

Electroacoustics — Hearing aids —

Part 4: Induction loop systems for hearing aid purposes — Magnetic field strength

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National foreword

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A list of organizations represented on EPL/29 can be obtained on request to its secretary.

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**Electroacoustics -
Hearing aids
Part 4: Induction loop systems for hearing aid purposes -
Magnetic field strength
(IEC 60118-4:2006)**

Electroacoustique -
Appareils de correction auditive
Partie 4: Systèmes de boucles d'induction
utilisées à des fins de correction auditive -
Intensité du champ magnétique
(CEI 60118-4:2006)

Akustik -
Hörgeräte
Teil 4: Induktionsschleifen
für Hörgeräte -
Magnetische Feldstärke
(IEC 60118-4:2006)

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CENELEC

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Foreword

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This European Standard supersedes EN 60118-4:1998 + A1:1998.

The purpose of this revision is to provide more information about practical considerations and methods of measurement. In addition, the requirements for magnetic field strength have been clarified and modified in the light of practical experience since EN 60118-4:1998 was published. Requirements for the provision to the end-user of information about the system have been introduced, intended to help to keep systems working once they have been correctly set up.

The following dates were fixed:

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Endorsement notice

The text of the International Standard IEC 60118-4:2006 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Audio-frequency induction loop systems are widely used to provide a means for hearing aid users, whose hearing aids are fitted with induction pick up coils, to minimise the problems of listening when at a distance from a source of sound, shielded from the person speaking by a protective window, and/or in a background noise. Background noise and distance are two of the main causes of hearing aid users being unable to hear satisfactorily in other than face-to-face quiet conditions. Induction loop systems have been widely installed in churches, theatres and cinemas, for the benefit of hearing-impaired people. The use of induction loop systems has been extended to many transient communication situations such as ticket offices, bank counters, drive-in/drive-through service locations, lifts/elevators etc. The widespread provision of telephone handsets that provide inductive coupling to hearing aids is another significant application, where ITU-T Recommendation P370 “Coupling hearing aids to telephone sets” applies.

Transmission of an audio-frequency signal via an induction loop system can often establish an acceptable signal-to-noise ratio in conditions where a purely acoustical transmission would be significantly degraded by reverberation and background noise.

One form of audio frequency induction loop system comprises a cable installed in the form of a loop usually around the perimeter of a room or area in which a group of hearing impaired persons wish to listen. The cable is connected via an amplifier to a microphone system or other source of audio signal, such as a radio receiver, CD player etc. The amplifier produces an audio-frequency electric current in the induction loop cable, causing a magnetic field to be produced inside the loop. The design and implementation of the induction loop is determined by the construction of the building in which it is installed, particularly by the presence of large amounts of iron, steel or aluminium in the structure. In addition the layout and position of electrical cables and equipment may generate high levels of background audio frequency magnetic fields that may interfere with the reception of the loop signal.

Another form of induction loop system employs a small loop, intended for communication with a hearing-aid user in its immediate vicinity. Examples are: neck loops, ticket-counter systems, self-contained 'portable' systems and chairs incorporating induction loops. (See Annex A)

The pick-up device for an audio-frequency induction loop system is usually a personal hearing aid, of a type fitted with a pick-up coil; however, special induction loop receivers may be used in certain applications.

The use of personal hearing aids as loop system receivers enables the wearers of these aids to take advantage of induction loop signal transmission wherever such loops are provided, particularly in public places. For this advantage to be most effective it is necessary for a standard value of magnetic field strength to be adopted, thus allowing a corresponding adjustment of the sensitivity of the pick-up coil in the hearing aid. The magnetic field strength has been chosen so that:

- it is high enough to produce an acceptable signal-to-noise ratio over background magnetic noise from power installations etc.;
- it is not so high as to cause overloading of the hearing aid.

The lower limit of magnetic field strength is governed by the expected level of background magnetic noise, measurements of which have been made in a number of homes, churches, schools, theatres, etc., in order to determine typical values. Measurements have also been made on hearing aids, to determine an acceptable range of input levels and on which the higher limit is based. See IEC 60118-1:1995, amendment 1:1998.

