC        LEVEL
```

Figure 2.1.3—Pop-up Help Screen

2.1.4 Using the [EXIT] and [RESET] keys

The [EXIT] and [RESET] keys can be used to exit from any screen, menu, or window.

The [RESET] key resets the analyzer and returns you to the Opening screen. **Caution:** Many settings, measurements, and test conditions are erased or returned to their default conditions with the push of this key. Use [EXIT] instead of [RESET] to avoid the loss of data.

The [EXIT] key will close a pop-up window or local menu. When all such windows and menus are closed, the [EXIT] key will exit you from the current screen, *leaving all settings, measurements, and test conditions as is.*

2.2 Opening Screen

The Opening Screen of the FP35 hearing aid analyzer is the starting point and the returning point for all operations. To switch between coupler measurements, real-ear measurements, and the automated test sequences, you always do it through the Opening Screen. It is also the only screen from which the Default Settings Menu is accessible.

2.2.1 Entering the Opening Screen

You can reach the Opening Screen by turning the FP35 on (plug it in or press the [OPERATE] key if it is powered down), by pressing the [RESET] key, or by repeatedly pressing [EXIT] from any other screen on the analyzer.

2.2.2 Opening Screen Display

The Opening Screen displays the Frye Electronics logo, the factory mailing (not shipping) address, the factory phone number, the software version currently being used by the FP35, the instrument's ID number, the microphone's ID number, and the option code. See Figure 2.2.2. A thick line above one of the function keys indicates that was the last screen exited.
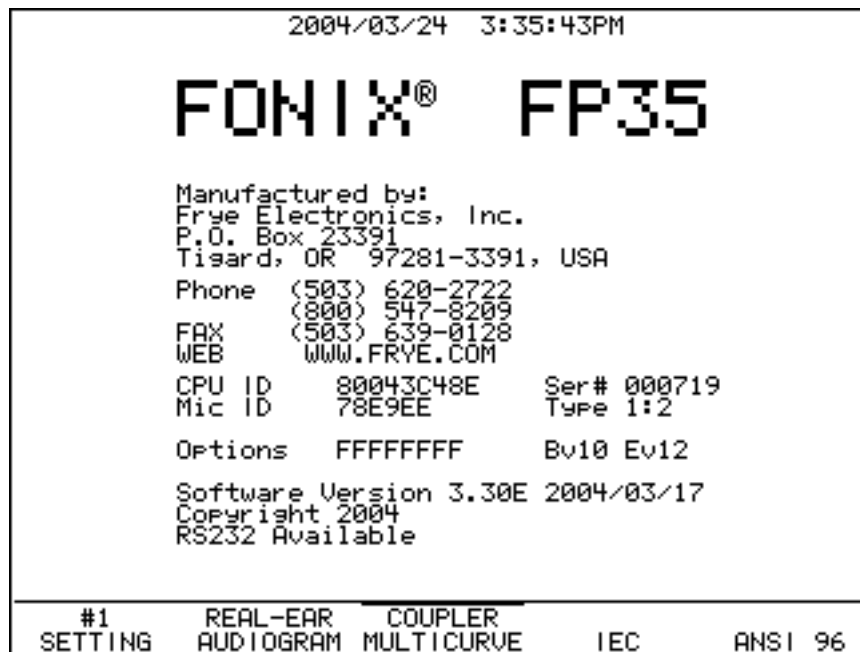
Figure 2.2.2 –Opening Screen

2.2.3 Switching Between Settings

The FP35 analyzer lets you save up to three different sets of default settings. You may want to set up your analyzer in different ways for testing analog hearing aids versus digital hearing aids. Or you may have multiple users, each with his own default settings preferences. See Section 2.3.1 for details on saving default settings setups.

[F1] in the Opening Screen is normally used for switching between different setups. Push [F1] to switch between SETTING 1, SETTING 2, or SETTING 3. See Section 2.3.2 for more information on how the [F1] key can be used.

2.3 The Default Settings Menu

The Default Settings menu contains all the choices that you can adjust and save as defaults. See Figure 2.3. This allows you to program your FP35 hearing aid analyzer so that when you turn it on, your favorite settings are already selected. A default setting can always be overridden by making an adjustment in a local menu.

Just like the local menus, the Default Settings menu is divided into three parts—the main menu, an advanced menu, and a resets menu. The main menu contains basic settings that users will most likely want to adjust to fit their needs. The advanced menu contains settings that advanced users may care to adjust. The resets menu contains the default amplitudes and delay times for source signals.
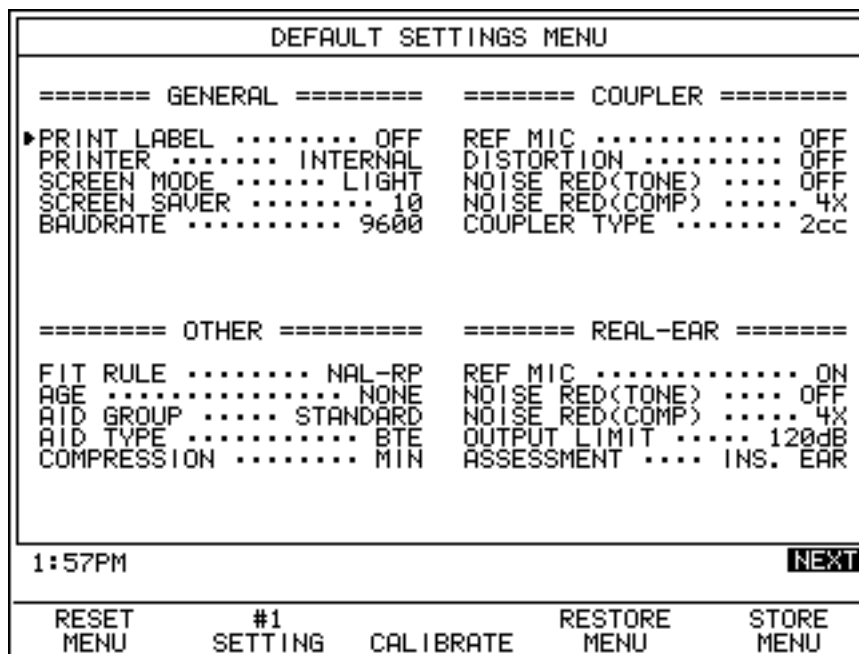
Figure 2.3—Default Settings

2.3.1 Customizing Your Instrument Default Settings

All of the settings available in the Main, Advanced, and Resets Default Settings menus can be saved to the FP35 analyzer's power-on default condition. In recognition that the FP35 might be used by several different users who prefer different default settings, three different sets of defaults can be stored to SETTING 1, SETTING 2, and SETTING 3, respectively.

To store the default settings:

1. Press [MENU] from the Opening screen to open the Default Settings menu.
2. Use [F2] to select the desired user number.
3. Set up the Default Settings menu as you like it. See Sections 2.3.5, 2.3.6 and 2.3.7 for an explanation of the different available settings.
4. Press [F5] to store the menu.
5. Press [START] to complete the action and store the new defaults. Pressing any other key will cancel the action.

To change the setting number:

Use [F2] in the Default Settings menu to change the setting number. This switches the FP35 to the default settings programmed with that setting number. To save new default settings to this setting number, follow the instructions outlined above.

To quickly switch between the default setting programs without entering the Default Settings menu, you can change the setting number in the Opening screen using the [F1] key.

To reset default settings:

- Press [F1] to return all the settings in the Default Settings menu to their factory default condition.
- Press [F4] to return all the settings to the default condition specified for the selected setting number.

2.3.2 Switching between Easy and Advanced User Levels

The FP35 analyzer has "Easy" and "Advanced" user levels. When in Easy Mode, the measurement screens have a cleaner look with less information about the test conditions. The more advanced menu items have also been eliminated in Easy Mode.

To switch between user modes:

1. Press [MENU] in the Opening screen to open the Default Settings menu.
2. Press [NEXT] to go to the Advanced Default Settings menu.
3. Use the [▼, ▲] keys to select USER LEVEL
4. Use [◄, ►] to choose either EASY or ADVANCED.
5. Press [F5] and [START] to save the new setting as default.
6. Press [EXIT] to close the Default Settings menu and return to the Opening screen.

2.3.3 Changing the use of [F1] in the Opening screen

By default, [F1] is used in the Opening screen to switch between default settings (as described in Section 2.3.1). However, if you do not need different sets of default settings, you can use it as a shortcut to any real-ear or coupler screen. Unlike [F2] and [F3], whose functions change depending upon the last real-ear or coupler multicurve screen you entered, the function of [F1] will remain constant. This ability is only available if you have the Real-Ear Option.

To change the function of [F1] in the Opening screen:

1. Press [MENU] from the Opening screen to enter the Default Settings menu.
2. Press [NEXT] to enter the Advanced Default Settings menu.
3. Select the F1 KEY with [▼, ▲].
4. Use [◄, ►] to select one of the following: USER SETTING, CP MULTICURVE (Coupler Multicurve), CP TARGET (Coupler Target), CP EARSIM (Coupler EarSim), AUDIOGRAM (Audiogram Entry), SPL (Real-Ear SPL), GAIN (Real-Ear Aided & Unaided), and INS. GAIN (Real-Ear Insertion Gain). The USER SETTING selection programs [F1] to choose between the different user settings. Choosing one of the other options instead programs it to be used as a shortcut key to a particular screen.
5. Press [EXIT] to return to the Opening screen.

2.3.4 Setting the date and time

The FP35 contains a lithium battery-powered clock chip to keep track of the time and date.

To change the settings of the clock:

1. Press [MENU] from the Opening screen to enter the Default Settings menu.
2. Press [F3]—CALIBRATE
3. Press [F2]—SET TIME.
4. Use the [◄, ►] keys to choose the time unit you would like to change. The XM choice selects between AM, PM, and 24 hour format.
5. Use the [▼, ▲] keys to adjust the setting.
6. Press [EXIT] to leave the Time Setup Screen. Your changes will automatically be stored.

2.3.5 Changing the external monitor colors

When the FP35 analyzer is connected to an external monitor, you can change the colors it uses. Although most color computer monitors can be used with the FP35 analyzer, only two colors can actually be displayed on the external display: the foreground color and the background color. These colors can be changed in the Main Default Settings screen with the VIDEO FOREGND and VIDEO BACKGND settings. These settings are only available when the FP35 analyzer has the external monitor option hardware installed.

The following 15 colors are available in each selection: BLACK, BLUE, GREEN, CYAN, RED, MAGENTA, YELLOW, GRAY, L BLUE, L GREEN, L CYAN, L RED, L MAGENTA, L YELLOW, WHITE. You cannot set both the VIDEO FOREGND and VIDEO BACKGND selections to be the same color except for BLACK and WHITE.

If BLACK is selected as both the FOREGND and the BACKGND colors, both selections will change to DEFAULT display mode, which will follow the FP35 LCD display settings. That is, if the LCD display is set to LIGHT, both screens will show black text on a white background. If the LCD display is set to DARK, both screens will show white text on black background.

If WHITE is selected as both the FOREGND and the BACKGND colors, both selections will change to INVERT display mode, which will invert the FP35 LCD display settings. That is, if the LCD display is set to LIGHT, the external display will use white text on a black background, and if the LCD display is set to DARK, the external display will use black text on a white background.

2.3.6 Explaining the Settings in the Main Default Settings Menu

When you first press [MENU] from the Opening screen, you will enter the Main Default Settings menu, containing the most basic of the possible default settings. Here is an explanation of the purpose of each of these settings:

General:

PRINT LABEL—Status of the printing label. Choose ON or OFF. See Section 2.6.2 for details.

PRINTER—Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

SCREEN MODE—Background color of the LCD screen. Choose between LIGHT and DARK.

SCREEN SAVER—Minutes of inactivity before the LCD display will go dark. Choose from 10, 15, 30, 60, 90 and 120. A choice of OFF will deactivate the screensaver.

VIDEO FOREGND—Color of the text on an externally connected monitor. This setting is only available when the external monitor option is installed.

VIDEO BACKGND—Color of the background on an externally connected monitor. This setting is only available when the external monitor option is installed.

BAUDRATE—The speed at which the FP35 communicates with a computer. The choices are 9600, 19200 38400 and 57600.

Other:

FIT RULE—The fitting rule used for real-ear and target coupler measurements. Choose from NAL-RP, POGO, BERGER, 1/3 GAIN, 1/2 GAIN, 2/3 GAIN, DSL LIN, DSL WDRC, NAL-NL1 and DIRECT (direct entry). Available with Real-Ear Option only.

AGE—The age of the patient. This is used for creating real-ear and coupler targets. Available with Real-Ear Option only.

AID GROUP—Type of hearing aid being tested. Choose STANDARD, AGC or ADAPTIVE (for adaptive AGC circuits). This selection sets the various delay times used in pure-tone tests so that they are appropriate to the aid's circuitry. See Section 2.4 for more information on delay times.

AID TYPE—Style of hearing aid being tested, used for creating coupler targets. Choose from BTE, ITE, ITC, CIC and NONE. Available with the Real-Ear Option only.

COMPRESSION—Compression kneepoint, used for creating real-ear and coupler targets. Selections are available in 1 dB steps, from MIN (the widest available compression) to 69 dB SPL. Available with the Real-Ear Option only.

TARGET REF—Aided curve used to generate the real-ear target. In the real-ear mode, the target is generated using the settings of one of the three available aided measurement curves. Select a curve number to always use a particular curve when generating the target. Choose AUTO to always use the current selected curve when generating the target.

Coupler:

REF MIC—Status of the reference microphone during coupler measurements. See Section 3.8.3 for more details.

DISTORTION—Type of distortion measured when performing a pure-tone measurement. Choices are 2ND, 3RD and TOTAL (2ND and 3RD) or OFF.

NOISE RED (TONE)—The amount of noise reduction used for pure-tone coupler measurements. See Section 2.5.1.3 for more information.

NOISE RED (COMP)—The amount of noise reduction used for Composite and Digital Speech coupler measurements. See Section 2.5.2.3 for more information.

COUPLER TYPE—The type of coupler being used in making sound chamber measurements. Selections of CIC and MZ turn on corresponding software correction factors (see Sections 3.6 and 3.7). A selection of 2CC labels the curve with the coupler type but doesn't use any software corrections. A selection of NONE neither labels nor applies correction factors to the curve. This selection is only available when the CIC or OES Options are ordered.

TELECOIL—Status of coupler telecoil measurements. OFF disables telecoil measurements in the coupler measurement screen. TMFS EAR enables the use of a connected Telewand in coupler measurements through the earphone jack. TMFS SPKR enables the use of the Telewand through the speaker jack (new style, rear panel only). TCOIL EAR enables the use of a connected external telecoil board and/or Telewand for coupler measurements through the earphone jack. TCOIL SPKR enables the telecoil measurements through the speaker jack (new style, rear panel only). See Section 2.5.8 for more details.

Real-Ear (only available with the Real-Ear Option)

REF MIC—Status of the reference microphone during real-ear measurements.

NOISE RED (TONE)—The amount of noise reduction used in pure-tone real-ear measurements. See Section 2.5.1.3.

NOISE RED (COMP)—The amount of noise reduction used in Composite or Digital Speech real-ear measurements. See Section 2.5.2.3 for more information.

OUTPUT LIMIT— The maximum dB SPL value that the analyzer will allow when taking real-ear measurements. When this value is exceeded, the measurement will automatically stop and the source will turn off in order to protect the patient.

ASSESSMENT—The transducer used to take RECD/REDD and audiometric measurements.

TELECOIL—Status of the real-ear telecoil measurements. OFF disables telecoil measurements in the real-ear measurement screens. TMFS EAR enables the use of a Telewand connected through the earphone jack. TMFS SPKR enables the Telewand through the speaker jack (new rear panel only). There is no support for the external telecoil board in real-ear measurements. See Section 2.5.8 for more details.

VISIBLE SPEECH—Display used when the FP35 analyzer is in Spectrum Analysis mode (requires Composite/Digital Speech Option). BARS displays a set of vertical bars representing the maximum peaks of the measurements that reach above the lower limits of the speech banana. AVERAGE displays a long term average of the response using a peak decay method.

2.3.7 Explaining the Settings in the Advanced Menu

The Advanced Default Settings menu contains items that may be useful to some advanced users. To reach it, press [MENU] from the Opening screen and then push [NEXT]. The [BACK] key will return you to the Main Default Settings menu.

General:

F1 KEY—Operation of the F1 quick key in the Opening screen. Choose from USER SETTING, CP MULTICURVE (Coupler Multicurve), CP TARGET (Coupler Target), CP EARSIM (Coupler EarSim), AUDIOGRAM (Audiogram Entry), SPL (Real-Ear SPL), GAIN (Real-Ear Aided & Unaided) and INS. GAIN (Real-Ear Insertion Gain). Available only with Real-Ear Option. See Section 2.3.2 for details.

F2 KEY—Operation of the F2 key in the Opening screen. Choose from ◄ none ► (no selection), AUDIOGRAM (Audiogram Entry), SPL (Real-Ear SPL), GAIN (Real-Ear Aided & Unaided) and INS. GAIN (Real-Ear Insertion Gain). Available only with Real-Ear Option.

F3 KEY—Operation of the F3 key in the Opening screen. Choose from MULTICURVE (Coupler Multicurve), TARGET (Coupler Target) and EARSIM (Coupler EarSim). TARGET and EARSIM are only available with the Real-Ear Option.

F4 & F5 KEY—Operation of the F4 and F5 keys in the Opening screen. These settings will appear only if you have more than two automated test sequences on your analyzer. These are the available choices: ANSI 96, IEC, JIS and ACIC (ANSI 96 with CIC correction factors).

USER LEVEL—User level affects screen layout and menu selections. Choose from EASY and ADVANCED. See Section 2.3.2.

Resets:

AUTO-SCALE—Type of scaling used when taking measurements. Choosing ON scales the graph to the selected curve. Choosing OFF scales the graph to the highest curve displayed.

REFERENCE STATUS—The status of the RMS measurement of the reference microphone. A selection of RMS measures the overall RMS of the reference microphone. A selection of FULL measures the overall RMS and the signal quality of the reference microphone. A selection of NONE turns off these measurements. See Section 2.5.4.

AVG FREQS— The frequencies used for averaging in pure-tone measurements. The last frequency of the three-frequency pair is used as the selection. See Section 2.5.1.5 for a full list of the available frequencies.

EAR—The ear meant for the hearing aid being tested. Choose LEFT, RIGHT, or NONE. The NONE selection doesn't label the ear.

FREQ—The default frequency of the single tone measurement.

EQ INPUT NOISE—Type of equivalent input noise (EIS) included in the ANSI test. NORMAL sets the EIN to use the entire 200-8000 Hz frequency band. A selection of 5 KHz sets the frequency band to 200-5000 Hz (recommended), and a selection of OFF skips the EIN entirely

Coupler:

DISPLAY—The type of display used in the Coupler Multicurve and Coupler Target screens. Choose between GAIN and SPL.

RESET SRC—The default source used in the Coupler Multicurve and Coupler Target screens.

LEVELING SOURCE—The amplitude used for leveling the sound chamber. This is useful if you need to level with the chamber door open, and you don't want to use the loud default level of 90 dB SPL. Choose between 60 and 100 dB SPL.

LEVELING AUTO CLEAR—Behavior of sound chamber leveling. When set to ON, currently displayed curves are automatically deleted when leveling the sound chamber. When set to OFF, currently displayed curves are unaffected by leveling.

OUTPUT LIMIT—The maximum dB SPL value that the analyzer will allow when taking coupler measurements. When this value is exceeded, the measurement will automatically stop and the source will turn off.

SPEAKER—Selected source device. Choose INTERNAL to present your signals through the source connected to the internal speaker jack, EXTERNAL to present your signals through the source connected to the external speaker jack, or AUTO to use the internal jack for coupler tests and the external jack for real-ear tests.

OUTPUT JACK— Status of the external source devices in the coupler screens. SPEAKER enables only the speaker jack. MONO EAR enables only the left channel of the earphone jack. STEREO EAR enables both channels of the earphone jack. ALL ON enables the speaker jack and both channels of the earphone jacks. See Section 2.5.5 for details.

Real-Ear (only available with Real-Ear Option):

RESET SRC—The default source used in the real-ear measurement screens.

RESET SMOOTHING—Type of smoothing used for real-ear measurements. Choose ON or LOG. Smoothing rounds off a curve, removing minor peaks.

DEFAULT UNAIDED—The type of unaided measurement used by default. Choose from CUSTOM, which requires the unaided response to be measured for each patient, AVG, which uses the KEMAR unaided response, and AUTO, which sets the unaided response to custom in the insertion gain screens and average in the SPL screen.

LEVELING AUTO CLEAR—Behavior of real-ear leveling. When set to ON, currently displayed curves are automatically deleted when leveling the sound field. When set to OFF, currently displayed curves are unaffected by leveling.

SPEAKER—Selected source device. Choose INTERNAL to present your signals through the source connected to the internal speaker jack, EXTERNAL to present your signals through the source connected to the external speaker jack, or AUTO to use the internal jack for coupler tests and the external jack for real-ear tests.

OUTPUT JACK—Status of the external source devices in the real-ear screens. SPEAKER enables only the speaker jack. MONO EAR enables only the left channel of the earphone jack. STEREO EAR enables both channels of the earphone jack. ALL ON enables the speaker jack and both channels of the earphone jacks. See Section 2.5.5 for details.

AUTO DURATION—Length of time used by the Real-Ear Auto Test. All settings are in seconds. Available selections are: 0.5, 1.0, 2.0, 5.0, 10.0.

AUTO TEST—Status of the Real-ear Auto Test. See Section 5.4.3 for details.

2.3.8 Explaining the Settings in the Resets Default Settings Menu

The Resets Default Settings lets you set up your own default source levels. To reach it, press [MENU] from the Opening screen and then push [NEXT] twice.

Coupler:

CRV #1-4 SRC LEVEL: Set the default source level for curves 1-4 in the Coupler Multicurve, Coupler Target and Coupler EarSim screens.

STD/AGC/ADAPT PREDELAY/SETTLE: Set the default delays for each aid type and delay type displayed.

MIC PORT: Choose the microphone used for coupler measurements. Select AUTO, INTERNAL, EXTERNAL or EXT LINE. See Section 2.5.9 for details.

EXTERNAL VOLUME: Adjust the volume of the external line-in input used in the Coupler Multicurve, Coupler EarSim, and Coupler Target screens. Choices range from -30 to +10 dB. A selection of DIRECT removes the ability to adjust the volume on the FP35, but is recommended since such volume adjustments are very crude and should be made on the external player when possible. See Section 3.8.9 for more information.

Real-Ear:

CRV #1-4 SRC LEVEL: Set the default source levels for the AIDED 1, 2, 3 and UNAIDED curves, respectively, in the real-ear measurement screens.

STD/AGC/ADAPT PREDELAY/SETTLE: Set the default delays for each aid type and delay type displayed.

MIC PORT: Choose the microphone used for Real-ear measurements. Select AUTO, INTERNAL, EXTERNAL or EXT LINE. See Section 2.5.9 for details.

EXTERNAL VOLUME: Adjust the volume of the external line-in input used in the real-ear measurement screens. Choices range from -30 to +10 dB. A selection of DIRECT removes the ability to adjust the volume on the FP35, but is recommended since such volume adjustments are very crude and should be made on the external player when possible. See Section 5.6.1 for more information.

2.4 Aid Types and Delay Times

The AID GROUP setting automatically changes the delays used in most measurements. These delays give the hearing aid time to adjust to the test signal before a measurement is taken. Without adequate delays built into the test, measurements can be inaccurate.

When the AID GROUP is set to STANDARD, minimal delays are used with each test. When the AID GROUP is set to AGC, the delay timings are increased. The ADAPTIVE setting uses longer delays than the AGC. The AID GROUP setting is available in the local menu of each measurement screen.

When the USER LEVEL setting is set to ADVANCED (see Section 2.3.2), the user can further fine tune the delays used in each test. There are three different delay settings. They are located in the advanced menu of each screen (the USER LEVEL setting must be set to ADVANCED).

- The PREDELAY time is the amount of time the FP35 analyzer presents the first tone in a test. The tests that the predelay setting affects are frequency sweeps, FOG measurements in the automated test sequences, reference test gain measurements (automated test sequences), harmonic and intermodulation distortion measurements, and equivalent input noise measurements.

- The SHORT SETTLE time is the amount of time each frequency in a pure-tone sweep is presented before a measurement is made, and the additional delay to the "on" time in a digital speech signal. It is also used in intermodulation distortion sweeps.

- The LONG SETTLE time is the amount of time each frequency in an input/output sweep is presented before a measurement is made. It also sets the delay between the individual frequencies of three-frequency averages and distortion measurements.

The default delay times are as follows:

Standard	PREDELAY:	100 ms
	SHORT SETTLE:	0 ms
	LONG SETTLE:	0 ms
AGC	PREDELAY:	500 ms
	SHORT SETTLE:	50 ms
	LONG SETTLE:	100 ms
Adaptive	PREDELAY:	3000 ms
	SHORT SETTLE:	100 ms
	LONG SETTLE:	250 ms

When you are testing an adaptive AGC aid, any test using the three frequency average defined in AVG FREQS (full-on gain, reference test gain, distortion measurement) is actually taken four times. In order to give the aid a chance to settle, the first three measurements are discarded. The fourth measurement is what appears on the screen as the final measurement.

2.5 Source Types & Measurements

The FP35 analyzer comes standard with the following pure-tone signals:

- NORM—A detailed frequency response curve that gives you information on the amplification of 43 different frequencies between 200 and 8000 Hz.

- FAST—A continuous pure-tone sweep that updates as quickly as once a second. It takes measurements at 16 different frequencies between 200 and 8000 Hz.

- SHORT—A single pure-tone sweep of 10 different frequencies. It takes about a second to complete.

- SINGLE—A single pure-tone frequency, or a continuous three frequency average selected in the Advanced Menu.

- LONG—A frequency response curve that measures 64 different frequencies, containing more information (and taking longer) than the standard NORM sweep.

- COMP—A continuous real-time, speech-weighted signal made up of 79 different frequencies that update up to 5 times a second. The composite signal gives you the advantage of seeing how an aid behaves to noise that more closely simulates speech, and it lets you see immediately how the aid responds to any change in the amplitude of the signal.

- DIG SPCH—A randomly interrupted composite signal designed to mimic speech. This signal is for use with hearing aids with a "noise reduction" or "speech enhancing" feature that lowers the gain of the aid in the presence of a continuous signal (such as the regular composite signal). See Appendix F for more details.

2.5.1 Understanding Pure-Tone Signals

The different adjustments and measurements that you can make with pure-tone signals are described in this section, including a discussion of the delay settings, harmonic distortion, noise reduction, and warble rates.

2.5.1.1 Delay Settings

You can refine your pure-tone measurements by adjusting their delay times. These adjustments are provided because some hearing aid circuits take a longer time than others to adjust to changes in amplitude or frequency. If the measurement is made too quickly, a testing artifact can result. If the measurement takes too long, the test is longer than necessary.

In determining the length of time needed for a proper measurement, a good rule is to use twice the published attack time of the hearing aid. If you are unsure of the attack time, you can experiment with longer times and shorter times and see if there is any difference in the test results. Linear aids can be tested very quickly, so a delay of 20 msec is usually fine. Other aids are quite variable. See Section 2.4 for a description of the available delay settings.

2.5.1.2 Harmonic Distortion

Harmonic distortion occurs when a hearing aid clips the peak of a pure-tone input signal, resulting in artifacts at harmonics (integer multiples) of that input signal. For example, if you present a 500 Hz tone to the hearing aid, distortion artifacts could occur at 1000 Hz and 1500 Hz.

The harmonic distortion measurement is expressed as the percentage of the power of these distortion artifacts to the power of the input signal. All hearing aids will have some amount of distortion.

Usually, the strongest artifacts occur at the second and third harmonics of the frequency. With the FP35 analyzer, you can test the amount of distortion available in the second harmonics, the third harmonics, or both harmonics (considered "total harmonic distortion").

In general, you should ignore the harmonic distortion measurement when the amplitude of the response curve measurement at the second harmonic is more than 12 dB greater than the amplitude at the first harmonic. This is called the 12 dB rule and is part of the ANSI S3.22 standard.

Historically, the harmonic distortion measurement has been taken only at signal levels below 90 dB SPL. This is because it was assumed that most hearing aids went into saturation at that loud of a level, resulting in very high harmonic distortion measurements. For this reason, we introduced a "90 dB harmonic distortion" rule on our analyzers that automatically turned off harmonic distortion measurements with signals that are 90 dB SPL or higher. On the FP35 analyzer, this was implemented as the DIST 90 DB RULE setting in the Custom menu of the Coupler Multicurve and real-ear measurement screens. (The USER LEVEL must be set to ADVANCED. See Section 2.3.2.) In recent years, however, hearing aids have become more sophisticated and better able to handle loud signals, making harmonic distortion a more useful measurement at 90 dB SPL. The DIST 90 dB RULE is still available, but we have turned it OFF by default.

Definitions

- 2ND Harmonic: Energy of the second harmonic or twice the presented frequency.
- 3RD Harmonic: Energy of the third harmonic or three times the presented frequency.
- TOTAL: Combined 2ND and 3RD harmonic distortion.

2.5.1.3 Noise Reduction

Noise reduction is used in noisy testing environments. Pure-tone noise reduction takes several measurements at each frequency and averages those measurements together. Larger noise reduction numbers lead to smoother curves but increase the amount of time it takes to complete a pure-tone sweep.

For example, if you select "4" as the pure-tone noise reduction setting, 172 measurements (43 x 4) will be taken with every normal pure-tone sweep

2.5.1.4 Warble Rates

When you take pure-tone measurements in a sound field environment, it is useful to warble the tones to reduce standing wave effects and create more accurate measurements. (Warbling is not usually necessary in a sound chamber testing environment.)

The FP35 analyzer allows you to change the warbling rate of its pure-tone signals. You do this by altering the WARBLE SOURCE selection in the Custom Menu of the Coupler Multicurve Screen and the Real-Ear Measurement Screens. The USER LEVEL must be set to ADVANCED. See Section 2.3.2.

Some types of warbling can cause problems when used to test digital hearing aids. This is because the digital processing delay of the aid conflicts with the warbling timing. We have altered our SLOW warble signal to account for this problem. This type of warbling is automatically selected during real-ear measurements when the AID TYPE is set to ADAPTIVE in the local menu of the measurement screen.

Here is an explanation of the available warble selections:

- FAST is usually used in real-ear measurements. In all screens except the Audiogram Entry Screen, it warbles at a rate of 33 Hz. In the Audiogram Entry Screen, it warbles at a rate of 20 Hz, ±5% deviation from the central frequency.
- SLOW is used for testing digital hearing aids and for audiometric measurements. It warbles at a rate of 6.25 Hz, ±5% deviation.
- OFF turns off all pure-tone warbling in all measurements.
- AUTO makes the following warbling selections:

  - OFF for all sound chamber measurements and real-ear measurements made with NORMAL or SHORT pure-tone sweeps.

  - FAST for real-ear measurements made with either a FAST pure-tone sweep or SINGLE pure-tone with an AID TYPE of STANDARD or AGC.

  - SLOW for real-ear measurements made with either a FAST pure-tone sweep or SINGLE pure-tone with an AID TYPE of ADAPTIVE.

2.5.1.5 Adjusting the Signal Skew

The SIGNAL SKEW selection, available in the Custom Menu of several measurement screens, is the number of samples from when the source signal leaves the speaker and when it is measured by the microphone. (The USER LEVEL must be set to ADVANCED. See Section 2.3.2.)

The amount of time it takes for a sound signal to travel from the speaker, through the hearing aid (or device being measured), and to the ear or coupler, where it is measured by the FP35's microphone, varies naturally depending upon the distance of the FP35 microphone from the speaker and the amount of digital processing delay inherent in the hearing aid. This time delay is normally so small that it does not affect the quality of the hearing aid measurements. However, some digital hearing aids have a signal processing delay significant enough to make this amount of time more meaningful.

A warbling pure-tone signal, in particular, is dependent upon the FP35's ability to synchonize the source signal and the measurement processing. When the hearing aid adds additional delay through its internal signal processing, it can throw the FP35's internal synchonization off. The SIGNAL SKEW menu item lets you adjust for this delay by specifying the number of samples between the source emitting the signal and the FP35 processing it. There are 39 uS (microseconds) in each sample for 100 Hz-interval frequency. The SIGNAL SKEW selection is applied to all source types, but it should only have an effect on pure-tone measurements.

2.5.1.6 Three-Frequency Averages

Three-frequency averages are usually performed within an automated test sequences. When the USER LEVEL is set to ADVANCED (see Section 2.3.2), you can also perform them from within the Coupler Multicurve, Target Coupler, or any of the real-ear measurement screens. The three frequencies that are used to perform the average measurements are chosen in a menu selection and represented by the last frequency of the three-frequency average. Here is a complete listing of the available averages.

- HFA 1000, 1600, **2500**
- SPA 1250, 2000, **3150**
- SPA 1600, 2500, **4000**
- SPA 2000, 3150, **5000**
- SPA 800, 1250, **2000**
- IEC 500, 1000, **2000**

Choose the three-frequency average that is closest to that recommended by the manufacturer. When this average is unknown, choose the average that represents the frequency range that the aid amplifies the most. The default frequencies are HFA 1000, 1600, 2500.

2.5.2 Understanding Composite Signals

There are two types of composite signals: Composite and Digital Speech. The Composite signal is a continuous broadband signal containing 79 different frequencies presented simultaneously. This signal is "speech weighted," which means that the lower frequencies have a higher emphasis than the higher frequencies.

The Composite signal is both a faster and a more realistic signal than a pure-tone sweep because there is no waiting for a progression of tones to complete, and, like speech, a broad spectrum of frequencies is used simultaneously. The Composite signal updates several times a second.

Digital Speech is an interrupted version of the Composite signal used for test-

ing high end digital hearing aids. Many high end digital aids (though not all) use a technology called "speech enhancement" or "noise reduction." These aids respond to any continuous signal as if it were noise, and lower the gain at the offending frequencies. Unfortunately, these aids regard the Composite signal or pure-tone sweeps as noise, making them difficult to test using traditional methods.

Digital Speech was developed as a way to test these high end hearing aids. Instead of presenting a continuous signal, it presents an interrupted signal that the aid regards as speech instead of noise.

2.5.2.1 Filter Type

Filters are the type of speech weighting applied to the test signals as they are presented to the hearing aid. By default, the FP35 analyzer automatically chooses the appropriate speech weighting to use with a particular type of signal.

For instance, when you use a pure-tone signal, a flat weighting is used. That is, every frequency of the pure-tone sweep has the same amplitude. When you use the composite signal, the Frye ANSI speech weighting is used. That is, the low frequencies have higher amplitudes than the higher frequencies.

The FP35 allows you to specifically choose the type of speech weighting you want to use. You do this by altering the FILTER selection in the Advanced Menu of the Coupler Multicurve Screen and the Real-Ear Measurement Screens. Here is an explanation of the available filter selections:

- FLAT—No speech weighting used. All frequencies have the same amplitude.
- ANSI—The standard Frye composite signal weighting which starts 3 dB down at 900 Hz and continues to roll off the high frequencies at a rate of 6 dB per octave.
- ICRA—The speech weighting taken from the CD of sounds developed by the International Collegium of Rehabilitative Audiology.
- C-LTASS—The child long term average speech spectrum used by the University of Western Ontario in their DSL fitting method.
- A-LTASS—The adult long term average speech spectrum used by the University of Western Ontario in their DSL fitting method.
- ANSI-92—The speech weighting specified in the ANSI S3.22-1992 standard. It is very similar to the ANSI weighting except that it contains a low frequency filter at 200 Hz.

When AUTO is selected, the following filters are automatically applied:

Coupler Multicurve Screen:
- FLAT with pure-tone signal
- ANSI with Composite/Digital Speech signal

Real-Ear SPL Screen:

- FLAT with pure-tone signal above 85 dB SPL
- ANSI with non-DSL fitting rule (all other signal types)
- A-LTASS with DSL fitting rule for adults (all other signal types)
- C-LTASS with DSL fitting rule for children (all other signal types)

Real-Ear Unaided & Aided Screen and Insertion Gain Screen:

- FLAT with non-DSL fitting rule and pure-tone signal
- ANSI with non-DSL fitting rule and Composite/Digital Speech signal
- FLAT with DSL fitting rule and pure-tone signal above 85 dB SPL
- A-LTASS with DSL fitting rule for adults (all other signal types)
- C-LTASS with DSL fitting rule for children (all other signal types)

2.5.2.2 Intermodulation Distortion

IM distortion occurs when more than one frequency is present in the source signal and those frequencies combine to create new frequencies not actually present in the source. It is visible as jagged peaks in the frequency response of the hearing aid when a composite signal source is used.

The IM distortion test was developed as a more precise measurement of the amount of IM distortion created by the hearing aid than can be obtained by just eyeing the jagged peaks of a composite source response curve. It works by presenting two different frequencies to the aid at the same time and measuring the aid's response to those frequencies. IM distortion occurs when the aid produces components at frequencies other than the two input frequencies. These additional components usually occur at frequencies that are mathematically related to the input frequencies (multiples of the sum and difference of the original frequencies and their harmonics).

The two input frequencies are known as the "primary" and the "secondary" frequencies. The primary frequency is controlled either by the user with the [◄ ►] keys, or by the analyzer when it is doing a sweep test. The secondary frequency is always at a fixed distance from the primary frequency. You can select the fixed distance between the primary and the secondary frequency in the measurement screen menu.

Types of IM distortion tests

You can perform either a static IM distortion test or an IM distortion sweep. In the static IM distortion test, the FP35 analyzer produces a signal consisting of the primary and secondary frequencies, and shows the resulting response as a composite type display. The measurement is updated in real-time until you turn it off. You can change the primary frequency by using the [◄ ►] keys. The secondary frequency will also adjust as you change the primary. In this manner, you can manually step through the different frequencies and see when the aid produces IM distortion.

In the IM distortion sweep test, the FP35 analyzer produces a sweep of the two frequency combination. This is similar to a normal pure-tone frequency sweep, but two frequencies are used at a time instead of one at a time. The FP35 analyzer measures the IM distortion by looking at frequencies that have a mathematical relationship to the primary frequencies. Any amplification at those frequencies is considered IM distortion. The frequencies chosen are selected in the DISTORTION menu selection. See the next section for details. The results are displayed as a double wide line with a percentage scaling found on the right side of the graph.

Harmonic Distortion measurement test

If desired, IM distortion tests can be performed with only one frequency instead of two. This turns the test into a simple harmonic distortion test. The only difference between this type of harmonic distortion test and the standard harmonic distortion test is that the results are displayed as a line on the graph instead of bars, and more frequencies can be measured than in the standard harmonic distortion measurement. See Section 2.5.1.2 for more details on harmonic distortion.

Range of available frequencies

The range of frequencies available for the IM distortion sweep is dependent upon the IM FREQ DIFF and the DIST SWEEP END settings. When the USER LEVEL is set to EASY, the IM FREQ DIFF setting is available in the Coupler Multicurve Advanced Menu. When the USER LEVEL is set to ADVANCED, the IM FREQ DIFF and DIST SWEEP END settings are available in the Coupler Multicurve Custom menu. See Section 2.3.2 for information on the USER LEVEL setting.

The FP35 analyzer can produce signals and take measurements at 100 Hz intervals between 200 Hz and 8000 Hz. Both the primary and secondary frequencies used in the IM distortion measurement must be within this range. Therefore, the beginning of the range is always IM FREQ DIFF + 200 Hz. The ending of the range is always 8000 – IM FREQ DIFF, or DIST SWEEP END, whichever is lower.

Examples:

If the IM FREQ DIFF is 1000 Hz, the primary frequency will have a range of 1200 Hz to 8000 Hz. The secondary frequency will have a range of 200 Hz to 7000 Hz.

If the IM FREQ DIFF is 200 Hz, the primary frequency will have a range of 400 Hz to 7000 Hz. The secondary frequency will have a range of 200 Hz to 7800 Hz.

If the DIST SWEEP END is less than or equal to the first primary frequency, only the primary frequency will be tested; there will be no IM distortion sweep.

The range for the static IM distortion test is IM FREQ DIFF + 200 Hz through 8000 − IM FREQ DIFF. The DIST SWEEP END setting has no effect on the static IM measurement.

Frequencies measured for IM distortion

When performing an IM distortion sweep, the FP35 analyzer looks at frequencies with a mathematical relationship to the primary frequencies of the test to determine IM distortion. You can select which frequencies are examined by using the DISTORTION selection in the Coupler menu. Use 2ND or 3RD for a faster test. Use TOTAL for a longer, more complete test.

Here's the technical details of the frequencies examined for those of you who are interested:

> 2ND: [F1 + F2] + [F1 − F2]_3RD: [(F1*2) + F2] + [(F1*2) − F2] + [(F2*2) − F1] + [(F2*2)+F1]_TOTAL: All frequencies excluding F1 and F2.

(F1 and F2 are the primary frequencies of the IM distortion sweep.)

Delays

Just like a pure-tone sweep, you can change the delays in the IM distortion sweep. The PREDELAY time sets how long the first signal will be presented in a distortion sweep before the measurement is made. The SHORT SETTLE time determines how long the source is presented for the remaining sweep frequencies in the distortion sweep. See Section 2.4 for more information. The USER LEVEL must be set to ADVANCED to change these settings. See Section 2.3.2.

Distortion measurement noise

When measuring distortion, particularly IM distortion, it is important to understand the contribution of noise in the measurement. The more distortion components that are measured, the more that noise affects the results.

When distortion is being measured, it is usually desirable to find out how much the hearing aid distorts the original signal. However, room noise also distorts the signal. For example, for total IM distortion, a noise floor 20 dB below the source will result in a 1% distortion contribution of noise to the test results. For this reason, it is recommended that the IM distortion test be performed 30 dB above the noise floor of the room. This will dramatically reduce the influence of room noise in the IM distortion test.

Conversely, it is also important to be careful not to measure IM distortion with too loud of a source level because you could risk creating distortion caused by overdriving the hearing aid or the hearing aid analyzer.

You can reduce the affect of noise on the IM distortion test results by reducing the number of frequencies that are measured in the test. Do this by measuring the 2nd or the 3rd IM distortion instead of the total IM distortion. See Section 4.2.6.3.

Impulse rejection

Impulse rejection can be used to reduce distortion caused by impulses in the room noise. When noise reduction is used with IM distortion measurements, several measurements are made to obtain the test results. When impulse rejection is on, the FP35 analyzer looks at the peak response of each measurement. If the peak of the last measurement plus the impulse rejection amount is more than the peak of the current measurement, the current measurement will be rejected and taken again. This can reduce the effect of room noise in the overall test results. Impulse rejection applies to all measurements, not just intermodulation distortion.

Default Settings

When IM DIST is saved as the COUPLER or REAL-EAR RESET SRC in the Advanced Default Settings Menu, the IM FREQ DIFF, DISTORTION SWEEP, and DIST SWEEP END settings in the local menu will also be saved as default settings, even though these settings are not available in any of the Default Settings Menus.

2.5.2.3 Noise Reduction

Composite noise reduction is a little different than pure-tone noise reduction (discussed in Section 2.5.1.3), even though both are used for noisy testing environments.

Noise reduction for a composite signal averages together several of the previous measurements with the current measurement to produce the next curve. When you start measuring with a composite signal, the noise reduction displayed on the screen will show the number of curves averaged so far in the measurement. Thus, when the composite signal is first turned on and only a few measurements have been taken, the noise reduction will begin as a low number. This number will increase as more measurements are taken, eventually reaching the target noise reduction selected in the menu.

Larger noise reduction numbers lead to smoother curves but increase the amount of time it takes the analyzer to update the composite display.

2.5.3 Measuring RMS

RMS ("root mean square") is a measurement of the average energy of a response curve. It comes from a mathematical formula in which the response at each frequency is squared. The RMS is the square-root of the sum of all these squares. RMS is normally used in all Composite and Digital Speech measurements for both coupler and real-ear measurements. It is also used in pure-tone measurements greater than 90 dB SPL in coupler mode, or greater than 85 dB SPL in real-ear mode.

On the FP35 analyzer, the RMS analysis is normally done using an estimated RMS (ERMS). In ERMS, the FP35 compensates for system response errors that, while minimal, can amount to several dB SPL in some situations. Compensation for these errors is done by passing the signal through an FFT (fast Fourier transform), correcting the response, then converting the data back to RMS. This allows for greater RMS accuracy as long as there is not a lot of noise in the signal.

A problem with ERMS is that, in order for the measurement to be optimal, the signal measured must be synchronized to the measurement system. When using a source generated by the FP35, this will be the case. However, if the FP35 is in Spectrum Mode, or if there is a lot of noise in the signal, part of the measurement data may not be fully analyzed by the FFT, particularly if there is high frequency noise that is outside the range of the FFT. Normally, the errors associated with the ERMS analysis method are less than the errors with the True RMS (TRMS) method, but in specific cases, TRMS might be slightly more accurate.

True RMS (TRMS) does not compensate for system response errors. It can be more accurate for measurements using external signal sources or measurements in an extremely noisy test environment. It is also a much faster measurement because it doesn't use an FFT – using TRMS can speed up the measurement by nearly 50%. TRMS does contain a frequency response correction at 1 kHz, regardless of the selected frequency.

TRMS cannot be used with the probe microphone. This is because the probe microphone of the FP35 analyzer does not have a flat response – to achieve an accurate measurement, the analyzer must compensate for the response of the microphone. As such, all RMS measurements made with the probe microphone are always done as ERMS.

TRMS also cannot be used when the input speech filter is enabled. Measurements made with the Composite and Digital Speech signals are usually speech weighted. ERMS must be used for those measurements.

Corrected True RMS (CRMS) is True RMS with a correction in the frequency response at the current selected frequency. CRMS can provide slightly more accurate measurements when using the FP35 signal source, but potentially can be less accurate if the dominant signal is not the source signal or there is no source signal.

The accuracy difference between the different RMS analysis methods is normally +/- 3 dB, and typically less than 2 dB. By allowing different RMS methods to be selected, the user can improve the accuracy for a particular measurement. For best accuracy, the microphones should be custom calibrated.

The RMS analysis method can be set in the Custom menu of the real-ear measurement screens and the Coupler Multicurve, Coupler Target and Coupler EarSim screens. The USER LEVEL must be set to ADVANCED to change these settings. See Section 2.3.2 for details.

