

BS EN 60118-13:2011



BSI Standards Publication

Electroacoustics — Hearing aids

Part 13:
Electromagnetic
compatibility (EMC)

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National foreword

This British Standard is the UK implementation of EN 60118-13:2011. It is identical to IEC 60118-13:2011. It supersedes BS EN 60118-13:2005 which is withdrawn.

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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English version

**Electroacoustics -
Hearing aids -
Part 13: Electromagnetic compatibility (EMC)
(IEC 60118-13:2011)**

Electroacoustique -
Appareils de correction auditive -
Partie 13: Compatibilité électromagnétique
(CEM)
(CEI 60118-13:2011)

Akustik -
Hörgeräte -
Teil 13: Elektromagnetische
Verträglichkeit (EMV)
(IEC 60118-13:2011)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 29/737/FDIS, future edition 3 of IEC 60118-13, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60118-13 on 2011-05-16.

This European Standard supersedes EN 60118-13:2005.

EN 60118-13:2011 introduces a new set of requirements for use of hearing aids with mobile phones.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2012-02-16
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2014-05-16

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive MDD (93/42/EEC). See Annex ZZ.

Annexes ZA and ZZ have been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60118-13:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60118-4 NOTE Harmonized as EN 60118-4.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60118-0	-	Hearing aids - Part 0: Measurement of electroacoustical characteristics	EN 60118-0	-
IEC 60118-2	-	Hearing aids - Part 2: Hearing aids with automatic gain control circuits	EN 60118-2	-
IEC 60118-7	-	Electroacoustics - Hearing aids - Part 7: Measurement of the performance characteristics of hearing aids for production, supply and delivery quality assurance purposes	EN 60118-7	-
IEC 60318-4	-	Electroacoustics - Simulators of human head and ear - Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts	EN 60318-4	-
IEC 60318-5	-	Electroacoustics - Simulators of human head and ear - Part 5: 2 cm ³ coupler for the measurement of hearing aids and earphones coupled to the ear by means of ear inserts	EN 60318-5	-
IEC 61000-4-3	-	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3	-
IEC 61000-4-20	-	Electromagnetic compatibility (EMC) - Part 4-20: Testing and measurement techniques - Emission and immunity testing in transverse electromagnetic (TEM) waveguides	EN 61000-4-20	-

Annex ZZ (informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers only the following essential requirements out of those given in Annex I of the EC Directive 93/42/EEC:

- ER 3, only for the aspect of electromagnetic compatibility for performance.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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INTRODUCTION

This standard introduces specifications for EMC requirements for hearing aids.

Hearing aids basically consist of a microphone, an amplifier, a induction pick-up coil and a small earphone (receiver). For behind the ear (BTE) hearing aids the sound is often fed to the ear canal by means of an individually made ear mould (ear insert). In the ear (ITE) hearing aids have the active circuitry located in the auditory canal.

The power source normally used is a small battery. On some hearing aids, the user can perform some adjustments of the controls of the hearing aid, which in some cases is by means of a remote control.

The standard only deals with hearing aid immunity, as experience has shown that hearing aids do not emit electromagnetic signals to an extent that can disturb other equipment. Other EMC phenomena, such as RF emission and electrostatic discharge, are not currently known to be a significant problem in connection with hearing aids. Based on new knowledge, they could be considered in connection with future revisions or extensions of this standard. Hearing aids containing RF transmitting equipment are covered by this standard regarding immunity, however the RF transmitting equipment is not covered. Experience in connection with the use of hearing aids in recent times has identified digital wireless devices, such as DECT wireless phones and GSM mobile phones as potential sources of disturbance for hearing aids. Interference in hearing aids depends on the emitted power from the wireless telephone as well as the immunity of the hearing aid. The performance criteria in this standard will not totally ensure hearing aid users interference- and noise-free use of wireless telephones but will establish useable conditions in most situations. In practice a hearing aid user, when using a digital wireless device, will seek, if possible, to find a position on the ear which gives a minimum or no interference in the hearing aid.

Hearing aids are battery powered devices, and therefore disturbances related to a.c. or d.c. power inputs are not relevant and are therefore not considered in this standard.

Hearing aids whose outputs are non-acoustic, e.g. cochlear implants and bone conduction hearing aids, are not covered by this standard.

In some cases, hearing aids are connected to other equipment by cable, but this standard does not cover common mode transients and common mode surges on such cable connections.

Based on experience in connection with the use of hearing aids, relevant sources of disturbance for hearing aids include low frequency radiated magnetic fields, which may interact with the induction pick-up coil input included in some hearing aids. As the induction pick-up coil input is an intended feature of some hearing aids, and the hearing aid therefore must have a certain sensitivity to low frequency magnetic fields, it is not relevant to specify immunity against disturbing low frequency magnetic fields. To avoid unintended interference from low frequency magnetic noise fields, the recommendations specified in IEC 60118-4 [1]¹, regarding specifications for induction loop systems, should be followed.

