

COCHLEAR™ NUCLEUS®
HYBRID™ HEARING SOLUTION*

DESK REFERENCE GUIDE

Cochlear™
Hybrid®
HEARING



* Only approved for use with the Nucleus Hybrid L24 Implant

Hear now. And always



INTRODUCTION

The Cochlear™ Nucleus® Hybrid™ System is innovation at its best.

After years of continuous development and evaluation through clinical trials spanning the globe, the Nucleus Hybrid System is now available as a new treatment option to address the unique needs of those patients with high frequency loss.

Only Cochlear can provide the option to stimulate low frequency hearing and simultaneously restore access to the high frequencies through electric stimulation. We can do this because Hybrid Hearing is built into every Cochlear Nucleus 6 Sound Processor and can be accessed by attaching the Hybrid Hearing acoustic component for use with the Hybrid L24 Implant. This never before achieved integration of two technologies has shown significant improvement over hearing aids alone and overall patient satisfaction.¹

This Hybrid clinical reference guide is intended to outline efficient clinical practices to ensure the best outcomes for you and your patients.

¹ Cochlear Nucleus Hybrid L24 North American Clinical Trial

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Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

CANDIDACY FOR A NUCLEUS HEARING IMPLANT

1 COMPREHENSIVE AUDIOMETRY*(Air & bone conduction thresholds & speech audiometry)*

- Review of hearing history
- Air conduction thresholds using insert earphones at 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz for each ear
- Bone conduction thresholds at 250, 500, 750, 1000, 1500, 2000, and 4000 Hz for each ear
- Tympanometry and acoustic reflex threshold measurements
- Additional tests may be warranted based on clinical assessment e.g., otoacoustic emissions

2 VERIFICATION OF AMPLIFICATION

- Verification should be completed based on current clinic practices prior to aided speech perception testing
- Considerations:
 - **Existing hearing aids:**
 - Evaluation via test box with appropriate 2cc coupler, RECD or real ear in situ measures with a probe microphone
 - Input levels for these measurements should include an input of 60 dB SPL for a speech or speech like signal to approximate average conversational level speech (*Pearsons et al., 1977; Olsen, 1998*)
 - If necessary, adjustment or re-programming should be completed to optimize the fitting of these devices prior to speech perception testing
 - **Nonoperational or no longer appropriate hearing aids:**
 - Consider appropriately fit loaner hearing aids to complete the evaluation and a hearing aid trial period to further assess the benefit of amplification. Additional testing should be considered after the completion of the trial period to determine overall benefit and candidacy

3 SPEECH PERCEPTION ASSESSMENT

- It is important that appropriate consideration be made for plugging and muffing the contralateral ear during aided testing with subjects having relatively good low-frequency hearing bilaterally
- Complete aided testing in the soundfield at 60 dBA for recorded CNC Words and AzBio Sentences
 - CNC Words each ear
 - AzBio Sentences each ear and bilateral
- Complete aided testing at 65 dBA at +5 SNR when AzBio scores in quiet are greater than 50% and/or CNC Words are greater than 10% in the poorer ear
 - AzBio Sentences in Noise one list in each ear

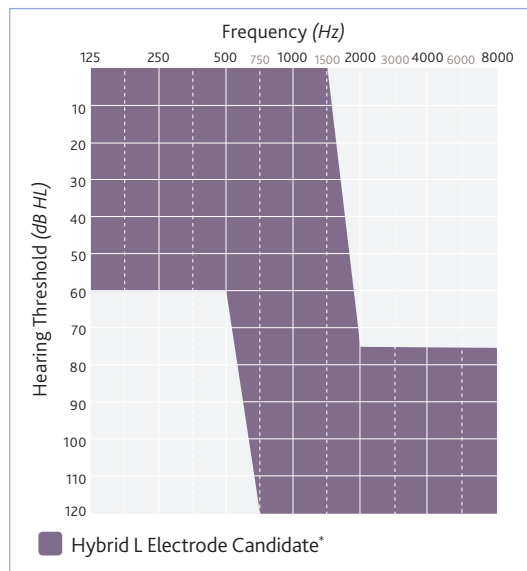
Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

CANDIDACY FOR A NUCLEUS HEARING IMPLANT

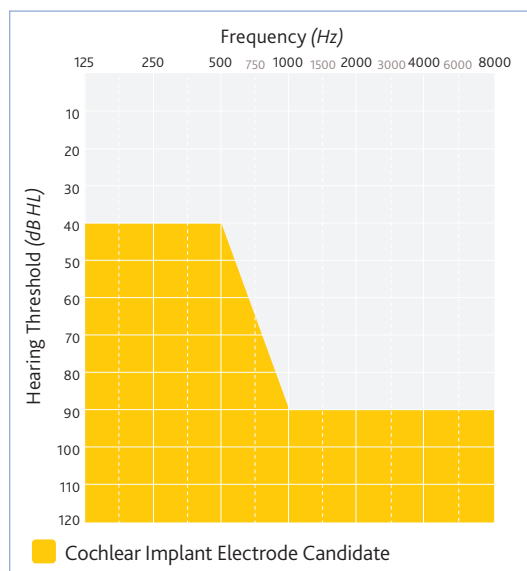
4 AUDIOMETRIC/SPEECH PERCEPTION REVIEW

- Review the audiogram and speech perception data to help determine if the patient is a candidate for a Hearing Implant: Hybrid or Cochlear Implant

Tip: Refer to the Pre-operative Hearing Implant Candidate Worksheet FUN1946 for additional guidance.



Word (CNC) score $\geq 10\%$ and $\leq 60\%$ (thresholds no poorer than 60 dB HL up to and including 500 Hz), with a PTA (2,3,4 KHz) ≥ 75 dB HL in the ear to be implanted. Word (CNC) score $\leq 80\%$ and a PTA (2,3,4 KHz) ≥ 60 dB HL in the opposite ear.



Sentence Score (AzBio) $\leq 50\%$ in the ear to be implanted
Sentence Score (AzBio) $\leq 60\%$ in the best aided condition

5 REVIEW HISTORY

Determine if the patient has any contraindications:

- ☐ Deafness due to lesions of the acoustic nerve or central auditory pathway
- ☐ Active middle ear disease, with or without tympanic membrane perforation
- ☐ Absence of cochlear development
- ☐ Severe-Profound Hearing loss > 30 years

6 COUNSELING

Considerations for counseling and implantation

- ☐ Duration of hearing loss
- ☐ Progression of hearing loss
- ☐ Fluctuating and/or sudden hearing loss
- ☐ Realistic expectations
- ☐ Self-assessment scales (consider using the SSQ12 at www.ihr.mrc.ac.uk/products/display/ssq)
- ☐ Continued use of contralateral amplification-Combined hearing
- ☐ Bimodal vs bilateral cochlear implants

Tip: Use FUN1948 Counseling Flash Cards to assist in the counseling process.

7 MEDICAL EVALUATION

8 INSURANCE PREAUTHORIZATION

Refer to OMS Pre-Surgical Insurance Support. Otologic Management Services (OMS) is a no-charge service that is available to help patients and providers obtain necessary insurance coverage and to assist in appealing denied coverage for Cochlear Americas' implantable hearing solutions.

OMS contact information – phone: 1-800-633-4667
fax: 303-524-6765 – www.omsinsurancehelp.com

* Use in patients aged 18 years and older

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

ACOUSTIC COMPONENT SELECTION AND ORDERING

1 MEASURE

The Cochlear EAC200 Series Power Speaker Unit comes with one of five different cable lengths for the left or right ear.

a

Order:

1. Side: **L** or **R**
2. Size: **1, 2, 3, 4, 5**

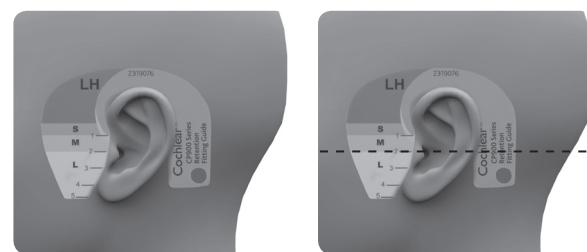


Use the double-sided Cochlear Nucleus 6 Fitting Template (*Figure b*) in the Hybrid Hearing Clinic Troubleshooting Kit to select the appropriate Power Speaker Unit:

b



c



Place the template on the ear so it fits like a behind-the-ear (BTE) sound processor.

Measure the left ear with the blue side or the right ear with the red side of the template.

Look into the ear canal. Your eye should be level with the ear canal. Use the template to measure the top of the ear canal and note the number on the template that is adjacent to the top of the canal (*in this example, #2*).

Tip: If measure is in-between, choose the higher number.

2 CHOOSING THE PROPER DOME SIZE

Power Domes (*Figure d*) or Plus Dome (*Figure e*) are the standard options for the acoustic component. A package of 10 of either the power domes or plus domes will be sent with each speaker unit. The dome can be used to fit the acoustic component temporarily if an earmold has not yet been ordered.

- Complete an otoscopic examination to evaluate the size and shape of the ear canal
- Choose the dome size that best matches the ear canal size

Cochlear EAC200 Series Power Domes (8,10,12 mm):

Power Domes fit more snugly. No venting.
8 mm most common size

d



Cochlear EAC200 Series Plus Dome:

One-size-fits-all option.
Built-in venting action=1.4 mm

e



3 CUSTOM EARMOLD

A custom fit earmold is recommended for use with the acoustic component as this provides maximum comfort, improves headroom prior to feedback, enables a defined vent, and provides maximum use of residual hearing. Various manufacturers offer different styles of earmolds.

Refer to Appendix for additional information on selecting an earmold type.

Based on your clinic's workflow, protocol and recipient's degree of hearing loss pre-operatively, you may choose to take an earmold impression prior to the post-operative audiometric evaluation or wait until after post-operative hearing thresholds have been measured.

4 ORDER

Complete the Cochlear Americas Implant Activation form.

ACOUSTIC COMPONENT SELECTION AND ORDERING

1 OPTIONS FOR ORDERING

System orders

- Select "Hybrid Hearing Kit" on the Nucleus 6 Order Form
– Located in the Accessories section

Aftermarket

- Contact Customer Service and order FUZ107 – Hybrid Hearing Kit

Plus One

- Save your 4th accessory choice for later and redeem it for a Hybrid Hearing Kit

2 WHAT IS IN THE HYBRID HEARING KIT?

- The components needed to convert the Nucleus 6 Sound Processor into a Hybrid Sound Processor
- It includes:
 - 1 EAC200 Series Power Speaker Unit
 - 1 Hybrid Earhook
 - 1 pack of EAC200 Series Power or Plus Domes (*based on completed order form*) (10 domes per pack)
 - 1 EAC200 Series Waxstop Wax Management System (8 filters per pack)
 - 1 EAC200 Series Screwdriver


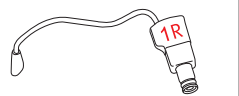
3 CLINIC HYBRID TROUBLESHOOTING KIT

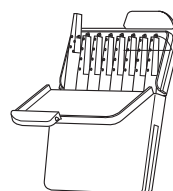
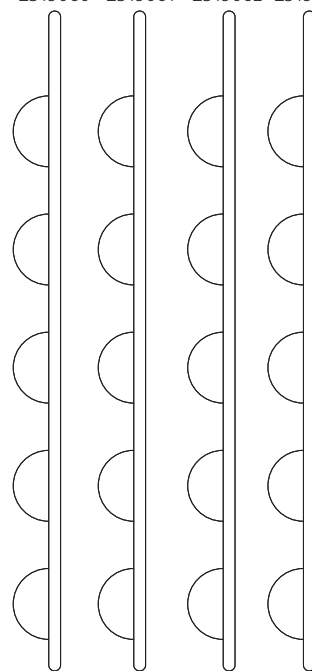
- Provided with first Hybrid Hearing Kit Order
- Convenient storage box with common Hybrid accessories. Contains designated items in Figure a

How do I get it?

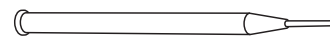
- Upon first order of the Hybrid Hearing Kit, Cochlear will supply the account with one Hybrid Clinic Troubleshooting Kit when selected on the order form
- Afterwards, additional Hybrid Clinic Troubleshooting Kits can be ordered for \$749.00
- Individual components can be purchased for replenishment at any time

a

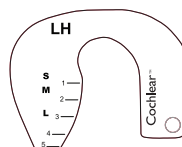
			
1L*	Z319070	1R*	Z319065
2L	Z319071	2R	Z319066
3L	Z319072	3R	Z319067
4L	Z319073	4R	Z319068
5L*	Z319074	5R*	Z319069



Z322475



Z322477



Z319076



Z274093



Z322709

* For reference only. These sizes are not included in this kit.

FITTING THE ACOUSTIC COMPONENT

1 COMPLETE UNAIDED AUDIOMETRIC THRESHOLDS WITH INSERT EARPHONES FOR BOTH EARS

- Air conduction thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz
- Bone conduction thresholds at 250, 500, 750, 1000, 1500, 2000, and 4000 Hz
- Tympanometry (*if medically cleared for this test*)

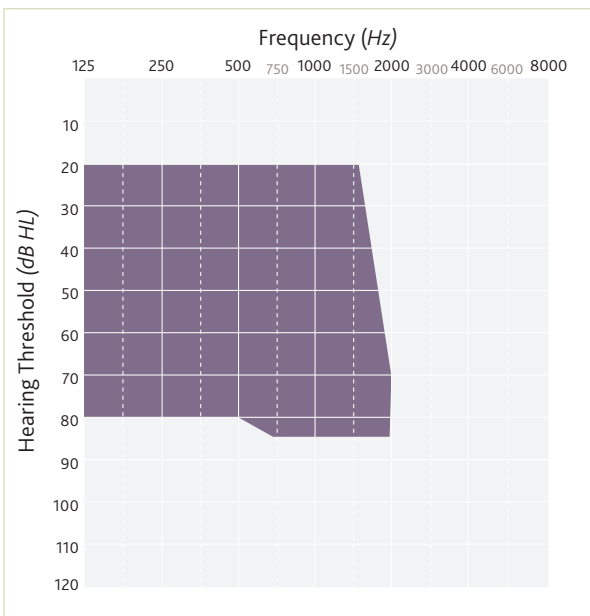
Tip: It is possible to see a temporary or permanent conductive component post-operatively.

