

## Phonak CROS System

An innovative solution for total unilateral hearing loss

---

### Introduction

Total unilateral hearing loss (UHL), also known as single sided deafness, refers to the total loss of hearing in one ear with either normal hearing or aidable hearing loss in the better ear. Total hearing loss in one ear has been found to be very debilitating; affecting social, work and home interactions due to the reduced ability to localize sounds and to discriminate in background noise (Baguley et al., 2006).

With limited options available for medical treatment, one solution is to transmit sound from the unaidable ear to a receiver on the normal hearing ear. An example of this is a CROS (Contralateral Routing of Signal) hearing aid. This type of fitting attempts to overcome the adverse consequences of the head shadow effect by providing awareness of sound especially from the side with little or no usable hearing (Pumford, 2005).

The new Phonak CROS is the smallest and most stylish wireless CROS/BiCROS solution designed to match the individual needs and preferences of each client with total unilateral hearing loss. The digital wireless Phonak Spice Technology enables fast transmission and a clear signal quality. Phonak CROS consists of only two parts – a transmitter microphone for the unaidable ear and a receiver hearing instrument on the hearing ear. This means that clients do not have to worry about additional attachments like wires, receivers or audioshoes.

---

### Total unilateral hearing loss

Total unilateral hearing loss refers to a profound or total loss of hearing in one ear that is unaidable. Most cases of total unilateral hearing loss are permanent, acquired either at birth due to a congenital defect or later in life; suddenly, or due to trauma. In some cases where the hearing loss occurs suddenly, it is possible that hearing may return fully or partially over a period of time.

The number of newly diagnosed cases with total unilateral hearing loss is estimated at 60,000 every year in the United States and 9,000 in the United Kingdom; however no reliable figure exists on the actual number of patients because of

limited medical records. This could be due to a lack of awareness among family doctors and the general public (Sinopoli, 2003).

---

### Causes of total UHL

Causes of unilateral hearing loss can be congenital, present at or just after birth due to some malformation of the inner ear or acoustic nerve. It can also be acquired later on in life due to various causes. Idiopathic or sudden onset deafness is the most common cause of total unilateral hearing loss (Fayad et al., 2003). It can occur very suddenly or over a period of a few days. Full recovery of hearing can be spontaneous in the first two weeks after onset but typically, the longer it takes to recover the more severe the hearing loss will be (Fritsch et al., 2003). The cause is usually unknown but could be related to many factors such as ototoxic drugs, immunological diseases or infectious disorders (Fayad et al., 2003).

Another common cause of total unilateral hearing loss is an acoustic neuroma, a slow growing tumor on the VIII<sup>th</sup> cranial nerve (acoustic nerve) that leads from the inner ear to the brain.

---

### Consequences of total UHL

A market research report conducted by the Advisory Group for Single Sided Deafness, supported by Entific Medical Systems, showed that 39% of people with total unilateral hearing loss due to an acoustic neuroma found work more difficult and almost 25% of those questioned had been forced to stop working (Dimmelow et al., 2003). When it came to social interaction, the study found that the lack of "stereo" hearing made participation in single or group conversations very difficult. Furthermore, people with total unilateral hearing loss felt embarrassed and often felt "afraid of offending people by not hearing what was being said" (Dimmelow et al., 2003). They usually experienced a loss of

confidence, feelings of isolation, embarrassment and social exclusion (Dimmelow et al., 2003).

The study concluded that total unilateral hearing loss

- Impairs the ability to ascertain the direction of sound due to the head shadow effect.
- Impairs the ability to hear from the direction of the unaidable side.
- Impairs the ability to separate background noise from target sounds. Social conversations involving more than two people in a noisy environment can make group conversations very tiring and frustrating for the person with total UHL.

### Treatment solutions for total UHL

In some countries, total UHL is a recognized disability; however, there are limited solutions available. The most common solutions are hearing instruments, either bone anchored or air conduction, both trying to restore the sensation of hearing from the unaidable side by sending a signal to the hearing side via bone or air conduction (Dimmelow et al., 2003).

