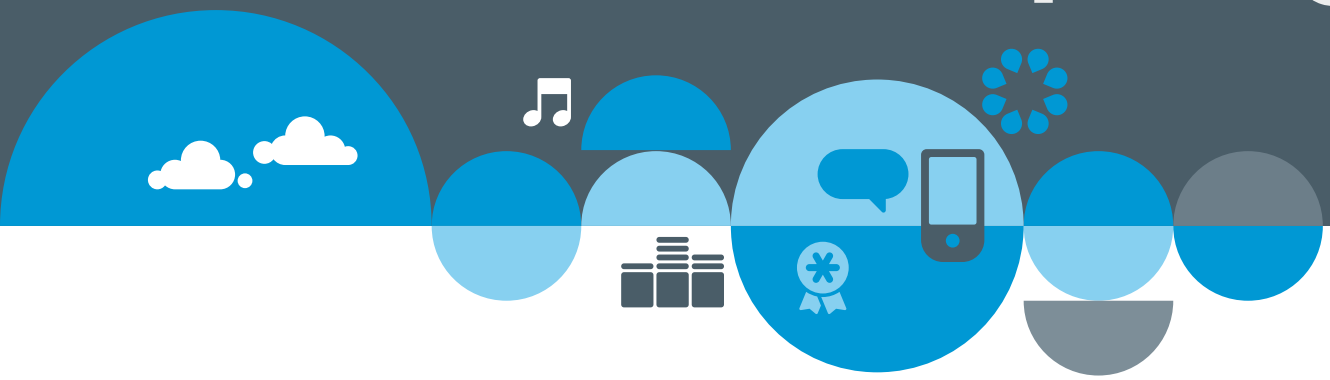
Sonic Spotlight



Binaural Coordination: Making the Connection

Binaural Coordination is the global term that refers to the management of wireless technology in the latest hearing instruments from Sonic. With Binaural Coordination, independent functionalities merge to create a single, unified, and natural listening experience for individuals with hearing loss. Always at work, Binaural Coordination is in command of many features, including Environment Classification, Non-Telephone Ear Control and Binaural Synchronization. This paper describes the benefits of using Binaural Coordination and explains the basic concepts behind its design.

Binaural Coordination

Binaural Coordination is the technology that makes wireless communication between binaurally fitted hearing instruments possible. In the past, right and left hearing instruments worked independently from each other. At times, this lead to dissatisfaction in complex listening situations, or frustration when program or volume control changes had to be made manually on separate sides (Kochkin, 1992). Binaural Coordination provides a link between two hearing instruments, creating a unified system and providing a seamless and balanced acoustic listening environment. Just as important, it ensures simplicity of use for patients managing bilateral hearing loss. Environment Classification, Non-Telephone Ear Control and Binaural Synchronization are the three main features wirelessly united to deliver one natural auditory experience for demanding and dynamic listening situations.

The dynamic environment

Imagine the varied listening environments that a person may go through on a typical day: a quiet one-on-one conversation in the morning; a loud lunchtime discussion in a noisy restaurant; a phone conversation outside on a busy street; a child's musical performance in a school auditorium. Dynamic listening environments like these construct the very spectrum of human communication and interaction that people experience over the course of their everyday lives.

For people with normal hearing, the healthy cochlea naturally processes dynamic listening environments with ease. According to Canlon (2010), the basilar membrane selectively controls variations in amplitude, by amplifying low-level and compressing high-level sounds, while the tonotopic arrangement of inner and outer hair cells maintains the sharp frequency contrast of speech. At the same time, psychoacoustic properties of time and level differences between ears help determine spatial separation and location of sound sources. Altogether, these biological processes constitute our natural perception of audition.

