MAESTRO

FUNCTIONALITIES FOR AUDIOMETRY AND IMPEDANCE TESTING

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Summary

CHAPTER 1

Introduction

This manual explains how to conduct audiological tests using the Maestro software application.
The Maestro software is interfaceable with Inventis audiometers and middle ear analyzers connected to a computer by way of a USB port. Depending on the type of device

- *PC-based*
- *Hytech hybrid*
- *Stand-alone*

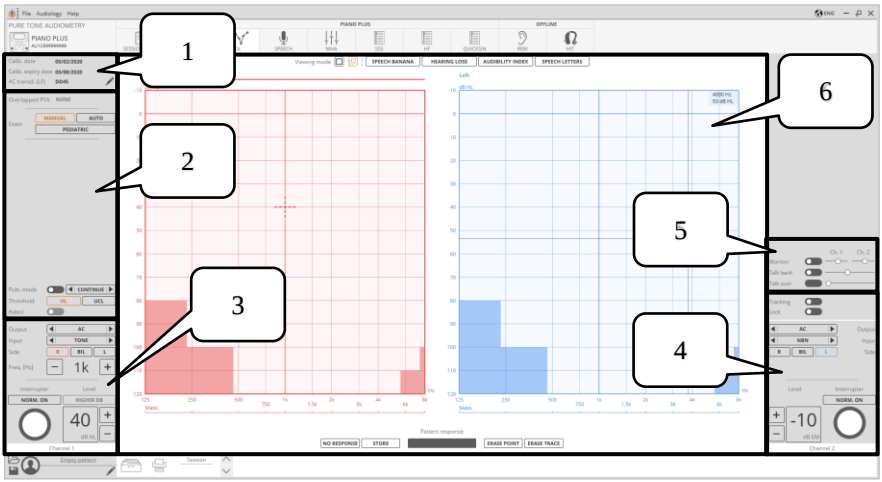
a user can control the device when conducting the supported tests and/or transfer test data from the device to the Maestro archive.

The graphic interface of the software and the test procedures are described generically in the manual, taking account of the features offered by all Inventis devices. Headings and/or sections marked with a "(*)" describe functionalities supported only by certain devices: for a description of the features offered by each device, refer to the relative operator manual which also indicates the technical specifications.

CHAPTER 2

General functions and settings

To conduct audiometric exams using a PC-based audiometer or a *Hytech Hybrid* audiometer in control mode, simply connect the device to the computer by plugging in the USB cable and select the exam to be carried out.



Whatever the type of exam selected, the window will always contain the following areas:

1. Information panel (last calibration date and calibration expiration date) and AC transducer selection;
2. How the currently selected exam is conducted, if any;
3. Audiometer channel 1 control panel, typically used as a stimulus channel;
4. Audiometer channel 2 control panel, typically used as a masking channel;
5. Control panel for operator-patient communication;
6. Area displaying the exam, containing the graph or results table, if any, and controls for saving the exam data (screenshot shows the pure tone audiogram and controls for saving data and deleting points).

2.1 INFORMATION PANEL AND TRANSDUCER SELECTION

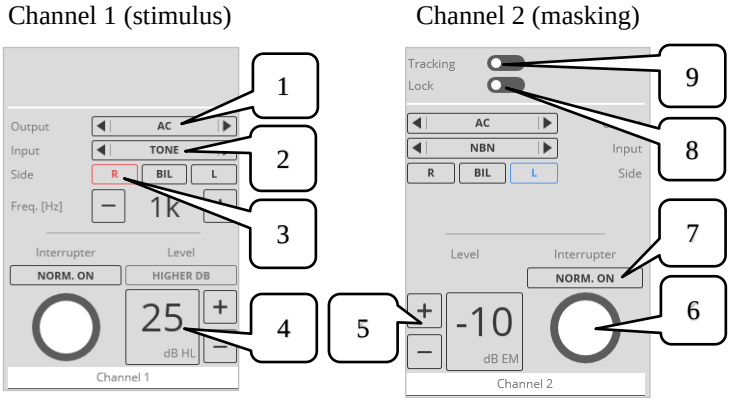
This panel indicates the date of the last calibration performed and its expiration date. For exam in air conduction, the AC transducer section makes it possible to select the following transducer types, if supported by the device:

- Headphones;
- Insertion earphones;
- High frequency earphones.

Make absolutely certain that the type of transducer selected here is the same as that effectively being used. If the setting and the transducer are different, the audiometry reading will not be correct.

2.2 CHANNEL CONTROLS

This section describes the controls for management of the stimulus channel and masking channel. The controls for the two channels appear in mirror image, as shown in the following illustration.



1. *Output.* The type of transducer can be selected by clicking the corresponding button with the mouse pointer.
Various transducers can be used according to the type of test, the stimulus or masking channel and the specific device:
- air conduction (AC - supra-aural headphones / AC-INS - insert earphones / AC-HF - circum-aural headphones, also suitable for high frequency audiometry);
- bone conduction (BC);

- free field (FF);
- insert type earphones for masking (INS).

The stimulus transducer and the masking transducer can be changed by clicking “O” and clicking “Ctrl + O”, respectively.
If a given transducer is found not to be calibrated, the control indicator at the relative output will turn red and it is not possible to present the tone to the patient.

2. *Input.* The type of stimulus can be selected by clicking the corresponding button with the mouse pointer.
The inputs available vary according to the type of exam, the stimulus or masking channel and the specific device:
- Pure tone (TONE);
- Narrowband noise (NBN);
- White noise (WN);
- Speech noise (SN);
- Live speech microphone (MIC);
- External audio source (EXT1/EXT2);
- Speech material saved in the PC (EXT1/EXT2 or USB1/USB2);
- Speech material saved in the device's flash memory (INT1/INT2).

The stimulus signal and the masking signal can be changed by clicking “T” and clicking “Ctrl + I”, respectively.

3. *Side*. Stimulation and masking can be selected on either side, or both: right (R), left (L) or bilateral (BIL).
Selecting the side in the stimulation channel automatically sets the opposite side in the masking channel.
The stimulus side and the masking side can be exchanged with the contralateral one by clicking “TAB” and clicking “Ctrl + TAB”, respectively. To set a specific side, on the other hand, click “R”, “L” or “B” for the stimulus side and “Ctrl + R”, “Ctrl + L” or “Ctrl + B” for the masking side.
The stimulus side can also be changed by clicking directly on the left and right audiograms.

4. *Frequency.* Allows selecting the frequency of the stimulus by pressing the "+" and "-" keys respectively to increase and decrease the frequency. The frequencies available vary depending on the type of exam, the specific device and the transducer selected:
- From 125 Hz to 8 kHz for pure tone audiometry, SISI and *Stenger* exams;
- From 8 kHz to 20 kHz for the high frequency audiometry exam.

The frequency of the stimulus can also be changed:

- using the mouse scroll wheel to adjust the value while keeping the cursor inside the frequency area;
- clicking the desired frequency on the audiogram (only if the stimulus and masking functions are not active);
- using the keyboard's "right arrow" and "left arrow" keys.

Where the concept of frequency is applicable to masking signals (for example for an NBN signal), the masking frequency will always be the same as the stimulus frequency. Frequency settings are not possible with speech type audiometry tests.

5. *Intensity.* Allows changing the intensity of the stimulus and masking signal by pressing the "+" and "-" keys respectively to increase and decrease the intensity.

The intensity of the stimulus and masking can also be changed:

- using the mouse scroll wheel to adjust the value while keeping the cursor inside the intensity area;
- using the mouse scroll wheel to adjust the value while keeping the cursor on the audiogram,
- clicking the desired intensity on the audiogram (only if the stimulus and masking functions are not active);
- from the keyboard, by pressing the configured keys (see section 2.4).

For safety reasons, once 100 dB HL is reached the controls to increase the intensity are disabled. To further increase the intensity of the stimulus signal, press the *HIGHER DB* button.

The intensity of the stimulus is adjusted by fixed steps of 1, 2, 3 or 5 dB, depending on the specific device and the selected setting (see section 2.4). However, it is always possible to increase and decrease the intensity of the minimum available step regardless of the step selected in the settings, in the following ways:

- holding down the "Alt" key and clicking with the mouse on the "+" and "-" keys;
- using the mouse scroll wheel to adjust the value while keeping the cursor inside the masking intensity area and holding down the "Alt" key;
- using the mouse scroll wheel to adjust the value while keeping the cursor on the audiogram and holding down the "Alt" key;
- from the keyboard, by pressing the configured keys (see section 2.4).

6. *Interrupter switch.* Allows sending the stimulus and masking signal by placing the mouse cursor over the button to avoid any noise.

The stimulus signal can also be sent by:

- right-clicking with the mouse, keeping the cursor above the audiogram;
- from the keyboard, by pressing the configured key (see section General settings).

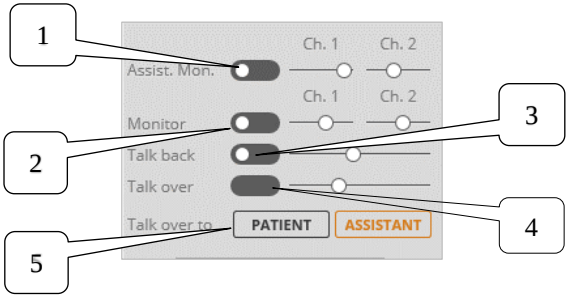
The masking signal, on the other hand, can be presented using the “AltGr” key.

7. *Norm. On.* Selecting this option inverts the *Interrupter* operation logic: when *Norm. On* is selected the signal is always active and can be switched off via the *Interrupter*.
   It is also possible to enable/disable *Norm. On* by clicking the "N" button for the stimulus and "M" for the masking.

8. *Tracking.* If tracking is active, the current difference between the intensity of the stimulus and masking signal is kept constant as the stimulus intensity changes.

9. *Lock* (*). When the lock option is selected, the masking signal will be switched on and switched off synchronously with the stimulus signal. If the lock option is active, the *Interrupter* and the *Norm. On* button of the masking channel are disabled.

2.3 OPERATOR-PATIENT COMMUNICATION



1. *Assist. Mon* (*). Allows the assistant to activate the stimulus and masking signals monitor. The volume of the signals monitor can be adjusted by sliding the relative cursor, or alternatively turning the scroll wheel of the mouse while keeping the pointer in the monitor area. The levels set in this way are retained every time the module is started up. The assistant can listen to the monitor signal via headphones/speakers connected to the device's assistant monitor output.

2. *Monitor* (*). Allows the operator to activate the stimulus and masking signals monitor. The volume of the signals monitor can be adjusted by sliding the relative cursor, or alternatively turning the scroll wheel of the mouse while keeping the pointer in the monitor area. The levels set in this way are retained every time the module is started up. The operator can listen to the monitor signal:

- via headphones/speakers connected to the device's monitor output (operator-patient communication in *audiometer* mode);
- on speakers connected to the computer (operator-patient communication in *PC* mode).

3. *Talk back* (*). Allows activating communication from the patient to the operator. The talk back function can be activated/deactivated by clicking the “p” key. The volume of the communication can be set by sliding the relative cursor, or alternatively turning the scroll wheel of the mouse while keeping the pointer internally of the talk back area. The levels set in this way are retained every time the module is started up.
Talk back remains enabled even after the button has been released; to deactivate it the operator must press the button again.
The operator can hear the patient's voice:
- via headphones/speakers connected to the device's monitor output (operator-patient communication in *audiometer* mode);
- on speakers connected to the computer (operator-patient communication in *PC* mode).

4. *Talk over.* Allows activating communication between the patient and the operator. The talk over function can be activated by clicking the corresponding button or by holding down the "T" or "F" key on the keyboard depending on the configuration (see section 2.4). As long as the communication channel remains active, the sending of any other signal will be inhibited, and then re-enabled only when the corresponding button is released. The volume of the communication can be set by sliding the relative cursor, or alternatively turning the scroll wheel of the mouse while keeping the pointer in the talk over area. The levels set in this way are retained every time the module is started up.
For the talk over function the operator can use:
- a microphone connected to the device's talk over input (operator-patient communication in *audiometer* mode);
- (*) a microphone connected to the computer (operator-patient communication in *PC* mode).

5. *Talk over to* (*). Allows to route the talk over signal to the assistant or to the patient.

6. *Patient response.* Displays the status of the patient response button: the orange LED lights up when the patient presses the button.

7. Speech material and live speech playback

To obtain information about the patient's ability to hear and understand the spoken voice, a series of standardized vocal stimuli like monosyllables, words or phrases are presented to the patient. The purpose of the test is to measure certain aspects of the patient's hearing capability, in particular verbal intelligibility, i.e. the ability to recognize input signals as sound stimuli that have meaning. The speech material can be presented directly by the operator over a microphone, recorded on a CD or a cassette tape and transmitted from a suitable player connected to the EXT input of the audiometer, or stored on the computer and transmitted to the device by way of a USB* cable or via cables connected to the EXT inputs.