2 FIT THE ACOUSTIC COMPONENT

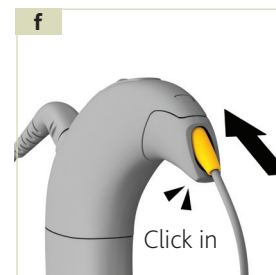
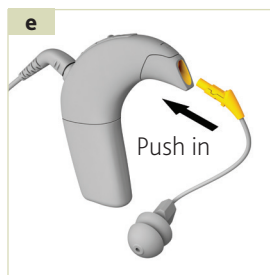
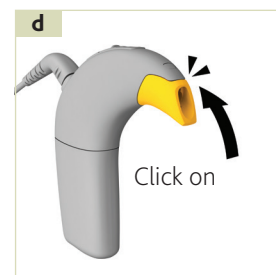
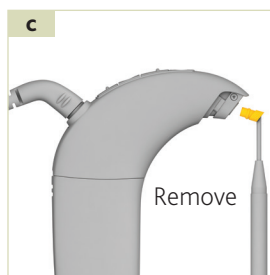
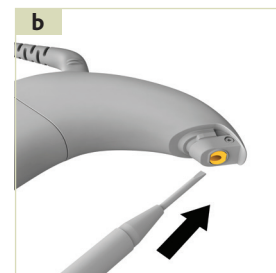
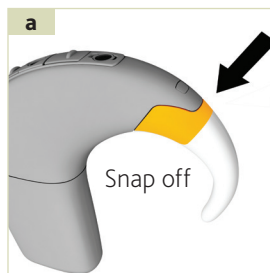
Post-operative thresholds within the shaded range (*below*) can be amplified by the acoustic component. Attempting to fit thresholds outside of the shaded area will exceed the gain available with the acoustic component.

Tip: Timing of the post-operative assessment may vary depending on the clinic's protocol and medical clearance. Average time frame is 3-4 weeks.

Fitting range for the acoustic component of Nucleus 6 Sound Processor in Hybrid mode



3 ATTACH THE ACOUSTIC COMPONENT TO THE SOUND PROCESSOR

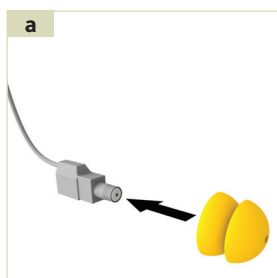


Tip: Refer to the Care and Maintenance section for more information on how to remove the acoustic component. The recipient will be provided this information in the supplement that is included in their Hybrid Hearing kit.

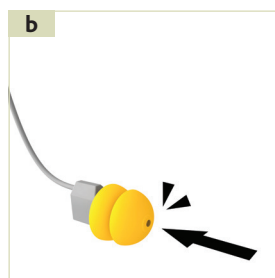
4 ATTACH A DOME OR EARMOLD TO THE ACOUSTIC COMPONENT

A dome can be fit temporarily for the initial activation if an earmold has not yet been ordered OR if an earmold impression has not yet been taken. **Refer to the Earmold manufacturer for information on how to attach the earmold to the acoustic component.**

Important: No contact should be made between the Power Speaker Unit & the coil magnet. This can lead to possible damage of the receiver.



Push the dome directly onto the Power Speaker Unit.



Push the dome again until it clicks securely in place.

5 INSTRUCT THE RECIPIENT ON PROPER INSERTION AND REMOVAL OF DOMES AND EARMOLDS

It is important to teach the recipient proper insertion and removal of the dome/earmold. Avoid pulling on the speaker cable to remove the device from the ear. Use the removal cord on an earmold and instruct the recipient to use their fingers/nails to remove a dome. *(Refer to Care and Maintenance section for more information)*

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

WHAT IS THE GOAL OF HYBRID HEARING?

The Nucleus 6 integrated sound processor lets clinicians fit recipients who have functional low frequency hearing with a combined acoustic and electric signal. This provides the recipient with audibility across the frequency range 125-→ 6000 Hz with the low frequencies being acoustically amplified and the high frequencies coded via electrical stimulation. Electric hearing restores access to audibility to the high frequencies that are critical for speech understanding. The acoustic signal provides low frequency temporal fine structure information that currently is not conveyed in the electrical signal. This increased low frequency spectral resolution is important for musical and voice pitch perception. The acoustic signal better represents pitch and fundamental frequency (F_0) and frequency selectivity

(F_1 [270 ~1000 Hz] vowel cues and low frequency consonant cues such as those for voicing and manner) which together enable a listener to take advantage of pitch differences between speakers and to segregate speech targets from noise. These low frequency cues contribute to improved speech understanding, especially in background noise (e.g., Turner et al., 2004; Chang et al., 2006; Qin and Oxenham, 2006, Kong and Carlyon, 2007). In addition, low frequency acoustic information gives a more natural sound quality compared to electric hearing alone.

1 FITTING HYBRID HEARING

When fitting Hybrid Hearing, Custom Sound uses the audiogram to determine which frequencies receive an acoustic signal, which frequencies receive an electrical signal and which frequencies receive acoustic and electric signals (*referred to as overlap*). The boundary chosen for what is provided acoustically versus electrically is known as the cross over frequency. Typically, the lower electrical (CI) frequency boundary is set slightly above the upper acoustic channel frequency boundary. Custom Sound automatically provides a MAP with a minimal amount of overlap between acoustic and electric signals. This lower electrical frequency boundary can be modified within Custom Sound if necessary. Refer to the Appendix-Programming section.

2 SETTING THE ACOUSTIC BOUNDARY FOR HYBRID HEARING

The first question in the fitting is what can be fit acoustically. For thresholds less than 90 dB HL out to 2200 Hz, Custom Sound applies an acoustic signal. It is important to verify what can be fit acoustically through real ear measurements or if this is not possible by sound field thresholds. If target is not met or there is not good audibility for that frequency(s) then disable the acoustic channel(s) and provide an electrical signal at that frequency(s).

3 FITTING THE ELECTRIC BOUNDARY FOR HYBRID HEARING

Now that it has been determined what can be fit acoustically, evaluate where the CI frequency boundary should be set to provide the recipient with good audibility in the higher frequencies. Based on the most recent post-operative audiogram, set the lower CI frequency boundary to the lowest frequency where the threshold is greater than (*i.e. poorer than*) 70 dB HL. This is more conservative than what is currently used in Custom Sound and will more effectively fit steeply sloping and flat hearing losses with an appropriate electric cut off.

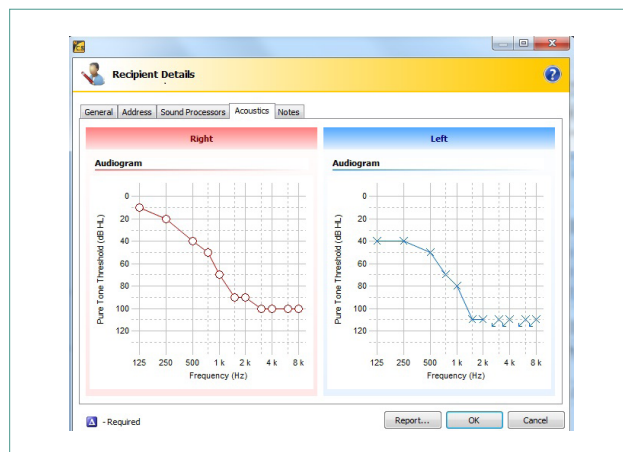
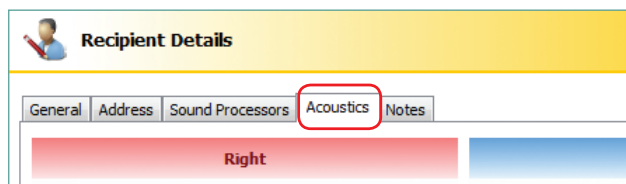
4 WHAT ABOUT ACOUSTIC TO ELECTRIC OVERLAP?

While there is ongoing research investigating the amount of overlap to provide a recipient, currently there is no clear consensus on what this should be. Therefore the extent of overlap may vary depending on the degree of residual hearing and individual listening preferences. Consider providing additional MAPs with a lower CI cut off frequency (*and thus greater acoustic and electric overlap*) for the recipient to evaluate.

INITIAL ACTIVATION

1 CREATE A NEW RECIPIENT

Enter recipient details as required. Add implant, select Hybrid L24. Enter pure tone thresholds under Acoustic tab by clicking on the level for each frequency (*including inter-octaves*) in the Recipient Details screen.

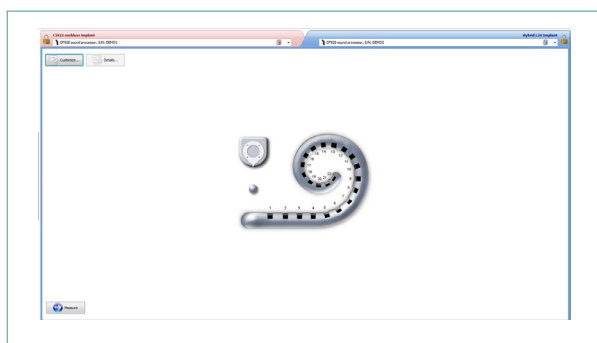


Tip: Note where thresholds are equal to or better than 70 dB HL.

Tip: Right click on a threshold to delete, clear or mark as no response. Update the pure tone thresholds with current results each time you see the recipient for programming.

TIP: Pure tone thresholds must be entered to create a Hybrid Mode MAP.

2 MEASURE IMPEDANCES



3 CREATE A NEW MAP

The screenshot shows the 'Create a New MAP' window. It has a table of parameters: Processor (CP900 Series sound processor), Strategy (ACE / ACE (RE)), Mode (MP1+2), Rate (900), Maxima (8), Pulse Width (25), and Hybrid Mode (checked). The 'Hybrid Mode' checkbox is highlighted with a red box. There is a 'Create' button at the bottom right.

Create a New MAP using the default parameters. Check the box for Hybrid Mode.

4 FITTING THE ACOUSTIC COMPONENT

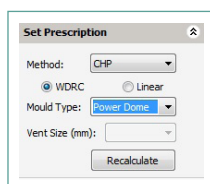
It is recommended you start the fitting with the acoustic component. Remove the coil from the head.



Click on the Acoustics icon in the tool bar to open the Acoustics screen.



Select the fitting prescription (CHP, DSL or NAL-RP), compression (WRDC or linear), mold type and vent size.

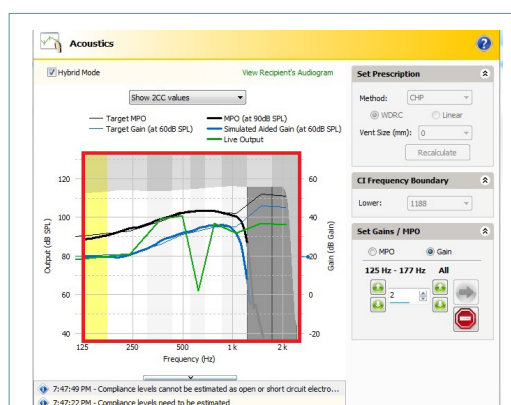


By default CHP and WRDC are selected. (See Appendix for a further description of the acoustics screen)

Tip: Click "recalculate" if you update the recipient's audiogram. This recalculates MPO and gain settings. If you change the vent size the software automatically changes the target gain & target MPO based on the change. You must click "recalculate" to change the MPO and Simulated Aided Gain values.

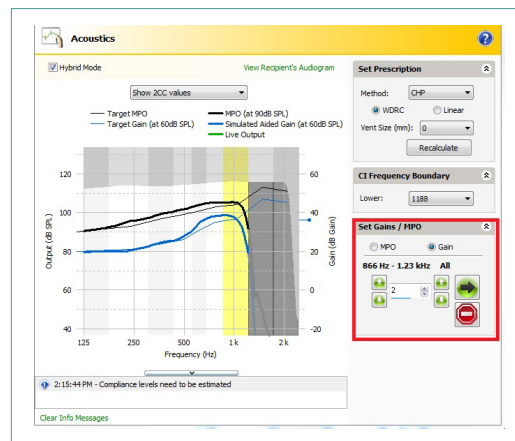
5 GO LIVE WITH ACOUSTIC STIMULATION

Go Live with acoustic stimulation only in the Acoustics screen (click green arrow). The Live Output green line will be displayed (second image below).



TIP: The Live Output green line alerts the clinician the acoustic signal is turned on and you are live.

Complete Real ear measurements to verify the acoustic output at each frequency matches the slope/shape of the target curve and does not exceed the UCL of the recipient. (See Appendix for a further description of verification). Take into account the subjective feedback of the recipient. Make any necessary adjustments to gain and MPO for all channels as required using the up down arrows under **ALL** or an identified channel. If the desired acoustic gain cannot be met in a channel, you may need to enable the adjacent channel to determine if additional gain is made available to meet target. If not, you may need to lower the CI frequency boundary further (*see step 6*) and disable any additional acoustic channels that did not meet target.



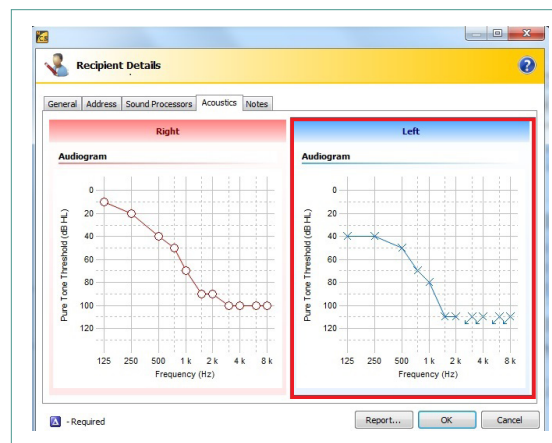
6 EVALUATE CI FREQUENCY BOUNDARY

Custom Sound will automatically create a MAP with minimal overlap between frequencies presented acoustically and those presented electrically.

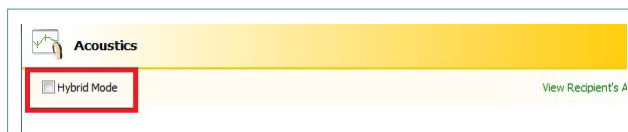
Based on the audiogram, set the lower CI frequency boundary to the lowest frequency where the threshold is greater than (*i.e. poorer than*) 70 dB HL. You can view the audiogram by clicking on "view recipient's audiogram" in the acoustics screen.

Tip: If the unaided threshold is greater than 70 dB HL, it should be mapped electrically. In some cases a full electric MAP (188-7938) may be needed.

The left audiogram shows a threshold greater than 70 dB HL at 750 Hz. The CI frequency boundary can be lowered to 688 to provide more electrical stimulation.

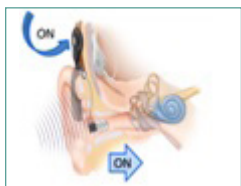


7 MEASURE T AND C LEVELS

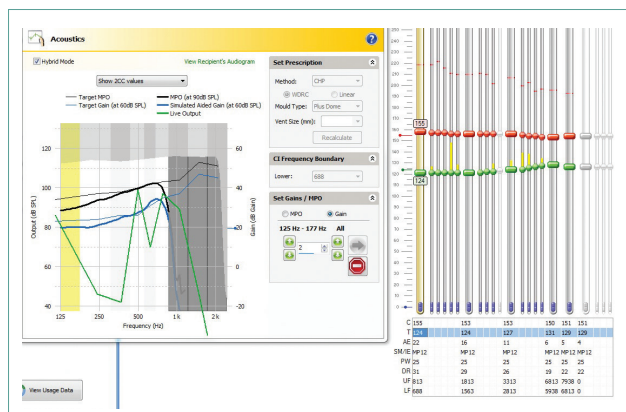


Measure T levels: **Use the streamline programming method** to measure T levels on electrodes 22, 16, 11, 6, 5. Electrodes 4-1 will be disabled when selecting a Hybrid L electrode. Enable and measure individual T levels to determine if they can be active in the MAP. Additional electrodes should be measured if there are large differences between the selected electrodes.

