



Current Thinking Guide to Audio Frequency Induction Loop Systems (AFILS)

Induction Loops (AFILS) use a feature provided by all hearing aids (both analogue and digital types) which carry NHS or similar approval or comply with IEC118-1, to deliver high quality sound directly to the hearing aid. The main advantages of AFILS (Loop systems) over other forms of assistive listening devices are the fact that the hearing aid user always carries and maintains their own receiver and the fact that the system is totally discreet.

How Induction Loops Work

An induction loop system allows an audio signal (such as speech or music) to be transmitted to the listeners by means of a magnetic field. This is done by varying the current flow through a wire loop in proportion to the audio signal, creating a magnetic field within the loop. A coil mounted in a hearing aid or other suitable receiver (Such as the Current Thinking ETRX loop receiver) receives the magnetic field in the same way a transformer works, with the loop acting as the primary and the receiver's coil as the secondary. The elimination of a local sound path helps to reduce the interfering effects of distance and background noise, which causes particular problems for hearing aid users.

The pickup coil in a hearing aid is usually selected by means of a switch marked 'M' for Microphone and 'T' for Telephone (the coil within the hearing aid is normally used to pick up the magnetic field from a telephone earpiece). Sometimes a combined position is provided allowing simultaneous use of both microphone and coil. For hearing aid purposes only the magnetic field in the vertical direction is considered. This conforms to the general mounting direction of coils in hearing aids, however, if a listener bends his or her head then a change in sound level will almost certainly be noticed. Normally the listener should listen within the area of the loop.

System Design

A basic loop system is quite simple to put together. In fact it is rather like a standard sound system but with the loudspeaker replaced by the induction loop.

Sometimes a public address or sound system may already be installed, or perhaps a more sophisticated arrangement may be planned with inputs from various sources.

Where a satisfactory sound system is already installed the loop amplifier can be fed from the mixer or pre-amplifier stage of the system. This will save on duplication of microphones if these have been well

chosen and sited in the first place but still give independent control of signal from the loop.

In the absence of an existing sound system it will be necessary to provide microphones and inputs to the loop amplifier for any other signals. When microphones are to be used it is vital that they are positioned to pick up sound, which is free from reverberation and other noises. If the microphones receive a poor signal then the signal transmitted to the listener will be poor no matter how good the design of the loop and other equipment. It is also necessary to ensure that the microphones are matched electrically to the amplifier so that it is 'driven' adequately when the loop is in operation.

When positioning microphones in rooms, the microphones should be as close to the person speaking as is practicable, for example in a classroom if the microphone is placed in the ceiling in the room centre, the loop microphone will be further away from the speaker than the microphone in the hearing aid of someone sitting on the front row of the class!

All loop installations in the UK should conform to the Code of practice BS7594, this gives advice on the minimum areas to be covered, positioning of microphones and commissioning the system.

It is important to consider the loop itself as forming an integral part of a sound system. A British Standard Code of Practice for the 'Planning and Installation of Sound Systems' BS 6259: 1982 gives valuable information to engineers on various design aspects of such systems.

Before installing any loop system a survey should be undertaken to determine the construction of the building, and the location the loop cables can be placed in, certain materials, such as raised steel deck flooring or aluminium ceiling tiles will prevent the loop from being placed above or below these items, if you are in any doubt always lay a test loop before proceeding with the installation.





Legislation

The following is a brief guide to the current UK legislation relating to induction loops,

BS8300 Design of New Buildings

British Standards BS8300 is the code of practice for the design of new buildings and their approaches to meet the needs of disabled people.

BS8300 states that a "hearing enhancement system, using induction loop, infra-red or radio transmission must be installed in rooms or spaces used for meetings, lectures, classes, performances, spectator sports or films and used at service or reception areas where the background noise level is high or where glazed screens are used".

The standard 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.

Building Regulations (1992)

The building regulations state that newly erected or substantially reconstructed non-domestic buildings must provide aids for the hearing impaired. The aim is to enable both members of the public and employees to play a full part in the use of the building.

Areas requiring cover include booking and ticket offices where the customer is separated by the vendor by a glazed screen, reception areas, auditoria and meeting rooms in excess of 100M².

The regulations state that a person with a hearing disability must receive a signal some 20dB above that received by a person with normal hearing. The system should be able to suppress reverberation, audience and other environmental noise.