To change the method:

1. Press [MENU] in one of the screens described above to enter a local menu.
2. Press [NEXT] twice to enter the Custom menu.
3. Use [▼, ▲] to select RMS ANALYSIS.
4. Use [◄, ►] to choose the selection. The choices are: ERMS, TRMS, NONE, AUTO.

The RMS analysis choices are described here:

AUTO or ERMS:

- RMS OUT will be measured as ERMS with Composite or Digital Speech
- ERMS will be measured with real-ear pure-tones at or above 85 dB SPL.
- ERMS will be measured with coupler pure-tones at or above 90 dB SPL.

TRMS:

- RMS OUT will be measured as TRMS with Composite or Digital Speech.
- ERMS will be measured with real-ear pure-tones at or above 85 dB SPL.
- ERMS will be measured with coupler pure-tones at or above 90 dB SPL when the reference microphone is *on*.
- TRMS will be measured with coupler pure-tones at or above 90 dB SPL when the reference microphone is *off*.

NONE:

- RMS OUT will not be measured for Composite or Digital Speech.
- ERMS will be measured with real-ear pure-tones at or above 85 dB SPL.
- ERMS will be measured in coupler pure-tones at or above 90 dB SPL when the reference microphone is *on*.
- CRMS will be measured in coupler pure-tones at or above 90 dB SPL when the reference microphone is *off*.

2.5.4 Measuring the RMS of the reference microphone

The Advanced menus of the Coupler Multicurve, Coupler Target, Coupler EarSim, and real-ear measurement screens contain the REFERENCE STATUS menu item. This controls the RMS measurement of the reference microphone. (The USER LEVEL must be set to ADVANCED to change these settings. See Section 2.3.2 for details.) The following selections are available:

- NONE (default)—The RMS of the reference microphone is not measured.
- RMS—The overall RMS of the reference microphone will be displayed when the reference microphone is on.
- FULL—The reference signal quality as well as the overall RMS will be displayed when the reference microphone is on.

When set to RMS or FULL, the REF ON status display in the measurement screen will be replaced with REF NNdB indicating the overall RMS of the reference microphone. If the microphones are reversed (see Section 3.8.4), it will be displayed as "REV NNdB." If the microphones are split (see Section 3.8.5), the reference RMS information is not displayed.

When set to FILL, the reference signal quality will be displayed immediately to the left of the "REF NNdB" status in a slightly smaller font. It will appear as "nnREF NN dB." If the quality value exceeds 99, a double exclamation "!!" will be shown, indicating that the data is out of range.

The signal quality information is obtained by determining the worst deviation in dB from a perfect source signal. For instance, if the source measured by the reference microphone is perfect (looks exactly as it looked when leveled), except for a 3 dB error at 500 Hz, the reference quality will be "3." Only the worst error is indicated. In order to minimize the effect of noise and other problems on the reference quality, only the frequencies between 260 Hz and 6000 Hz are checked for quality.

Most of the chamber quality errors encountered will be the result of probe tube errors. Doing a custom calibration of the probe microphone with the probe tube that will be used with the measurement will improve this. It will not make the response "perfect," because minor changes in the probe tube placement can result in minor variances in the readings. It is normal to have one to two dB errors with the probe tube, even when it's in the sound chamber. Sound field errors may be even greater because of noise and reflections.

Note: When RMS ANALYSIS is set to NONE, the reference RMS and quality signal will not be measured. See Section 2.5.3 on the RMS analysis method.

2.5.5 Using the Earphone Jack

The earphone jack on the FP35 analyzer is normally used for RECD measurements and telecoil measurements. However, it might also be used for special purpose testing, such as a loop-back cable to test electrical (non-acoustic) operation, or a special user-supplied transducer, such as one that might be used to test a cochlear implant. It is not used as an external speaker jack, which has its own connector.

By default, the earphone jack on the back of the FP35 is disabled in all screens except the Audiogram Entry screen when the telecoil is disabled. (See Section 2.5.8 for details on telecoil measurements.) This is to prevent confusion and to make sure that if an external speaker is being used, it is plugged into the proper speaker jack instead of the earphone jack.

You can choose to deliver the FP35 analyzer's signal to:

- Only the speaker (this can be internal or external)
- Only the left channel of the earphone jack
- Both the left and right channels of the earphone jack
- Both channels of the earphone jack and the speaker simultaneously

To select the output device:

1. Set the USER LEVEL to ADVANCED in the Default Settings menu. See Section 2.3.3.
2. Press [MENU] in the measurement screen.
3. Press [NEXT] twice to enter the Custom menu.

4. Select OUTPUT JACK using the [▲ ▼] keys.

5. Choose SPEAKER to enable only the speaker, MONO EAR to enable only the left channel of the earphone jack, STEREO EAR to enable both channels of the earphone jack, or ALL ON to enable both earphone jack channels and the speaker.

6. Press [EXIT] to return to the measurement screen.

2.5.6 Using Impulse Rejection

Impulse rejection reduces the amount of noise measured in the testing environment by working together with the noise reduction setting. When the impulse rejection is set, the FP35 looks for sudden increases in the signal equal to at least as much as the set impulse rejection and lasting at least half as many measurements as the set noise reduction. If an impulse is found meeting those specifications, that measurement is ignored. For example, if the noise reduction setting is 8, and the impulse rejection is 12, the FP35 analyzer will look for (and reject) impulses of at least 12 dB, lasting for up to 4 measurements. This is useful for noisy testing environments. The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.3

2.5.7 Using an External Speaker or Sound Chamber

It is possible to use an external sound chamber for performing coupler measurements, and an external sound field loudspeaker for performing real-ear measurements.

In order to make the FP35 analyzer as portable and lightweight as possible, its sound chamber necessarily had to be fairly small. We have compensated for its size by making every effort to occlude exterior noise from entering the sound chamber, and by recommending that the coupler be included in the chamber during the leveling process. However, a large chamber will give better sound isolation and make it easier to position hearing aids.

If you have the Real-Ear Option, you might also find it handy to use an external sound field speaker for your measurements. The external speaker can be mounted on a floor stand or a swing arm. A swing arm is especially convenient because you can move the speaker around the patient when you switch ears, rather than orient your patient to the speaker.

The external sound chamber and the external sound field speaker can both use the external sound field speaker jack on the back panel of the FP35. If it is desired to connect the external sound chamber and the external sound field speaker at the same time, the internal speaker can be disconnected entirely, and the internal speaker jack can be used to connect the external sound chamber. If this is done, the external sound chamber will be treated as the "internal" speaker by the FP35 analyzer's software.

Figure 2.5.7—External sound field speaker setup

To set up your FP35 software to use an external speaker:

1. Press [MENU] from the Opening screen to enter the Default Settings menu.

2. Press [NEXT] to enter the Advanced Default Settings menu.

3. Select SPEAKER under REAL-EAR and/or COUPLER with [▼, ▲] keys. Use [◄, ►] to make the selection. The SPEAKER selection under REAL-EAR selects whether the INTERNAL or EXTERNAL speaker will be used for real-ear measurements. The SPEAKER selection under COUPLER selects whether the INTERNAL or EXTERNAL speaker will be used for coupler measurements. The AUTO selection chooses the internal speaker for sound chamber measurements and the external speaker for real-ear measurements.

4. Use [F5] to save the settings to permanent memory.

5. Press [EXIT] to return to the Opening screen.

You can also set the speaker selection by using the SPEAKER menu item in the Advanced or Custom menu of most measurement screens. (Press [MENU] from the measurement screen and press [NEXT] once or twice until the setting is shown in the menu.)

2.5.8 Measuring Telecoil

The telecoil function of a hearing aid can be measured by using an external telecoil board or by using a Telewand. These are both optional accessories that can be plugged into the earphone jack.

In February 2007, a new rear panel was introduced on the FP35 analyzer. The earphone jack connector was changed from 3.5 mm to 1⁄4 in to match the standard size of an insert earphone. The speaker jack was changed from a non-stan-

dard modular plug to a 3.5 mm connector. If you have the new style rear panel, you can use either the earphone jack or the speaker jack to connect the external telecoil board or the Telewand device. You will need a 3.5 mm to 1/4 inch adapter to use a 3.5 mm phone plug with the new rear panel.

1. Press [MENU] from the Opening Screen.
2. Use [▼, ▲] to select TELECOIL under COUPLER.
3. Use [◄, ►] to choose one of the following settings:
   - TMFS EAR if you want to be able to use the Telewand in the earphone jack in coupler mode.
   - TCOIL EAR if you want to be able to use the Telewand *or* an external telecoil board in the earphone jack in coupler mode.
   - TMFS SPKR if you want to be able to use the Telewand in the speaker jack in coupler mode (new style rear panel only)
   - TCOIL SPKR if you want to be able to use the Telewand *or* an external telecoil board in the speaker jack in coupler mode (new style rear panel only)
   - OFF if you want to disable telecoil measurements in coupler mode.
4. Use [▼, ▲] to select TELECOIL under REAL-EAR.
5. Use [◄, ►] to choose one of the following settings:
   - TMFS EAR if you want to be able to use the Telewand in the earphone jack in real-ear mode.
   - TMFS SPKR if you want to be able to use the Telewand in the speaker jack in real-ear mode (new style rear panel only)
   - OFF if you want to disable telecoil measurements in coupler mode. (an external telecoil board cannot be used for real-ear measurements)
6. Press [EXIT] to return to the Opening Screen.
7. Enter the measurement screen you want to use to test telecoil and turn on the telecoil test in that screen. For ANSI measurements, see Sections 4.1.5 and 4.1.6. For Coupler Multicurve measurements, see Section 3.8.7. For real-ear measurements, see Section 5.7.6.

Testing Location

It is very important to pick a testing location that is free of magnetic disturbanes, 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 and a telecoil switch.
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 insert 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.

2.5.9 Changing the Microphone Selection

In November 2008, the FP35 had a major revision (the "-09" main board) that added an external microphone to the front of the analyzer. This connector is for use with the new style probe microphone with the integrated ear hook. A 3.5mm jack labeled "Line-in" was also added for the use of external inputs from a CD player.

By default, the external microphone is used for real-ear measurements and the internal microphone (connected inside the sound chamber), is used for coupler measurements. However, if you have a special circumstance, you can change these selections.

If you would like to temporarily change the microphone input from the local menu of the measurement screen, you must set the USER LEVEL of the analyzer to ADVANCED. See Section 2.3.2 for details. Once this is done, go to the measurement screen and press [MENU], [NEXT], [NEXT]. This will take you to the "Custom Menu" of the measurement screen. Change the MIC PORT setting. These are the possible selections:

* AUTO: Use the external microphone port for real-ear measurements if it is available. Use the internal microphone port for coupler measurements if it is available.

* INTERNAL: Use the internal microphone port for all measurements.

* EXTERNAL: Use the external microphone port for all measurements.

* EXT LINE: Use the "line in" jack on the back of the analyzer as an external measurement input. This is a special case used for devices such as cochlear implants that are not measured with conventional hearing aid measurement techniques.

If you would like to make one of these options more permanent as a default, you can change this setting in the Default Settings Menu. From the Opening screen of the analyzer, press [MENU], [NEXT], [NEXT] to enter the Resets Default Setting Menu. The MIC PORT setting with the selections described above are available in this screen.

2.6 Printing

The FP35 analyzer comes equipped with an internal thermal printer so that the ability to print a hard copy of your results is always available. The thermal printer prints a clear, easy-to-read image of the display. You can also hook up an external printer to print your results on normal office paper. You can use any external printer that supports HP PCL (Hewlett Packard Printer Computer Language) version 3.0 and above.

The general operation of the FP35 printer is easy:

- Press [PRINT/FEED] to print any screen.
- Press [PRINT/FEED] again to stop printing. (**You can do this even if the screen has blanked out!)**
- Press and hold down the [PRINT/FEED] key to feed the paper forward.

2.6.1 Choosing the Printer

If you are in the middle of a test, and you want to switch between using the internal and the external printer in the local screen without changing the default printer:

1. Press [MENU] from any test screen.
2. Press [NEXT] to enter the Advanced Menu.
3. Select PRINTER with the [▲] key.
4. Select either INTERNAL or EXTERNAL with the [▶] key.
5. Press [EXIT] to return to the test screen.

If you want to change the default printer:

1. Press [MENU] from the Opening screen to open the Default Settings menu.
2. Select PRINTER using the [▲] key.
3. Choose either INTERNAL or EXTERNAL with the [▶] key.
4. Press [F5] to save the current selection as the default.
5. Press [EXIT] to return to the Opening Screen.

2.6.2 Adding a Label

A label with your printout allows you to record useful information about the client and hearing aid to go along with the test results. See Figure 2.6.2. To view the label set on your analyzer, press [MENU] from the Opening screen to enter the Default Settings Menu, and then press [BACK]. This will display the label that will be printed on your analyzer printout whenever labeling is turned on.

If you are in the middle of a test, and you want to add a label for a printout in the local screen without changing the default setting:

1. Press [MENU] from any test screen.
2. Press [NEXT] to enter the Advanced Menu.
3. Select PRINT LABEL with the [▲] keys.
4. Select YES with the [▶] key.
5. Press [EXIT] to return to the test screen. Any printout in the current screen will now include a label until you turn off the analyzer.
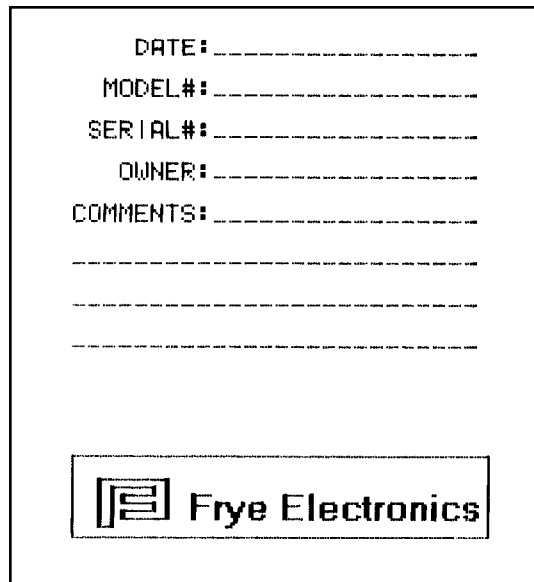
Figure 2.6.2—Label generated with printed results

If you want to include a label on all printouts by default:

1. Press [MENU] from the Opening Screen to open the Default Settings Menu.
2. Select PRINT LABEL using the [▲] key.
3. Select YES with the [▶] key.
4. Press [F5] to save the current menu setup.
5. Press [EXIT] to return to the Opening Screen.

Note: With the RS232 Option, you can use a computer to store your own label and graphic logo in the FP35. A program called "Set Label," available in the "download" section of our website *www.frye.com*, will help you change your analyzer's label.

The internal printer of the FP35 uses high quality thermal paper. This section will show you how to change the paper, fix any paper jams, and minimize the fading of the thermal printout.

2.6.3 Changing the Thermal Paper

To change or refill the printer paper:

1. Remove the printer door by pulling up on the notch at its top.
2. Remove the empty spool or the roll of paper. You are likely to feel some resistance as you pull it upward. If you are removing a full roll of paper, see Figure 2.6.3B.
3. **Do not pull the paper backward out of the printer.** Instead, cut or tear the end off the spool of paper and pull it through the printer in the direction it is meant to feed. Taking this step will help avoid unnecessary wear on the printer.

4. Remove the plastic rod from the empty spool or the roll of paper.

5. Place a new roll of paper on the plastic rod.

6. Cut the paper into a point. This will make it easier to thread into the printer.

7. Thread the paper, shiny-side-down, into the slot at the lower, back of the printer until it comes out the top.

    Note: It is possible to feed the paper below the slot, in which case printing will not work. After you have threaded the paper, press and hold [PRINT/FEED] to make sure the paper feeds properly. See Figure 2.6.3A.

8. Set the plastic rod (with the paper roll still on it) into the slots in the printer cavity, and replace the printer door, so that the paper feeds through the opening.
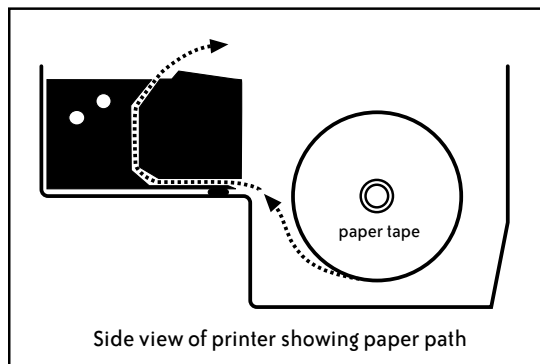

Figure 2.6.3A—Paper path for FP35

Note: If the roll of paper is full, it can be difficult to grip. Loosen some of the paper, pinch it into a fold, and use the fold to pull the paper and spool out of the cavity, as in Figure 2.6.3B
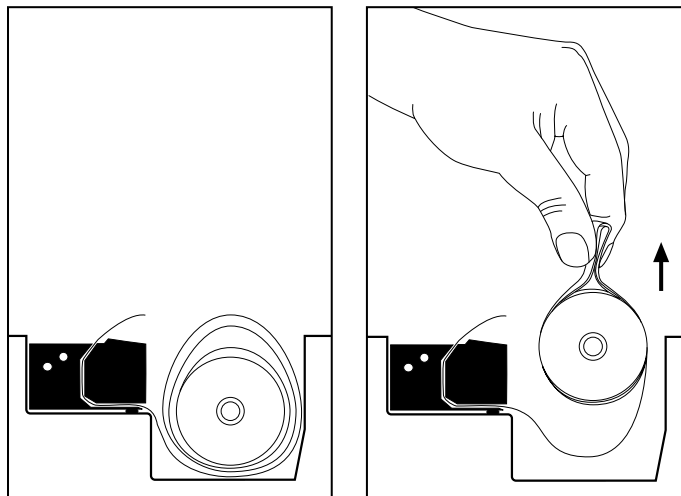

Figure 2.6.3B—Removing a full roll of paper

2.6.4 Fixing Paper Jams

If you do not get a response from pressing the [PRINT/FEED] key, check for a paper jam. In the event of a paper jam, manually pull paper through the printer 6–12 inches and try again.

2.6.5 Minimizing Fading

Although the paper used in the FONIX FP35 is a good quality thermal paper, any thermal printing can eventually fade over time. To minimize fading, store print-outs away from the light in a cool, dry place. Do not 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.

2.6.6. Using an External Printer

You can hook up an external printer to your FP35 analyzer to print your results on normal office paper. This eliminates the problem of fading associated with thermal printouts, and often makes it easier to store your results.

You can use any external printer that supports HP PCL (Hewlett Packard Printer Computer Language) version 3.0 and above. We keep a list of printers that work with our analyzers on our website: www.frye.com/products/analyzers/printerlist.html.

To connect an external printer to the FP35 analyzer:

1.   Unplug the FP35 analyzer and the external printer from any power source.
2.   Connect a standard printer cable to the external printer.
3.   Connect the other end of the cable to the connector on the back of the FP35 labeled "PRINTER."
4.   Plug the FP35 analyzer and the external printer into their respective power sources.
5.   Follow the directions found in Section 2.6.1 to select the external printer in the FP35 software. You are now ready to use the external printer.

2.7 Display & Data

This section describes how to view individual response curves in terms of their numerical data. It also describes the Curve ID box that is present in the real-ear and coupler measurement screens.

2.7.1 Data Display

It's often useful to look at the actual numerical data from a response curve. There are two ways you can use the data display on the FP35—you can convert a completed curve to a data table, or you can run a test and have the display update in data format. Either way, the data tables give you detailed numerical

information on the gain or output that the hearing aid provides. Figure 2.7.1 shows a printout of the data format.

Figure 2.7.1—Display of numerical test data

To use the data feature, select it as your DISPLAY in the menu:

1. Press [MENU].
2. Select DATA/GRAPH using the [▼, ▲] keys.
3. Set DATA using the [◄, ►] keys.
4. Press [EXIT].

To see the numerical data of an existing curve, press [F2] to select desired curve. To gather new information, press [START/STOP], and a new curve will be run, updating the data table once the measurement is complete. If you are using the composite or fast sweep signal, the information will continue to be refreshed with each new measurement until you push [START/STOP] again.

When the LONG signal source is selected and a distortion measurement is turned on, the data tabulation will not show the last four frequencies of the sweep. The last frequency displayed is 6500 Hz. The last four sweep frequencies 6700, 7100, 7500, and 8000 Hz will not be displayed.

2.7.2 Curve ID Box

The curve ID box provides you with much useful information about the curves. It has three main columns: # (curve number), SRC (source), and TYP (type).

Figure 2.7.2—Curve ID box

Number: This identifies the number of the relevant curve. The arrow to the right of these numbers indicates the current selected curve.

Source: This identifies the amplitude of each curve.

Type: The curve type is a little more complicated; each curve is identified by three letters.

First letter:
        I = Intermodulation Distortion
        C = Composite
        P = Pure-tone
        D = Digital Speech
Second letter:
    For pure-tone:
        N = Normal pure-tone
        F = Fast pure-tone
        S = Short pure-tone
    For composite or digital speech:
        W = Weighted composite
        F = Flat weighted
        S = Spectrum
Third letter:
        P = SPL measurement
        G = Gain measurement
        % = Percent

Note: When you toggle back and forth between Gain and SPL in the menu, all curves are converted to the new format, except for spectrum measurements made with the reference microphone turned off.

Lastly, between the SRC and TYP columns, the FP35 uses symbols to describe the display status of the curves.

≡   Curve is completely on the graph

•   Curve is measured but turned off

↓   Curve is partially off the bottom of the graph

↑   Curve is partially off the top of the graph

▲   Curve is on, but is out of view above the graph

▼   Curve is on but is out of view below the graph

↕   Curve is partially off the graph in both directions

Coupler Measurements

Coupler measurements are electro-acoustical tests performed using a coupler acting as an artificial ear inside the sound chamber. This chapter describes how to perform coupler measurements manually in the Coupler Multicurve screen. For instructions on how to perform ANSI, IEC, or other automated test sequences, see Chapter 4, *Automated Test Sequences*.

In the Coupler Multicurve screen, you can perform up to four different coupler frequency response measurements using a variety of puretone and broadband signals (the Composite/Digital Speech Option is required for broadband signals). Test results can be displayed in terms of either SPL (output) or Gain.

To enter the Coupler Multicurve screen, press [F3] from the Opening screen. If this opens the Coupler Target or Coupler EarSim screen, use the [NEXT] or [BACK] keys to go to the Coupler Multicurve screen.

3.1 Coupler Multicurve Display
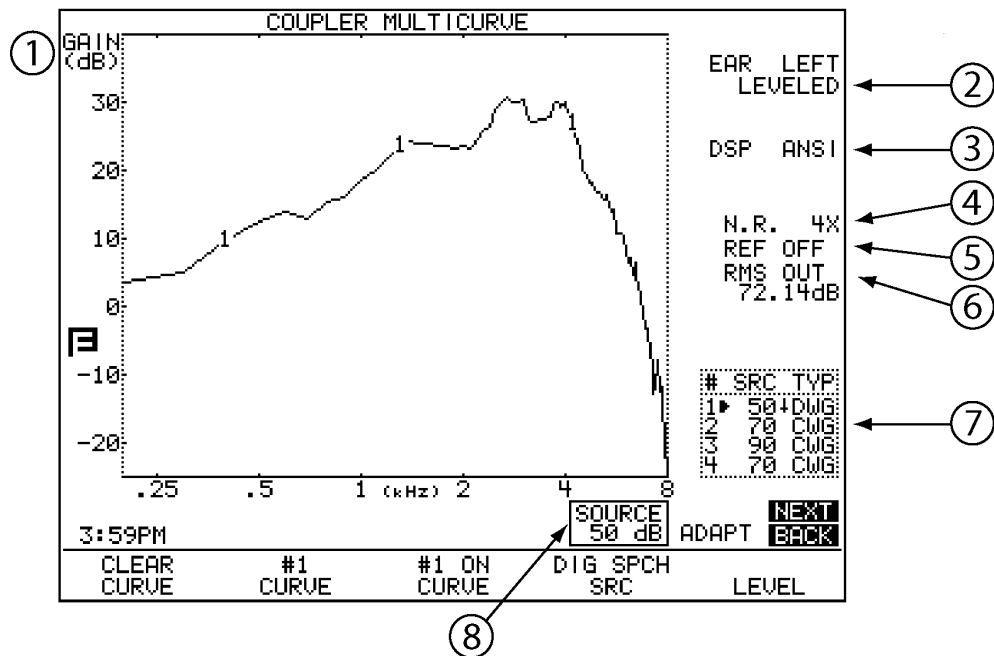
Figure 3.1—Coupler Screen

Refer to Figure 3.1 for the following explanation of the graphical display:

1. Type of display. This will be either dB SPL (coupler output) or dB Gain (coupler gain). Select between the two in [MENU].

2. Displays leveling status of the sound chamber. See Section 3.2 for more information.

3. Displays the signal and weighting types used with the selected curve.

4. N.R. = Noise reduction. Select this in [MENU].

5. Status of reference microphone. Select this in [MENU].

6. RMS/HFA data: If a composite signal is selected, the RMS OUT will be displayed here. Otherwise, the selected HFA or SPA will be displayed. Press [MENU] to select HFA/SPA frequencies.

7. Curve ID box. See Section 2.7.2 for more information.

8. Source Signal Statistics Box. The information in the box is dependent upon signal type.
   - COMP, DIG SPCH—Displays the RMS source amplitude.
   - NORM, FAST, SHORT, SINGLE—Displays the source amplitude, frequency, distortion, and output/gain.

3.2 Leveling the Sound Chamber

Leveling is the process by which the response of the sound chamber is measured and computer-corrected so that a "flat" sound field is achieved. Usually leveling is performed using only the coupler measurement microphone. However, a reference microphone can also be used that theoretically will make the leveling (and measurement) process more accurate. The reference microphone is available when the Real-Ear option is included on the FP35 or the M300 two microphone setup is specifically ordered with a sound chamber-only analyzer. For most clinical situations, leveling with only the measurement microphone (described in Section 3.2.1) is adequate.

There are three level states:

LEVELED—Indicates the leveling process was correct within 2 dB.

UNLEVELED—Indicates the leveling process was incorrect by at least 6 dB, or that the system has not yet been leveled.

◄BLANK►—If the display is blank where the words LEVELED or UNLEVELED usually appear, the leveling process was correct between 2 dB and 6 dB. You should attempt to level again. However, if repeated attempts fail to reach a leveled status, you can consider this status "good enough."

Note: Sections 3.2.1 and 3.2.2 describe how to level the sound chamber in the Coupler Multicurve screen. These procedures also work in the Coupler Target and automated test sequence screens.

3.2.1 Leveling without the Reference Microphone (Standard)

Leveling the sound chamber using only the measurement microphone is accurate enough for most clinical tests.

1. Enter the Coupler Multicurve screen by pressing [F3] in the Opening screen.

2. Open the sound chamber and place the coupler microphone at the center of the speaker cone in the sound chamber.

   If the microphone cables are not positioned properly, the chamber lid can pinch and eventually damage them. **Avoid damage by placing the cables between the arrows** at the bottom of the speaker face. The foam on the chamber lid is thicker and softer in this area, offering more protection.

3. Place the coupler that you will be using inside the chamber next to the coupler microphone. This is necessary because of the small volume of the FP35 internal sound chamber, and measurement results, particularly in the high frequencies, could be affected by the space the coupler takes up inside the chamber. See Figure 3.2.1.

4. Close the sound chamber lid securely so that it latches in place.

5. Make sure the environment is as quiet as possible.

6. Press [F5], followed by [START/STOP], to level the sound chamber.

7. Follow the instructions in Section 3.2.3 to save the leveling, if desired.

Note: When testing, make sure the hearing aid microphone is located where the grill of the measurement microphone was placed during the leveling process (usually at the center of the speaker cone in the sound chamber). This will increase accuracy through the low frequency range.
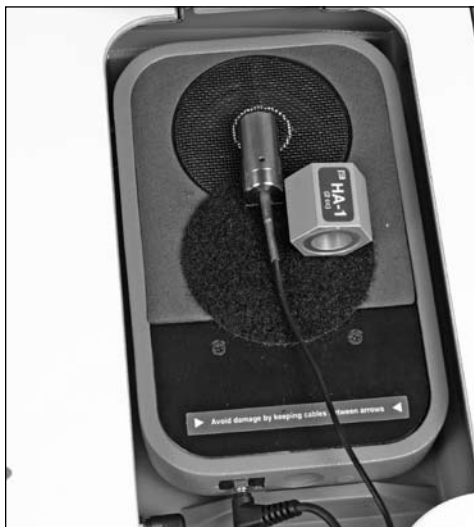
Figure 3.2.1—Normal leveling setup

3.2.2 Leveling Using the Reference Microphone

If your analyzer has the M300 two microphone setup, you can level using the probe microphone as a reference microphone. If you choose to do this type of leveling, you will need to level every time the hearing aid set up changes significantly (e.g. you begin to test a different style or model of aid). This method is more exact than the general purpose leveling described in the previous section and is performed at the factory. It is useful to note that for most practical purposes, there is little difference between the results of these two methods of leveling.

1. Enter the Coupler Multicurve screen by pressing [F3] in the Opening screen.

2. Look in the middle of the right side of the screen. If it reads REF OFF, you will need to turn on the reference microphone. To do this, press [MENU] and use the arrow keys to turn the REF MIC selection ON, and press [EXIT] to return to the Coupler Multicurve screen.

3. Set up the hearing aid that you are going to test. See Section 3.3 for details. Make sure the hearing aid is off.

4. Place the hearing aid/microphone assembly in the sound chamber with the hearing aid microphone at the reference point.

5. Attach a probe tube to the smaller reference (probe) microphone, and secure the end of the probe tube with a bit of blue adhesive putty so that the tip is right next to the microphone of the hearing aid.

6. Position the microphone cables between the arrows on the speaker face. The Velcro on the coupler will help secure the assembly in place. See Figure 3.2.2.

7. Close and latch the chamber lid.

8. Make sure the environment is as quiet as possible.

9. Press [F5], followed by [START/STOP], to level the sound chamber.

10. Follow the instructions in Section 3.2.3 to save the leveling, if desired.

Figure 3.2.2—Leveling using the reference microphone

3.2.3 Saving the Leveling Information

The FP35 can store leveling so that you do not need to re-level the sound chamber every time you turn on the FP35 analyzer.

To store leveling:

1. Press [MENU] from the Opening screen to enter the Default Settings Menu.
2. Press [F3] to enter the Calibration Menu.
3. Use the [▼, ▲] keys to move the cursor to the selection "Store Chamber Leveling in EEROM"
4. Press [START/STOP]. The FP35 will confirm that you want to store the leveling.
5. Press [START/STOP] again to proceed.
6. Press [EXIT] twice to return to the Opening Screen.

3.2.4 Changing the Leveling Source

By default, sound chamber leveling is performed at 90 dB SPL. (Real-ear leveling is performed at 70 dB SPL.) In special circumstances, you may want to perform coupler measurements with the aid positioned in front of an upright speaker. For instance, this is a technique often used to test directional hearing aids.

A loud leveling source, such as the default 90 dB SPL, is more accurate than softer leveling sources because there is less noise interference. However, the loud leveling source also requires the speaker to be close to the microphone. When you move the microphone away from the speaker, the leveling source will often have to be lowered. So, when performing coupler measurements with an upright speaker, it is often useful to turn the leveling source down.

To do this:

1. Press [MENU] from the Coupler Multicurve or Target Coupler screen to enter the local menu.

2. Press [NEXT] to enter the Advanced menu. (If the USER LEVEL is set to ADVANCED in the Default Settings menu, you will need to press [NEXT] again to go to the Custom menu.)

3. Use [▼, ▲] to select LEVELING SOURCE.

4. Use [◄, ►] to choose the desired level.

5. Press [EXIT] to return to the measurement screen.

3.3 Hearing Aid Setup

To set up the analyzer and the hearing aid for testing, you connect the hearing aid to a coupler. The standard couplers of the FP35 analyzer are the HA-1 and HA-2 couplers. These couplers contain 2 cc of space, simulating the amount of space in a person's ear canal. The procedure for connecting a hearing aid to those couplers is described in this section.

Other available couplers include the MZ-series couplers (used in the OES and JIS Options) and the CIC coupler.

3.3.1 Setting up a BTE

1. Adjust the tone and gain controls of the aid to the desired positions.
2. Insert the end of the earhook of the hearing aid into the plastic tubing of the ear level adapter.
3. Insert the measurement microphone into the HA-2 coupler.
4. Snap the ear level adapter on to the end of the coupler.
5. Place the hearing aid/coupler assembly into the sound chamber so that the microphone of the aid is directly over the center of the speaker. The Velcro on the coupler will help secure the assembly in place. See Figure 3.3.1.

Figure 3.3.1—Setup for a BTE

3.3.2 Setting up an ITE

Roll the blue adhesive putty provided with each instrument into a rod long enough to go around the transmitting end of the aid (approx. 2 in or 5 cm). Modeling clay can also be used, but it doesn't work as well.

Bend the blue adhesive putty rod around the canal end 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 blue adhesive putty. This is a good idea if the vent does not go all the way through the aid.)

With the measuring microphone removed from the HA-1 coupler, align the sound opening of the aid with the small hole at the end of the coupler. Look through the larger hole at the other end to be sure the sound opening of the aid is clear of obstructions and correctly placed.

Seal the outside opening of any vent of the aid with a small kernel of blue adhesive putty.
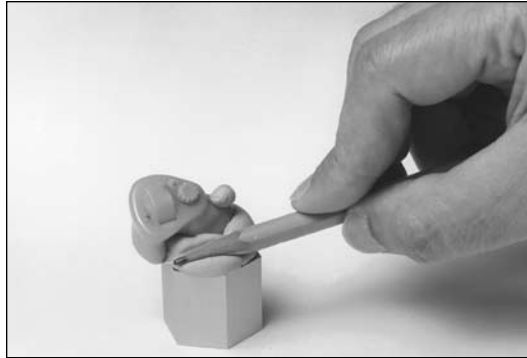
Press down on the blue adhesive putty with a pencil or your finger to create an acoustic seal between the aid and coupler.

You may want to double-check the aid placement through the open end of the coupler at this point. Slowly insert the microphone into the coupler. You may feel an initial resistance when the mic reaches the O-ring. Continue to push the microphone until it stops.
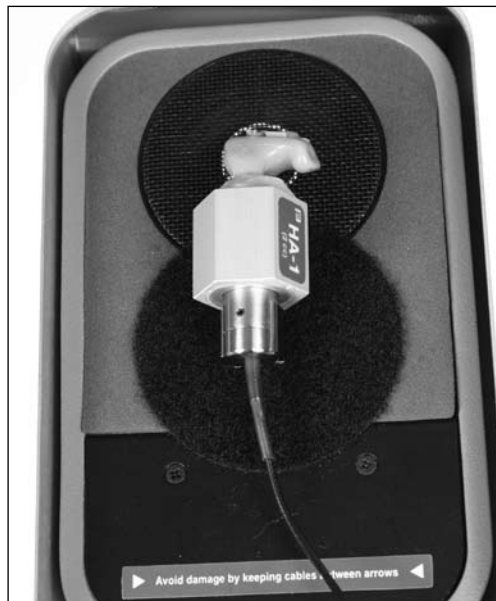
Place the completed assembly over the center of the speaker in the test chamber. With ITEs, the position of the aid can affect the frequency response. Point the faceplate to the right or left. Place the mic cable between the arrows (secure it with a bit of blue adhesive putty if necessary). The Velcro on the coupler will help hold the assembly in place. Be consistent with your setup for repeatable results.

Set the hearing aid's gain control to the desired position, and adjust the source level to the desired amplitude.

3.3.3 Setting up a Body Aid

Place the hearing aid into the sound chamber so that the microphone of the aid is centered over the speaker. Adjust the tone and gain controls to the desired positions. Insert the FP35 microphone into the HA-2 coupler and snap the receiver onto the end of the coupler (you will not need the ear level adapter for this setup). Place the coupler outside the sound chamber and close the lid if possible.

Adjust the source level to the desired test drive amplitude.

3.4 Frequency Responses

In the Coupler Multicurve Mode of the FP35, you can perform the following measurements: response curves, single-frequency measurements, harmonic distortion, and intermodulation distortion.

3.4.1 Running a Test Curve

1. Enter the Coupler Multicurve screen by pressing [F3] from the Opening screen. If the Coupler Target or Coupler EarSim screen is displayed when you do this, instead of the Coupler Multicurve screen, use the [NEXT] key.

2. Press [MENU] from the Coupler Multicurve screen to make any necessary selections. See Section 3.9 for details.

3. Level the sound chamber as described in Section 3.2, if necessary.

4. Set up the aid in the sound chamber as described in Section 3.3.

5. Use [F2] to select a curve number.
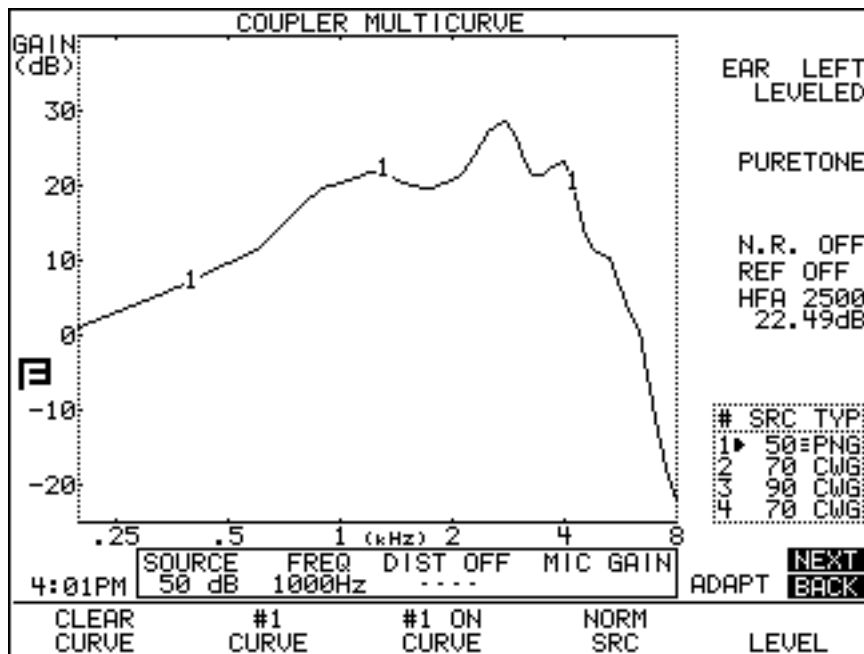
Figure 3.4.1A—Pure-tone measurement

6. Use [▼, ▲] to adjust the source level to the desired amplitude.

7. Use [F4] to select the source type. See Section 2.5 for an explanation of the available source types

8. Press [START/STOP] to initiate the frequency sweep. If you are using the NORMAL, SHORT or LONG selections, the test will stop when the sweep is complete. The COMP, DIG SPCH and FAST signals are continuous, making it necessary to press [START/STOP] again when you want the signal to stop.

9. Use [◄, ►] to scroll back through the last four real-time measurements if you used the COMP or DIG SPEECH signals.

10. Repeat steps 5-9 to take another measurement.

Figure 3.4.1A shows a completed normal pure-tone sweep.

Example

Following the instructions above, run 4 Gain curves using amplitudes 50, 60, 70 and 80 dB SPL. Use a signal source of NORM, COMP or DIG SPCH.

This scenario will provide you with a family of curves. Whenever the curves sit on top of each other, the gain of the aid is the same for the amplitudes of those curves. This indicates the aid is running linearly. If the curves provide progressively less gain as the input rises, then the aid has some sort of compression circuit. Figures 3.4.1B and 3.4.1C show two examples of this scenario.
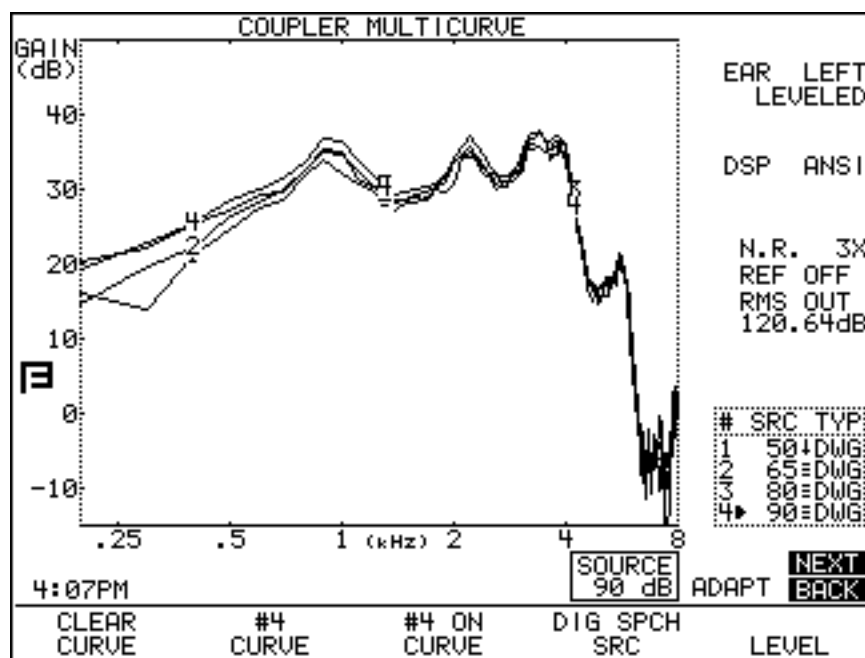
Figure 3.4.1B—This aid has very little compression between 50 dB and 90 dB.
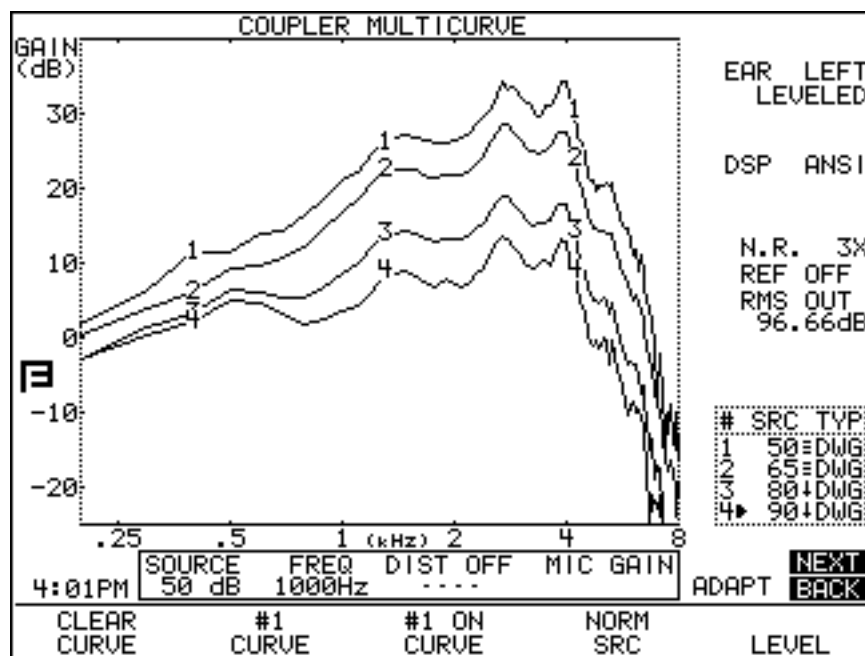
Figure 3.4.1C—This aid shows a great deal of compression between 50 dB and 90 dB.

3.4.2 Running a Single Frequency Measurement

At times, you may want to find out what the frequency response of the hearing aid is to a single pure-tone signal.

1. Push [F4] and hold the key down for half a second until the Source Selection box appears.
2. Use [▼, ▲] to choose SINGLE.
3. Press [START] to make the selection and close the selection box.
4. Use [◀, ▶] to select the frequency you want to use as the source signal. Use [▼, ▲] to select the amplitude.
5. Press [START] to start the measurement. When finished, press [START] again to stop the signal.
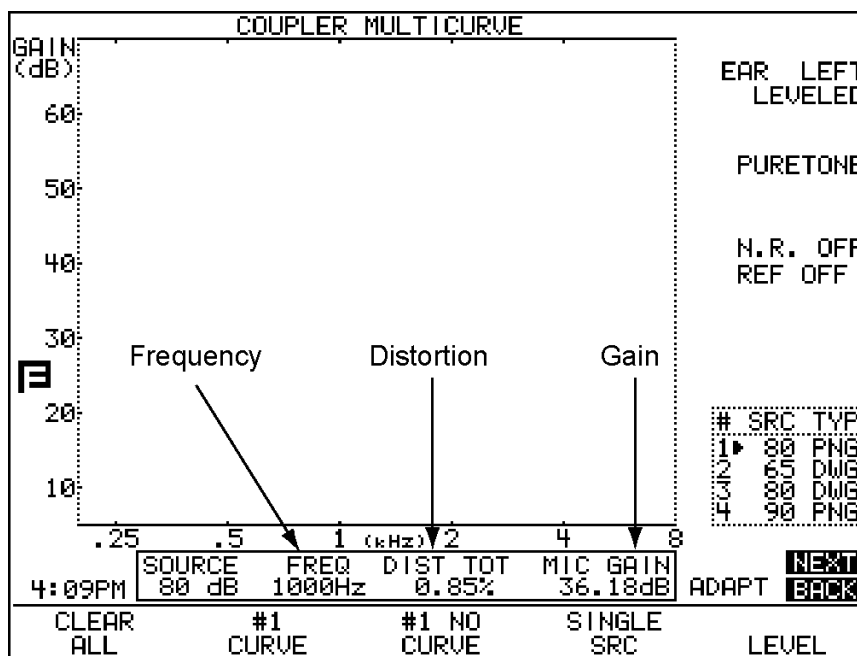
Figure 3.4.2—Measuring a single frequency

3.5 Distortion Measurements

There are several different methods to measure distortion in a hearing aid. This section describes how to measure harmonic distortion and intermodulation distortion.

3.5.1 Measuring Harmonic Distortion

Harmonic distortion is when the hearing aid returns energy at frequencies not present in the source signal. The FP35 allows you test for this phenomenon very easily. See Section 2.5.1.2 for more information on harmonic distortion.

