Audioscan Verifit®
User's Guide 4.14

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CE 0086

Table of Contents

1 About Verifit

This section provides a listing of features new in this software release, describes the Audioscan Verifit, provides contact, warranty and trademark information, safety warnings and notices and instructions for accessing the electronic User's Guide.

Note that the User's Guide may be viewed on the Verifit at any time by pressing <Help>. (For long Help pages, use the mouse to switch between the Help index and the Help page, and to scroll through the page).

Product description

The Verifit is a hearing instrument analyzer intended to be used by hearing care professionals such as audiologists and hearing instrument specialists to verify the electro-acoustic performance of a hearing instrument connected to a standard earphone coupler or while worn on the ear of the end user. The Verifit is a Programmable Electrical Medical System (PEMS). The system consists of a real-ear measurement (REM) display unit, a hearing instrument test (HIT) acoustically-treated binaural test box, and numerous attachable components and accessories:

Display Unit

A real-ear measurement (REM) display unit housing a flat-panel LCD high resolution display, signal generation, measurement and control electronics, and two sound field loudspeakers.

On the sides of the display unit, there are connections for:

> 1.monitor headphones on the lower right side
>
> 2.a USB jack on the lower left side (for the Audioscan update stick, for example)
>
> 3.magnet mounts on both sides of the display unit, approximately 8cm (3 in.) down from the top (this is where you store the probe dock when not in use)

On the rear of the display unit, there are connections for:

> 1.an external monitor
>
> 2.a network connection
>
> 3.external loudspeakers
>
> 4.power supply
>
> 5.test box cable
>
> 6.probe dock cable
>
> 7.four USB jacks (for a keyboard, printer, and a mouse) - the USB stick for the mouse is already inserted into one of these USB jacks

The following components are shipped with the display unit

Component	Description
	External power supply connected to a hospital grade power cord (in North America) or a country-specific power cord (international markets) . Electrical supply input requirement: 100 – 240 Vac 47 – 63 Hz 1.35 – 0.53 A
	Probe dock, shown here with 2 probe microphones (which nest into, and are connected to, the probe dock). This is the configuration of these components when they are shipped to you. The probe dock has connections for the 2 probe microphones, the WRECD transducer, and the tele-test handset. It is intended that the probe dock clips near to or on the patient. There is a probe cables adjust clip on the probe microphone cables that allows you to adjust the probe microphones flat against the client's cheek
	Probe tubes, package of 36

Component	Description
	WRECD transducer used to measure the wideband real-ear to coupler difference (WRECD) useful in estimating the sound level produced in an individual ear from measurements in a coupler **Foam eartips** for measuring WRECD. The package contains: •Qty 5 ER3-14A adult foam eartips •Qty 5 ER3-14B pediatric foam eartips
	Wireless mouse
	Monitor headphones provided with a 130cm (51 in.) detachable (from the headphone) cable. Cable has a 3.5mm stereo plug and includes a 3.5mm-to-1/4-inch adapter to connect to the 1/4-inch headphone jack on the Verifit2 display unit.

Component	Description
	Tele-test handset used to provide an inductive stimulus for simulating operation with a telephone in Speechmap and for performing ANSI TMFS test.
	Audioscan update USB stick
	Quickstart setup guide

Test Box

Hearing instrument test (HIT) acoustically-treated binaural test box which houses a telecoil test loop, 3 loudspeakers and connections for:

- •two reference microphones,
- •binaural coupler microphone
- •battery pill substitutes

The following components are shipped with the test box

Component	Description
	Test box cable to connect the test box to the display unit
	Binaural coupler microphone for the purpose of measuring the sound level produced in the standard coupler by a hearing instrument
	Testbox reference microphones for controlling the signal from the loudspeakers (2)

Component	Description
	0.4cc wideband couplers for Speechmap and all binaural/wideband tests.
	HA-1 (ITE) 2cc coupler (1) NOTE: for ANSI/IEC tests only. Not to be used for Speechmap.
	HA-2 (BTE) 2cc coupler (1) NOTE: for ANSI/IEC tests only. Not to be used for Speechmap.
	Hearing instrument stabilizers, attached to the 0.4cc couplers to support BTE-style instruments
	TRIC adapters (Thin-tube, Receiver In Canal) designed for use with 0.4cc and HA-1 (ITE) 2cc couplers

Component	Description
	Earmold substitutes (HA-4 tubing) inserted in a second set of TRIC adapters to allow BTE instruments to be coupled to the 0.4cc coupler without earmold. Two replacement tubes are also supplied. If this tubing cracks or dries out replacements can be ordered from Audioscan (part #3986, qty 6 per package)
	Putty, to attach custom hearing instruments and earmolds to the coupler 0.4cc and HA-1 (ITE) 2cc couplers
	Battery pill substitutes, kit consisting of: 1 - E352 Battery Size #10A 1 - E353 Battery Size #13A 1 - E354 Battery Size #312 1 - E355 Battery Size #675

Accessories

RE367-36 probe tubes for single patient use (36 per bag)

ER3-14A and ER3-14B foam eartips (package containing 5 of each)

Associated items and supplies

VA-112 External speaker with folding stand and probe dock extension cable

VA-131 Microphone extension cable (90cm / 36 in.) for use with binaural coupler microphone

VA-134 Probe dock extension cable (375cm / 12 ft.) for use with the probe dock

VA-201 Noah® module allows a networked PC running Noah to exchange data with Audioscan analyzers

RE-791 Binaural coupler microphone adapter for use with B&K 4231 or Quest QC10/20 calibrators (1 in.)

SAFETY WARNINGS and NOTICES

For purposes of IEC 60601-1, this product is Class I with Type BF applied parts. The applied parts are:

    1.Probe tube

    2.Foam eartip

    3.Probe microphone

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

This Class A digital apparatus complies with Canadian ICES-003

⚠	This symbol on the product is a WARNING describing a foreseen risk
⚠	**WARNING:** To avoid the risk of electrical shock, use only the power supply and power cord supplied with the Verifit and connect it only to a grounded (protectively earthed) electrical outlet.
⚠	**WARNING:** To allow electrical power to be rapidly disconnected in the event of an emergency, position the power supply in an accessible location so that the power cord may be quickly disconnected.
⚠	**WARNING:** To avoid the risk of electrical shock, any line-powered peripheral equipment connected to this product must comply with UL/IEC 60601-1 OR comply with UL or IEC and ISO safety standards for such equipment AND a) be operated from an isolating transformer complying with UL/IEC 60601-1 OR b) be kept at least 1.8m (6 ft.) from the patient.
⚠	**WARNING:** This equipment is not suitable for use in an oxygen-rich environment or in the presence of flammable anesthetic mixtures with air or with oxygen or nitrous oxide.
⚠	**WARNING:** To ensure proper operation of this product, no modification of this equipment is permitted
⚠	**WARNING:** Probe tubes are for single-patient use only. Care is required when sliding the probe tube into the ear canal. Be careful not to advance the probe tube further into the ear canal when inserting an earmold or custom hearing instrument into the ear or when inserting the foam tip into the ear
⚠	**WARNING:** Foam eartips are for single-patient use only
⚠	**WARNING**: To ensure that the operation of this product is not affected by EMC emissions from other products, this product should not be used adjacent to or stacked on other equipment. If this is necessary, its operation should be verified as normal in this configuration. Portable and mobile RF communications equipment can affect the performance of this product
⚠	**WARNING**: To reduce the risk of contamination, hearing instruments should be clean before putty is applied and putty should be replaced frequently
⚠	**WARNING**: The included magnet may effect some medical or electronic devices. Keep magnet at least 5cm (2in.) from implantable devices and other magnetically sensitive devices.
⚠	**WARNING**: Keep magnet out of reach of children and pets. If a magnet is swallowed seek immediate medical attention.
⚠	**WARNING:** The magnet used with the tele-test handset cannot be applied for more than one (1) minute when the telecoil test is conducted with the hearing instrument on the client's head

	This symbol on the product is a **WARNING** that failure to follow instructions in this part of the User's and/or Quick Start Guides could place the operator or patient at risk.
	Failure to follow the operating instructions for connecting to a network, a local printer, a keyboard, or an external monitor could place the operator at risk
	Failure to follow the operating instructions for connecting the monitor headphones, the mouse, or the Audioscan update stick could place the operator at risk
	This symbol on the product is a **WARNING** describing a required action
	Use only an approved test box cable to connect the test box and the display unit
	The test box can only be connected to the display unit
	The VF2 power supply can only be connected to the mains using the supplied power cord
	The probe dock can only be connected to the display unit
	Only use the magnet provided with the tele-test handset or one explicitly intended for telecoil activation
	This symbol on the product means that the parts applied to the patient meet the safety requirements of IEC 60601-1 for type BF isolated (floating) applied parts

Environmental safety

	This symbol on the product means that this product is not to be disposed of in unsorted municipal waste because electrical and electronic waste may contain hazardous substances which could endanger the environment and human health.

This product and its associated items must be disposed of in accordance with local disposal regulations for electrical and electronic waste. Consult your local waste disposal authority regarding applicable regulations.
The probe tubes (used with the probe microphones) and the foam eartips (used with the WRECD transducer) are for single patient use. After use, they may be disposed of in unsorted municipal waste or as required by your facility's waste management policy.

Declaration of Electromagnetic Compatibility (EMC)

Medical electrical equipment needs special precautions regarding EMC and needs to be installed and put into service according to the following information:

- The Verifit should not be used adjacent to or stacked on other equipment. If this is necessary, its operation should be verified as normal in this configuration.
- Portable and mobile RF communications equipment can affect medical electrical equipment and may affect the performance of the Verifit.
- Performance degradation due to electromagnetic disturbances (including electrostatic discharge) is considered normal and acceptable

The compliances listed in the following table are met with the supplied WRECD transducer, binaural coupler microphone, probe microphones, reference microphones, monitor headphones, mouse, and a keyboard, all of which are connected, and with unterminated speaker cables (2), USB cables (5), Ethernet cable, test box cable, and HDMI display cable connected. The connection of other devices may result in increased emissions.

Guidance and manufacturer's declaration - electromagnetic emissions		
The Verifit is intended for use in the electromagnetic environment specified below. The user of the Verifit should assure that it is used in such an environment.		
Emissions test	*Compliance*	*Electromagnetic environment - guidance*
RF emissions CISPR 11	Group 1	The Verifit uses RF energy only for internal function. Therefore RF emissions are very low and not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The Verifit is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Warranty, Trademarks, Acknowledgments

The Audioscan Verifit is manufactured by Etymonic Design Inc., 20 Ludwig St., Dorchester, Ontario, Canada, N0L 1G4. Web site www.audioscan.com.

Phone: 800-265-2093 (USA only); 519-268-3313   **Fax:** 519-268-3256

Email: info@audioscan.com or service@audioscan.com

The authorized representative for this product in the European Union is:

EC REP Medical Device Safety Service GmbH, Schiffgraben 41, 30175 Hannover, Germany

Warranty: The Verifit is warranted against defects for two years from date of purchase. Within this period, it will be repaired without charge for parts, labor or return shipping when returned prepaid to your authorized Audioscan service agent. This warranty does not apply to equipment that, in our sole judgment, has been subject to misuse, or unauthorized alteration or repair.

Trademarks:

Audioscan, Speechmap, and Verifit are registered trademarks of Etymonic Design Inc. DSL is a registered trademark of Western University. All rights reserved. HP LASERJET is a registered trademark of Hewlett-Packard Company. Noah is a registered trademark of the Hearing Instrument Manufacturer's Software Association. QUEST is a trademark of Quest Technologies Inc. PostScript is a registered trademark of Adobe Systems, Inc.

Acknowledgments:

DSL 5.0 is used under license from Western University which is solely responsible for its content. We acknowledge the support received from past and present staff at the National Centre for Audiology at Western University in implementing the DSL method.

CAMFIT is used under license from Prof. Brian C.J. Moore, University of Cambridge, UK. We are indebted to the University of Memphis hearing instrument Research Laboratory for permission to use some of their recorded speech material.

NAL-NL1 is used under license from the National Acoustics Laboratories, Australia.

NAL-NL2 is used under license from Hearworks Pty Ltd, Australia.

Software licenses:

Audioscan distributes selected software components under various open source licenses. These licenses generally give you the right to copy and change the affected component's software source code. For details, see the license files distributed with the software, or contact Audioscan.

EC Declaration of Conformity

audioscan
A Division of Etymonic Design Incorporated

EU Declaration of Conformity

Manufacturer:

Etymonic Design Incorporated
(operating as Audioscan)
20 Ludwig Street
Dorchester, Ontario,
CANADA, N0L 1G4

European Authorized Representative:
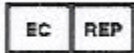
Medical Device Safety Service
Schiffgraben 41
30175 Hannover, Germany

EC | REP

CE-marked Products:

Audioscan Model Verifit VF-2, Hearing Instrument Fitting System
Audioscan Model Axiom, Hearing Instrument Fitting System
Audioscan Model RM500SL, Hearing Instrument Fitting System
Audioscan Model Verifit VF-1, Hearing Instrument Fitting System

Products Classification:

Class IIa medical devices as defined by European Medical Devices Directive 93/42/EEC

Declaration:

We, the manufacturer, hereby declare and ensure with sole responsibility, that the above mentioned Medical Devices meet the provisions of Council Directive 93/42/EEC (Medical Device Directive) which apply to them.

The obligations laid down in Annex V are fulfilled with a quality system approved for the manufacture of the products via certification issued by BSI, ID #0086, certificate# CE 543241

Date of Validity:

November 29, 2016

D. B. Whitred
Regulatory Affairs Manager,
Quality System Management Representative

audioscan®

20 Ludwig Street, Dorchester, Ontario, N0L 1G4 • www.audioscan.com • Tel: (519)268-3313 / Fax: (519)268-3256 / USA 1-800-265-2093

Electronic User's Guide

	Failure to follow the operating instructions could place the operator at risk.

You can download the current User's Guide directly from *www.audioscan.com*. A printable User's Guide is also provided with each new instrument and each software update. A .pdf file viewer, such as Acrobat Reader (5.0 or higher) or Foxit Reader is required to view the User's Guide. Except for some additional reference material, the information in the User's Guide is available to you on the Verifit at any time by right-clicking and selecting [**?**] .

A printable User's Guide is on the Audioscan update stick supplied with the instrument. This User's Guide will be updated each time you download new software from *www.audioscan.com* to the Audioscan update stick.

To view the User's Guide:

1. Insert the Audioscan update stick into a USB port on your PC.

2. If your PC does not open the Audioscan update stick automatically, select My Computer, then the Removable Disk drive (usually E or F).

3. Double click the User_Guide folder to open it.

4. Double click the English folder and copy the Verifit Users Guide.pdf file to an appropriate location on your PC. Double click on the file to open it for viewing.

When you have finished copying the file from the Audioscan update stick, click on the safely remove icon on your PC and remove the Audioscan update stick when you are notified that it is safe to do so.

STORE THE AUDIOSCAN UPDATE STICK IN A SAFE PLACE. YOU WILL REQUIRE IT TO INSTALL FUTURE SOFTWARE UPDATES.

How to Avoid Undesirable Side Effects

During the development of the hearing instrument analyzer, Audioscan performed a rigorous Risk Assessment to identify any undesirable side effects that a user could be exposed to during the use of the Verifit, and incorporated numerous risk reduction design elements into the Verifit to minimize the risk to users and patients.

Following are the actions which a user should take to ensure that these risk control measures continue to be effective

Loud Sounds

The Verifit is designed to produce sound pressure levels as high as 85 dB at the probe reference microphone. Exposure to these levels for more than 7 hours can produce hearing damage. When such levels are amplified by a hearing instrument, the level in the ear canal will be determined by the settings of the hearing instrument but may reach levels that can produce hearing damage in less than 30 seconds. To avoid this possibility,

a) Hearing instruments should be adjusted to limit sound pressure levels to safe levels

b) The maximum TM SPL setting (see Max TM SPL Setup) should be used to terminate tests if an unsafe level is detected in the ear canal

c) Test levels should be limited to 70 dB SPL except when necessary to verify the limiting levels of the hearing instrument, in which case, the test should not last longer than 15 seconds

d) Be aware of the test signal and patient reaction during a test and be prepared to respond to any sign of discomfort by reducing the SPL setting, switching off the equipment or the hearing instrument, or removing the

patient from the area.

When using the equipment to measure the WRECD or RECD in small ear canals, it is possible to induce a hearing loss if the test is allowed to continue for more than 1 hour. Since accurate results can be obtained in less than 10 seconds, this possibility should never occur in normal practice.

Power and Grounding

This product contains numerous safety features to ensure that the probability of electrical shock is as low as reasonably practicable. In order to ensure that all of the safety features work optimally you must ensure that the power cord is plugged into a grounded outlet. Any line-powered peripherals connected to Verifit must comply with UL/IEC 60601-1 OR comply with UL or IEC or ISO safety standards for such equipment, AND a) be operated from an isolating transformer complying with UL/IEC 60601-1, OR b) be kept at least 1.8m (6 ft..) from the patient.

Ear Infection

Probe tubes (used on probe microphones) or foam eartips (used on the WRECD transducer) should not be re-used on another patient. There is a possibility of transferring an ear infection to the other patient. Probe tubes and foam eartips are for single-patient use only. Probe tubes can be wiped with alcohol wipes for re-use with the same patient, but must not be used with multiple patients. Do not attempt to clean or re-use the foam eartips.

To avoid cross-contamination between patients, hearing instruments should be cleaned with disinfectant towlettes (e.g., audiowipes) prior to being puttied into a coupler, and the putty should be replaced if it becomes soiled.

Ear Canal Discomfort

An otoscopic examination should always be performed prior to inserting a probe tube into the ear canal to ensure that it is healthy and free of obstructions. Care is needed when inserting probe tubes into the ear canal. Although the probe tubes are made of soft, flexible material specially designed for this application, it is possible to scrape the ear canal or touch the eardrum causing brief discomfort. You should carefully follow the instructions in Positioning the probe tube section of this User's Guide.

Implantable Electronic Device

The tele-test handset comes with a small magnet attached. This included magnet may affect some medical or electronic devices. Keep the magnet more than 5cm (2 in.) from implantable devices and other magnetically sensitive devices.

All pacemakers respond to a magnet by switching to an asynchronous pacing mode at a programmed atrioventricular (AV) delay and a fixed magnet rate depending on the manufacturer, device model, and the status of the battery. The programmed mode DDD switches to DOO, VVI switches to VOO, and AAI switches to AOO. The rate response feature is switched to 'OFF' on magnet application in pacemakers. In biventricular pacemakers, both the right and left ventricles continue to be paced in the above modes with magnet application so long as the device is at or above ERI. However, from below ERI voltage, this response is unpredictable.

In general, magnet application suspends anti-tachycardia therapy without any effect on the pacing mode. Implantable cardioverter defibrillator models from St. Jude Medical and Boston Scientific, however, have additional programmable features to ignore the magnet or respond differently to a magnet. All biventricular ICDs behave like any other ICDs of the corresponding manufacturer. In most cases, anti-tachycardia therapy resumes with removal of the magnet. However, in some instances, magnet removal may or may not re-enable anti-tachycardia therapy. Specific care should be exercised in Guidant/Boston Scientific ICDs since some of the older models are equipped with circuitry that enables the magnet to permanently programme the anti-tachycardia therapy to 'OFF'. In addition, magnet application on Sorin ICDs changes the pacing rate without altering the pacing mode. Rate response of ICDs is not influenced by magnet application.

2 Getting Started

This section provides instructions for unpacking the Verifit and connecting various components and associated items.

Office setups

1. Conventional. In the standard setup the Verifit display unit and test box are placed either side by side or co-linear (test box in front) on the same surface. The distance between them is only limited by the test box cable that connects them. If an external speaker is not being used, the display unit should be positioned so that a client will be less than 100cm (3 ft.) from the speakers above the display (see also, Positioning the client).

2. Wall mounted. The display unit can be mounted on a wall bracket with a standard 100mm x 100mm VESA mount. Use care to route cables appropriately to avoid accidental damage and avoid mounting the Verifit where it will protrude into walkways or other thoroughfares. Screws supplied with the Verifit should be kept installed when not using a wall mount. For wall mounting longer screws will be necessary. Length will depend on thickness of mount. IMPORTANT: Please ensure that any screws used do not exceed a length which would cause them to penetrate the Verifit rear panel to a depth greater than 16mm (5/8").

3. Remote operation. As the Verifit can be run from your PC desktop in On-top mode, more unconventional office setups are possible as the display unit does not necessarily need to be in front of the practicioner (see also, Networking).

Unpacking and connecting

⚠️	**WARNING:** To avoid the risk of electrical shock, use only the power supply and power cord supplied with the Verifit and connect it only to a grounded (protectively earthed) electrical outlet. **WARNING:** To allow electrical power to be rapidly disconnected in the event of an emergency, position the power supply in an accessible location so that the power cord may be quickly disconnected. **WARNING**: To ensure that the operation of this product is not affected by EMC emissions from other products, this product should not be used adjacent to or stacked on other equipment. If this is necessary, its operation should be verified as normal in this configuration. Portable and mobile RF communications equipment can affect the performance of this product.
🛈	Use only an approved test box cable to connect the test box and the display unit. The test box can only be connected to the display unit. The VF2 power supply can only be connected to the mains using the supplied power cord. The probe dock can only be connected to the display unit.
👁	Failure to follow the operating instructions could place the operator at risk.

1. Carefully unpack the two parts of the Verifit and check the contents of the shipping box against the enclosed packing list. Note that some parts may be packed inside the test chamber.

2. Locate the included wireless mouse and turn it on using the switch on the underside. The wireless receiver is already connected to the Verifit.

3. Connect the test box via the test chamber cable to the rear of the main display unit. The cable can be routed under the display unit to the test chamber if the test chamber will be used in front to the display unit. Note: all on-ear functions will operate without the test box connected to the display unit.
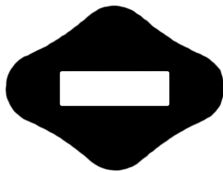
Text box cable provided uses HDMI connector, but is distinguished by a diamond-shaped marker at both ends.
IMPORTANT: Use only Audioscan-supplied cables for this purpose.

4. The Verifit can also be connected to an external monitor. Connect a video monitor (HDMI or DVI with adapter) to the MONITOR connector on the rear connector panel.

5. Open the lid of the test chamber by using your thumb to roll the rubber roller toward the front of the Verifit. This is made easier by placing your fingers under the front lip. When sealing the chamber in its closed

position, place your fingers on top of the lid and use your thumb to roll the rubber roller toward the rear of the Verifit.

6. Connect the Verifit power supply (included) to the power connector on the rear connector panel.

7. Connect the power cord (included) from the Verifit power supply to a GROUNDED electrical outlet. In the USA and Canada, this outlet should be marked Hospital Grade.

Microphone connection

1. Plug the reference microphones and the binaural coupler microphone into the connectors in the test chamber as shown. The binaural coupler microphone is positioned in the test chamber magnetically.

Probe microphones

Probe dock

Probe cables
adjust clip
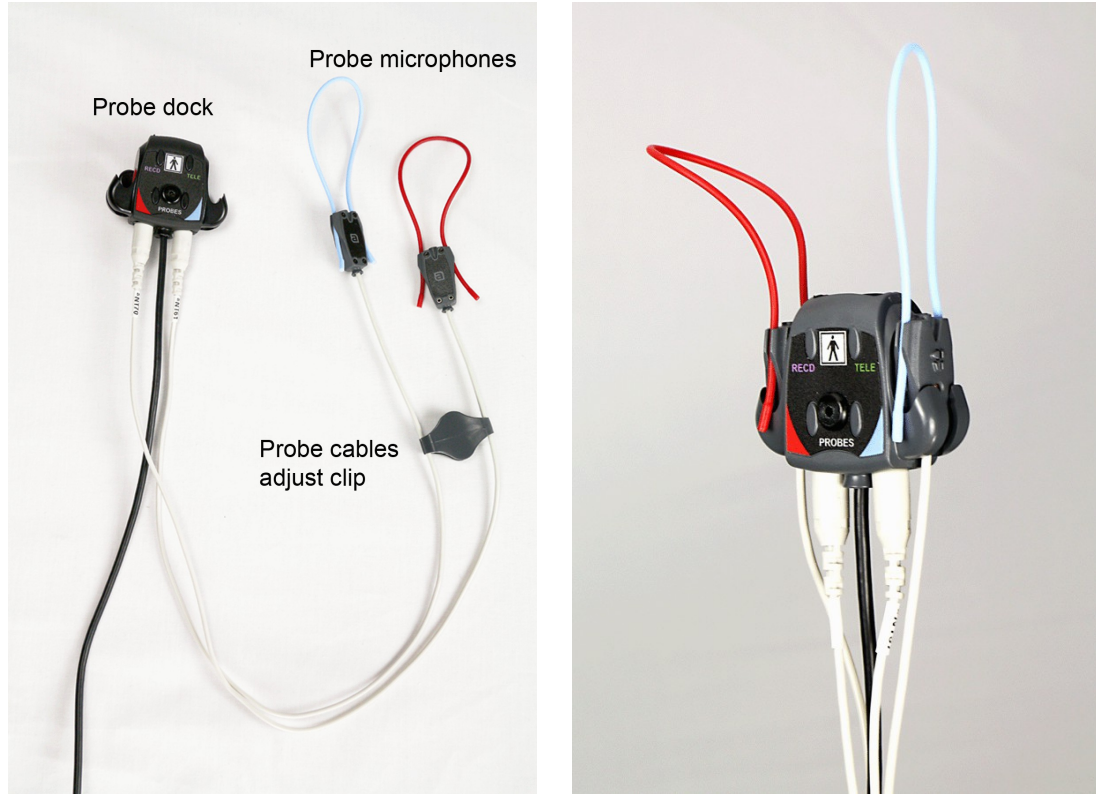
2. Connect the probe microphones to the left (blue) and right (red) connectors on the bottom of the probe dock. The probe microphone modules should be kept in the probe dock when not in use, positioned with the reference microphone ports facing outward.

3. Link the probe microphone cables with the probe cables adjust clip as shown above.

4. Connect the 8 pin mini DIN connector of the probe dock to the rear of the main display unit.

5. The probe dock can be attached to the main display unit via the magnet mount.

NOTE: A coupler microphone extension cable (VA-131) is available from Audioscan. Standard audio extension cables should not be used. They will substantially increase noise levels.

General care instructions

Probe tubes are for single patient use only. They may be wiped with alcohol wipes for re-use with the same patient, but must not be used with multiple patients. Attempts at ultrasonic cleaning usually result in cerumen becoming lodged in the lateral end which causes irreparable damage to the probe microphones.

The case can normally be cleaned/dusted with a damp cloth, however if it is soiled we recommend wiping with a mild solution of water and detergent, or with alcohol-impregnated wipes deemed safe for use on electronic equipment. Parts that come into contact with patients (the probe module body, cable, and red and blue lanyards) should be regularly wiped down with alcohol wipes.

Hearing instruments should be cleaned prior to introduction to the test chamber due to the difficulty of sanitizing the acoustic foam. Custom hearing instruments must be cleaned with disinfectant towlettes (i.e. audiowipes) prior to placing in the test for this reason and to minimize contamination of the blue putty used with the HA-1 (ITE) coupler. The acoustic foam in the floor of the test chamber is easily removed and should be replaced if badly worn or soiled. The black rubber TRIC (Thin-tube & Receiver In Canal) adapters may be cleaned with disinfectant towlettes if they becomes soiled with use.

Audioscan recommends periodic replacement of the blue putty used with the HA-1 coupler to ensure cleanliness. Couplers can be wiped down with alcohol wipes as needed.

Ensure that all safety and usage recommendations on cleaning product packages are followed.

Microphone care

Binaural coupler microphone:

1. **DO NOT** leave the coupler microphone plugged in when transporting.

2. **DO NOT** clean coupler gaskets with alcohol or other substances that will dry out the rubber.

3. **DO** make sure that the couplers are fully connected to the coupler microphone when performing hearing instrument tests. Coupler leakage can cause feedback and erratic response curves.

4. **DO** make sure the tubing on the HA-2 (BTE) coupler is free from any cracks/tears.

5. **DO** make sure that any replacement tubing used on the BTE coupler is either obtained from Audioscan, or is #13 heavy wall earmold tubing exactly 10 mm (.38 inches) in length.

Probe microphone:

Debris can alter the probe module reference microphone calibration and frequency response and can permanently clog the probe module port.

1. **DO NOT** reuse probe tubes. Probe tubes can be wiped with alcohol wipes for re-use with the same patient, but must not be used with multiple patients. Attempts at ultrasonic cleaning usually result in cerumen becoming lodged in the lateral end which causes irreparable damage to the probe microphones.

2. **DO NOT** attempt to open or repair the probe microphone. Attempting to repair the probe module may lead to damage or alteration of the factory calibration.

3. **DO** keep the probe module and probe tubes in a clean area.

4. **DO** stow the probe module when not in use or when transporting the Verifit.

Mouse and keyboard

	Failure to follow operating instructions could place the user or operator at risk.

The Verifit may be operated from a mouse or a standard computer keyboard, which may also be used to enter headers and comments on printouts. A USB mouse or keyboard may be plugged directly into any of the USB ports provided. See Input device operation.

Monitor headphones

	Failure to follow operating instructions could place the user or operator at risk.

You can use the supplied monitor headphones to listen to the signal from the coupler or the probe microphone. This is useful for:

1. Listening to the hearing aid to troubleshoot sound quality complaints

2. Listening to the wearer's own voice to troubleshoot occlusion effect complaints

3. Verifying program settings and their notification beeps

4. Demonstrating hearing aid features to parents, teachers and significant others

5. Making simultaneous comparisons between two hearing instruments

Use the mouse scroll wheel to control the monitor headphone. To adjust the volume, scroll the mouse wheel forward and backward. The normal volume range is indicated in gray. Once this range is exceeded an extended range will be shown in yellow. Use the extended range for low gain hearing instruments. To mute the headphone output, click the mouse wheel. To unmute, click the mouse wheel again.

To connect the monitor headphones, insert the headphone plug into the stereo jack on the lower right-hand side of the display unit.
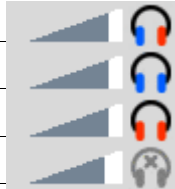
In Dual View of most applications the monitor headphones present the left and right microphone signals to the left and right sides of the headphones. You can optionally focus your listening attention by selecting only the left or right microphone signals. By repeatedly clicking the mouse wheel, you rotate your selection among the binaural, left-only, right-only and muted headphone presentation options.

In Single View or in Dual View when only L or R is selected, the monitor headphones present the same signal to both ears, as indicated by the solid black headphone icon.

The following table outlines the headphone presentation options and the corresponding microphone signals for each ear.

Selection	*Left ear*	*Right ear*	*Presentation*
Monaural	Active mic	Active mic	

Binaural	Left mic	Right mic	
Left-only	Left mic	Left mic	
Right-only	Right mic	Right mic	
Mute	Off	Off	

External peripherals

⚠	**WARNING**: To avoid the risk of electrical shock, any line-powered peripheral equipment connected to this product must comply with UL/IEC 60601-1 OR comply with UL or IEC and ISO safety standards for such equipment AND a) be operated from an isolating transformer complying with UL/IEC 6061-1 OR b) be kept at least 6 feet (1.8 m) from the patient.

An external video monitor (HDMI or DVI with adapter) may be connected to the HDMI connector on the rear of the main display unit. The internal display and external monitor will operate simultaneously. The external monitor must be capable of displaying 1024 x 768 at a refresh rate of 60Hz. Ensure that the external display is powered up and set to the correct input prior to powering on the Product.

An external printer may be connected to one of the USB ports. See Printing and Storing Results for guidance in selecting a printer model.

Connectors for external front and back sound field speakers are provided. The VA-112 external speaker with a multipurpose folding stand is available from Audioscan but any small, **non-powered** 4 - 8 ohm speaker having a smooth frequency response and good efficiency may be used. The rear external speaker is automatically selected when required by a test but the front speaker must first be selected in Setup. See External sound field speaker setup
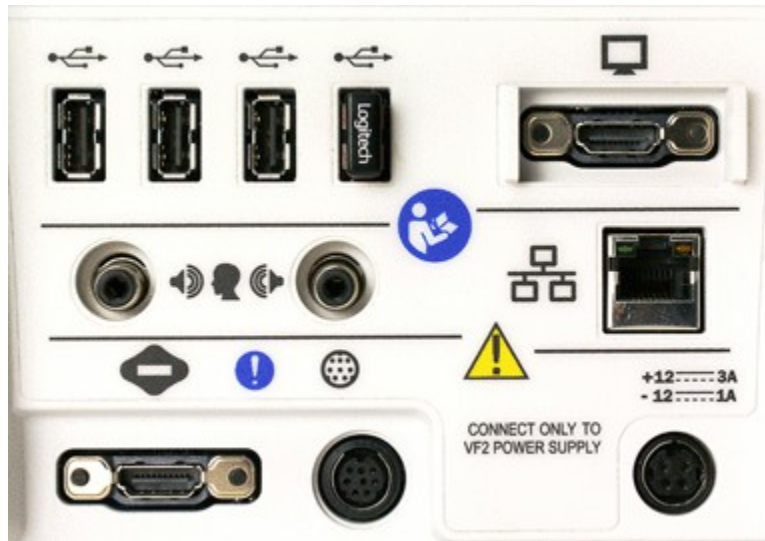
Display unit rear connector panel

3 General Operation

This section describes the use of a mouse or connected USB keyboard to control the Verifit and to enter data. It also provides instructions for updating the Verifit operating software.

Switching ON/OFF

See Getting Started for instructions on connecting the Verifit to its external power supply module, the module to an electrical outlet and the location of the standby switch.

To start the Verifit, set the standby switch ⏻ to its "ON" position. The Audioscan logo on the front of the display unit will light and the instrument will begin its start-up sequence which will take a few seconds.

To shut down the Verifit, switch the standby switch ⏻ to its "OFF" position.

Note that the Verifit receives low voltage electrical power from the external power supply module. The standby switch ⏻ on the rear of the Verifit disconnects this electrical supply but the power supply module is always on as long as it is connected to a live electrical outlet. The green light on the power supply module indicates that it is receiving electrical power from the outlet.

Input device operation

The Verifit is operated with a USB mouse (included) or a keyboard (not included) to select icons and menu items, operate on-screen buttons and to enter audiometric data. Upon starting the Verifit presents the home menu for accessing all tests and major functions. To see the home menu at any time, right click the mouse.
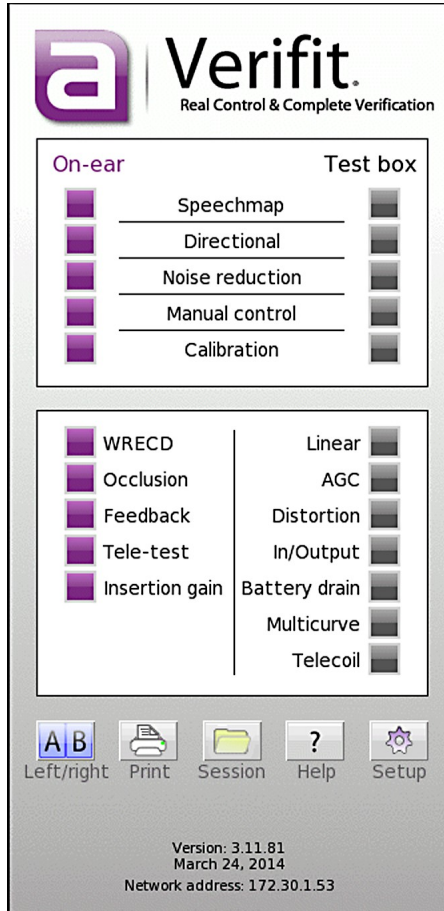
To activate an on-screen icon or button, or to select an item from a menu, use the mouse to place the screen pointer over the icon, button or menu item and left click. To enter a data point on a chart, such as an audiogram, place the screen pointer over the desired point on the chart and left click. To move the data point, place the screen pointer near the new location and left click. To delete a data point, place the screen pointer on the data point and left click. To summon a cursor on a graph, place the screen pointer on the graph and left click, then navigate to the point you want to identify; left click again to hide the cursor. The scroll wheel may be used to traverse the Help contents, multiple Help pages or long menu lists. *Note that mouse speed can be changed by clicking* [⚙] *and* [Display].

The functions of the screen icons and connected keyboard keys are explained in the following table:

Screen icon	Function	Keyboard
✓	Continue. Proceed from current state	↵
✗	Cancel. Revert to previous state	[Esc]
	Show menu of all available tests and functions (mouse right click)	[F3]
L R A B	Switch between Left/Right on-ear data or switch between A/B test box data	[F5]
?	Show on-line help	[F1]
⚙	Show the setup menu	[F2]
🖨	Print screen to an external printer or a file	[Print Screen]
📁	Show menu for erasing data or exchanging data with network files or USB memory	[F4]
	Position the screen pointer over the icon, button or menu item	[Arrow keys]
	Activate a screen icon or button, or select an item from a menu (mouse left click)	[Enter] on numeric keypad
	Accept text or numbers typed into any text entry field.	[Enter] on numeric keypad
⌨	Text entry widgets allow the use of a virtual keyboard for entering via mouse only. Widgets with this button allow a virtual keyboard to be used. Press to show virtual keyboard.	Not available
⌨	Press to remove the virtual keyboard and close the text widget, saving what has been entered.	Not avaiable

Network connection

	Failure to follow operating instructions could place the user or operator at risk.

The Verifit includes two options for connecting to a computer network, either through the built-in wireless networking feature, or through an external wired connection. The built-in wireless networking feature requires no additional attachments to the Verifit. The external wired connection requires inserting a standard network cable into the network connection on the rear of the display unit, as illustrated in the figure below. You can choose between either the wireless or wired network connection through the software user interface, as described in the section Networking.
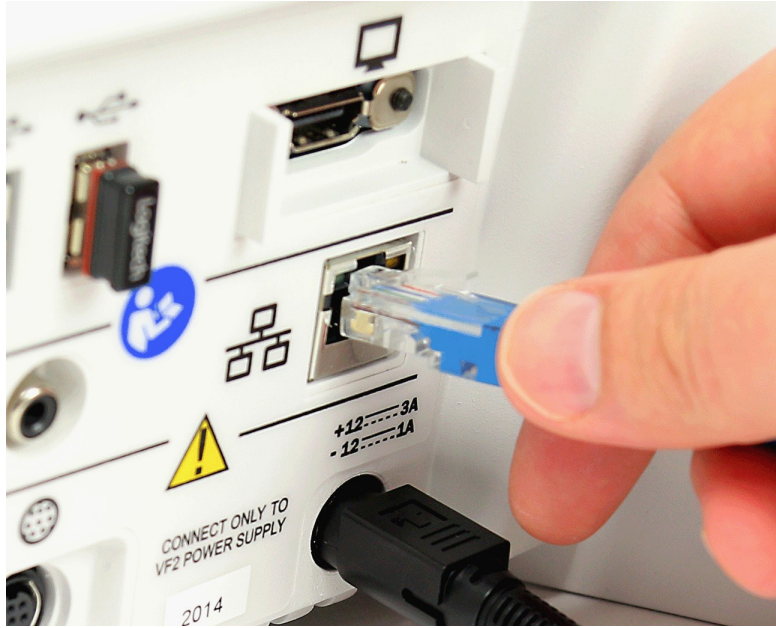
Inserting the cable for a wired network connection

Printer connection

	Failure to follow operating instructions could place the user or operator at risk.

The Verifit can use printers connected locally through USB, or remotely through a computer network. Connecting a local printer requires inserting the printer's USB cable into any of the five USB connections available on the side or rear of the display unit, as illustrated in the figure below. You can choose among the local and network-connected printers through the software user interface, as describe in the section Printing and Storing Results.

Inserting the USB cable for a locally-connected printer

Menus, lists and buttons

Buttons containing descriptive text perform an action like opening a prompt. A screen button with a down arrow indicates that it will summon a drop-down list of options, the current selection being shown in the window to its left. A plain button toggles between two choices; the current choice is shown in the window to its left. A sunken text field with a gray background show the state of something that can be changed elsewhere.

Positioning the mouse cursor over a menu button changes it from gray to white; positioning it over a window with a screen button changes the button from dark gray to light gray. Left clicking the mouse operates the selected button. A menu button or the window containing a screen button, selected using the arrow keys on a connected keyboard is surrounded by a heavy line and is operated by pressing the Enter key on the *numeric keypad* on the connected keyboard. This process also selects the highlighted item in a drop-down option list.

Screen messages and Help

The Title bar (top line of the display screen) informs you of the selected Test (e.g., Speechmap).

The Message bar (bottom line of the display screen) suggests the next step in a test or informs you of the state of the instrument or conditions that could affect your data. For example, it will inform you if the microphones need to be calibrated.

Context-sensitive help is available by clicking on ⸨ ? ⸩ on the Home prompt or pressing F1 on a connected keyboard. The Help index (left panel) or Help page (right panel) may be selected by left clicking the mouse on either panel or by pressing the F5 key on a connected keyboard. The side scroll bars on each panel may be used to scroll through the Help index or long Help pages. This may also be accomplished using scroll wheel on the mouse or the arrows on a connected keyboard.

Software updating

The Verifit software is available on the Audioscan website, www.audioscan.com. After it is downloaded to your computer, it can be installed to your Verifit using a USB memory stick.

To update the Verifit:

1.Using your computer, open a browser like Internet Explorer, Firefox, or Chrome and navigate to www.audioscan.com .

2.Click on [Software Updates] and fill in the requested information.

3.Double-click the downloaded software.

4.Save the *audioscan* folder to an appropriate location on your computer, like the desktop.

5.Connect the provided Audioscan update USB stick (or any empty USB stick) to your computer.

6.Double click the audioscan folder, then double click audioscan_update.

7.Click on [Transfer software to USB Stick].

8.When the Software is successfully transferred to the USB Stick, remove the USB stick from your computer and connect it to any USB port on the Verifit.

9.Turn on the Verifit and follow on-screen directions.

4 General Setup

This section covers Date and Time setup, Display settings (including mouse pointer speed setting) and Saving test setup.

Date and time setup

To set the date and time that appears on printouts and calibration screens:

1. Press ⚙ , then highlight and select [Date & Time] on the Setup poster.

2. To change the date, click on the month window to display a drop-down list of months.

3. Select the desired month on the list.

4. Repeat the previous step to change the date, year and time in the appropriate windows.

5. When the new date and time information has been set, press ✓ to exit.

Display settings

To change the screen saver timing or mouse pointer speed:

1. Press ⚙ , then select [Display].

2. To change the idle time before the screen saver blanks the screen to prolong display life, click the Screen saver window.

3. Select the desired screen saver timing from the drop-down list.

4. In this screen you can also select the Mouse pointer speed button and select the response speed from the drop-down list.

5. Left and right ear presentation in dual view may be selected with the toggle marked "Set dual view to:". The product will require restarting to complete this change.

6. Press ✓ to exit setup.

Saving test setup

This feature lets you retain the last-used stimulus type and level for most tests when the power is turned off and the last-used target method and transducer type in Speechmap and Insertion Gain tests. This feature also lets you determine how assessment parameters, test levels and stimuli are treated when 📁 , [Erase data] is selected.

To enable/disable saving of test levels, stimuli and assessment parameters:

1. Press ⚙ , then click on [Save option]

2. Click [Save test setups on power off] to toggle between Yes and No.

To enable/disable erasing of test levels, stimuli and assessment parameters when Erase data is selected:

1. Press ⚙ , then click on [Save option]

2. Click [Save test setups on erase data] to toggle between Yes and No.

To set current test levels, stimuli and assessment parameters as Power-on defaults:

1. Press ⚙ , then click on [Save option]

2. Click [Set POD].

5 On-Ear Measures - Setup

For accurate, repeatable measurements, the Verifit must be properly set up and calibrated, the client must be properly positioned and the probe tube must be properly positioned in the ear canal. Some common terms:

Real-Ear Unaided Response (*REUR*): SPL, or band SPL, in the open (unaided) ear canal for a given stimulus.

Real-Ear Unaided Gain (*REUG*): Difference, in dB, between the REUR and the stimulus SPL, or stimulus band SPL.

Real-Ear Aided Response (*REAR*): SPL, or band SPL, in the ear canal for a given stimulus, with a working hearing aid in place.

Real-Ear Aided Gain (*REAG*): Difference, in dB, between the REAR and the stimulus SPL, or stimulus band SPL.

Real-Ear Saturation Response (*RESR*): The REAR obtained using a narrow-band signal at a level high enough to saturate the hearing aid (usually 85 - 90 dB SPL).

Real-Ear-to-Coupler Difference (*RECD*): Difference, in dB, between the SPL produced in the ear canal and the SPL produced in a coupler by the same sound source.

Audioscan Wideband Coupler (AWC): A cylindrical coupler having a volume of 0.4 cc.

Thin-tube and Receiver In Canal (TRIC) adapter: Silicone attachment to the AWC which accepts the nozzle of a thin-tube or RIC type hearing aid. It will also accept the nozzle of the RECD transducer, an ER-3A insert earphone and #13 standard earmold tubing.

Wideband Real-Ear-to-Coupler Difference (W*RECD*): The difference in SPL produced in an occluded ear canal and in the 0.4cc coupler by a high impedance coupled sound source.

External sound field speaker setup

In some installations, the internal sound field speakers may not be convenient or may yield speaker overdriven errors because of severe standing waves from nearby walls or shelves. In these cases, an external speaker having a smooth response from 200 - 16000 Hz and an impedance of 4 ohms or greater may be connected to the Front on-ear measure speaker connector on the rear connector panel. The VA-112 speaker is available for this purpose.

The speaker should be mounted at ear height, well away from reflective surfaces. See Positioning the client.

To select this speaker:

1. Right-click to raise the home menu, then left-click [Speakers].

2. Toggle the Sound field speaker button between [Internal] and [External].

3. Click ✓ to exit Setup

For on-ear directional tests, connect an external speaker (see requirements above) to the back on-ear speaker connector on the rear connector panel. Position the back speaker directly behind and facing the back of the client's head so that front and rear speakers are at the same height and are at the same distance from the center of

the client's head. This speaker will be automatically used for the on-ear directional test.

On-ear calibration facts

The probe microphone and its associated tubing does not have a flat frequency response. The on-ear calibration process compares this response with the flat, factory-calibrated response of the on-ear reference microphone and compensates all subsequent probe-tube measurements for this difference. It may be performed as often as desired but will be invalidated at 12 am the following day or at 12 am the following week, depending on the choice of daily or weekly calibration interval. After the calibration has expired, you will be prompted to calibrate whenever you attempt a test that uses the on-ear measurement microphones.

It is suggested that a copy of the calibration curves for the probe modules when new be posted near the Verifit for comparison with daily or weekly curves. If there is a drift in calibration with time, the module may need replacement. See Calibration check for probe module.

Calibration should be repeated if a probe module is replaced or if a probe-tube with different dimensions is installed.

Switching left and right probe modules after calibration will result in the wrong calibration curve being applied.

Calibration of on-ear probe microphone

For convenience, the probe microphones can be calibrated while seated in the probe dock. Ensure the connectors of both probe microphone assemblies are plugged into the appropriate jack on the bottom of the probe dock. See Microphone connection and On-ear calibration facts

1. Right-click to raise the home menu and click on [Calibration] under [On-ear measures].

2. Press the enlarged end of a probe tube as far as it will go, into the recessed opening at the top of the probe module.

3. Position the open end of the probe tube in front of the reference microphone inlet and press it between the posts as shown.

4. Hold the probe dock 15 - 90 cm (6 – 36 in.) away from and directly in front of the sound field loudspeaker with the microphone to be calibrated facing the speaker.

5. Left-click calibrate. The resulting curve should be similar in shape to that shown but may be shifted +/- 5 dB.

6. To change the calibration interval, toggle [Daily] or [Weekly].

7. To change the Weekly calibration day, right-click to raise the home menu, left-click [Setup], then left-click [Date & Time].