With regard to high frequency radiated electromagnetic fields originating from RF wireless devices such as digital mobile telephone systems, only sources of disturbance which are currently known to be a problem in connection with hearing aids are covered. Reference is made to IEC 61000-4-3, which identifies digital radio telephone systems operating in the frequency ranges 0,8 GHz to 0,96 GHz and 1,4 GHz to 2,48 GHz to be potential sources of interference. Future versions may add tests for other frequency bands, as they come into more common use. Hearing aids are used in all environments as outlined in IEC 61000-4-3.

¹ Figures in square brackets refer to the bibliography.

Various test methods have been considered for determining the immunity of hearing aids. When a wireless telephone is used close to a hearing aid, there is an RF near-field illumination of the hearing aid. However, validation investigations in preparing this standard have shown that it is possible to establish a correlation between the measured far-field immunity level and the immunity level experienced by an actual hearing aid used in conjunction with a digital wireless device. The use of a far-field test has shown high reproducibility, and is considered sufficient to verify and express the immunity of hearing aids. Near-field illumination of the hearing aid (i.e. by generating an RF field using a dipole antenna) could however bring valuable information during design and development of hearing aids.

ELECTROACOUSTICS – HEARING AIDS –

Part 13: Electromagnetic compatibility (EMC)

1 Scope

This part of IEC 60118 in principle covers all relevant EMC phenomena for hearing aids. EMC phenomena, such as RF emission and electrostatic discharge, are not currently known to be a significant problem in connection with hearing aids and are therefore not dealt with. Based on new knowledge, they could be considered in connection with future revisions or extensions of this standard. Hearing aid immunity to high frequency electromagnetic fields originating from digital wireless devices operating in the frequency ranges 0,8 GHz to 0,96 GHz and 1,4 GHz to 2,48 GHz is currently identified as the only relevant EMC phenomenon regarding hearing aids. Future editions of this part of IEC 60118 may add tests for other frequency bands, as they come into more common use. IEC 61000-4-3 is the basis for relevant EMC tests to be conducted on hearing aids. Measurement methods and acceptance levels are described in this part of IEC 60118.

For the purpose of this part of IEC 60118, two immunity classes of hearing aids are defined (see 3.1) related to their use. "Bystander compatible" ensures that a hearing aid is usable in environments where digital wireless devices are in operation in the proximity of the hearing aid wearer. "User compatible" hearing aids ensures that a hearing aid is usable when the wearer is using a digital wireless device at the wearer's own aided ear.

Measurement methods for hearing aids with non-acoustic outputs and for hearing aids connected to other equipment by cables are not given in this standard.

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.

IEC 60118-0, *Hearing aids – Part 0: Measurement of electroacoustical characteristics*

IEC 60118-2, *Hearing aids – Part 2: Hearing aids with automatic gain control circuits*

IEC 60118-7, *Electroacoustics – Hearing aids – Part 7: Measurement of the performance characteristics of hearing aids for production, supply and delivery quality assurance purposes*

IEC 60318-4, *Electroacoustics – Simulators of human head and ear – Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts*

IEC 60318-5, *Electroacoustics – Simulators of human head and ear – Part 5: 2 cm³ coupler for the measurement of hearing aids and earphones coupled to the ear by means of ear inserts*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-20, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60118-0, IEC 60118-7, and IEC 61000-4-3 as well as the following apply.

3.1

hearing aid

wearable instrument, containing a variety of individual adjustment facilities, intended to aid a person with impaired hearing. Consisting of a microphone, amplifier, an induction pick-up coil (optional) and earphone, powered by a battery

NOTE Hearing aids can be placed on the body (BW), behind the ear (BTE) or in the ear (ITE).

3.2

bystander compatibility

immunity of a hearing aid that ensures it is usable in environments where digital wireless devices are in operation in the proximity of the hearing aid wearer (2 m, see A.4)

3.3

user compatibility

immunity of a hearing aid that ensures it is usable when the wearer is using a digital wireless device at the wearer's own aided ear

3.4

reference orientation (of a hearing aid)

orientation of the hearing aid with respect to the RF emitting source which corresponds to the orientation of the hearing aid under actual use on a person facing or using an RF emitting source

3.5

input related interference level

IRIL

level used to characterise the immunity of the hearing aid

NOTE Acoustic IRIL is expressed relative to 20 μ Pa in decibels, and is calculated by subtracting the gain of the hearing aid from the level of a 1 kHz signal measured at the output of the hearing aid during exposure to a 1 kHz modulated RF field in microphone mode. The gain of the hearing aid is determined at 1 kHz using an input sound pressure level of 55 dB.

If the hearing aid provides an additional directional microphone, the gain determined with the omnidirectional microphone is used for determination of IRIL.

