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With this instruction manual, we present a useful tool which reflects all the fitting possibilities of our new

QUATTRO SYSTEM

- an acoustical and technical breakthrough, which presents important new possibilities for hearing rehabilitation which will prove to be evidently advantageous for your patients.

The system is, however, of little use if it is not thoroughly understood and appreciated by you, the fitting expert.

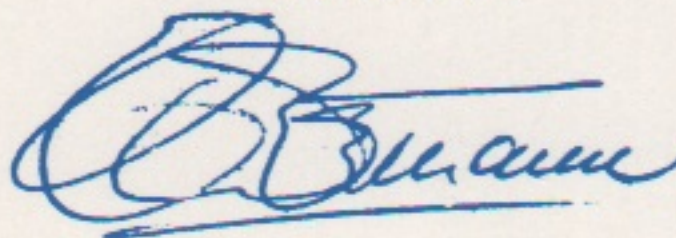
We at Widex, therefore, strongly recommend that you study the manual with utmost care before the fitting of the QUATTRO takes place.

Once you have acquainted yourself entirely with its contents, you will have an easily accessible reference book, where you can search for specific answers under the various headings.

The binder shape allows us to update the manual continuously. Although a considerable amount of research and tests have been carried out, we realize that we are on entirely new ground with this new system, and we therefore appreciate and welcome any suggestions and feedback from you, so that we can pass it on to your colleagues, worldwide.

Erik Westermann

President.





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The QUATTRO system designed for the fitting of hearing loss and optimization of listening comfort consists of a remote control and one or two earlevel hearing instruments (Q8). The remote control communicates with the hearing instrument(s) via radio waves permitting the remote control to be used without having visual contact with the hearing instrument(s).

The remote control serves two different purposes:

1. It is the patient's tool for adjusting the hearing instrument(s)
2. When a special programming key has been inserted at the back of the remote control it also functions as the programming unit, choosing and storing the different settings.

The QUATTRO has four different listening programs for different listening situations. Each program may be programmed independently, and in case of binaural fittings, there are four programs for each ear. ►



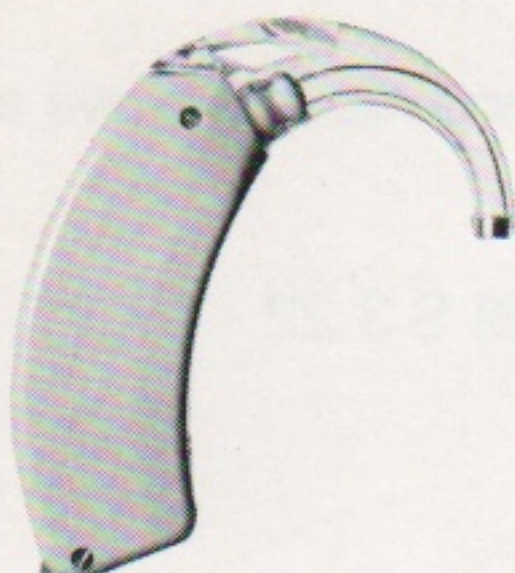
The programming is carried out in close cooperation with the patient, who is able to listen to the effects of the adjustments, as each adjustment is transmitted instantly to the hearing aid(s). This subjective factor may be combined with objective insertion gain measurements to obtain "double assurance" of an ideal fitting.

With traditional hearing instruments, even the very best fitting will always represent a compromise between the various listening situations of the hearing impaired. A balance is found somewhere between listening comfort in quiet surroundings and speech intelligibility in noisy surroundings. Unfortunately, the chosen setting will be ideal in neither of the two environments.

Having four programs in the QUATTRO means that fitting compromises are no longer needed. One program is used for quiet surroundings, one for speech intelligibility in noisy surroundings, and there are still two programs left for other environments. So, depending on the environment and the purpose of listening, the user can select at random THE program and THE response that suits each particular situation best.

As each Q8 has its own ID code, the risk of interference from other nearby transmitters has been virtually eliminated. The individual ID numbers also makes it possible for the remote control to distinguish between the right and left Q8, e.g. when adjusting the volume.

On the following pages you will find a description of the Q8 and the remote control, as well as a guide to the programming. Finally, we shall recommend a couple of programming procedures: which settings to choose for what environments.



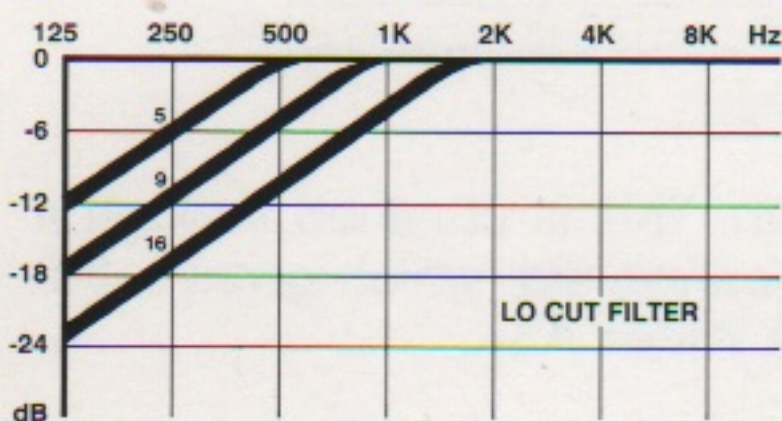
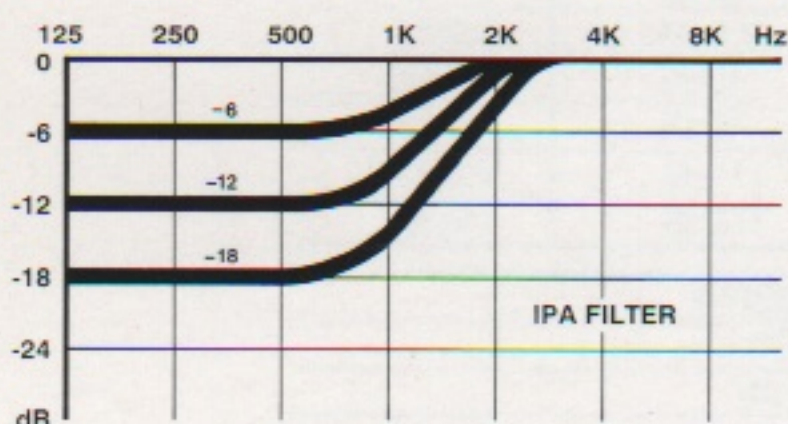
The Q8 is a small, unobtrusive BTE instrument with an up/down digital volume control.

Before moving on to the actual data, it is useful to have a look at the filter functions as such. The QUATTRO has three adjustable filters:

IPA Filter

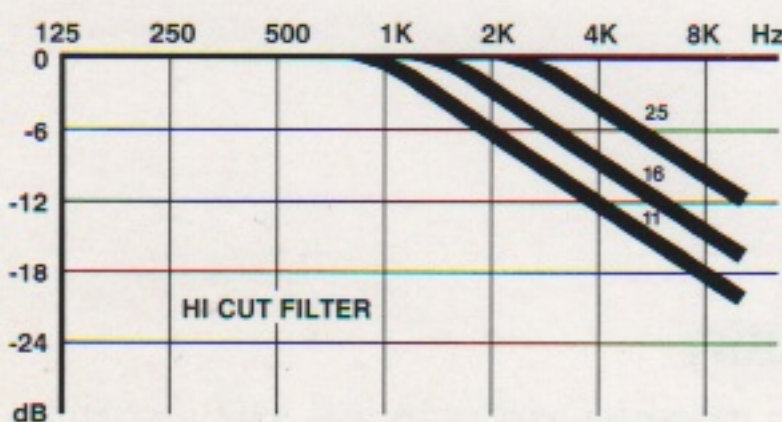
(Inverse Presbycusis Adaptation)

This filter has been specially designed to accomodate the typical "old age" sloping hearing loss, and it can be used in any combination with the High Cut and Low Cut filters. It attenuates the low frequencies in such a way that a characteristic is obtained corresponding to that of an "adjustable" stepped response microphone.



Low Cut Filter

A normal Low Cut filter where you adjust the cut-off frequency. The setting of this filter should be based primarily upon the noise environment.



High Cut Filter

The High Cut can be programmed to take place at different frequencies.



After these general observations on the filter functions, let us have a look at the Q8 and its data.

The performance characteristics: (ANSI S 3.22 - 1987)

Supply Voltage: 1,3V

Coupler: 2cc HA-2

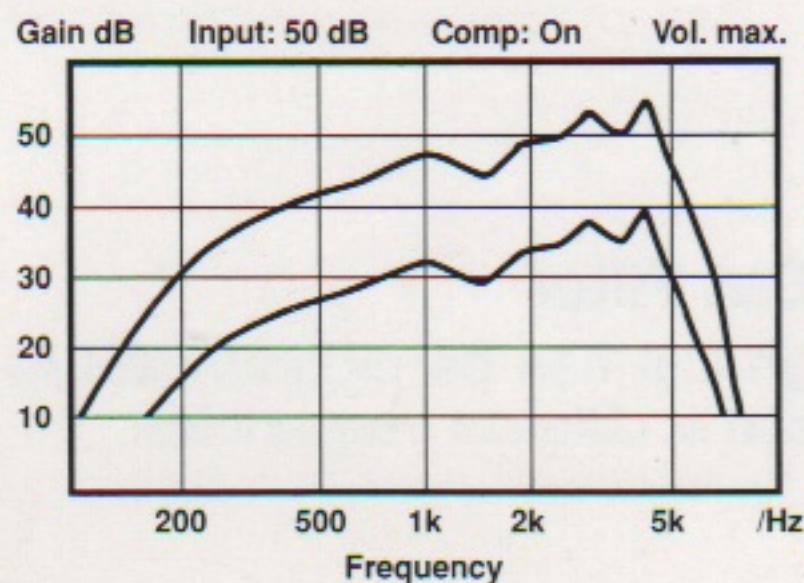
Internal Impedance: 6ohm

Tube: 2Øx25mm

Output Control	0 dB	-3 dB	-6 dB	-10 dB
HF Avg. Gain (comp: Off)	48 dB	48 dB	48 dB	48 dB
HF Avg. SSPL 90 (comp: Off)	118 dB	118 dB	112 dB	108 dB
Peak SSPL 90 (comp: Off)	121 dB (124)	118 dB	115 dB	111 dB
Battery Current Drain	2,5 mA (2,8)	2,2 mA	2,1 mA	2,0 mA
* Battery Type 13 Zinc/Air	90hrs.	105hrs.	110hrs.	115hrs.
HF Avg. Full On Gain (comp: On)	48 dB	48 dB	48 dB	48 dB
HF Avg. SSPL 90 (comp: On)	113 dB	112 dB	111 dB	110 dB
Peak SSPL 90 (comp: On)	118 dB (124)	118 dB	116 dB	114 dB
Frequency Range	170 - 6500 Hz			
Harmonic Distortion 500 Hz	4% (7)			
Harmonic Distortion 800 Hz	1,5% (3)			
Harmonic Distortion 1600Hz	2,0% (4)			
Telecoil Sensitivity	97 dB			
Compression Attack Time	9 ms			
Compression Release Time	120 ms			

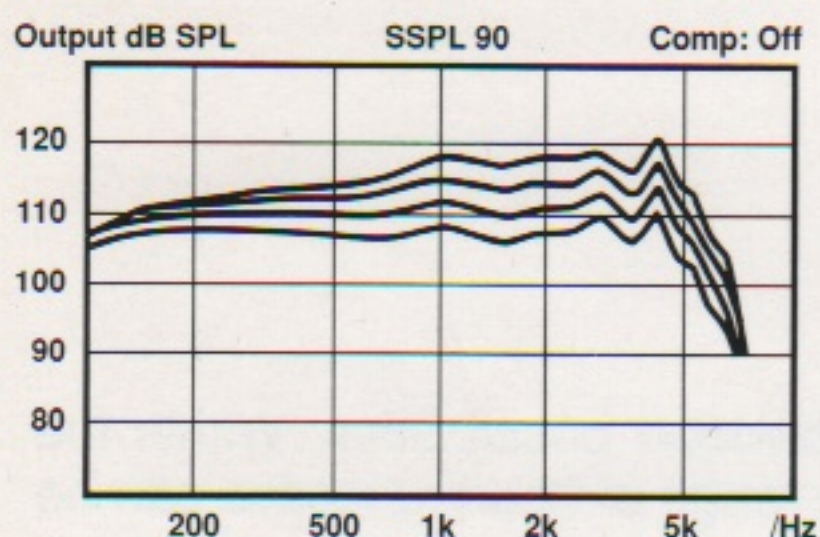
* Please note that these are average figures, based on typical use.

The frequency response is extremely smooth. This is obtained through a new acoustic filter resonator built into the hearing aid, which gives a frequency response even superior to that of the Widex A8+.



