

Phonak CROS

A guide to verifying CROS and Bi-CROS fittings using probe-microphone measures

Introduction

A common management approach for those with hearing loss in one ear that isn't directly aidable but normal/near-normal hearing in the other ear is to fit a system that transfers sound from the unaidable side across to the better side. Known as Contralateral Routing of the Signal, or CROS (Harford & Barry, 1965), this approach generally entails a microphone worn on/in the unaidable ear which sends its output via either a wire or wireless transmission to an amplifier and receiver worn behind/in the normal/near-normal hearing ear. A so called transcranial CROS can also be achieved by transferring information from the unaidable to good ear via bone conduction using either a high powered in-the-ear hearing aid (Hayes & Chen, 1998) or a bone anchored hearing aid (Hol et al., 2010). Because the hearing in the better ear is normal/near-normal, little or no amplification is provided to the crossed signal as the concept is simply to overcome the head-shadow effect (Courtois et al., 1988).

For patients who also have a hearing loss in their better hearing ear, a Bi-CROS (Bilateral Contralateral Routing of the Signal) solution will be more suitable (Dillon, 2001). In a Bi-CROS system, a microphone is worn behind both ears. Again, the signal from the unaidable ear is transferred from one side of the head to the other; however, this signal is then amplified according to the hearing loss in the better ear. At the same time, the microphone behind the better albeit impaired ear is also amplified according to the hearing loss on this side.

Interestingly, Mueller & Hawkins (1992) reported that patients sometimes find it challenging to reliably report whether their CROS system/transmitter is operational, particularly if the better ear is normal/near-normal. Thus, probe microphone measures present an ideal, objective way for verifying if CROS/Bi-CROS systems are functioning and overcoming the head shadow effect (Pumford, 2005). Further support for utilizing probe-microphone measures comes from MarkeTrak findings, showing those patients receiving best fitting practice experience double the reduction in hearing handicap compared to those that don't (Kochkin, 2011).

This document is based on the verification protocol outlined by Pumford (2005) and uses case examples, photos of the test set-up and typical electro-acoustic results to clearly illustrate how to verify CROS/Bi-CROS fittings using both the real-ear insertion-gain (REIG) and Speech-Map (SpMap) method.

Equipment Set-Up & Requirements

To enable accurate probe microphone measures of CROS/Bi-CROS system function, real-ear measurement systems (such as the Audioscan Verifit system) must have **two reference microphones, one placed on each ear, and the ability to switch between these whilst keeping the same probe-microphone active.** This enables the hearing healthcare professional to switch the active reference microphone across ears, which is essential for accurately comparing output when sound is presented to the better versus unaidable ear. **Regarding equipment set-up, the probe-microphone is only inserted into the normal/better hearing ear.** This is because the better hearing ear is the only ear that has an output from the CROS/Bi-CROS system.

CROS Fittings

To illustrate the method for verifying CROS fittings, consider this case of a 24 year old male who suffered a sudden severe-profound sensorineural hearing loss on the right, with very poor residual speech discrimination in this ear. The left ear has normal hearing (Fig. 1). He attends university and is having difficulty hearing in tutorials, especially people on his right side. This difficulty also occurs socially, when he is a passenger in the car (left hand drive road system) and in his part-time job. He is keen for help with his hearing and his hearing healthcare professional fitted a Phonak Cassia microM and Phonak CROS BTE transmitter for trial.

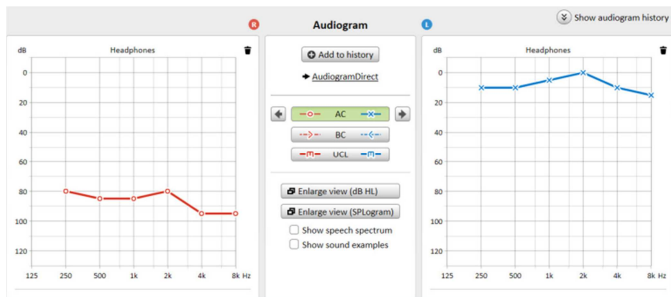


Fig. 1: Audiogram for the 24 year old male showing a severe-profound hearing loss on the right and normal hearing on the left.

Step 1: Record the response when the stimulus is presented to the better ear.