Measure C levels:



Go live and obtain C levels using global shift in live voice. Make adjustments so sound is comfortably loud to the recipient.



8 LOUDNESS BALANCE

Sweep at C level in small groups to loudness balance.

9 BALANCE FOR LOUDNESS

Go Live. Ensure acoustic and electric signals are comfortably loud when presented together. Present each signal separately if the recipient has a complaint of loudness or sound quality. Balance for loudness with the contralateral hearing aid. **Save the MAP.**

10 ADDITIONAL MAPS

In addition to the primary MAP, consider providing other MAPs with additional overlap. For example: Based on the audiogram and unaided threshold at 750 Hz of greater than 70 dB, 688 Hz was chosen. A lower cut off of 563 may be considered.

11 CHECK BATTERY SUITABILITY

Check battery suitability and personalize MAPs by adding SmartSound iQ options. Program 1 primary MAP with SCAN and Program 2 with Custom Sound defaults. Programs 3 and 4 can be used to try other cut offs with SCAN. Add telecoil, tones and alerts as needed. **Save the MAP(s).**

12 WRITE MAPS

Write MAPs to the sound processor and finalize the programming session. Close Session.

13 VERIFICATION

Though it is recommended that you follow AAA and ASHA recommendations for hearing aid verification with real ear measures, if real ear measurements were not completed, measure sound field thresholds across the frequency range 250-6000 Hz including inter-octaves to confirm good audibility (≤ 25 dB HL).

Complete this step using the acoustic component only (*remove the coil from the head*) and repeat using electric stimulation only by removing the acoustic component from the ear canal.

Tip: If low-frequency thresholds are not in this range and the gain cannot be increased in that frequency band(s), lower the CI low frequency cut off and disable the associated acoustic channel(s). If electrical stimulation channels do not provide good audibility, T-levels may need to be increased along with a recheck of C-levels.

Note: Real ear verification is strongly recommended within the first month when using a dome or earmold. A custom earmold is recommended when attempting to fit Hybrid Hearing to thresholds that require more gain i.e. greater than a moderate hearing loss in the lower frequencies.

Custom Sound™ for Nucleus® 6 Hybrid™ L24 Implant & Nucleus® 6 Sound Processor

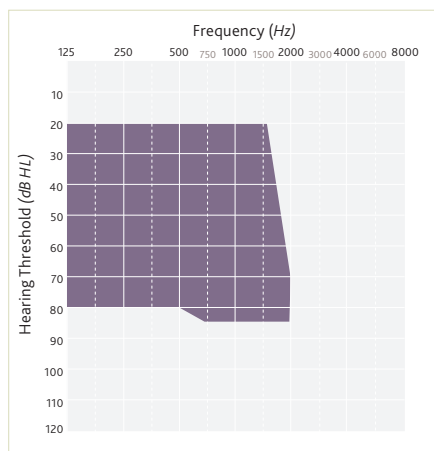
EXISTING RECIPIENTS

This section is intended for existing recipients who have experience with electrical stimulation being fit with Hybrid Hearing for the first time.

The steps in programming are similar to a new recipient however there are several minor differences. Please refer to the Initial Activation section to view screen shots for steps 6-9.

1 COMPLETE AN UNAIDED AUDIOGRAM

Determine if the unaided thresholds are in the Hybrid Hearing Fitting range.



If the recipient is not a candidate for Hybrid Hearing, program per your clinic's standard clinical protocol.

2 EVALUATE SPEECH PERCEPTION

If not completed in the past 12 months, evaluate performance in quiet and noise with the most current MAP.

Tip: This information can be used to compare to performance when using Hybrid Hearing. e.g., electric and acoustic hearing.

3 MEASURE FOR THE ACOUSTIC COMPONENT

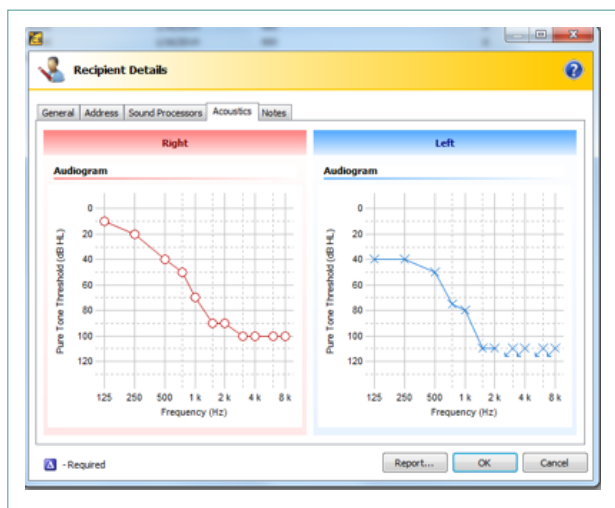
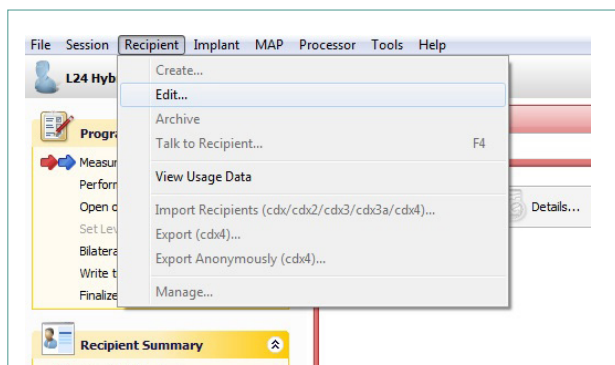
Measure for acoustic component cable length using the template and choose the proper dome size. Select the proper component from the Hybrid Troubleshooting kit. Attach the acoustic component to the recipient's existing N6 sound processor. (Refer to the sections on Ordering and Fitting for detailed information.)

4 ATTACH N6 SOUND PROCESSOR

Attach the sound processor to the programming pod and software.

5 ENTER AUDIOGRAM

Select Recipient/edit/acoustic tab. Enter the audiogram including inter-octaves.



Tip: Note where thresholds are better than or equal to 70 dB HL.

Tip: Right click on a threshold to delete, clear or mark as no response. Update the pure tone thresholds with current results each time you see the recipient for programming. Pure tone thresholds must be entered to create a Hybrid Hearing MAP.

6 MEASURE IMPEDANCES

7 OPEN AN EXISTING MAP

It is recommended you start the fitting with the acoustic component.

Enable Hybrid Mode: Remove the coil from the head. Click on the Acoustics icon in the tool bar to open the Acoustics screen. Check the box for Hybrid Mode.

8 SELECT FITTING PRESCRIPTION

Select the fitting prescription (*CHP, DSL or NAL-RP*), compression (*WRDC or linear*) and vent size. By default CHP and WDRC are selected. (*See Appendix for a further description of the acoustics screen.*) **Click recalculate, this updates the Acoustics tab to include the newly entered audiometric information**

Tip: You must click "recalculate" when you update the recipient's audiogram. This recalculates MPO and gain settings. If you change the vent size the software automatically changes the target gain & target MPO based on the change. You must click "recalculate" to change the MPO and Simulated Aided Gain values.

9 GO LIVE WITH ACOUSTIC STIMULATION

Go Live with acoustic stimulation only in the Acoustics screen (*click green arrow*). The Live Output green line will be displayed.

Complete Real ear measurements to verify the acoustic output at each frequency matches the slope/shape of the target curve and does not exceed the UCL of the recipient. (*See Appendix for a further description of verification.*) Take into account the subjective feedback of the recipient. Make any necessary adjustments to gain and MPO for all channels as required using the up down arrows under ALL or an identified channel. If the desired acoustic gain cannot be met in a channel, you may need to enable the adjacent channel to determine if additional gain is made available to meet target. If not, you may need to lower the CI frequency boundary further (*see step 10*) and disable any additional acoustic channels that did not meet target.

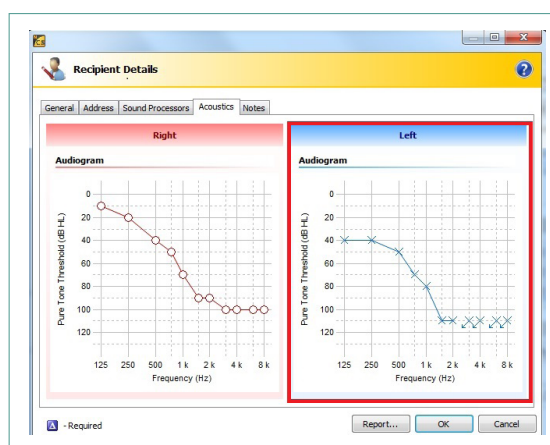
10 EVALUATE CI FREQUENCY BOUNDARY

Custom Sound will automatically create a MAP with minimal overlap between frequencies presented acoustically and those presented electrically.

Based on the audiogram, set the lower CI frequency boundary to the lowest frequency where the threshold is greater than (i.e. poorer than) 70 dB HL. You can view the audiogram by clicking on "view recipient's audiogram" in the acoustics screen.

Tip: If the unaided threshold is greater than 70 dB HL, it should be mapped electrically. In some cases a full electric MAP (188-7938) may be needed.

The left audiogram shows a threshold greater than 70 dB HL at 750 Hz. The CI frequency boundary can be lowered to 688 to provide more electrical stimulation.



11 MEASURE T'S AND C'S IF NEEDED

Place the coil on the head. Reprogram if necessary per your clinic's protocol. Talk to the recipient using electric and acoustic stimulation and make adjustments so sound is comfortably loud.

12 BALANCE FOR LOUDNESS

Ensure acoustic and electric signals are comfortably loud when presented together. Present each signal separately if the recipient has a complaint of loudness or sound quality. Balance for loudness with the contralateral hearing aid.

Save the MAP.

13 FINALIZE PROGRAMMING

In addition to the primary MAP, consider providing other MAPs with additional overlap. For example: Based on the audiogram and unaided threshold at 750 Hz of greater than 70 dB, 688 Hz was chosen. A lower cut off of 563 may be considered.

Check battery suitability and personalize MAPs by adding SmartSound iQ. Program 1 primary MAP with SCAN . Program 2 default. Program 3 and 4 can be used to try other cut offs with SCAN or their preferred quiet and noise programs. Add telecoil, tones and alerts as needed. Save the MAP(s).

Write MAPs to the sound processor and finalize the programming session. Close Session.

Though it is recommended that you follow AAA and ASHA recommendations for hearing aid verification with real ear measures, if real ear measurements were not completed, measure sound field thresholds across the frequency range 250-6000 Hz including inter-octaves to confirm audibility (≤ 25 dB HL). Complete this step using the acoustic component only (*remove the coil from the head*) and repeat using electric stimulation only by removing the acoustic component from the ear canal.

Tip: If low-frequency thresholds are not in this range and the gain cannot be increased in that frequency band(s), lower the CI low frequency cut off and disable the associated acoustic channel(s). If electrical stimulation channels do not provide good audibility, T-levels may need to be increased along with a recheck of C-levels.

Tip: See the recipient back in 2-4 weeks. Test CNC words and sentences in noise. If the recipient's subjective response is positive and/or performance is equal to or better than with electric only hearing, order the acoustic component and replace the stock in the Hybrid Troubleshooting Kit. Order a custom fit earmold. Use real ear measurements to verify gain and match to target and/or repeat the sound field audiogram.

Note: Real ear verification is strongly recommended within the first month when using a dome or earmold. A custom earmold is recommended when attempting to fit Hybrid Hearing to thresholds that require more gain i.e. greater than a moderate hearing loss in the lower frequencies.

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

HYBRID RECIPIENT: POST ACTIVATION MANAGEMENT

The recommended follow-up schedule is the same as your typical cochlear implant clinical protocol (For example: 1A, 1, 3, 6, 12 months post activation and annually thereafter). Consider the following steps during follow-up visits:

1 INTERVIEW THE RECIPIENT

- Concerns or complaints?
- Utilize Data Logging in Custom Sound to evaluate usage patterns and help focus conversation
 - Note volume and sensitivity changes
 - Note program use preferences

2 INSPECT EQUIPMENT/ LISTENING CHECK/ANALYSIS

- Inspect the sound processor, ensure cables are not cracked or broken, the acoustic component is correctly connected and the wax guard is clean and in place. Use/replace if needed



Note: Use the Remote Assistant (RA) to help troubleshoot.

- Check for correct insertion (*by the recipient*) of the dome or earmold and proper fit
- Check that domes are not discolored or have lost shape. Replace if necessary
- Check that earmolds are not cracked or broken. Replace if necessary
- Listening check of the sound processor using monitor earphones
 - If distorted, check/change mic protectors
 - If still distorted or not working consider replacing or using clinic CP900 series processor for comparison/ additional troubleshooting
- Listening check of the acoustic component using hearing aid stethoscope
 - If distorted, check/change wax guards

3 COMPLETE OTOSCOPIC EXAMINATION

- Ensure there is no wax blockage in the ear canal
- Manage according to your clinic's cerumen management protocol

If the recipient reported a complaint during the interview, and it is not related to the equipment or cerumen, continue to the next step. Otherwise, measure unaided audiometric thresholds using insert earphones.

4 ISOLATE THE COMPLAINT BETWEEN ACOUSTIC AND ELECTRIC

- Have the recipient listen in the acoustic only, electric only and acoustic plus electric conditions

Note: Coil is off the head when listening in the acoustic only condition

- Refer to Hearing Mentor in Custom Sound for complaints related to the electric signal
- Refer to the table in the troubleshooting section for complaints related to the acoustic and/or combined signal

5 MEASURE UNAIDED AUDIOMETRIC THRESHOLDS USING INSERT EARPHONES

- Check for any clinically significant change in hearing in the implanted ear (*10 dB or greater*) as well as the contralateral ear
- Consider Tympanometry
- Refer for medical evaluation if clinically indicated

6 COMPLETE REPROGRAMMING (IF NEEDED)

Consider the following steps in reprogramming:

- View Usage Data (*Data logging*) in CS; discuss with recipient
- Measure impedances (*compare impedances over time to ensure no significant changes or unusual patterns*)
- If a change in hearing, update audiogram in Custom Sound (CS) and make adjustments to the acoustic component through real ear verification

- Re-measure T levels using the streamline programming method. Sweep to ensure all T levels are audible
- Enable Hybrid Mode and set C levels in live mode ensuring loudness is comfortably loud. For any channel(s) out of voltage compliance, widen the pulse width to 50 μ s. Re-measure T- and C-levels on any channel(s) out of compliance
- Balance C levels for loudness
- Ensure acoustic and electric signals are balanced for loudness in the same ear and between ears
- Check battery suitability and personalize MAPs by adding SmartSound iQ. Add telecoil, tones and alerts as needed
- Consider having a non-Hybrid MAP if the recipient will be involved in water activities where the acoustic component will not be used. Refer to the Appendix for more information
- Write to processor and finalize MAPs
- If real ear measurements were not completed, measure sound field thresholds across the frequency range 250-6000 Hz including inter-octaves to confirm good audibility (≤ 25 dB HL). Complete this step using the acoustic component only (*remove the coil from the head*) and repeat using electric stimulation only by removing the acoustic component from the ear canal. If low-frequency thresholds are not in this range and the gain cannot be increased in that frequency band(s), lower the CI low frequency cut off and disable the associated acoustic channel(s). If electrical stimulation channels do not provide good audibility, T-levels may need to be increased along with a recheck of C-levels

7 POST-OPERATIVE SPEECH PERCEPTION TESTING (3, 6, AND 12 MONTHS & ANNUALLY THEREAFTER)

Note: The contralateral ear should be plugged/muffed for speech perception testing.