If the hearing aid provides an induction pick-up coil, the control settings used for acoustic measurement are used. Induction pick-up coil IRIL is expressed as the equivalent acoustic input r.m.s levels re 20 μ Pa in decibels, based on the assumption that the magnetic field strength level re 1A/m of –20 dB is practically equivalent to the acoustic sound pressure level of 70 dB.

The induction pick-up coil IRIL is calculated by subtracting the output of the hearing aid²⁾ in dB minus 55 dB, from the level of 1 kHz signal measured at the output of the hearing aid during exposure to a 1 kHz 80% modulated RF field in induction pick-up coil mode.

Decreasing values of IRIL indicate increasing immunity.

Further details are given in Annex A.

3.6

GSM

global system for mobile communication

²⁾ Determined at –35 dB input level re 1A/m at 1 kHz.

3.7

TEM cell

closed measuring device in which a voltage difference creates a TEM-mode electromagnetic field

3.8

radio frequency

RF

frequency of electromagnetic radiation within the range of 30 kHz to 30 GHz

4 Requirements for immunity

Table 1 states the field strengths of RF test signals to establish immunity for bystander compatible and user compatible hearing aids. Bystander compatibility shall be fulfilled as a minimum specification, whereas user compatibility is an additional feature, which can be claimed if the specifications are met by the hearing aid.

Table 1 – Field strengths of RF test signals to be used to establish immunity for bystander compatible and user compatible hearing aids

	Bystander compatibility IRIL ≤ 55 dB for field strengths, E in V/m						User compatibility IRIL ≤ 55 dB for field strengths, E in V/m					
	<0,8	0,8-0,96	0,96-1,4	1,4-2,0	2,0-2,48	>2,48	<0,8	0,8-0,96	0,96-1,4	1,4-2,0	2,0-2,48	>2,48
Frequency range GHz												
Microphone mode	Unnecessary	3,5	Unnecessary	2	1,5	Unnecessary	Unnecessary	90	Unnecessary	50	35	Unnecessary
Induction pick-up coil mode ^a	Unnecessary	3,5	Unnecessary	2	1,5	Unnecessary	Unnecessary	90	Unnecessary	50	35	Unnecessary
Directional microphone mode ^a	Unnecessary	3,5	Unnecessary	2	1,5	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Test field strengths are given as unmodulated carrier levels.												
^a If provided by the hearing aid.												

NOTE 1 Table 1 has been updated for frequencies above 2,0 GHz. Wireless services like Bluetooth operate in the 2,0 GHz to 2,48 GHz range. Services in this frequency range are typically running at lower power levels compared to services below 1 GHz. TDMA modulation (eg. used in GSM mobile phones and DECT wireless phones) has been shown to generate the most aggressive interference in hearing aids to date, while CDMA and other modulations schemes are less aggressive. The test levels used since the first edition of IEC 60118-13 in 1996 have through testing of more than 1 000 hearing aid models demonstrated to be sufficiently high to ensure well-functioning hearing aids in daily life, with only a few complaints from hearing aid users who are annoyed by interference from digital wireless devices. A test field strength 3 dB below the 1,4 GHz to 2,0 GHz range is considered sufficient to sustain well-functioning hearing aids in daily life regarding interference in the 2,0 GHz to 2,48 GHz range because services in the latter frequency range are typically running at lower power levels compared to services below 1 GHz. Additional national standards may supplement ranges in Table 1.

NOTE 2 As sources of disturbance in the frequency range 0,96 GHz to 1,4 GHz, below 0,8 GHz and beyond 2,48 GHz are not known to affect hearing aids, testing in this frequency range is not considered necessary. If the hearing aid provides an additional microphone input option – directional microphone intended for distant listening in noisy environments – user compatibility is not considered relevant in this position. Compatibility in induction pick-up coil mode is considered important to establish interference free conditions in induction loop environments, and to ensure the ability to use the induction pick-up coil as an input transducer for assistive listening devices for digital wireless devices, e.g. portable hands free kits.

NOTE 3 The requirements to generate high field strengths might drive the RF power amplifier to generate distortion. Care should be taken to ensure that distortion does not affect the measurement results.

