The Equinox Platform
Operation Manual

Introduction

The Equinox Hardware Platform

System Installation

The AC440 Audiometry

Contents

Operation Manual for AC440

- for the Equinox

1 Introduction

This manual describes the functions of the AC440 software for the Thor Platform. This platform is built into a cabinet called Equinox.

The manual is divided into 5 sections:

1) **Introduction**

2) **The Thor Hardware Platform**

3) **System Installation – to get a new system ready for use**

4) **The AC440 audiometry software – including:**

- A quick instruction - to quickly get going on systems already installed

- Use – provides the procedures and options for traditional use

- Technical Information

5) **Technical notes**

Please note that this manual does not include basic information on e.g. how to evaluate the tone or speech audiogram.

1.1 Intended use of the AC440 software and the Equinox

AC440 Audiometry Software

The audiometry software, AC440, for the Equinox is a fully NOAH compatible air, bone, speech audiometer that can be operated either from a PC keyboard or a dedicated audiometer keyboard.

The AC440 is a device for diagnosing a hearing loss. Output and specificity of this type of device are based on the test characteristics defined by the user, and may vary depending on environmental and operating conditions. The diagnosing of hearing loss using this kind of audiometer depends on the interaction with the patient. However, for patients not responding well possibilities of various tests allow the tester of having at least some evaluative result. Thus, a "normal hearing" result should not allow for ignoring other contra indications in this case. A full audiologic evaluation should be administered if concerns about hearing sensitivity persist.

It is intended to be used by hearing aid dispensers and hearing healthcare professionals.

The Equinox is controlled by a computer through the USB interface.

2 The Thor Hardware Platform

2.1 Precautions

Warning – Interacoustics will not make any guaranty to the functionality of the system if any other software is installed, with exception of the Interacoustics measurement AC440 module and a NOAH3 or a NOAH3 compatible Office System.

Notice   - The specification for the instrument is valid if the instrument is operated within the following environmental limits:

Temperature: 15°C to 35 °C.

Humidity: 30 %RH to 90 %RH

Supply voltage:100 – 240 Vac

Supply frequency: 50 – 60 Hz

Notice - The instrument must warm up for at least 1 minute before use.

Notice - The reference and the probe microphones can be verified using the procedures described in calibration software.

Notice - Be sure to use only stimulation intensities, which will be acceptable for the patient.

Notice - The transducers (headphones, bone conductor, etc.) supplied with the instrument are calibrated to this instrument - exchange of transducers requires a new calibration.

Notice -   It is recommended that parts which are in direct contact with the patient (e.g. earphone cushions) are subjected to standard disinfecting procedure between patients. This includes physically cleaning and use of a recognized disinfectant. Individual manufacturer's instruction should be followed for use of this disinfecting agent to provide an appropriated level of cleanliness.

Notice - Please note that if connection is made to standard equipment like printers and network, special precautions must be taken in order to maintain medical safety. Optical isolation unit for USB is available from your supplier.

Notice – No installation precautions are necessary to avoid unwanted sound radiation from the audiometer.

Notice – Connecting this device to other devices in order to make a system may cause the safety specifications to be invalid. It is therefore recommended to insert a galvanic separation between the device and the host computer, unless the computer is battery operated or supplied by a medical approved power supply.

Notice: Although the instrument fulfils the relevant EMC requirements precautions should be taken to avoid unnecessary exposure to electromagnetic fields, e.g. from mobile phones etc. If the device is used adjacent to other equipment it must be observed that no mutual disturbance appears.

If this apparatus is connected to one or more other devices with medical CE marking, to make up a system or pack, the CE marking is only valid also for the combination if the supplier has issued a declaration stating that the requirements in the Medical Device Directive article 12 are fulfilled for the combination.

Note!

Within the European Union it is illegal to dispose electric and electronic waste as unsorted municipal waste. Electric and electronic waste may contain hazardous substances and therefore has to be collected separately. Such products will be marked with the crossed-out wheeled bin shown below. The cooperation of the user is important in order to ensure a high level of reuse and recycling of electric and electronic waste. Failing to recycle such waste products in an appropriate way may endanger the environment and consequently the health of human beings.

2.2 General Maintenance Procedures

The performance and safety of the instrument will be kept if the following recommendations for care and maintenance are observed:

1 It is recommended to let the instrument go through at least one annual overhaul, to ensure that the acoustical, electrical and mechanical properties are correct. This should be made by an authorised workshop in order to guaranty proper service and repair.

2 Before the connection to the mains network, be sure that the local mains voltage corresponds to the voltage labelled on the instrument. Always disconnect the power cord if the instrument is opened or by control / replacement of the mains fuses.

3 Observe that no damage is present on the insulation of the mains cable or the connectors and that it is not exposed to any kind of mechanical load, which could involve damage.

4 Consult the Operating Manual for the instrument in question to see how long time it takes from turning on the instrument until it is stabilised and ready to use.

5 For maximum electrical safety, turn off the power from a mains powered instrument when it is left unused.

6 Do not site the instrument next to a heat source of any kind, and allow sufficient space around the instrument to ensure proper ventilation.

7 To ensure that the reliability of the instrument is kept, it is recommended that the operator at short intervals, for instance once a day, perform a test on a person with known data. This person could be the operator him/herself.

8 A plastic cover can be provided to protect the instrument against the accumulation of dust. The cover should only be used when the instrument is left unused with the power turned off.

9 If the surface of the instrument or parts of it are contaminated, it can be cleaned using a soft cloth moistened with a mild solution of water and dish washing cleaner or similar. The use of organic solvents and aromatic oils must be avoided. Always disconnect the mains conductor during the cleaning process, and be careful that no fluid is entering the inside of the instrument or the accessories.

10 After each examination of a patient, it should be ensured that there is no contamination on the parts in connection with the patient. General precautions must be observed in order to avoid that disease from one patient is conducted to others. If ear cushions or ear tips are contaminated, it is strongly recommended to remove them from the transducer before they are cleaned. By frequent cleaning water should be used, but by severe contamination it may be necessary to use a disinfectant. The use of organic solvents and aromatic oils must be avoided.

Great care should be exercised by the handling of earphones and other transducers, as mechanical shock may cause change of calibration.

2.3 Unpacking and Inspection

Check box and contents for damage

When the instrument is received please check the shipping box for rough handling and damage. If the box is damaged it should be kept until the contents of the shipment have been checked mechanically and electrically. If the instrument is faulty please contact your local distributor. Keep the shipping material for the carrier's inspection and insurance claim.

Keep carton for future shipment

The Equinox comes in its own shipping carton, which is specially designed for the Equinox. Please keep this carton. It will be needed if the instrument has to be returned for service.

If service is required please contact your local distributor.

2.4 Reporting Imperfections

Inspect before connection
Prior to connecting the Equinox to the mains it should once more be inspected for damage. All of the cabinet and the accessories should be checked visually for scratches and missing parts.

Report immediately any faults

Any missing part or malfunction should be reported immediately to the supplier of the instrument together with the invoice, serial number, and a detailed report of the problem. In the back of this manual you will find a "Return Report" where you can describe the problem.

Please use "Return Report"

Please realise that if the service engineer does not know what problem to look for he may not find it, so using the Return Report will be of great help to us and is your best guarantee that the correction of the problem will be to your satisfaction.

2.5 Concerning Repair and Maintenance

1. Interacoustics A/S is only considered to be responsible for the validity of the CE marking, effects on safety, reliability and performance of the equipment if:

   > assembly operations, extensions, readjustments, modifications or repairs are carried out by authorised persons,

   > a 1 year service interval is maintained

   > the electrical installation of the relevant room complies with the appropriate requirements, and

   > the equipment is used by authorised personnel in accordance with the documentation supplied by Interacoustics A/S.

It is important that the customer (agent) fills out the RETURN REPORT every time a problem arises and sends it to Interacoustics A/S, Drejervaenget 8, DK-5610 Assens, Denmark. This should also be done every time an instrument is returned to Interacoustics A/S. (This of course also applies in the unthinkable worst case of death or serious deterioration to patient or user).

## 2.6 Connection Panel Equinox
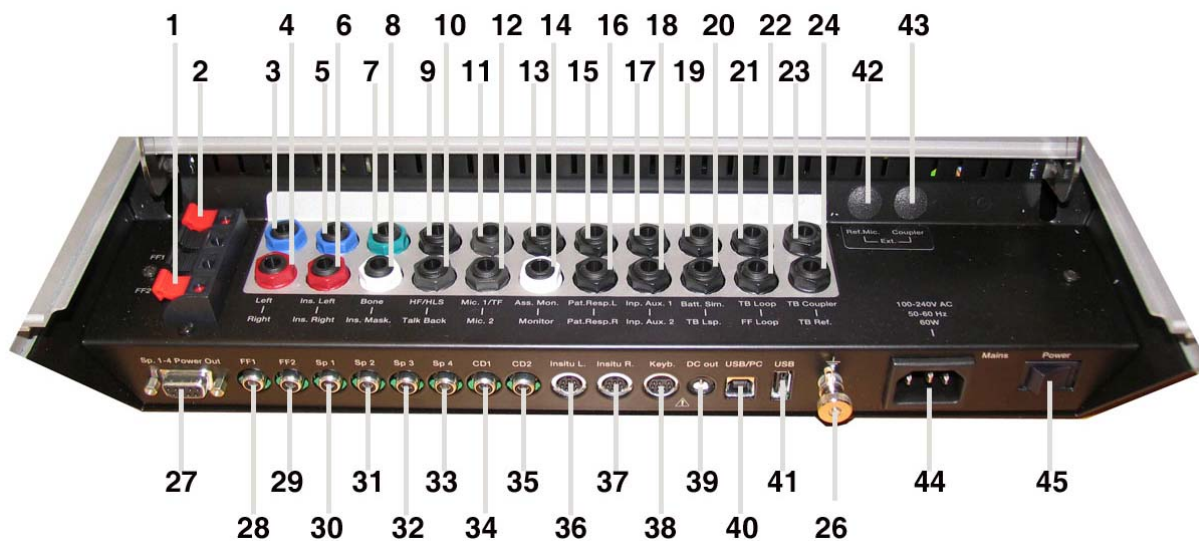
Position:	Symbol:	Function:
1	FF1	Balanced output for a 4 or 8 Ohm loudspeaker used for free field measurements.
2	FF2	Balanced output for a 4 or 8 Ohm loudspeaker used for free field measurements.
3	Left	Socket for left AC headphone
4	Right	Socket for right AC headphone
5	Ins. Left	Socket for left insert earphone
6	Ins. Right	Socket for right insert earphone
7	Bone	Socket for bone conductor
8	Ins. Mask.	Socket for insert earphone for masking
9	HF/HLS	Socket for High Frequency headphone or Hearing Loss Simulator
10	Talk Back	Socket for talk back microphone
11	Mic. 1/TF	Socket for microphone / talk forward
12	Mic. 2	Socket for microphone
13	Ass. Mon.	Socket for assistant's headset
14	Monitor	Socket for monitor headset
15	Pat. Resp. L	Socket for left patient response button
16	Pat. Resp. R	Socket for right patient response button
17	Inp. Aux. 1	Socket for input aux. 1
18	Inp. Aux. 2	Socket for input aux. 2
19	Batt. Sim.	Socket for battery simulator
20	TB Lsp.	Socket for test box loudspeaker
21	TB Loop	Socket for test box loop
22	FF Loop	Socket for free field loop
23	TB Coupler	Socket for test box coupler
24	TB Ref.	Socket for test box reference microphone
26		Ground

27	Sp. 1-4 Power Out	Balanced output for 4 or 8 Ohm loudspeakers.
		Pins 1 and 6: Speaker 1
		Pins 2 and 7: Speaker 2
		Pins 3 and 8: Speaker 3
		Pins 4 and 9: Speaker 4
28	FF1	Line output for external amplifier
29	FF2	Line output for external amplifier
30	Sp 1	Connection of loudspeaker 1
31	Sp 2	Connection of loudspeaker 2
32	Sp 3	Connection of loudspeaker 3
33	Sp 4	Connection of loudspeaker 4
34	CD1	Input Socket for CD 1
35	CD2	Input Socket for CD 2
36	Insitu L.	Connection of Insitu Headset Left
37	Insitu R.	Connection of Insitu Headset Right
38	Keyb.	Connection of Keyboard
39	DC	Socket for power supply for optical USB extension cable
40	USB/PC	Socket for USB cable or PC
41	USB	Socket for USB cable (NOAH link)
42	Ref.Mic./Ext.	Connection of external reference microphone
43	Coupler/Ext.	Connection of external coupler
44	Mains	Socket for mains cable
45	Power	Turns power on/off.

External connections

For further information see service manual.

2.7 Explanation to symbols which can be found on the instrument:

I	On (Power: connection to the mains)
O	Off (Power: disconnection from the mains)
~	Alternating current
⊏⊐	Fuse
⏚	Ground
⚡	Dangerous voltage
⚠	See explanation in manual
🛉	Type BF equipment

2.8 Technical Specifications Equinox Hardware

Specifications Equinox Hardware:

CE mark:	The CE-mark indicates that Interacoustics A/S meets the requirements of Annex II of the Medical Device Directive 93/42/EEC. Approval of the quality system is made by TÜV – identification no. 0543.
PC requirements:	800 MHz Pentium 3 class CPU (or better) with at least 128 MB ram, CD-ROM drive, USB connector. Display: minimum 800x600 and at least 500 MB free disk space. System RAM: 128 MB
Supported Systems:	Windows 98 SE/2000 (SP2 or later)/ XP (SP1 or later and compatible)
Available modules:	AC440.
NOAH:	3.0
Computer Communication:	Built-in USB1.1 computer interface.
Construction:	Painted metal cabinet bottom and moulded plastic top.
Power:	AC 50/60 Hz. 100 - 240V.
Fuses:	5 x 20 mm, 2 AT
Consumption:	75 W.
Dimensions:	LxWxH: 37x43.5x7.7 cm/14.5x17x3 inches.
Weight:	5.1 kg / 11.3 lbs.

2.9 FAQ Equinox Hardware

My standard USB cable does not fit the USB connector in the Equinox?

There are two USB connectors in the Equinox. One is labelled "USB" which is for e.g. Blue Tooth transmitter for NOAH Link. The other USB connector labelled USB/PC is the one you should use for connecting to your PC.

3 System Installation

3.1 To know before you start installation

Do not connect Equinox and the computer before the software has been installed!

- You need the CD-Rom, USB cable and the Equinox.

- Your computer must have NOAH3 or a NOAH3 compatible Office System installed prior to the Equinox and AC440 installation. (See **item 3.1.2** for a complete list of supported NOAH3 Office systems)

- If you are using AuditBase System 4 you must ensure to launch this office system prior to this installation of Equinox and AC440 software.

- You must have administrative rights to the computer on which you are installing the Equinox and AC440 software

3.2 Supported Noah3 Office Systems

- NOAH3 (from HIMSA)
- AuditBase System 4
- Mirage
- Practice Navigator
- Power Office
- AkuWin
- He@r-O
- Entendre 2

3.3 Installation on various Windows® versions

Installation on Windows® 2000 .... see section 3.3.1
Installation on Windows® XP .... see section 3.3.2
Installation on Windows® 98SE .... see section 3.3.3

3.3.1 Windows 2000 operative system –install Equinox driver and software

<u>Step 1:</u>

Power up your computer and launch windows and wait for the desktop to appear.

Put the CD in the computer and wait until the AC440 starts installing. If it does not start automatically, open Windows Explorer and double click on the file called "Setup.exe" on the CD-ROM.
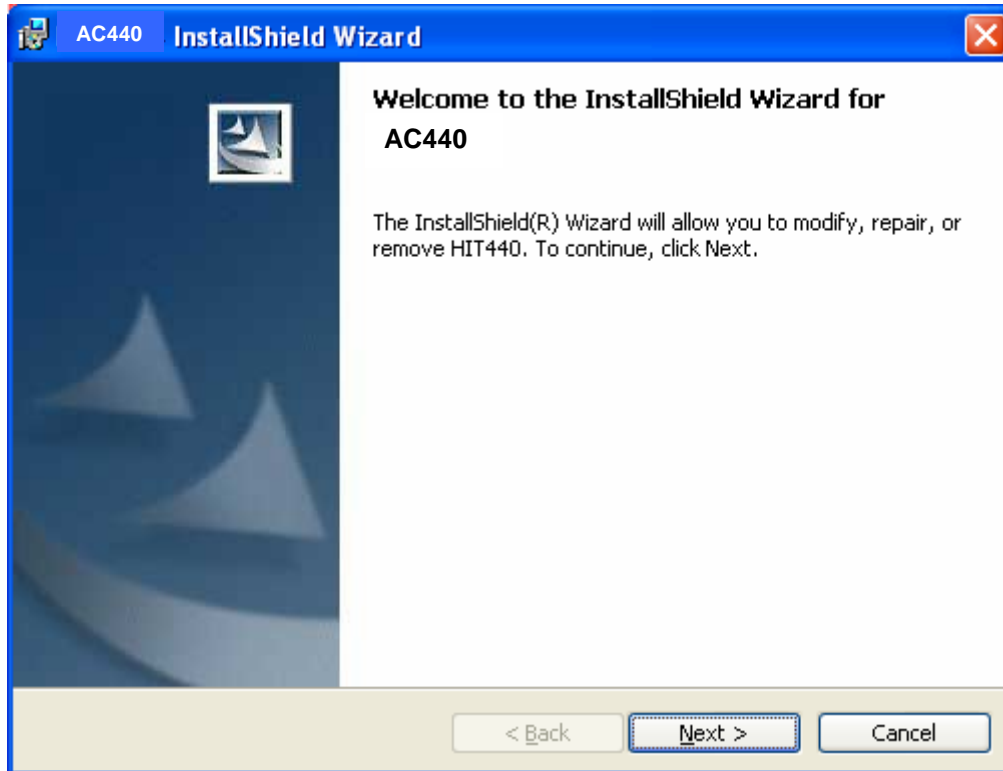
Press "Next" and follow the directions on the screen.
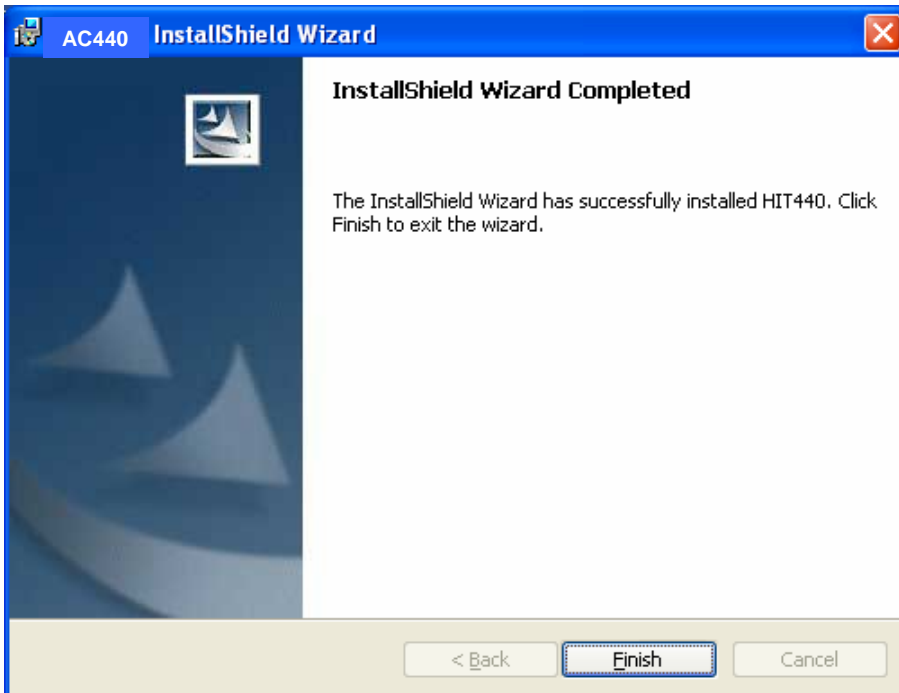
Finally you will see this dialog which means that your software has been correctly installed. Press "Finish" to finish the installation.

Now you are ready to connect the Equinox hardware to your computer.

Installation of Language specific files.:

Right click the start button on your desktop
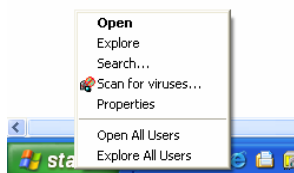
Click "Explore"
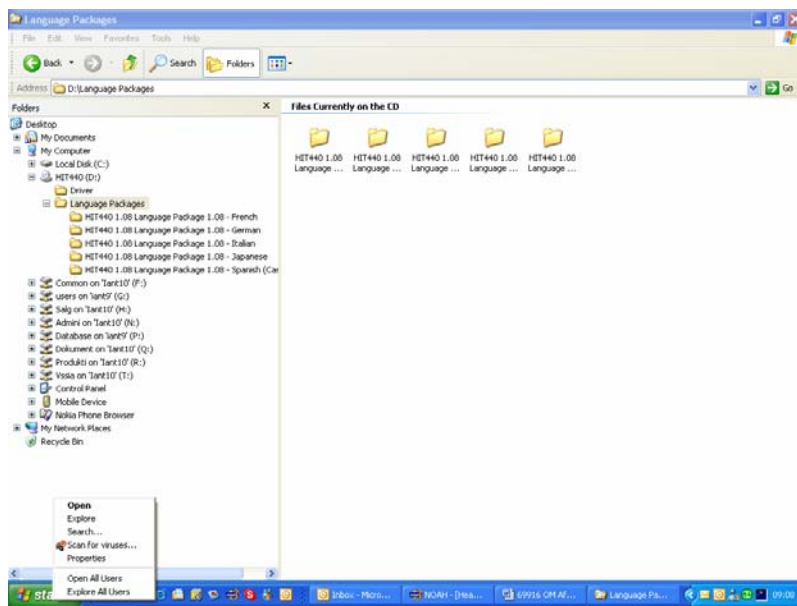
Choose the folder containing the language you prefer
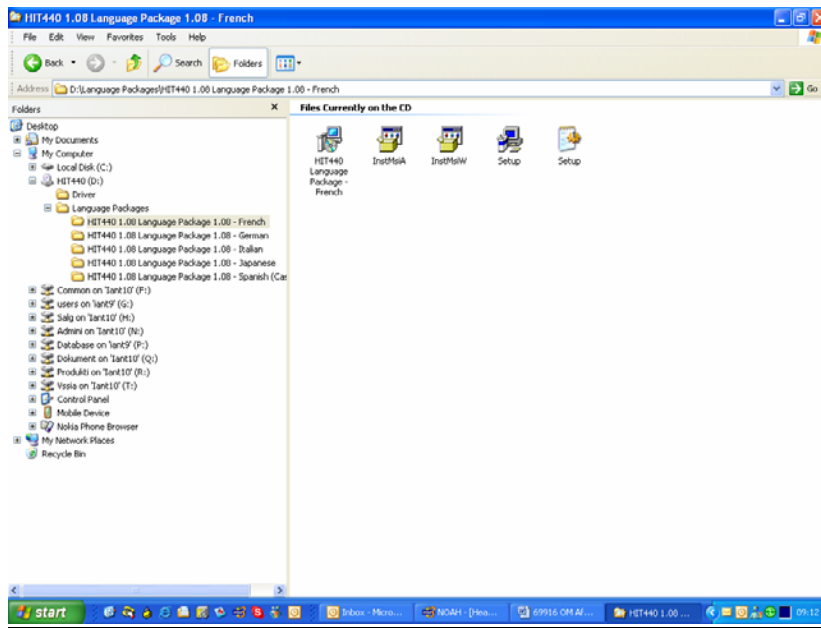
Click the setup file
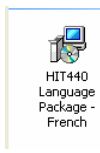
After next restart of your module the choices of languages will appear in the general setup.
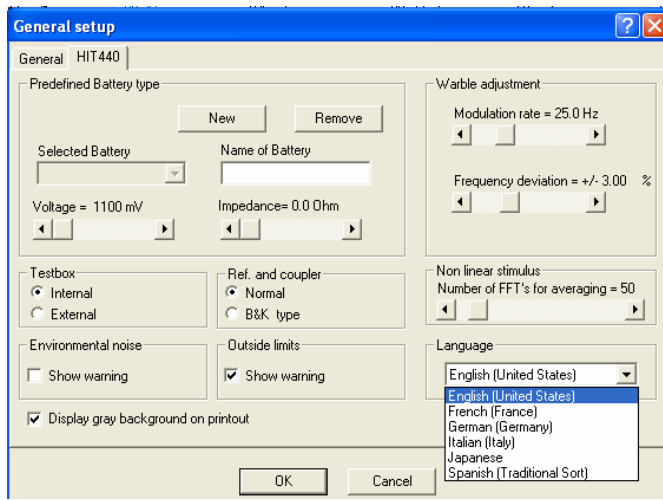
Step 2:

Turn on the Equinox and connect the USB cable to the back of the Equinox labelled USB\PC and plug the other end of the USB cable into a USB slot on your PC and you will see this screen:

Press Next and this screen comes up:

Press Next.

