



Australian Government
Department of Health and Aged Care



A Guide to Understanding Hearing Aid Technology

Prepared by the National Acoustic Laboratories for the
Australian Government – Department of Health and Aged Care

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Acknowledgement of Country

NAL acknowledges the Aboriginal and Torres Strait Islander peoples – the traditional custodians of the lands across Australia on which we work, live and learn. We pay our respects to ancestors and Elders past and present.


NAL is committed to honouring Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to the land, waters and seas and their rich contribution to society.

We are committed to a future in which Aboriginal and Torres Strait Islander people take up their rightful opportunities; grow strong in their identity, culture and language; and in which ear and hearing problems do not alter the trajectory of Aboriginal and Torres Strait Islander peoples' lives.

Features Families and Features in detail



Speech Understanding

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|--|
| Directional Microphones  <p>Part of a hearing aid that picks up sound from a given direction, often from in front of you. The microphone can amplify the voices and sounds you want to hear and not amplify the noise.</p> | Automatic directional microphones automatically switch between hearing aid microphone directionality modes depending on the surrounding noise level. For example, switching from picking up sounds from all directions (omnidirectional setting) to picking up sound mostly from a specific direction (directional setting) based on background noise level. This is typically used to focus on sounds from in front of the wearer to reduce the amount of background noise. Adaptive directional microphones can automatically change or steer the microphone sensitivity in different directions to adapt to changes in direction of speech or interfering noise. For example, it can change from picking up sounds from all directions (omnidirectional) to picking up sound mostly from a specific direction (directional). This feature not only switches between microphone directionality mode (i.e. omnidirectional and directional settings), but also adjusts the hearing aid setting based on the sound field (e.g. may adjust or steer microphone based on background noise level, speech detection, location of talkers/noises, etc). | <ul style="list-style-type: none">• Speech understanding• Reduce listening effort <ul style="list-style-type: none">• Speech understanding• Reduce listening effort |

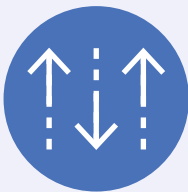
Speech Understanding



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| | Binaural directionality – Super directional microphone or Binaural beamformer uses a powerful combined directional pattern from left and right hearing aid microphones to narrowly focus on sounds in front of the wearer such as speech. | <ul style="list-style-type: none"> • Speech understanding • Reduce listening effort |
| | Binaural directionality – Better-ear-effect is a type of Binaural Directionality that emphasizes sounds on the better ear when there is more noise detected in one ear compared to the other. | <ul style="list-style-type: none"> • Speech understanding • Reduce listening effort |
| Remote Wireless Microphones | FM systems use frequency modulation ('FM') and radio waves to transmit audio signals directly to hearing aids from an external microphone or audio source. An FM system helps people hear better in noisy listening situations or when the talker is at a distance. | <ul style="list-style-type: none"> • Speech understanding • Audibility • Reduce listening effort |
|  <p>Separate devices that pick up and send sound directly to your hearing device using radio waves. Enhances volume, clarity and quality of speech, especially in the presence of background noise or speech coming from a distance.</p> | Table and remote microphones are microphones that use wireless technologies such as Bluetooth to transmit sound directly to hearing aids in group settings such as meetings or in noisy environments. These microphones can help the hearing aid wearer focus on the person speaking for improved speech understanding by transmitting the signal directly to the hearing aid. | <ul style="list-style-type: none"> • Speech understanding • Audibility • Reduce listening effort |


Speech Understanding



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| Gain and Compression  <p>Automatically make quiet sounds louder and loud sounds quieter. Makes it easier to hear speech and other sounds while maintaining comfortable listening levels.</p> | Bands or Channels generally refer to the number of independently operating frequency bands the hearing aid has. These are distinct from the frequency bands that can be adjusted by the audiologist to meet the fitting target/prescription of the wearer. | <ul style="list-style-type: none"> • Speech understanding • Comfort • Audibility |
| | Wide Dynamic Range Compression is a feature used to make soft sounds louder and prevent loud sounds from being uncomfortably loud. In effect, this expands the range of sounds that are audible and ultimately helps the wearer hear softer sounds such as soft speech that they would otherwise not hear. | <ul style="list-style-type: none"> • Speech understanding • Comfort • Audibility |