Now consider how dynamic environments affect individuals with hearing loss, with respect to loudness, speech discrimination, background noise, and localization of sounds. Without a hearing instrument, these individuals are at a disadvantage. If they do have hearing instruments, they may be additionally limited by the processing capabilities of their devices, or feel burdened by having to make manual adjustments to their instruments themselves as Kates (1995) identified. Perhaps they forget to press a button to activate their noise program, or cannot face the speaker due to the room set-up. Maybe the wind outdoors, reverberation in a large hall, or large distance from the speaker is detrimental to the directionality setting chosen to hear better in noise. The scenarios are endless, as are the results that may occur. Fortunately, the Environment Classification algorithm from Sonic analyzes all acoustic signals to provide the best adaptive response for the situation.

What is Environment Classification?
Environment Classification is a method of acoustic signal analysis that attempts to recognize a complex set of patterns typically encountered in auditory environments (Kates, 1995). With an extremely fast speed of just 300 milliseconds, the Sonic Environment Classification algorithm can do just that - detect, measure and classify various temporal and spectral characteristics from a signal, as shown in Figure 1. For example, detection of a signal's modulation rate determines if speech is present or absent; estimation of the signal-to-noise ratio (SNR) establishes how much noise exists; variations in sound pressure level arriving at each microphone verify interaural time and level differences; and periodicity identifies the harmonics found in speech, music, or other signals like wind.

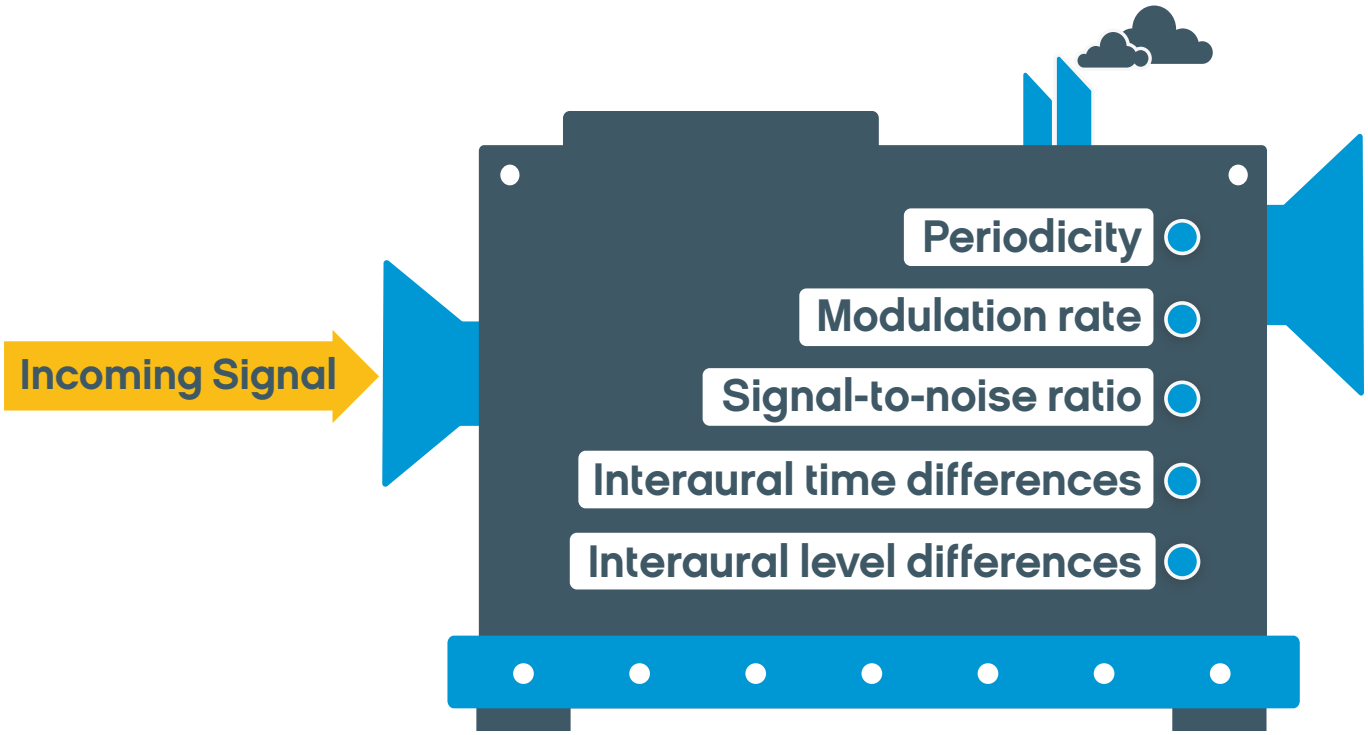


Figure 1:
Features extracted from a signal that contribute to the environmental classification of an auditory scene

