

To Loop or not to Loop ... Advanced Technology  
Induction Loop Systems for Hearing Aids and  
Cochlear Implants

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#### 1) Introduction:

Reverberation, background noise, and  
long-distance-to-the-sound source are the three  
main enemies of speech intelligibility for people  
with hearing aids and cochlear implants. To fight  
these enemies there are three weapons: 1)  
Induction Loop 2) Infrared 3) Frequency  
Modulation (FM).

I am convinced that the Audio Frequency Induction  
Loop System (AFILS) is the most adequate, the  
psychologically least problematic, and the most  
cost effective technology. Therefore I will  
concentrate in my paper purely on AFILS.

There are certain situations in which you have to  
use infrared or FM, but the AFILS confirming to  
state-of-the-art technology is, according to my  
view, the basic technology for assistive  
listening devices.

#### 2) The need for assistive listening devices:

a) A Hearing Aid is not enough. A hearing aid or  
a cochlear implant is a great help to people who  
are hearing impaired, but it is not enough. While  
communication between two persons facing each  
other works very well, it will become impossible  
in a place with strong reverberation, background  
noise, or long distances to the sound source  
(e.g. a person speaking or a loudspeaker).

b) Technology does not (yet) replace our brain.  
With intact ears our brain can select which sound  
source you want to hear. When two persons talk to  
each other in a room where the radio is on, and a  
clock is ticking at the same time, our brain can  
partly filter out the music or the sound of the  
clock. Even the most advanced digital hearing aid  
can do this only partially or not at all.

c) We need hearing aids / cochlear implants +  
(Plus!). In difficult hearing situations (e.g.  
house of worship, auditorium) there is a strong  
need for additional assistive listening devices  
in conjunction with the hearing aid or cochlear

implant.

d) The aim of the assistive listening system is to minimize the distance to the sound source and to cut out reverberation and background noise.

e) Although the AFILS is the oldest technique, it has been widely neglected until recently. A renaissance of this system worldwide is vital and I am "fighting" for it.

f) In my view the AFILS has been neglected due to the following reasons: The AFILS is the cheapest system and is therefore not very profitable for the installer. You can earn much more money by installing an expensive FM-system, or an infrared system which requires special receivers for each hearing impaired person. Therefore installers are not very much interested in the AFILS.

g) The AFILS is an invisible technique for an invisible impairment. Once installed nobody can see anything of the system. If a public address-system does not function, people realize it immediately because no sound comes out of the loudspeakers. If the AFILS malfunctions, only the user is affected.

h) Icons which signalize the installation of this invisible technique are missing in most looped venues. In 1985 the International Federation of Hard of Hearing People (IFHOH) adopted an icon as the official symbol for AFILS. It should be used worldwide because this would allow immediate recognition.

i) Most AFILS are installed incorrectly not fulfilling the standard IEC118-4 which was set by the International Electrotechnical Commission in 1981. Hard of Hearing organizations should insist that this norm should be adhered to. The customer should make a written contract with the installer, that the AFILS conforms to IEC 118-4. If not, the installer should be fined. This would eliminate firms which have very little knowledge of AFILS.

j) A lot of hard of hearing people know little to nothing about the function of the telecoil in the hearing aid. Even in looped areas they therefore fail to use the AFILS.

k) Hearing aid manufacturers have included telecoils of different strengths in their hearing aids. Since the telecoil is quite large in comparison to the rest of the electronic components in the aid, smaller telecoils are included to reduce the overall size of the hearing aid. The amplification is then weaker in the T-position than in the M-position.

1) In many In-the-Ear hearing aids and especially in Completely-in-the-Canal (CIC) hearing aids, there is no room for the telecoil. Because a lot of hard of hearing people consider hearing impairment as a stigma, they want "almost invisible" hearing aids.

m) As far as I know, until now only two manufacturers of cochlear implants "COCHLEAR" and "Advanced Bionics" produce speech processors with a telecoil up to now. I urgently advise the other manufacturers to do the same, because reverberation, background noise, and long distances to the sound source are even greater problems with the CI than with the hearing aid.

3) Personal experience:

30 years ago I met a hard of hearing person for the first time. At that time my fiancé was staying with her aunt, who has been hard of hearing since childhood. This aunt could never understand me on the telephone. I tried to speak louder but that only made things even worse.

Someone told me that you could get a special phone with inductive coupling. With this phone you could use the telecoil of the hearing aid.