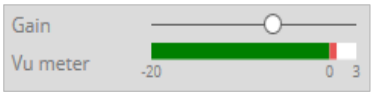
2.3.1 Selection of input

The input signals for speech audiometry vary according to the particular device, and include:

- Microphone (MIC input): the exam can be performed in live speech mode using a microphone connected to the MIC input on the rear panel of the device (operator-patient communication in audiometer mode) or a microphone connected to the PC audio capture device (operator-patient communication in PC (*) mode);
- External audio source (EXT1/EXT2 inputs): it is possible to reproduce the signal from external audio sources (CD or cassette player) connected to the EXT1/EXT2 inputs on the device;
- Speech material stored on PC: speech material stored on a computer can be reproduced by selecting inputs EXT1/EXT2 and transmitting the audio signal via cables connected to the EXT1/EXT2 inputs of the device (speech material playback in EXT mode) or selecting inputs USB1/USB2 and transmitting the audio signal via the USB cable (speech material playback in USB (*) mode);
- Speech material stored in the flash memory* of the device: in the case of devices that support an internal flash memory, speech material can be reproduced by selecting inputs INT1/INT2.

2.3.2 Adjustment of input gain

The figure below represents the section dedicated to adjusting the input *Gain* in the Maestro interface during a vocal exam:



The gain adjustment of the selected input must be carried out before starting the exam. The purpose of this operation is to ensure that the speech material used or the operator's voice (in the case of a live speech exam), has the correct intensity.
Where recorded speech material is used, the input gain will be correct if, sending a calibration tone supplied with the material, the intensity measured on the VU-meter indicator of the two channels — displayed on the screen of the computer — reaches 0 dB, i.e. the point at which the meter changes from green to red.
In the case of a live speech exam using the MIC input, the VU-meter of channel 1 should register 0 dB on average when the words are pronounced, keeping at a fixed distance from the microphone.
The gain value of each input is memorized and set again at the same level every time the same type of input is used thereafter.

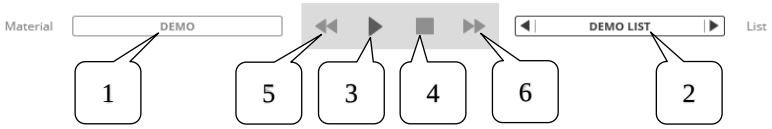
2.3.3 Speech material

Speech material saved in the computer or flash memory of the device can be indexed. It is possible to define the list of words contained in each audio track: during reproduction of the audio tracks, the current word is displayed in the control panel relative to the speech material, in such a way that the operator can monitor the words presented to the patient.

In the event that speech material stored on the computer is being used, the operator must deactivate all audio effects installed on the computer (e.g. Dolby) and set the sound card volume to maximum.

The indexing of audio tracks can be accomplished with the aid of Inventis *ATIT* software. The folder of the computer where the speech material is stored contains as many subfolders are required for each of the different types of speech material (e.g. *monosyllabic words* or *spondaic words*). Each sub-folder contains the tracks and the lists of words to be reproduced (*.wav* files).

Located in the central area of the speech audiometry window are the controls for reproduction of the speech material, which appear as illustrated below:



The following table describes the operation of the keys used for reproduction of the lists of speech material:

1. *Material.* Allows selection of the speech material to be utilized, from among all the folders in the directory (enabled only when playback is not currently active)

2. *List.* Allows selection of the specific list to be reproduced, from the selected folder of speech material (enabled only when reproduction is not currently active).

3. *Play/Pause (or "F5" key on the keyboard).* Activates speech material playback or allows pausing it when active;

4. *Stop (or "ESC" key on the keyboard).* Ends playback of a list;

5. *Rewind.* If speech material playback is active and the material is indexed, it repeats the last word spoken or returns to the previous word if pressed twice in succession;

6. *Forward.* If speech material is currently playing and the material is indexed, it moves on to the next word;

If the speech material is indexed, the list of words in the selected list is displayed in the top-right section while the word (or phrase) being pronounced is displayed above the reproduction controls.

2.4 GENERAL SETTINGS

Below is a list of the general parameters of the audiometer, accessible from the *Audiology* menu, located in the upper bar of the Maestro window (menu available only for audiometric exams).

Settings are divided into the following categories:

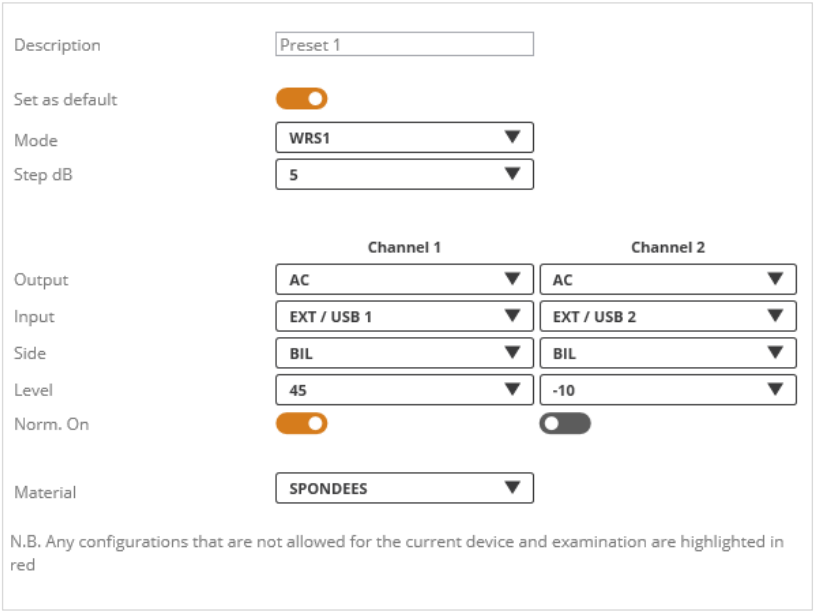
- New exam;
- Preset for speech audiometry;
- Display options;
- Test settings;
- Pediatric audiometry settings;
- Audio settings;
- Free field level adjustment;
- Device connection mode;
- Device information.

2.4.1 New Exam

To acquire an audiometric exam, simply launch Maestro and select the desired exam type from the top bar. If there is an exam in progress, click on *Audiology* → *New Exam* to create a new one. The previous exam will be temporarily saved and can be managed from the bottom bar of the Maestro window.

2.4.2 Preset for speech audiometry

The speech audiometry preset function, accessible from the menu under *Audiology* → *Preset for speech audiometry* or from the main speech audiometry window, allows you to create and then modify or delete different speech audiometry start-up presets. These presets consist of a set of parameters, including exam mode, step dB, channel status (output, input, side, level, etc.) and speech material, which are set upon entering the speech audiometry window. The following figure shows the window for creating/editing a preset:



By selecting the *set as default* option, the selected preset is automatically set when the software starts and every time a new exam is created during the session.
From the *Audiology* → *Preset for voice audiometry* → *Preset list* menu it is possible to select the preset to be set among those created.

2.4.3 Display options

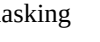
Below are the symbols used to represent the audiometric thresholds, accessible from the *Audiology* → *Drawing preferences* menu.

The symbols used to indicate masking for air conduction, bone conduction with and without masking and the UCL threshold can be preset. The possible symbols are indicated below, together with the relative default values.

Air conduction

	Right	Left	Bilateral	Default
HL threshold without masking				✓
HL threshold with masking				✓
				
UCL threshold				✓
				
				
				

Bone conduction

	Right	Left	Default
HL threshold without masking			✓
			
			
			
HL threshold with masking			✓
			
			
			

There is also the option of joining bone conduction symbols or otherwise.

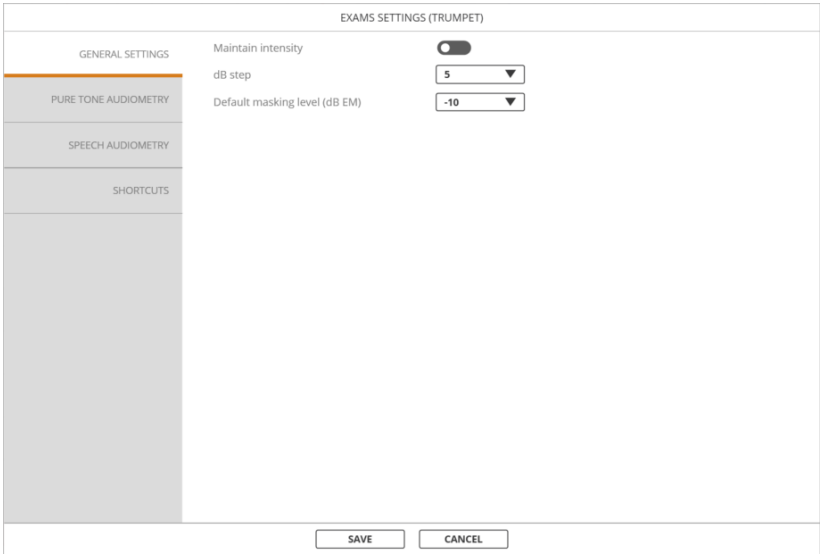
Free field

	Right	Left	Bilateral	Default
HL threshold without masking				✓
HL threshold with masking				✓
Aided HL threshold				✓

2.4.4 Exam settings

General settings

Below are the control settings common to exams accessible from the *Audiology* → *Exam settings* menu, *General settings* section.



Maintain intensity. If enabled, the level of the stimulus on the primary channel stays the same (i.e. does not revert to the default value) when changing the stimulation side, output, input or frequency. Default value: No.

Maintaining the previous intensity of the stimulus when changing frequency, transducer or stimulation side can result in potentially harmful signals being presented to the patient.

Step dB (*). Allows selection of the incremental step for the attenuators, which can be 1, 2, 3 or 5 dB, depending on the device in use. Default value: 5.

Default masking level (dB EM) (between -10 and 80 dB EM). Default value: -10 dB EM.

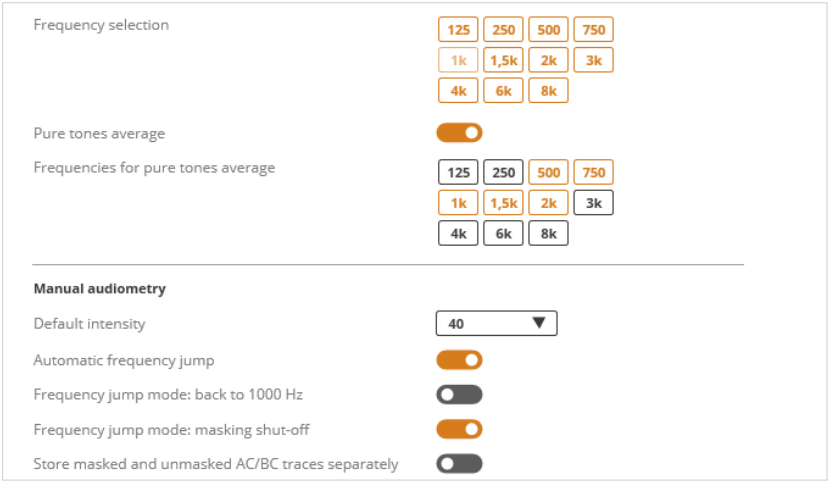
Extended FF intensity range (*). The intensity range for free field audiometry tests, in other words the maximum output values. It can be normal or extended. Default value: No (not extended).

Beep on patient response. Enables or disables the beep signal generated when the patient response button is pressed. Default value: No.

Auxiliary response switch (*). If the audiometer is equipped with two response buttons (right/left), the use of both can be enabled. Default value: No.

Pure tone audiometry

Below are the pure tone audiometry control settings accessible from the *Audiology → Exam settings* menu, *Pure tone audiometry* section.



Frequencies to examine. Allows selection of the set of the frequency selection. The 1 kHz frequency is selected by default and cannot be deselected. Default value: all frequencies.

Pure tones average. Allows averaging of thresholds. If the option is enabled, allows selection of the set of the frequencies with which calculate the average.

Manual Audiometry

Default intensity. Default intensity value of the audiometer (between -10 and 60 dB HL). Default value: 40 dB HL.

Automatic frequency jump. Enables or disables automatic transition to the next frequency after a threshold value on the audiogram has been saved (using the Store function). Default value: Yes.

Frequency jump mode: back to 1000 Hz. Allows selection of the next frequency value, once the maximum value of 8 kHz has been reached. If return to 1000 Hz is activated, the frequency reverts to 1 kHz, if not, it will default to 125 Hz. Default value: No.

Frequency jump mode: masking shut-off. Allows to automatically shut-off the masking signal when a point is stored. If masking shut-off is activated, the masking signal is shut-off, if not, it will stay active. Default value: Yes.

Custom pulsed period. Duration of period in pulsed tone presentation mode with customized pulse duration. Default value: 1500 ms.

Duration of a single pulse. Duration of the pulse in *single pulse* mode. Default value: 1000 ms.

Store masked and unmasked AC/BC traces separately. The operator can save both masked and non masked AC/BC traces in the audiogram. Default value: No.