Position the Verifit reference microphones on both ears. Insert the probe microphone into the better ear only, which in this case is the left ear (red arrow, Fig. 2a). Position the CROS transmitter and hearing instrument on/in the respective ears and activate both (*Note: you have to exit the Phonak Target fitting session to activate the CROS transmitter*). Select the relevant hearing instrument type in the Verifit, in this case <BTE>, then turn the clients head by 45 degrees so that the better ear is facing the sound source, as shown in Fig. 2a. For the REIG method, record the real-ear unaided-response (REUR) for a pink noise stimulus presented at either 55- or 60-dB SPL. Given this fitting is not occluding; the REUR response is relatively unchanged (Fig. 2b). For the SpMap method, record the response for a speech stimulus presented at either 55- or 60-dB SPL (Fig. 2c).

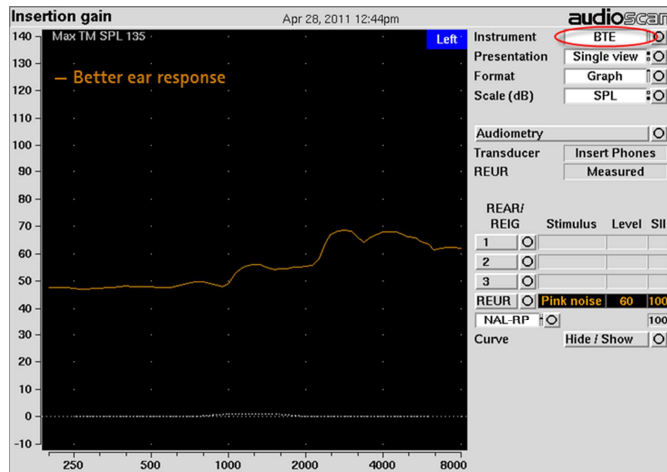


Fig. 2b: REUR recorded for a pink noise stimulus presented at 60 dB SPL for the REIG method.

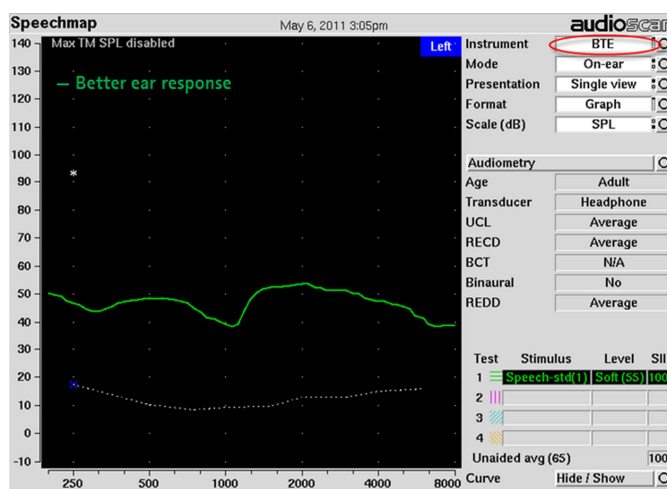


Fig. 2c: Response recorded for speech stimulus presented at 55 dB SPL using the SpMap method.

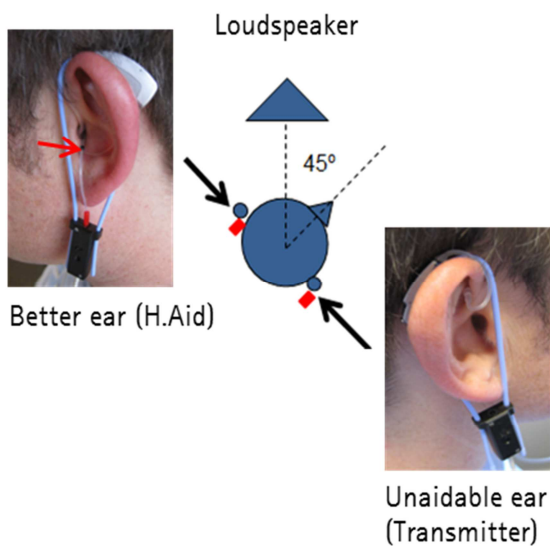


Fig. 2a: Equipment set-up for measuring the better ear response.

