

Operating Instructions

MAICO MI 44





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1 Introduction

Thank you very much for purchasing a quality product from the MAICO family. This automatic Tympanometer MAICO MI 44 is manufactured to meet all quality and safety requirements, and has been certified with the CE symbol according to Medical Directive 93/42/EEC. Please note: This medical instrument should only be operated by skilled personnel.

In designing the MAICO MI 44 we placed particular importance in making it a user-friendly device, meaning its operation is simple and easy to understand. And because all functions are software controlled, upgrading later to new, extended measurement functions will be simple and inexpensive. That means that you have invested in a device that will adjust to your future needs.

This user manual should make it as easy as possible for you to become familiar with the functions of the MAICO MI 44. Please open out the flap of illustrations on the last page. The description of the position (e.g. ⑤) of controls, displays and connections, found again in the text, will make it easier for you to learn how to operate the MAICO MI 44.

If you have problems or have ideas for further improvements, please get in touch with us. Simply call.

Your MAICO-team



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2 Description

2.1 Purpose

The MI 44 is an automatic instrument designed for efficient middle ear examination. Tests include automatic and manual pump control, tympanometry with selectable pressure ranges and pump speeds, ipsi- and contralateral reflex tests and reflex decay. Eustachian Tube Function may be performed on patients with intact or perforated eardrums. Test results are displayed on the front panel LCD (liquid crystal display) screen and may be printed.

The MI 44 performs all impedance screening functions and offers a complete middle ear function screening.

The design of the MI 44 allows fast and reliable measurements.

2.1.1 PC-Interface:

An USB-interface for data transfer to a connected computer is built in.



The MAICO MI 44 is laid out according to the EN of 60 601-1 „medically electrical devices “. In order to ensure this also with attached computer, the computer must correspond to the EN 60 601-1. If not, please look to chapter 16.5 Patient safety.

2.1.2 Environmental conditions for the MI 44

The MI 44 should be operated in a quiet room.

The test room must be at normal temperature, usually 15° C / 59° F to 35° C / 95° F, and the instrument should be switched on about 10 minutes before the first measurement to guarantee precise measuring results. If the device has been cooled down (e.g. during transport), please wait until it has warmed up to room temperature.

2.2 Tympanometry

Tympanometry is the objective measurement of middle ear mobility (compliance) and pressure within the middle ear system. During the test, a low-pitched probe tone (226 Hz) is presented to the ear canal by means of the hand-held probe. This tone is used to measure the change in compliance in the middle ear system while the air pressure is varied automatically from a positive value (+200 daPa) to a negative value (-400 daPa max.).



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Maximum compliance of the middle ear system occurs when the pressure in the middle ear cavity is equal to the pressure in the external auditory canal. This is the highest peak of the curve as it is recorded on the chart. The position of the peak on the horizontal axis and on the vertical axis of the chart will provide diagnostic information regarding the function of the middle ear system. Examples of normal and abnormal tympanograms can be found in a later section of this manual.

Gradient calculations are reported as the Tympanogram width at half of peak compliance expressed in daPa. A "limits" box is available on both the display and printout to aid in diagnosis.

Compliance is measured with respect to an equivalent volume of air, with the scientific quantity milliliter (ml). Air is measured in deca-Pascals (daPa).

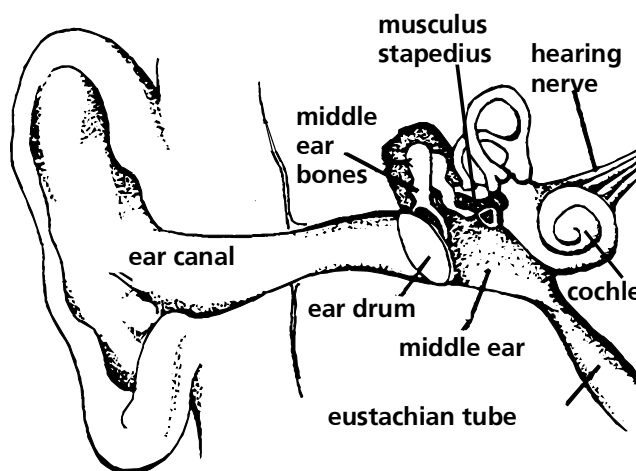


Figure 1 the middle ear

NOTE: 1.02 mmH₂O = 1.0 daPa.

2.3 Acoustic Reflex

An acoustic reflex, or contraction of the stapedial muscle, occurs under normal conditions when a sufficiently intense sound is presented to the auditory pathway. This contraction of the muscle causes a stiffening of the ossicular chain which changes the compliance of the middle ear system. As in Tympanometry, a probe tone is used to measure this change in compliance.

When the stimulus presentation and measurement are made in the same ear by means of the probe, this acoustical reflex is referred to as an ipsilateral acoustic reflex. When the stimulus presentation and measurement are made in opposite ears, the reflex is referred to as a contralateral acoustic reflex.



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For best results, this reflex measurement is automatically conducted at the air pressure value where the compliance peak occurred during the tympanometric test. Stimulus tones of varying intensities at 500, 1000, 2000 or 4000 Hz are presented as short bursts. If a change in compliance greater than 0.05 ml is detected, a reflex is considered present. Because this is an extremely small compliance change, any movement of the probe during the test may produce an artifact (false response). The level at which a reflex occurs is recorded as a number, as PASS/FAIL and in graph form.

If the tympanometric results display any abnormal findings, the results of the acoustic reflex testing may be inconclusive and should be interpreted with care. If a "flat" tympanogram is observed, showing a non-mobile middle ear system, the MI 44 will not perform an acoustic reflex test. Theoretically, a compliance peak is necessary to observe a reflex at peak pressure.



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3 Getting started

Your MI 44 was carefully inspected and packed for shipping. However, it is good practice to thoroughly inspect the outside of the shipping container for signs of damage. If any damage is noted, please notify the carrier immediately.

3.1 Unpacking

Save all the original packing material and the shipping container so the instrument can be properly packaged if it needs to be returned for service or calibration.

Please check that all accessories listed below are received in good condition. If any accessories are missing or damaged, immediately notify your MAICO Special Instrument Distributor.

Accessories

- 1 Diagnostic probe
- 1 Screening probe insert
- 1 Shoulder strap for diagnostic probe
- 1 Contraphone TDH 39 with headband and probe hold
- 24-count eartips kit:
 - (4) yellow, 7 mm
 - (4) green, 9 mm
 - (4) white, 11 mm
 - (4) yellow, 13 mm
 - (4) green, 15 mm
 - (4) blue, 18 mm
- Thermal printer paper (1 roll)
- Calibration test cavity
- Main cable
- Connector Cover

3.2 Connect probe

Connect the probe cable to socket © on the rear of the instrument. Insert the plug into the socket and protect the connection by fastening the two screws of the connector.

Insert the pressure tube into the socket ® and press it until it has a safe fit on the socket.



Figure 2
Diagnostic probe
with additional
screening probe tip

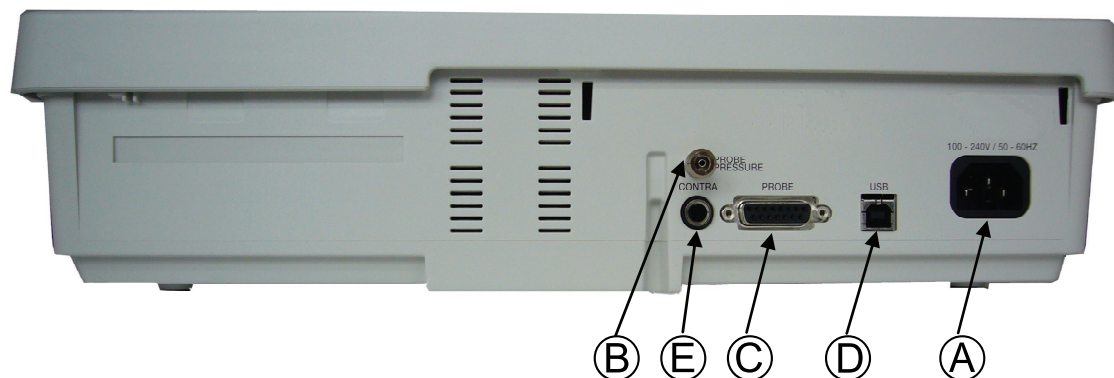


Figure 3 Connectors at the rear of the MI 44

- | | |
|-----------------------------|---------------------------|
| Ⓐ = mains connection socket | Ⓑ = probe tube connection |
| Ⓒ = probe connection socket | Ⓓ = USB PC-interface |
| Ⓔ = contra receiver socket | |

3.3 Connect Mains Cable and Accessories

Put the enclosed mains cable into the power connection socket Ⓐ and its mains plug into a power socket. The instrument is now operational.

Your MI 44 is equipped with a contra receiver. Plug the cable in the contra receiver socket Ⓔ.

3.4 Switch the instrument on

Switch the mains switch ⑭ on. The LCD display ⑮ shows for a moment the instrument type and the software version. Then the basic measuring figure appears. The MI 44 should be switched on about 10 minutes before the first measurement to guarantee precise measuring results. If the device has been cooled down (e.g. during transport), please wait until it has warmed up to room temperature.



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3.5 Getting familiar with the MI 44



Figure 4 the controls of the MI 44

- | | |
|---|---------------------------|
| ① = Print key | ② = Right/left ear key |
| ③ = Reflex measurement off/ipsi/contra ipsi+contra/Setting of high probe tone | ④ = TYMP-key |
| ⑨ = Left (cursor control) | ⑧ = Menu key |
| ⑪ = Right (cursor control) | ⑩ = Down (cursor control) |
| ⑬ = Enter | ⑫ = Up (cursor control) |
| ⑮ = Reflex Decay key | ⑭ = Power switch |
| | ⑯ = ETF key |

The use of the extended functions is described in chapter 12 "Individual Setup of the MI 44".



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3.6 The display of the MI 44

The test result is shown during the measurement on the LCD display. The measurements are saved automatically and can be printed out in a fast and quiet way with the integrated printer.

In figure 5 the initial empty measurement screen is shown. The measurement screen shows actual settings, test results and the graphical display of the tympanogram and reflexes.

The top line shows from left to the right the type of test (in example figure 5 Impedance), the selected test ear left or right and the selected reflex test "ipsi", "contra" or "Tympanogram" if no reflex test is selected.

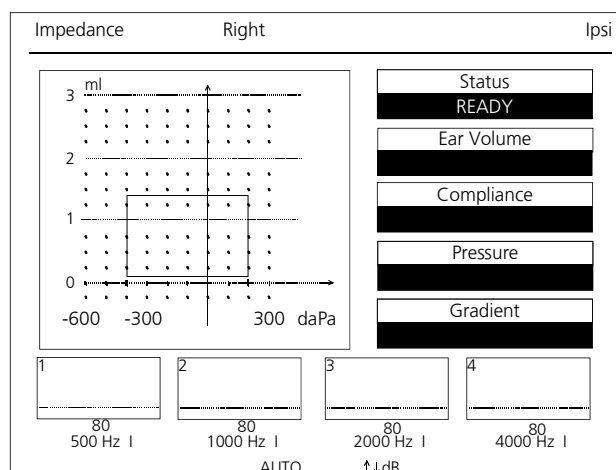


Figure 5 the measurement screen of the MI 44

At the left centre the graph of the tympanogram is shown. At the right five boxes show the status and test values.

The upper box shows the actual status of the instrument:

- READY means that the instrument is ready for testing
- IN EAR shows that the probe is inserted in the ear
- TESTING means that the test is in progress
- BLOCKED means that probe is blocked in the ear
- LEAKING indicates that the air seal of the ear tip in the ear is not proper

When the test is finished, the boxes below show the volume of the ear canal, the compliance, the pressure at maximum compliance and the gradient of the tympanogram.

The four boxes below the tympanogram, marked 1 to 4, show the graphical reflex curves after the test. Below each box the test level and the test frequency are shown. After the frequency an "I" shows the ipsilateral testing is selected.

At the bottom line in figure 5 the word "AUTO" and $\uparrow\downarrow$ dB Scale is shown. It means that the reflex test level increases automatically until a reflex was



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found or the maximum level is reached. With the cursor up button $\text{\textcircled{12}}$ or down button $\text{\textcircled{10}}$ the test level can be changed to a fixed level. The dB values below the boxes change accordingly. It is possible to have fixed levels from 70 dB to 100 dB and AUTO.



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3.7 Calibrate the probe

With the calibration test cavity you can adjust your impedance with measuring instrument. Do the same when you change the probe (from screening probe to diagnostic probe and vice versa). The calibration is very easy and takes only 20 seconds.

Press the menu key ⑧ and the main menu (figure 6) appears on the LCD display ⑤. Select the menu option Calibration with the Down button ⑩. Press Enter ⑬ and follow the instructions on the LCD display ⑤, as shown in Figure 7.

Put the probe tip ⑥ without ear tip into the hole of the test cavity labeled 0.5 ml and wait. When the text on the display ⑤ changes to the request for the 2 ml calibration put the probe tip ⑥ in the 2 ml cavity and proceed as described above. After the successful calibration of the 5 ml volume the MI 44 switches automatically to the tympanometry mode. The basic menu for the impedance measurement appears again and you are ready for measurements.