Found New Hardware Wizard

Locate Driver Files
Where do you want Windows to search for driver files?

Search for driver files for the following hardware device:

Equinox

The wizard searches for suitable drivers in its driver database on your computer and in any of the following optional search locations that you specify.

To start the search, click Next. If you are searching on a floppy disk or CD-ROM drive, insert the floppy disk or CD before clicking Next.

Optional search locations:
☐ Floppy disk drives
☑ CD-ROM drives
☐ Specify a location
☐ Microsoft Windows Update

< Back   Next >   Cancel

Insert the CD-ROM in your PC's CD-ROM drive and Press Next

Found New Hardware Wizard

Driver Files Search Results
The wizard has finished searching for driver files for your hardware device.

The wizard found a driver for the following device:

Equinox

Windows found a driver for this device. To install the driver Windows found, click Next.

d:\driver\iausb.inf

< Back   Next >   Cancel

Press Next.

If the installation of the drivers is made correctly this screen comes up:
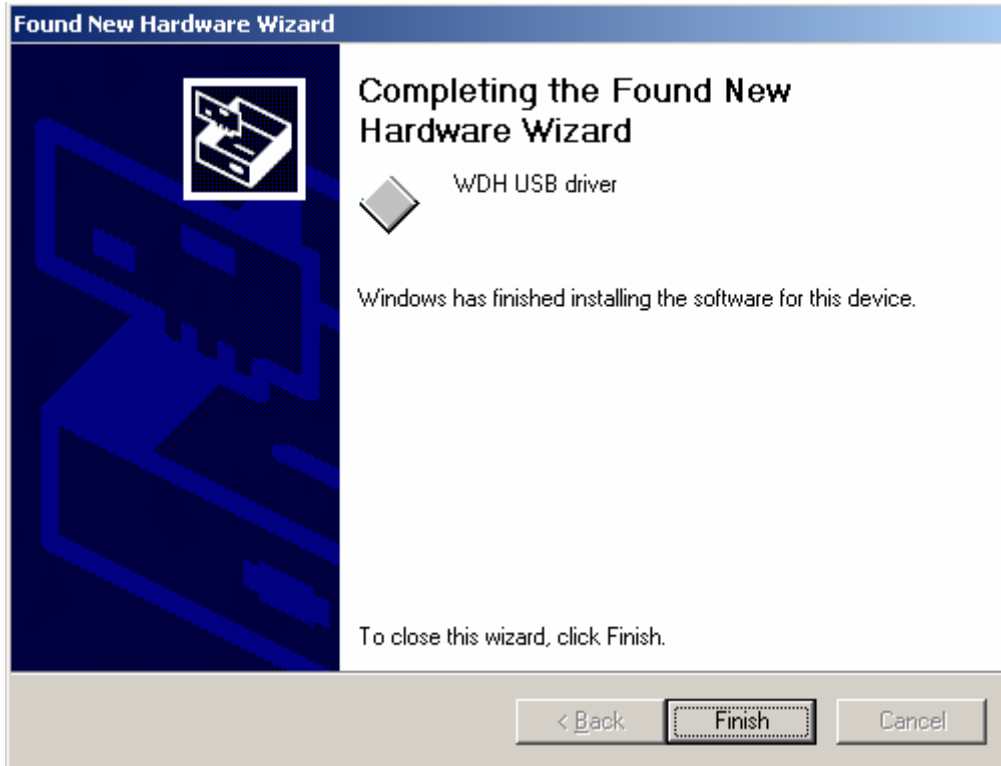
Click Finish.

3.3.2 Windows XP operative system – how to install Equinox driver and software

You need the CD-Rom and USB cable.

Power up your computer and launch the windows desktop screen, do not power up the Equinox or plug in the USB cable.

Note: Before you move on with installation of the AC440 software a NOAH3 compatible office system must be installed.

Insert the CD-ROM and the install shield wizard for Equinox AC440 comes up (be aware that you have to have administrator rights to install the software. If you do not have this, contact your Administrator of the network).

Press Next and follow the on screen instructions. When options are given between different choices, please follow the default suggestion, to achieve a standard installation.

Installation of Language specific files.:
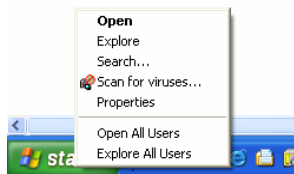
Right click the start button on your desktop

Click "Explore"

Choose the folder containing the language you prefer

Click the setup file

HIT440
Language
Package -
French
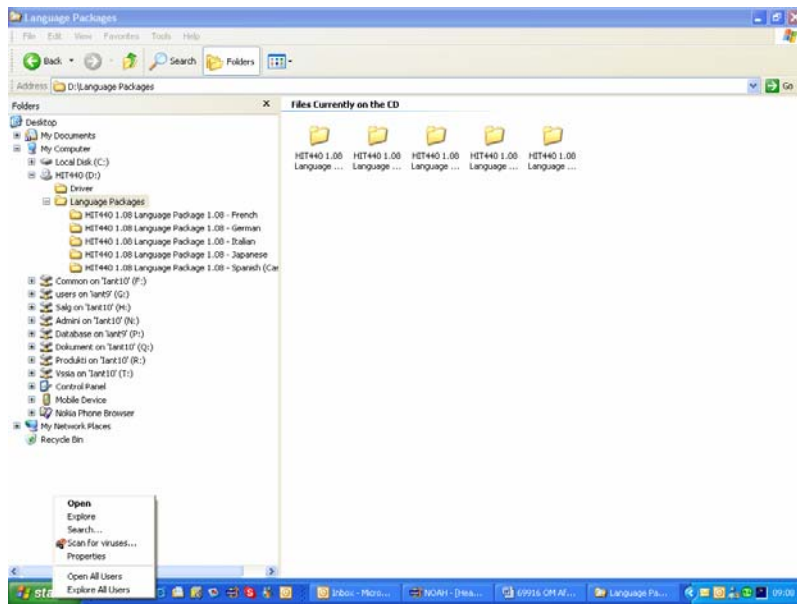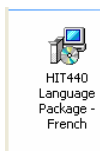
After next restart of your module the choices of languages will appear in the general setup.
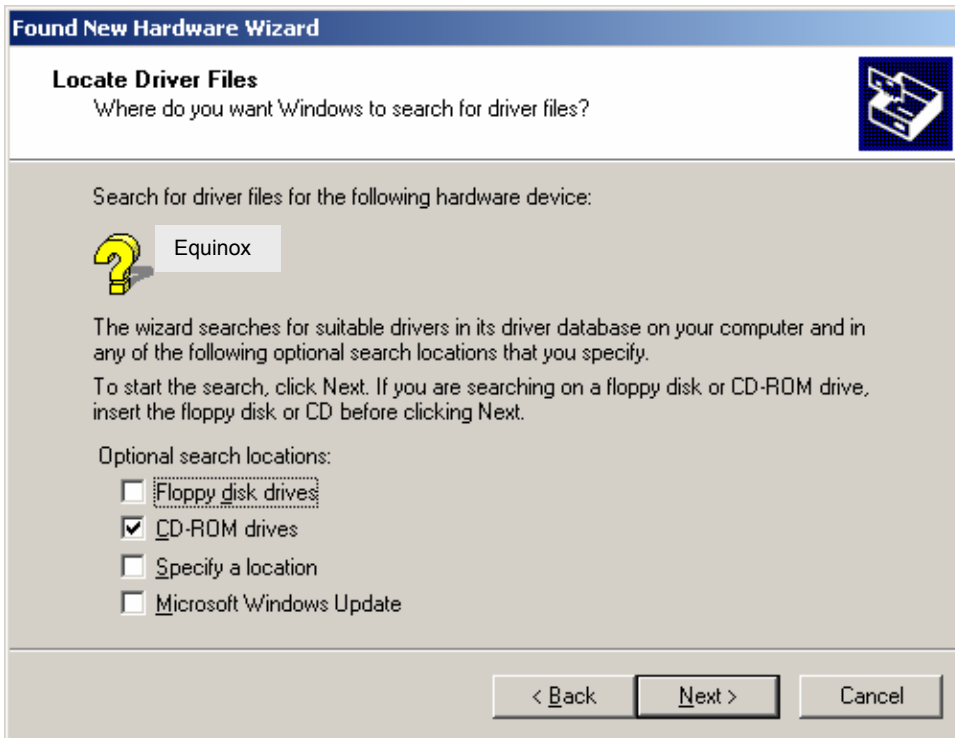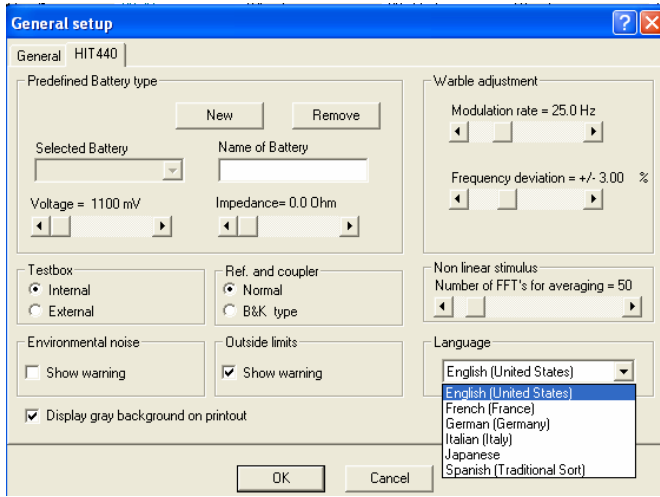

When the installation is done, click finish.

Turn on the Affinity, connect the USB cable at the back of the Affinity labelled USB\PC and plug the other end of the USB cable into a USB slot on your PC, and you will see a small box saying " windows found new hardware" and after short time, up to 2 minutes, this screen will come up:
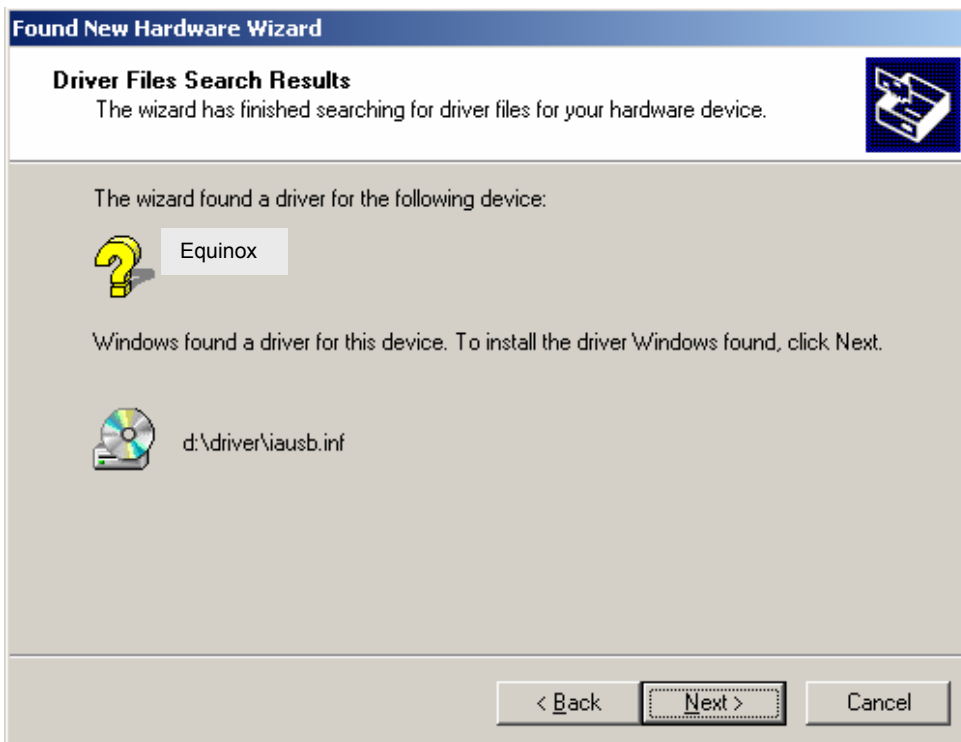
Click next. The wizard will automatically find the USB drivers on the CD-ROM where the AC440 software also is located.

Click Finish, then a small box appears in the lower right corner which says "you can now use the hardware found by windows".

3.3.3   Windows 98SE operative system – how to install Equinox driver and software

You need the CD-Rom and USB cable.

Power up your computer and launch the windows desktop screen, do not power up the Equinox or plug in the USB cable.

Note: Before you move on with installation of the AC440 software a NOAH3 compatible office system must be installed.

Insert the CD-ROM and the install shield wizard for Equinox will come up.

Press Next and follow the on screen instructions. When options are given between different choices, please follow the default suggestion, to achieve a standard installation.
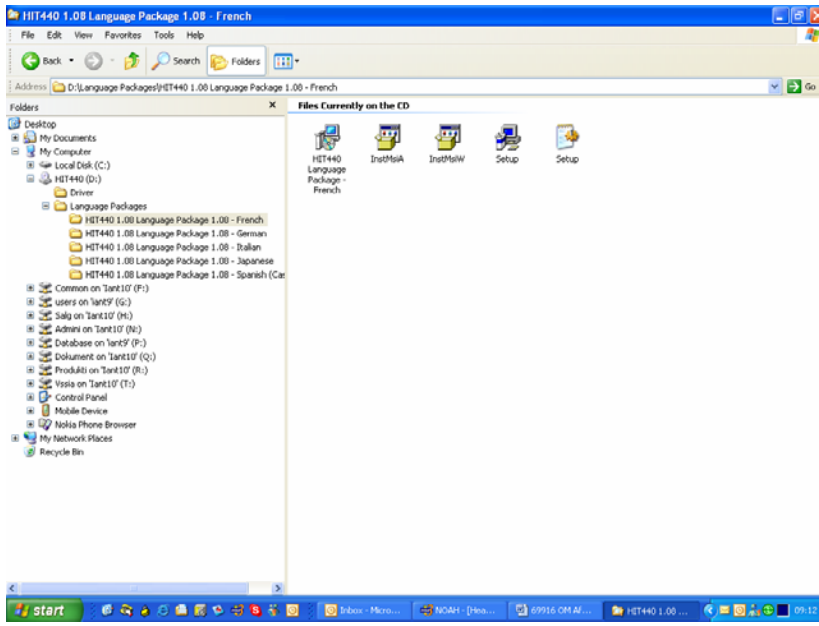
When the installation is done, click finish.

Turn on the Equinox and connect the USB cable at the back of the Equinox labelled USB\PC and plug the other end of the USB cable into a USB slot on your PC, and you will see the "add new hardware wizard", note it may take up to 2 minutes before this screen comes up:
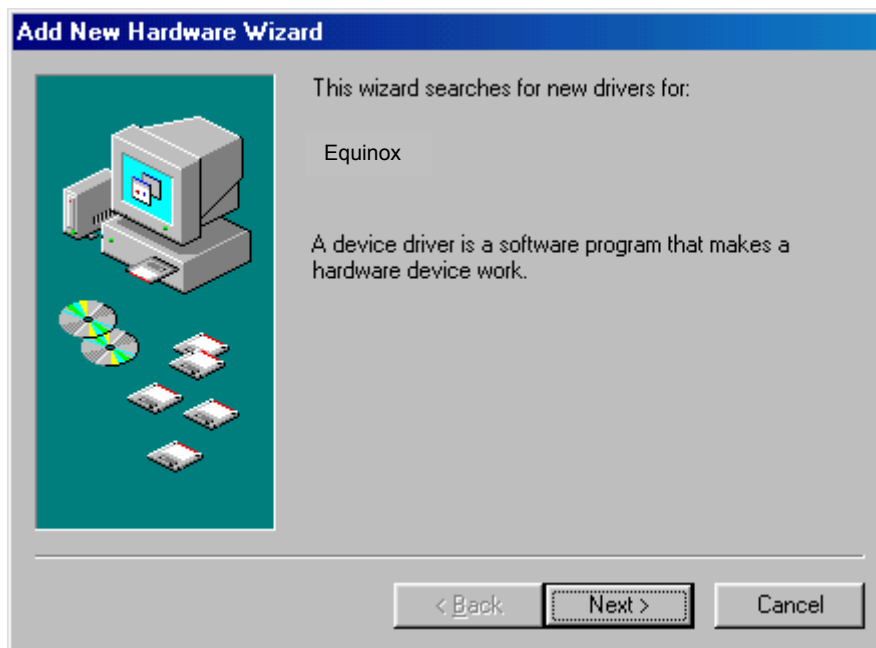
Press Next.

Press Next.

Click in "Specify a location" and press Browse and choose your CD-ROM drive letter, in this case E and mark the folder Driver, then press OK and your screen will look like this.

Note: do not click in CD-ROM drive as the driver then cannot be found by Windows.

Press Next.

Press Next.

Press Finish.

3.4 How to install a shortcut in the NOAH toolbar for direct access to the Equinox software

If you are using HIMSA'S Noah 3 Office System and you want a button shortcut for the installed module, please follow these steps.

Start NOAH3, go to the menu item "Tools->Module buttons". Select one of the two available buttons and select the Equinox software name in the drop down list. Press "OK" and your module will be launched when the appropriate button gets pushed.

3.5 How to install a shortcut for launching without NOAH

If you do not have NOAH on your computer you can make a shortcut for direct launching of the AC440 software as a stand alone module.

You can find the exe file for this purpose on C/ProgramFiles/Ia/Equinox/IaAUD. However, you will not be able to save your recordings when using this way of working.

3.6 Working with OtoAccess™

If you want to launch the AC440 software from OtoAccess™ this is also possible.

Start the database by clicking on the OtoAccess™ shortcut or select the OtoAccess™ from the Start menu.

To launch the instrument software, double click on the relevant instrument software icon in the client tab.
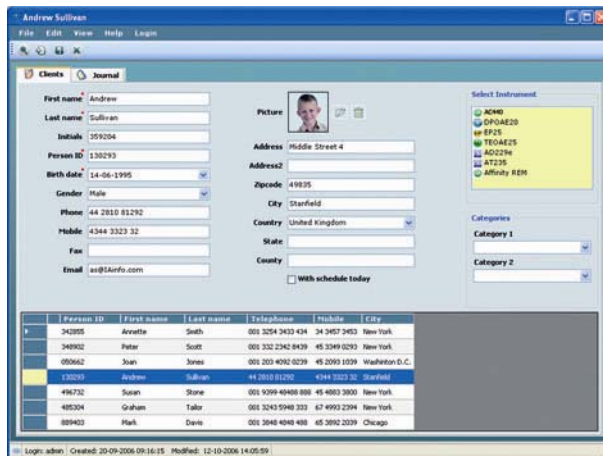
For further instructions about working with the database, please see the operation manual for OtoAccess™.

3.7 License

When you receive an Equinox it already contains the license including the software you have ordered.

4 The AC440 Audiometry Software

Notice: When using free field please see the instructions in the last chapter of this manual: "Guide to audiometry in free field - set-up and calibration of equipment".

4.1   Use of the AC440 software (Quick Instruction)

4.1.1   Tone Audiometry:

1.   Open NOAH.

2.   Enter patient data (see NOAH manual) or Double click on any client.

3.   Place the headphones on the patient's head.

4.   Instruct the patient how to use the patient response button when he/she hears a tone.

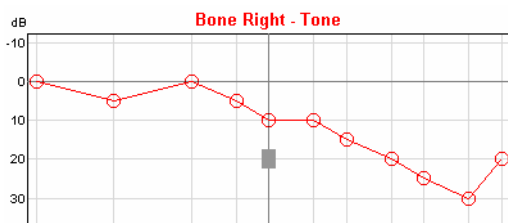5.   Open "Module Selection" .

6.   Select the "Measurement" tab. .

7.   Select the "Affinity AC440" Icon.

8.   Select desired user in user drop down menu (upper left hand corner)

9.   Select Tone Audiogram if needed.

10.   Select test ear and transducer in "Channel 1 Output" (upper left hand corner).

11.   If masking is required select masking ear and stimulus in Channel 2 Output / Input

12.   Present a tone with mouse or Ctrl buttons (touch switches if dedicated keyboard is used)

13.   Change stimulus level with arrow keys (up / down). Masking levels controlled by PgUp / PgDn

14.   Store "Heard" by 's' or by left clicking mouse in stimulus field. Store "Not heard" by 'n' or by right clicking in stimuli field.

15.   Manual frequency selection by arrow keys (<- and ->)

16.   Save and exit by "Save and Exit" icon.

Note: If the dedicated Audiometer keyboard is used, its functions will be dependent on the programming that the selected user has entered as his default.

4.1.2   Speech Audiometry:

1. Open NOAH.

2. Enter patient data (see NOAH manual) or Double click on any client.

3. Place the headphones on the patient's head.

4. Instruct the patient to repeat the words presented.

5. Open "Module Selection" ⊞ .

6. Select the "Measurement" tab. Measurement .

7. Select the "Affinity AC440" Icon.

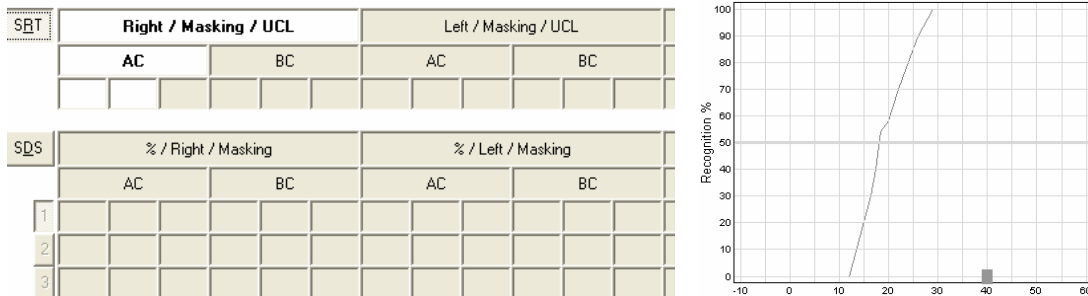8. Select Speech Audiogram ⊬ or suitable setup.

9. Select test ear and transducer in "Channel 1 Output" (upper left hand corner).

10. Select input (Mic. 1, Mic. 2, CD1, CD2) for live voice or recorded speech material.

11. Stimulus level controlled by arrow keys (up / down). Masking level controlled by PgUp / PgDn

12. Use Correct and Incorrect buttons to store patient's response.

13. The audiometer module will calculate the % of correct answers.

14. Store with yellow "Store" button

15. Shift between SRT / SDS / MCL / UCL / Aided by clicking on the desired function.

16. If display is in graph format the SRT value is indicated for 50% correct score.

Note: If the dedicated Audiometer keyboard is used, its functions will be dependent on the programming that the selected user has entered as his default.