Sound Quality

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|--|
| High Fidelity Sound  <p>A feature which enables hearing aids to detect sounds at very high or low frequencies, or very loud or soft levels, or tailors the sound quality to provide increased or enhanced enjoyment of music.</p> | Music Program is a specific hearing aid program which is intended to enhance enjoyment of music. | <ul style="list-style-type: none"> • Speech understanding • Reduce listening effort |
| | Extended frequency range refers to the capability of a hearing aid to reproduce a wider frequency range than is usual for standard hearing aid performance. The extended range can be at low frequencies, high frequencies, or both. This is intended to provide enhanced enjoyment of music and may also improve speech perception and localisation cues. | <ul style="list-style-type: none"> • Speech understanding • Reduce listening effort |
| | Extended dynamic range refers to a hearing aid technology capable of processing sound with a wide range between the softest and loudest input/output. This can prevent distortion from loud sounds, as well as provide more natural reproduction of music. | <ul style="list-style-type: none"> • Sound quality • Speech understanding • Audibility |


Sound Quality



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| Frequency Shaping  <p>Enhances the sound quality of a hearing aid by making sure it is as close to natural hearing as possible.</p> | <p>Spatial Cue preservation aims to preserve or simulate the acoustic characteristics of the person's head and outer ear which help to determine where a sound is coming from.</p> <p>This is done using either digital signal processing techniques or an additional microphone situated in the ear canal. These acoustic characteristics are often lost or distorted by the microphone placement in conventional hearing aids.</p> | <ul style="list-style-type: none"> • Sound quality • Localisation |
| | <p>Streamed audio equalisation improves sound quality by adjusting gain levels at specific frequencies. For example, compensating for bass leakage in open fittings and compensating for acoustic masking in noisy environments.</p> | <ul style="list-style-type: none"> • Sound quality • Audibility |
| Frequency Lowering  <p>Technology that changes the pitch of certain sounds so that you can hear them more easily.</p> | <p>Frequency Lowering is a hearing aid technology that will shift, or lower, frequencies that are too high for the wearer to hear and shift them at a frequency range That is audible. This is done through a combination of methods, such as frequency compression, frequency composition, frequency transposition, and frequency translation.</p> | <ul style="list-style-type: none"> • Speech understanding • Audibility |


Sound Quality



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| Sound Delivery  <p>Physical parts that allow the sound to be delivered to your ear via the hearing device. These can include the physical tubes, domes and earhooks that are components of the hearing device.</p> | <p>Coupling refers specifically to the earpiece of the hearing aid. This may take the form of a custom moulded earpiece, or a standard earpiece provided by the manufacturer. The primary purpose of the coupling is to help secure the aid to the ear in a way that is comfortable, manageable, and acoustically appropriate for the wearer. A variety of acoustic coupling options exist depending on the type of aid and manufacturer; this includes different styles of tubing, moulds, domes, sleeves, ear hooks, and receivers. Custom (In The Ear) hearing aids utilise a moulded shell that serves as both the body of the aid and the coupling.</p> <hr/> <p>CROS/BiCROS capability refers to hearing aids that are specifically designed for unilateral deafness, or hearing loss in one ear. In both a CROS and BiCROS system a device is worn on the poorer ear which transmits sound to a device worn on the better ear. This allows the better ear to access sounds arriving at both sides of the head. A CROS system is used when the better ear does not have a significant hearing loss and does not need aiding, while a BiCROS system provides amplification to both ears (i.e. when the better ear is determined to have an aidable hearing loss.</p> | <ul style="list-style-type: none"> • Sound quality • Comfort • Audibility <hr/> <ul style="list-style-type: none"> • Speech understanding • Audibility |



