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Electromagnetic compatibility and Radio spectrum Matters (ERM); Hearing Loop System (HLS) intended to assist the hearing impaired in the frequency range 0 Hz to 9 kHz; System Reference Document

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document includes necessary information to support the co-operation under the MoU between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The purpose of producing the present document is to lay a foundation for the industry to quickly bring innovative and useful products to the market while avoiding any harmful interference with other services and equipment.

Hearing Loop Systems (HLSs, also known as Audio frequency induction loop systems or AFILS) have been in use since the middle of the twentieth century, with the first recognizable patents appearing circa 1938. They are used in theatres, conference rooms, cinemas, places of worship, meeting halls, shopping areas, and education establishments, and also for passenger handling buildings associated with rail, sea and air transport. Smaller-scale installations are used in household premises and residential care homes to increase the enjoyment of radio, television programmes and personal computers. Hearing Loops can also prove to be valuable for interview areas, ticket booths and service counters (ticket office systems). They provide a huge benefit to users with impaired hearing.

Hearing loop transmissions are entirely by means of magnetic induction (H field), and there is no intentional E field content. Hearing Loop Systems operate at baseband audio frequencies with no form of modulation. Due to the Radio Equipment Directive defining the lowest frequency for radio transmissions as 0 Hz, rather than 9 kHz as previously, it has become necessary to define their function within the radio spectrum. No cases of radio interference have been reported, and the strength of the field from a hearing loop system falls off rapidly outside the intended coverage space. Where functional restrictions exist (such as a need for confidentiality of the material broadcast in the loop) phased array system is used to attenuate the field even more rapidly outside the intended coverage space.

1 Scope

The present document describes the application details, requirements and markets for Hearing Loop Systems (HLSs).

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEC TR 63079:2017+AMD1:2018+AMD2:2020 CSV: "Code of practice for hearing loop systems (HLS)".

[i.2] IEC 60118-4:2014: "Electroacoustics - Hearing aids - Part 4: Induction loop systems for hearing aid purposes - Magnetic field strength".

[i.3] IEC 62489-1:2010 + Amd 1:2014: "Electroacoustics - Audio-frequency induction loop systems for assisted hearing - Part 1: Methods of measuring and specifying the performance of system components".

[i.4] IEC 62489-2:2014: "Electroacoustics - Audio-frequency induction loop systems for assisted hearing - Part 2: Methods of calculating and measuring the low-frequency magnetic field emissions from the loop for assessing conformity with guidelines on limits for human exposure".

[i.5] IEC 60268-10: "Sound system equipment - Part 10: Peak programme level meters".

[i.6] IEC 61672-1: "Electroacoustics - Sound level meters - Part 1: Specifications".

[i.7] IEC 60065: "Audio, video and similar electronic apparatus - Safety requirements".

[i.8] ETSI EN 303 348: "Induction loop systems intended to assist the hearing impaired in the frequency range 10 Hz to 9 kHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

cochlear implant: electronic device that stimulates the auditory nerve through electrodes placed in the cochlea of the inner ear, allowing some severely deaf people to perceive sounds

hearing aid: personal amplification system, worn entirely on the listener, which is designed to enable a person with impaired hearing to hear more easily

NOTE: The hearing aid is typically prescribed and adjusted by an audiologist to cater for the hearing characteristics of the particular user.

hearing instrument: hearing aid or cochlear implant

hearing loop listener: portable stand-alone listening device which is designed to give an audible output in response to signals transmitted by a hearing loop system

hearing loop monitor receiver: stand-alone equipment designed to verify the performance of a hearing loop system by audio and visual means:

- providing visible indication that it is powered and when the strength of the magnetic field produced by the loop falls within a specified range; and
- providing an audio-frequency output by which the sound quality of the hearing loop system transmissions can be assessed

Hearing Loop System (HLS): system including amplifier(s), microphones and/or other signal sources, in which magnetic fields are created by the flow of audio-frequency current in a conductor arranged in the form of a loop or coil

NOTE: Historically called audio frequency induction loop systems or AFILS.

induction loop: current carrying loop or coil of a hearing loop system used to create the magnetic field

integral loop: loop designed as a fixed part of the equipment, without the use of an external connector and as such which cannot be disconnected from the equipment by the user

large area hearing loop system: hearing loop system that has an approximate coverage area greater than 400 m^2

loop listener: See hearing loop listener.

magnetic field strength level meter: instrument designed to measure the magnetic field strength of audio frequency magnetic fields