### Bone conduction hearing solutions

Bone conduction hearing solutions like the Baha®, an osseointegrated implant, are surgically implanted into the temporal bone of the unaidable ear and transmit sound waves received in the unaidable ear over to the better hearing cochlea directly via bone conduction (figure 1).

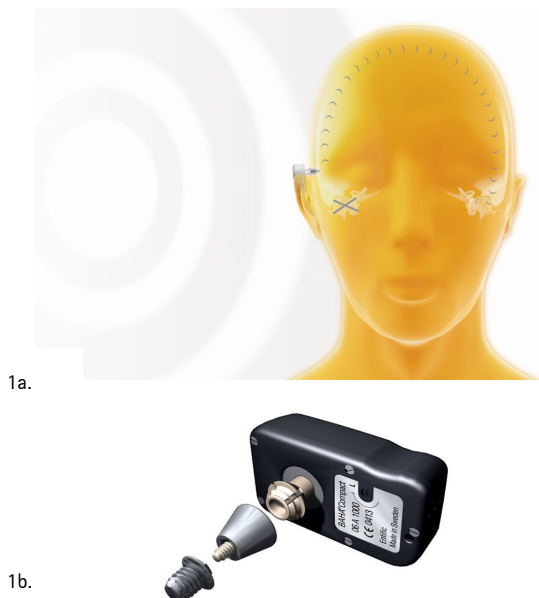


Figure 1a. The bone anchored implant is placed in the unaidable ear. The sound processor picks up sound waves and transmits them to the titanium implant. This then sends vibrations through the patient's skull to the hearing ear. ©Cochlear Bone Anchored Solutions

Figure 1b. Sections of the Bone Anchored Hearing aid showing the external sound processor, abutment and the titanium implant. ©Cochlear Bone Anchored Solutions

### Air conduction hearing aids

Air conduction hearing aids that contra-laterally transfer the signal from the unaidable ear to the hearing ear are commonly known as Contralateral Routing Of Signal (CROS) air conduction hearing aids. The CROS system is a non surgical solution available in a BTE or ITE style. A hearing instrument with only a transmitter (satellite) microphone placed on the unaidable ear sends the sound signals to a receiver microphone on the hearing ear (figure 2).

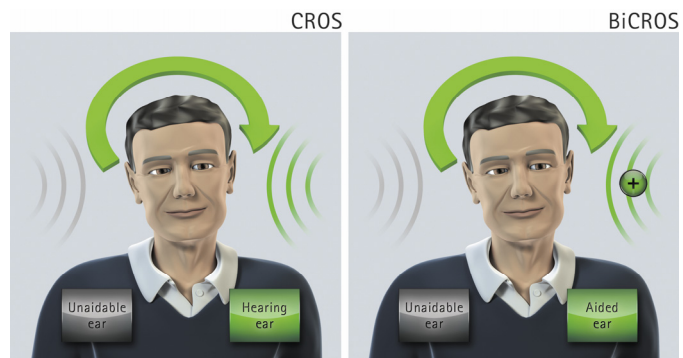


Figure 2. A CROS/BiCROS system. The microphone on the unaidable ear picks up sound waves and transmits them wired or wirelessly to the hearing ear (CROS system) or aided ear (BiCROS system).

The sound signal is typically transferred either by a wire connecting each device, or wirelessly by an amplitude or frequency modulated signal.

A necessary time delay associated with the transmission gives the user the necessary temporal cues to help determine from which side the sound originated (Hol et al, 2009). This provides improved awareness and understanding of speech and other sounds occurring on the unaidable ear.

If there is some degree of hearing loss on the good ear, a BiCROS (Bi-lateral Routing Of Signal) hearing system can be used. A BiCROS uses the same principle as a CROS system except that the better ear receives some amplification from a hearing instrument (Pumford, 2005).