Click on calibrate for the other ear and repeat the process for the other probe module.
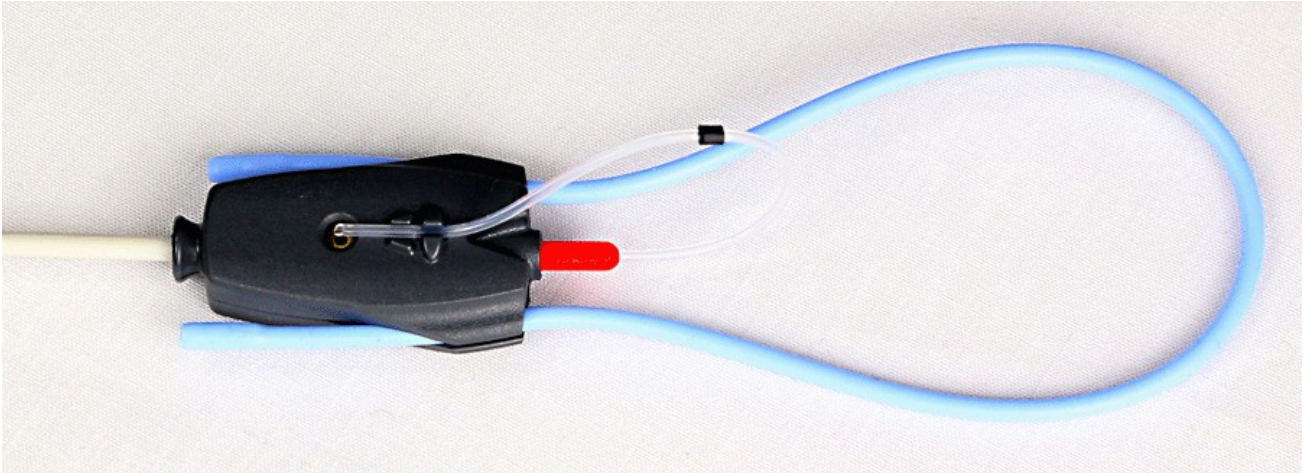
Position the probe tip over the reference microphone
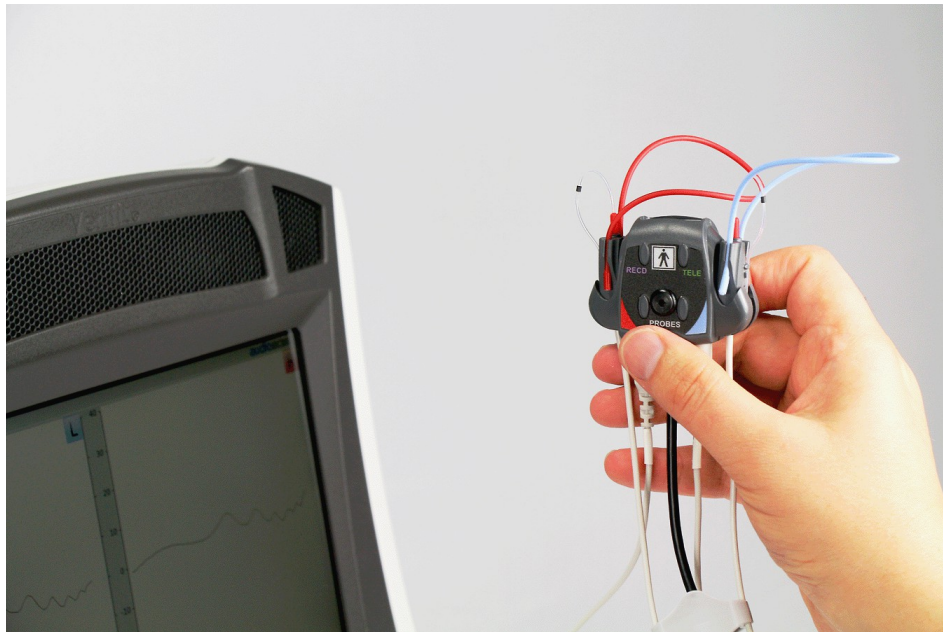
Hold probe dock with microphone to be calibrated facing speaker.
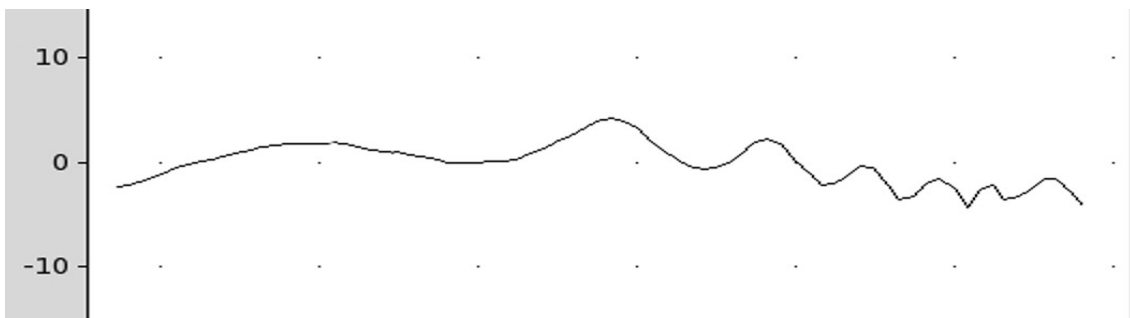
Typical calibration curve. Level may be shifted +/- 5dB.

Calibration check for probe module

The calibration curve for the probe module is a comparison of the response of the probe microphone (with tube) to the response of the on-ear reference microphone. Any change in the curve indicates a change in one of these microphones (or the probe tube). See Calibration of on-ear probe microphone. As part of a regular calibration schedule, or to investigate changing calibration curves, the on-ear reference microphone may be checked against a high quality sound level meter.

1. Right-click to raise the home menu and click [Manual control] under On-ear.

2. Click [Level], then select 70 from the drop-down list.

3. Click [Frequency], then select 2000 Hz from the drop-down list.

4. Click [Start test] (which changes to [Stop test]).

5. Hold the probe module about 45cm (18 in.) in front of the sound field speaker.

6. Hold the microphone of a calibrated sound level meter next to the on-ear reference microphone as shown. Set the sound level meter to C weighting and slow.

7. The sound level meter should read 70 ±2 dB.

8. Repeat with the frequency at 250 Hz.

9. To stop the measurement, left-click [Stop test].
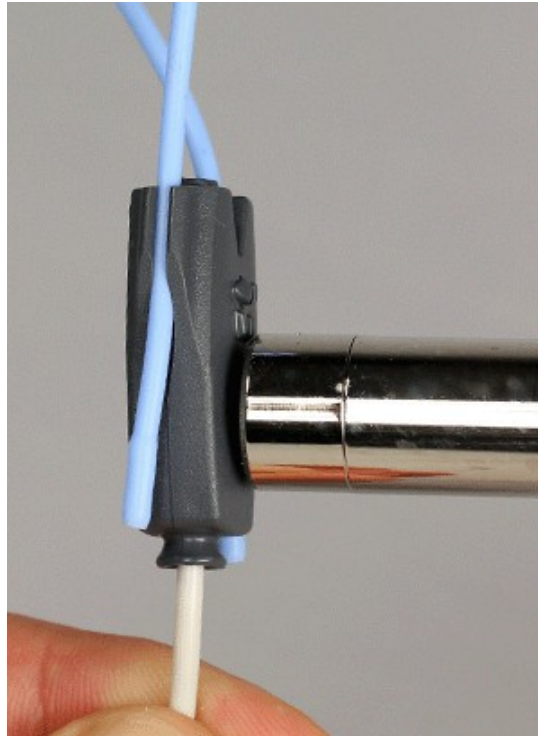
The probe module should be replaced if it fails this test.

Max TM SPL setup

The Max TM SPL safety feature allows you to set a limit on the SPL, measured by the probe microphone, above which a test terminates. The MAX TM SPL limit is shown on all on-ear measurement screens. The default limit is 120 dB.

To choose a different Max TM SPL setting:

1. Right-click the mouse to raise the home menu, then left-click ⚙ , then left-click [Max TM SPL].

2. Click on the current Max TM SPL setting and select the desired Max TM SPL setting from the drop-down list.

3. Click ✓ to exit Setup.

This Max TM SPL setting will be in effect until you change it.

If the limit is exceeded during an on-ear test, the Verifit will terminate the test and display the message '*Max TM SPL Exceeded'*. You must then decide to either reduce the maximum output limit of the hearing instrument or increase the Max TM SPL setting following the steps above.

If the Max TM SPL limit has been disabled, a notice will appear on each real-ear screen. Also, a message reminding you that the Max TM SPL limit has been disabled will appear when you select an on-ear test.

ABR nHL to eHL setup

Estimated Hearing Level (eHL): An estimate of the behavioral pure tone threshold that accounts for a measured ABR threshold.

Normalized Hearing Level (nHL): (a) Stimulus peak-to-peak equivalent SPL (pe SPL) at ABR threshold relative to the average stimulus pe SPL at ABR threshold of a normal-hearing jury OR (b) stimulus SPL at ABR threshold relative to the average stimulus SPL at behavioral threshold of a normal-hearing jury for the same stimulus. (Note that in this latter case, nHL is equivalent to eHL).

In Speechmap/DSL you have the option of entering ABR thresholds in either eHL or nHL. If eHL is selected, the threshold is treated as if it were a behavioral pure-tone threshold. If nHL is selected, the entered data will first be converted to eHL before SPL threshold and fitting targets are calculated. To do this, appropriate eHL to nHL conversion factors must be applied. You can choose to apply default conversion factors or enter new ones for each client.

This setup allows you to select the *default* conversion factors that are applied in Speechmap/DSL to convert ABR nHL threshold to eHL threshold.

1. Right-click the mouse to raise the home menu, then left-click ⚙ , then left-click [ABR eHL to nHL].

2. Left-click [DSL defined] or [User defined]

3. For [User defined], enter conversion factors using a mouse or a keyboard. See Assessment data entry.

Positioning the client

Sound reflections from nearby surfaces (including the operator) can cause large measurement errors, especially if the client moves between REUR and REAR measurements. Room noise can increase test time, cause errors and alter the operation of the hearing instrument being evaluated.

1. Choose a quiet location and position the client and the sound field speaker at least 1.5 m (5 feet) away from

any hard surfaces.

2. Position the client directly in front of, and facing, the sound field speaker at a distance of 45 to 60 cm (18 to 24 in.) from the center of the head. For success in simultaneous binaural on-ear measurements minimizing this distance is helpful.

3. Position the back speaker (if used) directly behind and facing the back of the client's head so that front and rear speakers are at the same height and are at the same distance from the center of the client's head.

Positioning the probe tube

⚠	**WARNING:** Probe tubes are for single-patient use only. Care is required when sliding the probe tube into the ear canal. Be careful not to advance the probe tube further into the ear canal when inserting an earmold or custom hearing instrument into the ear or when inserting the foam tip into the ear

1. Use an otoscope to ensure there is no ear canal obstruction (e.g. cerumen) and to get a sense of ear canal length.

2. Install a new probe tube on the probe module. Set the black marker ring approximately 28 mm from end of probe tube for adult females, approximately 30 mm from end of probe tube for adult males and approximately 20-25 mm from end of probe tube for children. These positions may be modified based on the otoscopic examination.

3. Clip the probe dock to the client's clothing, near the middle or to one side. If more convenient, it can alternatively be clipped to the chair back or to a lanyard. It needs to be positioned so that the probe microphone(s) will easily reach the subject's ear(s).

4. Hang the probe microphone on the ear, as shown below. *The reference microphone should face outwards.*

5. Adjust the blue or red lanyard until the probe microphone module is snug against the head, directly below the earlobe (cheek level). Use the probe cables adjust clip to take up slack in the cables where necessary to ensure correct positioning. It is not necessary to move the adjust clip up to the patient's chin level; raise it only as far as required to cause the probe modules to lay flat against the cheek.

6. Pull the front lanyard so that it passes behind the ear canal entrance and pass the end of the probe tube in front of the lanyard and into the ear canal.

7. Carefully slide the probe tube into the ear canal until the marker ring approaches the intertragal notch. Then let the front lanyard move forward to hold the probe tube in place. Use an otoscope to verify that the tube is 2 to 5 mm from the eardrum.
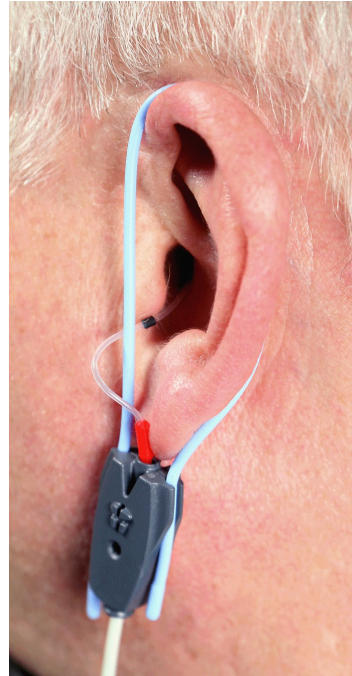
Probe dock positioned, clipped to client clothing, adjust clip holding probe microphone modules in place.
Probe tube insertion: the colored lanyard holds the tube in place and the depth marker is at the intertragal notch

6 On-Ear Measures Screen Setup

To accommodate your working preferences, the appearance of On-ear measurement screens may be changed in several ways.

On-ear single or dual view

Most on-ear screens give you the option of selecting either a single, full-screen view or a dual, side by side view. Some data may be dropped from the dual view.

To change the presentation, left click [Single view] or [Dual view].

To switch between left and right test panel in single view, right-click the mouse to raise the home menu and click the L|R button.

To switch between left and right test panel in dual view, left-click the mouse on a screen button in the inactive test panel or right-click the mouse to raise the home prompt and click the L|R button.

Graph, table or 2cc target format

Most on-ear test screens may be viewed in graphic or tabular format.

- In Speechmap, WRECD and Directional tests, left-click [Format] to toggle between [Graph] and [Table] views.
- In Insertion gain, left-click [Format], then select [Graph], [Table] or [2cc targets] from the drop-down list.
- In [2cc targets] format, reserve gain and fitting formula may be changed. Choose and change reserve gain or fitting formula from the drop-down list with a mouse left-click.

SPL or HL scale

In Insertion gain tests you may view results in either dB HL or dB SPL.

Insertion gain tests view the hearing aid as improving the sound field threshold. In Insertion gain, the HL scale presents aided results as improved sound field thresholds while the speech region remains fixed.

To change the scale in Insertion Gain:

Left-click [Scale] to toggle between a dB SPL and dB HL scale.

Speechmap tests view the hearing aid as increasing the ear canal SPL. Speech gets louder but the threshold remains fixed. All instructions given in this guide assume the SPL Speechmap scale.

Hide or show on-ear curves

To hide or show unaided and aided curves on the Speechmap screen:

1. Click on the Hide/Show buttons located beside the Play button and Test identifier numbers. Note that the Hide/Show aided button has 3 states – Curves hidden, display LTASS only and display LTASS + speech envelope (i.e. the 'speech banana').

Curves hidden   LTASS only   LTASS + speech envelope

Hiding a curve does not erase it. To erase curves click on ⌷ and select one of the Erase options.

To hide or show test curve(s) in all other applications:
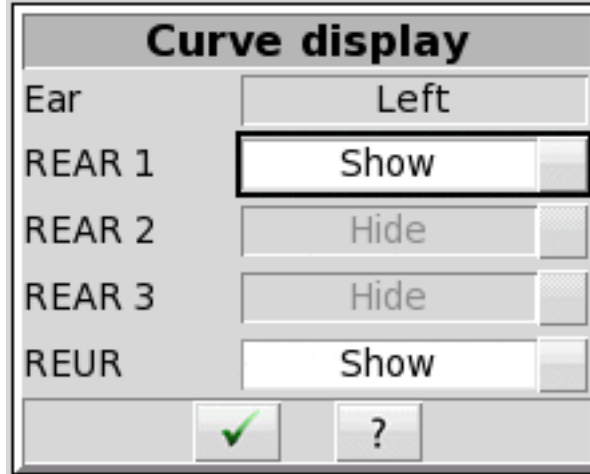
1. Left-click [Hide/Show].

2. Click on the desired test result to toggle between the Hide or Show options. The curves will toggle on or off when selected.

3. Click ✓ within the Curve Display poster to return to the test screen.

Hiding a curve does not erase it. To erase curves click on ⌷ and select one of the Erase options.

7 Speechmap

Speechmap presents hearing threshold, UCL and amplified speech spectra as SPL in the ear canal. The fitting goal is to make amplified speech audible and comfortable while avoiding discomfort for loud sounds.

Speechmap may be accessed by right clicking and selecting Speechmap under Test box or On-ear. See <u>On-ear or Test box mode</u> for details.

Speechmap is only used in SPL and this guide describes only this usage.

Speechmap facts

Speechmap is a trademarked hearing instrument fitting environment introduced by Audioscan in 1992. It presents hearing threshold, UCL and amplified speech spectra as SPL in the ear canal. The fitting goal is to make amplified speech audible and comfortable while avoiding discomfort for loud sounds. Originally speech was simulated using amplitude-modulated tonal signals. The Verifit replaces these simulated speech signals with real speech, both recorded and live. For details of the test signals and analysis methods, see <u>Speechmap Technical Details</u>.

Speechmap departs from insertion gain target methods in presenting amplification goals in the context of the residual auditory area, not as an isolated target line, and in the use of real speech, not tones or broad-band noise. This is extremely important for non-linear hearing aids, analog or digital, because their processing is signal-dependent. It also makes provision to correct audiometric data and coupler measurements for age-related or individually-measured acoustic differences between real ears and the couplers used for calibration and testing.

DSL 5 in Speechmap

DSL®*m*[i/0]   Copyright DSL ® 2004. Version 5.0

The *Desired Sensation Level (DSL)* method is a systematic eardrum sound pressure level (SPLogram) approach to hearing instrument fitting that seeks to ensure amplified speech will be audible and comfortable while loud sounds will not be uncomfortable. It takes into account individual acoustic factors in audiometric and electroacoustic data. DSL was developed by the National Centre for Audiology (NCA), London, Ontario. Audioscan has implemented DSL within its Speechmap fitting system since 1994.

In 2005, DSL underwent an extensive revision resulting in DSL 5.0. It was further revised in 2007 to version 5.0a and in 2014 to 5.2. See DSL 5.0 changes for details of the changes.

The Audioscan version of DSL 5.0 may differ from others in the following ways:

1. DSL 5.0 uses RECD values for ages > 119 months from a different source than for ages up to and including 119 months; Audioscan has used the RECD values for a 119 month old for ages > 119 months so all values come from the same study.

2. Input-output curve targets and compression threshold targets are not provided. Such steady-state parameters are of little value in estimating amplified speech levels. Matching amplified speech to the LTASS targets at levels from 50 to 80 dB SPL provides much better assurance that fitting goals are being met.

3. There is no provision to input the number of compression channels. This may be useful when the signal used for verification is not the signal for which the targets were developed. It is irrelevant when using real-speech signals to match speech targets and when using narrow-band signals to match narrow-band maximum output targets.

4. The term Uncomfortable Level (UCL) is used rather than Upper Limit of Comfort (ULC) in referring to the

ear canal SPL that should never be exceeded.

5. Broadband output limiting targets are not provided.

NAL-NL1 in Speechmap

The *NAL-NL1* procedure seeks to amplify speech such that all bands of speech are perceived with equal loudness while maximizing speech intelligibility and ensuring that the wearer perceives speech to be no louder than that which a normal hearing person would perceive. Although NAL-NL1 states its goals for speech, it derives insertion gain targets assuming noise as a verification signal. Because it is more accurate to verify a non-linear fitting using the signal for which the procedure was developed, Audioscan converts the NAL-NL1 insertion gain targets to LTASS targets for amplified speech in the Speechmap environment, resulting in *Speechmap/NAL-NL1*. The conversions use the same adult average RECD and REUG as used in DSL. The RESR targets are from Hearing Aids (Dillon, Thieme Publishing, 2001, p274).

An insertion gain version is available by selecting [Insertion gain] from the on-ear measures test menu. The pink noise stimulus should be used.

NAL-NL2 in Speechmap

Fitting targets, default age-related RECD and REUG are provided by a software library used under license from Hearworks Pty Ltd. which is solely responsible for their derivation.

This revision of NAL-NL1 has many more input parameters and output target formats than its predecessor. In implementing NAL-NL2, Audioscan has made the following simplifications and clarifications:

1. NAL-NL2 targets are provided as REAR targets in Speechmap. Insertion Gain targets are not provided.

2. There is no provision to select Insert earphones + earmold as the audiometric transducer since this invalidates the audiometer calibration and correction for this error is problematic.

3. Input-output curve targets and compression threshold targets are not provided. Such steady-state parameters are of little value in estimating amplified speech levels. Matching amplified speech to the LTASS targets at levels from 50 to 80 dB SPL provides much better assurance that fitting goals are being met.

4. There is no requirement to input client gender. The impact of gender on REAR targets is less than +/- 1dB.

5. There is no requirement to input hearing aid experience. An "Experienced" user is assumed.

6. There is no requirement to input the number of compression channels. This may be useful when the signal used for verification is not the signal for which the targets were developed. It is irrelevant when using real-speech signals to match speech targets and when using narrow-band signals to match narrow-band maximum output targets.

7. There is no requirement to input compression speed. It has no impact on REAR targets.

8. There is no requirement to input earmold tubing type. It has no impact on REAR targets.

9. There is no requirement to input vent size or fitting depth. They have no impact on REAR targets.

10. For sound field threshold the speaker is assumed to be at 45 degrees. For on-ear measurements, the speaker is assumed to be at 0 degrees and the reference microphone is assumed to be on the head surface.

11. The SII calculation is per ANSI S3.5-1997 and is the same for all fitting fitting methods.

Camfit in Speechmap

Camfit is an approach to fitting hearing aids developed by Brian Moore at the University of Cambridge, UK. It

specifies the level-dependent gain required to correct abnormal loudness as modeled by his cochlear hearing loss simulation. It provides two approaches to correcting for the hearing loss:

Camfit restoration aims to amplify sounds that are soft, comfortable and loud for a person with normal hearing so that they are soft, comfortable and loud for a hearing aid wearer. This is the stated goal of the IHAFF (International Hearing Aid Fitting Forum) fitting method.

Camfit equalisation aims to amplify speech to produce the same loudness in each critical band. It has been argued that this is likely to give the highest intelligibility for a given overall loudness. This is the rationale behind the NAL fitting methods and will generally produce similar targets.

Using Speechmap

The Speechmap fitting environment provides a number of distinctly different stimuli. Speech and noise are analyzed in 1/3 octave bands and for most speech stimuli data are presented as 3 curves. The top curve is the level exceeded 1% of the time (speech peaks), the lower curve is the level exceeded 70% of the time (speech valleys) and the middle curve is the average. Clicking ▶ causes the signal to be presented continuously - the speech signals run in a loop - and the curves are updated frequently to show any changes you make to the hearing instrument. Clicking on ● restarts the speech passage and the curves are then calculated for the entire passage, producing an accurate display of the speech region and LTASS, and an accurate SII calculation. When using live speech, a pause button [II] captures short-term speech features. See SII calculation in Speechmap and Speechmap Technical Details.

Before starting, please see On-Ear Measures - Setup, Speechmap Setup, Speechmap facts, On-ear or Test box mode.
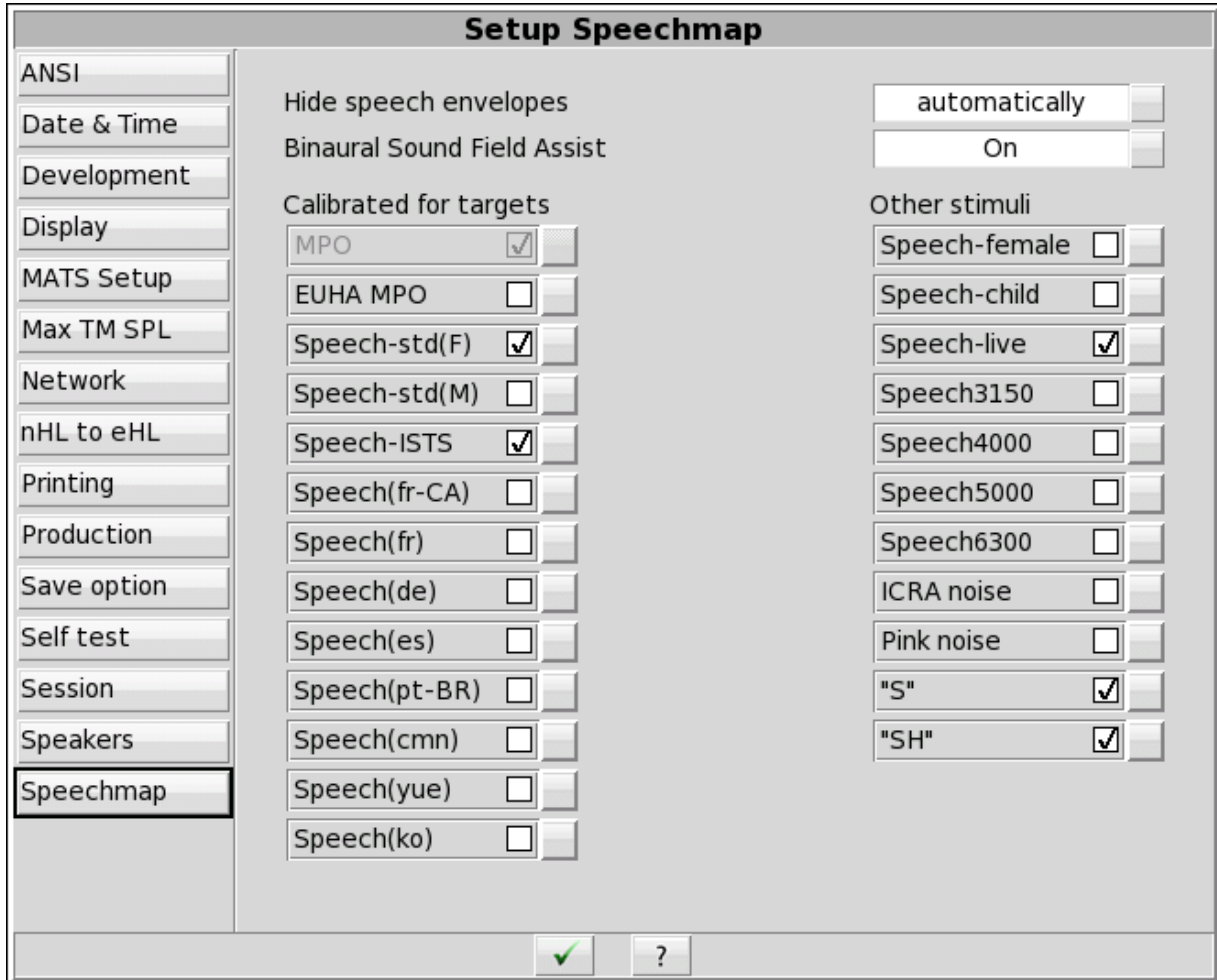
1. **To access Speechmap:** right click and then select Speechmap under On-ear or Test box.

2. **To change screen setup:** see On-Ear Measures Screen Setup, and On-ear or Test box mode.

3. **To set up hearing instrument type:** click on the first ▼ in the Audiometry section. For on-ear mode choices include: RITE (receiver in the ear), BTE, ITE, ITC, CIC, CIC-shallow, Body, or FM. For test box mode select from: RITE (receiver in the ear), BTE + mold, BTE + HA-4, ITE, ITC, CIC, CIC-shallow, Body, or FM. In test box mode this determines the RECD applied to the coupler microphone and the MLE (microphone location effects) applied to the speaker signal.

4. **To set up vent type:** click on the second ▼ in the Audiometry section. For On-ear mode and RITE, BTE, or ITE instruments, choices include Occluding or Open. For all other instruments venting is not applicable. Selection of Open vent will prompt for an additional equalization step. For Test box mode, vent will be set to Occluding.

5. **To enter audiometric data:** see Assessment data entry.

6. To start a test: click on ▶ in any of the test areas

7. To select stimulus type: click the down arrow beside the stimulus window and select from the list. See Setup Speechmap to customize the list.

8. To select stimulus level: click the down arrow beside the stimulus window and select from the list.

9. To complete a measurement and store the result: click on ● while the stimulus is running.

10. To stop a test without recording any test data: click on ■

11. To capture the current screen curves when using live speech: click on the pause button [II].

See, Screen tour and Speechmap Fitting Procedures.

Speechmap Setup

Speechmap provides a number of different test stimuli for fitting hearing aids and testing various aspects of their performance. Each time you run a test, you have the opportunity to select the stimulus from a list. You can manage which stimuli appear on this list by doing the following:

Right click and select ⚙ , then click [Speechmap].

The available Speechmap stimuli are in two columns. The left-hand column contains the MPO stimulus and speech stimuli that have the specific Long-Term Average Speech Spectrum (LTASS) required when matching prescription fitting targets such as DSL, NAL-NL1 or NAL-NL2. The MPO stimulus (used to verify that the maximum output SPL of the hearing aid does not exceed the uncomfortable level) is always selected. You must select at least one of the defined LTASS speech stimuli. An alternative MPO stimulus (EUHA MPO) is available.

The left-hand column includes several foreign language calibrated speech passages. These are labeled using ISO 639 codes. For reference these are: fr-CA – Canadian French, fr – French, de – German, es – Spanish, pt-BR – Brazilian Portuguese, cmn – Chinese Mandarin, yue – Chinese Cantonese, and ko – Korean.

1. To select a stimulus, click the box beside the stimulus you want to add to the list. A check mark will be placed next to the selected stimulus.

2. To remove a checked stimulus from the list, click the box beside the stimulus you want to remove.

You can also choose to have the envelopes of the speech test results automatically hidden (leaving only the LTASS) when you start another test. Click the Hide speech envelopes button to toggle between automatically and manually.

Binaural Sound Field Assist provides a guide for positioning the patient for binaural tests in Speechmap. The guide will only be shown when the binaural sound field error is greater than +/- 3 dB. Note: Binaural Sound Field Assist functions best when head to speaker distance is less than 60cm (24 in.). When Binaural Sound Field Assist is disabled, binaural tests may be extended to obtain accurate results.

When you have finished making your selections, click ✔ to exit Setup.

Screen tour - unaided screen
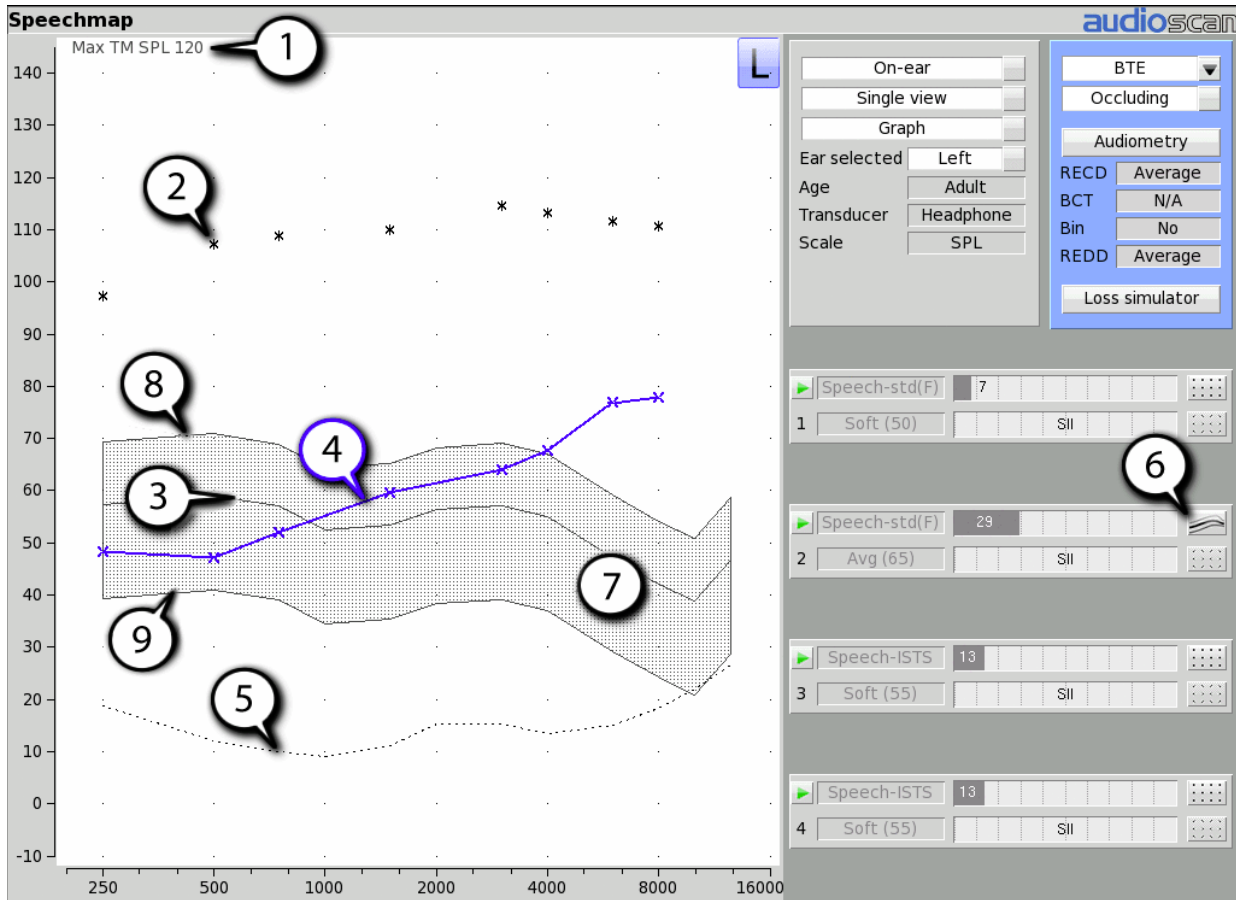
1. Max TM SPL (change this in Setup), 2. Estimated UCL, 3. Unaided long-term average speech spectrum (LTASS), 4. Impaired threshold, 5. Normal threshold (MAP), 6. Turn on/off display of unaided speech region, 7. Unamplified speech region, 8. LTASS +12dB, 9. LTASS -18dB

Screen tour - aided screen
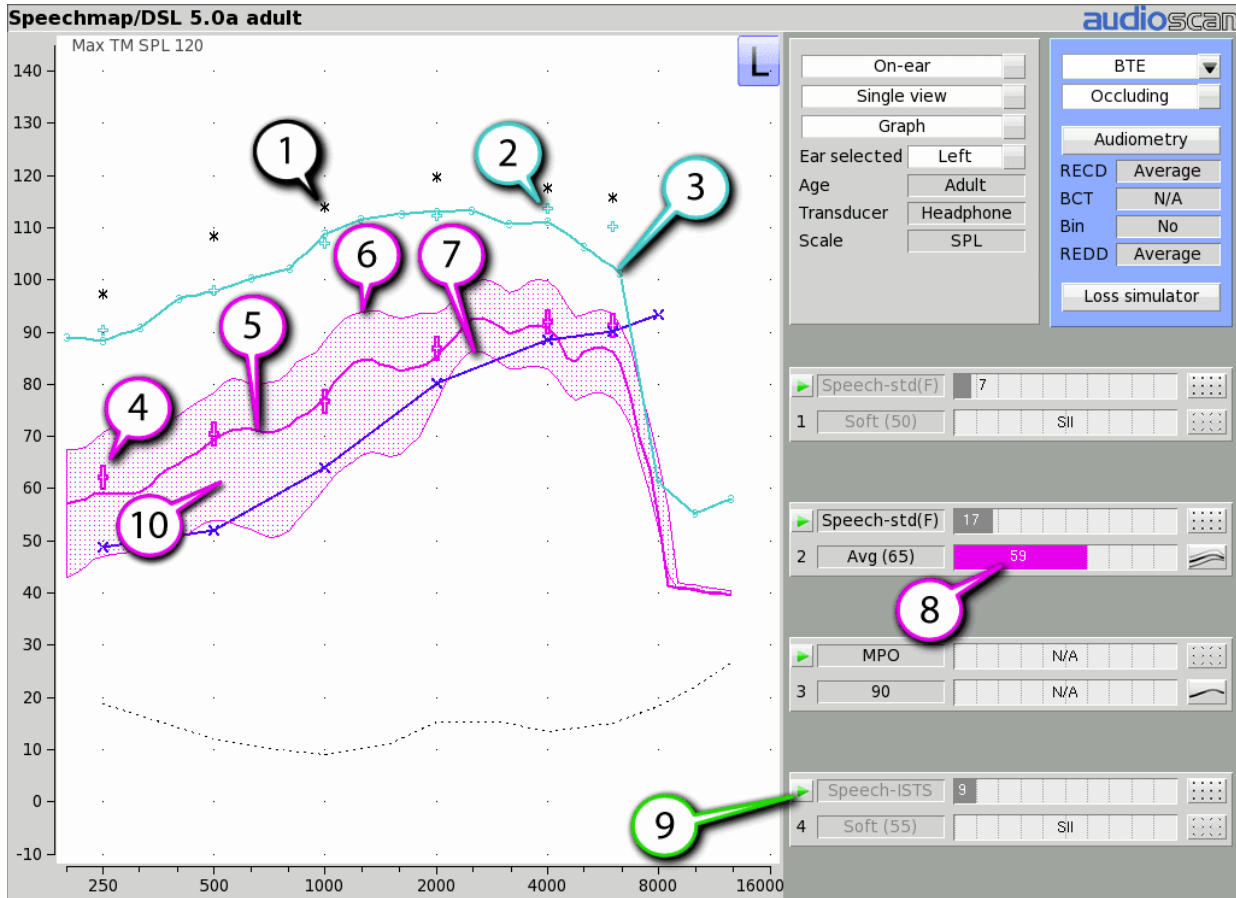
1. Estimated UCL, 2. 90dB target (for tones), 3. Result of test 3 (MPO), 4. LTASS targets for Test 2, 5. Long term average speech spectrum (LTASS) result of test 2, 6. Speech peaks (99th percentile), 7. Speech valleys (30th percentile), 8. Speech intelligibility index (SII), 9. Start test, 10. Amplified speech region

On-ear or Test box mode

The Speechmap environment provides two hearing instrument verification options: On-ear measures and Test box measures. Using on-ear mode, the stimulus is controlled by the reference microphone positioned below the pinna and SPL in the ear canal is measured by the probe microphone. In test box mode, levels measured in the silver 0.4cc coupler are converted to estimated ear canal levels using the RECD or WRECD values (age-appropriate average, entered, or measured) See Speechmap screen choices. In addition, the stimulus delivered to the hearing instrument microphone is modified to include average microphone location effects for the hearing instrument type indicated. The screen display for both modes is the same, showing SPL, measured or simulated, in the ear canal.

For On-ear mode: right click and click on Speechmap from the On-ear column. Review On-Ear Measures - Setup,

For Test box mode: right click and click on Speechmap from the Test box column. Review Calibrating test box reference microphone, Coupling the hearing instrument, Positioning the hearing instrument.

To switch modes: click on [Mode] to toggle between On-ear and Test box modes.

It is suggested that hearing instruments be preset in Test box mode with fine tuning done in On-ear mode.

Note that On-ear mode should be used for vented or open fittings. Vent effects depend on the vent, the ear and the hearing aid settings and cannot be reliably predicted from coupler measurements.

SII calculation in Speechmap

The Verifit calculates a Speech Intelligibility Index (SII) value (in %) for unaided speech at 65 dB SPL and for each aided test. The calculations use the 1/3 octave band method of ANSI S3.5 –1997 without the 160 Hz band and without masking effects with results expressed as a % by multiplying by 100. Level distortion effects are included but no hearing loss desensitization is applied. An idealized speech region of LTASS +/- 15 dB is used.

The speech recognition associated with a given SII is a function of the test material and the cognitive abilities of the listener. There is considerable individual variability in relating the SII to speech recognition, especially amongst impaired listeners. The following shows expected nominal recognition scores vs SII for normals when using a variety of speech stimulus conditions. (Killion and Mueller, Hearing Journal, January, 2010 pp 10-15).

SII (%)	% Cor. Digits	% Cor. IEEE Sentences	% Cor. NU6 Words
0	0	0	0
5	30	4	4
10	80	9	8
15	96	13	11
20	98	19	19
25	99	43	27
30	100	60	36
35	100	74	45
40	100	89	56
45	100	94	63
50	100	96	70
55	100	98	76
60	100	99	81
70	100	99	87
80	100	100	93
90	100	100	96

When DSL child is the selected target formula and the stimulus is a calibrated 55dB SPL or 65dB SPL speech signal, an SII target range representing a lower and upper normative value range will be shown in the SII Audibar. This normative SII range is represented with two lines: the lower range line, and the upper range line. If the child's aided SII values fall within the two lines, then the child's hearing aid fitting is considered electroacoustically acceptable for his/her PTA. SII normative ranges are provided by the National Centre of Audiology (NCA), London, Ontario. Please refer to the UWO PedAMP Instruction Manual for further information about SII normative ranges.

| Speech-std(F) | 19 | | ▶ | 23 | | Speech-std(F) |
| Avg (65) | 72 | | 2 | 69 | | Avg (65) |

Lower SII limit ↑   ↑ **Upper SII limit**
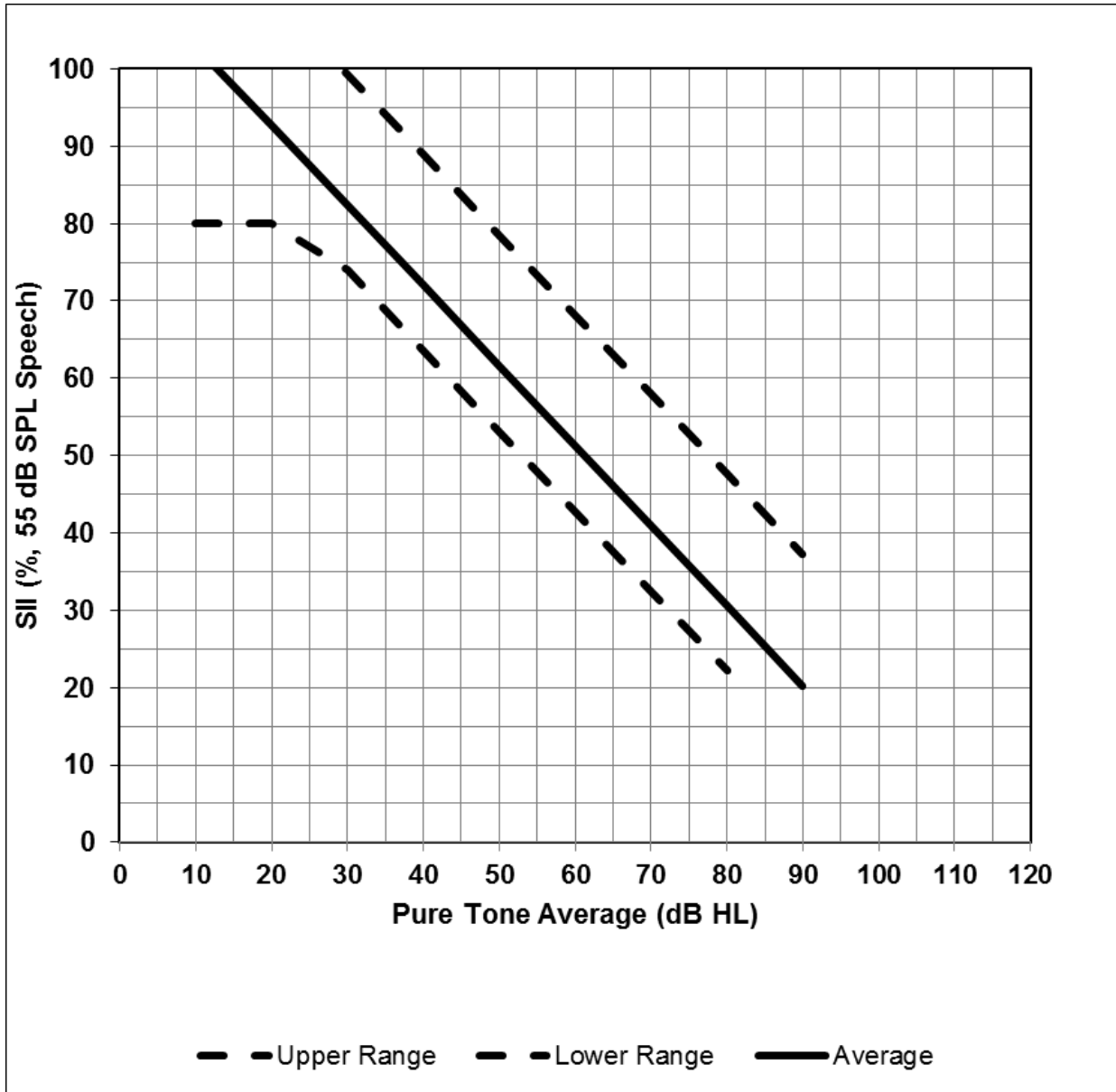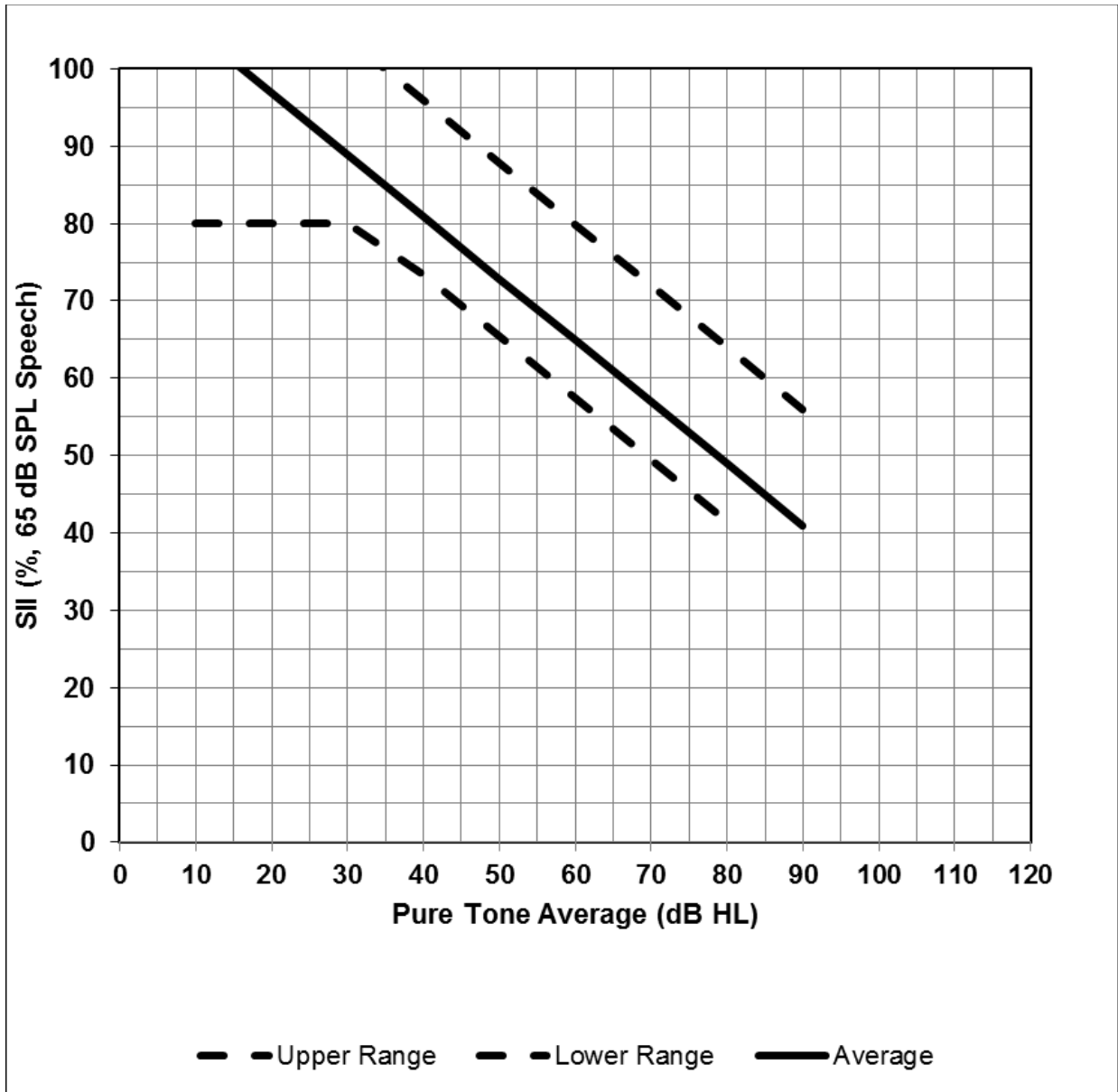
The solid line in each graph indicates the average normative aided SII values for DSL 5.0. The dashed lines indicate a 95% confidence interval around the mean (lower dashed line = 1 standard Deviation below the mean,upper dashed line = 2 standard deviations above the mean). If the aided SII values fall within the dashed lines, then the child's hearing aid fitting is electroacoustically acceptable for his/her PTA.