Step 2: Record the response when the stimulus is presented to the unaidable ear.

Rotate the client so that their unaidable ear is now on a 45° angle toward the sound source (Fig. 3a; *Note the probe microphone remains in the better ear, as indicated by the red arrow*). Select <CROS> in the hearing instrument area of the Verifit (*Note: this switches the reference microphone to the side of the transmitter*). Record the response for the same stimulus and level as used in Step 1; for the REIG method this should be stored as the real-ear aided-response 1 (REAR1) and for the SpMap method it will be Test 2. Ideally the 'better ear' and 'unaidable ear' responses should be identical, which for the REIG method would be reflected by a REIG response of zero (Fig. 3b). In the least instance, the curves should be similar, as they are shown in Fig. 3b and 3c. This means that the CROS system is both overcoming the head-shadow effect and at the same time isn't providing too much gain for the crossed signal. If they differ greatly, fine-tune the hearing instrument to have them match as closely as possible.

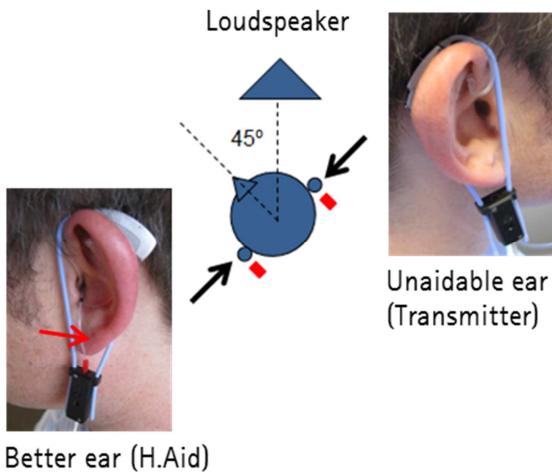


Fig. 3a: Equipment set-up for measuring the unaidable ear response.

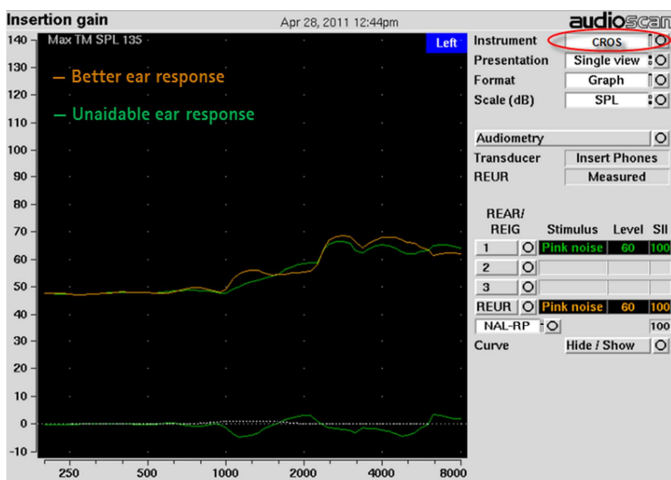


Fig. 3b: REAR1 recorded for a pink noise stimulus presented at 60 dB SPL for the REIG method.

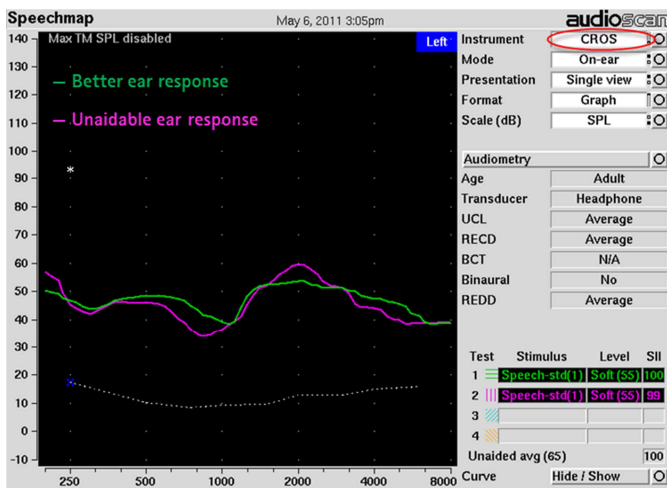


Fig. 3c: Response recorded for speech stimulus presented at 55 dB SPL using the SpMap method.