NOTE: Two types are in common use; a Peak-Programme Meter (PPM) type having dynamic characteristics similar to those of the Type II meter specified in IEC 60268-10 [i.5], and a true r.m.s. meter type that incorporates a true r.m.s. rectifier and meets the relevant requirements for a Class 2 sound level meter specified in IEC 61672-1 [i.6]. Full functional specifications for both types of meter can be found in IEC 60118-4 [i.2].

perimeter loop: hearing loop with one or more turns laid horizontally around the perimeter of the area of intended coverage

phased loop array: system of overlapping hearing loops in which the currents are not in phase with each other that provides more even field coverage over large areas and less overspill than a perimeter loop of the same size

portable hearing loop system: equipment intended to be carried, attached or implanted

reference magnetic field strength level: 0 dB reference for magnetic field strength levels, which is 400 mA/m

small area hearing loop system: hearing loop system designed to assist communication between (usually) two persons, sometimes through a transparent screen

telecoil: magnetic pickup coil intended to receive signals from a hearing loop system

NOTE 1: In accordance with IEC 60118-4 [i.2], also known as telecoil.

NOTE 2: A telecoil can be part of a hearing aid or of any other device for receiving signals from a hearing loop system in accordance with IEC 60118-4 [i.2].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	deciBel
E	electrical field strength
H	magnetic field strength
Ω	ohm

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AFILS	Audio Frequency Induction Loop System

NOTE: Also known as Hearing Loop System.

CEPT	European Conference of Postal and Telecommunications administrations
EC	European Community
ECC	Electronic Communications Committee
EMC	Electromagnetic Compatibility
HLS	Hearing Loop System

NOTE: Also known as AFILS.

IHLMA	International Hearing Loop Manufacturers Association
RED	Radio Equipment Directive
r.m.s	root mean square
TR	Technical Report

4 Comments on the SRDoc

4.1 Status of the present document

No comments were received during the SRDoc enquiry.

5 Executive Summary

5.1 Background information

5.1.0 Introduction

From information provided within the present document, it is clear that it is that the allocation of frequencies for HLS has to be properly defined in order to allow ongoing usage of HLS devices.

- Consideration should be given to establishing a harmonized band for HLS.
- Manufacturers and hearing instrument users need to be assured of Europe wide harmonization of HLS spectrum usage.

The present document describes a Hearing Loop System, how it helps the inclusion of disabled people, the equipment used to achieve this, and the extremely low likelihood of HLS being the cause of radio-frequency interference.

An HLS is a method of improving communication with hearing instrument users that uses a magnetic field to transmit audio signals.

The benefit of an HLS is that whilst hearing instrument(s) worn by a person with impaired hearing can provide a useful improvement to the effectiveness of hearing conversations within 2 m of the listener, they are not so effective when listening to speech or music at a distance. This is because the microphone of the hearing instrument picks up the wanted speech or music together with the general noise and reverberation of the room and the unwanted speech of other conversations.

A basic large area HLS comprises a cable in the form of a loop, often laid around the perimeter of the room, hall, church, theatre, etc. in which the Hearing Loop System is to be provided. One or more microphones or other source(s) of sound signals, such as a radio receiver or portable telephone are connected to a specially designed audio amplifier that produces an audio-frequency electric current in the loop cable, causing a magnetic field to be produced in the vicinity of the loop. This magnetic field is a reproduction of the signal(s) into the amplifier and can be picked up by suitable hearing instruments and receivers near the loop.

Small area HLS include portable systems with integral loops and systems for counters and fixed help point systems that are designed to cover a very localized space and where the field outside the confines of the loop are used by the hearing instrument.

Most hearing instruments in use today are equipped with a telecoil, which picks up the transmitted magnetic field. Use of the telecoil is often enabled by selecting the "T" position or programme of the hearing instrument. In newer hearing instruments, the "T" input may be assigned to a user-selectable program that can be selected by (typically) operating a small push-button on the hearing instrument. To receive HLS transmissions without a hearing instrument, a special "loop listener" is required.

The frequency range of human hearing is conventionally considered to be 20 Hz to 20 kHz. However, the extremes of this range are less important for intelligibility and so are not transmitted by HLS, which operate between 10 Hz and 9 kHz. Compliance with IEC 60118-4 [i.2] requires an HLS frequency response of 100 Hz to 5 kHz ±3 dB with respect to the response at 1 kHz for HLS designed for hearing instrument use, but wider frequency responses up to 9 kHz may be required for non-hearing instrument use (e.g. tour guides) and for future developments of hearing instrument technology.