Maximum frequency HF: 20000Hz. Allows the maximum value of 20000 Hz to be reached during the high frequency audiometry (HF) exam. The frequencies are available in air conduction modes only if enabled in the settings. Because stimulus signals at 18 kHz and 20 kHz are not standardized, their intensity cannot be expressed in dB HL, only in dB SPL. Consequently, these frequencies are not displayed on the audiogram.
Default value: No.

Automatic audiometry

Test mode. Allows selecting the automatic audiometry acquisition mode from the following:

- *Hughson - Westlake*: allows determining the hearing threshold based on the criterion of 2 out of 3 positive responses with increase/decrease of the stimulus level of +5 dB and -10 dB, respectively;
- *Quick Search:* determines the hearing threshold from the preset minimum level and based on the patient's first positive response;
- *Fixed Intensity:* rapid screening test, allows identifying test frequencies like heard/no response at a preset fixed intensity value.

Default test mode: *Hughson - Westlake*.
For more information on the test modes see section 3.2Exam status icons:).

Test levels. It is possible to set the minimum and maximum levels (dB HL) achievable during the automatic exam.

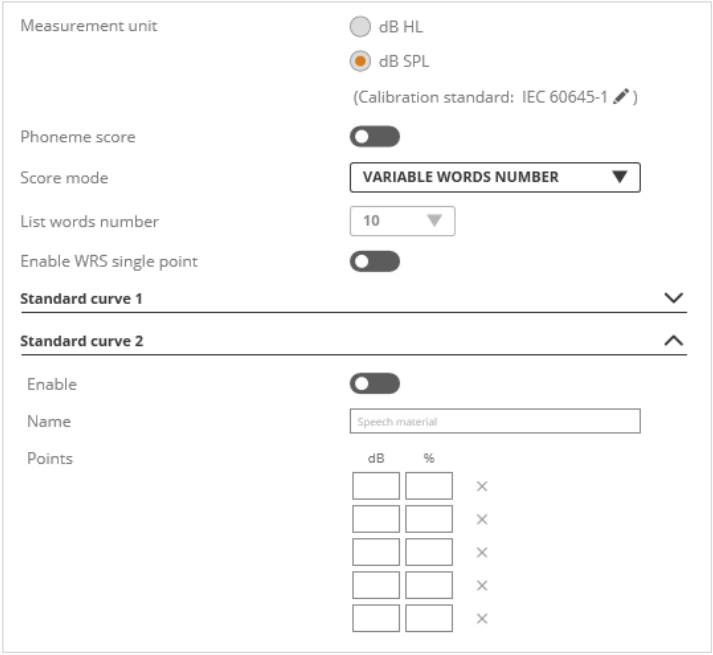
Default minimum intensity: -10 (dB HL).
Default maximum intensity: 100 (dB HL).
A single intensity level can be set for the fixed intensity test mode.
Default fixed intensity: 20 (dB HL).

Familiarization. Enables an initial familiarization phase during which the patient can be instructed on how to search for the threshold, and at the end of which the exam is automatically started. It is possible to enable this option only for the *Hughson - Westlake* test mode.

Default value: No.

Speech audiometry

Below are the pure tone audiometry control settings accessible from the *Audiology → Exam settings* menu, *Speech audiometry* section.



Measurement unit. Allows selecting the measurement unit for speech audiometry acquisition between HL and SPL.
The first time the SPL measurement unit is selected, the user is prompted to specify the calibration standard used to calibrate the device. The standard is visible below the HL/SPL selection and can be edited by clicking on the pencil icon.
Default value: HL.

Phoneme score. Enables calculation of the percentage of phonemes correctly identified in each of the words presented.
Default mode: No.

Score mode. Allows the operator to select either of the two modes of storing the correct/incorrect answers given by the patient.

- *Variable words number:* the operator keeps a tally of both correct and incorrect answers; accordingly, the current score reflects the total number of words presented.
- *Fixed words number:* the operator keeps a tally of correct answers only; accordingly, the current score reflects the total number of words in the list.

Default mode: Variable words number.

Number of words in list. Where *score mode* is set to *fixed words number*, allows selection of the number (1 to 99) of words making up each list.

Enable WRS single point. If enabled, allows calculation of a single numerical value when using speech audiometry in *WRS* mode. If the *WRS single point* option is enabled and the outputs currently selected are air conduction or free field, then *binaural* mode can be activated.
Default setting: No.

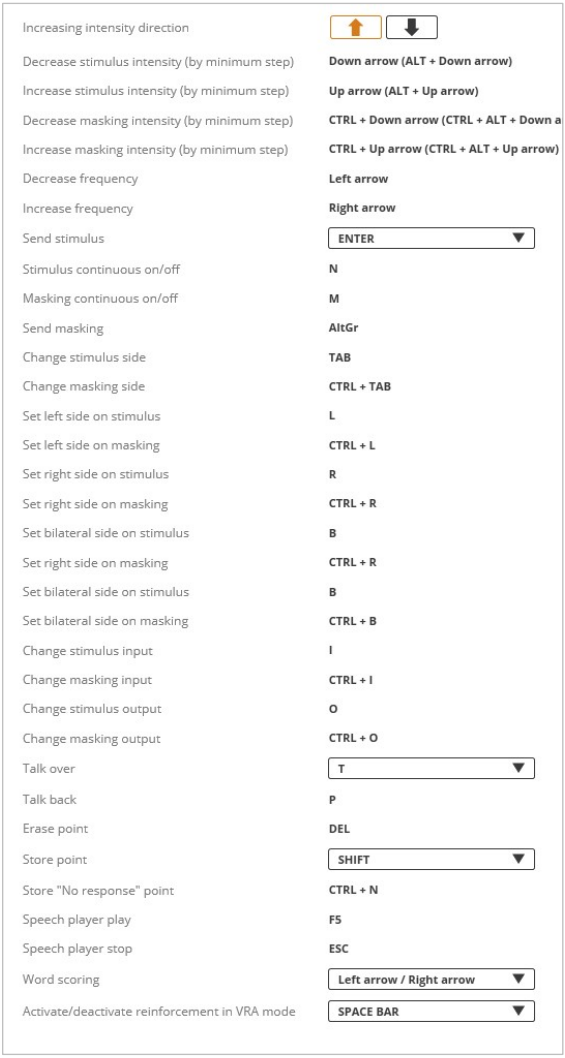
Pause after each word. *If the speech material is indexed, enabling this option allows the operator to suspend playback of the list automatically (*Pause) after each word.
Default setting: No.

Enable EQ filter for AC. Enables / disables the equalization of the speech audiometry output signal when conducting an air conduction test with TDH-39 or DD45 headphones.
Default setting: No.

Show standard curves. The operator can view a maximum of two normal hearing reference curves on the audiometry graph. The *Standard curve 1* and *Standard curve 2* sections allow the operator to perform actions on each of the two curves: enable viewing, set the name of the associated speech materials, and define the points (maximum of 5 points on each curve).

Shortcuts

Below are the shortcuts and their possible presets, which can be accessed from the *Audiology* → *Exam settings* menu, *Shortcuts* section.



Increasing intensity direction. Allows selecting the direction of increase in stimulus intensity. Choose between the "Up Arrow" and "Down Arrow" keys. Default key: "Up Arrow".

Send stimulus. Allows selecting the following keys to send the stimulus:

- "Space bar";
- "Enter";
- “Shift”.

Default key: "Enter".

Talk Over. Allows selecting the "T" or "F" keys for operator-patient communication (see section 2.3 for more details on the Talk Over function).
Default key: “T”.

Store point. Allows selecting the following keys to save the current threshold level:

- "Space bar";
- "Enter";
- “Shift”;
- “S”.

Default key: “Shift”.

Word scoring. Allows selecting the keys to increase the number of wrong/exact answers during speech audiometry:

- "Left Arrow" and "Right Arrow";
- “-” and “+”.

Default keys: "Left Arrow" and "Right Arrow".

Activate/deactivate reinforcement in VRA mode. Allows selecting the following keys to activate/deactivate reinforcement in VRA mode:

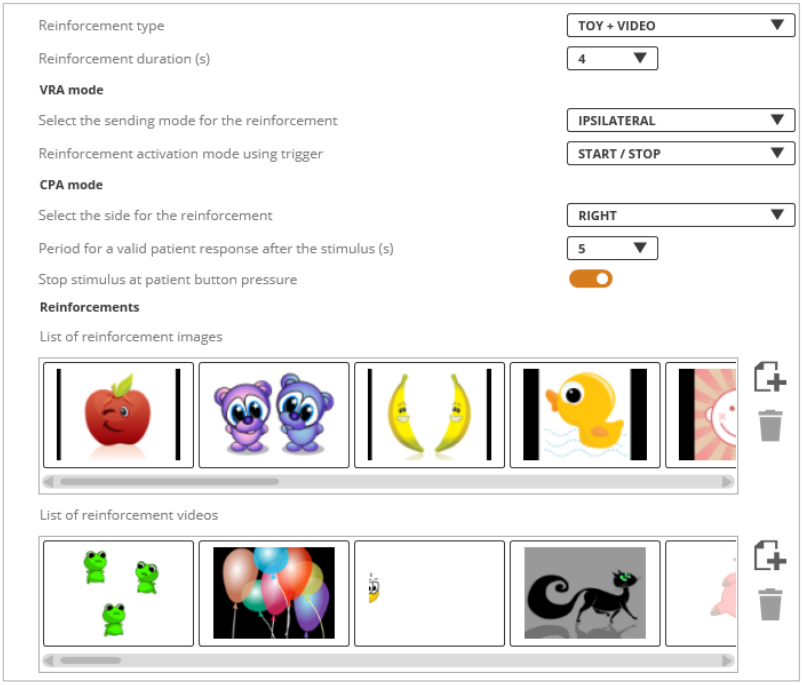
- "Space bar";
- "Enter";
- “Shift”;

Default key: “Space bar”.

2.4.5 Pediatric audiometry settings (*)

The devices available for conducting pediatric audiometry exams include the Piano Plus VRA (hybrid device) and the Cello (PC-based device). Listed below are the settings for pediatric audiometry, accessible from the menu *Audiology → Pediatric audiometry settings*.

General settings



*Reinforcement type **(*)***. Allows selecting the reinforcement type to send:

- Video
- Toy + Video
- Toy

Default type: Video.

Duration of reinforcement. Indicates the duration for which the reinforcement is activated, variable between 1 and 10 seconds (can always be cut short manually, whatever the setting).
Default duration: 5 s.

VRA mode

Select the sending mode for the reinforcement. Allows selecting the side used to send the reinforcement:

- *Ipsilateral.* The reinforcement is displayed on the side corresponding to the current side of the stimulus;

- *Selected display.* It is possible to select the side on which to display the reinforcement directly from the main pediatric audiometry window.

Default mode: *Ipsilateral.*

Reinforcement activation mode using trigger Allows setting how the button is used to activate the reinforcement:

- *Start/Stop*: the reinforcement is activated by pressing the button and stops automatically at the end of the interval set or by pressing the button again;
- *While pressing*: the reinforcement is only active when the button is held down.

Default mode: *Start/Stop.*

CPA mode

Select the side for video reinforcement. Allows selecting the side for the reinforcement between *Front*, *Left* and *Right*.
Default side: *Front*.

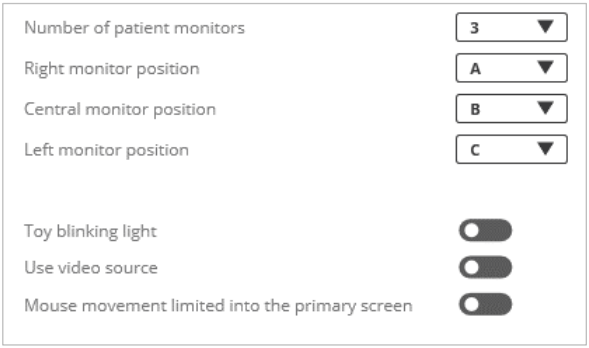
Period for a valid patient response after the stimulus (s)
Allows setting the time limit for a response on the part of the patient, at between 1 and 5 seconds from the end of the stimulus. If the patient presses the button when the tone is active or in the seconds following the end of the tone as set, the response is considered valid and reinforcement is automatically activated.
Default period: 3 s.

Stop stimulus at patient button pressure. If enabled, the stimulus stops when the patient presses the response button.
Default value: No.

Reinforcements

The two lists displayed at the bottom of the window contain images and clips that can be used as video reinforcements. An image or a clip can be removed from list by selecting the name and clicking the icon; similarly, new items can be added pressing the icon.
The formats supported for videos are *.mp4*, *.mpg*, *.mpeg*, widely available on the web. Images can be in *bmp*, *jpg* or *png* formats.

Advanced Settings



Number of patient monitors. Specifies the number of monitors used to send video reinforcements. The minimum setting is 1, the maximum setting 3.
Default value: 3.

Positioning of monitors. Associates each monitor with its position relative to the patient (left, right or front).

Toy blinking light. Enables / disables the blinking light of the toy reinforcement.
Default value: No.