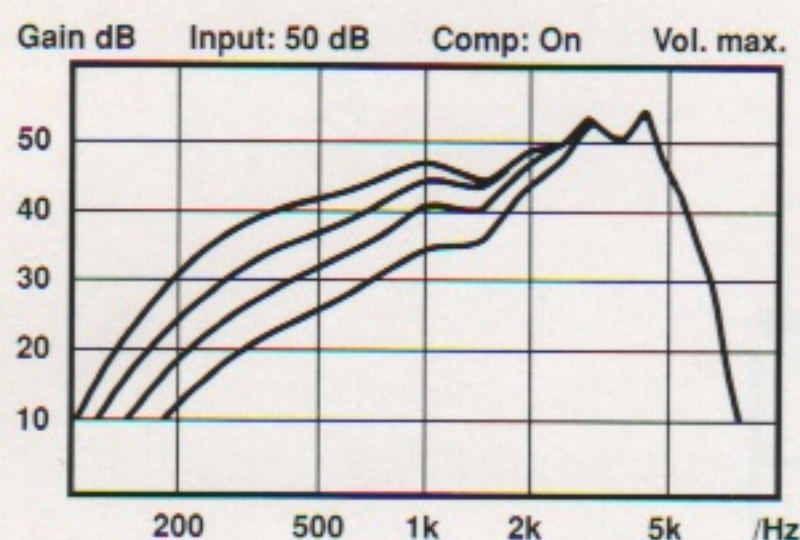
Max. Gain

The max. (peak) gain is 55 dB, and it can be reduced by 15 dB.



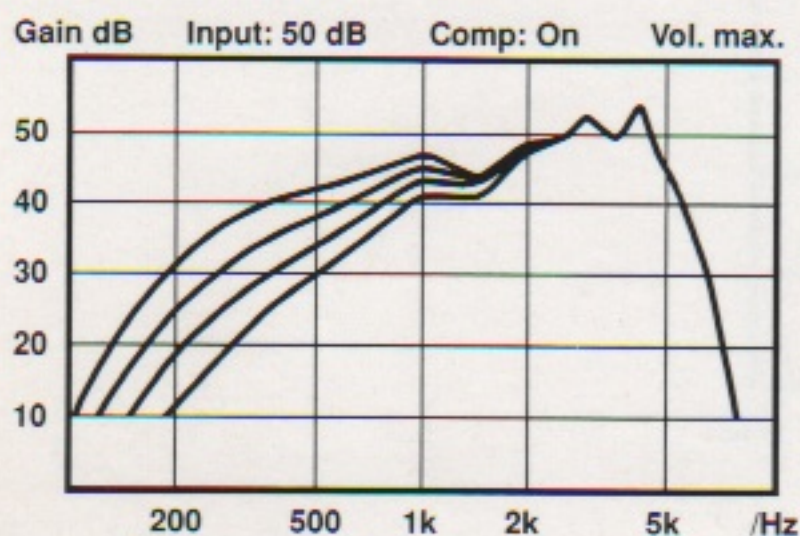
Output Control

The max. (peak) output is 121 dB SPL. Note that the output is further reduced by 6-7 dB when the compression system is on. The max. output can be reduced as shown.



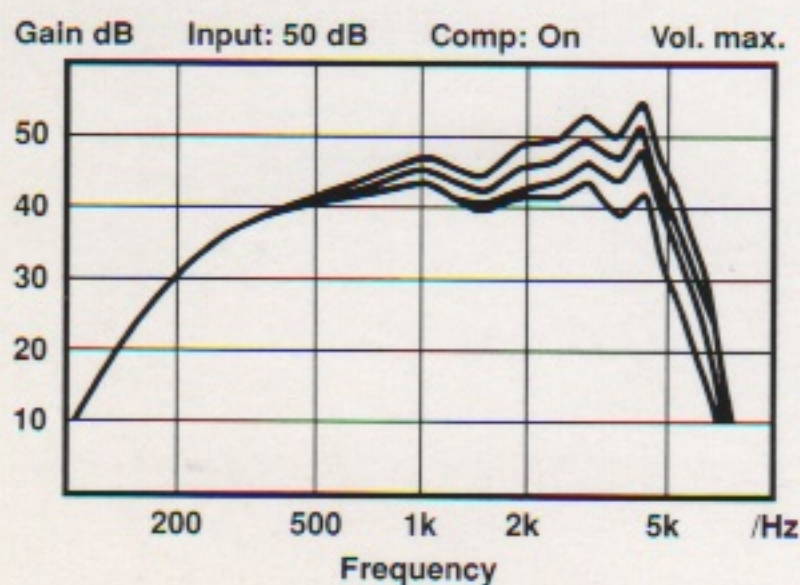
IPA Filter:

The low frequency gain below 800 Hz can be reduced by 0 - 6 - 12 or 18 dB in relation to the normal frequency response of the instrument.



Low Cut Filter:

The QUATTRO has a very efficient Low Cut filter where you can select the cut-off frequency: OFF, 500 Hz, 900 Hz and 1600 Hz.

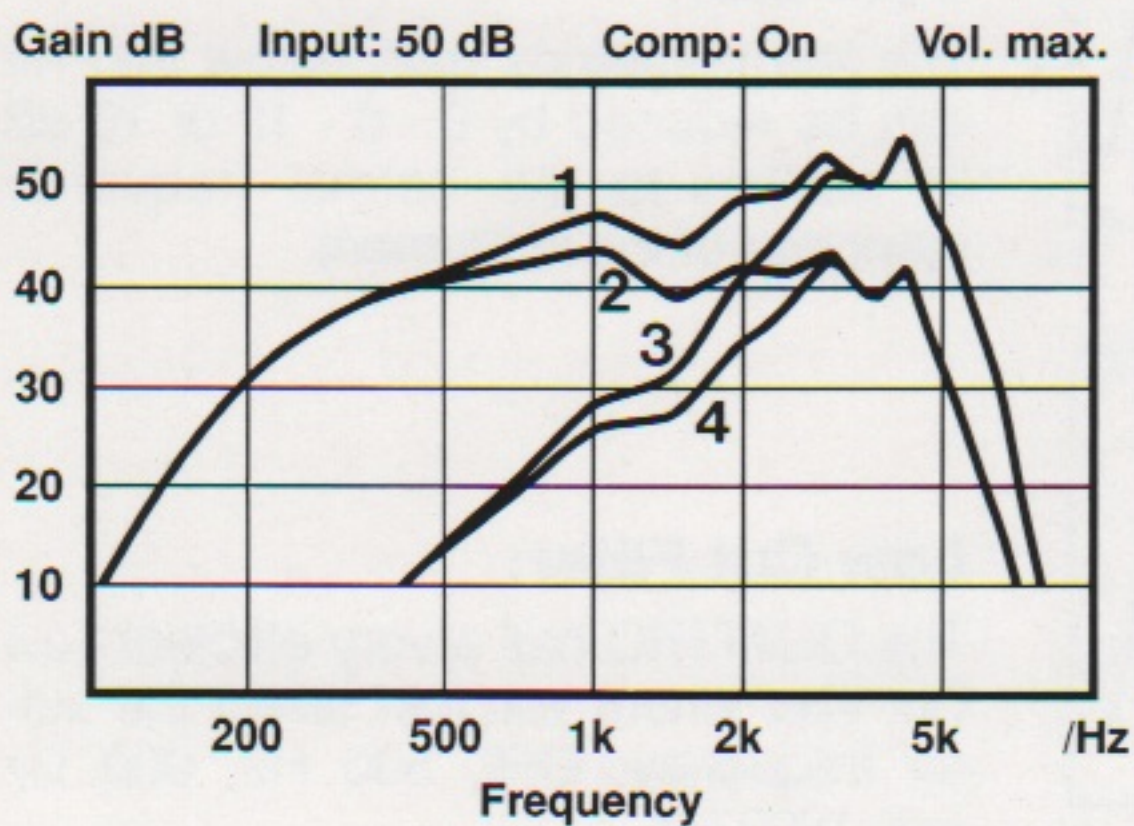


High Cut Filter:

The very effective High Cut filter can also be programmed to intervene at different frequencies: OFF, 2500 Hz, 1600 Hz and 1100 Hz.



The next illustration shows the filter combination possibilities. Within the two extremes, it is evident that a very wide range of hearing losses can be fitted.



1. Full frequency response
2. Max. High Cut
3. Max. low frequency reduction
(IPA and LCut combined)
4. Combined effect of IPA, LCut and HCut.



Compression:

The QUATTRO has a 20 dB output compression system which prevents overloading of the hearing aid and distortion. The compression system can be set to either off or on:





Pre-set Gain:

The max. gain can be lowered by 15 dB in 10 steps. This gain control makes it possible to off-set the gain in such a way that patients with an asymmetrical binaural hearing loss can use the VCs on the same display setting.

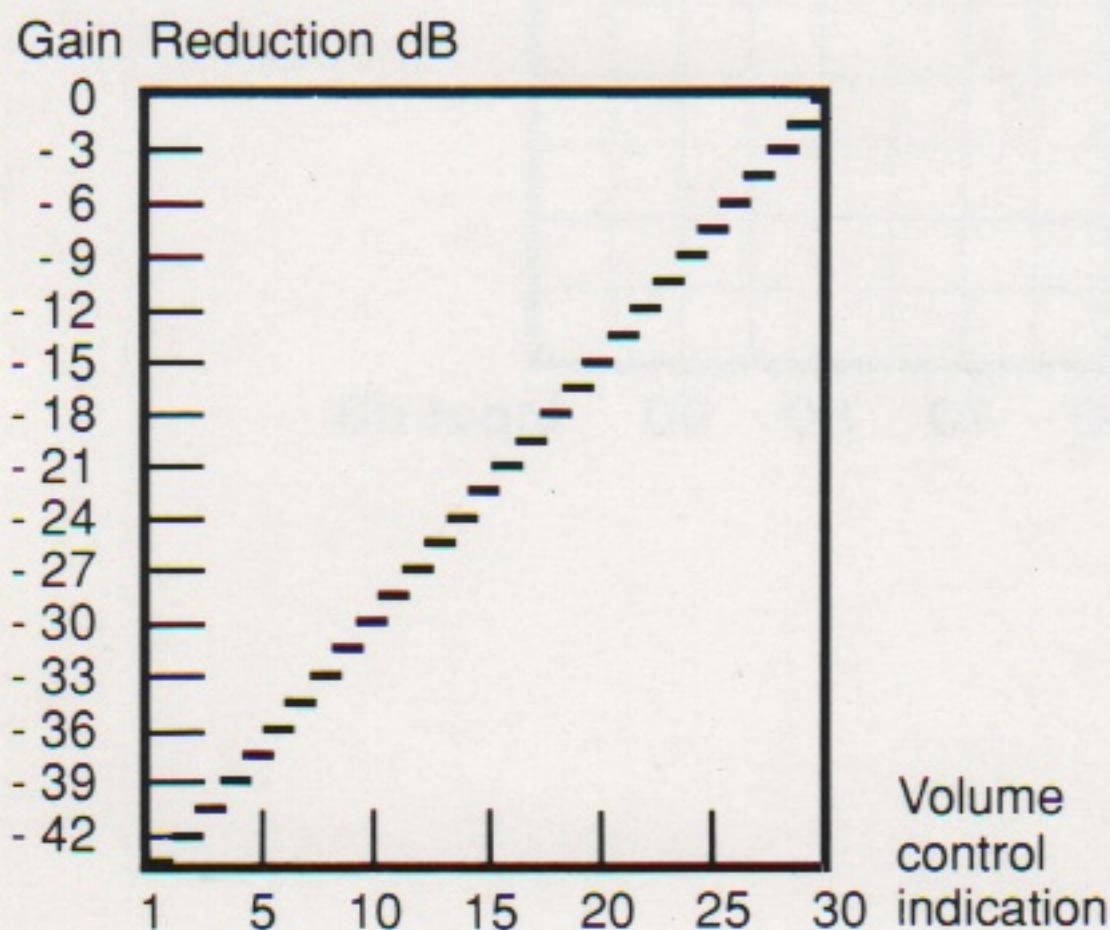
Telecoil Options:

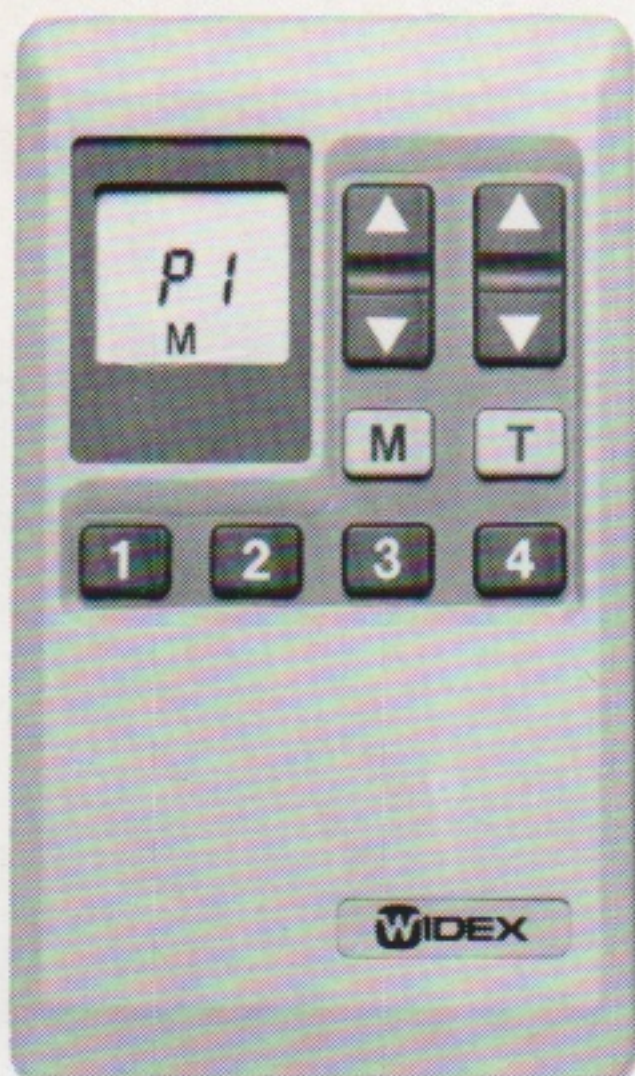
The QUATTRO has a highly effective telecoil with a sensitivity of 97 dB relative, and there are four different settings: On, OFF, -6dB, and PHO (a special setting for telephone conversations).