While the coupling between remote microphones and hearing instruments (or other listening devices) may be achieved by means of wires, infra-red radiation or radio transmission, magnetic induction provides a simple and internationally accepted means by which the very large user base of hearing instruments with the uncomplicated and affordable T-Coil (telecoil) can receive the transmissions without the need for additional equipment. Additional equipment, especially that uses a headset or earpiece, has the dual disadvantage of stigmatising the user and creating an additional administrative burden for the management of the building.

Emerging technologies such as Bluetooth® Low Energy do not offer a practical alternative to HLS in most cases due to practical problems such as latency, the need to pair, and short battery life. Even if these problems are solved there is a very large installed base of hearing instruments with telecoils that will benefit from HLS for many years.

5.1.1 Frequency spectrum

As a baseband transmission system, the transmitted output of a Hearing Loop System corresponds precisely with the bandwidth of the transmitted audio. There is no carrier frequency or modulation scheme. A correctly designed and installed HLS complying with the requirements of IEC 60118-4 [i.2] has a frequency response within the range ± 3 dB with reference to the response at 1 kHz, from 100 Hz to 5 kHz. The upper limit may be extended but will never exceed a maximum frequency of 9 kHz.

Figure 1 depicts the typical frequency spectrum usage for a hearing loop system.

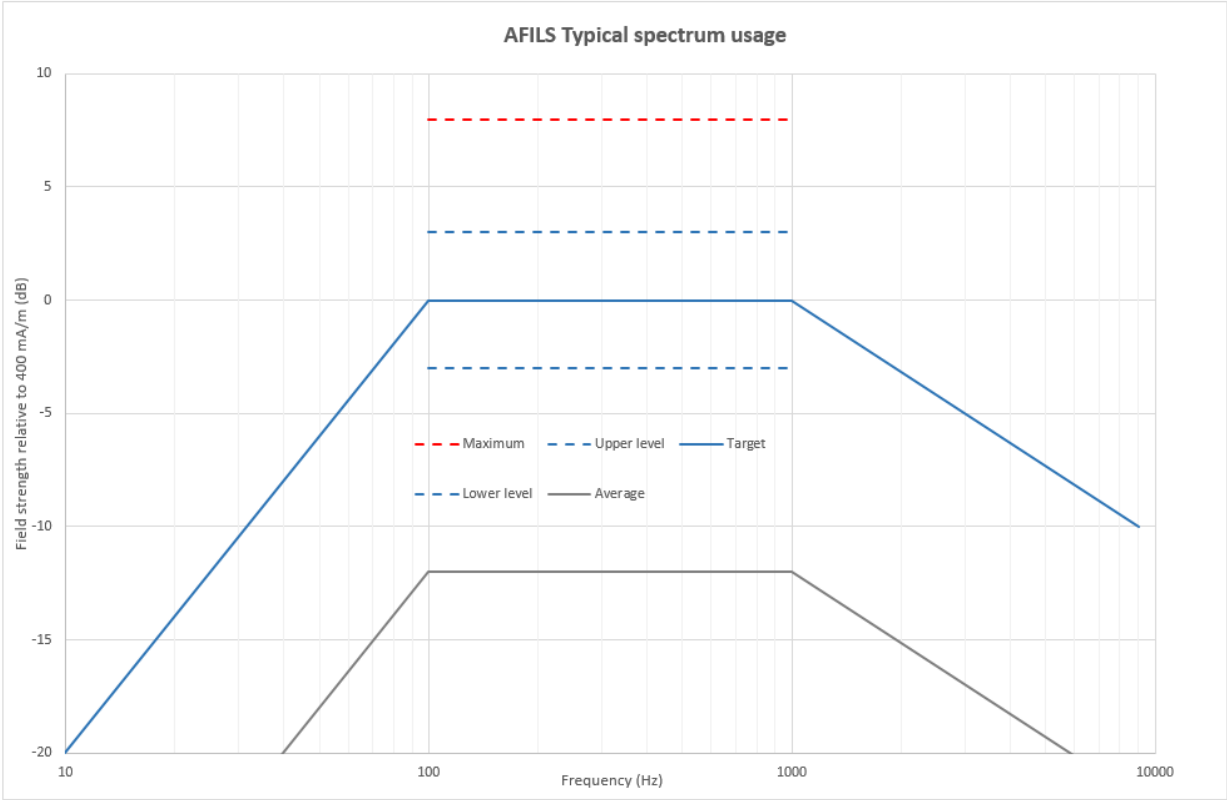

Figure 1

It should be noted that the HLS requires a flat frequency response for the H field within the defined frequency range, so the Hearing Loop System loop driver needs to have a constant current output to the loop to compensate for loop impedance variations with frequency. Hearing Loop Systems are not designed to transmit any E field.