Finally the aunt got such a phone, and since that time she can understand me perfectly on the phone. For me this experience was the key for my activism in favour of audio frequency induction loop systems.

4) History:

AFILS is a technology which has been known since the thirties or forties. The system became less popular when infrared systems and FM-systems appeared. These systems however require a special receiver. For the induction loop system, on the other hand, you only have to switch your hearing aid from microphone (M) to telecoil (T), allowing you to use the individual amplification of your personal hearing aid.

There is a renaissance of AFILS in Europe and also in the USA. Hard of hearing people and cochlear implant users realize the many advantages of this system. In my view it is especially suitable for countries where money is scarce because this is the cheapest technology of assistive listening devices.

5) Design of systems where spillover is no

problem:

1. Priority: The loop is placed alongside the walls of the room at floor level or up to 40 cm below floor level. 2. Priority: If it is not possible to place the loop at floor level, the loop can also be placed along the edges of the ceiling, if the room is not too high. For a ceiling loop however much more amplification is needed than for the floor loop.

The wire of the loop should be placed in a standard plastic pipe used for standard electrical installations. If the plastic pipe is put in a new building before the building is finished, the costs are almost nil. Therefore, AFILS should be planned early.

The plastic pipe should contain only the loop wire and no other electrical wires, because every wire in which electricity flows, produces a magnetic field. This field will be picked up and amplified by the induction loop system producing a disturbing hum. Other electrical wires should not be put parallel to the loop or within a distance of at least 20 cm. Electrical wires crossing the loop wire do not cause any harm. No high voltage wires should cross the loop area, because this produces additional disturbing hum. Already in the planning process the person planning the high voltage system should be in close contact with those responsible for the AFILS and the normal electrical wiring. If they communicate well a lot of irrevocable mistakes could be avoided.

In larger assembly areas with fixed seats (e.g. houses of worship) where there is an aisle in the middle of the room, a loop design like a figure 8 could be planned. If this is done the direction of the current must go in the same direction in the aisle area, because opposite directions will "kill" the magnetic field.

After installation, the loop driver has to be adjusted correctly conforming to standard IEC 118-4. Magnetic field strength and also frequency response should be measured.

6) Voltage versus current:

In former times the same amplifier that was used for the public address system was used as a driver for the induction loop. This actually works. But AFILS based on voltage perform poorly in the high frequencies which are so important for speech intelligibility. The impedance of the loop wire increases with the high frequencies. Therefore the amplifier has to furnish more

current. The audio amplifier based on voltage cannot produce a current which is independent of the frequency.

Advanced technology induction loop drivers using current instead of voltage perform well even in the high frequencies. Therefore the quality of the sound and the speech intelligibility is much better.

In new buildings and in renovated buildings only induction loop drivers based on current should be used (e.g. Ampetronic [United Kingdom] , Univox by Bo Edin AB [Sweden] , Logia / Oticon Lydsystemer AS [Denmark]).

#### 7) Low spillover systems:

Normal induction loop systems produce a certain "spillover" of the magnetic field. This could be awkward in adjacent rooms (e.g. classrooms, cinemas). Up to now this problem prevented installation in such rooms. This problem has now been addressed:

##### a) 3-D-Loop System of Oval Window Audio, USA:

The US manufacturer of AFILS Oval Window Audio in Nederland, Colorado has developed a so called 3-D-loop system with little or no spillover.

##### b) Phase Array System of Ampetronic Ltd., United Kingdom

The English firm Ampetronic has now developed a system, which limits the spillover of the magnetic field very much so that it is now possible to have AFILS even in rooms next to each other. You need a certain loop design which Ampetronic simulates for you on their computer according to the measurements of your room. A special phase shifter is also needed. Often there is an additional need for metal loss correction.

#### 8) The situation in Europe and in the USA:

Let me mention just some examples:

a) Denmark: Practically all churches are equipped with an excellent AFILS. The governing body responsible for churches issued recommendations for AFILS as early as March 1986. The loop system will be checked every year to see if it still meets the standards.

b) Norway: In the year 1993 the church council issued a publication on AFILS which was sent to all churches.

c) Sweden: In Sweden the Nordic Committee on Disability has issued "Requirement specification for hearing aids". The telecoil is an integral part of it.

d) Great Britain: There a special Code of Practice for AFILS exists. "Loop systems in public buildings must be installed to British Standard Code of Practice for Audio Frequency Induction Loop Systems BS 7594. If you quote this code of practice in all specifications and contracts, it should help to ensure that your induction loop system is designed and installed to professional standards, works properly, is safe, and meets regulations."

e) Austria: There are not many AFILS that meet the standard. According to an official regulation effective in 1991, every audiologist should have an induction loop system to check the inductive coupling of the hearing aid. According to the president of the Austrian Union for Hard of Hearing People (Ö"HB), Hans Neuhold, very few have such a system.