Battery drain:

The battery drain is 2.5 mA (1.5 mA stand-by) which gives a battery life of approx. 100 hours.

Characteristic of the volume control:





The QUATTRO remote control serves two different purposes:

1. For the patient's adjustments (user mode)
2. The dispenser's programming unit (programming mode).

First, we shall look at the user mode:

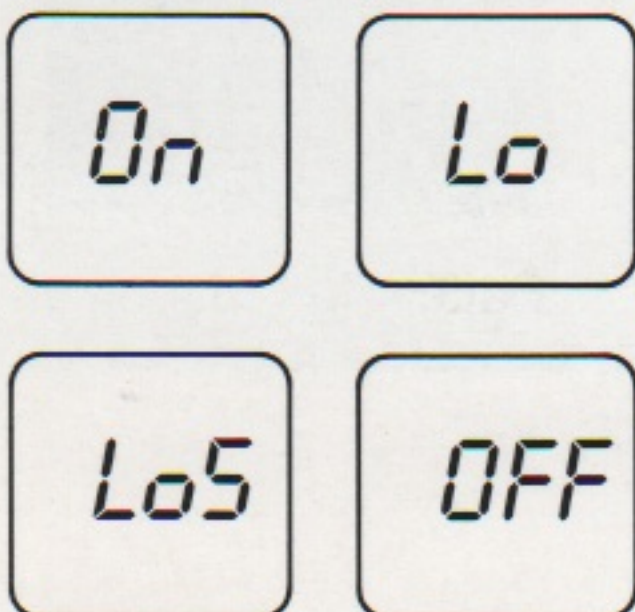
User mode

The user mode is the normal state of the QUATTRO in which the user can choose between the 4 program functions, choose microphone and/or telecoil signal, and adjust the volume controls for the right and left ear respectively.



Batteries.

When three new AAA/LR03 batteries have been correctly inserted in the remote control unit (as shown on the bottom of the compartment) the unit is activated and the display shows "On" indicating that the batteries have been correctly inserted. The remote control is now ready for use.



Without the three AAA/LR 03 batteries the remote control will only show "Lo" on the display. If you still try to activate the instrument by touching one of the keys, the display will show a flashing "Lo" and a number from 9 to 1, indicating the number of times the keys can be activated before the remote control stops transmitting and the display shows "OFF."



Optional Vol. Control

On-Off Switch

Battery Drawer

Vol. Control
Left

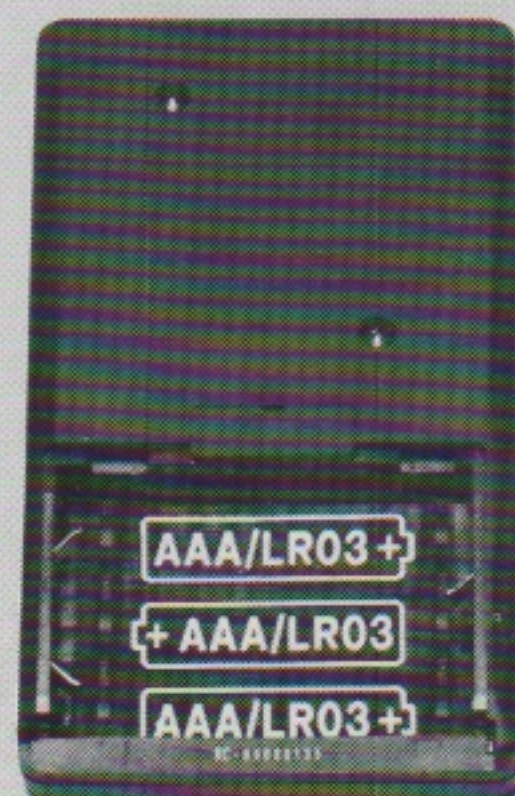
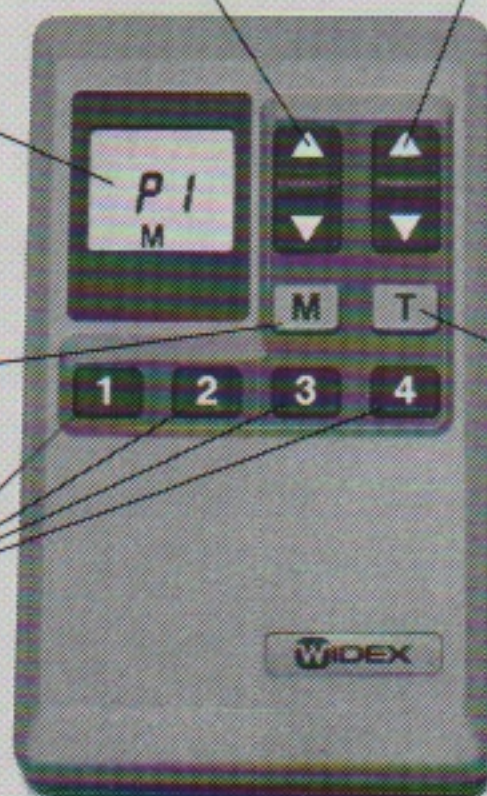
Vol. Control
Right

Display

Microphone
On-Off

Program
Select Keys

Telecoil
On-Off



Battery Compartment



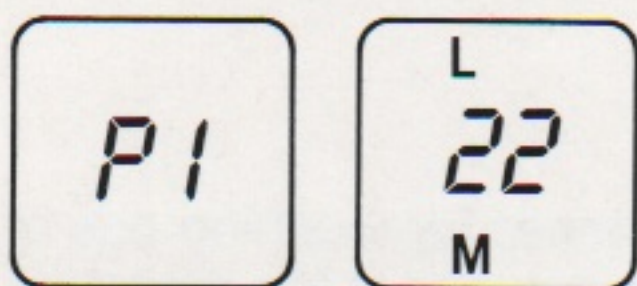
Operating the Remote Control

The pre-set programs in the remote control are chosen by touching one of the keys <1>, <2>, <3> or <4> whereby the user can adapt the response to four different groups of listening environments.

The microphone and telecoil can be turned on and off separately. Activating the <T> function is only possible when the chosen program allows use of telecoil on either the left or the right hearing aid.

The volume is adjusted separately on the left and the right side with the arrow keys. Fine adjustment of the volume is achieved by briefly touching the key. Rapid adjustment by keeping the key pressed until the desired level is reached.

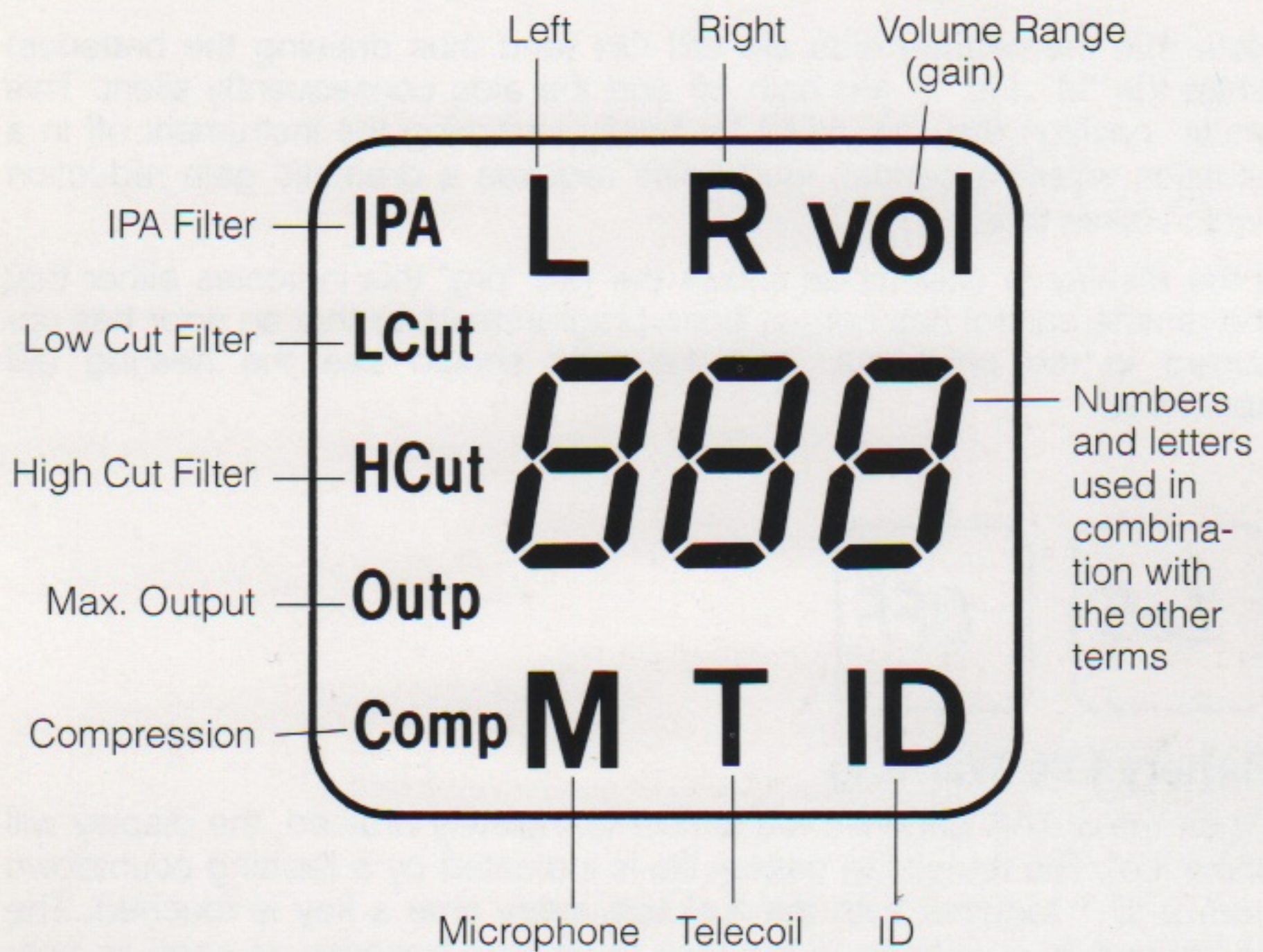
Simultaneous adjustment of two hearing aids is possible by pressing both keys at the same time. When only one hearing aid is worn, the volume can be adjusted by either of the two keys, (IF the ID code for the un-used side has been set at 0).

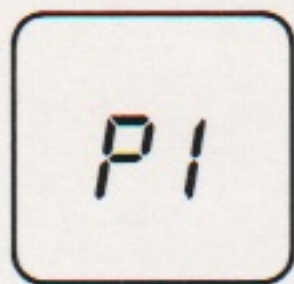


The Display

Every operation of the keys results in a corresponding indication on the display. The program choice is shown as "P1", "P2", "P3" or "P4", while the setting of the volume is indicated by a number between 1 and 30 plus an "R" or an "L" for right or left side. If both volume controls are activated at the same time, the display will show the "loudest" side.

The volume setting is shown for five seconds after the last adjustment. Then the display returns to showing the chosen program. The microphone/telecoil status is shown constantly, with "M" meaning the microphone is on, and "T" that the telecoil is on.





Note that the hearing aids are still ON (and thus draining the batteries) when the "M" and "T" are both off and the aids consequently silent. This "mute" position may be useful for briefly switching the instrument off in a situation where a sudden loud noise requires a dramatic gain reduction (which takes time!)

If the display in user mode shows the text "prg" this indicates either that the remote control has not yet been programmed, or that an error has occurred in the programs, and the user should see the hearing aid specialist.



Battery Life Warning

When the 3 AAA batteries are almost completely drained, the display will show "Lo". The remaining battery life is indicated by a flashing countdown from 9 to 1 together with the "Lo" text every time a key is touched. The countdown is a warning to the user to change batteries as soon as possible, because the remote control will stop transmitting (display showing "OFF") when the nine battery lives have been used.

In a situation where it is not immediately possible to get new batteries, the user should avoid overloading the batteries as much as possible by pressing the keys very briefly and giving the batteries a pause of at least 5-10 minutes between each adjustment.

The average lifetime for the remote control batteries will depend on how often the keys are touched. According to our estimates, the batteries will last at least one year, probably close to two years.