5.1.2 Magnetic field strength

A correctly designed and installed HLS complying with the requirements of IEC 60118-4 [i.2] with a 1 kHz sinewave input signal will be capable of producing an average magnetic field strength of 100 mA/m and a maximum magnetic field strength of 400 mA/m within the space where listeners' heads (and therefore hearing instruments) are expected to be. It should vary by no more than ±3 dB for a large area hearing loop system and by no more than ±8 dB for a small area system and should be measured with a true r.m.s. meter with 0,125 s averaging time. The 400 mA/m upper level allows for the highest peaks in the programme material (speech or music).

5.1.3 Magnetic field present outside the intended coverage space

The magnetic field produced by an HLS will extend beyond the space within which coverage is intended. However, the field strength decreases rapidly outside the space bounded by a simple perimeter loop as shown in Figure 2.

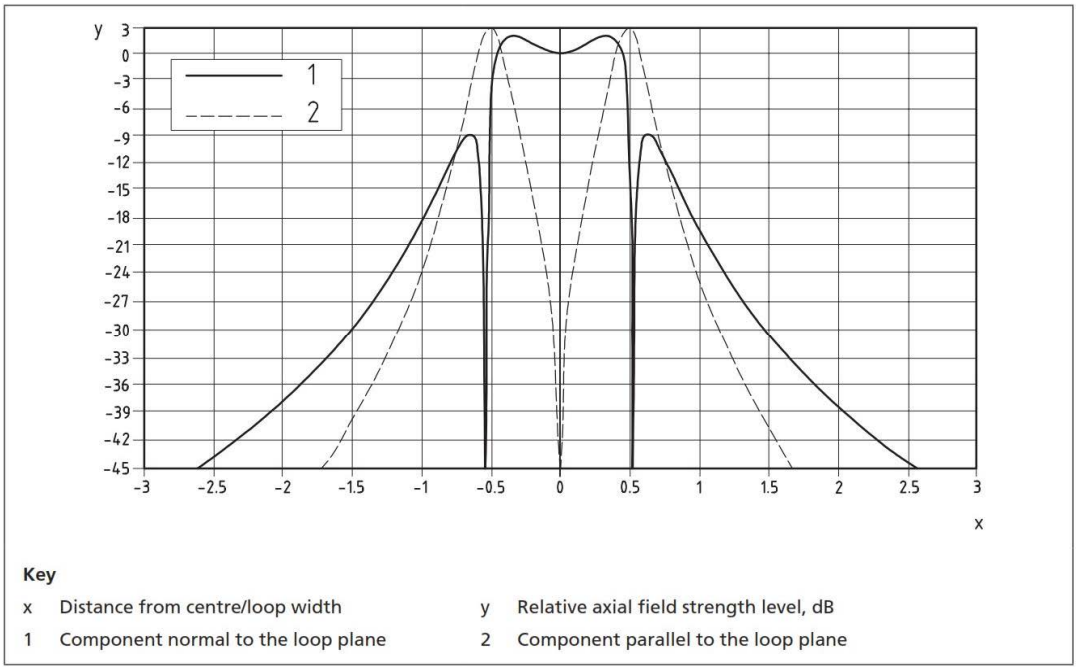

Figure 2

Figure 2 shows how the vertical and horizontal components of the magnetic field (the vertical component normal to the plane of the loop being optimum for most hearing aids) vary as one moves away from the centre of the loop. 0 dB on the vertical axis is 400 mA/m. As can be seen, it is usual for the field strength to reduce to -30 dB at one loop width and -44 dB at twice that distance. It is generally accepted that field strengths below -40 dB are below the level of audibility for hearing instruments.

In situations where even low levels of magnetic field are not acceptable outside the coverage space, a simple perimeter loop may be inadequate. In these cases, 'low-spill' loop amplifier and configurations with pairs of phase-shifted loop arrays are used to severely attenuate the overspill outside the loop.

Certain HLS (e.g. counter and help point HLS intended to cover a very localized space) rely on magnetic fields extending beyond the loop for their correct operation and, although the field strength in the centre of these loops will be higher than 400 mA/m in order to provide close to 400 mA/m at the listener's position, this field reduces in level with distance away from the loop in a similar manner to perimeter loops.