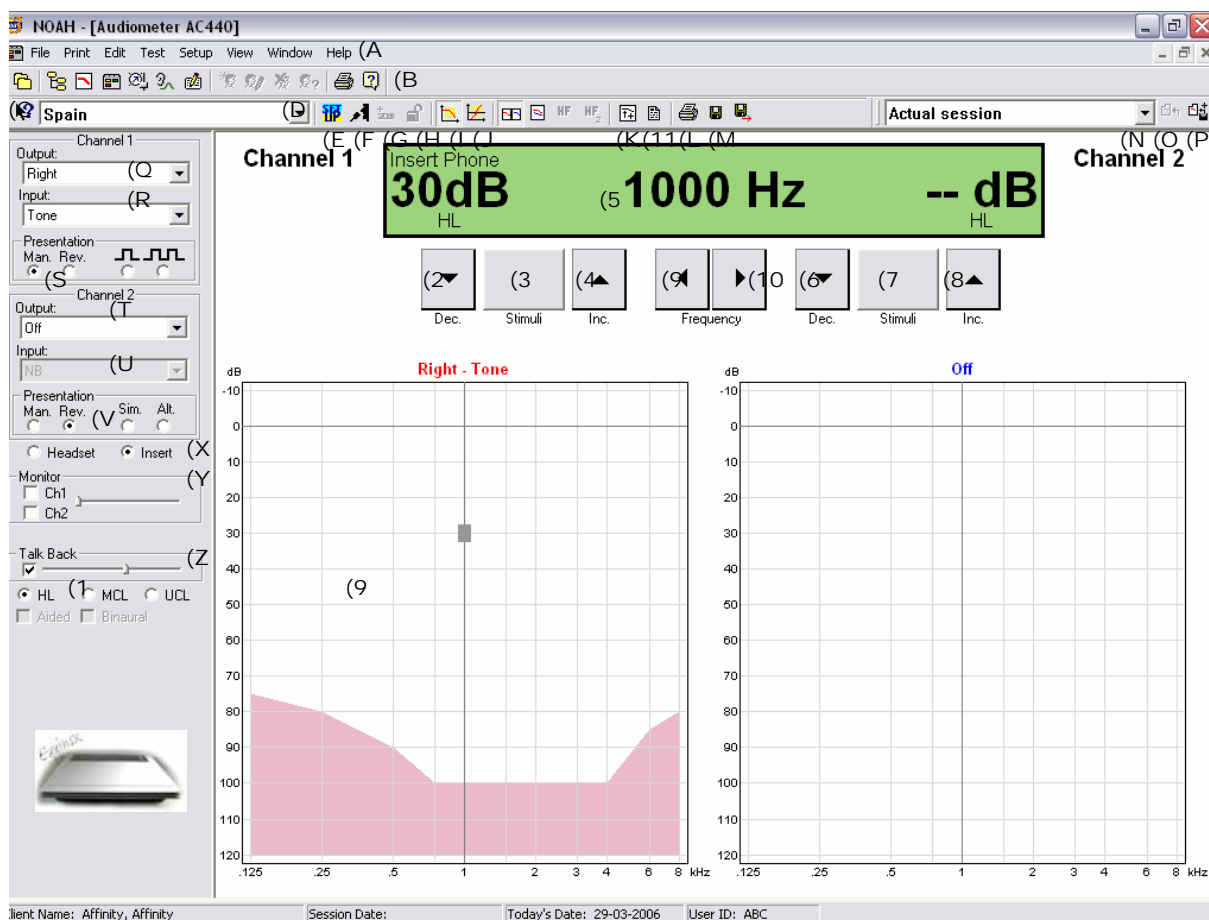## 4.2   Reading and Using the Tone Audiogram Screen

A: Drop Down Menus. See later in this chapter for details of the individual drop down options.

B: The tool bar of NOAH. It may have a slightly different appearance in your system, as it can be modified by the user. It is described in the Noah Help file.

C: Context sensitive HELP. Drag it with the mouse and click on buttons etc. that you need information about. This function may or may not be active in your system.

D: Selected Test Protocol to be used for this session. It is possible to select one of the pre-programmed Setups by activating the arrow on the right side.

E: Temporary Setup. Temporary changes to test protocols. Changes will be valid for this session only. The name of the Setup will be followed by a * (mns2*). When a new setup is selected the * will disappear and the normal setup will be active again.

F: Talk Forward. When this button is active it is possible to talk to the patient through the Talk Forward microphone. It will also be possible to adjust the sound level of the signal.

G: Extended Range +20 dB. When dB level in the headset is 20 dB below the max level, it is possible to activate this button. It will make it possible to reach the max intensity level.

H: Syncron. Activating this button will Lock the Ch1 attenuator to the Ch2 attenuator. The function can also be selected on the dedicated keyboard as an F function.

I: Tone. With this buttons it is possible to select Tone audiogram.

J: Speech. With this button it is possible to select Speech audiogram.

K: Edit. With this button it is possible to go into the Edit mode. It's here possible to delete the recorded points and to add new points to the audiogram. Further more it's also possible to see the properties for a stored point.

L: Print. Printout of the sessions acquired data.

M: Save and Exit. With this button it is possible to Save the recorded data in Noah and exit the AC440 module.

N: Direct action to view **historical sessions** – e.g. for comparison purposes.

O: Brings Session List back to **Actual Session**.

P: Freezes actual or historical session on the screen for comparison to other sessions.

Q: Output Ch.1. Selects Right, Left, Bone R, Bone L, FF1 or FF2 as output for Channel 1.

Note: If airborne sound is radiated from the bone conductor at frequencies above 2kHz an earplug can be inserted into the test ear.

R: Input Ch.1. Selects Tone or Warble Tone as input for Channel 1.

S: Presentation Ch.1. "**Man**" will present the signal to the patient only when the Stimuli of Channel 1 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 1 is activated. Furthermore you may select between single and continuous pulse presentation.

T: Output Ch.2. Selects Right, Left, Bone R, Bone L, FF1 or FF2 as output for Channel 2.

U: Input Ch.2. Selects Tone or Warble Tone as input for Channel 2.

V: Presentation Ch.2. "**Man**" will present the signal to the patient only when the Stimuli of Channel 2 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 2 is activated. Furthermore you may select presentation in both channels "**Sim.**" by locking channel 1 and channel 2 together or to have the presentation in the two channels alternating to each other "**Alt.**".

X: Choose which headset you will perform the test with TDH39 Headset or Insert phones.

Y: Monitoring of Channel 1 or Channel 2 or both Channels together.

Z: If the client is equipped with a microphone connected to the talk back input – you may listen to the patient.

1: Select if **HL** Hearing Level or **MCL** Most Comfortable Level or **UCL** Uncomfortable Level is tested.

2: dB HL decrease Ch.1. On the dB HL buttons the intensity in Ch1 can be decreased with 1 or 5 dB with a click of the mouse, or the arrow down on the computer keyboard (Ch1).

3: Stimuli Ch.1. When the mouse cursor is above the Stimuli area – the tone will be presented.

4: dB HL Increase Ch.1. On the dB HL buttons the intensity in Ch1 can be increased with 1 or 5 dB with a click of the mouse, or the arrow up on the computer keyboard (Ch1).

5: Frequency and Intensity display area. On the left side of the green area the dB value for Ch1 is shown and on the right side for Ch2. In the middle of the green area the frequency level is shown.

6: dB HL decrease Ch.2. On the dB HL buttons the intensity in Ch2 can be decreased with 1 or 5 dB with a click of the mouse, or PgUp on the computer keyboard (Ch2).

7: Stimuli Ch.2. When the mouse cursor is above the Stimuli area – the tone will be presented.

8: dB HL Increase Ch.2. On the dB HL buttons the intensity in Ch2 can be increased with 1 or 5 dB with a click of the mouse, or PgDn on the computer keyboard (Ch2).

9: The curves of the recorded tone audiogram will be displayed here.

10: Frequency. Clicking on the Frequency buttons the frequency will be increased or decreased.

11: Report page, allows to save and print journal entries and setup templates for commonly used words or frases like e.g. diagnoses.
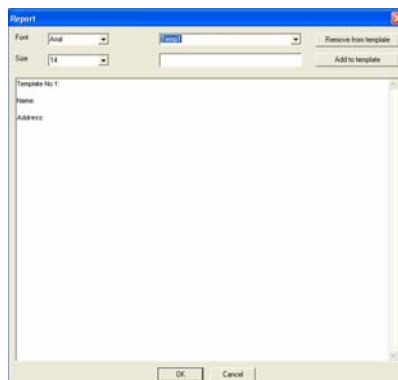
4.3 Additional features and tests

4.3.1 MF

The button MF (Multi Frequency) has been added.

4.3.2 MHA

In the Test menu the submenu MHA (Master Hearing Aid) has been added.

A: The input can be CD1, CD2, Mic1 and Mic2.

B: High Pass filters with a slope of -6dB, -12dB, -18dB and HFE (-24 dB) can be selected for both ears.
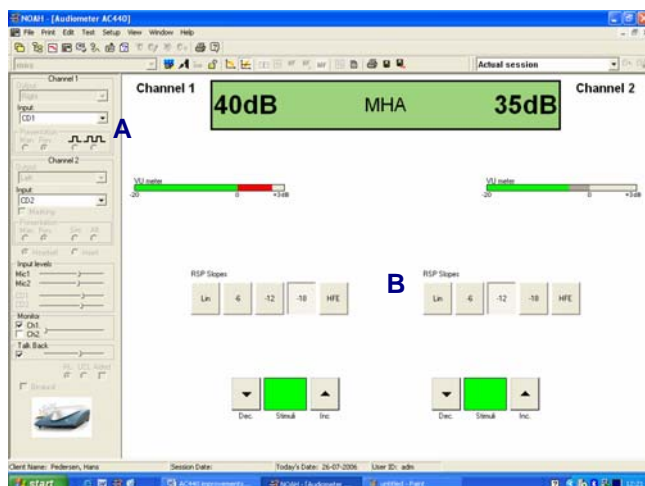
In the Advanced Setup for MHA the default settings for the 2 channels can be set.
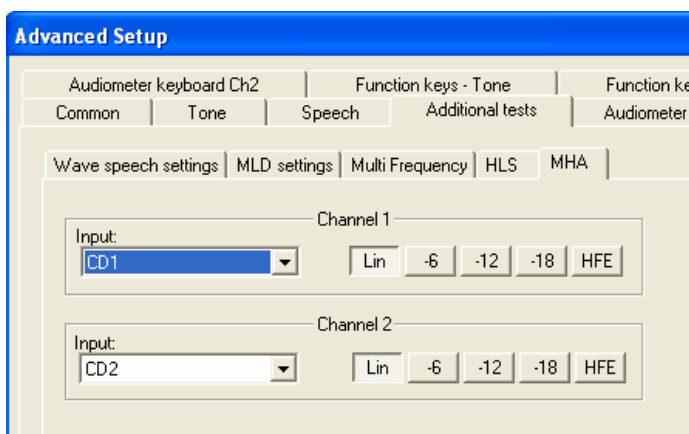
4.3.3 HLS

In the Test menu the submenu HLS (Hearing Loss Simulation) has been added.
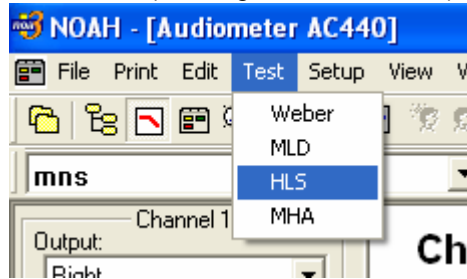
A: The input can be CD1, CD2, Mic1 and Mic2.

B: Possibility to select historical audiograms.
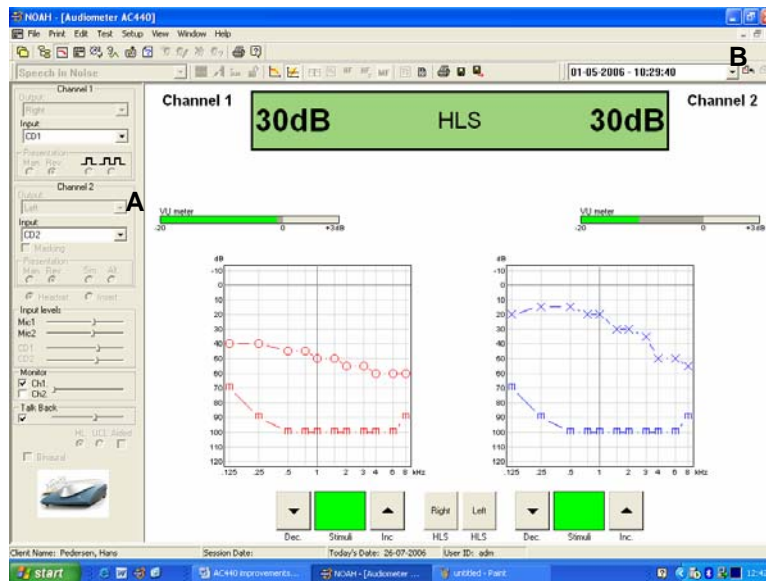
In the Advanced Setup for HLS the default settings for the 2 channels can be set.
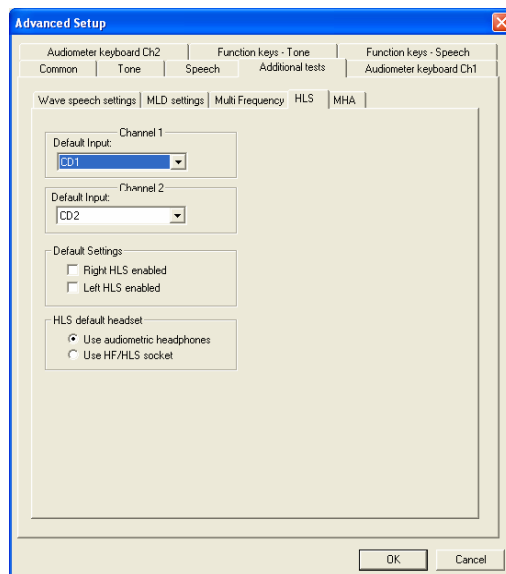
If the hardware is not connected or powered up, this message box will pop up.

If "Run in simulation mode" is selected, everything in the module will work except from the picture of the connected hardware, which is replaced by the text: "Hardware not connected!"
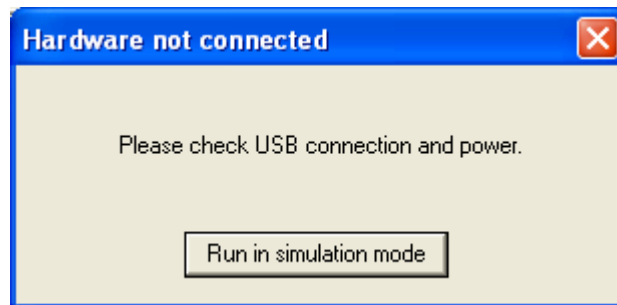
4.4   Reading and Using the Speech Audiogram Screen

A: Drop Down Menus. See later in this chapter for details of the individual drop down options.

B: The tool bar of NOAH. It may have a slightly different appearance in your system, as it can be modified by the user. It is described in the Noah Help file.

C: Context sensitive HELP. Drag it with the mouse and click on buttons etc. that you need information about. This function may or may not be active in your system.

D: Selected Test Protocol to be used for this session. It is possible to select one of the pre-programmed Setups by activating the arrow on the right side.

E: Temporary Setup. Temporary changes to test protocols. Changes will be valid for this session only. The name of the Setup will be followed by a * (mns2*). When a new setup is selected the * will disappear and the normal setup will be active again.

F: Talk Forward. When this button is active it is possible to talk to the patient through the Talk Forward microphone. It will also be possible to adjust the sound level of the signal.

G: Extended Range +20dB. When the dB level in the headset is 20 dB below the max level, it is possible to activate this button. It will make it possible to reach the max intensity level.

H: Tone. With this buttons it is possible to select Tone audiogram.

I: Speech. With this button it is possible to select Speech audiogram.

J: Edit. With this button it is possible to go into the Edit mode. It's here possible to delete the recorded points and to add new points to the audiogram. Further more it's also possible to see the properties for a stored point.

K: Print. Printout of the sessions acquired data.

L: Save and Exit. With this button it is possible to Save the recorded data in Noah and exit the AC440 software.

M: Direct action to view **historical sessions** – e.g. for comparison purposes.

N: Brings Session List back to **Actual Session**.

**O: Freezes actual or historical session** on the screen for comparison to other sessions.

P: Output Ch.1. Selects Right, Left, Bone L, Bone R, FF1 or FF2 as output for Channel 1.

Q: Input Ch.1. Selects Mic.1, Mic.2, CD1 or CD2 as input for Channel 1.

R: Presentation Ch.1. "**Man**" will present the signal to the patient only when the Stimuli of Channel 1 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 1 is activated. Furthermore you may select between single and continuous pulse presentation.

S: Output Ch.2. Selects Right, Left, Bone L, Bone R,FF1 or FF2 as output for Channel 2. **Input Ch.2.** Selects Mic.1, Mic.2, CD1 or CD2 input for Channel 2.

T: Presentation Ch.2. "**Man**" will present the signal to the patient only when the Stimuli of Channel 2 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 2 is activated. Furthermore you may select presentation in both channels "**Sim.**" by locking channel 1 and channel 2 together or to have the presentation in the two channels alternating to each other "**Alt.**".

U: select with which headset you will perform the test with TDH39 Headset or Insert phones.

V: Select input and level for Microphone 1 or 2 or CD 1 or 2.

X: Monitoring of Channel 1 or Channel 2 or both Channels together.

Y: If the client is equipped with a microphone connected to the talk back input – you may listen to the patient.

Z: Select if **SDS no.1, 2, 3** Speech Discrimination Score, **MCL** Most Comfortable Level or **UCL** Uncomfortable Level is tested or **Aided** threshold should be tested and whether it is a **Binaural** test.

1: Frequency and Intensity display area. On the left side of the green area the dB value for Ch1 is shown

2: Frequency and Intensity display area. On the right side of the green area the dB value for Ch2 is shown.

3: Frequency and Intensity display area. In the middle of the green area the % Speech Score is indicated as well as the word counter.

4: VU-meter CH.1 and CH.2. Indicate the speech signal of the live voice speech or the recorded speech. The level is adjusted by "V "to reach 0.

5: The speech curves will be displayed here.

6: dB HL decrease Ch.1 or Ch.2. On the dB HL buttons the intensity in Ch1/Ch.2 can be decreased with 1 or 5 dB with a click of the mouse, or the arrow down/PgUp on the computer keyboard.

7: Stimuli Ch.1 or Ch.2. When the mouse cursor is above the Stimuli area – the tone will be presented.

8: dB HL Increase Ch.1 or Ch.2. On the dB HL buttons the intensity in Ch1/Ch.2 can be increased with 1 or 5 dB with a click of the mouse, or the arrow up/PgDn on the computer keyboard.

9: When the word is understood and repeated activate **Correct** (green checkmark) .

10: When a word in not understood activate **Incorrect** (red cross).

11: Pressing the Store button will place a symbol in the speech audiogram field

12: The Speech from harddrive. If the license for this function is implemented, the "Wavefile" possibility will be displayed.
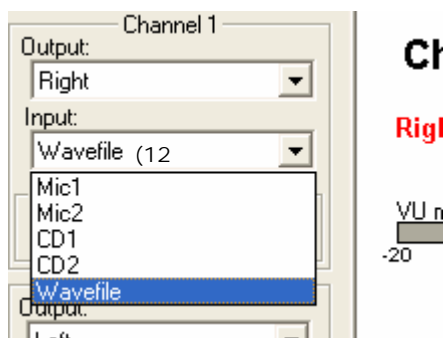
On the lower part of the screen a wordlist and additional keys (Play, Stop and Pause) will be displayed.

13: Start will activate the play function.

14: Stop will end the play function.

15: Pause will create a temporary break in the testing.

16: HF and HF2:

The audiometric scale can be expanded up to 20kHz by enabling the High-Frequency function embedded in the AC440 module. The High-Frequency function is optional to the AC440 module and requires a separate license to be activated from the menu of the application. Additionally, the module requires a dedicated high-frequency transducer in order to be performed. The Affinity is setup to enable the calibration of three (3) high-frequency transducers: KOSS 80, HDA200 and HDA280.
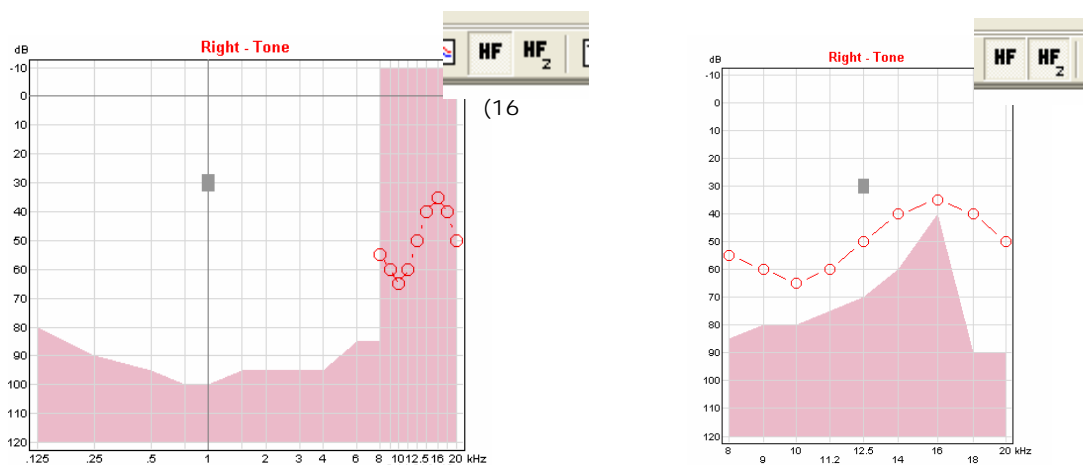
The High-Frequencies ranges have also been added in the User setup for the specification of individual preferences.
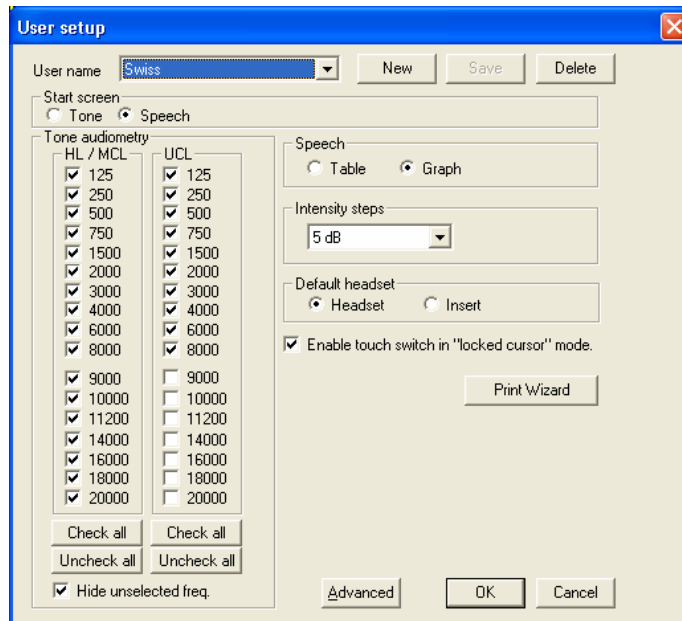
Manual placement of speech score (%)

Possibility to place the % (Speech score) value with the mouse in the graphical speech audiogram.

The cursor can be dragged and dropped in the vertical direction, using the mouse.
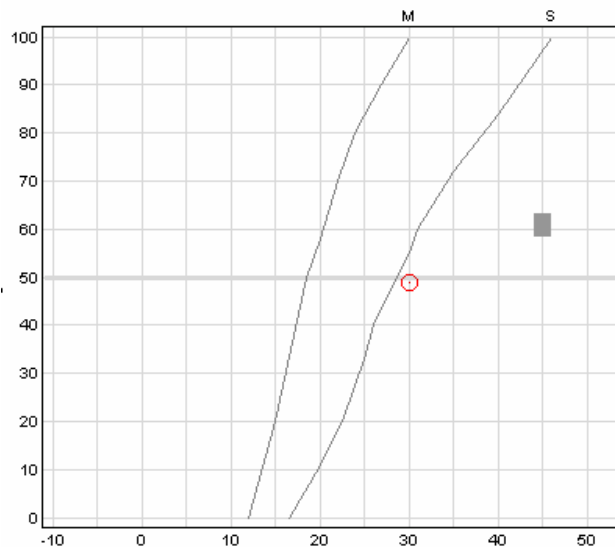
Store Speech Score

The value in the graphical speech can be stored using the Enter key on the computer keyboard.

Reset Speech Score

Advanced Setup Speech. When UCL or HL is selected on the user screen the speech score counter will be set to 0 if this checkmark is activated.
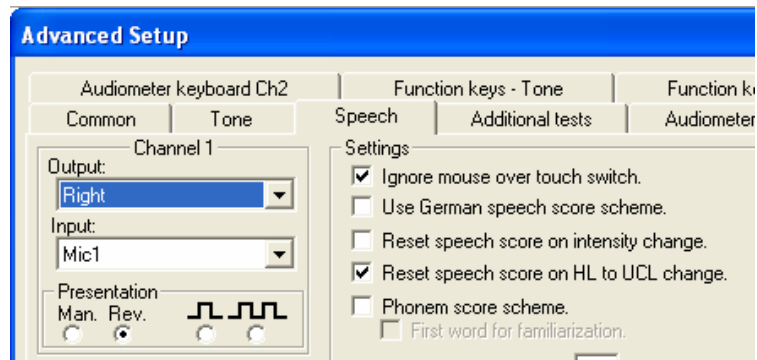
The +20 dB button in the Tone audiogram, can be activated 50 dB before the max level has been reached. It was earlier only 20 dB.