1. Press [MENU].
2. Select DISTORTION using the [▼, ▲] keys.
3. Select the distortion type desired by using the [◄, ►] keys.
4. Press [EXIT].
5. Press [F4] to select NORM.
6. Press [START/STOP] to run normal frequency sweep.

After running a normal sweep, the graph will have bars depicting the percentage level of harmonic distortion at different frequencies. The scale for the harmonic distortion measurements is given on the right vertical axis of the graph. See figure 3.5.1.

In the past, FONIX analyzers have not measured harmonic distortion when the signal level was set to 90 dB SPL or higher. This is called the "90 dB harmonic distortion rule." Since hearing aids in recent years have become more sophisticated and able to handle loud signals, we have turned this off this rule by default. However, if you would like to use it, first set the USER LEVEL to ADVANCED in the Default. See Section 2.3.2 for details. Then, go into the Custom Menu (press [MENU], [NEXT], [NEXT]) and turn ON the DIST 90 dB RULE.
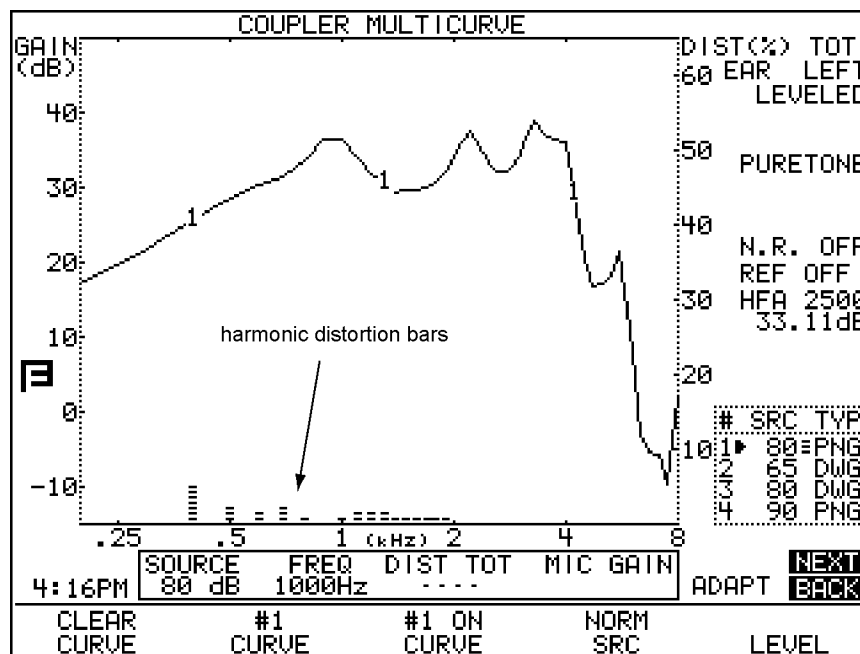
Figure 3.5.1—Measuring harmonic distortion

3.5.2 Measuring Intermodulation Distortion

Intermodulation (IM) distortion occurs when more than one frequency is present in the source signal and those frequencies combine to create new frequencies not actually present in the source.

In the static IM distortion test, the FP35 analyzer produces a signal consisting of the primary and secondary frequencies, and shows the resulting response as a composite type display. The measurement is updated in real-time until you turn it off. See Section 2.5.2.2 for more information on the FP35's IM distortion measurement.

1. Press [MENU] from the Coupler Multicurve screen to enter the local menu.
2. Make sure DISTORTION is set to OFF, and make sure the REF MIC is OFF. If necessary, use the arrow keys to make these selections.
3. Press [NEXT] to enter the Advanced menu.
4. Select IM FREQ DIFF using [▼, ▲].
5. Use [◀, ▶] to select the fixed distance between the primary and secondary frequencies used in the measurement. You can choose from no distance (HARM) to 4000 Hz.
6. Press [EXIT] to return to the Coupler Multicurve screen.
7. Press and hold down [F4]. This will pop up a list of the available selections, including DIST.
8. Use [▲,▼] to select DIST.
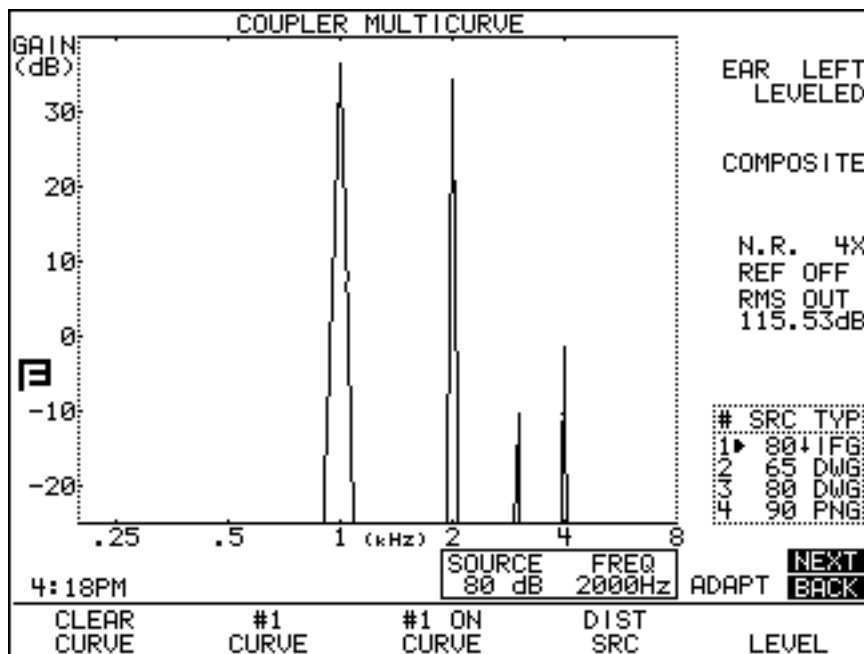
Figure 3.5.2—Measuring intermodulation distortion

9. Press [START/STOP] to make the selection.

10. Set up the aid in the sound chamber for testing as usual. Make sure to tightly close the lid of the sound chamber.

11. Press [START/STOP] again to start the static IM distortion measurement. See Figure 3.5.2.

12. Use [◀, ▶] to change the primary frequency of the test. The secondary frequency will also change, remaining a fixed distance (selected in Step 5) away from the primary frequency.

13. Use [▼, ▲] to change the RMS source of the test signals. Each signal will have an amplitude 3 dB below the RMS source.

14. Press [START/STOP] to stop the measurement.

3.5.3 Performing an IM Distortion Sweep

In the IM distortion sweep test, the FP35 analyzer produces a sweep of the two frequency combinations mentioned in the section above. This is similar to a normal pure-tone frequency sweep, but two frequencies are used at a time instead of one at a time. The FP35 analyzer measures the IM distortion by looking at frequencies that have a mathematical relationship to the primary frequencies. Any amplitudes at those frequencies is considered IM distortion. The results are displayed as a double-wide line with a percentage scaling found on the *right* side of the graph. See Section 2.5.2.2 for details.

1. Press [MENU] from the Coupler Multicurve screen to enter the local menu.

2. Use [▼, ▲] to select DISTORTION.
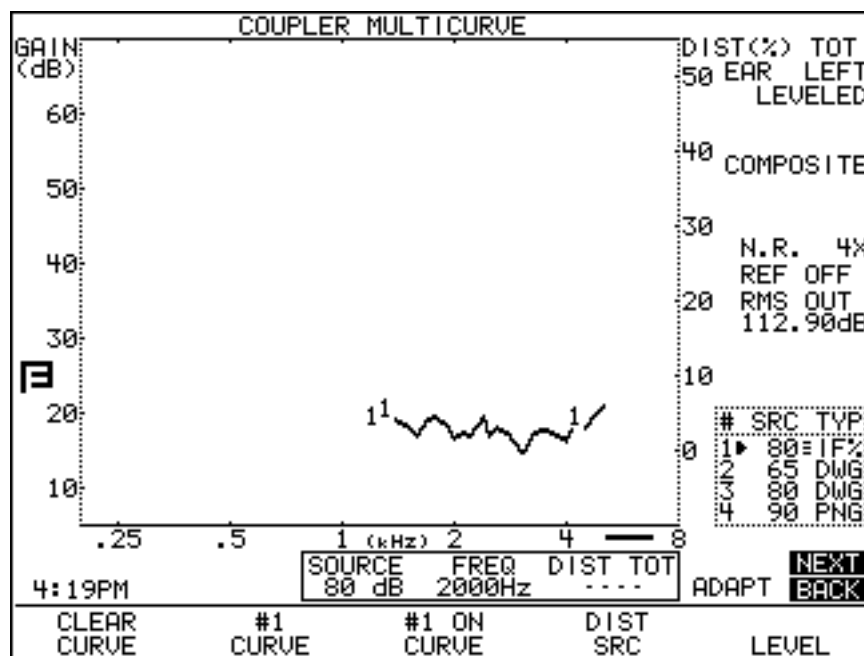
Figure 3.5.3—IM distortion sweep

3. Use [◄, ►] to select the harmonics where the IM distortion will be mea-
   sured. You can select the 2nd distortion, the 3rd distortion, or TOTAL,
   which is all frequencies except the primary and secondary frequencies.

4. Make sure the REF MIC is OFF. Use the arrow keys to make this selection, if
   necessary.

5. Press [NEXT] to enter the Advanced menu.

6. Use [▼, ▲] to select IM FREQ DIFF.

7. Use [◄, ►] to select the fixed distance between the primary and secondary
   frequencies used in the measurement. You can choose between no distance
   (HARM) to 4000 Hz.

8. Press [EXIT] to return to the Coupler Multicurve screen.

9. Use [▼, ▲] to select the RMS source of the test. Each frequency will have
   an amplitude 3 dB less than the RMS source.

10. Set up the aid for test in the sound chamber as usual. Make sure to close the
    lid of the sound chamber tightly.

11. Press [START/STOP] to perform the IM distortion sweep. The percentage
    scaling (DIST %) for the measurement is located on the *right* side of the
    graph. Notice the thick line below the lower right corner of the graph. This
    is an indication that the current selected measurement uses the right side
    scaling. See Figure 3.5.3 for an example.

3.5.4 Changing the Frequencies of an IM Distortion Sweep

By default, the IM distortion sweep is performed at the frequencies used in the
NORMAL pure-tone sweep. This can be changed to perform the measurements
at fewer frequencies (for a faster test), and more frequencies (for a more com-
plete test). The USER LEVEL must be set to ADVANCED in the Default Settings
menu. See Section 2.3.2 for more details.

1. Press [MENU] from the Coupler Multicurve screen to enter the Coupler
   Multicurve menu.

2. Press [NEXT] twice to enter the Custom Menu.

3. Use [▼, ▲] to select DISTORTION SWEEP.

4. Use [◄, ►] to make one of the following selections:
   • NORM: To measure at 1/12 octave frequencies closest to 100 Hz intervals
     (default test)
   • FAST: To measure at 1/3 octave frequencies closest to 100 Hz intervals
     (fastest test)
   • FULL: To measure at every 100 Hz interval (most complete test)

5. Use the arrow keys to select DIST SWEEP END and choose the final fre-
   quency in the IM distortion sweep.

6. Press [EXIT] to return to the Coupler Multicurve screen and follow the
   directions in Section 3.5.3 to perform the IM distortion sweep.

3.5.5 Turning on/off Impulse Rejection

Impulse rejection can be used to reduce distortion caused by impulses in the room noise. When noise reduction is used with IM distortion measurements, several measurements are made to obtain the test results. See Section 2.5.2.2 for more details. To change the impulse rejection settings, the USER LEVEL must be set to ADVANCED. See Section 2.3.2 for more details.

1. Press [MENU] in the Coupler Multicurve screen to enter the Coupler Multicurve menu.
2. Use [▼, ▲] to select NOISE REDUCTION.
3. Use [◀, ▶] to set the level of noise reduction. This must be at least 2X.
4. Press [NEXT] twice to enter the Custom menu.
5. Use [▼, ▲] to select IMPULSE REJ.
6. Use [◀, ▶] to select the amount of impulse rejection you would like in the IM distortion test. Lower values will make the FP35 analyzer reject more measurements. Higher values will make the FP35 analyzer less sensitive.
7. Press [EXIT] to return to the Coupler Multicurve screen to make your IM measurements. See Section 3.5.2 and 3.5.3.

Note: Impulse rejection applies to all measurements, not just IM distortion.

3.5.6 Using the Reference Microphone

If you are in a noisy testing environment, you might want to use the reference microphone to create more accurate measurements. Remember that any noise in the testing environment could be amplified by the device and show up as IM distortion, even though the distortion is coming from the testing environment and not from the aid itself.

When the reference microphone is turned on, you are no longer measuring absolute distortion, but relative distortion. That is, you are measuring the difference between what the measurement microphone is reading inside the coupler and what the reference microphone is reading outside of the coupler. If there is noise in the test environment, you will likely see negative distortion values. To remind you of the difference, the FP35 analyzer displays RLTV on the graph scale instead of DIST when the reference microphone is turned on.

3.6 CIC Option

The CIC Option is a way of performing a coupler test of a CIC hearing aid which more accurately reflects the real-ear performance of that aid than a regular 2-cc coupler measurement. It is not a way to check the manufacturing specifications of CIC hearing aids because those specifications are based upon 2-cc coupler measurements.

The CIC Option consists of a CIC coupler and software correction factors. Both need to be used in order to correctly perform the measurement.

To measure a CIC hearing aid:

1. Attach the CIC coupler to the CIC aid just as you would attach an HA-1 coupler to the aid, and set the hearing aid up for testing as shown in Section 3.3.2.

2. Press [MENU] from the Coupler Multicurve screen.

3. Highlight COUPLER TYPE with the [▼, ▲] keys.

4. Select CIC with the [◄, ►] keys.

5. Press [EXIT].

6. Select the desired source type with [F4].

7. Select the desired source amplitude with the [▼, ▲⇨ keys.

8. Press [START/STOP] to perform the measurement. You should see CPLR CIC appear on the right column of the screen. If necessary, press [START/STOP] to end measurement.

Figure 3.6 shows the difference between a CIC hearing aid tested with an HA-1 coupler, and the same aid tested with a CIC coupler and correction factors.
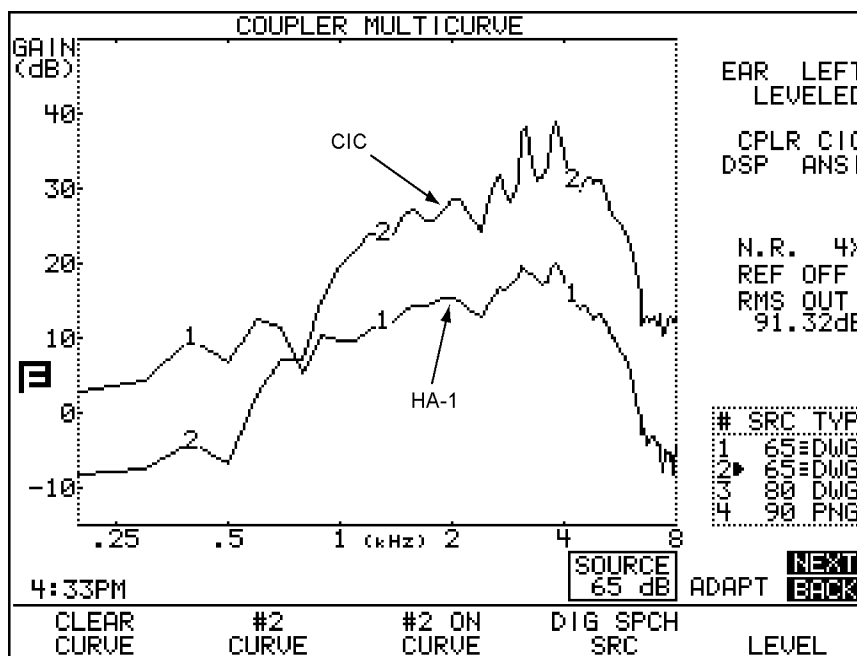
Figure 3.6— CURVE 1 uses 2-cc HA-1 coupler
          CURVE 2 uses CIC coupler + correction factors

3.7 OES Option

The Occluded Ear Simulator (OES) Option consists of software corrector factors and three special (MZ) couplers. Together, they allow you to obtain the same data you would get with a standard ear simulator (IEC 711 or Zwislocki coupler), providing the hearing aid or mold being tested is not vented. This should give you a coupler measurement that more accurately reflects a real-ear response of an occluded ear than a 2-cc coupler.

To use the OES Option:

1. Attach the MZ coupler to the aid. See Table 3.7 for details on choosing the correct MZ coupler.
2. Set up the hearing aid for testing as described in Chapter 3.
3. Press [MENU] from the Coupler Multicurve screen.
4. Highlight COUPLER TYPE with the [▼, ▲⇨ keys.

Table 3.7—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, 2-cc 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.

5. Select MZ with the [◄, ►] keys.
6. Press [EXIT].
7. Select the desired source type with [F4].
8. Select the desired source amplitude with the [▼, ▲⇨ keys.
9. Press [START/STOP] to perform the measurement. You should see CPLR MZ appear on the right column of the screen. If necessary, press [START/STOP] to end measurement.

See Figure 3.7 for a comparison of a BTE tested with an MZ coupler as opposed to a 2-cc coupler.
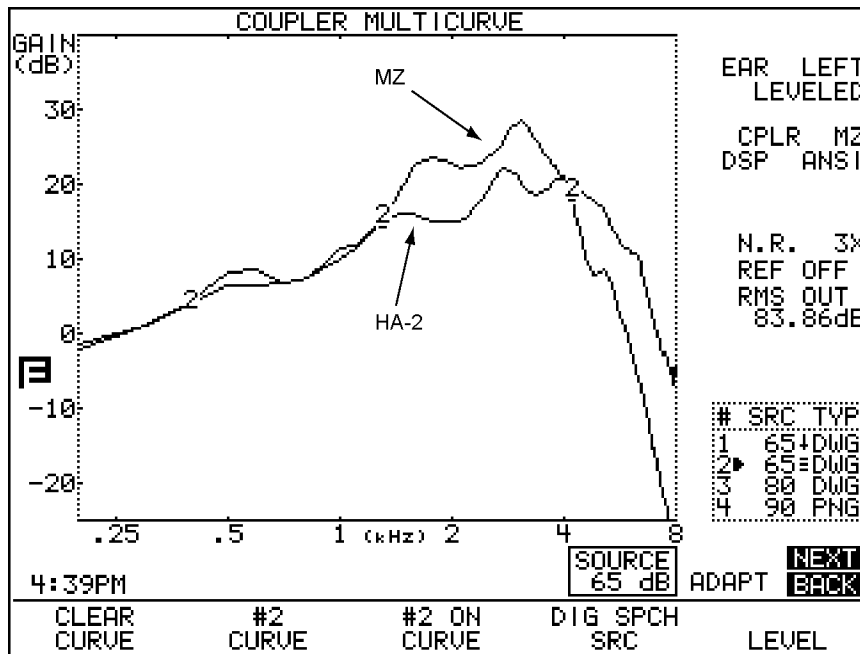
Figure 3.7—Comparison of the responses with the MZ and HA-2 couplers

3.8 Advanced Testing

This section contains information of interest to the advanced user, including instructions for testing digital and directional aids, and procedures for reversing and splitting the measurement microphones.

3.8.1 Testing Digital Hearing Aids

The FP35 seamlessly incorporates the testing of digital hearing aids into its normal testing procedures.

Just follow the steps outlined in Section 3.4.1, choosing DIG SPCH in Step 7. This digital speech signal source is an interrupted composite signal designed to imitate the rhythms of speech. The aid will respond to the signal source as it would respond to actual speech. See Appendix F for details about the digital speech signal.

Confusion with Terminology

With the new testing technology of hearing aid analyzers combined with the new technology of hearing aids, it's easy to get terminology confused. Frye Electronics has always used "noise reduction" to denote the averaging that the analyzer makes when analyzing data, as described in Section 2.5.1.3 and Section 2.5.2.3.

Some high-end hearing aids have a function often referred to as "speech enhancement" or "noise reduction." This function listens for continuous signals and lowers the gain of the hearing aid.

Just keep in mind that these are two separate applications of the phrase "noise reduction" that mean two different things.

3.8.2 Testing Directional Hearing Aids (FP35 with Real Ear option only)

At the most basic level, the function of directional hearing aids is to amplify sounds in front of the client while decreasing sounds behind the client, increasing his ability to listen to speech in a noisy environment. Perfect tests of directionality can only be performed in an anechoic chamber, something usually only available to hearing aid developers and researchers. However, you can use the FP35 Analyzer to perform a basic check of directionality in order to verify that the directional microphones are functioning properly.

To check directionality:

1. Take out the sound chamber speaker from its compartment.
2. Take out the extension pole located in the right side of the compartment, and slide the wide end into the hole located on the bottom right corner of the analyzer.
3. Install the speaker on the extension pole. See Figure 3.8.2A.

Figure 3.8.2A—Speaker on the extension pole

4. Enter the Coupler Multicurve screen.
5. Press [MENU] to open the local menu.
6. Use the arrow keys to make sure that DISPLAY is set to GAIN and REF MIC is set to OFF.
7. Press [NEXT] to enter the Advanced menu.

8. Use the arrow keys to change LEVELING SOURCE to 70 dBSPL.

9. Press [EXIT] to close the local menu and return to the Coupler Multicurve screen.

10. Hold the measurement microphone about six inches from the speaker, and press [F5] to level it. See Figure 3.8.2B. Also see Section 3.2.4 for information on changing the leveling source.

Figure 3.8.2B—Hold microphone six inches from the speaker

11. Attach the hearing aid to the appropriate coupler, and insert the measurement microphone, as you would for normal coupler testing. See Section 3.3.

12. Use [F1] to select CRV 1.

13. Use [F4] to select the source type for the test. It is recommended to use COMP or DIG SPCH, if available. Alternately, use the FAST pure-tone sweep.

14. Use [▼, ▲] to select the desired source level. It is recommended to use 65 dB SPL.

15. Hold the hearing aid, connected to the coupler and the microphone, six inches in front of the speaker so that the hearing aid is pointed forward.

16. Press [START/STOP] to start the measurement. When it stabilizes, press [START/STOP] to stop the measurement.

17. Press [F1] to select CRV 2.

18. Repeat Steps 9-10 to select the same source type and level as used for CRV1.

19. Press [START/STOP] to start the measurement. As it is running, slowing rotate the hearing aid, maintaining the same distance from the sound field speaker. The response of the aid should gradually diminish as the sound field enters the directional aid's "null" spot. When the response is at its minimum level, press [START/STOP] to stop the test.

Figure 3.8.2C—Make the measurement

20. Compare CRV 1 and CRV 2. See Figure 3.8.2D. If the hearing aid's response didn't change when you rotated the aid in Step 15, it is a good indication that the aid's directional microphones are not working properly.
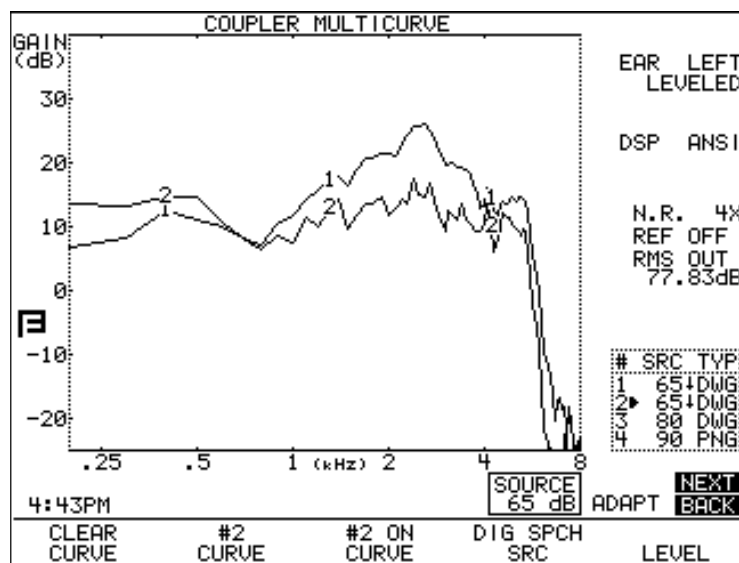
Figure 3.8.2D—Comparison of the directional response of the hearing aid at 0°(CRV1) and 180°(CRV2)

3.8.3 Testing with the Reference Microphone

If your FP35 has the M300 microphone, you have two microphones available for taking measurements. The normal, recommended method for taking coupler measurements involves the use of just the coupler microphone. The second microphone, referred to in Coupler Multicurve Mode as the "reference" microphone, is normally set to OFF in the menu settings. (In Real-Ear Mode, this microphone is referred to as the "probe" microphone.)

However, the FP35 is a true dual microphone system. This means that, if desired, you can take your coupler measurements using both the coupler microphone and the reference microphone. In this method, the analyzer compares the response of the aid from inside the coupler with the coupler microphone to the response of the sound chamber next to the microphone's receiver with the reference microphone.

This method of using both microphones is technically more exact than the normal method of using a single microphone. However, we have found that for most practical purposes, there is little difference between using one or both microphones. In fact, if you forget that the reference microphone is on, you might accidentally leave it outside of the test box during measurements, leading to wild results. For this reason, we recommend leaving the reference microphone off, unless you are doing research or have some other clinical reason for measuring with it.

Figure 3.8.3—Testing using the reference microphone

If you choose to use the reference microphone, you should use the leveling procedure described in Section 3.2.2.

1. Press [MENU]
2. Select REF MIC using the [▼, ▲] keys.
3. Set REF MIC to ON using [◄, ►] keys.
4. Press [EXIT] to exit from menu.
5. Set up the aid as described in Section 3.3.
6. Place the tip of the probe microphone as close as possible to the hearing aid microphone without touching it.
7. Test as usual.

Caution: If you set the reference microphone ON, you must use it to run tests. If you do not, the instrument will return erroneous results.

3.8.4 Reversing the Microphones

In normal operation, the coupler microphone functions as the "measurement" microphone. It takes measurements and, if the reference microphone is on, compares these measurements to the reference microphone.

It's possible that you might encounter a situation where you want to perform a measurement in the Coupler Multicurve screen, but the coupler microphone is too large or somehow otherwise unsuitable for the particular function. If you have the M300 two-microphone setup on your FP35, you can "reverse" the microphones in Coupler Multicurve screen so that the probe microphone works as the "measurement" microphone and the coupler microphone works as the "reference" microphone. The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for more details.

To reverse the microphones:

1. Press [MENU] from Coupler Multicurve screen.
2. Press [NEXT] twice to enter the Custom Menu.
3. Highlight MICROPHONES.
4. Use the [◀, ▶] keys to select REVERSE.
5. Press [EXIT] to return to Coupler Multicurve Mode.

Once you have reversed the microphones by following the above procedure, the coupler multicurve screen will be slightly altered. Instead of a display of REF ON or REF OFF, the display will read MIC REV if the microphones are reversed and the reference microphone is off, and REV ON if the microphones are reversed and the reference microphone is on.

3.8.5 Splitting the Microphones

You can display the simultaneous results of both microphones using the split microphone feature. This can be useful if you want to see what the reference microphone is doing separately from the coupler microphone. The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for more details.

To split the microphones:

1. From Coupler Multicurve Mode, press [MENU].
2. Highlight REF MIC using the [▼, ▲] keys.
3. Select ON using the [▶] key.
4. Press [NEXT] twice to enter the Custom Menu.
5. Highlight MICROPHONES.
6. Select SPLIT using the [▶] key.
7. Press [EXIT].

8. Select the desired source type with [F4].

9. Select the desired source amplitude using the [▼, ▲] arrow keys.

10. Press [START/STOP] to perform the measurement. If you're using the FAST pure-tone sweep or a composite type signal, press [START/STOP] again to end the measurement.

You should see two graphs on your analyzer. The graph number selected with [F2] will contain the measurement from the coupler microphone. The next graph number will contain the measurement from the reference (probe) microphone. So, if you have CRV 1 selected with [F2], CRV 1 will contain the coupler microphone measurement and CRV 2 will contain the reference microphone measurement. If you have selected CRV 4 with [F2], CRV 4 will contain the coupler microphone measurement and CRV 1 will contain the reference (probe) microphone measurement.
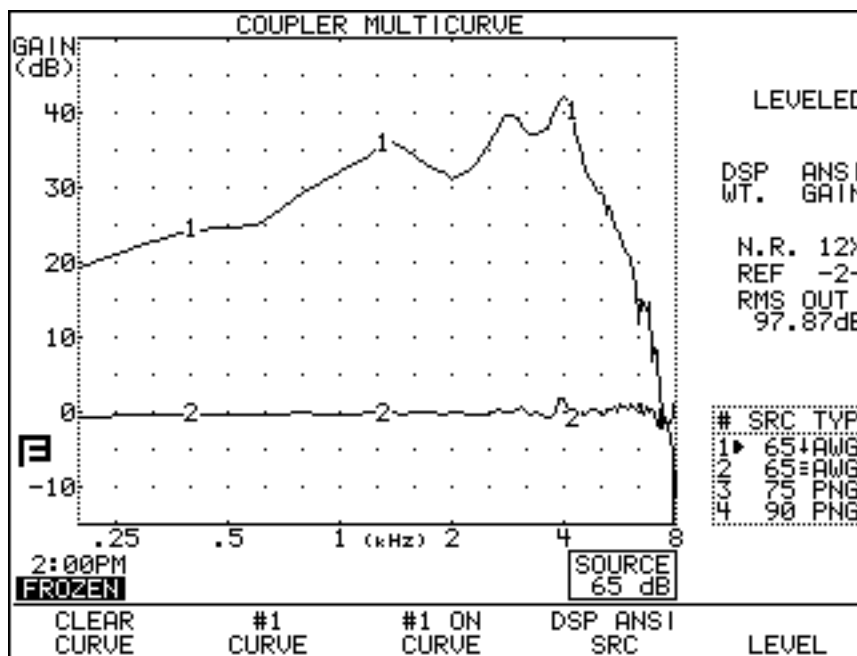
Figure 3.8.5—Curve 1 is the measurement microphone. Curve 2 is the reference microphone

3.8.6 Changing the Signal Filters

Filters are the type of speech weighting applied to the test signals as they are presented to the hearing aid. By default, the FP35 analyzer automatically chooses the appropriate speech weighting to use with a particular type of signal.

For instance, when you use a pure-tone signal, a flat weighting is used. That is, every frequency of the pure-tone sweep has the same amplitude. When you use the composite signal, the Frye ANSI speech weighting is used. That is, the low frequencies have higher amplitudes than the higher frequencies.

The FP35 analyzer allows you to specifically choose the type of speech weighting you want to use. You do this by altering the FILTER selection in the Advanced Menu of the Coupler Multicurve and Target Coupler screens and the Real-Ear Measurement Screens. See Section 2.5.2.1 for more information.

To change the filter in the Coupler Multicurve or Target Coupler screen:

1. Press [MENU] from the measurement screen to enter the local menu.

2. Press [NEXT] to enter the Advanced menu.

3. Use [▼, ▲] to select FILTER.

4. Use [◀, ▶] to select the desired filter type. See Section 2.5.2.1 for an explanation of the available selections.

5. Press [EXIT] to return to the measurement screen. The filter type you have chosen will now be in effect.

3.8.7 Running a Three-Frequency Average

The ANSI and IEC automated test sequences call for running three frequency average measurements. This can be done in the Coupler Multicurve screen when the USER LEVEL is set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

To measure the three frequency average:

1. Select a signal type of NORM with [F4] in the Coupler Multicurve screen.

2. Check the bottom left corner of your screen. You should see one of three messages: SINGLE, AVG or IDLE. If the message is SINGLE or IDLE, you will have to put the FP35 in AVG Mode. To do this:

    a. Press [MENU].
    b. Press [NEXT].
    c. Select AVG FREQS using [▼, ▲].
    d. Select the highest frequency of the three frequency average using [◀, ▶]. See Section 2.5.1.6 for a complete listing of the available frequencies.
    e. Select STATIC TONE using [▼, ▲].
    f. Select AVERAGE using [◀, ▶].
    g. Press [EXIT] to return to the Coupler Multicurve screen.

3. Look at the display. The FP35 will now be automatically performing the three-frequency average measurement. Adjust the amplitude using the [▼, ▲] keys.

If you want to easily turn on and off the three-frequency average, press and hold down the [F4] key to bring up the function key balloon menu. Use [▼, ▲] to select SINGLE and press [START/STOP] to complete the selection. Now use the [START/STOP] key to turn on and off the single pure-tone signal.

3.8.8 Measuring the Telecoil Response

Telecoil measurements can be performed in the Coupler Multicurve screen using any source type available on the analyzer. During a telecoil measurement, a magnetic field is used that is supposed to simulate the magnetic field of a telephone receiver. Two devices can be used to produce this field: an external telecoil board or the Telewand.

FP35 software setup

Follow these instructions to configure the FP35 for telecoil measurements in the Coupler Multicurve screen.

1. Follow the instructions found in Section 2.5.8 to set up the FP35 Default Settings Menu for telecoil measurements.

2. Press F3 from the Opening Screen to enter the Coupler Multicurve screen.

3. Press [MENU] to open the local menu.

4. Use [▼, ▲] to select TELECOIL and use [◄, ►] to choose ON.

5. Press [EXIT] to close the local menu. The source box at the bottom of the measurement graph will now indicate TMFS.

6. Follow the instructions in the Telecoil Board Setup or Telewand Setup sections below, depending upon the device you are using for your telecoil measurements.

Telecoil Board Setup

Follow these instructions for setting up the hearing aid and the FP35 analyzer for telecoil measurements using an external telecoil board.

1. Plug the telecoil board into the earphone jack or the speaker jack (new style rear panel only) on the back of the FP35 analyzer.

2. Attach the hearing aid to a coupler in the usual way and set the hearing aid to telecoil mode.

3. Use [▲] to select the desired mA/M strength for the telecoil test. This can range from 1 to 100 mA/M.

4. Use [F4] to choose COMP, DIG SPCH or FAST for the signal type.

5. Press [START/STOP] to begin the measurement. This will show the output of the telecoil response.

6. Orient the hearing aid at the center of the telecoil board for maximum output. Normally this will be when the hearing aid is positioned vertically. See Figure 3.8.8A.

7. Press [START/STOP] to stop the measurement, or continue to test, as desired. Adjust the source type with [F4] and the strength of the signal with [▼, ▲].
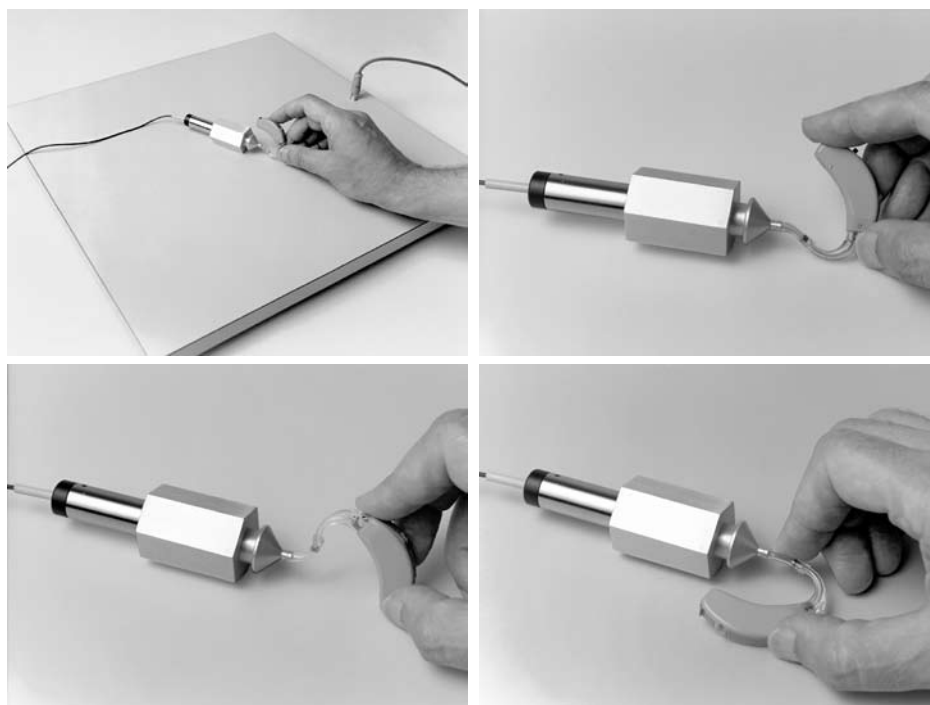
Figure 3.8.8A—Orienting hearing aid for maximum output

Telewand Setup

Follow these instructions for setting up the hearing aid and the FP35 analyzer for telecoil measurements using the Telewand.

1. Plug the Telewand into the earphone jack or the speaker jack (new style rear panel only) on the back of the FP35 analyzer.

2. Attach the hearing aid to a coupler in the usual way and set the hearing aid to telecoil mode.

3. Make sure the source box below the measurement graph in the Coupler Multicurve screen is showing TMFS. This is the proper strength setting for using the Telewand.

4. Use [F4] to choose COMP, DIG SPCH or FAST for the signal type.

5. Press [START/STOP] to begin the measurement. This will show the output of the telecoil response.

6. Hold the Telewand next to the hearing aid as if you were holding a telephone receiver to the hearing aid worn on the ear. That is, hold the Telewand parallel to the body of a BTE or next to the faceplate of an ITE.

7. Position the hearing aid for maximum output. This will normally be when the hearing aid is oriented vertically. See Figure 3.8.8B.

8. Test as desired. Make sure not to change the strength of the magnetic field from the TMFS setting.

Figure 3.8.8B—Using the Telewand

3.8.9 Measuring with an External Signal

Measurements with the FP35 analyzer are typically performed using the internal signals available in the analyzer, such as puretone sweeps, Composite or the Digital Speech signal. However, you can also use an external signal from a device such as a CD player or an MP3 player using the "line-in" 3.5 mm jack on the back of the analyzer (available on instruments manufactured November 2008 or later).

You will need the Composite/Digital Speech Option to use this feature.

Connecting the External Source

Connect the FP35 to the external source by using the 3.5mm "line-in" jack on the back of the analyzer. If your analyzer does not have this jack, then it was probably manufactured previous to the addition of this feature. Existing analyzers can be upgraded. Contact your FONIX distributor for details.

Setting up the FP35

To use an external source for coupler measurements:

1. Enter the Coupler Multicurve screen by pressing the [F3] key from the Opening screen.
2. Use [F4] to set the source type to COMP.
3. Use the [▼] key repeatedly until the source is OFF. This puts the analyzer in "spectrum analysis mode."
4. Press [START/STOP] to start the measurement.
5. Turn on the signal from the external player. The signal should now be playing from the FP35 speaker.

Calibrating the External Signal

We recommend that you calibrate the external signal for best measurement results. Many CDs used by hearing health professionals contain a calibration track as the first track of the CD. This is generally a puretone signal at a particular input level.

To calibrate the signal on the FP35:

1. Position the coupler microphone in the sound chamber at the reference point (middle of the white circle).
2. Put the analyzer in spectrum analysis mode and play the calibration track on the CD through the FP35 speaker using the setup described above. Make sure to start a measurement by pressing the [START/STOP] key.
3. Adjust the volume control on the external player until the RMS OUT matches the desired level of the calibration tone. This level should be indicated in the instruction materials of the CD.

Adjusting the FP35 External Volume

If your external player doesn't have a volume control, there are some rough adjustments that you can make on the analyzer, described below. However, we recommend using the external player volume control when possible.

1. Press [MENU] from the Opening screen and then press [NEXT] and [NEXT]. This will enter the Resets Default Setting Menu.
2. Change the EXTERNAL VOLUME setting so that it is set to 0 dB using the arrow keys.
3. Press [EXIT] to return to the Opening screen.
4. Press [F3] to enter the Coupler Multicurve screen.
5. Put the analyzer in spectrum analysis mode and play the calibration track on the CD through the FP35 speaker using the setup described in the section "Setting up the FP35" above. Make sure to press the [START/STOP] key to start a measurement.
6. Use the [F5] key to adjust the volume of the external signal until the RMS Out matches the desired level of the calibration tone. Available choices are: +10, +5, 0, -5, -10, -15, -20, -25, -30 dB.

3.9 Reference

This section contains specific information on the function of each of the function keys, and the function of each available menu item.

The menu system in the Coupler Multicurve Mode has been divided into three different screens: the Primary Menu, the Advanced Menu, and the Custom Menu. The Primary Menu contains the most basic selections; things you may want to change frequently. The Advanced Menu contains more advanced features that you will only need to access occasionally. The Custom Menu is for advanced users only – most people will probably not need to use it.

3.9.1 Defining the Function Keys

The following describes the function of each key in the Coupler Multicurve screen.

[F1]—Clears curves. Pressing it once deletes the current curve. Pressing it again will delete all curves.

[F2]—Cycles through the curve designations: 1, 2, 3, and 4.

[F3]—Turns the display of the selected curve ON and OFF. It doesn't delete the curves.

[F4]—Selects source type. Choose between NORM, SHORT, FAST, LONG, COMP, DIG SPCH. The last two are available only if you have the Composite Option.

[F5]—Levels the sound chamber.

3.9.2 Explaining the Menu Items

This section describes the menu selections available in the Coupler Multicurve screen. When the USER LEVEL is set to EASY in the Default Settings menu (see Section 2.3.2 for details), fewer menu items are available. The items starred (*) below are only available when the USER LEVEL is set to ADVANCED.

The menu system in the Coupler Multicurve screen has been divided into three different screens: the Main menu, the Advanced menu, and the Custom menu.

Main Coupler Menu

Press [MENU] from the Coupler Screen to enter the Main Coupler menu. Here are the selections:

EAR—Choose between LEFT, RIGHT, and NONE. The NONE selection will not display the ear selection on the screen.

DISPLAY—The type of display used in the Coupler Multicurve and Coupler Target screens. Choose between GAIN and SPL.

DATA/GRAPH—The type of display. Choose between a graphical display and a numerical display.

COUPLER TYPE—This setting will only be displayed if you have purchased either the CIC or the OES options. It turns on the software correction factors used with special couplers. If you have purchased the CIC Option, a coupler type of CIC will be possible here. If you have purchased the OES Option, a coupler type of MZ will be possible here. Also available: 2-cc. (Correction factors are not used with this selection.)

AID GROUP—The type of hearing aid being tested. Select STANDARD, AGC, or ADAPTIVE (for adaptive AGC circuits). This selection sets the various delay times used in pure-tone tests so that they are appropriate to the aid's circuitry. See Section 2.4 for more information on delay times.

DISTORTION—Type of harmonic distortion measurement during a pure-tone sweep. See Section 2.5.1.2 for more information.

NOISE RED (COMP)—Amount of noise reduction used for composite curve measurements. See Section 2.5.2.3 for more information.

NOISE RED (TONE)—Amount of noise reduction used for pure-tone sweeps. See Section 2.5.1.3 for more information.

REF MIC—Status of reference microphone. See Section 3.8.3 for more information.

Advanced Menu

For more advanced control of your unit, press [NEXT] to go to the Advanced Menu.

*AUTO-SCALE—The type of scaling used. ON scales the graph to the selected curve. OFF scales the graph to the highest curve displayed.

*REFERENCE STATUS—The type of RMS measurement made with the reference microphone. The following selections are available: RMS displays the overall RMS of the reference microphone, FULL displays the overall RMS and the signal quality of the reference microphone, and NONE turns off the RMS display of the reference microphone. See Section 2.5.4 for more information.

*AVG FREQ—The three frequencies used for averaging in pure-tone measurements. Each set is represented on the screen by the highest frequency in the set. See Section 2.5.1.6 for details.

*STATIC TONE—Status of the static pure-tone measurement. When a pure-tone source is selected and a sweep isn't running, measure the response and distortion of a single frequency (SINGLE), the three frequency average chosen in AVG FREQS (AVG), or no measurement (NONE).

FILTER—The type of speech weighting used on the signal sources. In most cases, this should be set to AUTO. See Section 2.5.2.1 for more details.

*SMOOTHING—Type of smoothing used. Smoothing rounds off the curve, removing minor peaks. Usually only used for sound field measurements, this should be off for normal coupler operation. Choose between OFF and LOG.

IM FREQ DIFF—The frequency difference of the two tones presented together for the intermodulation distortion measurement. See Section 3.5.2.

*EXT SOURCE—The channel selected of the external source. The external source (see Section 3.8.9) uses a dual channel connector. This means that the input signal has potentially two different channels. This selection lets you choose which channel to use as the input signal. Choices are EXT CH1 and EXT CH2.

*PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken in a pure-tone measurement. See Section 2.4 for more information.

*SHORT SETTLE—The time delay between frequencies in a pure-tone sweep, and the additional delay in a digital speech signal.

*LONG SETTLE—The time delay between frequencies in an input/output measurement, a three-frequency average measurement, or a harmonic distortion measurement.

PRINT LABEL—Status of the printing label.

PRINTER— Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

Custom Menu
Press [NEXT] from the Advanced Menu to enter the Custom Menu.

*OUTPUT LIMIT—Level of output limiting, which shuts off the source when the measured signal exceeds the limit set here. Choices are: OFF and 80-140 dB SPL. This is usually used only for real-ear type measurements.

*WARBLE SOURCE—The warble rate in pure-tone signals. Warble is usually used in sound field speaker measurements to reduce problems caused by standing waves. This is usually turned off for normal coupler measurements. See Section 2.5.1.4 for more details.

*SIGNAL SKEW—The number of samples from when the signal source leaves the speaker to when the FP35 analyzes it. See Section 2.5.1.5 for details.

SPEAKER—Selected speaker output. INTERNAL uses the internal speaker jack, which is usually connected to the internal sound chamber. EXTERNAL uses the external speaker jack, which can be connected to an external sound chamber. AUTO uses the internal jack for sound chamber measurements and the external jack for real-ear measurements.

*MIC PORT—Choose the microphone used for Real-ear measurements. Select AUTO, INTERNAL, EXTERNAL, or EXT LINE. See Section 2.5.9 for details.

*OUTPUT JACK—Select which external source devices are enabled in the coupler screens. SPEAKER enables only the speaker jack. MONO EAR enables only the left channel of the earphone jack. STEREO EAR enables both channels of the earphone jack. ALL ON enables the speaker jack and both channels of the earphone jacks. See Section 2.5.5 for details.

LEVELING SOURCE—The amplitude used for leveling the speaker. This is useful if you need to level with the chamber door open, and you don't want to use the loud default level of 90 dB SPL. Choose between 60 and 100 dB SPL.