Due to a limited amount of SII normative data in the severe to profound PTA range, SII ranges should be used with caution when the PTA exceeds 70 dB HL.

Using custom stimuli in Speechmap

Custom digital sound files can be used as stimuli in Speechmap. If you connect a USB stick with WAV files on it to the Verifit, Speechmap will make those files available as stimulus selections. This feature provides the freedom of using any stimulus in Speechmap with all the features that Speechmap offers. Please note that fitting targets are not available for custom stimuli.

A USB stick is required for this feature. It is highly recommended that the USB stick is formatted for data using the Audioscan Updater prior to using this feature. The Audioscan Updater comes with any current Audioscan software download. Visit www.audioscan.com to obtain software updates.

Note: some USB sticks are bootable and may cause issues on start-up if left connected you your Verifit after use. These should be removed during start-up of your Verifit and then re-connected after.

To use digital sound files as stimuli in Speechmap:

1. Connect a USB stick to your PC.

2. Format the USB stick for data using the Audioscan Updater.

3. Create digital sound files that are compatible with Speechmap (see Creating WAV files for Speechmap).

4. Copy the WAV files from the PC to the top level directory (i.e. not in any folder) of the USB stick.

5. Disconnect the USB stick from the PC and connect it to the USB port on the Verifit.

6. Start a Test in Speechmap (see Using Speechmap).

7. Click [Stimulus]. Compatible WAV files will appear as selectable options in the stimulus list below the default stimuli. You may need to scroll down to see all the stimuli.

8. Choose your custom stimulus. After a short delay, your stimulus will begin playing.

9. Use your new stimulus with all the features of Speechmap.
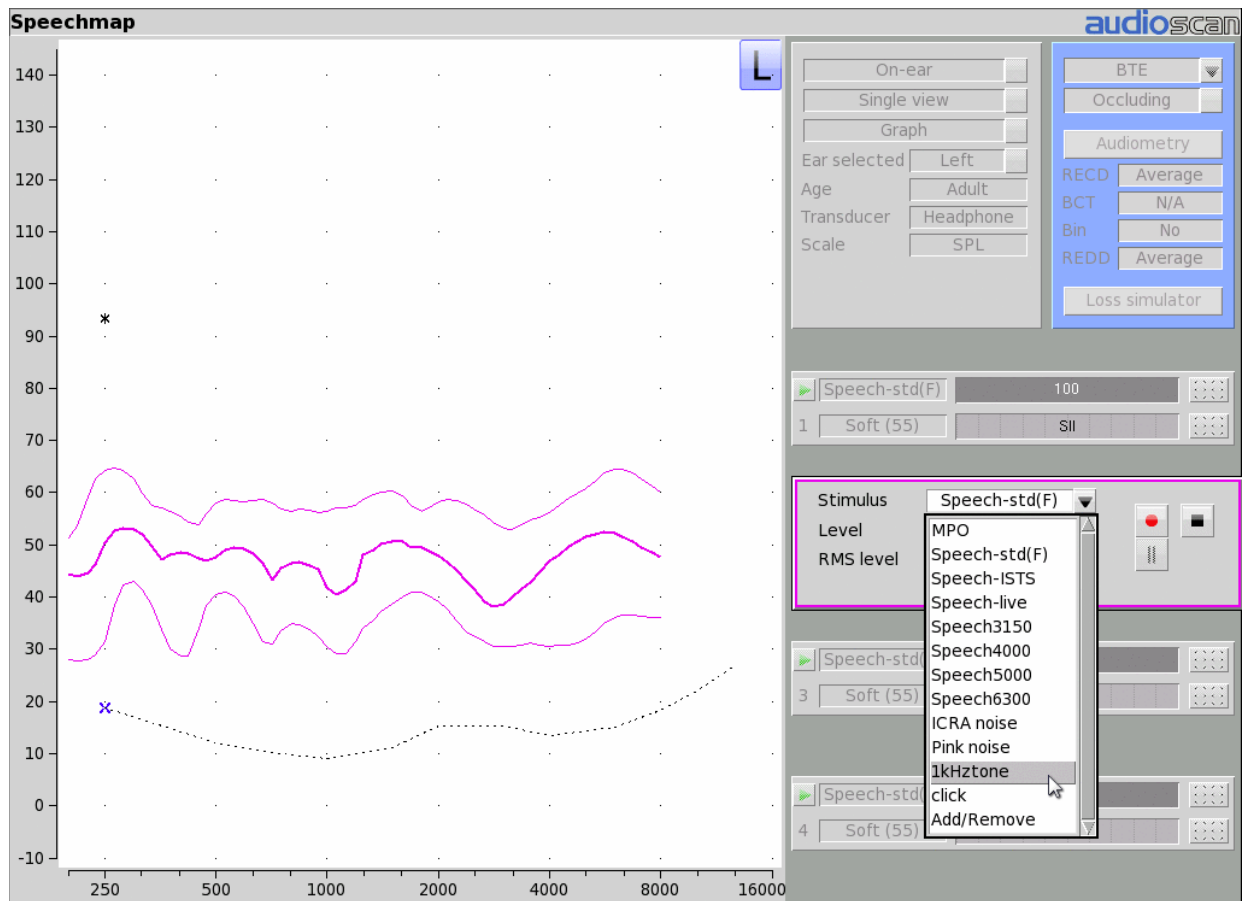
Example of two custom files, *click.wav* and *1khztone.wav*, in the stimulus list.

To remove custom stimuli from Speechmap: close any Test prompts and disconnect the USB stick from the Verifit.

Notes:

1. Files that are greater than 60 seconds in duration will be truncated to 60 seconds.

2. Speechmap will show up to 10 compatible WAV files. If you have more than 10, we recommend that you use multiple USB sticks or organize your files into folders, moving them into the top level directory of the USB stick as needed.

3. Removing the USB stick while a Test poster is open may cause unexpected behavior. Close the Test poster before removing the USB stick from the Verifit.

Creating WAV files for Speechmap

WAV is a commonly used format for digital audio and can be created/edited by nearly all audio editing and recording software. A WAV file has many properties that define the format of the digital audio. When a USB stick is connected to the Verifit, Speechmap looks for files in the top level directory that have the following properties:

File format: WAV
Data format: PCM (no compression)
Sampling Rate: 32 kHz
Bit precision: 16 or 32 bit
Channels: Mono
File name: 24 characters or less, not including .wav extension

Existing WAV files can easily be converted to match these specifications using your preferred audio editing software.

Leveling Options

By default, Speechmap will automatically level the WAV file so that the SPL matches the level selected for the test.

The automatic leveling of the WAV file can be modified by inserting a tag in the filename. This feature allows you to fine tune the output level of your stimulus. The tag must be added at the end of the filename but before the extension.

Example: **filename_+2.5.wav**

The tag must consist of an underscore, followed by a plus or minus sign, followed by the modifier in dB. In the example above, the tag "_+2.5" will level the file to be 2.5 dB above nominal.

There are no restrictions on the magnitude of the modifier; there is built-in protection against speaker overdrive. Precision is limited by the character limit of the filename.

Note: in Test-box Speechmap user sound files will have the MLE applied according to the selected Instrument type. See Speechmap Technical Details.
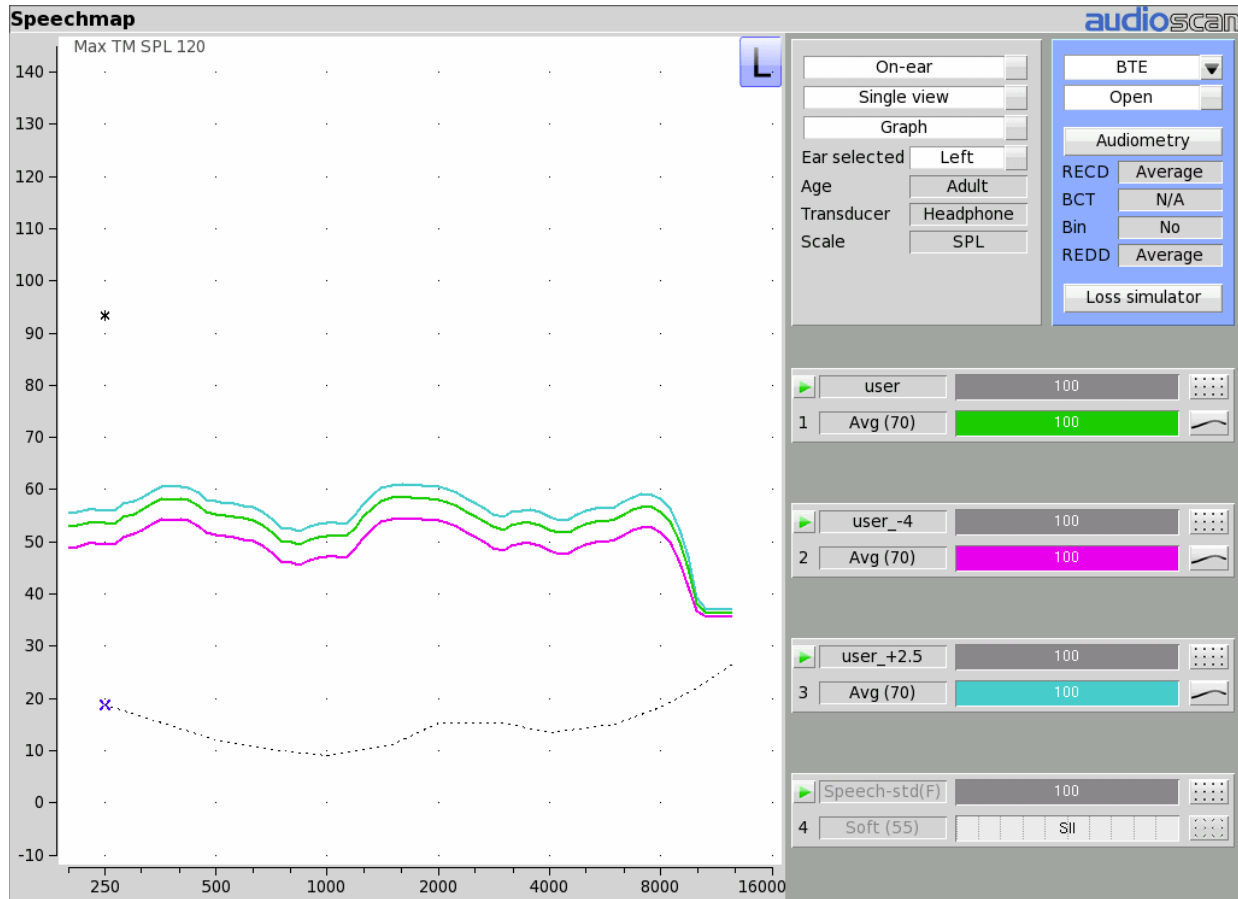
Example of user-supplied files, *user.wav*, *user_-4.wav* and *user_+2.5.wav*.

RMSE (root mean square error) from target in Speechmap

Aided audibility has been found to be significantly predicted by the proximity to prescriptive targets for a hearing aid fitting (McCreery et al., 2013). RMS error from target (RMSE) in Speechmap provides an easy way to determine the proximity to prescriptive targets for the purpose of assessing the quality of a hearing aid fitting. An RMSE criterion of 5dB from prescriptive targets has been the precedent in academic research, and is attainable for most mild to severe hearing losses.

RMSE from target in Speechmap is calculated by first determining the deviation from target across the selected frequencies. By default the frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz are used, however any audiometric frequencies between 250 Hz and 12.5 kHz can be configured in 'Setup' under 'Speechmap'. To arrive at a single RMSE value, the difference between the target and the measured value at each frequency is squared, the average is determined, and the square root is taken.
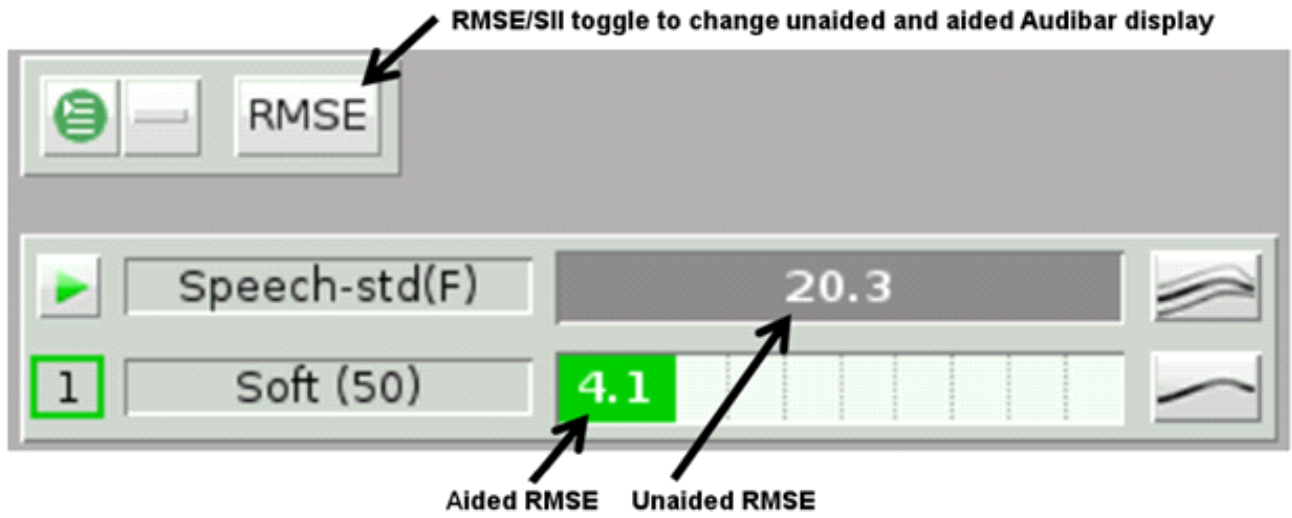
8 Speechmap Fitting Procedures

The Speechmap fitting screen provides a number of choices for inputting and applying audiometric data for the verification of hearing instrument fittings. The procedures in this section assume a familiarity with Test Box Measures - Setup, On-Ear Measures - Setup, On-Ear Measures Screen Setup and Speechmap.

Speechmap configuration

Speechmap screen choices are made by clicking on the relevant buttons for [On ear or Test box], [Graph or Table], [Dual view or Single view], [L or R or L+R], [Audiometry], [RITE, BTE + HA-4, BTE + mold, ITE, ITC, CIC, CIC-shallow, Body, FM, CROS, or BAHD], [Occluding or Open] and [Loss simulator]. Clicking on [Audiometry] will cause a related selection poster to be presented. Changes made on this poster are applied and the poster closed by clicking on [✓]. The poster may be closed without applying the changes by clicking [X] .

Defaults are the last-used choices if test setup memory has been turned on. See Saving test setup.

1. **Targets:** Fitting rule. Select from DSL Adult, DSL Child, NAL-NL1, NAL-NL2, Camfit restoration, Camfit equalisation, DSL Adult -noise, DSL child -noise, or None. The target selection also defines audiometric transforms for calculating SPL thresholds. If None is selected, audiometric data is transformed to SPL up to 12.5kHz if possible. Where high frequency data does not exist, audiometric data will be transformed as per DSL Adult.

2. **HL Transducer:** Sound source is used to obtain the audiogram. Select from [Headphone, Insert + foam, Insert + mold (DSL only), LS 0, LS 45, LS 90 (sound field) or ABR (DSL only). If Headphone is selected, average

adult real-ear to dial difference (REDD) is used to convert entered HL values to ear canal SPL. If Insert + foam is selected the appropriate real-ear to coupler difference (RECD) is used to convert entered HL values to ear canal SPL values. If Insert + mold is selected, the audiometer is no longer calibrated and a measurement protocol is provided for accurate conversion of entered HL values to ear canal SPL. If Measure is not selected, entered HL values are converted to ear canal SPL as if a foam tip had been used to obtain the audiogram. If LS 0, 45, or 90 is selected appropriate real-ear unaided gain (REUG) values @ 0, 45, and 90 degrees azimuth respectively, will be used to convert HL values to ear canal SPL values.

3. **RECD:** Real-ear to coupler difference. Unless otherwise indicated, RECD is the difference between the SPL in an occluded ear and the SPL in the HA-1 2cc coupler produced by the same high (acoustic) impedance sound source with the same acoustic coupling. Because of standing waves in the 2cc coupler, it is not useful above 8 kHz. The Verifit has adopted a 0.4cc coupler to extend the capabilities of Speechmap Test box to the 1/3 octave band at 12.5 kHz. The term Wideband real-ear to coupler difference (WRECD) has been coined to denote an RECD based on a 0.4cc coupler rather than the HA-1 coupler. The **WRECD** is the difference between the SPL in an occluded ear and the SPL in the 0.4cc coupler produced by the same high (acoustic) impedance sound source with the same acoustic coupling.

   The WRECD is used to convert 0.4cc coupler SPL measured in the test box to estimated ear canal SPL. The WRECD is used to convert entered HL data (thresholds and UCL's) to ear canal SPL when Insert +Foam is selected as Transducer. Below 8 kHz, the Verifit converts between RECD and WRECD as necessary.

   Except for Camfit targets, RECD choices are Average, Enter, or Measure.

   If Average is selected and DSL child or NAL-NL2 is the target rule, age-appropriate average RECDs will be applied. However, these target rules provide different average values which will result in differing SPL thresholds. Average RECDs for frequencies above 6 kHz are set equal to the 6 kHz value for purposes of converting HL thresholds and 0.4cc coupler SPL to ear canal SPL.

   If Enter is selected, after threshold entry has been completed, a selection must be made between HA-2 RECD, HA-1 RECD and 0.4cc WRECD. Once a choice has been made, an 8 kHz RECD entry screen or a 12.5 kHz WRECD entry screen becomes available.

   If Measure is selected, the Measure WRECD screen is provided after threshold entry is completed. See <u>WRECD measurement</u>.

4. **RECD Coupling:** Select from [Earmold, Foam tip]. Specifies the coupling between the RECD transducer and ear.

5. **Age:** Select from Adult, 6 – 10 years, 1 – 60 months. This changes the RECD applied if DSL Average or NL2 Average has been selected when using these target rules.

6. **ABR nHL to eHL:** Normalized HL to estimated HL conversion factors. Permitted only if [Transducer] = ABR (nHL). Select from [Default, Enter]. If [Enter] is selected, an entry screen will be provided after threshold data have been entered. Otherwise default factors will be used. These may be set to DSL values or to values that you have entered in Setup. Note that, in some facilities, nHL is defined in such a way that it is effectively eHL; in these cases, ABR (eHL) should be selected and no conversion factors will be applied. See <u>ABR nHL to eHL setup</u>.

7. **Binaural:** Select from [Yes, No]. Determines if fitting targets will be adjusted for binaural summation effects.

8. **REDD:** Real-ear-to-Dial Difference. [Average] (this cannot be changed). REDD values are similar for adults and children. If Headphone is selected as the transducer type, adult average values will be used to transform dB HL audiometry to dB SPL.

9. **Language:** Select from [Non tonal, Tonal]. Determines if NAL-NL2 fitting targets will be adjusted for tonal language.

Type of instrument or fitting to be verified: In Test box mode, select from RITE (receiver in the ear), BTE +

HA-4, BTE + mold, ITE, ITC, CIC, CIC-shallow, Body, FM, and BAHD. In On-ear mode, select from RITE (receiver in the ear), BTE, ITE, ITC, CIC, CIC-shallow, Body, FM, or CROS. Additionally, select the Vent from Occluding or Open when applicable. In Test box mode, the fitting selection determines the microphone location effects applied to the stimulus. The selection of Open, FM, CROS, or Open Vent determines the test protocol used. In the case of CIC, a deep insertion factor is applied to the estimated ear canal SPL. See Speechmap Technical Details.

Loss simulator: An electro-acoustic simulation intended to allow normal-hearing listeners to hear sounds as if they had the elevated threshold and altered loudness perception caused by outer and inner hair cell damage. See Sensory loss simulator.

Assessment data entry

Threshold data and other audiometric parameters may be entered manually using a mouse or an external keyboard. See Mouse, keyboard, and Input device operation.

To enter audiometric data manually:

1. On the Threshold, BCT and UCL entry prompt, enter each data point using a mouse or an external keyboard. Left click the mouse to enter a point. Click again to delete the point. On the keyboard, the arrow keys change frequency and level and the ENTER key on the numeric keypad enters or deletes a point. The keyboard's numeric keypad can also be used to type in data. Switch sides by moving mouse cursor over to other side. Switch between Threshold entry, BCT entry or UCL entry by clicking the appropriate button.

2. Use the X button to erase the curve next to it.

3. Use the Copy button at the bottom of the entry screen to copy points on either side to the other side if there is data one one side and no data on the other. The button is disabled and does nothing if both side contain data or both side do not contain data.

4. RECD entry works in a similar manner as Threshold, BCT and UCL entry prompt.

5. Click ✓ to save the data and exit the entry screen. Click ✗ to exit the entry screen without saving the data.

Fitting to targets for soft speech

See Speechmap screen choices for setup and audiometric data entry. See Using Speechmap.

1. Follow the instructions in Speechmap screen choices to enter audiometric data and select the fitting rule.

2. Click ▶ in the "1" area to start the first test . Once the test is started, click the [Stimulus] list button to select the stimulus type. Click the [Level] list button and select a stimulus level of 50 dB.

3. While the passage is being presented, adjust the hearing instrument's frequency shaping and gain for soft sounds so that the middle curve (the LTASS) falls within the target range, shown by the ⚕ symbols, especially between 500 - 4000 Hz. These target symbols are automatically adjusted for the stimulus level you select.

4. Click ● to signal average and store a complete passage. Repeat as necessary.

5. Click ■ to stop the test without recording any test data.

6. Upon completion of a test recording, a colored Aided Audibar shows the SII for the aided soft speech signal.

7. The upper bar in the "1" area, shows the SII for the unaided stimulus at 50 dB SPL (the Unaided Audibar). The difference between the unaided and aided SII score (and the associated length of their respective

'Audibars') visually quantifies the speech intelligibility improvement for soft speech likely provided by the hearing instrument being fit. To further demonstrate the improvement, the unaided speech 'banana' may be displayed by clicking [::::] beside the Unaided Audibar.
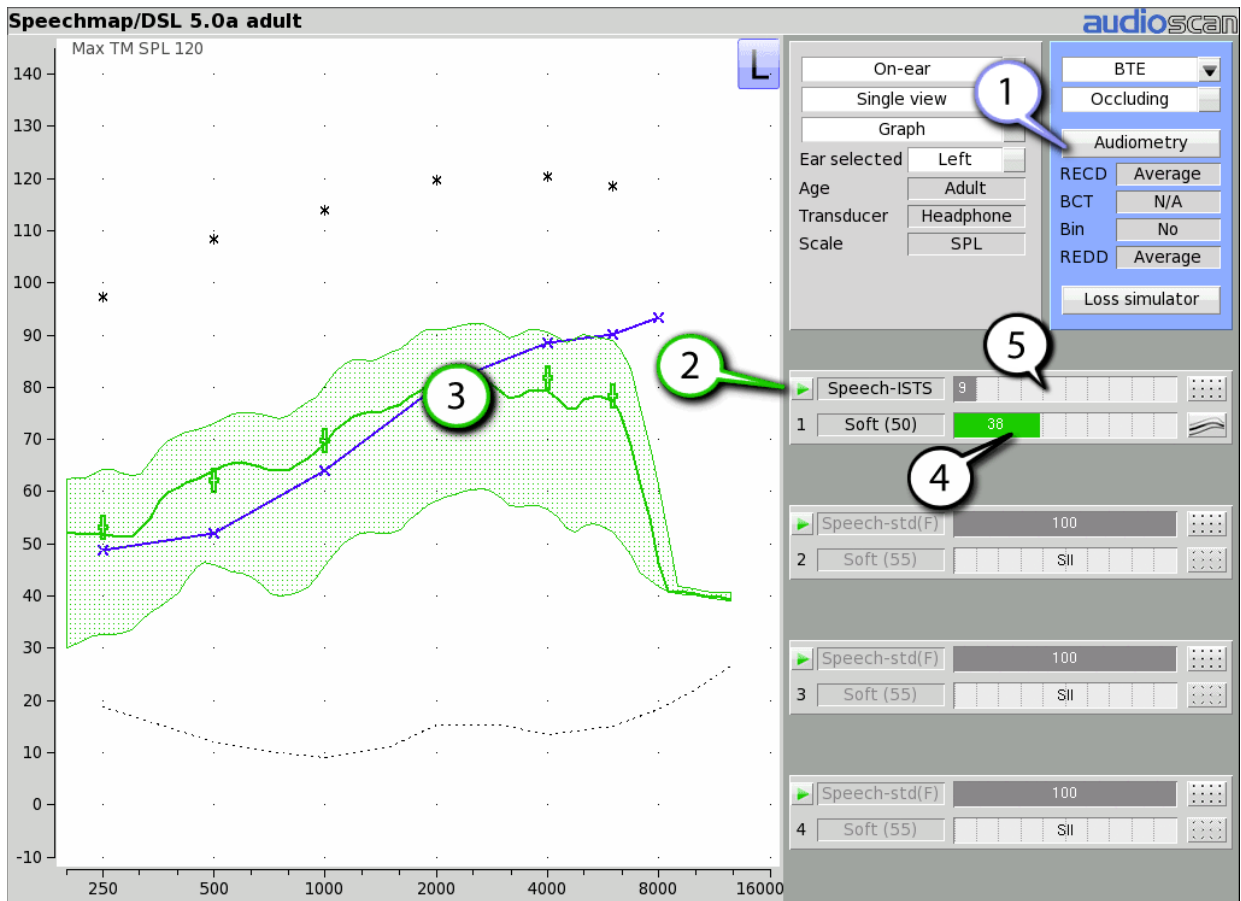
After completion of a test, the chosen stimulus type and level will become the default. To change this behavior, see Saving test setup.

Fitting to targets for average speech

See Speechmap screen choices for setup and audiometric data entry. See Using Speechmap.

1. Follow the instructions in Speechmap screen choices to enter audiometric data and select the fitting rule.

2. Click ▶ in the "2" area to start the second test. Once the test is started, click the [Stimulus] list button to select the stimulus type. Click the [Level] list button and select a stimulus level of 65 dB. The upper bar in this area shows the SII for the unaided stimulus at 65 dB SPL (the Unaided Audibar). *When you start a new test, the speech envelope of the previous test may be automatically hidden. See Speechmap Setup to change this behavior. To change the default stimulus type and level see Saving test setup.*

3. While the passage is being presented, adjust the hearing instrument's frequency shaping and gain for average sounds so that the middle curve (the LTASS) falls within the target range, shown by the ⊹ symbols, especially between 500 - 4000 Hz. These target symbols are automatically adjusted for the stimulus level you select.

4. Click ⬤ to signal average and store a complete passage. Repeat as necessary.

5. Click ■ to stop the test without recording any test data.
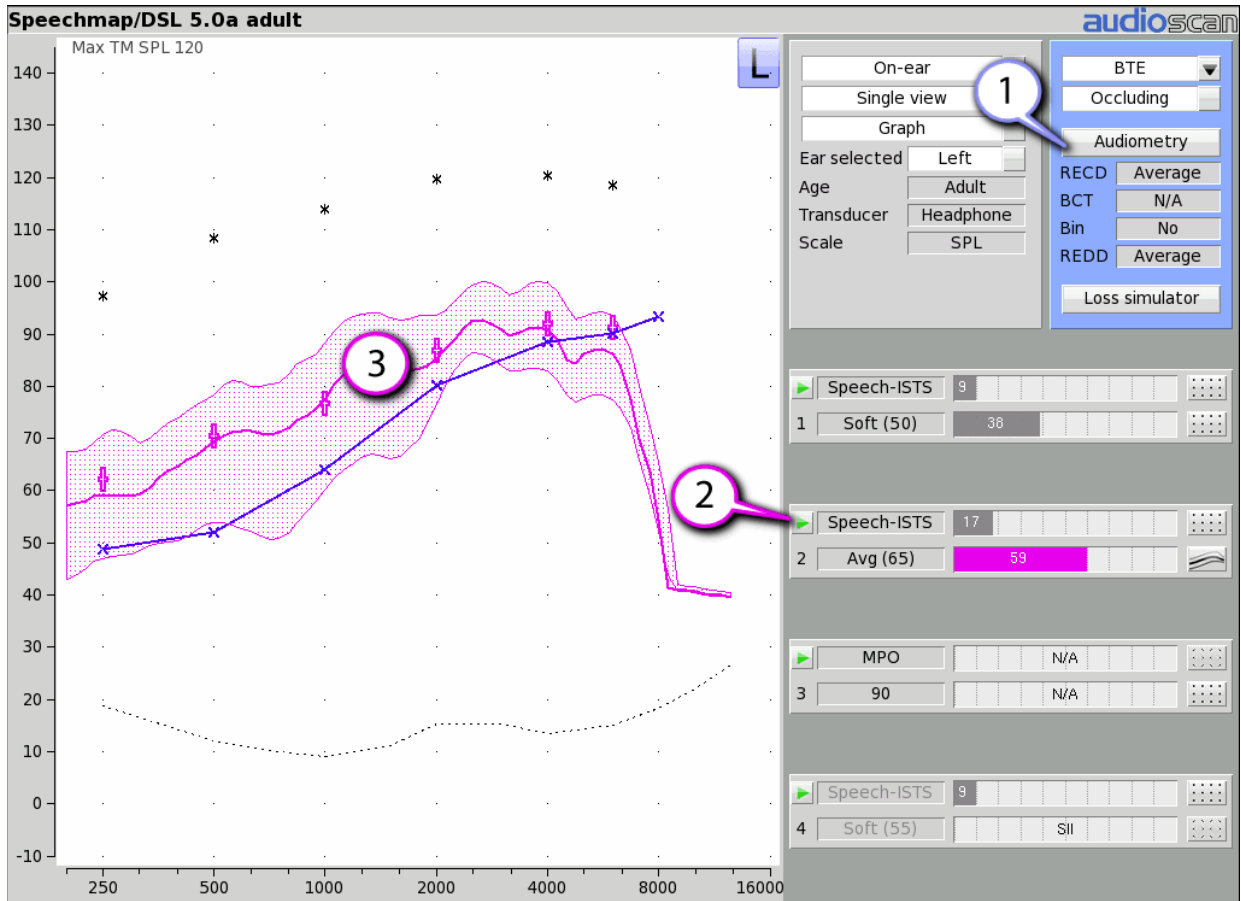
Upon completion of a test recording, a colored Aided Audibar shows the SII for the aided average speech signal. The difference between the unaided and aided SII score (and the associated length of their respective 'Audibars') visually quantifies the speech intelligibility improvement for soft speech likely provided by the hearing instrument being fit. To further demonstrate the improvement, the unaided speech 'banana' may be displayed by clicking ⣿ beside the Unaided Audibar.

Adjusting the Maximum Output Level

See Speechmap screen choices for setup and audiometric data entry. See Using Speechmap.

Follow the instructions in Speechmap screen choices to enter audiometric data and select the fitting rule.

1. Click ▶ in the *3* area to start the third test. Once the test is started, click the [Stimulus] list button to select the stimulus type as MPO. When you start a new test, the speech envelope of the previous test may be automatically hidden. See Speechmap Setup to change this behaviour. To change the default stimulus type and level see Saving test setup.

2. In Test box mode, while the 90 dB sweep is being presented, adjust the hearing instrument's high-level gain and/or output limiting (e.g. MPO, PC) so that the curve matches the + REAR90 targets (DSL) or approaches but does not exceed the UCL estimates (*) at all frequencies.

3. Click 🔴 to run and store a complete sweep. Repeat as necessary.

TM SPL setup). Click [●] to run and record a single sweep. Adjust the gain and output for loud sounds as for test box measures, factoring in client response. Note: MPO stimulus is run at 85dB for On-ear mode, and DSL REAR90 targets are adjusted accordingly.
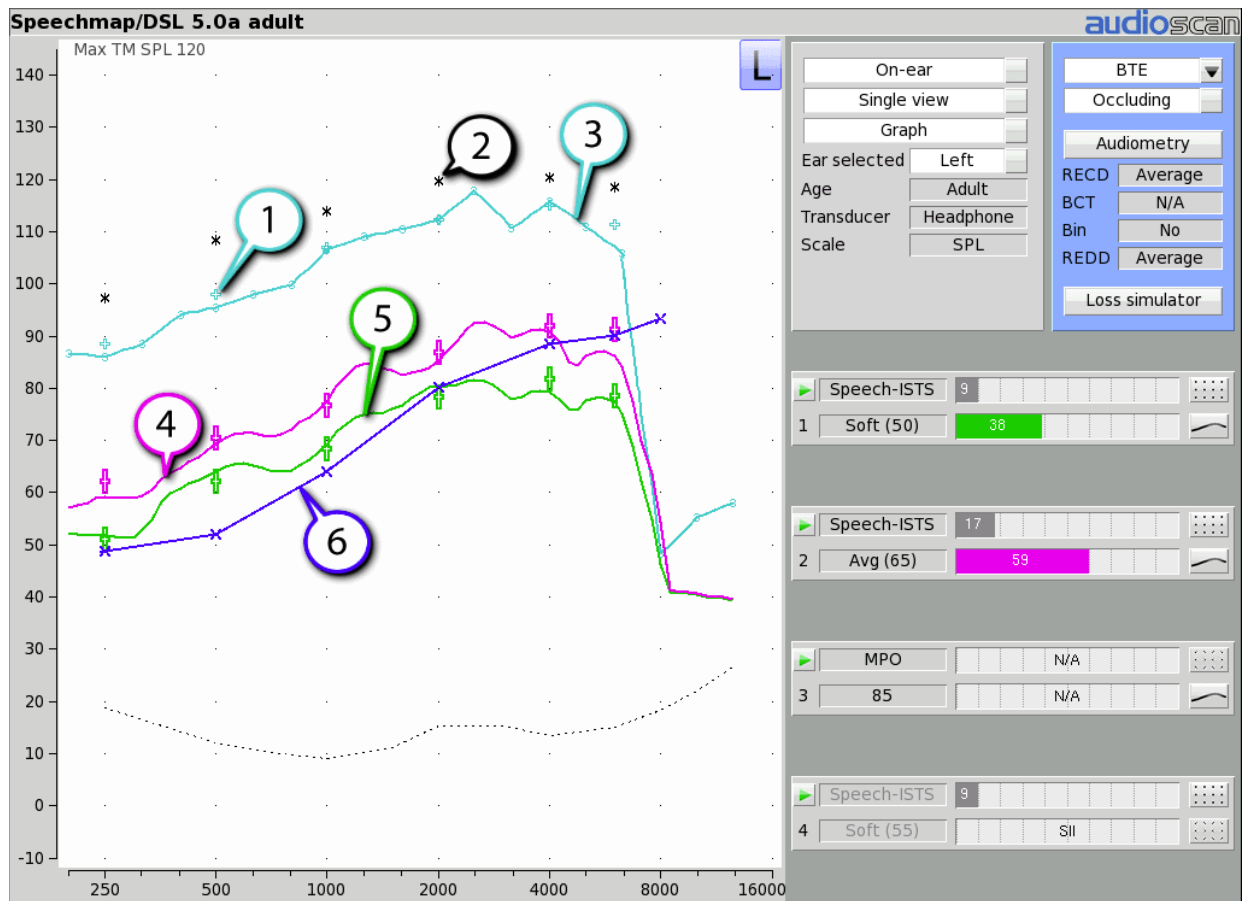
1. DSL REAR90 target, 2. Estimated UCL, 3. Measured MPO, 4. LTASS 65, 5. LTASS 40, 6. SPL Threshold

Open fittings in Speechmap

On-ear mode should be used for open and vented fittings. There are no special real-ear SPL targets for open fittings - it doesn't matter how the sound reaches the TM, the perception is the same. However, the sound that escapes from a vent or open fitting may be detected by the on-ear reference microphone, interfering with the sound field equalization. For this reason, the hearing instrument must be muted during sound field equalization.

1. With Speechmap in the [On-ear] mode, click the Instrument pull-down menu and select RITE, BTE, or ITE.

2. Click the Vent selector to choose Open.

3. Position the client and probe tube and enter audiometric data. See On-Ear Measures - Setup, Speechmap, and Fitting to targets for soft and average speech and Adjusting the Maximum Output Level.

4. Place the open-fit hearing instrument on the ear with the probe tube in place, making sure to mute the hearing instrument.

5. Access Test 1, 2, 3 or 4. If this is the first test since selecting Open, you will be prompted to mute or turn off the hearing instrument and click the Equalize button on the setup poster. After equalization, unmute or turn the instrument on and follow the fitting procedures presented previously in this section. *It is necessary to repeat the Equalize procedure whenever the client or nearby objects are moved.*

To set up vent type: click on the second *down arrow* in the Audiometry section. In On-ear mode, for RITE, BTE, or ITE instruments there is a choice of Occluding or Open. Occluding assumes either fully occluded or vented; Open assumes either a fully open coupling to the ear or a vent large enough that a stored equalization is required. For all other instrument types venting is not applicable.

Selection of Open vent will prompt for an additional step to ensure that amplified sound outflow from the ear canal does not reach the reference microphone during sound field equalization. For Test box mode, vent will be automatically set to Occluding as there is no provision made for testing open canal products in the test box.

Binaural fitting in Speechmap

When Speechmap is set to Dual view, it is possible to analyze both left and right hearing instruments simultaneously.

1. Follow the instructions in Speechmap screen choices to enter audiometric data and select the fitting rule.

2. Click binaural link between the L and R selections. Both the L and R buttons will highlight when binaural operation is active.

3. Click ▶ in any of the test areas to start a test. The output from both hearing instruments will be display simultaneously.

4. Once the test is started, click the [Stimulus] list button to select the stimulus type. Click the [Level] list button and select a stimulus level.. *When you start a new test, the speech envelopes of the previous test may be automatically hidden. See Speechmap Setup to change this behaviour. To change the default stimulus type and level see Saving test setup.*

5. While the passage is being presented, adjust the hearing instrument's frequency shaping and gain for average sounds so that the middle curve (the LTASS) falls within the target range, shown by the ✙ symbols, especially between 500 - 4000 Hz. These target symbols are automatically adjusted for the stimulus level you select.

6. Click ⬤ to measure and store the long-term signal-averaged result. IF the input level at each ear is significantly different, the signal may be repeated twice for accurate results.

7. Click ■ to stop the test without recording any test data.

Verifying Frequency Compression/ Frequency-Lowering Hearing Instruments in Speechmap

Frequency lowering is used when it is not possible to amplify the high frequency components of speech sufficiently to raise them above threshold. In this case, the high frequency components may be shifted to a lower frequency with a better hearing threshold where the available gain will render them audible.

Four modified versions of the Speech-std (1) test stimulus (Speech3150, Speech4000, Speech 5000 and Speech6300) are provided in Speechmap to assist in verifying and adjusting frequency lowering devices. In each of these modified test stimuli, the 1/3 octave band levels above 1000Hz are reduced by 30dB, except for an isolated 1/3 octave band centered at the frequency indicated in the selected test stimulus' name. With these reduced band levels, the resulting LTASS produces a distinct 'cavity' between 1000Hz and the selected high frequency band.

While these signals can be used to demonstrate frequency lowering function, the phonemic-like stimuli based on the /s/ and /sh/ extracted from the ISTS signal (Scollie et al., 2016) are recommended for the adjustment of adaptive frequency lowering systems. These stimuli can help provide rapid evaluation of the aided levels and spectral shape of the phonemes /s/ and /sh/ and also may support phonemic analysis of hearing aid responses.

Using the MAOF-Highlighter with the 'S' and 'SH' Stimuli

When using the /s/ stimulus to adjust frequency lowering, the goal is to add the least amount of frequency lowering required to put the upper shoulder of the /s/ response into the MAOF, or Maximum Audible Output Frequency range (Scollie et al., 2016).

This is identified as the region between the point where the SPL threshold crosses the LTASS of 65dB speech and where it crosses the peak line of the same test. The Verifit2 MAOF highlighter provides a colored target range which indicates the MAOF region to make the adjustment process easier.

To test frequency-lowering:

1. Right click to show the home menu and choose Speechmap from either the On-ear or Test box columns.

2. Program the hearing instrument so that the frequency-lowering feature is inactive.

3. Access Test 1, 2, 3 or 4 by clicking on the appropriate ▶ to start that test.

4. Choose one of the calibrated speech stimuli. Choose 65dBSPL from the Level pull-down menu. Verify aided speech audibility or target match (as described elsewhere in this section) for frequencies below the isolated band.

5. Click ● to measure and store the long-term signal-averaged result. If the isolated band does not appear in the Test 1 curve, it may indicate that the hearing aid has no gain at the selected band frequency. This does not mean that the hearing aid will be unable to transpose the band to a lower frequency when frequency lowering is enabled.

6. Program the hearing instrument to activate the frequency-lowering feature.

7. Click ▶ to start another test and select the "S" stimulus. Note that only the LTASS is shown for these stimuli and targets (if selected) have been suppressed.

8. Once "S" has been selected from the Stimulus pull-down menu, the MAOF selection tool will be active. Click "Show MAOF" selector and choose the test performed in step 3 above.

9. Adjust the frequency lowering function in the hearing instrument to move the upper shoulder of "S" into the MAOF target region indicated on screen.
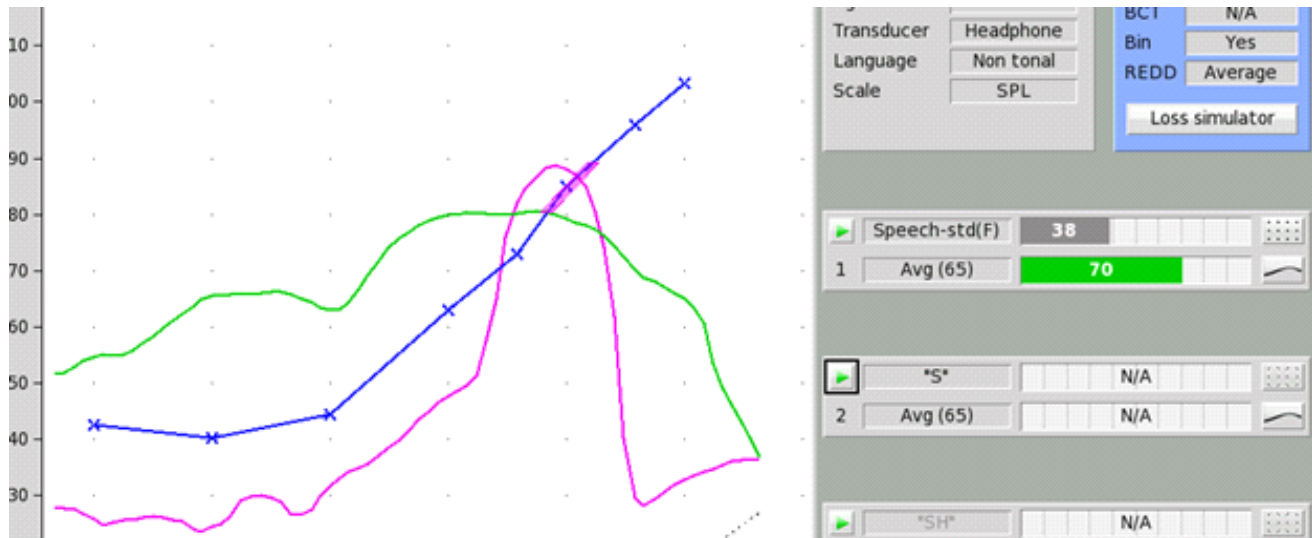
10. Click ⦿ to measure and store the "S" result.

11. Once the frequency-lowering properties of the hearing instrument have been adjusted, start another test and select the "SH" stimulus. Determine whether it is audible, and also whether it has some frequency separation from the "S" stimulus. If they are overlapping, the listener may have difficulty perceiving them as two different speech sounds. Fine tune as needed.

12. Perform a listening check, considering whether the sound quality and distinction of "S" and "SH" in speech are acceptable. At the time of fitting and follow up, consider the listener's responses, therapist feedback, and/or outcome measurements that provide insight into the perceived sound quality and ability to distinguish "S" and "SH".

CROS fitting in Speechmap

See Using Speechmap.

1. Place a probe module on each ear and insert the probe tube into the good ear only. Position the CROS instruments on (in) the ears and turn them ON.

2. Position the speaker at 45 degrees to the good ear and set Instrument to [RITE] or [BTE].

3. Click ▶ in test 1 area to start test and record a response using [Pink noise] at Soft (55). It should be like a normal REUR. If not, the ear may not be fully open.
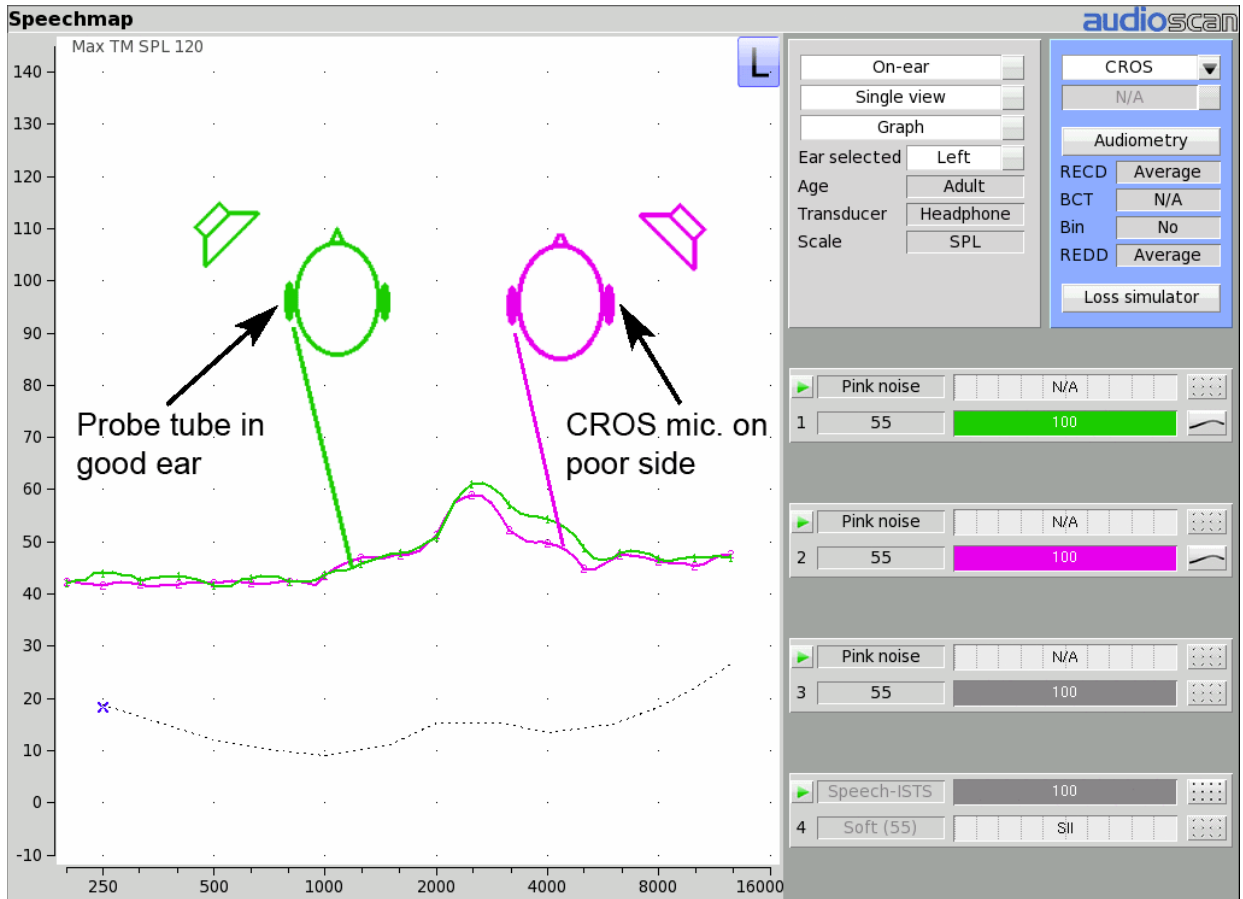
4. Position the speaker at 45 degrees to the poor ear.