Change in the Speech Table

The SDS1 to 3 are now dedicated buttons. Will save you for one click when going from SRT to SDS compared to earlier
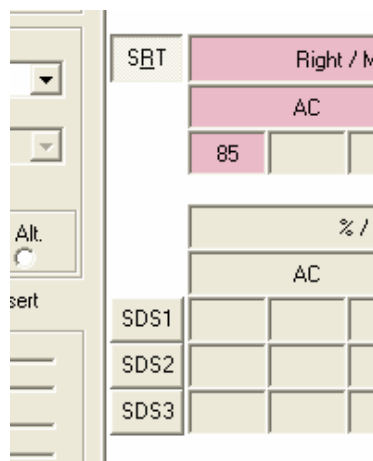
Copy of Setup settings

When New is activated a copy of the preceding Setup settings are made. In this case a copy of mns is made
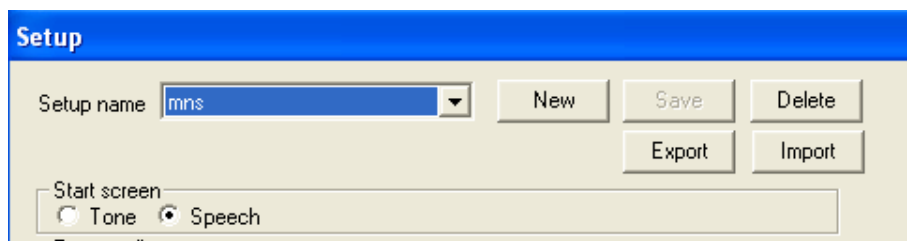
Export/Import

The Export and Import buttons have been added. A Setup can now be exported as standard or as Read Only.
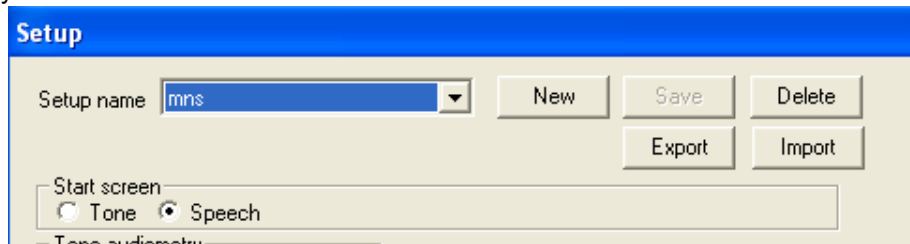
Speech Table Edit possibility

Make a right click in the where you want a number to be and select Edit.
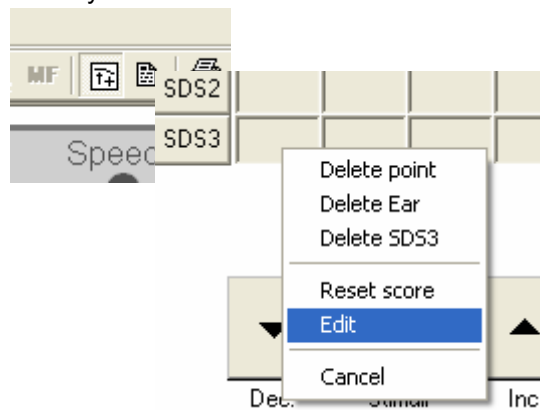
A dialog box will pop up. Write the number you want to have in the speech table in the preselected field.

Default values will be placed in the corresponding fields in order to define the value as a point in the speech table.

That is if a % value is written then a dB value will be added.

Independent of this setting the attenuator will always go to 30 dB when switching from or to Tone, Speech and different Tests.
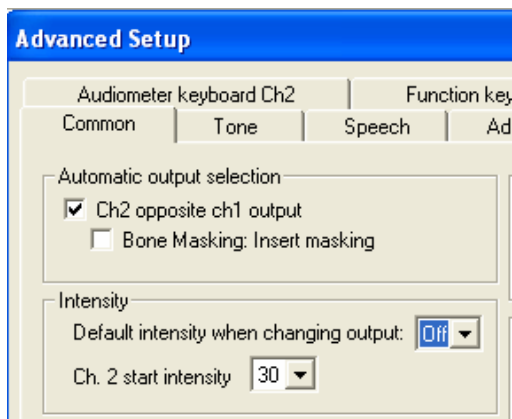
4.5 Reading and Using the Speech Audiogram Table Screen
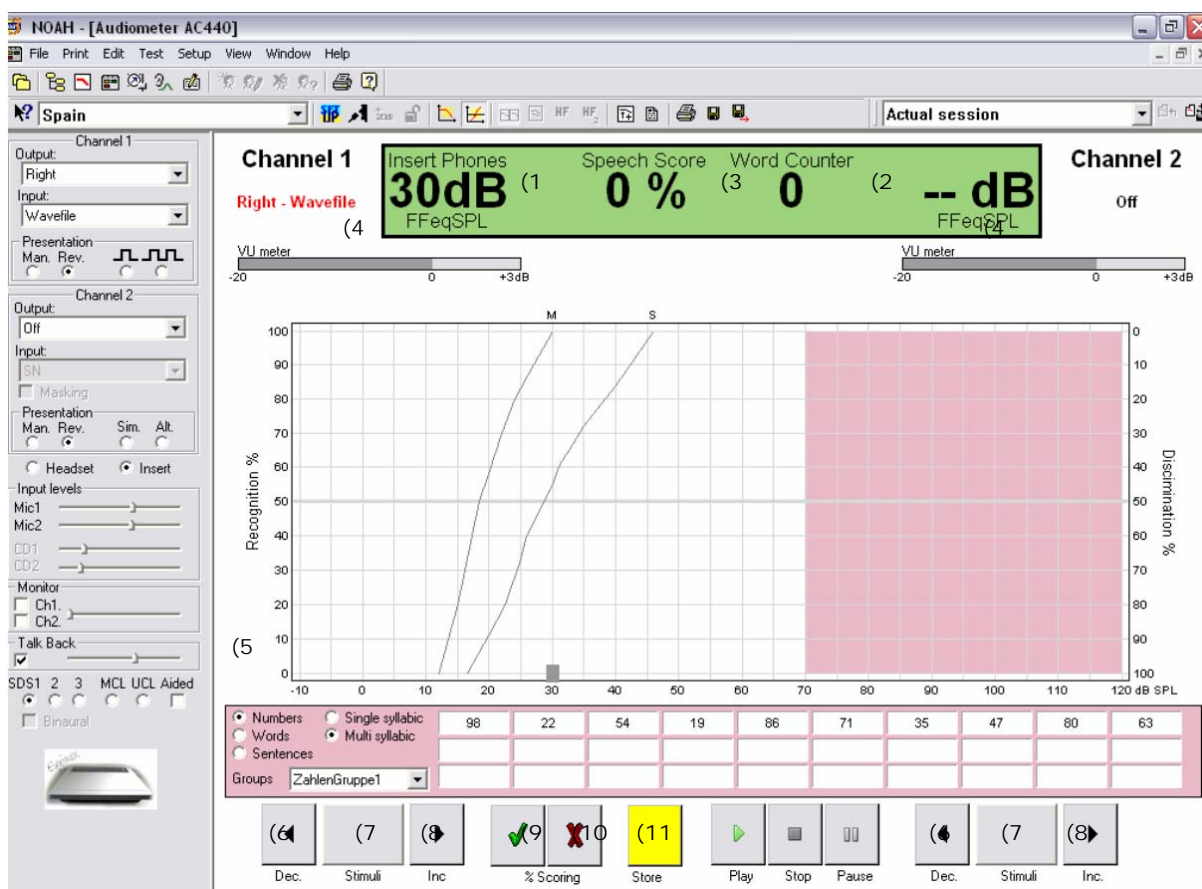
1: Frequency and Intensity display area. On the left side of the green area the dB value for Ch1 is shown

2: Frequency and Intensity display area. On the right side of the green area the dB value for Ch2 is shown.

3: Frequency and Intensity display area. In the middle of the green area the % Speech Score is indicated as well as the word counter.

4: VU-meter CH.1 and CH.2. Indicate the speech signal of the live voice speech or the recorded speech. The level is adjusted by "V "to reach 0.

5: The values for the SRT – Speech Reception Thresholds and SDS – Speech Discrimination Score are displayed here for the selected output.

6: dB HL decrease Ch.1 or Ch.2. On the dB HL buttons the intensity in Ch1/Ch.2 can be decreased with 1 or 5 dB with a click of the mouse, or the arrow down/PgUp on the computer keyboard.

7: Stimuli Ch.1 or Ch.2. When the mouse cursor is above the Stimuli area – the tone will be presented.

8: dB HL Increase Ch.1 or Ch.2. On the dB HL buttons the intensity in Ch1/Ch.2 can be increased with 1 or 5 dB with a click of the mouse, or the arrow up/PgDn on the computer keyboard.

9: When the word is understood and repeated activate **Correct** (green checkmark) .

10: When a word is not understood activate **Incorrect** (red cross).

11: Pressing the Store button will place one or more figures in the selected table field. Clicking on SRT, SDS 1-2-3 will make the fields white depending on the outputs selected.

12: Phonem Scoring can be choosen in the setup.
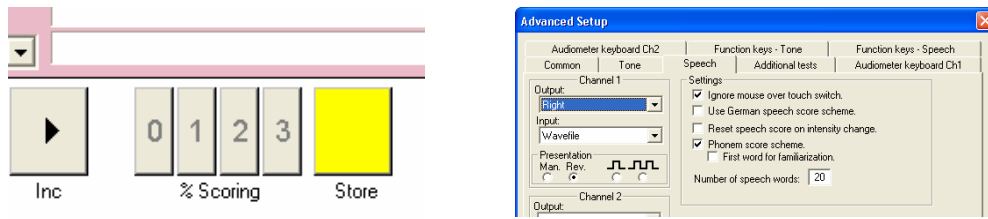
NOTE: That the if the speech from hard drive license is added the user interface will contain the same screen bar as illustrated in 5.3

In the Advanced Setup is a tap called Multi Frequency. Here it is possible to set the frequency resolution to 1/12- or 1/24 octave. Furthermore Multi Frequency can be selected active upon start of the application.
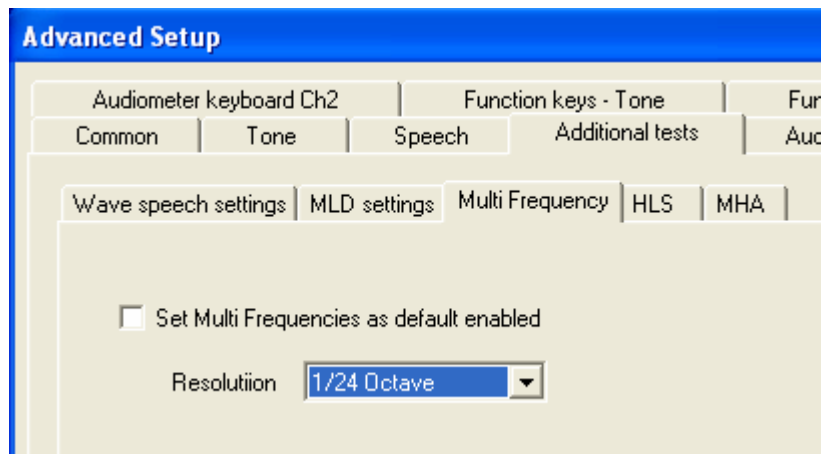
In the Advanced Setup for MHA the default settings for the 2 channels can be set.
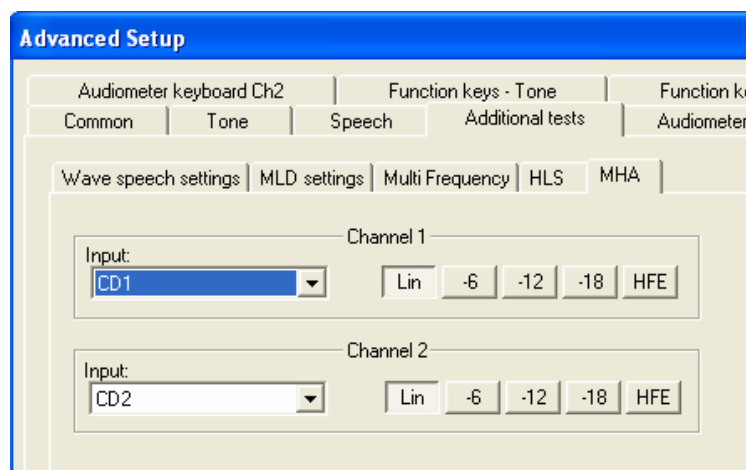
4.6   Menu Items

4.6.1   File
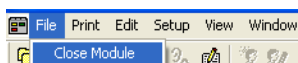
When choosing *Close Module*, the program will close, but if you have any unsaved data, a dialog box will appear, asking if you want to save the changes in the Noah database. The dialog box looks like this:
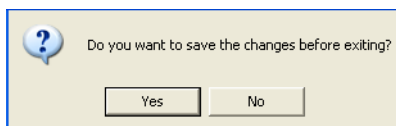
4.6.2   Print
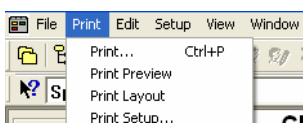
Print
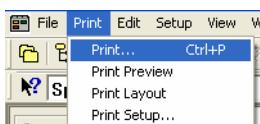
By activating this menu item the standard Windows print dialog will appear. The dialog may look like this, depending on the version of your Windows:
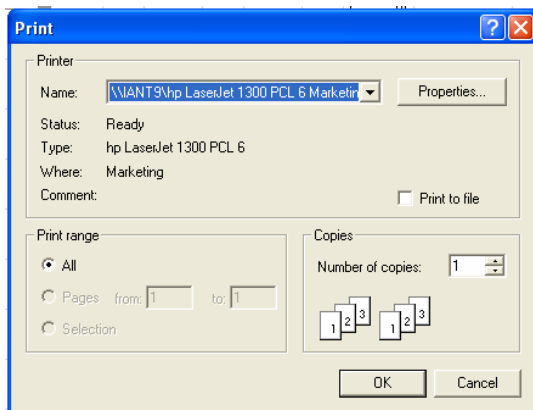
When "All" is selected all pages will be printed.

Otherwise if "Pages" is selected, you can select which pages you want to print.

Print Preview
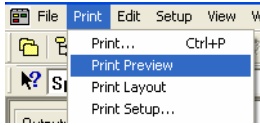
By activating this menu item, the program enters the print preview mode which shows all pages that will be printed.

Print Layout
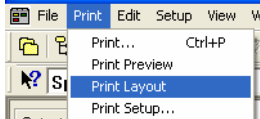
By activating this menu item, the Printer Wizard will appear.

It is possible make your own hard copy layout.
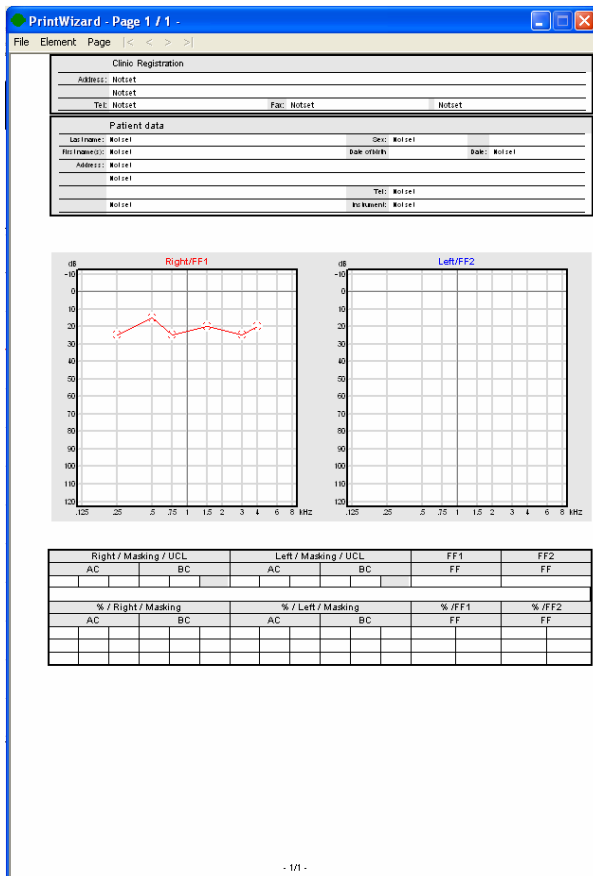
Menu descriptions print layout:

File
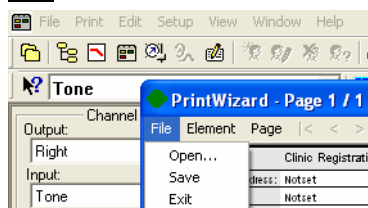
Open: Opens an existing Print Wizard.
Save: Saves the Print Wizard.
Exit: Exits the Print Wizard.

Element
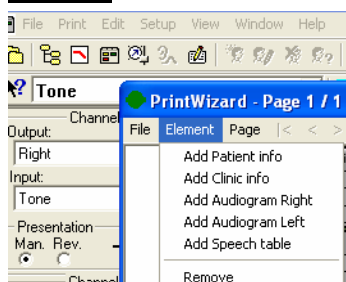
Add Patient info: Adds the Patients info field.
Add Clinic info: Adds the Clinic info field.
Add Audiogram Right: Adds the Tone audiogram for the Right ear.
Add Audiogram Left: Adds the Tone audiogram for the Left ear.
Add Speech Audiogram: Adds the Speech audiogram.
Remove: Can remove the single fields described above.

Page
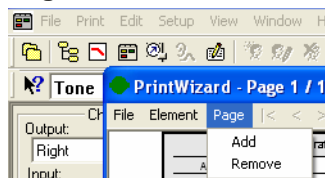
Add/Remove

Here it is possible to Add or remove a page.

The I< < >>I is used to select the previous page or the next page.

Print Setup…
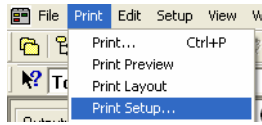
By activating this menu item the program enters the traditional Windows Print Setup dialog, which may look like this:
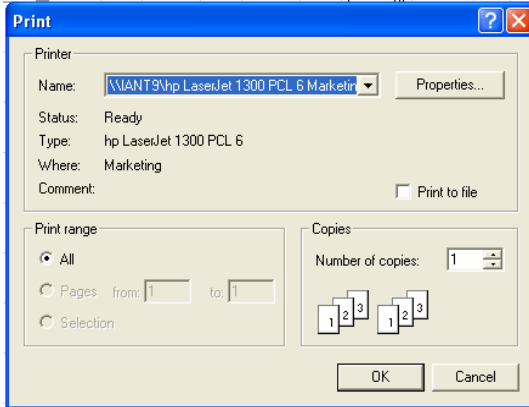
4.6.3   Edit

Export…

By activating this menu item it will be possible to export all audiograms from one stored session in XML format.

4.6.4　Tests
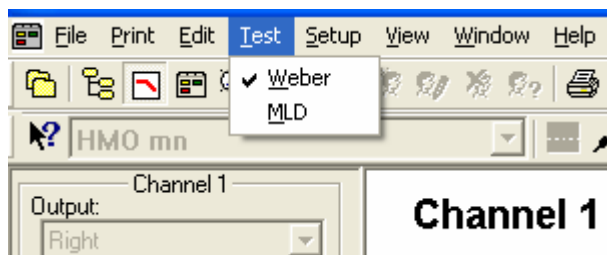
Test allows for the choice of all dedicated tests available under AC440

NOTE: If test is greyed out the license for the test is optained – call your local distributor.

Weber

The Weber test is included in the Affinity platform as a pre-defined test with a dedicated screen layout. The test is deployed to disclose whether a unilateral or asymmetric loss is conductive or sensory-neural.

A normal patient would report that the sound is heard equally in both ears. A patient with a conductive hearing loss would hear the sound louder in the affected ear. This is because the affected ear cannot hear ambient noises as well because of its conductive hearing loss and so is effectively masked to these noises and able to focus more on the sound conducted through the skull. You can replicate this yourself by plugging one ear with your finger (i.e. mimicking a conductive hearing loss) and performing the Weber test on yourself.

A patient with a sensory-neural hearing loss would hear the sound louder in the normal ear, because the affected ear is less effective at picking up sound even if is transmitted directly by conduction into the cochlea.
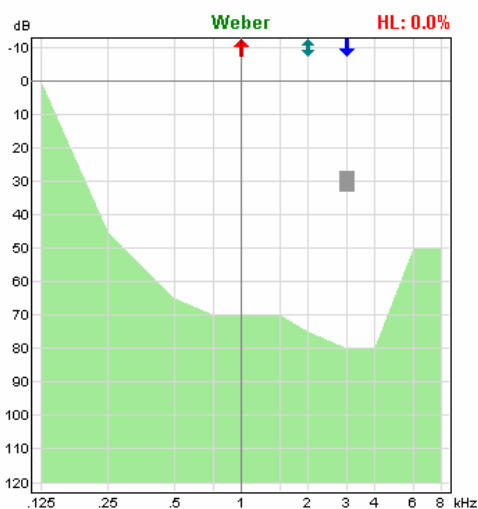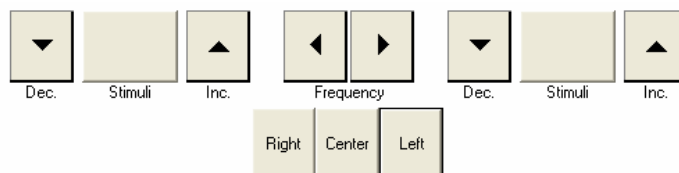
MLD

The MLD test is another pre-defined test included with a dedicated screen and setup menu. The MLD test is an optional function to the AC440 module and requires a separate license to be activated from the menu of the application.