If the error information **Cavity calibration out of range** appears during the calibration please control if the opening of the probe tip ⑥ is clean and try to recalibrate the probe. For more information about cleaning the probe also read Chapter 13: Cleaning the probe.

If the error information appears again, the probe or the instrument is probably defect. Inform your service to get immediate help.

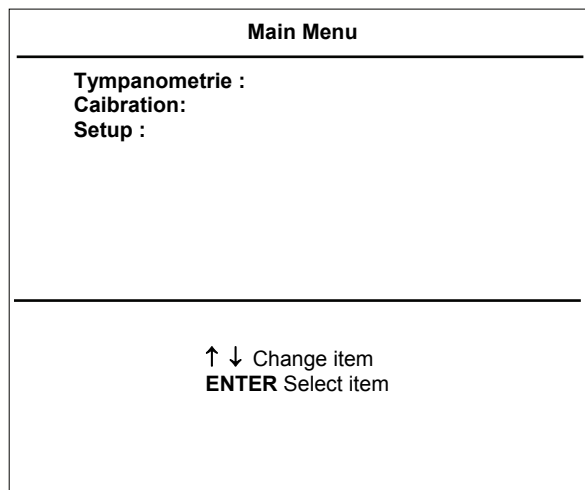


Figure 6
Display MI 24 Main Menu

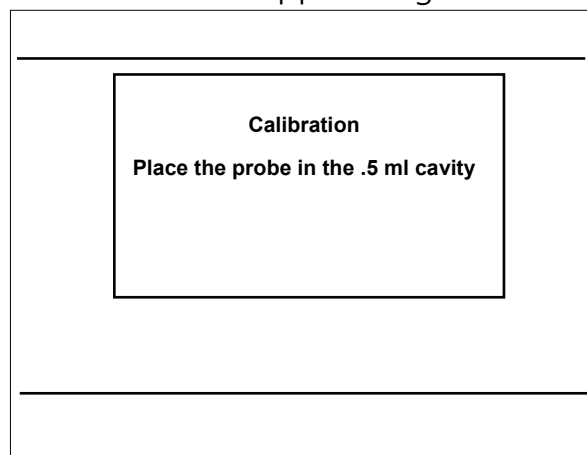


Figure 7 Display MI 44 Calibration

3.6 Getting familiar with the probe

The probe of the MI 44 is shown in figure 8. The probe head is adjustable in three steps (0°, 60° und 80°). It is adjusted by releasing the fixation screw (Figure 9 ①) at the bottom of the probe a few turns, using a coin or a screw driver. Adjust the probe head ② by pulling it into the required position until it rests. To do this hold the probe handle ③ with the other hand. After it is set to the required position fasten the fixation screw ① again.

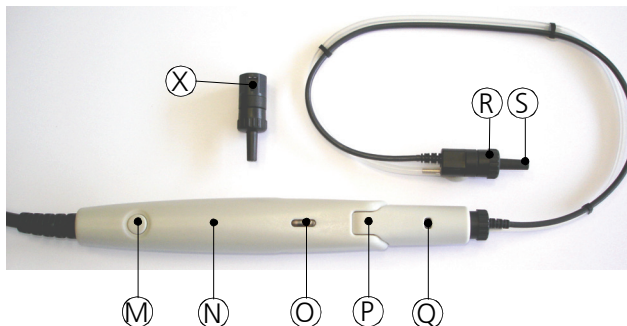


Figure 8 MI 44 probe with additional screening probe tip ⑧

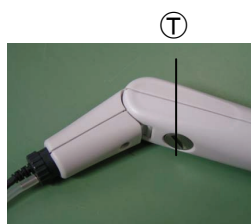


Figure 9

Notice! To avoid damages on the sensitive measuring equipment, only bent the probe toward fixation screw!

Transforming the Probe from Handheld to Clinical and Reverse:

To exchange the probe insert press the release button ④ of the probe with a tool or a pen. Remove the screening probe insert.

Insert the diagnostic probe insert ⑤ into the probe head ②. Please recognize the right position of the connector of the diagnostic probe insert ⑤. Press the diagnostic probe insert ⑤ into the probe head ② until it fastens.

Note! The squared hole in the probe connection should face in the same direction as the push-button.

Control lights and Display

The probe button ⑥ can be used to select the required test ear. The colour of the control light ④ changes accordingly to red (right ear) or blue (left ear). If selected in the setup menu pressing the probe button ⑥ during



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operation pauses also the test.

The colour of the control light ④ of the probe indicates in standby the selected ear and in operation the fitting of the probe in the auditory canal: A red control light ④ indicates that the right ear is selected. The system is ready for measurements. As soon as you have put the probe into the auditory canal the control light ④ lights green. Now the test runs off. Do not change the position of the probe any more until the green control light ④ is going out indicating the end of the measurement.

A blue control light ④ indicates that the left ear is selected. The system is ready for measurements. As soon as you have put the probe into the auditory canal the control light ④ lights green. Now the test runs off. Do not change the position of the probe any more until the green control light ④ is going out indicating the end of the measurement.

A yellow control light ④ indicates an error. The kind of the error is indicated on the LCD-display ⑤ under status:

LEAKING: The ear tip does not make the auditory canal airtight. Change the position of the probe until the control light ④ lights green. If you are not successful use a bigger ear tip.

BLOCKED: Indicates the seal of the probe opening. Change the position of the probe which points maybe at the side of the auditory canal until the control light ④ lights green. If you are not successful please check if the probe is blocked with ear wax.

The complete probe insert can be changed by pressing the release button ④ and removing the probe insert.

If the probe tip ⑤ is clogged you can remove it by opening the fixation ring ⑥. After cleaning of the probe tip ⑤ or selection of a new one, the tip must be fixed again by fastening the fixation ring ⑥.

3.7 Choose an appropriate ear tip

Choose an ear tip of the appropriate size from the ear tip set. Put the ear tip tightly on the probe tip. The probe tip should close up with the end of the ear tip. It should not disappear with more than about 1 mm in the ear tip or just out of the ear tip.



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By choosing an appropriate ear tip and placing it correctly on the probe you create the basic conditions for measurements without problems and mistakes.

Now all preparations are concluded and you can start the impedance and reflex measurement. Please read the following chapters.

4 How to create a Tympanogram

In the following paragraph we will deal shortly with the principle and the background of the impedance measurement to create a better understanding. If you want to begin the measurements immediately just skip this paragraph and continue reading with **4.3 Preparing the measurements**.

4.1 The basics of the impedance measurement

The impedance measurement serves the diagnosis of the condition of the middle ear and can therefore not be compared directly with other audiometrical tests such as sound or speech audiometry which serve the measurement of the hearing. Furthermore the impedance measurement is an objective measuring method which does not depend on the cooperation of the test person and can therefore not be falsified by him.

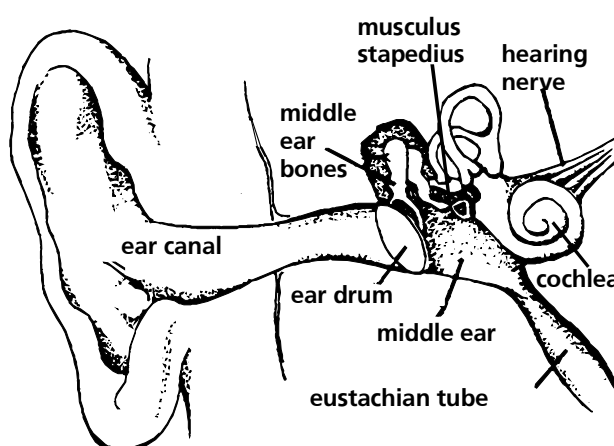


Figure 10
The middle ear

The two most important impedance measuring methods possible with your MI 44 are Tympanometry and the measurement of the Stapedius reflex which is treated in chapter 6. "How to measure the stapedius reflex".

The impedance measurement examines the acoustic resistance of the middle ear. If the eardrum is hit by a sound a part is absorbed and sent via the middle ear to the inner ear while the other part is reflected. The stiffer the eardrum is the more sound is reflected and the less sound reaches the inner ear. In the probe of the impedance measuring instrument a small loudspeaker is installed which emits a sound of low frequency via a tube **A** (see Figure 11) into the

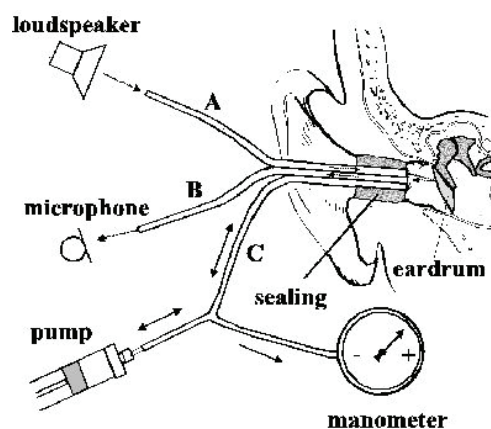


Figure 11 – Principle of impedance measurement



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auditory canal before the eardrum. Another tube **B** is connected with the microphone in the probe which receives the sound. Both tubes are lead together with tube **C** nearly to the eardrum and are made airtight against the outside pressure by the ear tip. A manometer and a pump which can produce both over- and under-pressure are connected with tube **C**. The less sound is reflected by the eardrum to the microphone the more stiff the eardrum is and with it the middle ear - the eardrum transmits the biggest part of the sound via the middle ear to the inner ear. The highest compliance is normally reached with an air pressure corresponding to the outside pressure.

When performing Tympanometry during a measurement a continuous change of over- and under-pressure is performed by the pump of the instrument in the outer auditory canal before the eardrum which is sealed by the ear tip in addition to the measurement with normal pressure. The compliance is measured simultaneously and shown in a diagram, the Tympanogram, which illustrates the compliance in ml over the pressure in daPa. In figure 12 the area for normal Tympanogram curves is hatched. Here you can see that the highest compliance is reached with normal pressure. When you create over- or under-pressure the eardrum stiffens - the compliance decreases. So you can draw conclusions on the condition of the middle ear from the form and the values of the Tympanogram.

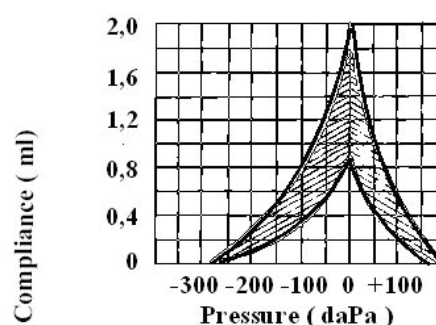


Figure 12 – Tympanogram (normal curve area is hatched)

4.2 Training of the test person

Explain to the test person that the measurement is painless, that nothing gets into the auditory canal and that he does not have to answer when he hears the faint and deep test sound and the pressure in the auditory canal changes. In no case the test person should swallow, chew or move his head during the measurement.



Figure 13



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4.3 Preparing the measurement

Before you start a new measurement, delete former test results (see also chapter 4.7.) The LCD display shows the empty measurement screen for the right ear and the control light of the probe lights red. If you want to measure the left ear change the side by pressing the **L/R**-key or the probe button $\text{\textcircled{M}}$. Then the selected test ear shown in the middle of the top of the LCD display $\text{\textcircled{5}}$ will change from **Right** to **Left** and the control light $\text{\textcircled{C}}$ of the probe lights blue. Switch off the reflex measurement by pressing the **REFLEX**-key $\text{\textcircled{3}}$. The word Tympanometry must appear at the right top of the display $\text{\textcircled{5}}$. Control if the auditory canal is free. Choose the right ear tip according to the size of the auditory canal and put it firmly onto the probe tip.

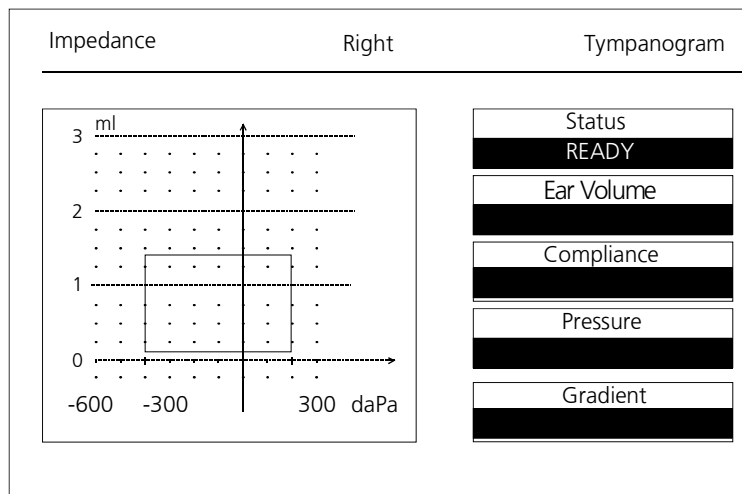


Figure 14 - Measurement screen (only Tympanogram)

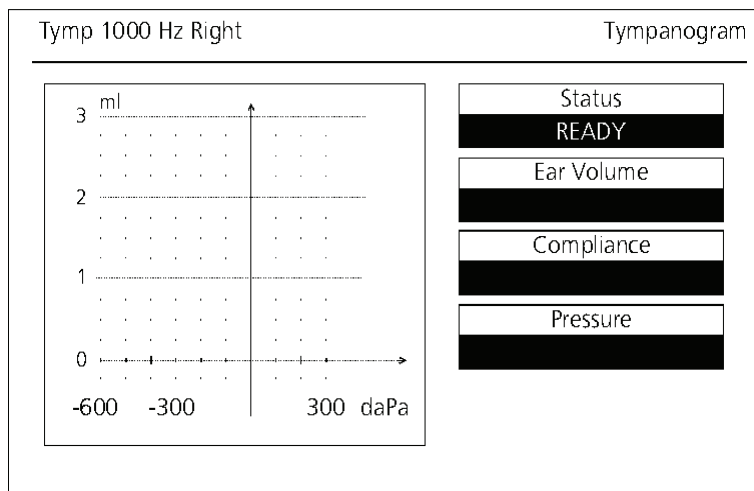


Figure 15 - Measurement screen hightone



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4.4 Measuring the Tympanogram

Take hold of the top of the outer ear and pull it back. Insert the probe with the ear tip into the auditory canal until the control light ④ of the probe is green. In order to start the test press the Enter button ⑬ and the control light in the probe is lighting permanently green. The status in the display changes to "Testing". Do not move the probe until the green light goes out; the patient may not swallow or speak during the measurement. During the test you can watch on the LCD display how at first the Tympanogram is written on the left side and then how the values are put down on the right side. After about 4-5 seconds the test is completed, the green light turns off. Now you can remove the probe from the ear.