ELECTROACOUSTICS – HEARING AIDS –

Part 4: Induction loop systems for hearing aid purposes – Magnetic field strength

1 Scope

This international standard is applicable to audio-frequency induction loop systems producing an alternating magnetic field at audio frequencies and intended to provide an input signal for hearing aids operating with an induction pick-up coil.

The standard 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 (see Annex B), information that should be provided to the operator and users of the system (see Annex C), and other important considerations.

The standard does not specify requirements for loop driver amplifiers or associated microphone or audio signal sources, or for the field strength produced by equipment, such as telephone handsets, within the scope of ITU-T P.370.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

reference magnetic field strength level

the 0 dB reference for magnetic field strength levels is 400 mA/m

NOTE This is measured as specified in 6.3.1 and 6.3.6.

3.2

long-term average magnetic field strength level

long-term average level of the magnetic field strength produced by the system

NOTE 1 In the previous edition of this standard, this term was used to define the reference for magnetic field strength level measurements, but it is difficult to measure, so the maximum short-term magnetic field strength (see 6.3.1) is used in this edition for that purpose. This does NOT represent a technical change to the requirements for field strength. See also Annex D.

NOTE 2 'Long term' is not equivalent to 'S' time weighting as defined in IEC 61672-1. The $L_{eq,60s}$ is a good indication for the long-term average for some speech signals.

NOTE 3 An acoustic input sound pressure level of 70 dB and long-term average field strength of 100 mA/m in a hearing aid are assumed to give the same acoustic output level. See IEC 60118-1:1999, Clause 6.

3.3

useful magnetic field volume

volume within which the system provides hearing-aid users with a signal of acceptable quality (see 6.7).

NOTE 1 In the previous edition of this standard, the concept of 'specified magnetic field area' was defined, because that edition did not consider the very important 'height' dimension (the perpendicular distance between the hearing aid pick-up coil and the plane of the loop). See Annex E.

NOTE 2 The base area of the useful magnetic field volume is often different from the plan area of the induction loop.

4 Suitability of the site for the installation of an audio-frequency induction-loop system

4.1 General

NOTE 1 This clause is included at this place in the text because it should be considered before a system is installed and its text has to precede 6.4 for clarity.

It may not be possible to obtain acceptable conditions for an induction loop system in all places where it is desirable. It is therefore necessary *in the planning stage* to examine a proposed location with respect to the following conditions:

- the magnetic noise level from electric installations, e.g. heating systems in the floor or roof, the electrical control of lighting systems (especially in theatres);
- the influence of magnetic and electrically-conducting materials in the structure in which the loop is intended to be installed;
- the presence of other induction loop systems in the neighbourhood, the signals of which may interfere with that of the planned loop system.

NOTE 2 Techniques exist to reduce radiation outside an induction loop, but previously-installed systems may not be so designed.

4.2 Measurement of magnetic background noise level

4.2.1 Method of measurement

Measurements of magnetic noise levels shall be performed by using an A-weighting network in the measuring instrument. The measured values, expressed as the maximum average short-term (0,125 s averaging time) of the r.m.s. values of the magnetic field strength, measured with a pick-up coil whose magnetic axis is vertical (unless otherwise specified, see 6.1), shall be expressed as levels in dB referred to the reference magnetic field strength level (see 3.1).

The induction loop system shall be switched off. The magnetic background noise level shall be measured at a sufficient number of points in the useful magnetic field volume. The selection of points may be randomly distributed, but should be influenced by the height range of the users (normally measurement height of 1,2 m for seated listeners and 1,7 m for standing listeners should be used), specific seating requirements, physical layout of the location and potential influence from metal and interfering signals.

NOTE It is useful to listen to the noise, to form a subjective impression of its spectrum, and thus the likely disturbing effect on listeners.

4.2.2 Recommended maximum magnetic noise levels

Ideally, the difference between the reference magnetic field strength level and the A-weighted magnetic background noise level, which for clarity is referred to as 'reference signal-to-noise ratio' in this standard, should be greater than 47 dB. This value is appropriate in situations where the aesthetic value of the speech is important and the background acoustic noise level is very low, i.e. in theatres and similar locations. Such low levels of magnetic (and acoustic – see Note 2) noise may not always be present. In cases where communication takes priority over aesthetic considerations, a higher magnetic noise level may be tolerable. It should also be considered that high levels of magnetic background noise can be tiring and thus should only be tolerated where the communication is of a short and essential nature. The actual audible impact of the interfering signal should then be considered in assessing whether the overall benefit of the system to hearing-aid users is preferable to the absence of a loop system or the use of an alternative technique requiring a special receiver (i.e. infra-red or radio).