- Complete recorded CNC Words at 60 dBA in the Hybrid Hearing condition



Electric + Acoustic

- Complete AzBio Sentences in Noise at 65 dBA +5 dB SNR in the following conditions:
 - Hybrid Hearing



Electric + Acoustic

- Combined Hearing



Acoustic Only

Electric + Acoustic

Note: If there is a profound loss in the implanted ear, test in the CI only and bimodal conditions for both recorded CNC and AzBio Sentences.



CI Only



Acoustic Only

CI Only

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

TROUBLESHOOTING FOR THE ACOUSTIC COMPONENT

Symptom	Action	Description
Occlusion – Barrel/Bucket	Check vent for obstruction	Clean with tool
	Pull earmold slightly out of ear and see if sound quality improves	Vent too small—open and/or decrease length of vent; another option: increase length of canal portion into bony portion, if tolerable
	Reduce gain	Try reducing gain on lowest frequency channels. If necessary reduce overall gain. If real ear measurements available check if gain exceeds targets in a frequency area
High Distortion	Check wax system for blockage	Replace wax filter
	Listen to microphone	Replace mic covers or processor
	Listen to the acoustic component (AC)	Replace speaker unit from Hybrid Hearing Clinic Tool Kit
Feedback/Whistling	Check earmold/dome fits properly	If using dome, consider taking earmold impression. Order new earmold if already using earmold. If using earmold consider lengthening canal portion
	Otoscopic exam	Excessive cerumen in the ear-manage according to clinic protocol
	Check positioning of sound processor and acoustic component (AC). Check Power Speaker Unit cable length. If too long, cable will not sit correctly against the ear. If too short, the dome or earmold may fall out	Replace the Power Speaker Unit by using a longer or shorter cable length from the Hybrid Hearing Clinic Tool Kit
	Check the size of the vent	Reduce size of vent if possible or order earmold with smaller or no vent
Intermittent Contact, Crackling Sound	Listening check to verify problem with acoustic or electric	
	Check for wax or moisture	Replace wax filters/mic covers
	Check for loose connection at the point where the earhook and processor connect. Use feedback from CR230 remote to verify connection	Try changing earhook. If complaint does not resolve replace power speaker unit
	Check for torn or frayed cables	Replace Power Speaker Unit cable
	Otoscopic exam/tympanometry	Rule out excessive cerumen in ear canal and middle ear effusion

TROUBLESHOOTING FOR THE ACOUSTIC COMPONENT

Symptom	Action	Description
Recipient Can't Hear Anything Through the Acoustic Component	Listening check to verify no sound	If no problem, identified with output of acoustic component, confirm hearing thresholds have not changed. Adjust gain if hearing is still aidable. Medical referral
	Clean or replace wax system	Wax stop filter and/or wax guard in earmold. Complete otoscopic exam. Manage occluding cerumen per clinical protocol
	Fit with another acoustic component	Replace power speaker unit from Hybrid Hearing Clinic Tool Kit
	Replace sound processor	Use clinic processor or patient back up processor – send primary for repair
	Confirm that the map is a Hybrid map	Use Custom Sound to review maps in processor slots
Too Loud	Check overall loudness	Go live using acoustic stimulation only and adjust overall gain to obtain a loudness scale rating of "comfortable but slightly soft". Do the same with electrical stimulation only. Go live using both electrical and acoustic stimulation and verify that loud sounds are comfortable. Add the contralateral hearing aid and verify that overall sound is rated as comfortably loud
	Check gain and MPO, conduct real ear measurements	MPO and/or gain may be set too high. Confirm targets. Consider trying a larger vent size
Too Soft	Check for wax in acoustic component and Hearing aid if they wear in opposite ear	Clean or replace wax management system
	Check gain and MPO, conduct real ear measurements	MPO and/or gain may be set too low. Confirm targets. Consider if a smaller vent should be tried. If using dome, consider increasing gain by 5 dB across all frequencies
	Check for loose contacts	Check the hardware for intermittent contacts
	Verify receiver and HA function	Check the acoustic component for wax blockage. Clean or replace the wax management system. Listen to acoustic component with a stethoscope to confirm there is acoustic output. Reproduce the OSPL90 curve from the Data Sheet. Listen to the contralateral hearing aid and make measurements in a Hearing Aid Test Box. (<i>Refer to Appendix</i>)
	Check residual hearing in both ears	If hearing has changed, enter the new audiometric thresholds and recalculate the prescription. Confirm fitting by conducting real ear measurements. Confirm HA is functioning in contralateral ear
	If patient is at limits of AC audiometrically	Switch to Linear if in WDRC

Symptom	Action	Description
Soft Sounds Too Loud	Determine if this is for acoustic, electric hearing or both	This could be too much gain for the acoustic component. If loud sounds are comfortable, try reducing gain only. If also for electric hearing, refer to suggestions for the CI found in Custom Sound Hearing Mentor
	Modify the acoustic component prescription	If using WDRC switch to linear
High Pitched/Sharp/Tinny/Metallic/Screeching	Recheck Gain/MPO Adjust CI frequency boundary	Try increasing Gain/MPO. The low frequency acoustic signal may need to be louder to balance out the tinny or sharp quality. Try lowering the CI frequency boundary
	Check vent size	Determine if reducing the vent size improves sound quality
	Check residual hearing	If change to low frequencies, update audiogram and recalculate. Consider full frequency electric MAP if thresholds outside acoustic component fitting range. Refer to the programming section of the Appendix for instructions on fitting a non-Hybrid MAP
Fuzzy/Humming	Verify receiver and HA function	Check the acoustic component for wax blockage. Clean or replace the wax management system. Listen to acoustic component with a stethoscope to confirm there is acoustic output. Reproduce the OSPL90 curve from the Data Sheet. Listen to the contralateral hearing aid and make measurements in a Hearing Aid Test Box. <i>(Refer to Appendix)</i>
	Check for acoustic feedback	Check for acoustic feedback by holding hand flat towards the processor/acoustic component. If the device is "on the edge" of feedback this should make it feedback. Perform otoscopy to check for impacted or excessive cerumen present in the ear canal which can result in feedback. If there are no obvious leaks in acoustic component, try deactivating an acoustic channel
Fit Uncomfortable	Check speaker length—EC200 hook should rest at the pinna-face junction	Use longer/shorter power speaker unit cable length
	Check coil cable length—verify that coil cable is not too short and pulling assembly posteriorly	Use longer coil cable
	Check concha, canal, and helix areas for reddened areas	Modify mold as appropriate

CARE AND MAINTENANCE

1 CARE FOR DOMES

Power Domes or Plus Domes should be changed regularly to optimize performance and hygiene. Change them whenever they lose shape or look dirty or discolored and whenever the inbuilt wax filter in the dome is clogged.

Tip: Domes may lose their shape if placed in an active electronic drying unit. It is recommended the dome be removed from the speaker unit before placing the sound processor in the drying unit

Acoustic components that are fitted with domes have the benefit of an additional wax filter fitted in the Power Speaker Unit. A supply of WaxStop tools is provided for changing the wax filters. Change the Cochlear EAC200 Series WaxStop filter in the Power Speaker Unit whenever it is clogged with wax or whenever the volume reduces.

2 CARE FOR EARMOLDS

Earmolds should be cleaned every day to remove any wax and to optimize acoustic performance. Clean the earmold and Power Speaker Unit Cable with a dry cloth. Traces of wax should be wiped away from the vent opening.

3 MAINTAIN THE ACOUSTIC COMPONENT – FOR CLINICIANS ONLY

There are extra steps you can take to clean and maintain a recipient's acoustic component when they come to see you.

- If the recipient is using earmolds, check the fit is still correct as the ear may change with time and weight fluctuations. Examine the ear with an otoscope to check for any sore spots inside and around the ear
- Replace the power speaker unit cable if it is broken, stretched or twisted
- Replace domes whenever they lose shape or look dirty or discolored
- Inspect earmolds for dirt or cracks. Clean or replace if necessary
- The earhook has a soft material on the underside that cushions the ear and will break down with use. You should check the soft and hard plastic sections of the earhook regularly and replace the earhook whenever it shows signs of wear

4 WAX MANAGEMENT

Wax filters must always be used when wearing the system in Hybrid mode. Instruct the recipient to inspect daily and replace when required.

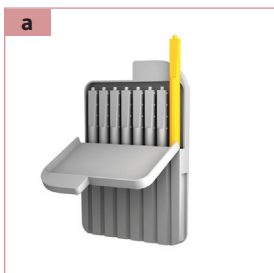
WaxStop filters for fitting with Power Domes and Plus Domes

Power Domes and Plus Domes provide the benefit of two wax filters—one built in the dome, and one removable WaxStop filter fitted in the Power Speaker Unit. Dispose of domes whenever they are clogged with wax, and change the WaxStop filter in the Power Speaker Unit whenever it is clogged with wax or whenever sound quality changes. WaxStop filter tools are supplied.

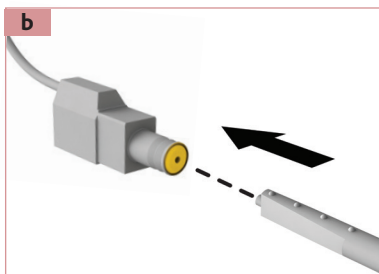
Refer to the specific earmold manufacturer being used for guidance on wax management.

5 REPLACE A WAXSTOP FILTER

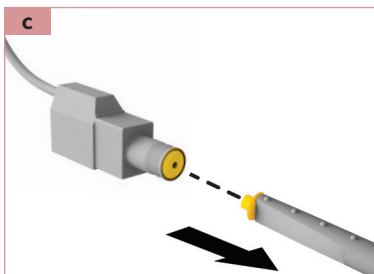
a. Remove a new WaxStop from its shell



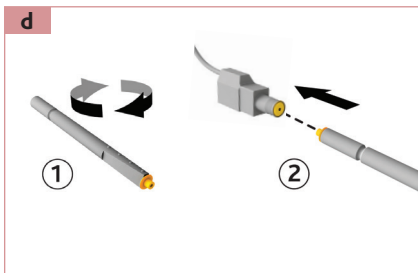
b. The tool has two ends, one with the removal tool and one with the new filter. Insert the removal tool into the existing wax filter



c. Pull the used filter out slowly, keeping the tool straight



d. Flip the tool around and insert the new filter (*on the end of the tool*) into the sound outlet. Carefully pull the tool free and dispose of the used tool and filter



6 REMOVING THE ACOUSTIC COMPONENT

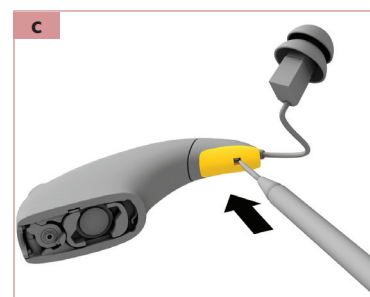
a. Remove the battery module from the processing unit by twisting the two parts as shown



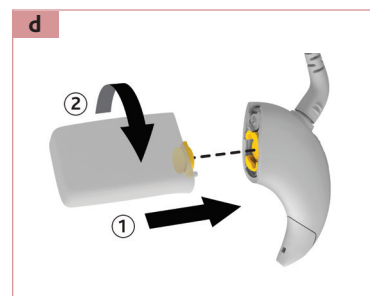
b. Locate the opening under the earhook



c. Insert a Cochlear EAC200 Series Screwdriver into the hole. Carefully push and twist the screwdriver until the speaker unit cable disconnects



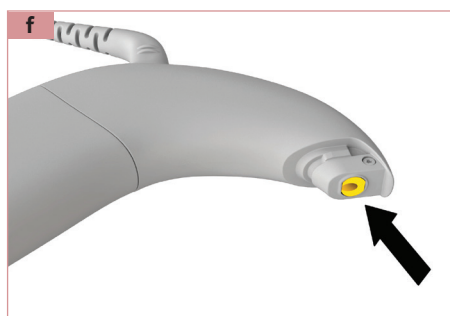
d. Re-attach the battery module



e. Press firmly on top of the Cochlear EAC200 Series Earhook with your thumb to click it off the sound processor



f. Insert a new processing unit plug into the speaker unit cable socket. Make sure the plug goes all the way in



g. Click the standard earhook into place



7 CARE FOR THE SYSTEM

Refer to the user guides for the Nucleus 6 System sound processors and Nucleus 6 remote devices for additional care instructions.

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

SERVICE AND REPAIR

1 SERVICE AND REPAIR OVERVIEW

For any problems with the acoustic component, first see the Troubleshooting chapter.

For any problems with the rest of the Nucleus 6 System, refer first to the support material provided.

If the issue cannot be resolved, replace the acoustic component or contact your local Cochlear representative to identify replacement options. Depending on the warranty status of the component, it may be replaced at no additional charge.

2 SERVICEABLE COMPONENTS

You can service the acoustic component yourself as long as you maintain a well-stocked Clinic Hybrid Troubleshooting Kit. Check the fit of the acoustic component and replace the earmold as needed.

If the acoustic component or earhook breaks or is lost or damaged, you can replace it from your existing stock or order it from Cochlear. Customer Service will determine which components you should return to Cochlear. This may or may not include the acoustic component. **EXCEPTION: Custom earmolds should not be returned to Cochlear.** If an earhook is lost or damaged, you can replace it from your Clinic Hybrid Troubleshooting Kit. If an earmold is damaged, fit a dome if possible and order a new or replacement earmold.

The CP910 or CP920 processing units are serviceable by Cochlear. Check the recipient's warranty documents or contact your local Cochlear representative to find out more.

3 WARRANTIES

Refer to the warranty document in the recipient docupack or contact your local Cochlear representative for details.

4 CUSTOM EARMOLDS

Patients should not send custom earmolds to Cochlear. Cochlear is not responsible for lost or damaged custom earmolds.

APPENDIX

Earmold Selection

Post-Operative Verification

Programming – Acoustic Screen Details

Electroacoustic Analysis of the Acoustic Component

Cochlear Nucleus CP900 Series Sound Processor – Hybrid Mode Technical Specification

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

EARMOLD SELECTION

There are different styles of earmolds that can be used with the Cochlear EAC200 Series Power Speaker Unit: The earmold can be ordered from the manufacturer of your choice.



Use these general guidelines when selecting an earmold.