Another option is the use of a "transcranial CROS" device. Placing a conventional high-gain/high-output air conduction ITE or BTE hearing aid in the unaidable ear assumes and takes advantage of the 0 dB inter-aural attenuation for bone conducted signals. By presenting an air conducted signal of high intensity to the cochlea of an impaired ear, the signal will be heard in the cochlea of the better ear since the intensity is enough to overcome inter-aural attenuation between the cochleas (Valente et al., 1995).

Now, for the first time ever, Phonak has created a CROS system that transmits the signals wirelessly, by full bandwidth digital wireless audio streaming (Figure 3).

Wired	AM	HiBAN
		
Audioshoe	CROSLink	Phonak CROS

Figure 3: Images and examples of the different ways a sound signal is transferred in a Contralateral Routing of Signal (CROS) system.

## Phonak CROS System

For many years, Hearing Care Professionals (HCP) have been asking for a better CROS/BiCROS solution based on digital wireless technology. Phonak CROS, developed with Phonak Spice Technology, the latest generation of wireless technology, is the new solution designed to meet the needs of CROS and BiCROS clients in both appearance and functionality.

The Phonak CROS System consists of

1. A transmitter microphone device in a very small housing on the unaidable side
2. A Phonak hearing aid with wireless Spice Technology acting as the receiver on the hearing side

Phonak CROS is compatible with all wireless Phonak Spice Generation hearing instruments in all form factors, styles and hearing performance levels. This supports the HCP in meeting the needs of CROS and BiCROS clients with a new level of options for the fitting of CROS/BiCROS instruments.

### Phonak Spice Generation wireless technology

Improving on the wireless technology of the CROSLink system, the Phonak CROS utilizes a digitally-coded, inductive transmission technology with a transmission frequency of 10.6 MHz. By creating a Hearing Instrument Body Area Network (HiBAN), Phonak CROS transmits the full audio bandwidth from the CROS transmitter to the hearing instrument.

### Enhanced esthetics

The Phonak CROS Transmitter is available as a BTE in the Audéo S SMART BTE housing or as a custom product in a half shell or full shell option.

### Phonak CROS BTE

The BTE CROS transmitter comes with a choice of retention options to hold it securely in place. Clients who desire a more cosmetically acceptable solution can be fit with a Phonak CROS Tip, the new SlimTip specially designed for Phonak CROS (Figure 4a). A hollow shell open at both ends, the CROS Tip is made from a hard acrylic material to comfortably fit the individual contour of the ear.

A more universal solution is the innovative Phonak CROS Retention. Made from a soft, comfortable and hypoallergenic material, Pebax®, it keeps the unaidable ear completely open. It is attached to the transmitter and fits at the top of the pinna for a secure and stable fit. This solution is more appealing than the traditional solution of tubes and earmold (Figure 4b).



Figure 4a. The Phonak CROS System with the Phonak CROS Tip.  
Figure 4b. The Phonak CROS System with the CROS Retention.

### Phonak CROS 312

Phonak CROS 312 is a custom made ITE with a 312 battery. Available in an ITC, half shell (Figure 5a) or full shell option (Figure 5b), the CROS transmitter microphone has a very open vent to increase the comfort and reduce the occlusion.



5a.  
5b.  
Figure 5. The Phonak CROS 312 Half Shell (a) and Full Shell (b)

### Control and performance

The Phonak CROS System includes a host of features designed to improve the listening experience of CROS clients such as:

#### SoundFlow

An acoustic environment is made up of many different sound situations that vary constantly. SoundFlow, the multi-base automatic feature of the Phonak CROS System, seamlessly adapts and integrates the right set of parameters to ensure optimal listening for every sound environment. The streamed signal from the CROS transmitter and the signal from the hearing instrument on the better ear undergo the same SoundFlow signal processing. So depending on what environment the client is in, both signals are simultaneously optimized to the changing environment in real time.