The term MLD corresponds to Masking Level Difference and refers to the improvement in intelligibility (effective signal-to-noise) under noise conditions when a tone or speech is presented out of phase rather than in phase. The patient is presented for both pure tone and noise concurrently while conducting the test.
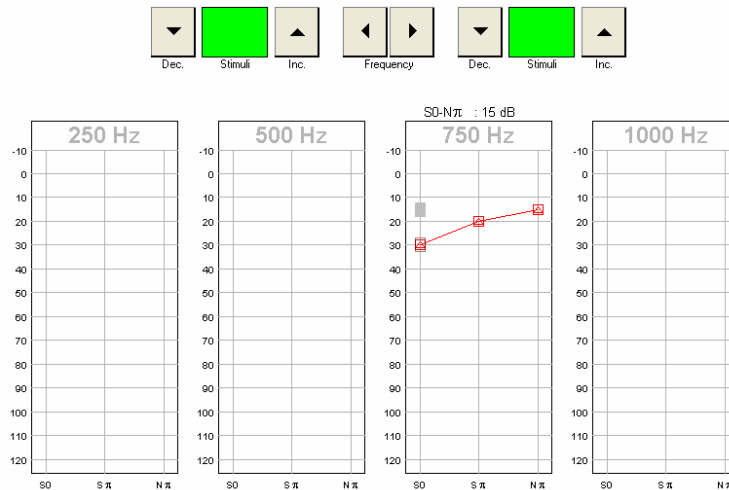
In the MLD test a Start/Stop button has been added to activate/deactivate the stimulus.
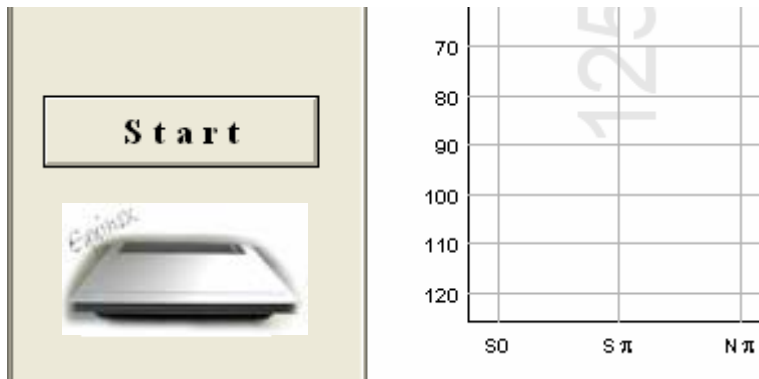
4.6.5   Setup
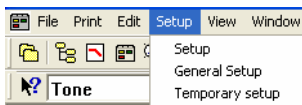
Setup
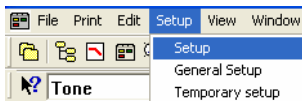
By activating this menu the program enters the Setup dialog.
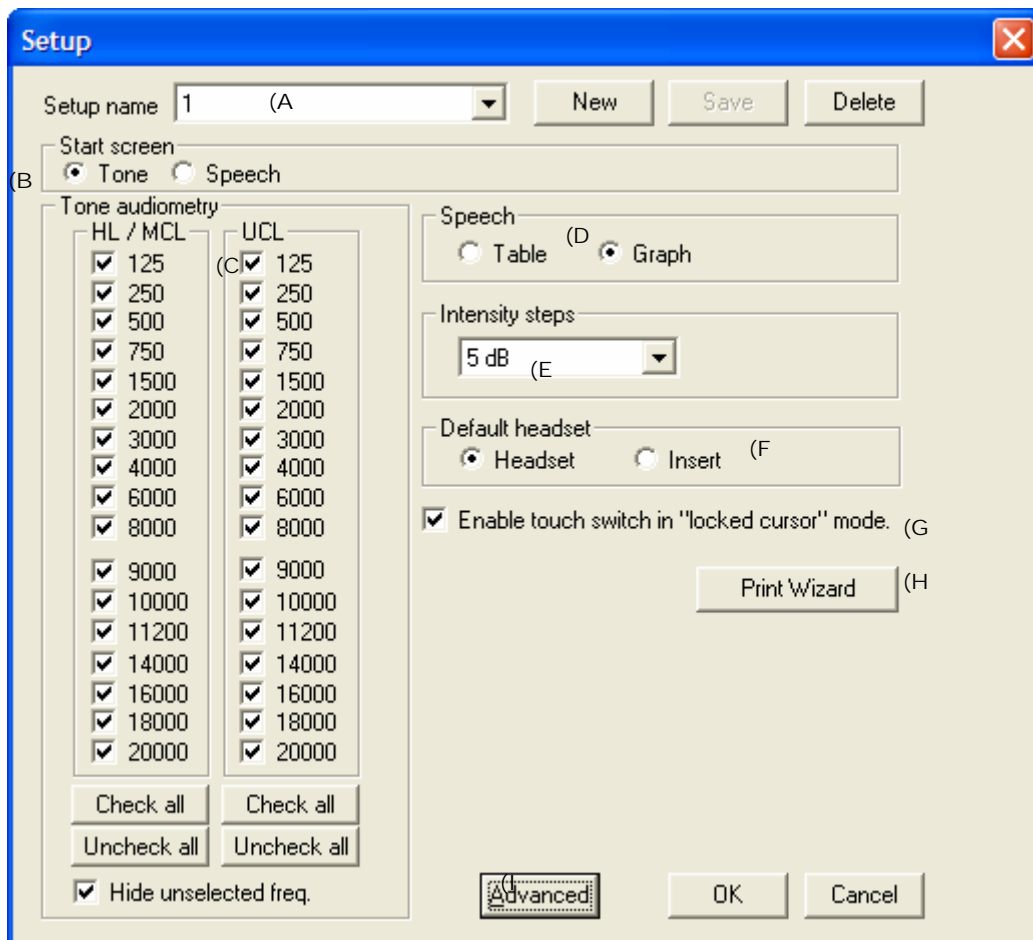
A: Setup: Activating **New** will create a pop up Box called Setup, where you can type in the name of the new setup. Activating **Delete** will delete the displayed Setup.

B: Start Screen: Here you can choose if you want your start screen to be the Tone Audiogram or the Speech Audiogram when you launch the module.

C: Frequency List: Selecting/deselecting some of the 11 audiometric standard frequencies for HL (Hearing Level), MCL (Most Comfortable Level) and UCL (Uncomfortable Level).

D: Speech: The speech Audiogram can be displayed in Table form (USA) or Graphic form.

E: Intensity steps: Choose between 1 dB or 5 dB in level step size.

F: Default headset: Choose insert phones or standard headset.

G: Enable Touch switch in "locked cursor" mode: Select whether the touch switch shall be activated when the mouse is crossing the touch switch area in the Tone audiogram, or if the Audiometer shall be in the "locked cursor mode".

H: Print Wizard: is described in the chapter Print Layout.

I: Advanced: For entering of the advanced setup – described in chapter Advanced Setup.

Advanced Setup:

Common
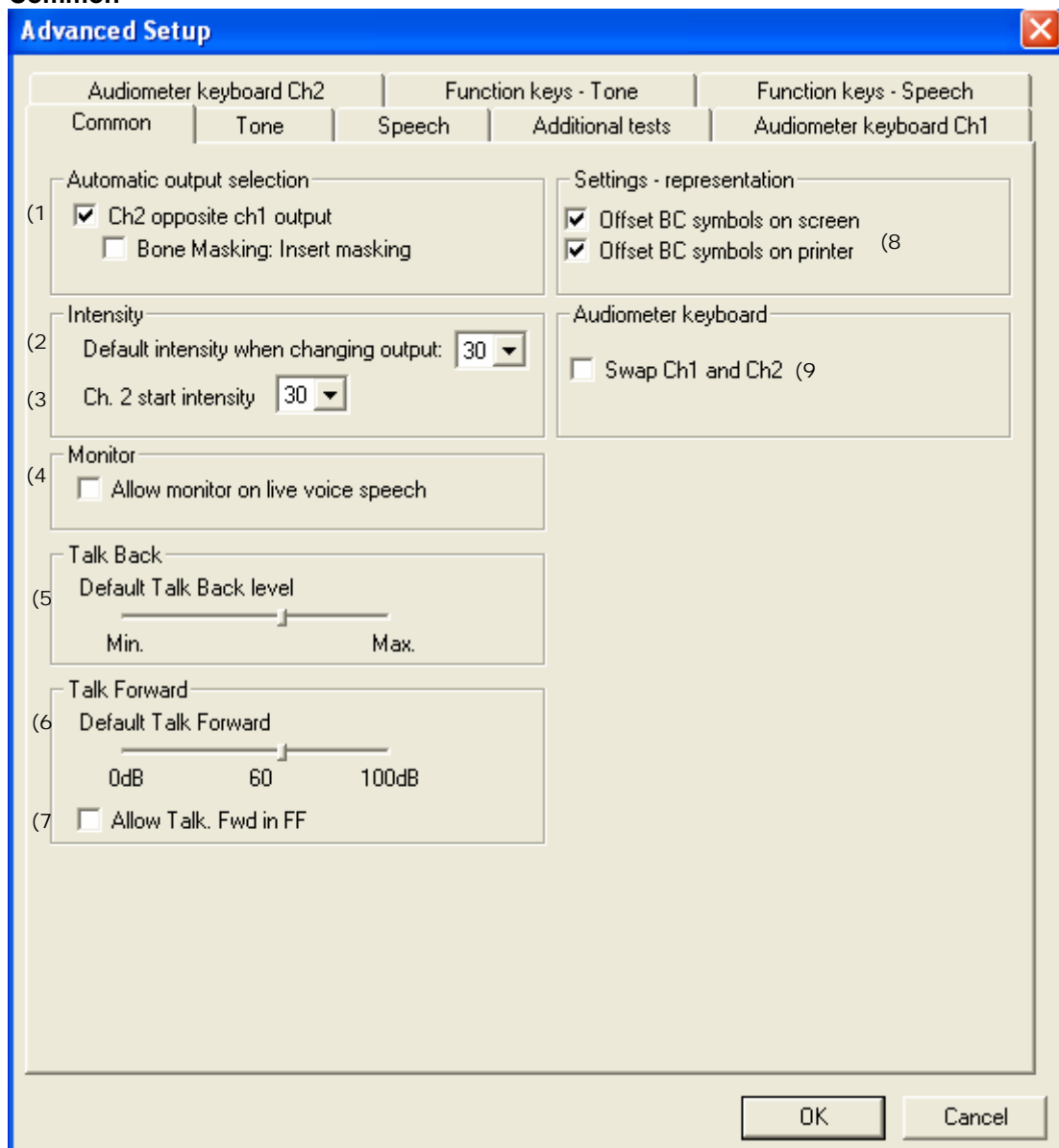
1: Ch2 opposite ch1 output: When this is on, the output of Ch2 automatically will be opposite to Ch1. When Right is selected in Ch1 then Ch2 automatically selects Left etc.

2: Default Intensity when changing output: When output is changed the attenuator will set to this level.

3: Ch2 start intensity: When ch2 is changed from Off to an output the attenuator will be set to this value.

4: Allow monitor on live voice speech: When monitor is selected then you can choose here whether the live voice speech shall be routed to the monitor loudspeaker or not.

5: Default Talk Back level: You can set the Talk Back start up level here.

6: Default Talk Forward level: You can set the Talk Forward start up level here.

7: Allow Talk Forward in FF: Here you can choose whether the Talk Forward signal shall be routed to the FF loudspeakers or not.

8: Representation of BC symbols on printouts or on the screen. Activating these functions will change the actual layout slightly in order to have an easier overview.

9: Swap Channel 1 and Channel 2 on optional keyboard.

Even if no data have been recorded it's possible to print out empty audiograms or other frames
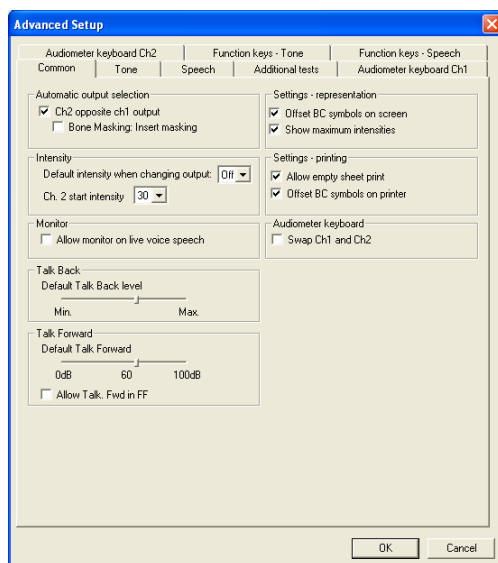
Tone
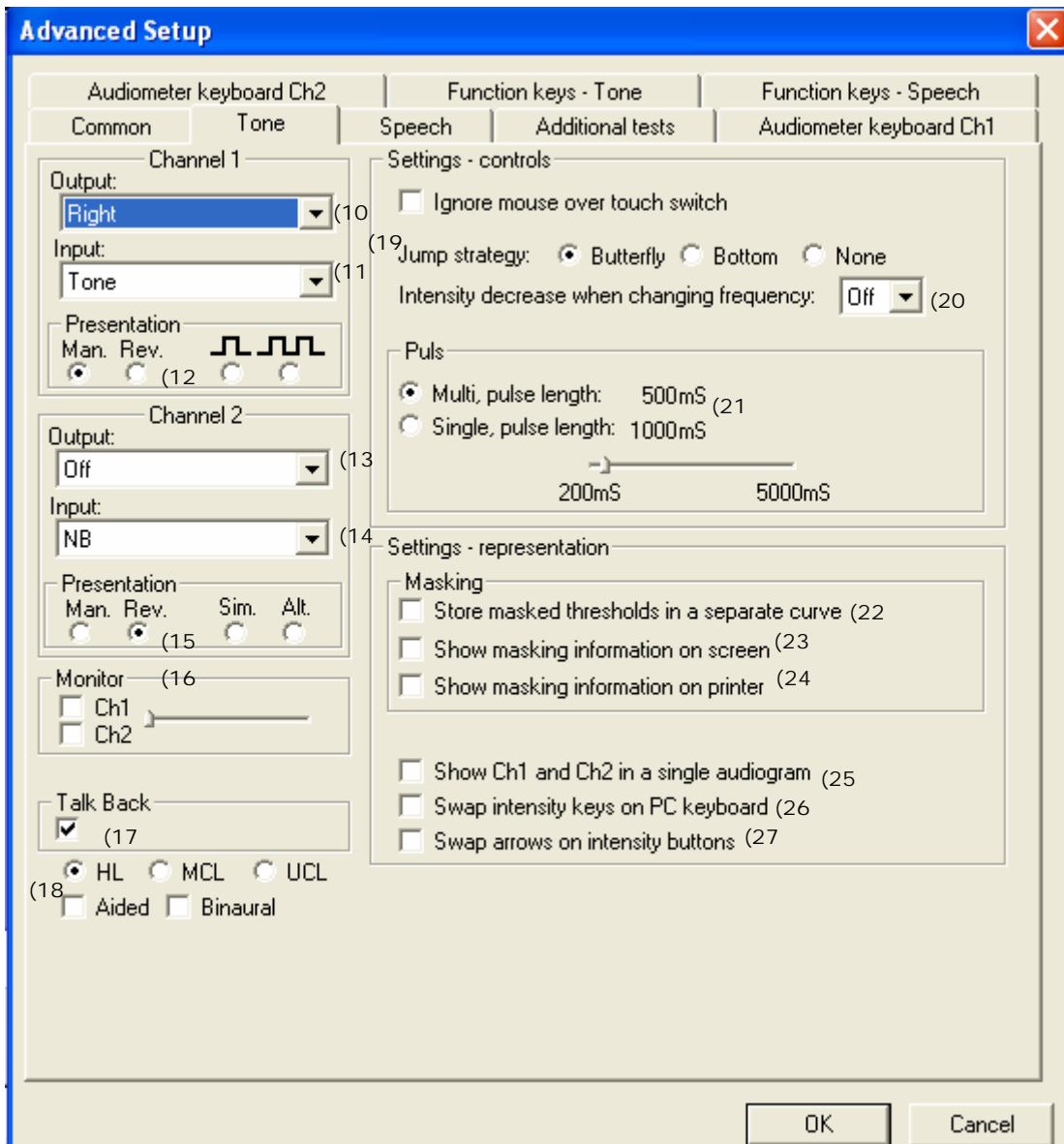
10: Output Ch.1. Selects Right, Left, Bone R, Bone L, FF1 or FF2 as default output for Channel 1.

11: Input Ch.1. Selects Tone or Warble Tone as default input for Channel 1.

12: Presentation Ch.1. Select as default between Man and Rev. "**Man**" will present the signal to the patient only when the Stimuli of Channel 1 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 1 is activated. Furthermore select default between single and continuous pulse presentation.

13: Output Ch.2. Selects Right, Left, Bone R, Bone L, FF1 or FF2 as default output for Channel 2.

14: Input Ch.2. Selects Tone or Warble Tone as default input for Channel 2.

15: Presentation Ch.2. Select as default between Man and Rev. "**Man**" will present the signal to the patient only when the Stimuli of Channel 2 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 2 is activated. Furthermore select as default if the presentation shall be in both channels simultaneously "**Sim.**" by locking channel 1 and channel 2 together or if the presentations in the two channels should be alternating to each other "**Alt.**".

16: Select if Monitoring of Channel 1 or Channel 2 or both Channels together shall be default.

17: Activate if Talk back shall be default.

18: Select if **HL** Hearing Level or **MCL** Most Comfortable Level or **UCL** Uncomfortable Level or Aided or Binaural shall be set as default.

19: Butterfly or Bottom: When the Store function is activated, butterfly means that the frequency will start at 1000 Hz and increase to max (8000 Hz), then jump back to 1000 Hz and decrease to lowest frequency (125 Hz). By Bottom the frequency go from 1000 Hz to 8000 Hz and then down to lowest frequency (125 Hz) and increase to 1000 Hz.

20: Intensity decrease when changing frequency: Every time the frequency is changes the level will be decreased by the number in the box. Select between Off and from 5 to 40 dB in 5 dB steps.

21: Multi Pulse length and Single Pulse length: The two pulse times can be set between 250- and 5000 mS in 1 mS steps.

22: Representation of Masking values in separate curve (on/off)

23: Representation of Masking values on screen (on/off)

24: Representation of Masking values on print out (on/off)

25: Show audiogram in combined view (left/right)

26: Swap intensity keys on pc keyboard.

27: Swap arrows on pc keyboard.

Speech
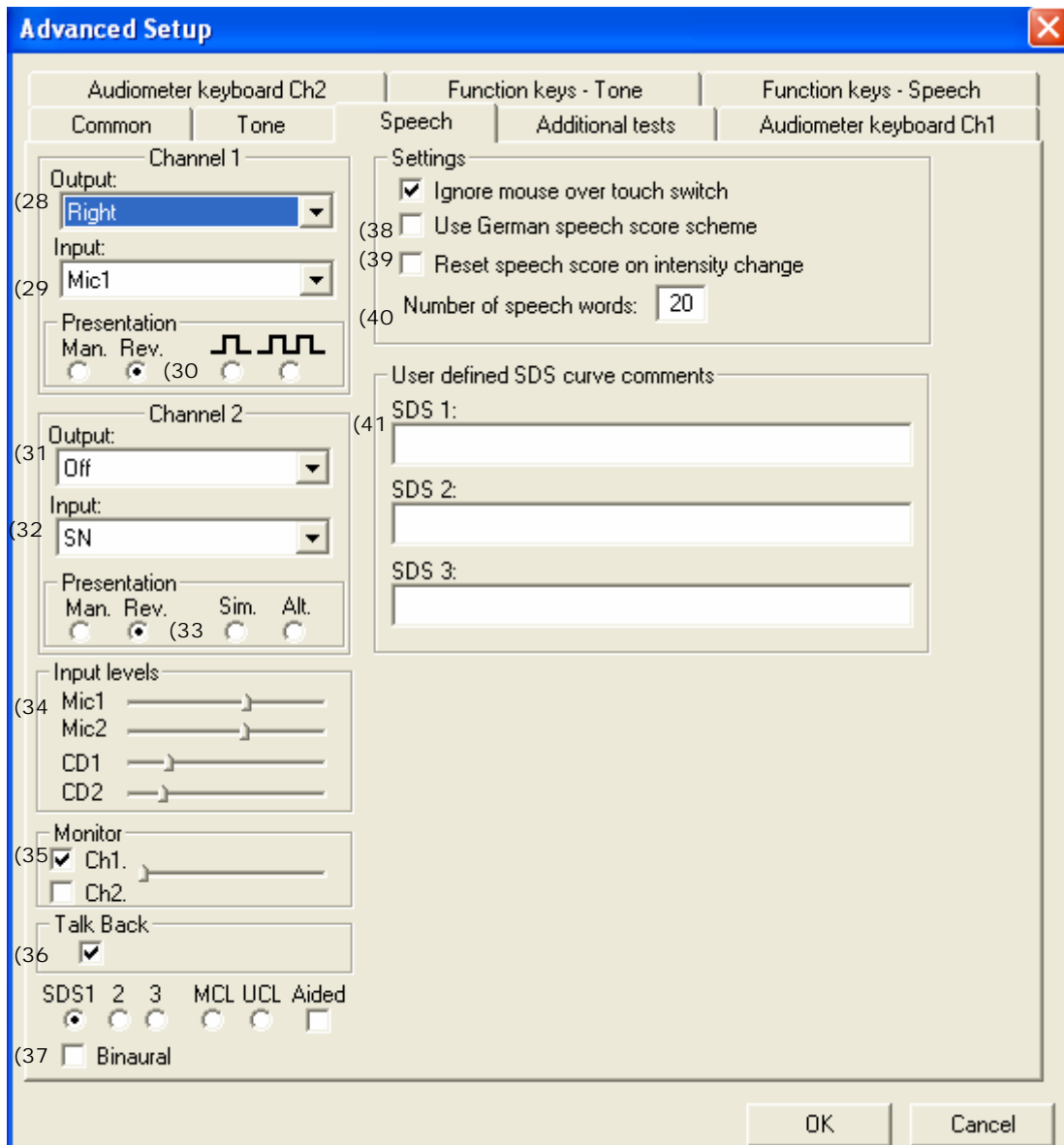
28: Output Ch.1. Selects Right, Left, Bone L, Bone R, FF1 or FF2 as default output for Channel 1.

29: Input Ch.1. Selects Mic.1, Mic.2, CD1 or CD2 as default input for Channel 1.

30: Presentation Ch.1. "**Man**" will present the signal to the patient only when the Stimuli of Channel 1 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 1 is activated. Furthermore you may select between single and continuous pulse presentation. Both options can be set as default.

31: Output Ch.2. Selects Right, Left, Bone L, Bone R, FF1 or FF2 as default output for Channel 2.

32: Input Ch.2. Selects as default Mic.1, Mic.2, CD1 or CD2 input for Channel 2.

33: Presentation Ch.2. "**Man**" will present the signal to the patient only when the Stimuli of Channel 2 is activated. "**Rev**" will cause the signal to be presented continuously, only disappearing when the Stimuli of Channel 2 is activated. Furthermore you may select presentation in both channels "**Sim.**" by locking channel 1 and channel 2 together or to have the presentation in the two channels alternating to each other "**Alt.**".

34: Select as default input including level for Microphone 1 or 2 or CD 1 or 2.

35: Select if Monitoring of Channel 1 or Channel 2 or both Channels together shall be default.

36: Select if Talk back shall be default on or off.

37: Select if 1, 2 or 3 individual SDS (Speech Discrimination Score) curves, MCL (Most Comfortable Level), HL, UCL (Uncomfortable level) should be selected as default for speech testing. All tests can be made Aided or Unaided and/or Binaural by checking the Aided and/or Binaural mark.

38: Use German speech score scheme. Allows for inverted calculation according to German preferences. NOTE: that the incorrect button is inactive in this mode.

39: Reset of Speech score upon intensity change.

40: Number of Speech words: Select as default the number of presented words which has to been reached, before the speech test is stopped.

41: Label comment box for SDS curve 1, 2,& 3.

Additional tests
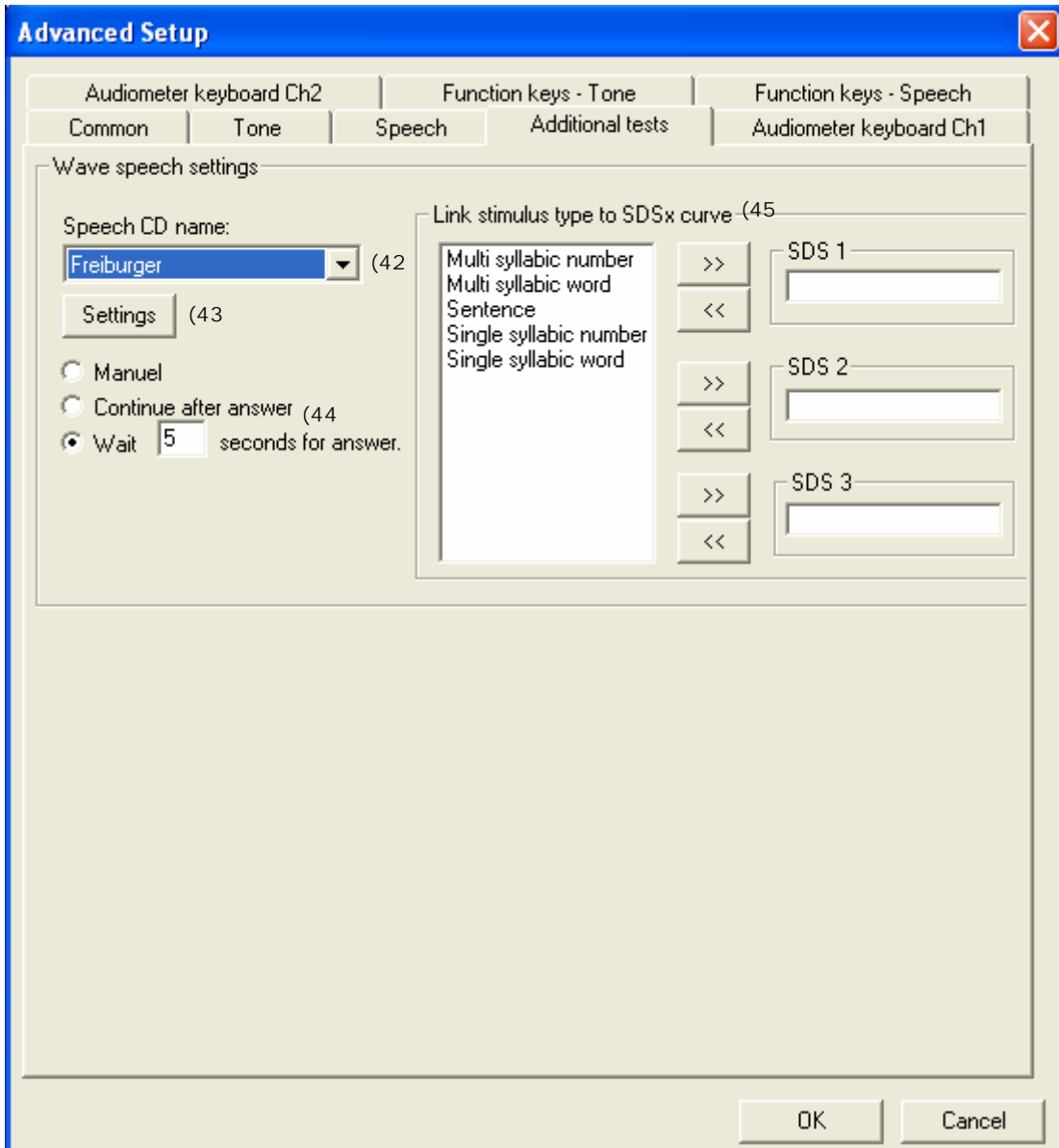
42: Chosen CD's name.