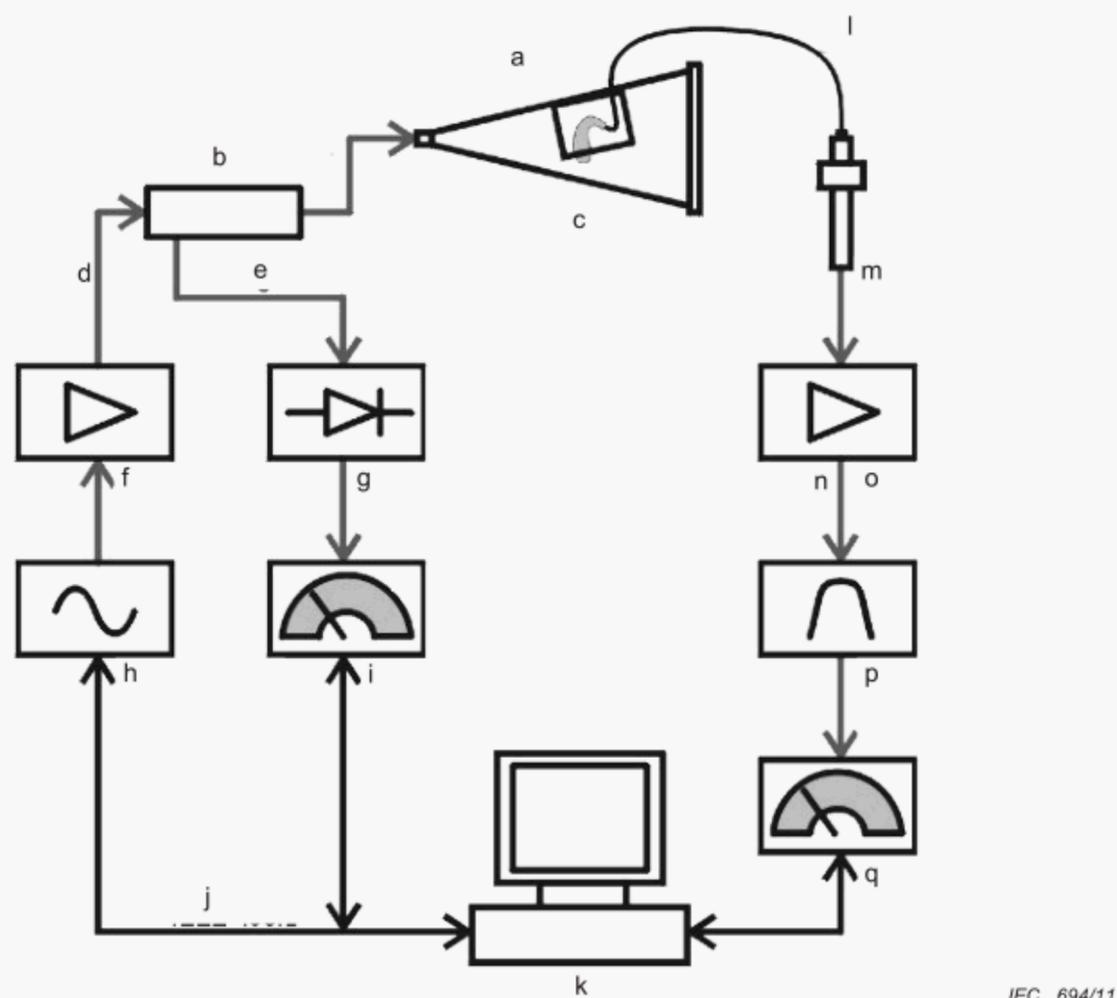
5 Immunity test procedures

5.1 A typical RF-test equipment, test configuration and test procedures, e.g. as specified in IEC 61000-4-20 shall apply. This requires that a 1 kHz 80% sine modulation of the carrier wave is used. As described in A.2, this is a suitable signal for immunity test of hearing aids.

NOTE For small systems without wires (such as hearing aids) suitable GTEM cells and striplines may be used as indicated in IEC 61000-4-20.

5.2 No objects, other than the hearing aid, which could distort the RF-field, shall be present in the test volume.

In order to remove the metallic ear simulator or coupler as specified in IEC 60318-4 and IEC 60318-5 from the test volume, the normal tubing between the hearing aid and the coupler shall be replaced by tubing of 2 mm bore and with a length between 50 mm and 1 000 mm. The choice of ear simulator or coupler and the length of the tubing are not critical, but identical setup should be used for measurement of hearing aid gain and IRIL. For in-the-ear instruments, the outlet from the receiver shall be coupled to the tubing by a suitable adapter. This adapter and the length of the tubing are not critical, as the hearing aid gain is determined in each individual test configuration. An example of a suitable test arrangement is given in Figure 1.



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NOTE Measurements should be made to ensure that the background noise level of the test configuration is at least 10 dB lower than the lowest measured acoustic output from the hearing aid.

Key

- a hearing aid
- b directional coupler
- c TEM cell
- d RF signal
- e RF signal
- f power amplifier
- g power sensor
- h RF generator
- i power meter
- j measurement instrument interface
- k measuring programme
- l 500 mm Ø2 mm tubing
- m coupler or ear simulator
- n audio signal
- o microphone power supply
- p BP filter, 1 kHz, one-third-octave
- q multimeter

Figure 1 – Example of a test arrangement for hearing aid immunity measurements using a one-port TEM cell (asymmetric septum)

5.3 The hearing aid gain control shall be adjusted to the reference test setting and the other controls shall be set to the basic settings as described in IEC 60118-7.