Once analysis of the temporal and spectral information is complete, the Environment Classification algorithm organizes the auditory scene into one of five possible listening categories: Speech in Noise, Speech in Quiet, Noise Only, Quiet Only and Wind, as shown in Figure 2.

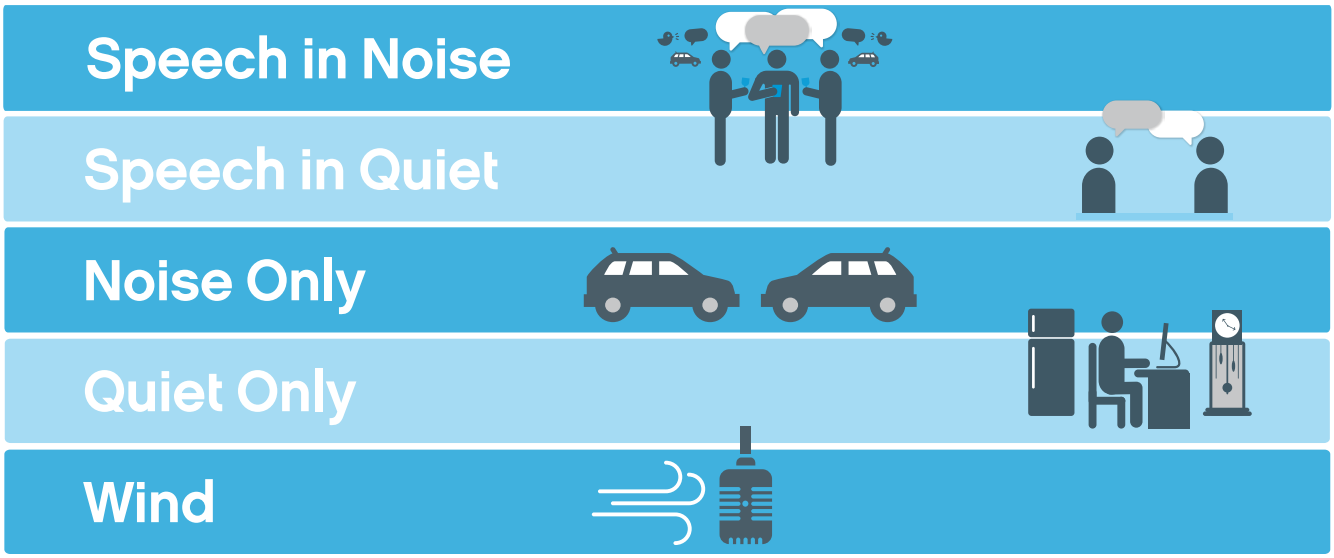


Figure 2:
Environment Classification categories

Next, Binaural Coordination takes place. Through it, prioritization and synchronization of environmentally classified categories occur between hearing instruments. If both hearing instruments detect different environments, then the highest priority environment dominates, and both hearing instruments synchronize their behavior to the dominant environment. The Universal Environment features Speech in Noise as the highest prioritized category, giving an extra 'hands-free' advantage for speech when noise is present. For example, if the system detects Speech in Noise in the right instrument and Speech in Quiet in the left instrument, both devices will be optimized for Speech in Noise. The following chart summarizes the prioritization order for the Universal Environment listening program. Excluded is the Wind category, which manages wind noise monaurally.