Step 3: Record a response with the stimulus presented at 0° azimuth.

This ensures that the REAR response is smooth and there are no irregularities in the response. This can be done with either reference microphone selected (i.e., <CROS> or <BTE> selected in the Verifit hearing instrument menu) because they are equidistant from the sound source.

Bi-CROS Fittings

To illustrate the method used for Bi-CROS fittings, consider the case of a 48 year old male who had longstanding mild-moderate hearing loss bilaterally which he tolerated. Unfortunately, he sustained a head injury during a car accident that fractured his right temporal bone causing a profound hearing loss on this side (Fig. 4). His previously annoying but tolerable hearing issues have now become a huge burden and are impacting on the quality of his life. Therefore a Phonak Solana microM and Phonak CROS BTE are fitted for trial.

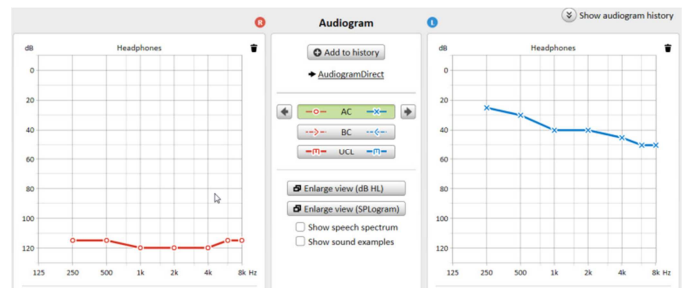


Fig. 4: Audiogram for the 48 year old male showing a profound hearing loss on the right - following the head injury and a mild-moderate hearing loss on the left.

Step 1: Fit and verify the hearing instrument in the conventional way.

Position the Verifit reference microphones on both ears and insert the probe microphone into the better ear only (red arrow, Fig. 5a).

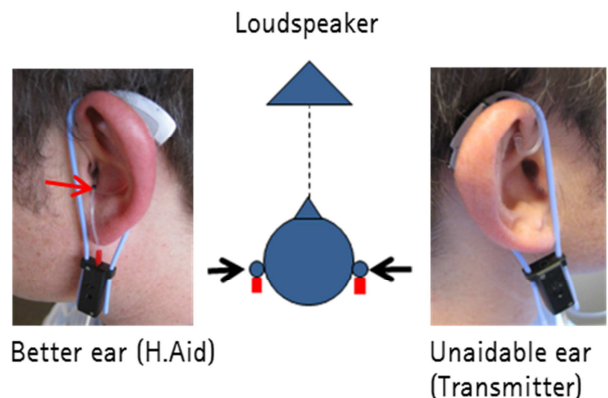


Fig. 5a: Test set-up for conventional verification of the left hearing instrument.



Fig. 5b: Example of electro-acoustic results using the REIG method.

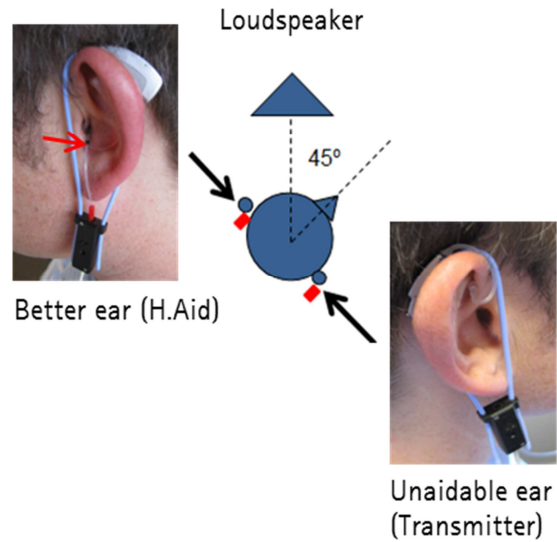


Fig. 6a: Equipment set-up for measuring the better ear response.

