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Wireless Technology is Constantly Changing. ARE YOU KEEPING UP?

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The pace of technology development in modern hearing aids has reached a stage where maintaining deep knowledge of various technological implementations is — to say the least — challenging. It is nearly a requirement that one remains versed in relevant engineering topics, a daunting problem for those facing the demands of a daily clinical routine. This article will describe each of the modern wireless strategies used in hearing aids. The strengths and weaknesses of each wireless strategy will be reviewed and the wireless protocol that makes Made for iPhone ® (MFi) Hearing Aids possible will be discussed in detail.

There is little new about the concept of a wireless hearing aid. Hearing aids have had wireless components capable of audio transmission for decades. The earliest components, known to consumers and hearing care professionals as telecoils, are a magnetic rod wrapped in copper wire. The telecoil acts as an electromagnetic net to catch electromagnetic signals modulated at audio frequency ranges and transformed to electrical signals by the telecoil.

Today, telecoils are the only standard means for wireless audio transmission to a hearing aid. A combination of low power requirements, small size and low cost were the fundamental ingredients to a recipe that led to acceptance and eventual standardization. Over the years, telecoils have advanced; today's coils are smaller and — for an equivalent size — introduce less noise than the ones of the past.

For many people with hearing loss, the telecoil is an indispensable tool for accessing audio from the magnetic output of telephones or magnetic induction fields that are installed for public audio broadcast (e.g. a classroom lecture or show at the theater). These same individuals would be quick to point out the disadvantages of telecoil use. Hearing aid orientation plays a large role in the successful use of a telecoil, and many savvy hearing aid wearers have developed compensatory strategies that help to address this particular challenge. Beyond orientation, the quality of induction loop installation or the magnetic field strength of a telephone receiver will greatly affect audio signal quality and consistency.

Regardless of signal quality or accessibility, one fundamental ability is absent from standard implementation of a telecoil: the ability to transmit complex data for signal processing purposes. For that reason, several more recent strategies for wireless communication with hearing aids have been introduced. At the time of this article, there are three commercially available strategies. Each of these are proprietary to the company developing the technology. A fourth wireless strategy, developed to work with Apple ® products is newly available and presents opportunities in wireless communication to hearing aids that were not previously possible. From this point forward, the actual wireless signal used in each wireless strategy will be referred to as a wireless protocol.

Wireless Signal Processing: An Overview

NEAR-FIELD MAGNETIC INDUCTION

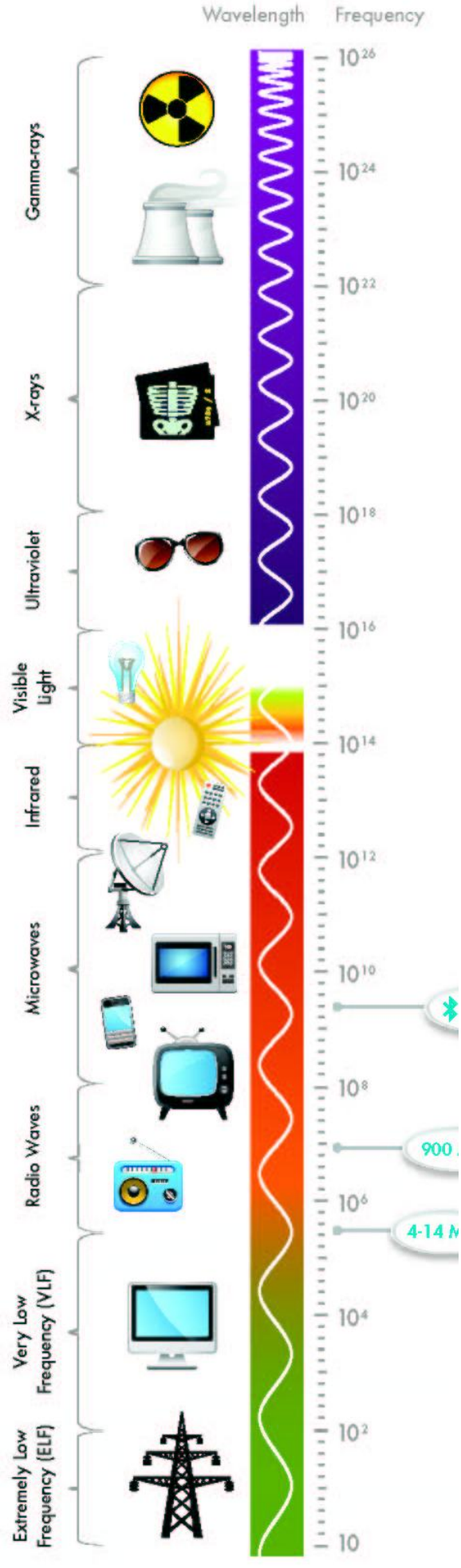
Approximately six years ago, the first generation of hearing aids capable of wireless signal processing and audio streaming were introduced. The wireless strategy used in these hearing aids is best described as near-field magnetic induction (NFMI). The hardware used in this implementation uses a small magnet wrapped in a copper coil as the antenna that transmits and receives the wireless data stream. The antenna connects to an integrated circuit called a radio; this radio is the brain of the entire wireless system, controlling the transmission and reception of digital information. Compared to the other wireless hearing aid protocols, NFMI is a low-frequency wireless signal that — depending on the manufacturer — ranges from 4 MHz to 14 MHz. This is the most common wireless strategy used in hearing aids today.

For the developers of hearing aid technology, it is reasonable to assume that NFMI was selected for a number of beneficial reasons. Those reasons include the small magnetic antenna that eases packaging of the wireless hardware into the hearing aid; the low-frequency wireless signal that transmits easily between ears allowing ear-to-ear signal processing at high data rates; magnetic signal transmission is low in power consumption; and, limited transmission distance from the hearing aid, easing management of wireless interference.