If an error occurs during the measurement the test is stopped. If leakage occurs, the control light ④ of the probe lights yellow and the display ⑤ under status "LEAKING" is reported. If the probe is blocked, the control light ④ of the probe lights yellow and at the display ⑤ shows under status "BLOCKED". Please proceed as described in chapter 3.6 "Getting familiar with the probe". If you want to measure the other ear, too, change the side by pressing the **L/R**-key ② or the probe button ⑭ and repeat the measuring procedure described above with the other ear.



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4.5 How to evaluate the Tympanogram display

After having carried out a measurement you can see the results on the LCD display.

On the left side of the display you see the Tympanogram. The area surrounded by the box is valid for "normal"

Tympanograms. You can change the area or switch it off. For details see

chapter 12 "Individual Setup of the MI 44". In the

middle of the top of the LCD display © the word **Right** or **Left** indicates the ear chosen at the moment.

Tympanogram at the right top indicates that the reflex measurement has been switched off.

In the boxes at the right the determined measurements are displayed:

- **Ear Volume** indicates the volume of the section of the auditory canal between the ear tip and the eardrum in ml (in the example 0.94 ml).
- **Compliance** indicates the maximum value of the compliance from the Tympanogram in ml (in the example 0.81 ml).
- **Pressure** indicates the pressure with the highest measured Compliance (in the example -37 daPa).
- **Gradient** calculations are reported as the Tympanogram width at half of peak compliance expressed in daPa (in the example 32 daPa).

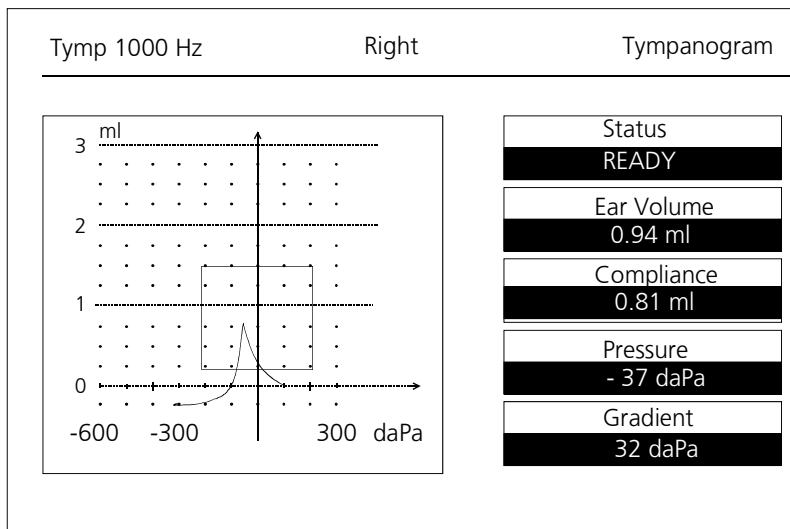


Figure 16 Display of a 1000 Hz Tympanogram



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4.6 How to print out the test result

After the end of a test you can print out the results for your records by pressing the PRINT button ①. The quiet thermal printer prints out the example used in the previous paragraph 4.5 in only 6 seconds. While the printer is working no key action is possible and the probe is inactive. Figure 17 shows the printout:

Id No.: Here you can put down the patients social Id number.

Date: Here the actual test date can be stated.

Name: Here you can put down the patients name.

Examiner: State here the reference for the test person.

Remarks: Additional information about the test or patient can be stated here.

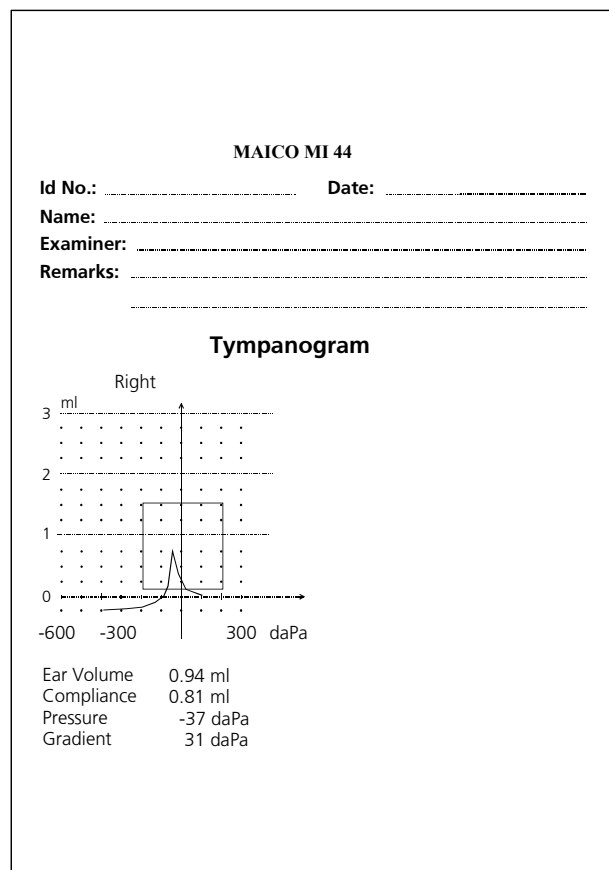


Figure 17 – Printout of Tympanogram

All other values and the Tympanogram correspond to those you have seen on the LCD display and which were explained on the previous page under 4.5.

The “intelligent” printer control helps you to save paper. It will only print out what has really been measured. So the printout of the reflex frequencies misses in the example above because only the Tympanogram was measured.

If you have saved two Tympanograms (for example for both the left and the right ear) both are printed out side by side.

You can produce as many printouts as you want by pressing several times the PRINT button ①.



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4.7 How to delete the test results

By pressing the **R/L**-key ② longer the measurement memory will be deleted. On the LCD-display ⑤ the message "Delete all Data?" occurs. Press the ENTER button ⑬ to delete all patient data. Then the LCD display shows an empty measurement screen.

If you press the MENU button ⑧ you return to the measurement screen without deleting the measurement data.




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5. Advanced Impedance Possibilities

In addition to the standard 226 Hz probe tone tympanometry, the MI 44 has a high frequency probe tone of 678 Hz, 800 Hz or 1000 Hz that can be selected by the user. A tympanogram recorded using the high probe tone is generally better suited for screening newborns and provides more accurate results for those subjects.

5.1.1 Measurement with high frequency probe tone

When the instrument is switched on, it automatically powers-up in the standard tympanometry mode. In order to choose tympanometry with high probe tone, press the Tymptone button .

The screen for high probe tone tympanometry looks very similar to the normal tympanometry mode, however the following differences will appear on the screen:

- The scaling is now measured in mmho
- The pre-selected frequency is displayed in the upper left hand side of the screen. The High frequency 678 Hz, 800 Hz or 1000 Hz will selected in the Setup menu 12.2 (Tympanogram Setup Menu)
- The tympanometry test with high probe tones is performed in the exact same way as a normal tympanometry test.

It is possible to perform normal tympanometry and high probe tone tympanometry in one test session and print the results for comparison. When the first tympanometry curve has been drawn, press the Reflex key for two seconds to switch to high probe tone tympanometry. Now the next curve will be drawn automatically. Press Print and a printout presenting both curves will appear.

Note: It is not possible to perform reflex tests on the basis of a high probe tone tympanogram.



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5.2 Manual pump control

In addition to the automatic features the MI 44 offers a manual control of pump speed and pressure for advanced diagnostic.

To switch from Standard to Manual Mode press the key PUMP. To get back into Tympanometry Mode press either PUMP or TYMP. The display will look as shown in figure 18a. To display the measurement curve on the display, choose Record On by the ▼ Key before you start measuring.

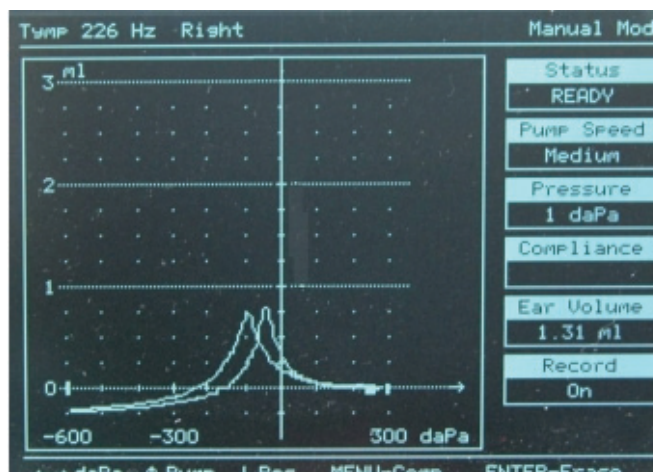


Figure 18a: Display in Manual Mode

Compensated Mode

Curves can be displayed in two different versions. MI 44 can be set to either Compensated Mode or Uncompensated Mode (see figure 18b) by pressing the key MENU. Compensated Mode is used when you want the tympanometric curve to be displayed at the floor of the coordinate system of the tympanogram. (See figure 18a).

Non Compensated Mode is used when you want the tympanometric curve to be displayed including the ear canal volume.

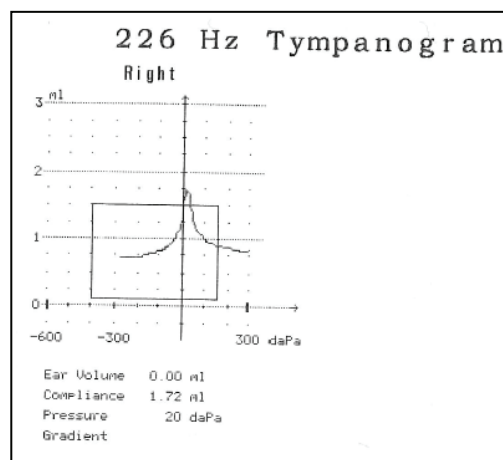


Figure 18b: Uncompensated Mode

Status

Here you can see the actual status of the measurement as in the tympanometric standard mode.

Pump Speed

There are four different pump speed settings:

- Minimum (17 daPa/sec.): slow, very precise results
- Medium (50 daPa/sec.): compromise of speed and precision



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- Maximum (>150 daPa/sec.): fast, screening
- Automatic (Dynamic from 150 daPa/sec. for low gradient and 50 daPa for a gradient larger than 5)

A slow speed is more time consuming, but may give more detailed information.



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To change the pump speed, choose Tymp Mode by pressing the Tymp Key. Within the Tymp Mode activate MENU and select SETUP with ↓ and confirm with ENTER. Now choose Tympanogram Setup and select Pump Speed to change within the pump speed setting.

Pressure

For advanced diagnostic measurements the manual change of the pressure from + to - gives more detailed information about a possible lesion of the eardrum. The pressure can be varied by left and right arrow keys.

Record

To display the measuring results choose Record On before you start measuring.

Print

There is only memory allocated to store the last curve. To get a printout of the screen hold the PRINT key for two seconds.

6. How to measure the Stapedius reflex

6.1 The basics of the Stapedius reflex measurement

While the Tympanometry method measures the change of the compliance caused by changing pressure in the outer auditory canal, the Stapedius reflex measurement works with a changing compliance caused by contraction of the Stapedius muscle in the middle ear. The contraction - called Stapedius reflex - causes a decrease in compliance and is caused by loud acoustic stimuli.

Regardless whether the acoustic stimulus is active on the left or on the right or on both sides the Stapedius reflex is always binaural, i.e. it occurs in both ears at the same time.

The Stapedius reflex is caused in ears of adults with normal hearing by sine sounds with sound pressure levels between 70 and 105 dB.