*IMPULSE REJ—Status of impulse rejection, which rejects noise in the testing environment. See Section 2.5.6.

*DIST 90 dB RULE—Harmonic distortion measurements are generally made only when the source of the test signal is below 90 dB SPL. To measure harmonic distortion at 90 dB SPL or higher, turn this rule OFF.

*DISTORTION SWEEP—The frequencies used in the intermodulation distortion measurement. NORM uses 1/12 octave frequencies to the nearest 100 Hz. FAST uses 1/3 octave frequencies to the nearest 100 Hz. FULL uses every 100 Hz frequencies available.

*DIST SWEEP END—The last frequency tested when performing an IM distortion sweep. If the selected frequency is less than or equal to the first primary frequency in the IM distortion sweep, only the primary frequency will be tested; there will be no IM distortion sweep.

*MICROPHONES—Special operational selections for your microphones. Choices are NORMAL, REVERSE, and SPLIT. See Sections 3.8.4 and 3.8.5 for more details.

*SPECTRUM WINDOW—When performing spectrum analysis of random signals such as speech or room noise, leave this ON. If you would like to perform a spectrum analysis of a "phase synchronous" signal, such as might be found in one of our other instruments, turn this OFF. See Chapter 9 for more details.

*OUTPUT—Select which external source devices are enabled in the Coupler Multicurve screen. The AUTO and SPEAKER selections enable only the speaker jack. EARPHONE enables only the earphone jack. BOTH enables both the speaker and the earphone jacks. See Section 2.5.5 for details.

* only available when the USER LEVEL is set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

Automated Test Sequences

There are several different automated test sequences available with the FP35 analyzer. One test sequence of your choice is included as a standard feature when the FP35 is ordered. The other test sequences can be added as optional features.

The available automated test sequence include: ANSI 96, ANSI 03, IEC, JIS, and ISI.

4.1 The ANSI Sequence

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 two versions of the ANSI S3.22 standard on the FP35 analyzer: ANSI 96 and ANSI 03. As of the printing of this manual, ANSI 96 is the current standard to which the FDA requires hearing aid manufacturers to label their hearing aids. ANSI 03 will eventually replace this standard, but the date of the switchover is not yet known.

Here are the major differences in the two versions of the standard:

- 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 value needs to be 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 96. 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.
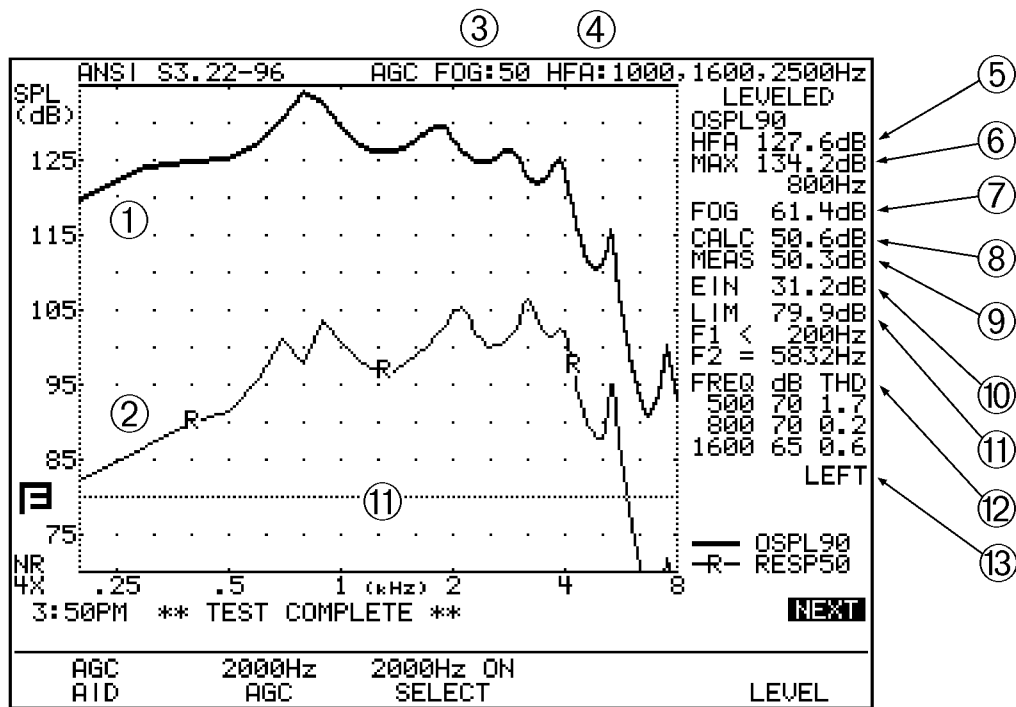
4.1.1 Viewing the ANSI '96 Display

Figure 4.1.1A—ANSI 96 test results, Frequency Response Screen
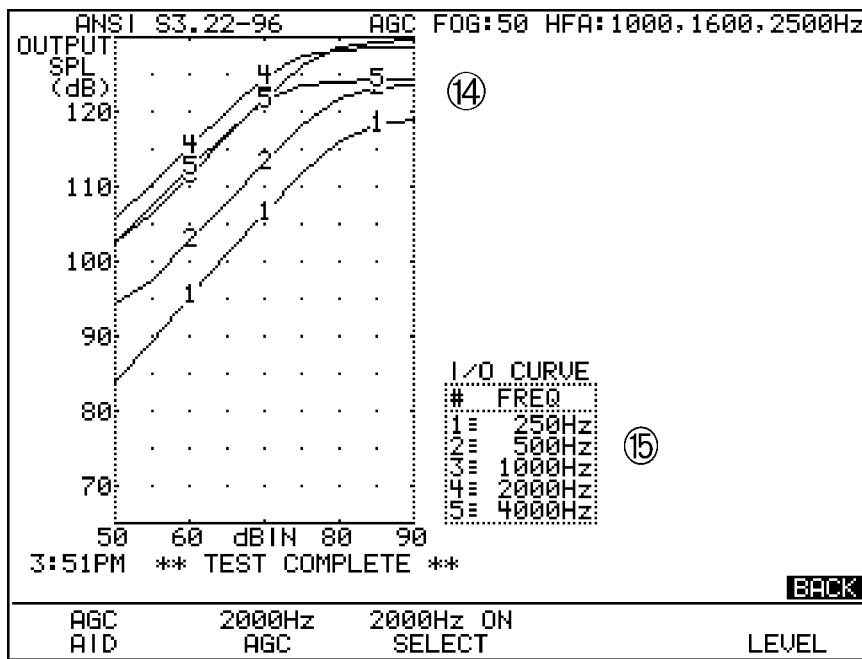

Figure 4.1.1B—ANSI 96 test, I/O Screen

Refer to Figure 4.1.1A and 4.1.1B 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. FOG: amplitude of the full-on gain measurement.
4. HFA/SPA: three frequency average chosen in the MENU.
5. OSPL 90 HFA: three frequency average of the OSPL 90 curve.
6. MAX: amplitude and frequency of the maximum output of the aid.
7. FOG: full-on gain three frequency average taken at the amplitude of the response curve.
8. CALC: target reference test gain.
9. MEAS: measured reference test gain.
10. EIN: equivalent input noise measurement.
11. 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.
12. TDH: total harmonic distortion measurements and the frequencies and amplitudes at which they are taken.
13. Ear tested.
14. I/O curves: the input/output measurements taken of AGC aids. Only selected frequencies are tested.
15. I/O curve selection box: the key to the I/O graph, listing which frequencies go with which curve.

4.1.2 Defining the Function Keys

[F1]—Selects hearing aid type.

[F2]—Selects I/O frequency (only available with aid type of AGC or ADAPTIVE AGC).

[F3]—Sets whether to test I/O frequency selected with F2.

[F5]—Starts the leveling procedure.

4.1.3 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 be affecting the testing environment.

The ANSI standard requires that you do a special leveling that accounts for everything that will be in the chamber during the test. If your unit has the Real-Ear Option, you can level using the reference microphone as described in Section 3.2.2. Otherwise, follow the procedure described in Section 3.2.1.

Note: For most clinical purposes, the standard leveling procedure (not using the reference microphone) is adequate.

4.1.4 Switching between ANSI 96 and ANSI 03

To switch between ANSI 96 and ANSI 03, first enter the ANSI test screen by using either [F4] or [F5] from the Opening screen: select the function key labeled either ANSI 96 or ANSI 03. From the ANSI screen, push [MENU] to open the local menu. Use [▼, ▲] to select ANSI TEST and [◄, ►] to switch between S3.22-1996 and S3.22-2003. **After switching between the standards, you must press [MENU] twice to update the local menu if you want to make any further menu changes.**

For instructions on changing the default ANSI test selection, see Section 2.3; the ANSI TEST selection is available in the Advanced Default Settings screen.

4.1.5 Setting up for ANSI testing

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 otherwise 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. Set the aid up in the sound chamber as described in Section 3.3. If you leveled with the reference microphone on, you can turn it off for measurement purposes — just make sure to leave it in place in the sound chamber.
7. To measure the telecoil function, follow the instructions in Section 2.5.8 to enable telecoil measurements on the FP35. Then use [F4] in the ANSI Screen to turn on the ANSI telecoil test.

Setting up a Linear Aid

For ANSI 96, use [F1] to select LINEAR 50 or LINEAR 60. Your selection should be based upon manufacturer specifications. If the specifications are unavailable, use:

- 50 dB for aids with high gain and relatively low output.
- 60 dB all other aids.

If you are unsure which to choose, press [EXIT] to return to the Main Screen and [F3] to enter the Coupler Multicurve screen. Run a full-on SPL curve at 60 dB and at 90 dB. (See Section 3.4.1 for more information.) If there is less than a 4 dB difference at any frequency between 200 and 5000 Hz, use LINEAR 50 as your aid type. Choose LINEAR 60 for all other aids.

In ANSI 03, the full-on gain measurement is always taken at 50 dB SPL, so this selection is not available.

Setting up an AGC Aid

Use [F1] to select AGC or ADAPTIVE AGC.

When you run the ANSI sequence on an AGC aid, you may run up to five different input/output curves. The frequencies that you can choose from are 250, 500, 1000, 2000 and 4000 Hz. Choosing AGC or ADAPTIVE AGC with [F1] will result in additional selections appearing above [F2] and [F3] that let you control the input/output settings.

Push [F2] to toggle through the frequencies. Use [F3] to turn the input/output curve for the current frequency on or off.

Press [NEXT] to see the ANSI I/O Screen. If you haven't yet run an ANSI test, the I/O curve selection box will show which curves you have selected to test.

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:

1. Press [MENU] to open the local menu.
2. Make sure that ANSI TEST is set to S3.22-2003. If it isn't, change the ANSI TEST selection and press [MENU] twice to refresh the local menu.
3. Adjust the AGC SWITCHING selection. 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.

4.1.6 Running an ANSI Test

After making any necessary menu selections as described in Section 4.1.8, leveling the sound chamber as described in Section 3.2, and setting up the aid as described in Section 3.3, follow these instructions:

1. Press [START/STOP] to begin the test.

2. Usually the FP35 will 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 MEASURED gain matches TARGET gain.

    b. Close the sound chamber lid when finished.

    c. 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.)

3. Press [START/STOP] to continue the test sequence. If you have enabled the telecoil test, do the following. Otherwise, skip to step 4.

    a. Wait for the analyzer to pause for you to set up the hearing aid for the telecoil test.

    b. Set the hearing aid to telecoil mode and position it for maximum output. See Section 3.8.7 for instructions on how to determine this position.

    c. Press [START/STOP] to run the telecoil measurement.

    d. Wait for the analyzer to pause, set the hearing aid back into microphone mode, and reposition the hearing aid in the test box.

    e. Press [START/STOP] to continue the ANSI test sequence.

4. If you are measuring an ANSI test, push [START/STOP] to continue the test. If you are measuring to ANSI 03 and have set the aid type to AGC or ADAPTIVE, 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/STOP] again to complete the test sequence. The analyzer will not pause if the ANSI TEST is set to S3.22-1996 or if AGC SWITCHING is OFF in the local menu. (See Section 4.1.5)

5. Press [NEXT] to view the ANSI I/O Screen for AGC aids.

6. Press [PRINT] for a hard copy of the results.

4.1.7 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 FP35 has no provisions for incorporating composite or digital speech into the ANSI 96 or ANSI 03 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 4.1.6.

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 mode via the procedures described in Chapter 3 and Chapter 5 using the digital speech (DIG SPCH) signal source.

4.1.8 Understanding Menu Items

There are two menus for the ANSI test screen. The first contains the most basic items; things you may want to change frequently. The advanced menu contains more advanced features that most users probably don't need to access.

Main ANSI Menu

Press [MENU] from the ANSI test screen to enter the local menu. Here are the selections:

ANSI TEST—ANSI standard selected for the test sequence. Choose between S3.22-1996 and S3.22-2003. Once this selection is changed, you will need to press [MENU] twice to update the local 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 4.1.5.

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

AVG FREQS—The three frequencies used in the ANSI three frequency averages. The last frequency of the three-frequency pair is used as the selection. See Section 2.5.1.6 for a complete list of available frequencies.

EQ INPUT NOISE—The type of equivalent input noise measurement (EIN) made with the ANSI test. NORMAL sets the EIN to use the entire 200 Hz - 8000 Hz frequency band. A selection of 5KHz sets the frequency band to 200 Hz - 5000 Hz (recommended), and a selection of OFF skips the EIN entirely.

NOISE RED—The amount of noise reduction used for the pure-tone measurements. See Section 2.5.1.3.

REF MIC—The status of the reference microphone.

Advanced ANSI Menu

Reach the following menu choices by pressing [NEXT] while the main menu is open.

HDIST 12DB—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.

PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken. See Section 2.4 for more information.

SHORT SETTLE—The time delay between the frequencies of a pure-tone sweep and input/output curves.

LONG SETTLE—The time delay between the frequencies of a three frequency average and distortion measurements.

IO PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken in an input/output curve. This selection is only available when the aid type of the hearing aid is set to AGC or ADAPTIVE.

IO SETTLE—The delay after the second tone (and all subsequent tones) is presented and before the measurement is taken in an input/output curve. This selection is only available when the type of hearing aid is set to AGC or ADAPTIVE.

PRINT LABEL— Status of the printing label. Choose ON or OFF.

PRINTER— Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

4.2 IEC Testing

The IEC 118-7 standard was designed by the International Electrotechnical Commission to assess hearing aids. The performance part of that standard can be included as an automated sequence on your FP35.

Press [F4] from the Opening Screen of the FP35 analyzer.

4.2.1 Viewing the IEC Display

Refer to Figure 4.2.1A and Figure 4.2.1B for the following explanation of the graphical display.

1. OSPL 90 curve: full-on gain frequency sweep taken at 90 dB SPL.
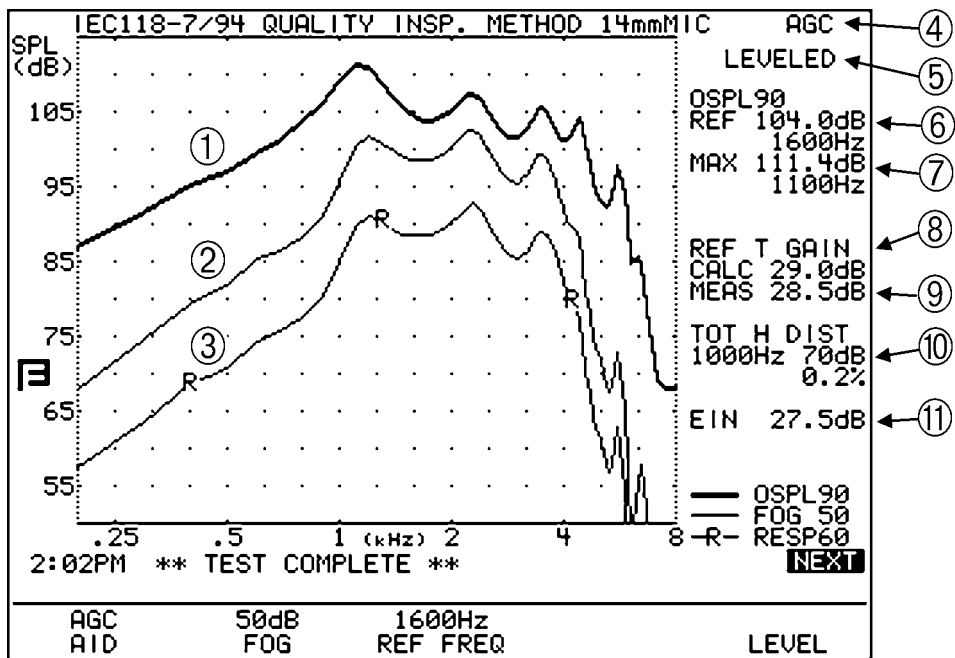2. FOG: full-on gain curve taken at 50 or 60 dB SPL. Select with [F2].

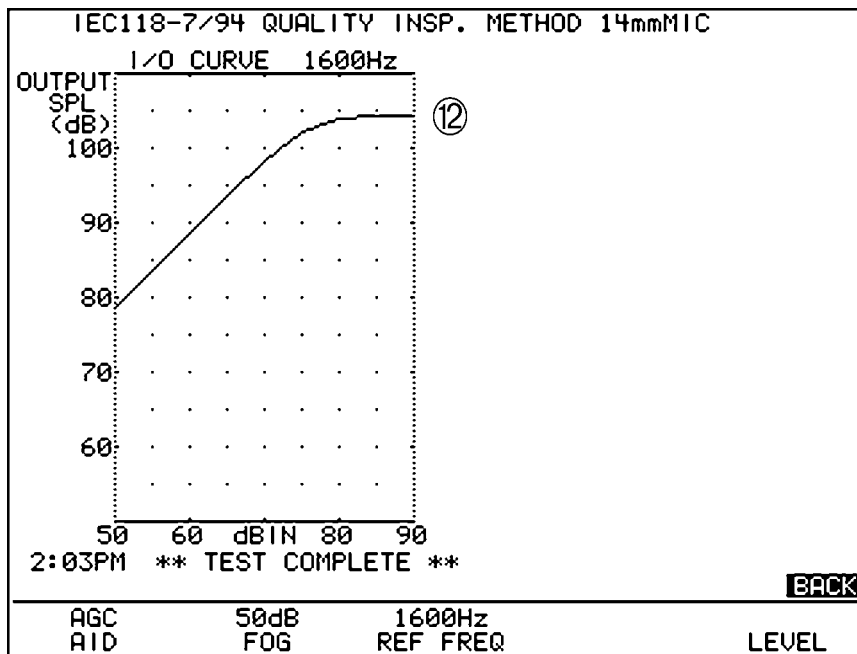*Figure 4.2.1A—IEC test results, Frequency Response Screen*

Figure 4.2.1B—IEC test results, I/O Screen

3. RESP: reference test gain frequency sweep taken at 60 dB SPL.

4. Aid type. Select with [F1].

5. Leveling status.

6. OSPL90 REF: frequency response of OSPL90 curve at reference frequency (1600 or 2500 Hz). Select with [F3].

7. MAX: amplitude and frequency of the maximum output of the aid.

8. CALC: target reference test gain.

9. MEAS: measured reference test gain.

10. TOT H DIST: total harmonic distortion measured at frequency selected in [MENU].

11. EIN: equivalent input noise measurement.

12. I/O CURVE: input/output curve at reference frequency (1600 or 2500 Hz). Select with [F3].

4.2.2 Defining the Function Keys

[F1] Selects aid type: LINEAR, AGC or ADAPTIVE AGC.

[F2] Selects whether full-on gain curve will be run at 50 dB or at 60 dB.

[F3] Selects the reference test position to be 1600 Hz or 2500 Hz.

[F5] Levels the sound chamber.

4.2.3 Setting Up the Hearing Aid for Testing

1. Set the controls on the aid (except for compression controls) to give the maximum output and gain.

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

3. Set AGC aids for maximum compression.

4. Make sure that the gain control of the aid is full on.

5. Set the aid up in the sound chamber as described in Chapter 3.

6. Press [F1] to select aid type.

7. Press [F2] to select between a full-on gain measurement at 50 dB or at 60 dB.

8. Press [F3] to select a reference frequency of 1600 Hz or 2500 Hz. Select 2500 Hz for high frequency emphasis aids.

4.2.4 Running an IEC Test

1. Level the sound chamber as described in Section 3.2, if needed.

2. Push the [START/STOP] key.

3. The FP35 will 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 MEASURED gain matches TARGET gain.

      b. Close the sound chamber lid when finished.

      c. The MEASURED gain should be within 1 dB of the TARGET gain.

4. Push [START/STOP] to complete the test.

5. Press [NEXT] to view the I/O Screen if the aid type was set to AGC or Adaptive AGC.

6. Press [PRINT] for a hard copy of the results.

4.2.5 Defining the Menu Items

There are two menus for the IEC Screen. The first contains the most basic items; things you may want to change frequently. The Advanced Menu contains more advanced features that most users probably don't need to access.

Main IEC Menu

Open the main IEC Menu by pressing [MENU] from the IEC Screen.

EQ INPUT NOISE—The type of equivalent input noise measurement (EIN) made with the IEC test. NORMAL sets the EIN to use the entire 200 Hz - 8000 Hz frequency band. A selection of 5KHz sets the frequency band to 200 Hz - 5000 Hz (recommended), and a selection of OFF skips the EIN entirely.

DISTORTION FREQ—The frequency used to take the harmonic distortion test.

NOISE RED—The amount of noise reduction used for the pure-tone measurements. See Section 2.5.1.3.

REF MIC—The status of the reference microphone.

Advanced IEC Menu

Reach the following menu choices by pressing [NEXT] while the IEC Menu is open.

PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken. See Section 2.4 for more information.

SHORT SETTLE—The time delay between the frequencies of pure-tone sweeps and input/output curves.

LONG SETTLE—The time delay between the frequencies of three frequency averages and distortion measurements.

PRINT LABEL—Status of the printing label. Choose ON or OFF.

PRINTER—Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

4.3 JIS Testing

The JIS 2000 automated test sequence allows you to test hearing aids according to the Japanese Instrument Standard.

To enter the JIS screen, look at the function key labels above [F4] and [F5] in the Opening screen. If one of them reads "JIS," press it to enter the screen. Otherwise, press and hold down [F4] or [F5] until a function key balloon menu appears. Use the arrow keys to select JIS, and press [START/STOP] to enter the screen.

4.3.1 Viewing the JIS Display

Refer to Figure 4.3.1A and Figure 4.3.1B for the following explanation of the graphical display.

1. OSPL 90 curve: full-on gain frequency sweep taken at 90 dB SPL.
2. FOG: full-on gain curve taken at 50 or 60 dB SPL. Select with [F2].
3. RESP: reference test gain frequency sweep taken at 60 dB SPL.
4. Aid type. Select with [F1].
5. CPLR: coupler typed used. Select in menu.
6. FOG: level with which the full-on gain curve was measured.
7. REF: reference frequency used.
8. Leveling status.
9. OSPL90 500: frequency response of OSPL90 curve at 500 Hz.
10. OSPL90 REF: frequency response of OSPL90 curve at reference frequency (1600 or 2500 Hz). Select with [F3].
11. OSPL90 MAX: amplitude and frequency of the maximum output of the aid.
12. FOG CALC: target reference test gain.
13. FOG MEAS: measured reference test gain.
14. EIN: equivalent input noise measurement.
15. LIM: response limit level determined by taking the frequency response of the RESP 50 (or 60) curve at the reference frequency and subtracting 15 dB.

    F1: frequency at which the RESP 50 (or 60) curve crosses the response limit level on the way up.

    F2: frequency at which the RESP 50 (or 60) curve crosses the response limit level on the way down.
16. TOT H DIST: total harmonic distortion measurements and the frequencies and amplitudes at which they are taken.
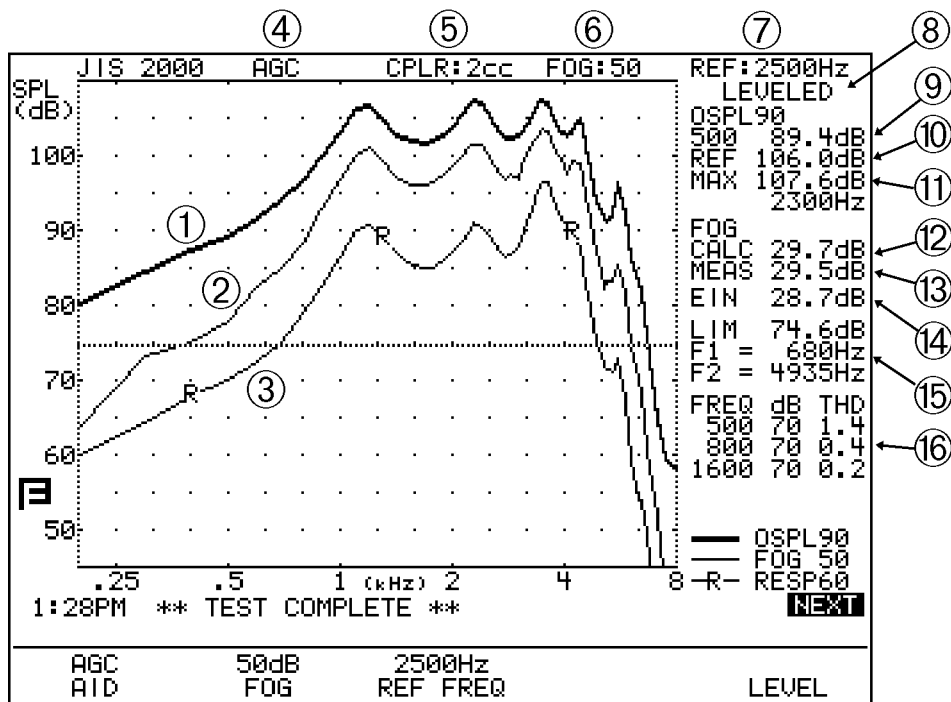17. I/O CURVE: input/output curve at reference frequency (1600 or 2500 Hz). Select with [F3].

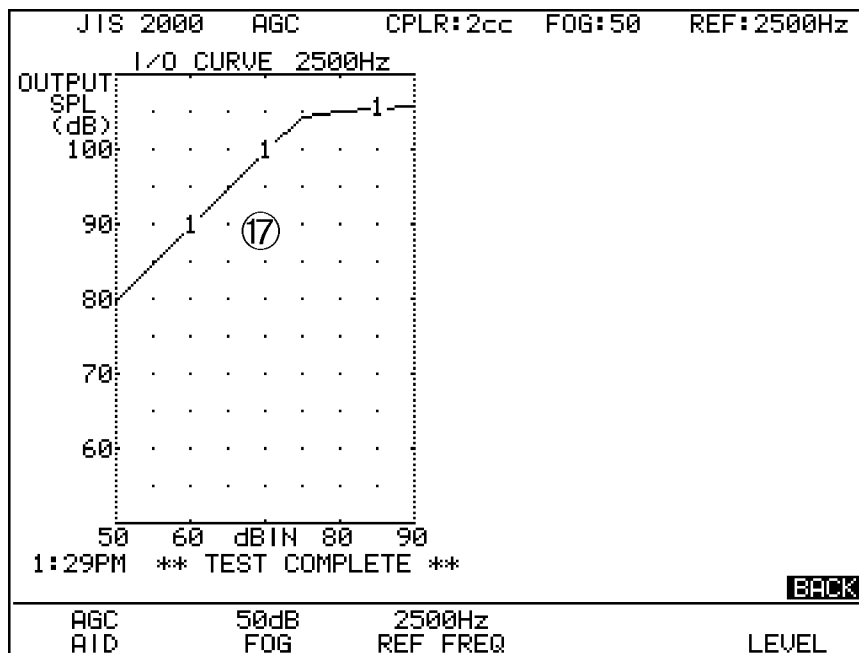*Figure 4.3.1A—JIS test results, Frequency Response Screen*

Figure 4.3.1B—JIS test results, I/O Screen

4.3.2 Defining the Function Keys

[F1] Selects aid type: LINEAR, AGC or ADAPTIVE AGC.

[F2] Selects whether the full-on gain curve will be run at 50 dB or at 60 dB.

[F3] Selects the reference test position to be 1600 Hz or 2500 Hz.

[F5] Levels the sound chamber.

4.3.3 Setting Up the Hearing Aid for Testing

1. Set the controls on the aid (except for compression controls) to give the maximum output and gain.
2. Set the aid for the widest frequency response range.
3. Set AGC aids for maximum compression.
4. Make sure that the gain control of the aid is full on.
5. Set the aid up in the sound chamber as described in Chapter 3.
6. Press [F1] to select aid type.
7. Press [F2] to select between a full-on gain measurement at 50 dB or at 60 dB.
8. Press [F3] to select a reference frequency of 1600 Hz or 2500 Hz. Select 2500 Hz for high frequency emphasis aids.

4.3.4 Running the JIS Test

1. Make sure the sound chamber is leveled. Follow the instructions found in Section 3.3, if needed.
2. Push the [START/STOP] key.
3. The FP35 will 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 MEASURED gain matches TARGET gain.
   b. Close the sound chamber lid when finished.
   c. The MEASURED gain should be within 1 dB of the TARGET gain.

4. Push [START/STOP] to complete the test.
5. Press [NEXT] to view the I/O Screen.
6. Press [PRINT] for a hard copy of the results.

4.3.5 Defining the Menu Items

There are two menus for the IEC Screen. The first contains the most basic items; things you may want to change frequently. The Advanced Menu contains more advanced features that most users probably don't need to access.

Main JIS Menu

Open the main JIS menu by pressing [MENU] from the JIS Screen.

COUPLER TYPE—Type of coupler used for the test sequence. Choose between 2cc, MZ, and CIC.

EQ INPUT NOISE—The type of equivalent input noise measurement (EIN) made with the JIS test. NORMAL sets the EIN to use the entire 200 Hz - 8000 Hz frequency band. A selection of 5KHz sets the frequency band to 200 Hz - 5000 Hz (recommended), and a selection of OFF skips the EIN entirely.

NOISE RED— The amount of noise reduction used for the pure-tone measurements. See Section 2.5.1.3.

REF MIC— The status of the reference microphone.

Advanced Menu

Reach the following menu choices by pressing [NEXT] while the JIS Menu is open.

HDIST 12DB—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.

PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken. See Section 2.4 for more information.

SHORT SETTLE—The time delay between the frequencies of pure-tone sweeps and input/output curves.

LONG SETTLE—The time delay between the frequencies of three frequency averages and distortion measurements.

PRINT LABEL— Status of the printing label. Choose ON or OFF.

PRINTER— Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

4.4 ISI Testing

The ISI automated test sequence tests hearing aids to the ISI IS-10775-1984 standard. ISI is very similar to the IEC automated test sequence except that it calculates the three-frequency HFA of the OSPL90 instead of the one-frequency reference response, it tests the harmonic distortion at three different frequencies instead of only one, and it provides an intermodulation distortion measurement taken with tones at 1500 and 2500 Hz, referred to as the "difference frequency distortion" (DF DIST).

Because the FP35 does not support battery current drain measurements, if the 1.0 volt testing part of the ISI standard needs to be performed, the user will need to attach an external 1.0 volt battery simulator (or a weak battery) to the hearing aid and run the ISI test sequence again, marking the results as being done at 1.0 volts.

To enter the ISI screen, look at the function key labels above [F4] and [F5] in the Opening screen. If one of them reads "ISI," press it to enter the screen. Otherwise, press and hold down [F4] or [F5] until a function key balloon menu appears. Use the arrow keys to select ISI, and press [START/STOP] to enter the screen.

See Section 4.2 for instructions on running the IEC test sequence. ISI testing is performed in the same manner.

Refer to Figure 4.4A and Figure 4.4B for the following explanation of the ISI test results:

1. OSPL90: Response curve made at full-on gain at 90 dB SPL
2. FOG: Full-on gain response curve made at 50 or 60 dB SPL
3. RESP50: Response curve at 50 or 60 dB SPL at reference test gain
4. Aid type
5. Amplitude used to measure the full-on gain curve
6. Reference frequency
7. Leveling status
8. OSPL90 HFA: High frequency average of the OSPL90 curve
9. OSPL90 MAX: Maximum output of the OSPL90 curve and the frequency at which it was measured
10. FOG: Reference frequency response made at full-on gain
11. HFA: High frequency average made at full-on gain
12. CALC: Calculated reference test gain
13. Equivalent input noise
14. LIM: Response limit
    F1: Frequency at which the response curve first crosses the response limit.
    F2: Frequency at which the response curve last crosses the response limit.
15. Total harmonic distortion
16. DF DIST: Difference frequency distortion, also known as intermodulation distortion
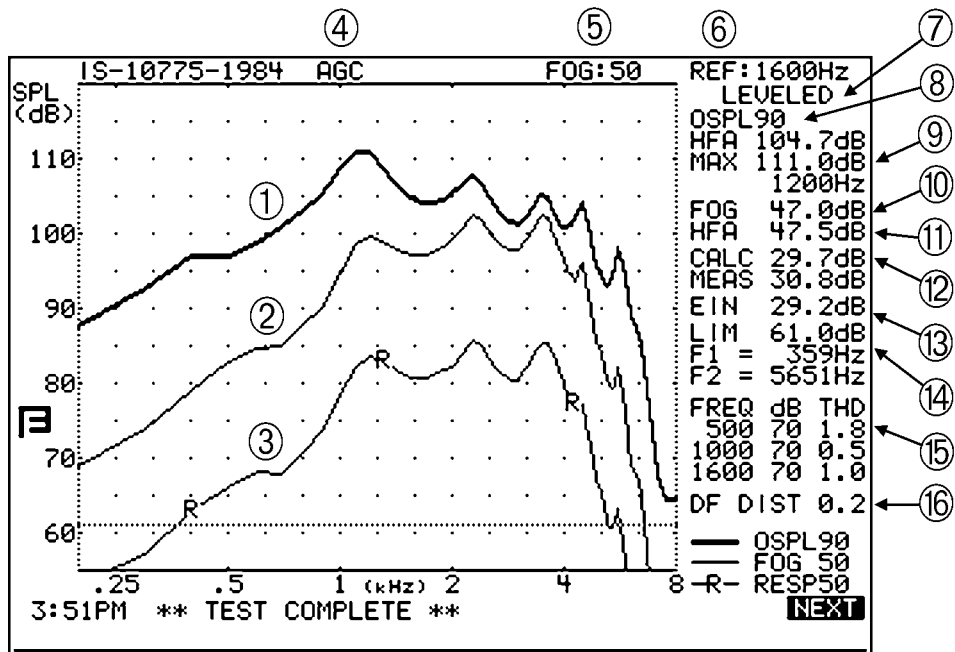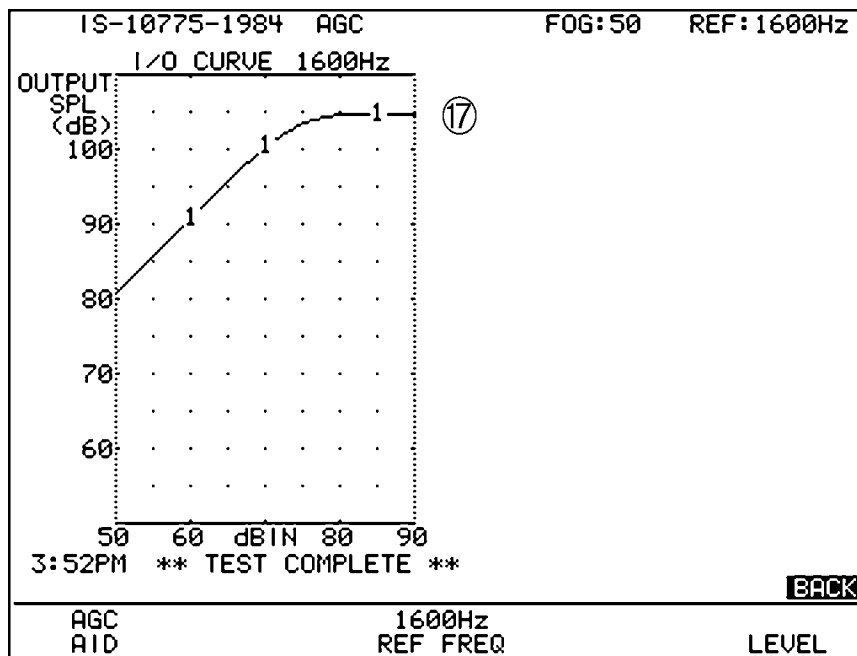17. I/0 curve

Figure 4.4A—ISI test sequence results

Figure 4.4B—ISI test sequence results

Real-Ear Measurements

5.1 Introduction

When the Real-Ear Option is ordered with your FP35 analyzer, you can test the hearing aid inside the patient's ear using the probe microphone. When performed correctly, this is the most accurate test available of the hearing aid's performance because it is measured using the patient's own ear canal resonance.

In the real-ear measurement screens, you can input an audiogram, generate a target, and take insertion gain and SPL measurements.

5.1.1 Real-Ear Screens

There are four different real-ear screens on the FP35 analyzer. One of these screens is for creating a real-ear target: the Audiogram Entry Screen. The other three screens are for performing real-ear measurements: the Unaided & Aided, Insertion Gain, and SPL Screen—the insertion-gain technique for fitting hearing aids has been separated into two separate screens to make it easy to distinguish between gain curves and insertion gain curves.

Audiogram Entry—Enter your audiograms, choose your fitting rule, perform RECD and REDD measurements, and generate a target in this screen.

Real-Ear SPL—View thresholds, UCLs, targets, and aided measurements in real-ear SPL on one screen. This gives you a complete picture of the client's hearing range and where the aided responses are falling in that range.

Real-Ear Unaided & Aided—Measure and display your client's unaided and aided measurements. You can run up to three separate aided curves and display them all on the same screen.

Insertion Gain—Measure and view your client's unaided and insertion gain measurements. Up to three insertion gain measurements can be displayed at one time.

5.1.2 Navigation

To enter the Real-Ear Mode, press [F2] from the Opening Screen of the FP35. This will open one of the Real-Ear Screens. To navigate through the four screens of the Real-Ear Mode, press the [NEXT] and [BACK] keys. Continuously pressing one of these keys will cycle you through the four choices, eventually bringing you back to screen where you started. See Figure 5.1.2.

To leave the Real-Ear Mode, press [EXIT] at any time.
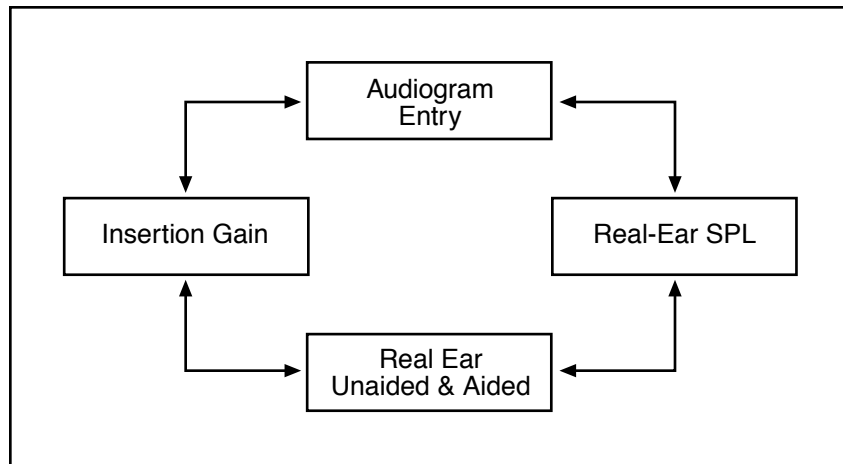
Figure 5.1.2—Real-ear navigation using next and back keys

5.2 Real-Ear Setup

If you are using the FP35 as a portable unit, you can easily convert the internal sound chamber into a sound field speaker. If you are using the FP35 primarily in an office or clinical setting, you may wish to set up an external speaker for real-ear measurements.

5.2.1 General Setup

When testing, the loudspeaker should be about 12 inches (30 cm) from the surface of the client's head (near the temple) and pointing toward the ear to be tested. We recommend 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 5.2.1.

Figure 5.2.1—Real-ear measurement setup

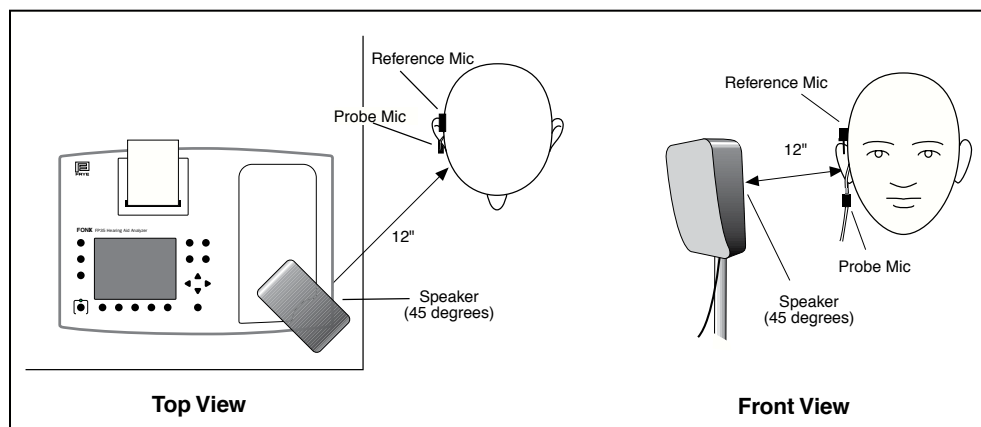Note: If you are using a 90 dB signal, the 12 inch distance is very important. If the client is too far away, a message box will open, alerting you to move the client closer. Don't forget to relevel for the client's new position.

5.2.2 Internal Speaker Setup (for Sound Field Use)

The technique for converting the FP35 analyzer's internal sound chamber into a sound field speaker to use for real-ear measurements is described in this section.

Removing the speaker from the FP35 compartment

- Open the sound chamber lid. Do this by pressing down on the metal latch at the front of the sound chamber lid.
- Lift the speaker out of the compartment.

Installing the speaker on the extension pole

- Locate the extension pole at the right side of the compartment. Remove the pole and place the wide end in the hole at the bottom, right corner of the sound chamber.
- Place the speaker on the tapered end of the pole. If the speaker does not reach your client's ear height, you may want to add the optional extension pole that raises the speaker by an additional 6.5 inches (16.5 cm).
- Position the FP35 at one edge of a table. The speaker can be rotated so that the correct angle for testing is easily achieved.

Figure 5.2.2—Internal sound field speaker setup

Replacing the speaker when the test is complete

- Remove the speaker from the pole.

- Lift the pole out of its hole and return it to the right side of the compart-
  ment. You must first slide one end of the pole into the notch toward the
  front of the FP35 analyzer. The pole will then fit easily onto the ledge.

- Make sure all cables in the compartment are put away so they will not
  interfere with replacing the speaker.

- Set the speaker back in the compartment. As you do this, guide the speaker
  wire so it stays to the side of the speaker, not underneath it.

5.2.3 External Speaker Setup

If desired, you can use an external speaker to perform your real-ear measure-
ments. The external speaker can be mounted to a floor stand or to a swing arm.
A swing arm is especially nice because you can move the speaker around the
patient when you switch ears, rather than move your patient around the speaker.

Figure 5.2.3—External sound field speaker setup

To set up your FP35 software to use an external speaker:

1. Press [MENU] from the Opening screen to enter the Default Settings menu.

2. Press [NEXT] to enter the Advanced Default Settings menu.

3. Select SPEAKER under RESETS with [▼,▲] keys.

4. Set AUTO with [◄,►]. All real-ear measurements will now be done with the
   external speaker and all coupler measurements will be done with the internal
   speaker.

5. Press [EXIT] to return to the Opening screen.

6. Press [F2] to enter Real-Ear Mode again.

5.2.4 Placing the Probe Tube

To ensure the proper insertion depth of the probe tube into the ear canal, 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 5.2.4A 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. Attach the probe tube to the integrated probe microphone and place the earhook of the microphone on the client's ear.

4. 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 would be. See Figure 5.2.4B.

5. Insert the hearing aid making sure the mark on the probe tube remains aligned with the outside of the aid. See Figures 5.2.4C.

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 5.2.4B) If necessary, adjust the integrated microphone for better positioning. If desired, use surgical tape to hold the tube in position.

NOTE: Figures 5.2.4B and 5.2.4C contain pictures of the integrated probe microphone. The probe microphone setup with the older style M300 separate probe microphone set is shown in Figure 5.2.4D.
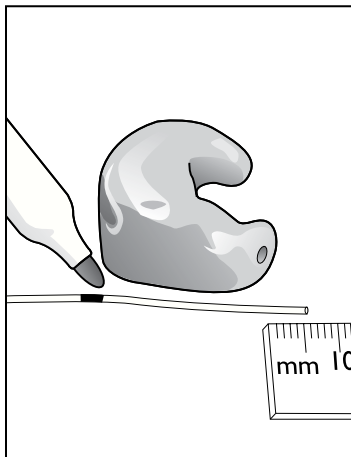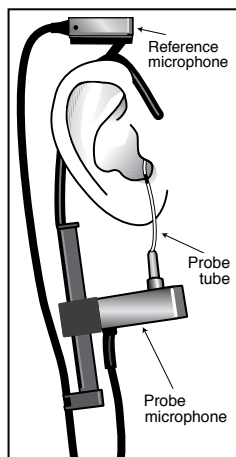

Figure 5.2.4A
Mark the probe tube.

Figure 5.2.4B
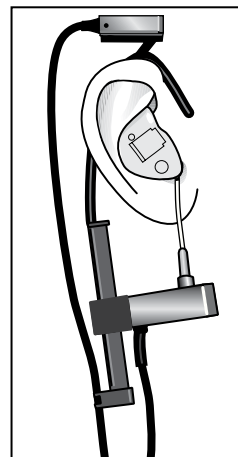*Place the microphones.*

Figure 5.2.4C
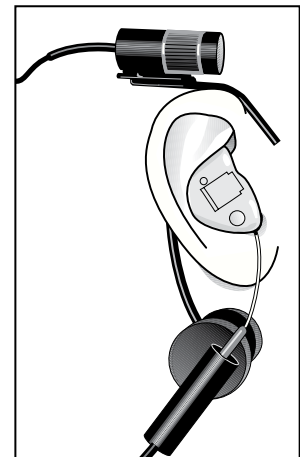*Insert the hearing aid.*

Figure 5.2.4D
Real-ear setup using M300 separate microphone set.