Care Standards Act (2002)

The act provides 'minimum standards below which no provider is expected to operate' and will effect local authority homes, charter homes and other homes not currently registered (domiciliary care agencies, fostering agencies and residential family centres).

These new regulations demand that care homes provide certain adaptations and equipment for residents, specifically:-

Standard 22.6 - 'Facilities, including communication aids (e.g. a loop system),

and signs are provided 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.'

Disability Discrimination Act

The aim of the Disability Discrimination Act is to stop discrimination against disabled people - including the hearing impaired. The DDA was extended in 2002 to cover education in schools and colleges and will be strengthened further from October 2004 as the Disability Rights Commission's (DRC) DDA Code of Practice comes into effect.

Service providers, (companies or organisations offering goods, facilities and services to the general public), must make 'reasonable' adjustments to ensure they do not unlawfully discriminate against disabled people, and document these procedures.

Under the DDA 'reasonable adjustments' include the provision of various auxiliary aids including induction loop systems, to enable deaf or hard of hearing people to access goods, facilities or services available to the general public.

Service providers who fail to make the adequate provision for people with hearing disabilities face prosecution.

It is not enough to simply install an induction loop system - it must be properly maintained and staff must know how to use and test it, in addition it must be fit for the purpose.

For example: a portable unit stored in the managers office is not suitable for use in a shop with checkouts, it is deemed discriminatory for someone to have to ask for a loop unit to be fetched and placed on the counter, when a permanent counter loop fitted to a small number of checkout positions and clearly signed with the 'EAR' symbol would allow a hearing impaired customer to choose which checkout to use without making their disability known to other store users.

Service providers who advertise disabled aids, and do not supply them when asked, or the units are not fit for purpose (incorrect type of unit or flat batteries) are liable to prosecution and a fine of up to £5000 per offence.





Field Strength

The most important part of setting up an induction loop is the strength of the magnetic field. Fortunately international agreement has been reached on the most appropriate field strength for hearing aid purposes and this specification is the subject of an international standard IEC118-4 (British Standard BSEN60118 pt.4): *Magnetic field strength in audio induction loops for hearing aid purposes*. The Radio Communications Agency regulations covering the use of induction loops are aligned with the recommendations of this standard.

The recommended field strength is 0.1 amp/metre to correspond with the **long-term average level** of a speech signal. However, the natural peaks of speech can exceed the average value by as much as four times and consequently the maximum field strength produced by the loop must be sufficient to meet these needs i.e. 0.4 amp/metre. The particular value of field strength was selected on the basis of sensitivity tests on typical hearing aids and considerations of adequate (magnetic) signal to noise ratio. Before commencing a major installation it would be wise to measure the level of background 'magnetic noise'. In some situations this could be too high to permit the satisfactory operation of a loop. The recommended frequency range is 100-5000 Hz (± 3 dB relative to the level at 1000 Hz).

The standardised value of field strength should ensure that when a person listening through a hearing aid switches from 'T' to 'M' the sound of someone speaking normally should be about as loud as the signal from the loop. Any gross departure from the recommendation could result in an unsatisfactory system. How this field strength relates to amplifier output requirements will be covered in a later section.

Note: Although a certain level of electromagnetic radiation emits from an Induction loop, a licence is not required to operate such a loop. The Radio Communications Agency document MPT1370 does, however, require that these systems conform to the field strength requirements laid down in BSEN60118-4 and the upper frequency response is limited to 16 KHz.

Calculating The Loop Current

The following analysis relies only on calculations of current. Magnetic field strength is proportional to current flowing in the loop and consequently 'power' is required only to overcome the resistance of the loop wire. As large loops, or loops with several turns (N), have relatively high values of inductance (proportional to N^2) problems exist in the maintaining the magnetic field strength at the higher frequencies. This is where the application specific amplifiers come into their own with the feedback control based on current and not voltage as with normal speaker amplifiers. Although this point should be considered, it has not been included in this simple analysis. The following will assist in deciding the type and 'size' of amplifier required.

AMP/METRE: A magnetic field strength of 1 amp/metre exists at the centre of a circular loop of diameter one metre when a current of one amp flows in the loop.

These following calculations relate to simple loop shapes, squares and rectangles and are quite satisfactory for most applications.