Phonak CROS System offers, for the first time, full access to automatic functionality. For specific situations the HCP can create a customized manual program to suit the listening needs of each client, e.g. a music program. More information about SoundFlow can be found on the Phonak website, [www.phonak.com/com/b2b/en/elearning/publications/phonak\\_insight.html](http://www.phonak.com/com/b2b/en/elearning/publications/phonak_insight.html)

### Real Ear Sound

Precise localization of sounds is needed to feel comfortable and secure in all acoustic environments. This is achieved with the help of the natural directivity of the pinna. It provides important monaural spectral information, in particular in the high frequencies, which is necessary to avoid front-back confusions. The location of the microphone in a BTE instrument degrades pinna cues and worsens localization. Real Ear Sound, a monaural directivity algorithm, simulates the pinna by utilizing advanced signal processing schemes restoring the front to back localization.

The Phonak CROS instrument is equipped with Real Ear Sound to improve the localization capability of the client as well as improve speech when in noisy situations. More information about Real Ear Sound can be found on the Phonak website [www.phonak.com/com/b2b/en/elearning/publications/phonak\\_insight.html](http://www.phonak.com/com/b2b/en/elearning/publications/phonak_insight.html)

### QuickSync

Control of the hearing instruments is important for CROS clients. With one touch of the button on either the CROS transmitter or hearing instrument, QuickSync instantaneously changes the volume or program settings on the Phonak CROS device and on the hearing instrument. So, clients can now control their Phonak CROS System with one button. An additional control option for Phonak CROS is provided by myPilot or Phonak PilotOne remote controls.

---

## BiCROS system

Phonak CROS System also functions as a BiCROS system for those who present with unaidable hearing on one ear and a hearing loss in their better ear. Consisting of just 2 parts, a BiCROS fitting will ensure that clients also receive amplification of signals on the better hearing ear with a Spice hearing instrument.

With their hearing instrument, BiCROS clients have access to the Spice platform features such as automatic SoundFlow, UltraZoom, WhistleBlock, NoiseBlock, SoundRecover and manual programs.

BiCROS clients can also use Phonak AccessLine accessories with their hearing instruments, including Phonak PilotOne, myPilot, iCom, and Dynamic FM.

A choice of acoustic options, from domes to a traditional earhook, earmold and standard tubing, are available to attach onto the receiver microphone hearing instrument. With a full choice of possibilities, both the HCP and the client can enjoy the wide range of options with full flexibility to meet all fitting needs.

---

## Easy to fit

Phonak CROS System is easy to fit using Phonak Target™ (1.1 onwards).

When connecting Phonak CROS and a Spice Generation hearing instrument for the first time, the HCP can select between a CROS or BiCROS fitting. For a CROS fitting, Phonak Target™ applies optimal pre-calculation settings ideal for the client. A BiCROS fitting will also apply the appropriate pre-calculations and features based on the client's hearing loss. It is important that an audiogram is entered for the better ear even if the hearing is normal. This is to ensure that Phonak Target™ applies the right settings to the CROS or BiCROS fitting.

Other features available in Phonak Target™ for a Phonak CROS fitting are:

### CROS/ BiCROS Settings

The CROS/BiCROS Settings screen allows the HCP to change Phonak CROS from a CROS fitting to a BiCROS fitting when the hearing in the better ear begins to decline. To ensure that the loudness of the amplified signal as well as the streamed signal are balanced in a BiCROS fitting, the microphone adjustment tool, a specially designed tool for Phonak CROS, can be used to adjust and maintain an equal loudness between instruments.

### Signal alerts

It is important for CROS clients to have a robust and reliable connection between the CROS transmitter and the hearing instrument. Phonak CROS System is the first CROS instrument to have clear and distinct connection alerts that are activated in the unlikely event that the wireless connection has been lost, and when it has been re-established. The Phonak CROS also has battery status alerts for the CROS transmitter and hearing instrument, providing further security.

### CableFree Fitting

Programming Phonak CROS with the iCube fitting interface is a fast and reliable cable-free process. Phonak CROS can also be programmed using NOAHlink and HI-PRO fitting interfaces that are supported by Phonak Target™.