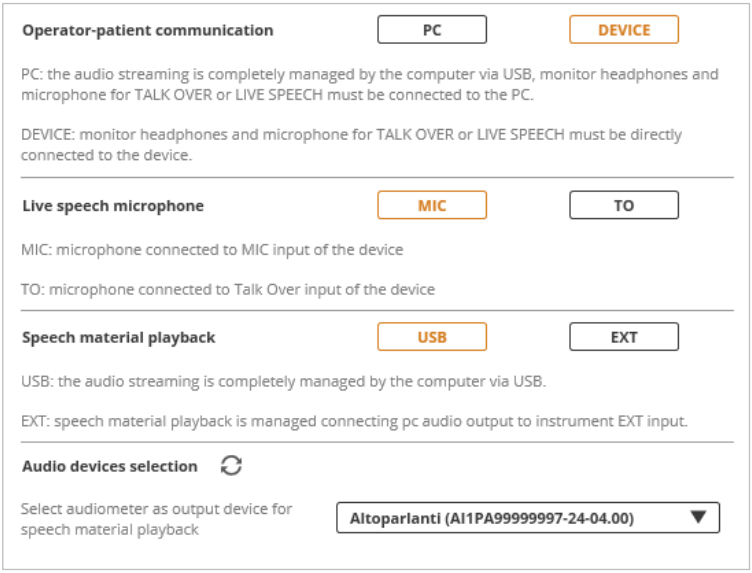
Use video source. Enables / disables the use of a video camera to picture the child in the VRA module. If enabled, the video source selected in the Maestro general settings will be used.
Default value: No.

Limit movement of mouse to primary monitor. Enables / disables the possibility of limiting the movement of the mouse to the primary monitor, i.e. that of the operator.
Default value: No.

2.4.6 Audio settings

Below are the settings for speech material playback and operator-patient communication, accessible from the *Audiology* → *Audio settings* menu.

Audio Settings



Operator-patient communication.

- *Audiometer*: microphone for talk over and live speech connected to the device's talk over and MIC input, monitor headphones connected to the device's monitor output.
- *PC* (*): operator microphone for talk over and live speech connected to the computer's audio input, monitor headset connected to the PC's audio output.

Default value: *Audiometer*.

Live speech microphone. Selectable if operator-patient communication is set to *Audiometer*.

- *MIC*: live speech microphone connected to the device's MIC input
- *TO*: live speech microphone connected to the device's TO input

Default value: *TO*.

Speech material playback.

- *USB* (*): speech material playback saved on PC via USB cable
- *EXT*: speech material playback saved on PC via audio cable connected to the PC's audio output and the audiometer's EXT input.

Default value: *USB* (if supported by the device). *USB* mode is set automatically when operator-patient communication is set to *PC*.

Audio devices selection. In this section it is possible to select the microphone and headphones for operator-patient communication (when set to *USB*) and the PC's audio output the cable is connected to for speech material playback (when set to *EXT*).

The *detect* function automatically identifies the audio output of the PC that the audio cable is connected to.

By enabling *control of the audio devices at the input of the speech exams* it is possible to activate an automatic control of the correct connection of the audio cable for the speech material playback (when set to *EXT*).

If the output currently selected for speech material playback matches the default output of the operating system, a warning message warns the patient that the computer sounds will be heard in the headphones. In this case, it is best to change the operating system's default output from the computer's audio settings panel.

Speech material

Using the *browse* it is possible to access the folder where the audio files of the speech material can be manually saved.

2.4.7 Device connection mode (*)

For devices that support the *Hytech Hybrid* function it is possible to choose how to connect to the computer by accessing the *Audiology → Device connection mode* menu:

- *Control*, device controlled by the computer;
- *Device > PC* device connected to the computer to transfer the exams.

Default mode: *Device > PC.*

2.4.8 Free field level adjustment

To perform the free field level adjustment, go to the *Audiology → Exams settings* menu, *Calibration → Free field level adjustment* section.

Adjusting the free field levels is an operation entirely managed by the Maestro software and can be performed with the PCE-MSM-4 sound level meter. No other model of sound level meter can be used in combination with Maestro.
The PCE-MSM-4 sound level meter is equipped with its own internal, non-rechargeable battery. When dead, the battery must be replaced. Alternatively, it can be powered by plugging it in.

The free field level adjustment procedure can be performed on all Inventis audiometers that allow for free field audiometric exams.
For audiometers that support the *Hytech Hybrid* function, the procedure can only be performed when the device is in control mode (see section 2.4.7).

It should be noted that, according to reference standards, calibration requires a Class 1 sound level meter. Using the PCE-MSM-4 class 2 sound level meter is referred to as free field REGULATION, not CALIBRATION. The software therefore does not allow the generation of a calibration report.

Connection with the sound level meter
To use the PCE-MSM 4 sound level meter, its drivers must first be installed. With the sound level meter disconnected, run the installation file "CP210xVCPInstaller_x64.exe" or "CP210xVCPInstaller_x86.exe" supplied with the Maestro software suite build and available in "Drivers\PCE-MSM 4 sound level meter\".

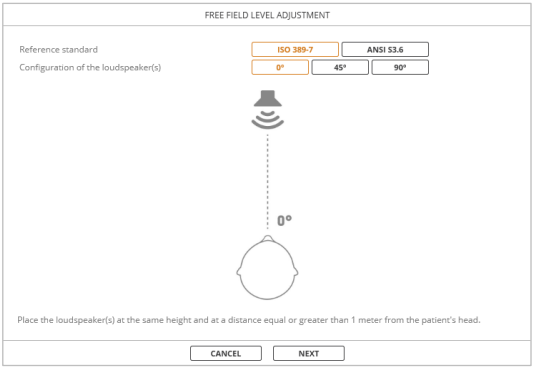
When installation is complete, connect the sound level meter to the computer using a USB cable. Start the Maestro software and click on the *Tonal* or *Speech* exam icon. Go to the *Audiology* menu and click on: *Calibration → Free field level adjustment* to start the adjustment procedure.

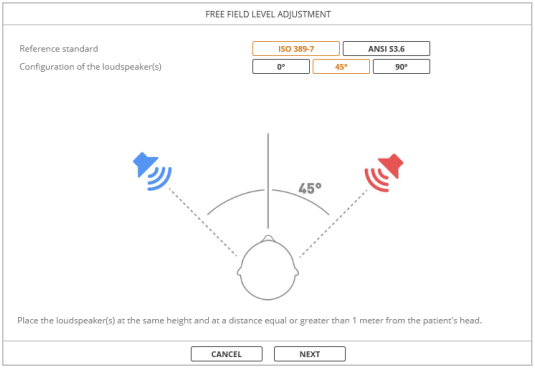
The user is invited to read the instructions provided by Maestro carefully so as not to compromise the outcome of the operation.

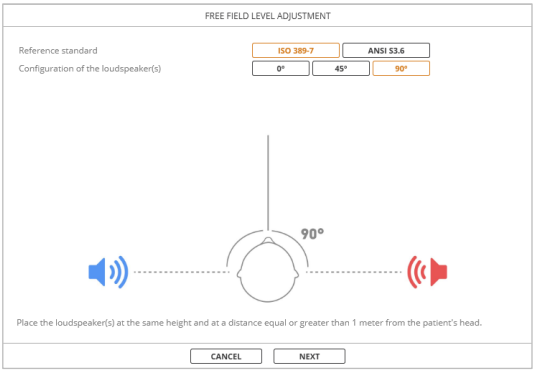
Proceed by turning on the sound level meter: Maestro performs an automatic search (AUTO) of the COM ports available for communication with the PCE-MSM 4.

Alternatively, the selection can be forced by manually choosing a COM port from those listed.
When the *Next* button is pressed Maestro starts communication with the sound level meter and configures it.

Configurations
Proceed by selecting the reference standard to be used for free field level adjustment (ISO 389-7 or ANSI S3.6) and the spatial configuration of the speakers that can be positioned in front of the patient (0°) or at an angle of 45° or 90° with respect to the patient's position.



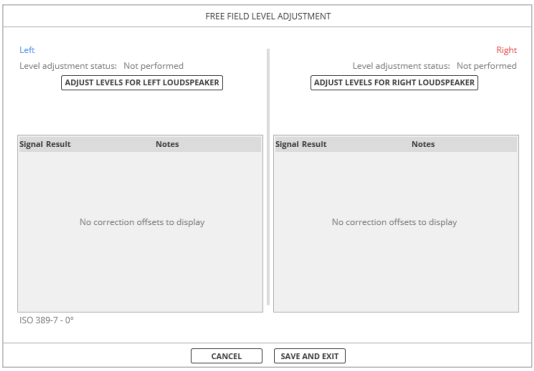




Adjustment procedure

Clicking *Next* opens a screen from which the actual adjustment procedure can be launched.

Proceed by clicking on *Adjust levels for left/right speaker*. The software will automatically adjust the level of all available signals for the device (pure tones, NBN, white noise and speech noise).



If the audiometer is equipped with a single integrated speaker, the level adjustment screen will have a single *Adjust speaker levels* button, without distinguishing between right and left sides.
To complete the procedure and save the adjustment offsets to the device's internal memory, press the *Save and Exit* button.

2.5 DEVICE INFORMATION

From the *Audiology* → *Device information* menu the user can access a window with the following information about the connected device:

- Device
- Serial number
- Device licenses (*)
- Service information.

In particular, it is possible to activate the licenses provided for the device purchased (such as, for instance, optional exams). Any activation of licenses will be memorized by the device. The window shows all the licenses available for the model of device connected to the computer. To activate a particular exam, click or tap the corresponding *Enable* button and enter the activation code. Users can obtain the code by contacting their dealer or technician, providing the serial number of the device on which the license is to be activated.

Additional service and service information is available and useful for technical support purposes.

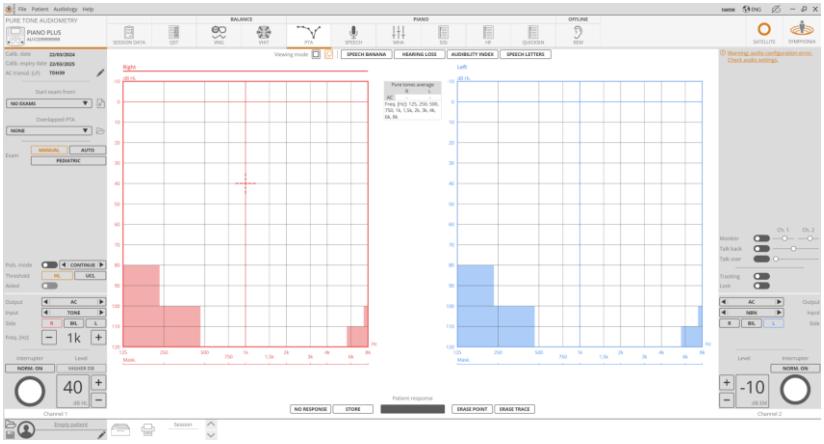
CHAPTER 3

Pure tone audiometry

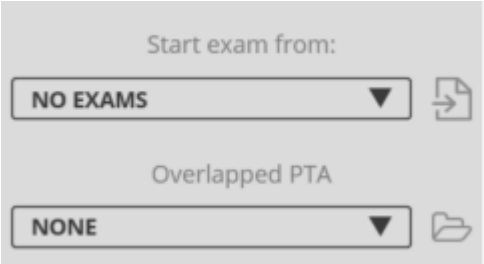
Pure tone audiometry is the standard hearing test: it allows the ENT specialist to determine the type and extent of hearing loss at different frequencies and consequently provides the basis for diagnosis and care of the patient.
To start the *pure tone audiometry* exam, click the button on the top bar of Maestro's main screen, as in the figure:

3.1 PURE TONE AUDIOMETRY WINDOW

Once the *pure tone audiometry exam* has been selected, the main window appears as illustrated below:

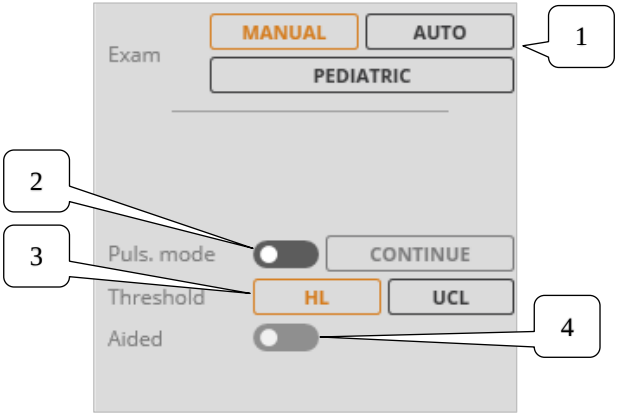


In addition to the common controls described in section *2.2*, the left part of the pure tonal audiometry screen has the following functions for selecting the exam mode:



Start exam from: The operator can decide to perform the examination starting from a pure tone audiometry. The operator can choose from any of the pure tone audiometries previously conducted and saved for that patient.

Overlapped PTA: The operator can select the pure tone audiometry to overlay on the examination being performed.



1. *Type of test*:
   - *Manual*;
   - *Auto*: Allows automatic audiometry to be performed (see section 3.2);
   - *Pediatric* (*): Allows video-VRA pediatric audiometry to be performed (see section 3.3).