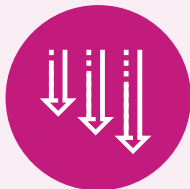
Comfort

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|--|---|
| Noise Reduction  <p>Features that reduce noise to improve listening comfort and make it easier to hear the sounds you want to hear.</p> | Adaptive noise reduction attempts to reduce bothersome background sounds while preserving speech understanding. These technologies differentiate which parts of a sound is primarily speech and which is primarily noise, and this information is used to enhance the speech signal above the noise. | <ul style="list-style-type: none"> • Comfort • Speech understanding • Reduce listening effort |
| | Low-level expansion or soft noise reduction reduces quiet noises that the wearer may find annoying (such as environmental noise or microphone noise) while preserving the amplification of the sounds they do want to hear. | <ul style="list-style-type: none"> • Comfort |
| | Reverberation reduction uses signal processing methods to detect and lower the level of echoes in large rooms and halls. Reverberation reduction may improve speech understanding and reduce listening effort. | <ul style="list-style-type: none"> • Comfort • Speech understanding • Reduce listening effort |
| | Feedback prevention technology addresses high-frequency whistling (feedback), which occurs when the sounds hearing aids generate in the ear canal leaks out of the ear canal back to the microphone. Feedback cancelling systems minimise the problem of feedback by detecting the problem sounds and subtracting them from the microphone input. | <ul style="list-style-type: none"> • Comfort |

Comfort




| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|--|--|
| | <p>Transient noise reduction reduces the discomfort of loud temporary noises while preserving speech signals. As sound is processed by the hearing aid, any sudden loud noises are reduced, making them more comfortable to the wearer</p> | <ul style="list-style-type: none"> • Comfort |
| | <p>Wind reduction features address wind noise, which can be loud and irritating to a hearing aid wearer. Wind reduction features use signal processing methods to reduce the loudness of wind noise to the wearer and improves comfort.</p> | <ul style="list-style-type: none"> • Comfort |
| <p>Tinnitus therapy</p> | <p>Tinnitus management features actively help reduce the wearer's perception of tinnitus, such as by presenting sounds that cover up ('mask') the tinnitus or by not amplifying sounds that are similar to a wearer's tinnitus.</p> | <ul style="list-style-type: none"> • Comfort |
| <p>Features that mask or reduce the sound of tinnitus or help manage the effects of tinnitus, such as anxiety or stress. These include relaxation exercises, meditation, and helpful tips.</p> | <p>Tinnitus resources are tools and information that help the wearer understand their tinnitus and to help them manage the impacts of tinnitus, including effects on their wellbeing.</p> | <ul style="list-style-type: none"> • Comfort |




Comfort



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|--|--|
| Wearing comfort  <p>Features that improve listening comfort for people using hearing aids for the first time, or for a person's own voice. Helping you to wear your hearing aids more often and for longer periods.</p> | Acclimatisation management helps the wearer get used to new hearing aids, which can take time, especially for people using hearing aids for the first time. This feature gradually increases amplification over a set period of time to allow the wearer to adjust to the new amplified sound slowly. It is intended to improve wearer acceptance and results in more consistent hearing aid use. | <ul style="list-style-type: none"> • Comfort |
| | Processing of Wearer's Voice addresses the fact that many hearing aid wearers find the sound of their own voice amplified through hearing aids to be distracting and unnatural. These features detect the hearing aid wearer's speech and reduces amplification to maintain a comfortable and natural perception of their voice. | <ul style="list-style-type: none"> • Comfort |