Listening program	Binaural prioritization of settings*
Universal Environment	Speech in Noise
	Speech in Quiet
	Noise Only
	Quiet Only

*Hearing instrument dependent

Environment Classification categories
Finally, each of the five categories optimizes certain parameters to maximize audibility or comfort. Specifically, directionality, noise reduction and gain settings undergo optimization, depending on the classified environment detected:

- Adaptive Directionality and Hybrid Adaptive Directionality fade between the most advantageous polar plots necessary for the situation
- Speech Priority Noise Reduction attenuates background noise, only as much as needed, to restore listening comfort
- Gain settings adapt in various ways, as shown in Table 1

Category	Optimized gain settings*
Speech in Noise	Compression of speech-related input is decreased to maximize phonemic cues in noise
Speech in Quiet	Amplification of speech-related input is increased to accentuate conversation with less listening effort
Noise Only	Amplification of loud inputs is reduced for greater comfort in noise when speech is not present
Quiet Only	Amplification of soft inputs is reduced for a transparent sound in quiet
Wind	Low-frequency amplification is reduced only for the affected side; the opposite side remains unaffected

*Hearing instrument and program dependent

Table 1: Optimized hearing response settings for each Environment Classification category

Environment Classification and Binaural Coordination at work

Applying this multi-faceted technology to hearing instrumentation requires great processing power and wireless capabilities such that a sophisticated algorithm can rapidly extract and share all relevant features from the incoming signal for analysis. The Sonic digital signal processer provides the computational power needed to offer a robust, fast acting, and accurate Environment Classification system. Furthermore, the wireless technology of Binaural Coordination fuses the acoustic scene into a stable auditory picture. Wireless information is exchanged at a net rate of 120,000 bits per second, which allows extremely rapid binaural detection and synchronization of environmentally classified settings between ears. Constantly working behind the scenes, Environment Classification is responsible for managing an array of dynamic listening situations and selecting the appropriate response accordingly. It swiftly analyzes many signal features before organizing the auditory scene into one of five specialized categories. Binaural Coordination wirelessly prioritizes and links the categories. Each category undergoes optimization of adaptive settings (gain, directionality, and noise reduction). Finally, instantaneous adjustments ensure a smooth, synchronized hearing response at all times.

The result? A full 360° binaural optimization of the auditory environment.

The benefit? A hands-free, unified auditory experience for the listener in dynamic environments.

Non-Telephone Ear Control

Listening on the telephone often presents special challenges for hearing instrument wearers, especially in noisy environments (Kochkin, 2005). Sonic believes that telephone use should not be an obstacle. Rather, picking up the phone should be as simple and as effortless as possible. The Auto Telephone Program not only provides that benefit, but also goes one step further, and offers an extra advantage with its binaurally coordinated Non-Telephone Ear Control, which can reduce gain or mute microphones in the opposite ear.

How Non-Telephone Ear Control works

When Auto Telephone is active, the user simply places a phone with an adequate magnetic field next to the hearing instrument. A magnetic switch inside the instrument immediately engages the Auto Telephone Program for the listening ear. With Binaural Coordination active, a contralateral response occurs simultaneously in the opposite ear. This response, known as Non-Telephone Ear Control, can be configured in the following three ways:

Configuration	Non-telephone ear behavior
O dB	No change occurs to the non-telephone ear during phone use
-6 dB	Amplification of the non-telephone ear is attenuated by 6 dB
Mute	Amplification of the non-telephone ear is silenced completely

Suggestions for use

Use the following guidelines to understand how to apply Non-Telephone Ear Control based on individual patient needs. It is important to counsel your patient on which option has been implemented for use.

Control option	Best setting for:
O dB	Patients who are not distracted by background noise during phone use
-6 dB	Patients who are slightly bothered by background noise during phone use, but still want to retain some auditory awareness of the environment while on the phone
Mute	Patients who are disturbed by environmental noises while using the phone

Versatility at its finest

The Auto Telephone Program with Non-Telephone Ear Control remains the most flexible way to hear on the phone. Thanks to Binaural Coordination, the feature is not side-dependent, meaning the listener can use the phone on either ear and have the desired changes occur on the opposite side, even during the same call. Hearing instrument wearers who frequently need to switch listening ears on the telephone appreciate this versatile advantage.