5.4 With the acoustical coupling described in 5.2 and the test conditions described in 5.3, the input-output response of the hearing aid shall be measured at 1 000 Hz as described in IEC 60118-2. This test applies for all hearing aids. From the input-output response curve, determine the gain obtained at 55 dB SPL input level. If the hearing aid provides an induction

pick-up coil, determine the output sound pressure level for an input level re 1 A/m of -35 dB. Examples of input-output response curves are given in Figure 2.

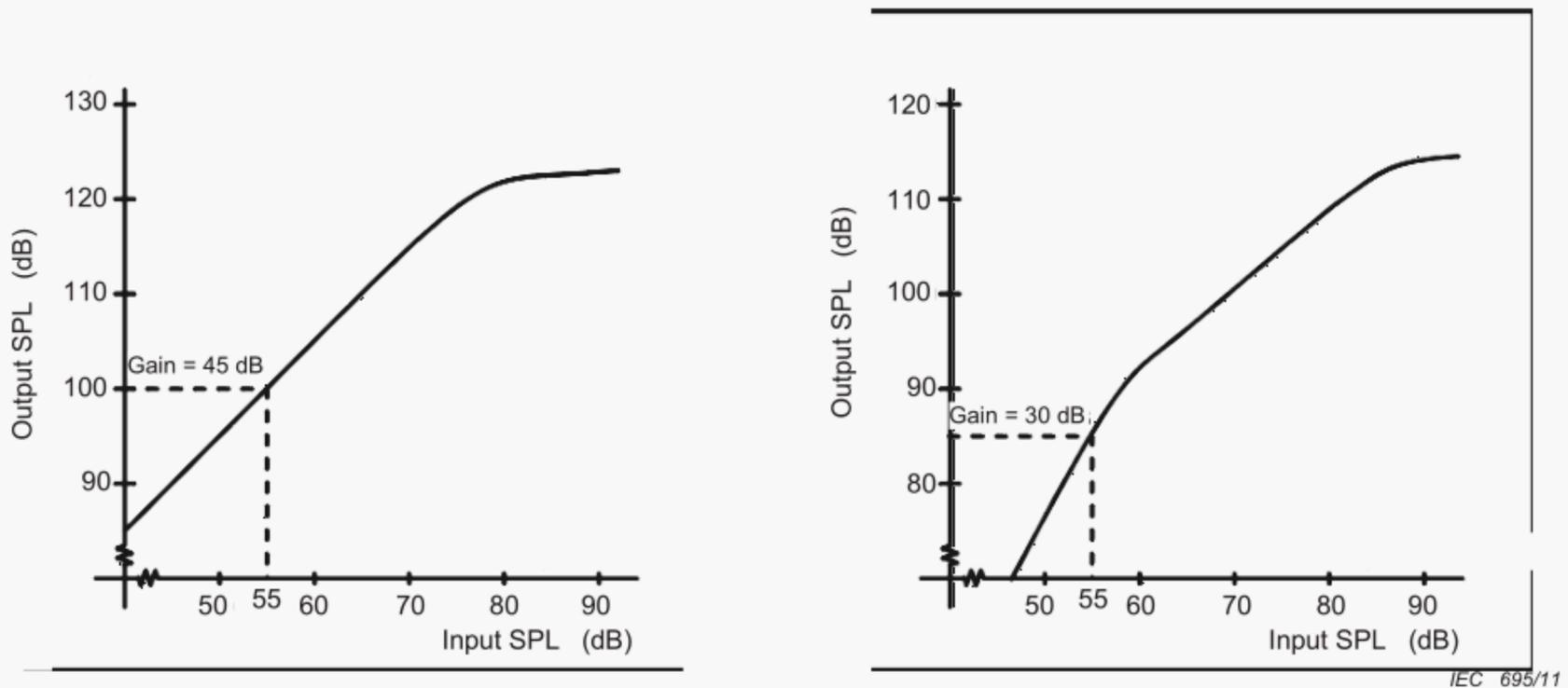


Figure 2 – Examples of input-output response curves at 1 000 Hz and the determination of gain at an input level of 55 dB

5.5 The hearing aid, with the controls set as in 5.3, shall be placed in the RF field, and the sound pressure level of the hearing aid at 1 000 Hz shall be determined with the use of a band-pass filter with a maximum bandwidth of one-third octave.

The hearing aid shall be placed in the reference orientation (see Figure 3 and 3.4) and then rotated in steps of 90° in the horizontal plane. For each orientation the carrier frequency shall be stepped or swept as specified in IEC 61000-4-3, using a step size of 1% of the carrier frequency.