5. Set Instrument to [CROS].

6. Click ▶ in test 2 to start test and obtain a response using [Pink noise] at Soft (55). Adjust the response to match that obtained in step 3.Position the speaker directly in front of the client. Click ▶ in test 3 area to start test and use [Pink noise] at Soft (55) to check for a smooth response. Repeat with Instrument set to [BTE]. An irregular response may be the result of reflections from nearby objects (including the operator) or it may indicate phasing problems in the aids.

FM fitting and verification

FM Offset or FM Transparency method in Speechmap (after Platz 2004)

It is assumed that the hearing aid has been set up for optimal audibility and maximum output. See Speechmap screen choices for setup and audiometric data entry. See Using Speechmap

1. Before attaching the FM receiver, couple the hearing aid to one of the 0.4cc couplers in the test box, right click and select Speechmap from the Test box menu.

2. In the Audiometry section, select the hearing aid type from the list. (typically RITE).

3. Click ▶ in test 1 area, then choose one of the calibrated speech stimuli at a Level of 65 dB. Click 🔴 to run and record the speech passage.

4. Attach the FM receiver to the hearing aid and set the FM receiver to the default setting. The FM transmitter should be ON and set to MUTE. Repeat step 2 but use Test 2 instead of Test 1. If the results of Test 1 & Test

2 are not similar, the presence of the FM receiver has changed the intended performance of the hearing aid. Where possible, make programming adjustments to compensate -being careful not to make adjustments that will change Test 1 results.

5. Move the hearing aid, attached to the coupler and microphone, outside the test box at least 30 cm (12 in.) from the FM transmitter*. Put the FM transmitter microphone, set to Omni, within 2mm of the test box reference microphone corresponding to the coupler used in step 1. Close the lid of the box.

6. With the FM transmitter unmuted, repeat step 2. Note that the hearing aid is outside the test box during this test - Quiet please! The results should be within +/- 2 dB of the results from step 3. If not, change FM settings and repeat.

* A coupler mic. extension cable is available. See Microphone connection.

Real-ear verification of FM-only open fittings in Speechmap (based on AAA Clinical Practice Guidelines: Remote Microphone Hearing Assistance Technologies for Children and Youth from Birth to 21 Years. April 2008)

Open fittings must be verified in On-ear mode. See <u>Speechmap screen choices</u> for setup and audiometric data entry. See <u>Using Speechmap</u>

1. Enter Audiometry data and select the FM hearing instrument type from the list.

2. Put the FM transmitter microphone, set to Omni, inside the test box and position the test box reference microphones within 2mm of the FM transmitter microphone(s), which should be aligned along the axis of the test box speaker. Then place the probe tube in the ear canal, and couple the FM-only device to the ear canal as in normal use.

3. At maximum volume setting, select the MPO stimulus. Adjust the receiver settings to meet targets. See <u>Adjusting the Maximum Output Level</u>.

4. At use volume setting, select one of the calibrated speech stimuli and choose FM chest (84 dB SPL) or FM boom (93 dB SPL) for the level. Adjust the FM receiver gain/volume settings to meet targets in the 1000 – 4000 Hz range.

5. Repeat step 3 at use volume setting.

T-Loop fitting and verification in Speechmap

This test allows the T-Loop response of the hearing instrument to be measured so that it can be compared against acoustic responses.

1. Set the instrument to 'T' (Telecoil input).

2. Click ▶ in any of the test areas to start test.

3. Click ⌄ to show additional options, and change Source to "T Loop".

4. Select a speech stimuli and level from the Stimulus and Level picklists.

5. Click ● to measure and store the long-term averaged result. The result can be directly compared against an acoustic response at the same level, as shown below.
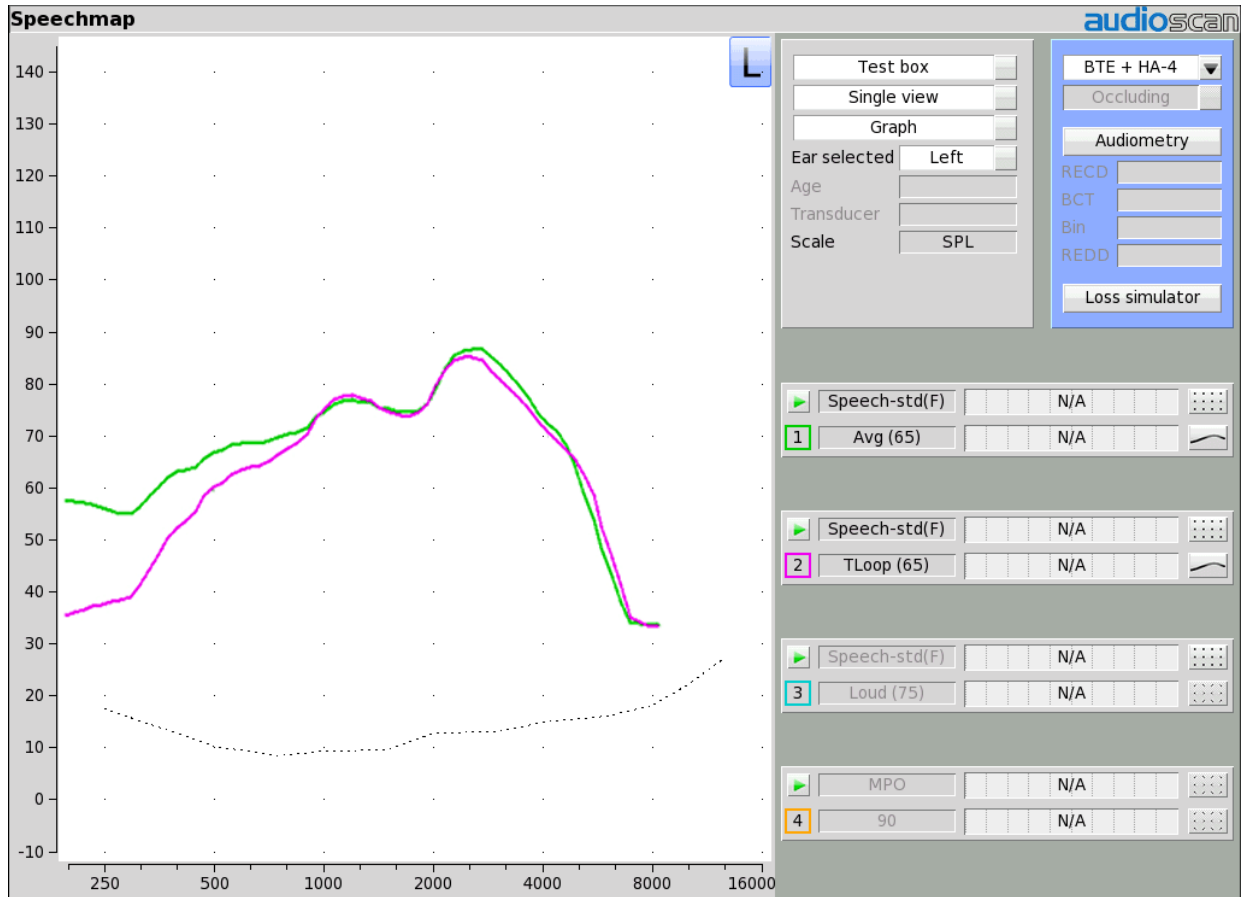
Note: The T-Loop produces a magnetic field strength equivalent to the IEC specification (70dB SPL = 100 mA/m) and the ANSI specification (60 dB SPL = 31.6 mA/m) for a linearly operating hearing aid.

Tele-test fitting and verification in Speechmap

⚠️	**WARNING**: The included magnet may effect some medical or electronic devices. Keep magnet at least 5cm (2in.) from implantable devices and other magnetically sensitive devices.
	WARNING: Keep magnet out of reach of children and pets. If a magnet is swallowed seek immediate medical attention.
	WARNING: The magnet used with the tele-test handset cannot be applied for more than one (1) minute when the telecoil test is conducted with the hearing instrument on the client's head.
🛇	Only use the magnet provided with the tele-test handset or one explicitly intended for telecoil activation.

This test allows the telecoil response of the hearing instrument to be measured so that it can be compared against acoustic responses. In addition, auto-coil, binaural coordination and binaural streaming features can be verified. The tele-test handset comes with a small magnet attached that may affect implantable devices. See How to Avoid Undesirable Side Effects.

Magnet use position markers

Switching magnet in storage position
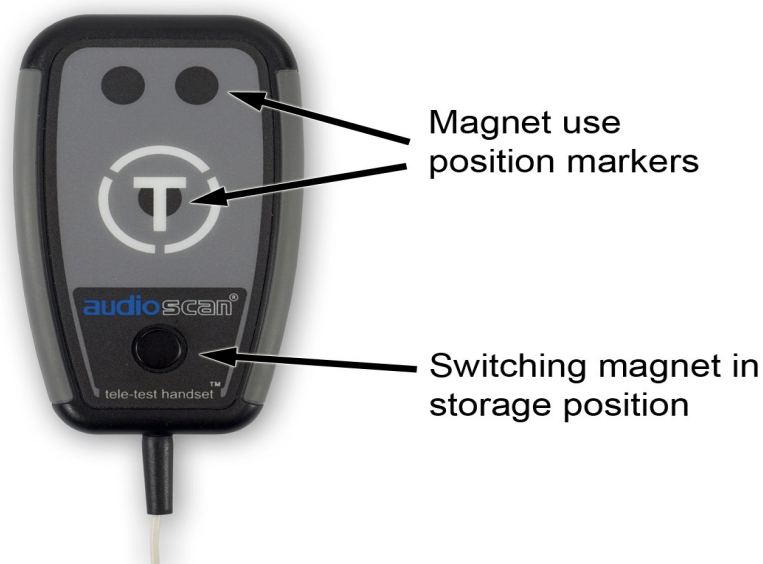
The tele-test handset can be used in both Test-box and On-ear Speechmap modes. For tests in the test box the lid must remain open while the handset is positioned near the hearing instrument; output is measured with the coupler microphone. For on-ear tests the handset is positioned near the hearing instrument while on the client's ear; output is measured with the probe microphone.

1. Set the instrument to 'T' (Telecoil input) or enable the auto-coil feature.

2. Click ▶ in any of the test areas to start a test.

3. Click ⌄ to show additional options, and change Source to "Tele-test".

4. Optionally, change Bandwidth to "Telephone (TB)" for the output to simulate telephone bandwidth (300 Hz to 3300 Hz).

5. Select a speech stimuli and level from the Stimulus and Level picklists. The Tele-test handset will produce an inductive signal approximating an equivalent acoustic stimulus when positioned close to the hearing instrument.

6. If using an auto-coil feature, a magnet will be required to activate the T-coil function. Move the Audioscan switching magnet from the storage position near the base of the handset to one of the three indicated positions. Ideal positioning will vary with hearing instrument type. Alternatively, a switching magnet provided with the hearing instrument may also be used.

7. Position the Tele-test handset within 1 cm of the hearing instrument such that the front face of the Tele-test handset is parallel to the height of the hearing instrument (e.g. like holding a telephone handset or cellphone).

8. Activity on the graph indicates that the hearing instrument is receiving the inductive stimulus.

9. Click 🔴 to measure and store the long-term averaged result. The result can be directly compared against an acoustic response at the same level.

BAHD fitting in Speechmap

Bone anchored hearing devices (BAHD) can be verified in Speechmap with the use of the optional Verifit Skull Simulator (part # VA-300). This accessory allows verification of fit using DSL-BCD adult and DSL-BCD child formulas for percutaneous bone-anchored devices. There currently no correction for soft-band devices in the formula.

Connecting Skull Simulator.

1. Disconnect binaural coupler microphone in Verifit2 test box.

2. Connect the Verifit Skull Simulator to the jack marked CPLR.

3. Position the Verifit Skull Simulator with the black dots over the black crossbar in the test chamber floor, perpendicular to the main speaker.

4. If testing a left BAHD device, ensure the abutment is facing towards the left side of the test box. If testing a right BAHD device, face the abutment towards the right side of the test box. A blue (left) or red (right) marking on the Verifit Skull Simulator will be visible when testing to confirm proper orientation.

Position for left device   Position for right device

Positioning Bone Anchored Hearing Device.

1. The artificial abutment on the skull simulator is designed to accept connection of both Ponto- and BAHA-style devices. Couple the device to the abutment according to the manufacturer's recommendations.

2. For directional devices, ensure the axis of maximum sensitivity is facing the front speaker.

3. Position the appropriate reference microphone 1-3 mm from the front microphone opening.

Speechmap testing

1. Right-click to open main menu. Select Speechmap from Test box tests menu.

2. Select BAHD from the instrument type list. This will clear any previous Speechmap measurements made on air conduction devices.
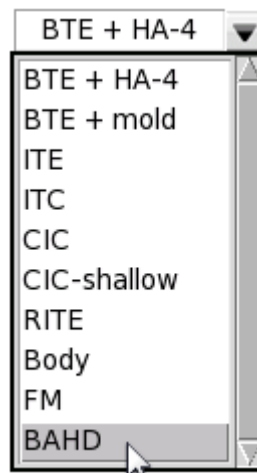
3. Select "Audiometry"

4. **Targets:** Select fitting rule from DSL-BCD adult, DSL-BCD child, or none.
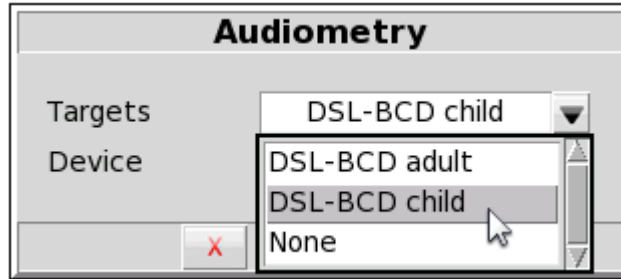
5. **Device:** Select the type of device to be verified from the drop-down device list. In the DSL-BCD formula the fitting targets are specific to the BAHD model.
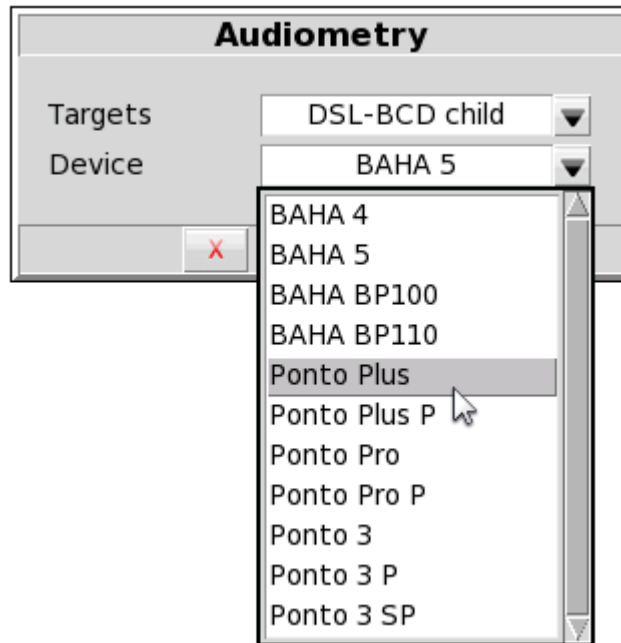
6. **Binaural:** Select from [Yes, No]. Determines if fitting targets will be adjusted for binaural summation effects. This option is not available for [DSL-BCD child] targets.

7. Select ✔ to continue.

8. Enter DL (dial level) thresholds and DL UCL if measured **See Assessment data entry**

Note: threshold and UCL values must be BAHD-generated (direct dial level). There is currently no support for traditional BC audiometric data.

9. Select ✔ to close Audiometry entry window. Patient DL thresholds and UCLs if entered will be plotted on the Speechmap screen. Rather than the familiar SPL, the graph area will follow a force level (FL) scale.
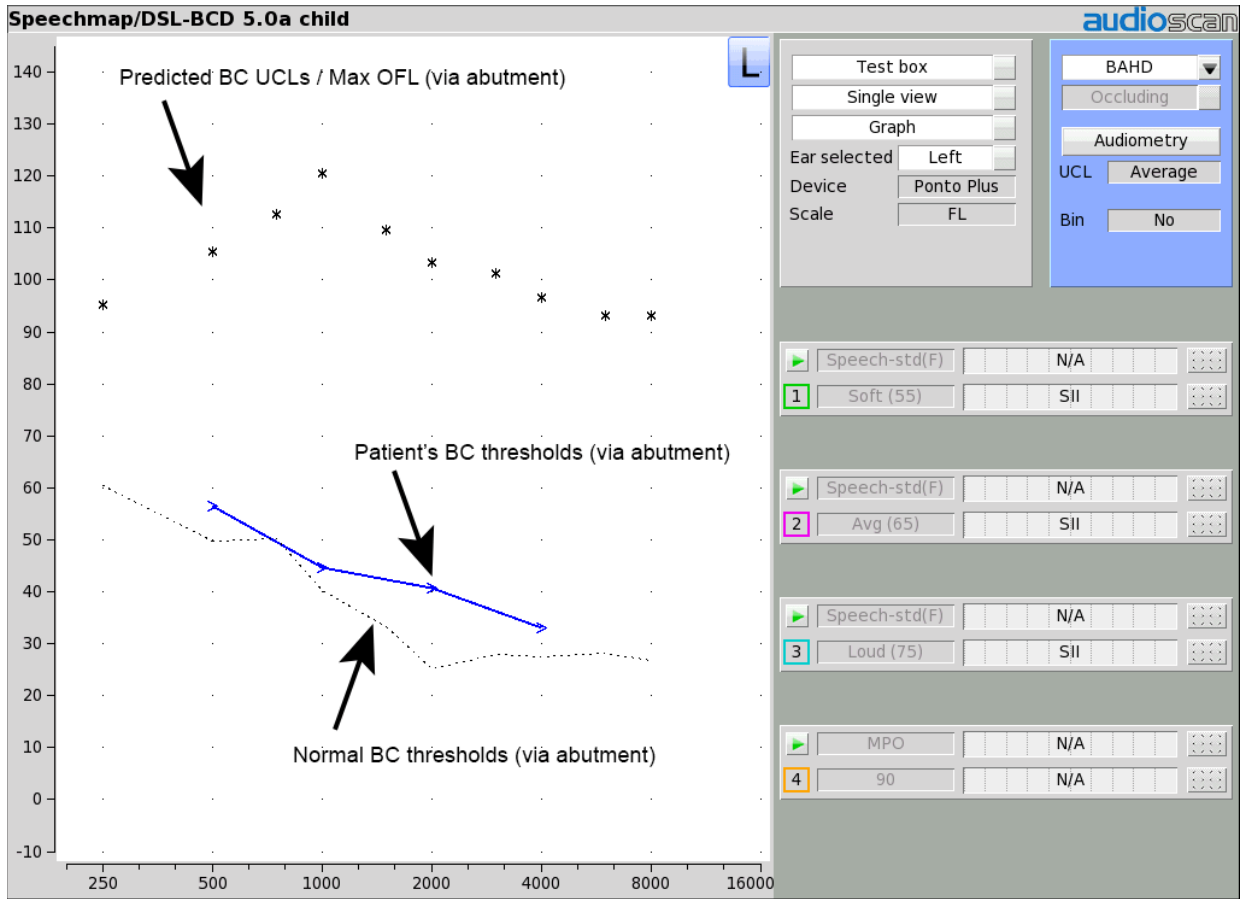
10. Speechmap verification follows the same procedure as with air conduction instruments in test box mode. FL LTASS targets will be displayed for calibrated speech stimuli at each selected presentation level as well as FL REAR90 targets for the MPO stimulus.
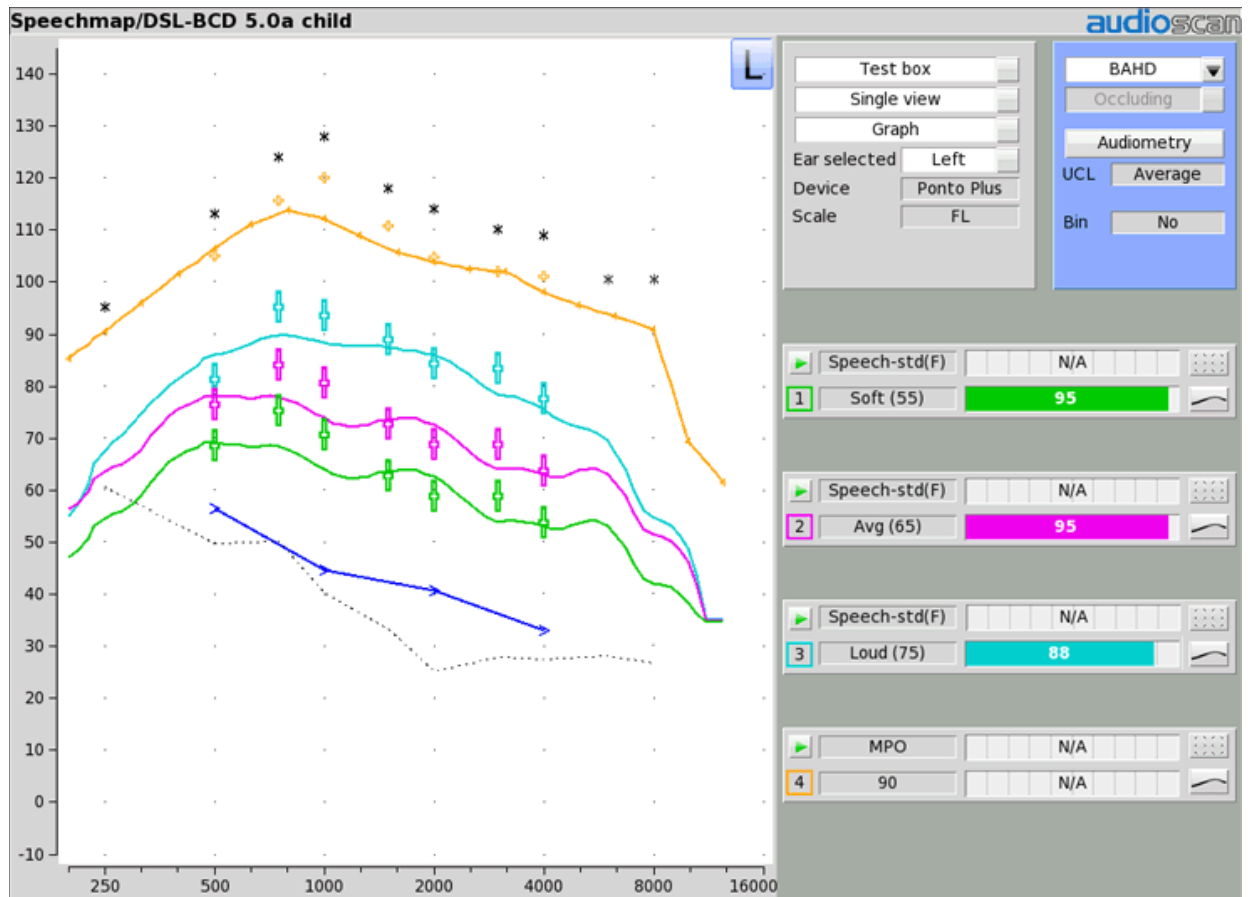
Note: dual view is selectable to show both left and right curves at once, however simultaneous binaural testing is not possible with the Verifit Skull Simulator.

Noise floor verification in Speechmap

The noise floor stimulus in Speechmap measures the circuit noise of the hearing instrument.

Selecting Noise floor from the stimulus list in Speechmap allows a test of the internal noise produced by the hearing instrument. Environmental sounds should be kept as low as possible during the test; however, this test is designed to automatically exclude ambient impulse sounds where possible.

If HL thresholds have been entered in Speechmap, the resulting curve allows comparison between the hearing instrument internal noise level and the SPL thresholds to determine audibility of the circuit noise. The 1/3rd octave noise curve becomes audible where it exceeds the SPL threshold and typically becomes objectionable at 5-12dB above this level (Agnew, 1998).

Automatic test sequencing

Speechmap allows tests to be played automatically in sequence. Tests will play the level and stimulus that has previously been setup for each test.

1. Click Test sequence button to Play all tests. All tests will play in order starting at one with the stimulus and level previously selected.

2. If less than all tests should be played, click ▭ on Test sequencing button to bring up the menu.

3. Select tests to play.

4. Click Play selected.

5. The selected tests will play in order with the stimulus and level previously selected.

6. Click to replay selected tests.

7. Click ▭ and select Play all to change to Play all.

9 Speechmap Technical Details

The following sections outline the principles underlying Speechmap stimuli and measurements, especially for wideband tests.

Wideband measurements in Speechmap

The availability of hearing instruments claiming to provide amplification above 8 kHz, and the reported benefit of those wider bandwidths for young children has motivated Audioscan to extend the bandwidth of the Verifit to 16 kHz which encompasses the 12.5 kHz third octave band. This necessitated several significant advances:

1. Microphones with a flat response to 16 kHz and a low noise floor and development of production calibration processes.

2. A 0.4cc coupler to overcome standing wave problems in the 2cc coupler and increase the signal level.

3. Digitized speech stimuli with measurable energy to 16 kHz.

4. A Wideband RECD (WRECD) measurement protocol based on the 0.4cc coupler and improved to reduce errors associated with the effects of earmold and coupler tubing.

5. Provisions for threshold and WRECD entry to 12.5 kHz.

6. Conversion of entered and normative RECD values to WRECD values for frequencies below 8 kHz.

7. Derivation of Microphone Location Effects (MLE) to 12.5 kHz.

Speechmap stimuli

Speechmap provides a variety of stimuli for the testing of non-linear hearing aids with a range of digital processing features.

The Speechmap fitting environment provides a number of well-controlled, distinctly different stimuli for both On-ear and Test box measurement modes. Several different digitized speech passages are provided as well as the International Speech Test Signal (ISTS) and the single-talker International Collegium of Rehabilitative Audiology (ICRA) distorted speech signal. Two speech passages have been filtered to provide the same long-term average speech spectrum (LTASS) as the ISTS for average vocal effort. In addition, one of these passages has been filtered to suppress the 1/3 octave bands above 1 kHz by 30 dB with the exception of a 1/3 octave band at 3.15 kHz (Speech 3150), a band at 4 kHz (Speech4000), a band at 5kHz (Speech5000) and a band at 6.3 kHz (Speech6300). These latter signals may be used to determine the amount of frequency shift provided by frequency-lowering hearing aids and the sensation level of the lowered components of the speech signal. Pink noise at levels of 50 to 80 dB SPL in 5 dB steps and a tone burst at 85 or 90 dB SPL are also available. The ICRA noise, female and child speech signals are presented as recorded with no spectral shaping.

The ISTS consists of 500 ms segments from recordings of 6 female talkers reading the same passage in American English, Arabic, Chinese, French, German and Spanish. These segments have been spliced together with appropriate pauses and filtered to match the average female spectrum from Byrne et al, An international comparison of long-term average speech spectra. J. Acoust. Soc. Am. 96 (1994), 2108-2120. The 15 second version of this signal has been provided.

Live speech may also be used.

The noise floor stimulus provides no acoustic excitation signal and uses a unique measurement algorithm to reject impulsive noise sources and extract the long term minimum value in the standard Speechmap 1/3 octave measurement bands. This measurement is representative of the noise floor of the hearing aid when tested in a quiet environment.

The speech, ISTS and ICRA signals are presented unfiltered for levels from 50 to 70 dB SPL. At 75 and 80 dB SPL, the spectrum is filtered to represent a 'loud' vocal effort. An 'own voice' filter is also available at the 75 dB SPL level. This is intended to produce a spectrum and level at a BTE microphone location similar to that produced by the voice of an average wearer.

A tone burst (MPO) stimulus provides 128 ms bursts with 128 ms gaps at 1/3 octaves with a level of 90 dB SPL in the test box and 85 dB SPL for on-ear mode.

A EUHA standardized MPO stimulus begins with 5 seconds of ISTS at 55 db SPL, followed by five tones at 90 db SPL (test box), separated by a 250 ms gap. The tones have a duration of 300 ms each, including a 25 ms slope in and out, at 0.5, 1, 2, 3, 4 kHz. The total duration of the stimulus is 7.75 seconds (including the 250 ms pause after the 4 kHz tone). The tones have a level of 85 dB SPL for on-ear mode.

In test box mode, all signals are filtered to include BTE, ITE, ITC, CIC, CIC-shallow, Body microphone location effects. The selected overall rms level is established prior to filtering.

For fitting FM systems, the stimuli may be modified to represent the level (84 dB SPL) and spectrum at a chest microphone location and the level (93 dB SPL) and spectrum at a boom microphone location. These are presented in the test box in both on-ear and test box modes.

The overall SPL, 1/3rd octave band SPL, vocal effort and microphone location effects are given in the following tables for the various broad-band signals available.

Stimulus spectra

Speech signals calibrated for matching to targets have the same LTASS as the ISTS. Modification for Loud spectrum is from ANSI S3.5-1997. Modification for Own voice spectrum is from Cornelisse et al (1991) adjusted to a 1 m reference.

The LTASS of the ISTS is the average female spectrum from Byrne et al (1994), which differs less than 2 dB from the *universal* LTASS (or International LTASS) suggested in this paper and less than 2 dB from the LTASS of Cox & Moore (1988). For all practical purposes, they are equivalent.

For telephone bandwidth simulation, a bandpass filter with cutoffs at 300 Hz and 3300 Hz is applied.

1/3 octave band SPL for speech at 70 dB SPL from Byrne et al (1994) and Cox & Moore (1988)
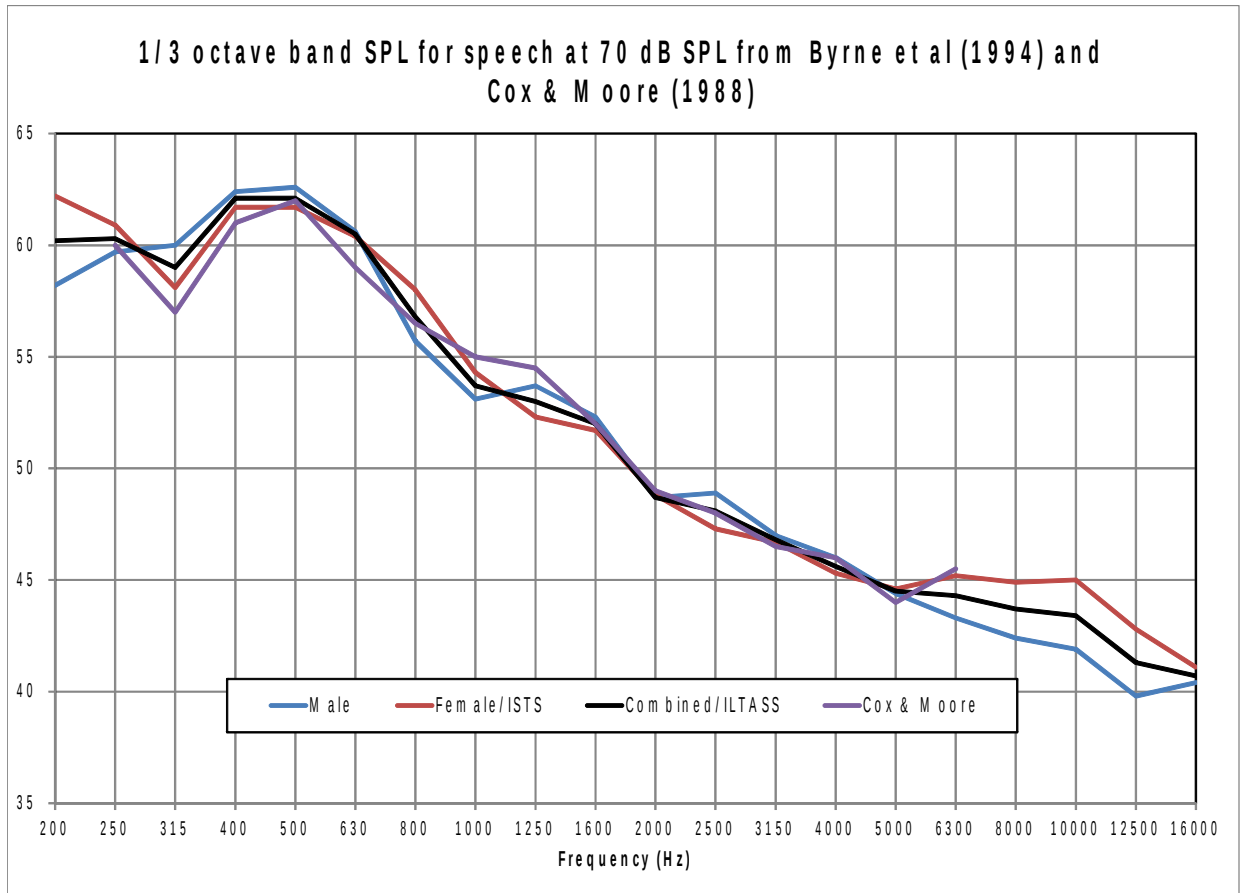
	1/3 octave band SPL					Add to band SPL for			
	Speech			ICRA Noise	Pink Noise	Own Voice	Loud	FM Chest	FM Boom
Hz	Calibrated	Female	Child						
200	57.6	54.6	39.4	53.3	52.2	9.6	-3.0	6.3	16.5
250	56.3	53.7	52.7	55.4	52.2	10.7	3.1	11.7	21.9
315	53.5	49.7	56.5	55.9	52.2	10.9	9.1	16.5	25.5
400	57.1	55.4	54.1	57.4	52.2	10.0	6.0	13.5	22.7
500	57.1	57.2	55.1	57.3	52.2	10.1	8.6	13.8	26.2
630	55.8	58.0	60.6	55.1	52.2	10.5	11.6	21.4	28.3
800	53.4	54.8	56.2	52.3	52.2	10.8	13.5	26.0	31.2
1000	49.7	52.3	53.4	50.4	52.2	10.1	16.3	26.9	34.0
1250	47.7	50.6	45.1	48.5	52.2	4.4	17.7	22.2	36.4
1600	47.1	52.0	41.7	46.5	52.2	4.2	16.4	22.2	34.8
2000	44.2	50.7	39.3	44.3	52.2	5.9	17.0	20.9	33.8
2500	42.7	48.7	35.2	41.9	52.2	5.6	16.1	18.2	33.2
3150	42.1	48.0	30.0	40.5	52.2	1.7	14.9	13.8	30.8
4000	40.7	40.8	31.5	38.7	52.2	-0.6	14.5	12.2	30.3
5000	40.0	36.0	30.7	36.8	52.2	-1.1	9.2	13.0	27.8
6300	40.6	40.9	33.1	35.0	52.2	-0.2	5.1	11.3	27.1
8000	40.3	39.6	34.9	33.1	52.2	-3.8	3.9	11.9	27.7
10000	40.4	28.0	34.1	31.4	52.2	-7.1	2.3	10.7	26.5
12500	38.2	22.6	31.3	29.9	52.2	-10.6	3.1	9.7	25.5
Overall	65	65	65	65	65	75	75	84	93

The above values may differ slightly from previous software versions due to reanalysis of all stimuli and modifiers using newer equipment and analysis software.

Microphone location effects

Microphone location effects (MLE) for RITE, BTE, ITE, ITC and CIC aids were measured in an anechoic chamber on a KEMAR manikin relative to a microphone location on the cheek below the earlobe. The MLEs in the following table are added to the stimulus after the overall rms level has been set.

Deep insertion compensation

The deep insertion of a hearing aid or ear-mold causes the ear canal SPL to be higher than would be estimated by adding and RECD or WRECD to the coupler SPL measured in the test box. This most commonly occurs with Completely-in-Canal (CIC) hearing aids. When this hearing aid type is selected in Speechmap Test box, a deep insertion factor is automatically added to the estimated ear canal SPL. The factor in the following table is from DSL 5.0 and has been interpolated to 1/3 octave frequencies and extrapolated for frequencies above 6 kHz.

	Microphone Location Effects					Deep Insertion
	Add to all stimuli in test box mode					Add to Est. Canal SPL
	Hearing instrument type					
Frequency	RITE/BTE	ITE	ITC	CIC	BODY	CIC
200	0	0	0	0	3.0	1.9
250	0.3	1	0.9	1.3	3.0	1.9
315	0.7	1.3	1.2	1.8	3.0	2.6
400	0.2	0.8	0.8	1.2	3.0	3.3
500	-0.1	0.8	1	1.3	4.0	4.0
630	-1.7	-0.3	-0.2	0.2	3.0	4.6
800	-2	-0.6	-0.4	0.1	2.0	5.2
1000	-2.2	-1.1	-0.9	-0.4	0	5.8
1250	-0.3	-0.6	-0.5	0	0	6.0
1600	4.9	3.9	3.7	4.2	-4.0	6.1
2000	6.1	6.9	6.9	8.1	-4.0	6.1
2500	1.8	5.1	5.5	7.4	-3.0	6.4
3150	-0.4	2.7	2.9	5.7	-2.0	6.6
4000	0.2	6	4.8	8.6	0.0	7.7
5000	2.6	10.4	7.9	12.7	0.0	8.1
6300	3	5.2	1.2	9	0.0	8.4
8000	3.7	-1.6	-0.4	3.5	0.0	8.4
10000	3.7	1.6	4.6	0.8	0	8.4
12500	2.3	2.2	3.3	3.2	0	8.4

T-Loop field strengths

The T-Loop produces a magnetic field strength equivalent to the IEC specification (70 dB SPL = 100 mA/m) and the ANSI specification (60 dB SPL= 31.6 mA/m) for a linearly operating hearing aid.

Equivalent Acoustic Level (dB SPL)	Magnetic Field Strength (mA/m)
50	10
55	17.8
60	31.6 (ANSI)
65	56.2
70	100 (IEC)
75	178
80	316

Speech signal analysis

One of the most-used measures of a speech signal is the long-term average speech spectrum (LTASS). This is a 1/3 octave spectrum averaged over a sufficiently long portion of the speech material to provide a stable curve. In practice a 10 second average meets this requirement and, for this reason, all Verifit passages are at least 10 seconds long.

The dynamic nature of speech is often characterized by the distribution of short-term levels in each 1/3 octave band. These levels are determined by calculating a spectrum for each of a series of short time periods within the passage. Historically, time periods of 120, 125 or 128 ms have been used. The Verifit uses a 128 ms time period, resulting in 100 levels (or samples) in each 1/3 octave band for a 12.8 second passage. The level in each band that is exceeded by 1% of the samples (called L1 or 99th percentile) has historically been referred to as the speech peak for that band. The curve of the 99th percentile is approximately 12 dB above the LTASS. The level in each band that is exceeded by 70% of the samples (called L70, or 30th percentile) has historically been called the valley of speech for that band. The curve of the 30th percentiles is approximately 18 dB below the LTASS. The region between these two curves is often called the speech region, speech envelope or speech 'banana'. The speech envelope, when derived in this way, has significance in terms of both speech detection and speech understanding. Generally, speech will be detectable if the 99th percentile is at or near threshold. The Speech Intelligibility Index (SII) is maximized when the entire speech envelope (idealized as a 30 dB range) is above (masked) threshold. This will not be an SII of 100% (or 1) because of loudness distortion factors, but higher SII values will not produce significantly higher scores on most test material. The speech-reception threshold (SRT) is attained when the LTASS is at threshold (approximately - depending on test material and the individual).

10 On-Ear Instrument Measures

A number of the tests covered in Test box measures can also be performed with the hearing instrument coupled to the ear of a client rather than to a coupler. The on-ear results may be expected to differ from the test box results because of the different acoustic environment and the different acoustic load.

On-ear directional test overview

The Verifit directional test measures directional performance in real-time and displays simultaneous curves representing stimulus delivered to the front and back of the hearing instrument. It is compatible with all forms of hearing aid processing, including frequency lowering, feedback compensation, and other non-linear algorithms. Speech is added as a conditioning signal to ensure automatic, speech-activated directional programs become active.

Test levels are selectable in 5 dB steps. When speech is active it is presented from the front speaker and noise is presented from the back speaker(s) at a selectable signal-to-noise ratio. At periodic intervals, the level of the speech and noise is momentarily reduced and an additional noise burst is played from either the front or back speaker to measure the response from that direction. This burst is extremely fast and will not influence the behavior of the hearing aid. The measured SPL is analyzed into two curves labeled F (front) and B (back) to indicate which speaker generated the curve. The real-time nature of the test allows the operation of adaptive directional systems to be readily visualized.

Optionally, speech may be disabled which will cause the directional test to alternate noise bursts from the front and back speaker. This test may not produce a directional response in all hearing aids.

Once directional performance is observed, the test may be terminated.

Because this measurement is carried out in a real room, results are not expected to agree with data taken in large anechoic chambers. Due to strong reflected signals, measurements made in small, reverberant rooms will show less separation between front and back response curves, just as the benefits of directional technology will become less apparent in similar situations. When performed in a sound booth or relatively anechoic space, this test can be used to demonstrate and verify directional benefit and to provide assurance that the directional microphone array has been correctly assembled and programmed and has not deteriorated due to element drift or clogged ports.

On-ear directional testing

Best results are obtained using external front and back sound field speakers positioned well away from reflective surfaces. See <u>External sound field speaker setup</u>. Refer to <u>On-Ear Measures - Setup</u> to prepare the system for use and for proper positioning of the client and the probe tube.

1. Insert the earmold or custom hearing instrument into the ear, being careful not to advance the probe tube further into the ear canal. A lubricant applied in the vicinity of the probe tube will ease insertion and prevent slit leaks.

2. Right-click the mouse to raise the Home prompt and select [Directional] under On-ear.

3. Select which ear to test, or select the binaural link to test both ears (Dual view only).

4. Select Test 1, 2, 3 or 4 by pressing ▶. Two real-time curves will appear on the screen for each ear under test – the thick curve is the response from the front speaker and the thin curve the response to the back speaker signal. For a non-directional instrument, the two curves will be nearly identical. Setting the instrument for directional operation should produce a separation of the curves.

5. On the Test control poster, select a level from the [Level] drop-down list. For an adaptive directional instrument, a stimulus level between 60 and 70 dB should cause the separation to change over a 15 to 45

second period. For a noise-reducing instrument, both curves may change with time and stimulus SPL.

6. Select a signal to noise ratio from the [Speech S/N] drop-down list. A S/N ratio between 0 and 6 dB will usually induce directional performance after 15 to 45 seconds. Optionally, select [Speech SN] and select Off. This setting presents only noise alternating between the front and back speaker. Speech-adaptive directional instruments may appear to be non-directional if [Speech S/N] is set to Off.

7. Click 🔴 to capture curves or click ⬛ to abort the test.

On-ear feedback test

This test shows the LTASS (upper graph) and the power concentration ratio (PCR) (lower graph) for a speech signal. The PCR measures the degree to which a large amount of power is concentrated at a small number of frequencies in the hearing aid output (see Freed & Soli in <u>References</u>). In the Verifit, the PCR is the ratio of the average power of the dominant frequency components in a 1/12 octave band to the power in the entire band, expressed in dB. Because the gain of a compression hearing aid varies with the signal it is processing, the PCR is calculated in real time while a speech signal is presented to the hearing aid. The upper graph shows the LTASS for the speech signal while the lower graph shows the PCR relative to the PCR for speech without feedback. Feedback results in a peak in the speech spectrum and in the PCR. Incipient feedback results in a peak in the PCR curve.

Refer to <u>On-Ear Measures - Setup</u> to prepare the system for use and for proper positioning of the client and the probe tube.

1. Insert the earmold/tip or custom hearing instrument into the ear, being careful not to advance the probe tube further into the ear canal. A lubricant applied in the vicinity of the probe tube will ease insertion and prevent slit leaks.

2. Set the instrument as it will be used, with feedback suppression enabled and initialized.

3. Right-click the mouse to raise the Home prompt and select [Feedback] under On-ear.

4. Left-click Test 1 and set the Stimulus to Speech-std(F) and the level to 50 or 60 dB SPL. As the speech passage plays, observe the feedback bar and the lower graph. A yellow Feedback bar and peaks with yellow markers in the lower curve indicate incipient feedback which may impact sound quality. A red Feedback bar and peaks with red markers in the lower curve indicate feedback that may be audible and should be mitigated. Click 🔴 to run the full speech passage and capture average results for the passage.

5. Repeat for Test 2, 3 and 4 as needed. These tests may be used to explore the effects of jaw movement and the presence of hands, hats and telephone handsets.

On-ear noise reduction test

The noise reduction test measures the ability of a hearing instrument to suppress broadband, steady-state noise. When the test starts, noise is presented to the hearing instrument at the selected level. The response of the hearing instrument is captured before the noise reduction activates and is shown as a thick curve on the graph. A comparison curve shows the hearing instrument reacting to the noise in real-time. The overall RMS noise reduction value in dB from the captured curve to the current curve is reported. A timer shows the duration of the test. This timer can be used to determine how long the noise reduction took to activate and for repeated comparisons.

Noise reduction may be run binaurally. In binaural mode, the responses from two hearing instruments can be observed simultaneously. Select the binaural link before starting a test to enable binaural mode.

The initial curve captured when the test is started actually reflects the output of the hearing instrument two seconds from the first presentation of the noise signal. For most hearing instruments this represents the

amplification before the noise reduction activates. Some models of hearing aid, however, have fast acting noise reduction circuits in which gain may drop prior to the capture of this initial curve. To test these accurately, use the pink noise stimulus. When pink noise is selected as a stimulus the test becomes adaptive and the initial curve will capture the peak level produced by the hearing instrument regardless of the speed of NR onset.

To access the On-ear noise reduction test, right-click the mouse to raise the Home prompt and select [Noise reduction] under On-ear.

1. Refer to <u>On-ear Measures – Setup</u> to prepare the system for use and for proper positioning of the client and the probe tube.

2. Click on ▶ in any of the test areas.

3. Select a noise stimulus type from the list box.

4. Select a stimulus level in dB SPL from the list box.

5. Click ▶ to begin the test.

6. Click ● to capture the comparison curve once the noise reduction function has responded.

7. At any point click ■ to stop the test without recording any data.

On-ear noise reduction stimuli

Noise reduction offers the following stimuli for evaluating the noise reduction performance of a hearing instrument.

Air conditioner is an example of the noise created by a household air conditioner.

Vacuum is a sample of noise from the operation of a vacuum cleaner on a carpeted floor.

Multi-talker Babble is the combination of ten different adult talkers; seven of the talkers are female and three are male. Eight of the talkers are speaking English, one is speaking French, and the last one is speaking German. All talkers were normalized to the same overall output level before being positioned at random positions around the listener. Loudness smoothing was performed on the babble in 1/3rd octave bands to reduce the magnitude of short-term peaks and valleys.

Pink noise is an internally generated steady state stimulus with a flat frequency spectrum. This stimulus is capable of measuring hearing aids with fast acting noise reduction using a custom algorithm that can extract the peak curve faster than the other stimuli.

On-ear manual control

1. Refer to On-Ear Measures - Setup to prepare the system for use and for proper positioning of the client and the probe tube.