NOTE 1 If such a system is used it can only be used with headphones because the magnetic background noise is picked up by a hearing aid switched to 'T', as is necessary if a neck loop is used. The headphones should be suitable for hearing aid wearers.

If the magnetic noise has no significant undesirable tonal quality or is mostly at low frequencies, then a higher level of interfering signal may be acceptable. For example, a reference signal-to-noise ratio as low as 22 dB may be tolerable. If the actual ratio is less than 32 dB, this shall be reported and consideration given to remedial measures.

NOTE 2 Hearing-aid users are exposed to acoustic noise at the site, as well as magnetic noise. There is no point in requiring a magnetic noise level far lower than the acoustic noise level *as perceived by hearing-aid users*.

5 Test signals

5.1 General

It is possible to use several different types of test signal for the setting-up and measurement of the frequency mid-band value (in case of doubt, the average value over the octave band centred on 1 kHz) and the frequency response of the magnetic field strength. However, some signals are not suitable for some purposes, and the suitability depends on the amplitude characteristic of the amplifier in the system (see 6.2). The test signal specified by the amplifier manufacturer shall be used, unless the use of a different signal can be justified.

5.2 Speech signals

5.2.1 Live speech signals

Live speech is suitable only for use as a test signal for the final verification of the operation of an induction-loop system. However, live speech is an essential element in the subjective assessment of loop systems.

5.2.2 Recorded speech material

Speech that has been recorded under controlled conditions and evaluated both subjectively and objectively may be used for test purposes. See also B.2.1.

5.2.3 Simulated speech material

Simulated or synthetic speech material contains the features of speech in terms of its amplitude, frequency components and temporal characteristics, but has no recognizable intelligibility. ITU-T P.50 is accompanied by a CD containing a standardized form of synthetic speech that may be used for making objective measurements. See also B.2.2.

5.3 Pink noise signal

The signal shall be bandwidth limited, with a peak-to-peak voltage (as measured with an oscilloscope) to true r.m.s. voltage ratio of $18 \text{ dB} \pm 2 \text{ dB}$ (crest factor = 4), with a third-octave-band spectrum flat within $\pm 1 \text{ dB}$ from 100 Hz to 5 kHz

Bandwidth limitation shall be carried out by means of at least third-order Butterworth high pass and low pass filters giving -3 dB responses at 75 Hz and 6,5 kHz. See also B.2.3.

NOTE 1 This specification is given to ensure that the test signal stimulates the system in a manner similar to normal speech.

NOTE 2 The tolerance of $\pm 1 \text{ dB}$ is necessary because the theoretical responses of the specified 3rd order Butterworth filters are $-0,8 \text{ dB}$ at 100 Hz and $-0,7 \text{ dB}$ at 5 kHz, and component tolerances affect the exact values. This effect is taken into account in the method of measuring frequency response using the pink noise signal.

5.4 Sinusoidal signal

This should provide at least the three frequencies 100 Hz, 1 kHz and 5 kHz (one at a time), with less than 2 % total harmonic distortion in a 20 kHz bandwidth. The output voltage should be capable of being set to the ranges 0 mV to 10 mV and 0 V to 1 V (so as to be suitable for microphone and line-level tests). The output source impedance should be 600 Ω or less.

A sinusoidal signal can be used for the tests specified in 6.6, if the amplitude characteristic of the amplifier (see 6.2) includes a range of input signal voltages for which the output current is proportional to the input voltage. Amplifiers with automatic gain control normally exhibit such a range. Amplifiers with expansion or more complex signal-processing cannot usually be measured satisfactorily, other than for the amplitude characteristic and the field strength produced at 1 kHz, with sinusoidal signals. See also 5.2.