5.2.5 Placing the Sound Field Speaker

The placement of the sound field speaker can have a big influence on the accuracy and repeatability of your real-ear measurements. Research has shown that a consistent placement of 45 degrees azimuth to the client produces the most repeatable testing results. Some clinicians, however, prefer to use the more traditional 0 degrees azimuth to the client. See Figure 5.2.1 for a diagram of a client being tested at 45 degrees azimuth.

In both instances, we recommend a distance of 12–15 inches from the speaker to the client. A larger distance might make the FP35 analyzer unable to produce a 90 dB SPL signal to the client. A smaller distance might place the client in an unstable place in the field of the speaker.

You can specify which azimuth you are using for your real-ear measurements. This will have an effect on:

1. Which average REUR is used in creating SPL and insertion gain targets (when the measured REUR has not been taken).
2. DSL LIN and DSL WDRC targets.
3. NAL-NL1 targets.

To set the position of the speaker:

4. Press [MENU] in any real-ear measurement screen or in the Audiogram Entry screen.
5. Use [▼,▲] to select SOUND FIELD.
6. Use [◄,►] to select 0º or 45º.
7. Press [EXIT] to return to the real-ear screen.

Notes:

- If you took your audiometric measurements with a sound field speaker, it is recommended that you use the same azimuth for the real-ear measurements as you used in the audiometric assessment.
- The speaker position is set when the sound field is leveled. If you want to change the speaker position after leveling, you must re-level the sound field speaker for the change to take effect.
- The leveling status will reflect the selected sound field speaker azimuth. By default, this is set to 45º.

5.2.6 Leveling the Sound Field Speaker

The leveling process measures the sound field at the client's ear and accounts for inconsistencies in the testing environment. It is essential for obtaining accurate real-ear measurements. **You must re-level the sound field for every client and for every ear**.

The client must be in the same position for leveling and real-ear testing—you can use either a 0º azimuth or a 45º azimuth for leveling, as long as it is consistent with the speaker position used for the real-ear measurements.

Only the reference microphone is used during the leveling process. However, to speed things up and ensure the client is in the same position during leveling and during the measurement process, it is recommended that you insert the probe tube in the client's ear for the leveling process. See Section 5.2.2 for more details.

To level:

1. Place the integrated probe microphone on the client's ear. See Figure 5.2.4B.
2. Insert the probe tube into the client's ear, if desired. (The probe microphone is not used during the leveling process.)
3. Position the sound field speaker 12–15 inches from the client's head at a 0º or 45º azimuth. (We recommend 45º azimuth in order to produce the most repeatable results.)
4. Select the azimuth used in the SOUND FIELD setting in the real-ear menu. See Section 5.2.5 for details.
5. Press [F5]—LEVEL in any of the real-ear measurement screens.
6. Press [START/STOP]. The instrument will now attempt to level the sound field speaker.

These are the possible leveling status:

*   LEVELED 0º or LEVELED 45º—The leveling process was correct within 2 dB. The azimuth used is indicated.
*   UNLEVELED—The leveling process was incorrect by at least 6 dB. You should check the speaker, client, and reference microphone position and try to level the instrument again. No azimuth is indicated for this status.
*   0º or 45º—A status showing only the azimuth indicates that the leveling process was correct somewhere between 2 dB and 6 dB. Just as with the UNLEVELED status, you should check the speaker, client and reference microphone position and try to level the instrument again. However, if repeated attempts fail to reach a leveled status, you can consider this stage "good enough." Be aware that measurements when the instrument is in the in-between stage will not be as accurate as measurements taken when the sound field is leveled.

Note: The environment should be quiet during leveling. Noise can affect the leveling results, though the FP35 does use measurement methods to minimize the impact of external noise.

5.2.7 Testing Digital Aids

The FP35 seamlessly incorporates the testing of digital hearing aids into its normal testing procedures.

If you have the Composite/Digital Speech Option, just follow the steps outlined in Section 5.4.4 (Insertion Gain) or Section 5.5.2 (SPL), choosing a signal source of DIG SPCH with [F4] in the Real-Ear Testing Screens. The Digital Speech signal is an interrupted composite signal designed to imitate the rhythms of speech. The aid will respond to Digital Speech as it would respond to actual speech, without lowering the gain of the hearing aid. See Appendix F for more details.

If you do not have the Composite Option, put the aid into "test" mode via its programming software. You should also set the AID GROUP to ADAPTIVE. This will automatically use the SLOW pure-tone warble, which has been adjusted for the group delay of digital hearing aids.

1. Press [MENU] from a measurement screen.
2. Change AID GROUP to ADAPTIVE using the arrow keys.
3. Press [EXIT] to return to the measurement screen.

See Section 2.5.1.4 for details on pure-tone warbling.

5.2.8 Testing Body Aids

The setup below is recommended for Body aids. Follow normal insertion gain measurement procedures.
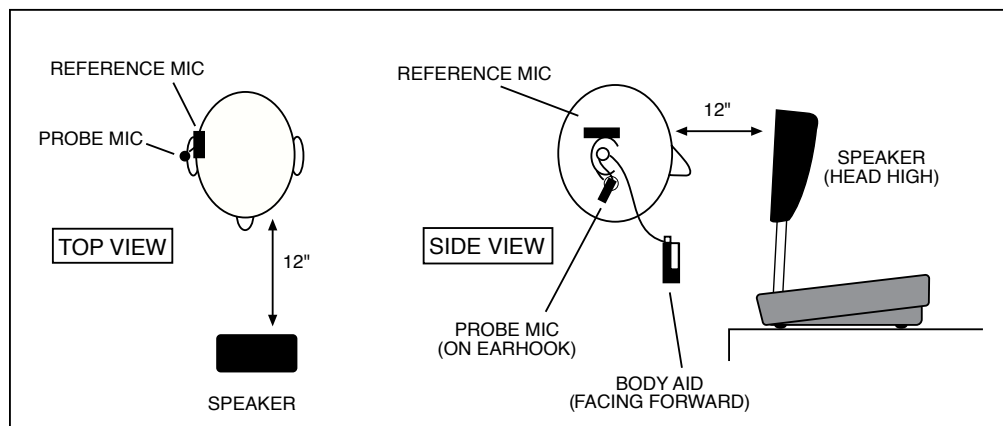

Figure 5.2.8—Setting up a body aid for real-ear testing

5.3 Audiogram Entry Screen—Creating A Target

Creating a target for one or both ears is actually something you can do before the client even enters the office. The first thing you have to do is enter the audiogram.

5.3.1 Entering the Audiogram Screen

- If necessary, press [F2] from the Opening Screen to enter the Real Ear Mode.
- The FP35 will automatically bring you to the Real-Ear Screen you left the last time you did a real-ear measurement.
- If necessary, use the [NEXT] or [BACK] keys to reach the Audiogram Entry Screen.

5.3.2 Audiogram Display

Please refer to Figures 5.3.2 for the following listing. Some fields are only visible with certain selections.

1. Column denoting frequency of data.
2. Thresholds data.
3. Uncomfortable level data.
4. Bone data.
5. Selected ear and aid group.
6. Age of client, fitting rule, and type of loss.
7. Number of channels of the aid, compression threshold, and type of limiting on the aid.
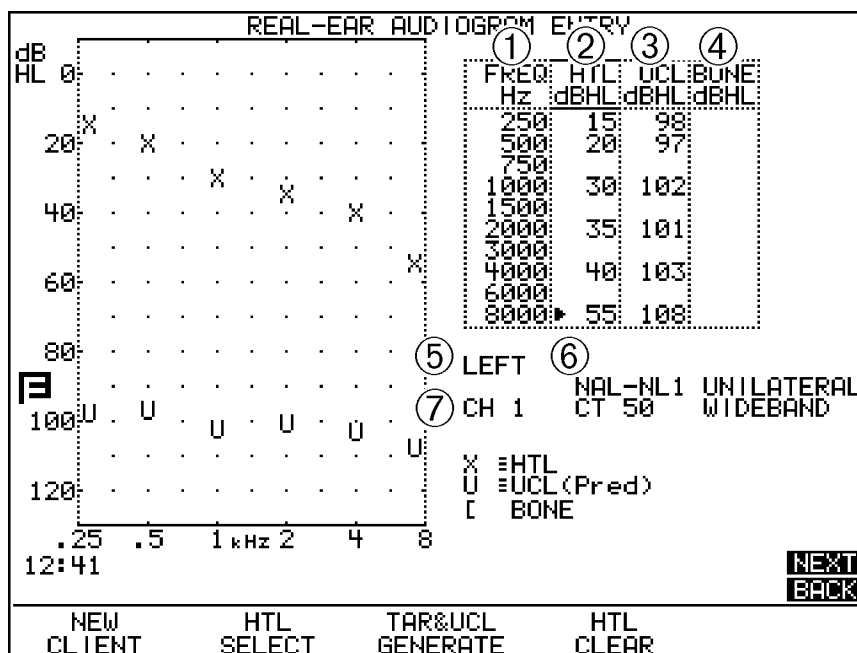

Figure 5.3.2—Display when editing audiometric data

The display will change, depending upon the selection made with [F2]:

- A selection of HTL or UCL displays the audiometric information in dB HL.
- A selection of TARGET displays the target curve in dB insertion gain or dB SPL.
- A selection of RECD or REDD displays that data in dB gain.

5.3.3 Entering Audiometric Information & Creating A Target

Use the following instructions to create a non-NAL-NL1 target. See Section 5.3.4 for NAL-NL1 instructions. The following step-by-step instructions assume that you are in the Audiogram Entry Screen.

1. Press [MENU] to enter the main local menu, and select the desired EAR and ASSESSMENT.
2. Press [BACK] to enter the Target Menu, and select the desired FIT RULE and AGE.
3. Press [EXIT] to return to the Audiogram Entry Screen.
4. Use [F2] to select HTL. A small arrow cursor will appear next to a frequency in the HTL column of the data entry box.
5. Use the [▼,▲] keys to move the cursor through the frequencies. Use the [◀,▶] to enter the client's threshold levels in dB HL at each frequency.
6. If you have measured your client's uncomfortable levels:

   a. Press [F2] to select UCL.

   b. Use the [▼,▲] keys to move the cursor through the frequencies.

   c. Use the [◀,▶] to enter the client's uncomfortable levels in dB HL at each frequency.

7. Press [F3] to generate a target using your selected fitting rule. If you did not enter any measured UCLs, predicted UCLs will also be generated.
8. Press [MENU] and change the selected EAR, if desired. Press [EXIT] to exit the audiogram menu. If you entered the thresholds for the other ear, those thresholds will automatically be copied to the current ear as a starting point. The UCL and target values will not be copied.
9. Repeat steps 2-5 for the new ear, if desired.

Note: See Appendix E for information on how we predict the UCL values from the threshold data.

5.3.4 Creating an NAL-NL1 Target

The NAL-NL1 fitting rule is more adjustable and slightly more complicated than DSL and the traditional linear fitting rules. In addition to the client's air conduction thresholds, it takes into consideration the client's bone conduction thresholds, whether the fitting is binaural or monaural, the number of channels of the

hearing aid, and the type of limiting the aid has. The steps to creating an NAL-NL1 target are very similar to creating a DSL or a linear target – NAL-NL1 just requires a few more menu selections.

To create an NAL-NL1 target:

1. Press [MENU] in the Audiogram Entry screen and use the arrow keys to select the following:
   - EAR: Current ear
   - ASSESSMENT: Type of transducer used in creating the audiogram

2. Press [BACK] to enter the Target menu. Use the arrow keys to select the following:
   - FIT RULE: NAL-NL1
   - AGE: Age of the client
   - COMPRESSION: The first compression kneepoint of the hearing aid.
   - CHANNELS: The number of channels of the hearing aid.
   - AID LIMITING: The type of output limiting on the hearing aid.
   - FIT TYPE: Unilateral or bilateral
   - REFERENCE: Leveling reference. If leveling is performed with the patient in the sound field, set this to HEAD SURFACE (recommended). If leveling is performed by holding the reference microphone in front of the speaker, set this to UNDISTURBED.

3. Press [EXIT] to return to the Audiogram Entry screen.

4. Press [F2] until HTL is selected. A small arrow cursor will appear next to a frequency in the HTL column of the data entry box.

5. Use the [▼,▲] keys to move the cursor through the frequencies. Use the [◄,►] keys to enter the client's threshold levels in dB HL at each frequency.

6. (Optional) Press [F2] and select BONE in order to enter the client's bone conduction thresholds. Use the arrow keys to enter the bone values in the same manner as you entered the HTL values.

7. (Optional) Press [F2] to select UCL, and use the arrow keys to enter the client's UCL values in the same manner as you entered the HTL values.

8. (Optional) If you selected a FIT TYPE of "bilateral" in Step 1, you need to enter audiometric data from both ears to generate a target.

9. Press [MENU] to enter the menu.

10. Change the EAR by using the arrow keys.

11. Press [EXIT] to return to the Audiogram Entry screen. The threshold values for the first ear will be displayed on the screen as a starting point for the entry of the new audiogram.

12. Repeat Steps 3-4 to enter the audiogram for the new ear.

13. Press [F3] to generate the NAL-NL1 target. If you did not enter any measured UCL values, predicted UCLs will also be generated.

5.3.5 Modifying a Target

If the target generated by the FP35 does not meet your client's needs, you can modify it so that it does. To modify the target:

1. Press [F2] until TARGET is selected. In the data entry box, the cursor will now be in the TARG column.

2. Use the [▼,▲] keys to move the cursor through the frequencies.

3. Use the [◄,►] keys to change the target values. The values will be adjusted in 1 dB increments. Holding down the arrow key will change the numbers more rapidly.

If you want to enter your own target values, use these same steps. In such a case, it is unnecessary to generate the target. If you want to predict UCLs and enter your own target values, choose DIRECT as your target fitting rule. Then pushing [F3] will generate UCL values, but not IG values.

Note: You cannot modify DSL targets.

5.3.6 Measuring the Real-Ear to Coupler Difference

The real-ear to coupler difference (RECD) is the acoustical difference between the response of an insert earphone in the ear versus in a 2-cc coupler. It involves two measurements: a coupler measurement, and a real-ear measurement. Both measurements are performed with an insert earphone.

The coupler part of the RECD is performed when you "calibrate" the insert earphone used in the measurement. When this calibration is performed, the coupler measurement is saved into the FP35 analyzer's permanent memory. See Appendix C for instructions on performing the calibration of the insert earphone.

See *Chapter 6: 2CC-Targets* for information on performing coupler measurements to a target.

5.3.6.1 Analyzer Setup for RECD

This section describes how to set up the analyzer to perform the real-ear portion of the RECD.

1. Enter the Audiogram Entry Screen (See Section 5.3.1).

2. Press [MENU].

3. Select desired EAR, using [◄] if necessary.

4. Select ASSESSMENT with [▼,▲] keys.

5. Press [◄,►] to select INS. EAR.

6. Press [EXIT] to return to Audiogram Entry Screen.

7. Press [F2] repeatedly until RECD (or REDD) is selected. You will see an additional column of average RECD information for the selected age appear on the screen.

8. Make sure that SHOW RECD is displayed above [F5]. If it isn't, press [F5] to toggle the display.

9. Look at the bottom right corner of the LCD screen. If you see the message "Earphone not calibrated," you will need to follow the instructions found in Appendix C for calibrating the insert earphones. See Figure 5.3.6.1.

10. Press [F3] to select MEASURE RECD.

11. Plug the insert earphone into the "earphone" jack in the back of the FP35.

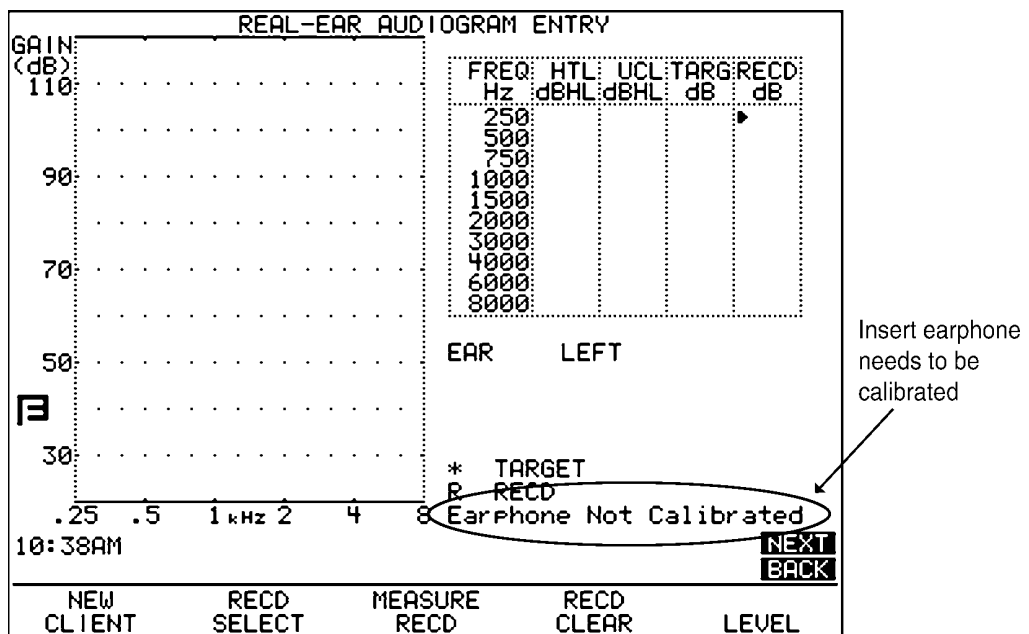*Figure 5.3.6.1—This screen indicates that the coupler part of the RECD needs to be taken.*

5.3.6.2 Client Setup for RECD

This section describes how to set up the client for the real-ear portion of the RECD measurement.

1. Insert the probe microphone into your client's ear. See Figure 5.3.6.2A.

2. Insert custom earmold or foam eartip coupled to the insert earphone into your client's ear. See Figure 5.3.6.2B.
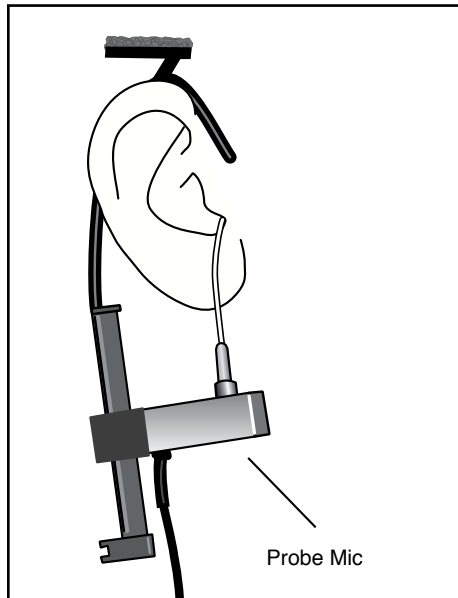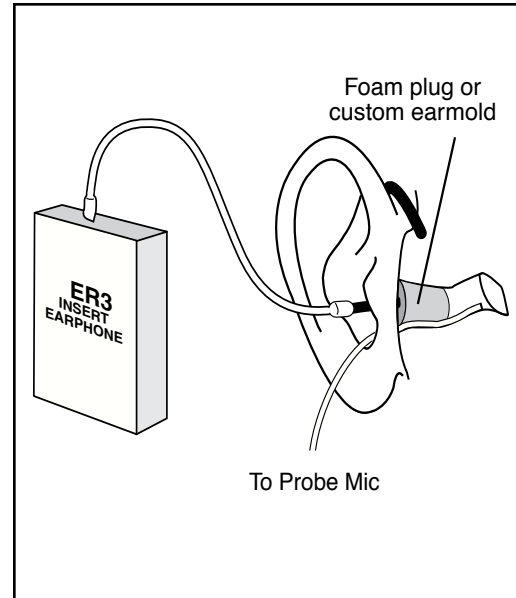
Figure 5.3.6.2A—Insert probe microphone

Figure 5.3.6.2B—Insert foam eartip connected to insert microphone

5.3.6.3 Taking the RECD Measurement

If you've performed the steps described in Sections 5.3.6.1 and 5.3.6.2, you just have to press [START/STOP] to take the RECD measurement. Results will be displayed in graphical format in dB GAIN as well as numerical format in the data table.

To erase the measured RECD, press [F4] and [START/STOP].

See *Chapter 6: 2CC-Targets* for information on performing coupler measurements to a target.

5.3.7 Measuring the Real-Ear to Dial Difference

The real-ear to dial difference (REDD) is the difference between an audiometer's output in dB HL and the unaided response of the client in dB SPL.

To take the REDD measurement on the FP35 analyzer, you perform a probe microphone measurement using an insert earphone or the sound field speaker as the transducer of the test. In other words, when you perform an RECD measurement (using an insert earphone), or an REUR measurement (using the sound field speaker), you get the REDD as an added bonus.

- When SPEAKER is selected in the ASSESSMENT field in the menu, the REUR and REDD are obtained simultaneously by taking a sound field unaided measurement.
- When INS EAR is selected in the ASSESSMENT field, the RECD and REDD are obtained simultaneously by taking an unaided measurement using an insert earphone.

WARNING

Choose OUTPUT LIMITING carefully (see procedure below). You don't want to damage your client's hearing or cause discomfort during testing. To ensure safety and comfort, the FP35 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 "PROBE OUTPUT LIMIT EXCEEDED" appear on the screen, and program automatically stops.

The default setting for OUTPUT LIMITING is 120 dB SPL. You can set the OUTPUT LIMITING to any level between 80 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, we recommend *extreme* caution when using pure tones for real ear SSPL measurements.

Whenever the output limiting function has stopped the test signal, you must turn down the hearing aid, lower the source SPL, or change the output limit.

To view or change the OUTPUT LIMITING Setting:

1. Push [MENU].

2. Use the [▲,▼] keys to move the cursor next to OUTPUT LIM.

3. Use the [◄,►] to select the desired limit.

4. Press [EXIT] to return to the testing screen.

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.

DO NOT REUSE INSERT EARPHONE EARTIPS.

Insert earphone eartips are used primarily for performing RECD and audiometric measurements. Sterilization of these eartips is not possible. When performing these measurements, make sure to use a new ear tip for each patient. You may spread infections if you reuse insert earphone eartips.

Follow the directions in Section 5.3.6 to obtain an REDD using an insert ear-phone. Follow the directions in Section 5.3.8 to obtain an REDD using the sound field speaker. After performing the measurements, press [F5] to toggle the view to show REDD.

When TDH is the selection for the ASSESSMENT field, the REDD cannot be measured automatically with the FP35 analyzer. Instead, the average values will be used, or measured values can be entered manually.

To measure the REDD transform with the FP35 analyzer and a separate audiometer (the Composite option is required):

1. Enter the Aided & Unaided measurement screen by using the [NEXT] and [BACK] keys from the Audiogram Entry screen.

2. Press [MENU] and use the arrow keys to set the REF MIC to OFF. Use [EXIT] to return to the measurement screen.

3. Use [F4] to set the source type to COMP. This will put the analyzer in spectrum analysis mode.

4. Use [▼] repeatedly to turn the source OFF.

5. Insert the probe tube connected to the probe microphone into the client's ear, preferably within 4 mm of the eardrum. Use an otoscope for assistance. We recommend using a bit of surgical tape to affix the probe tube in place at the helix.

6. Place the TDH headphones on the client.

7. Press [START/STOP] to begin the spectrum analysis measurement.

8. Deliver 70 dB HL from the audiometer, and record the RMS OUT value as measured by the FP35 analyzer for each audiometric frequency. This value is the eardrum SPL.

9. Subtract 70 dB from each SPL value to get the custom REDD.

10. Press [START/STOP] to end the measurement when finished.

11. Use [NEXT] repeatedly to enter the Audiogram Entry screen.

12. Use [F2] repeatedly to select RECD or REDD. If RECD is shown, use [F5] to select SHOW REDD. An REDD column will appear on the screen to the right of the HTL, UCL, and TARG columns.

13. Use the arrow keys to enter the measured REDD values that you obtained in step 9.

5.3.8 Measuring the Unaided measurement

If you used a sound field speaker to take your audiometric measurements, you should use an REUR (real-ear unaided response) as the HL to SPL transform and for the generation of targets.

If you measure the unaided response in the Audiogram Entry screen, the measurement results will be copied into the Unaided and Aided screen for use with insertion gain measurements. Likewise, any unaided measurement made in one of the real-ear measurement screen will be copied into the Audiogram Entry screen.

1. Press [MENU] in the Audiogram Entry Screen.
2. Select the desired EAR using the arrow keys.
3. Select SPEAKER in the ASSESSMENT field using the arrow keys.
4. Select the azimuth used (0º or 45º) when performing the audiometric assessment in the SOUND FIELD entry by using the arrow keys. This will be the azimuth you should use in your real-ear measurements.
5. Press [EXIT] to return to the Audiogram Entry Screen.
6. Press [F2] repeatedly until REUR is selected.
7. Set up the client for an unaided measurement with the reference microphone on an earhook above the client's ear and the probe tube inserted into the ear. See Figure 5.2.4B. The speaker should be 12 inches from the client at the selected azimuth.
8. Press [F5] to level the sound field speaker.
9. Press [START/STOP] to measure the unaided response. This unaided response will be available for use and display in the Real-Ear Measurement Screens. See Figure 5.3.8.
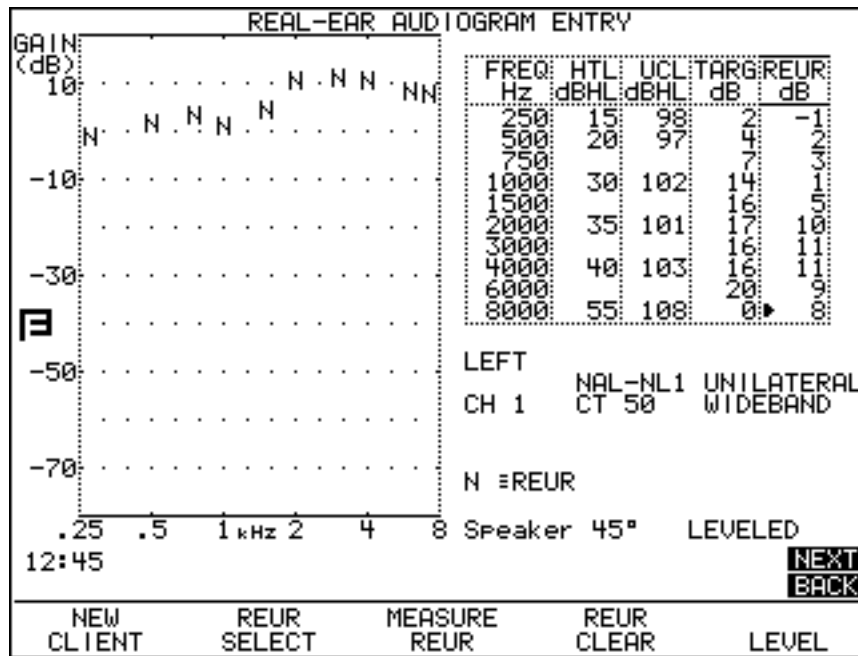

Figure 5.3.8—Unaided Measurement in the Audiogram Entry Screen

5.3.9 Starting a New Client

When you have finished performing the real-ear (or target coupler) measurements on the hearing aid and patient, pressing [F1] in the Audiogram Entry screen will erase all measurements and restore settings in order to make setting up for a new patient quick and easy.

In addition to all audiometric and real-ear measurements being erased, the following menu items are reset when [F1] is pressed in the Audiogram Entry screen. They are also set when the analyzer is powered on or when the [RESET] key is pressed.

- CHANNELS – 1 (used by NAL-NL1 only)
- AID LIMITING – Wideband (used by NAL-NL1 only)
- FIT TYPE – Unilateral (used by NAL-NL1 only)
- VENT – Tight (used by NAL-NL1 Target Coupler only)
- TUBING – Libby #4 (used by NAL-NL1 Target Coupler only)
- SOUND FIELD – 45 degrees
- TARGET REF – REF #2
- TABULATION – Target
- REF METHOD – HEAD SURFACE

The following menu items are set to their default values only when the analyzer is first powered on. They aren't reset when NEW CLIENT is pressed or when [RESET] is pressed. Their default values can be changed in the Default Settings menu. See Section 2.3.1. (The listed values are the factory defaults.)

- FIT RULE – NAL-NL1
- AGE – Adult
- ASSESSMENT – Ins. Ear
- COMPRESSION – 52 dB (used by NAL-NL1 and DSL only)
- AID TYPE – ITC
- AID GROUP – Standard
- REF MIC – ON
- COUPLER TYPE – 2 cc (used by Coupler measurement screens only)

5.3.10 Defining the Menu Items

This section describes all the menu items in the Main and Advanced Audiogram Entry menus.

Main Audiogram Entry menu

Press [MENU] from the Audiogram Entry screen to open the Audiogram Entry menu. The following choices are available:

EAR—The ear tested. Select LEFT or RIGHT.

AID GROUP—Type of aid being tested. Choose STANDARD, AGC, or ADAPTIVE (for adaptive AGC circuits). See Section 2.4 for more information.

ASSESSMENT—The transducer used in performing the audiometric measurements. If you have the Audiometer Option, this will activate the selected transducer. (The FP35 cannot use the TDH transducer to make audiometric measurements.)

SOUND FIELD—The sound field azimuth you are using with the real-ear measurements. We recommend 45° for more repeatable results.

OUTPUT LIMIT—The maximum output of the hearing aid, as read by the probe microphone, before the analyzer automatically shuts off its speaker. This limit is designed to protect the hearing of your client from accidental overexposure to noise while being tested.

NOISE RED (TONE)—The amount of noise reduction used when taking measurements.

REF MIC (SPEAKER)—The status of the reference microphone when making sound field measurements.

Target Menu

Press [BACK] from the Main Audiogram Entry menu to enter the Target menu.

FIT RULE—The fitting rule used to create the real-ear and coupler targets. Selections are: NAL-NL1, NAL-RP, DSL WDRC, DSL LIN, POGO, BERGER, 1/3 GAIN, 1/2 GAIN, 2/3 GAIN and DIRECT. A selection of NAL-NL1 will add several menu selections to the menu screen.

AGE—The age of the client. A selection of NONE sets the age to ADULT but turns off the age display.

COMPRESSION—The type of wideband compression threshold the aid has. This is selectable in increments of 1 dB, and it is only available with a fitting rule selection of DSL WDRC or NAL-NL1.

CHANNELS—The number of channels the aid has. This is only available with a fitting rule selection of NAL-NL1.

AID LIMITING—The type of output limiting the aid has. If the aid has output limiting, usually WIDEBAND should be selected. If the aid has output limiting, and if the aid has more than one channel, this can be set to MULTICHAN. If the aid doesn't have limiting, set this to NONE. This selection is only available with a fitting rule selection of NAL-NL1.

FIT TYPE—Type of fitting. Choose from UNILATERAL and BILATERAL. Bilateral fittings require the audiograms of both ears to be entered.This is only available with a fitting rule selection of NAL-NL1.

AID TYPE—Style of hearing aid. Choose from BTE, ITE, ITC, and CIC.

VENT—Type of venting on the hearing aid. Choose from OPEN, TIGHT, NO VENT, 1 mm, 2 mm and 3 mm. This selection is only available with a fitting rule selection of NAL-NL1.

TUBING—Type of tubing on the BTE hearing aid. Choose from LIBBY 4, LIBBY 3, CFA #2 HORN, CFA #2 BORE, #13, 6C5, and 6C10. This selection is only available with a fitting rule selection of NAL-NL1 and an AID TYPE of BTE.

REFERENCE—Type of leveling used in the real-ear measurement. When HEAD SURFACE is selected, leveling is performed with the patient within the sound field and the reference microphone on top of the ear. When UNDISTURBED is selected, leveling is performed by holding the reference microphone in front of the sound field speaker. This selection is only available with a fitting rule selection of NAL-NL1.

Advanced Audiogram Entry Menu

Press [NEXT] from the Main Audiogram Entry menu to enter the Advanced Audiogram Entry menu.

SPEAKER—The sound field speaker selection. Choose to use the INTERNAL or an EXTERNAL speaker.

WARBLE SOURCE—Type of pure-tone warbling used when taking measurements. Choices are AUTO, FAST, SLOW, and OFF. It is recommended to set this to AUTO. See Section 2.5.1.4 for more details on warbling options.

PROBE MIC (HL)—The status of the probe microphone (ON or OFF). This selection is only available if you have the Audiometer Option.

LEVELING SOURCE—The amplitude used for leveling the sound field speaker. The default is 70 dB for real-ear measurements. See Section 3.2.4.

PRINT LABEL—The status of the printer label.

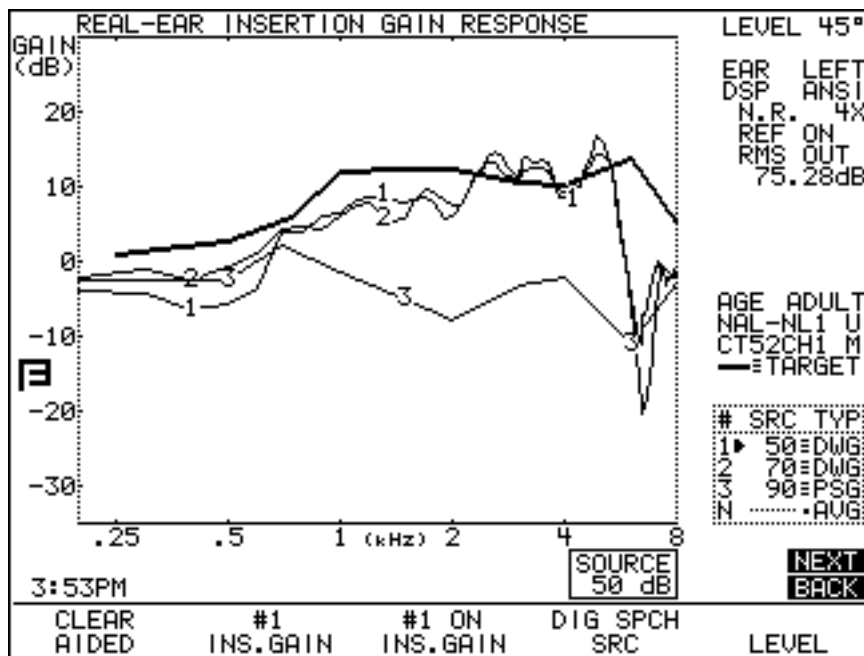PRINTER—The printer selected. Choose between using an INTERNAL or an EXTERNAL printer.

5.4 Insertion Gain Testing

An insertion gain test measures how much gain the hearing aid is providing over the client's unaided response. **This section assumes you have already generated a target curve (see Section 5.3.3 and 5.3.4) and are ready to test.**

The Unaided & Aided Response screen and the Insertion Gain Screen are two parts of the same insertion gain method of fitting hearing aids. The Unaided & Aided Response Screen lets you measure and view aided gain measurements of the hearing aid. See Figure 5.4A. The Insertion Gain screen displays the insertion gain target and lets you measure and view insertion gain measurements of the hearing aid. See Figure 5.4B. We divided insertion gain into two screens in order to clearly distinguish between the aided gain and insertion gain curves.

Insertion gain is the difference between the client's unaided response and his/her aided response. In other words, insertion gain is the actual gain that the aid is producing. Aided gain, in contrast, is the gain the aid is producing plus the natural gain of the ear.

Figure 5.4A—Unaided and Aided Screen

Figure 5.4B—Insertion Gain Screen

5.4.1 Measuring the Unaided Response

The first step in taking an insertion gain measurement is to measure the unaided response. You can do this from either the Unaided & Aided Response Screen or the Insertion Gain Screen.

If you are using the average unaided response, skip to the next section.

1. Place the probe tube in your client's ear as described in Section 5.2.4. Level the sound field speaker. See Section 5.2.6.

2. Press [MENU] and make any necessary menu selections. See Section 5.8.2 for a list of menu selections. Press [EXIT] to exit the menu.

3. Press [F4] to select the signal type. Use COMP if you have the Composite Option. If not, use NORM.

4. Press [F2] to select CUSTOM UNAIDED.

5. Use the [▼,▲] keys to adjust the source amplitude to 65 or 70 dB SPL.

6. Have the client sit still in the same position they were in during leveling, and press [START/STOP] to begin measuring the unaided response. If you are using the composite signal, press [START/STOP] when satisfied with the measurement.

7. The real-ear unaided response (REUR) will be displayed on the graph as a dotted line marked with the letter N.
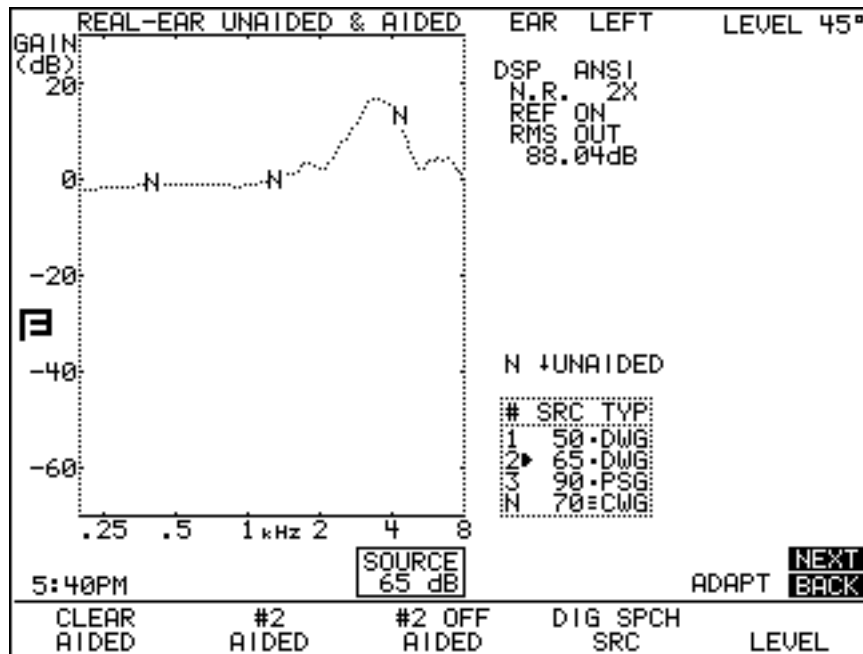
Figure 5.4.1—Unaided response

8. If you used the composite signal for testing, use the [◀,▶]keys to show the
    last four measurements taken while the signal source was running.

Note: To display the average unaided measurement, set UNAIDED to AVERAGE
in the menu. Then select AVG UNAIDED with [F2] and turn ON its display with
[F3].

5.4.2 Measuring the Aided Response

The second step in an insertion gain measurement is the aided response.

If you would like to view the measurement as an insertion gain curve and com-
pare it to an insertion gain target, take this measurement from the Insertion Gain
Screen. If you would prefer to view the aided gain, take this measurement from
the Unaided & Aided Response Screen.

Whenever you take a measurement in one of these screens, it will automatically
be converted and placed into the other screen.

To take an aided measurement:

1. Place the aid into the client's ear taking care not to drag the probe tube fur-
    ther into the ear canal. Once the aid is in the ear, the red mark on the probe
    tube should be at the same position it was for the unaided test. See Figure
    5.2.4C.

2. Have the client set the aid's gain control to the normal use level.

3. Press [F4] to select the source type.

4. Use the [▼,▲] keys to adjust the source amplitude to the desired level, usually the same level used for the unaided measurement.

5. Instruct the client to resume the position they were in for leveling and testing. Tell them to sit very still while the signal is on.

6. Press [START/STOP] to introduce the signal. The aided response will appear on the graph as a thin line labeled with a curve number.

   Note: If you are using the COMP, DIG SPCH or FAST signal, you can change the source amplitude during testing to see how the aid responds to such changes.

7. Press [START/STOP] to end the measurement if you are using the COMP, DIG SPCH or FAST signal.

8. If you used the COMP or DIG SPCH signal, use the [◀,▶]keys to view the last four curves measured while the signal source was running. This should help eliminate any momentary peaks in the response.

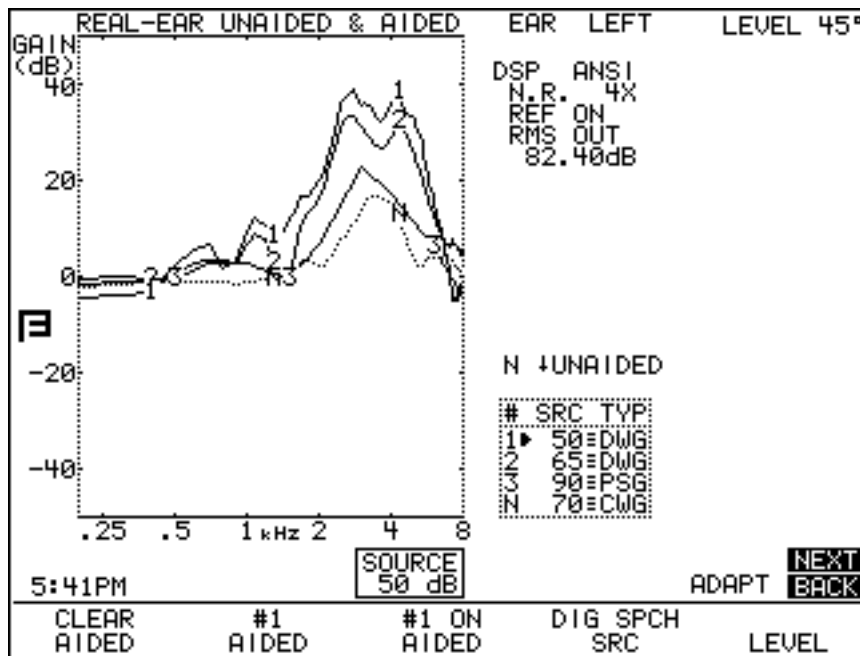9. If desired, press [F2] to select a another curve number and repeat steps 3-8.

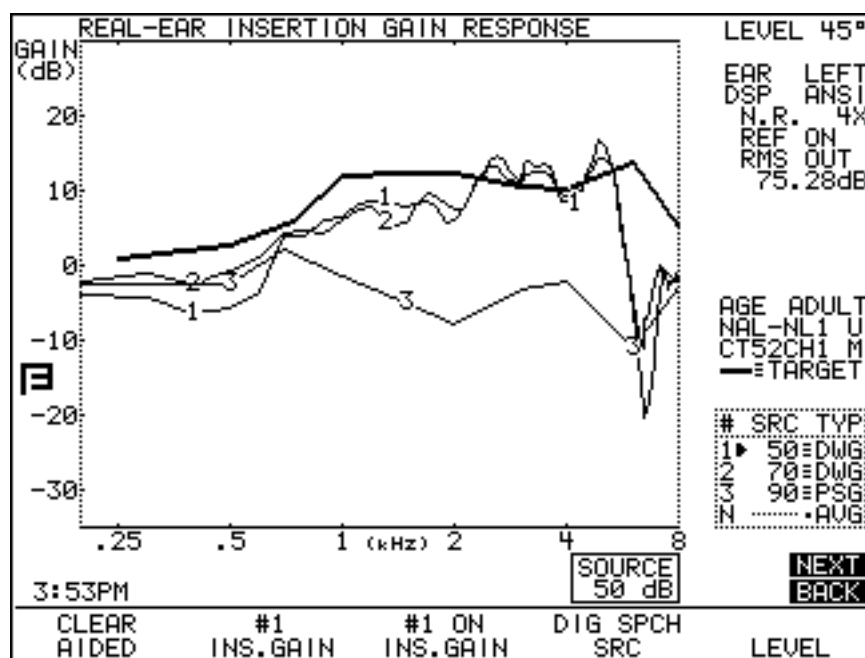*Figure 5.4.2A—Unaided and aided response*

Figure 5.4.2B—Insertion gain

5.4.3 Automatic Testing

The FP35 analyzer has the capability of performing automatic real-ear aided measurements. This feature automatically tests the three aided measurements automatically without needing user intervention between measurements. Auto Test always measures AIDED 1, 2, and 3, in that order.

To enable auto test:

1. Press [MENU] in the real-ear measurement screen.
2. Use [▼,▲] to select AUTO TEST and set it to ON.
3. Press [EXIT] to close the menu.
4. Press [START/STOP]. The analyzer will automatically test AIDED 1, AIDED 2 and AIDED 3.

The Auto Test feature default can be set to ON. See Section 2.3 for details.

5.4.4 Testing Directional Hearing Aids

The Insertion Gain screen is a good place to perform a directionality test for directional hearing aids. In an insertion gain measurement, the unaided curve is subtracted from the aided curve in order to arrive at the insertion gain curve. You can use this functionality in order to find out how much advantage the directional microphones of the hearing aid are providing.

To test directionality:

1. Place the probe tube in your client's ear as described in Section 5.2.4, and level the sound field speaker as described in Section 5.2.6. Although we recommend a 45° azimuth for real-ear measurements, for this measurement you should use a 0° azimuth, with the sound field speaker directly in front of the patient.

2. Place the hearing aid in your client's ear, making sure not to move the probe tube.

3. Enter the Unaided & Aided Response screen. Use the [NEXT] and [BACK] keys if necessary.

4. Press [MENU] to enter the real-ear menu. Make sure that CUSTOM is selected for UNAIDED. Use the arrow keys to make the selection, if necessary. Press [EXIT] to return to the real-ear measurement screen.

5. Press [F1] to clear all existing curves, if necessary.

6. Use [F2] to select AIDED #1.

7. Use [F4] to select the signal type. Use NORM, COMP or DIG SPCH.

8. Use [▼,▲] to select a signal source of 65 dB SPL.

9. Press [START/STOP] to take the measurement. If you're using a COMP or DIG SPCH signal, press [START/STOP] again to stop the signal once the measurement has stabilized. This curve will be the "forward" measurement.

10. Turn your client around so that the back of his head is facing the speaker. See Figure 5.4.4A. Alternately, if you are using an external speaker on a swing arm, you can swing the speaker around in back of the client.

11. Use [F2] to select CUSTOM UNAIDED. Although this is an aided measurement, the "unaided" measurement slot will give you a nice directional subtraction curve when the second measurement is completed.

12. Use [F4] to select the signal type used in the "forward" measurement.

13. Use [▼,▲] to select a signal source of 65 dB SPL.

14. Press [START/STOP] to take the measurement. If you're using a COMP or DIG SPCH signal, press [START/STOP] again to stop the signal once the measurement has stabilized. This curve is the "reverse" measurement. See Figure 5.4.4B.