The remote control is transformed into a programming unit when the programming key is inserted at the back of the unit. To do this:

1 First remove the battery compartment cover.

2 You will see a second, smaller cover plate above the battery compartment.

3 With a screwdriver (preferably a plastic one with a hard tip) insert it into the slot at the top of this smaller cover plate. Now pull this coverplate DOWN and OUT.

4 Carefully insert the programming key with the thin end (no pins) pointing towards the top of the remote control.

The dispenser can now create and place in the QUATTRO four different responses for each ear. The following 7 acoustic parameters can be programmed:

IPA Filter

Low Cut

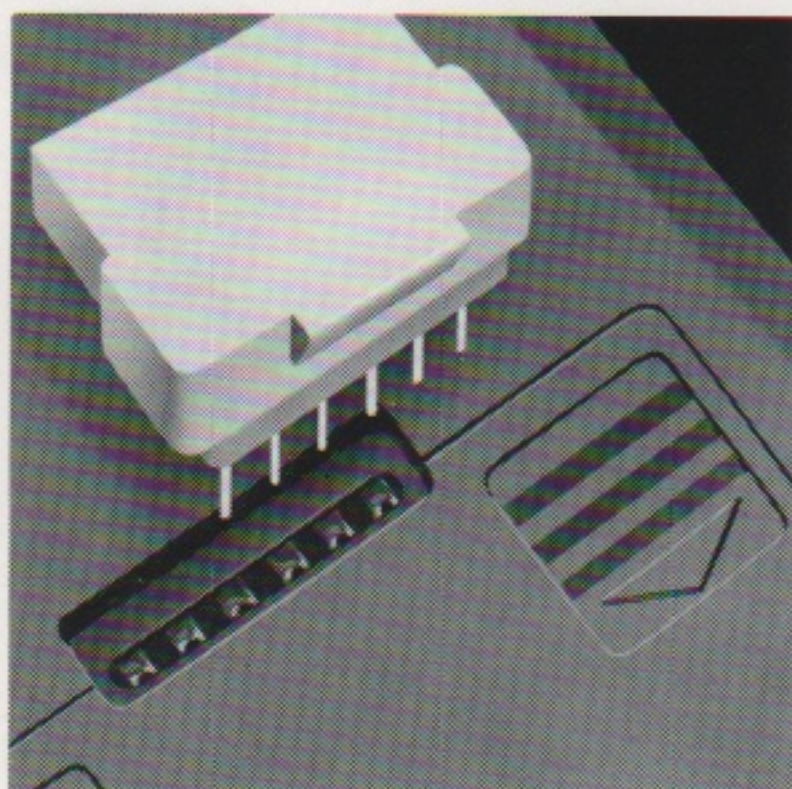
High Cut

Max. Output

AGC (Compression)

Telecoil

Pre-set gain (vol: pre-setting of the volume ranges.)



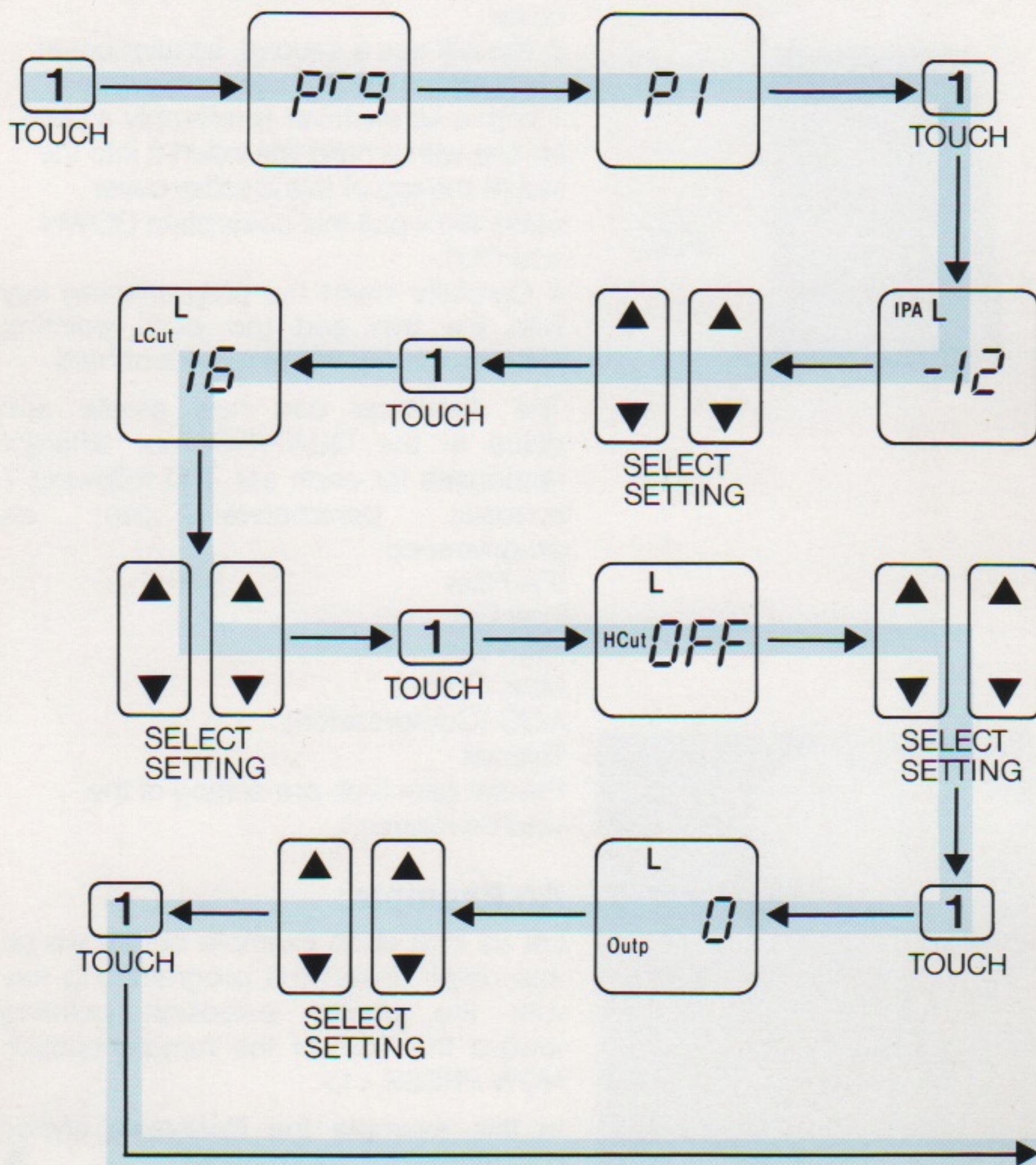
An Example:

Let us look at an example before we go into detail. Insert the programming key with the plastic extension pointing toward the TOP of the remote control. NOW PRESS <1>.

In this example the illustration shows parameters for the left side. ►



Touch <1> to get into IPA and use the arrow keys to choose the relevant setting. Once you have reached the desired setting, it is locked by touching <1> and moving on to the next function.

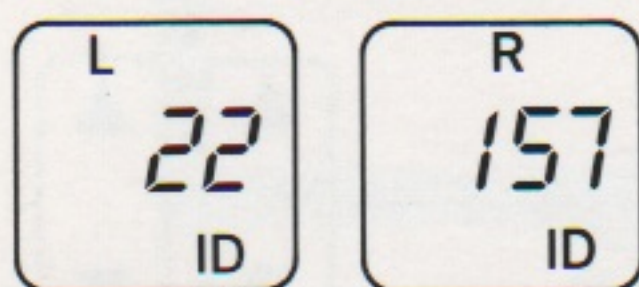




Changing the ID Codes

When the QUATTRO system is delivered (with one or two Q8s) the ID codes have already been entered into the remote control.

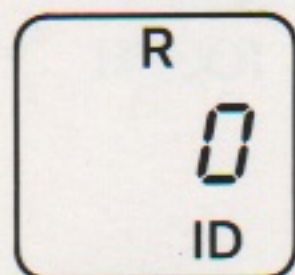
For binaural fittings, delivered as a system, it is important to check on the display which ID code corresponds to which ear. For monaural fittings the dispenser may have to "move" the ID code from the left to the right side.



If a patient is to be binaurally fitted later on, the dispenser will have to enter an ID code for the second aid. For that reason it is necessary to know HOW to enter the ID codes:

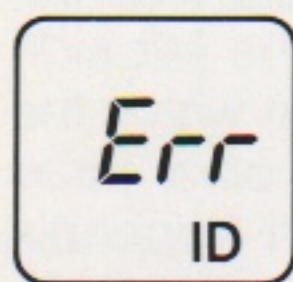
Insert the programming key, and touch any key, e.g. <1>, and wait for "prg" to appear for two seconds on the display. Then press the <1> and <4> keys SIMULTANEOUSLY to enter the ID mode.

The ID code corresponding to the right or left hearing aid is set by using the respective arrow keys. The ID code is counted up or down in accordance with the direction of the arrows. To accelerate the counting, the key can be kept activated until the counting gets close to the desired code. Then proceed with single touches until the code is correct. (Note that the code counter is cyclic, i.e. continues beyond 250 by starting all over again.)



IMPORTANT: When only one hearing aid is worn, the ID code for the opposite side must be set at "0" as this will give the user two major advantages:

1. the volume can be adjusted on that one ear by EITHER of the arrow keys
2. less current drain in the remote control.



Inspecting the ID Codes

It is always possible to check the ID code(s): insert the programming key, press <1>, and then press <1> and <4> simultaneously and the ID code for the left ear is shown. Touch the right arrow key, and the ID code for the right side is shown. If the display is showing you the ID code for the right side and you want to check the left side, just touch the left arrow key once more. When you press the same arrow key a SECOND time, the code counter will start running.

When the ID codes have been chosen, the ID mode is left by pressing any of the program keys (<1> being recommended). It is not possible to leave the ID mode if the left and right codes are identical. The display will call attention to this error by showing a sequence of alternating left-right ID codes interrupted by the text "Err" (Error). The error is then corrected by keeping any key pressed down for about one second and then changing one of the ID codes.



The Four Programs

Each program contains the settings of six parameters for one Q8 (monaural fitting) or for two Q8s (binaural fitting). Note that the settings for two Q8s (binaural fitting) need not be identical.

The six adjustable functions are illustrated in the table below.

Furthermore, there is the additional possibility of choosing the range of the volume control for the right and left side. It should be noted that the volume range can only be set once for all four programs on the left side and once for all four programs on the right side. The program in which the volume range is last set will determine the volume range in the other three programs. (See the schematic table of the program memory in Appendix 1, p. 47). These seven functions are similar to the trimmer functions on conventional hearing aids.

Program No.	1		2		3		4	
Side:	L	R	L	R	L	R	L	R
IPA:								
LCut:								
HCut:								
Output:								
Comp.:								
T:								
Vol.:	Left (L)		Right (R)					

It is possible to proceed in the program memory in two ways:

1. by following one program column from top to bottom (the normal procedure)
2. by completing one row of parameters at a time ("across" programming). P1, P2, P3 and P4 may be taken in random order.

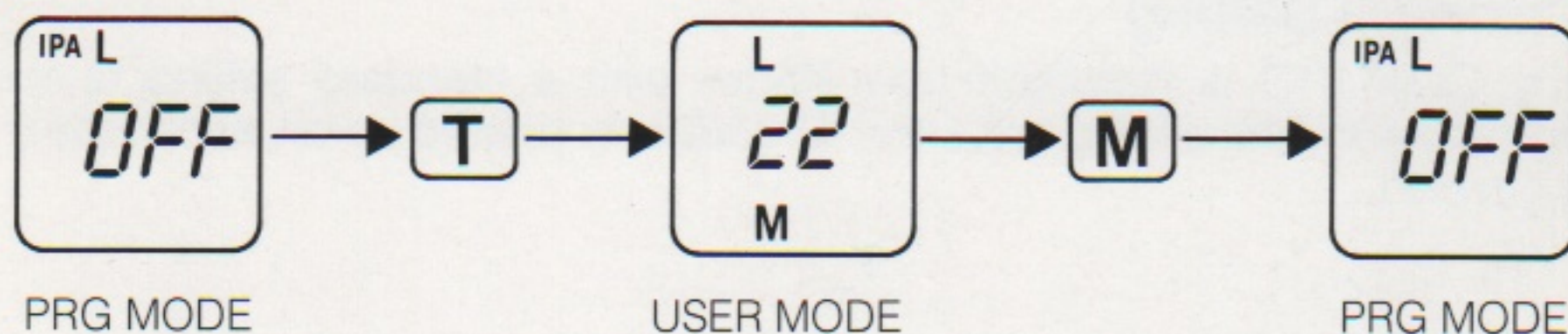
This procedure is mainly intended for comparing the settings.

In both cases one may complete one side (e.g. left) or both sides (left and right) before proceeding to the next parameter or program.



Patient Listening in on the Programming:

As soon as the ID codes have been set in accordance with the hearing aids, the remote control becomes active, transmitting all program choices and parameter adjustments to the patient's hearing aids (remember: the transmitting range of the remote control is approx. 5 feet/1.5m). This gives the patient the possibility of following and commenting on the programming of each of the four programs.



