Verifying Open Canal Fittings with the Affinity

Decisions regarding vent size are crucial in the fitting process and must be selected carefully to ensure that the gain target is reached and, where possible, without occlusion. Small vents or entirely closed fittings are usually recommended for hearing losses that require high levels of gain especially in the low frequencies. They have the advantage of minimizing problems with feedback squealing as the signal has limited possibilities to leak back into the microphone. However, when the ear canal is completely occluded by a closed fitting, people with thresholds better than approximately 40 dB HL in the lower frequency range are likely to experience discomfort from their own voice. It will sound unnatural, as if they were speaking in a barrel. Closed fittings may introduce this occlusion effect and make the patient feel “plugged up” (Dillon 2001, Mueller & Ricketts 2006).

Fortunately, for people with normal or near normal hearing, this occlusion effect can be prevented by using Open Canal Fittings. Such fittings have become increasingly popular in recent years (Fabry 2007, Staples & Aiken 2006). Open Canal Fittings are non-occluding. They represent a two-way passage that allows the low frequencies to leak into the residual ear canal without being amplified by the hearing instrument and out of the ear while providing gain in the high frequencies. This results in a much more comfortable fit with a much more natural sound. Furthermore, open canal fittings often have the advantage of being small, have thin tubing and a fashionable design making them cosmetically appealing (Dillon 2001, Mueller & Ricketts 2006, Staples & Aiken 2006).

Although Open Canal Fittings have many advantages relating to comfort and sound quality, they have some implications for verification. In Real Ear Measurements involving traditional hearing aids the reference microphone monitors the amplitude of the signal reaching the hearing instrument from the loudspeaker. If the input level is higher or lower than the desired level, the reference microphone will turn the volume down or up accordingly (Dillon 2001). However, with an open fitting, some frequencies may escape out of the ear canal and into the reference microphone causing the input level to be reduced to compensate. This results in an erroneous curve below the target (Staples & Aiken 2006). The size of the error may depend on more than one factor (e.g. stimulus used, hearing aid gain). If the stimulus used has more energy in a specific frequency region there will be a greater risk of leakage in this area due to the amplification of the hearing aid. This will in turn have an effect on the measured curve. The characteristics of the hearing loss also affect the gain of the hearing aid and this will naturally influence the extent of the leakage from the ear canal.

The problem of leakage in Open Canal Fittings creates a number of questions and some uncertainty concerning verification with Real Ear Measurements. The aim of this paper is therefore to provide guidelines for how to overcome these problems when verifying using the Affinity REM440 module.

Considerations before you begin

For both closed and Open Canal Fitting it is important to make sure that the vent size displayed in the fitting software is correct before you enter the REM440 module. Otherwise the fitting will be based on incorrect data and this will have consequences for the outcome.

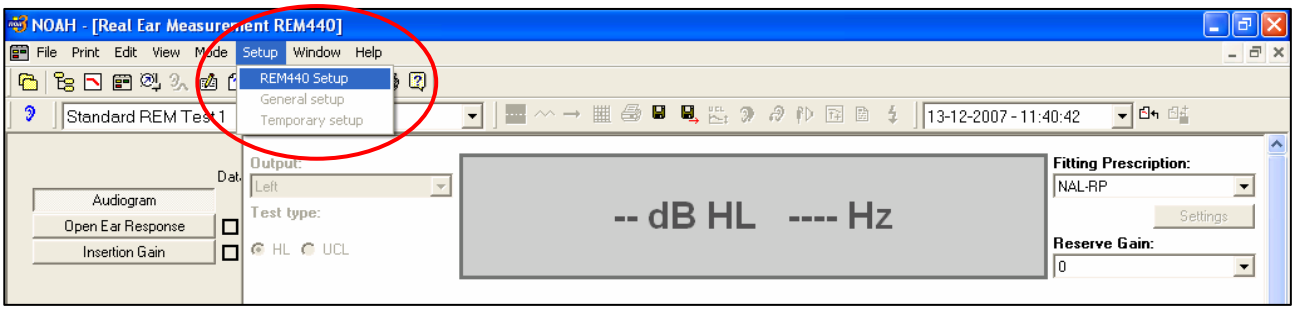
Getting started:

There are two different methods of verifying Open Canal Fittings using the Affinity:

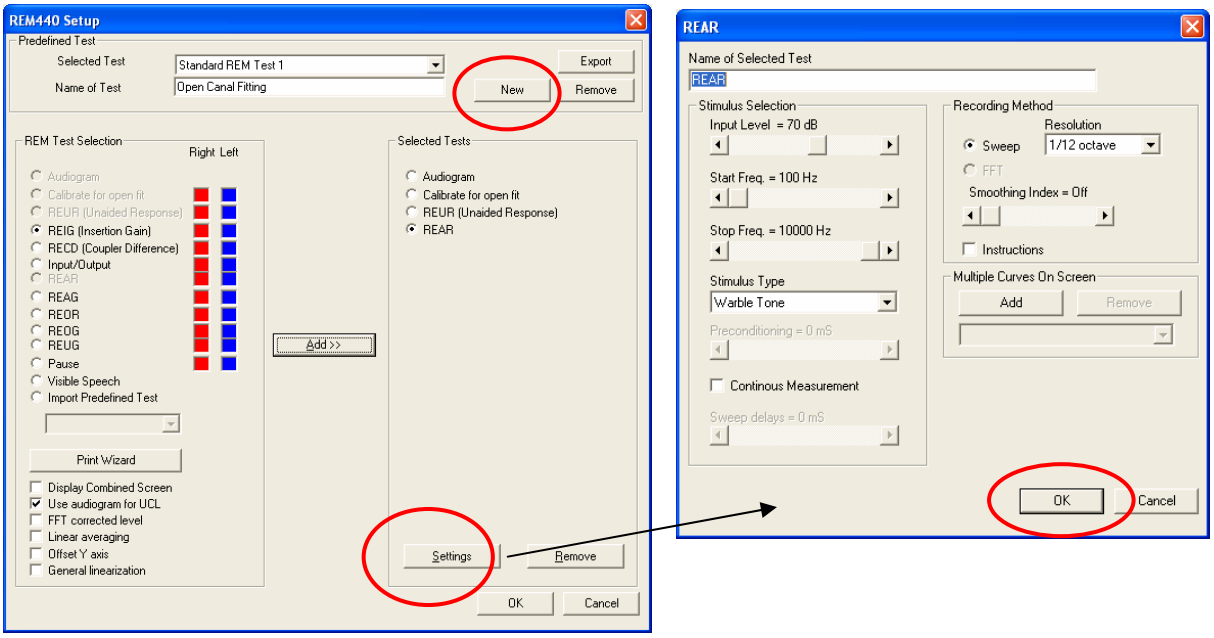
a. Setting up REM440 for Open Canal Fit
b. General Linearization

a) Setting up REM440 for Open Canal Fit

One way to start could be to create your own protocol to be used for all patients with Open Canal Fittings. When verifying in these cases it is important to perform the "Calibrate for open fit" test that disables the reference microphone.

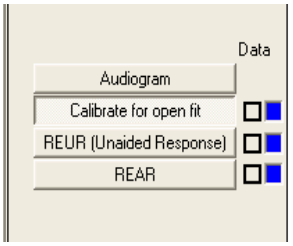


1) To create your own protocol for Open Canal Fittings enter the "REM440 Setup" (see message box below). Click "New" and name your test protocol. Start by adding the "Calibrate for open fit" test followed by other tests you wish to perform on a regular basis. You may also want to add the "Audiogram" as this gives the Affinity a basis for target calculation later on.
   Note that you can make adjustments to each added test by selecting it in "Selected tests" and clicking on the "Settings" button. This prompts a message box to pop up with various options (e.g. change the stimulus, input level, number of curves). See **"Working with Protocols in the Affinity REM440 Module"** for additional information on protocol adjustments.
   When you are satisfied with your protocol and settings click "OK" to proceed.

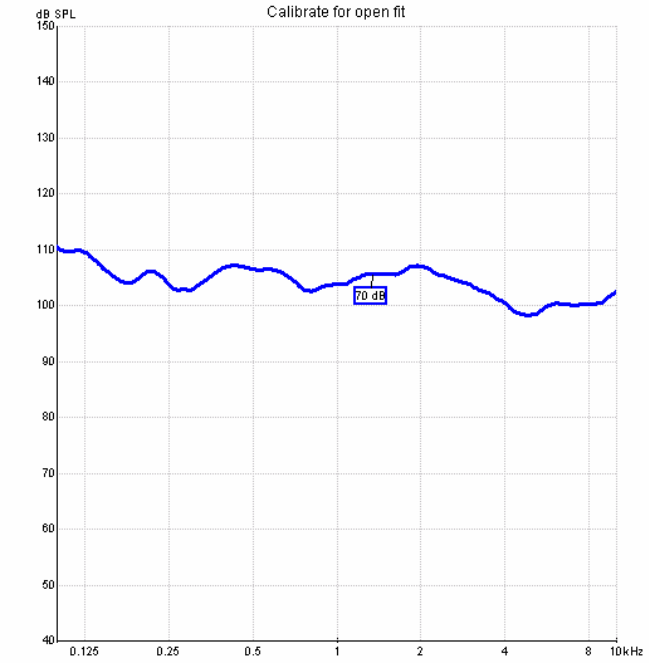


2) Place the patient in front of the Affinity loudspeaker wearing the in-situ headset but without the hearing aid (or with the hearing aid turned off).

3) Choose “Calibration for Open fit” in your protocol to the left and press Start



The Affinity will now record a sweep of 70 dB while the reference microphone on the in-situ headset continuously regulates the SPL at each frequency. Afterwards the Affinity will remember how many dBs the reference microphone had to adjust for the SPL constantly to remain at a level of 70 dB at this particular measurement.