2. Right-click the mouse to raise the Home prompt and select [Manual control] under On-ear.

3. To switch ears, move mouse cursor to the appropriate side.

4. Use [Mode] to toggle between On-ear or Test box modes.

5. Click the Level window, then select the desired stimulus level from the drop-down list.

6. Click the Frequency window, then select the desired frequency from the drop-down list. (Distortion measurement data is available only from 200-2500 Hz.)

7. Click [Start test] to start the test. [Start test] changes to [Stop Test]. To stop the measurement, click [Stop test]. You may change Level and Frequency without stopping the test.

Sound level meter using on-ear microphones

The manual control feature enables the Verifit to be used as a sound level meter to perform C-weighted, A-weighted or 1/12th octave analysis of sound as measured by the probe and reference microphones. A and C-weighted measurements are limited to frequencies above 100 Hz and the averaging time and update rate are 384 ms.

1. Refer to On-Ear Measures - Setup to prepare the system for use and for proper positioning of the client and the probe tube.

2. Right-click the mouse to raise the Home prompt and select [Manual control] under On-ear.

3. Click the Level window, then select 0 dB stimulus level from the drop-down list.

4. Click the Filter window, then select 1/12th octave, A-weighted, or C-weighted from the drop-down list.

5. For 1/12th octave filter, click the Frequency window, then select the desired frequency from the drop-down list.

6. Click [Start test] to start the test. [Start test] changes to [Stop Test]. To stop the measurement, click [Stop test]. You may change Level and Frequency without stopping the test.

11 WRECD measurement

The WRECD (Wideband Real-Ear to Coupler Difference) may be individually measured to improve the accuracy of hearing aid fittings. The measurement procedure may be accessed by selecting WRECD from the *On-ear tests* list on the home menu or from the Audiometry poster within *Speechmap*.

Calibration of WRECD Transducer

⚠	**WARNING:** Foam eartips are for single-patient use only
⚠	**WARNING:** The WRECD transducer may be adversely affected if it comes in contact with a magnet. Do not store where it may come in contact with any permanent magnet. If contact with a magnet is suspected, transducer re-calibration is recommended prior to any patient measurements,

WRECD values are stored and expressed as referenced to the 0.4 cc wideband coupler. A calibration of the Audioscan RECD transducer in this coupler is required at a minimum of weekly.

1. Connect the WRECD transducer to the WRECD jack on the Probe Dock. Prepare the system for test box tests. See Microphone connection, Calibrating test box reference microphone.

2. Choose WRECD from the On-ear list on the home menu.

3. Select the RECD coupling method that will be used on the ear. Audioscan software supports both foam eartips and personal earmold, however this choice must be made prior to measurement.

4. Attach the TRIC adapter to the 0.4cc coupler and attach this to the blue coupler microphone.

5. Insert the nozzle of the WRECD transducer all the way into the opening of the TRIC.

6. Click [✔]. This causes a broadband signal to be applied to the WRECD transducer and the 0.4cc coupler SPL to be recorded and displayed.

7. Select Interval to toggle the measurement interval for the coupler response between daily and weekly.

8. To change the Weekly calibration day, right-click to raise the Home menu, left-click [Setup], then left-click [Date & Time].

Measure WRECD

Connect the RECD transducer to the RECD jack on the Probe Dock. See <u>WRECD coupler response</u>.

Prepare the system for on-ear tests. See <u>Calibration of on-ear probe microphone</u>.

1. Select [WRECD] on the home menu.

2. Select the WRECD coupling method that will be used on the ear. Audioscan software supports both foam eartips and personal earmolds, however this choice must be made prior to measurement.

3. If no RECD calibration exists or the measurement interval has been exceeded, go to 15.3: Calibration of WRECD transducer. If a valid transducer calibration exists, select [Measure real ear].

4. Couple a standard insert earphone foam eartip to the nozzle of the WRECD transducer. If using an earmold, seal any vent at its medial end.

5. Refer to Positioning the probe tube and insert the probe tube into the ear canal to within 2 - 5 mm of the eardrum.
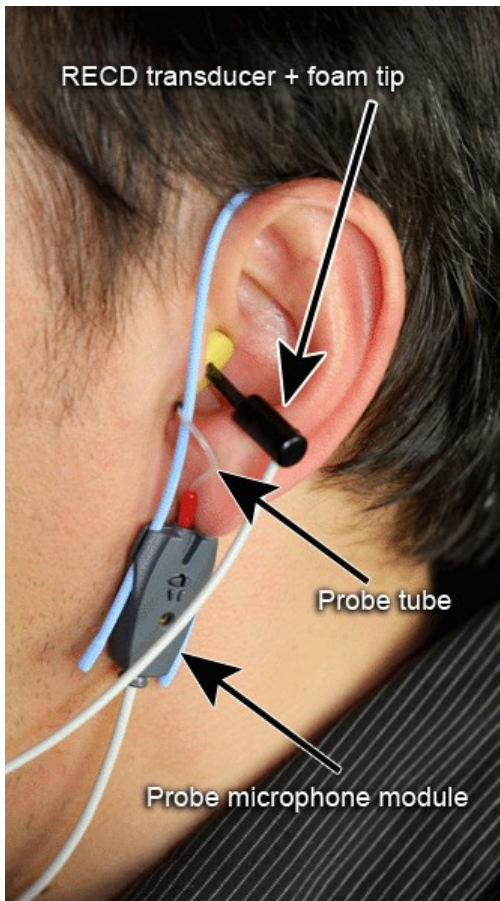
6. Insert the foam tip or earmold into the ear, being careful not to advance the probe tube further into the ear canal. Insertion depth should be as used with insert phones. *Allow the foam tip to fully expand in the ear.* Insertion depth should be as used with insert phones.

7. Select ✓ to generate the real-ear response curve (magenta) and the WRECD curve (blue). If the WRECD

curve is *negative and unstable* in the low frequencies, check the seal of the foam tip. Increase the tip size and/or apply a lubricant to the foam tip to improve the seal. If the WRECD curve deviates more than 10 dB from the average in the 4 - 6 kHz region, check for proper probe placement and possible blockage of the tube by the foam tip or cerumen.

8. When these curves are stable, select ✓ to save them.

9. Use the Copy button to copy from either side to the other. The button is disabled if both sides are empty or both sides contain measured WRECD data.

10. The Delete button can be used to erase measured WRECD data.

11. An equivalent HA-1 RECD converted from the measured WRECD may be shown on the graph using the hide / show button. HA-1 RECD may be used for troubleshooting measurement issues

For comparison purposes, the age-related average WRECD is shown as a dotted curve on the screen. If you have accessed WRECD from the main menu, you may click the Age box to change the age for this reference curve.

WRECD results

The WRECD measurement screen shows the response of the WRECD transducer in the 0.4cc coupler (1) and in the real ear (2). The difference between these curves is the WRECD (3). The age-appropriate average WRECD is shown for reference (4).

Since WRECD uses the 0.4cc coupler rather than 2cc, it is normal to see negative numbers since the volume of the wideband coupler more closely matches that of an ear. A WRECD with large negative slope in the low frequencies may indicate a poor seal between the foam tip and the ear canal, or an open vent in an earmold. A negative WRECD above 1 kHz often indicates a blocked or pinched probe tube. See WRECD facts.

WRECD protocols

To facilitate wideband Test box Speechmap, the Verifit 2 requires a WRECD. For threshold corrections in the HL-to-SPL transform, the 0.4cc WRECD is converted to an HA-1 RECD or an HA-2 RECD including tubing effects, based on whether the stated HL transducer is Insert+foam or Insert+mold respectively. If the RECD was measured with an earmold, these tubing effects will be specific to the client's earmold; if it is measured with a foam tip, they will be based on average earmold tubing.

For Test box Speechmap involving BTE instruments the earmold tubing must be considered. If the BTE is coupled to the 0.4cc coupler using the personal earmold, the tubing effects will be part of the measurement. If the TRIC adapter with HA-4 tubing (earmold substitute) is used, the 0.4cc wideband coupler WRECD will be converted to an HA-4 0.4cc WRECD. As with the threshold correction above, the use of the earmold in RECD will include the effects specific to the client's earmold, otherwise an average earmold is assumed.

The following describes acceptable RECD measurement protocols and Test-box Speechmap coupling combinations for BTE instruments and the implications of each in the test box simulation.

ANSI S3.46 method:

WRECD On-ear measurement: Audioscan WRECD transducer + foam eartip

Test-box Speechmap coupling: client's personal earmold + 0.4cc wideband coupler

With this method, WRECD is a property of the ear only, and not dependent on the transducer or sound source coupling. The earmold effects will be part of the measurement in the test box. Measured WRECD is appropriate for coupler simulation and error is minimized.

Alternate method #1:

RECD On-ear measurement: Audioscan WRECD transducer + client's personal earmold

Test-box Speechmap coupling: HA-4 tubing (earmold substitute), TRIC adapter, and 0.4cc coupler

This method utilizes the client's personal earmold for the on-ear RECD measurement. The 0.4cc WRECD is converted to HA-4 reference with earmold effects retained and is applied in Testbox Speechmap.The error introduced is the difference between the earmold effects when connected to the hearing instrument receiver and earmold effects when connected to the WRECD transducer.

If the total earmold tubing length is less than 35mm, it is recommended that Foam tip be selected in the WRECD Coupling field. This will bypass the correction and increase accuracy for small earmolds.

Alternate method #2:

RECD On-ear measurement: Audioscan WRECD transducer + foam eartip

Test-box Speechmap coupling: HA-4 tubing (earmold substitute), TRIC adapter, and 0.4cc coupler.

Since the RECD here is measured with a foam eartip, an average earmold is added to obtain an HA-4 RECD with earmold effects. The error involved will be the difference between the actual earmold and the average used.

Alternate method #3:

RECD On-ear measurement: Audioscan WRECD transducer + client's personal earmold

Test-box Speechmap coupling: client's personal earmold + 0.4cc wideband coupler.

An average earmold will be subtracted from the measured RECD to obtain a 0.4cc coupler WRECD without earmold effects. The actual earmold will be introduced during test box simulation, but error will exist equal to the difference between the earmold measured on the RECD transducer and the average earmold that was subtracted.

WRECD facts

Individual RECD values are derived by comparing the SPL produced by a sound source in the closed ear canal to that produced by the same sound source in a 2cc coupler. It is commonly assumed that the RECD so measured is a property of the individual ear and is independent of the sound source used to obtain it, making it useful for (1) correcting hearing level (HL) data measured using insert earphones for individual ear acoustics when the standard foam tip has been used (2) correcting hearing level (HL) data measured using insert earphones for individual acoustics and the use of a custom earmold in place of a standard foam tip, and (3) converting measured coupler SPL in Test box mode to estimated occluded ear SPL. However, this assumption is true, only if the acoustic impedance of the sound source is significantly higher than the acoustic impedance of the ear canal or the coupler. This is the case for ITE and ITC hearing aids and is approximately true for insert earphones with the supplied foam tips. The acoustic impedance of insert earphones drops if the foam tip is replaced by an earmold or the tubing that forms part of the HA-2 coupler. At some frequencies, for BTE hearing aids with their earhooks and earmold tubing (or the HA-2 coupler tubing), the acoustic impedance approaches that of an adult ear and falls below that of a child's ear. Each of these sound sources will produce a different RECD and, if the acoustic impedance of the sound source differs for the ear canal and 2cc coupler measurements, further RECD differences will result.

The Verifit requires RECD data up to 12.5 kHz to facilitate wideband testing, and as a result RECD has been

renamed to WRECD (Wideband Real Ear to Coupler Difference) and utilizes the 0.4cc wideband coupler in place of the ANSI 2cc coupler. The Audioscan WRECD measurement protocol uses the Audioscan WRECD transducer as the sound source for ear canal SPL measurement and the 0.4cc wideband coupler calibration. The use of the 0.4cc coupler in Test box Speechmap is desirable because it raises the high frequency SPL of the hearing aid by more than 20 dB, making the rising noise floor of the coupler microphone less significant. Its use for high frequency RECD measurement is desirable because of resonances in the HA-1 coupler.

The revisions of ANSI S3.46 (2013) and IEC 61669 (now in process) define RECD as utilizing a high impedance coupled sound source and the HA-1 coupler. The Audioscan wideband transducer with a foam tip meets the high impedance requirement but the use of the 0.4cc coupler in the Verifit 2 means that the resulting WRECD is not the RECD defined in the revised standards.

If you use insert ear phones for audiometry OR if you verify using the test box, you should measure WRECD (preferred) or use age-related average WRECD.

If you use headphones or sound field for audiometry AND you use on-ear tests for verification, WRECD is not applied in any way and need not be measured.

Insert phone audiometry with measured WRECD and on-ear verification provides the best fitting accuracy, with test box verification being slightly less accurate. Insert phone HL data with age-related average WRECD is next best.
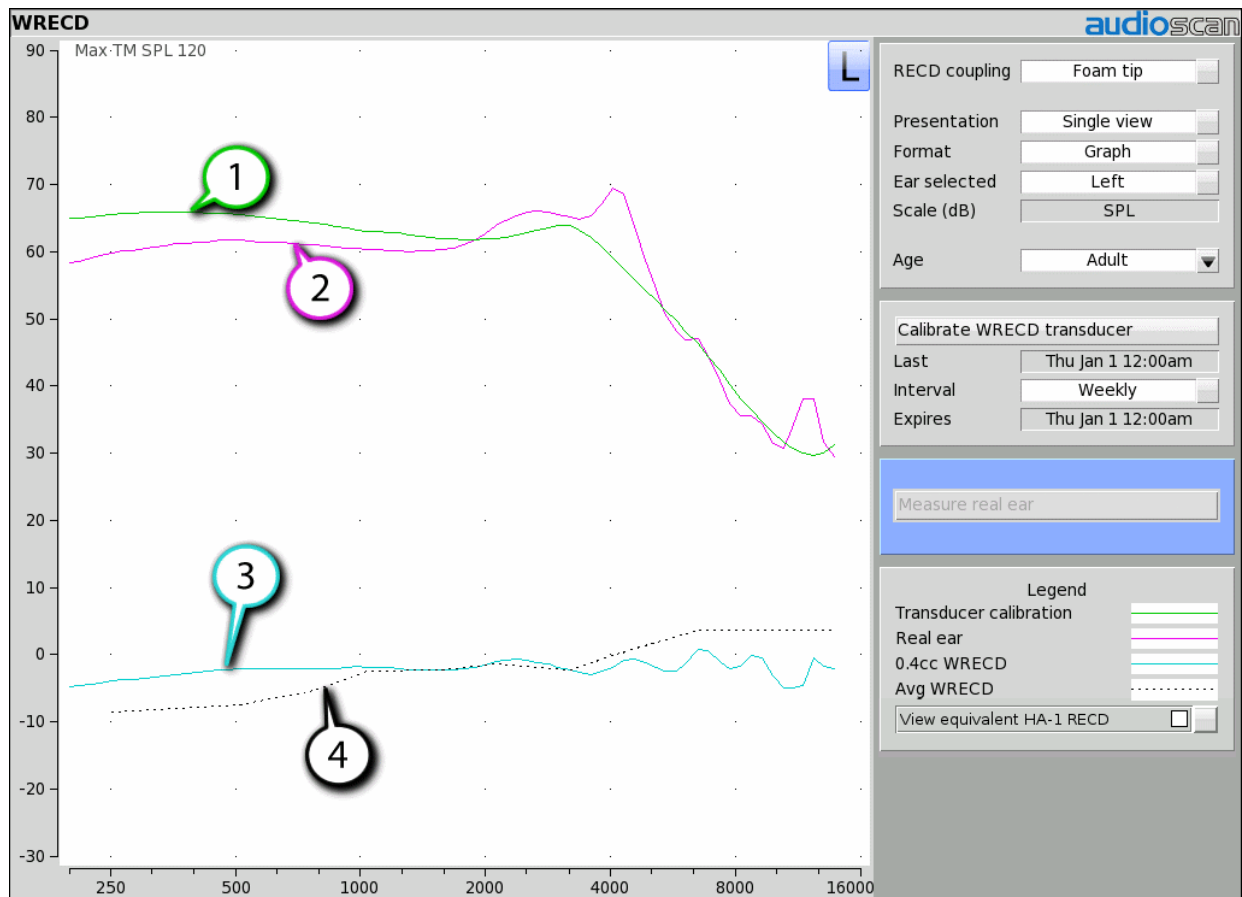
12 Occlusion Effect Test

The occlusion effect refers to the unnatural sound of one's own voice that results from occluding the external ear. It is the result of the high SPL produced at the back of the throat during a closed vowel utterance coupling to the closed ear canal via bone conduction. Ear canal levels in a closed ear canal can exceed 90 dB SPL for closed vowels such as 'ee'. The effect is greatest below 1000 Hz. Clients with mild-moderate low frequency hearing loss may describe their own voice as sounding 'hollow' or as if they were talking 'in a barrel'.

The occlusion effect is measured by comparing the SPL in the ear canal to that outside the external ear while the client vocalizes 'ee' with the hearing aid in place and turned off. Differences greater than 10 dB may result in complaints. This occlusion effect measurement is useful in quantifying the extent to which venting or deep insertion is addressing the underlying cause of the complaint.

Occlusion effect measurement

1. Refer to On-Ear Measures - Setup to prepare the system for use and for proper positioning of the client and the probe tube.

2. Insert the earmold or custom hearing instrument into the ear, being careful not to advance the probe tube further into the ear canal. A lubricant applied to the earmold or custom instrument shell in the vicinity of the probe tube will make insertion easier and prevent slit leaks around the tube.

3. To switch ears, move mouse cursor over the appropriate side.

4. *Turn the hearing aid OFF.*

5. Right-click and select [Occlusion].

6. Click [Start test]. [Start test] changes to [Stop Test].

7. While the client vocalizes 'ee' in a normal voice, left-click [Stop test] to stop the test and freeze the screen. A red occlusion bar indicates an occlusion problem, a yellow bar indicates a possible problem and a green bar indicates no problem.

8. Increase venting and repeat the test until a green bar is obtained.
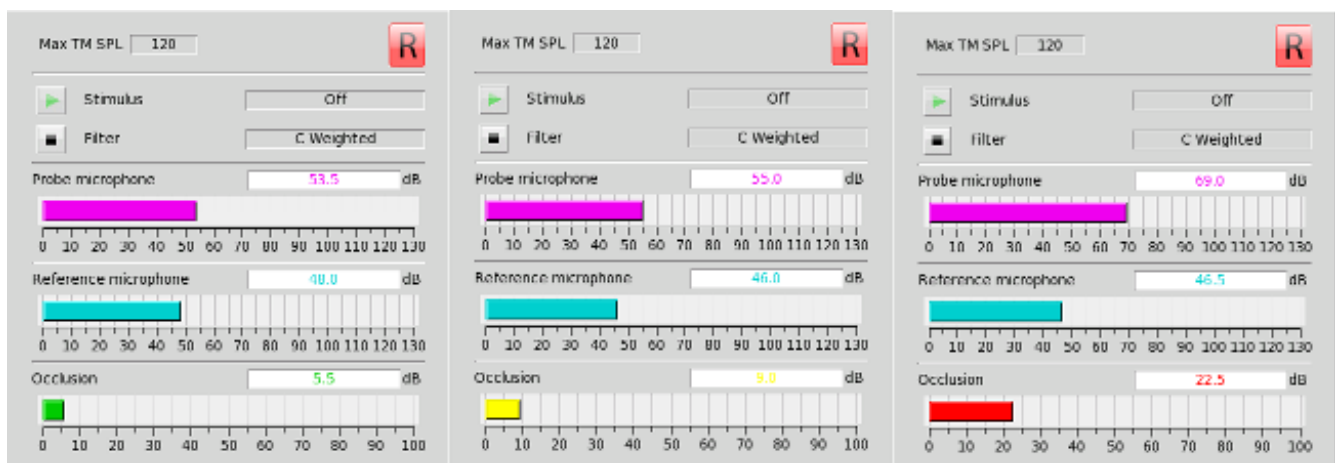
13 Sensory loss simulator

This sensory loss simulator (SLS) is intended to allow normal-hearing listeners to hear sounds as if they had the elevated threshold and altered loudness perception caused by outer and inner hair cell damage. It is based on the cochlear hearing loss model described in Moore & Glasberg (2004).

Sensory loss simulator description

A pure conductive loss attenuates loud and soft sounds equally, and is easily simulated by just turning down the volume or inserting an earplug. Losses of a sensory nature are more complex and more difficult to simulate.

The most common sensory loss is caused by *outer hair cell* damage and results in loss of audibility for soft sounds but near-normal loudness for loud sounds. *Inner hair cell* damage elevates threshold and reduces loudness for both soft and loud sounds, possibly somewhat more for soft sounds.

In this simulation, losses less than 58 dB SPL are considered to be due entirely to outer hair cell damage. Any loss greater than this is considered inner hair cell loss.

This SLS does not simulate broadening of the auditory filters or other distortions that may accompany cochlear hearing loss.

To properly experience the simulation, listeners should be within 1m of the sound field speaker and in a quiet room.

Sensory loss simulator operation

1. Right-click mouse to raise home menu and select [Speechmap] in either the Test box or On ear mode.

2. If an audiogram has previously been entered in Speechmap or Insertion gain, go to step 5. Otherwise, click on the [Audiometry] button.

3. Enter HL threshold values using the mouse. Click the mouse on the audiogram form to enter a point. Click again to delete the point.

4. Click ✔ to return to the [Speechmap] screen when all points have been entered.
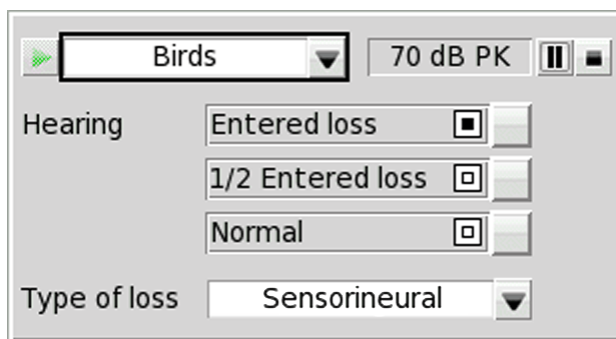
5. Click the [Loss simulator] button.

6. Click ▶. Sound, processed to simulate the entered hearing loss, will be presented via the sound field speaker. *Listeners should be within 1m (approx. 3 ft) of the sound field speaker and in a quiet room.*

7. Click on the field next to the play button to choose from a list of sounds to play.

8. Click one of the Hearing buttons to simulate the Entered loss, 1/2 Entered loss, or Normal hearing.

9. Click [Type of loss] to toggle between [Sensorineural] and [Conductive] hearing loss simulations.

10. Click ▣ or ▯▯ to stop the demonstration and freeze the stimulus speech banana on the screen.

11. Click on ☒ to exit from the Sensory Loss Simulation screen.

14 Insertion Gain

Insertion gain is the difference between aided and unaided ear canal SPL (REIG = REAG - REUG). It inherently assumes a sound field audiogram. For non-linear hearing aids, REIG is stimulus-dependent and the dependency is specific to each hearing aid. Insertion gain fitting methods ignore these facts. **Speechmap is recommended for fitting all linear and non-linear hearing instruments.**

Refer to <u>On-Ear Measures - Setup</u> and <u>On-Ear Measures Screen Setup</u> for terminology and information on preparing the system for use and for proper positioning of the client and the probe tube.

Insertion gain in SPL

1. Click the right mouse button and then select [Insertion gain].

2. Click [Instrument] to chose from BTE, ITE, ITC, CIC, CROS, Body. This changes the CORFIG used for 2cc targets.

3. Click fitting method to chose from FIG6, NAL-NL1, NAL-R, POGO II, Berger, Libby, User, None
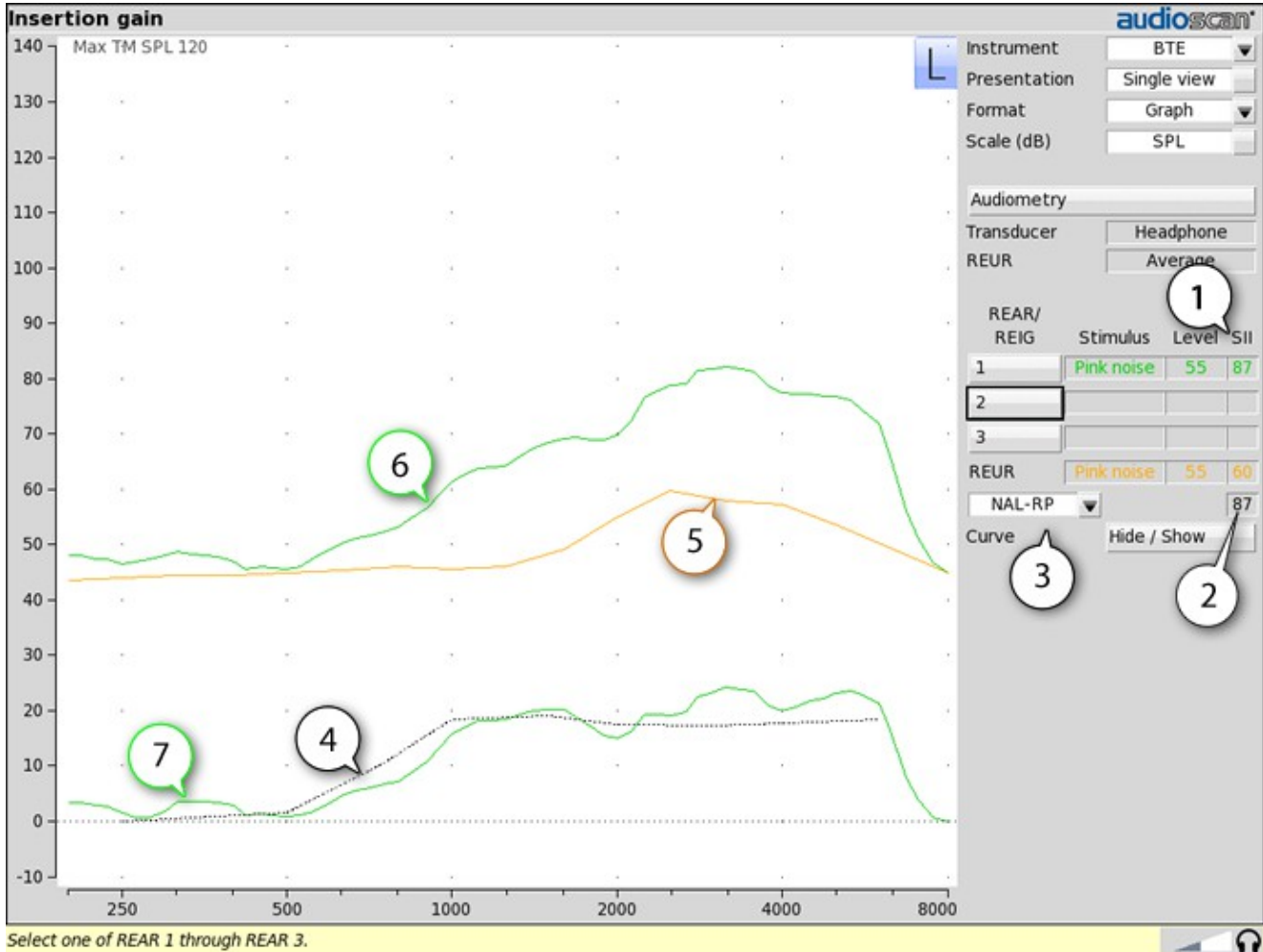
1. Speech Intelligibility Index (SII), 2. SII for target, 3. Fitting method, 4. Target REIG, 5. REUR, 6. REAR 1, 7. REIG 1.

Insertion gain in HL

Refer to <u>On-Ear Measures - Setup</u> and <u>On-Ear Measures Screen Setup</u> for terminology and information on preparing the system for use and for proper positioning of the client and the probe tube.e

1. Click the right mouse button and then select [Insertion gain]

2. Click [Instrument] to chose from BTE, ITE, ITC, CIC, CROS, Body. This changes the CORFIG used for 2cc targets.

3. Click the fitting method button to chose from FIG6, NAL-NL1, NAL-RP, POGO II, BERGER, LIBBY, USER, NONE.

An estimated aided threshold curve is calculated by shifting the unaided threshold curve upward by the REIG. This estimate assumes a) the *unaided threshold is a sound field threshold* and b) a *linear aid* (i.e. REIG doesn't depend on level).

The REUR curve uses the right-hand SPL scale and is shown for reference only.
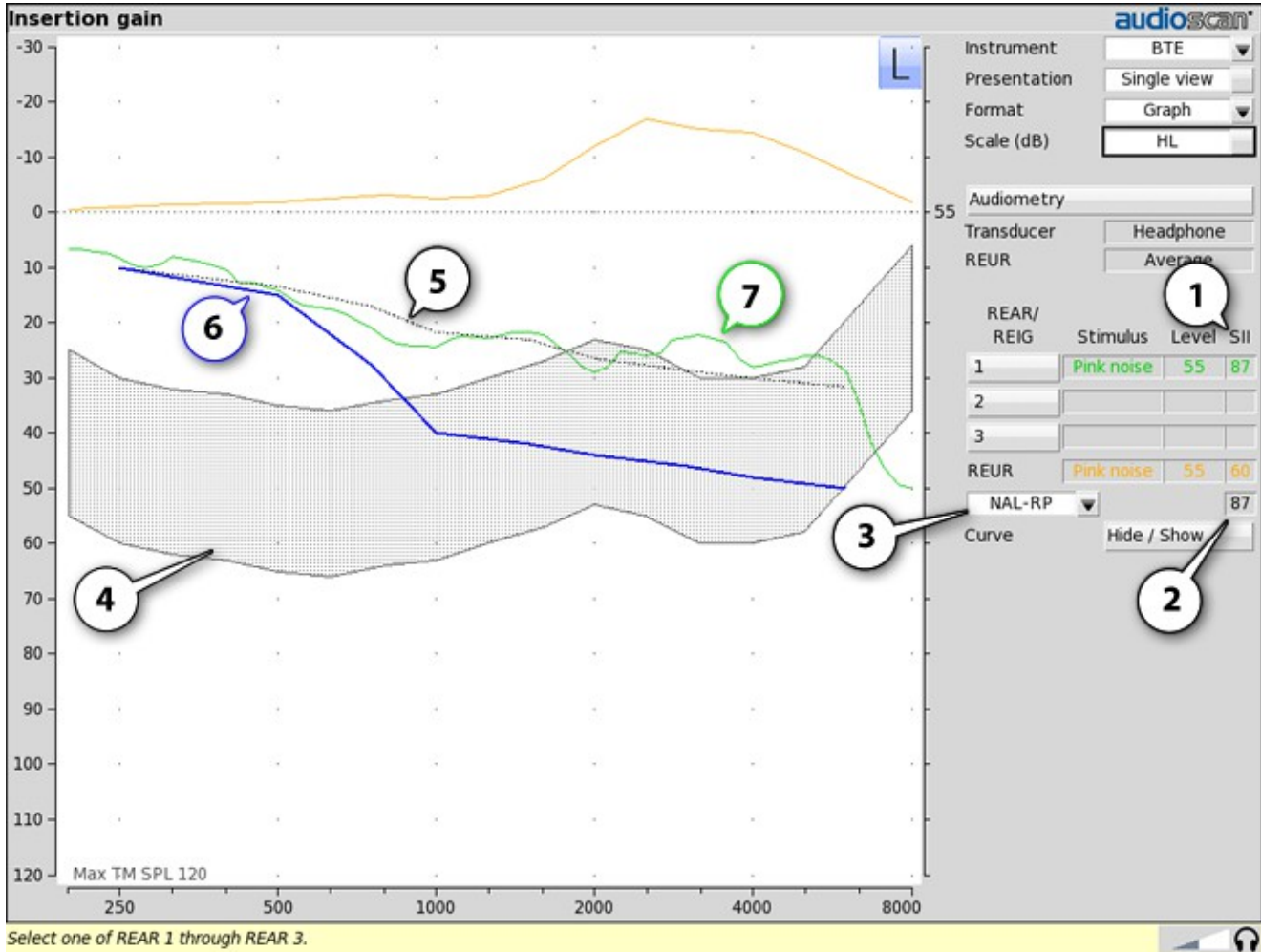
1. Speech Intelligibility Index (SII), 2. SII for target Aided Threshold, 3. Fitting method, 4. Speech Region (@70 dB SPL), 5. Target Aided Threshold, 6. Unaided Threshold, 7. Estimated Aided Threshold.

Audiometric data entry

Threshold data and parameters may be entered by manually using a mouse, or the numeric keypad on an external keyboard. See Mouse, keyboard, and Input device operation.

To enter assessment data and parameters manually:

1. Select [Audiometry].

2. Select [Transducer], then choose from the list.

3. Click [REUR] to toggle selection.

Measured REUR should be used with a sound field threshold because individual REUR is part of the threshold. *Average REUR should be used with headphone or insert phone thresholds* because individual REUR isn't part of these thresholds.

4. When all selections have been completed, press ✓.

5. Enter HL threshold values using a mouse. Left click the mouse on the audiogram form to enter a point. Click again to delete the point.

6. Press ✓ when all points have been entered.

The HL for the highest frequency is used for aided targets at higher frequencies.

REUR measurement procedure

Performing a REUR test erases all existing REAR and REIG data associated with the current test ear. REUR should be measured only if Transducer = Soundfield. Otherwise it is more accurate to use average. See Audiometric data entry.

1. Click the right mouse button and then select [Insertion gain]

2. Referring to On-Ear Measures - Setup and On-Ear Measures Screen Setup, prepare the system, position the patient and insert the probe tube.

3. If REUR is set to Average, select [Audiometry] then click [REUR] to toggle to [Measure]. Press ✓ to advance to the Threshold entry poster. You may enter threshold data at this time (see Audiometric data entry) or press ✓ to proceed with the measurement.

4. Click REUR (below REAR/REIG test 3).

5. Press ✓ to accept the default 55 dB SPL Pink noise stimulus and capture the REUR curve OR select [Stimulus] and [Level] to select other values. These choices have no impact on the resulting REIG.

6. If there is a notch in the 4000 to 8000 Hz region, try advancing the probe tube 2 mm and repeating step 3. If the notch moves to a higher frequency, repeat this step until the notch moves beyond the highest frequency of interest.

Because it is analyzed in 1/3 octave bands, the Noise stimulus produces a REUR 12 dB below that produced by the Swept stimulus at the same overall level.
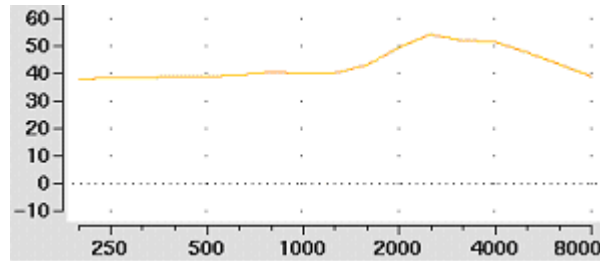
The Average REUR used is shown above. Measured REUR will vary from this.

For small children the peak may shift to the right and become sharper. Drainage tubes and perforated ear drums will cause large differences - usually around 1 kHz.

REAR measurement procedure

1. Click the right mouse button and then select [Insertion gain]

2. Referring to On-Ear Measures - Setup and On-Ear Measures Screen Setup, prepare the system, position the patient and insert the probe tube. (For tight-fitting hearing aids or earmolds, the probe tube may be inserted through a vent.)

3. Without disturbing the probe tube, insert the hearing instrument or earmold.

4. Referring to Audiometric data entry, enter threshold data.

5. Click button 1, 2, or 3 in the REAR/REIG column. This will present a signal from the sound field speaker and display the REAR Setup box.

6. Click [Stimulus], then select [Pink noise] or [Swept]. Use pink noise when using the NAL-NL1 fitting formula. Use Swept when testing maximum output capabilities.

7. Click [Level], then select a stimulus level from the list box. Use the level shown on the target REIG curves (if present). If no level is shown, use the lowest level required to overcome background noise.

8. Adjust the hearing instrument so that the REIG curve (SPL scale) or Aided threshold curve (HL scale) approximates the dotted target curve. For multi-level targets, match each curve using the stimulus level indicated.

9. Press [✓] to complete the test and capture the data.

See Insertion gain in SPL and Insertion gain in HL for an explanation of screen curves. See SII calculation in Insertion gain

NOTE: Because it is analyzed in 1/3 octave bands, the Noise stimulus produces a REAR up to 12 dB below that produced by the Swept stimulus at the same overall level. The REIGs will be similar except at levels which cause non-linear operation of the hearing instrument.

SII calculation in Insertion gain

The Verifit calculates a Speech Intelligibility Index (SII) value for unaided speech at 70 dB SPL (REUR), the target REIG and for each aided test. The calculations use the 1/3 octave band method of ANSI S3.5 –1997 without the 160 Hz band and without masking effects with results expressed as a % by multiplying by 100. Level distortion effects are included but no hearing loss desensitization is applied. An idealized speech region of LTASS +/- 15 dB is used.

The speech recognition associated with a given SII is a function of the test material and the cognitive abilities of

the listener. There is considerable individual variability in relating the SII to speech recognition, especially amongst impaired listeners. The following shows expected nominal recognition scores vs SII for normals when using a variety of speech stimulus conditions. (Killion and Mueller, Hearing Journal, January, 2010 pp 10-15).

SII (%)	% Cor. Digits	% Cor. IEEE Sentences	% Cor. NU6 Words
0	0	0	0
5	30	4	4
10	80	9	8
15	96	13	11
20	98	19	19
25	99	43	27
30	100	60	36
35	100	74	45
40	100	89	56
45	100	94	63
50	100	96	70
55	100	98	76
60	100	99	81
70	100	99	87
80	100	100	93
90	100	100	96

CROS fitting using Insertion gain

See Insertion gain in SPL.

1. Place a probe module on each ear and insert the **probe tube into the good ear only**. Position the CROS instruments on (in) the ears and turn them ON.

2. Position the speaker at 45 degrees to the good ear and set Instrument to [BTE].

3. Select REAR 1 and record a response using [Pink noise] at 55. It should be like a normal REUR. If not, the ear may not be fully open.

4. Position the speaker at 45 degrees to the poor ear.

5. Set Instrument to [CROS].

6. Select REAR 2 and obtain a response using [Pink noise] at 55. Adjust the response to match that obtained in step 3.

7. Position the speaker directly in front of the client. Select REAR 3 and use [Pink noise] at 55 to check for a smooth response. Repeat with Instrument set to [BTE]. An irregular response may be the result of reflections from nearby objects (including the operator) or it may indicate phasing problems in the aids.
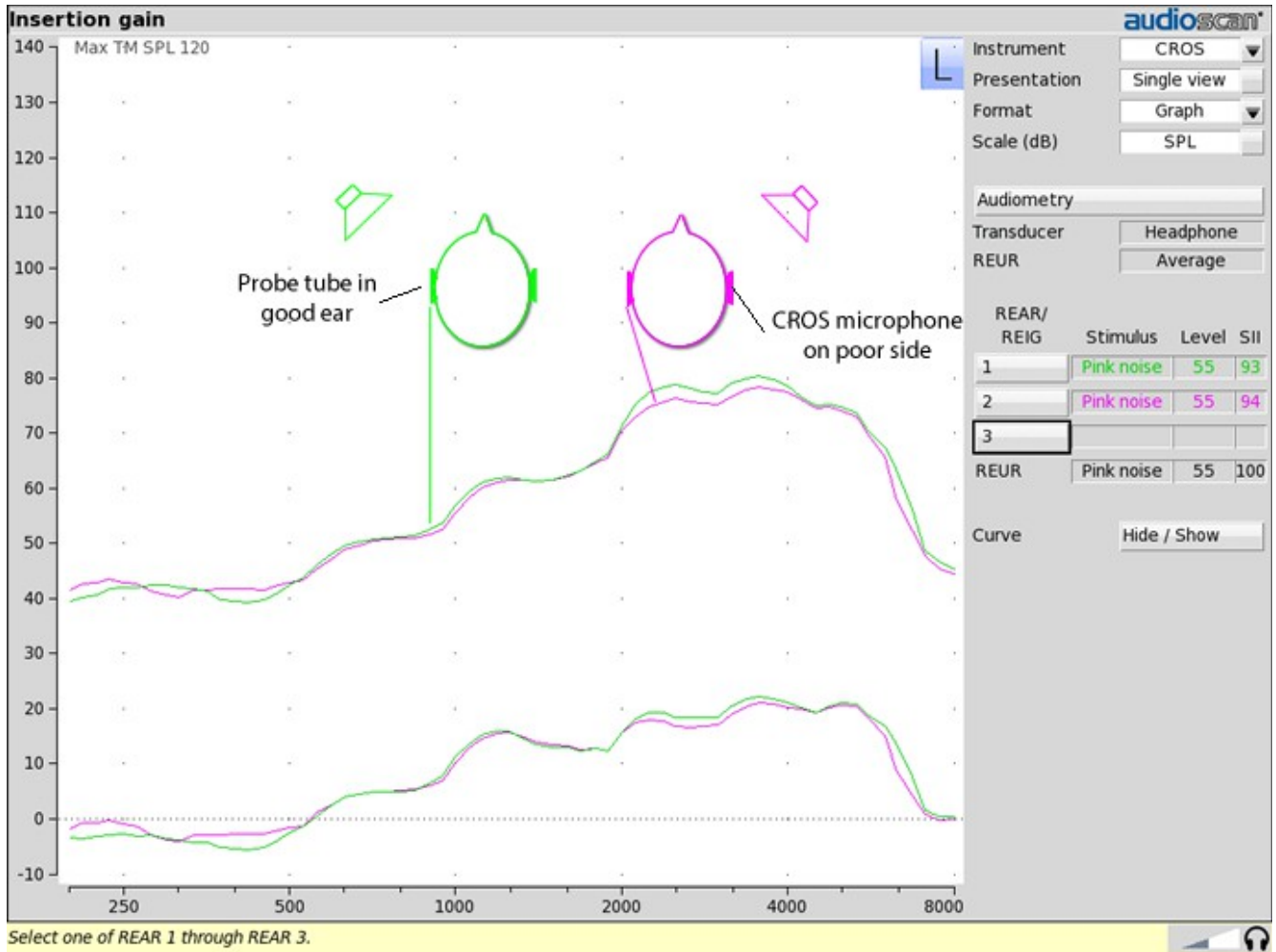
15 Test Box Measures - Setup

The appearance of test box screens may be changed in several ways. Most screens may be viewed as a single, full-screen or dual, side by side panels. Most screens may be formatted to show results in graphical or tabular format. The Multicurve screen may be scaled in dB SPL or dB Gain. Individual curves may be hidden (but not erased).

Test box screen

Except for Input/Output, Battery drain and Manual control screens, you have the option of selecting either a single, full-screen view or a dual, side by side view. *Some data may be dropped from the dual view.*

To change the presentation, click [Single view] or [Dual view].

To switch between A and B test panel in single or dual view, right-click the mouse to raise the home menu and click A|B

In dual view, you may switch panels by left-clicking the mouse on a screen button in the inactive test panel. However, this also operates the button.

ANSI S3.22-2003 AGC

audioscan

Presentation	Single view
Format	Graph
Scale	dB SPL

Start test

Gain control full on
OSPL90 curve
Max OSPL90 (dB) 117 @ 2800 Hz
Average OSPL90   113 dB
Average gain @50dB   26 dB

Gain control at RTS
Response curve @60dB
Average gain @ 60dB   26 dB
Frequency range 250 - 6300 Hz
Equivalent Input noise   31 dB
500 Hz distortion @70dB   1 %
800 Hz distortion @70dB   1 %
1600 Hz distortion @65dB   1 %

Frequency	Attack	Release	
250Hz	15	0	ms
500Hz	15	6000	ms
1000Hz	15	0	ms
2000Hz	15	0	ms
4000Hz	15	0	ms

HFA/SPA: 1000 1600 2500 Hz

HFA/SPA Average Frequencies

Test complete. Select "Start test" to restart.

Format

Except for Distortion, Input/Output and Manual control screens, you have the option of selecting either a graphic or tabular format.

To change the *data format*, click [Graph] or [Table].

Scale

On the Multicurve test screen, you have the option of displaying test results in SPL (dB) or gain (dB).

To change the *scale*, click [dB SPL] or [dB Gain]

Hide or Show test box curves

To hide or show unaided and aided curves on the Speechmap screen:

1. Click on the Hide/Show buttons located beside the Play button and test identifier numbers. Note that the Hide/Show aided button has 3 states – Curves hidden, display LTASS only and display LTASS + speech envelope (i.e. the 'speech banana').
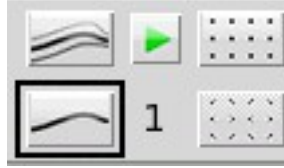
Hiding a curve does not erase it. To erase curves click and select one of the Erase data options.

To hide or show test curve(s) in all other applications:
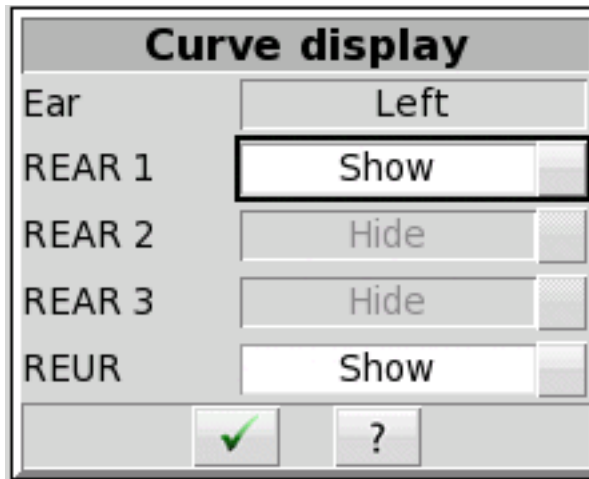
1. Left-click [Hide/Show].

2. Click on the desired test result to toggle between the Hide or Show options. The curves will toggle on or off when selected.

3. Click within the Curve Display poster to return to the test screen.

Hiding a curve does not erase it. To erase curves click on and select one of the Erase data options.

ANSI test frequencies

Automated hearing aids tests may be conducted according to the ANSI S3.22-2003 or ANSI S3.22-2009 test standards. See ANSI S3.22-2003 and ANSI S3.22-2009 facts

The Frequencies feature allows hearing instruments to be evaluated at the Special Purpose Average (SPA) frequencies defined by ANSI S3.22, rather than the default High Frequency Average (HFA) frequencies. The choice of SPA (or HFA) frequencies influences the average OSPL90, average full-on gain, reference test gain, bandwidth and equivalent input noise. The frequencies at which distortion is measured are one-half the selected SPA frequencies. You can also select the frequencies at which attack and release times are measured.

To change the averaging frequencies:

1. Right-click, choose and then click [ANSI].

2. Select the desired HFA/SPA test frequencies.

To change the frequencies for attack and release time measurements:

In the list of available frequencies, click on the frequencies to be used to measure attack and release time.

Click on [✓] to save your selections.

Test box calibration facts

Test box microphone calibration establishes a correction curve for each uncalibrated test box reference microphone by comparison with the factory calibrated coupler microphone. It may be performed as often as desired but will be invalidated at 12 am the following day or at 12 am the following week, depending on the choice of Daily or Weekly calibration interval. After the calibration has expired, the message window will turn blue and you will be prompted to calibrate whenever you attempt a test that uses the test box microphones.

Your calibration curve should be similar to the one shown but may be at a different level. It should remain stable over time. Irregularities in the calibration curve may be the result of not properly aligning the microphones. See Calibrating test box reference microphone.

Calibrating test box reference microphone

Remove any coupler from the coupler microphone before calibration.