Adjusting the Volume while Programming:

As the preferred volume setting can vary from one listening environment to another, the hearing aid specialist needs the possibility - any time in the programming phase - of adjusting the volume. As the arrow keys in programming mode are used for setting the parameters, we need a way to briefly give back the arrow keys their Volume Control function. This is done by touching the <T> key, adjusting the volume in the usual manner, and then returning to the programming mode by pressing the <M> key.

Because of this special function of the <T> key in the programming mode, it is not possible for the patient to listen in on the telecoil. The telecoil, therefore, is automatically "turned off" during the programming.



Standard Setting

The QUATTRO is delivered from Widex with a standard setting of the parameters. This setting, plus the ID codes, is printed on an accompanying report.

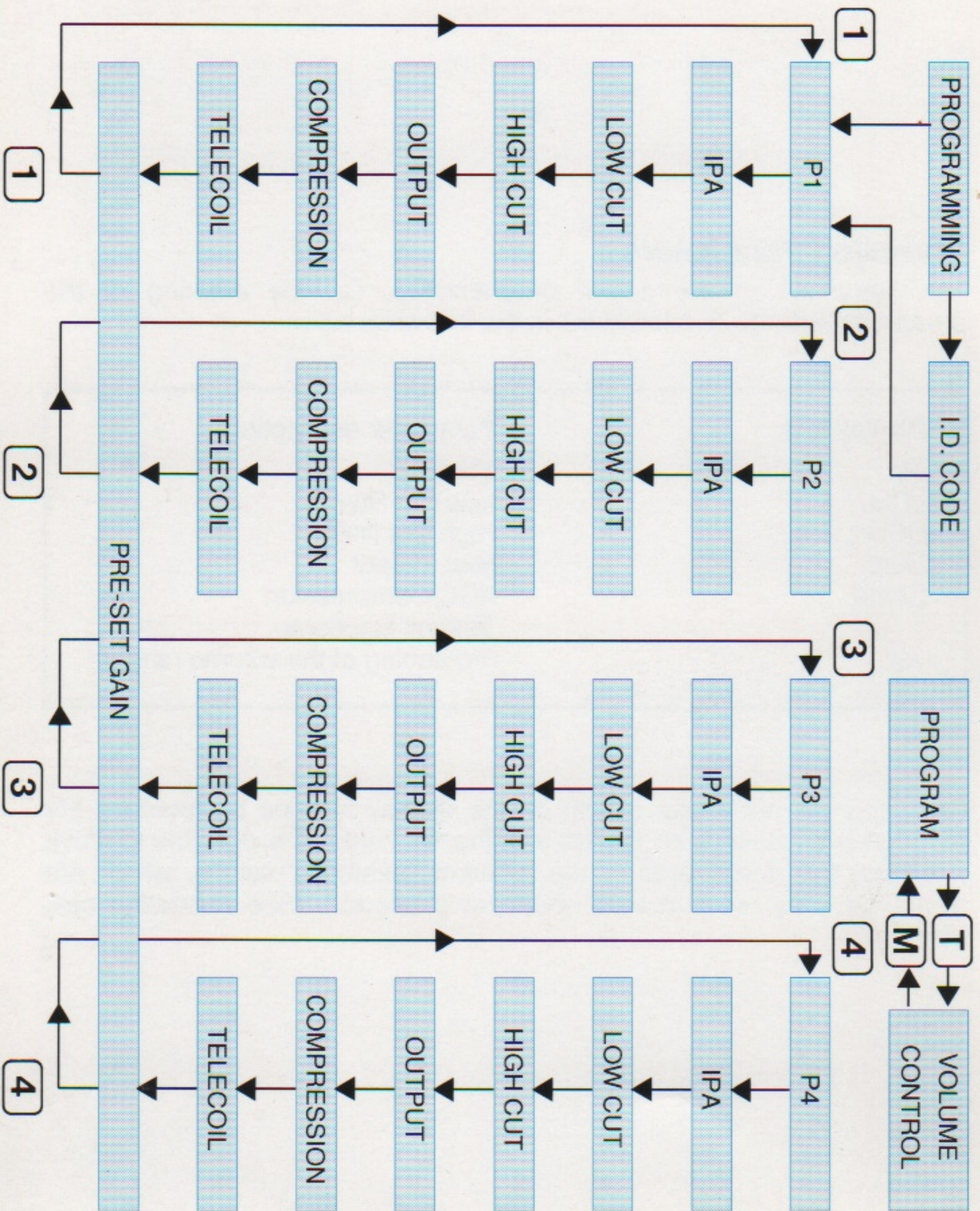


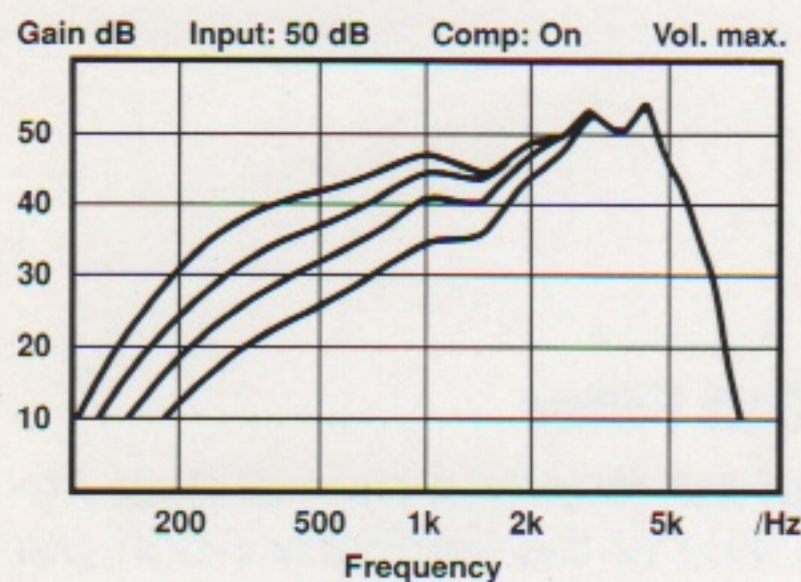
Choosing Parameters

The sequence of the actual programming, i.e. the entering of the parameter settings, is carried out in the following order:

Display text	Parameter description
IPA	IPA filter
LCut	Low Cut filter
HCut	High Cut filter
Outp	Max. output
Comp	AGC/Compression
T	Telecoil functions
vol	Pre-setting of the volume ranges

Changing the parameter shown on the display is done by touching the respective arrow keys for the left and the right side. It is possible to move upwards and downwards in the different parameter values, which are cyclic, i.e. they are repeated whenever exceeded. (See illustration next page.)





IPA Filter

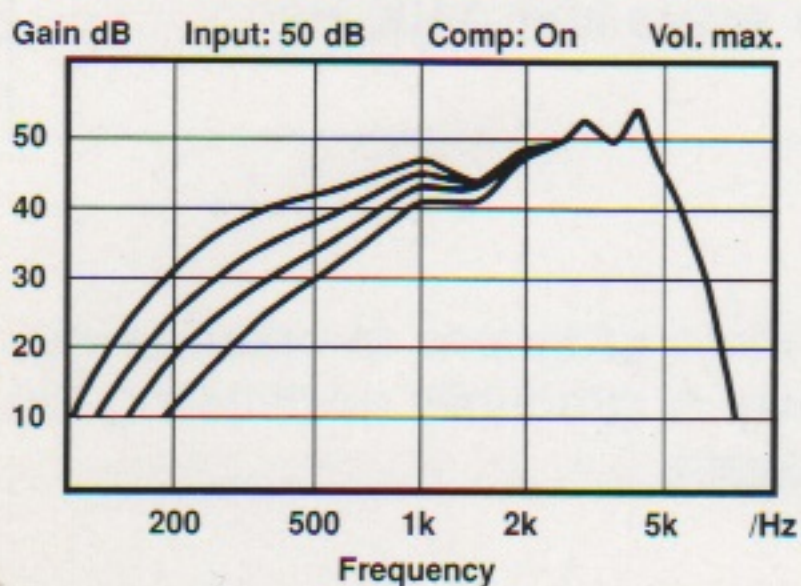
The IPA filter is a special type of low frequency filter producing a response which, below 800 Hz, can be reduced in steps of 6 dB in relation to the normal frequency of the instrument.

Display text

IPA OFF
IPA -6
IPA -12
IPA -18

Parameter description

IPA filter is off
Low frequency level = -6 dB
Low frequency level = -12 dB
Low frequency level = -18 dB



Low Cut Filter

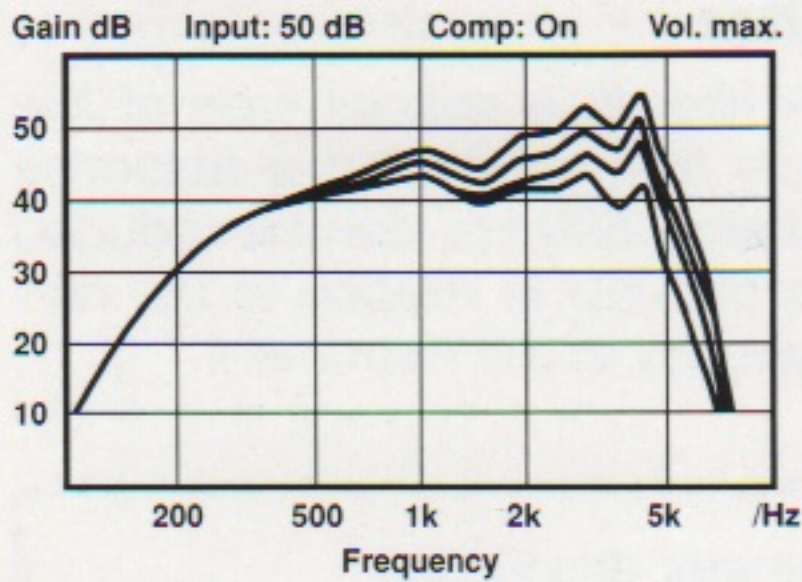
The low cut filter is a normal first order (-6dB per octave) low frequency filter with selectable cut-off frequencies. The actual cut-off frequency is shown on the display as follows:

Display text

LCut OFF
LCut 5
LCut 9
LCut 16

Parameter description

Low cut filter is off
Filter active from 500 Hz
Filter active from 900 Hz
Filter active from 1600 Hz



High Cut Filter

The high cut filter is a normal high frequency filter of the first order (-6dB per octave). The actual cut-off frequency is shown as follows:

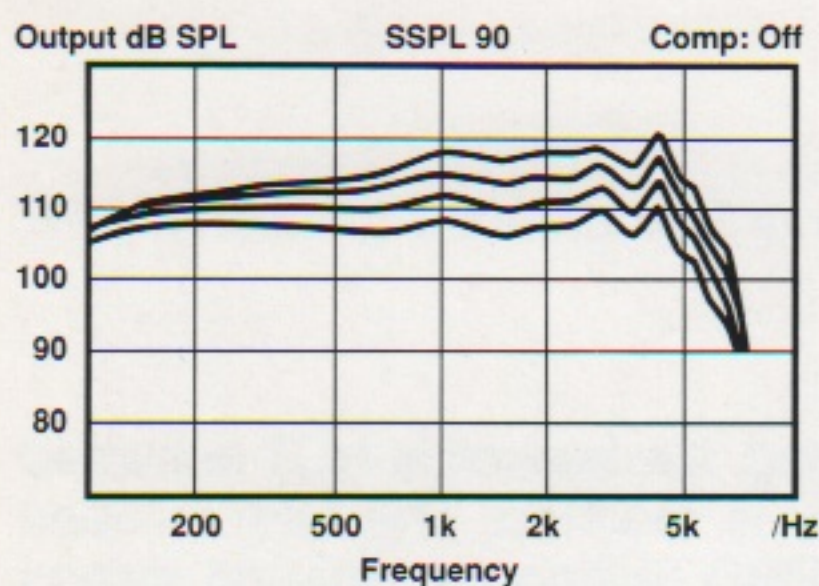
Display text

HCut OFF
HCut 25
HCut 16
HCut 11

Parameter description

High cut filter is off
Filter active from 2500 Hz
Filter active from 1600 Hz
Filter active from 1100 Hz

The high cut filter can be used in one or more programs to optimize discrimination or listening comfort, or as a way of gradually acclimating the patient to hearing high frequency sounds again.



Output Control

The output control makes it possible to reduce the max. output of the hearing aid by 0 - 3 - 6 or 10 dB. The output reduction can be read directly on the display as follows:

Display text

Outp 0
Outp -3
Outp -6
Outp -10

Parameter description

Max. output permitted
Max. output -3 dB
Max. output -6 dB
Max. output -10 dB



Compression

Two selections are possible: the compression is either off or on.

The output compression system prevents distortion and the passage of excessively loud sounds.