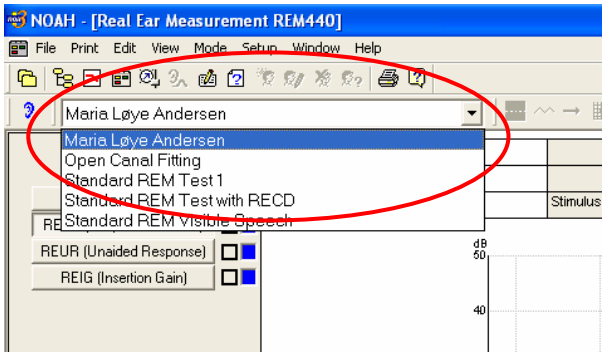


4) You are now ready to turn on the hearing aid and do the preferred measurements (e.g. Real Ear Aided Response (REAR) with a Warble Tone stimulus). When you press the “START” button the Affinity will use the correction values recorded by the reference microphone during the “Calibration for Open Fit” to regulate the sound pressure level of the loudspeaker. This way you avoid using the reference microphone for regulation of the SPL at the REAR measurement and the regulation is thereby not interrupted by the output of the hearing aid.

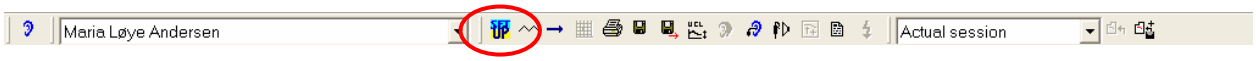
b) General Linearization

If you do not want a specific protocol for Open Canal Fittings or if you already have a protocol you would like to be able to use independently of the ear mold tightness you also have the option to do a General Linearization when using non linear stimuli like noise or wave files.

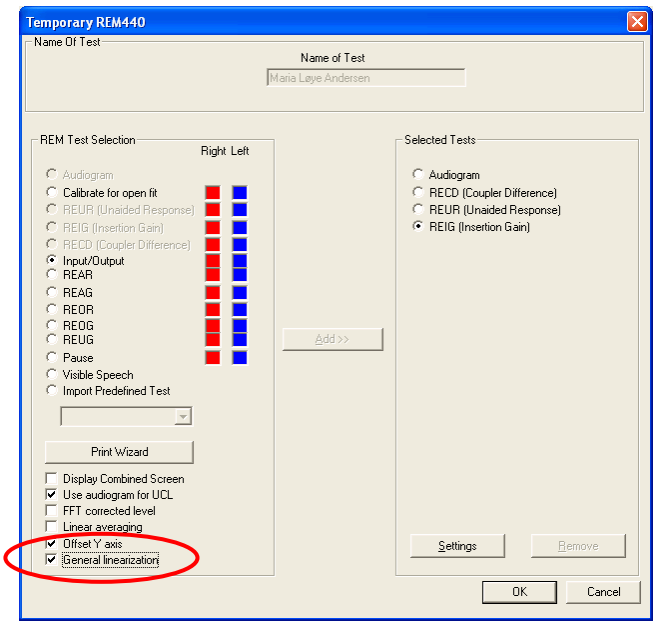
1) Select your protocol in the drop down menu in the upper left corner as usual.



2) Press the "Temporary Setup" button in the Affinity tool bar.



3) A message box now appears allowing you to make temporary changes to your protocol that will automatically disappear when closing the session. Mark "General Linearization" in the lower left corner of the message box and press "OK".
By choosing this option the Affinity will do a short linearization using a broadband signal before the first curve is recorded. After this the reference microphone will be turned off and you will get the same effect as if you had done the "Calibration for Open Fit".



Advanced note: Having done either the Calibration for Open Fit or General Linearization the Affinity has measured the extent of leakage from the Open Canal Fitting for you. However, if you would like a more visual representation of the amount of sound escaping out of the ear canal when stimulating with a specific signal you have the possibility to make another measurement.

1) Place the patient in front of the Affinity loudspeaker wearing the in-situ headset and the hearing aid (turned off). The probe tube should be placed in front of the reference microphone.
2) Enter the "REM440 Setup" or "Temporary Setup" as described above and add Real Ear Unaided Response (REUR) and Real Ear Insertion Gain (REIG) if they are not already a part of your protocol. Choose your stimulus in the under "Settings". Click "OK" when you are finished.
3) Do a REUR curve with the hearing aid turned off.
4) Turn the hearing aid on and do the REIG.

The REIG shows the leakage directly (REIG = REAR – REUR).

Finishing the fitting

After finishing the measurements, close the REM440 module, return to your fitting software and complete the fitting as usual. However always keep in mind that for Open Canal Fitting you should never attempt to extend the fitting range by trying to fit the low frequencies on the basis of your Real Ear Measurement. Open Canal Fittings are designed mainly for hearing aid users with high frequency losses a more occlusive solution such as an ear mold is required to compensate for the vent loss below a 1000 Hz (Staples & Aiken 2006). Attempts to fit the low frequencies will most likely cause distortion and thereby discomfort.

References:

Dillon, H. 2001 *Hearing Aids*. Forlaget Thieme. Boomerang Press Sydney
Mueller, H. G. & Ricketts, T. A. (2006) Open-canal fittings: Ten take-home tips. *The Hearing Journal, vol 59, No. 11* Nov. pp. 24-39.
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