43: Settings for that CD. Index if material consists of Numbers, Words or sentences. As well as if material is single syllabic or multi syllabic.

44: Presentation mode: Manual mode will allow for full manual mode and the speech will not move on. Continue after answer will only allow for the speech to continue after answer. Wait (seconds) before next word is presented.

45: Various lists can be addressed for different SDS scores (SDS1, SDS2 & SDS3)

Audiometer keyboard Ch1

Here you can configure the external audiometer keyboard connected to the Affinity Box.
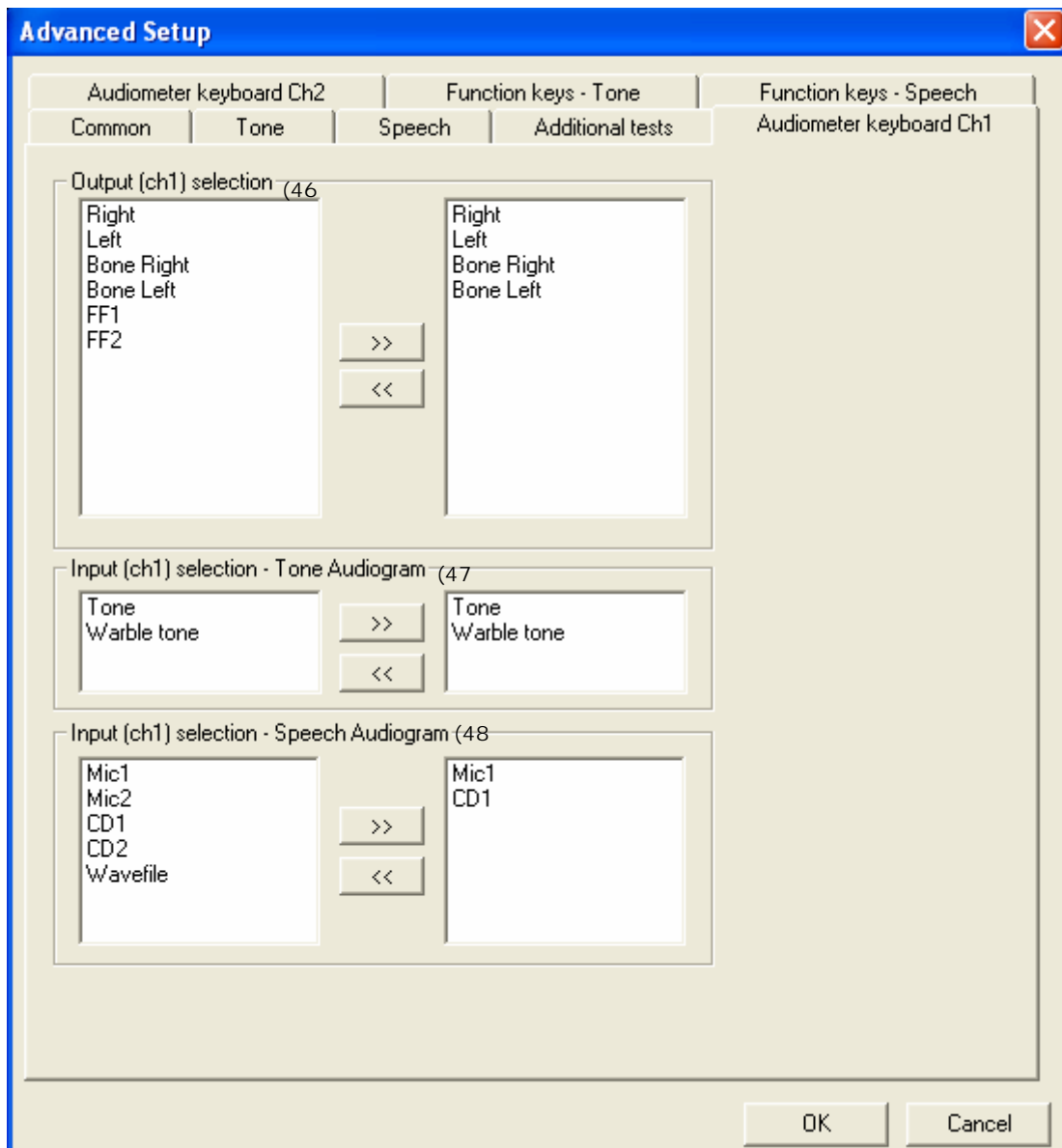
46: Output (ch1) selection: Setup of output channel 1. Select an item and double-click on the right mouse button or use the >> to transfer this item to the box on the right hand side. When the Output key on the keyboard is activated these items will be toggled through.

47: Input (ch1) selection-Tone Audiogram: Setup of input channel 1 Tone **-** see above.

48: Input (ch1) selection-Speech Audiogram: Setup of input channel 1 Speech **-** see above

Audiometer keyboard Ch2

Here you can configure the external audiometer keyboard connected to the Affinity Box.
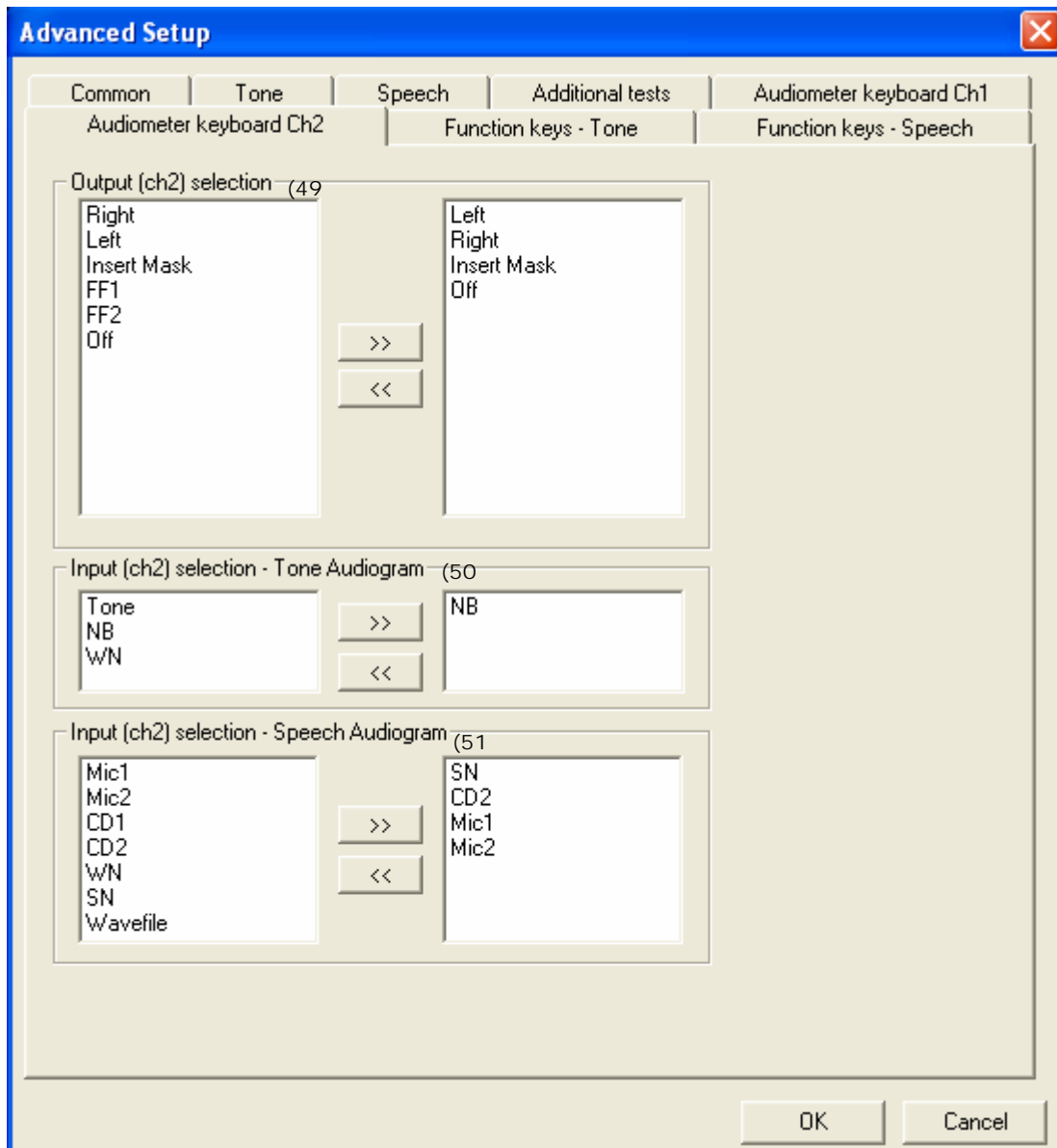
49: Output (ch2) selection: Set up of output Channel 2.Select an item and double-click on the right mouse button or use the >> to transfer this item to the box on the right hand side. When the Output key on the keyboard is activated these items will be toggled through.

50: Input (ch2) selection-Tone Audiogram: Setup of input channel 2 Tone - see above.

51: Input (ch2) selection-Speech Audiogram: Setup of input Channel 2 Speech **-** see above

Function keys-Tone

Here you can configure the F-keys of the external audiometer keyboard connected to the Affinity Box, when the Tone Audiogram is selected.
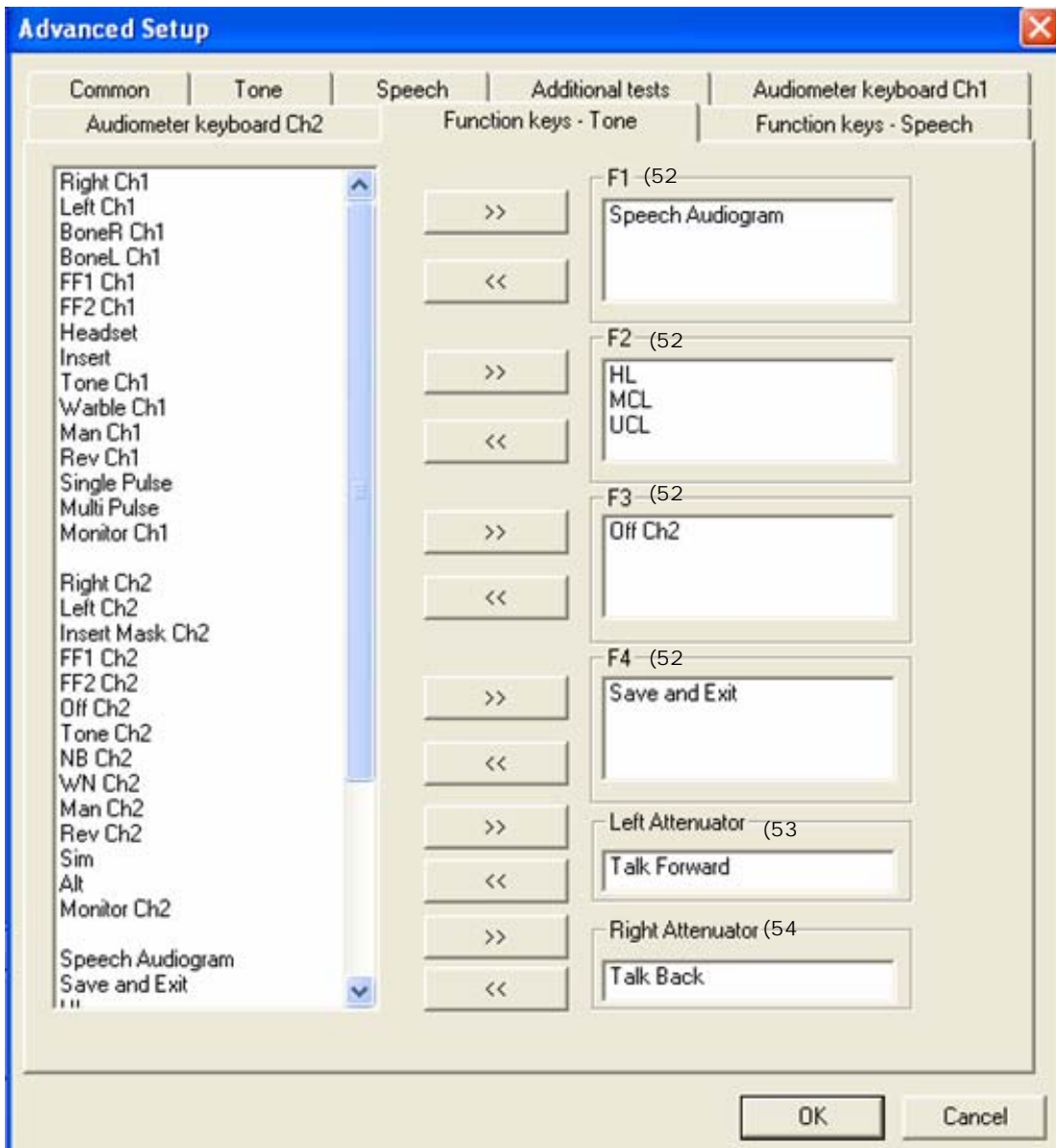
52: F1-F2-F3-F4: Set up of F-keys for Tone. Select the item(s) in the row of possibilities in the left box. Use >> to transfer the selected item to the right F-key box. If more items are selected they will be toggled through when the corresponding F-key is activated.

53: Left Attenuator: Set up of Left Attenuator for Tone. Select the function to be activated, when the Ch1 Attenuator rotary knob is pressed.

54: Right Attenuator: Set up of Right Attenuator for Tone. Select the function to be activated, when the Ch2 Attenuator rotary knob is pressed.

Function keys-Speech

Here you can configure the F-keys of the external audiometer keyboard connected to the Affinity Box when the Speech Audiogram is selected.
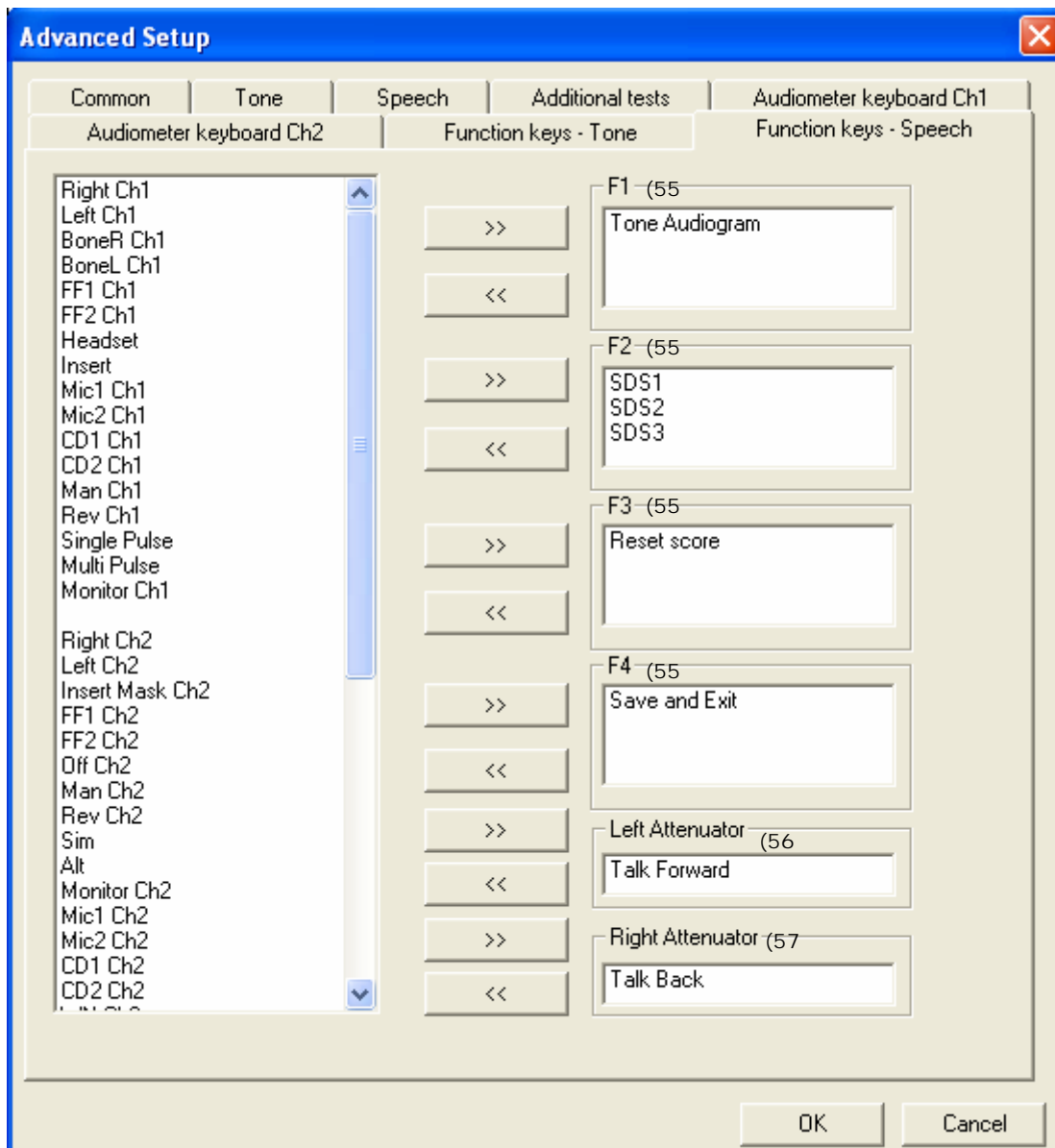
55: F1-F2-F3-F4: Set up of F-keys for Speech. Select the item(s) in the row of possibilities in the left box. Use >> to transfer the selected item to the right F-key box. If more items are selected they will be toggled through when the corresponding F-key is activated.

56: Left Attenuator: Set up of Left Attenuator for Speech. Select the function to be activated, when the Ch1 Attenuator rotary knob is pressed.

57: Right Attenuator: Set up of Right Attenuator for Speech. Select the function to be activated, when the Ch2 Attenuator rotary knob is pressed.

General Setup
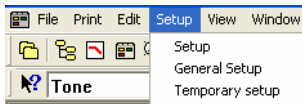
By activating this menu item the program enters the General Setup dialog.
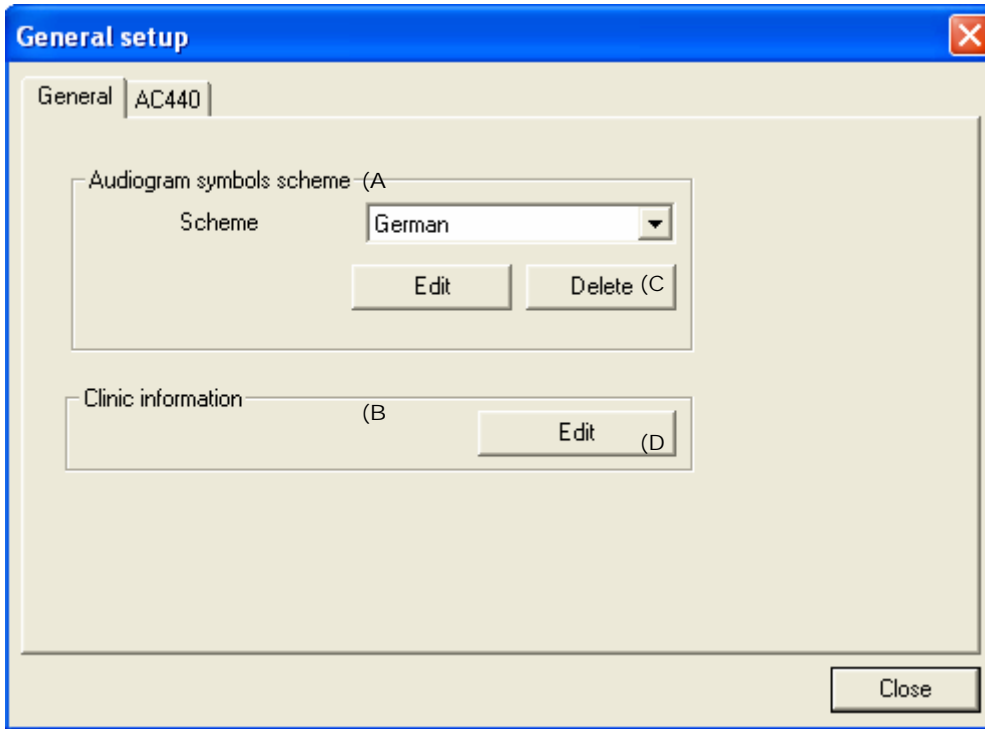
A: Audiogram symbol scheme. Choose between installed symbols.

B: Edit. This feature allows you to draw your own symbols used in the Tone and Speech Audiograms. The symbols drawn are depending on the setting of the parameters on the left side of the Dialog box.
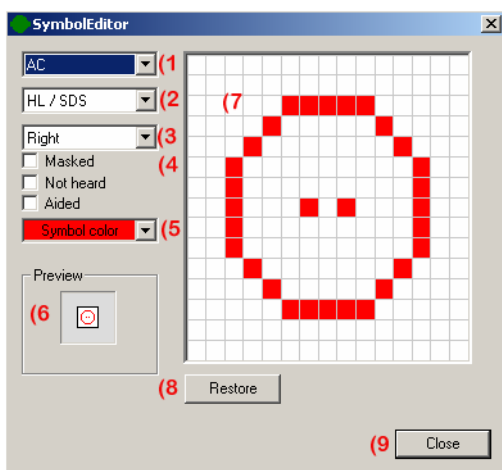
1: Select Air Conduction AC, Bone Conduction BC, or Free Field FF. For each symbol a colour can be selected from a colour palette.

2: Select Hearing Level HL, Speech Discrimination Score SDS, Most Comfortable Level MCL, or Uncomfortable Level UCL. For each symbol a colour can be selected from a colour palette.

3: Select Right / Left

4: Select Masked / Not Masked, Not heard / Not Heard or Aided / Unaided. For each symbol a colour can be selected from a colour palette.

5: Select preferred colour

6: Preview of the symbol design

7: By clicking the Left mouse button a dot will be drawn in the drawing field. Clicking the right mouse button the dot will be erased. A preview of the symbol will be displayed.

8: Restore the design: If the symbol is edited and you regret, then click Restore.

9: Close and exit.

B: Clinic information

The Clinic information allows you to type in the information of your Clinic making. This information will be printed on the print out, if selected in the Printer Wizard.

C: Delete country specific symbol scheme.