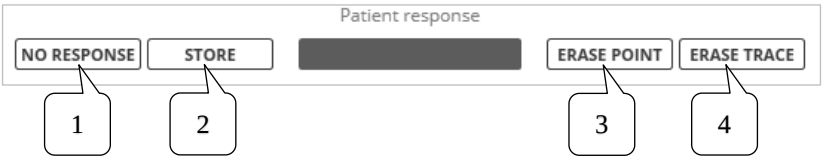
2. *Pulsed mode*:
   - *Continuous*;
   - *Single pulse* with programmable duration (see section 2.4.4);
   - *Pulsed* at a rate of 0.5 Hz, 1 Hz, 2 Hz or set by the operator.

   Consult the technical specifications of the devices for information on the pulse modes supported.

3. *Threshold*:
   - *HL*: hearing threshold;
   - *UCL*: sound intensity at which stimuli become unbearable to the patient (Uncomfortable Level).

4. *Aided*. When performing the exam in the open field and the patient is wearing a hearing aid, the option can be activated to save the track points as acquired with a hearing aid.

The controls for saving thresholds during audiometry, located in the middle of the screen below the audiograms, have the following functions:



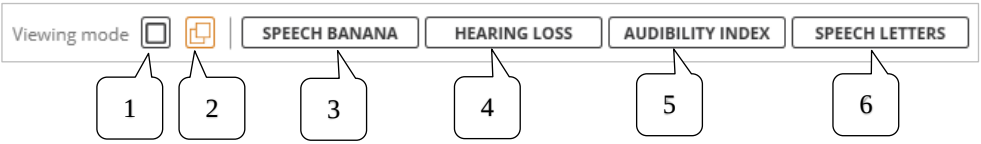
1. *Not heard.* If the patient has not responded, the threshold level can be marked with a different symbol: an arrow pointing downwards is added at the bottom of the symbol.

2. *Store.* Memorizes the threshold at each frequency. The same operation can also be performed via the keyboard, pressing the preset key (see section General settings). If the *Automatic frequency skip* setting is selected, after saving a threshold the frequency is automatically set to the next test frequency (see section 2.4.4).

3. *Del. Point*. Removes the symbol on the audiogram corresponding to the selected side, transducer, condition (*Aided* or *Unaided*) and frequency. The operator can also remove the current data item by pressing "DEL" on the keyboard.

4. *Del. Trace.* Removes the entire current trace.

Above the audiograms there are audiogram display options, as in the figure:



Display mode. It is possible to select two audiogram viewing modes: *1. Single graph*. The left and right audiograms are superimposed; *2. Separate graphs*. There are audiograms for both the right and left side.

Audiogram masks. The following masks to be displayed as the background of the audiogram can be selected:

3. *Speech banana;*
4. *Hearing loss*: a gray scale corresponding to the level of hearing loss, with variations at 15 dB, 25 dB, 40 dB, 55 dB, 70 dB and 90 dB (JG Clark (1981), *Use and abuse of hearing loss classification*. ASHA; 23: 493-500);
5. *Audibility index*: index representative of the ability to understand spoken words (H. Gustav Mueller and Mead C. Killion (1990). *"An easy method for calculating the Articulation Index"*. *The Hearing Journal*, vol. 43, no. 9);
6. *Phonemes* (referred to the English language).

Audiogram. The highlighted areas of the audiogram correspond to frequency / intensity values not obtainable with the selected transducer. Left-clicking on the audiogram, frequency and intensity of the stimulus channel are set at the value corresponding to the point selected with the mouse pointer.

Pure Tone Average Display. When the corresponding option is enabled (see section 2.5.4), the pure tone average can be displayed in a table format:

Pure tones average		
	R	L
AC	-	-
Freq. [Hz]: 125, 250, 500, 750, 1k, 1,5k, 2k, 3k, 4k, 6k, 8k		

The table shows values for both sides, with each row indicating the specific output. The outputs considered include those currently under examination and/or those for which a trace has been saved. Possible values are:

- A number representing the average threshold calculated from the data acquired across all selected frequencies (see section 2.5.4).
- A "–" if no data points have been saved for that specific side/output combination.
- A "–*" if data points have been saved, but not for all frequencies selected for the calculation.

Audiometry comparison. A pure tone audiometry can be superimposed on the pure tone audiometry in progress, or on pure tone tests saved previously. This option can be activated by selecting the menu item *Audiology → Overlap pure tone audiometry* and identifying the pure tone audiometry to superimpose, or by dragging the desired audiometry from the exam bar. In the left side bar of the window, a reference to the superimposed exam (date and time of the exam) is displayed. Clicking on it opens its display window. The overlapped pure tone audiometry is also shown on the printout of the test.

Pure tone audiometry display. Each exam can be reopened in a screen to display the results. Not only does the control screen show the display modes indicated in the control window, it can also be made to show:

- The classification of audiometries, *Merluzzi* or *MPB* (Enrico Pira, Davide Bosio, Franca Merluzzi: *La prevenzione dei danni uditivi da rumore in ambiente di lavoro*. Guidelines proposed by the Italian Society of Occupational Medicine and Industrial Hygiene);
- The average of the thresholds (PTA): it is possible to set the frequencies to be used for the calculation of the average, by default 500 Hz, 1000 Hz and 2000 Hz.

For more information about tonal audiometry acquisition settings, see section 2.4.4.

3.2 AUTOMATIC AUDIOMETRY

The automatic pure tone audiometry allows identifying the auditory threshold at different frequencies by means of an automatic procedure. For each of the selected test frequencies, the patient must press the response button whenever he or she perceives the stimulus, the stimulus presentation level is automatically adjusted accordingly until the minimum stimulus level that the patient is able to hear is identified.
The automatic procedure starts by testing the 1 kHz frequency, proceeds in ascending order with frequencies above 1 kHz, then in descending order with frequencies below 1 kHz and ends by testing the 1 kHz frequency again.

The operation of the three automatic audiometry modes available in Maestro is described below:

Hughson-Westlake: the threshold is identified as the level at which at least 2 positive responses are obtained from the patient out of 3 repetitions of the same stimulus. The method of determining the threshold involves an increase in the stimulus level of 5 dB in the case of a negative patient response and a reduction of 10 dB in the case of a positive response.
For this test *Familiarization* can also be enabled to train the patient on the threshold determination procedure. During familiarization, the responses given by the patient are not recorded and at the end of the familiarization the threshold test begins automatically.

Quick Search: the threshold is identified as the minimum level at which the patient's first positive response is obtained. The threshold determination method provides for a 5 dB increase in the stimulus level in case of a negative patient response. In the event of a positive response, the search continues on to the next frequency starting from the minimum level set.

Fixed intensity: rapid screening test that identifies the same fixed level for each test frequency as heard/not heard depending on the patient's positive/negative response.

For more information about automatic audiometry settings, see section 2.4.4.

To select the side from which to start the test, simply click on the desired graph from Maestro's pure tone audiometry window or the RH or LH *Side* button from the channel 1 control panel.
To begin the test, press the *Start* button. The test finishes automatically once all the enabled frequencies have been analyzed for both ears. The test can be terminated by pressing the *End* button.
The *Suspend* button can also be used to temporarily interrupt the test. The test will remain suspended until the *Resume* button is pressed.

3.3 PEDIATRIC AUDIOMETRY

The devices available for conducting pediatric audiometry exams include the Piano Plus VRA (hybrid device) and the Cello (PC-based device). Pediatric audiometry involves the use of visual stimuli, reinforcements, consisting in practice of:

- up to three LCD displays (one in front and one on either side of the patient), on which images or video clips are shown during the test;
- up to three physical toys (one in front and one on either side of the patient), whose light is turned on during the test.

The test can be conducted adopting the two conventional modes, namely VRA (*Visual Reinforcement Audiometry*) and CPA (*Conditioned Play Audiometry*), described below.

3.3.1 Conducting the test

To conduct a pediatric audiometry test, select the relevant type of pure tone audiometry, *Pediatric*.
The controls used in conducting the test are the same as for standard pure tone audiometry, except for the selection of CPA or VRA mode and the dedicated visual reinforcements panel.

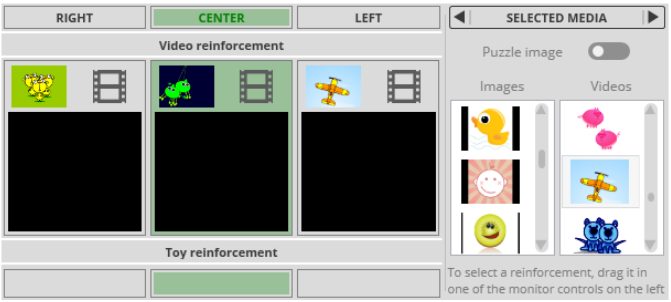
Exam modes

The operator can switch from one mode to the other simply by selecting the CPA button or the VRA button. The only difference between the two tests is the manner of presenting the visual reinforcement: in VRA mode it is the operator who decides when to activate the reinforcement, whereas in CPA mode the reinforcement is activated automatically when the patient presses the response button following presentation of a stimulus.

In VRA mode, the activation and deactivation of the reinforcement is controlled via the patient button used in traditional audiometry. The same operation can also be performed via the keyboard, pressing the preset key (see section General settings). However, the button used by the patient in CPA mode corresponds to the auxiliary response button.

Managing video/toy reinforcements

The central part of the screen, illustrated below, is dedicated to the management panel for video and/or toy reinforcement.



Video reinforcements can be sent to one, two or three displays and consist of images or video clips. The software is supplied with a series of pre-installed images and videos. To add others, see section 2.4.5.
There are three ways to send the video reinforcement:

- *Random image/video*: random images and animations;
- *Selected Media*: the same image or video is always used.

Toy reinforcements can be sent to one side at a time and consist of lighting up the toy.

The pediatric reinforcement panel is organized as follows:

- The upper part of the panel displays the side.
- The middle part of the panel is for the video reinforcement and displays a preview of the image/video currently displayed on the patient monitors.
- The lower part of the panel is for the toy reinforcement and displays a label ACTIVE when the toy reinforcement is being sent.

The column of the side that appears highlighted is the one where the reinforcement will be sent and depends on the choice made in the pediatric audiometry settings window (see section 2.4.5).

In the case of a CPA exam, if the video reinforcement is an image it can be viewed one piece at a time like a puzzle by pressing the *Puzzle image* button.

The right part of the panel includes lists of images and videos that can be used as video reinforcement. To use them drag and drop the image or video onto

one of the monitors in the central part of the panel. If the *Random image* or *Random video* option is selected, the list of rewards will be disabled, and images or videos cannot be selected individually.

Camera

The left part of the panel shows the live feed from the webcam trained on the kids, if the device is connected and configured (see section 2.4.5). The camera makes it possible to take pictures of the patient, which can then be used as reinforcements projected onto the displays.

For more information about pediatric audiometry video-VRA acquisition settings, see section 2.4.4.

CHAPTER 4

High frequency pure tone audiometry

High frequency pure tone audiometry is used to identify the hearing threshold at frequency values from 8 kHz up to 20 kHz (16 kHz in free field).
Analysis conducted in this frequency range allows the identification of hearing damage caused by exposure to noise, or by treatments requiring the use of ototoxic drugs. In effect, such impairments tend to occur earlier at these frequencies than at traditional frequencies.
To start the high frequency audiometry exam, click the button on the top bar of Maestro's main screen, as in the figure:

4.1 THE HIGH FREQUENCY AUDIOMETRY WINDOW

Once the *high frequency audiometry* exam has been selected, the main window appears as illustrated below:

The controls for the exam are the same as for pure tone audiometry, except for the audiograms, here related to the high frequency range 8 kHz - 16 kHz.

For more information about the high-frequency audiometry acquisition settings see 2.4.4.