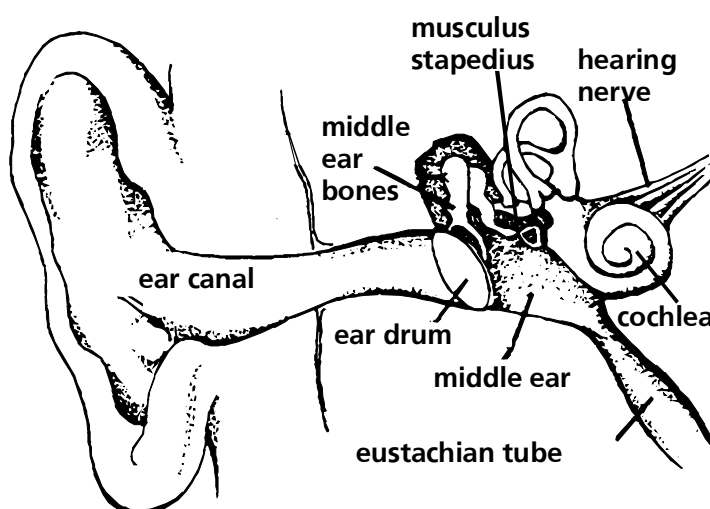


Figure 19 The middle ear

The reflex method measures continuously in one ear, the "probe ear", the compliance with the pressure which caused before the highest compliance. Simultaneously the "stimulus ear" is irritated by the sound which causes the contraction of the Stapedius muscle.

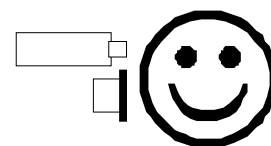


Figure 20 Ipsilateral test

The ipsilateral reflex measurement uses the same ear for the probe and the stimulus. The contra-lateral measurement uses different ears for the probe and the stimulus. The acoustic stimulus is offered to the ear opposite to the "probe ear".

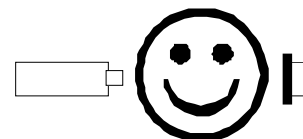


Figure 21 Contra lateral test

If the offered stimulus causes a reflex the impedance measuring instrument registers a decrease in compliance in the "probe ear" which indicates a



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Stapedius reflex at the actual test frequency and the test level. The test level which was set when the reflex occurred is called reflex threshold and is shown in dBHL (dB hearing loss).

6.2 Training the test person

In addition to the general introduction described in chapter 4.2 you should explain to the test person that loud test sounds will occur during the reflex measurement. It is very important that the patient does not move his head at all because a reflex can be registered already with a change of compliance of 0.05 ml.

6.3 Preparing the ipsilateral measurement

The LCD display shows the empty Tympanogram for the right ear and the control light © of the probe lights red.

If you want to measure the left ear change the side by pressing the **L/R**-key ② or the probe button ④. Then the selected test ear shown in the middle of the top of the LCD display ⑤ will change from **Right** to **Left** and the control light © of the probe lights blue.

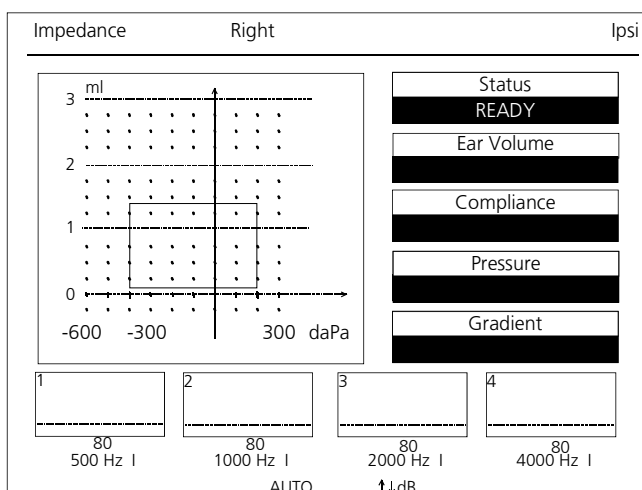


Figure 22 Display Tympanogram + Reflex (ready for measurement)

Switch the reflex measurement on by pressing the **REFLEX**-key ②. The word **Ipsi** must appear at the right top of the display ⑤. The sound stimuli for the reflex measurement are reproduced by the receiver integrated in the probe.

Set the desired volume level with the Down-key ⑩ respectively the Up-key ⑪. On the LCD display ⑤ below the reflex boxes at the bottom the selected level in dB (in example figure 20, 80 dB) appears. The "I" indicates that an ipsilateral test is selected. You can choose between the fixed levels 70, 75, 80, 85, 90, 95 and 100 dB_{HL} and AUTO with a starting level of 70 or higher. If you choose AUTO the MI 44 starts with the lowest level 70 dB_{HL} or higher and increases the level automatically until a reflex is registered or the maximum value is reached. You can choose your



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individual starting level and maximum level (see **12.3 Reflex pre-settings**). If you have chosen a fixed level the instrument measures only with this level.

Control if the auditory canal is free.

Choose the right ear tip according to the size of the auditory canal and put it firmly onto the probe tip.



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6.4 Doing the ipsilateral measurement

Carry out the measurement as described in chapter 4.4 "Recording the Tympanogram". The Stapedius reflex is measured after the measurement of the Tympanogram. During the measurement of the Stapedius reflex the change of the compliance is represented in real time on the LCD display ⑤. When the test is finished the curves for the changes of compliance for 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz are shown in four separate graphs at the bottom of the measurement screen (see Figure 23). Below each curve you see the test level where a Stapedius reflex was registered automatically. This is indicated by a "PASS" below the frequency. If no reflex was detected, a "FAIL" is reported and the maximum level is shown.

You can judge watching the real time graph if you have a "real" Stapedius reflex or only disturbance and artifacts. The lower dotted zero-line of a graph indicates the measured compliance without a test sound. All the positive or negative changes of compliance are shown as deviation from the zero-line. If a Stapedius reflex occurs the compliance decreases and the curve rises. The box which occurs during the test symbolizes the threshold at which the MI 44 accepts a change of compliance as valid Stapedius reflex.

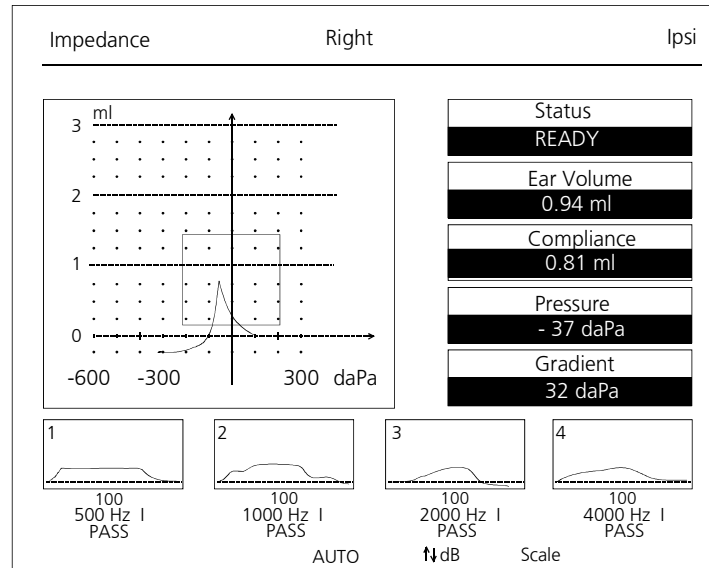


Figure 23 Example of a normal Tympanogram with ipsilateral reflex results

6.5 Preparing the contralateral measurement

Switch on the contralateral reflex measurement by pressing again the red **REFLEX**-key ③ (The word **CONTRA** must appear on the right top of the LCD - display ⑤). Here the highest fixed level is 120 dB_{HL} (with TDH 39 contra phone only).

The contralateral measurement produces more reliable results because the receiver emitting the test signal and the probe measuring the compliance are separated.

If you are using an insert phone for contralateral measurement, put an appropriate ear tip on the insert phone and insert it in the contralateral ear.

Continue now as described previously for the ipsilateral measurement.

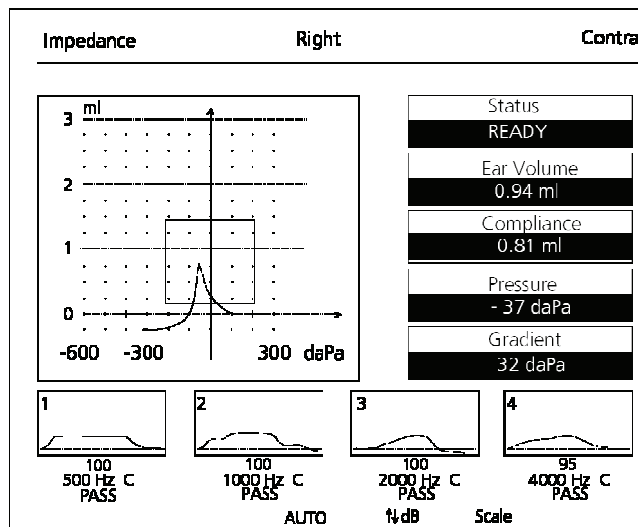


Figure 24 Example of a normal Tympanogram with contralateral reflex results

6.6 How to interpret the reflex display

After having carried out a measurement you can read the recorded values on the LCD display.

In addition to the Tympanogram shown on the left side and the values shown on the right, now you can see the results of the reflex measurement in the lower part of the display ⑤. In four boxes marked 1 to 4 the stapedius response is shown graphically. Below each box the test level, the test frequency, the type of the test (I=ipsi, C=contralateral) are shown. Also the test result is shown as "PASS" or "FAIL". In the example in Figure 24 for 500 Hz a stapedius reflex was registered at 100 dB_{HL} and for 4 kHz at 95 dB_{HL}. If no reflex

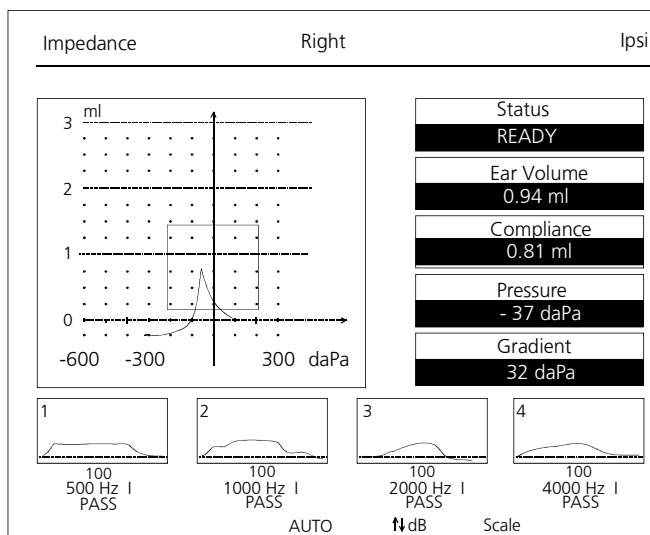


Figure 25 Example of a normal Tympanogram with ipsilateral reflex results



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threshold was registered the information **FAIL** appears below the frequency.

A correct interpretation of the measuring results can only follow in connection with the Tympanogram, the graphic reflex display and other actual data. But in principle you can say that a Stapedius reflex indicates that the patient hears on the "stimulus ear" and that the sound lead on the "probe ear" functions.



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6.7 How to print out the test result

After a test you can print out the result for your documents by pressing the PRINTER button ①. The quiet thermal printer prints out the example used in the previous paragraph 6.6 in only 12 seconds.

While the printer is working no key action is possible and the probe is inactive.

In addition to the printing text treated in chapter 4.6 the result of the reflex test is printed out:

The level value (dB_{HL}) at which a reflex had been measured appears below the graph.

If no reflex had been registered FAIL is printed on the top of the graph behind the test frequency.

The printout supports you, to evaluate the test results correctly.

The graphs of tympanogram and reflex are useful for interpretation: The tympanogram displays the middle ear mobility. The horizontal axis shows the pressure, the vertical axis the compliance.

The reflex is displayed in four charts.

Here the x-axis stands for time, the y-axis shows the changes of compliance.

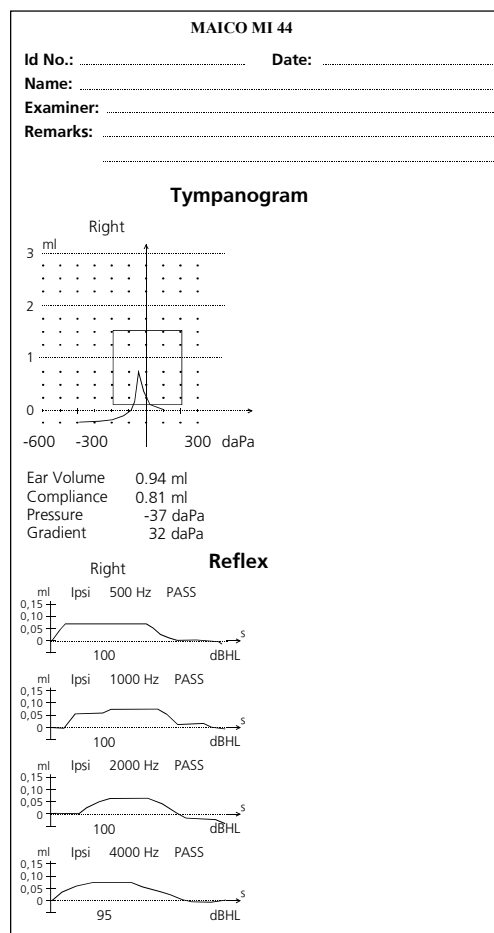


Figure 26 - Printout of a Tympanogram with ipsilateral reflex tests



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7 Reflex Decay Test Operation

The diagnostic probe insert must be used for this test. If you are currently using the optional screening probe insert, do not use it for this test!

