Frequency Modulation Systems (FM Systems)

The FM System is considered the most important and essential educational tool developed for children with hearing loss who use hearing aids and/or cochlear implants.

It aims to improve the comprehension of speech signal in noisy and reverberant environments, as well as in the distance between the individual and the sound source, mainly in the school environment.

What is it?

The FM System is a wireless microphone comprised by two gadgets: a transmitter and a receiver.

The transmitter has a microphone that can be internal (attached to the circuit) or external (e.g., a headset microphone).

How does it work?

The transmitter picks the signal of the sound source and sends it to the receivers.

A single transmitter can send the signal to several types of receivers.

For transmission to occur, receivers must be within the transmission area (30 m / 98.5 ft) and synchronized with the same frequency channel of the receivers.

Goals of the FM System fitting

- Proper audibility and intelligibility.
- Perception of speech compatible with the performance obtained in ideal hearing situations.
- Auditory monitoring of one's own voice and consistent speech audibility in the communication environment.
- Reduction of effects of distance, noise, and reverberation.
- Consistent signal of the speaker, regardless of the head movement.
- Technology that will be effectively used by the individual, parents and/or teachers.

NOTE: The name "Frequency Modulation System" has originated from the radio frequency used by this type of remote microphone since its development in the 60s.

However, the first Digital Modulation System (DM) emerged in 2010, and studies have shown the advantages of the digital transmission for hearing aids and cochlear implant users when comparing the DM system with the FM system.

Types of FM Systen

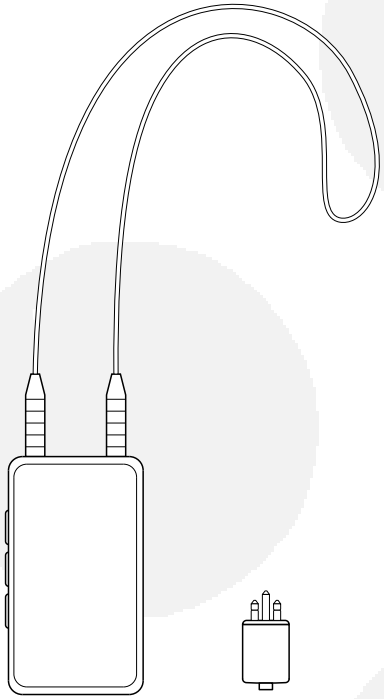
They may be classified according to the receiver usage mode and the signal-processing mode.

Receiver Usage Mode

Personal FM System

The receiver is at the user's ear level, connected to the hearing aid and/or to the cochlear implant.

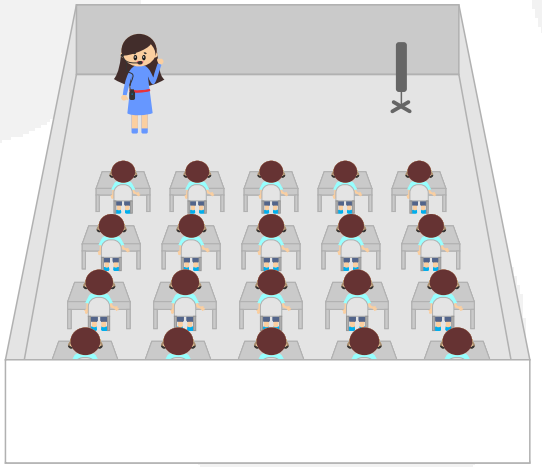
Receivers



Sound Field System

In this case, the receiver is attached to one or more speakers strategically positioned in the classroom.

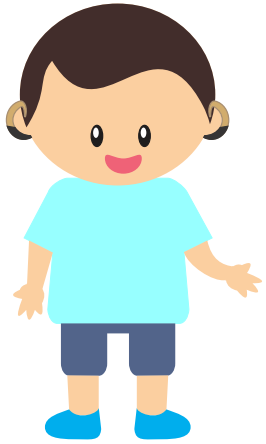
This type of system is mainly used to avoid the teacher's vocal effort and assure a proper S/N ratio for people with normal hearing or with peripheral hearing loss.



The free-field FM system is categorized as a CADS (Classroom Audio Distribution System), regulated by the ASA/ANSI S12.60 (ANSI, 2010).

Signal-processing Mode

Fixed FM System



The FM gain set is fixed, regardless of the background noise level. If the noise level is intense, to reach a proper FM advantage, the user must alternate from the **FM+M** mode to the **FM** only, or even reduce the microphone sensibility of the cochlear implant speech processor.

Depending on the hearing aid technology or the cochlear implant speech processor mapping, the option to alternate between FM+M to FM only may not be available. Besides, the deactivation of the hearing aid microphone is not recommended because the child might lose his/her own voice monitoring or the perception of the sounds around.