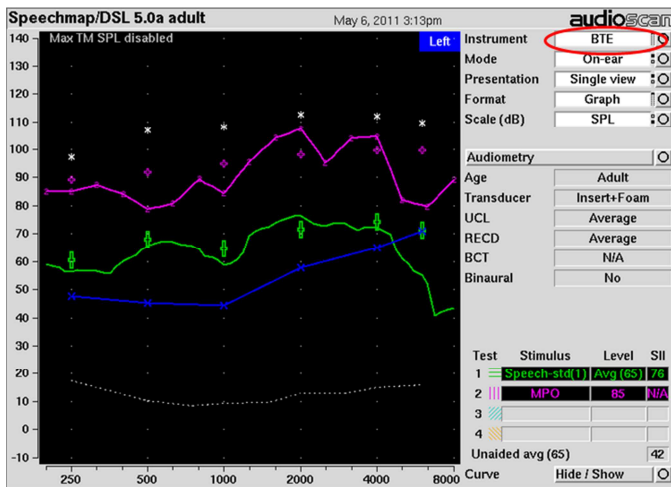


Fig. 5c: Example of electro-acoustic results using the SpMap method.

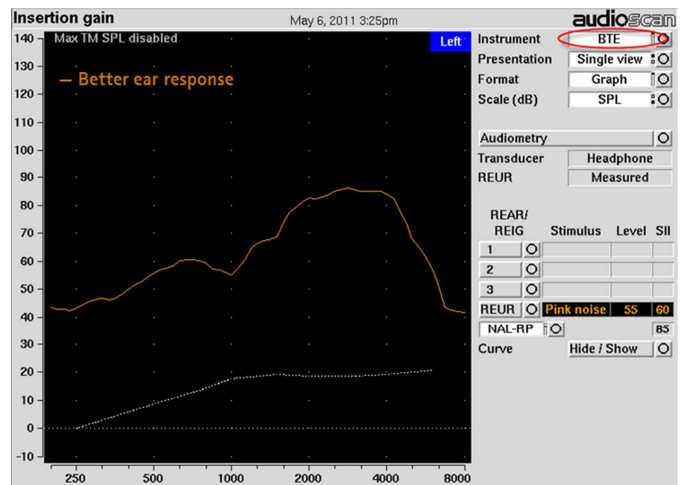


Fig. 6b: REUR recorded for a pink noise stimulus presented at 55 dB SPL for the REIG method.

Position both the hearing instrument and CROS transmitter on/in the ears and select <on ear measure> & the relevant hearing device in the Verifit, in this case <BTE>. Activate the hearing instrument only and verify your hearing instrument in the normal fashion using either the REIG or SpMap method (Fig. 5b and 5c respectively).

Step 2: Record the response from the better ear.

Turn the CROS transmitter on (*Note: you need to exit Phonak Target fitting session to activate the CROS transmitter*). Keep the hearing instrument type the same in the Verifit, in this case <BTE>. Turn clients head by 45 degrees so that the better ear is angled toward the sound source (Fig. 6a). For the REIG method, present a pink noise stimulus at either 55- or 60-dB SPL and record this response as the REUR (Fig. 6b). For the SpMap method, present a speech stimulus at either 55- or 60-dB SPL and record this as Test 1 (Fig. 6c).

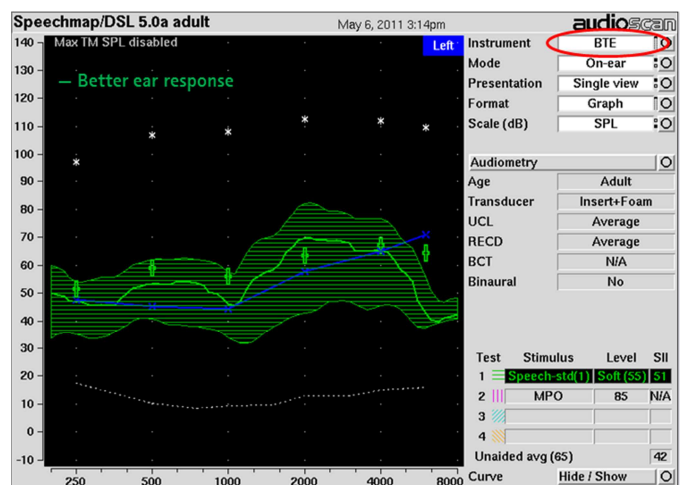


Fig. 6c: Response recorded for speech stimulus presented at 55 dB SPL using the SpMap method.