6 Characteristics to be specified, methods of measurement and requirements

6.1 General

The manufacturer of the system (and in some cases, the amplifier alone) should specify values for those characteristics that are independent of the particular installation. The installer should measure the values of those characteristics that are specific to the installation, and provide the results to the system operator for future reference.

Measurements shall be done with a receiver having the pick-up coil axis vertical, unless specifically requested due to a special situation. These may be encountered in places of worship, hospitals and recovery areas, where people may be kneeling, prone or supine.

Where these situations exist, the measurement shall be done with the measuring receiver positioned at the appropriate orientation. The recommendations for background interfering signal levels and the requirements for field strength and frequency response remain unchanged from the requirements for a normal system.

The levels of speech signals, and ambient magnetic noise levels, may vary over periods of several seconds or even minutes. It is important to observe the signal levels for a sufficient time so that such variations can be observed and taken into account.

During the measurements the induction loop system shall be operated under the conditions deemed to be normal during use. Other power installations such as lighting shall be adjusted to the conditions deemed to be normal during the use of the induction loop system.

A warm up time of at least 5 min shall be allowed before any measurements take place. When changing the input levels to the system, consideration shall be given to the release time of the AGC circuit, if any, which may be several tens of seconds.

NOTE AGC (automatic gain control) does not create short-term non-linear distortion, and it is necessary to distinguish between gain changes which are needed to keep the average signal level fairly constant while maintaining linear short-term amplification and actual transfer characteristic non-linearities introduced by some specialized signal processing, which change the peak to average ratio. A correctly-performing AGC system is not short-term non-linear in common understanding.

The methods of measurement using different signals are alternatives: it is required to use one method only, but results for different methods may be presented if desired.

6.2 Amplitude characteristic of the system (or amplifier)

6.2.1 Characteristic to be specified

The relationship between the output current and the input voltage of the system (or amplifier), over the useful range (between the noise level and the onset of overload) of input voltages for each input of the amplifier.

NOTE This characteristic should be considered first, because it determines how the subsequent tests should be carried out.

6.2.2 Method of measurement with a speech signal

This signal is not suitable.

6.2.3 Method of measurement with pink noise

This signal is not suitable.

6.2.4 Method of measurement with a sinusoidal signal while an AGC system is enabled

Connect the amplifier to a loop, or a substitute load of appropriate resistance and inductance. Arrange to measure the output current using a current probe, a current transformer or a very low-value series resistor.

NOTE 1 If a series resistor is used, it is essential to take into account that neither end of the resistor may be at signal common potential.

NOTE 2 It is recommended that any inductor used in the substitute load is air-cored, so as to avoid any possibility of saturation effects.

If provided, set any control for varying loop current to a low setting, so as to prevent unwanted overload of the amplifier output stage. Apply a sinusoidal input signal at 1 kHz, large enough to bring any AGC circuit, if provided, into operation or until the output stage produces almost its maximum rated current (for example the output current level is 1 dB below the maximum stated by the manufacturer).

Decrease the input signal in steps, noting the input voltage and the output current at each step. Present the results graphically, using linear scales in decibels, or as a table.

6.2.5 Method of measurement – other

Not applicable.

6.2.6 Requirements

None.

NOTE No performance requirements are set, because they are outside the scope of this standard, although it is strongly recommended that the amplifier should include automatic gain control with an input level range of at least 32 dB for a maximum output level change of 3 dB. The total harmonic distortion plus noise of the output current over this range should not exceed 5 %.

6.3 Magnetic field strength

6.3.1 Characteristic to be specified

The maximum value of the short-term average (averaging time 0,125 s) of the r.m.s. value of the magnetic field strength, measured with a pick-up coil whose magnetic axis is vertical (unless otherwise specified – see 6.1), produced by the system at one point, at least, within the useful magnetic field volume (see 6.7).

The methods of measurement given in 6.3.1 to 6.3.5 are based on the use of an amplifier which has a 'loop drive' gain control following an AGC stage, and are intended ONLY to show that the amplifier is capable of producing the required magnetic field strength. If such a control is not provided, the manufacturer's instructions shall nevertheless be followed. In order to determine that the whole system is capable of producing the required magnetic field strength from the microphone(s) and any other signal source(s), the procedure described in 6.4 is necessary.