



BSI Standards Publication

Electroacoustics - Hearing aids

Part 4: Induction-loop systems for hearing aid purposes - System performance requirements

National foreword

This British Standard is the UK implementation of EN IEC 60118-4:2015+A1:2018. It is identical to IEC 60118-4:2014, incorporating amendment A1:2017. It supersedes BS EN 60118-4:2015, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee EPL/29, Electroacoustics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Akustik – Hörgeräte – Teil 4: Induktionsschleifen für Hörgeräte – Leistungsanforderungen

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European foreword

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61938 NOTE Harmonized as EN 61938.

IEC 61260-1 NOTE Harmonized as EN 61260-1.

Foreword to amendment A1

The text of document 29/952/CDV, future edition 1 of IEC 60118-4:2014/A1:2017, prepared by IEC/TC 29 "Electroacoustics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60118-4:2015/A1:2018.

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60268-3	2013	Sound system equipment -- Part 3: Amplifiers	EN 60268-3	2013
IEC 60268-10	1991	Sound system equipment -- Part 10: Peak programme level meters	HD 483.10 S1	1993
IEC 61672-1	2013	Electroacoustics - Sound level meters -- Part 1: Specifications	EN 61672-1	
IEC 62489-1		Electroacoustics - Audio frequency induction loop systems for assisted hearing -- Part 1: Methods of measuring and specifying the per- formance of system components	EN 62489-1	2010

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FOREWORD

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International Standard IEC 60118-4 has been prepared by IEC technical committee 29: Electroacoustics.

This third edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition: Addition of [Annexes G, H and I](#) where more information is provided about practical considerations and methods of measurement.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60118 series, published under the general title *Electroacoustics – Hearing aids*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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, generally known as 'telecoils', 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 [\[1\]](#)¹⁾ 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 (telecoil); however, special induction loop receivers may be used in certain applications.

1) Numbers in square brackets refer to the Bibliography.

Electroacoustics - Hearing aids —

Part 4:

Induction-loop systems for hearing aid purposes - System performance requirements

1 Scope

This part of IEC 60118 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 (telecoil). Throughout this standard, it is assumed that the hearing aids used with it conform to all relevant parts of IEC 60118.

This 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.

This standard does not specify requirements for loop driver amplifiers or associated microphone or audio signal sources, which are dealt with in IEC 62489-1, 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60268-3:2013, *Sound system equipment — Part 3: Amplifiers*

IEC 60268-10:1991, *Sound system equipment — Part 10: Peak programme level meters*

IEC 61672-1:2013, *Electroacoustics – Sound level meters — Part 1: Specifications*

IEC 62489-1:2010, *Electroacoustics — Audio-frequency induction-loop systems for assisted hearing – Part 1: Methods of measuring and specifying the performance of system components*

3 Terms and definitions

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

3.1

reference magnetic field strength level

level of 0 dB referred to a magnetic field strength of 400 mA/m

Note 1 to entry: This is measured as specified in [8.2](#).

3.2 useful magnetic field volume

volume (of 3-dimensional space) within which the system provides hearing-aid users with a signal of acceptable quality (see 8.4)

Note 1 to entry: In the first 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 to entry: The base area of the useful magnetic field volume is often different from the plan area of the induction loop.

3.3 telecoil

inductor with an open magnetic circuit, intended for detecting the magnetic fields of audio-frequency induction-loop systems

A1 3.4 automatic gain control AGC

process or device by which the gain of an amplifier is controlled by the level of the output signal so as to reduce changes in this level as compared with the changes in the input signal