Usability

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|---|
| Environmental adaptation  <p>Analyses the environment you are in and adjusts the hearing aid settings for you in real-time using sounds in your listening environment tracking your location, or other information.</p> | <p>Environmental classifiers enable hearing aids to group different environments into categories based on the types of sounds present in those environments. This allows specific features to be activated or deactivated as appropriate.</p> <hr/> <p>Automatic environment-based adjustments means that hearing aids can make automatic adjustments to settings such as wearer's volume control settings and program preferences when a certain sound environment (for example; a noisy environment vs. a quiet one) is detected by an environmental classifier. More advanced implementations of environmental adaptation use artificial intelligence technologies such as machine learning and deep neural networks. These features help improve speech understanding and listening comfort even when a wearer is moving through rapidly changing sound environments, and without the need to make frequent manual adjustments.</p> | <ul style="list-style-type: none">• Usability• Speech understanding• Comfort• Reduce listening effort <hr/> <ul style="list-style-type: none">• Usability• Speech understanding• Comfort• Reduce listening effort |


Usability



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| | <p>Advanced sensors (accelerometer, GPS, etc) can act as inputs to environmental classifiers. Environmental classification has been mostly achieved by the acoustic sensors in hearing aids, which measure acoustic characteristics of the incoming sound, such as amplitude (loudness) and modulation (pitch). Hearing aids also use other types of “advanced sensors”, such as motion or location sensors to provide further information to optimise the hearing settings for different listening environments or collect health information such as physical activity and location, social engagement, and provide insights into a wearer’s health and lifestyle.</p> | <ul style="list-style-type: none"> • Usability |
| <p>Ear-to-ear communication</p>  <p>Allows two hearing aids to work together as one system. Control settings such as volume, programs, can be coordinated or information can be shared to help select microphone modes or adjust other features to improve sound quality, comfort or ease of use.</p> | <p>Bilateral synchronisation is the ability of two hearing aids to synchronise by transmitting information wirelessly. This technology can enable both hearing aids to be controlled by adjusting one side only (e.g., changing volume or program selection). It can also be used to ensure that automated changes to device settings, such as changes due to acoustic scene classification, take place at the same time on both hearing aids.</p> | <ul style="list-style-type: none"> • Usability |

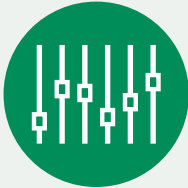
Usability



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|--|
| <div>Rechargeability</div> <div></div> <div>Charge your hearing aids like your mobile phone and avoid the need for small non-rechargeable button batteries.</div> | <p>Rechargeability refers to the use of battery technology such as lithium-ion instead of disposable zinc air batteries. Rechargeable hearing aids are designed to be small and easy to use. Some brands provide both an induction charger and a portable charging options that do not need to be plugged into a wall mains outlet. Other brands offer inductive chargers that also dry while charging or use UVC cleaning and drying technology. A full charge is typically designed to last for a full day of use.</p> | <ul style="list-style-type: none">• Usability |



Usability



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|--|--|
| Device control  <p>Allows you to activate your favourite settings and adjust the volume to suit different listening situations.</p> | <p>Smartphone app control gives the wearer control over their hearing aids via a smart phone application. Although volume control and program options have been available in hearing aids for many years, these smartphone ‘apps’ often allow the wearer to adjust other features and properties, such as frequency balance and noise reduction. These controls can be used real- time in challenging listening environments to immediately address issues with speech understanding and comfort. Apps can also function like assistive listening devices, byrouting phone calls or other sources of sounds directly to a wearer’s hearing aids. Additionally, hearing device manufacturers have also implemented a variety of additional applications including converting speech into text, language translation, monitoring of physical and social activity, and location-based trackers to find misplaced hearing aids. Some apps also allow the wearer to contact their hearing care provider, run diagnostic checks and monitor battery life.</p> | <ul style="list-style-type: none"> • Usability • Personalisation |
| | <p>On-device control (i.e., a physical control on the device) is typically used to adjust the volume or program setting. Some manufacturers expose similar functionality without the need for a physical button or switch, such as by tapping or double-tapping the hearing aid.</p> | <ul style="list-style-type: none"> • Usability |





