

GN Otometrics, April 2007

Best Practice #3

Verifying Hearing Instrument Dynamic Features

Digital hearing instruments are dynamic, changing the amount of amplification based on the input they receive from the environment and the location of sound. These new devices have many dynamic features that can be demonstrated to the patient when selecting a hearing instrument, verified during the hearing instrument fitting or verified to be functioning properly if concerns arise. This document describes how to verify the functionality of many dynamic features.

1. Directionality

Most digital hearing instruments with directionality incorporate two or more microphones into the hearing instrument. By monitoring the time difference for the signal to reach the front and back microphones, the direction of the signal can be determined. In directionality mode the hearing instrument will amplify signals coming from the front more than those coming from the rear.

Patterns of directionality may be fixed or time variant. For fixed directional patterns the pattern of directionality remains the same for all settings. The hypercardioid is the most commonly utilized pattern. The hypercardioid provides less amplification to sounds from behind and to the side of the individual and more amplification to sounds in front of the individual. The pattern of directionality remains the same for all settings. With digital hearing instruments, adaptive directionality can be implemented. This means that the hearing instrument changes the pattern of directionality it is using to best fit the environment based on the input it receives. It is constantly assessing the sounds from the environment and determining the pattern of directionality that will give the individual the best signal to noise ratio.

a. Hearing Instrument Setup

When verifying directionality, two measurements will be collected: the first with directionality deactivated and the second with directionality activated. A comparison

of the two curves will illustrate the benefit (i.e. reduction of background noise) of directionality. Keep in mind the following:

- Turn noise suppression off. A noise stimulus is used to verify directionality. If noise suppression is turned on, the measurements obtained will not be accurate.
- For most hearing instruments, it takes ~ 10 seconds for the hearing instrument to respond after activating directionality. Wait 10 seconds before taking the second measurement.

b. Hypercardioid Directionality

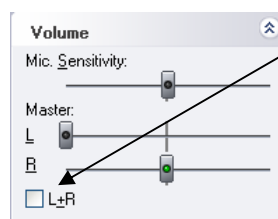
This type of directionality can be verified with a single signal (noise) presented either at 90 degrees (beside the patient) or at 180 degrees (behind the patient). Present a 65 dB ANSI speech noise or babble. The curve obtained with directionality activated will have smaller amplitude than the curve obtained deactivated.

c. Adaptive Directionality

This type of directionality requires a dual signal for verifying directionality. The dual signal consists of speech that is presented from the front of the patient and noise that is presented from either 90 degrees (beside of patient) or 180 degrees (behind the patient). While presenting a 65 dB ANSI speech noise or babble at 90 or 180 degrees, read the "Rainbow" passage directly in front of the patient. The patient will perceive a greater difference than what will be visually represented by the difference between the curves.

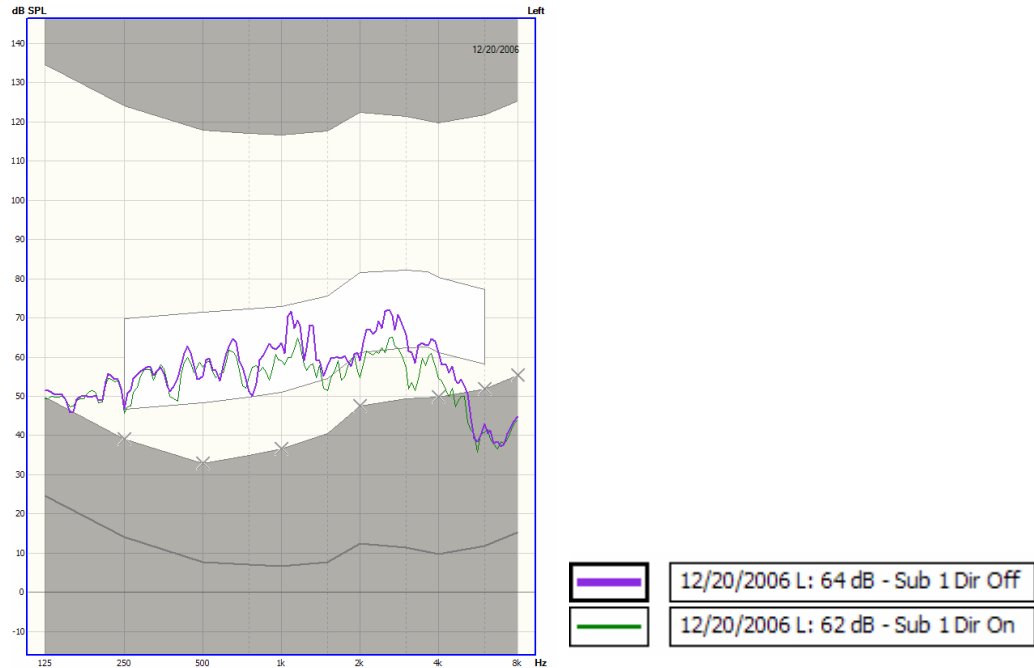
d. Verification Procedure for Hypercardioid Directionality