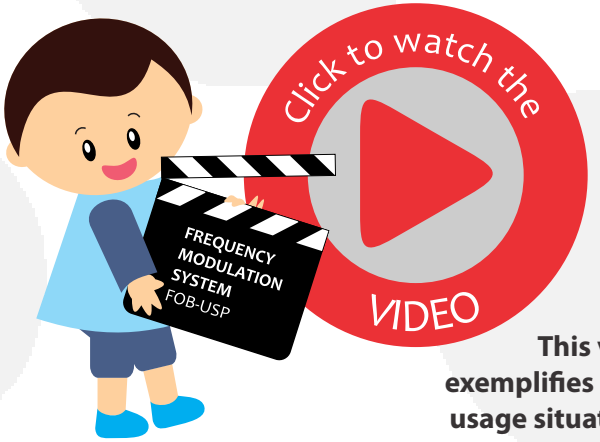
Adaptive/dynamic FM System

In the adaptive FM System, the FM gain automatically varies according to the background noise level.

When the background noise exceeds a pre-established intensity level, the transmitter sends a command to the receivers and it can have an increase of up to +15 dB at the FM gain to ensure a positive signal/noise ratio, even with intense noise. If the background noise level reduces, the FM System also reduces the automatic gain.

Digital radio frequency system

Both signal-processing modes are found in the digital radio frequency system: fixed-gain digital radio frequency system and adaptive digital radio frequency system.



This video exemplifies some usage situations.

Transmitter Models

Receiver Models

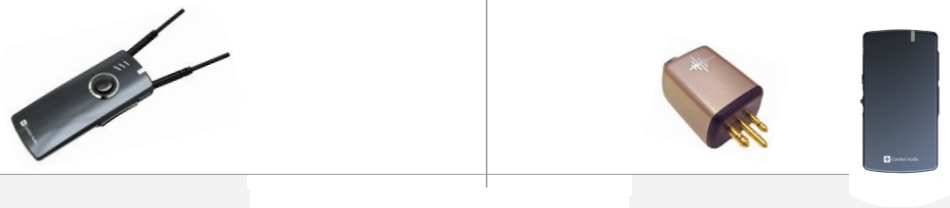
Phonak

Conversor

Scola

Oticon

Comfort Audio



Manuals available for download:

Comfort Audio
http://www.comfortaudio.com/about-comfort-audio/information-material/

Oticon
https://www.oticon.com/support/downloads?primaryID=e17f255e-d857-4303-bb2e-06f700c2402e&secondaryID=%7BC01D7A73-C53A-448F-ADB1-7C92D5F1F15C%7D

Oticon videos
https://www.youtube.com/playlist?list=PLe2jD82VHz97mq4qwlbhlfJCxKOYFI5Ev

Phonak
https://www.phonakpro.com/com/en/support/product-support/wireless-accessories.html

Links for the manufacturers' website:

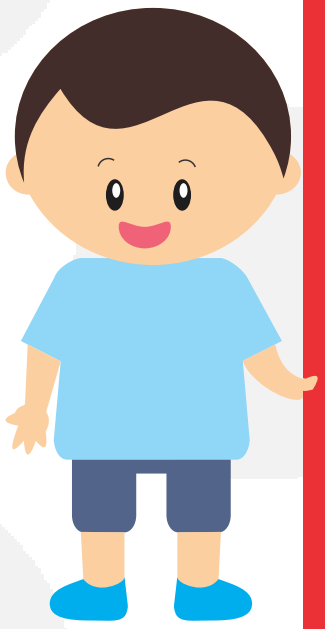
Comfort Audio
http://www.comfortaudio.com/

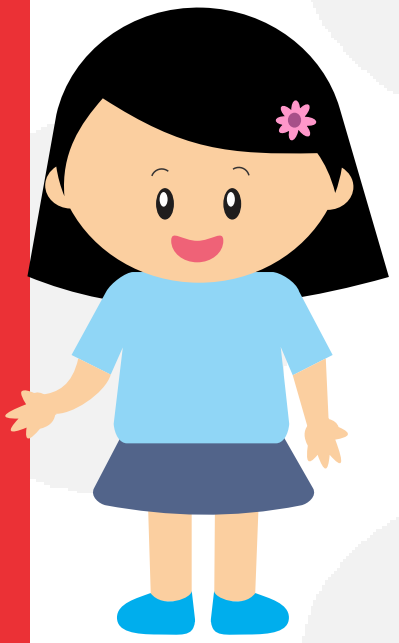
Conversor
https://www.conversorproducts.com/

Oticon
https://www.oticon.com/solutions/for-children/amigo-fm

Phonak
https://www.phonak.com/us/en/hearing-aids/accessories/use-cases/understanding-in-classroom.html

Widex
https://global.widex.com/en/hearing-aids/hearing-aid-accessories/dex-hearing-aid-remote-controls/fm-dex





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