To exchange the probe insert press the release button ③ of the probe with a tool or a pen. Remove the screening probe insert. Insert the diagnostic probe insert ④ into the probe head ⑤. Please recognize the right position of the connector of the diagnostic probe insert ④. Press the diagnostic probe insert ④ into the probe head ⑤ until it fastens.

Place the black shoulder strap firmly over the patients shoulder. Slip the probe into the holder of shoulder strap (as shown in figure 27). Make sure you can see the LEDs of the probe. Place an appropriately sized eartip firmly on the probe tip. Insert the tip into the ear canal, enough to make a seal and provide support for the probe tip.

If you are doing a contralateral test apply an appropriate ear plug on the insert phone and insert it in the contralateral ear.

If you're using the headset contra phone, place the phone over the opposite ear, making sure the receiver lines up directly with the ear canal.

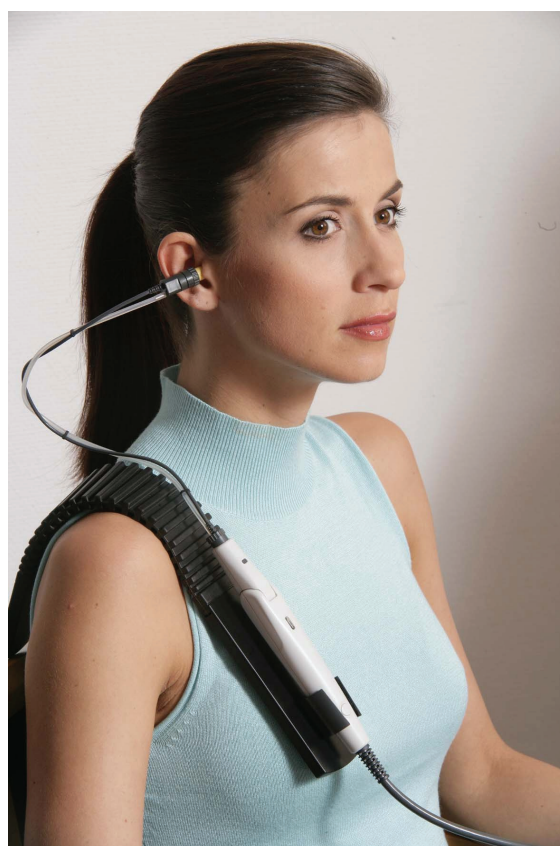


Figure 27
Fixation of the diagnostic probe

Run a tympanogram and reflex test as described before.

Highlight REFLEX DECAY on the main menu or press the **DECAY** key ⑮ to advance to the reflex decay test.

Select a frequency test level.

The test level should be set 10 dB above the reflex threshold measured before.



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Set the desired volume level with the Down-key ⑩ respectively the Up-key ⑪. On the LCD display ⑤ below the left reflex box at the bottom the selected level in dB appears. The starting level is always 80 dB.

If you like to change the test frequency from the default 1 kHz use the Left-key ⑨ respectively the Right-key ⑫. On the LCD display ⑤ below the reflex boxes at the bottom below the selected level in dB, the test frequency appears.

The pressure will automatically be set at the peak pressure for maximal compliance.

Instruct the patient not to talk, swallow, yawn or move until the test is over. Any movement or sound will give unreliable results.

Press the ENTER button ⑬ when ready to run the test.

Watch the probe LEDs for an indication of test operation. See chapter 3.6 for an explanation of the LEDs.

An individual whose peak amplitude decays 50% within the 10 second time limit shows signs of adaptation, or decay. The percentage value is displayed after 10 seconds.

In figure 28 test result is shown. The emphasized black bar below the 0 ml line indicates the duration of the test stimulus.

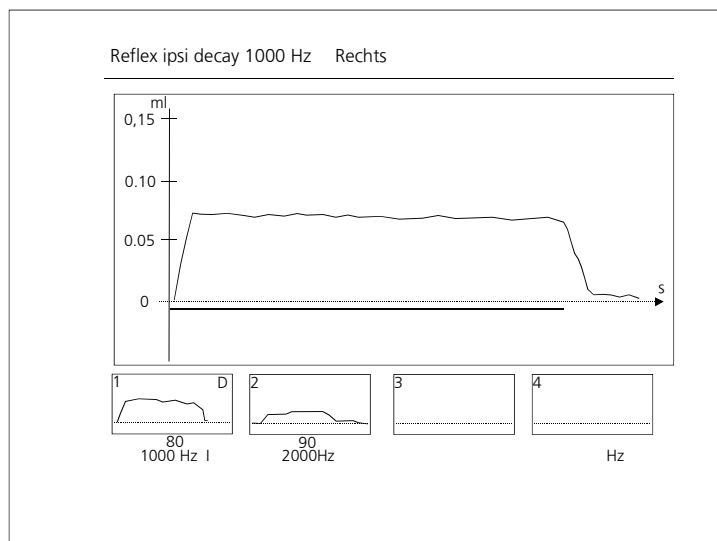


Figure 28
The reflex decay screen with test result

To save the result and or / perform an additional test press the **DECAY** key ⑭. On the LCD display ⑤ in the left reflex box at the bottom the last result is now shown.

The next right test box is now highlighted. You can do now a test with different level or frequency. Select it as described before.



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When you finished all decay tests and have **pressed the DECAY-key**, you can print out the result for your documents by pressing the blue PRINT key①.



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8 Eustachian Tube Test Operation

The diagnostic probe must be used for this test. If you have an additional impedance screening probe (option), do not use it for this test!

If you have not already done so today, press the MENU-button, highlight CALIBRATION and calibrate the diagnostic probe (as described in chapter 3.5).

The Eustachian tube test can be used in patients with intact TM or in patients who have a perforated TM or PT tubes in place.

8.1 ETF test for patients with intact TM

Highlight ETF Intact from the main menu and press the ENTER button ⑬ or press the **ETF**-key ⑯ to advance to the Eustachian Function Test screen (see figure 29). It is not necessary to run a tympanogram before running this test.

The text ETF Intact occurs at the upper right corner of the LCD display ⑮.

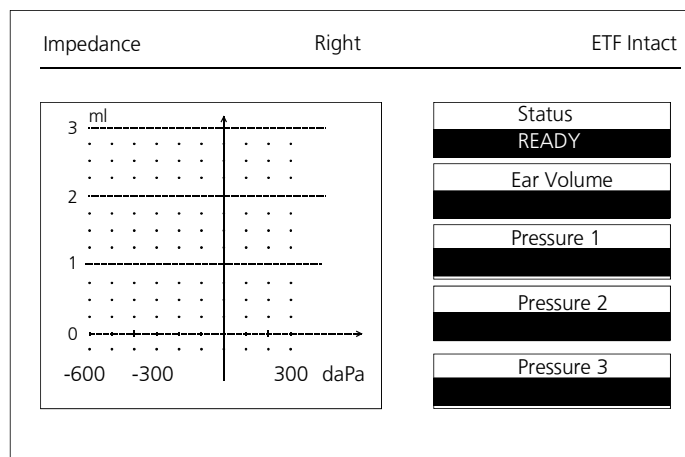


Figure 29 The ETF screen

Connect the probe as described in chapter 6 "Reflex decay test". Place an appropriately sized eartip firmly on the probe tip. Insert the tip into the ear canal, well enough to make a seal and provide support for the probe tip.

Instruct the patient not to move or talk until the test is over, as any sound or movement will give unreliable results.

Press the ENTER button ⑬ when ready to begin the test.

The pressure value at the maximum compliance is shown under "Pressure 1".



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Now the text "Make the patient decrease middle ear pressure by Swallowing" occurs at the LCD display ⑤ (see figure 30).

Press the ENTER button ⑬ when ready to begin the second test.

The pressure value at the maximum compliance with decreased middle ear pressure is shown under "Pressure 2".

Now the text "Make the patient increase middle ear pressure by Valsalvation" occurs at the LCD display ⑤.

Press the ENTER button ⑬ when ready to begin the second test.

The pressure value at the maximum compliance with increased middle ear pressure is shown under "Pressure 3".

After a test you can print out the result for your documents by pressing the blue PRINT- key ①.

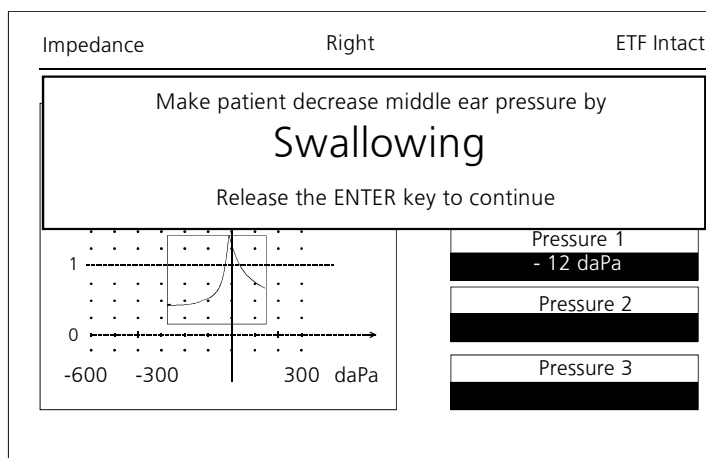


Figure 30 The ETF screen after first test cycle (Pressure 1)

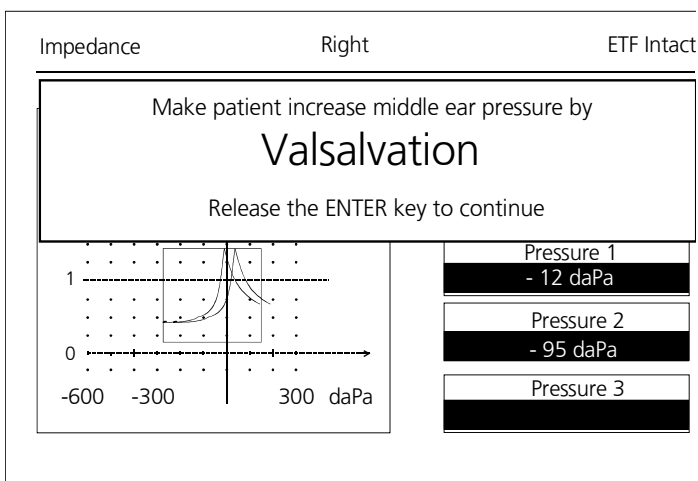


Figure 31 The ETF screen after second test cycle (Pressure 2)

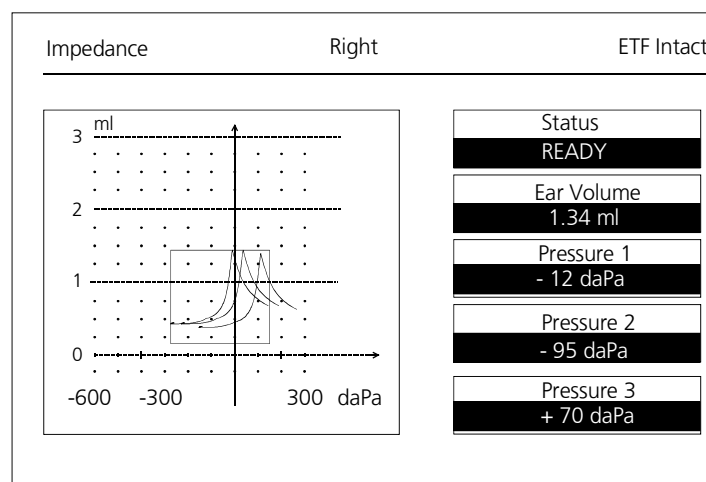


Figure 32 The ETF screen after third test cycle (Pressure 3)



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8.2 ETF test for patients with perforated TM

The test determines if the patient can open his/her Eustachian tube in the presence of positive pressure delivered by the probe to the external ear canal. The amount of positive pressure is predetermined and can be set as high as +300 daPa. While pressure is being applied the patient is instructed to swallow. If the Eustachian tube opens, a drop in pressure is recorded. A positive test result will show a "stair step" effect or a complete drop to 0 daPa as the Eustachian tube opens. The graph displays the vertical axis as pressure, and the horizontal axis as time.

Highlight ETF Perforated from the main menu and press the ENTER button ⑬ or press the **ETF**-key ⑯ to advance to the Eustachian Function Test screen. It is not necessary to run a tympanogram before running this test.

Press the **ETF**-key ⑯ again and the text ETF perforated occurs at the upper right corner of the LCD display ⑤.