- Turn noise suppression and directionality OFF.
- Place the patient at 90 or 180 degrees to the speakers. Uncheck the L+R box. For the speaker that is in front of the patient, slide the Master volume control to the left (turning it off).



- Select the **Snapshot** mode and the **Continuous Stimulus** mode.
- Select **ANSI speech noise** or **Babble** stimulus file.
- Select **On Top mode**.

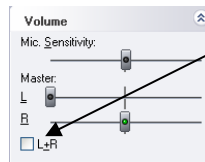
- Present the stimulus at 65 dB SPL.
- Click the **Snapshot** (camera) button to take the first curve.
- Modify the legend to read "Dir Off".
- Turn the directionality ON.
- Wait 10 seconds.
- Click the **Snapshot** (camera) button to take the second curve.
- Modify the legend to read "Dir ON".



Measurement was taken with a GN Resound Plus 5 with hypercardioid directionality.
 Top curve – Directionality OFF
 Bottom curve – Directionality ON

e. Verification Procedure for Adaptive Directionality

- Turn noise suppression and directionality OFF.
- Place the patient at 90 or 180 degrees to the speakers. Uncheck the L+R box. For the speaker that is in front of the patient, slide the Master volume control to the left (turning it off).



- Select the **Snapshot** mode and the **Continuous Stimulus** mode.
- Select **ANSI speech noise** or **Babble** stimulus file.
- Select **On Top mode**.
- Present the stimulus at 65 dB SPL while reading the "Rainbow" passage directly in front of the patient.
 - Click the **Snapshot** (camera) button to take the first curve.
 - Modify the legend to read "Dir Off".
 - Turn the directionality ON.
 - Wait 10 seconds.
 - Continue presenting the stimulus at 65 dB SPL while reading the "Rainbow" passage directly in front of the patient.
 - Click the **Snapshot** (camera) button to take the second curve.
 - Modify the legend to read "Dir ON".

2. Speech Recognition

Some hearing instruments have algorithms that detect speech. When a signal representing the characteristics of speech is detected, the hearing instrument will increase the gain for that signal. Verify that a change in gain occurs when speech is presented.