Display text

Comp OFF
Comp On

Parameter description

No compression
Active compression

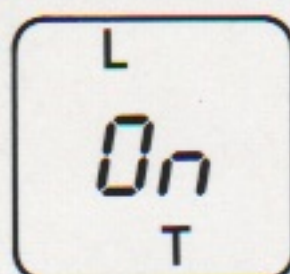


Telecoil Functions

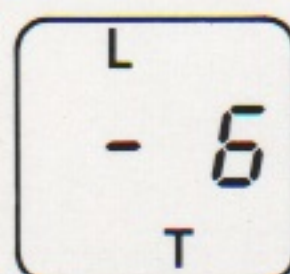
In this parameter group there is a choice of four different functions: OFF, On, -6dB, and PHO.



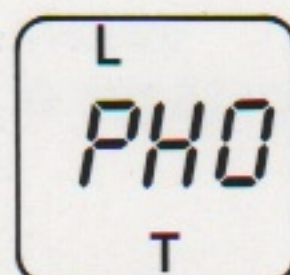
OFF: With this setting, the telecoil is NOT activated when the <T> key is touched. The OFF is used together with the PHO setting for binaural fittings (see below), or it may be used for programs where the telecoil is never used (e.g. traffic) to make sure the telecoil is not even switched on unintentionally.



On: The normal function, corresponds to the performance of telecoils in traditional hearing aids. In this position the user can listen via the telecoil (on both ears, if binaurally fitted), and also in combination with the microphone (MT).



-6dB: Same performance as the On function, but with a reduction of the telecoil sensitivity (-6dB) in relation to the microphone signal. This balancing alternative can be used by those who prefer a microphone emphasis in the MT position.



PHO: The last possibility in this group has the display text "PHO" (telePHOne), indicating a function which is useful for telephone conversations. When the user activates the <T> key to answer or use the phone the microphone is automatically turned off and the telecoil activated. The microphone will be re-activated in accordance with the display status "M" when the <T> key is touched again.



When two hearing aids with telecoils are used, the telecoil on the ear used for telephoning should be set at PHO and the telecoil on the opposite side should be set at OFF to give the user the advantage of being able to hear surrounding sounds through the other hearing aid with a volume which can be adjusted with the arrow key.

The "PHO" function can also be used for a strictly telecoil program (e.g. P3 = PHO), but it is primarily intended for work situations where the user needs to quickly activate the telecoil when the telephone rings, together with an interruption of the microphone on the same ear, avoiding background noise interference and microphone feedback.

When programming the telecoil functions, the display reads as follows:

Display text	Parameter description
T On	Choice of telecoil possible
T -6	Tel. sensitivity reduced by 6 dB
T OFF	Telecoil is off
T PHO	For telephone use (-mic.)



Pre-setting of the Volume Range (Max. Gain Reduction)

This last feature makes it possible to pre-set the maximum VC range individually for the left and right hearing aids. As we mentioned above, the chosen range is shared by all four programs for each side!

The QUATTRO system has been prepared for hearing aids more powerful than the Q8. For that reason the VC range may be extended to span 40 steps (1-40) which is chosen with the display code "0". This extended VC range has a gain variation of no less than 58.5 dB (1.5 dB per step), and hence is not relevant for the Q8.

The normal VC range consists of 30 steps (1-30) corresponding to a gain variation of 43.5 dB. For each step you move down the display code scale from 40 to 30 the VC range is moved downwards by 1.5 dB and consequently the max. gain is lowered by 1.5 dB.

This makes it possible to have patients with asymmetrical hearing losses use their QUATTRO with identical VC display showings (e.g. 20 on both left and right side).

This function can also be used to reduce the max. gain deliberately to avoid feedback problems.



The many possibilities can be illustrated as follows:

Display text in prg. mode		Parameter description
vol	0	Extended VC range (1-40) (not relevant for the Q8)
vol	40	Normal VC range (1-30) with max. gain
vol	39	Max. gain -1,5 dB
vol	38	Max. gain -3,0 dB
vol	37	Max. gain -4,5 dB
vol	36	Max. gain -6,0 dB
vol	35	Max. gain -7,5 dB
vol	34	Max. gain -9,0 dB
vol	33	Max. gain -10,5 dB
vol	32	Max. gain -12,0 dB
vol	31	Max. gain -13,5 dB
vol	30	Max. gain -15,0 dB

For more details, see Appendix 2, p. 48.



End of Programming

The programming is ended simply by removing the programming key from the back of the remote control. Before doing so, you may wish to inspect the programs to check that all settings are in accordance with the desired parameters for the left and right sides. This is done by repeatedly touching the program-select keys (<1>, <2>, <3> and <4>). Note that this will not change any of the settings.



As an alternative to programming via the keyboard on the remote control, it is possible to program the QUATTRO by connecting it to a personal computer (PC).

The remote control automatically goes into PC programming mode when it is attached to the Widex Interface and any key is touched.

Widex will deliver the necessary software together with a special manual for PC programming.



With a conventional hearing aid the patient has the possibility of adjusting only a few parameters, such as the volume control and the on/off switch. Remaining controls are set by the audiologist or hearing aid specialist in order to achieve the best average performance in a variety of listening situations.

The potential of the QUATTRO system offers the possibility of optimizing the parameter settings in four different listening situations. These situations may very well differ from one patient to another. This challenging feature on the other hand calls for an untraditional fitting philosophy differing substantially from many traditional fitting procedures.

Below, you will find a number of different procedures which can be used individually or in combination.

In practice, the procedure should be to interview the patient to define the four most important listening environment groups and then - with the help of the audiogram - somehow estimate the optimal adjustments for each environment group. Later, when the patient has tried out the programs in each environment, it may be necessary to readjust one or more of the programs in accordance with the patient's listening experience and observations.



The ideal procedure, of course, is to follow the patient into the various listening situations that constitute his daily routine and then adjust each program so that it is ideal in these specific situations!

Unfortunately, this is not a very practical procedure: most hearing aid professionals cannot spend a day or more on fitting each patient. The principle, however, is valid: the programmer is completely free to create each program in accordance with both the acoustic composition of the patient's various environments and his or her hearing loss.

Before proceeding any further, it may be practical to examine some typical listening situations according to the intensity and frequency content of the speech or music signals and of the background noise - and to group them accordingly.

Grouping of Listening Situations

1. Quiet surroundings, face-to-face conversation.
2. Listening to music in quiet surroundings/concert hall/theater.
3. Listening to speech in restaurants or at parties.
4. Traffic noise (riding in car or train, or walking in traffic).
5. Communication in a background of loud industrial or impact noise.
6. Listening to speech or telephone conversation in offices, or shopping.
7. Listening to speech in high frequency noise (metal works, sawing, etc.).



On request, Widex will supply professionally recorded tapes with examples of these background noises.

The list can be made longer, but it is necessary to stop when the programs differ minimally. It is essential that the user experience a real change when switching between two programs.

Below, you will find three different procedures which can be used individually or in combination.

A: Using Audio Tapes

(fitting simulated environments)

Instead of following the patient into different listening situations, such as a factory or an office, a tape recording or a compact disc containing sound examples may be played during the actual programming. As the patient is listening via his own hearing aid while the programming is carried out, he or she will be able to judge the effects of the various settings. Obviously, this is not the same as being at the office/factory/party, etc. but it is as close as we can get without physically being there. And it will give the patient a preference for a specific setting in each environment.

B: Using Environmental Corrections

As an alternative to using audio tapes, the following approach may be suggested.

First, program 1 is fitted for quiet situations with perhaps one or two persons speaking. Next, the remaining three programs are constructed on the basis of the preferred listening situations selected by the patient. This is achieved by adding the corrections in table I to the parameter settings just determined for program 1.



When adjusting program 1 Widex suggests using either a very mild fitting rule (around one third of the hearing loss, without further corrections) or simply benefit from the fact that the fitting situation itself is a quiet listening environment and as such can be used to optimize program 1. We suggest that factors like listening comfort and naturalness are emphasized. If cutting the low frequencies is necessary, the IPA filter should be used, as the Low Cut filter will be used to correct for background noise.

Table I contains a number of corrections which, when added to the settings of program 1, will produce programs appropriate for a number of typical listening environments. Some of the values in this table are absolutes (e.g. 16, 9, 5) as they are functions primarily of the noise. Others are relative to adjust the tonal balance (e.g. up 1 step, down 2 steps). If a relative correction would demand more steps than available, stop at the maximum.

Environment	Parameter				
	IPA	LCut	HCut	Max. Outp	Comp
1. Quiet	same	same	same	0	OFF
2. Music	Δ 1 step	same	Δ 1 step	0	OFF
3. Party	same	∇ 2 steps	Δ 1 step	∇ 1 step	OFF
4. Traffic	∇ 1 step	16	16	∇ 2 steps	On
5. Industry	same	9	11	∇ 3 steps	On
6. Office	same	5	Δ 1 step	0	On
7. High freq.	same	same	11	∇ 2 steps	On

Table I: Environmental corrections

As this approach does not take the patient's PARTICULAR listening environments into account, he or she will have to learn from experience which program is ideal for the various situations.

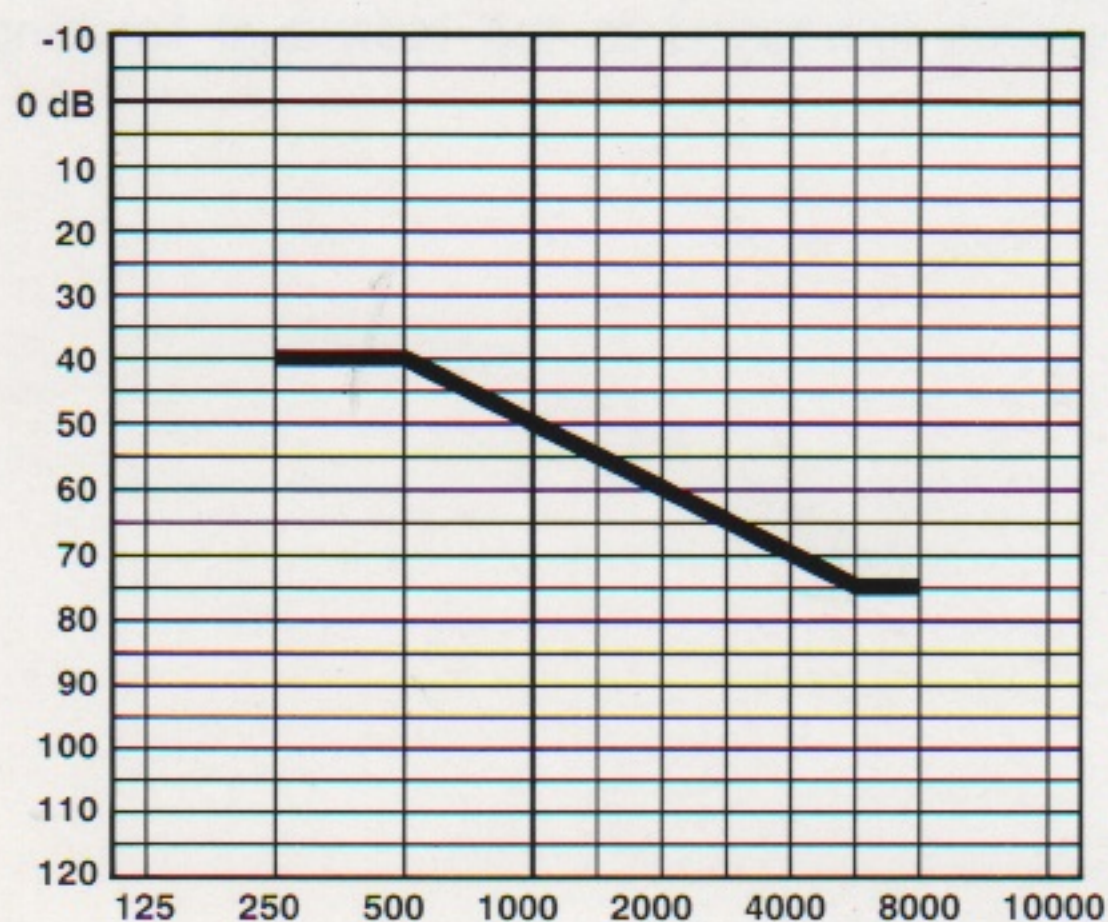


C: Selecting Pre-defined Programs

The table below contains suggested parameter settings in the seven different listening environment groups. The point of departure is an average hearing loss with no particular tolerance problems (see illustr.). Where the audiogram deviates substantially from this average hearing loss, the programmer should use procedure A or B instead.

Environment	Parameter				
	IPA	LCut	HCut	Max. Outp	Comp
1. Quiet	-12	OFF	16	0	OFF
2. Music	-6	OFF	25	0	OFF
3. Party	-12	9	25	-3	OFF
4. Traffic	-18	16	16	-6	On
5. Industry	-12	9	11	-10	On
6. Office	-12	5	25	0	On
7. High freq.	-12	OFF	11	-6	On

Table II: Recommended parameter settings in seven listening environment groups.



Average hearing loss with no particular tolerance problems.



You will notice that the IPA and HCut filters are never OFF in this table. This is due to the average hearing loss which was our point of departure. Different hearing losses would result in more extreme settings.