For a square loop of one turn the field strength at the centre is given, with *a* being the length of each side, by:

$$H = \frac{2\sqrt{2}}{\Pi} \cdot \frac{i}{a}$$

This means that a magnetic field strength of 0.1A/m would be generated by a current *i*:

$$i = \frac{\Pi a}{20\sqrt{2}} \approx \frac{a}{9}$$

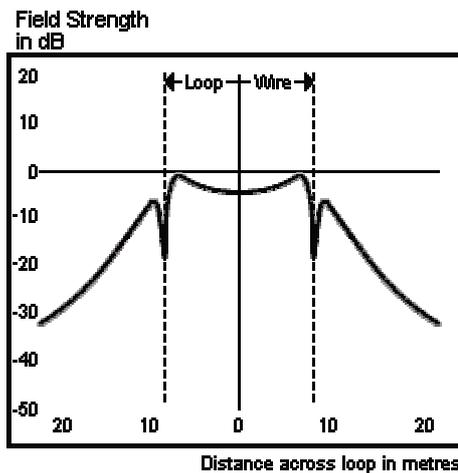
However, because the natural peaks of speech can exceed the average value by some 12dB, the short term maximum current requirement from the amplifier will be about four times the average value, so:

$$i \approx \frac{4a}{9}$$



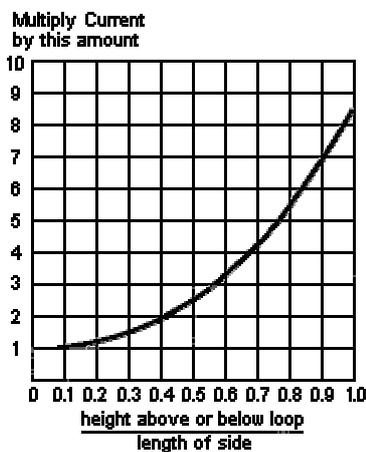


Naturally this calculation gives the field strength only at the centre of the loop but we need to know about the distribution of the field over the whole area of the loop. The next diagram shows how the field at ear level of a seated listener will vary across a loop 15m x 15m, if it is assumed that the loop is laid at floor level. The analysis is based on equations from standard magnetic theory (which are too long to go into here).



Effect Of Height

Sometimes it will be necessary to fix the loop some way above or below the 'listening' plane. The next graph can be used to find the increased current needed to



offset such a difference in height.

First the height should be expressed, as a ratio of the loop size, then by checking off this ratio on the axis of the graph the curve will show the factor by which the current must be increased.

Rectangular Loops

Even for long, narrow loops the field strength over the centre of the loop will not differ by more than three decibels from the corresponding field strength values for a

square loop based on the smaller dimension of the rectangle. Therefore the square loop calculations we have shown can be used as a guide with the knowledge that the actual field from a rectangular loop will be a little more or less depending on the height above the loop. This simple rule holds good if the height is no greater than the length of the shorter side of the rectangle.

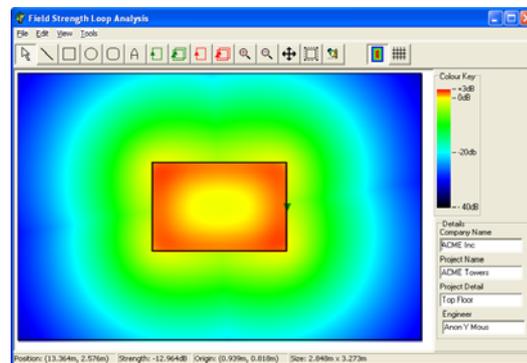
Complex Loop Shapes

When highly irregular shapes are involved, or an intricate design is planned, exact computation is not practicable and estimates should be supported by tests with the loop in place.

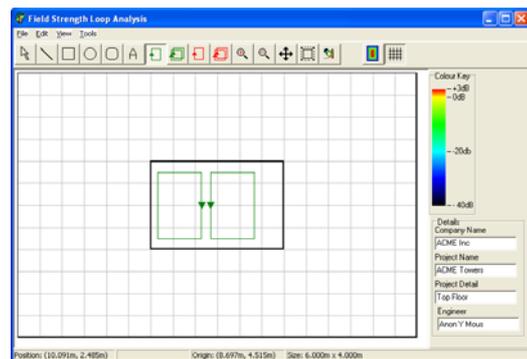
Low Spill Loop Systems

There are many situations where the loop coverage needs to be contained within a specific area, either for security (such as council chambers or courts) or where many rooms exist side by side (such as schools and colleges).

In general the overspill from a perimeter loop is equal to the width of the loop in all directions, so a 10M by 6M loop will produce an overspill area 22M by 18M.