D: Clinic Information. Type in your clinics name, address etc.
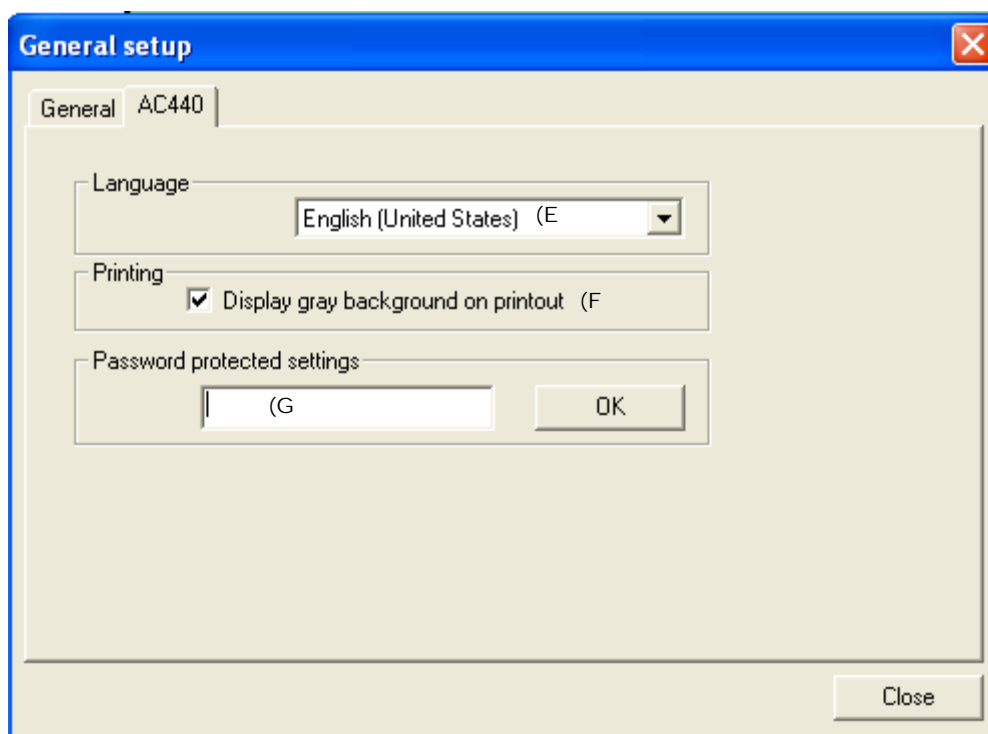
E: Language of module.

F: Display grey background on print reports. Save ink.

G: Password protected settings

1: Select if the IEC or ANSI standard shall be active.

2: Select if the Equivalent filter for IEC or ANSI speech standard shall be active or not.

NOTE: Changing this setting will allow the Audiometer to present 120dB sound level – which can be harmful to patients/clients.

The password protected settings allow a change of the password.

3: Type new password

4: Confirm new password

5: Click Set new password

Temporary Setup
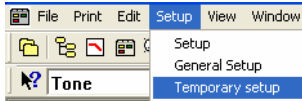
It is possible to make temporary changes to selected test protocol. Just select the "Temporary Setup" to make a temporary Test Protocol Designer appear, in which you can make the desired changes.
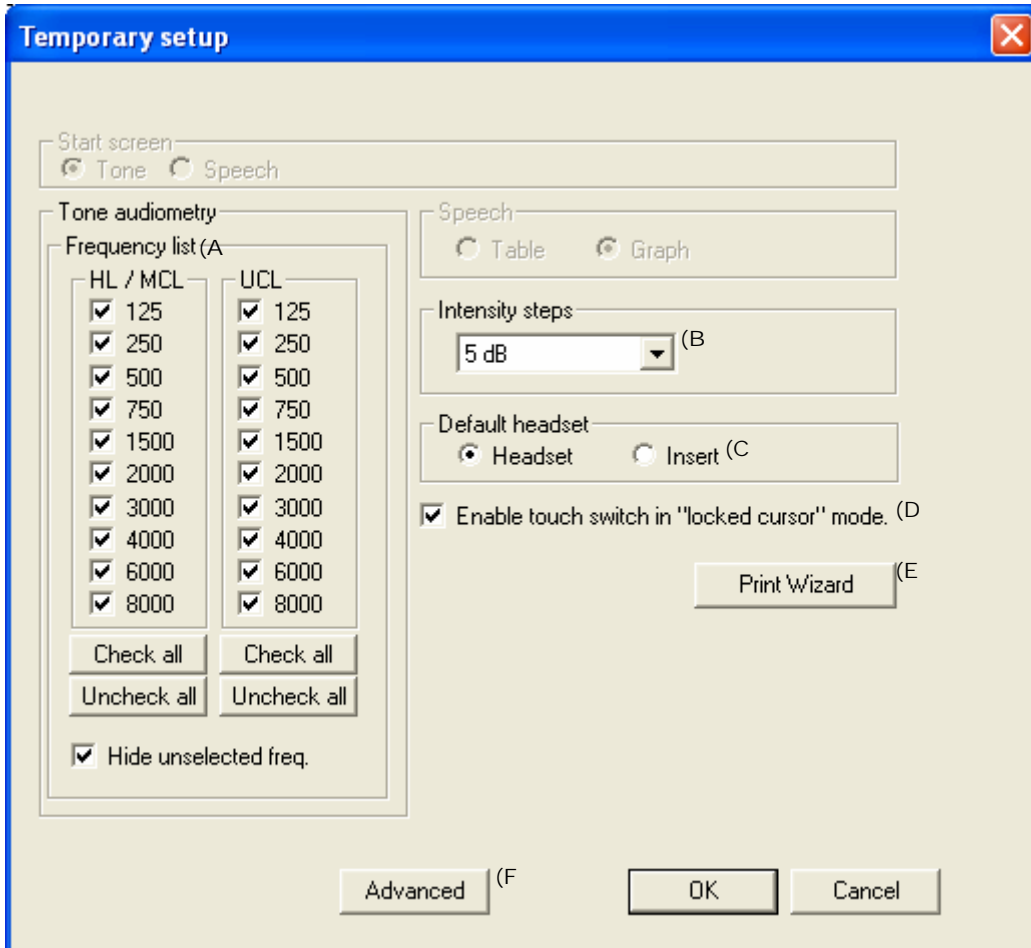
A: Frequency List: Selecting/deselecting some of the 11 audiometric standard frequencies for HL/MCL and UCL.

B: Intensity steps: Choose between 1 dB or 5 dB in level step size.

C: Default headset: Choose insert phones or standard headset.

D: Enable Touch switch in "locked cursor" mode: Select whether the touch switch shall be activated when the mouse is crossing the touch switch area in the Tone audiogram, or if the Audiometer shall be in the "locked cursor mode".

E: Print Wizard: is described in the chapter Print Layout.

F: Advanced: For entering of the advanced setup – described in chapter Advanced Setup.

The asterix following the test protocol name indicates that certain parameters are temporarily changed.

Temporary changes will be valid for the current session only, and the test protocol will return to its original state in the next new session.

4.6.6 View

Toolbar

The Toolbar function enables you to switch the AC440 Toolbar off or on.

4.6.7 Window
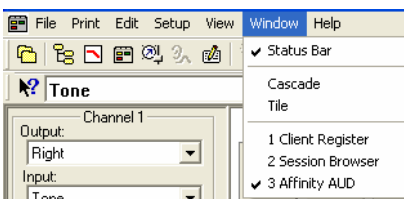
The Status Bar/ Cascade and Title are standard Windows items

With Client Register/ Session Browser and AC440 software, you can view one of these windows. The two first items are related to Noah.

4.6.8 Help
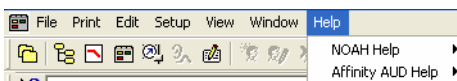
Noah Help

By activating this menu item the Noah Help will pop up.

AC440 Help

By activating this menu item the AC440 About box will pop up. In this box is written the Version number of the Hardware, Firmware and the AC440 software. Furthermore it is here possible to enter a License code that will open for some selected items in the AC440 software. These items are Tone Audiogram and Speech Audiogram.
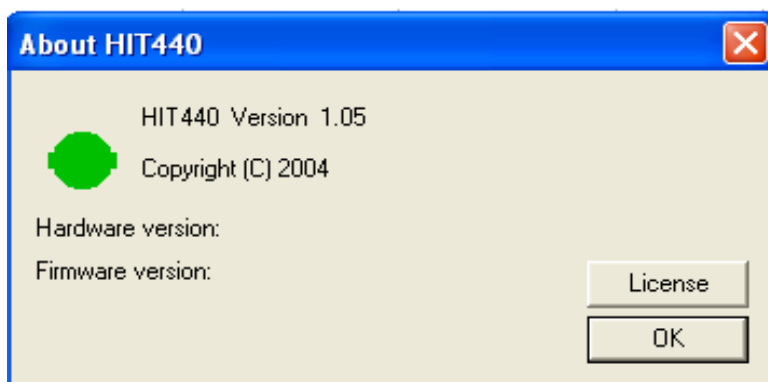
4.7   PC Shortcuts

4.7.1   General Shortcuts:

F1	Not implemented – Default windows behavior is "Help"
F2	Start / Stop test i.e. MLD, SISI.
F3	Temp setup
F4	Talk forward
F5	+20dB (Extended Range).
F6	Tone screen
F7	Speech screen
F8	Print
F9	Save - and exit
F10	Jump to actual session
F11	Add historical layer
F12	Edit mode
Shift+F2	Mousetrap test mode
Shift+F5	Toggle Multi Frequency
Shift+F6	Toggle Dual and Single Audiogram
Shift+F7	Toggle High frequency (Normal -> HF Show -> HF Zoom -> Normal)
Shift+F9	Save - without exit
Shift+F12	Report page
Left Ctrl	Stimulus primary channel
Space	Stimulus primary channel
Right Ctrl	Stimulus secondary channel
0	Reset Speech score (Speech screen). Reset SISI responses (SISI screen)
1	Toggle Output Ch1 (duplicates audiometer keyboard functionality)
2	Toggle Input Ch1 (duplicates audiometer keyboard functionality)
3	Toggle Output Ch2 (duplicates audiometer keyboard functionality)
4	Toggle Input Ch2 (duplicates audiometer keyboard functionality)
S	Store threshold
Enter	Store threshold
N	Store not heard threshold
R	Select Right output in Ch1.
L	Select Left output in Ch1.
Alt+F, P	Print.
Alt+F, V	Print preview
Alt+F, Y	Print layout manager.
Alt+F, R	Windows print setup dialog.

Alt+E, T	Transfer historical to actual session
Alt+E, E	Export historical session to XML
Alt+S, S	Setup dialog
Alt+S, G	General setup dialog
Alt+S, T	Temporary setup dialog
Alt+T, M	MLD screen.
Alt+T, W	Weber screen.
Alt+T, H	HLS, Hearing Loss Simulation.
Alt+T, M	MHA, Master Hearing Aid.
Alt+T, S	SISI screen.
Alt+H, A	About-box, access to version number and license manager.
Escape etc.	Returns from special modes like; MLD, Weber, HLS, MHA, SISI, Mousetrap test mode

Tone Screen:

Arrow up	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).
Arrow down	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).
Arrow right	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).
Arrow left	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).
Page up	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).
Page down	Change Intensity or Frequency (Ch1 or Ch2 depending on Setup selections).

Weber Screen:

R	Store a right side marking.
L	Store a left side marking.
C	Store a center side marking.
Esc	Leave Weber test

MLD Screen:

F2	Start/Stop MLD testing
Esc	Leave MLD test.

HLS Screen:

Z	Right filter toggle ON / OFF.
X	Left filter toggle ON / OFF.
Esc	Leave HLS test

MHA Screen:

Z	Right, Select next available filter, circular toggle.
X	Left, Select next available filter, circular toggle.
Esc	Leave MHA test.

SISI Screen:

0	Reset responses and presentations.
Z	Changes Intensity increases 0, 1,2 and 5dB. Circular toggle.
F2	Start/Stop SISI testing
Esc	Leave SISI test.

Speech Screen:

Arrow up	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
Arrow down	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
Arrow right	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
Arrow left	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
Page up	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
Page down	Change Intensity or Scoring correct/incorrect (depending on Setup selections)..
SHIFT	Enables CD input adjustment
0	Reset Speech score
P	Play - wave files
O	Stop – wave files
U	Pause – wave files
D	Phonem 0
F	Phonem 1
G	Phonem 2
H	Phonem 3
Z	Select SRT in speech table mode.
X	Toggle circular SDS1, 2 and 3 in speech table mode.
F1	Not implemented – Default windows behavior is "Help"
F2	Mousetrap test mode
F3	Temp setup
F4	Talk forward
F5	+20dB (Extended Range).
F6	Tone screen
F7	Speech screen
F8	Print
F9	Save - and exit

F10	Jump to actual session
F11	Add historical layer
F12	Edit mode
Shift+F6	Toggle Dual and Single Audiogram
Shift+F7	Toggle High frequency (Normal -> HF Show -> HF Zoom -> Normal)
Shift+F9	Save - without exit
Shift+F12	Report page
Left Ctrl	Stimulus Ch1
Space	Stimulus Ch2
Right Ctrl	Stimulus secondary channel
0	Reset Speech score (Speech screen)
1	Toggle Output Ch1 (duplicates audiometer keyboard functionality)
2	Toggle Input Ch1 (duplicates audiometer keyboard functionality)
3	Toggle Output Ch2 (duplicates audiometer keyboard functionality)
4	Toggle Input Ch2 (duplicates audiometer keyboard functionality)
S	Store threshold
N	Store not heard threshold
Alt+F, P	Print.
Alt+F, V	Print preview.
Alt+F, Y	Print layout manager.
Alt+F, R	Windows print setup dialog.
Alt+E, T	Transfer historical to actual session
Alt+E, E	Export historical session to XML
Alt+S, S	Setup dialog
Alt+S, G	General setup dialog
Alt+S, T	Temporary setup dialog.
Alt+T, M	MLD screen
Alt+T, W	Weber screen
Alt+H, A	Aboutbox, access to version number and license manager.
Escape	Returns from special modes like; MLD, Weber, Mousetrap test mode etc.

4.8   Technical Specifications of the AC440 Software

**Specifications
AC440 module:
Standards:**

Audiometer:	Tone: EN60645-1/ANSI S3.6 Type 1
	Speech: EN60645-2/ANSI S3.6 Type A or A-E

Calibration: AC: ISO389-1
                            ISO389-2
                        BC: ISO389-3

EMC: EN 60601-1-2

Safety: EN 60601-1, Class I, Type B
                       UL 2601-1
                       CAN/CSA-C22.2 No. 601.1-M90
                        EN 60601-1-1

Warning: Only recorded speech material with a stated relationship with the calibration signal should be used. In the calibration of the instrument it is assumed that the calibration signal level is equal to the average level for the speech material. If this is not the case, the calibration of the sound pressure levels will be invalid and the instrument needs recalibration.

Notice – No installation precautions are necessary to avoid unwanted sound radiation from the audiometer.

Notice – To establish conformity with the IEC 60645-2 standard, it is important that the speech input level is adjusted to 0VU. It is equally important that any free field installation is calibrated at the site where it is used and under the conditions that exists during normal operation.

Audiometer: **Maximum Hearing
                        Levels:**

	AC (dBHL)	AC (dBHL)	AC (dBHL)	BC (dBHL)	NB (dBHL)	Extern FF (dBHL)
Hz	TDH39	HDA200	EARTone5A	B71	TDH 39	
125	90	100	95	-	75	80
250	110	110	100	45	95	95
500	120	115	110	65	110	100
750	120	120	120	70	110	105
1000	120	120	120	70	110	105
1500	120	115	120	70	110	105
2000	120	115	120	75	110	105
3000	120	115	120	80	110	110
4000	120	115	120	80	110	110
6000	120	105	105	50	110	105
8000	110	105	100	50	100	85

Tolerances: The tolerances for the sound pressure levels are ± 2 dB.
                       The tolerances for the vibration force levels are ± 5 dB.

Distortion Levels: Distortion levels are below 1.5 % for AC and 3 % for BC.

Calibration: The output level control for speech signals is calibrated in terms of hearing level for the A type audiometer and SPL for the A-E type

                       Masking levels are calibrated in terms of hearing level for type A and SPL for type A-E.

**Extended Range
Function:**   If not activated, the AC output will be limited to 20 dB below maximum output.

Input: Tone, Warble Tone, CD1, CD2, Mic1, Mic2.

Warble Tone: (±12½%, 0-100Hz), sine wave or triangular.

Frequency Range: 100-10000Hz.

Frequency Response: The frequency response with a TDH39 headphone is 125 – 8000 Hz, with or without equivalent free field output.
                        The frequency response with a B71 bone vibrator is 250 – 6000 Hz.

FF Loudspeaker Output:	Max 6 W into 8 ohms, max 10 W into 4 ohms.
Line Out 1-4:	100-10000 Hz
Minimum Load Impedance:	4.7 kΩ
VU-meter for speech:	Response time approx. 350 mS, dynamic range: -20 - +3dB
Speech RETSPL value:	12.5 dB in accordance with ANSI 3.6.
Masking Stimulus:	Narrow Band Noise or White Noise or Speech Noise
Narrow Band Noise bandwidth:	1/3 - 1/2 octave.
Speech Noise bandwidth:	Weighted random noise with a constant amplitude from 125 to 1000Hz and falling 12 dB/octave from 1000Hz to 6000Hz.
Outputs:	AC Left + Right, BC Left + Right, Insert Phone Left + Right, Insert Masking, FF1 and FF2.
Transducers:	TDH39 Audiometric headset. (The audiometer has equivalent free field output for TDH39 headphones). EAR-Tone 5A Insert phones (optional) HDA200 Audiometric headset (optional) B71 Bone conductor – calibrated for mastoid placement. (The bone vibrator output is not available with equivalent free field output).

RETSPL levels for transducers:

Frequency Hz	TDH39 dB (re 20 µPa)	HDA200 dB (re 20 µPa)	E-A-R Tone 5A dB (re 20 µPa)		NB effective masking levels	B71 dB (re 20 µN)
			IEC 126	IEC711		
125	45,0	29,5	26,0	28,0	+4	82,5
250	25,5	18,0	14,0	17,5	+4	67,0
500	11,5	9,5	5,5	9,5	+4	58,0
750	7,5	6,5	2,0	6,0	+5	48,5
1000	7,0	6,5	0,0	5,5	+6	42,5
1500	6,5	5,5	2,0	9,5	+6	36,5
2000	9,0	3,0	3,0	11,5	+6	31,0
3000	10,0	3,0	3,5	13,0	+6	30,0
4000	9,5	8,5	5,5	15,0	+5	35,3
6000	15,5	9,5	2,0	16,0	+5	40,0
8000	13,0	16,0	0,0	15,5	+5	-

Note:
RETSPL = Reference Equivalent Threshold Sound Pressure Level
The TDH39 is calibrated on an IEC60318-3 compliant head and ear simulator.
The HDA200 is calibrated on an IEC60318-1 compliant head and ear simulator.
The B71 is calibrated on a IEC R373 compliant mastoid simulator, using a static force of 5,4N.
The E-A-R Tone 5A is calibrated using either an IEC126 coupler or an IEC711 simulator.

Sound attenuation values for earphones			Difference between free field and coupler sensitivity levels. Used by Free Field equivalent earphone output (Type A-E or B-E)	
Freq.	Attenuation		Freq.	Correction values
[Hz]	TDH39 with MX41/AR or PN 51 cushion [dB]	EAR-Tone 5A [dB]	[Hz]	TDH39 with MX41/AR or PN 51 cushion using IEC 303 coupler [dB]
125	3	32.5	125	-17.5
160	4	-	160	-14.5
200	5	-	200	-12
250	5	36	250	-9.5
315	5	-	315	-6.5
400	6	-	400	-3.5
500	7	37.5	500	-0.5
630	9	-	630	0
750	-	-	750	-
800	11	-	800	-0.5
1000	15	36.5	1000	-0.5
1250	18	-	1250	-1
1500	-	-	1500	-
1600	21	-	1600	-4
2000	26	33	2000	-6
2500	28	-	2500	-7
3000	-	-	3000	-
3150	31	-	3150	-10.5
4000	32	39.5	4000	-10.5
5000	29	-	5000	-11
6000	-	-	6000	-
6300	26	-	6300	-10.5
8000	24	42.5	8000	1.5

Tone Presentation: Manual or Reverse. Single or multiple pulses.

Patient signal: One or two (optional) hand held push button.

Patient communication: Talk Forward and Talk Back.

Monitor: Channel 1 and Channel 2

Storing capability: Tone audiogram: dB HL, MCL, UCL
Speech Audiogram: SDS1, SDS2, SDS3, MCL, UCL, Aided, Unaided.

Compatible Software: NOAH 3, IaBaseII.

4.9 Included Parts AC440 Software

- Affinity AC440 Software on CD
- TDH39 Audiometric Headset
- B71 Bone Conductor
- APS2 Patient Response Button
- Standard USB Cable
- Power Cable 120 or 230V
- Operation and Multilingual CE Manual

4.10 Optional Parts AC440 Software

- Audiometer Keyboard with live voice mic.
- EarTone5A Audiometric Headset
- ACC60 Affinity carrying Case
- CIR22 Insert Masking Earphones
  Audiocup Enclosures
- Peltor Noise Excluding Headset

Return Report – Form 001

Company: _____

Address: _____

_____

Phone: _____

Fax: _____

Contact person: _____

Date : _____

Address

Drejervaenget 8

5610 Assens

Denmark

Phone (+45) 63713555

Fax (+45) 63713522

Following item is reported to be:

☐ returned to INTERACOUSTICS for: ☐ repair, ☐ exchange, ☐ other: _____

☐ defective as described below with request of assistance

☐ repaired locally as described below

☐ showing general problems as described below

Item: Type: _____ Quantity: _____

Serial No.: _____ Supplied by: _____

Included parts: _____

Description of problem or the performed local repair: _____

Returned according to agreement with: ☐ Interacoustics, ☐ Other : _____

Date : _____ Person : _____

☐ **The above mentioned item is reported to be dangerous to patient or user** [1]

In order to ensure instant and effective treatment of returned goods, it is important that this form is filled in and placed together with the item.

Please note that the goods must be carefully packed, preferably in original packing, in order to avoid damage during transport. (Packing material may be ordered from Interacoustics)

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[1] EC Medical Device Directive rules require immediate report to be sent, if the device by malfunction deterioration of performance or characteristics and/or by inadequacy in labelling or instructions for use has caused or could have caused death or serious deterioration of health to patient or user.

GUIDE

TO
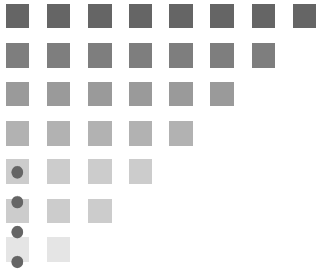
AUDIOMETRY IN FREE FIELD

SET-UP AND CALIBRATION OF EQUIPMENT

Index

1. Background

For normal audiometry using air- and bone conduction, the users are generally well informed about the required equipment, set-up and routines, but there seems to be a need for the same concerning free field audiometry.

It is a well known fact, that free field audiometry is made in many different ways, not always according to valid standards, but we hope that this script will help the user to achieve more knowledge to the field and thereby obtain reliable test results.

This guide is made in order to make a description of the set-up and calibration of the equipment used by audiometric examinations with loudspeakers in free field. These requirements and the test routines are all found in the valid standards, but we have made an effort to collect the most relevant demands on the subject in this script, together with some other helpful information.

It should be noted that all international standards are subject to revisions, which means that there may be issued changes after the release of this script.

Interacoustics 96-11-28/EC

1.1 General about free field audiometry

Audiometry in free field has many applications, e.g. audiometry on children and evaluation of hearing aid settings.

Unfortunately, audiometry in free field has some disadvantages which is not seen in normal audiometry using earphones. Some of these are:

— it is actually not possible to ensure that the tested person (especially children) stays in the exact reference position during the whole test;

— dimensions of the heads of the tested persons will vary - resulting in different distances from the ear to the reference point;

— reflections and standing waves in a standard test room will affect the sound field - thus eliminating the use of pure tones as test signals.

2. Step by step procedure for set-up and calibration of equipment for free field audiometry

1. Examine and control the ambient noise in the test room as described in section 3.2

2. Consider the positioning of the loudspeakers in order to make angels, height and distances in agreement with fig. 1. Install and connect the equipment.

3. Mark the reference point using a weight, hanging down in a string from the ceiling. Check the sound field in and around the reference point as described in section 3.4. If necessary rearrange the position of the reference point and/or the loudspeakers together with eventual furniture/equipment in the room.