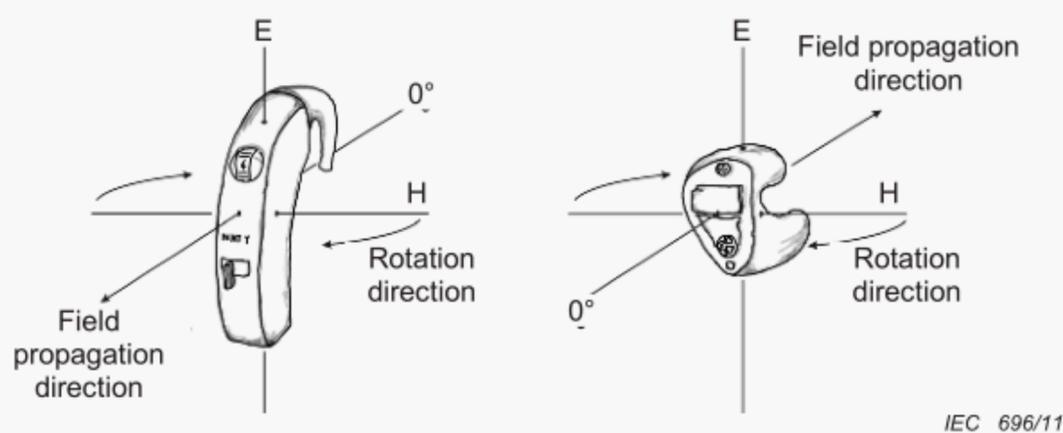


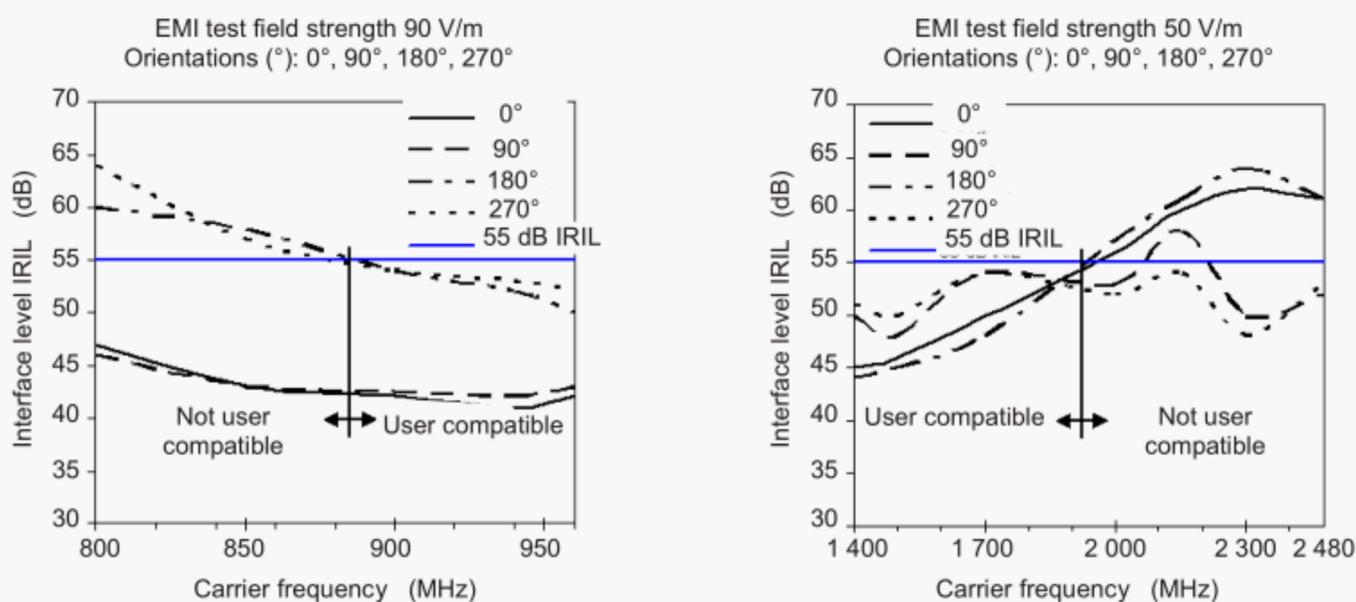
Figure 3 – Positioning of hearing aid during RF exposure

Gain changes in the hearing aid may occur due to RF carrier effects. This phenomenon can be investigated by applying increasing field strength levels and monitor the acoustic output of the hearing aid for saturation effects, or by applying a 1 300 Hz acoustic bias signal to the microphone input tube, which sets the hearing aid to a known acoustic output level. With a frequency analyzer the hearing aid acoustic output at 1 300 Hz can be measured to reveal gain changes in the hearing aid. If gain changes are observed during the measurement it shall

be stated in the test report, and results should be interpreted with care as the RF carrier effects may have activated the signal processing in the hearing aid in an unpredictable way.

NOTE Rotation of the hearing aid in four discrete positions corresponding to the hearing aid placement under actual use is found to be suitable for hearing aid immunity testing (see Annex A).

5.6 Measurements for user compatibility and bystander compatibility can be carried out as two separate tests according to Table 1. There is no need to perform a bystander compatibility test if user compatibility is demonstrated. The measurements shall be carried out with the microphone, directional microphone (if provided) and induction pick-up coil (if provided). For directional microphones, the output value measured in 5.4 with the omnidirectional microphone is used for determination of IRIL. For an induction pick-up coil, the output value measured in 5.4 with an input level re 1 A/m of -35 dB is used for determination of IRIL. Figure 4 gives examples of determination of IRIL.