Connectivity

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|--|
| Telecoil  <p>A small coil inside the hearing aid that picks up sound directly by induction from compatible telephones and rooms with hearing loops used in public places such as auditoriums and theatres. Telecoils use different wireless technology to Bluetooth because they pick up electromagnetic signals.</p> | Telecoil or t-coil is a wireless feature that receives and converts electromagnetic signals generated by compatible telephones and rooms with audio induction loops. Because the signal of interest is directed to the hearing aid's processor without using the microphone, a telecoil can improve the signal-to-noise ratio while eliminating the potential for feedback. Public performances, tours, exhibits and worship services are commonly made accessible to individuals with hearing loss via hearing loop and telecoil. | <ul style="list-style-type: none">• Connectivity• Speech understanding |
| Mobile phone and device connectivity  <p>Connect your hearing aids to other Bluetooth devices for phone calls, audio streaming and hearing aid control.</p> | Streaming technologies (e.g. Made for iPhone (MFI), Made for Android, and Bluetooth) allow the wearer to connect and stream audio and phone calls using their smartphone, television and other consumer devices. Wearers can pair their streaming-enabled hearing aids to consumer devices using standard Bluetooth. | <ul style="list-style-type: none">• Connectivity• Speech understanding• Sound quality |



Connectivity



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|--|--|
| Accessory connectivity  <p>Accessory connectivity describes links to other devices such as remote microphones for improved audibility in difficult listening environments, and other accessories that provide additional functionality beyond that of the hearing aid alone.</p> | Accessory connectivity provides wireless connectivity to accessories that can provide benefits such as improve audibility and provide additional functionality. For example, a remote microphone for improving audibility in noisy environments, a control accessory that allows a facilitator to adjust settings for multiple hearing aids simultaneously, or a TV streamer for streaming television audio directly to a hearing aid. | <ul style="list-style-type: none"> • Connectivity • Speech understanding |
| Phone assistive technology  <p>Improves the experience of using the telephone while wearing hearing aids by detecting that a telephone is being used and adjusting hearing aid settings automatically.</p> | Phone assistive technology detects when a phone is held up to the ear and activates a phone streaming program. There are two standard phone detection methods: inductive and acoustic. The inductive phone detection method requires a hearing aid with a telecoil and operates by detecting the magnetic field produced by a stationary phone handset or a small magnet located on a handset or mobile phone. The acoustic phone detection method uses the hearing aid microphones to detect the acoustic signature associated with a phone held in close proximity to the ear. In the case of both methods, when the hearing aid detects that a handset is in close proximity to the ear, the hearing aid switches to a special phone program, which may reduce the gain of the opposite ear and/or stream the phone conversation to both ears. | <ul style="list-style-type: none"> • Connectivity • Speech understanding |




Personalisation

| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|---|---|
| Manual adjustment  <p>Set up different programs on your devices that can help you to easily customise your listening experience in the moment.</p> | Custom programs allow wearers to change specific parameters or features of the hearing device other than basic controls such as volume or program change. This is typically done via a smartphone app but can also be achieved through other means; e.g., tapping or touching the devices. Examples include changing the direction of the microphone 'beam' (i.e., which direction they should be most sensitive to sounds), changing treble/middle/bass balance, and noise & wind reduction settings. | <ul style="list-style-type: none">• Personalisation |
| Smart personalisation  <p>Technologies that aim to learn what your preferences are based on how you use your hearing aids.</p> | Training/self-training involves the hearing aid learning from the wearer's input and applying algorithms and technologies such as artificial intelligence to learn their preferences over time. This can include tracking when and how they adjust volume settings, program choice, and other settings. Over time, the hearing aids can begin to make these changes automatically. | <ul style="list-style-type: none">• Personalisation• Usability |