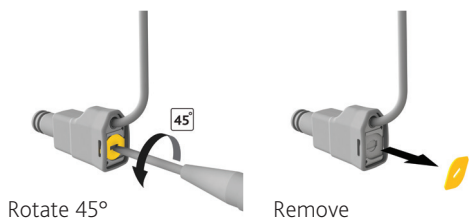
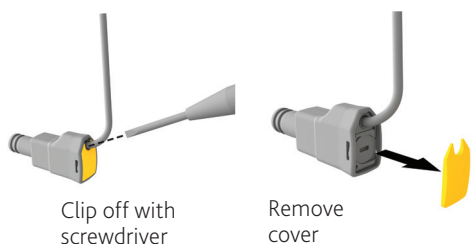
- Style options may include the canal lock, skeleton and full shells depending on the manufacturer. For example: Westone Laboratories canal earpiece (*Style #88*)
- The earmold company may require you to send the speaker unit with the earmold impression to ensure a proper fit
- You may need to disassemble the plastic housing from the actual receiver in order to fit the unit into the earmold. (*See Figure b*)
- A removal cord is recommended to reduce the likelihood of damage to the speaker cable
- Different wax management systems may be available depending on the earmold manufacturer. It is important to have some type of wax management system. Refer to the earmold manufacturer for more information

These are the companies that are known to supply compatible earmolds for the Power Speaker Unit.

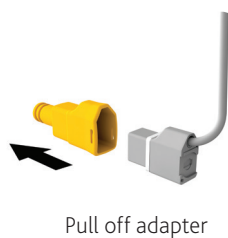
- Westone Laboratories, Inc. – 2235 Executive Cir., Colorado Springs, CO 80906 – (800) 525-5071 www.westone.com
 - Earmold Style #88 is designed to fit our speaker unit
 - Wax management components will be included if you specify the earmold will be used with the Nucleus 6 Hybrid Sound Processor and they will include the wax management components
 - You will need to disassemble the plastic housing from the actual receiver using the steps in Figure b. The power speaker has a friction fit inside of the housing of the mold
- Microsonic Inc. – 2960 Duss Ave., Ambridge, PA 15003 (800) 523-7672 – www.microsonic-inc.com
 - Mailing boxes and order forms can be ordered online at no charge <http://store.microsonic-inc.com/maillingandamporderingsupplies.aspx>
- Emtech Laboratories – 7745 Garland Cir., Roanoke, VA 24019 (800) 336-5719 – www.emtechlaboratories.com
 - Order form available from <http://www.emtechlabs.com/images/stories/neworderforms.jpg>
- Oticon Inc. – 580 Howard Ave., Somerset, NJ 08873 (800) 526-3921 – www.oticonusa.com
 - Specify the earmold is for commercial use with the Nucleus Hybrid Sound Processor
 - Clinic must **have an Oticon account number**

b

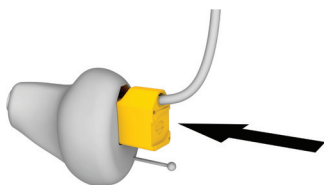
1. Gently remove adapter cover with screwdriver
2. Unlock lockplate and lift it off



3. Disconnect the adapter from Power Speaker Unit*



4. Slide in the power speaker into the mold



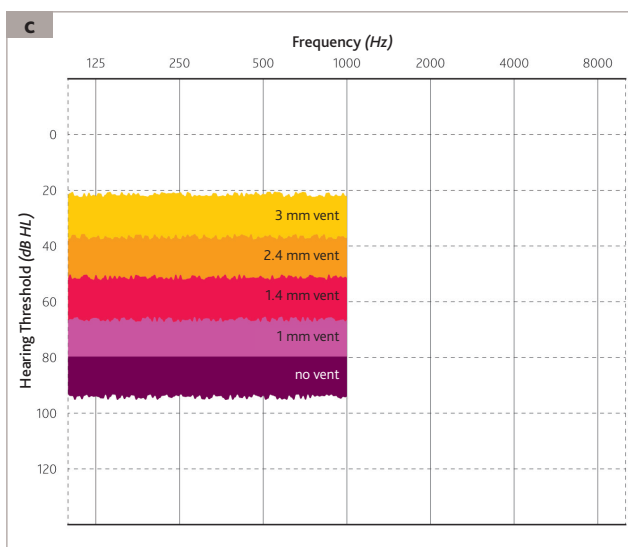
* Removing the speaker housing does not void the existing speaker warranty.

If the waxstop system is ordered, pull the used filter out slowly, keeping the tool straight. Turn the tool around and insert the new filter (*on the opposite end of the tool*) into the sound outlet. Carefully pull the tool free and dispose of the used tool and filter.

1 VENTING

Venting can help reduce complaints of occlusion and feedback, reduce moisture in the ear and increase overall listening and wearing comfort. Use Figure c below as a general guideline to help select the vent size based on the degree of hearing loss or refer to the earmold manufacturer's guidelines. If the loss is sloping or falls between two vent sizes, consider choosing the smaller vent size.

Tip: When in doubt order a select-a vent that includes vent plugs that can vary the vent size as needed.



Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

POST-OPERATIVE VERIFICATION

Audiology best practice guidelines state that probe microphone verification measures should be done to ensure that acoustic gain and output characteristics meet prescribed targets for the individual. In the American Academy of Audiology's *Guidelines for the Audiologic Management of Adult Hearing Impairment*, an expert task force recommends that "prescribed gain from a validated prescriptive method should be verified using a probe microphone approach that is referenced to ear canal SPL" (Valente, et al., 2006).

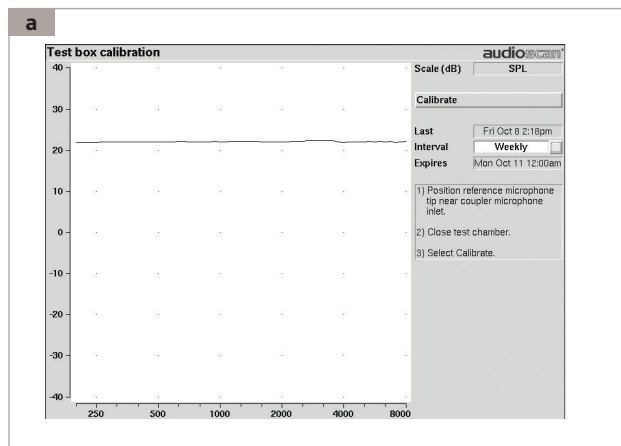
Hybrid Hearing

- Use Real Ear measurements to assess the degree to which real-ear targets are met. Input levels for these measurements should include an input of 60 dB SPL for speech or a speech-like signal
- For thresholds less than 90 dB HL out to 2200 Hz, Custom Sound applies an acoustic signal. It is important to verify what can be fit acoustically through real ear measurements or if this is not possible by sound field thresholds. If target is not met or there is not good audibility for that frequency(s) then disable the acoustic channel(s) and provide an electrical signal at that frequency(s)
- Use these measures to verify that the slope of the frequency response is within 5 dB per octave of the target slope
- If real ear measurements cannot be completed, measure sound field thresholds using narrow band or warble tones across the frequency range 250-6000 Hz including inter-octaves to confirm audibility (≤ 25 dB HL). Complete this step using the acoustic component only (remove the coil from the head) and repeat using electric stimulation only by removing the acoustic component from the ear canal.
- In some cases, the final values may need to deviate from prescription target values because of individual listening needs or sound quality

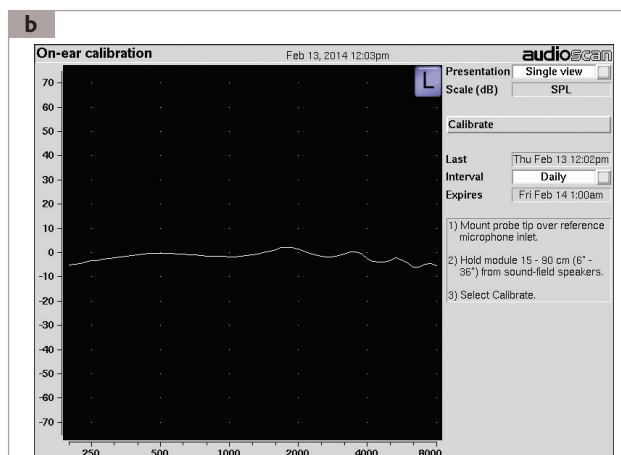
The following information is the procedure for using the Verifit from Audioscan. However the steps in the verification process are similar regardless of the type of equipment being used. Refer to the manufacturer's manual for specific guidance.

1 CALIBRATION

1. Calibrate the test box



2. Calibrate the probe tube



2 OPEN CUSTOM SOUND

1. Connect the sound processor
2. Open the recipient's MAP
3. Go to the acoustics screen within the Custom Sound software

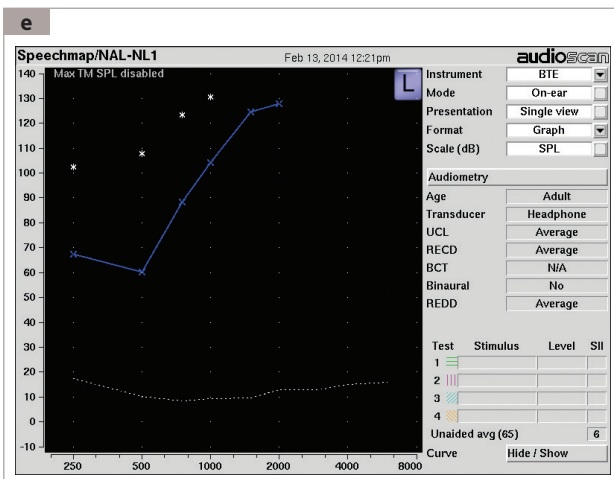


3 OBTAIN REAL EAR AIDED RESPONSE

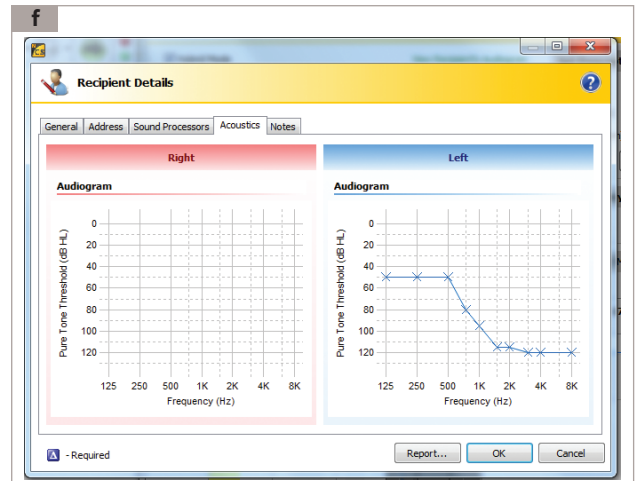
1. Position the recipient one meter in front of the speaker



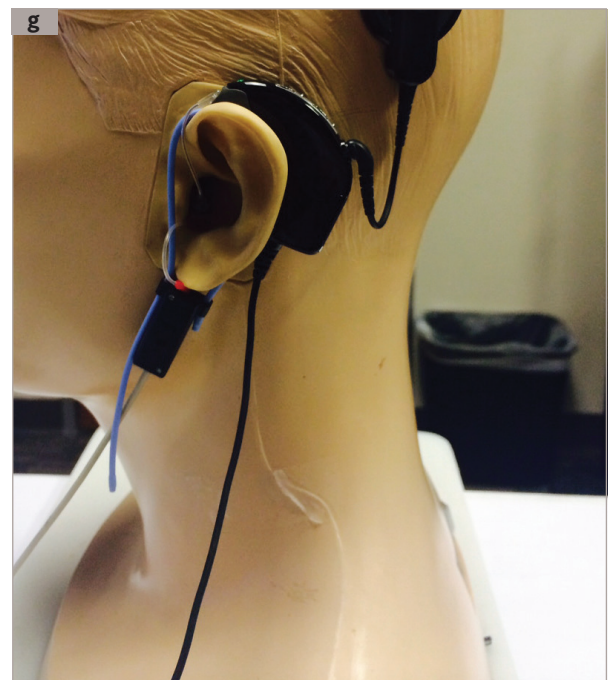
2. Enter the recipient audiogram into the real ear software
3. Select the preferred fitting prescription targets in the real ear gain software NAL-NL2 or DSL i/o prescriptions or insert the CHP targets NAL-NL1/2 into the real ear gain software if the analyzer has this option
 - a. The blue X's represent the hearing loss converted to dB SPL and the asterisks represent the UCL values
 - b. Most real ear measurement systems have a minimum requirement for the number of frequencies that must be inputted and many do not have a "no response" marker. For this system one must input some data up to 2 kHz. The target at 1 kHz in this case cannot realistically be obtained but it is displayed on the screen



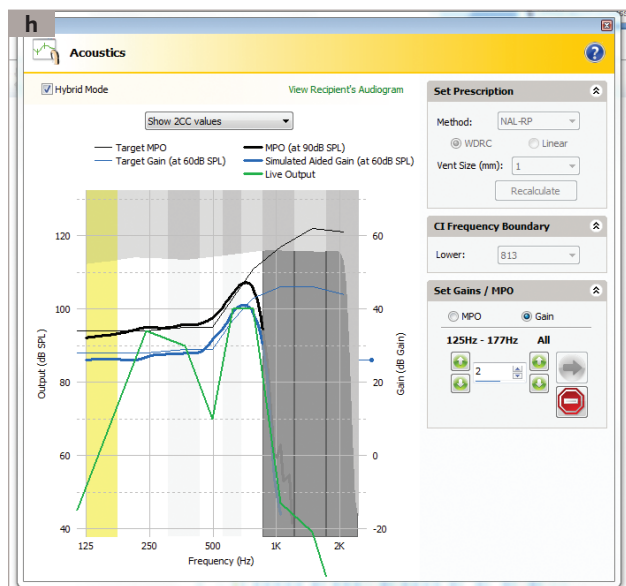
Tip: NAL-RP may not be a choice in the real ear system you are using. NAL-RP and NAL-NL1 prescribe similar gain-frequency responses for input levels approximately around 60-65 dB SPL.