15. Press [NEXT] to enter the Insertion Gain screen. The displayed measurement curve is the difference between the "forward" and the "reverse" measurements, or the amplification advantage provided by the directional microphones of the hearing aid. See Figure 5.4.4C.
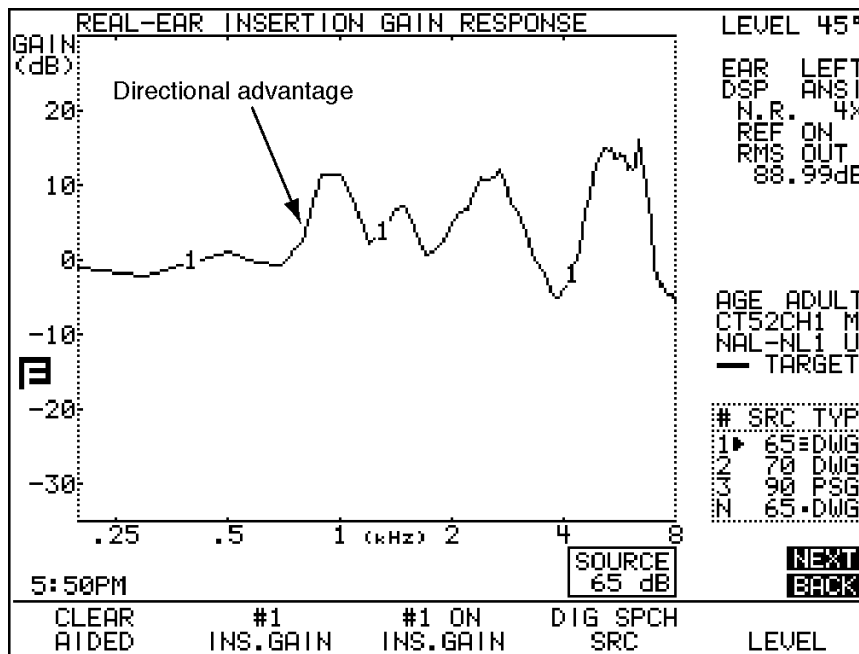
Figure 5.4.4A—"Reverse" directional aid setup

Figure 5.4.4B—"Forward" and "reverse" directional aid measurements in the real-ear unaided & unaided screen

Figure 5.4.4C—Amount of amplification advantage provided by the directional microphones

5.4.5 Testing Open Fit Hearing Aids

Open fit hearing aids have been known to interfere with the reference microphone measurement outside the ear. To determine if a particular hearing aid is interfering with the reference microphone, perform the following measurement in any real-ear measurement screen. The feedback cancellation and other features normally used by the patient should be enabled on the hearing aid.

1. Measure the aided response as described in Section 5.4.2.
    *   The sound field speaker should be LEVELED.
    *   The reference microphone setting should be ON. The reference microphone status is displayed in the column of data to the right of the graph (REF ON or REF OFF).
    *   [F2] should be set to AIDED 1.
    *   The source amplitude should be set to 65 dB SPL. Use the up-down arrow keys to adjust the source if necessary.
    *   [F4] should be set to DIG SPCH.

2. Press [START/STOP] to start the measurement. Press [START/STOP] again when the measurement has stabilized.

3. Use [F2] to select AIDED 2

4. Press [MENU] to open the local menu. Use the arrow keys to set the REF MIC to OFF. Press [EXIT] to close the local menu.

5. Measure the aided response as described in Section 5.4.2.

    • The source amplitude should be set to 65 dB SPL. Use the up-down arrow keys to adjust the source if necessary.

    • [F4] should be set to DIG SPCH.

6. Press [START/STOP] to start the measurement. Press [START/STOP] again when the measurement has stabilized.

7. Look at the difference between AIDED 1 and AIDED 2.

If there is no more than 2 dB of difference between AIDED 1 and AIDED 2 at any frequency, you can perform real-ear measurements using that particular model of open ear hearing aid without adjusting the hearing aid analyzer. If the two measurements are different by 3 dB or greater at any frequency, it is recommended to disable the reference microphone when performing REMs using this type of device. To disable the reference microphone, follow the instructions found in Step 4 above.

When performing a real-ear measurement while the reference microphone is disabled, it is particularly important to make sure the patient doesn't move after the sound field speaker has been leveled because the reference microphone will not be able to compensate for any changes in the patient's position.

5.5 The Real-Ear SPL Screen

The SPL screen permits the user to view all the major components of a client's hearing loss and hearing aid fitting on one screen in dB SPL. The hearing thresholds and uncomfortable loudness levels, which are generally measured in HL, are converted to SPL. The insertion gain target is also converted to SPL. You can measure and display the unaided response and three aided responses, in SPL, at three different source amplitude levels. 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.

The factory default amplitudes used in this program are generally 50, 65 and 90 dB. (When DSL is the selected fitting rule, these default levels will vary.) The user may choose other amplitude levels while conducting the tests. The idea is to make sure that:

• Soft sounds are audible (AIDED 1).

• Moderate sounds are comfortable (AIDED 2).

• Loud sounds do not exceed the user's uncomfortable loudness level (AIDED 3).

This technique is especially appropriate for non-linear hearing aids.

5.5.1 The SPL Display

The information on the SPL screen is similar to the information in the other real-ear measurement screens. However, in addition to the measurement curves and the SPL-converted target, the SPL Screen also displays SPL-converted thresholds and uncomfortable levels, allowing you to directly compare the measurement curves to the audiometric information.

> X denotes left thresholds
> O denotes right thresholds
> * denotes the target
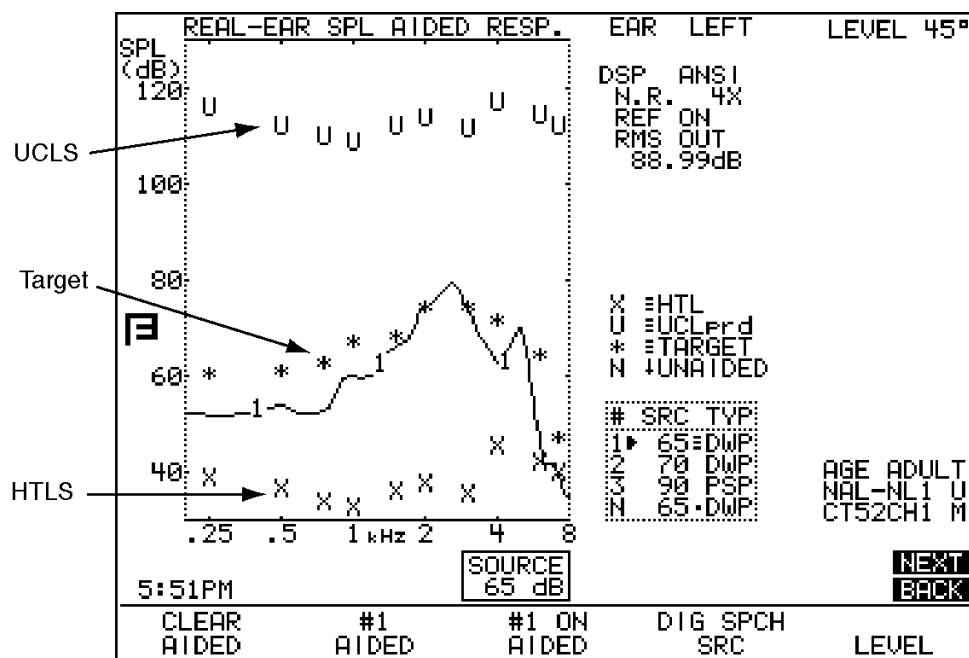> U denotes the uncomfortable levels.

Figure 5.5.1—SPL display

5.5.2 Running an SPL Test

This section assumes you have already entered the client's audiometric data in the Audiogram Entry Screen, and that you have generated a target. See Section 5.3.3 and 5.3.4 for more details.

1. Place the probe tube into the client's ear following the instructions provided in Section 5.2.4.

2. Insert the aid into the client's ear, being careful not to drag the probe tube farther into the ear canal (See Figure 5.2.4C). Do not turn the aid on.

3. Instruct the client to remain still when the signal is on.

4. Press [F5] to level.

5. Have the client turn the aid on and set the gain control to the normal use level.

6. Use [F2] to select AIDED 1.

7. Use [F4] to select the source type for AIDED 1, and use the [▼,▲] keys to set the source amplitude

8. If necessary, adjust noise reduction and output limiting with [MENU].

9. Have the client resume the position they were in during leveling, and remind them to stay still while the signal is on.

10. Press [START/STOP] to test. If you are using the COMP, DIG SPCH or FAST signal source, you will need to press [START/STOP] again to stop the signal.

11. Repeat steps 6 through 10 for AIDED 2 and AIDED 3.

In general, AIDED 1 is tested at low levels (50 dB SPL) to make sure soft sounds are above the patient's threshold values. AIDED 2 is tested at medium levels (65-70 dB SPL) to make sure that the aid meets the target. AIDED 3 is tested at loud levels (90 dB SPL) to make sure that loud sounds are beneath the patient's UCLs.

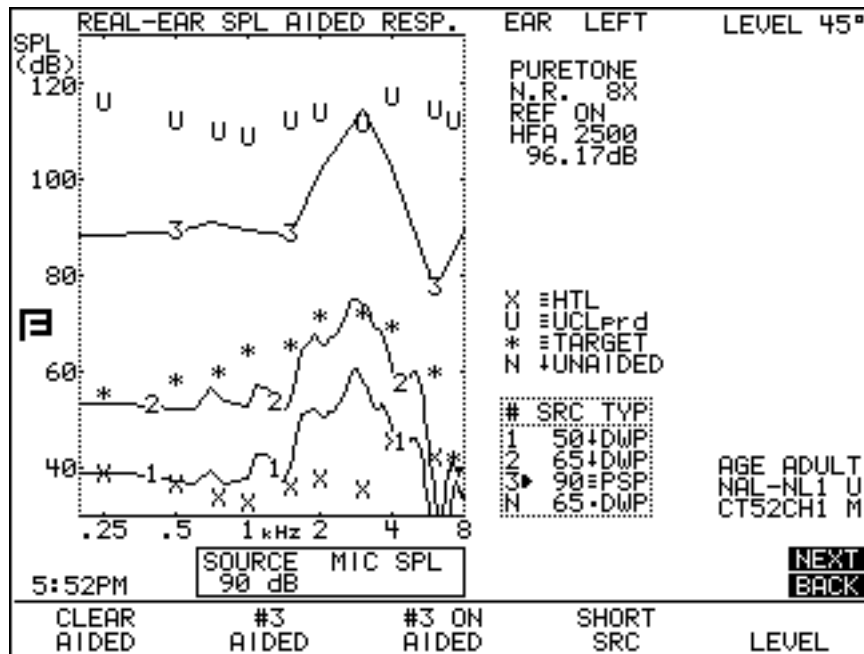Note: See Section 5.4.5 for information on testing open fit hearing aids.

Figure 5.5.2—SPL display with measurements

5.5.3 Important Notes on SPL Testing

This section contains somewhat technical details relating to the real-ear SPL screen.

5.5.3.1 Speech-Weighting Effects on Pure tones

When the normal pure-tone or fast sweep of less than 85 dB is chosen as an SPL source signal, it is always speech weighted. The corresponding target is also speech weighted. The measurements and the target will therefore look different from the target curves displayed in the Insertion Gain Mode.

5.5.3.2 Target Formulas

The target appearing in the SPL Screen normal changes according:

- AIDED 2 source type
- AIDED 2 amplitude
- Average or custom unaided response

When UNAIDED AVERAGE is chosen in [MENU], the target takes into consideration the KEMAR average unaided response.

When UNAIDED CUSTOM is chosen in [MENU], the target takes into consideration the measured unaided response. If the unaided response has not been measured before an aided response is taken, the unaided selection automatically reverts back to AVERAGE, and the target adjusted accordingly.

If no measurement for AIDED 2 has been taken, the target will adjust to the amplitude and source type of AIDED 2 while you push the keys. If AIDED 2 has been measured, the target will remain adjusted to the source type and amplitude of the measured curve. Once you press [START/STOP] to take a new AIDED 2 measurement, the target will adjust to any new source type or amplitude selected.

If you would like to tie the target to a curve other than AIDED 2:

1. Press [MENU] from the real-ear measurement screen.
2. Press [BACK] to enter the Target menu.
3. Use [▼,▲] to select TARGET REF.
4. Use [◄,►] to select CURVE 1, CURVE 2, CURVE 3 or AUTO. The AUTO selection always uses the current selected curve to generate the target.
5. Press [EXIT] to return to the measurement screen.

5.5.4 Important Notes on DSL Testing

The DSL fitting method is slightly more complicated than the other fitting rules available on the FP35 analyzer. For this reason, it is important to keep a few things in mind when using DSL:

- DSL was initially developed for children. For this reason, it is important to input the client's age when generating a target for a child. If no age for the client is set, the analyzer will assume that it is generating a target for an adult. See Section 5.3.4 for instructions on how to generate a target.

- The DSL WDRC target will change depending upon the source level of CRV 2. So, if you would like to see the DSL WDRC target for 80 dB SPL, for example, set the amplitude of CRV 2 to 80 dB SPL. The DSL LIN target will also adjust to the amplitude of CRV 2, but its adjustments will be linear.

- DSL demands a slightly different speech weighting in its measurement signals than the speech weighting we usually use. When fitting an adult, DSL requires the adult long-term average speech spectrum (A-LTASS) weighting. When fitting a child, DSL requires the child long-term average speech spectrum (C-LTASS). The FP35 will automatically use these speech weightings unless specifically directed otherwise. See Section 2.5.2.1 for more details.

- When DSL LIN or DSL WDRC is the fitting method, the FP35 will put three lines on the SPL Testing Screen, denoting the LTASS. Once a real-ear measurement is taken, these lines will disappear. See Figure 5.5.4.
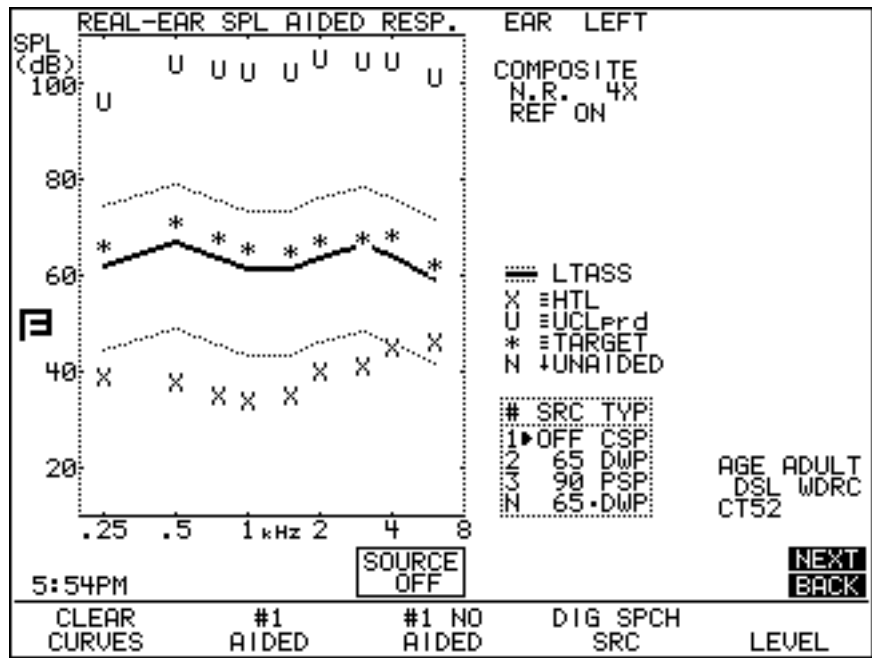

Figure 5.5.4—SPL Testing Screen with a DSL WDRC target and the LTASS speech banana.

5.6 Live Speech Testing

The Spectrum Analysis mode lets you use the external signal of your choice with your real-ear measurements. You can use sounds from a CD player, the patient's own voice, or the voice of a spouse or family member. This section describes several different methods of using external signal in your real-ear measurements.

When you use live speech in the real-ear SPL screen, you can compare the hearing aid's response to the actual speech to the patient's threshold and uncomfortable levels. This can be a great counseling tool for your patient.

5.6.1 Using Speech as a Test Signal

Visible Speech testing can be performed with a live voice signal or with a prerecorded stimulus from an external CD player or MP3 player. This is especially useful if you have the spouse or family member of the client in the testing room. You can use his/her voice as the test signal in order to educate both the client and the spouse how close they need to be to each other in order for the hearing aid to work effectively.

Visible Speech can be performed in any real-ear measurement screen, but this section will focus on measurements in the Real-ear SPL screen.

To set up for Visible Speech:

1. Follow the instructions in Section 5.2.4 and 5.2.5 to set up the client and hearing aid for real-ear measurements. The sound field speaker does not need to be leveled for live speech testing.

2. Insert the patient's hearing aid carefully and turn it on with the volume control at the normal user setting.

3. Follow the instructions in Section 5.3 to create a real-ear target, if desired.

4. Enter the Real-Ear SPL screen. See Section 5.1.2 for instructions.

5. Make sure that AIDED #1 is shown above F2. If necessary, use [F2] to change the curve number. Visible Speech will not function when the UNAIDED curve is selected.

6. Use [F4] to select COMP.

7. Press [▼] repeatedly until the SOURCE is turned OFF. This is displayed in the source box on the display above the F3 key.

8. Press [MENU] to open the local menu.

9. Use [▼,▲] to select VISIBLE SPEECH. The BARS selection will display a set of vertical bars indicating the maximum and minimum response to the test. The AVERAGE selection will display a second curve during the measurement, indicating the average response over the time of the test using a peak decay method.

10. Use [▼] to select NOISE RED (COMP) and [◄,►] to select the amount of averaging you would like to do when the measurements are performed. Large noise reduction numbers will create a smoother curve that will update more gradually with more averaging. If the noise reduction is turned to a low number or OFF, the measurement curve will update more quickly with less averaging.

11. Press [EXIT] to close the local menu.

To use an external CD/MP3 player

If your FP35 has been manufactured after October 2008, you can connect an external CD player or MP3 player to the FP35 analyzer and play the signal through the FP35 speaker using the 3.5mm "line-in" jack on the back of the analyzer. If your analyzer does not have this jack, then it was probably manufactured previous to the addition of this feature. Existing analyzers can be upgraded. Contact your FONIX distributor for details.

When the FP35 is in spectrum analysis mode (as described in the "To set up for Visible Speech" section above) and an external player is connected using the line-in jack, then the FP35 will automatically play any input coming from the external player.

To calibrate a pre-recorded signal

We recommend that you calibrate the external signal for best measurement results. Many CDs used by hearing health professionals contain a calibration track as the first track of the CD. This is generally a puretone signal at a particular input level.

1. Set up the patient for real-ear measurements as described in the "To set up for Visible Speech" section above.

2. Put the analyzer in spectrum analysis mode and play the calibration track on the CD through the FP35 speaker. Make sure to start a measurement by pressing the [START/STOP] key.

3. Adjust the volume control on the external player until the REF measurement (located to the right of the measurement graph, above the RMS OUT measurement) matches the desired level of the calibration tone. This level should be indicated on the instruction materials of the CD.

To start measuring:

1. Press [START/STOP] to start the measurement.

2. Start your input signal:

   a. If you are using a live voice, such as the patient's spouse, have the person speak to the patient from about 6 feet away (2 meters). It helps to have something for them to read.

   b. If you are using a pre-recorded signal, start the signal from the external player.

3. Examine the measurement graph. The screen will display the hearing aid's response to the live voice or pre-recorded signal and how it relates to the displayed speech banana. If you chose the BARS setting in step 8, you will also see a succession of bars on the screen, indicating the maximum peaks of the speech. If you chose the AVERAGE setting, you will see a second curve composed of small diamonds indicating the long term average response over the time of the test. See Figure 5.6.1.
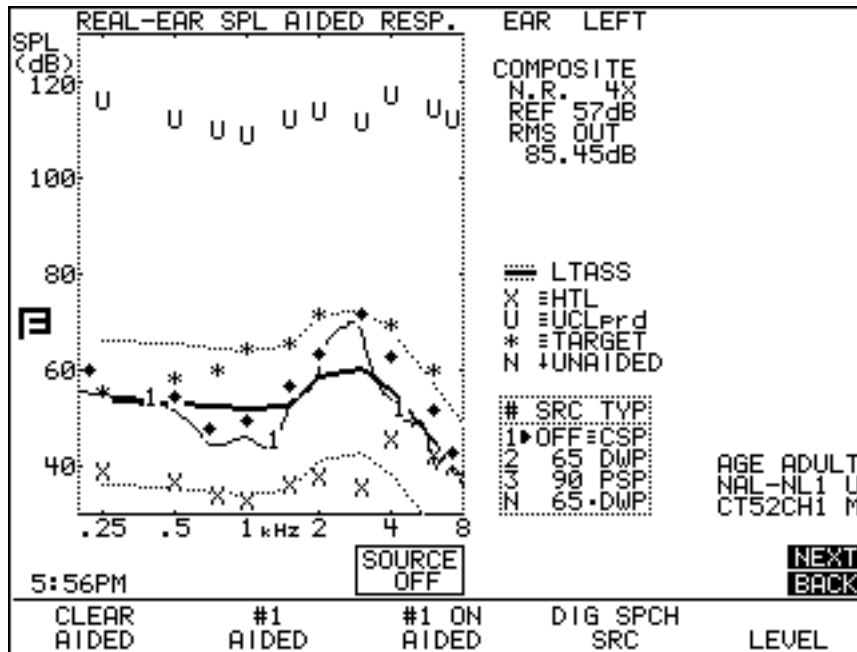

Figure 5.6.1—Visible Speech Testing

4. Press [START/STOP] to stop the measurement. Show your patient and his spouse how the hearing aid amplified the signal.

5. Press [F2] to select AIDED 2 and [START/STOP] to start a second measurement. If using a live voice signal, instruct your patient's spouse to stand 3 feet away (1 meter) and speak again.

6. Press [START/STOP] to stop the measurement. When used with a live voice signal, this exercise can show how distance improved the gain of the frequency response.

7. Experiment in this manner with different distances. This will help demonstrate how close your patient and his spouse need to be to each other for maximum speech intelligibility.

Notes

The target displayed in the Real Ear SPL screen when in spectrum analysis mode assumes a 60 dB SPL input level.

5.6.2 Measuring the occlusion effect

You can use the Aided & Unaided screen in order to measure the "occlusion effect" of a hearing aid. By analyzing the spectrum of your patient'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.

To set up for measuring the occlusion effect:

1. Enter the Unaided & Aided screen. See Section 5.1.2 for instructions.

2. Follow the instructions in Section 5.2.4 to insert the probe tube into your patient's ear. There is no need to level the sound field speaker when measuring the occlusion effect.

3. Insert the patient's hearing aid, being careful not to move the probe tube. The hearing aid can be turned on or off.

4. Use [F2] to select UNAIDED.

5. Use [F4] to select COMP.

6. Press [▼] repeatedly until the SOURCE is turned OFF. This is displayed in the source box on the display above the F3 key.

7. Press [MENU] to open the local menu, and use the arrow keys to change NOISE RED (COMP) to 16X. This will increase the amount of averaging the analyzer does when the measurements are performed.

To measure the occlusion effect:

1. Press [START/STOP] to start the measurement.

2. Instruct your client to sustain the vowel sound "eee."

3. Press [START/STOP] while the "eee" is still sounding and the curve has stabilized. The patient can now stop vocalizing.

4. Look at the gain in the low frequencies. If it seems high, you may consider adjusting the vent to a more open condition in order to prevent occlusion-effect discomfort.

5. Press [F2] to select AIDED 1. Make sure COMP is the selected source type above F4, and the SOURCE is OFF. Use [F4] and [▼] to make these selections, if necessary.

6. Press [START/STOP] to start a second measurement.

7. Ask your patient to sustain an "eee" sound again. Press [START/STOP] during the vocalization when the measurement has stabilized. (You can then tell your patient to stop.)

8. Compare AIDED 1 to the "UNAIDED" measurement to see how your vent adjustments have changed the response of the hearing aid.

9. Press [NEXT] to view the Insertion Gain screen. This will show you the actual difference that your adjustments made—the first measurement is subtracted from the second measurement.

5.7 Miscellaneous Real-Ear Measurements

The measurements and information described in this section can be performed in the SPL screen, the Unaided and Aided screen, and the Insertion Gain screen.

5.7.1 Measuring a Single Frequency Response

It is sometimes useful to be able to determine the response of the hearing aid to a single frequency and how that response changes as the frequency and amplitude of the signal changes.

The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

To measure the single frequency response:

1. Hold down the [F4] key for half a second in any of the real-ear measurement screen.
2. Use the [▼,▲] keys to select SINGLE.
3. Press [START/STOP] to make the selection.
4. Press [START/STOP] again to start the single frequency signal. It will be a pure-tone warble.
5. Use [◄,►] to change the frequency of the pure-tone warble.
6. Use [▼,▲] to change the amplitude of the pure-tone warble.

See Section 2.5.1.4 for information about changing the warble rate (or turning off the warble) of the pure-tone signal.

5.7.2 Measuring Harmonic Distortion

Harmonic distortion is when the hearing aid returns energy at frequencies not present in the source signal. The FP35 allows you test for this phenomenon very easily. See Section 2.5.1.2 for more information on the harmonic distortion measurement.

The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

1. Press [MENU] from any real-ear measurement screen.
2. Press [NEXT] to enter the Custom menu.
3. Select DISTORTION using the [▼,▲] keys.
4. Select the distortion type desired by using the [◄,►]keys. See below for definitions of distortion types.

5. Press [EXIT].

6. Press [F4] to select NORM.

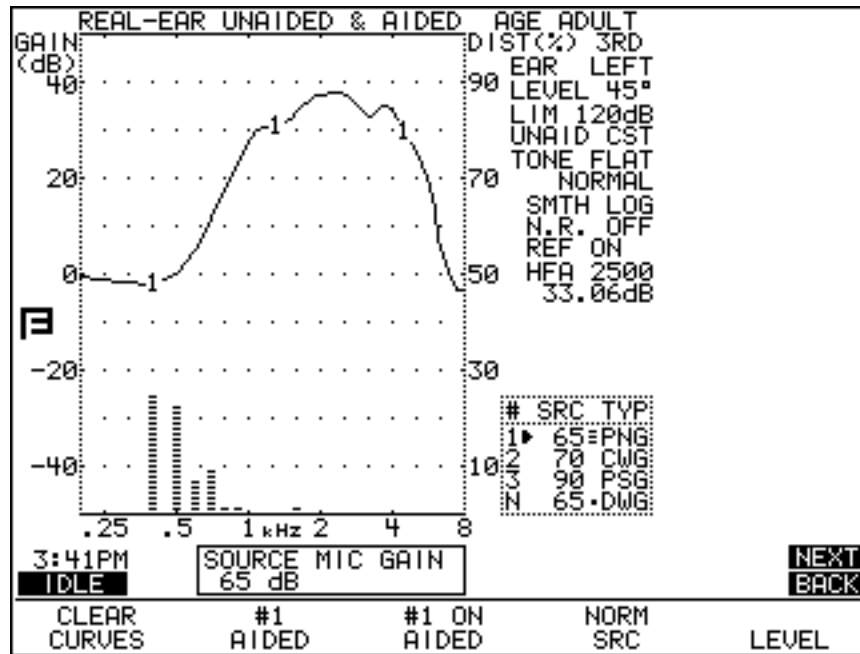7. Press [START/STOP] to run normal frequency sweep.

Figure 5.7.2—Measuring harmonic distortion

After running a normal sweep, the graph will have bars depicting the percentage level of harmonic distortion at different frequencies. The scale for the harmonic distortion measurements is given on the right vertical axis of the graph.

In the past, FONIX analyzers have not measured harmonic distortion when the signal level was set to 90 dB SPL or higher. This is called the "90 dB harmonic distortion rule." Since hearing aids in recent years have become more sophisticated and able to handle loud signals, we have turned this off this rule by default. However, if you would like to use it, go into the Custom Menu (press [MENU], [NEXT], [NEXT]) and turn ON the DIST 90 dB RULE.

5.7.3 Measuring Intermodulation Distortion

This section describes how to make various intermodulation distortion measurements. See Section 2.5.2.2 for technical details on those measurements.

The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

5.7.3.1 To perform a static IM distortion test

1. Press [MENU] in the real-ear measurement screen to enter the real-ear menu.

2. Make sure the REF MIC is OFF. Use the arrow keys to make this selection, if necessary.

3. Press [NEXT] twice to enter the Custom menu.

4. Make sure that DISTORTION is OFF. Use the arrow keys to make this selection if necessary.

5. Use [▼,▲] to select IM FREQ DIFF.

6. Use [◄,►] to select the fixed distance between the primary and secondary frequencies used in the measurement. You can choose from no distance (HARM) to 4000 Hz.

7. Press [EXIT] to return to the real-ear measurement screen.

8. Press and hold down [F4]. This will pop up a list of the available selections, including DIST.

9. Use [▼,▲] to select DIST.

10. Press [START/STOP] to make the selection.

11. Use [▼,▲] to select the RMS source of the test. Each frequency will have an amplitude 3 dB less than the RMS source.

12. Set up the client, the aid, and the analyzer for real-ear testing. Make sure to level the sound field speaker.

13. Press [START/STOP] to start the static IM distortion measurement. See Figure 5.7.3.1.

14. Use [◄,►] to change the primary frequency of the test. The secondary frequency will also change, remaining a fixed distance (selected in Step 6) away from the primary frequency.

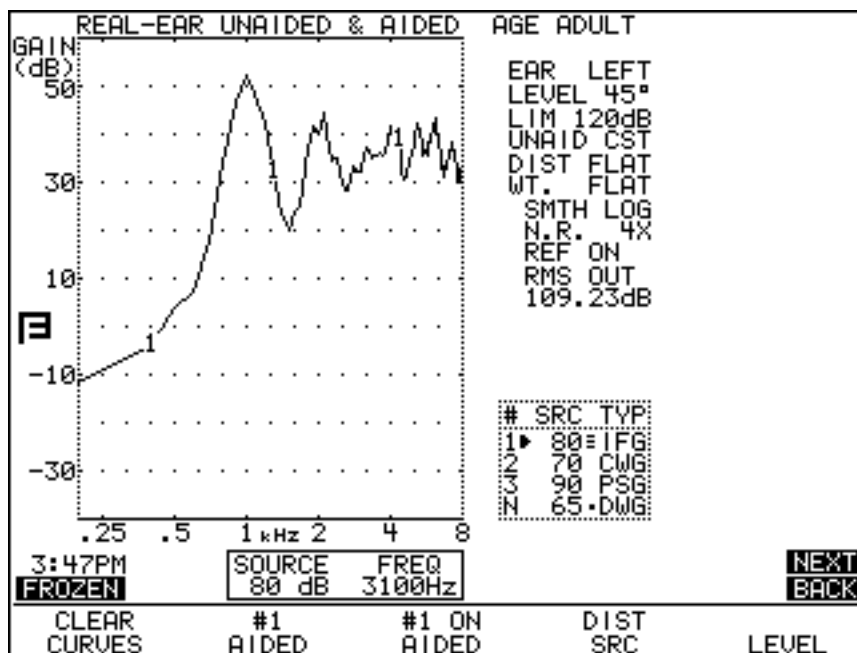15. Press [START/STOP] to stop the measurement.

Figure 5.7.3.1—Real-Ear static IM distortion test

5.7.3.2 **To perform an IM distortion sweep**

1. Press [MENU] in the real-ear measurement screen to enter the real-ear menu.

2. Make sure the REF MIC is OFF. Use the arrow keys to make this selection, if necessary.

3. Press [NEXT] twice to enter the Custom menu.

4. Select DISTORTION with [▼,▲].

5. Use [◄,►] to select the harmonics where the IM distortion will be measured. You can select the 2nd distortion, the 3rd distortion or TOTAL, which is all frequencies except the primary and secondary frequencies.

6. Use [▼,▲] to select IM FREQ DIFF.

7. Use [◄,►] to select the fixed distance between the primary and secondary frequencies used in the measurement. You can choose from no distance (HARM) to 4000 Hz.

8. Press [EXIT] to return to the real-ear measurement screen.

9. Press and hold down [F4]. This will pop up a list of the available selections, including DIST.

10. Use [▼,▲] to select DIST.

11. Press [START/STOP] to make the selection.

12. Use [▼,▲] to select the RMS source of the test. Each frequency will have an amplitude 3 dB less than the RMS source.
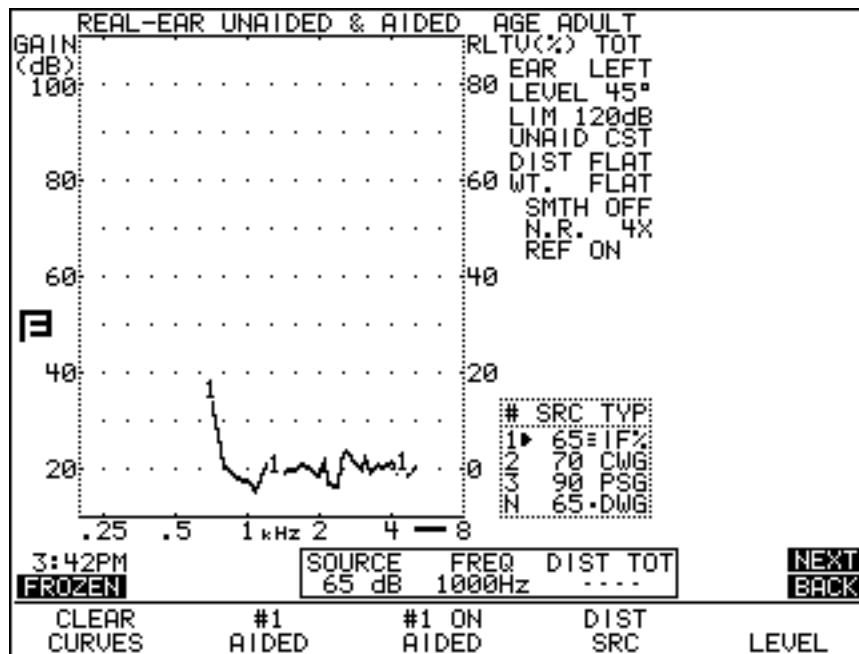

Figure 5.7.3.2—Real-Ear IM distortion sweep

13. Set up the client, the aid, and the analyzer for real-ear testing. Make sure to level the sound field speaker.

14. Press [START/STOP] to start the IM distortion sweep. See Figure 5.7.3.2. The measurement will stop when finished. The percentage scaling for the measurement is located on the right side of the graph. Notice the thick line below the lower right corner of the graph. This is an indication that the current selected measurement uses the right side scaling.

5.7.3.3 To change the frequencies used in the sweep

By default, the IM distortion sweep is performed at the frequencies used in the NORMAL pure-tone sweep. This can be changed to perform the measurements at fewer frequencies (for a faster test), and more frequencies (for a more complete test).

1. Press [MENU] from the real-ear measurement screen to enter the real-ear menu.

2. Press [NEXT] twice to enter the Custom Menu.

3. Use [▼,▲] to select DISTORTION SWEEP.

4. Use [◄,►] to make one of the following selections:
   • NORM: To measure at 1/12 octave frequencies closest to 100 Hz intervals (default test)
   • FAST: To measure at 1/3 octave frequencies closest to 100 Hz intervals (fastest test)
   • FULL: To measure at every 100 Hz interval (most complete test)

5. Press [EXIT] to return to the real-ear measurement screen and follow the directions in Section 5.7.3.2 to perform the IM distortion sweep.

5.7.4 Using the Reference Microphone

The microphone that sits on top of the client's ear is always used for leveling the sound field speaker. It can also be used in real-ear gain and insertion gain measurements. When the reference microphone is turned on in the Unaided and Aided measurement screen, or in the Insertion Gain screen, the analyzer subtracts the reference microphone measurement, made just outside the client's ear, from the probe microphone measurement, made inside the client's ear in order to derive gain and insertion gain results.

When the reference microphone is turned off during these measurements, the FP35 analyzer assumes that the sound field outside the client's ear is absolutely perfect, and just relies on the leveling information to achieve the gain (or insertion gain) response. While this can lead to smoother response curves, the measurement will not be quite as accurate. For most purposes, it is recommended to perform gain and insertion gain measurements with the reference microphone on. In a noisy testing environment, it might be advantageous to turn the reference microphone off in order to get a smoother response.

To change the reference microphone status:

1. Press [MENU] in the real-ear measurement screen.
2. Use [▼,▲] to select REF MIC.
3. Use [◄,►] to turn the reference microphone ON or OFF.
4. Press [EXIT] to return to the measurement screen.

5.7.5 Viewing Target Data

You can view the numerical data of your response curves with the DATA/ GRAPH selection in the main local menu of the real-ear measurement screen and using [F2] to select the desired curve. However, if you want to view the numerical data of the target curve itself, you must use the TABULATION field in the Advanced real-ear menu. This will add a table to the right of the real-ear measurement graph, displaying the target in numerical format.

The USER LEVEL must be set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

To view the target in numerical format:

1. Press [MENU] to enter the main real-ear menu.
2. Press [NEXT] to enter the Advanced real-ear menu.
3. Use [▼,▲] to select TABULATION.
4. Use [◄,►] to select TARGET.
5. Use [EXIT] to return to the real-ear measurement screen. The target data will now be displayed. See Figure 5.7.5.
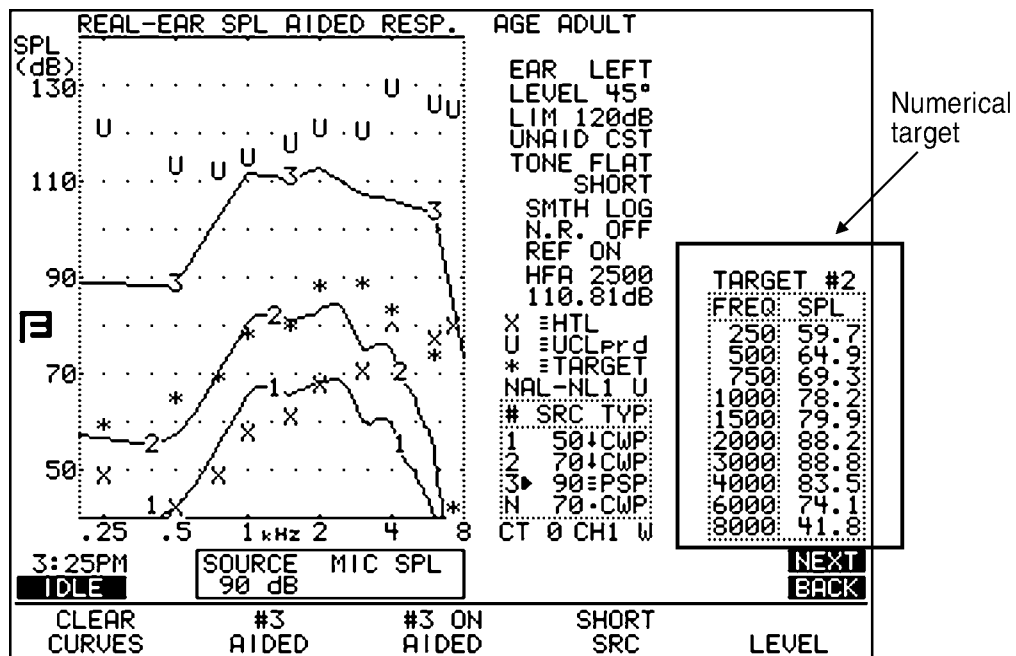

Figure 5.7.5—Numerical display of target data

5.7.6 Measuring the Telecoil Response

Telecoil measurements can be performed in the real-ear measurement screens using any source type available on the analyzer. You must use the optional Telewand to perform this measurement.

To test the telecoil function in a real-ear measurement:

1. Follow the instructions found in Section 2.5.8 to set up the FP35 Default Settings Menu for telecoil measurements.

2. Press [F2] from the Opening Screen to enter the Real-ear mode and use [NEXT] or [BACK] to enter one of the real-ear measurement screens.

3. Press [MENU] to open the local menu.

4. Use [▼,▲] to select TELECOIL and use [◄,►] to choose ON.

5. Press [EXIT] to close the local menu. The source box at the bottom of the measurement graph will now indicate TMFS.

6. Plug the Telewand into the earphone jack or the speaker jack (new style rear panel only) on the back of the FP35 analyzer.

7. Set up the patient for real-ear measurements in the usual way. It is not necessary to level the sound field speaker for this measurement.

8. Set the hearing aid to telecoil mode.

9. Use [F4] to choose the desired source type.

10. Instruct the patient to hold the Telewand next to his ear as if he were holding a telephone receiver next to his ear. See Figure 5.7.6A.

11. Press [START/STOP] to run the measurement and test as desired. See Figure 5.7.6B.

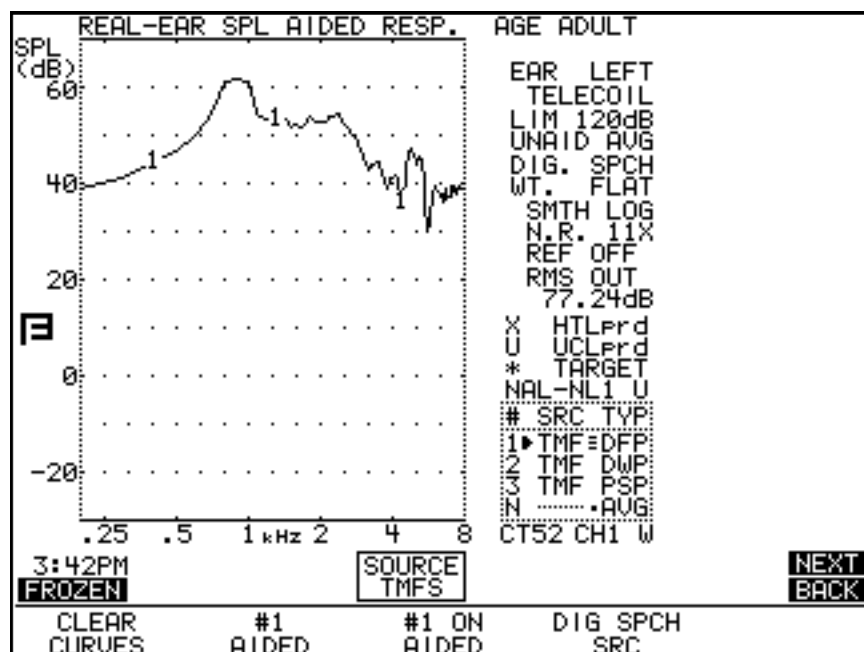*Figure 5.7.6A—Measuring telecoil response with the Telewand.*

Figure 5.7.6 B—Screenshot of Telewand test results

5.8 Reference

This section contains a description of the real-ear measurement displays and definitions for each menu item available in the real-ear measurement screens.

5.8.1 Viewing the Real-Ear Screens

The display for each of the three Real-Ear Measurement Screens has similar information.

Please refer to Figures 5.8.1A, 5.8.1B, and 5.8.1C for the following listing.

1. Ear tested. Select with [MENU].
2. Leveling status. See Section 5.2.6.
3. Signal type and weighting selected.
4. N.R is the noise reduction used for the selected curve.
5. Status of the reference microphone.
6. RMS/HFA/SPA: If a composite signal is selected, the RMS OUT will be displayed here. Otherwise, the selected HFA or SPA will be displayed.
7. Curve ID box. See Section 2.7.2 for more details.
8. The N curve is the unaided response curve.
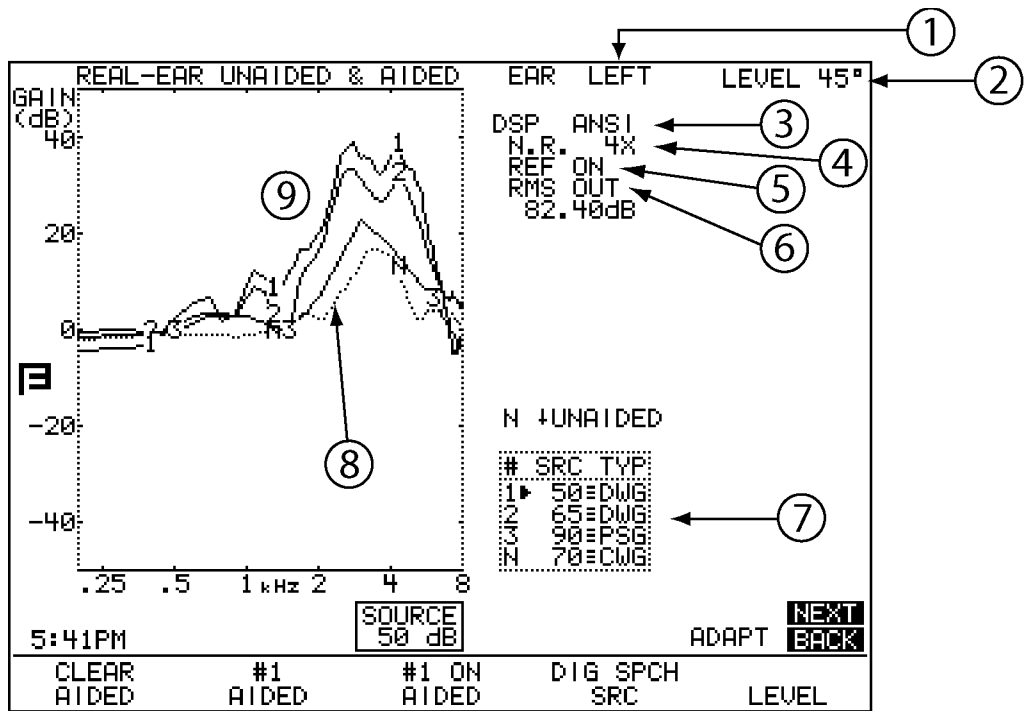9. Response curves labeled with identifying numbers.