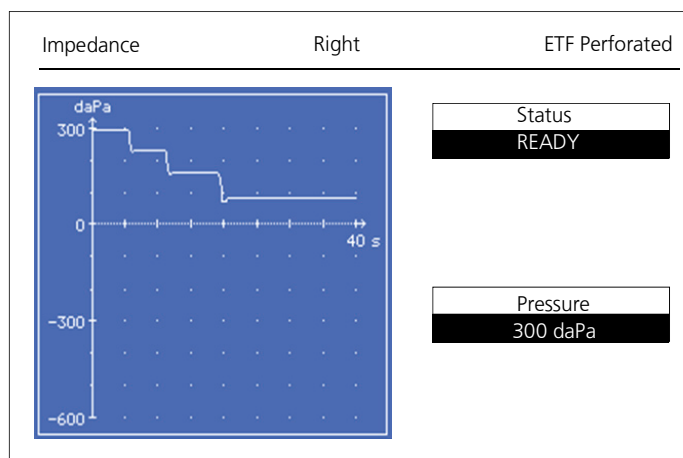


Figure 33
The ETF test perforated TM

Set the maximum pressure using the **Up-Cursor** ▲ ⑫ or **Down-Cursor** ▼ ⑩ buttons.

Connect the probe as described in chapter 7 "Reflex decay test". Place an appropriately sized ear tip firmly on the probe tip. Insert the tip into the ear canal, well enough to make a seal and provide support for the probe tip.

Instruct the patient not to move or talk until the test is over, as any sound or movement will give unreliable results.

Press the ENTER button ⑬ when ready to begin the test. Pressure will increase to the predetermined setting. Let the pressure run a few seconds at peak pressure to verify a successful seal.

Once the peak pressure has been obtained ask the patient to swallow. If the Eustachian tube opens, a drop in pressure will be recorded. Repeated



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attempts to swallow will display a "stair case" effect, or a complete drop to 0 daPa.

The test will stop after the allotted 40 seconds have elapsed.
After a test you can print out the result for your documents by pressing the blue PRINT-key ①.



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9 Interpreting Test Results

9.1 Understanding the printout

The printout contains the following information: Ear volume, Compliance, Pressure, Gradient, Reflex Test Results (PASS, FAIL) and IPSI, CONTRA or Tympanogram (depending on the test you have done). This information provides the data you need to interpret the test results.

A graph of the Tympanogram is provided (Figure 34) to assist you in visual interpretation of the test. This graph is a representation of the relative mobility of the middle ear system. The horizontal axis shows the changes in air pressure and the resulting mobility of the system. The compliance is recorded on the vertical axis. This mobility is expressed as a change in the volume of the ear canal in ml.

The reflex is shown in up to four graphics with time on the horizontal axis and the change of the compliance on the vertical axis.

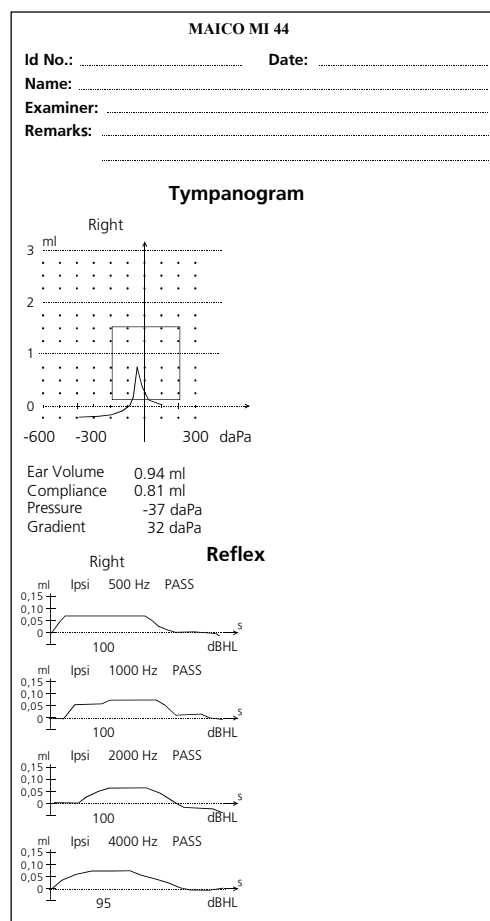


Figure 34 - Printout of a Tympanogram

9.2 Interpreting the tympanometric test result

As a general rule, values for ear canal volume should be between 0.2 and 2.0 ml (children and adults). A variance will be seen within this range depending on the age and ear structure of the person. For example, a 2.0 ml or larger reading in a small child could indicate a perforation in the tympanic membrane, while it may be a normal reading in an adult. You will become more familiar with the normal ranges when you use the instrument.



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The normal range for compliance is 0.2 ml to approximately 1.8 ml. A compliance peak within the range indicates normal mobility of the middle ear system. A peak found outside of these limits may be indicative for one of several pathologies.

Middle ear pressure should be equivalent to ambient air pressure (0 daPa on an air pressure scale). Minor shifts of the peak compliance to the negative may occur with congestion and are rarely to the positive side. Establish criteria for abnormal negative pressure when you become more familiar with using the equipment. It is generally accepted that negative pressure of greater than -150 daPa indicates a referral for medical evaluation.

9.3 Abnormal Values

It is the purpose of this section to provide samples of tympanograms which reflect abnormal states of the middle ear mechanism. It is not the intention of this section to provide you with a complete guide to interpreting results. Complete information regarding pathologies and abnormal impedance testing can be found in the literature referenced.

A perforation in the tympanic membrane will cause a high ear canal volume measurement because the instrument will measure the volume of the entire middle ear space. The MI 44 may refuse to run the test, with the probe indicating a volume out of tolerance by illuminating the red light, or a flat tympanogram will be recorded since no movement will occur with a change in air pressure. Without a peak compliance of at least 0.1 ml, the reflex test will not initiate.

An extremely flaccid tympanic membrane or an ossicular chain discontinuity will yield a very high peak compliance in the presence of normal middle ear pressure. Ear canal volume will be normal and the reflex will be absent.

A fixation of the ossicular chain, as in otosclerosis, will produce a tympanogram with very low compliance in the presence of normal middle ear air pressure. Ear canal volume is normal and the reflex is absent.

Middle ear fluid such as serious otitis media will yield a very flat tympanogram with no definite peak and negative air pressure. A resolving case or beginning case may produce a reduced peak in the presence of severe negative middle ear pressure. The ear canal volume is normal and the reflex is either absent or at an elevated level.



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Eustachian tube dysfunction in the absence of fluid will show a normal compliance curve, but it will be displayed to the negative side of the tympanogram. Ear canal volume will be normal and the reflex may be present, depending on the degree of involvement.



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10 How to test children

The practice of the impedance measurement is difficult especially with small children. You could have problems with the child being restless or afraid of the examination or reacting sensitively to the change of pressure and the loud test sound but also with different conditions of the eardrum and the middle ear which do not appear in ears of adults.

During the measurement the minimum compliance must come to 0.08 ml, if it is less a straight line runs over the zero line.

It is difficult to reach a probe seal with restless children. If the child yawns or cries it is impossible for the instrument to create a stable pressure in the outer auditory canal. In addition speaking cause's stapedius muscle reflexes which lead to a permanent change of the compliance of the eardrum.

So the child should be made familiar with the surroundings and the ear being touched by the probe in order to carry out a successful impedance measurement. This could be done by getting in touch with the child and by touching the ear in a playing way with the probe. If you can touch the ear without problems the child will normally accept the probe being inserted.

If the child has accepted the surroundings and the touch of the ear it is important to distract the child's mind from the measurement. Here you can succeed in diverting the child by many different methods. Your phantasy is nearly unlimited; you just have to avoid loud sound.

In case you measure very small children and have to calm them with e.g. a dummy or a tea-bottle the result might be slightly falsified, maybe by a slightly irregular line of the Tympanogram.



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11 Recommended literature

Auditory Disorders: A Manual for Clinical Evaluation

Jerger, Susan, and James Jerger
Boston: College Hill Press, 1981

Handbook of Clinical Audiology

Katz, Jack
Baltimore: William & Wilkins, 1994

s Audiology Desk Reference

Roeser, Ross J.
New York / Stuttgart: Thieme, 1996

Auditory Diagnosis

Silam, Shlomo and Carol A. Silvermann
San Diego / London: Singular Publishing
Group, 1997



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12 Individual Setup of the MI 44

While getting familiar with the MI 44 in the previous chapters you had the chance to find out how easy the instrument is to control. You can carry out all normal measurements and print them out, too.

In addition the MI 44 offers many "hidden" chances for the experienced user to adapt the instrument to his individual demands.

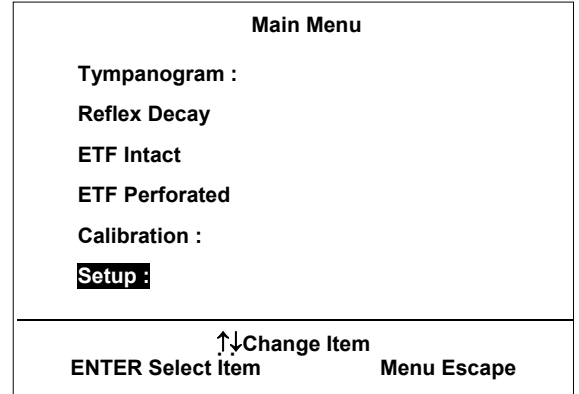


Figure 35
Main Menu (Setup activated)

In the following all the setup options are treated precisely. The settings shown in the figures are the standard settings. If you have altered a value by accident you just have to return to the standard setting shown here and the instrument will work as before.

By pressing the menu key ⑧ you can return from every sub-menu to the main menu and after all to the Tympanometry mode.

You can change the menu options with the cursor keys: Up ⑫, Left ⑨, Down ⑩ and Right ⑪. The menu option actually selected is marked inverse on the LCD display ⑤ (SETUP in the example Figure 35). You select the chosen menu option by pressing Enter ⑬.

12.1 The setup menu

Select the menu option SETUP as illustrated in Figure 36 and the main setup menu will appear on the LCD display ⑤. You can make different settings for the measurement of the tympanogram and the stapedius reflex, for instrument setup (for example the contrast of the LCD display ⑤). All your settings are saved permanently until you will change them again. The settings also survive when the instrument is switched off.

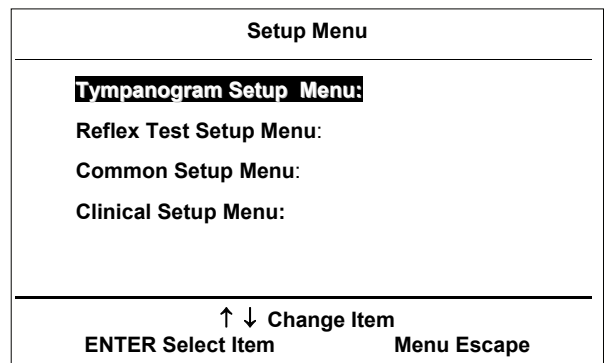


Figure 36 Main Menu (Setup activated)



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12.2 The Tympanogram Setup Menu

Select the menu option “Tympanogram Setup Menu”: as illustrated in Figure 35 and the Tympanogram setup menu will appear on the LCD display ⑤.

You change the menu options with the cursor keys DOWN ⑩ respectively UP ⑫. You can change the invers displayed item with the cursor keys LEFT ⑨ respectively RIGHT ⑪. The following settings are possible:

Pump speed:

With this option you can set the measurement speed. With “Automatic” the pump speed adjusts automatically to the test conditions. It is possible to choose also Minimum, Medium or Maximum. Of course a lower pump speed creates a higher precision of the measurement but needs more test time.

Tympanogram Setup Menu	
Pump Speed:	Automatic
Display limits:	ON
Press. Limit hi.:	150 daPa
Press. Limit Lo.:	-400 daPa
Comp Limit hi.:	1.5 ml
Comp. Limit lo.:	0.1 daPa
Seal sensitivity:	Medium
↑ ↓ Change item	
ENTER choose item	MENU Escape

Figure 37
Tympanogram Setup Menu

Display limits:

With ON you switch on the “field for normal curves” surrounded by a broken line in the Tympanogram. With OFF you switch it off.

Press. Limit hi:

With this option you can set the right limit of the box for normal Tympanograms to a value between 0 daPa and +200 daPa in steps of 25 daPa.

Press. Limit lo:

With this option you can set the left limit of the box for normal Tympanograms to a value between -400 daPa and -25 daPa in steps of 25 daPa.

Comp. limit hi:

With this option you can set the upper limit of the box for normal Tympanograms to a value between 0.1 ml and 3 ml in steps of 0.1 ml.



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Comp. limit lo:

With this option you can set the lower limit of the box for normal Tympanograms to a value between 0.1 ml and 1ml in steps of 0.1 ml.

Seal sensitivity:

Minimum: This gives reproducible results. Requires quiet probe handling.

Medium: Quicker seal detection and less sensitive than the above selection.

Maximum: Quick seal detection. AGC on the probe tone is disabled.

High Probe Tone Frequency:

Preset the high tone frequency that should be assigned to the TYMP Tone button: 678 Hz, 800 Hz or 1000 Hz.

To leave the Tympanometry Setup Menu press the MENU button ⑧.



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12.3 The Setup menu for Reflex Test

Select the menu option “Reflex Test Setup Menu”: from the main setup menu as described before for the Tympanometry setup menu and the reflex setup menu will appear on the LCD display ⑤.

The reflex setup menu offers the following options:

Auto start dB:

With this option you can choose the acoustic pressure level the MI 44 starts the reflex level measurement with if the automatic identification of the reflex threshold is switched on. You can choose the acoustic pressure levels from 70 dB_{HL} till 100 dB_{HL} in steps of 5 dB.