4. Calibrate the audiometer at the relevant test frequencies according to section 5.1.

5. Calibrate the audiometer at speech audiometry according to section 5.3.

6. Make records for calibration and adjustment of the equipment. Calibration and check is performed:

   — when the equipment is installed

   — often, e.g. once a month in the first period of use, until the performance of the equipment is known

   — if equipment/furniture is added or moved around in the room

   — with an interval of 3 - 6 month
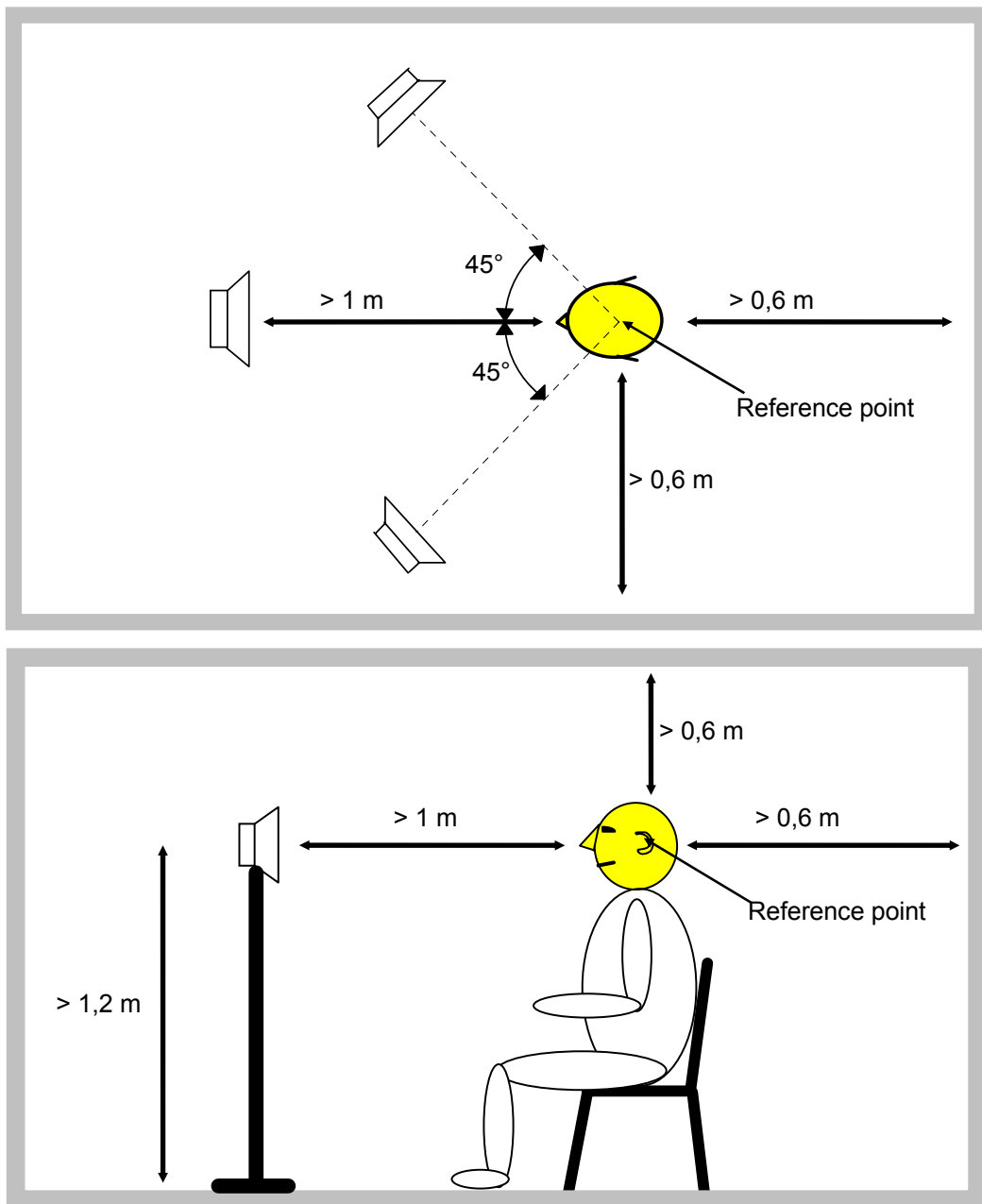
Fig. 1   Free field arrangement according to ISO 8253-3 (speech), seen from above and one side

3. Test room and sound field

3.1 Background noise

As by audiometry with earphones, it is necessary to know the level of the ambient noise in the test room during the audiometry session.

The ambient noise may mask out the test signals, resulting in erroneous test results.

If a threshold determination is made in free field, the demands to the levels of the ambient noise has to be sharpened, as the basic test is binaural and no attenuating cushions from earphones are present.

3.2 Control of test room / background noise

The ambient noise level in the test room is measured using 1/3 octave spectrum analyser or a sound level meter with similar functions. Fig. 2 shows the maximum permissible levels for ambient noise (ISO 8253-2) with either 125 Hz or 250 Hz as the lowest test frequency.
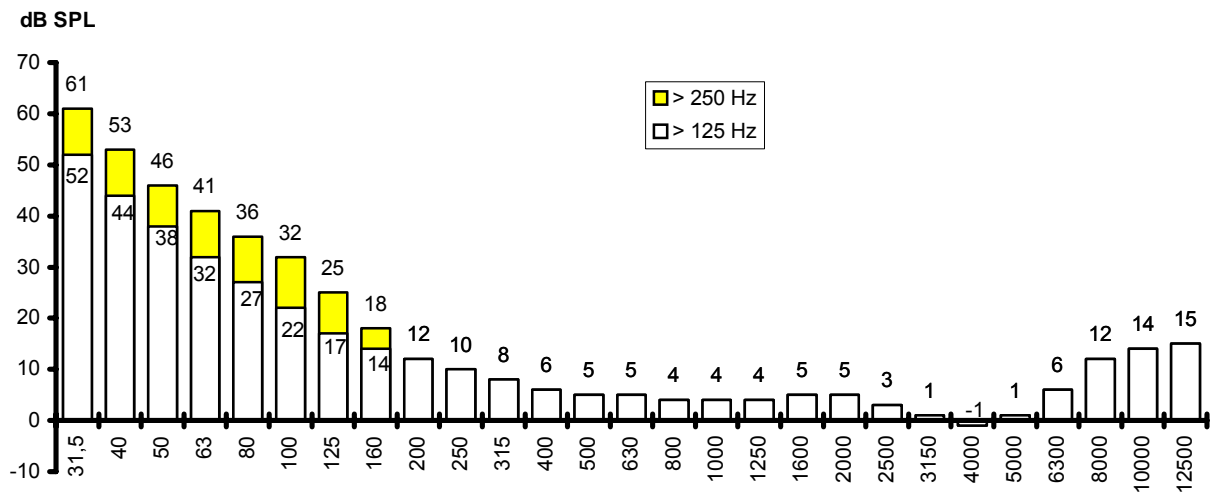
Fig.2   Maximum background noise levels for sound field audiometry

Note:

− The values in figure 2 are valid for test of hearing thresholds down to 0 dB HL, with a maximum uncertainty of ±2 dB due to the ambient noise. If it can be accepted to have an uncertainty of ±5 dB, the levels of figure 2 can be raised by 8 dB.

− Most conventional sound level meters are not capable of measuring levels below 5 dB SPL.

3.3 Reflections

Common rooms with rigid walls, ceiling and floor will reflect the sound waves, resulting in standing waves (figure 3). Test rooms intended for free field audiometry should therefore have the lowest possible reflections.
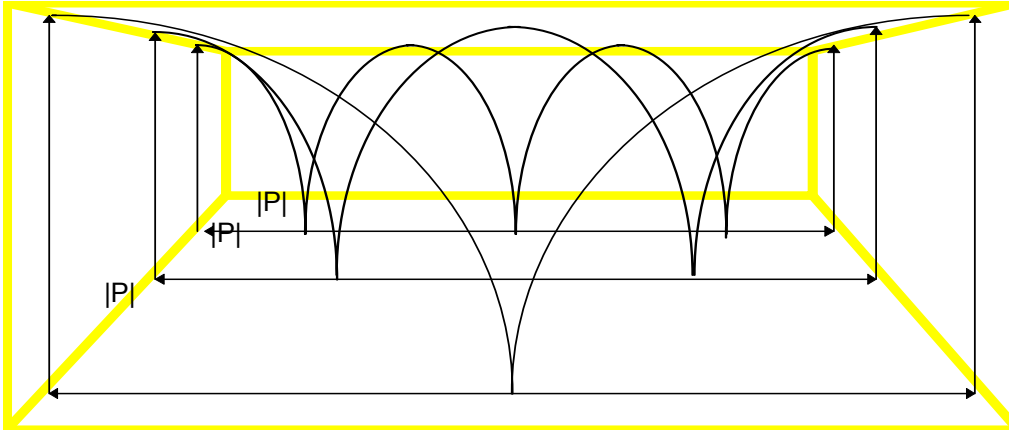
Fig. 3   Standing waves

Reflections and standing waves will result in an uneven sound pressure level from the loudspeaker when the distance is changed. Depending on the shape of the room and the position of the loudspeaker, there will be peaks and valleys on the curve (figure 4).
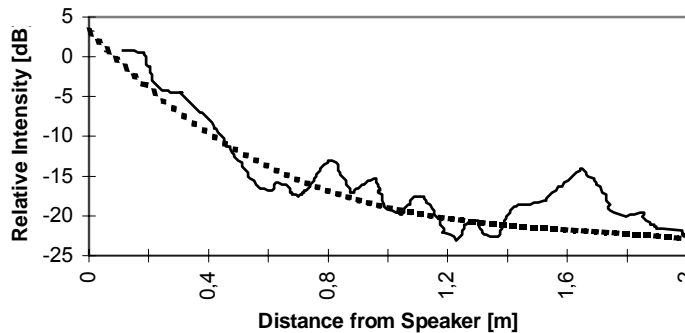
Fig. 4   Sound pressure level of a 1350 Hz pure tone as function of the distance in a typical test room. The dotted line shows the "Inverse distance law".

Traditional pure tone stimulation cannot be used in free field , unless the test room is a so called anechoic room. Instead of pure tones, narrow band noise or frequency modulated (FM) tones are used, also called warble tones.

3.4 Positioning of loudspeakers and control of test room / reflections (quasi-free sound field)

ISO 8253-3 prescribes the position of loudspeaker (for speech audiometry) as shown in figure 1. The test person is placed on the axis of the loudspeaker producing the test signal. Noise are produced by two loudspeakers in a position of 45° to each side of the person under test. As an alternative to the position shown in figure 1 the centre loudspeaker could be placed in a corner and the side loudspeakers at the walls, which might be suitable in small test rooms.

The ISO 8253-2 describes further than free field (anechoic room or outdoor) and diffuse sound field (test room with large reflections), a quasi free sound field. In the quasi free sound field, the reflecting areas has only moderate influence on the sound field. The conditions below should be followed in order to control and establish a quasi free sound field:

1. The loudspeaker is placed in head-height of a seated test person. The loudspeaker shall point against the reference point, which is defined as centre of a straight line between the ear-openings of the test person. The distance between the loudspeaker and the reference point shall be at <u>least</u> 1m.

2. Without the presence of the test person and the chair and with all equipment and other furniture placed as in the test situation, it is checked that the sound pressure level from the loudspeaker in a distance of 15 cm to the right and left and 15 cm above and below of the reference point is within±2 dB from the level in the reference point. This is done at all test frequencies.

3. Under the same conditions, it is checked that the sound pressure level on the axis from the loudspeaker through the reference point is within ±1 dB from the theoretic values given in the inverse distance law (see table below) at positions of 10 cm in front and behind the reference point. This is done at all test frequencies.

Inverse distance law - P_{ref} is the sound pressure level in the reference point				
Distance from loudspeaker to reference point	Sound pressure level in reference point -10 cm		Sound pressure level in reference point +10 cm	
	Distance [m]	Sound pressure level [dB]	Distance [m]	Sound pressure level [dB]
1 m	0,9	P_{ref} + 0,9	1,1	P_{ref} - 0,8
1,5 m	1,4	P_{ref} + 0,6	1,6	P_{ref} - 0,6
2 m	1,9	P_{ref} + 0,4	2,1	P_{ref} - 0,4

Before the above mentioned test is performed, using the present test signals (warble tones), the minimum and maximum values using pure tones can be measured. These values will be very explicit when pure tones are used and must of course be avoided when the reference point is chosen.

Example on calculations for control of sound field using a distance from the loudspeaker to the reference point on 1,5 m.

Sound pressure level measured in the reference point:	$P_{ref.}$ = 68,5 dB SPL
Limits for sound pressure level 15 cm above, below, to the right and to the left of the reference point:	68,5 ±2 dB = 66,5 to 70,5 dB SPL
Limits for sound pressure levels 10 cm in front of the reference point:	(68,5 + 0,6) ±1 dB = 68,1 to 70,1 dB
Limits for sound pressure levels 10 cm behind the reference point:	(68,5 -0,6) ±1 dB = 66,9 to 68,9 dB

The test room is checked, using a sound level meter in position "Fast". The sound level meter should be equipped with an extension piece or placed on a stand, in order to avoid reflections from the person using the sound level meter. If a linear scale is used, relatively small fluctuations in the sound pressure will produce large deviations on the meter. If the needle is fluctuating due to warble signals, the maximum deflection is used as the result.

The sound pressure in the reference point is first determined at the lowest test frequency used (the influence of the room has here the greatest influence). Measure the values around the reference point. If the conditions are not fulfilled, the reference point and/or the loudspeakers and equipment has to be moved to another position and the measurements are repeated.

Experience shows that the movement should be of at least 0,5 m before any measurable effect is seen.

The sound field must be checked in the whole frequency range, using the current test signals (e.g. warble tones at the audiometric frequencies in the range of 250 Hz to 8000 Hz). It is checked that the deviations around the reference point are not exceeding the noted values.

The reference point can be marked, using a weight in a string hanging down from the ceiling.

Also mark the position of the equipment used, e.g. by the means of tape on the floor. Please note that the sound field can be affected if new furniture/equipment is placed in the test room. The chair should be equipped with a headrest.

4. Test signals

As mentioned earlier, pure tones are not recommended as test signals for threshold determination, unless the test room is a distinctly anechoic room. Therefore many audiometers are equipped with the facility of producing warble tones. International standards like ISO 389-7 can be used for calibration of warble tones.

Another possibility is the use of filtered noise. Calibration values are found in the standards for diffuse field (ISO 389-7).

4.1 Warble tones (FM)

Is e.g. used for determination of threshold and functional gain examinations.

Centre and modulation frequency, bandwidth and curve shape for the modulated signal is stated by the manufacturer of the audiometer and can normally not be altered by the user. ISO 8253-2 specifies the following for FM tones:

ISO 8253-2	Common audiometers
The centre frequencies should be as specified in IEC 645-1 or ISO266, with the tolerances of less than ±3%	Will normally be fulfilled by all audiometers
The shape of the modulating signal should be sinus or triangular with symmetrical up and down traces on a linear or logarithmic axis	Will normally be fulfilled by all audiometers
The modulation frequency should be between 4 and 20 Hz with a tolerance of less than ±10%	Will normally be fulfilled, but varies with the manufacturer. See the specifications for the audiometer.
The bandwidth should be between ±2,5% and ±12,5% relative to the centre frequency and with less tolerance than ±10%	Will normally be fulfilled, but varies with the manufacturer. See the specifications for the audiometer.

Furthermore there are demands for distortion and gating of the signal. This will normally be fulfilled by the manufacturer.

4.2 Narrow band noise

This has the same applications as warble tones. Narrow band noise must fulfil the demands in either IEC 225 (e.g. 1/3 octaves) or the demands in IEC 645-1 for narrow band masking noise. Most audiometers has masking noise, meeting these demands, but it can be a problem to use this noise as test signal for free field audiometry.

Hearing impaired test persons can, due to the relatively high frequency content of the noise signals, hear the signal in the stop band, but not necessarily in the pass band. This is caused by the fact that the attenuation outside the pass band is not always sufficient, as the specifications describes a demand of 12 dB/octave. E.g. the level at 500 Hz only has to be 12 dB lower than the 1000 Hz level to fulfil IEC 645-1.

The requirements for the attenuation outside the pass band are made with respect to the demands for effective masking of pure tones by earphones, and are sufficient for this.

For tone audiometry in free field it is therefore recommended to use warble tones as test signal.

4.3 Speech

Speech audiometry in free field can be used for evaluation of hearing impairments in occupational noise matters and by evaluation of discrimination loss (DL) with and without the use of a hearing aid.

The material for speech audiometry must be recorded on either tape or CD (Compact Disk) and must fulfil the demands given in ISO 8253-3. It must contain the speech test material (words) and a signal for calibration of the VU-indicator of the audiometer as well as signals for the check of the frequency response and distortion. The speech material will be different from country to country and is not covered here.

Live voice testing is not sufficiently reliable and should be avoided.

The position of the speech loudspeaker is recommended to be 0° (frontal)

ISO 8253-3 prescribes the use of speech weighted noise (re. IEC 645-2) for competing sound or contralateral masking (masking is performed, using air conduction, preferably using insert phone). The signals from the two noise loudspeakers, positioned in ±45°, should be non-coherent (essential for the consequence of the masking effect of the noise signal). This is achieved by inserting a delay in one of the loudspeakers.*

> *** Note:** This solution may be difficult to realise, due to the fact that it often will be necessary to have a delay of 1-2 seconds. In practice, it is recommended to connect the two loudspeakers in parallel to the power amplifier. This solution is not estimated to have any significant effect to the results.
>
> Alternatively, two CD-players with speech noise could be used, where no. two is started 5 seconds later than no. 1. This procedure will enable the examination of the effect of coherent/non-coherent situation.

IEC 645-2 describes two general types of speech audiometers, one with free field equivalent earphone output and one without. Furthermore there is a distinguish between types with a wide range of facilities and with basic facilities only (A or B respectively).

Speech audiometers with free field equivalent earphone output are different from the conventional ones, without equalisation, in the fact that they make it possible to make a direct comparison of results

made with earphone and loudspeaker. This kind of speech audiometer is containing -E in the type designation (e.g. A-E).

5 Calibration

5.1 Warble tones

As reference for the calibration of warble tone sound pressure levels, the values from ISO 389-7 are used (binaural, on-axis).

Freq. [Hz]	125	250	500	1000	2000	4000	6300	8000
dB SPL	22,0	11,0	4,0	2,0	-1,5	-6,5	4,0	11,5

ISO 389-7 values for the main frequencies

In the test situation the measuring microphone is placed in the reference point and the audiometer setting is e.g. 60 dB HL.

The level of the calibration for each frequency is calculated as the sum of the setting and the value from the table e.g.:

250 Hz, 60 dB setting, calibration level = 60 + 11,0 = 71 dB SPL

The monaural free field threshold is 3 dB higher than shown in the table. By monaural threshold determination in free field, the opposite ear canal must be occluded or masked. An insert earphone with masking noise will often be the best solution.

For tests using off-axis positioning of the loudspeakers in 45° and 90°, appendix 1 gives some recommended values.

5.2 Narrow band noise

As mentioned in section 4.2, it is not recommended to use narrow band masking noise from the audiometer as test signal. It will further be problematic to use a noise signal for determination of monaural thresholds, if there is a need for louder masking levels than obtainable by normal occlusion of the ear canal.

Calibration values for narrow band noise can anyhow be found in ISO 389-7 using the values for diffuse field, if special applications requires this.

5.3 Speech audiometry

ISO 8253-3 recommends a speech level of 65 dB by the test of speech in competing noise.

Before the equipment is calibrated, the frequency characteristic should be measured and eventually equalised. For this purpose, the national speech CD should be used, playing back the recorded track with pink noise, together with a 1/3 octave spectrum analyser, or a sound level meter with similar facilities.

If such equipment is not available, a conventional sound level meter can be used together with a CD with 1/3 octave noise bands (e.g. "Westra digital audiometrie disc nr. 1").

IEC 645-2 specifies the following demands to the maximum deviation from straight frequency response:

Frequency range [Hz]	Tolerance* [dB]
125 - 250	0 / -10
250 - 4000	±3
4000 - 6300	±5

   *   The specifications are valid using digital material as CD or DAT. If analog equipment as tape recorder is used, the tolerances of the medium frequency range can be increased with ±1 dB, while ±2 dB for the upper and lower range.

For the calibration of the level in free field, the speech material (CD or tape) should contain either a band of noise or a warble tone centred at 1 kHz having a bandwidth of at least 1/3 octave. The level of this should be the average of the speech material

In IEC 645-2 it is recommended that the audiometer is calibrated in either SPL or HL, meaning that the sound pressure level from the loudspeaker could be either as shown on the attenuator of the audiometer or 20 dB higher. 20 dB corresponds to the standard recognition level for normal hearing persons.

The SPL calibration is recommended to be used when the audiometer has the ability of producing a free field equivalent output in the earphones, while the HL calibration is used when the earphone signal is not equalised*.

> ***Note:** IEC 645-2 supplies the values of equalisation for 4 different types of earphones, DT48, TDH39, TDH49 and DH80. If other types are used, only HL-calibration will be valid.

Eventually check the specifications for the audiometer to state the actual calibration method and make sure that the audiometric personnel are correctly informed.

Example on calculation of the calibration level using 1 kHz warble tone from the CD:

        60dB HL audiometer setting, calibration level = 60 + 20 = 80 dB SPL

The competing noise signals from the two loudspeakers are each calibrated to a level of 3 dB lower, which gives the correct level (= speech level) in the reference point using two (non coherent) loudspeakers.

The calibration could eventually also be checked in the reference point using both loudspeakers simultaneously, by measuring the sound pressure level for running speech or the noise signal, using an integrating sound level meter (L_{eq} value).

ISO 8253-3 recommends the general use of C-weighting by the measurement of the sound level for speech.

For lists with single words, the sound level can be estimated by the average value of the maximum levels minus 5 dB, with the sound level meter in "Impulse" and C-weighting.

6 Appendix 1

6.1 Correction values for 45° and 90° position of loudspeakers

Values according to ISO 8253-2 (informative)

Frequency [Hz]	45° [dB]	90° [dB]
125	0,5	1
250	1	2
500	3	4,5
1000	4	5,5
2000	3	2
4000	4	-0,5
6000	7,5	9,5
8000	5,5	8,5

The table is used by correction of calibration levels at free field tone audiometry when 0° is not used as prescribed in ISO 389-7.

Example on calculation of the calibration level for 90°:

250 Hz, 60 dB HL, calibration level = 60 + 11 + 2 = 73 dB

7 Appendix 2

7.1 Survey of relevant standards for audiometry

IEC 225	Octave, half octave and third octave band filters intended for the analysis of sounds and vibrations
IEC 303	IEC provisional reference coupler for the calibration of earphones used in audiometry
IEC 318	An IEC artificial ear, of the wide band type, for the calibration of earphones used in audiometry
IEC 373	Mechanical coupler for measurements on bone vibrators
IEC 645-1	Audiometers - Part 1: Pure tone audiometers
IEC 645-2	Audiometers - Part 2: Equipment for speech audiometry
IEC 645-4	Audiometers - Part 4: Equipment for extended high frequency audiometry
IEC 1027	Instruments for the measurement of acoustic admittance/impedance
ISO 266	Acoustics - Preferred frequencies for measurements
ISO 389-1	Acoustics - standard reference zero for the calibration of pure tone air conduction
ISO 389-2	Acoustics - Reference equivalent threshold sound pressure levels for pure tones and insert earphones
ISO 389-3 (ISO 7566)	Acoustics - standard reference zero for the calibration of pure tone bone conduction
ISO 389-4 (ISO 8798)	Acoustics - Reference levels for narrow-band masking noise
ISO 389-5	Acoustics - Reference levels for high frequency
ISO 389-7 (ISO 226-1) Draft	Acoustics - Reference zero for the calibration of audiometric equipment - Part 7: Reference thresholds of hearing under free field and diffuse field listening conditions
ISO 6189	Acoustics - Pure tone air conduction threshold audiometry
ISO 8253-1	Acoustics - Audiometric test methods. Part 1: Basic pure tone air and bone conduction threshold audiometry
ISO 8253-2	Acoustics - Audiometric test methods. Part 2: Sound field audiometry with pure tone and narrow band test signals
ISO 8253-3	Acoustics - Audiometric test methods. Part 3: Speech audiometry

Note: The standards in brackets are older issues, identical in content to the new ones