5.1.4 The effect of abnormal loads on Hearing Loop System drivers

HLS drivers (or amplifiers) are designed to work into a range of load impedances, typically from tenths of an ohm to tens of ohms and tens to hundreds of microhenries. Should the driver be presented with a load impedance outside of the designed range the driver will limit its output to prevent improper operation, and in extreme cases will cease supplying the load in order to protect itself. Protection is normally provided against short-circuit and open-circuit loads, and loads that cause excessive dissipation of heat in the amplifier output stage.

5.1.5 Existing national and international standards and legislative requirements for Hearing Loop Systems

5.1.5.0 Introduction

There are international standards and legislative requirements for Hearing Loop Systems.

5.1.5.1 IEC TR 63079:2017+AMD1:2018+AMD2:2020 CSV

IEC TR 63079 [i.1] gives recommendations for and guidance on the design, planning, installation, testing, operation and maintenance of HLS intended for communicating speech, music and/or other signals.

It is mainly concerned with HLS for hearing enhancement, in which the signals are communicated to users of hearing aids equipped with magnetic pick-up coils. This standard does not apply to induction-loop systems that use a carrier frequency, nor to other systems for hearing enhancement purposes which do not use magnetic induction.

This standard refers to IEC 60118-4 [i.2] for performance requirements.

5.1.5.2 IEC 60118-4: 2014

It specifies requirements for the field strength in audio-frequency induction loops for hearing aid purposes, which will give adequate signal-to-noise ratio without overloading the hearing aid. The standard also specifies the minimum frequency response requirements for acceptable intelligibility.

Methods for measuring the magnetic field strength are specified, and information is given on appropriate measuring equipment, information that should be provided to the operator and users of the system, and other important considerations.

5.1.5.3 IEC 62489-1: 2010 + Amd 1: 2014

This standard applies to the components of audio-frequency induction loop systems for assisted hearing. It may also be applied to such systems used for other purposes, as far as it is applicable. This standard is intended to encourage an accurate and uniform presentation of manufacturers' specifications, which can be verified by standardized methods of measurement.

5.1.5.4 IEC 62489-2: 2014

This standard is intended for the assessment of human exposure to low-frequency magnetic fields produced by the system, by calculation and by in-situ testing.

This standard does not deal with other aspects of safety, for which IEC 60065 [i.7] applies, nor with EMC.

5.1.5.5 ETSI EN 303 348

This standard specifies technical characteristics and methods of measurements for audio frequency induction loop drivers.

5.1.5.6 Other Standards

All EU Member states have legislation on provisions for people with disabilities that include Hearing Loop Systems, and examples of these can be found in the Bibliography.

5.2 Market Information and Application Description

Some illustrations from the HLS industry follow. It will be noted that in all cases the hearing aid user(s) are either within the area enclosed by the loop, or in very close proximity (less than 2 metres) to it.