Auto maximum dB:

With this option you can choose the maximal acoustic pressure level the MI 44 uses if the automatic identification of the reflex threshold is switched on. You can choose the maximum acoustic pressure levels from 80 dB_{HL} till 120 dB_{HL} in steps of 5 dB.

Reflex sensitivity:

With this option you select the sensitivity of the stapedius reflex detection. With the setting “Sensitive” small changes of the compliance will achieve PASS as test results. With the setting “Robust” a larger compliance change is needed to detect a PASS. The setting “Normal” is the default setting.

Print graphic:

With this option you can switch ON and OFF the printout of the graphic reflex display for documentation.

500 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 500 Hz.

Reflex Test Setup Menu	
Auto start dB	: 80
Auto maximum dB:	105
Reflex Sensitivity:	Sensitive
Print graphic:	OFF
500 Hz :	ON
1000 Hz:	ON
2000 Hz:	ON
4000 Hz:	ON
Noise 1:	OFF
Noise 2:	OFF
IPSI AGC:	ON

↑ ↓ Change item
ENTER choose item MENU Escape

Figure 38
MI 44 Reflex setup Menu



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1000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 1000 Hz.

2000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 2000 Hz.

4000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 4000 Hz.

With this option you can switch on and off the stapedius reflex test for 4000 Hz.

Noise 1 / Noise 2:

Three different Noise Stimuli available:

Off: No noise or

LP: Low Pass – 500 – 1600 Hz

HP: High Pass – 1600 – 10.000 Hz

WN: White Noise – 500 – 10.000 Hz

Ipsi AGC:

With this option you can switch ON and OFF the automatic gain control (AGC) of the ipsi lateral test level.

With the setting ON the reflex test level in the ear is automatically adjusted to the desired test level compensating the effect of different ear canal volumes.

With the setting OFF the reflex test level in the ear is not adjusted to the individual ear canal volume.

To leave the Reflex Test Setup Menu for reflex press the MENU button ⑧.

12.4 The Common Setup Menu

Select the menu option “Common Setup Menu” from the main setup menu as described before and the common setup menu will appear on the LCD display ⑤.

The common setup menu offers the

Common Setup Menu	
Power-up:	: Tymp
High Probe Tone	: Off
Communication	: USB
Remote Switch	: L/R
Subject Data Printout	: ON
Clinic Data Printout	: ON
Print after Test	: OFF
Language	: English
Display adjust	:
↑ ↓ Change item	
ENTER choose item	MENU Escape

Figure 39
MI 44 common Setup Menu



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following options:

Power-up:

With this option you can choose the test mode of the MI 44 after switching on. With the setting Tymp only tympanometry is tested after power-up. With Tymp and Reflex tympanometry and reflex is tested after power-up.

High Probe Tone:

Default setting is OFF. Default probe tone is 226 Hz. With High Probe Tone ON the probe tone switches to 678 Hz, 800 Hz or 1.000 Hz which is selected in the Tympanogram Setup menu 12.2.

Communication USB:

This is only the reference to the USB interface.

Remote Switch:

With this option you can change the function of the probe button $\text{\textcircled{M}}$. You can choose between:

L/R where the test ear can be selected with the probe button $\text{\textcircled{M}}$

Pause where the test can be paused and restarted with the probe button $\text{\textcircled{M}}$

L/R or Pause where the test ear can be selected and the test can be paused and restarted with the probe button $\text{\textcircled{M}}$.

Subject Data Printout:

With this option you can switch ON and OFF the printout of the headline which allows you to enter the data of the patient.

Clinic Data Printout:

If you entered your clinic data the printout of the entered data can be switched ON and OFF with this option.

Print after test:

With this option you enable an automatic printout after you finished a test by setting it ON. With the setting OFF the printout will be only done after you press the PRINT button $\text{\textcircled{1}}$.

Language:

You can choose one of the languages German "Deutsch", French "Francais", English and Spanish "Espanol" for the text on the LCD display



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and the printout. After selection all the texts appear in the chosen language.

Display adjust:

The contrast of the LCD-display ⑤ can be changed with this option.

12.5 Insert your personal printout data

Select the menu option Clinic Setup Menu from the main setup menu to enter all required data of your clinic. These data will be printed out later together with the test result and the patient data. This screen is self explaining.

- Characters, numbers and signs can be chosen by up and down arrow keys
- Change position by left and right arrow keys
- Delete with REFLEX key
- Tab with ENTER key
- Exit with MENU key



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13 Care and maintenance of the instrument

Disconnect the power plug before cleaning!

To clean the instrument, probe, contralateral receiver and other accessories use a soft cloth dampened with a little warm soapy water or washing-up liquid; no alcohol or spirits should be used.

During cleaning, please ensure that no liquid runs into the switches, level control or probe openings.

Cleaning of Ear Tips

We recommend using a new ear tip for each patient. If the clinician rinses the ear tips they should be subjected to standard disinfection procedure between patients. This includes physically cleaning the ear tip and use of a recognized disinfectant. Individual manufacturer's instruction should be followed for use of this disinfecting agent to provide an appropriated level of cleanliness.

13.1 Cleaning of Probe Tip

In order to secure correct impedance measurements it is important to make sure that the probe system is kept clean at all times. Therefore please follow the below illustrated instruction on how to remove e.g. cerumen from the small acoustic and air pressure channels of the probe tip.

For the MI 44 two different probe systems exist; the Screening Probe System and the Diagnostic Probe System.

The two different probe systems can be seen in the below picture:



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Figure 40:



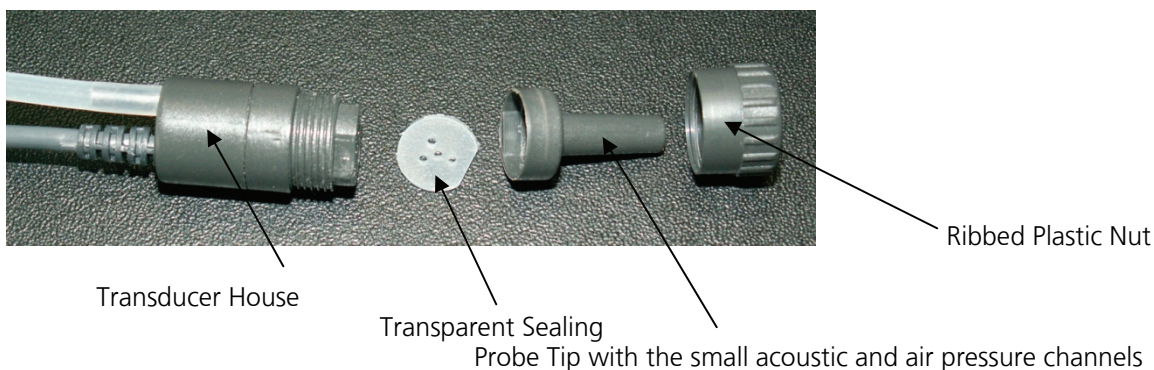
To clean the small acoustic and air pressure channels of the probe tip unscrew the small ribbed plastic nut that holds the probe tip:

Figure 41:



After unscrewing the small ribbed plastic nut it is possible to detach the small probe tip with the small acoustic and air pressure channels from the transducer house:

Figure 42:





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The cleaning of the acoustic and air pressure channels of the probe tip must be performed by means of the cleaning wire which can be found in the Ear tips Assortment provided with the MI 44.

When cleaning the acoustic and air pressure channels of the probe tip the cleaning wire must be inserted from the back of the probe tip according to Figure 43:

Figure 43:



Besides cleaning the holes ensure also a proper surface cleaning of the transparent sealing.

After cleaning all the acoustic and air pressure channels of the probe tip it can be reassembled. Make sure that the Probe Tip is connected correctly onto the Transducer Housing – a small flange will ensure correct positioning - before the plastic nut is gently tightened.

Figure 44





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Figure 45:

The cleaning tool: (Consisting of 3 parts: cleaning hooks, wire with brush and hand grip)

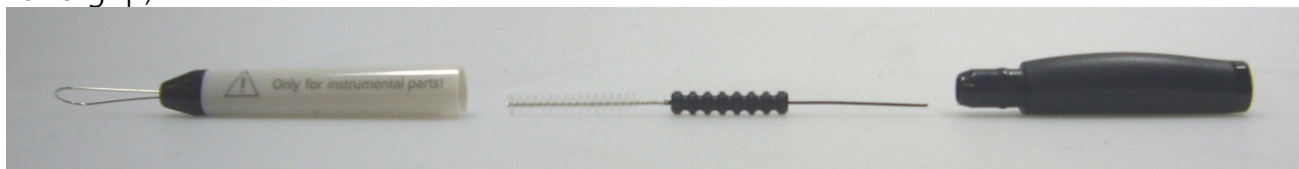


Figure 46:

With the hook of the cleaning tool you can remove cerumen from the ear tips.





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14 How to change the printer paper

Open the printer at the right side of the housing by pulling up the printer cover ⑥ using its finger mould in front.

Remove the printer cover ⑥.

Remove the empty paper roll.

Place the new paper roll in the paper compartment in such a way that the paper ascends from the lower part of the paper roll.

Pull the blue lever, which is located on the right front of the printer, into its forward position.

The paper must roll from the bottom because it is coated on one side only.

If it is inserted wrongly, no printout is visible!

Gently insert the paper end between the rubber roll and the black plastic part at the rear of the printer.

Transport the printer paper until it appears from the upper part of the rubber roll. Pull then the paper end app. 10 to 15 cm.

Push the blue lever into its backward position.

Guide the paper end through the paper slot ⑦ of the printer cover ⑥.

Close the printer cover ⑥ by putting the two guide rails at the end of the printer cover ⑥ into the appropriate slot of the paper compartment of the housing of MI 44. Press the front of the printer cover ⑥ down until it fastens.

The instrument is now ready to print.



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15 Warranty, Maintenance and Service

The MI 44 Tympanometer is guaranteed for 1 year. This warranty is extended to the original purchaser of the instrument by MAICO through the Distributor from whom it was purchased and covers defects in material and workmanship for a period of one year from date of delivery of the instrument to the original purchaser.

The tympanometer may be repaired only by your dealer or by a service centre recommended by your dealer. We urgently advise you against attempting to rectify any faults yourself or commissioning non-experts to do so.

In the event of repair during the guarantee period, please enclose evidence of purchase with the instrument.

In order to ensure that your instrument works properly the tympanometer should be checked and calibrated at least once a year. This check has to be carried out by your dealer.

When returning the instrument for repairs it is essential to also send the probe and all other accessories.

Send the device to your dealer or to a service centre authorized by your dealer.

Please also include a detailed description of the faults.

In order to prevent damage in transit, please use the original packing if possible when returning the instrument.

NOTE:



Within the European Union it is illegal to dispose electric and electronic waste as unsorted municipal waste. According to this, all MAICO products sold after August 13, 2005, are marked with a crossed-out wheeled bin. Within the limits of Article (9) of DIRECTIVE 2002/96/EC on waste of electrical and electronic equipment (WEEE), MAICO has changed their sales policy. To avoid additional distribution costs we assign the responsibility for the proper collection and treatment according to legal regulations to our customers.



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16 Safety Regulations

16.1 Electrical Safety:



The MI 44 tympanometer is constructed to comply with protection class I, Type BF of the international standard IEC 60601-1.

Protection from an electric shock is ensured even without the system earth connection.

The instruments are not intended for operation in areas with an explosion hazard.

16.2 Measuring security: To guarantee that the tympanometer works properly, the instrument has to be checked and calibrated at least once a year.

The service and calibration must be performed by an authorized service centre. In accordance with the regulations of the EU medical directive we will drop our liability if these checks are not done.

The use of non-calibrated Tympanometers is not allowed.

16.3 Device control:

The user of the instrument should perform a subjective instrument check once a week. This check can be done following the list for subjective instrument check (see next page). For your own security, you should copy the enclosed list, fill it in once a week and store it in your files.

16.4 Operation:

Only skilled personnel (Audiologists, ENT professionals or other with equivalent knowledge) should operate the instrument.

16.5 Patient Safety:

Please note that if connection is made to standard equipment like printers and network, special precautions must be taken in order to maintain medical safety.

Connecting this device to other devices in order to make a system may cause the safety



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specifications to be invalid. It is therefore recommended to insert a galvanic separation between the device and the host computer, unless the computer is battery operated or supplied by a medical approved power supply. Galvanic separation must fulfill the EN 60 601-1.



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17 Checklist for subjective device control

According to the manufacturer requirement the user should control the instrument once a week to find errors immediately and to avoid wrong test results. He should test Tympanogram and Reflex with an otologic normal person and compare the results with earlier measurements. The printout should be filed together with the subjective test protocol to the documents of the instrument. The test person should be healthy (no otitis etc.) and should by at least 12 hours not exposed to loud noise.

Instrument type:

Serial-No.:

Stick here the printout of Tympanogram and Reflex test for both ears

Test person:

- Connectors and cables OK?
- Instrument and probe?
- Is the green light of the probe blinking?
- Probe tip and ear tip clean?
- Are all controls easy to use?
- Are the test signals clear and non-distorted?