a. Verification Procedure

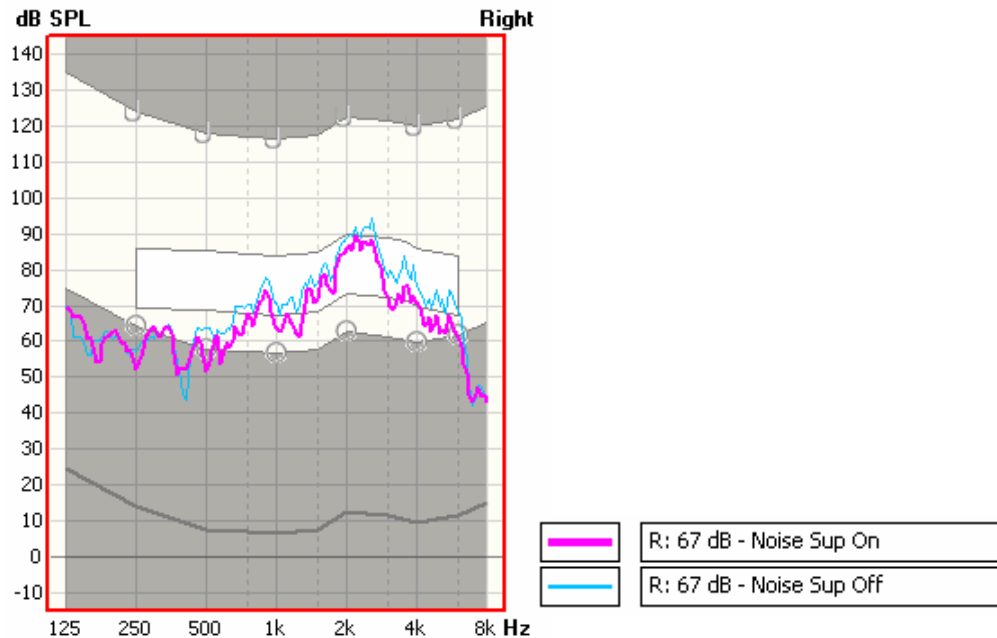
- Turn noise suppression OFF.
- Place the patient at 0 degrees to the speakers.
- Select the **Snapshot** mode and the **Continuous Stimulus** mode.
- Select **Pink Noise** stimulus file.
- Select **On Top mode**.
- Present the stimulus at 65 dB SPL.
- Click the **Snapshot** (camera) button to take the first curve.
- Modify the legend to read "Noise".
- Read the "Rainbow" Passage. Continue reading while collecting the second curve.
- Wait 10 seconds.
- Click the **Snapshot** (camera) button to take the second curve.
- Modify the legend to read "Speech".

3. Noise Suppression

Noise suppression assesses the amplitude modulation as well as other characteristics of speech to estimate the speech to noise ratio. If it does not match speech characteristics, then it is considered noise and the gain of the input is reduced. There are many different algorithms designed by hearing instrument manufacturers to achieve noise suppression. Since these algorithms function differently, you are not guaranteed that an artificial speech signal will successfully fool the instrument into identifying it as speech. Therefore, it is important that real speech is used to verify that speech is audible in the hearing instruments with noise suppression. To verify, present a 65 dB Pink noise with noise suppression activated and deactivated. The curve obtained with noise suppression activated will have smaller amplitude than the curve obtained with noise suppression deactivated. If the hearing instruments have noise suppression as part of the adaptive speech recognition, follow the speech recognition steps to verify the speech recognition feature.

a. Verification Procedure


- Turn noise suppression OFF for all channels.
- Place the patient at 0 degrees to the speakers.
- Select the **Snapshot** mode and the **Continuous Stimulus** mode.
- Select **Pink noise** stimulus file.
- Select **On Top mode**.
- Present the stimulus at 65 dB SPL.
- Click the **Snapshot** (camera) button to take the first curve.
- Modify the legend to read "Noise Sup OFF".
- Turn noise suppression ON for all channels.
- Wait 10 seconds.
- Click the **Snapshot** (camera) button to take the second curve.
- Modify the legend to read "Noise Sup ON".
- Explain to the patient how the attack time works so the patient has proper expectations for noisy environments.
- Continue to present the noise stimulus and begin talking to the patient at a level that is louder than the stimulus. The gain should increase for some channels. The time it takes for the gain to increase is the release time. Explain to the patient how the release time works so the patient has proper expectations for noisy environments.