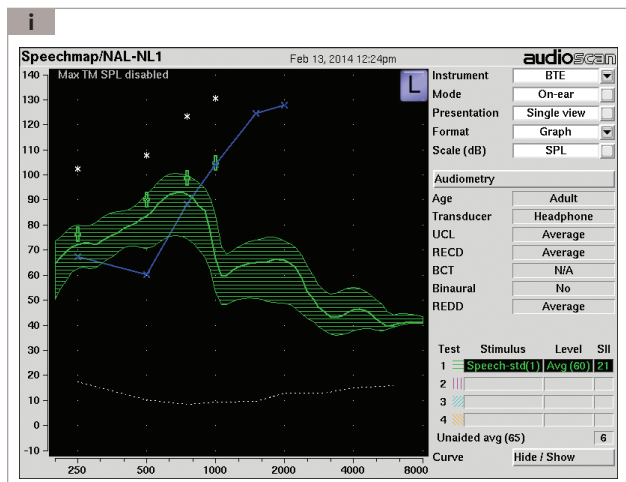
4. Place the probe tube in the ear canal approximately 4-5 mm past the end of the mold or dome. Place through the vent if possible. Use putty to seal any slit leaks
5. Insert the acoustic component



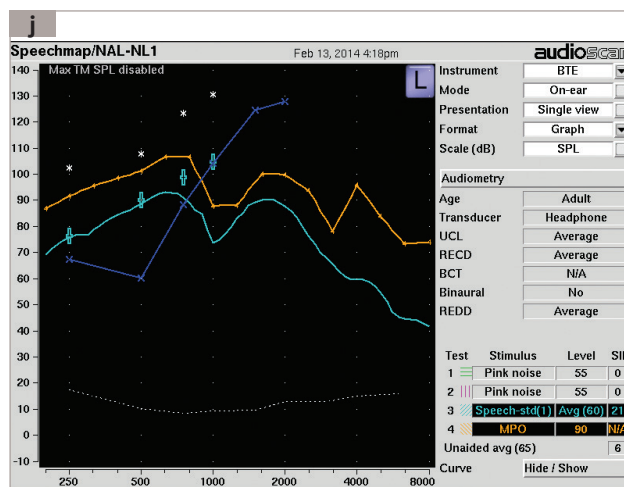
6. Go live with the recipient's MAP (*acoustic component only i.e. with the coil off the head*)

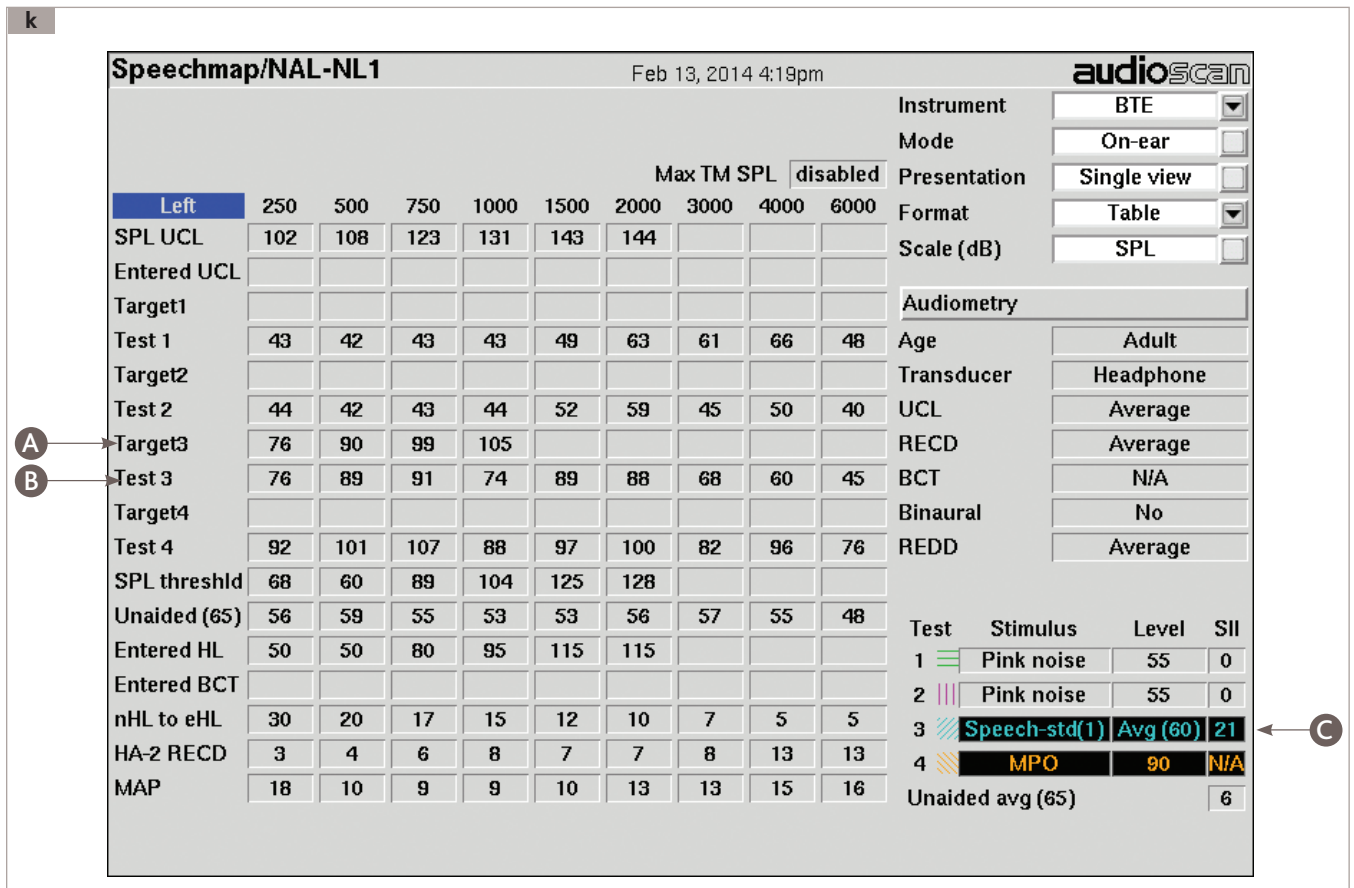


7. Select recorded speech at conversational level, 60 dB SPL
 - a. Graph view of Real Ear Aided Gain for acoustic component with a 60 dB SPL input
 - b. The green crosses represent the real ear target
 - c. The solid green line represents the averaged response; the upper green line shows the peaks while the lower green line shows the valleys



8. Make adjustments to gain in the Acoustic Screen in Custom Sound as needed so the slope of the frequency response is within 3-5 dB of the target response
9. Repeat for loud speech with the MPO test at 90 dB SPL making adjustments to the MPO within the Custom Sound software as needed
 - a. Real Ear Gain curve with 60 dB SPL input vs MPO curve to ensure that output does not exceed UCL

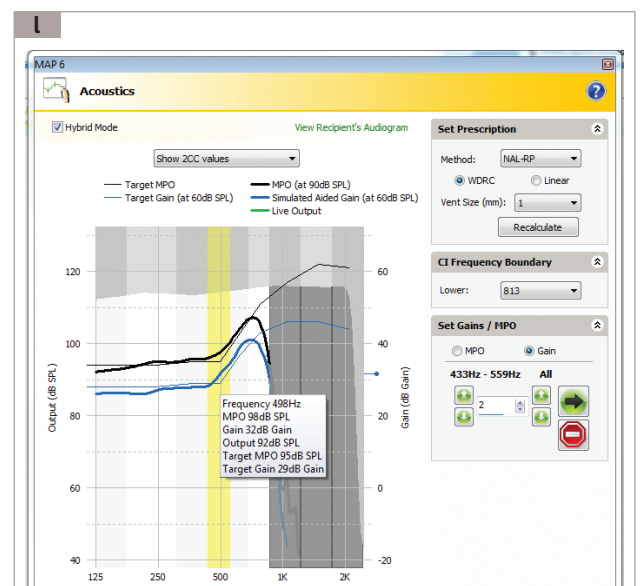




10. Use the table view to further evaluate if the response is within 5 dB of the target response

Subtract the input (60 dB) from the output (B-C) to obtain the amount of gain at each frequency. (See Figure k)

For example: At 500 Hz we are measuring approximately 29 dB of gain within the ear canal. The Custom Sound software estimates 29 dB of gain at 500 Hz. This verifies the settings are within 5 dB of what is being simulated within Custom Sound. (See Figure l)

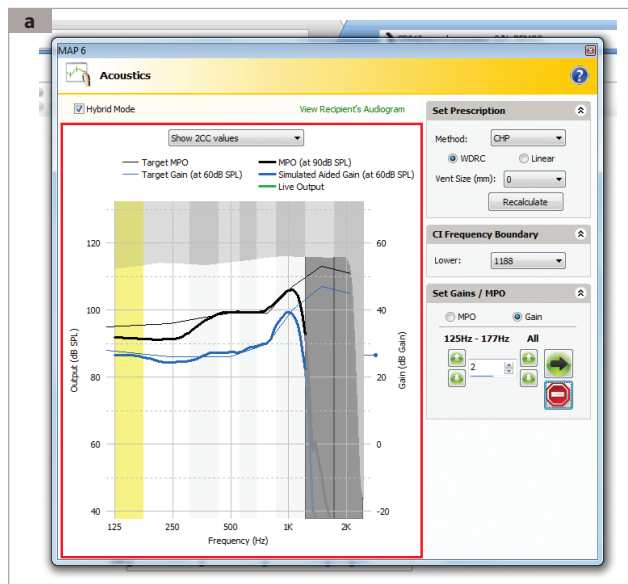


Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

PROGRAMMING



Click on the Acoustics icon in the tool bar to open the Acoustics screen:



The fitting graph shows four curves which are simulations:

1. **Target MPO:** Prescribed MPO in dB SPL 2cc or dB SPL real ear
2. **Target Gain (at 60 dB SPL):** Prescribed gain at 60 dB input
3. **MPO (at 90 dB SPL):** Calculated output at 90 dB input in dB SPL 2cc or dB SPL real ear
4. **Simulated Aided Gain (at 60 dB SPL):** This is the calculated Gain in dB SPL 2cc or dB SPL real ear

The gray shaded area is **Device Output Upper Limit**. This is the maximum achievable level in dB SPL 2cc or dB SPL real ear.

1 HYBRID PRESCRIPTION OPTIONS

The software provides three fitting formulas to give you a starting point for fine tuning adjustments to the frequency-gain characteristics of the system's acoustic output. There is no one fitting method that is universally accepted. The 3 prescriptions are: CHP, NAL-RP and DSL. Based on your verification system you may want to change from the CHP default.



CHP – Cochlear Hybrid Prescription. By Default, CHP with WDRC (*Wide Dynamic Range Compression*) is selected. This method is based on analysis of fitting data collected during the validation trials for the Hybrid sound processor and was developed specifically for Hybrid fittings. The gain is slightly greater than the half-gain rule. The formulae are channel specific rather than based on audiometric frequencies. In other words the rules specify target and gain MPO for each frequency band of amplification through the acoustic component.

NAL-RP – National Acoustic Laboratory Revision for Profound Losses. This prescription is a variation of the half-gain rule and also of the NAL-R prescription which was developed for individuals with mild to moderately severe losses. The objective of the NAL-RP is to maximize speech intelligibility by equalizing loudness in each frequency band. In other words, the prescribed gain should make speech equally loud in each frequency band. Research has shown that individuals with profound losses above 2 kHz preferred more gain in the low frequencies than individuals with less severe losses.

DSL – Desired Sensation Level Prescription. This prescription is also a variation of the half-gain rule. The underlying fitting rationale is to normalize loudness across frequencies to maximize speech intelligibility. Intelligibility is maximized when all speech bands are audible and comfortably loud.

Some long-time hearing aid users may have specific preferences for prescriptive gain, especially those who have used NAL or DSL prescriptions in the past. It is possible to use preferred prescription targets to manually match the acoustic gain and power output.

2 COMPRESSION SCHEME

WDRC Wide Dynamic Range Compression (Default) – WDRC provides more gain for softer input levels, allowing a large range of input levels to be audible within a narrow range of residual hearing. It is recommended for individuals with loudness tolerance or recruitment. The compression threshold is fixed and set to 52 dB SPL input, with output limiting fixed and set to 85 dB SPL input. The compression ratio is variable depending on gain and MPO, but limited between 1 and 6.

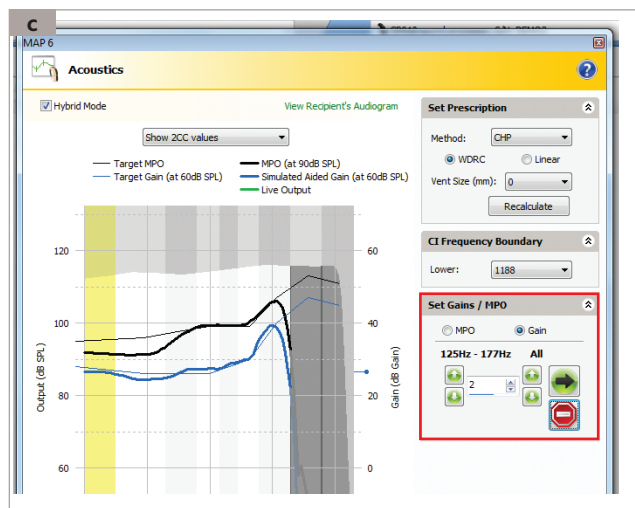
Linear – Linear amplifies all inputs equally until the output compression level of the acoustic component is reached.

Linear is advised if the threshold is > 75 dB HL at 500 and 1000 Hz.

3 SET GAINS/MPO

The gain and MPO profiles can be adjusted by using the Gain and MPO buttons. These adjustments can be made on a specific channel by highlighting a specific frequency channel or for all frequency channels by clicking increase or decrease button under all. Channels can be activated and deactivated by using the right mouse button. To add more acoustic channels, Right Click on the highest deactivated channel (*i.e. the shaded gray area*) and select Enable Channel. Disabling a channel follows the same procedure.

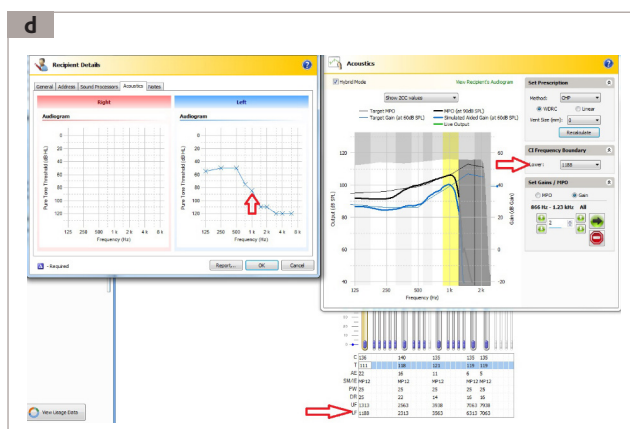
It is recommended that these adjustments be made while conducting real ear measurements.



4 CI FREQUENCY BOUNDARY

Custom Sound automatically determines the acoustic-to-electric crossover frequency based on the unaided audiogram in the acoustics screen. The software determines the first frequency where the unaided threshold is 85 dB HL. In this example the threshold at 1000 Hz is 85 dB HL, the software notes this as the cross-over frequency. The software enables all acoustic bands including the one whose upper end exceeds 1 kHz (*seven acoustic bands are enabled, with a top end of 1230 Hz*).

The software finds a CI boundary that is just below the acoustic top end (*which is 1188 Hz in this example*). The lower CI frequency boundary can be modified. Based on the most recent postoperative audiogram, set the lower CI frequency boundary to the lowest frequency where the threshold is greater than (*i.e. poorer than*) 70 dB HL. This is more conservative than what is currently used in Custom Sound and may more effectively fit steeply sloping and flat hearing losses with an appropriate electric cut off. Consider evaluating additional cut off frequencies.