IEC 697/11

Figure 4 – Examples of determination of IRIL by electromagnetic immunity (EMI) testing

5.7 The results shall be reported as IRIL values for all input options and carrier frequency ranges e.g. if $IRIL \leq 55$ dB SPL for a field strength of 90 V/m in the frequency range 800 MHz to 960 MHz, in microphone mode, the result shall be reported as follows: user compatible 800 MHz to 960 MHz, microphone mode.

User compatibility can be reported for frequency ranges more narrow than the complete test range, e.g. user compatible 1 714 MHz to 1 856 MHz. Consequently user compatibility to up-link frequencies in certain digital wireless devices networks, for example, can be claimed even if the hearing aid is not user compatible in the complete test range.

6 Measurement uncertainty

The measurement uncertainty is composed of several components:

- uncertainty derived from the equipment used, such as generators, level meters, measuring microphones, coupler etc.;
- variance in the acoustic coupling of the hearing aid to the coupler, for example relating to diameter and length of tubing;
- reproducibility of positioning the hearing aid.

Considering the above components the measurement uncertainty can be determined.

NOTE It is good practice to validate the uncertainty by comparing measurement results with an accredited test laboratory.

Manufacturers and purchasers may utilize the uncertainty differently. Manufacturers shall ensure that their production test results fall within prescribed tolerances that are reduced by the measurement uncertainty.

Purchaser may make their decisions based in the nominal data expanded by the measurement uncertainty.

Annex A (informative)

Background for establishing test methods, performance criteria and test levels

A.1 General

In 1994, the European hearing instrument manufacturers association (EHIMA) undertook a series of measurements to establish a basis for measuring the effects of interference on hearing aids, and for quantifying a practical limit of immunity. In Australia similar work was undertaken at around the same time. This work concentrated on providing the basis for measuring and specifying what is now known as the bystander compatibility. At that time, the issue of user compatibility and the need to deal with it was limited by the lack of knowledge on the subject and the low use of digital wireless devices in most countries.

However, the rapid growth in the use of digital wireless devices produced an urgent need to address the issue of the hearing aid wearer who wanted to use a digital wireless device. Work on this problem commenced in the USA in 1997 and led to proposals for methods of measurement for both hearing aids and mobile phones. This work led to the ANSI C63.19 [4] standard, which provided the impetus for further work in Europe to evaluate the proposals.

A.2 Test methods

The EHIMA GSM project was set up to establish a test environment enabling the GSM interference problems to be addressed. The project's final report [2] presents the results of the development phase. It also includes results from other investigations. The relevant parts of the project are summarised below.

Five hearing aid types were selected for a laboratory investigation, representing different electroacoustic characteristics, interference levels and interference spectra. The overall input related interference level (OIRIL), expressed as SPL, in decibels, was chosen to characterise the interference performance of the hearing aids.

First, the aids were tested acoustically according to IEC 60118-0. To enable the metallic ear simulator to be removed from the RF-field, coupling between the hearing aid and ear simulator was modified by using 500 mm long tubing. Relatively large variations in the acoustical effect of this modification were seen. This means that the hearing aid gain should be measured for the individual hearing aid under test in the determination of OIRIL.

The hearing aids were then exposed to a simulated GSM RF-field in an RF anechoic room, placed in a position corresponding to normal use. A test signal having a peak field strength of 10 V/m was used. This corresponds to a digital wireless device having a power of 8 W at a distance of 2 m, or a 2 W device at a distance of 1 m. The frequency spectrum of the interference signal at the orientation causing maximum interference was determined. The input related spectrum was then calculated by subtracting the hearing aid gain, and finally the OIRIL was determined.

The input related spectra appeared almost identical for all the hearing aids tested, the level of the harmonics decreasing with increasing frequency. This means that only the low frequency part of the spectrum is needed to determine OIRIL with sufficient accuracy for the purpose of measuring immunity.

It was seen that rotation of the hearing aid in the horizontal plane affected the interference performance to some degree and that maximum interference occurs at different angles for

different hearing aids. In practically all cases, vertical E-polarisation of the RF-field, as used in the GSM system, gave rise to the highest interference levels.

Relatively large differences in OIRIL between different hearing aid types were seen, and also in a small number of cases between samples of the same type.

A ratio of 1:2 between field strength and interference level, expressed in dB, was seen for a field strength range where the interference signal is above the noise floor of the (linear) hearing aid and does not saturate it (Figure A.1).