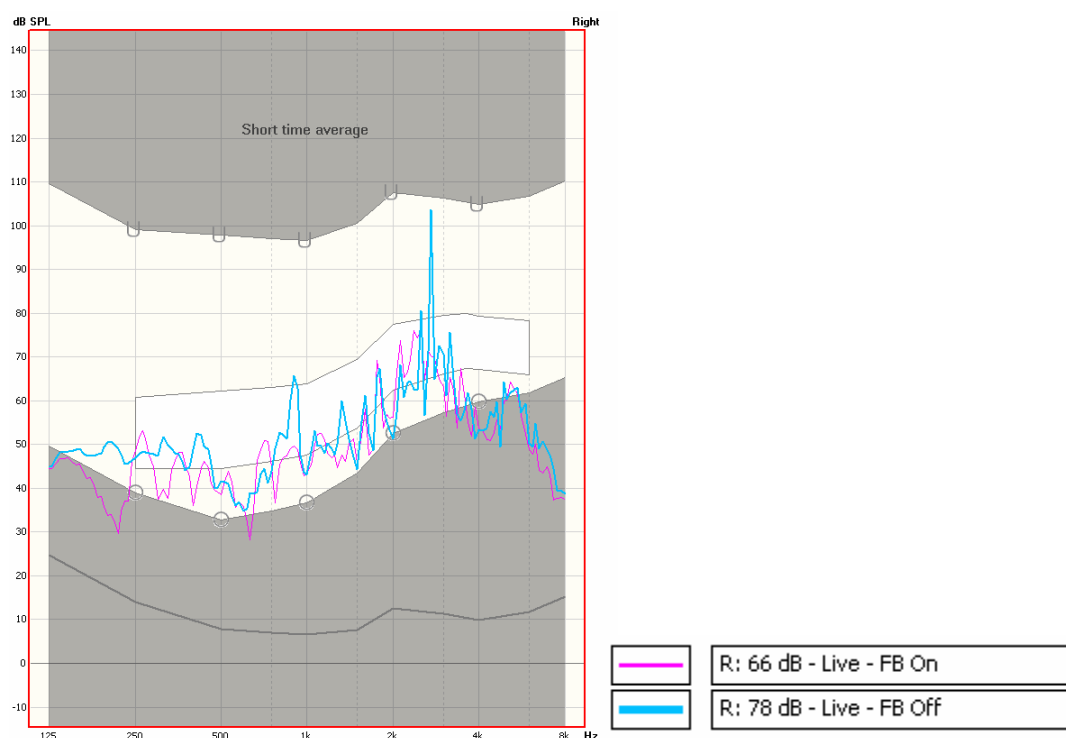
4. Feedback Suppression

Feedback suppression assesses the feedback path as a function of frequency. If feedback is present, the feedback suppression algorithm will reduce the gain or phase-cancel the feedback at this particular frequency. For phase cancellation, a digital filter is created that has the same frequency and amplitude as the feedback but has opposite phase as the feedback. When the feedback and the filter are added together, the feedback will be canceled out.

a. Verification Procedure

- Turn Feedback Suppression OFF.
- Place the patient at 0 degrees to the speakers.
- Select the **Snapshot** mode and the **Continuous Stimulus** mode.
- Select **Live Recording**. 
- Select **On Top mode**.
- Instruct the patient to cause acoustic feedback (e.g. opening mouth, holding telephone receiver, cupping ear).
- Click the **Snapshot** (camera) button to take the first curve.
- Modify the legend to read "Feedback Sup OFF".
- Turn Feedback Suppression ON.

- Instruct the patient to cause acoustic feedback (e.g. opening mouth, holding telephone receiver, cupping ear).
- Click the **Snapshot** (camera) button to take the second curve once feedback is canceled.
- Modify the legend to read "Feedback Sup ON".
- If the entire curve is reduced, the hearing instrument is using gain reduction to eliminate feedback. If a dip occurs at the feedback frequency, the hearing instrument may be using a notch filter to eliminate the feedback. If the amplitude at the feedback frequency is reduced without affecting other frequencies, the hearing instrument is using phase cancellation to eliminate feedback.
- For open canal hearing instruments, when trying to evoke feedback, if a small peak occurs and the peak is reduced the feedback suppression is constantly working to reduce feedback.