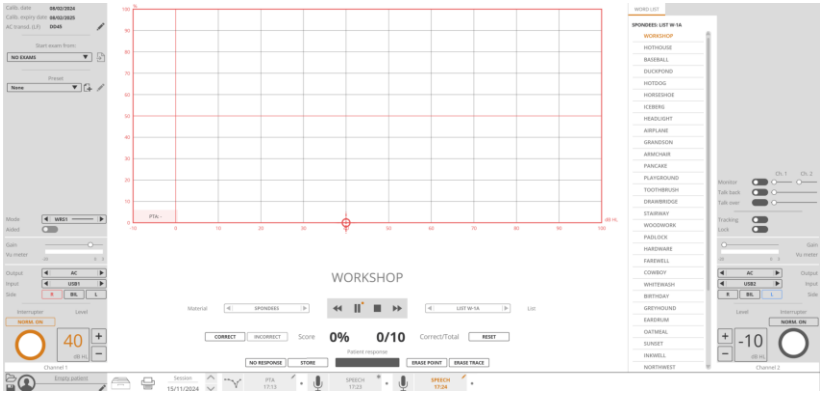
CHAPTER 5

Speech audiometry

By conducting a speech audiometry test the patient is presented with a succession of standardized speech stimuli, typically single syllables, words or phrases. The purpose of the test is to measure certain aspects of the patient's hearing capability, in particular verbal intelligibility, i.e. the ability to recognize input signals as sound stimuli that have meaning.
To start the speech audiometry exam, click the button on the top bar of Maestro's main screen, as in the figure:

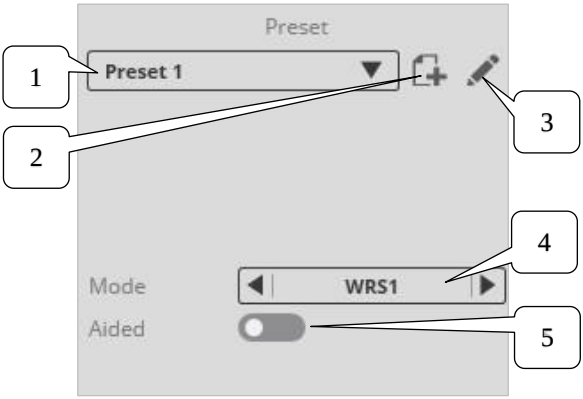
5.1 SPEECH AUDIOMETRY WINDOW

Once the *Speech audiometry* exam has been selected, the main screen appears as illustrated below:



Apart from the common controls described in section *2.2*, the speech audiometry screen presents a number of additional functions described under the following sections.

The following functions for the configuration and selection of the examination mode are in the left part of the window:



1. *Select configuration.* Using a dropdown menu it is possible to select a configuration from those available to acquire an exam according to preset parameters.
2. *Add new preset.* Allows adding a new preset after clicking on the icon indicated.
3. *Edit current preset.* Allows changing the parameters of the current preset after clicking on the icon indicated.

For more information about speech audiometry presets, see section 2.4.2.

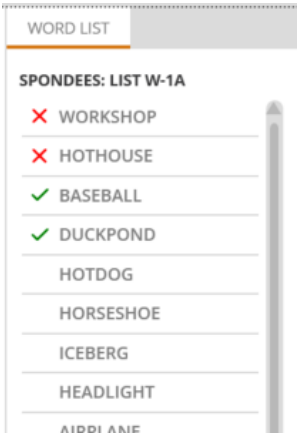
4. *Exam modes.* Allows selection of the type of speech audiometry, from Word Recognition Score (WRS), Speech Reception Threshold (SRT), Most Comfortable Level (MCL), and Uncomfortable Level (UCL). In WRS mode, the system can acquire and store data relative to three different speech signals when selecting modes WRS1, WRS2 and WRS3, respectively. Also, enabling the relative option from the settings menu, accessible from *Audiology* → *Exams settings*, the operator can activate the "*WRS single point*" function: in this case the WRS modes allow the system to save one percentage only of correct responses for a single value of intensity of the stimulus signal. In this configuration WRS1, WRS2 and WRS3 data will be presented in a table without the aid of the audiogram.
5. *Aided.* When performing the exam in the open field and the patient is wearing a hearing aid, the option can be activated to save the track points as acquired with a hearing aid.

Binaural mode. If *WRS single point* mode has been enabled and the current outputs are air conduction or free field, the *Binaural* button appears in the right part of the speech audiometry screen and can be used to select the same input for both channels. In this test mode the stimulus can be presented to the right ear and the left ear simultaneously and at different intensities.

The speech material can be presented directly by the operator over a microphone, recorded on a CD or a cassette tape and transmitted from a suitable player connected to the EXT input of the audiometer, or stored on the computer and transmitted to the device by way of a USB* cable or via cables connected to the EXT inputs.

In the central section of the screen there are controls for speech material playback, and on the side the input gain adjustment of both channels (for more information, see section 6).

On the right side, there is a panel that allows the operator to view the words from the currently selected list (if indexed). The panel can be opened or closed by clicking on the WORD LIST tab.



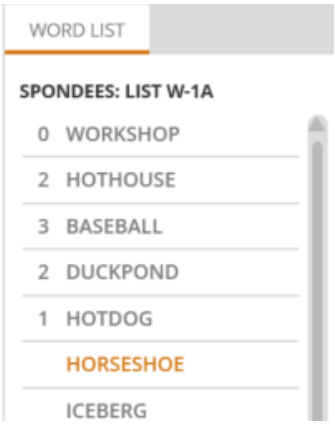
The section on determining the percentage of correct responses according to the selected mode is described below (for more information see section 2.4.4):

Percentage of correct responses. Using the *Correct* and *Incorrect* keys it is possible to define the percentage of correct responses given by the patient, depending on the selected word scoring mode:

- *Fixed words number*. The number of words sent to the patient is fixed, and the number of words correctly identified by the patient is increased with the Correct button. The Incorrect button decreases the number of correct responses by one, and is used only in the event of a response being identified wrongly as correct.
- *Variable words number*. The number of words sent to the patient is determined during the execution of the exam, the *Correct* button increases both the total number of words and the number of correct responses, while the *Incorrect* button only increases the total number of words.

The percentage of correct answers can be calculated not only using the *Correct/Incorrect* buttons, but also by way of the computer keyboard, pressing the allocated keys (see section 2.4.4).

Phoneme score. Allows the calculation of the percentage of phonemes correctly identified for each word using the "0," "1," "2," and "3" buttons displayed in the panel. In the word list panel, the number of selected phonemes is shown next to each word/phrase:



It is also possible to calculate the percentage of correct answers using the keyboard, pressing the preset keys (see section 2.4.4).
The controls for saving thresholds are located in the middle of the screen below the audiograms and have the following functions:

Reset. The *Reset* button allows resetting the currently calculated percentage to zero.

Save. Using the *Store* button, the percentage of correct answers given by the patient for each dB value of the stimulus, or the threshold level in SRT/MCL/UCL mode, can be memorized on the graph. The score and/or threshold can also be stored using the relative preset key on the computer keyboard (see section 2.4.4).

Delete point. To delete a saved point from the graph, select the specific dB value and press the *Del. Point* button or the "DEL" keyboard key (for more information see section 2.4.4).

Delete Trace. Allows eliminating all saved points associated with the current trace.
To eliminate threshold values stored in SRT/MCL/UCL modes, select the mode in question and remove using the *Delete Point* or *Delete Trace* button.

Pure Tone Average Display

If tonal audiometry has previously been performed and the "Pure Tone Average" option (section 2.5.4) is enabled, the calculated data is displayed on the speech audiometry acquisition screen.
The indication is shown graphically in the bottom-left corner (as “–” if the average has not been calculated).

In tabular format, the information is displayed beneath the label indicating the side under examination:

In both cases, the value corresponding to the calculation performed for the specific side/output combination currently set for the examination is displayed.

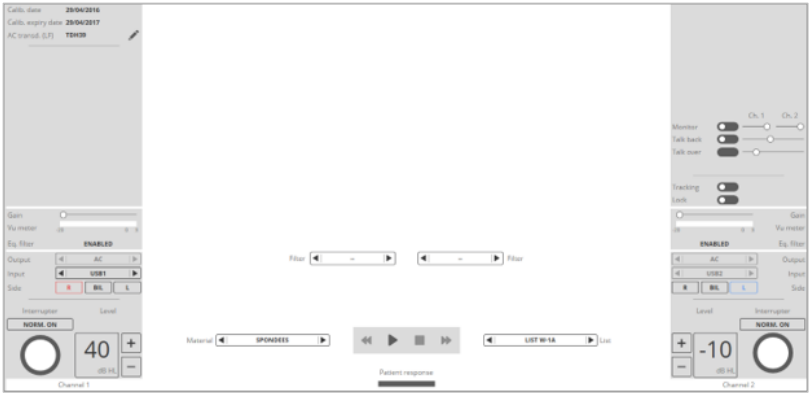
CHAPTER 6

Master Hearing Aid

The Master Hearing Aid (MHA) test is used to assist the selection of a hearing aid for patients with impaired hearing. With the MHA test, the audiometer can simulate the use of a hearing aid by filtering the speech signal sent to the patient; in this way it is possible to verify and quantify any improvement in speech recognition attributable to the introduction of a hearing aid.
To start the MHA test, click the button on the top bar of Maestro's main screen, as in the figure:

6.1 THE MHA TEST WINDOW

Once the MHA exam has been selected, the main screen appears as illustrated below:



In addition to the controls described under *CHAPTER 5 - Speech* audiometry, the central part of the MHA test window shows the filters active on each channel. By pressing in the corresponding area it is possible to choose the filter type, which can be activated independently for each channel. These are high-pass type filters with amplification of 6 dB, 12 dB, 18 dB and 24 dB per octave.
The MHA test does not include any save or store function, consequently there is no printout available.

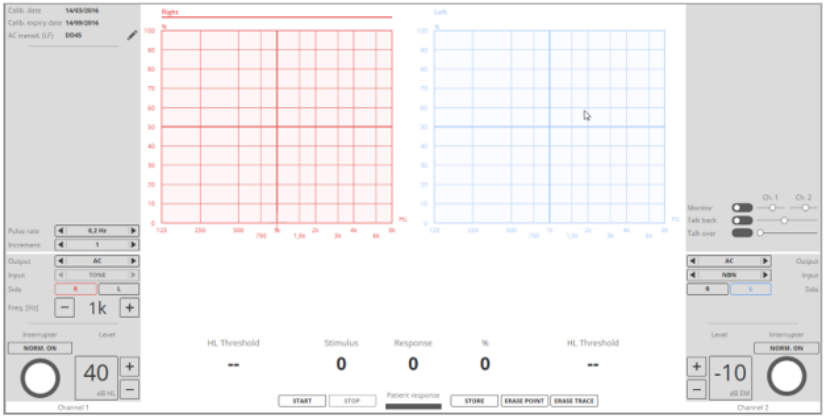
CHAPTER 7

SISI (Jerger)

The Short Increment Sensitivity Index (SISI) test assesses the ability of the ear to identify brief variations of intensity in a continuous pure tone.
To start the SISI exam, click the button on the top bar of Maestro's main screen, as in the figure:

7.1 THE SISI TEST WINDOW

Once the SISI exam has been selected, the main screen appears as illustrated below:



The panel on the left contains the common controls, as well as controls allowing the operator to change the amplitude of the increments, and the frequency with which the increments are presented:

Pulse rate. Allows selecting the presentation frequency of the increments between 0.2 Hz, 0.5 Hz and Random (random value including 0.2 Hz and 0.5 Hz that varies with each increment).

Increment. Allows selecting the amplitude of the increments between 0.2, 0.4, 0.6, 0.8, 1, 1.5, 2, 3, 4 and 5 dB. The increments of 3, 4, 5 dB are used for the initial familiarization phase of the exam. For more information on the amplitude of increments permissible for different devices, refer to the technical specifications of the particular audiometer.

The area below the exam graphics contains information on the conduct of the examination:

The *Stimulus* specifies the number of increments presented, the *Response* specifies the number of correct responses of the subject to the stimuli and *%* specifies the percentage value of responses out of the total number of stimuli presented.

If a pure tone audiometry is associated with the SISI examination, the left and right threshold levels determined for the current frequency and output are visible. See section 0 for more information on the association of pure tone audiometry with another exam.

Press the *Start* button to start the test: 20 increments are presented to the patient and the patient button presses are recorded, which are considered valid only if they occur within one second of the increment's presentation. It is possible to stop the exam at any time by pressing the *Stop* button.

The functions of the buttons for saving and deleting thresholds are described below:

Save. The *Save* button stores the percentage of increments correctly identified by the patient for each test frequency. The same operation can also be performed via the keyboard, pressing the preset key (see section General settings).

Delete point. To delete a saved point from the graph, select the specific dB value and press the *Del. Point* button or the "DEL" keyboard key (for more information see section 2.4.4).

Delete Trace. Allows eliminating all saved points associated with the current trace.

CHAPTER 8

QuickSIN™

The difficulty of understanding speech against background noise is a very common source of discomfort in patients affected by hearing loss. The measurement of SNR loss (reduction of signal to noise ratio) is fundamentally important, given that the ability to comprehend speech in noisy conditions cannot easily be assessed on the sole basis of a pure tone audiometry test (Killion & Niquette, 2000).
The QuickSIN™ test allows an assessment of SNR loss using phrases that are presented to the patient together with background noise consisting of four voices all speaking at the same time (*4-talker babble noise*). The lists of QuickSIN™ speech material consist in six phrases, each containing 5 key words, which are presented to the patient with a signal-to-noise ratio of 25, 20, 15, 10, 5 and 0 respectively. SNR loss is assessed by allocating a score for each one of the six phrases presented, calculated by attributing one point for each key word correctly identified.

For more information regarding the exam and interpretation of results, please refer to the QuickSIN™ Speech-in-Noise Test manual.

To start the QuickSIN™ exam, click the button on the top bar of Maestro's main screen, as in the figure:

8.1 THE QUICKSIN™ TEST WINDOW

Once the QuickSIN™ exam has been selected, the main screen appears as illustrated below:

When conducting the QuickSIN™ test, in addition to the common controls for the two channels, the operator can use the control panel for the reproduction of speech material (described in section 0). The specific functions of the QuickSIN™ test are described below.