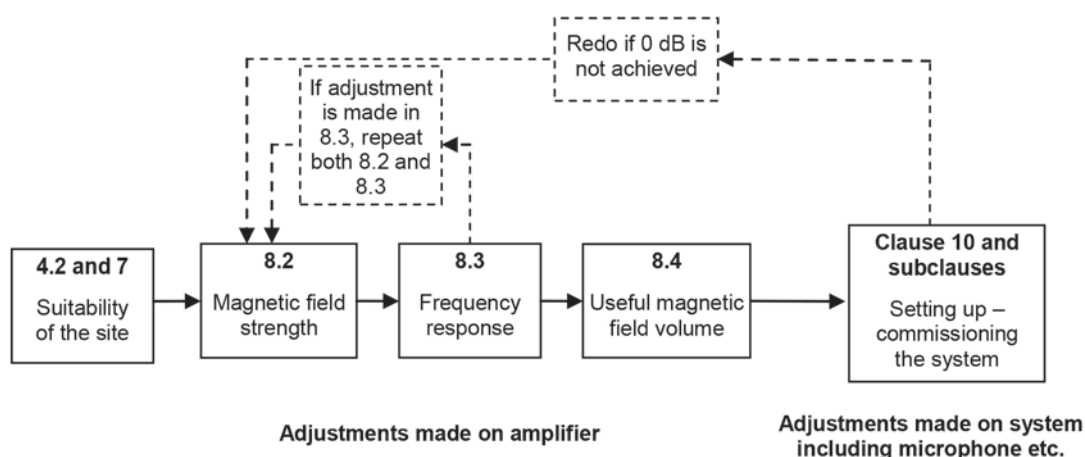
Note 1 to entry: Frequently, automatic gain control is used to keep the output signal level nearly constant.

Note 2 to entry: There is a consistent but more general definition in IEC 60118-7, but this standard may have a limited future, so the IEV definition is preferred. **A1**

4 General

4.1 Procedure for setting up and commissioning an audio-frequency induction loop system

The flow chart in Figure 1 shows the sequence of operations detailed in this standard.



IEC

Figure 1 — Flow chart for the operations in this standard

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

It may not be possible to obtain acceptable conditions for an induction-loop system in all places where it is desirable. It is therefore essential, , 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), (see [Clause 7](#));
- the influence of magnetizable 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 Techniques exist to reduce the magnetic field strength outside an induction loop, but previously-installed systems may not be so designed.

4.3 Relation of the magnetic field strength level at the telecoil to the sound pressure level at the microphone.

An acoustic input sound pressure level of 70 dB and a long-term average magnetic field strength level ($L_{eq,60s}$) of -12 dB ref. 400 mA/m, i.e. 100 mA/m, at the telecoil in a hearing aid are assumed to give the same acoustic output level.

5 Using components of a sound system in an induction-loop system

5.1 General

It may seem economically attractive to derive signals for an induction-loop system from a sound system serving the same space, but it may not be technically straightforward.

5.2 Microphones

Microphones for a sound system may not be positioned at the optimum places to obtain a signal as free as possible from ambient acoustic noise and reverberation. It is essential to listen to the signal, preferably with high-quality headphones, to assess its suitability. This should be done for all microphone signals that the sound system can produce in different modes or configurations.

5.3 Mixer

The signal for the induction-loop system shall be taken from the mixer at a point where the level of that signal is controlled independently from the signal level in the chain leading to the loudspeakers of the sound system.

5.4 Power amplifier

It is possible that a suitable signal can be obtained from the output of a power amplifier, but such a signal can be satisfactory only if it is applied to an induction-loop amplifier provided with an input of appropriate sensitivity and impedance, and with automatic gain control of a range sufficient to accommodate changes in the signal level in the sound system.

In general, it is not advisable to attempt to derive from a sound system a signal suitable for connection directly to an induction loop. Such an interconnection must be individually designed to suit the electrical characteristics of the sound system and the loop system.

6 Meters and test signals

6.1 Meters

6.1.1 Meters in general

For historical reasons, two types of magnetic field strength meter are in use, and it is not practicable to disallow the use of either of them. The results of measurements with the two types of meters are exactly equal only for sinusoidal signals but in most cases the differences are not so large as to cause serious problems. Indications are given in this standard of differences that may be expected in some cases. In case of doubt, the result of measurement with the meter specified in [6.1.3](#) shall be definitive.