Of course, with advantage also comes disadvantage. In the case of NFMI, the low- low frequency magnetic signal has a short transmission frequency distance, requiring a neck-worn relay device to translate the signal from a magnetic protocol to a high-frequency wireless protocol that is capable of longer distance signal transmission, most commonly the standardized Bluetooth ® protocol.

900 MHZ

The next wireless strategy, unique to Starkey Hearing Technologies, uses a 900 MHz proprietary wireless protocol for transmission of data and audio to and from a hearing aid. By transmitting at a higher frequency, less signal strength is lost when transmitting over a distance. As a result, transmission from hearing aid to a remote device is several meters, freeing the hearing aid wearer from the need of a neck-worn relay device. The 900 MHz transmission frequency is in a sufficiently low-frequency spectrum that ear-to-ear signal processing remains a possibility with the benefit of high-bandwidth, two-way data streaming. The 900 MHz frequency band also allows for long distance wireless hearing aids to be built in a canal form-factor, while retaining robust transmission quality. A disadvantage to the use of a 900 MHz wireless protocol is that there are no widely accepted standard protocols, and there are limitations to worldwide distribution of products that use this frequency band. The design of a 900 MHz antenna is also challenging, as it must be specially designed to work efficiently in each hearing aid style. The antenna is a small printed strip of copper that wraps the inside of each hearing aid.


Wavelength
Frequency
Gamma-rays
X-rays
Ultraviolet
Visible Light
Infrared
Microwaves
Radio Waves
Very Low Frequency (VLF)
Extremely Low Frequency (ELF)
10^{26}
10^{24}
10^{22}
10^{20}
10^{18}
10^{16}
10^{14}
10^{12}
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
10
900
4-14

2.4 GHZ

The last of the three wireless strategies currently available in hearing aids uses a proprietary wireless protocol that transmits around 2.4 GHz. It is the case that the 2.4 GHz band is the same frequency band that is used for the standardized Bluetooth wireless protocol. It should be noted, however, that this is not the Bluetooth protocol and many other wireless technologies transmit at 2.4 GHz that are not using Bluetooth (e.g. routers used for wireless Internet connections, remote video game controllers, remote computer mice and keyboards). Wireless signal transmission in the 2.4 GHz frequency band allows for long distance signal transmission, through which data and audio can be transmitted over several meters directly to a hearing aid without the need for a neck-worn relay. The high-frequency nature of this protocol inherently means that there is increased wireless signal absorption by the body. For this reason ear-to-ear communication is a more challenging prospect, limiting the data exchange rates and how deeply in the canal the hearing aid antenna can be placed. One benefit of the 2.4 GHz band is the fact that devices transmitting in this frequency range can be distributed globally. Though differences exist, the 2.4 GHz antennas are approximately similar to the printed copper antennas used at 900 MHz.

BLUETOOTH 4.0

It should be apparent that none of the three described wireless strategies and their transmission protocols are the standardized Bluetooth protocol. The reason for this is rather simple and relates to power consumption: the hardware required for Bluetooth transmission can be designed to fit into a hearing aid, but the power requirements would limit the battery life of a hearing aid’s zinc air battery to several hours — a period of time too short for any patient to accept.

Recently Bluetooth 4.0 was released, a version of the existing Bluetooth standard that allows for very low power consumption when sharing data wirelessly. Noteworthy new products that feature Bluetooth 4.0 are FitBit products and the Nike Fuel Band, products that monitor movement throughout the day. These devices use the Bluetooth 4.0 protocol to periodically share small amounts of data. The result is increased power efficiency when compared to similar tasks using the original Bluetooth protocol. This concept of smart power management has allowed for the development of MFi Hearing Aids. While useful for low-power applications, the Bluetooth 4.0 protocol does not allow for transmission of audio.

MADE FOR iPHONE HEARING AIDS PHONE

Starkey Hearing Technologies’ Halo ™ hearing aid is the company’s first MFi Hearing Aid. Halo hearing aids feature a new wireless protocol developed by Apple that provides a robust low-power data and audio connection between a patient's hearing aids and iPhone. Available as a receiver-in-canal, with options for 50-, 60-, or 70-gain receivers Halo can address a broad range of hearing losses. In addition to a broad palette of colors, two unique colors have been developed to match the discerning patient’s iPhone.

MFi Hearing Aids will not only allow for patients to benefit from high-quality audio streaming directly from their iPhone, it will also allow for transmission of data between the hearing aids and iPhone.

Simple, wireless data sharing between an iPhone and hearing aids is a powerful proposition. Halo hearing aids have constant access to audio and data from the Internet, movement of the phone in space, as well as position information from GPS satellites, all supported by the processing capabilities of the iPhone. The synergy of pairing the capabilities of iPhone with MFi Hearing Aids will afford a number of new performance enhancements. Patients will immediately benefit from the opportunity to use iPhone as a remote wireless microphone. The option to activate GPS location tracking creates a unique opportunity to define location-specific memories that can

automatically activate when walking into previously “tagged” locations. These are several of the many unique benefits provided by MFi Hearing Aids, supplementary articles describe these features and benefits in detail.

Starkey Hearing Technologies will continue to offer wireless hearing aids that feature the IRIS 900 MHz wireless protocol. The IRIS wireless protocol offers unique benefits with regard to binaural signal processing that cannot be achieved with any 2.4 GHz signal. The opportunity to select from a range of hearing aids with different benefits presents an opportunity for hearing care professionals to explore these technologies and offer more options than ever that will delight even the most demanding patient.

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