Playback of QuickSIN™ material Using the relative buttons of the section providing control over reproduction of the speech material, the operator can select the specific QuickSIN™ material to utilize. For standard *split-track* lists with phrases and babble noise recorded on two separate channels, it is possible to set the exam mode by selecting it in the left column of the window:

- *Subjective (SUBJ)*: the level of the stimulus signal and that of the background noise can both be set manually. It is not possible to calculate SNR loss in subjective mode;
- *Objective (OBJ)*: once the level of the stimulus signal has been set, the level of the background noise is set automatically, so that the SNR will be reduced progressively from 25 dB to 0 dB. It is not possible to calculate SNR loss in objective mode.

Having selected the list in the QuickSIN™ test window, the six phrases it contains will be displayed on the screen, with the key words highlighted in uppercase.
Pressing the *Play/Pause* button starts the playback of the list: the phrase currently being presented is displayed on the screen. When playing the list, it

is possible to toggle between one sentence and the next or the previous one using the *Forward/Rewind* buttons.

Saving data. At the end of each phrase, playback of the list is paused automatically, and the operator can set the relative score using the “0”, “1”, “2”, “3”, “4” and “5” buttons. Pressing *Play*, the next phrase of the list will be presented to the patient.

At the end of the test, if a score has been given for each of the six phrases, the operator can calculate the SNR loss and save the value by pressing *Store*.

Output selection. The lists of QuickSIN™ material can be presented to the patient through headphones (AC) or in free field (FF).

Gain adjustment. Before starting the QuickSIN™ test, the level of the signals must be adjusted using the 1-kHz calibration tone, which is included in the folder of QuickSIN™ material.
To set the level by way of a VU-meter, see section 2.3.2.

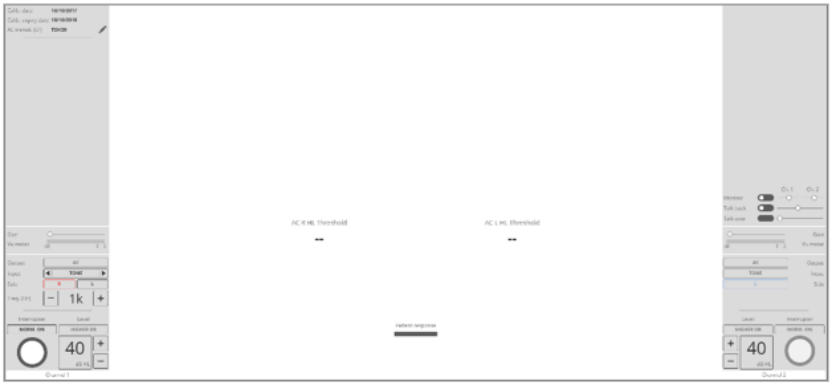
CHAPTER 9

Stenger

The Stenger test allows determining the truthfulness of the hearing threshold identified based on the Stenger effect: if tones of the same frequency but different intensities are presented to the two ears of a patient simultaneously, only the stimulus in the ear that receives the tone of higher intensity will be heard.
The Stenger test can be conducted using pure tone signals or speech material.
To start the *Stenger* test, click the button on the top bar of Maestro's main screen, as in the figure:

9.1 THE STENGER TEST WINDOW

Once the *Stenger* test has been selected, the main screen appears as illustrated below:



Selecting a pure *tone* or a *warble* signal as the input, the central area of the exam window is used to display the threshold levels identified for the right ear and the left ear during the course of the pure tone audiometry test, for the frequency and output currently selected, audiometry associated with the Stenger test.
To conduct the test using speech material, the operator simply selects the input from EXT1/EXT2, INT1/INT2 and USB1/USB2 (if the material presented to the patient is pre-recorded) or MIC/MIC PC (if the test is to be conducted in *live speech* mode), depending on what inputs are supported by the device and on the audio mode selected (see section 2.4.6). In this case, the central part of the exam window displays the controls for the speech material playback and in the side bars the controls for the adjustment of the *VU-meters* (see section 6).
The stimulus is always switched on and off synchronously for the two channels, so that the signal can be presented to the two ears simultaneously.
The *Stenger* test does not include any save or store function, consequently there is no printout available.

CHAPTER 10

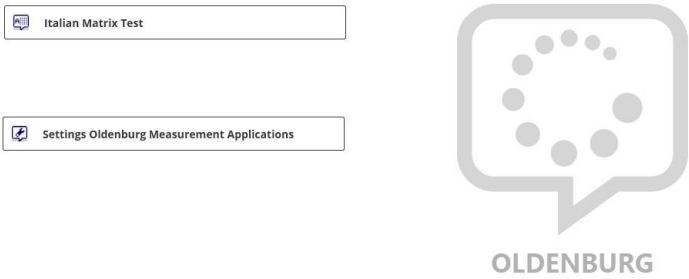
Oldenburg Matrix Test

The Oldenburg Matrix Test is a speech audiometry exam developed by the German university of the same name.
It consists of phrases in a certain language, made up of five words, with stationary noise in the background. These words are randomly selected from a matrix that contains 10 alternatives for each of the possible elements of the sentence, making it virtually impossible for the patient to learn the sentences and thus skew the test result when it is repeated.
The patients are asked to repeat the words understood: depending on whether they have heard more or less than half of the words making up the sentence just presented, the level of the next stimulus will be decreased (in the former case) or increased (in the latter).
The result of the test is the SNR value (difference in dB between the level of the stimulus and that of the masking) that allows the patient to understand 50% of the words of a sentence, also called SRT (Speech Recognition Threshold). This threshold can be changed by the user, and it is also possible to select whether to keep the noise level fixed and change the stimulus level or vice versa.

The Oldenburg Test is implemented entirely in an external program (OMA, Oldenburg Measurement Applications) that must be installed in addition to Maestro, along with the modules of the desired matrix exams: Maestro allows launching this program and storing the results within its or Noah's database.
To start the Oldenburg test, OMA must be installed on the PC (either before or after Maestro) and an AUD-licensed Trumpet must be connected. Then click the button on the top bar of Maestro's main screen, as in the figure:

10.1 THE OLDENBURG TEST WINDOW

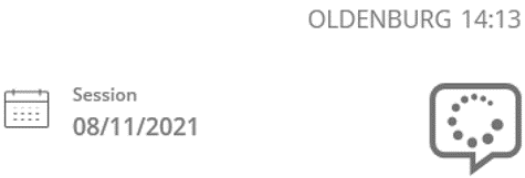
Once the *Oldenburg* test has been selected, the main screen appears as illustrated below:



On the left there is a list of buttons used to launch the Oldenburg tests installed together with the main program. The last button corresponds to the settings of the external program, used to change the language, the device settings and the calibration. These settings, including calibration, are stored by the external software and not in Maestro or the device. See the electronic PDF manuals installed by the Oldenburg program for more information.

When an Oldenburg test is clicked, Maestro launches the external application and waits. To then regain control of Maestro it is necessary to close the Oldenburg application. For information on the execution of the exam, refer to the electronic PDF manuals installed by the various Oldenburg tests.

If the exam was saved before the closure of the Oldenburg program, it will be displayed in the Maestro archive with the current date and session, and you can save it (saving the patient) or delete it:



Clicking on an Oldenburg exam saved in Maestro reopens the external application, where you can view the results and print them, but not edit them. Attention: it is not possible to print the result of an Oldenburg exam directly from Maestro, it is necessary to first open it in the external application by clicking on it.

CHAPTER 11

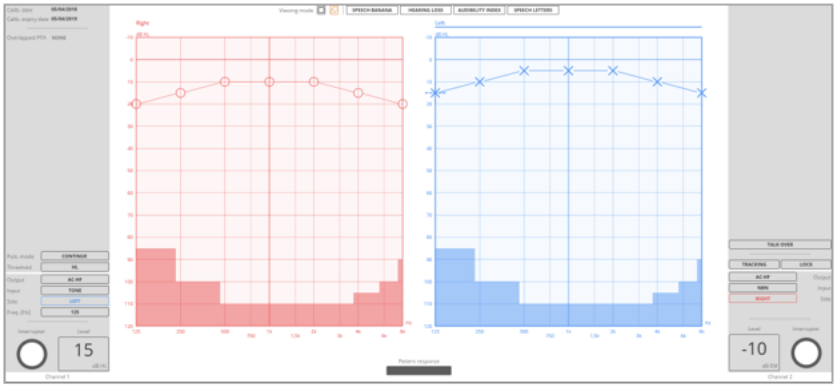
The live view function (*)

The *live view* function allows viewing the exam being carried out on the device on the computer screen and to transfer the completed exams to Maestro. This facility is available only for pure tone audiometry, pediatric audiometry, speech audiometry, tympanometry and acoustic reflex tests.
From the live function window it is also possible to transfer the exams performed with the device to Maestro's archive.
To access the *live view* function, click the button on the top bar of Maestro's main screen, as in the figure:

Make sure that you have selected the *Device* → *PC* device connection mode (see paragraph 2.4).

11.1 THE LIVE FUNCTION WINDOW

Once the *live view* mode has been selected, the main screen appears as illustrated below:



The window shows:

- the status of channel 1 (level, side, input, output and frequency);
- the status of channel 2 (level, side, input, output);
- the status of the response button: orange LED lights up when the patient presses the button.
- the presentation mode of the stimulus signal (continuous or pulsed);
- the current threshold (HL or UCL);
- the audiogram in progress.

Display mode. The operator can decide whether to display the right and left side audiograms superimposed or separately, clicking on the relative button positioned above the audiogram. It is also possible to add a mask to the background of the audiogram, which can be:

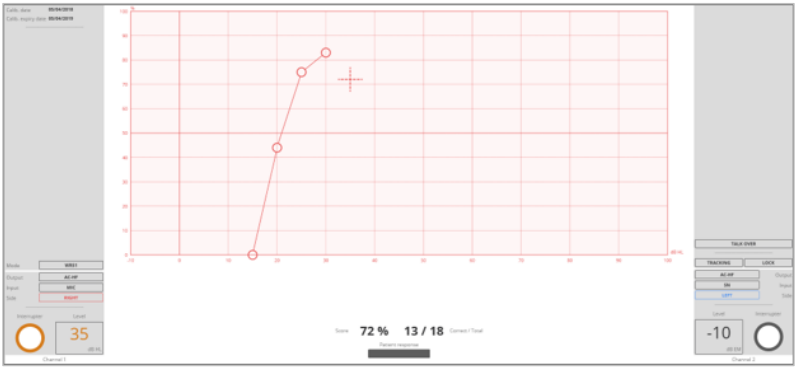
- *Speech banana*;
- *Hearing loss*: a gray scale corresponding to the level of hearing loss, with variations at 15 dB, 25 dB, 40 dB, 55 dB, 70 dB and 90 dB (JG Clark (1981), *Use and abuse of hearing loss classification*. ASHA; 23: 493-500);
- *Audibility index*: index representative of the ability to understand spoken words (H. Gustav Mueller and Mead C. Killion (1990). *"An easy method for calculating the Articulation Index"*. *The Hearing Journal*, vol. 43, no. 9);
- *Phonemes* (referred to the English language).

Audiogram. The highlighted areas of the audiogram correspond to frequency / intensity values not obtainable with the selected transducer.

A previous exam can be superimposed on the current audiogram. This option can be activated by selecting the menu item *Audiology* → *Overlap pure tone audiometry* and identifying the pure tone audiometry to superimpose, or by dragging the desired audiometry from the *session data management bar* in the main area of the graphic interface (see the *Maestro - General Functions* Product Insight).

In the case of pediatric audiometry, the screen shows the usual controls used for pure tone audiometry, plus the visual reinforcements panel. For more details, see under the section *Video-VRA pediatric audiometry*.

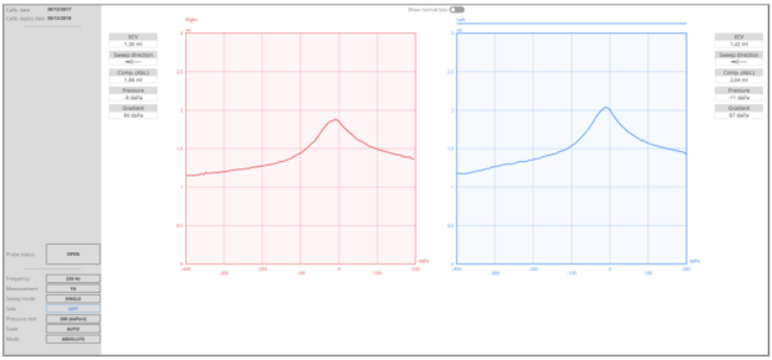
The following illustration shows the *live view* window for a speech audiometry exam.



In this instance, the window shows:

- the status of channel 1 (level, side, input, output and frequency);
- the status of channel 2 (level, side, input, output);
- the status of the response button: orange LED lights up when the patient presses the button.
- the test mode (WRS, SRT, MCL, UCL)
- if the selected input is the internal flash memory, the selected material, the name of the current word list and the last word played back;
- the articulation function, which also shows the current percentage of correct answers;
- the speech audiogram / table of thresholds.