## Summary

Specially designed for people with total UHL and better hearing on the other side, the Phonak CROS System uses the latest Phonak Spice Generation chipset technology to wirelessly stream the full bandwidth audio signal from the CROS transmitter microphone on the unaidable side to any wireless Spice Generation hearing instrument. With only two parts, a CROS transmitter and a hearing instrument, this makes Phonak CROS System the smallest and most technologically advanced CROS/BiCROS solution in the industry.

The Phonak CROS System offers clients full flexibility and compatibility with the complete range of Spice Generation hearing instrument types, models and styles to meet all client's needs and wishes. The modern look and feel of the Audéo S SMART housing or the small custom device improves

the cosmetic appeal of CROS. The new CROS Retention or the CROS SlimTip for BTEs ensures that Phonak CROS is secure on the ear while remaining minimally visible, comfortable and completely open.

BiCROS clients also benefit from the Phonak CROS System with a functioning wireless hearing instrument on the better ear. Features such as UltraZoom, SoundRecover and SoundFlow automatic enable clients to enjoy better hearing from both sides.

Phonak CROS can accommodate the widest range of hearing demands, from normal hearing (CROS) to any degree of hearing loss in the better ear (BiCROS). Clients now have ultimate CROS/BiCROS solution thanks to the Spice Generation.

## Available CROS/BiCROS systems

	Phonak Ambra, Phonak Solana, Phonak Cassia								Audéo S III, V, IX		
	BTE				custom products				CRT		
	Petite	microM	microP	SP	10 Petite 312 Petite 312 UZ Petite	312	312 UZ	13	SMART	YES	MINI
Phonak CROS (BTE)									1		
Phonak CROS 312 (ITE)						2					

1 Recommended CROS solution for BTE: Audéo S SMART III

2 Recommended CROS solution for custom products: Phonak Cassia

## References

- Baguley et al. 2006. The evidence base for the application of contralateral bone anchored hearing aids in acquired unilateral sensorineural hearing loss in adults. *Clin. Otolaryngol.* 31, 6–14
- Dimmelow et al. (2003). *Hear the Other Side – A Report by the Advisory Group for Single Sided Deafness.* www.entific.com
- Fayad et al. 2003. Etiologies and Treatment Options for Sudden Sensorineural Hearing Loss. *Hearing Review.*
- Fritsch et al. 2003. Sudden Hearing Loss: A Team Approach to Assessment, Treatment, and Rehabilitation. *Hearing Review.*
- Hol et al. 2009. Pilot study on the effectiveness of the conventional CROS, the transcranial CROS and the Baha transcranial CROS in adults with unilateral inner ear deafness. *Eur Arch Otorhinolaryngol.* 2010 Jun;267(6):889–96.
- Marriage et al. 2007. The effectiveness of the Real Ear Sound (RES) hearing aid algorithm for front/back localisation by hearing impaired children. [http://www.phonak.com/content/dam/phonak/b2b/C\\_M\\_tools/Library/Pediatric/Features/en](http://www.phonak.com/content/dam/phonak/b2b/C_M_tools/Library/Pediatric/Features/en)
- Pumford, J. October 2005. Using probe-mic measures with CROS/BiCROS fittings. *The Hearing Journal.* 10 (58) 10
- Sammeth C, and Cire G. 2009. Effectiveness in Treating Single-Sided Deafness with the Baha System. *Hearing Review.*16(4):34–41.
- Sinopoli, T. 2003. Single Sided Deafness: Issues and Alternatives. Viewed August 16 2010, www.Audiologyonline.com,.
- Valente et al. 1995. Wireless CROS versus transcranial CROS for UHL. *AJA* 4:52–59.
- Vestibular Schwannoma (Acoustic Neuroma) and Neurofibromatosis. February. 2004. National Institute on Deafness and Other Communication Disorders. Viewed October 07 2010 <http://www.nidcd.nih.gov/>