Step 3: Record the response from the unaidable ear.

Rotate the client so that their unaidable ear is now on a 45° angle toward the sound source (Fig. 7a; *Note - the probe microphone remains in the better ear, as indicated by the red arrow*). Select <CROS> in the hearing instrument area of the Verifit (*Note: this switches the reference microphone to the side of the transmitter*). Record the response for the same stimulus type and level as used in Step 2. For the REIG method, record this as the REAR1, and for the SpMap method it will be Test 2. Again, the better ear and unaidable ear responses should be identical, or in the least instance quite similar, as they are in this case (Fig. 7b and 7c). For the REIG method, close similarity between the better and unaidable ear responses is reflected by a REIG curve of approximately zero. When the responses have good similarity, this means that the Bi-CROS system is both overcoming the head shadow effect and the crossed signal is receiving appropriate gain for the hearing loss in the better ear. If they differ greatly, fine-tune the instrument using the microphone balancing tool in Phonak Target in order to have them match as closely as possible.

Step 4: Record a response with the stimulus presented at 0° azimuth with the Bi-CROS system active.

This is to ensure the response is smooth and there are no irregularities. This can be done with either reference microphone selected (i.e., <CROS> or <BTE> selected in the Verifit hearing instrument menu) because they are equidistant from the sound source.



Fig. 7a: Equipment set-up for measuring the unaidable ear response.

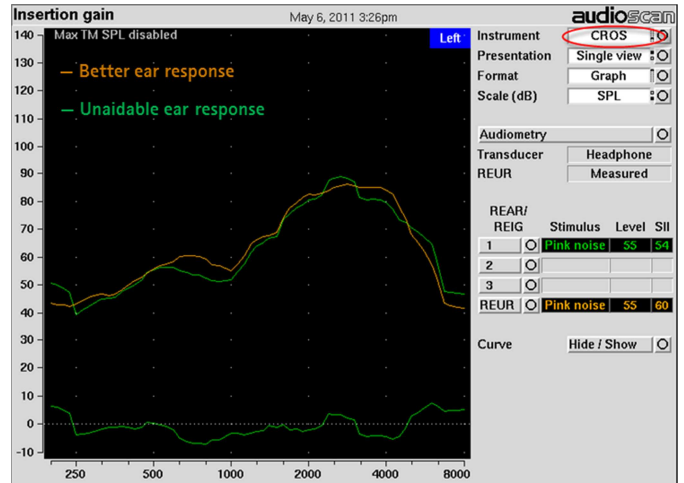


Fig. 7b: REUR recorded for a pink noise stimulus presented at 55 dB SPL for the REIG method.

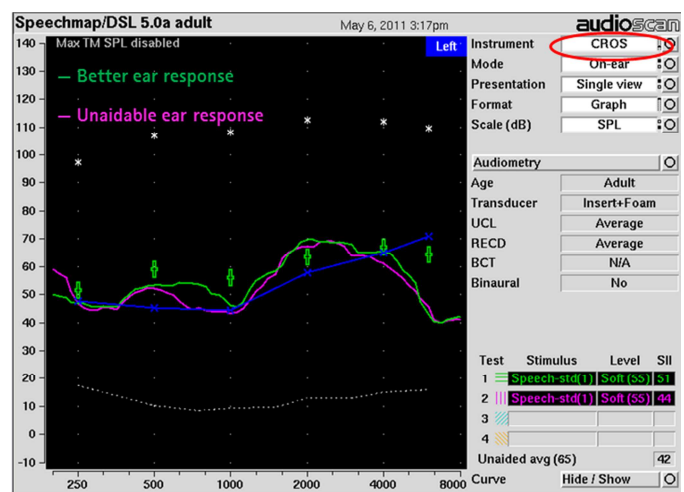


Fig. 7c: Response recorded for speech stimulus presented at 55 dB SPL using the SpMap method.

Summary

Probe microphone measures provide an easy, objective and reliable way to verify CROS and Bi-CROS fittings. You can use either the REIG or SpMap method depending on which you are most familiar with. The main system requirements are two probe and reference microphone complexes and the ability to switch reference microphones whilst keeping one probe microphone active to record output in the better hearing ear.

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