5. Wind Noise Reduction

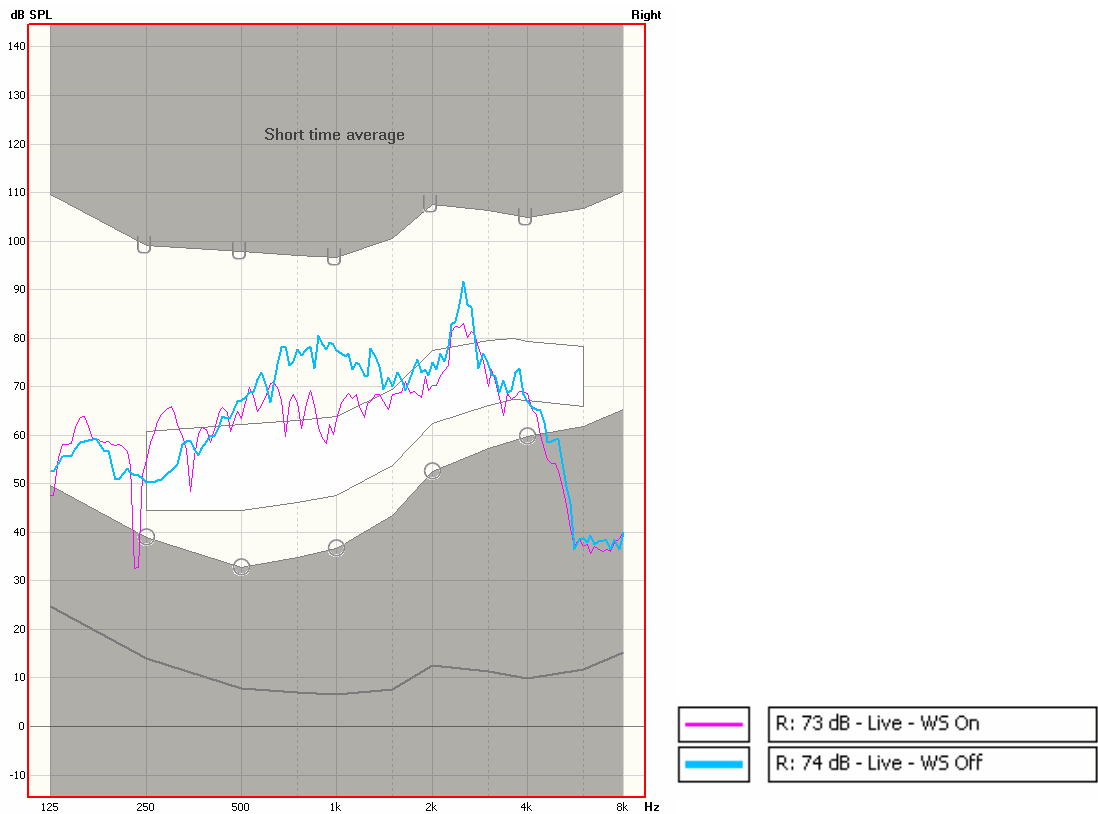
Wind noise reduction assesses the spectrum of the input using advanced algorithms to determine if low frequency noise is present due to turbulent air flow. If the algorithm identifies the presence of low frequency broadband noise, the hearing instrument will reduce the gain at these frequencies.

a. Verification Procedure

- Turn Wind Noise Reduction OFF.
- Place the patient at 0 degrees to the speakers.
- Select the **Snapshot** mode and the **Continuous Stimulus** mode.



- Select **Live Recording**.
- Select **On Top mode**.
- Place a small fan creating wind noise next to the hearing instrument.
- Click the **Snapshot** (camera) button to take the first curve.
- Modify the legend to read "Wind Reduction OFF".
- Turn Wind Noise Reduction ON.
- Wait 10 seconds
- Click the Snapshot (camera) button to take the second curve.
- Modify the legend to read "Wind Reduction ON".



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For more information, please contact GN Otometrics:

North America: 1 800 289 2150 or sales@gnotometrics.com
Other countries: +45 45 75 55 55 or info@gnotometrics.dk