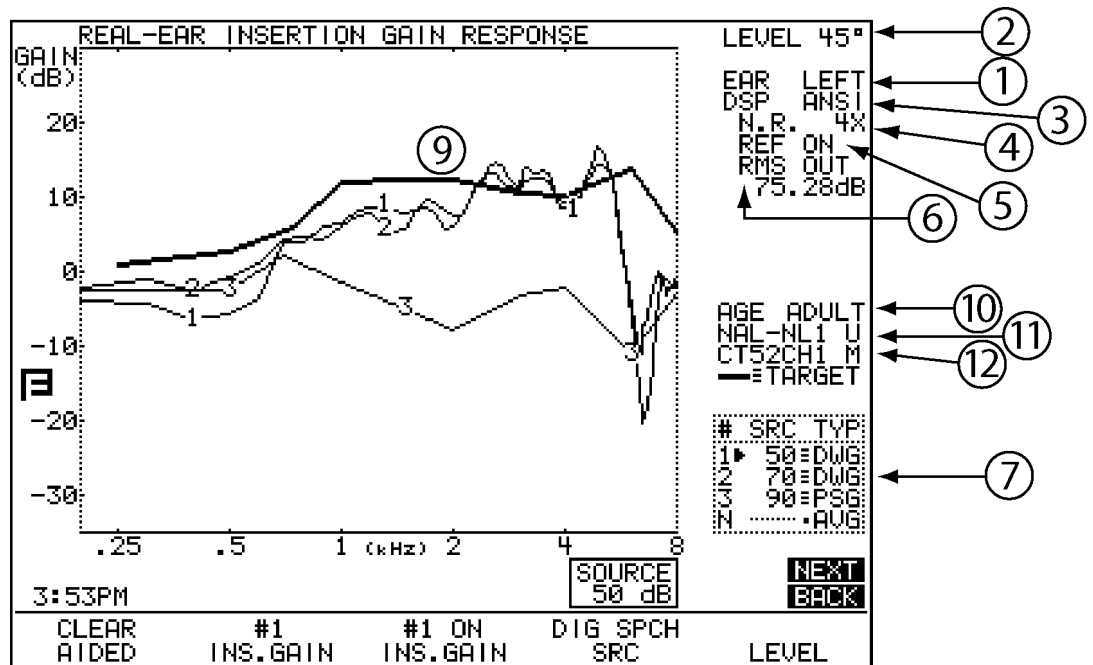*Figure 5.8.1A—Unaided and Aided Screen.*

Figure 5.8.1B—Insertion Gain Screen.

Figure 5.8.1C—Real-ear measurement screen with NAL-NL1 fitting rule

The Real-ear SPL and Real-ear Insertion Gain screens also contain information about the settings used to create the target: Not all settings are available with all targets.

10. Age of patient

11. Fitting rule selected and the type of fitting. "U" indicates a unilateral fitting. "B" indicates a bilateral fitting.

12. Compression threshold of the aid, number of channels of the aid, and the type of output limiting. "W" indicates wideband limiting. "M" indicates multi-channel limiting.

5.8.2 Defining the Menu Items

There are a number of menu settings that affect both measurements and targets. Some of these settings are only available when the USER LEVEL is set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details. These menu items are marked with an asterisk (*).

Main Real-Ear Menu

To enter the menu, push [MENU] from any of the Real-Ear Measurement screens. Use the arrow keys as you normally would to make selections.

EAR—The ear being tested. Select LEFT, RIGHT or NONE.

DATA/GRAPH—The type of display. Choose between a graphical display and a numerical display.

UNAIDED—The type of unaided response. Select AVG to use the average unaided response, or select CUSTOM if you are going to measure your client's unaided response.

AID GROUP—The type of hearing aid being tested. Select STANDARD, AGC, or ADAPTIVE (for adaptive AGC circuits). This selection sets the various delay times used in pure-tone tests so that they are appropriate to the aid's circuitry. See Section 2.4 for more information on delay times.

SOUND FIELD—The sound field azimuth you are using with the real-ear measurements. We recommend 45º for more repeatable results.

AUTO TEST—The status of the Auto Test. When enabled, the FP35 will automatically measure AIDED 1, AIDED 2 and AIDED 3 without stopping for user intervention. See Section 5.4.3 for details.

VISIBLE SPEECH—Display used when the FP35 analyzer is in Spectrum Analysis mode (requires Composite/Digital Speech Option). BARS displays a set of vertical bars representing the maximum peaks of the measurements that reach above the lower limits of the speech banana. AVERAGE displays a long term average of the response using a peak decay method.

OUTPUT LIMIT—Level of output limiting. Please review red warning page.

NOISE RED (TONE & COMP)—Select the amount of noise reduction suitable to your environment. See Section 2.5.1.3 and 2.5.2.3 for more details.

REF MIC—The status of the reference microphone.

Target Menu

Press [BACK] from the Main Real-Ear menu to enter the Target menu.

FIT RULE—The fitting rule used to create the real-ear and coupler targets. Selections are: NAL-NL1, NAL-RP, DSL WDRC, DSL LIN, POGO, BERGER, 1/3 GAIN, 1/2 GAIN, 2/3 GAIN and DIRECT. A selection of NAL-NL1 will add several menu selections to the menu screen.

AGE—The age of the client. A selection of NONE sets the age to ADULT but turns off the age display.

TARGET REF— The measurement curve that the target is based upon. Choose from CURVE 1, CURVE 2 and CURVE 3, and AUTO. See Section 5.5.3.2.

COMPRESSION—The type of wideband compression threshold the aid has. This is selectable in increments of 1 dB, and it is only available with a fitting rule selection of DSL WDRC or NAL-NL1.

CHANNELS—The number of channels the aid has. This is only available with a fitting rule selection of NAL-NL1.

AID LIMITING—The type of output limiting the aid has. If the aid has output limiting, usually WIDEBAND should be selected. If the aid has output limiting and it has more than one channel, this can be set to MULTICHAN. If the aid doesn't have limiting, set this to NONE. This selection is only available with a fitting rule selection of NAL-NL1.

FIT TYPE—Type of fitting Choose from UNILATERAL and BILATERAL. Bilateral fittings require the audiograms of both ears to be entered.This is only available with a fitting rule selection of NAL-NL1.

*REFERENCE—Type of leveling used in the real-ear measurement. When HEAD SURFACE is selected, leveling is performed with the patient within the sound field and the reference microphone on top of the ear. When UNDISTURBED is selected, leveling is performed by holding the reference microphone in front of the sound field speaker. This selection is only available with a fitting rule selection of NAL-NL1.

Advanced Real-Ear Menu

Press [NEXT] from the Main Real-Ear Menu to reach this screen.

*AUTO-SCALE—The type of scaling used. ON scales the graph to the selected curve. OFF scales the graph to the highest curve displayed.

*TABULATION—Target data display on the right side of the real-ear measurement screen. Choose TARGET or NONE. See Section 5.7.5 for details.

*REFERENCE STATUS—The type of RMS measurement made with the reference microphone. The following selections are available: RMS displays the overall RMS of the reference microphone, FULL displays the overall RMS and the signal quality of the reference microphone, and NONE turns off the RMS display of the reference microphone. See Section 2.5.4 for more information.

*AVG FREQ—The three frequencies used for averaging in pure-tone measurements. Each set is represented on the screen by the highest frequency in the set. See Section 2.5.1.6 for details.

*STATIC TONE—Status of the static pure-tone measurement. When a pure-tone source is selected and a sweep isn't running, measure the response and distortion of a single frequency (SINGLE), the three frequency average chosen in AVG FREQS (AVG), or no measurement (NONE).

FILTER—The type of speech weighting used on the signal sources. In most cases, this should be set to AUTO. See Section 2.5.2.1 for more details.

EXT SOURCE: The channel selected of the external source. The external source (see Section 5.6.1) uses a dual channel connector. This means that the input signal has potentially two different channels. This selection lets you choose which channel to use as the input signal. Choices are EXT CH1 and EXT CH2.

*SMOOTHING—Type of smoothing used. Smoothing rounds off the curve, removing minor peaks.

*SPEECH AVERAGE—Number of measurements used to obtain the Visible Speech average curve: 2, 4, 8. 16, 32, 64, 127.

AUTO DURATION—The length of time used by the Auto Test. This can be set in seconds: 0.5, 1.0, 2.0, 5.0 and 10.0.

*PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken in a pure-tone measurement. See Section 2.4 for more information.

*SHORT SETTLE—The time delay between frequencies in a pure-tone sweep, and the additional delay in a digital speech measurement.

*LONG SETTLE—The time delay between frequencies in an input/output measurement, a three-frequency average measurement, or a harmonic distortion measurement.

PRINT LABEL—Status of the printing label.

PRINTER— Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

Custom Menu

Press [NEXT] from the Advanced Menu to enter the Custom Menu.

*HIDE—The display of the non-measurement curves in the SPL screen. You can selectively hide HTL, UCL and target values. SHOW ALL does not hide any of these curves.

*WARBLE SOURCE—The warble rate in pure-tone signals. Warble is usually used in sound field speaker measurements to reduce problems caused by standing waves. See Section 2.5.1.4 for more details.

*SIGNAL SKEW—The number of samples from when the speaker emits the signal source to when the FP35 microphone reads and analyzes it. See Section 2.5.1.5 for details.

SPEAKER—The sound field speaker selection. Choose to use the FP35 analyzer's INTERNAL speaker or an attached EXTERNAL speaker.

*OUTPUT JACK: The external source devices enabled in the measurement screen. The AUTO and SPEAKER selections enable only the speaker jack. MONO EAR enables the left channel of the earphone jack. STEREO EAR enables both channels of the earphone jack. ALL ON enables all devices. See Section 2.5.5 for details.

MIC PORT: Choose the microphone used for Real-ear measurements. Select AUTO, INTERNAL, EXTERNAL or EXT LINE. See Section 2.5.9 for details.

*LEVELING SOURCE—The amplitude used for leveling the sound field speaker.

*IMPULSE REJ—Status of impulse rejection, which rejects noise in the testing environment. See Section 2.5.6.

*RMS ANALYSIS—The type of RMS analysis used for the measurements. Choose AUTO (estimated RMS) or NONE. See Section 2.5.3 for details.

*DISTORTION—The type of harmonic distortion of a single tone or of a normal sweep curve. Choices are 2ND, 3RD, TOTAL (2ND + 3RD) or OFF.

Note: Distortion is not normally measured in real-ear due to the noise levels in the test environment being seen as distortion.

*DIST 90 dB RULE—Harmonic distortion measurements are generally made only when the source of the test signal is below 90 dB SPL. To measure harmonic distortion at 90 dB SPL or higher, turn this rule OFF.

*DISTORTION SWEEP—The frequencies used in the intermodulation distortion measurement. NORM uses 1/12 octave frequencies to the nearest 100 Hz. FAST uses 1/3 octave frequencies to the nearest 100 Hz. FULL uses every 100 Hz frequency available.

*DIST SWEEP END— The last frequency tested when performing an IM distortion sweep. If the selected frequency is less than or equal to the first primary frequency in the IM distortion sweep, only the primary frequency will be tested; there will be no IM distortion sweep.

*IM FREQ DIFF—The distance between the primary and secondary frequency in the intermodulation distortion measurement. See Section 2.5.2.2 for more details.

* These menu items are only available when the USER LEVEL is set to ADVANCED mode. See Section 2.3.2 for details.

5.9 CROS, and BICROS

When using the FP35 probe with a CROS or BICROS aid, we suggest the following setups and procedures.

Four Goals:

5.9.1 - Measuring the Head Baffle Effect
5.9.2 - Measuring the Overcoming of the Head Baffle Effect
5.9.3 - Measuring the Overall Insertion Gain
5.9.4 - Measuring the Insertion Loss to the "Good" Ear

Each of these measurements uses the insertion gain measurement technique, taking advantage of the fact that the insertion gain is a difference curve between two measured curves (usually the unaided and aided response). The techniques assign the label of "unaided" to one measurement and a label of "aided" to another measurement.

Take all measurements in the Insertion Gain Screen. For measurements labeled "Unaided" (even if they aren't unaided) follow the instructions in Section 5.4.2. For measurements labeled "Aided" (even if they aren't aided) follow the instructions in Section 5.4.4.

5.9.1 Measuring the Head-Baffle Effect

The measurements described in this section are for both CROS and BI-CROS hearing aids.

Unaided—Real-Ear response on "bad ear" side

Set up the FP35 analyzer as follows.

- System UNLEVELED
- Reference microphone OFF
- Unaided CUSTOM
- Probe microphone over the bad ear, tube jutting just slightly forward of pinna
- Loudspeaker at 90º, 12 inches from bad ear
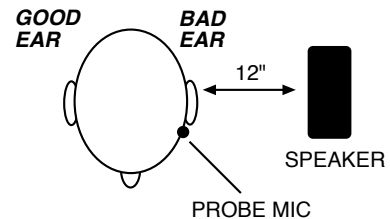
Aided—Real-Ear response on "good" ear side

Same setup as above except:

- Probe microphone over the good ear

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.
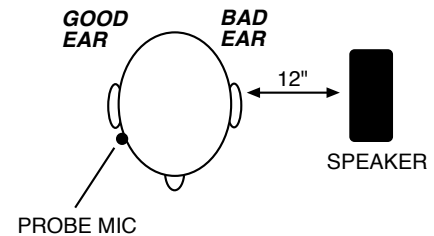
NOTE: Although the above two measurements call for the FP35 to be UNLEVELED with the reference microphone OFF, the rest of the measurements in this section call for the FP35 to be LEVELED with the reference microphone ON.

5.9.2. Measuring the Overcoming of the Head-Baffle Effect

This section describes how to measure how well the hearing aid overcomes the head-baffle effect. The methods are different for CROS hearing aids than they are for BICROS hearing aids.

5.9.2.1 CROS

Unaided—Measurement of the "good" ear canal (baffled by the head)

Set up the FP35 analyzer as follows.

- Reference microphone ON
- Sound field LEVELED
- Unaided CUSTOM
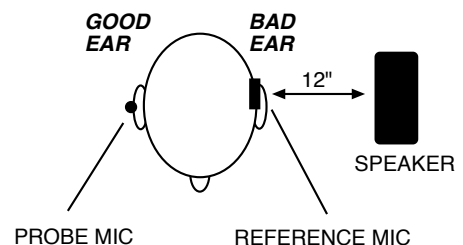
- Reference microphone over the pinna of the bad ear
- Probe microphone inside the unoccluded ear canal of the good ear
- Loudspeaker at 90º, 12 inches from the bad ear

Aided—Measurement of the "good" ear canal (baffle overcome by the aid)

Same setup as above, except:

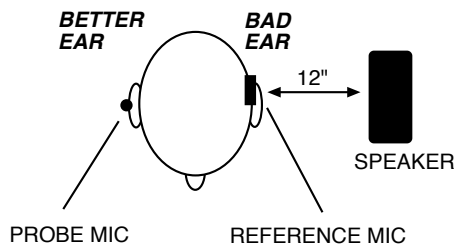- Aid in place in the good ear and set to normal user gain.

The difference curve, labeled "Insertion Gain" on the screen, shows the benefit the aid gives for sound arriving from the "bad" side.

5.9.2.2 BI-CROS

Unaided—Measurement of the "better" ear canal (baffled by the head)

Set up the FP35 analyzer as follows.

BETTER EAR   BAD EAR   12"   SPEAKER   PROBE MIC   REFERENCE MIC

- Reference microphone ON
- Sound field LEVELED
- Unaided set to CUSTOM
- Reference microphone over the pinna of the "bad" ear
- Probe microphone inside the ear canal of the better ear
- Hearing aid in the better ear, <u>on</u>, set at use gain
- Transmitter on the bad side turned <u>off</u>
- Loudspeaker at 90º, 12 inches from the bad ear

Aided—Measurement of the "better" ear canal (baffle overcome by the aid)

Same setup as above, except

- Transmitter on the bad side turned <u>on</u>

The difference curve, labeled "Insertion Gain" on the screen, shows the benefit of adding the second microphone for sound arriving from the "bad" side.

5.9.3 Measuring Overall Insertion Gain

The methods for measuring the overall insertion gain of CROS and BICROS aids are described in this section.

Since it has not been shown for CROS and BI-CROS 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 BI-CROS instruments.

5.9.3.1 CROS

Unaided—Measurement of the "good" ear

Set up the FP35 analyzer as follows.

- Reference microphone ON
- Sound field LEVELED
- Reference microphone over the pinna of the bad ear
- Probe microphone inside the unoc- cluded ear canal of the good ear
- Loudspeaker at 0°, 12 inches from the bridge of the nose
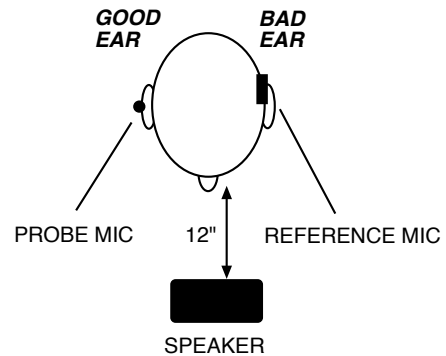
Aided—Measurement of the "good" ear

Same setup as above, except:
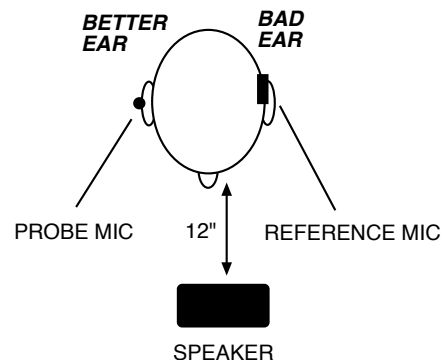
- Aid in place in the good ear and set to user gain.

The difference curve, labeled "Insertion Gain" on the screen, shows the overall benefit of inserting the hearing aid.

5.9.3.2 BI-CROS

Unaided—Measurement of the "better" ear

Set up the FP35 analyzer as follows:

- Reference microphone ON
- Sound field LEVELED
- Unaided response CUSTOM
- Reference microphone over the pinna of the bad ear
- Probe microphone inside the un- occluded ear canal of the better ear
- Loudspeaker at 0°, 12 inches from the bridge of the nose

Aided—Measurement of the "better" ear

Same setup as above, except…

- Complete aid in place in the better ear and set at use gain
- Both transmitters on

The difference curve, labeled "Insertion Gain" on the screen, shows the overall benefit of inserting the hearing aid.

5.9.4 Measuring Insertion Loss to the "Good" Ear (CROS)

The method for measuring insertion loss in the patient's "good" ear is described in this section. They are the same for CROS and BICROS hearing aids.

When a CROS aid has been prescribed to overcome a severe unilateral high-frequency loss, you may want to ensure that inserting an open ear mold into the good ear has not significantly attenuated the acoustic transmission to the good ear.

Since this is a monaural measurement, a 45° position of the loudspeaker is recommended.

Unaided—Unoccluded Ear canal Response of the "good" ear

Set up the FP35 analyzer as follows.

GOOD
EAR

BAD
EAR

REFERENCE MIC

PROBE MIC

12"

SPEAKER

- Reference microphone ON
- Sound field LEVELED
- Unaided CUSTOM
- Reference microphone over the pinna of the good ear
- Probe microphone inside the unoccluded ear canal of the good ear
- Loudspeaker at 45° toward the good ear, 12 inches from the surface of the head
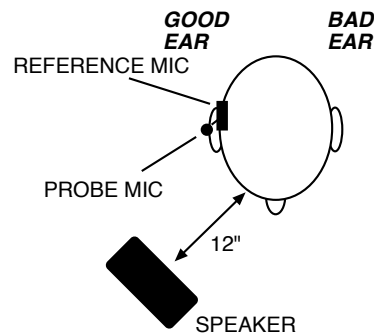
Aided—Occluded Response of the "good" ear.

Same setup as above, except

- Earmold in place in the good ear
- Hearing aid is turned <u>off</u>

The difference curve, labeled "Insertion Gain" on the screen, shows insertion loss, if any, caused by inserting the earmold into the good ear.

2-CC Targets

The 2-cc target screens allow you to measure hearing aids using a coupler in a sound chamber and compare them to a target. This type of testing is especially useful when fitting a patient who is unable to sit still for a real-ear measurement, such as an infant or a young child. There are two 2-cc Target screens available: the Coupler Target screen, which converts real-ear targets into coupler targets, and the Coupler EarSim screen, which converts coupler measurements into simulated real-ear measurements. **The FONIX real-ear option is required to access these screens.**

The Coupler Target screens convert real-ear targets into coupler targets so that you can compare them to coupler measurements. Targets and measurements can be displayed in either dB SPL or dB GAIN.

The Coupler EarSim screen uses the opposite approach, displaying actual real-ear targets. When coupler measurements are taken, the response curves are converted, using average or measured RECD transforms, into simulated real-ear measurements, which can then be directly compared to the displayed real-ear targets. Two displays are available: Insertion Gain and SPL. When the SPL display is selected, the patient's HTL and UCL values are also displayed on the screen. These HTL and UCL values are identical to the ones that would be displayed in the real-ear SPL screen.

The Coupler Multicurve (described in Chapter 3), Coupler Target, and Coupler EarSim screens are all connected to each other by the [NEXT] and [BACK] keys, similar to the way that the real-ear screens are connected to each other. Any measurements taken in one screen are automatically converted to the other screens, minimizing your measurement time.
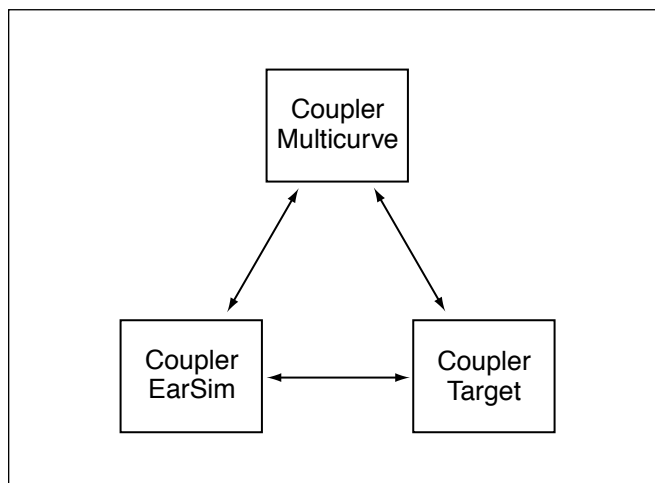
The sections in this chapter will explain the following:

- 6.1: Target creation
- 6.2: Displays
- 6.3: Measurements
- 6.4: Reference

6.1 Target Creation

In order to create a target for use in the Coupler Target screen or the Coupler EarSim screen, you must enter the Audiogram Entry screen, just as you would if you were creating a normal real-ear target.

1. Enter the Audiogram Entry screen by pressing [F2] from the Opening screen and using the [NEXT] and [BACK] keys if necessary.

2. Follow the instructions found in Section 5.3 to enter the patient's audiogram and to create a real-ear target.

3. Follow the instructions found in Section 5.3.6, if desired, to measure the patient's RECD.

4. Press [EXIT] to return to the Opening screen.

5. Press [F3] to enter one of the coupler multicurve screens. Use the [NEXT] and [BACK] keys to enter the Coupler Target screen or the Coupler EarSim screen.

6. Press [MENU] and [BACK] to enter the Target menu. Set the FIT RULE, AGE, and AID TYPE in this menu using the arrow keys. If you select NAL-NL1 as your FIT RULE, you will also have to set COMPRESSION, CHANNELS, AID LIMITING, FIT TYPE, TUBING and VENT. See Section 5.3.4 for details.

7. Press [EXIT] to return to the measurement screen. You are now ready to perform the measurements and compare them to the displayed target.

The Coupler Target screen converts the real-ear target into a coupler target displayed in either dB GAIN or dB SPL. The Coupler EarSim screen displays real-ear targets in either dB IG (insertion gain) or dB SPL. When the Coupler EarSim display is set to dB SPL, the patient's HTL and UCL values are also displayed. To switch between the gain and SPL displays in each screen, use the [MENU] key to open the local menu, and use the arrow keys to select GAIN or SPL in the DISPLAY field. [EXIT] will close the local menu.

Targets are usually tied to the source type and source level of CRV 2. If you would like to tie the target to a different curve, or to the currently selected curve, change the TARGET REF setting in the Target menu. See Section 6.3.3.

If you have modified the actual numerical target values in the Audiogram Entry screen, or entered your own target entirely, you will not be able to enter the Target menu from the Coupler Target or Coupler EarSim screens. This is because

those controls will have no effect on your custom target. To re-enable the target controls, you must return to the Audiogram Entry screen and use the Generate Target key (F3) to recreate an automatic target.

The NAL-NL1 targets in the Coupler Target screen have been slightly modified from the original NAL-NL1 formula in order to better represent low gain pre-scriptions. When the original NAL-NL1 formula calculates negative gain for a coupler target, this gain is "clipped" to zero so that the final formula will never prescribe negative gain for a patient. However, when measuring low gain hearing aids, it is possible for a coupler measurement to show up as negative gain while the corresponding real-ear measurement would show up as a slight positive gain. The FP35 instead clips the coupler gain at what would be the zero gain of the real-ear insertion gain. This may produce some negative gain in the Coupler Target screen. (The Coupler EarSim screen displays real-ear targets and should not be affected.)

6.2 The Coupler Target and Coupler EarSim Displays

The Coupler Target screen converts the real-ear target into a coupler target and displays it in either dB GAIN or dB SPL. The EarSim screen displays the real-ear target in either dB insertion gain or dB SPL, converting any measurement taken into simulated real-ear measurements.

Any measurement made in one of these screens will be automatically converted into the other screen.

6.2.1 Viewing the Coupler Target Screen

The Coupler Target screen converts the real-ear target into a coupler target. Coupler measurements can then be performed and compared directly to the target. The only major difference between this screen and the basic Coupler Multicurve screen (described in Chapter 3) is the addition of the coupler target.

To get the most accurate real-ear to coupler target conversions, measure the patient's unaided response in one of the real-ear measurement screens (Section 5.4.1) and the RECD in the Audiogram Entry screen (Section 5.3.6). When these measurements are not taken, the FP35 substitutes average data. These averages are sensitive to the selected age of the patient.

See Figure 6.2.1 for the following explanation of the dB GAIN display (the SPL display is similar):

1. Type of display. This will be either dB SPL (coupler output) or dB Gain (coupler gain).
2. Type of aid and the age of the patient.
3. Selected ear and leveling status of the sound chamber, including the real-ear speaker angle that the coupler target is duplicating.

4. The signal and weighting types used with the selected curve.

5. N.R. = Noise reduction.

6. Status of reference microphone.

7. RMS/HFA data: If a composite signal is selected, the RMS OUT will be displayed here. Otherwise, the selected HFA or SPA will be displayed. Press [MENU] to select HFA/SPA frequencies.

8. Selected fitting rule.

9. Curve ID box. See Section 2.7.2 for more information.

10. Source Signal Statistics Box. The information in the box is dependent upon signal type.

    • COMP, DIG SPCH—Displays the RMS source amplitude.

   • NORM, FAST, SHORT, LONG, SINGLE—Displays the source amplitude, frequency, distortion, and output/gain.
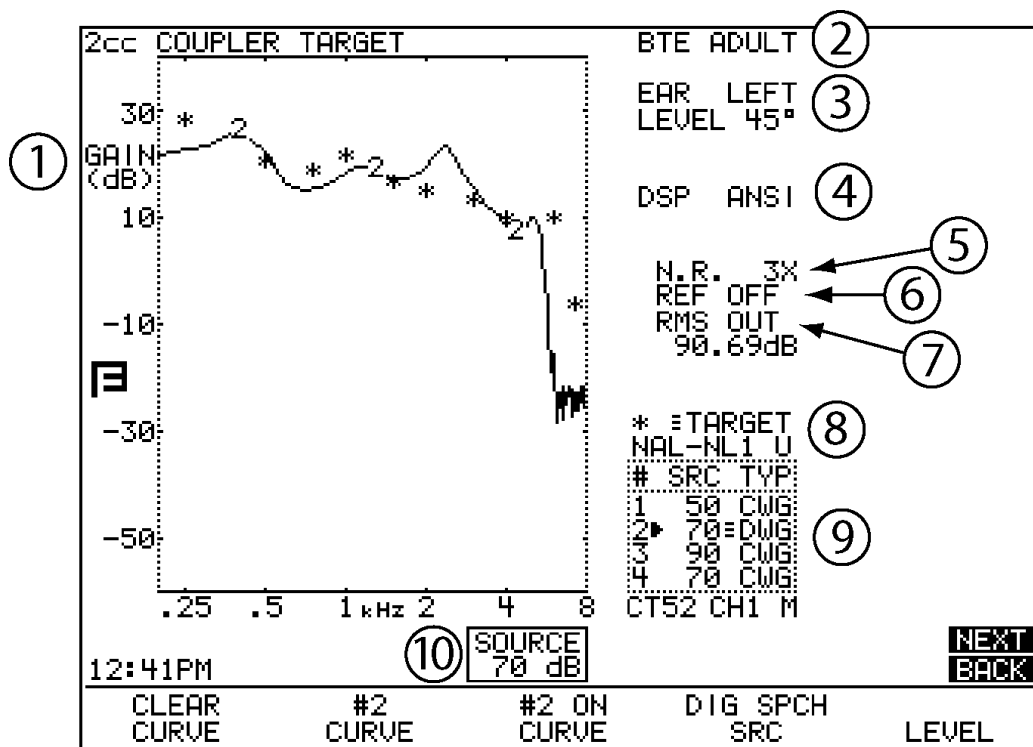
Fig 6.2.1—Target Coupler screen

6.2.2 Viewing the Coupler EarSim Screen

The Coupler EarSim screen displays the actual real-ear target prescribed for the patient. Targets are shown in either real-ear SPL or insertion gain. When SPL is selected, the patient's thresholds and uncomfortable levels are also displayed. Any coupler measurements taken in this screen are converted into simulated real-ear measurements using the average or measured real-ear unaided response.

To get the most accurate real-ear simulations possible, measure the patient's real-ear unaided response (REUR) in one of the real-ear measurement screens. The measured REUR will be used to convert the coupler measurements into simulated real-ear measurements. See Section 5.4.1 for instructions on performing the REUR measurement.

In the SPL display, the patient's audiometric data (HTL and UCL values) are displayed in dB SPL along with the target. To get the most accurate HL to SPL transform of this data (and the most accurate real-ear target), measure the patient's RECD in the Audiogram Entry screen. See Section 5.3.6 for instructions.

When the REUR and RECD are not measured, the FP35 substitutes average data to calculate the real-ear target and coupler measurement conversions. These averages are sensitive to the selected age of the patient.

See Figure 6.2.2 for the following explanation of the Coupler EarSim screen with the SPL display:

1. Type of display. This will be either dB SPL or dB I.G. (insertion gain).
2. U = uncomfortable levels, X = thresholds (right ear uses O), ∗ = coupler target
3. Coupler measurement curves converted into simulated real-ear
4. Type of aid and the age of the patient.
5. Ear selected.
6. Leveling status of the sound chamber, including the real-ear speaker angle that the coupler target is duplicating.
7. Unaided—custom (measured) or average.
8. The signal and weighting types used with the selected curve.
9. N.R. = Noise reduction.
10. Status of reference microphone.
11. RMS/HFA data: If a composite signal is selected, the RMS OUT will be displayed here. Otherwise, the selected HFA or SPA will be displayed. Press [MENU] to select HFA/SPA frequencies.

12. Displays the selected fitting rule.

13. Curve ID box. See Section 2.7.2 for more information.

14. Source Signal Statistics Box. The information in the box is dependent upon signal type.

- COMP, DIG SPCH—Displays the RMS source amplitude.

- NORM, FAST, SHORT, LONG, SINGLE—Displays the source amplitude, frequency, distortion and output/gain.
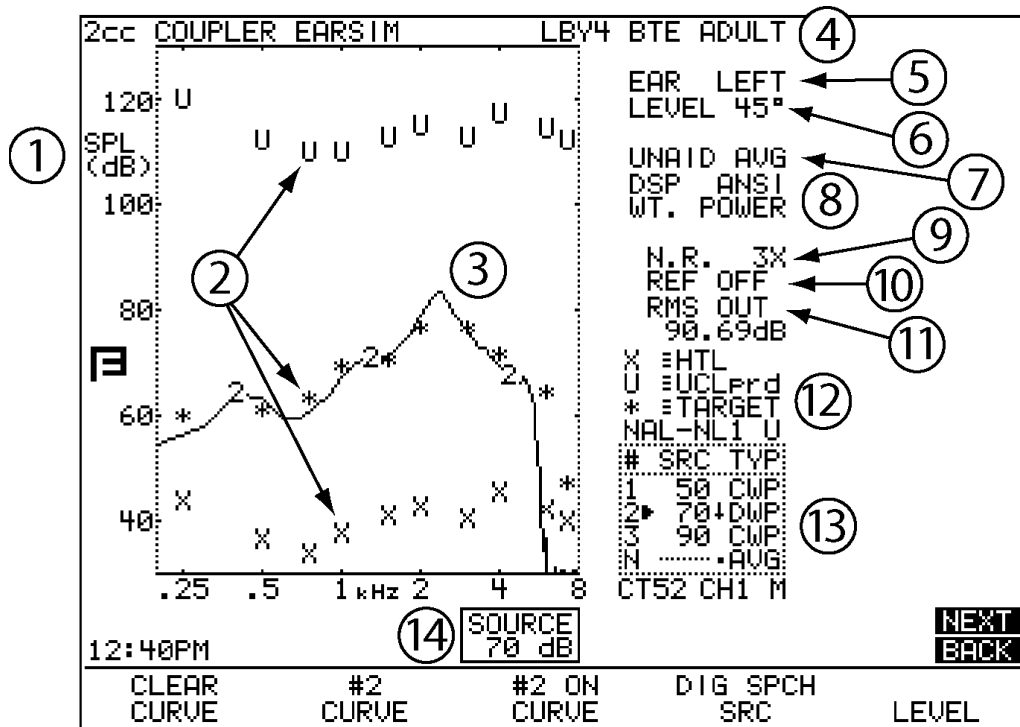
Fig 6.2.2—Coupler EarSim screen displayed with simulated insertion gain

6.3 Measurements & Adjustments

Taking measurements in the Coupler Target and the Coupler EarSim screens is just like taking measurements in the Coupler Multicurve screen. The only difference is the addition of the target (and possibly audiometric data) on the screen. Any measurements taken in one of these screens will show up in the other screens. For a detailed explanation of the measurements available in all coupler measurement screens, see Chapter 3.

The Coupler Multicurve and Coupler Target screens will show identical measurements. The Coupler EarSim screen converts these measurements into simulated real-ear measurements, so their numerical values will be different than those displayed in the other coupler screens.

6.3.1 Taking Basic Measurements

For your convenience, instructions for taking basic coupler measurements are given here:

1. Enter the Coupler Target or Coupler EarSim screen by pressing [F3] from the Opening screen and using the [NEXT] or [BACK] keys as necessary.

2. Press [MENU] from the measurement screen to make any necessary selections. See Section 6.4 for details.

3. Level the sound chamber as described in Section 3.2, if necessary.

4. Set up the aid in the sound chamber as described in Section 3.3.

5. Use [F2] to select a curve number.

You can measure 4 different curves in the FP35. By default, their source levels are:

   Curve 1: 50 dB
   Curve 2: 65 dB
   Curve 3: 75 dB
   Curve 4: 90 dB

6. Use [▲,▼] to adjust the source level to the desired amplitude.

7. Use [F4] to select the source type.

8. Press [START/STOP] to initiate the frequency sweep. If you are using the NORMAL, SHORT or LONG selections, the test will stop when the sweep is complete. The COMP, DIG SPCH and FAST signals are continuous, making it necessary to press [START/STOP] again when you want the signal to stop.

9. Use [◄,►] to scroll back through the last four real-time measurements if you used the COMP or DIG SPEECH signals.

10. Repeat steps 5-9 to take another measurement.

6.3.2 Viewing Target Data

You can view the numerical data of your response curves with the DATA/
GRAPH selection in the main local menu of the Target Coupler screen and using
[F2] to select the desired curve. If you want to view the numerical data of the
target curve itself, you must use the TABULATION field in the Advanced Target
Coupler menu. The feature is only available when the USER LEVEL is set to
ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

The tabulation feature will add a table to the right of the Target Coupler graph,
displaying the target in numerical format. Tabulation is only available when the
measurement data is displayed in graphical format. When numerical data for
the measured curve is displayed, there is not enough room for the target tabula-
tion box on the screen.

To view the target in numerical format:

1. Set the USER LEVEL to ADVANCED in the Default Settings menu. See
    Section 2.3.2 for details.

2. Press [MENU] from the Coupler Target or Coupler EarSim screen to enter the
    main menu.

3. Press [NEXT] to enter the Advanced menu.

4. Use [▲,▼] to select TABULATION.

5. Use [◀,▶] to select TARGET.

6. Use [EXIT] to return to the Target Coupler screen. The target data will now
    be displayed. See Figure 6.3.2.
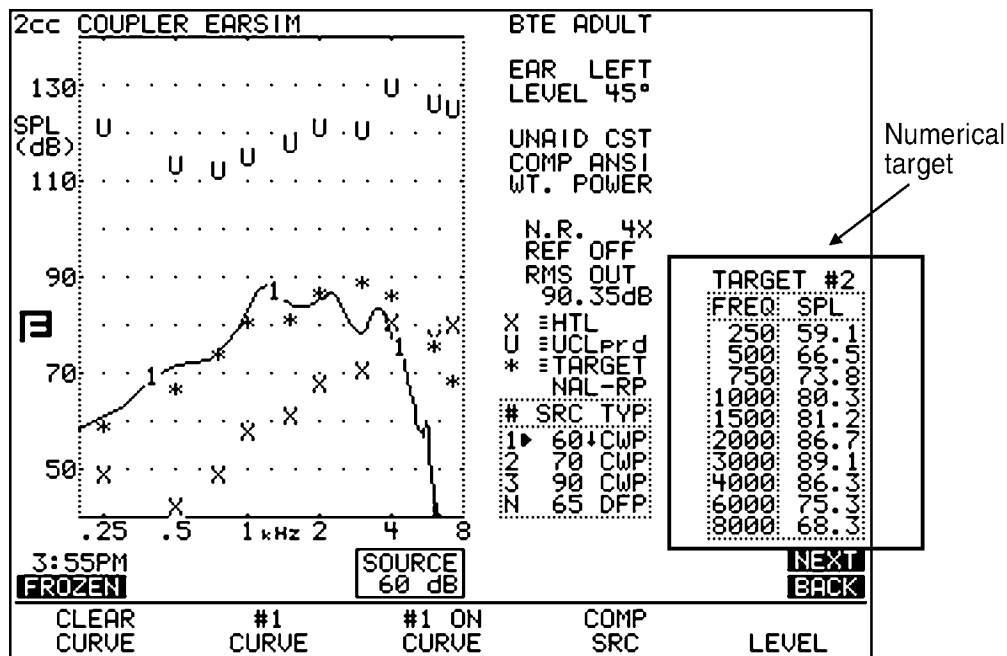
Figure 6.3.2—Numerical display of target data

6.3.3 Tying the Target to a Measurement Curve

By default, the target is always "tied" to the second measurement curve. That is, the source type and amplitude of that curve are used to create the target. Whenever you change the source amplitude or type of that curve, the target will alter as soon as you take a measurement.

If you would like to tie the target to a different measurement curve:

1. Press [MENU] from the Target Coupler screen to enter the local menu.
2. Press [BACK] to enter the Target menu.
3. Use [▲,▼] to select TARGET REF.
4. Use [◄,►] to choose CURVE 1-4. A selection of AUTO will always tie the target to the current selected curve.

6.4 Reference

The following is a description of the items available in the local menus of the Coupler Target and Coupler EarSim screens. The items in **bold** reference coupler targets specifically. Non-bold items are also available in the main Coupler Multicurve screen.

Some of the menu items listed are not available when the USER LEVEL is set to EASY in the Default Settings menu. These items are marked with an asterisk (*). See Section 2.3.2 for details.

Target menu

Press [MENU] to enter the local menu from the Coupler Target or Coupler EarSim screen. Press [BACK] from the main Target Coupler menu to enter the Target menu. The items found in that menu are:

FIT RULE—Fitting rule used to create the coupler target. Select NAL-NL1, NAL-RP, DSL WDRC, DSL LIN, POGO, BERGER, 1/3 GAIN, _ GAIN, 2/3 GAIN, DIRECT. A selection of NAL-NL1 will add several menu selections to the menu screen.

AGE—Age of the patient. Choose from NONE, 0-2 MN, 3-6 MN, 7-12 MN, 1-2 YR, 2-3 YR, 3-4 YR, 4-5 YR, ►5 YR, ADULT. The NONE selection sets the age to adult but does not display the age on the screen.

TARGET REF—The measurement curve that the target is based upon. Choose from CURVE 1, CURVE 2, CURVE 3, CURVE 4 and AUTO. See Section 6.3.3 for details.

COMPRESSION—The type of wideband compression threshold the aid has. This is selectable in increments of 1 dB. This will only be available with a fitting rule selection of DSL WDRC or NAL-NL1.

CHANNELS—The number of channels the aid has. This is only available with a fitting rule selection of NAL-NL1.

AID LIMITING—The type of output limiting the aid has. If the aid has output limiting, usually WIDEBAND should be selected. If the aid has output limiting, and if the aid has more than one channel, this can be set to MULTICHAN. If the aid doesn't have limiting, set this to NONE. This selection is only available with a fitting rule selection of NAL-NL1.

FIT TYPE—Type of fitting. Choose BILATERAL or UNILATERAL. This is only available with a fitting rule selection of NAL-NL1.TUBING. Note: If you select BILATERAL, you must enter the audiogram for *both* ears in the Audiogram Entry screen.

AID TYPE—Style of hearing aid. Choose from BTE, ITE, ITC, and CIC.

VENT—Type of venting on the hearing aid. Choose from OPEN, TIGHT, NO VENT, 1 mm, 2 mm and 3 mm. This selection is only available with a fitting rule selection of NAL-NL1.

TUBING—Type of tubing on the BTE hearing aid. Choose from LIBBY 4, LIBBY 3, CFA #2 HORN, CFA #2 BORE, #13, 6C5 and 6C10. This selection is only available with a fitting rule selection of NAL-NL1 and an AID TYPE of BTE.

Main Menu

Press [MENU] from the Coupler Target or Coupler EarSim screen to reach the main menu.

EAR—Ear assigned to the hearing aid. Choose LEFT or RIGHT.

DISPLAY—The type of display used in the Coupler Multicurve and Coupler Target screens. Choose between GAIN and SPL.

DATA/GRAPH—The type of display. Choose between a graphical display and a numerical display.

COUPLER TYPE—This setting will only be displayed if you have purchased either the CIC or the OES options. It turns on the software correction factors used with special couplers. If you have purchased the CIC Option, a coupler type of CIC will be possible here. If you have purchased the OES Option, a coupler type of MZ will be possible here. Also available: 2-cc. (Correction factors are not used with this selection.)

AID GROUP—The type of hearing aid being tested. Select STANDARD, AGC or ADAPTIVE (for adaptive AGC circuits). This selection sets the various delay times used in pure-tone tests so that they are appropriate to the aid's circuitry. See Section 2.4 for more information on delay times.

DISTORTION—Type of harmonic distortion measurement during a pure-tone sweep. See Section 2.5.1.2 for more information.

NOISE RED (COMP)—Amount of noise reduction used for composite curve measurements. See Section 2.5.2.3 for more information.

NOISE RED (TONE)—Amount of noise reduction used for pure-tone sweeps. See Section 2.5.1.3 for more information.

REF MIC—Status of reference microphone. See Section 3.8.3 for more information.

Advanced Menu

Press [NEXT] from the main menu to reach the Advanced menu.

*AUTO-SCALE—The type of scaling used. ON scales the graph to the selected curve. OFF scales the graph to the highest curve displayed.

*TABULATION—Target data display on the right side of the Target Coupler screen. Choose TARGET or NONE. See Section 6.2.4 for details.

*REFERENCE STATUS—The type of RMS measurement made with the reference microphone. The following selections are available: RMS displays the overall RMS of the reference microphone, FULL displays the overall RMS and the signal quality of the reference microphone, and NONE turns off the RMS display of the reference microphone. See Section 2.5.4 for more information.

*AVG FREQ—The three frequencies used for averaging in pure-tone measurements. Each set is represented on the screen by the highest frequency in the set. See Section 2.5.1.5 for details.

*STATIC TONE—Status of the static pure-tone measurement. When a pure-tone source is selected and a sweep isn't running, measure the response and distortion of a single frequency (SINGLE), the three frequency average chosen in AVG FREQS (AVG), or no measurement (NONE).

FILTER—The type of speech weighting used on the signal sources. In most cases, this should be set to AUTO. See Section 2.5.2.1 for more details.

*SMOOTHING—Type of smoothing used. Smoothing rounds off the curve, removing minor peaks. Usually only used for sound field measurements, this should be off for normal coupler operation. Choose between OFF and LOG.

IM FREQ DIFF—The frequency difference of the two tones presented together for the intermodulation distortion measurement. See Section 3.5.2.

*EXT SOURCE—The channel selected for the external source. The external source (see Section 3.8.9) uses a dual channel connector. This means that the input signal has potentially two different channels. This selection lets you choose which channel to use as the input signal. Choices are EXT CH1 and EXT CH2.

*PREDELAY TIME—The delay after the first tone is presented and before the first measurement is taken in a pure-tone measurement. See Section 2.4 for more information.

*SHORT SETTLE—The time delay between frequencies in a pure-tone sweep, and the additional delay in a digital speech signal.

*LONG SETTLE—The time delay between frequencies in an input/output measurement, a three-frequency average measurement, or a harmonic distortion measurement.

PRINT LABEL—Status of the printing label.

PRINTER— Printer used for printouts. Choose INTERNAL to use the built-in thermal printer. Choose EXTERNAL to use an attached laser or ink-jet printer.

Custom Menu

Press [NEXT] from the Advanced Menu to enter the Custom Menu.

OUTPUT LIMIT—Level of output limiting, which shuts off the source when the measured signal exceeds the limit set here. Choices are: OFF or 80-140 dB SPL. This is usually used only for real-ear type measurements.

*WARBLE SOURCE—The warble rate in pure-tone signals. Warble is usually used in sound field speaker measurements to reduce problems caused by standing waves. This is usually turned off for normal coupler measurements. See Section 2.5.1.4 for more details.

*SIGNAL SKEW—The number of samples from when the signal source leaves the speaker to when the FP35 analyzes it. See Section 2.5.1.5 for details.