Personalisation



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|---|
| Clinical tools  <p>Features and technologies that can help the clinician to fit and fine-tune your device efficiently and easily, and adjust your devices to suit your hearing loss, personal preferences and lifestyle needs.</p> | <p>Accessory connectivity provides wireless connectivity to accessories that can provide benefits such as improve audibility and provide additional functionality. For example, a remote microphone for improving audibility in noisy environments, a control accessory that allows a facilitator to adjust settings for multiple hearing aids simultaneously, or a TV streamer for streaming television audio directly to a hearing aid.</p> <hr/> <p>Wireless fitting allows the clinician to fit and fine-tune hearing aids while the wearer is wearing them and without having to connect them to a computer using wires. This provides for a more comfortable and efficient fitting process, and also makes it easier for the clinician and wearer to try out different settings and adjust to personal preferences.</p> | <ul style="list-style-type: none"> • Personalisation <hr/> <ul style="list-style-type: none"> • Personalisation |


Personalisation



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|--|--|
| Remote clinician adjustments  <p>Allows your audiologist or other hearing care provider to fit or fine-tune your hearing aids from the comfort of your home via your smartphone app, computer or tablet.</p> | Remote programming (sometimes referred to as App for Telehealth, Telecare, or Teleaudiology) is the ability of hearing devices to be paired with smart phone applications to allow for synchronous (i.e., real-time via video, audio, and/or text functions) and/or asynchronous (pre-programmed and provided through the app automatically) remote support. Using this feature, clinicians are able to conduct remote telehealth appointments or provide prompt feedback and advice to clients. These features enable clients to virtually consult with a clinician, have their hearing assessed and their devices adjusted via tele-health, without needing to present in person at a clinic for support. | <ul style="list-style-type: none"> • Personalisation |
| | Remote firmware updates allow the clinician to update the firmware (hearing aid software) on a wearer's hearing aids without them having to come into the clinic. <p>Software updates can be used to add new features over time, improve the performance of the device, and to address any problems that the manufacturer identifies with the devices over time.</p> | <ul style="list-style-type: none"> • Personalisation |


Personalisation



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|--|---|--|
| Artificial intelligence  <p>Uses smart computing to mimic human intelligence to analyse information, learn, make decisions, and perform tasks in hearing devices to maximise benefits to the wearer and enhance their experience.</p> | Wearer preference-based predictions & adjustments: <p>Technologies that determine wearer's preferences based on their behaviour in different listening situations, extrapolate these preferences by comparing them to other or past users' preferences, and then make automatic adjustments based on these observations to optimise sound. For example, perhaps the wearer increases the volume and switches to a directional microphone whenever they are seated at a café, then AI will learn to increase the volume and change to directional microphone automatically when in the cafe. Some of these implementations rely on active training sessions via an app, while others automatically train the device from data obtained during normal usage.</p> | <ul style="list-style-type: none"> • Personalisation • Speech understanding • Sound quality • Comfort • Audibility |
| | Acoustic scene and sound environment classifiers analyse the incoming sounds in a particular location and automatically makes decisions about what kind of listening environment they are likely to come from or what kind of listening activity the wearer is likely to be participating in. Hearing instruments can use this information to decide what sound to present to the wearer through adjustments to their hearing aid settings such as the amount of amplification, the use of noise management programs, and the microphone directionality settings. | <ul style="list-style-type: none"> • Personalisation • Speech understanding • Sound quality • Comfort • Audibility |

Personalisation



| Level 1 - Feature family | Level 2 - Features | Examples of intended purpose |
|---|--|---|
| <div></div> <p>Features that allow hearing devices to be used for a variety of purposes related to wellbeing in addition to hearing and amplification.</p> | <p>Health and lifestyle sensing and monitoring uses in built sensors integrated into hearing devices, to collect health information such as physical activity and location, social engagement, and provide insights into a wearer’s health and lifestyle. Data collected can then be used to set personalised healthcare goals, track progress and engagement, provide motivation, reminders (i.e. take medication), or alerts (i.e. fall detection). Broader applications for this feature include functions such as locating lost hearing aids, real time transcription, captioning, and translation.</p> | <ul style="list-style-type: none">• Personalisation• Usability |