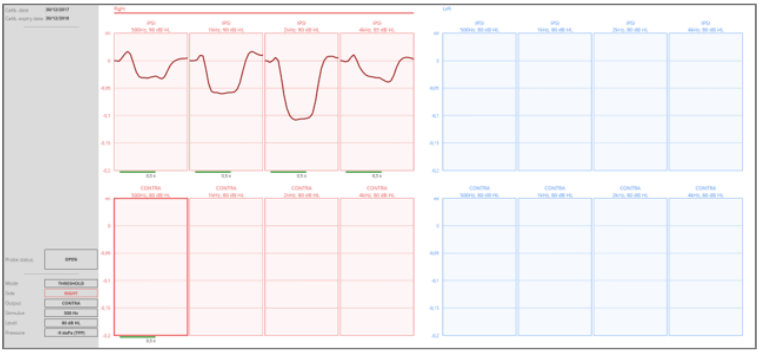
The following illustration shows the *live view* window for a tympanometry exam.



In this instance the screen shows:

- the probe status;
- the frequency of the probe tone;
- the stimulation side;
- the tympanogram display mode (compensated or absolute);
- the rate at which the pressure sweep occurs during the course of the test;
- the selection of single or multiple scan for the side being tested (*);
- the representation scale;
- the current measurement of the component displayed Y, B, G, B/G (*);
- the tympanogram and test results.

The following illustration shows the *live view* window for an acoustic reflex exam.



In this instance the screen shows:

- the probe status;
- the test mode (increasing intensity, fixed intensity, manual (*), threshold search);
- the transducer (Out), Ipsi or Contra;
- the frequency of the stimulus tone (Stim);
- the intensity of the stimulus tone;
- the representation of acoustic reflexes and test results.

11.2 TRANSFERRING TESTS

To download exams from devices to the Maestro archive, simply access the Maestro *live view* window and press the "TO PC" button on the device. Pressing the button when there is an exam displayed in the window, only this one exam will be downloaded. Conversely, pressing the button with the main screen of the device currently displayed, all exams conducted on the patient will be sent to the computer.
When downloading a pure tone audiometry or speech audiometry containing free field acquired traces and the option *Ask for saving FF traces as Aided/Unaided* has been selected in the *Audiology → Aided/Unaided FF traces* menu, the system will ask if the FF traces in the exam should be saved as acquired with or without hearing aid. If the option *Always save FF traces as Unaided* has been selected in the *Audiology → Aided/Unaided FF traces* menu, all traces acquired in free field are automatically saved as acquired without hearing aid.
Once the exams have been downloaded, they can be displayed, and deleted if necessary using the relative archive button.

CHAPTER 12

Data transfer (*)

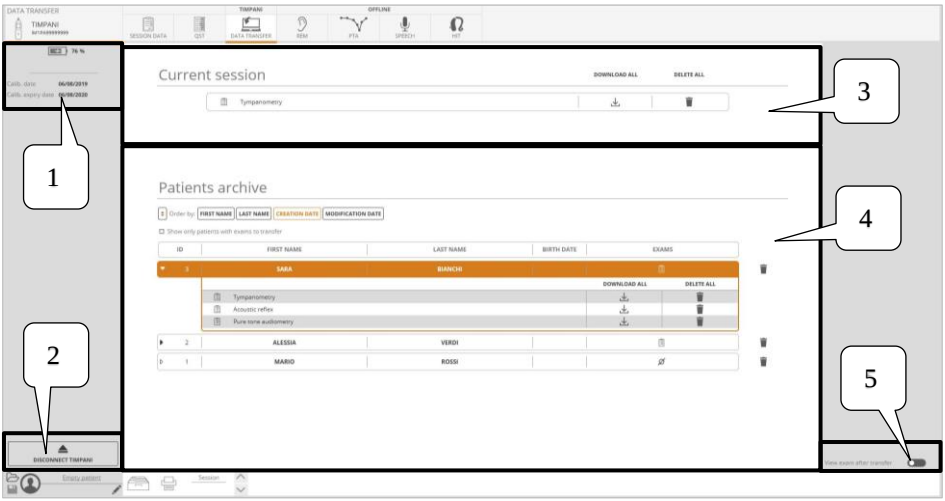
The *Data Transfer* (*) function allows viewing, transferring and managing exam data from the current session and exams saved in the archive of the connected device.

(To transfer exams from *Hytech Hybrid* devices, see section 11.2).

To access Maestro's data transfer function, click the button on the top bar of Maestro's main screen, as in the figure:

12.1 THE DATA TRANSFER WINDOW

Once the *Data Transfer* function has been selected, the main screen appears as illustrated below:



The screen consists of the following areas:

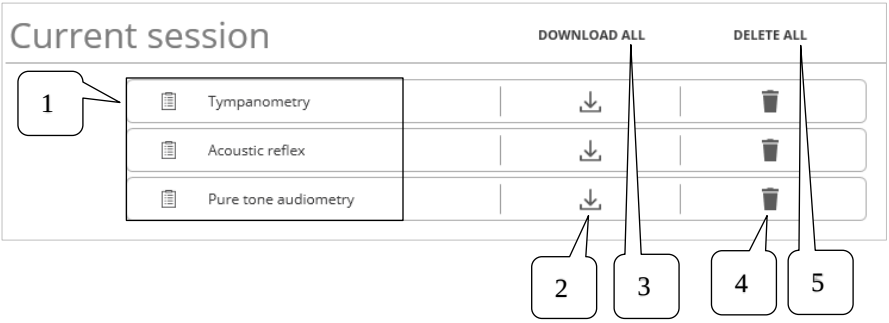
1. Information panel: here are shown the battery charge status, last calibration date and calibration expiration date;
2. Device disconnect button: once the *Disconnect *device name** button has been clicked, the device is disconnected and the Maestro data transfer mode is no longer active. The device can be used by the operator to acquire exams and, in the meantime, if the USB cable is connected, the device's battery continues to recharge;
3. Area dedicated to the management of the current session: contains the exams of the device's current session. It is possible to view and manage:
   - a tympanometry exam;
   - an acoustic reflex exam;
   - an audiometric exam.
4. Area dedicated to the management of the patient archive (exams saved in the device memory): contains the list of patients saved in the device's archive. Selecting the line of a specific patient name, the user can access the details associated with the person in question.

- personal details associated with the patient (the fields are empty if not specified);
- tympanometry exam associated with the patient (if stored);
- acoustic reflex exam associated with the patient (if stored);
- audiometry exam associated with the patient (if stored).

5. *View exam after transfer* option: if active, it allows entering the exam display screen immediately after transferring it to Maestro. Default value: Inactive.

12.2 DATA TRANSFER: CURRENT SESSION

Below is illustrated the exam area of the current session:



The area dedicated to the current session consists of the following functions:

1. Exam list: It is possible to view the list of exams present in the current session of the device (tympanometry, acoustic reflex, pure tone audiometry) and their transfer status (see section 12.4 for more information on transfer status).
2. Transfer single exam. Allows transferring the current exam to Maestro by clicking on the icon. The transferred exam will then be available for viewing and management in the lower bar of the Maestro window.
3. *Download all.* Allows downloading all exams of the current session by clicking the *Download All* button. The downloaded exams will then be available for viewing and management in the lower bar of the Maestro window.
4. Delete single exam. Allows deleting the current exam to Maestro by clicking on the icon. The exam is deleted from the current session of

the device only after asking the user for confirmation of the operation.

5. *Delete all.* Allows deleting all exams of the current session by clicking the *Delete All* button. The exams are deleted from the current session of the device only after asking the user for confirmation of the operation.

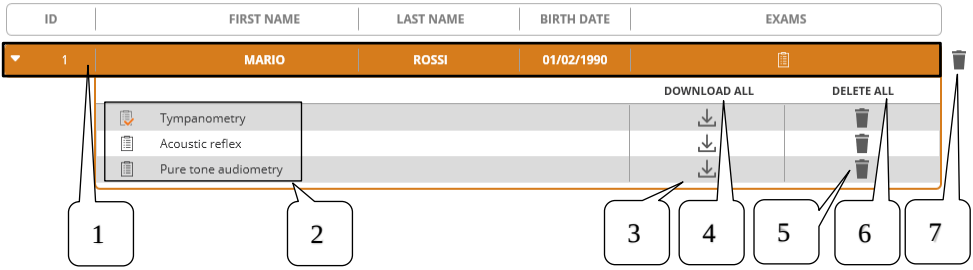
12.3 DATA TRANSFER: PATIENTS ARCHIVE

Below are the areas dedicated to the transfer of exams from the patients archive.
Area for the selection of patient list filtering and sorting criteria:

1. Area dedicated to the selection of the patient sorting criteria: patients can be sorted by name, last name, patient creation date and last modification date. The arrow keys to the left allow sorting in an ascending or descending order.

2. *Show only patients with exams to transfer.* Filter the patients in the table by displaying only those with associated exams that have not yet been transferred to Maestro.

Area related to an archived patient containing personal information and the list of associated exams:



1. Patient information. The following information is displayed for each patient saved in the device archive:
   - *ID*: unique identifier automatically associated with the patient at the time of its creation in the device archive;
   - *Name*: the patient's name, field empty if not specified;
   - *Last name*: the patient's last name, field empty if not specified;
   - *Birth date*: patient's birth date, field empty if not specified;
   - *Exam* status icon: transfer status of the exams associated with the patient (see section 12.4 for more information on transfer status).

2. Patient exams. The highlighted area contains the exams associated with the selected patient. The status icon of the individual exam shows its transfer status.

3. *Transfer single exam*. Allows transferring the individual exam associated with the patient to Maestro by clicking on the icon. The transferred exam will then be available for viewing and management in the lower bar of the Maestro window.

4. *Download all*. Allows downloading all exams associated with the selected patient to Maestro by clicking the *Download All* button. The downloaded exams will then be available for viewing and management in the lower bar of the Maestro window.

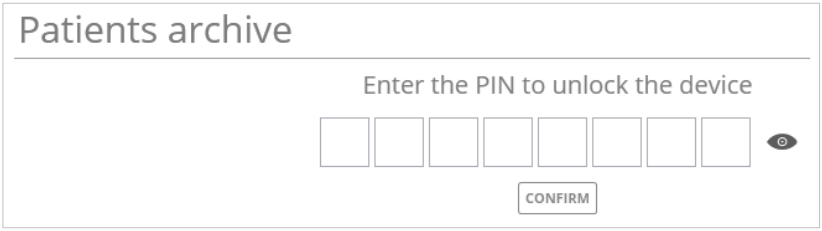
5. *Delete single exam.* Allows deleting the individual exam associated with the patient to Maestro by clicking on the icon. The exam is deleted from the device's archive only after asking the user for confirmation of the operation.

6. *Delete all.* Allows deleting all exams of the selected patient by clicking the *Delete All* button. The exams are deleted from the archive of the device only after asking the user for confirmation of the operation.

7. *Delete patient.* Allows deleting the selected patient from the device archive by clicking on the icon. The patient is deleted from the device's archive only after asking the user for confirmation of the operation.

Patient Data Protection

You can enable the security feature to protect sensitive patient data against unwanted access through the use of a PIN code that allows you to view the patient archive only after unlocking (see the user manual of the device provided for more information). If this option is active, once the device is connected via USB the archive section in the Maestro screen will not show the list of patients.



In order to view the patient list and download the data from the archive, the device must be unlocked using a PIN directly from the Maestro interface. Enter the PIN and press the “Confirm” button. The patient list will be available once the code entered has been confirmed.
The archive will be locked again only if the device enters stand-by mode.

12.4 EXAM STATUS ICONS:

The following describes the possible transfer states of the exams when using the *Data transfer* mode:

	Exam already transferred.
	Exam not transferred (if associated with a single exam) or patient containing at least one exam not yet transferred (if associated with a patient in the archive table).
	Patient in archive with no exams.

APPENDIX A:

Troubleshooting

Problem	Possible cause	Solution
Connection between PC and device cannot be established	USB port of the computer not working	Connect the device to a different USB port
	USB cable damaged	Replace the USB cable (standard USB cable, type A/B)
USB input cannot be selected in speech audiometry mode	Speech material management mode not set for USB	See chapter on device settings (audio settings section 2.4.6)
	Speech material not stored correctly on computer	Check that the speech material has been saved to the correct folder. Also, check by way of the *ATIT* software that the stored speech material is correct
Windows sounds sent to the patient's headphones	The output selected for speech material playback matches the default output of the operating system.	Change the operating system's default output from Window's audio settings panel.
A test cannot be accessed	Optional test not activated	Contact the Inventis technical service department to obtain the license, supplying the serial number of the device

Talk over, *talk back* and *monitor* functions cannot be enabled	Error in audio settings	If “PC” has been selected as the operator-patient communication mode, check that the microphone and headphones are connected to the computer and make certain they are selected correctly in the “Audio settings” window. Alternatively, select “DEVICE” as the operator-patient communication mode.

APPENDIX B:

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