SPEAKER—Speaker selection. INTERNAL selects the internal FP35 speaker. EXTERNAL selects the external device (sound chamber or sound field speaker) connected to the speaker jack. AUTO selects the internal speaker for sound chamber measurements and the external speaker for real-ear measurements.

*MIC PORT—Choose the microphone used for Real-ear measurements. Select AUTO, INTERNAL, EXTERNAL or EXT LINE. See Section 2.5.9 for details.

*OUTPUT JACK—Select which external source devices are enabled in the coupler screens. SPEAKER enables only the speaker jack. MONO EAR enables only the left channel of the earphone jack. STEREO EAR enables both channels of the earphone jack. ALL ON enables the speaker jack and both channels of the earphone jacks. See Section 2.5.5 for details.

LEVELING SOURCE—The amplitude used for leveling the speaker. This is useful if you need to level with the chamber door open, and you don't want to use the loud default level of 90 dB SPL. Choose between 60 and 100 dB SPL.

*MICROPHONES—Special operational selections for your microphones. Choices are NORMAL, REVERSE and SPLIT. See Sections 3.8.4 and 3.8.5 for more details.

*IMPULSE REJ—Status of impulse rejection, which rejects noise in the testing environment. See Section 2.5.6.

*SPECTRUM WINDOW—When performing spectrum analysis of random signals such as speech or room noise, leave this ON. If you would like to perform a spectrum analysis of a "phase synchronous" signal such as might be found in one of our other instruments, turn this OFF. See Chapter 8 for more details.

*RMS ANALYSIS—Type of RMS measured. See Section 2.5.3.

*DIST 90 dB RULE—Harmonic distortion measurements are generally made only when the source of the test signal is below 90 dB SPL. To measure harmonic distortion at 90 dB SPL or higher, turn this rule OFF.

*DISTORTION SWEEP—The frequencies used in the intermodulation distortion measurement. NORM uses 1/12 octave frequencies to the nearest 100 Hz. FAST uses 1/3 octave frequencies to the nearest 100 Hz. FULL uses every 100 Hz frequencies available.

*DIST SWEEP END—The last frequency tested when performing an IM distortion sweep. If the selected frequency is less than or equal to the first primary frequency in the IM distortion sweep, only the primary frequency will be tested; there will be no IM distortion sweep.

* These menu items are only available when the USER LEVEL is set to ADVANCED in the Default Settings menu. See Section 2.3.2 for details.

The Audiometer Option

7.1 Introduction

The audiometer option on the FP35 turns your hearing aid analyzer into a type 5 screening audiometer. In other words, you can use the FP35 for doing pure-tone air conduction screening using either insert earphones or sound field testing. It is not intended for use as a clinical audiometer.

7.2 Equipment

The audiometric testing is performed using either a sound field speaker or one or two insert earphones. If you use two earphones, you can set your client up with two earphones and perform your measurements one ear at a time. If you use one earphone, take the set of measurements for one ear, then switch the earphone into the other ear and take the other set of measurements. TDH headphones are not supported on the FP35.

7.3 Setup

The following describes how to set up the FP35 for audiometric measurements. If you are using the sound field speaker as the transducer, you must first level. This is described in Section 7.3.1. The insert earphone setup is described in Section 7.3.2.

7.3.1 Sound Field Speaker

There are two methods to leveling the sound field speaker for audiometric measurements. The first method, called the head surface method, is identical to the leveling method used for real-ear measurements – it is performed with the client present and the reference microphone in position above the client's ear. The second method, called the free field method, is performed with the microphone positioned in front of the sound field speaker without the presence of the client.

Head Surface Method

1. Set up your FP35 analyzer as you would for real-ear measurements with the sound field speaker in place. See Section 9.2.

2. Situate your client with the sound field speaker at a 45º or 0º angle azimuth. See Figure 7.3.1A. We recommend a testing distance of 12 inches from the sound field speaker. You can test at longer distances but it will limit the maximum output possible.

3. Enter the Audiometric Entry Screen by pressing [F2] and using the [NEXT] and [BACK] keys as necessary.

4. Press [MENU].

5. Select EAR and choose the desired ear.

6. Select ASSESSMENT and choose SPEAKER, using the arrow keys.

7. Select SOUND FIELD and use the arrow keys to choose 0º or 45º, depending up on the azimuth used in the client setup.

8. Select REF MIC (SPEAKER) and choose OFF, using the arrow keys. (The reference microphone will automatically be used for the leveling process, but you will probably not want to use it for the audiometric measurements.)

9. Press [EXIT].
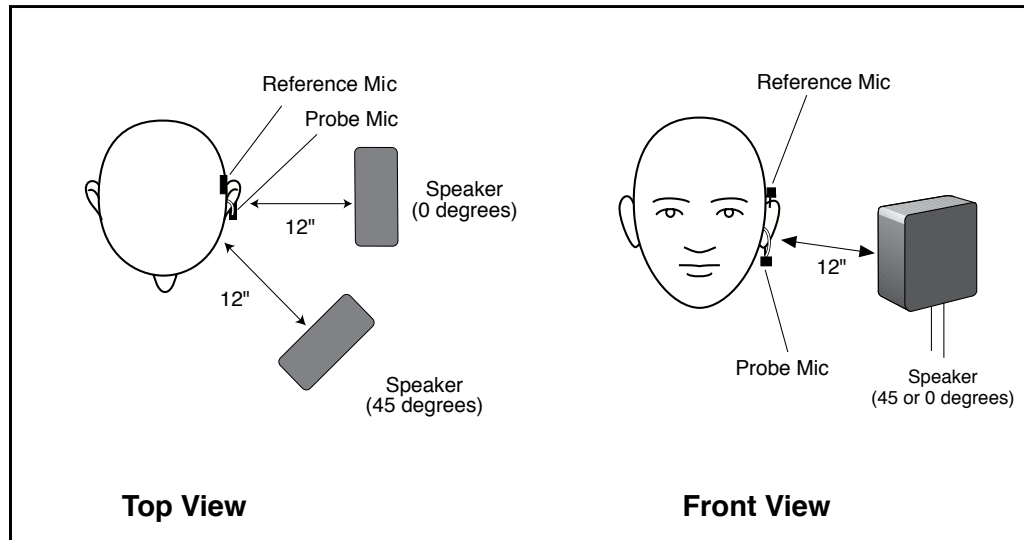
Figure 7.3.1A—Sound field speaker placement

10. Place the integrated probe microphone on the ear, making sure the reference microphone is placed above the ear. The probe microphone is not inserted for this task. See Figure 7.3.1B.

11. Press [LEVEL] to level the sound field speaker.

12. Remove the reference microphone from the ear if desired. (You may want to leave the reference microphone in place if you will be performing real-ear measurements.) Proceed to Section 7.4.

Free Field Method

1. Set up your sound field speaker as described in Section 9.2.2 or Section 9.2.3.

2. Set up your testing environment to perform an audiometric test. The client being tested and the chair in which the client will be sitting should not be present. All other items in the room,
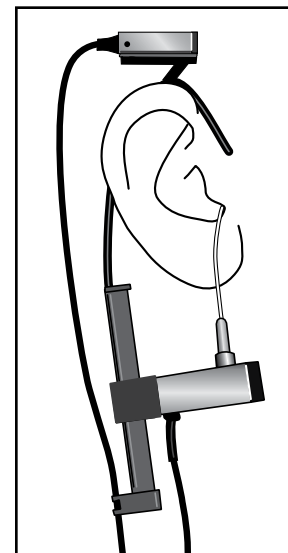
Figure 7.3.1B—Reference microphone placement

including the clinician performing the test, should be at the location they will be while the audiometric test is performed.

3. Remove the reference microphone from the integrated probe microphone (the flat microphone on the top of the ear hook), and position it on a stand 1 meter from the sound field speaker at the height of a seated listener. See Figure 7.3.1C.

4. Enter the Audiogram Entry screen by pressing [F2] in the Opening screen and using [NEXT] and [BACK] as necessary.

5. Press [MENU].

6. Select EAR and choose the desired ear, using the arrow keys.

7. Select ASSESSMENT and choose SPEAKER, using the arrow keys.

8. Select SOUND FIELD and choose 0°, using the arrow keys.

9. Select REF MIC (SPEAKER) and choose OFF, using the arrow keys. (The reference microphone will automatically be used for the leveling process, but you will probably not want to use it for the audiometric measurements.)

10. Press [EXIT].

11. Press [LEVEL] to level the sound field speaker.

12. Remove the stand and set the reference microphone aside. Proceed to Section 7.4 to perform the audiometric measurements.
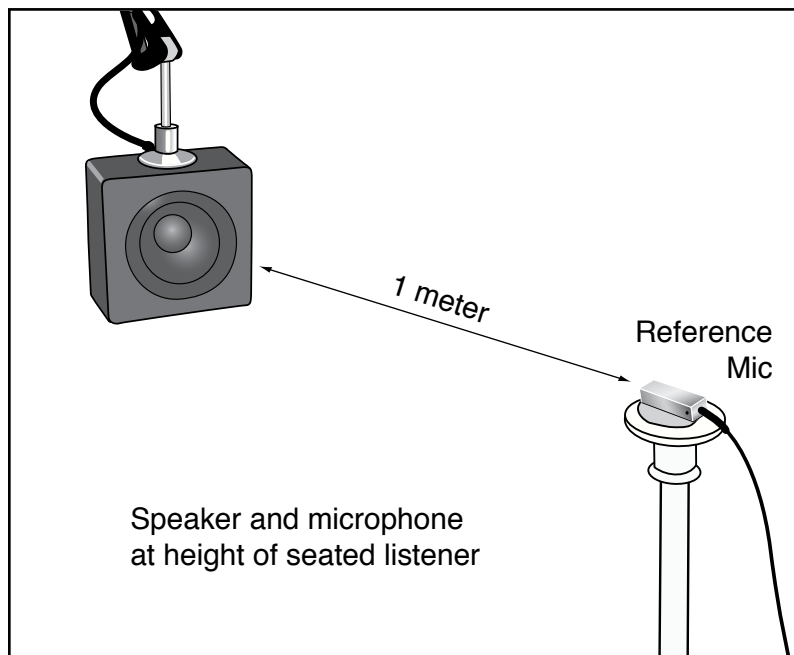
Figure 7.3.1C

7.3.2 Insert Earphones

1. Plug in the insert earphone (or insert earphone set) into the "earphone" jack on the back of your FP35 analyzer.

2. Insert the insert earphone (or insert earphone set) into your client's ear(s).

3. Enter the Audiometric Entry Screen by pressing [F2] and using the [NEXT] and [BACK] keys as necessary.

4. Press [MENU].

5. Select EAR and choose the desired ear with the arrow keys.

6. Select ASSESSMENT with [▼,▲].

7. Press [◀,▶] to select INS. EAR or TWO INS. EAR.

8. Press [EXIT].

7.4 Taking Audiometric Measurements

The procedures for measuring audiometric information is described in this section. HTL and UCL measurements are described in Section 7.4.1. Sections 7.4.2 and 7.4.3 contain more advanced instruction for measuring HTL and UCL values in dB SPL and dB Gain.

7.4.1 Measurements in HL

1. If you want to take threshold measurements, select HTL with [F2]. If you want to take loudness discomfort measurements, select UCL with [F2].

2. Using the [▼,▲] keys, select the desired frequency for testing. The selected frequency will be highlighted in the data box and will also appear under SOURCE below the HL graph.

3. Using the [◀,▶] keys, select the desired amplitude. The selected amplitude will appear next to the selected frequency in the data box. It will also appear under FREQ below the HL graph. See Section 7.5 for details on the output limitations of the FP35.

4. Press [START/STOP] to present the tone. Hold the key down for as long as you would like the tone to be presented. While the tone is being presented, you will see an ACTIVE label in the lower left corner of the display.

7.4.2 Measurements in SPL

While you take the audiometric measurements, you can also get a probe microphone measurement in dB SPL.

1. Press [MENU].

2. Press [NEXT] to enter the Advanced Menu.

3. Select PROBE MIC (HL) with [▼] if necessary.

4. Choose ON with [◀].

5. Press [EXIT].

Set up the client for testing as described in Section 7.3, but also use the earhook and insert a probe microphone in his or her ear. See Section 9.2.4 for more details.

Now, follow the procedure described in the previous section. As you present a tone, the output in dB SPL is displayed under MIC SPL at the bottom of the screen.

7.4.3 Measurements in Gain

To obtain measurement in dB Gain while performing audiometric measurements, follow the instructions in 7.4.2, but also turn REF MIC (SPEAKER) ON in the Menu. This will display results in dB GAIN at the bottom of the screen instead of the dB SPL.

7.5 Output Limitations

The minimum presentation level of the FP35 for both sound field speaker and insert earphones is 10 dB HL.

The maximum output of the sound field speaker is determined by the distance from the client to the speaker and the selected frequency. The maximum output of the insert earphones depends upon the insert earphone used and the selected frequency.

If you try to present a tone exceeding the minimum or the maximum output at the selected frequency, an error message will pop up.

Spectrum Analysis

The FONIX FP35 can be used as a sound spectrum analyzer in either the coupler (test box) or Real-Ear Test Modes. External sounds are measured through the microphones and displayed in an amplitude-vs-frequency format. See Section 5.6 for instructions on live speech testing.

8.1 Spectrum Analysis Measurements

Spectrum analysis measurements can be done in most measurement screens on the FP35 analyzer using the composite, digital speech or fast pure-tone signals.

If you are using a fast pure-tone sweep to take the spectrum analysis, measurements will only be taken at the frequencies normally measured by the fast sweep. If you have the Composite Option, it is recommended that you use the composite signal to take spectrum analysis measurements.

Once you have enter the desired measurement screen and selected your signal source with [F4], use the [▼] key to turn the source amplitude to OFF. Now press [START/STOP] to begin spectrum analysis testing.

8.2 Using the Spectrum Analysis Mode

You should find the following suggested applications clinically helpful, interesting and fun.

APPLICATION 1: MEASURING THE OCCLUSION EFFECT OF A HEARING AID.

This simple procedure will help you measure the occlusion effect of the hearing aid on the wearer's own voice. The spectrum analysis measurement will help you judge the sometimes-uncomfortable feeling caused by the occlusion effect of a hearing aid. You will be able to measure the effect and the improvements made after venting adjustments have been made.

Suggested procedure:

1. Enter the REAL-EAR Mode.
2. Press [NEXT] or [BACK] until you enter the SPL Screen.
3. Use [F2] to select AIDED 1.
4. Choose COMP or FAST with [F4]. Press [▼] repeatedly until the source is off.
5. Place the probe tube into the client's ear (see Section 7.2.4).
6. Place the hearing aid in the client's ear. The aid should be off.
7. Push the [START/STOP] key. Instruct the client to sustain the vowel sound "eee."

8. While the "eee" is still sounding and once the curve on the screen has stabilized, press [START/STOP] again. Note the total RMS Output in the ear canal as indicated in the status box.

9. If the SPL seems high, you might modify the vent size. Then select AIDED 2 with [F2] and, if necessary, use [▼] to turn off the source. Repeat steps 7 and 8. You should see a change in the RMS Output. Aided Curve 2 should be less than Aided Curve 1.

10. If desired, press [PRINT/FEED] to print the results.

Note: You could also measure the effects with the hearing aid on.

APPLICATION 2: INSERTION GAIN MEASUREMENTS USING AN EXTERNAL SOUND SOURCE.

For this procedure, you choose the external sound source. You may want to use a tape or a CD player through a loudspeaker. Any sustained sound source will work. Whether you use a cocktail noise tape or one of the new, environment CDs, you should find your test results interesting, especially when testing nonlinear signal processing hearing aids.

Suggested Procedure:

1. Prepare your sound source

2. Enter the IG Screen of the Real-ear Mode.

3. Do a typical UNAIDED and AIDED probe test using your external sound source by taking measurements with the internal source of the FP35 off.

8.3 Technical Details

The FONIX analyzers use phase synchronous signal sources to generate sound. This means that the sound has a predetermined repeatable source, which allows FONIX analyzers to make accurate measurements and use time averaging to improve the signal to noise measurement of the analyzer.

When you take spectrum measurements with the FP35, a sound source is not generated, and it is assumed that you will be measuring a non-repeating source such as speech or room noise. In most cases, these measurement results are improved with the use of a spectrum mode windowing filter. The windowing filter helps to make the signal seem like it is synchronous to the analysis routines.

Unfortunately, using the windowing filter on a synchronous source signal will result in mangling the results. You can see this by placing the FP35's measurement microphone in another analyzer's chamber along side that analyzer's own microphone. The results will not look the same on the two analyzers. The way to resolve this is to turn off the spectrum windowing filter. You can only do this in Coupler Multicurve and Target Coupler screens.

Synopsis:

If you are doing a spectrum analysis of speech or room noise, leave the Spectrum Window ON in the custom menu of the Coupler Multicurve or the Target Coupler screen.

If you are doing a spectrum analysis of a phase synchronous signal such as the source of a different analyzer, turn the Spectrum Window OFF in that menu.

Note: The SPECTRUM WINDOW setting is only available when the USER LEVEL mode is set to ADVANCED in the Advanced Default Settings Menu. See Section 2.3.2.

Specifications

Acoustical Outputs

Frequencies:	200-8000 Hz in 100 Hz intervals (user interface)
	200-8000 Hz in 1 Hz intervals (RS232)
Frequency Accuracy	1%.
Amplitudes:	40-100 dB in 5 dB intervals coupler, 40-90 dB in 5 dB intervals real-ear (user interface)
	40-100 dB in 0.01 dB intervals coupler, 40-90 dB in 0.01 dB real-ear (RS232)
Accuracy:	Coupler: ±2.5 dB from 300 to 5000 Hz, all others ±3.5 dB (after leveling)
	Real-ear: ±3 dB, 200-8000 Hz (after leveling)
Distortion (at 70 dB SPL):	Puretone: < 0.5%, 400-2500 Hz

Telecoil Outputs

Field Strength:	TMFS, 1, 1.78, 3.16, 5.62, 10, 17.8, 31.6, 56.2, 100 mA/m (user interface)
	0-180 mA/m in 0.01 mA/m specified intervals (RS232)
Accuracy:	± 2 dB

Digital Readout of Sound Pressure Level

Frequency Range:	200-8000 Hz
Amplitude Range:	0-150 dB SPL
Resolution	0.1 dB
Accuracy:	Coupler measurements: ±2.0 dB
	Probe measurements: ±2.0 dB
	Reference measurements: ±2.0 dB
Equivalent Input Noise:	< 50 dB RMS

Measurement Inputs

Probe Microphone:	Crosstalk from reference microphone: < -80 dB
	Crosstalk from coupler microphone: < -80 dB
Reference Microphone:	Crosstalk from probe microphone: < -80 dB
	Crosstalk from coupler microphone: < -80 dB

Harmonic Distortion Analyzer

Type	2nd, 3rd, and 2nd + 3rd = Total
Resolution	0.1 percent

Available Tests

Automated test sequences:	ANSI S3.22-1996, ANSI S3.22-2003, IEC 60118-7:1994, JIS:2000, ISI
Additional Coupler Tests:	Coupler Multicurve, Coupler Target, Coupler EarSim
Real-ear Test Screens:	Audiogram Entry, Insertion Gain, Real-ear Unaided & Aided, Real-ear SPL

Input Power

Voltage	90 - 250 VAC
Frequency	47 - 63 Hz
Power dissipation	27 watts typical with full operation. 23 watts when unit is in Standby.

Safety earth leakage current

Standard Unit 110VAC	< 200 uA
Standard Unit 220VAC	< 400uA
Medical Grade option	< 100uA

Physical Dimensions

Size:	16 x 11 x 4.9 inches
Weight:	12 lbs (5.45 Kg) with softcase and all accessories (except manual)

Printer, Internal

Type:	Thermal
Paper width:	80 mm (+0, –1 mm)

Printer, External

Interface:	Parallel
Language:	HP PCL3

Internal Sound Chamber Dimensions

Test area	2.65" W x 5.25"L x 1.1" H
Speaker	2.5" cone

Guarantee

The FONIX FP35 Portable Hearing Aid Analyzer and its accessories are guaraanteed to be free from manufacturing defects which would prevent the products from meeting these specifications for a period of one year from date of purchase.

Software Upgrades

As new features and options become available on the FP35 analyzer, you may need to upgrade your instrument. The FP35 analyzer is upgraded using computer software.

It is recommended that you close any open programs on your computer before executing the software upgrade. It is particularly important to close any other programs that are Frye programs. It is also recommended that you disable your screensaver.

Software upgrades are usually delivered via email in a .zip file. **These instructions assume that you have unzipped this file.** Ask your local computer technician for help, if needed.

B.1 Installing the Update Software

The software used to update your hearing aid analyzer needs to be installed on a Windows computer that is connected to your analyzer.

1. Open **setup.exe** in the directory where you unzipped your emailed software. This will open the Flash ROM Installation Program.

2. Click **Install** to begin the installation. Do not alter the installation directory unless you are an expert computer user.

3. Click OK to acknowledge when the Installation is complete. The Flash Rom Update Program will automatically start.
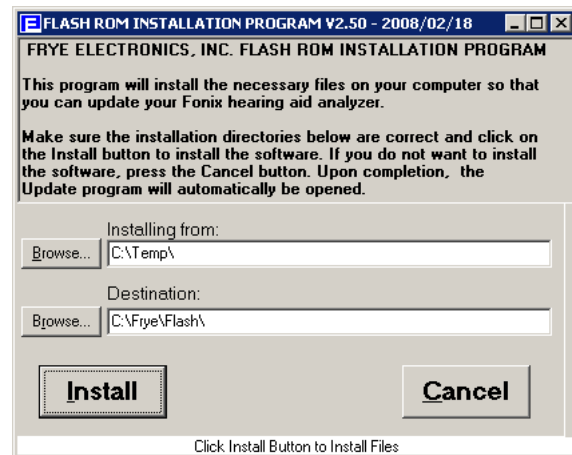
B.2 Connecting the FP35 to the Computer

If you regularly use your computer to connect to your FONIX hearing aid analyzer (for instance, when using the NOAH Real-ear Module or WinCHAP), then you can skip this section; your analyzer should already be connected to your computer. Otherwise, you will need to establish a connection between your hearing aid analyzer and your computer by using an RS232 or USB port.

RS232 Connector

The best way to connect your FONIX hearing aid analyzer to your computer is to use an RS232 connector on your computer. This is normally a 9-pin male connector. (Many hearing aid clinics regularly use this connector for their HI-PRO box.) Use the 9-pin female connector on the back of your FONIX hearing aid analyzer. A standard RS232 cable is used for this connection.
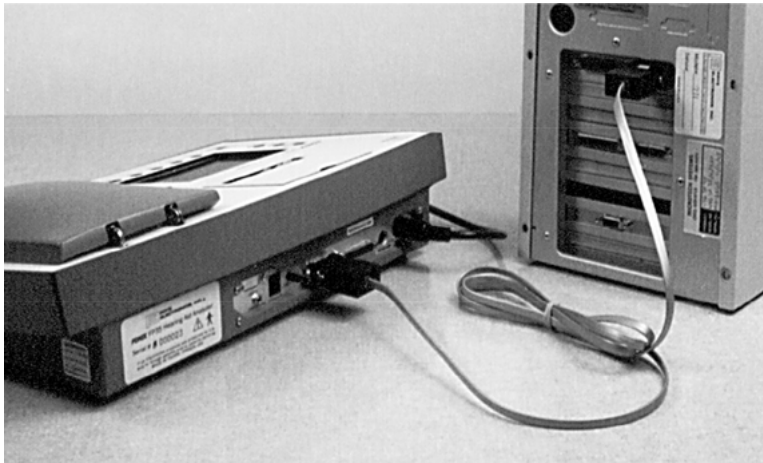
USB Serial Cable

All newer FONIX hearing aid analyzers are provided with a USB serial cable. This cable comes with a driver installation disk and instructions. Make sure to install this cable on your computer. (The hardware installation wizard for the USB cable normally runs twice.)

Connect this cable to the 9-pin female connector labeled "RS232" on the back of the FONIX analyzer.

B.3 Updating the FONIX Analyzer

If the Flash Rom Update Program is not already open, open the file: **C:\frye\ flash\update.exe**.
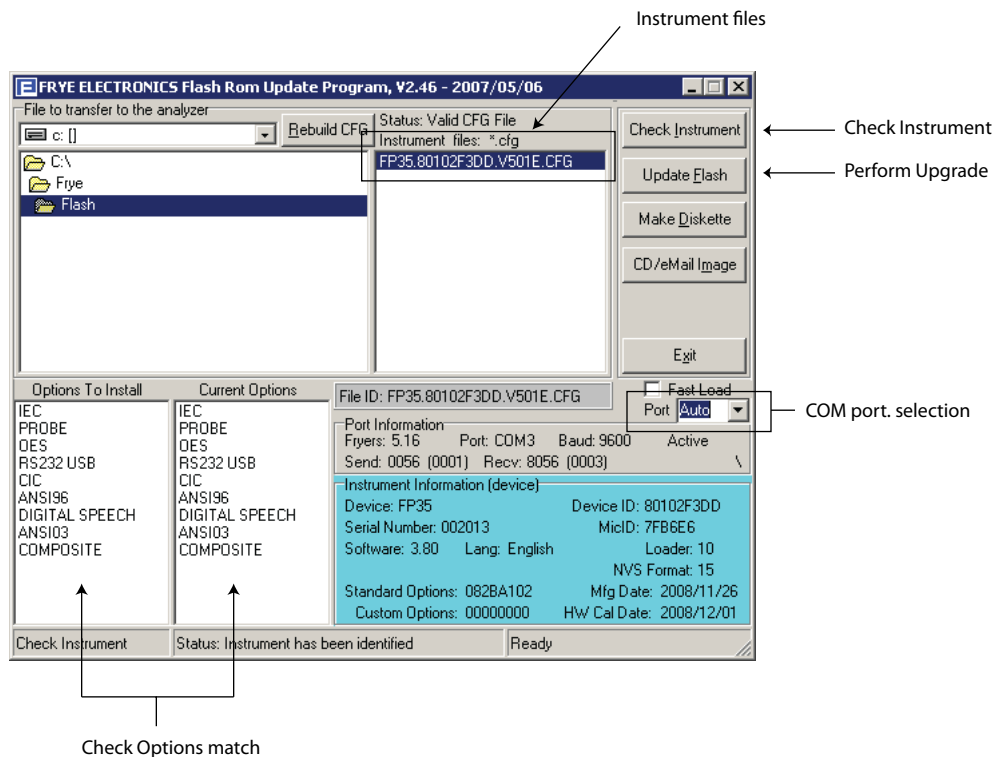
1. If necessary, click the **Instrument File** that matches the Instrument ID found on the Opening Screen of your FONIX analyzer. In most cases, there will be only one file and it will already be highlighted.

2. Click **Update Flash** to perform the flash ROM update. The computer will then proceed to rewrite the flash memory on your FONIX analyzer. This process may take about ten minutes. **Do not use the computer for other activities while this transfer is in process.** Options will also be transferred together with the new software upgrade.

3. Check that the **Options to Install** column matches the **Current Options** column. If these two columns don't match, return to step 1 and repeat.

4. Click **Exit** to close the update program.

Troubleshooting the Update

•   If your computer crashes during the upgrade process, or if the transfer is interrupted in any way, take the following steps:

    a. Please be patient. Wait at least five minutes for the system to repair itself (transfer may take up to ten minutes.)

    b. Shut down the FP35 by unplugging it and then replugging it in.

     c. Reboot your computer.

     d. Before attempting to upgrade the analyzer again, ensure that all programs are closed, all screensavers and power management functions are turned off, all desktop programs such as Office toolbar are closed, all programs running in the Tray are closed.

- The Flash ROM Update program automatically detects the communications port used in connecting to the FP35 analyzer. However, if you are having trouble connecting, you might try specifying the COM port that the Update program should use.

- When using a USB Serial cable, the computer turns the USB port into a COM port. In your Windows Device Manager, make sure the USB Cable is using COM 1-9. If it is using a higher COM port, the installation will not work. You may need to ask your local computer technician for help.

- The lower right corner of the screen displays instrument information. If you want to display information currently on the connected analyzer, click **Check Instrument**.

- Sometimes the instrument configuration file name can be damaged. This can happen if the package was copied through a computer system or program that does not understand long file names. If the name does not look right, or the Status says that the selected CFG file is not valid, try clicking on the Rebuild CFG button just above and to the left of the software CFG file selection. Normally that will correct a corrupted CFG file. If it does not, you will need to obtain a replacement file from Frye Electronics.

B.4 Configuring the FP35 Analyzer

The following instructions may not be necessary every time an upgrade is performed, but it may reduce user interface issues with menu settings.

1. Press [MENU] from the Opening Screen of the FP35.
2. Verify #1 SETTING is listed above the F2 key. Use F2 repeatedly to cycle through options, if necessary.
3. Press [F1] and [START/STOP] to reset the default settings.
4. Press [F5] and [START/STOP] to save the configuration.
5. Press [F2] to select #2 SETTING.
6. Repeat steps 3-4.
7. Press [F2] to select #3 SETTING.
8. Repeat steps 3-4.
9. Press [F3] to go to the Calibration Screen.
10. Press [F2] to go to the Date/Time Screen. Use the arrow keys to adjust the date and time as necessary.
11. Press [EXIT] three times to return to the Opening Screen of the analyzer.

12. Examine the Opening Screen below the copyright date for one of the following two messages:

"Hardware not Calibrated"

"System not Calibrated"

13. Perform the following action:
- If neither message appears, the calibration is complete.
- If "Hardware not Calibrated" appears, the analyzer will need to be sent back to the factory to perform this function.
- If "System not Calibrated" appears, follow the instructions in Appendix C, Section A: Calibrating the System.

Calibration

The FP35 provides you with a means to calibrate the system, the probe and coupler microphones, and the insert earphone(s).

The system calibration of the FP35 should be done once a year, but the microphones should be calibrated only when necessary. Even if you have determined that the microphones are out of calibration, you should contact the factory or your sales representative before calibrating the microphones. The reason for taking this precaution is that the microphone calibration is stored in the microphone connector rather than in the instrument. Because of this setup, the microphones should not go out of calibration. If they do, it may indicate that something more is wrong, and simply calibrating the microphones might not correct the problem.

Note: For best accuracy, allow the FP35 to stabilize to room temperature before performing a system calibration. The FP35 will stabilize to room temperature if it is left on for 15 minutes. The current internal temperature is displayed in the Calibration Screen.

A. Calibrating the System

To calibrate the system:

1. From the Default Settings Menu press [F3] to enter the Calibration Menu.
2. Use the [▲,▼] buttons to move the cursor next to "Calibrate System."
3. Press [START/STOP]. The FP35 will confirm that you want to calibrate the system.
4. Press [START/STOP] to begin the calibration (or press any other key to cancel). The FP35 will ask you to wait while the system is calibrating. Once calibration is complete, the FP35 will return to the Calibration Menu.
5. Select "Store Calibration in EEROM" in the menu.
6. Press [START/STOP] twice. The system calibration is now complete and stored.

B. Checking the Microphone Calibration

Do the following procedure to determine if the coupler and probe microphones are out of calibration.

B.1 Coupler Microphone

For the coupler microphone, you will need a sound level calibrator such as the Quest QC-10.

1. Press [F3] to enter the Coupler Multicurve Mode from the Opening Screen.
2. Use [F4] to choose NORM.
3. Press [MENU].
4. Set REF MIC to OFF, if necessary, using the arrow keys
5. Press [NEXT] to enter the Advanced Menu. Set STATIC TONE to SINGLE.
6. Press [EXIT] to return to the Coupler Multicurve Screen.
7. Press [▼] repeatedly until the single tone is turned off.
8. Use the microphone adapter supplied with the FP35 to fit the coupler microphone into the calibrator, and turn the calibrator on.
9. Observe the output. If it matches the specified amplitude level of the calibrator within ±1 dB, the coupler microphone is not out of calibration.

Note: if you are using a calibrator that uses a signal with a frequency not divisible by 100 Hz, you will need to check the calibration in the microphone calibration screen.

B.2 Probe Microphone:

1. Press [F3] to enter the Coupler Multicurve Mode from the Opening Screen.
2. Press [MENU].
3. Use the arrow keys to set:
    DISPLAY—GAIN
    NOISE RED (TONE)—16X
    REF MIC—ON
4. Press [EXIT] to return to the Coupler Multicurve Screen.
5. Locate the calibration clip and fasten it to the top edge of the coupler microphone.
6. Insert the probe tube through the tube on the clip until the tip of the probe is at the center of the coupler microphone grid (Figure C-1).
7. Put both microphones into the sound chamber and close the lid.
8. Set the source level to 70 dB or higher, using the arrow keys.

Figure C-1—Attaching the probe to the reference microphone

9. Select NORM with [F4]
10. Push the [START/STOP] button.
11. Look at the response. This curve represents the difference between the probe response and the reference response. The maximum deviation from the zero line should be 5 dB.

12. If there is more than a 5 dB deviation from the zero line at any point along the curve, the probe microphone is out of calibration.

C. Calibrating the Microphones

The FP35 microphones should be calibrated **after** the system calibration described in Section A.

There are three possible microphones on the FP35 analyzer:

- Coupler microphone
- Probe microphone
- Reference microphone

There are several variations of these microphones that may be available, depending upon when the analyzer was manufactured and whether or not it includes the Real-ear Option.

FP35 analyzers that do not include the Real-ear Option will only have the coupler microphone. This procedure for calibrating this microphone is described in Section C.1.

FP35 analyzers with the Real-ear Option manufactured during or after November 2008 will have an integrated probe microphone set in addition to the coupler microphone. This consists of a probe microphone integrated into the earhook and a rectangular reference microphone that attaches to the top of the earhook. The procedure for calibrating the integrated probe microphone is described in Section C.2. The procedure for calibrating the rectangular reference microphone is described in Section C.3.

FP35 analyzers with the Real-ear Option manufactured before November 2008 will have a two microphone set consisting of a larger 14 mm coupler microphone and a probe microphone. (The coupler microphone is used as a reference microphone during real-ear measurements.) The procedure for calibrating the coupler microphone is described in Section C.1. The procedure for calibration the probe microphone is described in Section C.2.

To perform the microphone calibrations, you will need the following equipment, depending on what type of microphones you are calibrating. The adapters come standard with the analyzer. You can purchase additional adapters and a sound calibrator from the factory. (Sound calibrators are special orders and may not be immediately available for purchase.)

- Sound calibrator such as a QC-10 (all calibrations)
- 14 mm-to-1 inch microphone adapter (coupler microphone calibration)
- Probe microphone adapter (probe microphone calibration)
- Rectangular reference microphone adapter (rectangular reference microphone on integrated probe microphone).

Figure C-2: Microphone calibration equipment

C.1 Calibrating the Coupler Microphone

This procedure describes how to calibrate the coupler microphone. (On FP35 analyzers manufactured before November 2008, the coupler microphone was also used as a reference microphone during real-ear measurements.)

From the Opening Screen, press [MENU] and [F3] *twice* to enter the Microphone Calibration Screen.

1. If you have an FP35 analyzer manufactured after November 2008, select the port the microphone is plugged into. The "internal mic" is the connector located inside the internal sound chamber. The "external mic" is the connector located on the front of the analyzer. This functionality is not available if the external microphone port is not on the analyzer. Normally the coupler microphone is plugged into the internal port.

2. Use the arrow keys to select "Custom Coupler Mic Cal." This may be the only selection available.

3. Attach the 14 mm-to-1 inch microphone adaptor into the sound calibrator.

4. Insert the coupler microphone into the adapter. See Figure C-3. Turn on the sound calibrator.

Figure C-3: Coupler microphone inserted into sound calibrator.

5. Press [START/STOP] to start the calibration.

6. Use the up/down arrow keys to adjust the "MEASURED dBSPL" until it matches the output of the calibrator. Pressing the keys briefly will result in 0.1 dB changes. Holding the buttons down will result in 1 dB changes.

6. Once the "MEASURED dBSPL" matches the calibrator, press [EXIT] to return to the Microphone Calibration Screen.

7. Press [F5] to store the calibration.

C.2 Calibrating the Probe Microphone

These instructions describe how to calibrate the probe microphone. There are two models of probe microphone on the FP35 analyzer: the old style 1 cm diameter microphone and the new style integrated microphone. The calibration procedure is the same.

From the Opening Screen, press [MENU] and [F3] twice to enter the Microphone Calibration Screen.

1. If you have an FP35 analyzer manufactured after November 2008, select the port the microphone is plugged into. The "internal mic" is the connector located inside the internal sound chamber. The "external mic" is the connector located on the front of the analyzer. This functionality is not available if the external microphone port is not on the analyzer. Normally the probe microphone is plugged into the external port when it's available.

2. Use the arrow keys to select "Custom Probe Mic Cal."

3. Attach the 14 mm-to-1 inch microphone adaptor into the sound calibrator.

4. Attach a new probe tube to the probe microphone.

5. Thread the probe microphone through the edged side of the probe microphone adapter so that the probe tube sticks out a coupler of millimeters from the other side of the adapter. See Figure C-4A and C-4B.

6. Secure the probe tube in place by putting a dab of blue adhesive putty on the edged end of the adapter.

7. Insert the probe microphone adapter with the attached probe microphone into the calibrator.

8. Turn on the calibrator.

9. Press [START/STOP] to start the calibration.

10. Use the up/down arrow keys to adjust the "MEASURED dBSPL" until it matches the output of the calibrator. Pressing the keys briefly will result in 0.1 dB changes. Holding the buttons down will result in 1 dB changes.

11. Once the "MEASURED dBSPL" matches the calibrator, press [EXIT] to return to the Microphone Calibration Screen.

12. Press [F5] to store the calibration.

Figure C-4A: Integrated probe microphone inserted into sound calibrator.

Figure C-4B: Old style probe microphone inserted into the sound calibrator.

C.3 Calibrating the Rectangular Reference Microphone

This procedure describes how to calibrate the rectangular reference microphone that is part of the new-style integrated probe microphone set. This microphone is not normally available on FP35 analyzers manufactured before November 2008.

From the Opening Screen, press [MENU] and [F3] twice to enter the Microphone Calibration Screen.

1. Select the port the microphone is plugged into. The "internal mic" is the connector located inside the internal sound chamber. The "external mic" is the connector located on the front of the analyzer. Normally, the integrated probe microphone is plugged into the external mic port.

2. Attach the rectangular reference microphone adaptor into the sound calibrator.

3. Remove the reference microphone from the integrated ear hook and insert it into the calibration adapter with the opening of the reference microphone pointing into the calibrator. See Figure C-5A. You can use a rubber band to hold the microphone onto the calibrator, if necessary. See Figure C-5B. Turn on the sound calibrator.

4. Use the arrow keys to select "Custom Reference Mic Cal."

5. Press [START/STOP] to start the calibration.

6. Use the up/down arrow keys to adjust the "MEASURED dBSPL" until it matches the output of the calibrator. Pressing the keys briefly will result in 0.1 dB changes. Holding the buttons down will result in 1 dB changes.

7. Once the "MEASURED dBSPL" matches the calibrator, press [EXIT] to return to the Microphone Calibration Screen.

8. Press [F5] to store the calibration.

Figure C-5A: Rectangular reference micro-phone inserted into sound calibrator

Figure C-5B: Using a rubber band to hold the microphone in place on the calibrator

D. Insert Earphone Calibration

Before you can perform RECD or audiometric measurements, it is necessary to calibrate the insert earphone(s) that you will be using. The calibration for the insert earphones is based on the ANSI S3.6-1996 specifications. There is no need to specifically calibrate individual HL levels because the following calibration procedure provides a sufficiently stable reference.

D.1 RECD coupler setup

1. Insert the insert earphone into the "earphone" jack on the back of your analyzer.
2. Plug the other end of the insert earphone into the tubing of the ear level adapter attached to an HA-2 coupler. See Figure C-6.
3. Insert coupler microphone into the HA-2 coupler. See Figure C-7.
4. From the Opening Screen, press [MENU] to enter Default Settings Menu.
5. Press [F3] to enter the Calibration Screen.
6. Press [F4] to enter the Earphone Calibration Screen.

Figure C-6—Insert earphone connected to ear level adapter and HA-2 coupler
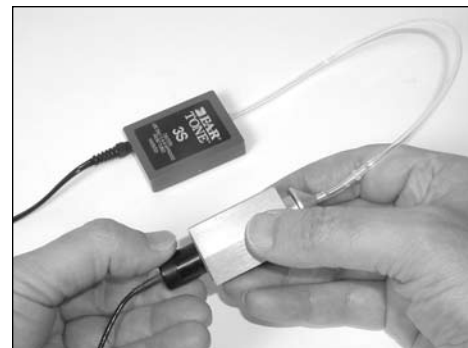
Figure C-7—Coupler microphone inserted into HA-2 coupler

D.2 RECD coupler measurement

1. Set up your insert earphone for calibration as described above.

2. Select "Cal Left (Single) Ins. Earphone (RECD)" with [▲,▼].

3. Press [START/STOP] twice to perform the calibration.

4. If you are using only one insert earphone for the RECD measurements, skip to step 8. If you are using two insert earphones (one per ear), proceed to the next step.

5. Set up the right insert earphone as described above.

6. Use [▼] to select "Cal Right Ins. Earphone (RECD)."

7. Press [START/STOP] twice to perform the measurement.

8. Press [F5] to save the insert earphone calibration.

9. Press [EXIT] to exit Earphone Calibration Screen.

D.3 Audiometer calibration setup

1. Attach the earphone calibration adapter to the HA-2 coupler

2. Insert the insert earphone into the "earphone" jack on the back of your analyzer.

3. Plug the other end of the insert earphone into the earphone calibration adapter. See Figure C-8.

4. Insert coupler microphone into the HA-2 coupler. See Figure C-9.

5. From the Opening Screen, press [MENU] to enter Default Settings Menu.

6. Press [F3] to enter the Calibration Screen.

7. Press [F4] to enter the Earphone Calibration Screen.

Figure C-8—Insert earphone connected to earphone calibration adapter and coupler

Figure C-9—Coupler microphone inserted into HA-2 coupler

D.4 Calibrating the audiometer

1. Set up the left insert earphone for calibration as described above.
2. Select "Cal Left (Single) Ins. Earphone" using [▲] if necessary.
3. Press [START/STOP] twice to perform the calibration.
4. If you're only using one earphone, skip to step 8. Otherwise, proceed.
5. Set up the right insert earphone for calibration as described above.
6. Use [▼] to select "Cal Right Ins. Earphone."
7. Press [START/STOP] twice to perform the calibration.
8. Press [F5] to save the insert earphone calibration.
9. Press [EXIT] to exit Earphone Calibration Screen.

D.5 Erasing the insert earphone calibration

If you want to set the calibration to be electrically flat to allow you to use the "earphone" jack for other devices, perform the following operation.

1. Press [F1] to erase the calibration.
2. Press [F5] to save this change.

Fitting Formula Tables

The conversions used by the FP35 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

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.

SPL Conversions

The Target IG is converted to the Target SPL in the following steps.

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.
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) - 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) (Except for DSL and NAL-NL1)

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 (Except for DSL and NAL-NL1)
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) (Except for DSL and NAL-NL1)
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		

Digital Speech Technical Details

The digital speech signal on the FP35 analyzer works by turning the composite signal on for a set period of time, taking a measurement, turning the signal off for a random period of time, and turning the signal back on again. This sequence is repeated until the user ends the test. Usually, either the ANSI S3.42 or the ICRA speech weighting is used to take the measurements.

The signal "on" time takes a minimum of 50 milliseconds. This includes the time to turn the signal on, take the measurement, and turn the signal off.

Some aids may require an additional delay before the measurement is taken to allow their circuits to settle. This additional delay time can be changed in the SHORT SETTLE setting in the Advanced Menu of Real-Ear or Coupler. The SHORT SETTLE is automatically adjusted according to the aid type selected. The settle time is added to the 50 ms minimum measurement time. The default settings are:

- STANDARD (linear): 0 ms
- AGC: 50 ms
- ADAPTIVE: 100 ms

The signal "off" time is random between 100 and 300 milliseconds. It is not controllable by the user.

Digital Speech is usually used with the ANSI or ICRA speech spectra (see Section 4.4.4 for a discussion on filters). There is a sizable difference between these two filters. The ICRA rolls off the high frequencies of the composite signal much more rapidly than the ANSI weighting. See Figure F-1 for a graphical representation of the differences between the two weightings.

Since the speech weightings of the signals are different, the responses of hearing aids to ANSI and ICRA will also be different. Figure F-2 shows an example of a digital hearing aid being tested with the ANSI and the ICRA digital speech signals.
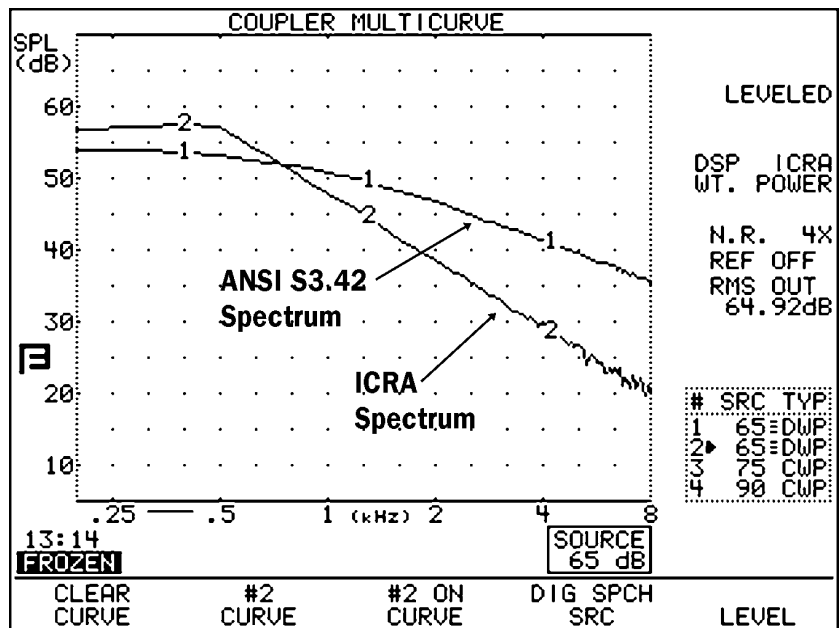
Figure F-1

Figure F-2

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Note: The word in all capital letter refer to the menu that appear on screen.