The result? A fully customized, automatic telephone setting for either ear.

The benefit? Simple and effortless telephone use with the advantage of easier telephone listening in noise.

Binaural Synchronization

Wireless hearing systems from Sonic allow two instruments to act as one when it comes to management of local controls. Binaural Synchronization is the wireless feature that coordinates manual changes on the following user-operated controls:

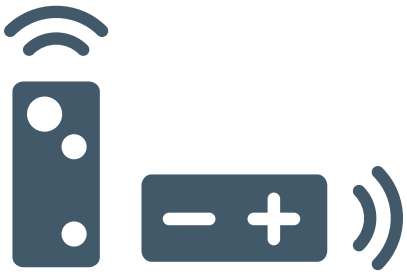
- Program Button
- Volume Control
- Push Button Mute

Using a carrier frequency of 3.84 MHz, Binaural Synchronization wirelessly transmits the action made on one instrument simultaneously to the other. Below is a summary of the configurable local controls and their corresponding actions:

Local control	Binaurally synchronized behavior
Program Button	A short press of the Program Button made on one instrument results in the same program change for both instruments
Volume Control	An increase or decrease of the Volume Control made on one instrument results in an equal volume change in the other instrument
Push Button Mute	A long press of the Program Button on one instrument simultaneously mutes both instruments

Binaural Synchronization with remote devices

Binaural Synchronization also ensures that remote control actions made by the SoundGate or RC-P Remote Control occur in both hearing instruments. These synchronized actions include volume changes, program changes and program muting.



Simplicity and accuracy of use

Hearing instrument wearers don't need to hassle with adjusting both instruments when they desire a program or volume change. Binaural Synchronization assures that program or volume changes can be made on either side. This is especially helpful when dexterity issues are present. Furthermore, using Binaural Synchronization guarantees accuracy between listening programs:

- Listening environments always match from side to side
- Volume levels evenly raise and lower from side to side

Making a change for both instruments is done more conveniently, accurately, and in half the time.

The result? Changes made using local controls on one device are simultaneously made on the other.

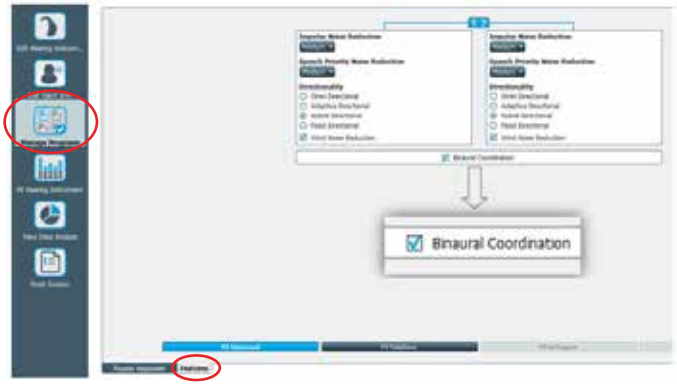
The benefit? Streamlined and accurate operation of local controls for the patient managing bilateral hearing loss.

Easy adjustments with EXPRESS*fit*

In keeping with the Sonic commitment to simplicity, the EXPRESS*fit* fitting software makes the selection of Binaural Coordination for Environment Classification, Non-Telephone Ear Control for Auto Telephone, and Binaural Synchronization of controls simple and straight-forward.