6.1.2 Requirements common to both types

The meter shall have a frequency response flat within ± 1 dB from 50 Hz to 10 kHz, falling at an ultimate rate of at least 6 dB/octave outside this range. A-weighting shall also be provided. The frequency response in A-weighted mode shall conform, within the frequency band 100 Hz to 5 kHz, to those for a Class 2 meter specified in IEC 61672-1. Other features can also be provided, such as other weighting characteristics.

6.1.3 True-r.m.s. meter

This meter was derived from the IEC sound level meter specified in IEC 61672-1 by replacing the microphone by a magnetic pick-up coil and an amplifier with frequency response correction. This meter has a true-r.m.s. detector and a 125 ms averaging time constant in 'F' mode.

A useful additional feature is a peak-hold indication.

6.1.4 Peak programme meter (PPM)

This meter was derived from the PPM Type II specified in IEC 60268-10 by adding a magnetic pick-up coil, usually together with a modern display (preferably a 'bar' type) in place of the original moving-coil pointer instrument.

It shall have dynamic responses conforming to the relevant requirements of IEC 60268-10, i.e. an attack time-constant of approximately 5 ms and a release time-constant of approximately 1,0 s.

6.2 Test signals in 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 IEC 62489-1). [Table 1](#) shows the range of applications of the specified test signals. The test signal specified by the amplifier manufacturer shall be used, unless the use of a different signal can be justified.

Table 1 — Application of signals

Clause number and measurement in this standard (unless otherwise specified)	Sine wave	Pink noise	Simulated speech	Reference speech	Combi	Other
IEC 62489-1 Amplitude characteristic	Y	N	N	N	Y	N
7.1 Magnetic noise level	N	N	N	N	N	Y (no signal)
8.2 Magnetic field strength	Y	Y	Y	Y	Y	N

Clause number and measurement in this standard (unless otherwise specified)	Sine wave	Pink noise	Simulated speech	Reference speech	Combi	Other
8.3 Frequency response	Y	Y	See Note to 8.3.2	N	Y	N
10.1 Commissioning the system	N	N	N	Y	N	Y (real signals)

The use of a wideband signal and wideband meter to determine the achievement of the reference magnetic field strength requires a special procedure to prevent serious errors. First the magnetic background noise level shall be measured, to ensure sufficient signal to noise ratio, followed by the frequency response of the wanted magnetic field, after making any adjustments to the amplifier controls so as to achieve the flattest possible response. The achievement of the reference magnetic field strength can then be determined.

The frequency-response controls are set to achieve the flattest possible response, otherwise it is possible that the reference magnetic field strength is not achieved at 1 kHz. Particularly in rooms with metal reinforcement, this may cause considerable errors. Also, if the signal-to-noise ratio is not sufficient, particularly if there are strong components in the noise, this method may not be accurate.

6.3 Speech signals

6.3.1 Live speech signals

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

6.3.2 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](#).

6.3.3 Simulated speech material

6.3.3.1 General

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.

6.3.3.2 ITU-T P.50

ITU-T P.50 [\[2\]](#) is accompanied by a CD containing a standardized form of synthetic speech. See also [B.2.2](#).

6.3.3.3 Reference speech signal

The ISTS (International Speech Test Signal) [\[3\]](#) is recommended for making objective measurements. It was developed by EHIMA (European Hearing Instrument Manufacturers' Association) is derived from 21 female speakers in six different mother tongues (American English, Arabic, Chinese, French, German and Spanish) and is based on natural recordings but is largely non-intelligible because of segmentation and remixing. This was then analysed and compared to the original recordings in respect of different criteria (involving many time, frequency and amplitude distributions) and found to be entirely representative.

6.4 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 at least 18 dB (crest factor = 4), with a third-octave-band spectrum flat within ± 1 dB from 100 Hz to 5 kHz.

Bandwidth limitation shall be carried out by means of at least one-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 ± 1 dB is necessary because the theoretical responses of the specified 3rd order Butterworth filters are $-0,8$ dB at 100 Hz and $-0,7$ 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.

6.5 Sinusoidal signal

The signal source should provide at least the three frequencies 100 Hz, 1 kHz and 5 kHz (one at a time or simultaneously, or both), 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 [8.2](#) and [8.3](#) if the amplitude characteristic of the amplifier (see IEC 62489-1) 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 [6.2](#).