1. Position the test box reference microphones with their openings concentric with the binaural coupler microphone openings and about 1 – 2 mm from as shown below.
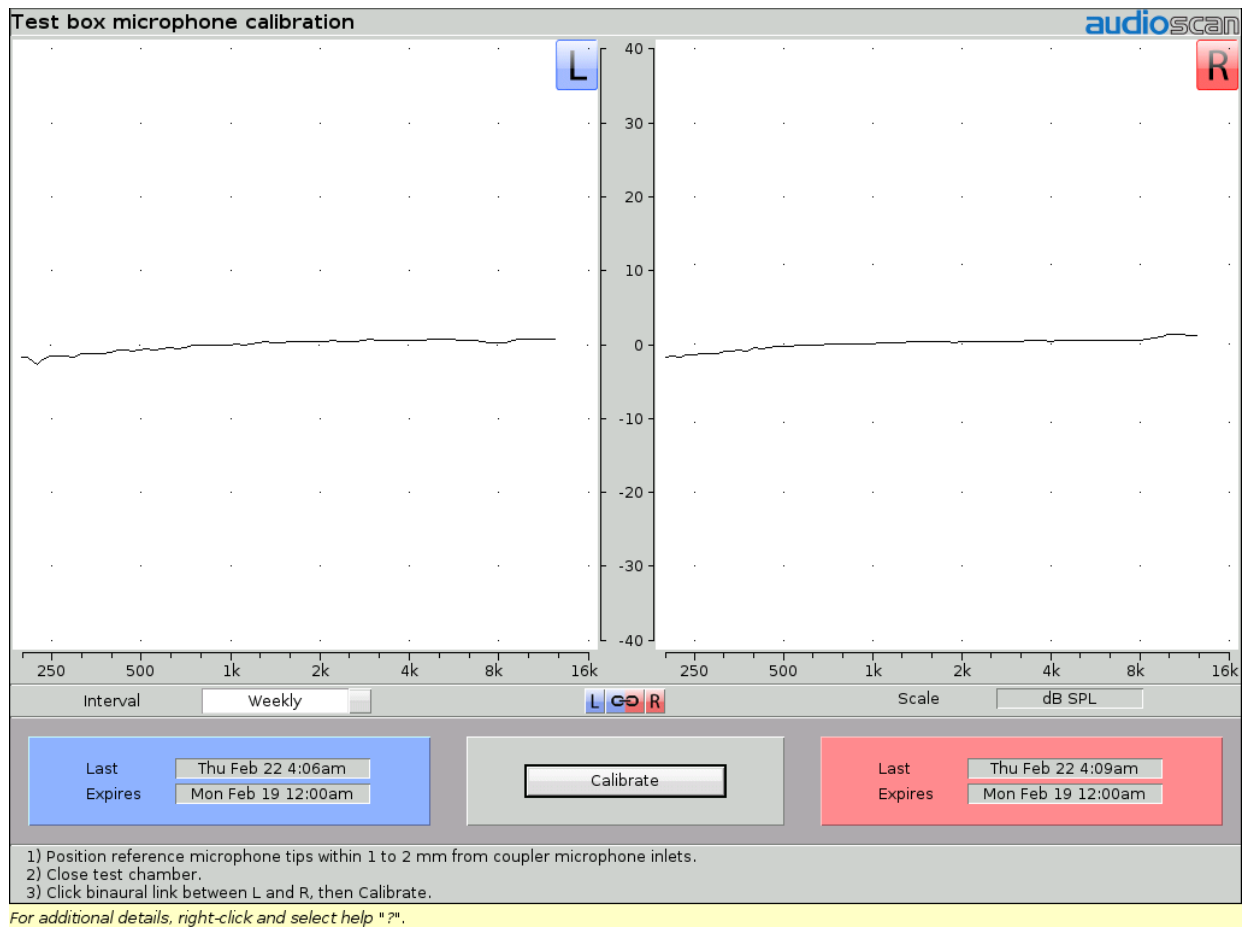
2. Close and seal the test chamber.

3. Right-click the mouse and click [Calibration] under Test box.

4. Click binaural link between the L and R selections. Both the L and R buttons will highlight when binaural operation is active.

5. Click [Calibrate]. See Test box calibration facts.

6. Each side may be calibrated separately by selecting L or R.

7. To change the calibration interval, toggle [Daily] or [Weekly].

8. To change the Weekly calibration day, right-click to raise the home menu, left-click [Setup], then left-click [Date & Time].

It is recommended that you print a copy of the initial calibration curve and compare it with your daily or weekly curve. Any change in this curve indicates a drift in either the coupler or the reference microphone which needs further investigation. See Calibration check for coupler microphone for an additional check.
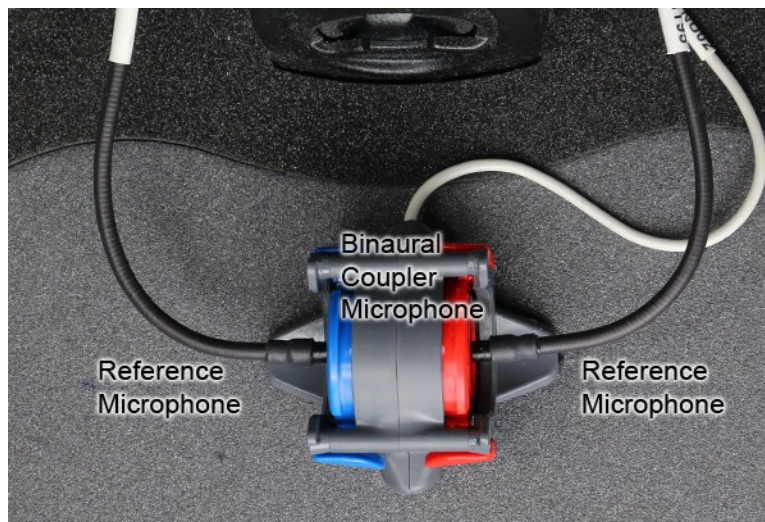
Calibration check for coupler microphone

Accuracy of test box measurements depends on the calibration of the coupler microphone. This should be checked regularly using a microphone calibrator with an adapter ring. The RE780 (1 1/8 in.) and RE781 (1in.) rings are designed for Quest CA22 and QC-10/20 respectively. To verify the coupler microphone calibration:

1. Calibrate the test box reference microphone. See Calibrating test box reference microphone

2. Screw the appropriate calibrator ring onto the coupler microphone.

3. Insert the coupler microphone with the attached calibrator ring into the calibrator opening.

4. Turn the calibrator on and adjust it to present one of the available frequencies and levels (e.g., 94 dB SPL at 1000 Hz).

5. Right-click the mouse and click [Manual control] under Test box.

6. Click the [Level] window, then select 0 from the drop-down list.

7. Click the [Frequency] window, then select the frequency of the calibrator (e.g. 1000 Hz) from the drop-down list.

8. Click the [Filter] window, then select 1/12th octave from the drop-down list.

9. Click [Start test] (which changes to [Stop test]).

10. Check that the Coupler microphone level is within 1 dB of the calibrator level setting, +/- the calibrator accuracy. For a 94 dB calibrator with +/- 0.3 dB accuracy, the indicated coupler microphone level should be 94 +/- 1.3 dB.

11. To stop the measurement, click [Stop test].

Coupler selection

Use the two silver-colored 0.4 cc wideband couplers for the test box tests above the menu division. Use the blue-colored 2cc ANSI couplers for test box test below the division. The exception is Multicurve in which either 0.4 cc

or 2cc couplers may be used. Also note: when the Left/right selection button (lower left of the main menu) displays a blue 'L' and red 'R' the use of .4cc couplers is expected. For other tests, this button will show as a blue 'A' and 'B' indicating an ANSI test.

Coupling for binaural/wideband tests

⚠️	**WARNING**: To reduce the risk of contamination, hearing instruments should be clean before putty is applied and putty should be replaced frequently

For non-ANSI test-box tests (e.g. Speechmap) the two 0.4 cc wideband couplers must be used. NOTE: under no circumstances are the blue 2cc couplers to be used in Speechmap. Test-box speechmap is designed for the 0.4cc volume; substituting a 2cc coupler will cause hearing aid output to be seriously under-reported. The binaural coupler microphone is coded with a red and blue side for right and left ear respectively.

When connecting the couplers onto the binaural coupler microphone, it is important that they produce a good acoustic seal. Ensure each coupler is fully inserted in the retention slot. To remove, push the red or blue levers while pulling up on the coupler.

BTE instruments are coupled to the 0.4cc coupler using the earmold and putty or using the provided earmold substitues (HA-4) coupled to TRIC adapters. When the earmold is used, ensure the eartip is flush with the inside of the coupler opening. Putty should not extend into the coupler cavity or block the sound outlet of the mold. *Vents should be sealed at the lateral end.* It is very important that the instrument be well-sealed to the coupler. Use the hearing instrument stabilizers to prop the BTE body in the vertical, as-worn position.

Custom instruments are sealed to the 0.4cc coupler with putty so that the end of the eartip is flush with the inside of the coupler opening. Putty should not extend into the coupler cavity or block the sound outlet of the instrument. *Vents should be sealed at the faceplate end.* It is very important that the instrument be well-sealed to the coupler.

Open fit instruments may not be fit in the test-box.

 RITE/RIC (Receiver In The Ear/In Canal) instruments which are fit with an occluded canal (e.g. with a micro-mold or occluding dome) are coupled to the 0.4cc coupler using the TRIC adapter. Insert the receiver, without dome, into the adapter so sound outlet is flush with inner surface. For particularly large receivers, insertion is easiest with the TRIC adapter not yet mounted on the coupler. Fold the TRIC adapter in half to open the hole temporarily to ease insertion of larger receivers.

Thin-tube instruments with occluded coupling to the ear canal should be coupled similarly using the TRIC adapter on the .4cc coupler. Select RITE as instrument type to ensure the correct MLE and RECD type will be applied

Excess low frequency output is usually due to open vents or a poor seal to the coupler.

For health reasons, hearing instruments should be clean before putty is applied and putty should be replaced frequently.

Positioning HI for binaural/wideband tests

1. The hearing instrument should be coupled to the 0.4cc coupler with a battery installed. See Coupling the hearing instrument for binaural/wideband tests

2. Place the binaural coupler microphone in the center of the test chamber so that the magnetic positioning aids hold it directly over the crossbar.

3. Connect the instrument and coupler to the coupler microphone on the appropriate side so that the microphone opening(s) of the instrument are facing forward, toward the main test box speaker.

4. Rotate the coupler and instrument so the angle approximates that of the instrument as worn on the client's ear.

5. Position the test box reference microphone on the appropriate side as close as possible to the (front-facing) microphone opening of the hearing instrument without touching it. Ensure the reference microphones are positioned within the safe zone, as indicated by the lighter colored test box foam.
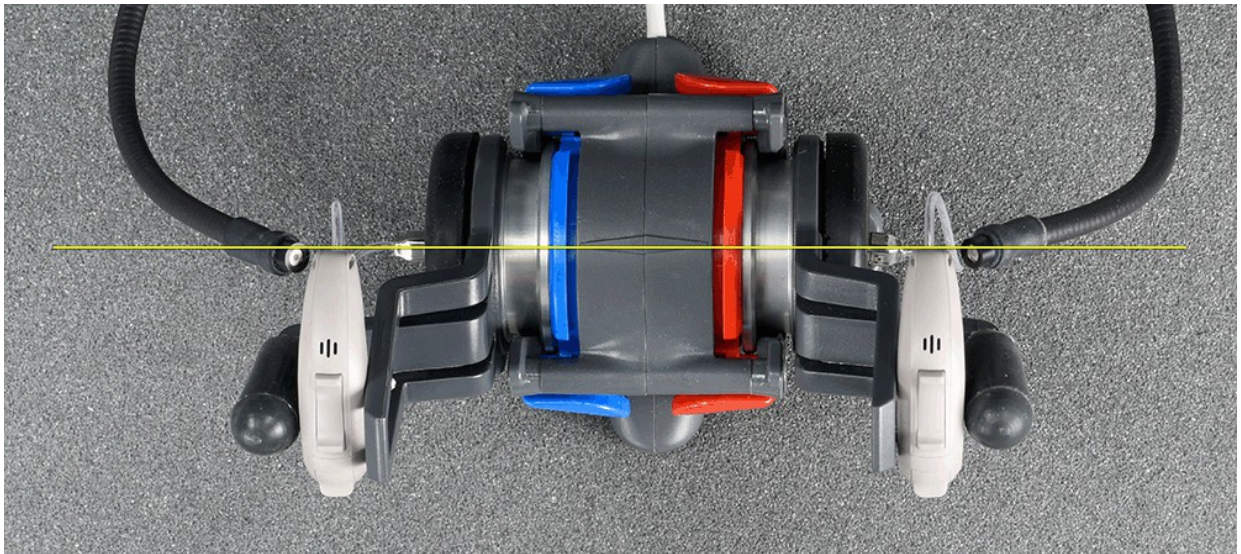
Note: *The diamond-shaped marking on the top of the Binaural Coupler Microphone. Position hearing instruments so that the front microphone (and thus the Verifit reference microphone) is at or behind an imaginary line drawn through this marking (see photo). Note: earlier Verifit2 models do not have this marking, but the line would run through the center of the binaural coupler microphone as shown.*

Coupling for ANSI/IEC tests

⚠️ **WARNING**: To reduce the risk of contamination, hearing instruments should be clean before putty is applied and putty should be replaced frequently

The Verifit is supplied with two blue-colored, metal, 2cc couplers, a type HA-1 (ITE) and a type HA-2 (BTE) for ANSI test box tests, and two silver-colored 0.4 cc wide-band couplers for all other test-box tests. *Note that an ANSI standard coupler for CICs does not exist;* these must be tested in the HA-1 coupler.

When connecting the couplers onto the binaural coupler microphone, it is important that they produce a good acoustic seal. Ensure each coupler is fully inserted in the retention slot. To remove, push the red or blue levers while pulling up on the coupler.

For all ANSI tests, the instruments are coupled to the blue (left) side of the binaural coupler microphone.

BTE instruments are coupled to the HA-2 coupler by means of a 9 mm length of black Viton tubing. The only purpose of this tubing is to seal the tip of the earhook to the coupler inlet. All of the tubing required by ANSI S3.22 is machined into the metal stem of the HA-2 coupler. The tubing should be inspected regularly for cracks or stretching which will cause feedback.

Custom instruments are sealed to the HA-1 coupler with putty so that the end of the eartip is flush with the inside of the coupler opening. Putty should not extend into the coupler cavity or block the sound outlet of the instrument. *Vents should be sealed at the faceplate end.* It is very important that the instrument be well-sealed to the coupler.

Open fit instruments must use the coupler and coupling system specified by the manufacturer. This may involve a hook that replaces the open fit tubing or an adapter tube that may be sealed to the opening of the HA-1 coupler with putty or by using the TRIC adapter where appropriate.

RITE (Receiver in the ear) instruments are coupled to the HA-1 coupler using the TRIC adapter, except where otherwise required by the hearing instrument manufacturer.

Excess low frequency output is usually due to open vents or a poor seal to the coupler.

For health reasons, hearing instruments should be clean before putty is applied and putty should be replaced frequently.

Positioning HI for ANSI/IEC tests

1. The hearing instrument should be coupled to the appropriate blue coupler and a battery pill or battery installed. See Coupling the hearing instrument for ANSI tests.

2. Place the instrument and coupler in the test chamber so that the microphone opening(s) of the instrument are on the crossbar within the test zone.

3. For directional instruments, the direction of maximum sensitivity should be oriented toward the speaker.

4. Position the test box reference microphone as close as possible to the (front-facing) microphone opening of the hearing instrument without touching it.

5. Close and seal the test chamber.

Positioning a BTE instrument for ANSI tests

Positioning an ITE instrument for ANSI tests

Positioning a RIC instrument for ANSI tests

16 ANSI/IEC Hearing Aid Tests

These tests follow the procedures of the ANSI S3.22 standard:

ANSI: An automated test sequence for hearing instruments per ANSI S3.22-2003.

ANSI / IEC: An automated test sequence for hearing instruments per ANSI S3.22-2009, ANSI S3.22-2014 and IEC 60118-7.

Input/Output: 1 - 4 curves of coupler SPL vs input SPL at .25, .5, 1, 2 and 4 kHz.

Telecoil: Tests for telephone sensitivity using a telephone magnetic field simulator (TMFS) in the tele-test handset and test loop sensitivity using a large coil in the test chamber floor.

ANSI S3.22-2003 and ANSI S3.22-2009/2014 facts

ANSI S3.22-2003, ANSI S3.22-2009 and ANSI S3.22-2014 have been designated a recognized standard by the FDA and are mandatory for reporting test data.

There is no difference between ANSI S3.22-2009 and ANSI S3.22-2014.

ANSI S3.22-2009/2014 and IEC 60118-7 have been harmonized. There is no difference between these standards.

The only difference between ANSI S3.22-2003 and ANSI S3.22-2009/2014 is that ANSI S3.22-2003 includes attack and release tests.

Full-on gain is determined with 50 dB input SPL and frequency response curves are run at 60 dB SPL for all aids.

The OSPL90 curve, the HFA (or SPA) and peak value of this curve, the frequency of the peak, the HFA (or SPA) full-on gain are determined at full-on gain setting. The response curve, frequency range, Reference Test Gain, battery drain, equivalent input noise, distortion, attack and release times are determined at RTS.

ANSI 2003 and 2009/2014 / IEC tests

1. Click the right mouse button to raise the home menu, then select [ANSI] for ANSI 2003 or [ANSI / IEC] for ANSI 2009/2014 depending on what has been selected in Setup.

2. Click [Start test] and follow the test setup instructions which are presented.

3. Refer to Test Box Measures – Setup, Coupling the hearing instrument, Positioning the hearing instrument and Battery pill use and care to prepare the instrument for testing.

4. Turn the instrument ON.

5. Set the gain control (manual or programmable) to maximum with all other controls set to provide the widest frequency response, greatest gain and highest maximum output. AGC controls and/or programmable parameters should be set to minimize AGC action (AGC off or threshold high, compression ratio close to 1).

6. Click [✓] to run the test or click [X] to abort the test. Note that, if required, the Verifit will pause during the test to request that the gain control be adjusted to the Reference Test Setting (RTS). If necessary, open the test box and, without moving the hearing instrument, adjust the gain control until the large vertical arrow on the screen prompt disappears. Press [✓] to resume the test.

During the ANSI S3.22-2003 test, the Verifit will pause to request that AGC controls or programmable parameters be set for *maximum* AGC effect. If the manufacturer does not provide settings to produce maximum AGC effect, use settings that result in the highest gain for soft sounds and the lowest gain for loud sounds. This will typically

result in the lowest compression threshold, a flat I/O curve and the longest attack/release times. These are not 'typical' characteristics but indicate the adjustment range possible for these parameters.

ANSI test results

Full-on average gain (1) is measured with a 50 dB input SPL, average gain at RTS (2) is always measured at 60 dB input SPL and the frequency response curve (3) is always run at 60 dB input SPL. An EIN of N/A means that the measurement system was unable to calculate an accurate EIN due to environmental noises in the test box. Ensure that the test box lid is closed and latched and minimize all sounds in the room.
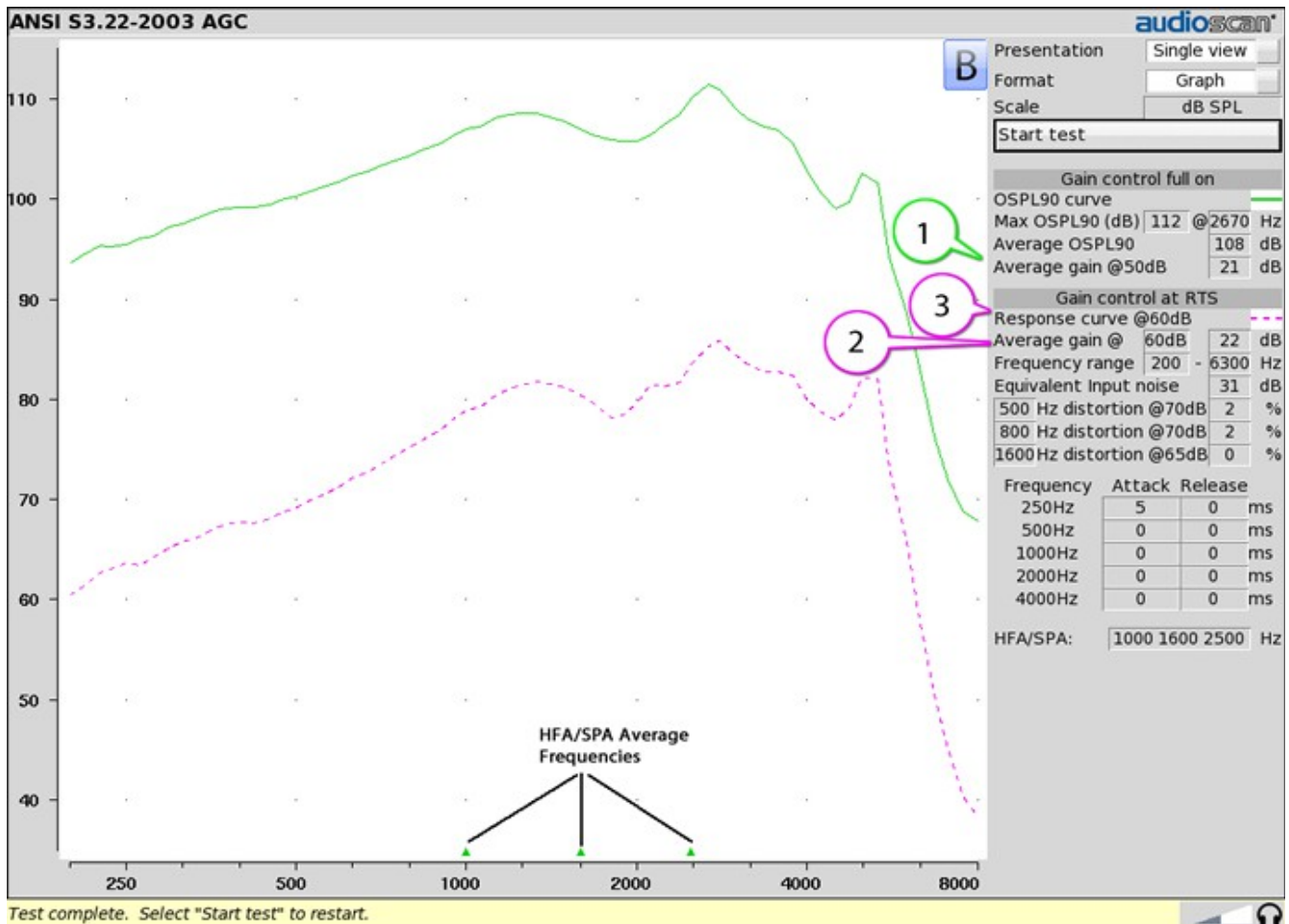
ANSI input-output curves

An input/output curve shows the output level of a hearing instrument as a function of input level and frequency. It is a steady-state pure-tone curve and does not reflect performance with complex signals such as speech.

You may run the tests at any setting of the instrument controls but ANSI S3.22 requires that certain settings be used. See ANSI S3.22-2003 and ANSI S3.22-2009/2014 facts. The [Input/Output] test allows you to generate up to 4 separate input/output curves at each of 5 individual frequencies (250, 500, 1000, 2000, 4000 Hz) as provided in ANSI S3.22.

1. Click the right mouse button to raise the home menu, then select [Input/Output].

2. Refer to Coupling the hearing instrument and Positioning the hearing instrument to prepare the instrument for

testing.

3. Turn the instrument ON; set AGC controls or programming parameters as in ANSI or ANSI / IEC tests

4. Click [Curve 1]. Test setup instructions will be displayed.

5. Press [✓] to generate a set of 5 input/output curves.

6. To measure another set of 5 input/output curves, click another [Curve #].

7. To summon a cursor to determine curve values, position the mouse pointer on a graph area and click the left mouse button. Click again to turn it off.

NOTE: Noise in the test area may cause erroneous results at low input levels (particularly at 250 and 500 Hz). Ensure that the test box is well sealed and ambient noise is low.

ANSI telecoil terminology

The Verifit 2 test chamber contains a telecoil test loop and the tele-test handset contains a telephone magnetic field simulator (TMFS), both of which meet the requirements of ANSI S3.22 and enable the measurement of coupler SPL produced by a hearing instrument with a telephone pickup coil. ANSI uses the following terms in telecoil testing:

RTG (reference test gain) is the average gain measured with the gain control in the reference test setting. See ANSI S3.22-2003 and ANSI S3.22-2009/2014 facts.

TMFS (Telephone magnetic field simulator). A 38.4-mm diameter coil spaced 16.5 mm below a test surface driven by a specified test signal. Intended to simulate a telephone handset receiver.

SPLITS (Coupler SPL for an inductive telephone simulator). SPL developed in a 2cc coupler by a hearing instrument with the gain control in the RTS when the input is the magnetic field generated by a TMFS.

HFA (or SPA) –SPLITS. Average of the SPLITS at HFA or SPA frequencies.

RSETS (relative simulated equivalent telephone sensitivity) is calculated as HFA SPLITS minus (RTG + 60). A positive RSETS indicates greater output when using the telephone than when using the microphone.

SPLIV (Coupler SPL in a vertical magnetic field). SPL developed in a 2cc coupler by a hearing instrument, positioned as worn, with the user gain control in the RTS when the input is a 31.6 mA/m vertical magnetic field.

HFA – SPLIV. Average of the SPLITS at HFA frequencies.

RTLS (relative test loop sensitivity) is calculated as HFA SPLIV minus (RTG + 60). A positive TLS indicates greater output when listening in a room loop than when using the microphone.

ANSI telephone simulator (TMFS) test

⚠	**WARNING**: The included magnet may effect some medical or electronic devices. Keep magnet at least 5cm (2in.) from implantable devices and other magnetically sensitive devices.
⚠	**WARNING**: Keep magnet out of reach of children and pets. If a magnet is swallowed seek immediate medical attention.

ANSI S3.22 requires that the gain control be set to RTS before running this test. The reference test gain (RTG) is required in order to calculate the or RSETS. The easiest way to meet both requirements is to run a [ANSI] or [ANSI / IEC] test before running this test. See ANSI 2003 and ANSI / IEC tests. The tele-test handset comes with a small magnet attached that may affect implantable devices. See How to Avoid Undesirable Side Effects.

1. First, complete an [ANSI] or [ANSI / IEC] test,

2. Click the right mouse button to raise the home menu, then select [Telecoil].

3. Set the aid to "T" (telecoil input).

4. Click [Start TMFS test]. Test setup instructions are displayed.

5. Position the aid on the 'T' on the tele-test handset. BTE aids should lie as flat as possible on the tele-test surface, while custom aids should be oriented with their faceplate parallel to the top surface (if possible) and touching it as shown.

6. Press ✔ to start the test.

7. While maintaining the orientation of step 5, move the hearing instrument around on the tele-test handset surface to maximize the number shown in the [Maximize Average-SPLITS Value] box.

8. Without moving the hearing instrument, press ✔ to store the Average HFA SPLITS value and run the SPLITS curve.

    If an RTG has been previously obtained, the RSETS will be shown.

ANSI test loop test

ANSI S3.22 requires that the gain control be set to RTS before running this test. The reference test gain (RTG) is required in order to calculate the RTLS. The easiest way to meet both requirements is to run a [ANSI] or [ANSI / IEC] test before running this test. See ANSI 2003 and ANSI 2009/2014 tests

1. First, complete an [ANSI] or [ANSI / IEC] test.

2. Click the right mouse button to raise the home menu, then select [Telecoil].

3. Set the aid to "T" (telecoil input).

4. Click [Start test loop test]. Setup instructions will be displayed.

5. Position the hearing instrument on the cross on the test box floor vertically oriented as worn by a seated individual as shown.

6. Without moving the hearing instrument, press ✅ to run the SPL in a vertical magnetic field (SPLIV) curve or press ❌ to abort the test.

   If an RTG has been previously obtained, the RTLS will be shown.
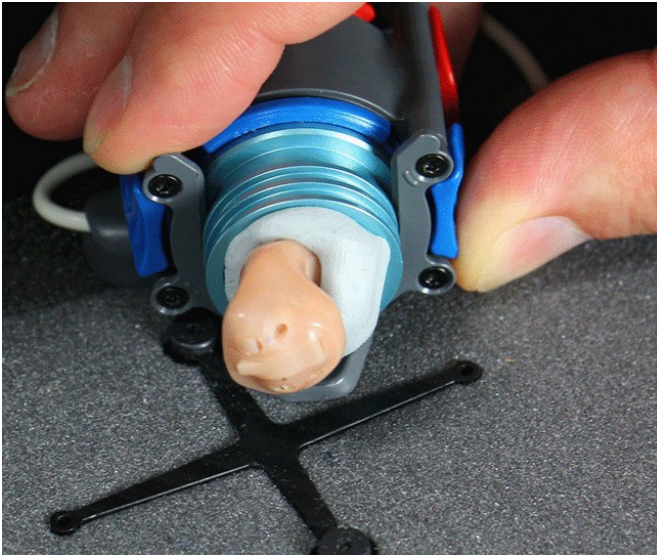
Telecoil test results
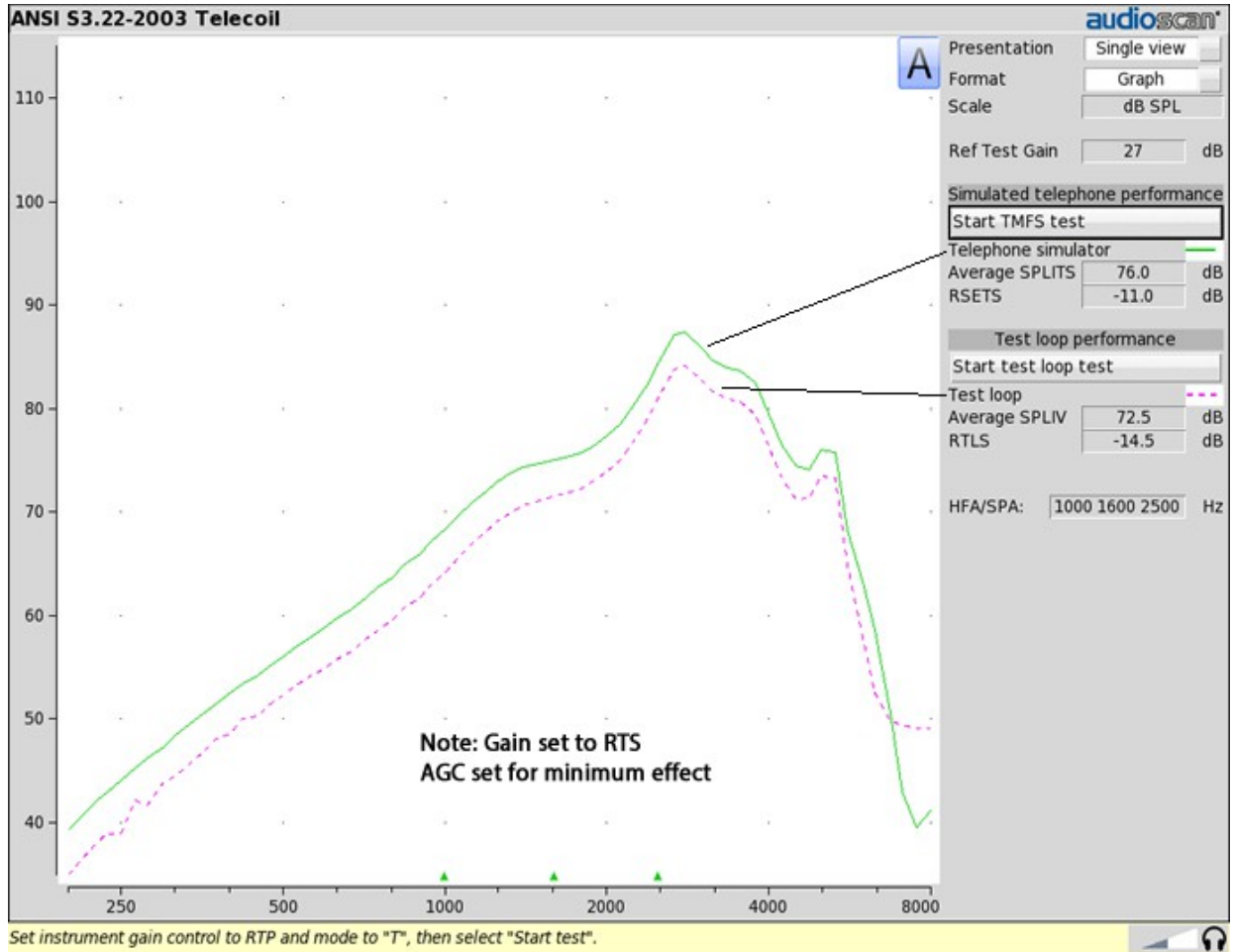
17 Other Test Box Measures

In addition to the tests of ANSI S3.22, the Verifit also provides the following tests in the test box:

Manual control: Coupler and test box reference mic. SPL and coupler mic. distortion at selected 1/12th octave frequencies and stimulus SPL of 0 and 40 – 90 dB in 5 dB steps. Can be used as a dual channel sound level meter with 1/12th octave, A and C filters.

Directional: A real time assessment of directional performance by analyzing the response to the front and rear speakers.

Distortion: Harmonic distortion at 2nd or 3rd harmonics and 2nd plus 3rd with input levels varying from 60 – 90 dB SPL.

Multicurve: 1 – 4 curves of coupler SPL or coupler gain for swept tones or pink noise in 1/12th octaves at selected input SPL of 0 or 40 to 90 dB in 5 dB steps. Can be used as a 1/12th octave spectrum analyzer by setting stimulus to 0 dB.

Battery drain: A 10 second test of battery current drain with no acoustic input, a 1 kHz 65 dB input SPL, and an average for 90 dB input SPL at the HFA or SPA frequencies selected in Setup.

Harmonic distortion

This test measures harmonic distortion at 2nd or 3rd harmonics with input levels varying from 60 – 90 dB SPL. It also presents the sum of 2nd and 3rd harmonics as total harmonic distortion (THD). For hearing aids, this differs little from true THD.

1. Right-click mouse to raise home menu and select [Distortion] under Test box.

2. Refer to Coupling the hearing instrument, Positioning the hearing instrument and Battery pill use and care to prepare the instrument.

3. Turn the hearing instrument ON.

4. Click [Start test].

5. Click [Harmonics], then select THD, 2nd or 3rd from the drop-down list.

6. Click [Input], then select the desired input level (60 – 90 dB SPL) from the drop-down list.

7. Click to run the test. Distortion will be displayed at 1/3 octaves in graphic and in tabular form.

Noise reduction

The noise reduction test measures the ability of a hearing instrument to suppress broadband, steady-state noise. When the test starts, noise is presented to the hearing instrument at the selected level. The response of the hearing instrument is captured before the noise reduction activates and is shown as a thick curve on the graph. A comparison curve shows the hearing instrument reacting to the noise in real-time. The overall RMS noise reduction value in dB from the captured curve to the current curve is reported. A timer shows the duration of the test. This timer can be used to determine how long the noise reduction took to activate and for repeated comparisons.

Noise reduction may be run binaurally. In binaural mode, the responses from two hearing instruments can be observed simultaneously. Select the binaural link before starting a test to enable binaural mode.

The initial curve captured when the test is started actually reflects the output of the hearing instrument two seconds from the first presentation of the noise signal. For most hearing instruments this represents the amplification before the noise reduction activates. Some models of hearing aid, however, have fast acting noise

reduction circuits in which gain may drop prior to the capture of this initial curve. To test these accurately, use the pink noise stimulus. When pink noise is selected as a stimulus the test becomes adaptive and the initial curve will capture the peak level produced by the hearing instrument regardless of the speed of NR onset.

To access the Noise reduction test, right-click the mouse to raise the Home prompt and select [Noise Reduction] under Test-box.

1. Set up the hearing instrument(s) as described in Coupling for binaural/wideband tests.

2. Click on ▶ in any of the test areas.

3. Select a noise stimulus type from the list box.

4. Select a stimulus level in dB SPL from the list box.

5. Click ▶ to begin the test.

6. Click ● to capture the comparison curve once the noise reduction function has responded.

7. At any point click ■ to stop the test without recording any data.

Noise reduction stimuli

Noise reduction offers the following stimuli for evaluating the noise reduction performance of a hearing instrument.

Air conditioner is an example of the noise created by a household air conditioner.

Vacuum is a sample of noise from the operation of a vacuum cleaner on a carpeted floor.

Multi-talker Babble is the combination of ten different adult talkers; seven of the talkers are female and three are male. Eight of the talkers are speaking English, one is speaking French, and the last one is speaking German. All talkers were normalized to the same overall output level before being positioned at random positions around the listener. Loudness smoothing was performed on the babble in 1/3rd octave bands to reduce the magnitude of short-term peaks and valleys.

Pink noise is an internally-generated, steady state stimulus with a flat frequency spectrum. This stimulus is capable of measuring hearing aids with fast-acting noise reduction using a custom algorithm that can extract the peak curve faster than the other stimuli.

Directional function test

The Verifit directional test measures directional performance in real-time and displays simultaneous curves representing stimulus delivered to the front and back of the hearing instrument. It is compatible with all forms of hearing aid processing, including frequency lowering, feedback compensation, and other non-linear algorithms. Speech is added as a conditioning signal to ensure automatic, speech-activated directional programs become active.

Test levels are selectable in 5 dB steps. When speech is active it is presented from the front speaker and noise is presented from the back speaker(s) at a selectable signal-to-noise ratio. At periodic intervals, the level of the speech and noise is momentarily reduced and an additional noise burst is played from either the front or back speaker to measure the response from that direction. This burst is extremely fast and will not influence the behavior of the hearing aid. When testing binaurally in the test box, both the left and right back speakers will activate simultaneously. The measured SPL is analyzed into two curves labeled F (front) and B (back) to indicate which speaker(s) generated the curve. The real-time nature of the test allows operation of adaptive directional

systems to be readily visualized.

Optionally, speech may be disabled which will cause the directional test to alternate noise bursts from the front and back speaker(s). This test may not produce a directional response in all hearing aids.

Once directional performance is observed the test may be terminated.

Because the Verifit test chamber is small and anechoic only at higher frequencies, results are not expected to agree with data taken in large anechoic chambers. The directional test is provided as a functional test of directional performance, providing assurance that the directional microphone array has been correctly assembled and programmed and has not deteriorated due to element drift or clogged ports.

Directional ITE positioning

Ensure that the left hearing instrument is tested on the left coupler and that the right hearing instrument is tested on the right coupler. Orient the instrument on the coupler the same as it would be worn on the client's head. Locate the test box reference microphone for each side at the front microphone opening on the faceplate and seal any vent at the faceplate. Other positions may be preferable for some instruments.
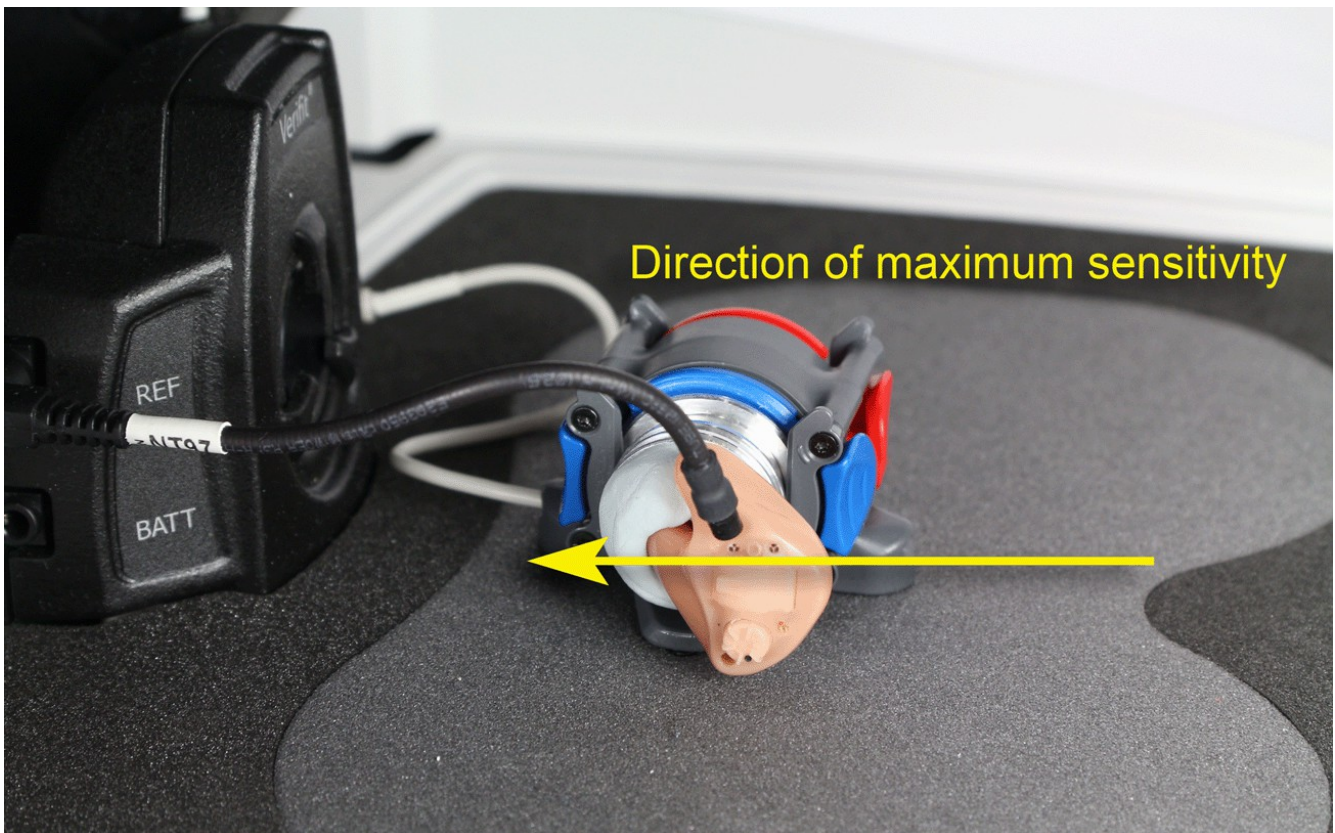
Directional BTE positioning

Ensure that the left hearing instrument is tested on the left coupler and that the right hearing instrument is tested on the right coupler. Orient the instrument on the coupler the same as it would be worn on the client's head. Position the test box reference microphone for each side at the front microphone opening on the instrument. Other positions may be preferable for some instruments.
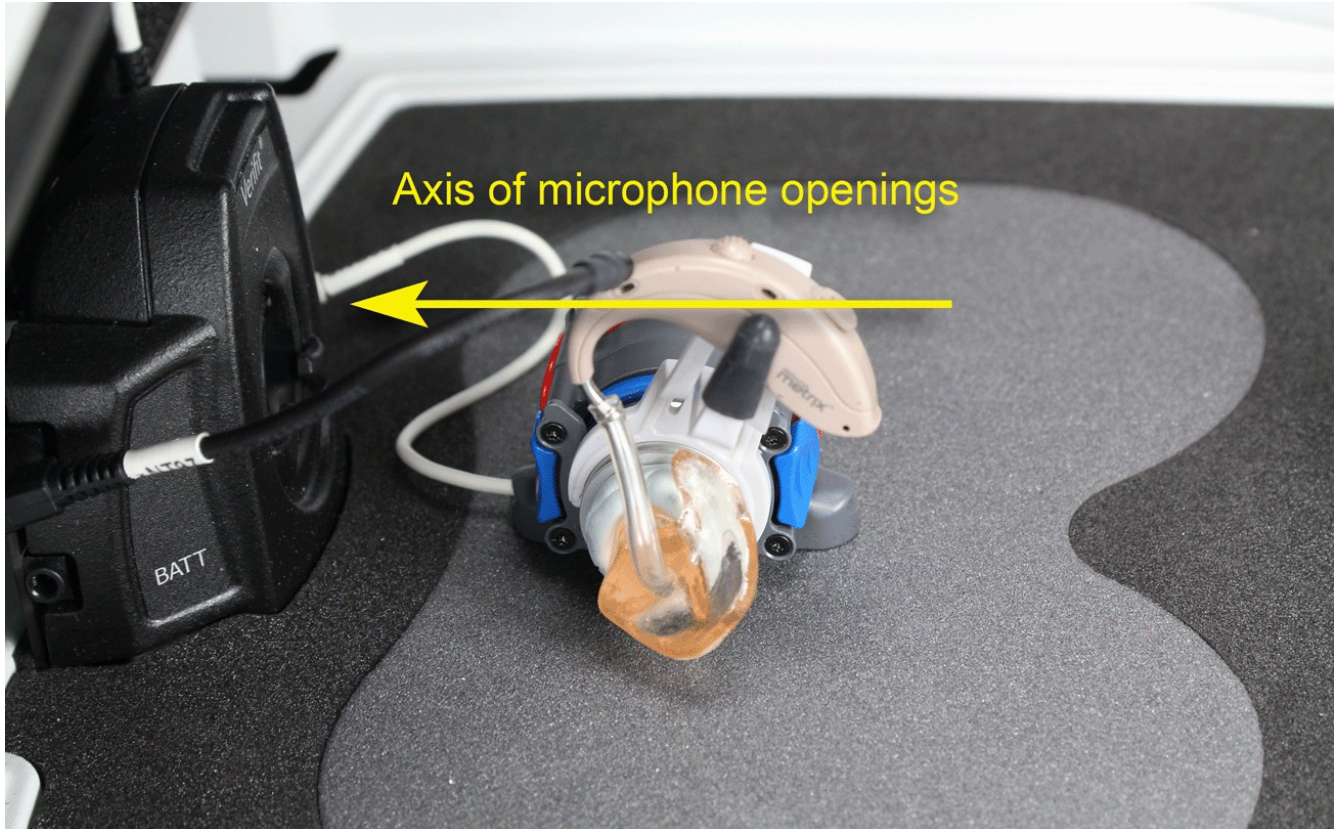
Test box directional procedure

To test directional function in the test chamber:

1. Mount the hearing aid to the 0.4cc wideband coupler (see Coupling the hearing instrument).

2. Position the hearing instrument in the test chamber as shown in Directional ITE positioning or Directional BTE positioning.

3. Right-click mouse to raise Home prompt and select [Directional] under Test box.

4. Select which ear to test, or select the binaural link to test both ears (Dual view only).

5. Select Test 1, 2, 3 or 4 by pressing ▶. Test signals are presented from the front speaker and the back speaker(s) depending on which ear has been selected. Two real-time curves will appear on the screen for each ear under test – the thick curve is the response from the front speaker and the thin curve the response to the back speaker(s) signal. For a non-directional instrument, the two curves will be nearly identical. Setting the instrument for directional operation should produce a separation of the curves.

6. On the Test control poster, select a level from the [Level] drop-down list. For an adaptive directional instrument, a stimulus level between 60 and 70 dB should cause the separation to change over a 15 to 45 second period. For a noise-reducing instrument, both curves may change with time and stimulus SPL.

7. Select [Speech S/N] within the Test control poster and select a signal to noise ratio from the list box. A S/N ratio between 0 and 6 dB will usually induce directional performance after 15 – 45 seconds. Optionally, select [Speech S/N] and select Off. This setting presents only noise alternating between the front and back speaker(s). Speech-adaptive directional instruments may appear to be non-directional if [Speech S/N] is set to Off.

8. Click ⏺ to capture curves or click ⏹ to abort the test.

To test directional function in situ, see On-Ear Instrument Measures.

Multicurve procedure

Multicurve generates 1 to 4 output or gain response curves using either pink noise or swept pure tones at input levels ranging from 40 – 90 dB SPL and 0 dB (off).

Multicurve allows the use of the 2cc HA-1 coupler or the 0.4cc Audioscan Wideband Coupler (AWC). The HA-1 coupler is not useful at high frequencies because of resonances and low signal levels. The use of the AWC is desirable because it raises the high frequency SPL of the hearing aid by more than 20 dB, making the rising noise floor of the coupler microphone less significant.