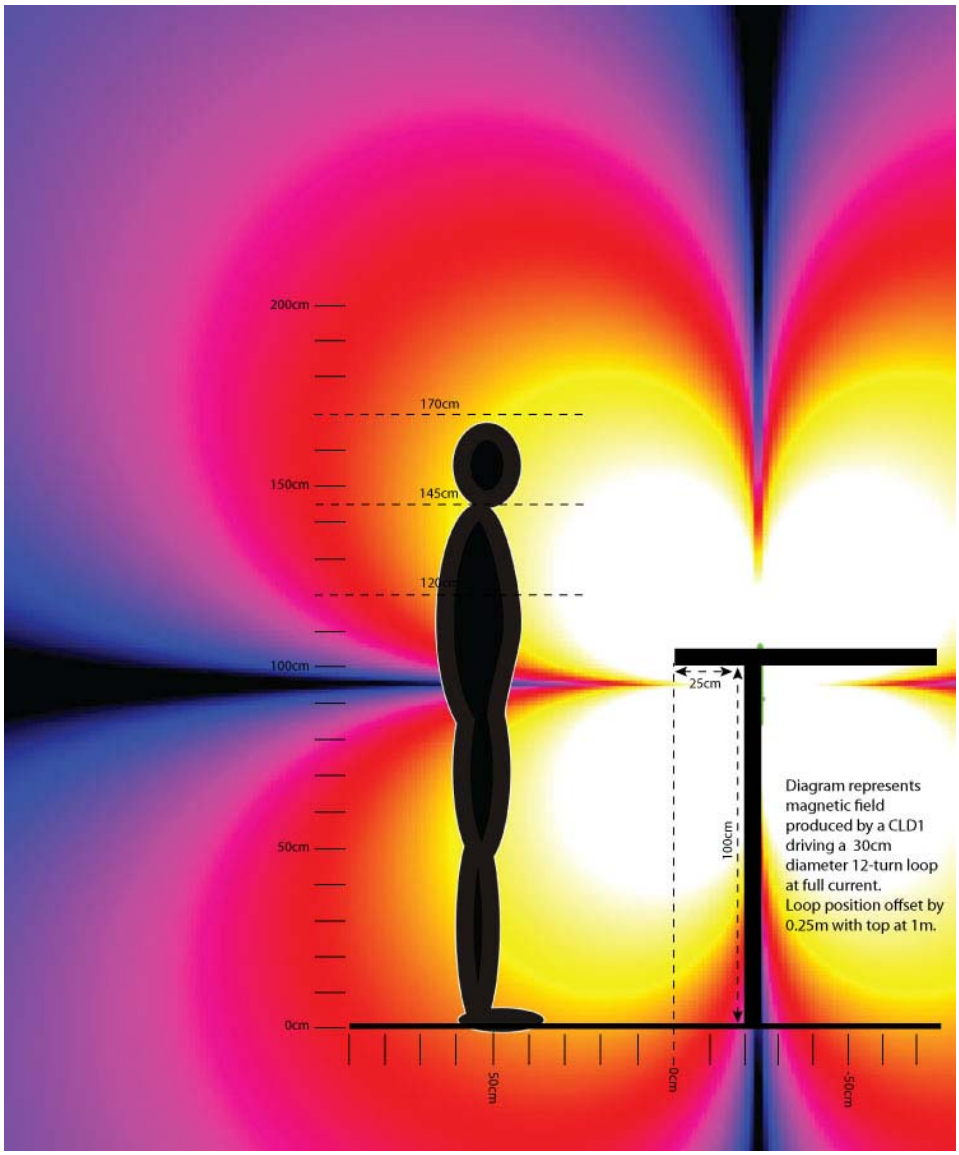

Figure 3: Small area counter hearing loop system

Figure 4: Small area hearing loop driver, typically installed under a counter

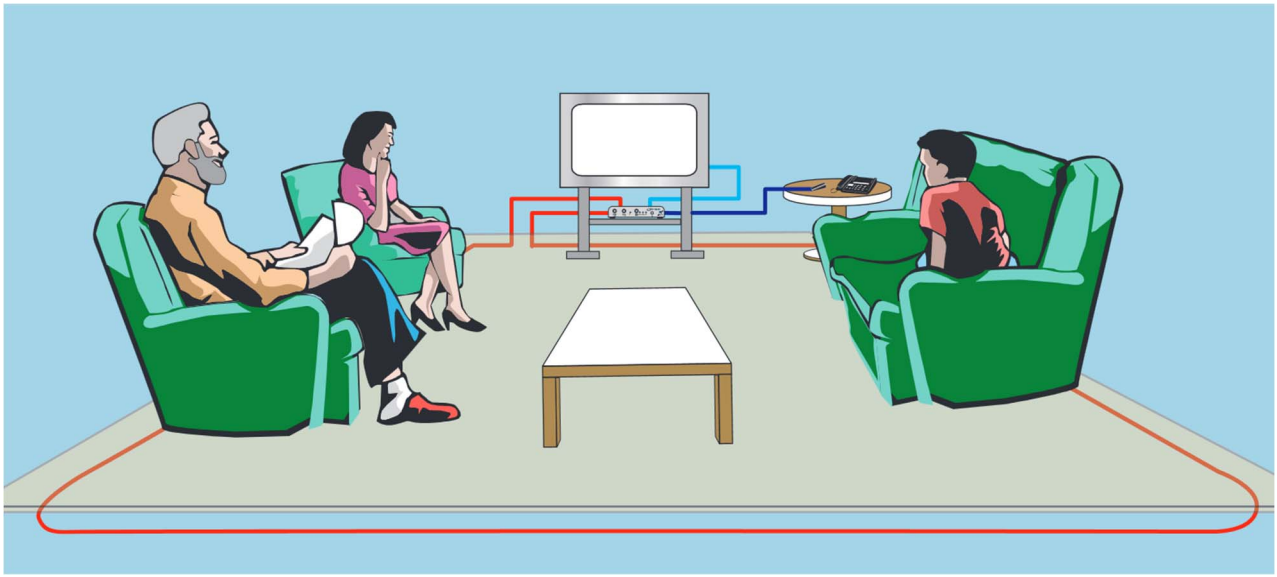

Figure 5: Large area domestic hearing loop system

Figure 6: Large area domestic hearing loop driver

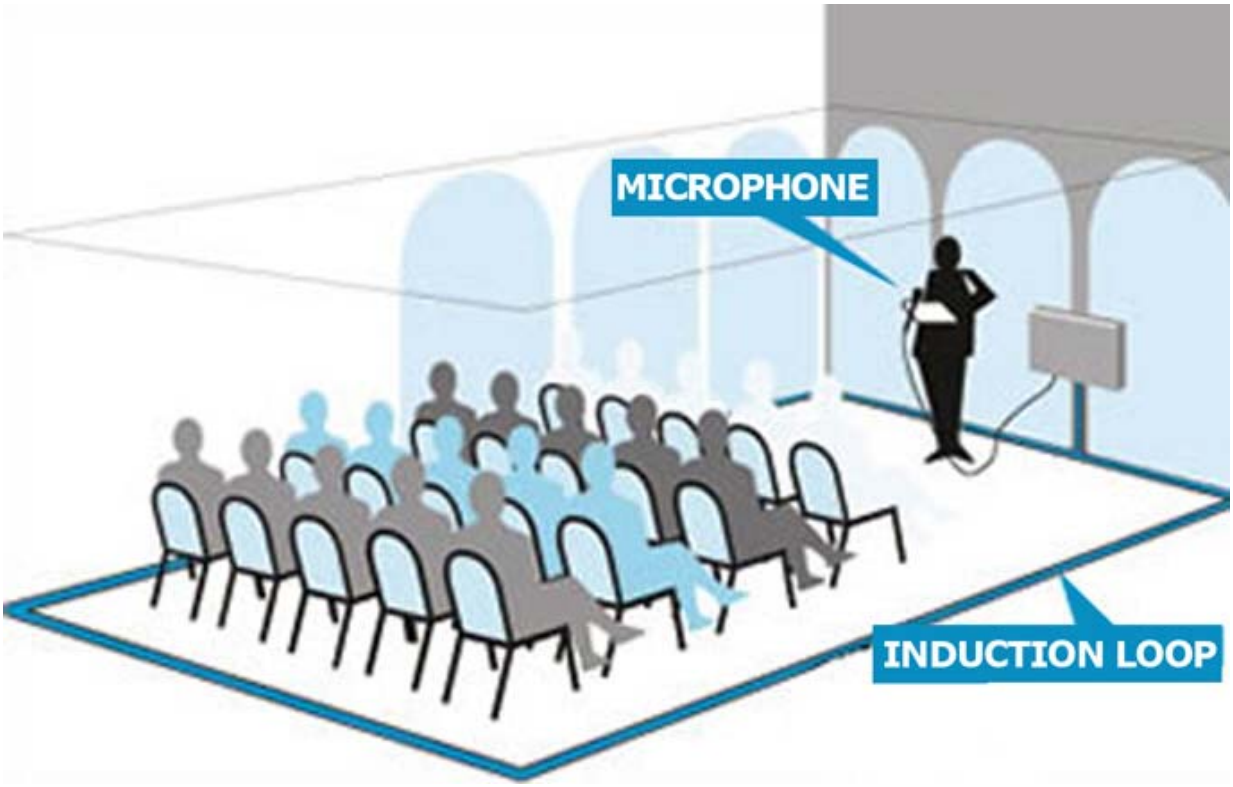

Figure 7: Large area meeting room hearing loop system

Figure 8: Large area meeting room hearing loop driver, which may be rack mounted

8 Conclusions

Hearing Loop Systems have been in use for many years in a wide variety of public and private scenarios without causing radio-frequency interference.

They have been of great economic, cultural and social benefit, primarily (but not exclusively) to people with hearing disabilities.

It is therefore important that the radio spectrum from 10 Hz to 9 kHz continues to be permitted for Hearing Loop Systems on a Europe-wide basis.

9 Requested ECC and EC Actions

ETSI requests ECC to consider the present document, which includes necessary information to support the co-operation under the MoU between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT).

10 Expected ETSI Actions and Standard Requirements

Support for the adoption of an ETSI standard for Hearing Loop Systems to demonstrate compliance with the RED that is being drafted by the International Hearing Loop Manufacturers Association (IHLMA).

Annex A:
Detailed Market Information

A.1 Applications

A.1.0 Introduction

HLS are intended for use in domestic and non-domestic applications, wherever a benefit to hearing instrument users is required.

HLS are used in theatres, conference rooms, cinemas, places of worship, meeting halls, shopping areas, and education establishments, and for passenger handling buildings associated with rail, sea and air transport. Smaller installations are used in household premises and residential homes can increase the enjoyment of radio, television programmes and personal computers. They can also prove to be valuable for interview areas, ticket booths and service counters (ticket office systems).