Since 1997 there has been a fantastic renaissance of AFILS in Austria, starting with the installation of a new AFILS in the Church of the Resurrection in Vienna.

f) Switzerland: All public telephone booths have inductive couplers. Most train stations have at least one ticket corner with AFILS. In most churches there are AFILS. Many of them do not meet IEC-standard 118-4 and are driven by voltage amplifiers instead of specific induction loop drivers using current. There has been an upsurge in the last years and there are many positive examples such as a tour bus in Winterthur or the United Bank of Switzerland (UBS) in Winterthur where two desks have been equipped with induction loop systems.

g) Germany. Not many AFILS exist and those are mostly not conforming to IEC 118-4. The German Hard of Hearing Union (Deutscher Schwerh?enbund) has published a brochure claiming that AFILS were "old fashioned".

h) USA. There is a small renaissance of AFILS. The main problem is that, according to Mark Ross, only thirty percent of the hearing aids in the USA are equipped with a telecoil. Self Help for Hard of Hearing People supports telecoils in a position statement: "SHHH recommends that all hearing aid dispensers inform their patients of the function and potential advantages of "T" coils during the course of the hearing aid selection process, and, further, strongly

suggests their inclusion in the hearing aids." SHHH and the Johns Hopkins Center for Hearing and Balance have also produced a video film on the same subject: The Telecoil: Plugging into Sound.

9) Technical Recommendations:

a) Use only single loop cable.

b) The diameter of the loop cable (0.5 mm<sup>2</sup>, 0.75 mm<sup>2</sup>, 1 mm<sup>2</sup>, 1.5 mm<sup>2</sup>, 2.5 mm<sup>2</sup>) has to be calculated according to the dimensions of the room.

c) A special induction loop driver using current and not voltage has to be used for the loop. You may pick up the signal from a separate microphone or from one which is already being used for the public address system.

d) After correct installation of the loop, the system has to be adjusted properly through a qualified person measuring the field strength and also the frequency response. Once the system is correctly adjusted, there is normally no need for readjustment.

e) The person responsible for the room should be instructed properly. A written user's manual should be handed out in which the location of the loop cable, its diameter and the measuring sheet should be included.

f) The international IFHOH icon (accepted in 1985) should be placed at the entrance of the room so that it is clearly visible to everybody that an AFILS is installed.

g) If it is not possible to install the loop in the whole room, a drawing should show which part of the room is looped.

h) A sign should remind people where the loop wire is installed (e.g. under the carpet) so that it will not be harmed if, e.g., a hole has to be driven in the floor for another installation purpose.

10) Recommendations for Hard of Hearing People and CI people

a) Accept only hearing aids or cochlear implants with a (strong) telecoil from your dispenser. This has nothing to do with costs. The telecoil is extremely cheap compared to the hearing aid or CI (about 2% of the cost of a hearing aid).

This eliminates Completely in the Canal (CIC)

hearing aids (although Bill Clinton wears them!) because there is not enough space to include a telecoil. If you have a small ear canal this even eliminates In-the-Ear (IO) hearing aids because of lack of space. Well designed (Porsche design?) Behind-The-Ear hearing aids with strong telecoils are the future!

b) Hard of Hearing People and Hard of Hearing Organizations should put pressure on hearing aid and CI manufacturers to encourage them to only produce hearing aids and CIs with telecoils.

c) In countries where hearing aids are financed by an organization (impairment insurance of the state, e.g. Switzerland for men below the age of 65 and women below the age of 63) the organization should subsidize only hearing aids or CIs in which a telecoil is included. If someone wants a hearing aid without a telecoil, he or she can get it on the free market but then should pay the full price himself or herself.

In Sweden only hearing aids with telecoils are subsidized by the state. I think this leads into the right direction.

d) In a room with more than 50 seats always ask for an AFILS. Handicapped persons in wheel chairs get their ramps and lifts even if only one handicapped person has to use it.

e) Don't forget to keep your head upright in a venue with an AFILS. If you fall asleep the telecoil is no longer in an upright position and you will not get the advantage of it anymore.