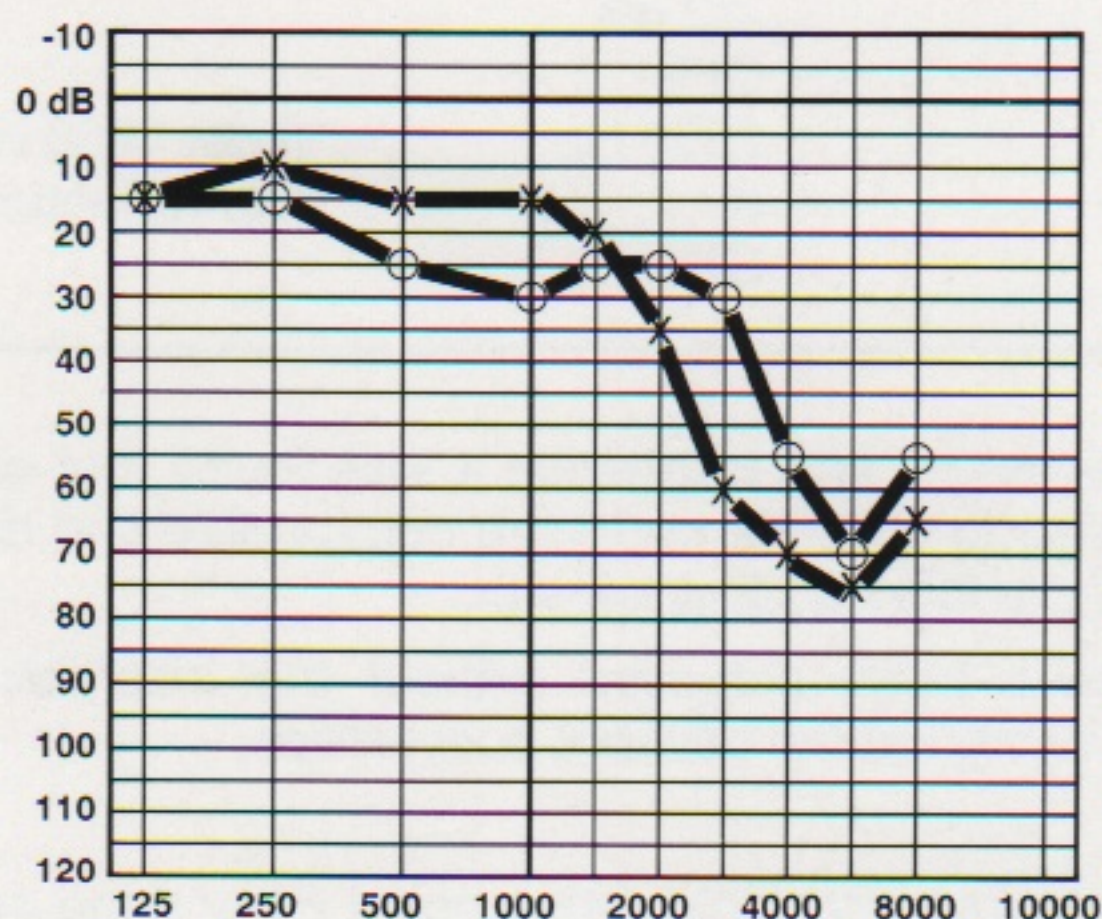
Supplied with this list of seven different programs, the hearing aid specialist is free to "pick any four" and enter those into the QUATTRO.

A variation of this procedure: Widex will supply the QUATTRO pre-set with four programs (see report accompanying each QUATTRO), and the dispenser can choose to pass on the QUATTRO to the patient without changing anything. Then arrange with the patient to come back in a couple of weeks to have the programs fine-tuned to the individual listening experience.



A FITTING EXAMPLE USING PROCEDURE B

The subject is a 74 year old male who is alert, active, and very interested in classical music and opera. His audiogram is shown below:



For this fitting approach B was chosen. As the subject was a previous BTE user, the actual fitting could start immediately using his existing earmolds to try out the QUATTRO binaurally.

During an interview it was agreed to arrange the programs so that

- P1 was intended for quiet, home, and conversation with a single person in quiet surroundings.
- P2 was to be used at parties, in restaurants, and with light to moderate background noise.
- P3 would be the music program to be used with music, concert hall and opera.
- P4 should then be used whenever heavy background noise was present, e.g. street noise, bus and train rides and wind noise.



Using insertion gain measurement and a simple 35% fitting rule (desired gain = 35% of the hearing loss at any frequency) the following settings were reached for P1:

IPA	-12 dB	
LCut	OFF	
HCut	2500 Hz	(later 1600 Hz)
Outp	0	(No reduction)
Comp	OFF	

During the following discussion and instruction it was found that cutting the high frequencies further to 1600 Hz was more comfortable and did not cause any problems when understanding speech.

This could probably have been achieved without the insertion gain measurement by simply trying out the different possibilities.

Next, the three other programs were calculated, using P1 and the corrections in table I. (C2, C3, C4 = Corrections for environments 2, 3, 4).

	P1	+	C3	=	P2 (parties, etc.)
IPA	-12	+	same	=	-12
LCut	OFF	+	∇2 steps	=	9
HCut	16	+	Δ1 step	=	25
Outp	0	+	∇1 step	=	-3
Comp	OFF	+	OFF	=	OFF

	P1	+	C2	=	P3 (music, etc.)
IPA	-12	+	Δ1step	=	-6
LCut	OFF	+	same	=	OFF
HCut	16	+	Δ1 step	=	25
Outp	0	+	0	=	0
Comp	OFF	+	OFF	=	OFF



	P1	+	C4	=	P4 (traffic, noise)
IPA	-12	+	∇1step	=	-18
LCut	OFF	+	16	=	16
HCut	16	+	16	=	16
Outp	0	+	∇2 steps	=	-6
Comp	OFF	+	On	=	On

After the four programs had been calculated in this simple fashion they were entered into the remote control using the programming key and the keys and display on the remote control. This only takes a few minutes.

Then the subject was instructed in the use of the remote control keys: volume, M and T on/off, and the four program select keys. As the subject could always listen in on each change, it was actually only a matter of 5 or 10 minutes before he fully understood how to control the system.

An appointment was made for two weeks later and the subject was sent home.

After two weeks the subject returned to be checked. He had now used the QUATTRO system in a number of different situations and seemed satisfied.



During the discussion it became evident that he would like to TRY to have some extra high frequencies for the music program (P3) and a further cut in the high tones when in heavy noise (P4). By using a tape with different music and another tape with different types of noise, the proposed changes were tested. It appeared that he actually preferred to have more high frequencies when listening to music, as the flutes became more audible. Also, he preferred an extra high frequency cut on P4. This was solely a question of comfort: when in noisy, windy or reverberant environments, a steep cut in the low and high frequencies was preferable.

Interestingly enough he also used P4 when he HAD to understand speech in VERY NOISY situations, even if the heavy noise was babble. ►



His four programs thus ended up like this:

Program No.	1		2		3		4	
Side:	L	R	L	R	L	R	L	R
IPA:	-12	-12	-12	-12	-6	-6	-18	-18
LCut:	OFF	OFF	9	9	OFF	OFF	16	16
HCut:	16	16	25	25	OFF	OFF	11	11
Output:	0	0	-3	-3	0	0	-6	-6
Comp.:	OFF	OFF	OFF	OFF	OFF	OFF	On	On
T:	On	On	PHO	OFF	On	On	On	On

He used P2 and left ear when telephoning.

APPENDIX 1: PROGRAMMING SCHEMATIC

47



Patient name:

Address:

H.A. Serial No. (L):

H.A. Serial No. (R):

ID No. Left (L)

ID No. Right (R)

Program No.	1		2		3		4	
Side:	L	R	L	R	L	R	L	R
IPA:								
LCut:								
HCut:								
Output:								
Comp.:								
T:								
Vol.:	Left (L)				Right (R)			

SETTINGS

IPA:	Off	-6	-12	-18	dB							
LCut:	Off	5	9	16	x 100Hz							
HCut:	Off	25	16	11	x 100 Hz							
Output:	0	-3	-6	-10	dB							
Comp.:	Off	On										
T:	On	-6	Off	Pho								
Vol.:	0	40	39	38	37	36	35	34	33	32	31	30



APPENDIX 2:

TABLE OF VC FUNCTION

GAIN dB	DISPLAY TEXT WHEN USING VC (user mode)												
	Extended VC range	Normal VC ranges											
Max	40	30											
-1,5	39	29	30										
-3	38	28	29	30									
-4,5	37	27	28	29	30								
-6	36	26	27	28	29	30							
-7,5	35	25	26	27	28	29	30						
-9	34	24	25	26	27	28	29	30					
-10,5	33	23	24	25	26	27	28	29	30				
-12	32	22	23	24	25	26	27	28	29	30			
-13,5	31	21	22	23	24	25	26	27	28	29	30		
-15	30	20	21	22	23	24	25	26	27	28	29	30	
-16,5	29	19	20	21	22	23	24	25	26	27	28	29	30
-18	28	18	19	20	21	22	23	24	25	26	27	28	29
-19,5	27	17	18	19	20	21	22	23	24	25	26	27	28
-21	26	16	17	18	19	20	21	22	23	24	25	26	27
-22,5	25	15	16	17	18	19	20	21	22	23	24	25	26
-24	24	14	15	16	17	18	19	20	21	22	23	24	25
-25,5	23	13	14	15	16	17	18	19	20	21	22	23	24
-27	22	12	13	14	15	16	17	18	19	20	21	22	23
-28,5	21	11	12	13	14	15	16	17	18	19	20	21	22
-30	20	10	11	12	13	14	15	16	17	18	19	20	21
-31,5	19	9	10	11	12	13	14	15	16	17	18	19	20
-33	18	8	9	10	11	12	13	14	15	16	17	18	19
-34,5	17	7	8	9	10	11	12	13	14	15	16	17	18
-36	16	6	7	8	9	10	11	12	13	14	15	16	17
-37,5	15	5	6	7	8	9	10	11	12	13	14	15	16
-39	14	4	5	6	7	8	9	10	11	12	13	14	15
-40,5	13	3	4	5	6	7	8	9	10	11	12	13	14
-42	12	2	3	4	5	6	7	8	9	10	11	12	13
-43,5	11	1	2	3	4	5	6	7	8	9	10	11	12
-45	10		1	2	3	4	5	6	7	8	9	10	11
-46,5	9			1	2	3	4	5	6	7	8	9	10
-48	8				1	2	3	4	5	6	7	8	9
-49,5	7					1	2	3	4	5	6	7	8
-51	6						1	2	3	4	5	6	7
-52,5	5							1	2	3	4	5	6
-54	4								1	2	3	4	5
-55,5	3									1	2	3	4
-57	2										1	2	3
-58.5	1											1	2

Vol code
(prg. mode)

0

40

39

38

37

36

35

34

33

32

31

30



The remote control has a built-in capability of performing a self-test of the internal functions. The self-test is intended to be the final way of checking whether problems with the remote control are due to "real" errors or erroneous handling/programming.

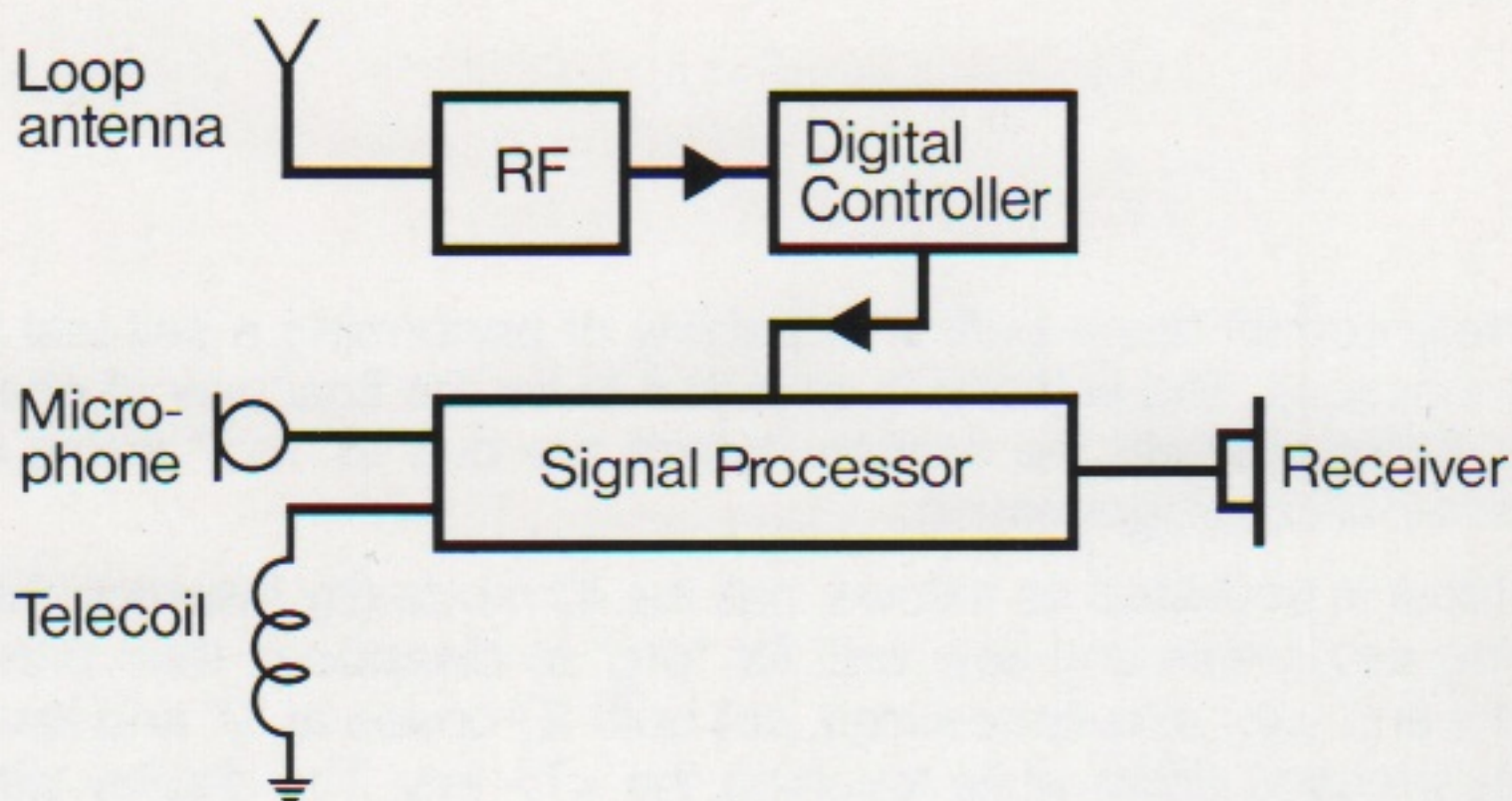
The self-test is activated as follows: call the ID mode (by inserting the programming key, press any key, wait for "prg" to disappear, then press the keys <1> and <4> simultaneously), set both ID codes at "0" and keep the <M> key pressed down while touching the <T> key. The display will then activate all its segments for approx. 3 seconds (see illust.) and then return to showing the ID status. If both ID codes are still "0", then the remote control is O.K. If an error code is shown, contact your Widex representative.