A.1.1 Application Categories

HLS applications fall into the following categories:

- Large, fixed installations

  E.g. Theatres, musical halls, congress centres, event halls, sports arenas

- Smaller communal and domestic settings

  E.g. Residential homes, meeting areas

- "One to one" settings

  E.g. Ticket offices, sales outlets

- Personal use

  E.g. Private television viewing

A.2 Market Size

A.2.1 Markets Covered

HLS are used worldwide. Both manufactures and users prefer harmonized solutions for the available equipment. Through the harmonization, the same equipment can be used in large areas and a huge number of countries. This lowers unit production costs and lowers the costs for the users.

A.2.2 Current Market Situation

It is estimated that within the UK, sales of Hearing Loop Systems are at least 10 000 systems per annum, and the existing base of HLS is estimated to be between 50 000 and 200 000 systems. Hearing Loop Systems are also common in countries such as Norway, Sweden, Denmark, Finland, The Netherlands, Germany and France. It is expected that the number of systems and their use in different countries will increase with as the population ages and with increasing observation of disability legislation.

A.2.3 Market forecast

HLS are likely to be required for the foreseeable future because of the very large user base, the number of installations and EU-wide legislative requirements for equality of access.

Annex B: Bibliography

- BS 8300 (2009)

British Standard BS 8300 is the code of practice for the design of buildings and their approaches to meet the needs of disabled people. The standard recommends that "a hearing enhancement system, using induction loop, infra-red or radio transmission, should be installed in rooms and spaces used for meetings, lectures, classes, performances, spectator sports or films, and used at service and reception counters where the background noise level is high or where glazed screens are used" (9.3.2). It pinpoints the following areas for consideration: seated waiting areas, ticket sales and information points, fitness suites and exercise studios, churches, crematoria and cemetery chapels, educational, cultural and scientific buildings.

- The UK Building Regulations Part M

Current building regulations for England and Wales state that newly erected or substantially reconstructed non-domestic buildings should make reasonable provision for people to gain access to and use their facilities (Requirement M1). In particular, the regulations state that reasonable 'aids to communication' should be provided for the hearing impaired in auditoria, meeting rooms, reception areas, ticket offices and at information points. One of the aims of Requirement M1 is to ensure all people can participate in proceedings at lecture/conference facilities and entertainment, leisure and social venues. According to the regulations, aids to communication will satisfy {part of} this requirement if 'a hearing enhancement system is installed in rooms and spaces designed for meetings, lectures, classes, performances ... and at service or reception counters when they are situated in noisy areas or behind glazed screens' (section 4.36/4.36b). The regulations acknowledge that a person with a hearing disability needs to receive a signal that is amplified in both volume and signal-to-noise ratio and that hearing loop, infrared, radio and sound field systems can provide this advanced level of sound (section 4.35, Design Considerations). In larger spaces, provision needs to be made for a permanent system, but in small meeting rooms, a portable hearing loop system would be acceptable.

- The UK Care Standards Act (2000)

The UK's Care Standards Act demands that care homes in England provide certain adaptations and equipment for residents, including: - 'facilities, including communication aids (e.g. a loop system), and signs to assist the needs of all service users, taking account of the needs, for example, of those with hearing impairment, visual impairment, dual sensory impairments, learning disabilities or dementia or other cognitive impairment, where necessary' (standard 22.6). These requirements apply to all care homes providing accommodation and nursing or personal care for older people in England. Regular inspections and enforcement of the legislation is now carried out by the UK Care Quality Commission (CQC).

- The UK Equality Act (2010)

The UK's Equality Act (2010) aims to protect disabled people including the hearing impaired. Under the Act (which combines and replaces previous discrimination legislation including the Disability Discrimination Act), all service providers and those providing goods and facilities in Great Britain are required to make changes, where needed, to improve service for disabled customers or potential customers. There is a legal requirement to make reasonable changes to the way things are done, to the built environment and to provide auxiliary aids and services (such as providing information in an accessible format, a hearing loop for customers with hearing aids, special computer software or additional staff support when using a service).

Employers should also take measures to ensure that employees are not disadvantaged in the workplace.

- The UN Convention on the Rights of Persons with Disabilities

The link below lists the 164 countries that signed up for the UN's Convention on the Rights of Persons with Disabilities and as such many will have legislation similar to the UK Equality Act in place.

https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html.

History

Document history		
V1.1.1	January 2022	Publication