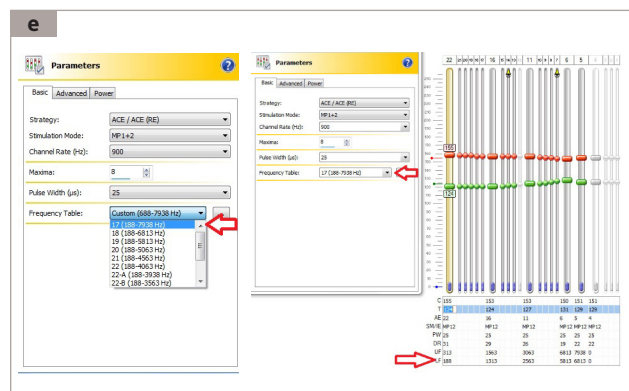
5 NON-HYBRID MAP

Reminder: The 900 Series processor is protected against failure from splashing water or access of foreign objects 1.0 mm in diameter or larger (*IP44 rated*) when you wear it with:

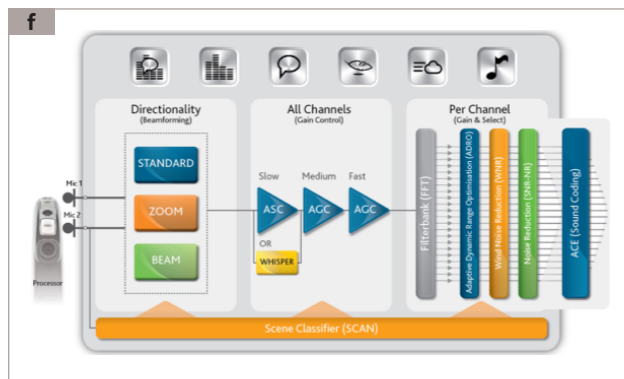
- A tamper resistant battery module
- A coil and coil cable
- A closed accessory socket
- An acoustic component worn in the ear

Consider having a non-hybrid MAP if the recipient will be involved in water activities where the acoustic component will not be used.

Note: When a Hybrid enabled MAP has the 'hybrid box' un-checked, the Hybrid Mode frequency allocation table does not automatically revert to the CI only default. If you want the default frequency table, you must do this manually by going to the MAP parameters screen and selecting the full frequency table of 188-7938. (See Figure e)



6 NUCLEUS 6 SIGNAL PATH FOR HYBRID HEARING

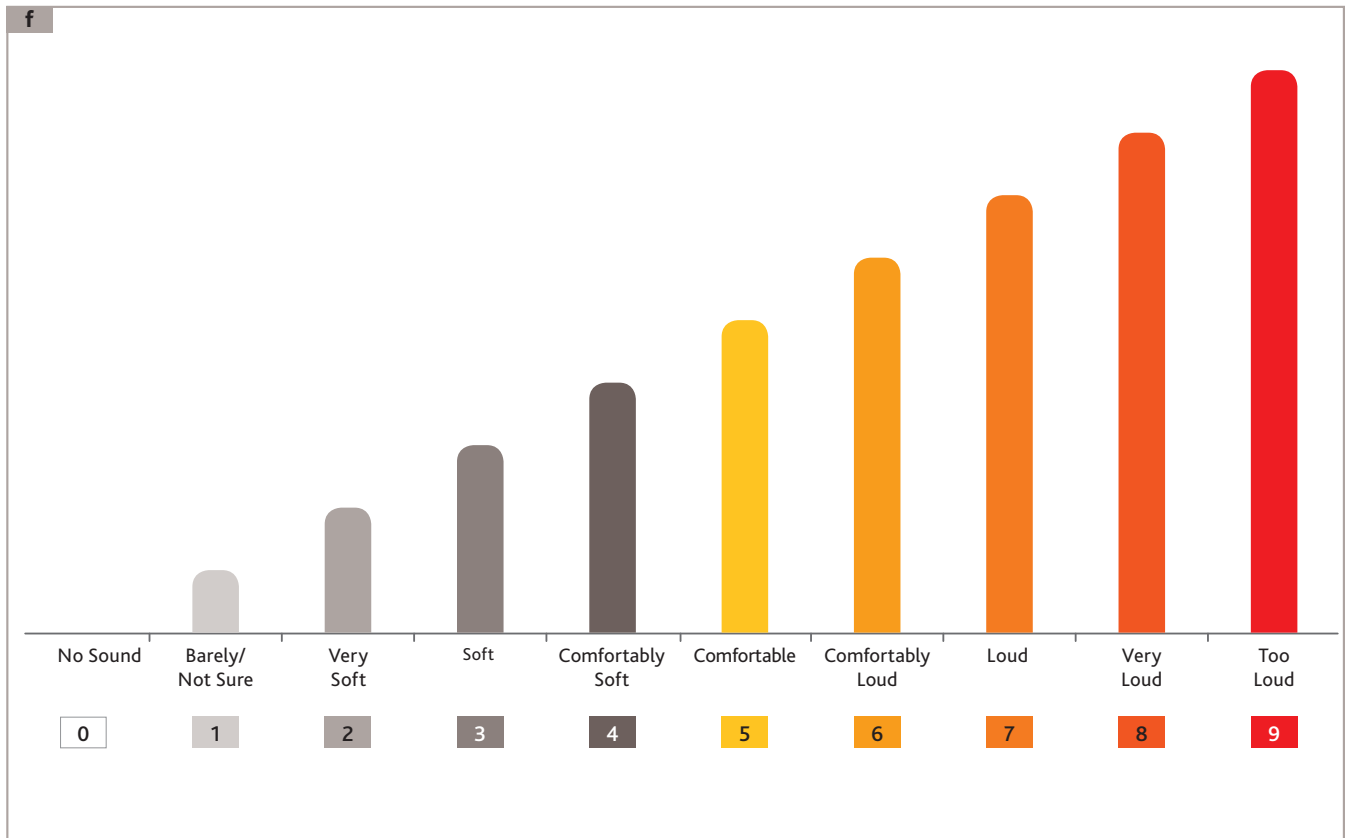


Summary of Electric and Acoustic Paths:

ACOUSTIC	ELECTRIC
<ul style="list-style-type: none"> ➤ Mic Directionality ➤ Sensitivity ➤ ASC ➤ WNR 	<ul style="list-style-type: none"> ➤ Mic Directionality ➤ Sensitivity ➤ Volume ➤ ASC ➤ ADRO ➤ Whisper ➤ SNR-NR ➤ WNR

- The volume control, which by default reduces C-levels by 20% in the MAP, only affects the electric path of the signal
- Note: the default can be changed in Custom Sound in the MAP Parameters Advanced tab.**
- The volume of the acoustic path is controlled by the gain levels set in the Acoustic Tab of the MAP
- The sensitivity is applied to both the acoustic and electric path equally, as it takes place at the front-end input of the microphones
- Automatic Microphone Sensitivity Control, the Wind Noise Reduction algorithm, and the microphone directionality (*Standard, Zoom and Beam*) are shared by both paths, while ADRO, Whisper and SNR-NR are only applied to the electric path
- The SCAN feature, which automatically applies these input processing combinations, continues to apply them as above

7 HOW LOUD IS THE SOUND?



Aim for **comfortably loud** when requesting feedback on the **Hybrid Hearing** condition (*acoustic+ electric stimulation*) and **Combined** hearing (*both ears*) if appropriate.

Aim for **comfortably soft** when requesting feedback on **acoustic stimulation alone** and **electric stimulation alone**.

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

ELECTROACOUSTIC ANALYSIS OF THE ACOUSTIC COMPONENT

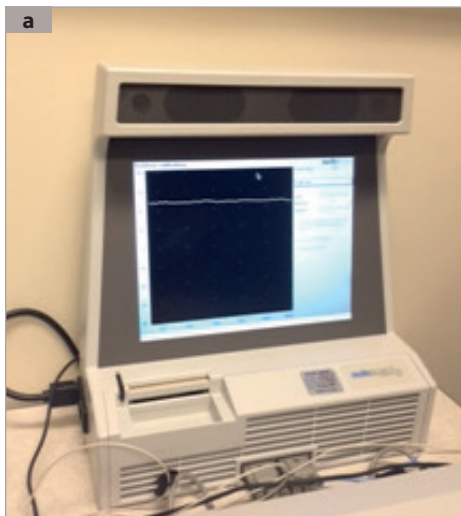
1 MEASURING OUTPUT FROM ACOUSTIC COMPONENT IN A TEST BOX

Equipment required:

- Hearing aid test box
- N6 Hybrid sound processor with acoustic component attached
- Programming pod with programming shoe and cable
- Computer with Custom Sound 4.1 or higher

1. Setting up equipment and conducting measurements (Refer to manual)

- 1.1 Ensure that test box is set up per manufacturer's instructions (*will depend on test box being used*) and perform required calibration



- 1.2 Connect the Hybrid sound processor to Programming pod and programming shoe and open Custom Sound 4.1
- 1.3 When installing Custom Sound 4.1, there will be a file called AcousticReferenceRecipient.cdx4 in the installed folder (e.g. C:\Program Files (x86)\Cochlear\Custom Sound Suite 4.1). Import FOG Nucleus 6 or RTG Nucleus 6. This will enable you to reproduce the Technical Datasheet; the FOG and RTG settings according to ANSI S3.22 or IEC 60118-0
- 1.4 Seal any vents on the acoustic component with Bostik blu tack (or some other type of sealing material) and align the sound bore with the opening of the ITE coupler adapter. Press the sealing material firmly into the ITE adapter
- 1.5 Attach acoustic component to the 2cc coupler with some Bostik blu tack and seal off any leaks

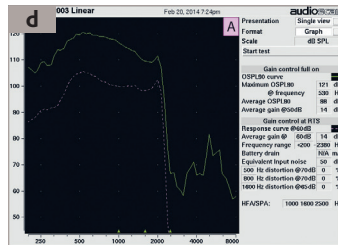


- 1.6 Place Hybrid sound processor (*still connected to programming pod*) into hearing aid test-box to measure performance of the acoustic component. Position the first microphone port of the Hybrid near the marker in the test box so that the sound coming from the loud speaker will hit this port at a similar angle as when sound comes directly in front of a recipient. Disconnect the transmitting coil otherwise artifacts in the response will be observed as shown below. Close test box lid

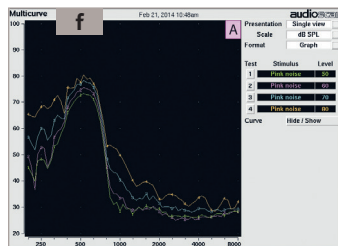
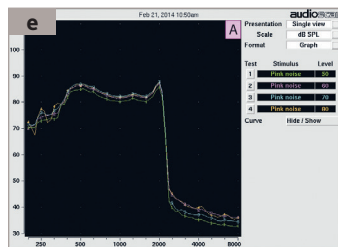


- 1.7 Click on the Go Live icon in the software
- 1.8 Make a 2cc coupler measure (*full-on gain*):
- a. Measure the gain-frequency response of the Hybrid sound processor. The gain-frequency response is obtained with an input level of 60 dB SPL input. The results can be shown with one of two vertical axes (*gain or SPL*). The gain at any frequency can be calculated as the output SPL at that frequency minus the input SPL, which in this case is 60 dB SPL

- b. Measure the OPSPL90 (MPO) of the Hybrid sound processor. The OSPL90 (MPO) is obtained using a 90 dB SPL input signal. This level is high enough to cause most hearing aids to reach their highest possible output level (*saturation*) at each frequency. The vertical axis of the OSPL90 response graph is always shown in dB SPL



- c. You may also run a family of curves from 60 through 90 dB SPL—the output response will be as follows (*note the difference when using the recipients custom prescription*)

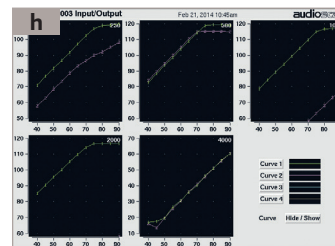


- d. With the CP900 processor attached to Custom Sound and the processor in the test box one can observe the change in output in the Acoustics Module as the sweep frequency in the test box progresses. What you see will depend upon the frequencies assigned to the acoustic component which is determined by the audiometric information entered into Custom Sound



Narrow Band Measurement signal can be a pure tone that automatically sweeps over a range (*typically from 125 Hz to 8 kHz*) or a broad band noise-like signal with all frequencies present simultaneously

- e. One can also compare the input/output curve by frequency comparing the 2cc coupler response of the recipient's prescription with the Reference Test Gain curves from the special CDX file as shown below



1.9 Stop Go Live function and close session

2 SPECIFICATIONS OF THE ACOUSTIC COMPONENT

Refer to the Cochlear Nucleus CP900 Series Sound Processor Hybrid Mode Technical Specification

Cochlear Nucleus 6 Sound Processor with Hybrid Hearing

HYBRID MODE TECHNICAL SPECIFICATIONS

The Cochlear Nucleus CP910 and CP920 Sound Processors use the most sophisticated technology available to deliver the best hearing performance across the widest range of listening environments automatically. For those who have residual hearing, the CP910 and CP920 are capable of delivering both acoustic and electrical stimulation simultaneously and seamlessly. In a few simple steps, a hearing professional can exchange the earhook on the sound processor with one that accommodates the acoustic component.

1 CP920 SOUND PROCESSOR IN HYBRID MODE



- 1 Coil
- 2 Coil magnet
- 3 Coil cable
- 4 Dual omni directional microphones
- 5 Indicator light
- 6 Hybrid ear hook
- 7 In-built telecoil
- 8 Buttons
- 9 Speaker unit cable
- 10 Processing unit
- 11 Serial number
- 12 Speaker unit receiver
- 13 Disposable dome
- 14 Compact rechargeable battery module

2 KEY FEATURES

- Fully software programmable 9 channel digital hearing instrument with adjustable cut off frequency for electrical and acoustic stimulation
- Acoustic amplification of low frequencies between 100 Hz and 2200 Hz
- Flexibility of instant fit domes or custom earmolds
- Water resistant to IP44 rating in accordance with IEC60529
- Detachable acoustic component with 5 cable length sizes
- Modular component configuration
- Full integration of Nucleus 6 SmartSound sound management system

3 PROGRAMMING/FITTING SOFTWARE

Custom Sound 4.1 and higher

Three acoustic stimulation prescription modes with both linear and Wide Dynamic Range Compression (*WDRC*) options:

- NAL-RP
- DSL
- CHP (*Cochlear Hybrid Prescription*)

Choice of programming in overlapping or non overlapping modes.