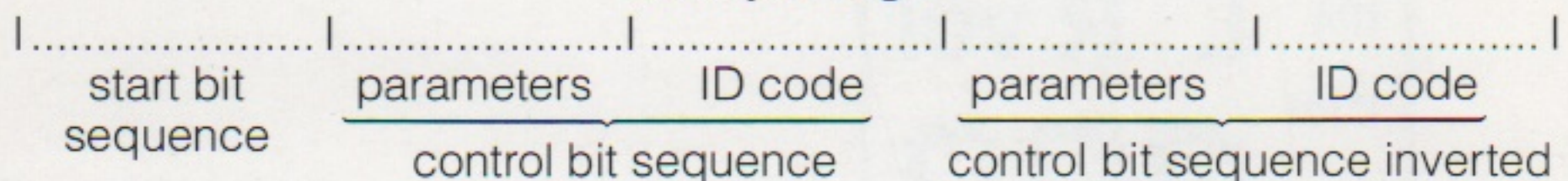
The QUATTRO hearing aid system consists of one or two hearing aids and a remote control.

The hearing aid consists of an RF receiver, a digital controller, and a digitally controlled analog signal processor.



The RF transmission is a frequency shift modulated signal of 137 to 148 kHz. Both transmitter and receiver antennas are of the loop type. The effective radiated power as a consequence is very low and the range of transmission is 1.5 meters (5 feet). Each time the remote control is activated, one or more data packages are transmitted.

Data package



One data package consists of a start bit sequence, followed by a message containing a number of bits for the parameter settings and a number of bits for an ID code, followed by the inverted message. The number of different possible ID codes is 250. This serial data package is pulse width modulated, and then the signal is FSK (Frequency Shift Keying) modulated, alternating between 137 and 148 kHz. The duration of a data package transmission is 0.1 sec. Serving two hearing aids, the remote control transmits alternatingly between right and left aid.



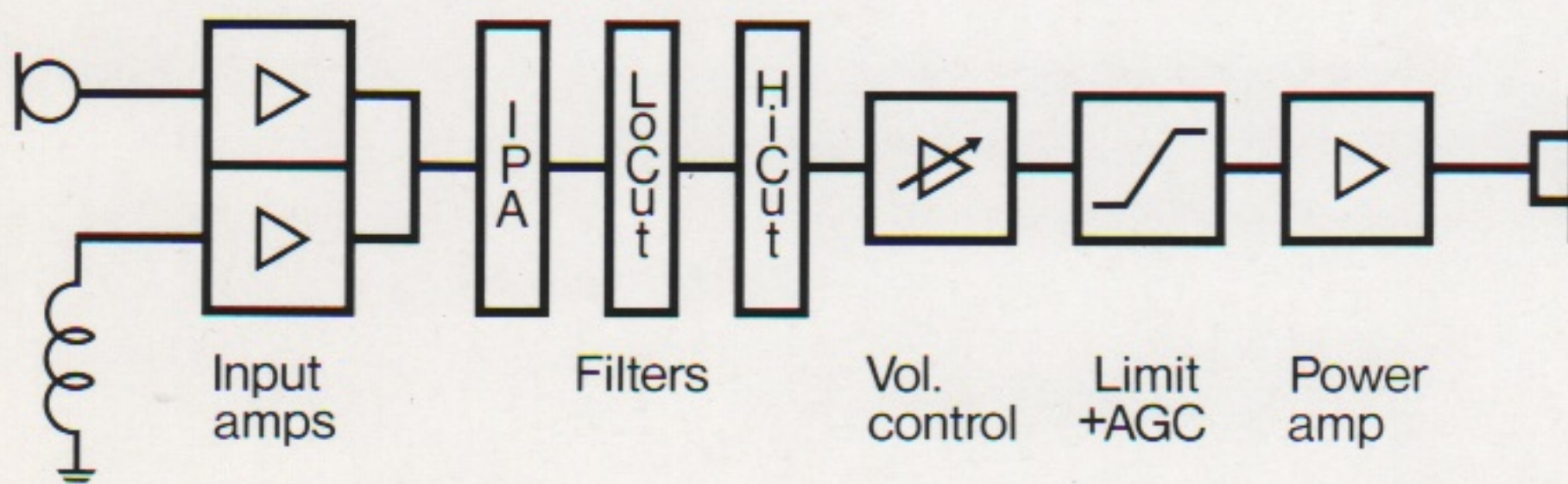
In the receiver, an FM phase locked loop type receiver extracts clock and data signals for the controller part. The controller demodulates the PWM (Pulse Width Modulation) signal, checks for correct pulse widths, synchronises to the start bit sequence and compares the received message to its inverted version and to the receiver ID code. If these tests are passed, the data bits for the parameter settings are transferred to an output latch controlling the analog signal processor.

The transmission system is very secure; i.e. a noise signal is extremely unlikely to be interpreted as a transmission, effecting an erroneous change of the settings. Powerful HF signals may reduce the max. transmission range, but as the received signal increases at the third power of the inverted transmission distance, it will always be possible for a user to control his/her hearing aids holding the remote control in his/her hand.

To enable the user to increase or decrease the volume without carrying the remote control, the hearing aid controller part has an input for an optional up/down volume control switch.

If the hearing aid has been turned off and is switched on again, it will wake up in a neutral setting in which it will remain until a program key is touched. In the neutral setting all the filters and the telecoil are off, the max. output is reduced by 10 dB, the AGC is on, and the volume set at 16 steps below maximum (i.e. max. volume -24 dB).

The analog signal processor consists of a number of circuits:





The microphone and telecoil signals are connected to input amplifiers that can be switched on/off independently. The combined signal is passed through three filters: the IPA filter, a Low Cut filter, and a High Cut filter. The IPA filter is a step response filter primarily designed for compensating the high frequency loss commonly found with elderly people. The Low Cut and High Cut filters are primarily made for cutting away environmental noise to ease speech intelligibility in noise. Each filter has four settings; i.e. off and three levels of filtering. Then follows the electronic volume control with a 60 dB range in 1.5 dB steps. Next follows the maximum output limiter, offering a max. output reduction of 10 dB in 4 steps. This block also allows on/off switching of a compressor circuit used for decreasing the gain at large inputs (to avoid clipping). The last circuit block is a class AB power amplifier driving the output transducer.

The active circuitry of the hearing aid is integrated into a single full custom IC chip measuring approx. 4 by 5 mm. Containing approx. 1500 gates, 450 transistors, and 250 passive components it consumes 1.5 m/A at a supply voltage of 1.1 to 1.5 Volt.

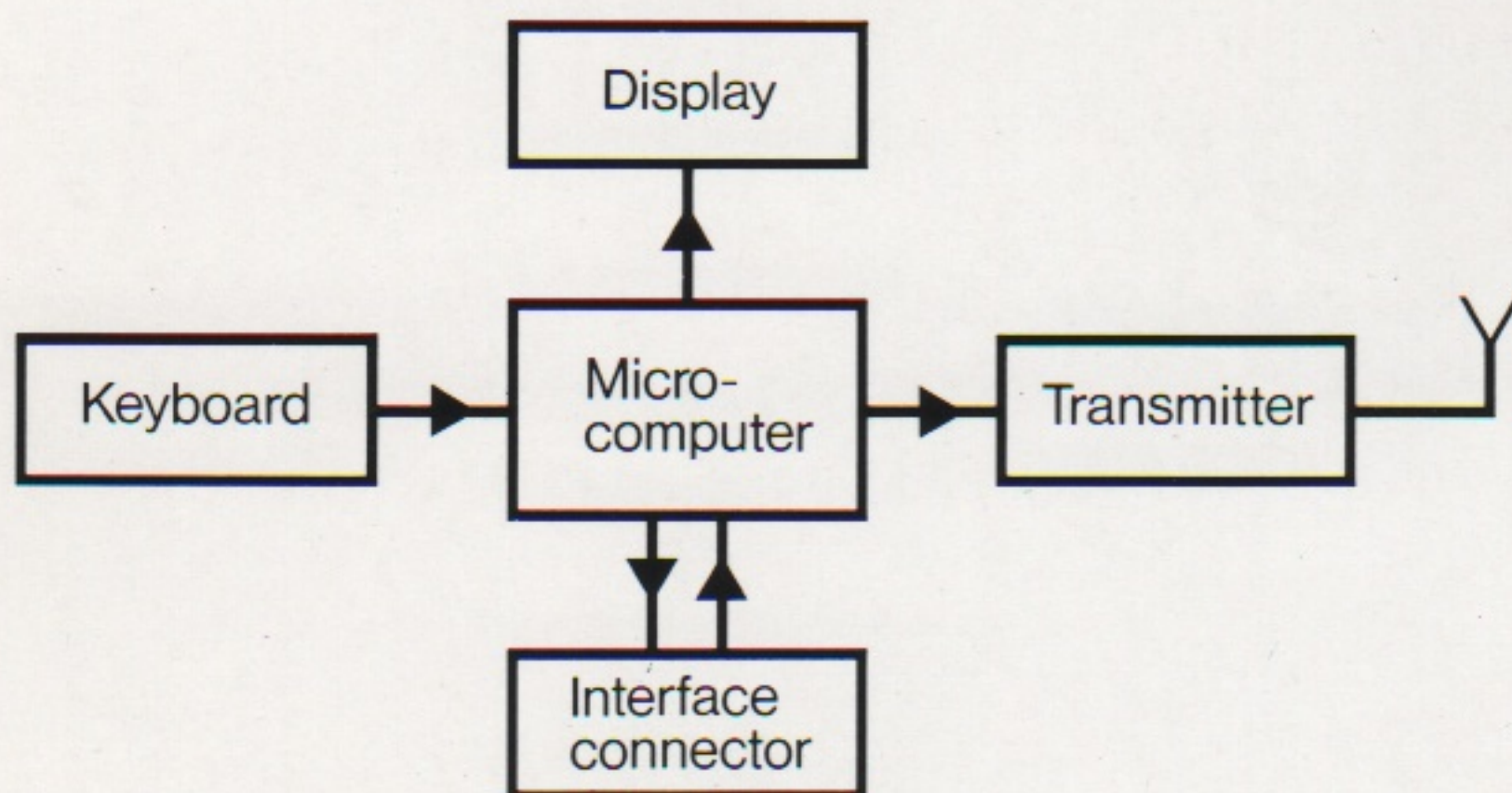


The remote control is a hand held device serving two purposes:

First, it allows the user to switch between four (x 2) responses tailored to his/her sound environments, and to adjust the volume and M/T settings in a precise and easy manner.

Second, it enables the hearing aid professional to set up the four programs for the user in an efficient and straightforward way.

The unit is built around a mask programmed single chip CMOS microcomputer.





It has an RF transmitter, a keyboard, a display, and an interface connector. To preserve the programs during battery changes, there is a lithium cell battery back up. The transmitting antenna is a tuned ferrite cored coil. The interface connector is used for connecting the unit to a personal computer for PC programming, if so wished, or for inserting a programming key to switch to the programming mode, if manual programming is preferred.

The level of RF radiation is low, i.e. below 15 $\mu\text{V}/\text{m}$ at a distance of 30 meters. The life expectancy of the batteries is more than one year of normal use. The back up cell is able to preserve the programs for two years without batteries inserted.