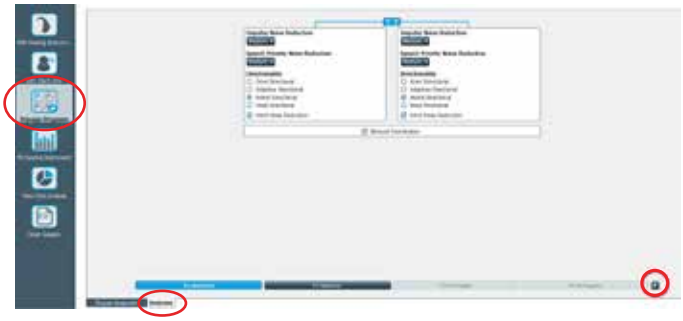
Binaural Coordination

Ease of use for the hearing care professional could not get any simpler. Binaural Coordination is activated by default in the Features tab in the Manage Programs screen. Please note that this feature is both hearing instrument and program dependent.



Non-Telephone Ear Control

Locate the Auto Telephone by accessing the additional programs under the Features tab in the Manage Programs screen. Simply check the Auto Telephone box to activate the program. Once activated, select one of three Non-Telephone Ear Control options, 0 dB, - 6 dB, or Mute, based on your patient's needs.



Binaural Synchronization

Select Synchronize Volume, Synchronize Programs, or Synchronize Mute on the Finish Session screen. Choose any or all three binaurally synchronized functions to streamline user management of local and/or remote control actions.

Making the Connection

Sonic believes that wearing hearing instruments shouldn't wear you out. With Binaural Coordination:

- Dynamic listening environments are stabilized with Environment Classification

- Telephone use becomes effortless with
- Non-Telephone Ear Control

- Manual volume and program changes are minimized with Binaural Synchronization

Binaural Coordination provides the wireless connectivity between instruments that promotes a natural, organic listening experience for individuals with hearing loss. Go ahead and make the connection.

For a demonstration or to learn more, please contact your local Sonic provider.

References

[1] Kochkin, S. (1992). MarkeTrak III identifies key factors in determining consumer satisfaction. Hearing Journal 45, 39-44.

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[3] Kates, J. M. (1995). Classification of background noises for hearing aid applications. Journal of the Acoustical Society of America, 97, no. 1, 461–470.

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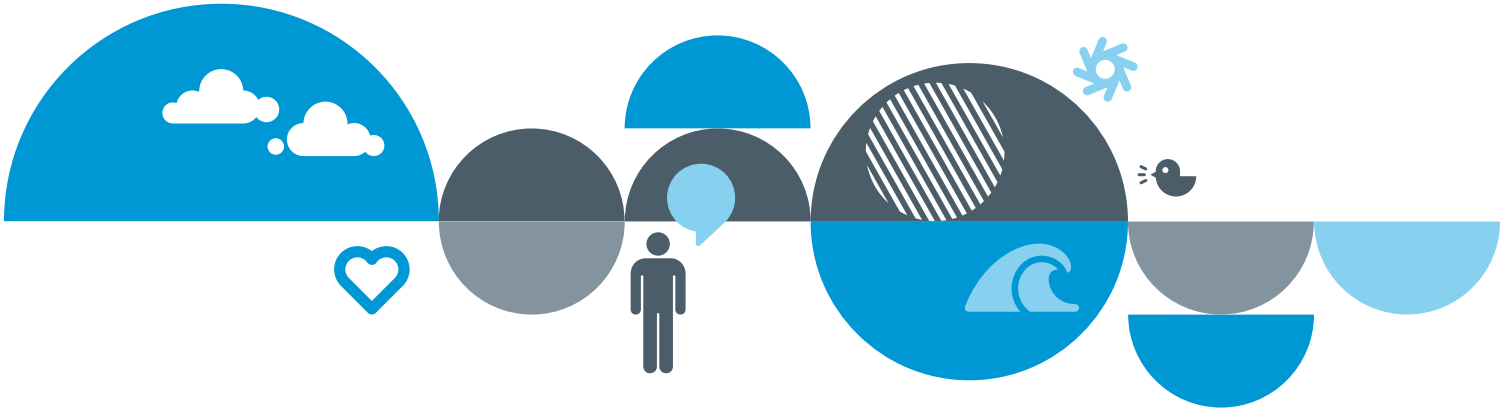

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