4 SPECIFICATIONS OF THE ACOUSTIC COMPONENT

COMPONENT	COLOR	MATERIALS
Power Speaker Unit cable	Clear	PA11 (<i>Polyamide 11</i>)
Power Domes	Opaque	TF4 STE TPE-S
Plus Domes	Opaque	Elastosil LR3003/40
Wax Stop	White	Polyethylene

SPEAKER UNITS INCLUDING CABLE:	EXPOSED WIRE LENGTH
Size 1	25.68 mm
Size 2	31.6 mm
Size 3	40.41 mm
Size 4	47.51 mm
Size 5	53.31 mm

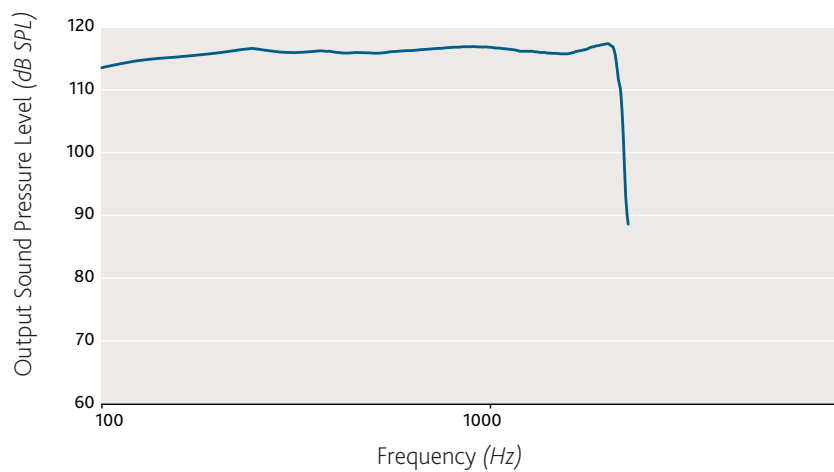
WEIGHT OF THE SPEAKER UNITS INCLUDING THE CABLE (*BASED ON SIZE 3*)

579 mg

SPEAKER UNITS RECEIVER ELEMENT	LENGTH	WIDTH	DEPTH
Dimensions	9.2 mm	4.7 mm	6.3 mm

Measurements According to ANSI S3.22-2009

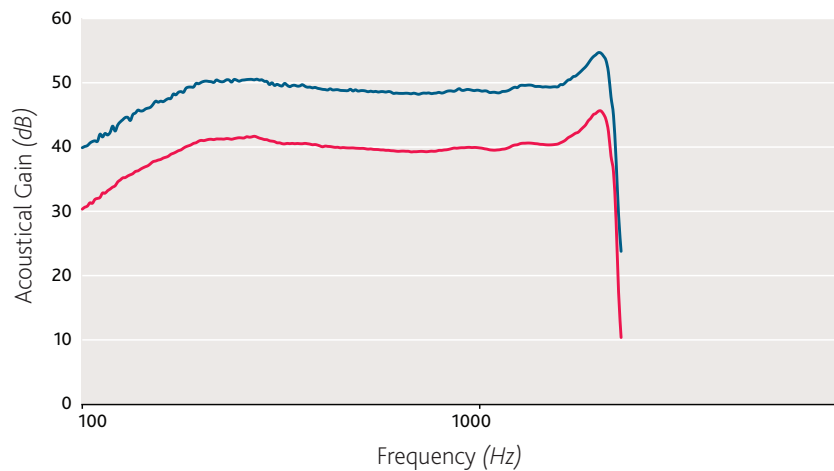
Output Sound Pressure Level (*OSPL90*)



SPA-OSPL90 = 116.5 dB SPL

OSPL90 max = 117.5 dB SPL

Full-on Gain and Reference Test Gain



Full-on gain

Maximum = 54.7 dB

SPA-full-on gain = 48.8 dB

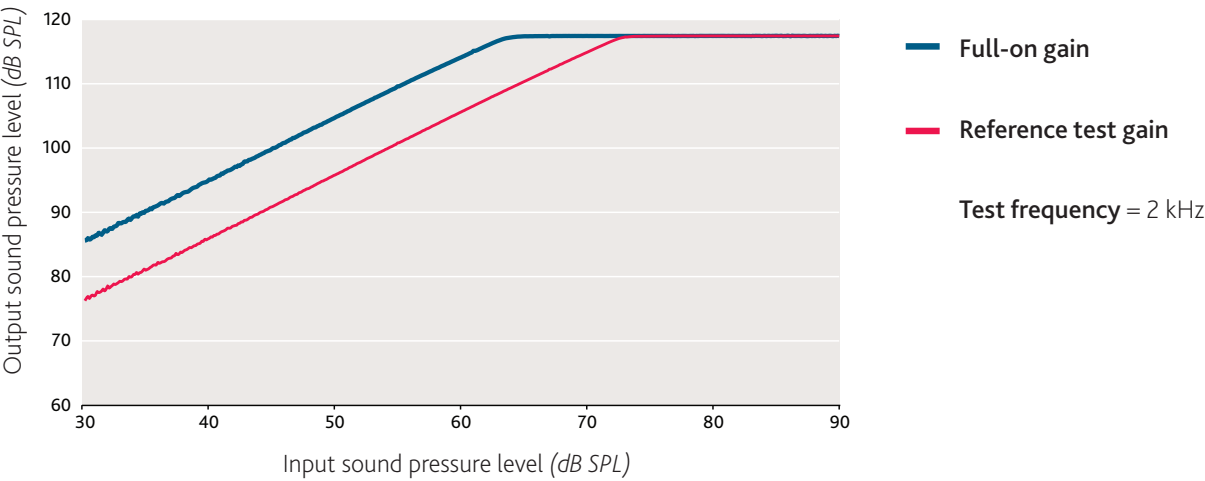
Reference test gain

SPA-Reference test gain = 39.9 dB

Frequency range:

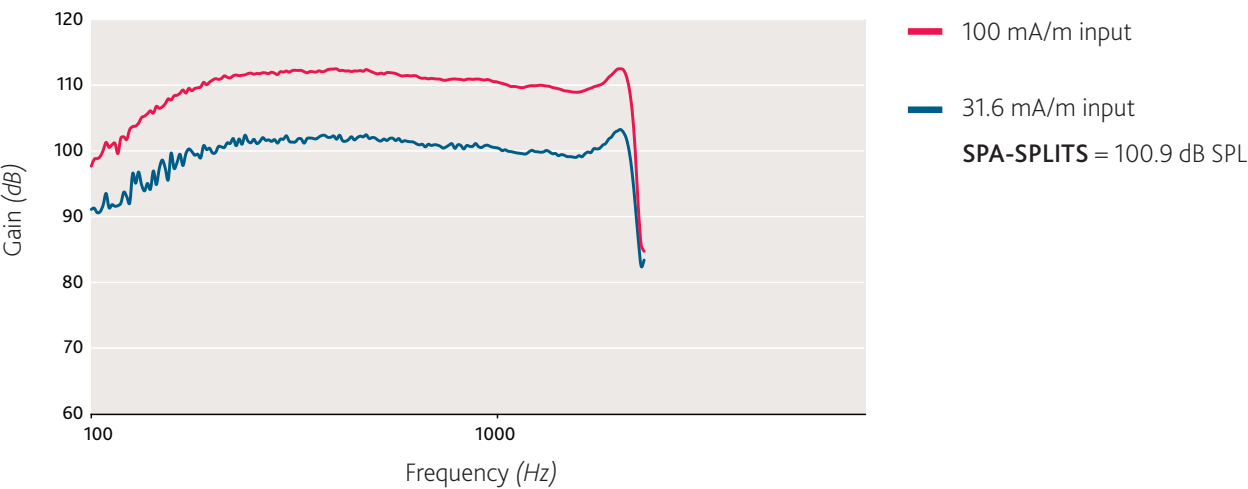
Between 100 Hz and 2200 Hz

Input/Output Characteristics



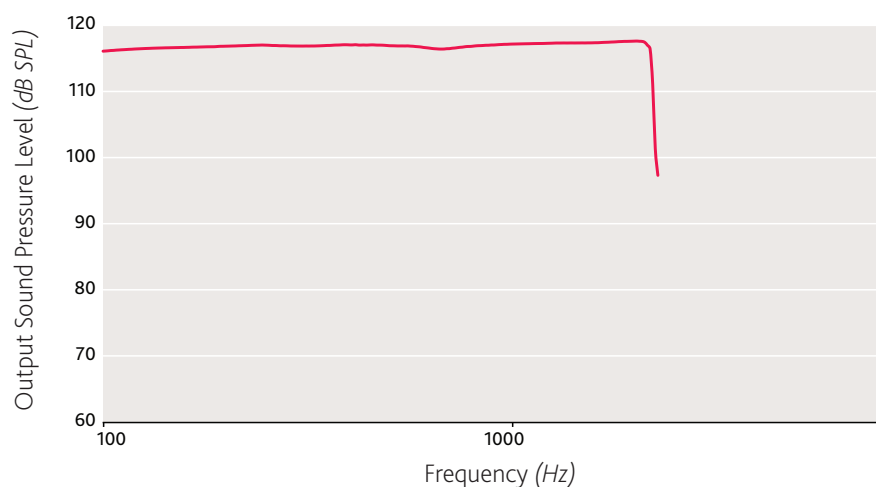
FREQUENCY	TOTAL HARMONIC DISTORTION	EQUIVALENT INPUT NOISE LEVEL
250 Hz	1.06% at 70 dB SPL	27 dB SPL
400 Hz	0.91% at 70 dB SPL	
625 Hz	0.81% at 65 dB SPL	

Induction Coil SPLITS



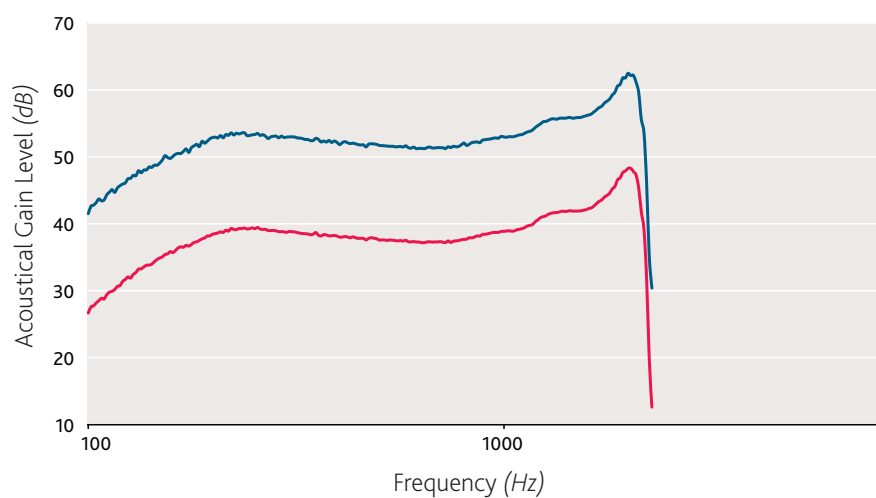
Measurements According to CENELEC EN 60118-0 (1993)

Output Sound Pressure Level at 90 dB SPL Input



— **Maximum** = 117.6 dB SPL
At 1600 Hz = 117.4 dB SPL

Full-on Acoustic Gain and Basic Frequency Response



— **Full-on gain**
 Maximum = 62.2 dB
 At 1600 Hz = 56.2 dB

— **Basic frequency response**

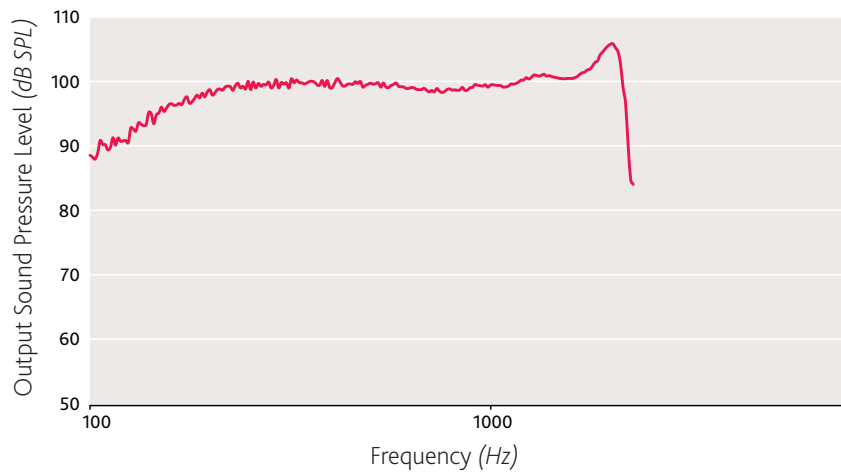
Basic frequency response
 At 1600 Hz = 42.3 dB

FREQUENCY	TOTAL HARMONIC DISTORTION
250 Hz	0.9% at 60 dB SPL
400 Hz	0.9% at 60 dB SPL
625 Hz	1.1% at 60 dB SPL

INTERNAL NOISE
 (SIMPLIFIED METHOD)

22.6 dB SPL

Characteristics of Hearing Aids with Induction Pick-Up Coil Input



— Input field strength:
31.6 mA/m

At 1600 Hz = 100 dB SPL

REFERENCES

Chang, J.E., Bai, J., Y., and Zeng, F. (2006) "Unintelligible low frequency sounds enhances simulated cochlear implant speech recognition in noise," IEEE. Trans. Biomed. Eng. 53, 2598.

Cochlear Nucleus Hybrid L24 North American Clinical Trial 2013

Kong, Y. Y., and Carlyon, R. P. (2007). "Improving speech recognition in noise in simulated binaurally combined acoustic and electric stimulation," J. Acoust. Soc. Am. 121 (6) 3717-3727.

Qin, M.K., and Oxenham, A.J. (2006). "Effects of introducing unprocessed low-frequency information on the reception of envelope-vocoder processed speech," J. Acoust. Soc. Am. 119 (4), 2417-2426.

Turner, C.W., Gantz, B.J., Vidal, C., Brehms, A., and Henry, B.A. (2004). "Speech recognition in noise for cochlear implant listeners: benefits of residual acoustic hearing," J. Acoust. Soc. Am. 115(4), 1729-1735.

Valente, M., Abrams, H., Benson, D., et al. (2006). Guidelines for the audiological management of adult hearing impairment. Audiology Today, 18(5)

As your patient's partner in hearing for life, Cochlear believes it is important to convey not only the benefits, but also the potential risks associated with any hybrid implant or cochlear implant.

Not everyone with hearing loss is a candidate a cochlear implant or hybrid implant. Before surgery for a cochlear implant or hybrid implant, please review the CDC recommendations regarding vaccination with your patient. Cochlear implants and hybrid implants are contraindicated for patients with lesions of the auditory nerve, absent cochlear development, active ear infections or active disease of the middle ear.

Cochlear implantation or hybrid implantations are surgical procedures, and carry the risks typical for surgery. Patients may lose residual hearing in the implanted ear. Electrical stimulation may result in some side effects, including ringing in the ear, stimulation of the facial nerve; in rare cases this may cause pain. Though rare, it is possible that additional surgery may be required at some point to resolve complications with a cochlear implant or hybrid implant. For complete information regarding indications, warnings and adverse effects, please refer to the Nucleus Package Insert available at www.Cochlear.com/US/NucleusIndications

Hear now. And always

As the global leader in implantable hearing solutions, Cochlear is dedicated to bringing the gift of sound to people with moderate to profound hearing loss. We have helped over 350,000 people of all ages live full and active lives by reconnecting them with family, friends and community.

We give our recipients the best lifelong hearing experience and access to innovative future technologies. For our professional partners, we offer the industry's largest clinical, research and support networks.

That's why more people choose Cochlear than any other hearing implant company.

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