Reflex test	500 Hz	1000 Hz	2000 Hz	4000 Hz
right ear				
90 dB _{HL}				
Reflex test	500 Hz	1000 Hz	2000 Hz	4000 Hz
left ear				
90 dB _{HL}				

If significant differences or damages are found please inform the service.

Tested by:

Date:



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18 Technical Data and Accessories



The Impedance meter MI 44 is an active, diagnostic medical product according to the class IIa of the EU medical directive 93/42/EEC.

Impedance measurement:

Type: Class 1 acc. to IEC 645-5 (EN 60645-5)

Tympanometer:

Test frequency: 226 Hz \pm 1% 85 dB_{SPL} in 2 cm³
678 Hz, 800 Hz, 1000 Hz
 \pm 1% 83 dB_{SPL} in 2 cm³

Pressure range: +200 to -400 daPa automatic mode
+300 to -600 daPa manual modus

Volume range: 0,1 to 6,0 ml

Accuracy: \pm 5 % or \pm 10 daPa

Compliance range: 0,1 to 6,0 ml

Reflex measurement:

Test frequencies: 500 Hz, 1 kHz, 2 kHz, 4 kHz \pm 2%

Test signals: Noise Stimuli in LP, HP and WN

Test method: ipsi lateral, contralateral

Intensities ipsi: 70 dB_{HL} ... 105 dB_{HL} (for 4 kHz ... 100 dB_{HL})

Intensities contra: 70 dB_{HL} ... 110 dB_{HL} (with button contra phone) optional
70 dB_{HL} ... 120 dB_{HL} (with TDH 39 contra phone)

Ipsilateral setting: automatic or manual

Ipsilateral reflex test: with AGC

Attack/release time: typical 10 ms

Pressure at test: Pressure @ max. compliance

Eustachian Tube Mode:

Pressure range: +400 to -400 daPa

General:

Test program: Reflex test selectable

Memory: Storage of test results for both ears

Probe: probe with diagnostic insert



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- LCD-display:** Graphical display of the Tympanograms and reflex curves, numeric display of max. compliance, pressure at max. compliance, canal volume, gradient and reflex thresholds
- Printer:** Thermal printer, paper roll width 110 mm
- Printing time:** 4 s (one Tympanogram) to 12 s (Tympanogram and Reflex for both ears)
- Power supply:** Mains 100 ... 240 V ~, 50/60 Hz
- Power consumption:** app. 25 VA

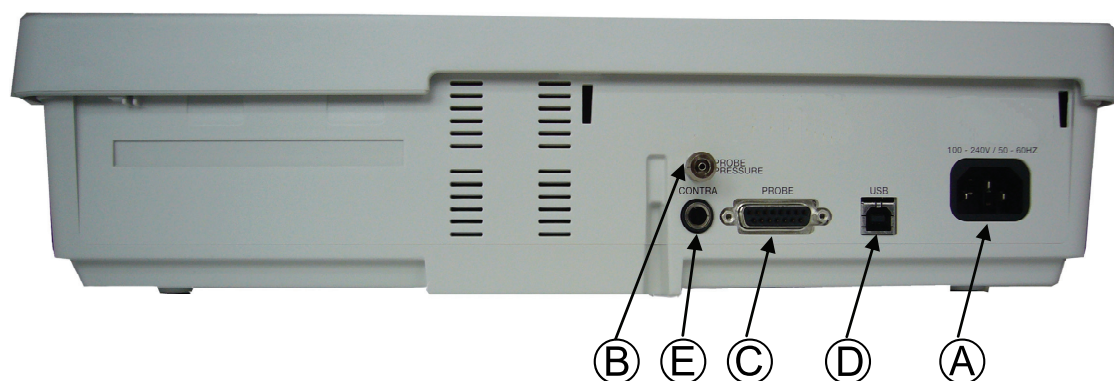


Figure 45 Connectors on the rear

Connection plugs:	Connection	Specification
Ⓐ mains connection socket	left/right=power,	100 ... 240 V~ 50 Hz
Ⓑ probe tube connection		
Ⓒ probe connection socket		
Ⓓ PC-interface		USB
Ⓔ contra receiver socket	sleeve=GND, tip=out	ZA=10 Ω, UA=8 Veff

Warm up time: less than 10 min after power on

Environment

Conditions: +15 ... +35 C / +59 ... + 95° F (operation)
+ 5 ... +50 C / +41 ... +122° F (storage)
Maximum humidity 90 % (storage and operation)



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Dimensions: W x D x H: 39 x 29 x 11 cm

Weight: app. 2,6 kg

Standard accessories:

- 1 hand-held probe with diagnostic probe inserts
- 1 shoulder strap for diagnostic probe
- 1 screening probe insert
- 1 contra phone receiver TDH 39 with headband
- 1 power cable
- 1 Connector cover
- 1 set of ear tips
- 1 calibration cavity (cavities 5ml, 2ml, 0,5ml) with probe holder
- 1 printer paper rolls (for app. 350 printouts)

Optional accessories:

- | | |
|---------------------------|-------------------------|
| Button receiver and cable | Part No. 4793 +1025+350 |
| Carrying case | Part No. 70 50 14 |
| Soft side carrying case | Part No. 1035-3002 |

Consumables:

- | | |
|---------------------------------------|-------------------|
| 1 roll printer paper | Part No. 70 50 78 |
| 1 set of 10 Ear tips yellow (7,4 mm) | Part No. 70 50 56 |
| 1 set of 10 Ear tips green (9 mm) | Part No. 70 50 57 |
| 1 set of 10 Ear tips white (11 mm) | Part No. 70 50 58 |
| 1 set of 10 Ear tips yellow (12,5 mm) | Part No. 70 50 59 |
| 1 set of 10 Ear tips green (15 mm) | Part No. 70 50 60 |
| 1 set of 10 Ear tips blue (18 mm) | Part No. 70 50 61 |



Operating Instructions MI 44

Specifications are subject to change.



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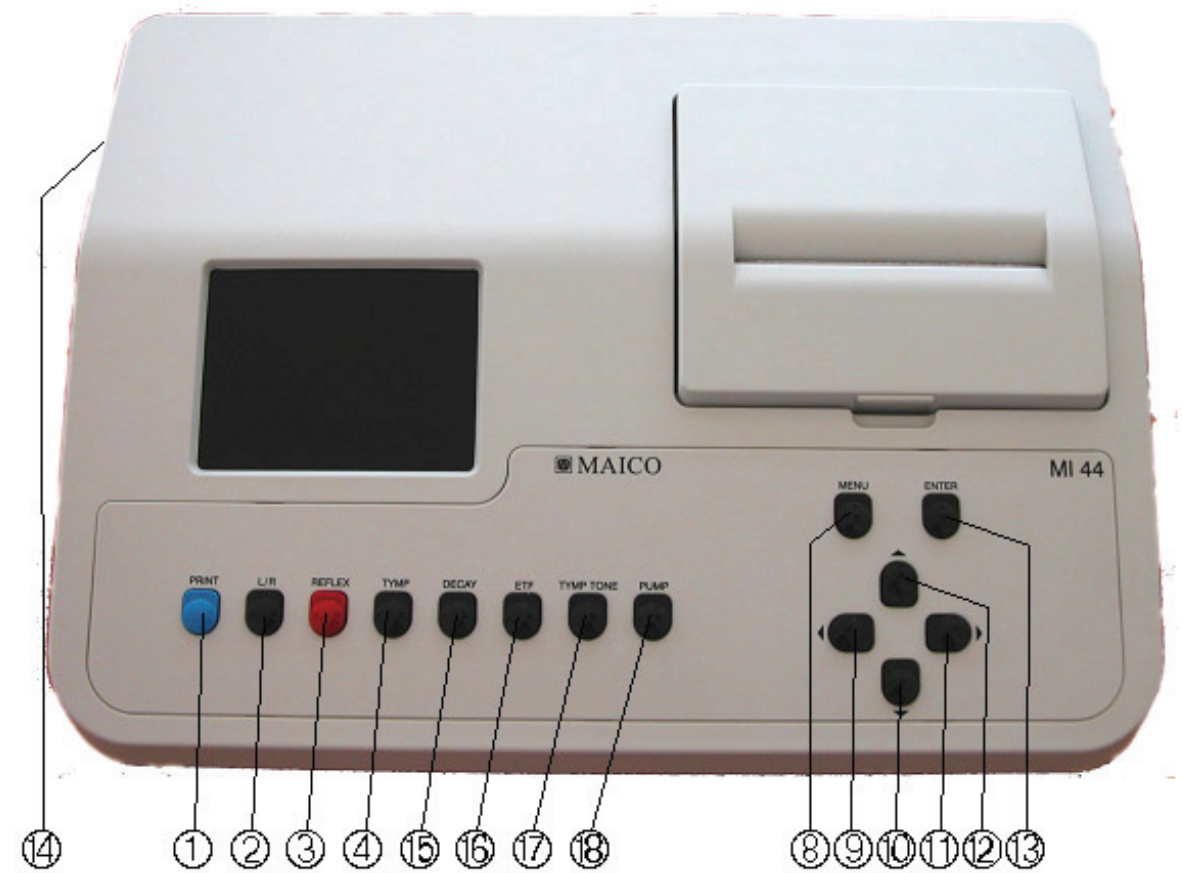
Telefax (++49) 30 70 71 46 - 99

internet: www.maico.biz

e-mail: export@maico.biz

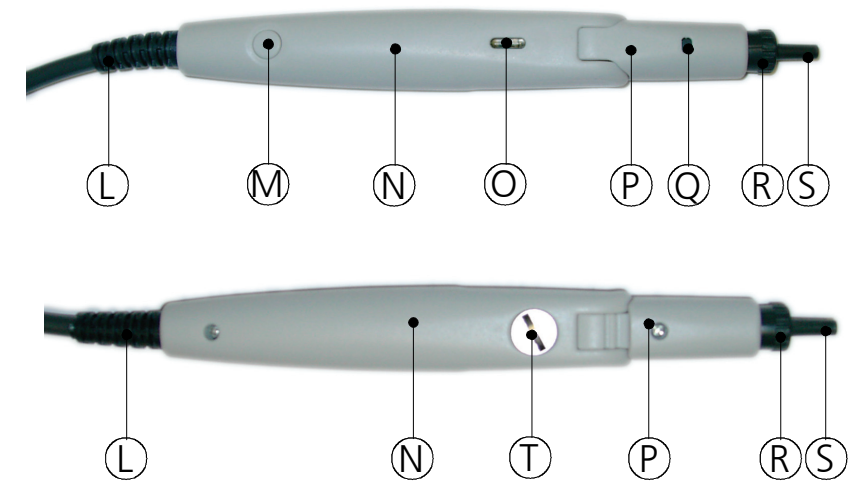
Front cover with display, controls and printer

- ① = Prints the test results
- ② = L/R - Changes test ear from left to right, or right to left
- ③ = REFLEX - Changes the reflex testing modes from IPSI to CONTRA, NO REFLEX or probe tone
- ④ = TYMP - selects tymp and reflex testing mode
- ⑤ = LCD-Display
- ⑥ = Printer cover
- ⑦ = Paper slot with paper cutting edge
- ⑧ = MENU - Enters the main menu screen
- ⑨ = Left-Cursor ◀ - Decreases the frequency (Hz) for reflex testing
- ⑩ = Down-Cursor ▼ - Decreases the intensity level (dB) of reflex testing
- ⑪ = Right-Cursor ▶ - Increases the frequency (Hz) for reflex testing
- ⑫ = Up-Cursor ▲ - Increases the intensity level (dB) of reflex testing
- ⑬ = ENTER ← - Enters the highlighted menu or the highlighted option
- ⑭ = ON/OFF SWITCH - Power switch; 1 is ON, 0 is OFF
- ⑮ = Decay -selects reflex decay testing mode
- ⑯ = ETF -selects eustachian tube function test
- ⑰ = Tymp Tone -selects tymp tone either 226 Hz or high frequency probe tone
- ⑱ = Pump -selectable manual pump control tympanometry with pressure ranges and pump speeds



Probe

- Ⓛ = Probe cable
 - Ⓜ = Probe button -Changes the test ear and/ or pauses the test
 - Ⓝ = Probe handle
 - Ⓞ = Indicator light - blue = left ear selected
- red = right ear selected
- green = test in progress
- yellow = probe fit error (leakage or blocked)
 - Ⓟ = Probe head - adjustable in three angles (0°, 60°, 85°)
 - Ⓠ = Release button for probe insert
 - Ⓡ = Fixation ring for probe tip
 - Ⓢ = Probe tip
 - Ⓣ = Fixation screw for probe head
 - Ⓤ = Diagnostic probe insert
 - Ⓥ = Diagnostic probe connection cable
 - Ⓦ = Diagnostic probe connection cable
- Part Ⓡ, Ⓢ, Ⓤ, Ⓥ, Ⓦ are one unit



Rear panel control and connectors

- Ⓐ = AC POWER - Connection for AC power cord (100 ... 240 V~ 50/60 Hz)
- Ⓑ = PRESSURE TUBE CONNECTION - Pneumatic connection for the probe cable
- Ⓒ = PROBE CABLE CONNECTION - Connection for probe cable
- Ⓓ = USB - Connection for computer interface
- Ⓔ = CONTRALATERAL PHONE CONNECTION - Jack for contralateral reflex phone (optional)