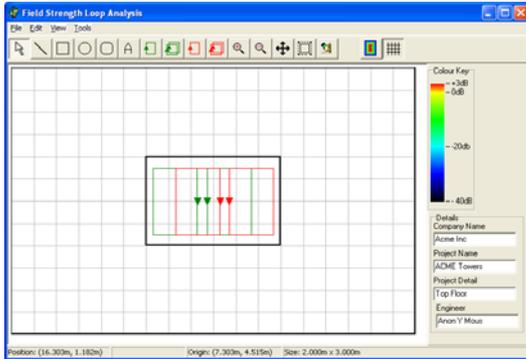


So in order to reduce the spillage from a loop, it seems obvious to make the loops narrower and place more of them in an area, however as you walk over the loop cables there is a dead spot or hole, making coverage un-even.

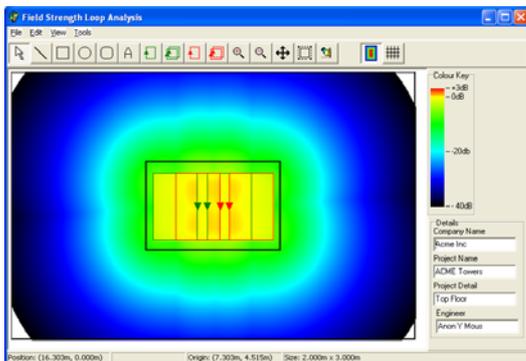




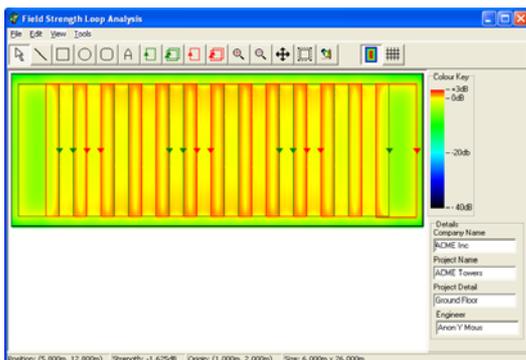
These dead spots are not acceptable, especially in large areas, so to cover the 'holes' in the coverage we can use a technique called 'De-Correlation', and produce two fields exactly 90° out of phase with each other, these fields operate independently and produce even coverage, with the phase shifted loop covering the "hole" in the main loop.



Current Thinking manufactures a phase shifter (ETPHASE) which is compatible with the ET Professional range of amplifiers (ET150, ET300 and ET450) and has a loop modelling program called ETPLAN to assist in the design of low spillage systems, please contact your distributor for details.



Another benefit of de-correlated loops is the ability to have very even coverage over large areas, IEC118-4 recommends a variation of no more than +/- 3dB field strength over the area to be covered, in rooms over 12M wide this is very difficult to achieve with a perimeter loop.



this shows a hall 60M by 30M (1800M²) covered using two ET450 and the ET Phase in two groups of seven loops 4 metres wide, notice the evenness of coverage.

Because the loops are narrower, a lower current is required to cover the area; the only limit is the length of the loop cables.

Commissioning A Loop System

Initial setting

An audio signal should be sent to the loop amplifier, either by placing a speaker and sound source of 65dBa near the microphones or by playing calibrated pink noise through the system.

Using a screwdriver adjust the input level for the audio source until the limiter moves from 0 dB to 6dB (on ET professional units) or the limit LED blinks on the ET120. Repeat the above for each input.

Then drive control on the loop amplifier until the LED representing the value of *i* (as determined by the room width above) lights.

Final Setting

Using the ETFSM held vertically and at the listening height (ear level) loop users will be at (standing or sitting), measure the field strength in the centre of the room. This should be 0dB peaking at +3dB when the compressor LED blinks from 0dB to 6dB, if this is not the case adjust the drive control on the amplifier to achieve this level.

Finally walk through the area covered and note the average level of the loop field, adjusting the loop amplifier if necessary so that the average field strength is between -3dB and +3dB over as much of the area as possible. It is also wise to mark on a plan, areas of poor coverage or high background noise so hearing aid users can be directed away from these areas.

Once commissioned, we recommend listening to the loop signal with a receiver such as the ETRX to gain a qualitative measurement of loop audio performance. It may be wise to supply the responsible person a loop receiver so they can periodically measure loop operation and record this in a logbook.