1. Right-click to raise the Home prompt and select [Multicurve] from under Test box.

2. Refer to Test Box Measures – Setup for connecting the hearing instrument to the coupelr microphone.

3. Ensure the hearing instrument is powered and turned on.

4. Select test 1, 2, 3, or 4 by pressing the respective ▶ button.

5. Select [Stimulus] and pick either Pink noise or Swept.

6. Select [Level] and pick a stimulus output level.

7. Click ⏺ to run a sweep or to capture a pink noise curve. Click ⏹ to abort the test.

8. To measure another response curve, click another test. Existing test data will be overwritten.

9. To change scale from dB SPL to dB Gain, highlight and select the Scale window.

Multicurve results

1. *Output* curves for the noise signal are in 1/12th octave bands. They will be approximately 19 dB lower than pure tone curves for a linear instrument.

2. *Gain* curves for a linear instrument will be the same for both swept and pink noise test signals.

3. For compression instruments, both gain and output curves may be expected to differ for the two test signals.

4. See Test Box Measures - Setup to change screen appearance.
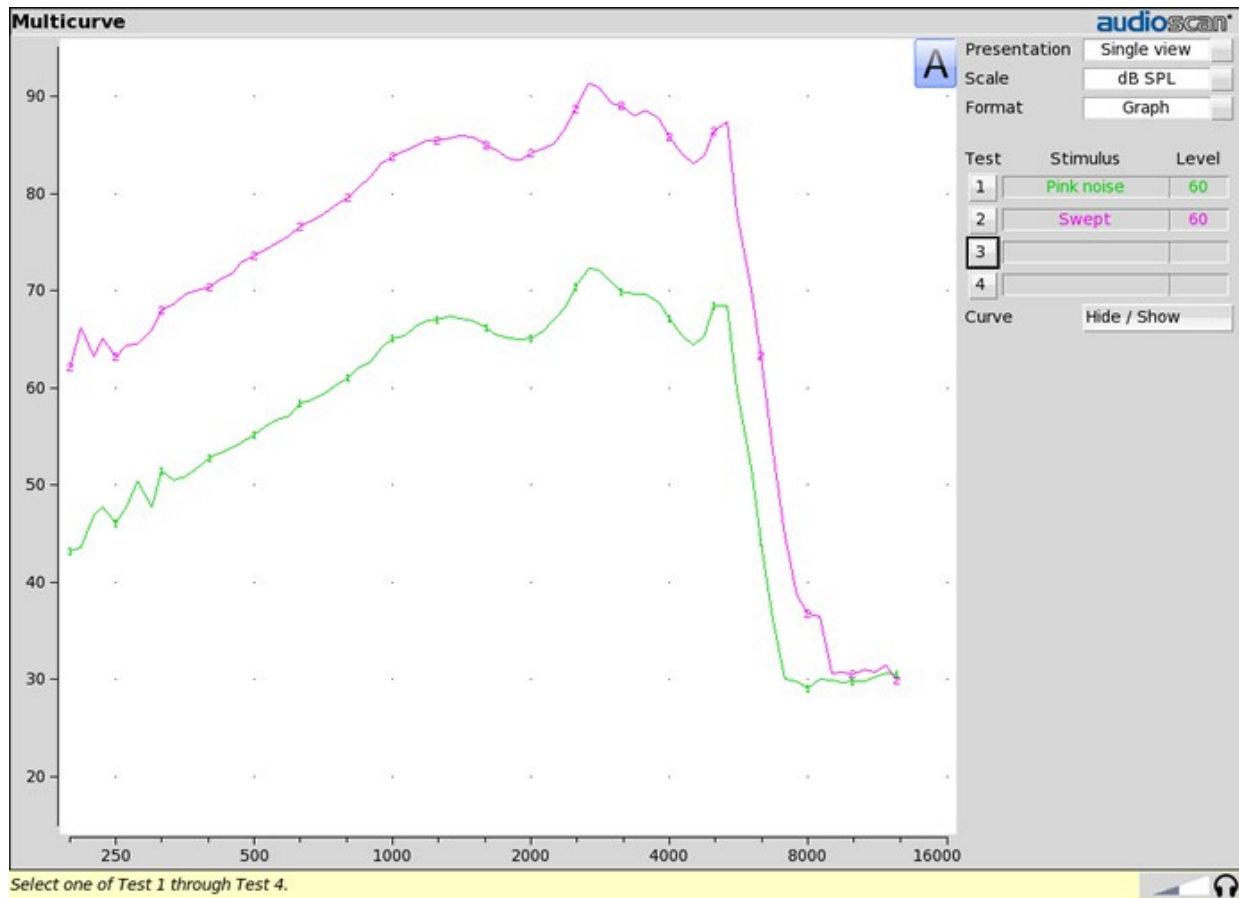
Spectral analysis in Multicurve

Selecting a stimulus level of 0 dB (off) in [Multicurve] presents a spectral analysis of the coupler microphone signal (Scale = dB SPL) or the difference between the coupler and reference microphone spectra (Scale = dB Gain). Binaural spectral analysis data is only available for dB SPL.

If the stimulus type is [Pink noise], the analysis is performed in 1/12th octave bands and displayed in real time. Pressing [Continue] captures the displayed spectrum.

If the stimulus type is [Swept], a swept filter analysis is performed in 1/12th octave bands and displayed at 1/3rd octave frequencies. Pressing [Continue] causes the swept filter analysis to be performed in 1/12th octave bands and displayed at 1/12th octave frequencies.

Battery drain test

The battery drain test automatically measures the battery current when there is no input signal (quiescent), when the input signal is a 1 kHz tone at 65 dB SPL and the average of the currents when the input signal is 90 dB SPL at the HFA or SPA frequencies (Avg @ 90 dB). Battery life is estimated assuming 80% quiescent and 20% Avg @ 90 dB use. With the hearing instrument set as normally used:

1. Right-click mouse to raise home menu and select [Battery drain] under Test box.

2. Install and connect the proper battery pill. See Battery pill use and care.

3. Click [Battery type] and select the installed battery pill.

4. Click [Hours per day] and select from the drop-down list.

5. Click [Start test]. Test setup instructions will be displayed.

6. Click to start the test.

7. Click on button 1, 2, 3 or 4 in the Test column.

Manual control procedure

Manual control displays the reference microphone SPL, the coupler microphone SPL, their difference in dB (gain) and coupler microphone signal distortion at any selected 1/12th octave frequency and at a selected input level from 40 to 90 dB (in 5 dB steps) and at 0 dB (off).

Manual control allows the use of the 2cc HA-1 coupler or the 0.4cc Audioscan Wideband Coupler (AWC). The HA-1 coupler is not useful at high frequencies because of resonances and low signal levels. The use of the AWC is desirable because it raises the high frequency SPL of the hearing aid by more than 20 dB, making the rising noise floor of the coupler microphone less significant.

1. Open the home menu using the right mouse button. Select [Manual control] from the Test box list.

2. Click on the Level window and select the desired stimulus level from the drop-down list.

3. To switch ears, move mouse cursor to the appropriate side.

4. Use [Mode] to toggle between On-ear and Test box modes.

5. Click on the Frequency window and select the desired frequency from the drop-down list. (Distortion measurement data is available only from 200-4000 Hz.)

6. Click on [Start test] to start the test. [Start test] changes to [Stop Test]. To stop the measurement, click [Stop test]. You may change Level and Frequency without stopping the test.

Sound level meter using manual control

When set for a stimulus level of 0 dB (off), the Manual control mode allows the Verifit to be used as a sound level meter. Sound at the test box reference microphone and the coupler microphone may be analyzed by 1/12th octave, A-weighted or C-weighted filters. A and C-weighted measurements are limited to frequencies above 100 Hz and the averaging time and update rate are 384 ms.

1. Open the home menu using the right mouse button. Select [Manual control] from the Test box list.

2. Click on the [Level] button and select 0 dB stimulus level from the drop-down list.

3. Click on the [Filter] button and select 1/12th octave, A-weighted, or C-weighted from the drop-down list.

4. For 1/12th octave filter, click on the [Frequency] button and select the desired frequency from the drop-down list.

5. Click on the [Start test] bar to start the test. [Start test] changes to [Stop Test]. To stop the measurement, click on [Stop test]. You may change Level and Frequency without stopping the test.

NOTE: Microphone extension cables (VA-131 & VA-133) are available from Audioscan. Standard audio extension cables should not be used. They will substantially increase noise levels.

18 Networking

Connecting the Verifit to a network allows for transferring data between the Verifit and other networked computers and printers, as well as for controlling the Verifit from computers running the Audioscan Remote software. See the section Printing and Storing Results for details about printing and storing data, including about the how to transfer data to the optional Audioscan Noah module.

If you have a wired network, see the General Operation section for instructions about how to connect the Verifit through a wired connection. If you have a wireless network, you can use the Verifit's built-in wireless feature. In either case, the following section describes how to set up the network connection in software, before transferring data, printing results, or using the Remote Operation software.

Networking standards

The Verifit connects to the network through its wireless or wired interface. The Verifit supports the 802.11 b, g, or n wireless network standards and speeds, as well as the following wifi security standards:

•WPA / WPA2   Passphrase   Most common

•WEP   10- or 26-digit hex key

•None   No security
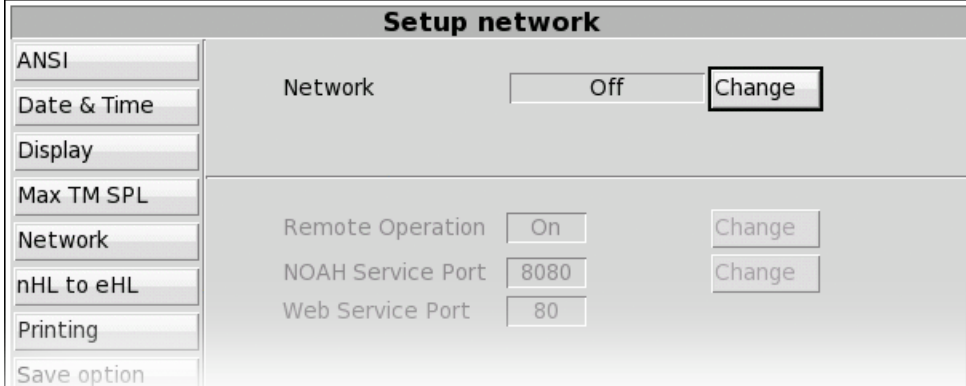
The Verifit can connect to a local area network (LAN or WLAN) using either automatic or static internet address assignment. Most home and small-office networks use automatic addressing through DHCP (Dynamic Host Configuration Protocol). Large corporate and institutional networks typically use static address assignment. For static address assignment, consult your network administrator.

With a wired Ethernet connection, the Verifit operates at 100base-T. Connection to Gigabit (GbE) ports on switches or routers is possible as long as the port is either configured to 10/100 or to automatically adjust the speed.

Network setup

Check Networking requirements and connect the Verifit to your network.

1. Click ⚙ and then choose [Network] from the Setup menu.

2. Click Network [Change].

3. To turn networking off select the *Off* position in the [Network] drop down.

4. Connecting to a wired (LAN) network

(a) Select [Change] to set [Network] to the *Wired* option.

(b) In most cases, your network will support automatic address assignment (DHCP) and you need to only enable [Auto].

(c) Click [Test settings] to test your settings.

(d) If the test is successful, your computer address will be reported.

(e) Click [✓] to apply your settings.
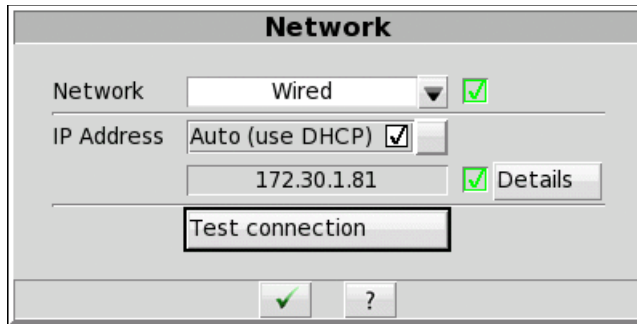
5. To connect to a wireless local-area network (WLAN):

(a) Select [Change] to set [Network] to the *Wireless* option.

(b) Click [Scan].

(c) The Wireless Network poster will be presented and the Verifit will automatically scan for available wireless networks.

Note: non-broadcast SSIDs are not supported and wifi networks containing {}[]'"|\ or non-English accented characters will not be displayed in the pull-down menu.

(d) Confirm the wireless security type for your network. If you are unsure of the security type, please consult your network administrator.

(e) Type the security key or pass phrase into the [Password] text field.

(f) Click [Test connection] to test your settings.

(g) Click [✓] to apply your changes.
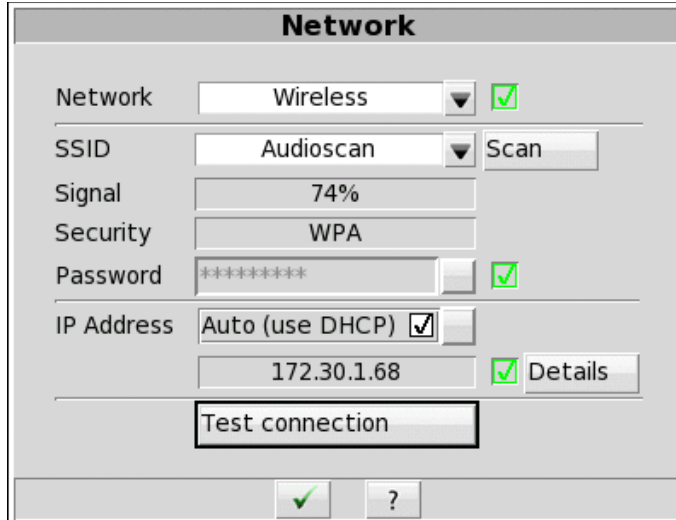
6. To assign a network address automatically using DHCP:

    (a) Simply enable [Auto].

    (b) Click [Test settings] to test your settings.

    (c) If the test is successful, your Verifit network address will be displayed (e.g., 172.30.1.44).

    (d) Click [✔] to continue.

Large, institutional computer networks sometimes use static address assignment. Ask your network administrator for help in performing the following steps.

7. To assign a static network address:

    (a) Disable Auto (DHCP).

    (b) Click the [Change] button.

    (c) Enter the network address details in the *Change network address* poster.

    (d) Click [✔] to apply your changes.
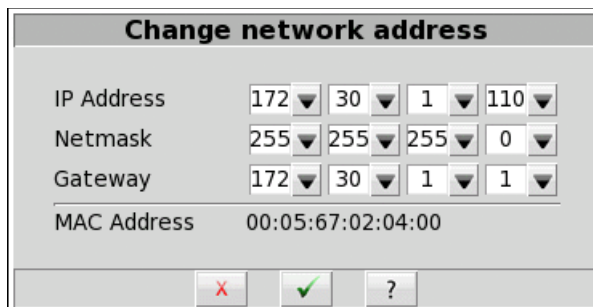
Remote Console
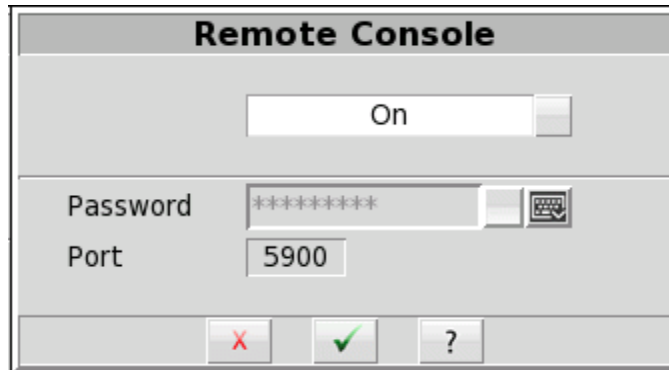
Once your Verifit is connected to a network, you can control it from any Windows PC using the Audioscan Remote Console application, available at no cost from software update download page at www.audioscan.com.

Remote Console works over both wired and wireless networks.

Changing the Remote Console settings

Remote Console is on by default. The default password is *audioscan*. Remote Console runs on port *5900*. You can change the password setting through the Remote Console poster.

1. Click Remote Console [Change].

2. Click [Off] or [On] to turn Remote Console off or on.

3. Type a password in the [Password] field.

4. Click ✓ to apply your settings to the remote console service.

The Audioscan Remote Console application communicates with the Verifit through the Remote Console network service. The Verifit provides the Remote Console service, this works through a single TCP port. The Windows computer running the application must be configured to access the same TCP port, which is 5900. Some Windows anti-virus software packages and some network firewalls prevent access to specific ports, including 5900. The presence of such security measures may require changing the rule within the anti-virus package to allow the Audioscan Remote application to run properly.

TeleAudiology

Once your Verifit is connected to a network, you can control it from any Windows PC using the Audioscan TeleAudiology application. The TeleAudiology application has been specifically designed use in a teleaudiology environment and optimized for long distance communications. A license is available for purchase if needed. The TeleAudiology service works over both wired and wireless networks, however a wired connection is strongly advised.

Changing the TeleAudiology settings

The TeleAudiology service is off by default. The default password is *audioscan*. The default port is *5950*. You can change any of these settings through the TeleAudiology poster.

1. Click TeleAudiology [Change].

2. Once the service has been licensed the following options are available

   (a) Click [Off] or [On] to turn the teleaudiology service off or on.

   (b) Type a password in the [Password] field.

   (c) Click ✓ to apply your settings to the teleaudiology service

Do not change the TeleAudiology port unless requested by your network administrator. Changing the port requires understanding your network's security policy, as well as of the details for the Windows PC running the TeleAudiology application. Your network administrator may find the following information helpful.

The Audioscan TeleAudiology application communicates with the Verifit through the TeleAudiology network service. The Verifit provides the TeleAudiology service works through a single TCP port. The Windows computer running the application must be configured to access the same TCP port, which is 5950 by default. Some Windows anti-virus software packages and some network firewalls prevent access to specific ports, including 5950. The presence of such security measures may require changing the TeleAudiology service port on both the Verifit, and in the Audioscan TeleAudiology application.

Noah Service Port

Consult your Network Administrator before changing the Noah service port. Changing the port successfully requires understanding the security polices on your Windows PC and computer network.

The Audioscan Noah Module communicates with the Verifit through the Noah network service. The Verifit provides the Noah service on a TCP port. The Windows computer running the module must be configured to access the same TCP port, which is 8080 by default. Some Windows anti-virus software packages and some network firewalls prevent access to specific ports, including 8080. Using the Noah module in the presence of such security settings may require changing the Noah service port on both the Verifit, and in the Audioscan Noah Module.

Note that changing the Noah service port requires restarting the Verifit.

Changing the Noah service port

1. Click [Change] next to the Noah service port.

2. Select the appropriate five digits to enter the desired port number. The software will prevent you from entering the same port as the Product web service (typically port 80).
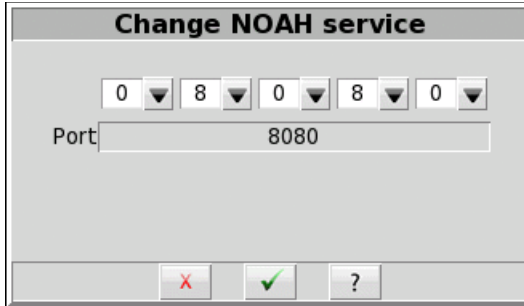
3. Click ✓ .

4. You will be prompted to restart the equipment. Click ✓ to restart, or click X to enter a different port number.

Testing the Noah service port

The Verifit provides the Noah service using the HTTP protocol to transmit XML-formatted data. Communication between the Windows PC and the Verifit can be tested using an ordinary web browser.

1. On the Windows PC, enter the Verifit network address and port number into a web browser following this example:

   http://172.30.1.86:8080/noah

2. If the communication is successful, the web browser will display Noah data formatted in XML:

   <noah> Example XML </noah>

VerifitLink

Once your Verifit is connected to a network, this network protocol will allow for automated fitting between Verifit and some hearing aid manufacturers modules.

Changing VerifitLink settings

VerifitLink is on by default. The VerifitLink server runs on port 8040. You can disable VerifitLink or change the VerifitLink port.

1. Click VerifitLink [Change].

2. Click [Off] or [On] to turn VerifitLink off or on.

3. Click ✓ to apply your settings.

VerifitLink

On

Port 8040 Change
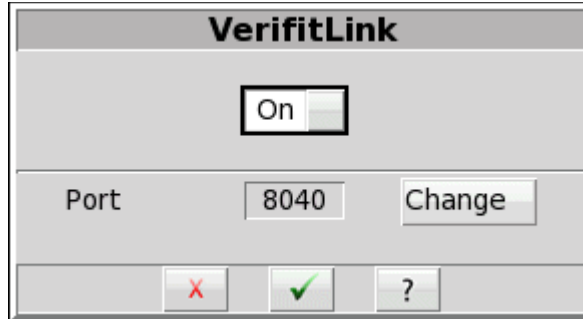
VerifitLink can communicate with some hearing aid manufacturers fitting software. The Verifit provides VerifitLink functionality through a single TCP port. The Windows computer running the fitting software must be configured to access the same TCP port, which is 8040. Some Windows anti-virus software packages and some network firewalls prevent access to specific ports, including 8040. The presence of such security measures may require changing the rule within the anti-virus package to allow VerifitLink to run properly.

Changing the VerifitLink port

1. Click [Change] next to the VerifitLink option.

2. Click [Change] next to the Port option

3. Select the appropriate five digits to enter the desired port number. The software will prevent you from entering the same port as the Product web service (typically port 80).

Change VerifitLink

0 ▼ 8 ▼ 0 ▼ 4 ▼ 0 ▼

Port 8040
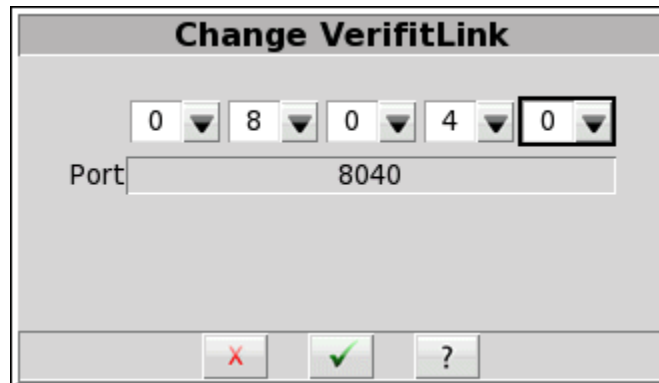
4. Click ✓ to set the port.

5. Click ✓ to apply the changes.

Web Service Port

.changewebservice

The Verifit provides a simple web server for retrieving information through a web browser. You can also use the web server for testing the Verifit's network setup. The Verifit and the computer must be on the same network, with the Verifit network setup enabled.

To use the web server, simply type the network address into your browser's address bar (e.g., 172.30.1.57). The browser will display the Verifit's web home screen. From here, you can capture the Verifit's screen image for printing or storing. See the section Printing and Storing results for more details.

19 Single Computer Connection

Most office computers today are already connected to a network, through either a wired or wireless (wifi) interface. In these cases, the Verifit must be added to the same network as the computer. (See Networking for details.) In cases where no network exists, the Verifit can be networked directly to a single computer. There are two methods, depending on the network hardware available. The following two sections describe the alternatives. The computer must be running Windows 7 or higher and have an available, functioning network port.

Please note: only use these methods of connection if your PC is not currently on any network (i.e. the computer does not print to a network printer, does not receive email, and does not have Internet access). Adding a second network connection to a Windows PC is complex and can have unexpected effects on the primary connection.

Automatic connection (recommended)

Automatic connection requires a small 10/100 network router. Most routers have DHCP address assignment active by default and do not require changes from the default Windows settings on the computer to establish a simple connection with a Verifit.

1. Connect a Cat 5 (RJ-45) cable from one router port to the Verifit network connector.

2. Connect a second cable from a router port to the network connector on the PC.

3. On the Verifit, right-click, select ⚙ and then click [Network].

4. Select [Change] to set [Network] to the *Wired* option. Ensure Auto (use DHCP) is checked, and click [Test connection].

A network address will be provided by the router and should show up in the 'Network address' window. By default, Windows computers have networking and DHCP enabled so at this point your connection should be complete.

If required, to check your PC settings:

1. Go to Control Panel / Network and Sharing Center then select 'Change Adapter Settings' on the left-hand panel.

2. Right-click on Local Area Connection and choose Properties. Ensure that Internet Protocol (TCP/IP or TCP/IPv4) is checked. Select this and select the Properties button. Ensure that 'Obtain an IP address automatically' is selected.

Static connection

A static connection requires an Ethernet switch. The Network addresses must be entered manually into the Verifit and into the computer's Windows network setup.

1. Connect a Cat 5 (RJ-45) cable from one port on the Ethernet switch to the Verifit network connector.

2. Connect a second cable from another port on the Ethernet switch to the computer's network connector.

3. In Windows 7 go to Control Panel / Network and Sharing Center then select 'Change Adapter Settings' on the left-hand panel.

4. Right-click on Local Area Connection and choose Properties. Ensure that Internet Protocol (TCP/IP or TCP/IPv4) is checked. Select this and click the Properties button.

5. Check 'Use the following IP address' and enter the following in the IP address box: 172.30.1.1. Enter 255.255.255.0 in the Subnet mask box.

6. On the Verifit, un-check Auto on the Setup network screen and click the Change button. Then set the network

addresses as shown below by clicking on the down arrow buttons and selecting from the drop-down lists.

7. Click [✓] to apply your settings.

20 Printing and Storing Results

The Verifit can print results for future reference, as well as store results in computer files for future use. Using a web browser, you can capture the Verifit's screen image for printing or saving on any computer. The Verifit can also store audiometric data and test results in the optional Audioscan Noah Module.

Printed output includes the graphical screen image that is showing when you select [Print]. Printed output can optionally include tabular results, text notes, and printed guidelines for handwritten notes. The Printing Setup controls which of these optional components are included in the output, as well as whether output is sent to a printer or saved in a file.

With the Verifit connected to a network, you can capture the Verifit screen image through your computer's web browser. You can then print or save the screen image using the computer's printer or file system.

The Verifit can store its input data and test results in *session* files. Restoring a session file restores the patient assessment data and test results as the Verifit was when the file was saved. The Session Setup controls where session files are stored. Session files can be stored locally on a local USB drive, or in a Windows-shared folder on a network.

Storing data in Noah

The Verifit can store data using the optional Audioscan Noah Module that runs in the Noah framework on a Windows PC. Using the Module requires that both the Verifit and the Windows Noah PC be connected to the same network.

The Noah Module allows you to store the client assessment data, such as HL, UCL and BCT audiograms, and the WRECD, for use in future client visits. Since the assessment data are stored in the HIMSA Noah public data format, then they can also be obtained from or exchanged with other Noah modules that comply with the public standard. For example, the Verifit can restore audiograms from another manufacturer's audiometer.

The data are stored as actions in Noah client records. The Verifit can later restore the assessment data from the Module as the starting point for follow-on measurements with the same client. The Module stores Verifit test results as screen images. The Noah Module can display or print the stored screen images for comparison with the future test results.

Contact Audioscan or visit www.audioscan.com for details about the Audioscan Noah Module.

! NOTE: If a printout or session file identifies the printed or saved data as belonging to an individual client, it becomes Individually Identifiable Health Information and must be protected under the HIPAA Security Rule. See Appendix 1: Manufacturer Disclosure Statement for Medical Device Security.

Printing results

The Verifit can print results on a printer or save results in a file for future printing and viewing. *Printing Setup* allows you to select the printer or file location, as well as to select the file output format. The *Page Setup* options allow you to select the content to be printed or saved. Results are printed as graphical images of the Verifit screen, and can optionally include the tabular view for tests that define it. Additional printed elements include informational headers and footers, as well as typed notes and guidelines. The following sections describe how to set up printers and files.

Printing setup

Use Printing Setup to control the output and page setup options for printed output. To enable printing, check [Enable]. To send the output to a printer, select Printer. To save the output to a file for printing or viewing

later, select File. In either case, to select the optional components to include in the output, click the [Page setup] button. To test your selected options, click the [Print test page] button. Background controls the print outp background. Normal means what you see on screen will be printed to File or Printer. White means some of the background will not be printed to speed printing and save ink or toner.
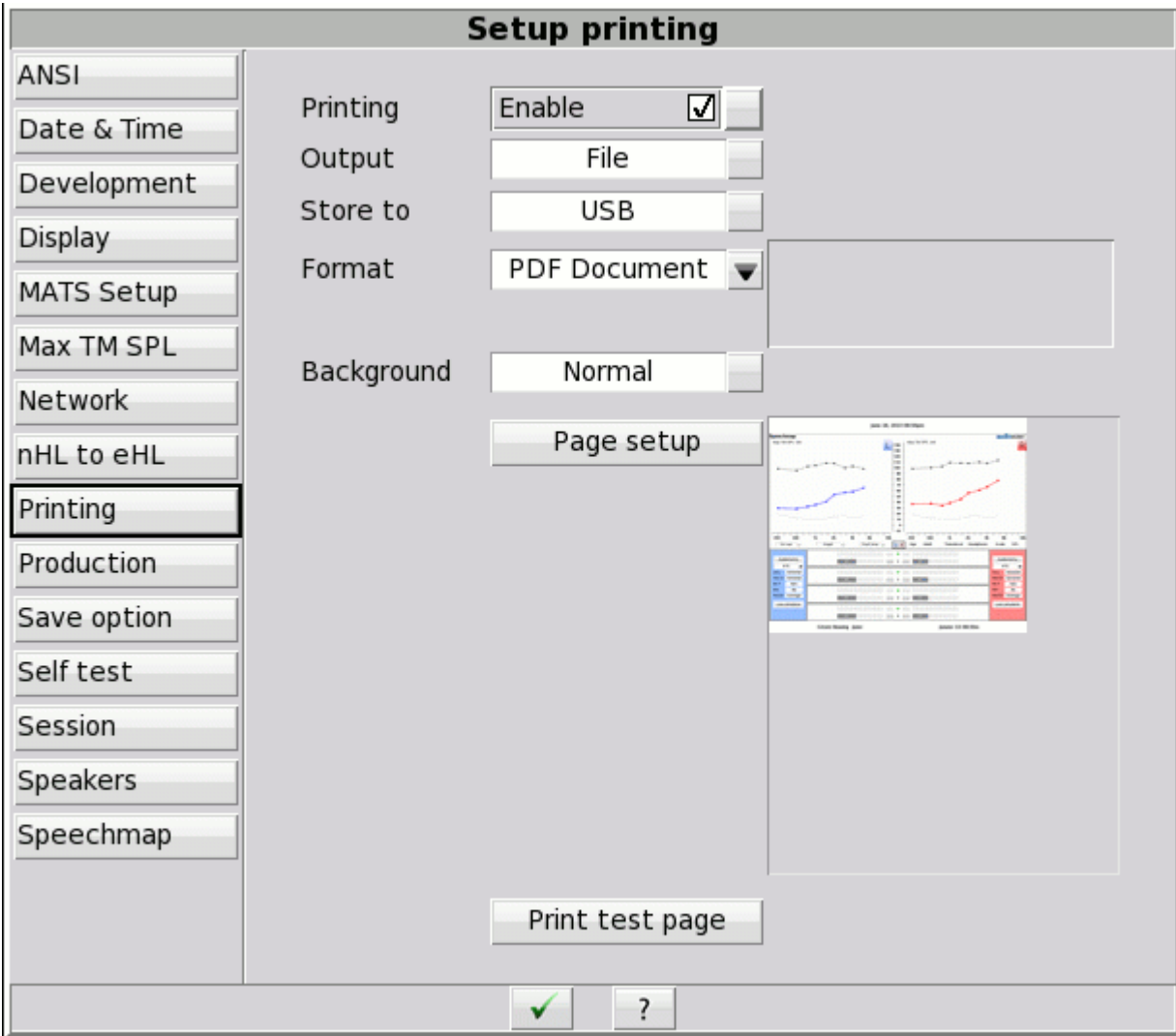
Printer connection

When using the *Printer* output option, you must also select the printer Connection and Type. If the printer connects directly to your Verifit through a standard USB cable, select *USB*. If the printer is accessible on a local area network (LAN), then select either *Windows Share* or *Network*.

Choose *Windows Share* if the printer connects through a Windows laptop, PC, or server computer. Windows shared printers are common in both small and large offices. See the section below, Windows-shared printers and folders, for instructions about setting up a Windows-shared printer.

Choose Network if the printer connects directly to the network through its own interface and cable. See the section below, Network printer, for instructions about setting up a Network printer.

Both *Windows Share* and *Network* printer connection options require that your Verifit be connected to a local area network. See Network Setup for details.

Printer types

You must select the printer type for the connected printer. Most laser printers and large office printers support Postscript. Otherwise, you must select a Hewlett-Packard printer model. See <u>HP printer</u>, described below.

Test your selection by clicking the [Print test page] button. You will get results only if the printer successfully prints the page, which can follow some delay. For example, it takes about fifteen seconds for a USB-connected HP printer to start printing the test page. Otherwise, check your settings and try again.

Alternatively, you may prefer to use a web browser to capture the Verifit screen image, and to print from the browser using the computer's printer. See <u>Web browser screen capture</u>, for details.

HP printer

If you use an HP printer then you must select the specific product model. From *Setup printing*, click the button that shows the printer model name. The Verifit will show almost all available HP printer models. Find and click on your printer model, then click ✓ to accept your choice.
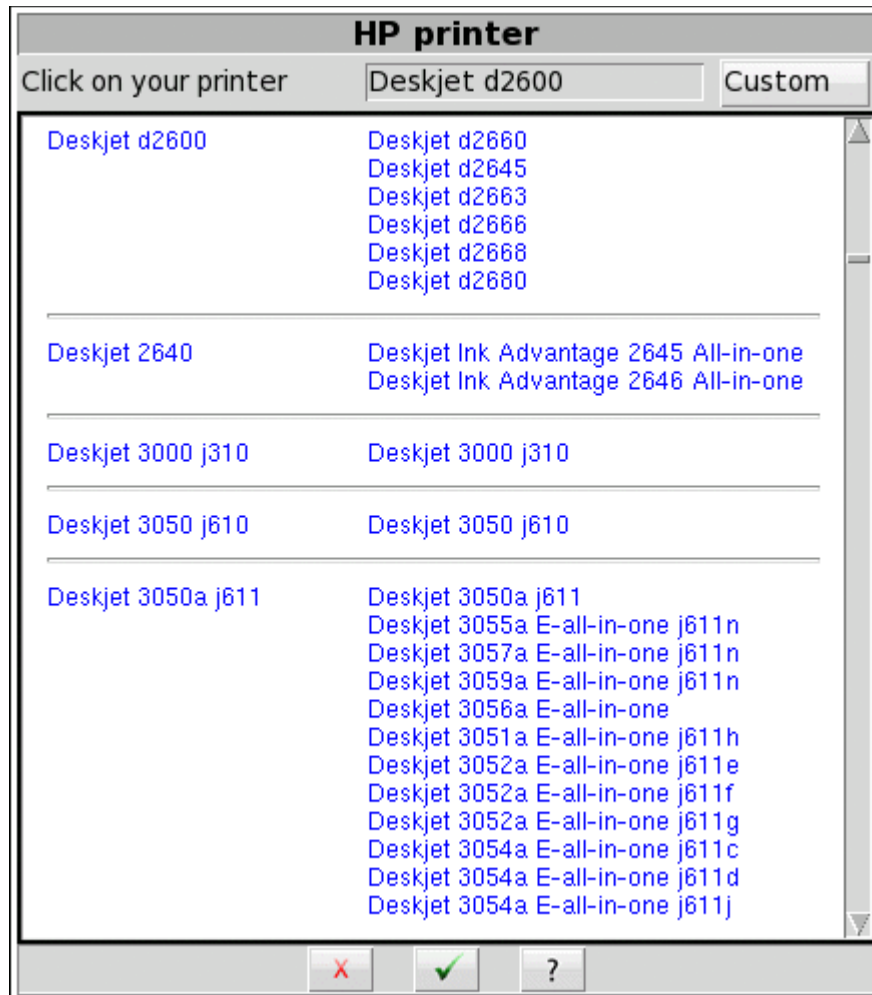
HP printer

Custom printer

Occasionally, your HP printer might not appear on the list, or the selected model might not operate as supplied. In

this case, you need to define a Custom printer. Please contact Audioscan for assistance. We can help define the custom settings, and will integrate your changes into future updates of the Verifit software for use by everyone.

In the HP Printer selection dialog shown above, click the [Custom] button. In the Custom dialog shown below, click the [HP Printer] button and select the model that most closely matches your desired printer. To copy its definition, click the [>>] button. Make changes, then click ✔ . The most common changes needed are to the DeviceModel, and to the PenSet.

To change the selection back to a standard printer, simply select the desired printer model again in the HP Printer dialog shown above.
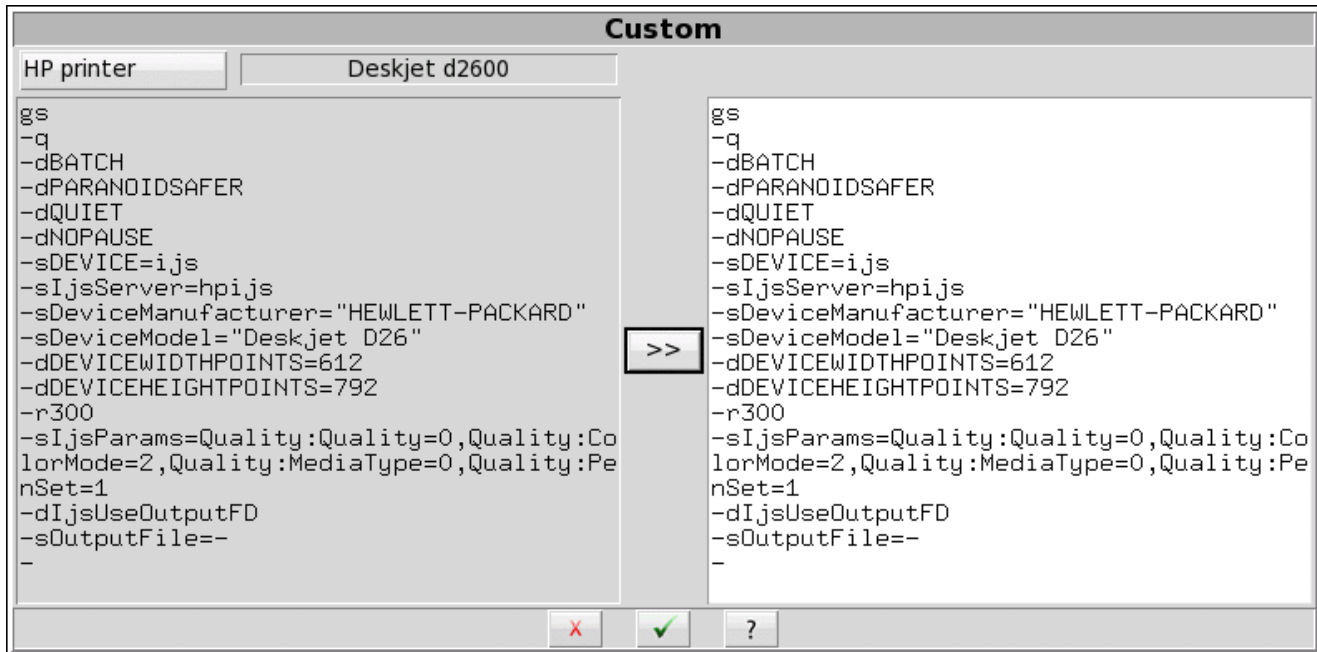
Custom HP printer

File output

The Verifit can print results in a file for future printing and viewing. You can also include these printed files in documents or display them in presentations.

In Printing Setup, select the *File* output option. To save the output on a USB drive, select *USB*. Note: some USB sticks are bootable and may cause issues on start-up if left connected you your Verifit after use. These should be removed during start-up of your Verifit and then re-connected after.

To save the file in a shared folder on a Windows computer, select *Windows Share*. See the section below Windows-shared printers and folders for instructions about setting up a Windows-shared folder.

File format

When printing your output to a file, you can select the saved file format as *PDF Document*, *PNG Graphic* or *GIF Graphic*. The Verifit automatically adds the corresponding extension to the output file name. The exact file name depends on the test results you are printing. If a similar file already exists, the Verifit assigns a unique digit to distinguish the new file, e.g., *Test_box_directional3.png*.

Page setup

You can select the components to include in the printed output by clicking the *Page setup* button. The page setup

applies to both printer and file output.

Printing page setup

! NOTE: If a printout or session file identifies the printed or saved data as belonging to an individual, it becomes Individually Identifiable Health Information and must be protected under the HIPAA Security Rule. See Appendix 1: Manufacturer Disclosure Statement for Medical Device Security.

Ask option

To have the Verifit stop and present the page setup options every time you print, enable the Ask checkbox. Enabling Ask allows you to change the page setup options with each printout, for example, to include Header text that identifies the patient, or to include Description notes that elaborate on the test results. With Ask disabled, the Verifit generates the output results immediately on the printer or in the file, without asking you to change the page setup.

Header and Date

To include custom text in the header, enable the [Header] checkbox and enter the text in the field below it. To include the date and time of printing in the header, enable the [Date] checkbox.

Graph with table

Patients often report changes in their hearing instruments' performance over time. Printed output provides a valuable record for comparing the changes. You may wish to include the Table View, which includes the precise numeric information required to repeat the original test under the same conditions. Table View provides the required numeric data.

To include a Table View along with any printed Graph view, enable the [Graph with table] checkbox.

Footer

To include a footer showing the Verifit model, serial number and Audioscan software version enable the [Footer] checkbox.

Notes

To include notes text with the printed output, enable the [Notes] checkbox and enter the text in the field below it. Enabling [Notes] will also include blank guidelines for handwritten notes.

Print test page

To test your selected options immediately, click the [Print test page] button. The test page includes all of your selected printing options using sample screen images. Results are generated on the printer or in a file, according to your selected options.

Windows-shared printers and folders

In Printing Setup and Session Setup, you can click the [Details] button to enter details for accessing Windows-shared printers or folders. The details include the domain, server and share names, as well as your username and password credentials for the selected domain and server. (Note that wherever these instructions refer to *domain*, you can substitute *workgroup*, which on many small networks is simply called WORKGROUP.)

Domain and Server

In Printing Setup and Session Setup, click on [Details]. The Verifit will briefly confirm the network connection. If the network connection fails, the will Verifit present the Network setup details, where you can correct any setup problems before trying again. See the section, Network Setup for details.

With a successful network connection, the Verifit will automatically scan for the domains and servers available on

your network. Most networks have only one Windows domain, which the Verifit will select automatically.
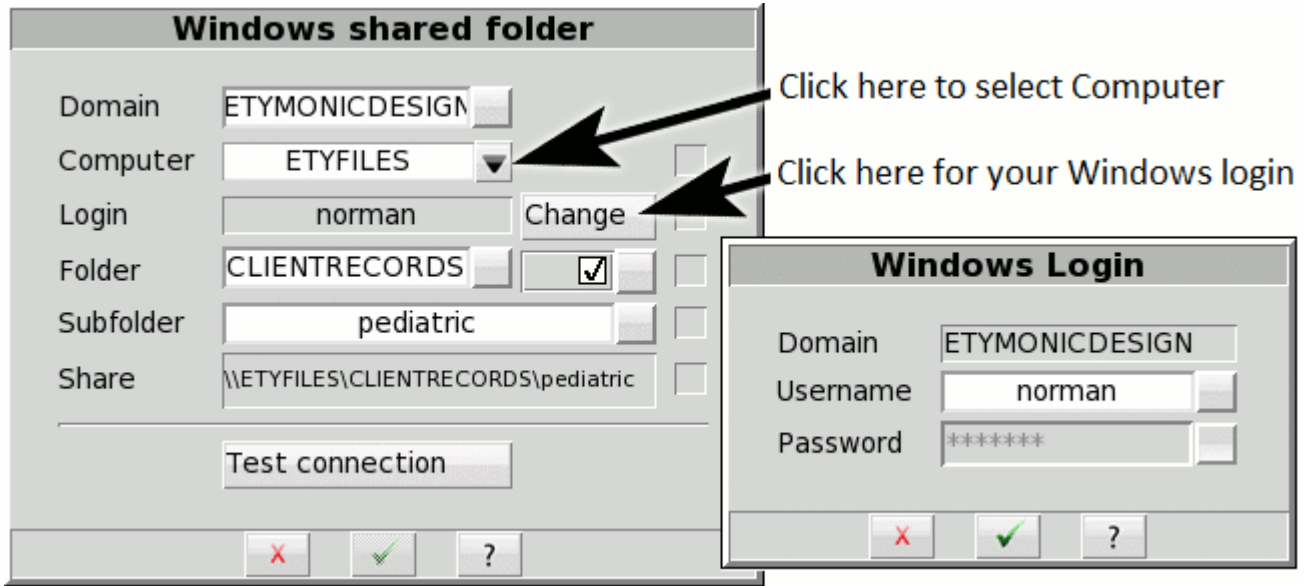
Windows shared folder setup

Windows login

If this is the first time that you have set up the Windows-share, then you will need to enter some details.

1. Select the Domain, if necessary – many networks have only one

2. Select the Computer from the list of available computers

3. Click [Change] to enter your Windows username and password

4. Click ✓ to accept the Windows Login details

Note that your Windows login details are stored separately for each of the printer share, the printing folder share and the session folder share. You will need to enter your username and password details separately for each, even if the details are the same for all of them.

Share name entry

The Verifit automatically scans for the available domains, computers and shares. To enter the share name directly, disable the checkbox, then type the printer or folder share name into the text field.

Test connection

Once you have selected or entered all required details, click the [Test connection] to test the Windows shared printer or folder. Any detail showing a red X indicates some error or omission which you need to correct before saving the details.
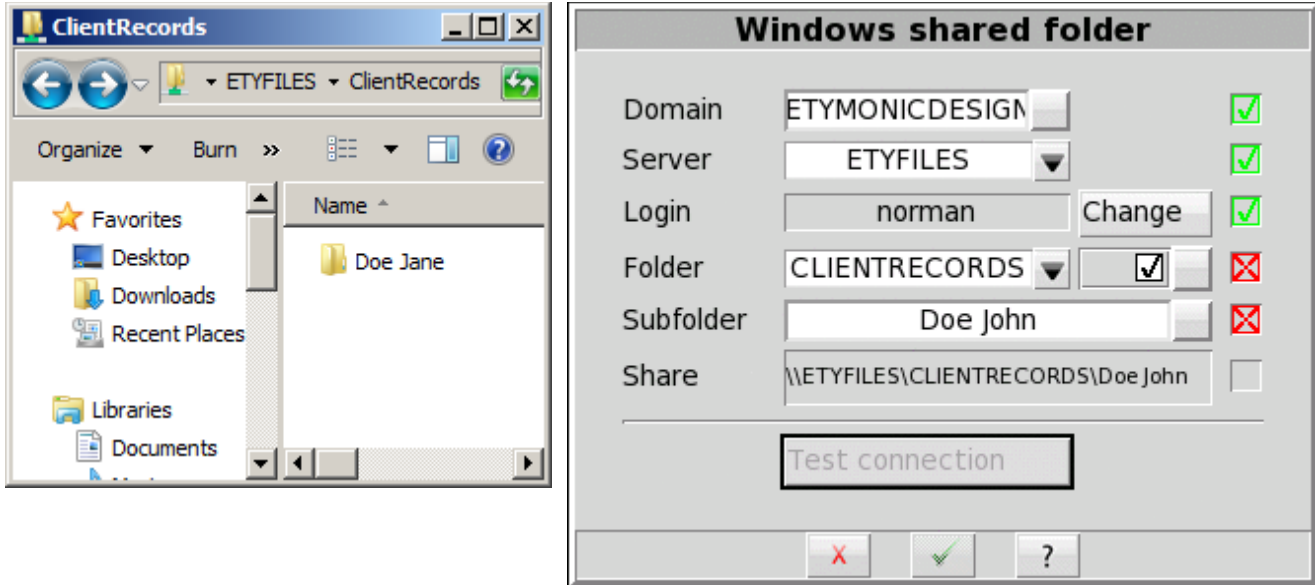
Windows shared folder example - Missing subfolder

The following table indicates the possible causes of each failure, and the corrective steps.