6.6 Combi signal

This is a signal consisting of shaped tone-bursts of 1 kHz sine wave interleaved with pink noise, and as such is suitable for any measurements specified in this standard that the 1 kHz sine wave or pink noise signal is suitable for.

The level of the 1 kHz sine wave can be measured, and with an amplifier employing a peak detecting AGC (automatic gain control), the lower r.m.s levels of the pink noise segments mean that overall it produces considerably less heating in the amplifier, which is an advantage when test times are long.

The length of the 1 kHz sine wave is limited to a minimum of 1 s to allow either meter specified in [5.1](#) to reach the correct measurement level and become stable enough for accurate reading before the transition.

The duration of the pink noise signal shall be long enough in relation to that of the sine wave signal (ratio $\geq 4:1$) in order to lower the overall amplifier heating, while providing reasonably frequent bursts of the sine wave signal for measurement purposes.

The specification of the combi signal is summarized in [Table 2](#).

Table 2 — Specification of the combi signal

Characteristic	Sinusoidal part	Pink noise part	Notes
Frequency, kHz	1	Not applicable	
3 dB bandwidth, Hz	Not applicable	See 6.4 and B.2.3	
Rise and fall times, ms	5	Not applicable	All transitions between signals shall be at zero-crossings.

Characteristic	Sinusoidal part	Pink noise part	Notes
Relative (r.m.s.) levels, dB	0	-6	The peaks of the sine wave signal are 3 dB below the maximum peak of pink noise having a crest factor of 4.
Duration, s	≥1	≥4	These minimum values may be increased but not decreased, and the ratio of 4:1 shall not be reduced.

7 Magnetic background noise level of the installation site

7.1 Method of measurement

Measurements of magnetic noise levels shall be performed by using an A-weighting network in the measuring instrument. The measured values of the magnetic field strength, measured with a meter as specified in 6.1, with a pick-up coil whose magnetic axis is vertical (unless otherwise specified, see 8.1), shall be expressed as levels referred to the reference magnetic field strength level (see 3.1) in dB.

The induction-loop system, if already installed, shall be switched off, but all other equipment normally operated at the site shall be switched on and dimmable lighting shall be set to half-dimmed. The magnetic background noise level shall be measured at a sufficient number of points in the required useful magnetic field volume. The selection of points may be randomly distributed, but should be influenced by the height range of the users (normally 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.

7.2 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 1) noise may not always be present.

NOTE 1 Hearing-aid users are exposed to acoustic noise at the site, as well as magnetic noise. There is normally no point in requiring a magnetic noise level far lower than the acoustic noise level as perceived by hearing-aid users, taking into account the effect of hearing loss on the audibility of the acoustic noise. However, this does not apply if the users wear ear-defenders.

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. For this reason, a signal-to-noise ratio of 32 dB is recommended as a minimum. If the actual ratio is less than 32 dB, this shall be reported and agreed with the system operator, so that consideration can be given to remedial measures.

Under some circumstances, a signal-to-noise ratio of 32 dB might be unacceptable.

However, 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 for short periods only. 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 2 Such a system can be used only with headphones suitable for hearing aid wearers, or accessories, such as wireless modules, giving a direct electrical input to the hearing aid, because, if a neck loop were used, the magnetic background noise would be picked up by a hearing aid switched to 'T'.

8 Characteristics to be specified, methods of measurement and requirements

8.1 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 made 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, all measurements shall be made 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 10 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.

The characteristics of AGC circuits vary, and this may affect the results of measurements on the installed loop system. If the AGC characteristics of the amplifier are not known, the relevant measurements specified in IEC 62489-1 should be carried out first.

AGC 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 non-linear over short time intervals (milliseconds) 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. If such results differ, the results of measurements using the methods specified in this standard, or used or recommended by the manufacturer, are definitive.

8.2 Magnetic field strength

8.2.1 Characteristic to be specified

The maximum value of the magnetic field strength, measured with a meter as specified in [5.1](#) and 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 [8.4](#)).