Failure	Cause / *Correction*
Server	The server cannot be found in the specified domain: *Change the server* *Change the domain*
Login	The username and/or password are not authorized for the server: *Change the server* *Change the username and/or change the password*
Printer	The printer cannot be found on the selected server: *Change the printer*
Folder	The folder or subfolder cannot be found on the selected server: *Change the folder* *Change the folder permissions on the server* *Change the subfolder* *Create the subfolder on the server* *Change the subfolder permissions on the server*

Once you have selected or entered all of the required details, click ☑ to save the Windows Share settings.

Network printer

If your chosen printer connects directly to the local area network through its own network interface and cable, then select the *Network* connection option. Ask your network administrator for the network printer's IP address and port that you enter in the *Network printer* details.

In Printing Setup, select *Network* for the connection and click the [Details] button. Enter the address (e.g., 172.30.1.9) and the port (e.g. 9100). To test the Network printer details, click the [Printer test] button. If the test fails, the Printer entry will be marked with a red X. If the test passes, the Printer will be marked with a green check and the printer will print the setup details on a sheet of paper.
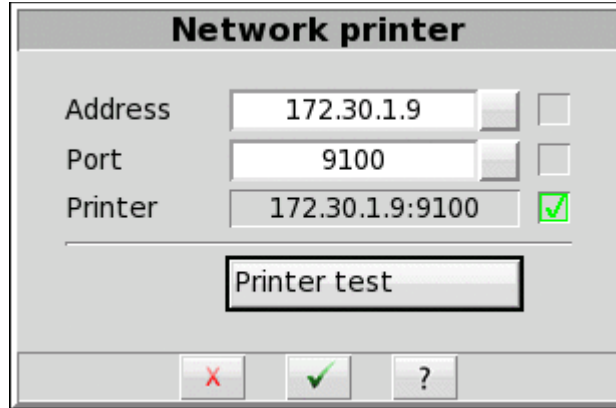
Network printer details – Printer test passed

Web browser screen capture

You can capture the Verifit screen image at any time using a web browser. Through the browser, you can print or save the image using the computer's printer or file storage.

Enable the Verifit networking as described above in Network Setup. Enter the Verifit network address in the browser address bar (e.g., 172.30.1.57). Select the Capture the screen link shown in the browser window. Alternatively, enter the direct link to the screen image in the browser address bar (e.g., 172.30.1.57/screen). The browser will display the current Verifit screen image. Use the browser features to save or print the image. In many browsers, you can right-click on the browser window, or open the browser menu.
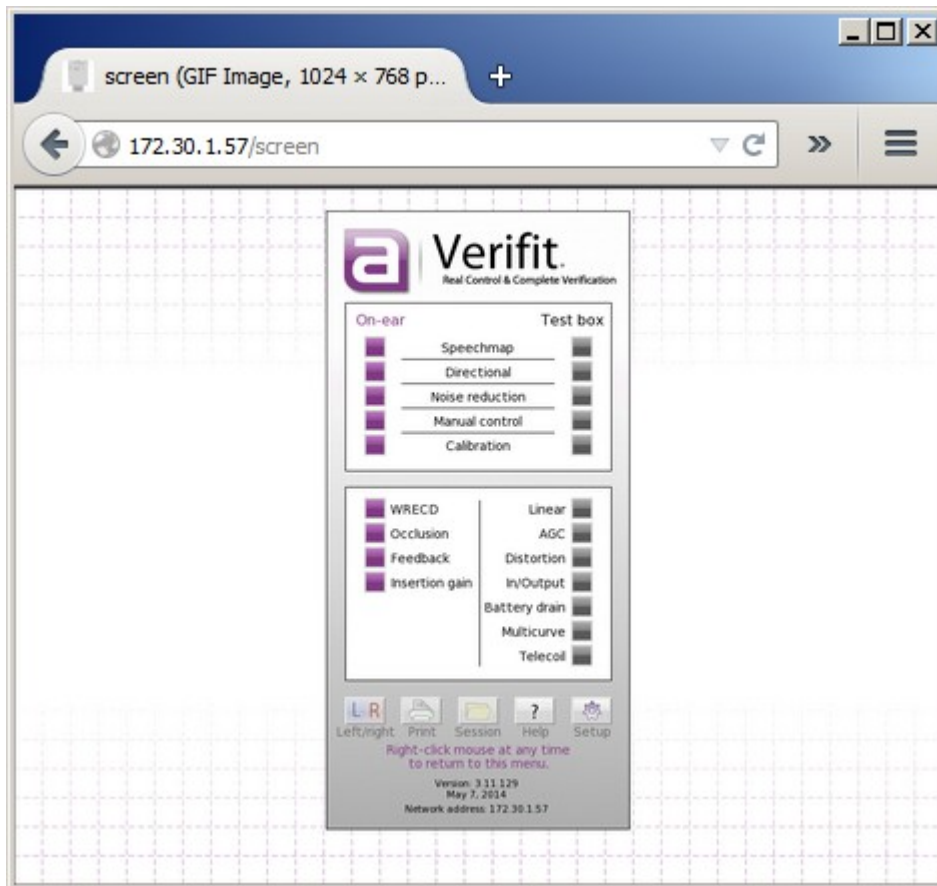
Session setup

The Verifit itself does not store data. All entered and measured data are lost when you turn the Verifit off. Also, each time you change clients you need to erase the Verifit's session data, so that the data and test results do not become mixed or confused among different clients or hearing instruments. The *Session* features allow you to erase data conveniently without turning the Verifit off. The Session features also allow you to store data permanently in Session files which you can later restore to the Verifit. To access the Session features, click the *Session* button [📁] and select one of the erasure or storage options.

You can store the Verifit data in session files on a USB drive or on a Windows shared folder. You can later restore the session files to the same Verifit or to other Audioscan equipment. Since the files use an XML data format. you can also view session file contents through a web browser, and you can load them in a spreadsheet program such as Microsoft Excel.

Note: some USB sticks are bootable and may cause issues on start-up if left connected you your Verifit after use. These should be removed during start-up of your Verifit and then re-connected after.

To enable and configure file-based data exchange:

1. Click [Setup] [⚙], then select [Session] [📁].

2. Click [Enable file based data exchange].

3. Click the storage file location [USB drive or Windows share].

Storing session files on a USB drive requires that you simply insert the drive into any of the Verifit's USB ports. Storing session files on a Windows shared folder requires that your Verifit be connected to the local area network, and that you create a shared folder to store the files on one of your computers. See the section above, <u>Windows-shared printers and folders</u>, for instructions about setting up a Windows-shared folder.

Storing and restoring session files

You can save a session file at any time by clicking [Session] [📁]. from the Verifit home menu, and then by selecting *Store session to file*. You can enter the session file name using an attached keyboard.

If the data originate from measurements with a client, then name the session file after the client, that is, using a unique *Client ID*. The Verifit will automatically append an increasing number to ensure that the file names are unique and grouped by Client ID. Since uppercase and lowercase letters are distinct, you should consistently use one or the other (e.g., all UPPERCASE), thereby avoiding the frustration of creating multiple Client IDs for the same client. If you do not enter a file name, the Verifit will use *session.xml*.

```
DOE_JOHN.1.xml, DOE_JOHN.2.xml, DOE_JOHN.3.xml
session.1.xml, session.2.xml, session.3.xml
```

! NOTE: If a printout or session file identifies the printed or saved data as belonging to an individual, it becomes Individually Identifiable Health Information and must be protected under the HIPAA Security Rule.

To store a session file:

1. Click [Session] [📁].

2. Select *Store session to file*.

3. Click the Client ID list button. This will display a list of Client IDs with the first entry highlighted.

To add a new Client ID:

1. Type the new Client ID. The highlight will move to any matching Client IDs as you type, then disappear once

you have entered a unique one.

2. When you finish typing the Client ID, click on the Client ID button to keep your entry

3. Click ✓ to store the current session data to the file in the Client ID window.

To add a session for an existing Client ID:

1. Select the client in the list using the mouse or a connected keyboard. The Verifit will highlight the closest match as you type.

2. Click on the matching Client ID.

3. Click ✓ to store the current session data to a new file.

Restore a session from a file

1. Click [Session] 📁.

2. Select *Restore session from file*.

3. Click the Client ID list button. This will display a list of Client IDs with the first entry highlighted.

4. Use the mouse or the arrow keys to select the Client ID, or start typing the Client ID on a connected keyboard. The highlight will move to the closest match as you type.

5. Click on a session file name.

6. Click the Show contents button to view test data available in the selected file.

7. Click ✓ to load the session data.

View a session file

You can view session files on any computer using a web browser or a spreadsheet program such as Microsoft Excel. To view a session file Excel, right click on the file and select *Open With.* Choose a browser program or *Microsoft Excel*. When prompted for a style sheet, select the *audioscan.xsl* from the same folder, which the Verifit saves alongside any session data files.

Session file name rules

The Verifit prevents you from entering the following characters in session file names:

! ~ ` @ # $ % ^ & * + = \ / ? < , . >

21 Troubleshooting

This section covers common problems encountered when using the Verifit. If you require further assistance, note your model and serial number (located on rear of display unit) and contact your local distributor, or Audioscan at 519-268-3313 800-265-2093 (USA only), 519-268-3256 (fax) or service@audioscan.com

PLEASE DO NOT SHIP YOUR UNIT BACK TO THE FACTORY. In most cases we can courier you a part that you can quickly and easily replace yourself.

Self test failures

Any failure during power-on self test (P.O.S.T.) is indicated on-screen and further use of the instrument is denied. Try the following steps to resolve the failure:

1. To access Self test, click on ⚙ and then click on [Self test].

2. If you received a Max out/in or a Routing failure, remove any hearing aids from the test chamber and rerun self test.

3. Unplug probe dock from display unit and unplug both the test box reference microphones and binaural coupler microphone from the test box. Click [P.O.S.T.] to rerun the self test. If self test passes, reconnect the microphones, one by one, running self test each time until a failure occurs. If the failure returns, display and print the test results and contact Audioscan for help.
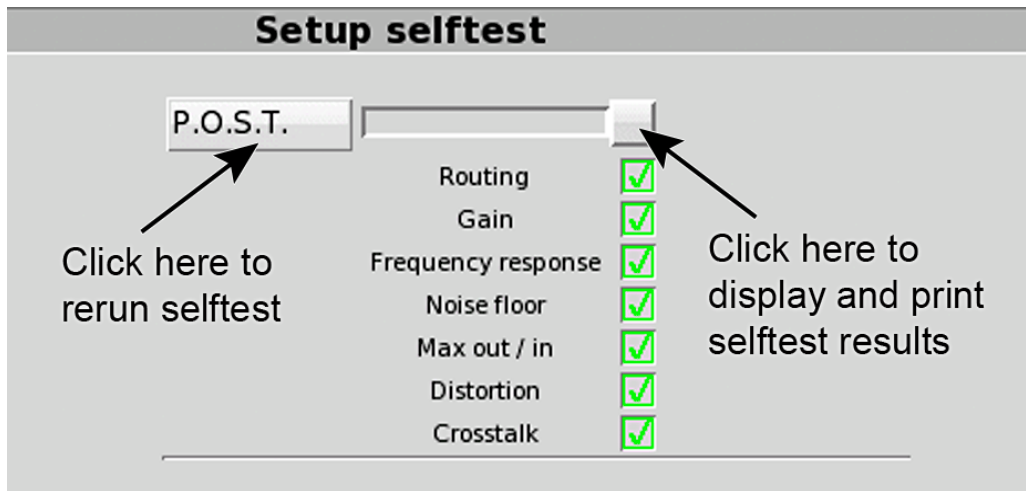
Initialize Function

Initializing your Audioscan unit will reset it to default factory settings. This erases the user preference files stored in internal memory. Any custom printer choice, network settings, test setups will need to be re-entered and the user calibrations will also be required.

1. To initialize, click on [Setup], then click on [Self test]

2. Click on [Initialize]. Verifit will automatically restart.

Inconsistent levels in speech stimulus

The speech stimulus changes in level and/or spectrum from loop to loop during the test.

- The level and spectrum of the Speechmap stimulus presented is controlled by the on-ear reference microphone. Any extraneous sound reaching this reference microphone during testing will cause the Verifit to lower the level of the stimulus, or lower the level of certain frequencies. Subsequent loops of the stimulus will sound either too quiet, muddy-sounding, or tinny-sounding.
- Keep test room as quiet as possible, watching for nearby computer fans, HVAC vents, or other sources of noise.
- Limit movement of personnel in the room while testing is taking place.

Test box high distortion or noise

High distortion and/or noise numbers in an ANSI test

- There may be a leak between the hearing instrument under test and the coupler it is connected to. For BTE type instruments, check the integrity of the tubing at the end of the coupler where it joins with the ear hook. Look for cracks. ITE type instruments need to have a good seal between the hearing instrument and the coupler. In addition, all vents need to be closed from the faceplate side of the hearing instrument.
- Ambient room noise may be leaking into the test chamber. Air conditioners, computer fans and similar noisemakers can yield artificially high noise figures. Check the sealing of the test chamber. Try turning off suspected noise sources to identify the cause.
- Vibration may be coupled into the test chamber from other equipment on the same table or wooden floor. Computers, fans and air conditioners may be the source of the vibration. Try turning off suspected sources to identify the cause. Relocate the source or the Verifit test chamber or mount the test chamber on a foam pad.

Test box curves inconsistent

The test box curves keep changing from test to test.

- The battery may be close to end of life or starved for air (zinc-air cells) because of a tight seal on the battery compartment. Try using a fresh battery.
- The test box reference microphone is incorrectly positioned. In order to control sound pressure levels precisely at the microphone inlet of the hearing instrument, the test box reference microphone must be positioned as close as possible to the hearing instrument's microphone without actually touching it.
- The noise or feedback reduction features are attempting to reject the test signal. These need to be disabled prior to tests with tones or noise.
- The instrument is on the verge of feedback due to a poor seal to the coupler, unplugged vent or a crack in the tubing on the BTE coupler.

Test box curves differ from specifications

The OSPL90 and response curves don't look like the manufacturer's.

- Check that all controls or program settings are the same as those used by the manufacturer.
- Check that vents on earmolds or ITE instruments are plugged at the faceplate.
- Check that ITE instruments are well sealed to the coupler.
- When puttying a hearing instrument into the ITE coupler, be sure to keep the canal portion of the instrument flush with the inside of the 2cc volume.
- Ensure that the test box is sealed tightly.
- Ensure that the test box microphone calibration was performed correctly.
- Check that the coupler is fully on the coupler microphone.

Test box speaker overdriven

Test box speaker overdriven! or *Test box front/rear speaker overdriven!*

The first message indicates that the rear (left) test chamber speaker is unable to produce the SPL required for a test. The second message will appear during the directional test if the front (center) or rear (right or left) speaker is unable to produce the required SPL. Check that the cable running between the test chamber and the main unit is securely connected.

- This message indicates that the test chamber speaker is unable to produce the SPL required for a test.
- Check that the test chamber lid is closed and sealed.
- Check that the test box calibration looks normal.
- Check that the hearing instrument under test is not feeding back.
- Try running an On-ear test

No test box reference mic. detected

No (right or left) test box reference mic. detected!

This message may be displayed when starting a hearing instrument test. It indicates that the Verifit is not measuring any sound at the (right or left) test box reference microphone. The test box reference microphones are the two black microphones located in the test chamber.

- Ensure that the (right or left) test box reference microphone is secure. Unplug the (right or left) test box reference microphone. Plug the microphone back in again, ensuring that it *clicks* into place. Try the calibration procedure again.
- Try switching the right and left test box reference microphones; if the fault follows the microphone to the other side, replacement may be indicated.
- Disconnect the black test box cable from the rear of the display unit and the rear of the test box. Re-connect this cable ensuring that both connectors are fully inserted into the jacks. A partially unplugged test box cable will often cause a ref mic error message.

Invalid test box calibration

Invalid test box microphone calibration!

This message may be displayed during the test box calibration procedure. It indicates that the calibration curve is significantly different from what is expected. It may be accompanied by a missing test box reference microphone error.

- Ensure that the test box cable is securely connected on both the test box and display unit ends.
- Check that the there are no couplers on the coupler microphones and that the microphones are correctly positioned for test box calibration.
- Check that the coupler microphone is securely plugged into the correct socket.
- Follow the suggestions in No test box reference mic. Detected.

Unable to calibrate test box microphone

Unable to calibrate test box microphone!

This message may be displayed during the test box calibration procedure. It indicates that the test box microphones could not be accurately calibrated due to significant ambient noise or possibly defective microphones.

- Check that the test chamber lid is closed and sealed.

- Turn off nearby sources of noise and vibration.
- Ensure that the test chamber is not bumped or moved during calibration.
- Follow the suggestions in <u>No test box reference mic. detected</u> and <u>Invalid test box calibration</u> if problem persists.

No on-ear ref. mic. detected

No (right or left) on-ear reference mic. detected.

This message may be displayed when starting an On-ear test. It indicates that the Verifit is not measuring any sound at the on-ear probe reference microphone.

- Check that a probe microphone assembly is securely plugged into the PROBE connector on the lower side of the probe dock, and that it is the correct socket for the ear you are trying to calibrate. Also, check that the cable has not become damaged.
- Try switching right and left probe microphone assemblies. If the fault follows the microphone to the other ear, it may be a faulty microphone.

Invalid on-ear calibration

Invalid on-ear microphone calibration!

This message may be displayed during the on-ear calibration procedure. It indicates that the calibration curve is significantly different from what is expected. It may be accompanied by an on-ear reference microphone error.

- Check that a probe microphone assembly is securely plugged into the PROBE connector on the lower side of the probe dock, and that it is the correct socket for the ear you are trying to calibrate. Also, check that the cable has not become damaged.
- Try using a new probe tube. Ensure it is correctly attached and positioned.
- Try switching right and left probe microphone assemblies. If the fault follows the microphone to the other ear, it may be a faulty microphone.
- Ensure not to attempt to use cleaned or sterilized probe tubes, as this causes the probe mic inlet tube to become clogged with cerumen, requiring microphone replacement and voiding microphone warranty.

Unable to calibrate on-ear microphone

Unable to calibrate on-ear microphone!

This message may be displayed during the on-ear calibration procedure. It indicates that the on-ear microphones could not be accurately calibrated due to significant ambient noise or possibly defective microphones.

- Turn off nearby sources of noise.
- Ensure the probe module is held steady during the calibration procedure.
- Ensure nothing makes contact with the probe tube during the calibration procedure.
- Follow the suggestions in <u>No on-ear ref. mic. detected</u> and <u>Invalid on-ear calibration</u> if problem persists.

Sound field speaker overdriven

Sound field speaker overdriven! or *External sound field speaker overdriven!*

This message may occur in on-ear directional or on-ear unaided or aided tests if:

- No external front speaker is connected but one has been selected in Setup. See External display, printer, speaker, External sound field speaker setup.
- No back speaker has been connected but an on-ear directional test is being attempted. See External sound

field speaker setup.
- The test environment is too reverberant for the distance between the client and the speaker(s). Move the on-ear speaker(s), internal or external, and client away from walls and hard objects. Move the client closer to the speaker(s).
- The speaker or connecting cable (external speakers only) is defective. If this is the case, you should not hear any sound coming from the internal or external speaker(s) during any test. Try a different speaker or cable.

Binaural tests run twice

Binaural tests run twice

Tests are automatically repeated when in binaural mode.

When making a binaural measurement, the input level at the left and right ear may be substantially different due to acoustic reflections from nearby objects and the position of the real-ear speaker. The Verifit produces a sound field that will minimize the input sound field error for both ears. Occasionally, the difference between the ears is large enough that the Verifit is unable to compensate and provide clinically relevant results. In these situations, the Verifit will perform the measurement twice to obtain an accurate result for both ears.

For best success using Verifit binaural mode on ear

- Ensure the patient and the Verifit real-ear speaker are directly facing each other and less than 60 cm (24 in.) apart.
- Position the patient and the Verifit real-ear speaker as equidistant as possible from walls and other large surfaces.
- Enable binaural equalization assistance from Setup Speechmap.

Invalid binaural equalization

Invalid Binaural EQ!

This message may be displayed in Speechmap when running in L+R mode in the testbox. It indicates that there was a significant difference between the left and right reference microphones.

- Check that both reference microphones are securely plugged within the test box.
- Position the reference microphones as symmetrically as possible on the left and right hearing instruments.
- If this error persists, run Speechmap in L and R modes separately.

Invalid WRECD transducer coupler calibration

Invalid WRECD transducer coupler calibration.

This message may be displayed during the coupler calibration for the RECD transducer. It indicates that the calibration is significantly different from normal which may cause significant error while fitting.

- Check that the WRECD transducer is connected to the probe dock and that the probe dock is connected to the rear unit.
- Check that the WRECD transducer is connected to the TRIC adapter on the 0.4cc coupler, and that the coupler is attached to the blue coupler microphone.
- Check that the coupler microphone is connected in the test box.

Invalid RECD real ear measurement

Invalid RECD real ear measurement.

This message may be displayed during the RECD real ear measurement. It indicates that the measurement is

significantly different from normal which may cause significant error while fitting.

- Check that the WRECD transducer is connected to the probe dock.
- Check that the probe module is connected to the probe dock. Ensure the probe tube is not pinched or blocked.
- Check that the probe dock is connected to the rear unit.
- Check that the WRECD transducer is inserted into the ear that is currently under test.

Headphone high distortion or noise

Headphone output contains uncomfortable distortions or noise

- Headphone output may be clipping when using a high powered hearing instrument.
- Reduce the headphone volume control using the mouse wheel.
- If distortion continues at reasonable headphone listening volume, then the source is likely the hearing instrument.

22 Technical Specifications

Specifications subject to change without notice

Environmental conditions

STORAGE & TRANSPORTATION
Temperature..- 20°C to +60°C
Relative humidity (non-condensing)..............5% to 95%

OPERATING
Temperature...+15°C to +30°C
Relative humidity (non-condensing)...........20% to 50%
Atmospheric Pressure.............................800–1060 hPA
Altitude...below 2000m

General

Power source:..100–240 V
....47–63 Hz
....1.35A-0.53A
Overall dimensions WxHxD
    Display unit.....................................36.0x41.7x16.5 cm
....14.2x16.4x6.5 in.
    Test box...35.9x13.7x32.7 cm
....14.1x5.4x12.9 in.
Weight...
    Display unit...3.0 kg
....6.6 lb
    Test box...4.0 kg
....8.8 lb
    Shipping..14.9 kg
.... 32.8lb
Display type...............................LED backlit active color
Display size..12.1" diagonal
Resolution....................................1024x768 (XGA)
Stereo headphone monitor amplifier
....250 mW into 16 ohms, L/R
Power amplifiers.................................2 @ 5 watts each
Simultaneous stimulus channels....................................2
Simultaneous measurement channels...........................2

CONNECTIVITY
WiFi...802.11 B/G/N
Ethernet (RJ45)...1
USB..5
HDMI for external display..1
External speakers (RCA)...2
Test box cable (HDMI-style)...1
Probe dock (Mini-DIN)...1
Probe microphone (3.5 mm stereo).............................2
WRECD transducer (3.5 mm stereo)............................1
Binaural monitor headphone (6.3 mm stereo)..............1
Test box reference microphone (3.5 mm stereo)........2
Binaural coupler microphone (3.5 mm stereo)..............1

Battery substitute (3.5 mm stereo)................................1
Power supply (4-conductor DIN)....................................1

Test Box

Working Space WxHxD......................28.0x7.5x12.3 cm
....11.0x3.0x4.8 in.
Speakers...3
....@ 30 mm
....@ 1.25 in.
Isolation @1 kHz...>25 dB
Induction coil...ANSI S3.22
....@ 23.5x16.9 cm
....@ 9.2x6,7 in.
Battery simulator...ANSI S3.22
Frequency range....................................200–12500 Hz
Coupler noise floor..............200–12500 Hz <40 dB SPL
Stimulus levels...40 to 90 dB
....in 5 dB steps
Inductive stimulus levels..............................ANSI S3.22
....31.5mA/m
Test stimuli distortion........................<2% at 90 dB SPL
....<0.5% at 70 dB SPL
Test stimulus accuracy at reference mic for tones.........
....200–2000 Hz ±1.5 dB SPL
....2000–8000 Hz ±2.5 dB SPL
....8000–12500 Hz ±4 dB SPL
Equalization method..
..............................Real-time modified pressure method
....(Stored for open fittings)
Analysis................................Frequencies per octave 12
....Filter bandwidth 1/12th-octave
Measurement accuracy for tones.......... @ 1kHz ±1 dB
....re: 1 kHz 200 – 5000 Hz ±1 dB
.....................................re: 1 kHz 5000–12500 Hz ±3 dB
Measurement range..............................30–145 dB SPL
Harmonic distortion...
............................Measurement *2nd and 3rd* or *2nd plus 3rd*
....Range 200–4000 Hz
Harmonic distortion accuracy
....@250 Hz 3.5-5.5%
....@1000 Hz 3.5-5.5%
....@2000 Hz 3.5-5.5%
....@4000 Hz 2.2-4.2%
Battery drain..Range 0–20mA
....Accuracy ±5%
....Resolution.±0.01 mA

STIMULI
Tone
Tone burst
Pink noise
Dual directional noise
ISTS
Calibrated speech
Filtered speech (for frequency-lowering tests)
Live speech
User-supplied stimuli

ANSI S3.22 TESTS AVAILABLE
OSPL90
Full-on Gain
Reference Test Gain
Frequency Response
Frequency Range
Maximum OSPL90
Harmonic Distortion
Attack & Release time
Equivalent Input Noise
Input/Output Curves
Coupler SPL - Telephone Simulator
Simulated Telecoil Sensitivity
Battery Drain

OTHER TESTS AVAILABLE
Speechmap®
Speechmap® for fitting telecoils
Real-time adaptive directional verification
Frequency-lowering instrument verification
Coupler SPL vs Frequency
Coupler gain vs Frequency
Spectral analysis
Noise reduction verification
Distortion vs Frequency
Manual measurement of output, gain and distortion

On-Ear

Speakers (ducted port)..2
....@5x9 cm
....@2x3.5 in.
Probe microphone tube......................................Silicone
....1 mm diameter x 75 mm long
Probe modules...2
.................Each with probe and reference microphones
Probe microphone noise floor...
....200–12500 Hz < 45 dB SPL
Frequency Range.....................................200–12500 Hz
Frequency modulation.....................................Sawtooth
....±3% over 128 ms
Stimulus levels at reference microphone for tones
....40–85 dB SPL
....5 dB steps
Stimulus accuracy at reference mic for tones
....200-2000 Hz ±1.5 dB SPL
....2000-8000 Hz ±2.5 dB SPL
....8000-12500 Hz ±4.0 dB SPL
Equalization Method
...............................Real-time modified pressure method
....(Stored for open fittings)
Analysis..
..............................Swept tone frequencies per octave 12
...............................Burst tone frequencies per octave 3
....Speech & Noise filter 1/3 octave
Measurement accuracy for tones @ 1kHz............±1 dB
....re: 1 kHz 200 – 5000 Hz ±1 dB
.....................................re: 1 kHz 5000–8000 Hz ±2.5 dB
...................................re: 1 kHz 8000–12500 Hz ±3.5 dB
Measurement range......200–2500 Hz 30–135 dB SPL
....2500–12500 Hz 30–140dB

STIMULI
ISTS
Frequency-modulated tone
Tone burst,
Pink noise
Dual-direction noise
Calibrated speech
Filtered speech (for frequency-lowering tests)
Live speech

ANSI S3.46 - 2013 TESTS AVAILABLE
Real-Ear Unaided Response
Real-Ear Aided Response
Real-Ear Occluded Response
Real-Ear Insertion Gain

OTHER TESTS AVAILABLE
Speechmap®
Real-time adaptive directional verification
Frequency-lowering instrument verification
Harmonic distortion
Spectral analysis
Noise reduction verification

Feedback suppression verification
Manual measurement of output, gain and distortion

FITTING METHODS AVAILABLE
Speechmap with.....................................DSL5.2
....NAL-NL1
....NAL-NL2
....CAMFIT
Insertion gain with................................NAL-RP
....NAL-NL1
....Fig6
....Pogo II
....Berger
....Libby

Sensory Loss Simulator

Simulation types..Sensorineural
....Linear conductive
...........................Non-linear outer hair cell cochlear loss
Simulation bands...65

23 Glossary

ABR, Auditory Brainstem Response, The auditory brainstem response (ABR) test gives information about the inner ear(cochlea) and brain pathways for hearing. This test is also sometimes referred to as auditory evoked potential (AEP). The test can be used with children or others who have a difficult time with conventional behavioral methods of hearing screening. The ABR is also indicated for a person with signs, symptoms, or complaints suggesting a type of hearing loss in the brain or a brain pathway.

AGC, **Automatic Gain Control**, the means by which gain is automatically controlled by the level of the signal being amplified. (ANSI S3.22)

AGC-I, input-controlled AGC (see "input compression").

AGC-O, output controlled AGC (see "output compression").

ANSI, American National Standards Institute.

Binaural, literally means "having or relating to two ears." Binaural hearing, along with frequency cues, lets humans and other animals determine direction of origin of sounds. Similar to diotic which is used in psychophysics to describe an auditory stimulus presented to both ears.

BSPL, **Band Sound Pressure Level**, the SPL within a restricted frequency band.

BTE, Behind-The-Ear (hearing aid).

Compression, a type of AGC in which an incremental change in the input level produces a smaller incremental change in the output level.

CR, **Compression Ratio**, the ratio of incremental change in input SPL to the resulting incremental change in output SPL. Used to characterize steady state AGC action; can be a function of input level, duration and frequency.

CROS, **Contralateral Routing Of Signals**; a type of hearing aid in which the microphone is at the ear opposite to the one receiving the amplified sound.

CORFIG, **coupler response for flat insertion gain**; the transformation added to real-ear insertion gain to obtain 2-cc coupler gain. Assumes linear amplification.

Coupler, a device used to acoustically couple an earphone or hearing aid to a measurement microphone and to provide an acoustic load.

DSL, **Desired Sensation Level Method**, a systematic eardrum (SPLogram) approach to the hearing aid fitting process that seeks to ensure amplified speech will be audible and comfortable while loud sounds will not be uncomfortable.

Directional hearing aid, a hearing aid for which the gain is dependent on the direction of sound incidence when measured under free-field conditions (ANSI S3.22).

EMC, Electromagnetic Compatibility, the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects (electromagnetic interference) that such energy may induce. EMC aims to ensure that equipment items or systems will not interfere with or prevent each other's correct operation through spurious emission and absorption of electromagnetic interference.

Equalization, process of controlling the SPL (or band SPL) of the stimulus, as a function of frequency, at the field reference point (ANSI S3.46).

FM, **frequency modulation**, a method of transmitting information in which the frequency of a radio wave (carrier) is varied (modulated) by the information (signal). Also, a method of reducing standing waves in a sound field in which the frequency of a test tone (carrier) is varied by a low frequency triangle or sine wave.

FM System, an assistive listening device consisting of a microphone, an fm radio transmitter and an fm receiver. The microphone and transmitter are worn by the speaker and the receiver is worn by the listener.

Gain (in dB), output sound pressure relative to input sound pressure, expressed in decibels; gain = 20log10 (output sound pressure / input sound pressure); also, gain = (output SPL) - (input SPL).

Gain control, a manually or electronically operated control for the adjustment of overall gain (ANSI S3.22).

HA-1 Coupler, a coupler having a volume of 2 cubic centimetres with direct access to the cavity. Used for testing in-the-ear and in-the-canal hearing aids; can also be used to test behind-the-ear hearing aids with a custom earmold attached. Aka the ITE coupler.

HA-2 Coupler, a coupler having a volume of 2 cubic centimetres with access through a rigid tube. When used for testing BTE hearing aids, the rigid tube consists of 18 mm of 3 mm tubing plus 25 mm of 2 mm tubing (ANSI S3.22). When used for calibrating insert earphones, the 2 mm tubing is not used (ANSI S3.6). Aka the BTE coupler.

Harmonic, a component of a tone complex that is an integer multiple of the lowest frequency component (fundamental).

Harmonic Distortion, the addition of harmonic components to a signal. The rms value of a harmonic component of a signal as a percentage of the rms value of the fundamental. If less than 20%, the rms value of the total signal may be used instead of the fundamental.

HFA, High Frequency Average, the average of values in dB at 1000, 1600, and 2500 Hz. (ANSI S3.22).

HL, Hearing Level, the hearing threshold referenced to the threshold of normal hearing, expressed in dB.

HI, Hearing instrument.

Input Compression, a form of AGC in which the signal level is regulated before the volume control.

Input / Output function, steady state, single-frequency plot of the coupler SPL on the ordinate as a function of input SPL on the abscissa with equal decibel scale divisions on each axis (ANSI S3.22).

ITE, In-The-Ear (hearing aid).

Kneepoint (compression threshold), the point on an input/output curve at which the slope digresses from unity indicating the signal level at which a non-linear process begins to take effect.1

LCD, liquid crystal display. A thin, planar information display.

Linear Amplification, amplification having the same gain for all input levels until the maximum output of the device is reached.

LTASS, Long-term average speech spectrum, the rms level of a speech passage in 1/3rd octave bands, averaged over the entire passage.

MAP, minimal audible pressure, SPL of a tone, measured or inferred at the tympanic membrane, at the threshold of audibility.

MPO, **Maximum Power Output**, the maximum SPL that a hearing aid can deliver in response to a steady narrow band input. The stimulus may be pulsed (a tone burst) to avoid discomfort and to approximate an aided UCL measurement stimulus.

Modulation, the process of varying a characteristic of one signal with another.

NAL, National Acoustic Laboratories (Australia)

NCA, National Centre for Audiology (Canada)

OSPL90 (output SPL for 90-dB input SPL), The SPL developed in a 2cc coupler when the input SPL is 90 dB, with the gain control of the hearing aid full-on (ANSI S3.22).

Output Compression, a form of AGC in which the signal level is regulated at the output.

PC, Peak-clipping, a method of limiting MPO by truncating the electrical signal supplied to the output transducer. The resulting acoustic signal may not be truncated but will be distorted.

PC, personal computer

PCL, **Printer Command Language**, a page description language developed by Hewlitt-Packard as a printer protocol and has become a defacto industry standard. Originally developed for early inkjet printers in 1984, PCL has been released in varying levels (1 through 6) for thermal, matrix printer and page printers.

PCM, Pulse-code modulation, a method used to digitally represent sampled analog signals. In a PCM stream, the amplitude of the analog signal is sampled regularly at uniform intervals, and each sample is quantized to the nearest value within a range of digital steps.

PCR, **Power Concentration Ratio**, a measure of the degree to which a large amount of power is concentrated at a small number of frequencies in the output of a hearing aid.

Postscript, a computer language for creating vector graphics. It is a dynamically typed, concatenative programming language created in 1982. It is best known for its use as a page description language in the electronic and desktop publishing areas.

Probe microphone, microphone (which may include an extension tube) having a sound inlet which is small enough to be acoustically unobtrusive when inserted into the ear canal (ANSI S3.46).

Pure tone, a signal containing one, and only one, frequency; a sinusoidal acoustic signal.1

REAG, Real-Ear Aided Gain, difference, in dB as a function of frequency, between the SPL (or BSPL) at a specified measurement point in the ear canal and the SPL (or BSPL) at the field reference point, for a specified sound field, with the hearing aid in place and turned on (ANSI S3.46).

REAR, Real-ear Aided Response, the SPL (or BSPL) as a function of frequency, at a specified measurement point in the ear canal for a specified sound field, with the hearing aid in place and turned on (ANSI S3.46).

RECD, Real-Ear-to-Coupler Difference, difference, in dB as a function of frequency, between the SPL (or BSPL) produced by an insert transducer at the eardrum and in a 2cc coupler. HA-1 or HA-2 coupler should be specified.

REDD, Real-Ear-to-Dial Difference, difference, in dB as a function of frequency, between the SPL (or BSPL) measured at the eardrum and the audiometer dial setting that produced it. It is specific to the client, headphone and audiometer used to generate it.

REIG, Real-Ear Insertion Gain, difference, in dB as a function of frequency, between the REAG and the REUG taken with the same measurement point and the same sound field conditions. REIG = REAG – REUG. ANSI S3.46.

REOR, Real-Ear Occluded Response, SPL (or BSPL), as a function of frequency, at a specified measurement point in the ear canal, for a specified sound field, with the hearing aid in place and turned off (ANSI S3.46). The REOR is used to evaluate the seal of an earmold. It is not related to the required gain of a hearing aid.

RESR, Real-Ear Saturation Response, obtained using a narrow-band signal at a level high enough to saturate the hearing instrument (usually 85-90 dB SPL)

REUG, Real-Ear Unaided Gain , difference, in dB as a function of frequency, between the SPL (or BSPL) at a specified measurement point in the ear canal and the SPL (or BSPL) at a field reference point, for a specified sound field, with the ear unoccluded (ANSI S3.46).

REUR, Real-ear Unaided Response, SPL (or BSPL), as a function of frequency, at a specified measurement point in the ear canal, for a specified sound field, with the ear canal unoccluded (ANSI S3.46).

Reference microphone, microphone used to measure the stimulus level in the measurement process or to control it in the equalization process.

Release Time, the time required for HA output to fall to within +/-4dB of its steady-state level for an input step from 90 to 55dB SPL. (ANSI S3.22)

REM, Real-ear Measurement.

RTG, Reference Test Gain, the HFA gain for a 60 dB input SPL with the gain control at RTS (ANSI S3.22).

Reference, Sound field, the calibration point of a sound field measurement.

RSETS, Relative Simulated Equivalent Telephone Sensitivity, difference in dB between the HFA-SPLITS (SPA-SPLITS) and the RTG plus 60 in the "M" (microphone) mode. RSETS = HFA-SPLITS - (RTG+60)

RTS, Reference Test Setting of the gain control, for a 60 dB input SPL, the setting of the gain control required to produce an HFA gain within 1.5 dB of the HFA-OSPL90 minus 17 dB. If the full-on HFA gain is less than the HFA-OSPL90 minus 17 dB, the RTS is the full-on setting of the gain control (ANSI S3.22).

Saturation, in a hearing aid, the limiting of output caused by the output circuitry and transducer reaching their maximum capability.

SPA, Special Purpose Average, the average of values in dB at three third octave frequencies separated by 2/3 of an octave (ANSI S3.22). See also HFA.

Spectrum, the BSPL as a function of frequency for a broad-band signal.

Speechmap, a trademarked hearing instrument fitting environment introduced by Audioscan in 1992. It presents hearing threshold, UCL and amplified speech spectra as SPL in the ear canal. The fitting goal is to make amplified speech audible and comfortable while avoiding discomfort for loud sounds. Originally speech was simulated using amplitude-modulated tonal signals. The Verifit replaces these simulated speech signals with real speech, both recorded and live. For details of the test signals and analysis methods, see Speechmap Technical Details.

SII, Speech Intelligibility Index, a quantity calculated from measures of speech, noise and hearing threshold that is highly correlated with the intelligibility of speech (ANSI S3.5).

Speech Region, a statistical range of short-term spectra present in a speech passage. The short-term spectra are typically 120 - 130 millisecond averages in 1/3 octaves. The statistical range is typically from the 70th to the 99th percentile.

SPL, Sound Pressure Level, rms sound pressure relative to 20 uPa, expressed in decibels. SPL = 20log10 (rms sound pressure / 20uPa).

SPLITS, coupler SPL for an inductive telephone simulator, SPL developed in a 2cc coupler by a hearing aid with the gain control at the RTS when the input is the magnetic field generated by a TMFS (ANSI S3.22).

TMFS, Telephone magnetic-field simulator, a device for producing a magnetic field of consistent level and geometric shape when driven by a specified current (ANSI S3.22).

THD, Total Harmonic Distortion, the power in all harmonic components as a percentage of the power in the fundamental. If less than 20%, the power of the total signal may be used instead of the fundamental. For most hearing aids, the inclusion of harmonics above the third will not significantly alter the THD (ANSI S3.22).

Transducer, a device which transforms energy from one form to another. For example, a microphone or earphone.

TRIC: Thin-tube Receiver In-the-Canal style of hearing instrument

UCL, Uncomfortable Listening Level, the level for a specified stimulus that is judged to be definitely uncomfortable.

Volume Control, a user-operated gain control.

Wideband, the extension of the frequency response bandwidth from 8kHz to 16kHz.

WRECD, **Wideband Real-Ear-to-Coupler Difference, t**he difference in SPL produced in an occluded ear canal and in the 0.4cc coupler by a high impedance coupled sound source.

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25 Appendix 1

Manufacturer Disclosure Statement for Medical Device Security

Manufacturer Disclosure Statement for Medical Device Security – MDS[2]

Device Category † **Hearing Aid Analyzer**	Manufacturer † **Etymonic Design Inc.**	Document ID	Document Release Date
Device Model **Verifit/RM500SL/Axiom**	Software Revision **See Page 1 of Users Guide**	Software Release Date: **See Page 1 of Users Guide**	

Manufacturer or Representative Contact Information:	Name **Chris Stokes-Rees**	Title **Technical Service Specialist**	Department
	Company Name **Etymonic Design Inc. / Audioscan**	Telephone # **800-265-2093**	e-mail **chris@audioscan.com**

MANAGEMENT OF ELECTRONIC PROTECTED HEALTH INFORMATION (ePHI) *As defined by HIPAA Security Rule, 45 CFR Part 164)*   Yes No N/A   Note #

1. Can this device transmit or maintain *electronic Protected Health Information* (ePHI)? ‡ .... **Yes** __1__
2. Types of ePHI data elements that can be maintained by the device:
   a. Demographic (e.g., name, address, location, unique identification number)? .... **No**
   b. Medical record (e.g., medical record #, account #, test or treatment date, device identification number)? .... **No**
   c. Diagnostic/therapeutic (e.g., photo/radiograph, test results, or physiologic data with identifying characteristics)? **No**
   d. Open, unstructured text entered by device user/operator? .... **Yes** __1__
3. Maintaining ePHI: *Can the device*
   a. Maintain ePHI temporarily in volatile memory (i.e., until cleared on by power-off or reset)?............................... **Yes** __2__
   b. Store ePHI persistently on local media?... **No**
   c. Import/export ePHI with other systems? .... **Yes** __3__
4. Mechanisms used for the transmitting, importing/exporting of ePHI: *Can the device*
   a. Display ePHI (e.g., video display)? .... **Yes**
   b. Generate hardcopy reports or images containing ePHI? .... **Yes** __1__
   c. Retrieve ePHI from or record ePHI to removable media (e.g., disk, DVD, CD-ROM, tape, CF/SD card, memory stick)?. **Yes** __1__
   d. Transmit/receive or import/export ePHI via dedicated cable connection (e.g., IEEE 1073, serial port, USB, FireWire)? .... **No**
   e. Transmit/receive ePHI via a network connection (e.g., LAN, WAN, VPN, intranet, Internet)?............................. **Yes** __3__
   f. Transmit/receive ePHI via an integrated wireless connection (e.g., WiFi, Bluetooth, infrared)?† .... **Yes** _3, 10_
   g. Other _____ ? .... _____

ADMINISTRATIVE SAFEGUARDS   Yes No N/A   Note #

5. Does manufacturer offer operator and technical support training or documentation on device security features?.......... **Yes** __4__
6. What underlying operating system(s) (including version number) are used by the device? **custom build of Linux, based on kernel 3.4.47**

PHYSICAL SAFEGUARDS   Yes No N/A   Note #

7. Are all device components maintaining ePHI (other than removable media) physically secure (i.e., cannot remove without tools)? **Yes**
8. Does the device have an integral data backup capability (i.e., backup onto removable media such as tape, disk)? .... **No**
9. Can the device boot from uncontrolled or removable media (i.e., a source other than an internal drive or memory component)? **Yes** __5__

TECHNICAL SAFEGUARDS   Yes No N/A   Note #

10. Can software or hardware not authorized by the device manufacturer be installed on the device?................................ **No**
11. Can the device be serviced remotely (i.e., maintenance activities performed by service person via network or remote connection)?. **No**
    a. Can the device restrict remote access to specific devices or network locations (e.g., specific IP addresses)? ... **No**
    b. Can the device log provide an audit trail of remote-service activity? .... **No**
    c. Can security patches or other software be installed remotely?... **No**
12. Level of owner/operator service access to device operating system: *Can the device owner/operator*
    a. Apply device manufacturer-validated security patches? .... **No**
    b. Install or update antivirus software?... **No** __6__
    c. Update virus definitions on manufacturer-installed antivirus software? .... **No** __6__
    d. Obtain administrative privileges (e.g., access operating system or application via local root or admin account)? **No**
13. Does the device support user/operator specific ID *and* password? .... **No**
14. Are access sessions terminated after a predetermined length of inactivity (e.g., auto logoff)? .... **No**
15. Events recorded in device audit log (e.g., user, date/time, action taken): *Can the audit log record*
    a. Login and logout by users/operators? .... **No** __7__
    b. Viewing of ePHI? .... **No** __7__
    c. Creation, modification or deletion of ePHI? .... **No** __7__
    d. Import/export or transmittal/receipt of ePHI? .... **No** __7__
16. Does the device incorporate an emergency access ("break-glass") feature that logs each instance of use? .... **No**
17. Can the device maintain ePHI (e.g., by internal battery) during power service interruptions? .... **No**
18. Controls when exchanging ePHI with other devices:
    a. Transmitted only via a physically secure connection (e.g., dedicated cable)? .... **No**
    b. Encrypted prior to transmission via a network or removable media? .... **No** __8__
    c. Restricted to a fixed list of network addresses (i.e., host-based access control list)? .... **No** __9__
19. Does the device ensure the integrity of the ePHI data with implicit or explicit error detection/correction technology? .... **No**

†Recommend use of ECRI's Universal Medical Device Nomenclature System (UMDNS).

Adapted from *Information Security for Biomedical Technology: A HIPAA Compliance Guide*, ACCE/ECRI, 2004.
ACCE – the American College of Clinical Engineering; ECRI – formerly the Emergency Care Research Institute.

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Manufacturer Disclosure Statement for Medical Device Security – MDS[2]

RECOMMENDED SECURITY PRACTICES

If possible, do not create ePHI. ePHI can only be created if a QWERTY keyboard is connected to the device. Not providing a keyboard is an effective way of restricting the creation of ePHI.

In the event that ePHI must be produced, the device is capable of outputting ePHI in several different forms as disclosed in this document. Any data containing ePHI should be de-identified before storing, whether it is to hard copy, network file, or USB. If de-identification is not possible physical access to the device or hard copies of data should be restricted to authorized personnel and saving to USB sticks should be prohibited.

EXPLANATORY NOTES *(from questions 1 – 19):*
IMPORTANT: Refer to *Instructions for the Manufacturers Disclosure Statement for Medical Device Security* for the proper interpretation of information provided in this form.

1. The device, if equipped with a QWERTY keyboard allows the operator to enter free-form text when saving or printing data. This data can be stored and retrieved from a USB stick or network file.

2. If an operator enters a header for printing, that header will remain on the machine until it is cleared or overwritten.

3. The device can import and export data and headers that may include ePHI, but only in the event that PHI was entered by the operator. The device can import/export via network connection or transfer via USB stick.

4. This document along with available phone support constitutes our support for HIPAA compliance.

5. The Verifit and Axiom devices boot from internal flash memory. The RM500SL device boots from a USB memory stick. The devices can boot from removable media only if it contains software supplied by the manufacturer.

6. There is no virus protection software available for the device; it is not required as it is not possible to load or execute software on the device except that which is provided by the manufacturer.

7. The device does not use any password protection and there is no device audit log.

8. The device does not encrypt data and cannot save to encrypted media such as an encrypted USB. Any PHI produced by the device should be de-identified appropriately.

9. The device can connect to any networked computer to store and retrieve data, provided the user name and password is entered. Once the username and password is entered it is maintained by the device.

10. Wireless 802.11 network connection standard on Verifit, optional on Axiom, n/a for RM500SL.

Adapted from *Information Security for Biomedical Technology: A HIPAA Compliance Guide*, ACCE/ECRI, 2004.
ACCE – the American College of Clinical Engineering; ECRI – formerly the Emergency Care Research Institute.

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