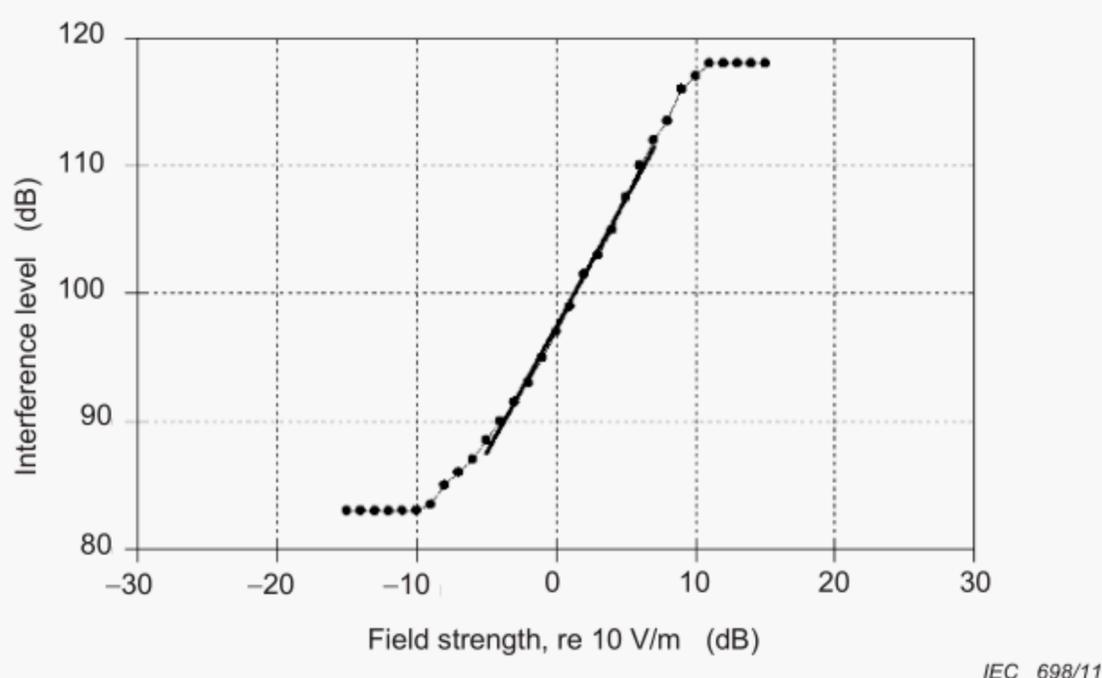


Figure A.1 – Ratio of 1:2 between field strength and interference level in dB

Experiments were carried out to determine the effect of placing the hearing aid behind the ear and in the ear. It turned out that the human head significantly attenuated the GSM signal when the head was between the transmitting source and the hearing aid, whereas no significant difference was seen when the hearing aid was facing the transmitting source. Based on these findings, it was therefore decided that no “human-factor” correction to the measuring results was required.

The investigations also showed that the use of 80 %, 1 000 Hz sine modulation with the same “peak RMS” level of the carrier as the simulated GSM signal produced approximately the same input related interference level in the hearing aid. This is in agreement with the conclusions and recommendations of IEC 61000-4-3. It was therefore decided to recommend sine modulation for testing of hearing aids. The measurement result is denoted IRIL (input related interference level). It is determined in the same way as OIRIL, but only the frequency component at 1 000 Hz is considered.

A.3 Performance criteria

To establish a basis for proposing acceptance levels a series of listening tests were carried out. As the input related spectrum of the interference signal was almost identical for all the hearing aids, only one of the signals was presented to a group of five people of normal hearing instructing them to judge the interference as “not annoying”, “slightly annoying”, “annoying” and “very annoying”. The interference signals were presented at different levels together with three different noise and speech signals to simulate different listening situations.

From the results of these tests, acceptance levels expressed as free field SPLs, are proposed.

Based on the results of these listening tests and the laboratory investigation, it is concluded that an acceptance SPL around 55 dB will probably ensure acceptable conditions for the hearing aid user in most practical situations. This value has been chosen as the performance criterion in this standard. The choice was confirmed by an additional investigation using hearing impaired subjects.

To summarise, IRIL – the input related interference level at 1 000 Hz measured as a sound pressure level in decibels – should be used to characterise the immunity of the hearing aid. Decreasing values of IRIL indicate increasing immunity. The acceptance level corresponding to IRIL equal to or less than 55 dB SPL will probably ensure acceptable conditions for the hearing aid user in most practical situations and is recommended as the performance criterion.

A.4 Test field strengths – Bystander compatibility

To be able to suggest realistic field strengths for testing hearing aids, i.e. field strengths which simulate situations where the hearing aid user is disturbed by a nearby person using a digital wireless device, a number of points should be taken into account.

Firstly, the proposed test procedure is based on a number of worst case considerations:

- The maximum interference level is found in each of four different orientations of the hearing aid relative to the disturbing field, and out of these four maxima the highest is used to characterise the interference level in the hearing aid.
- If compliance to the standard is documented, the maximum interference level within a wide frequency band is used to characterise the immunity of the hearing aid in the frequency band, even if the maximum interference level is only obtained at a single frequency.

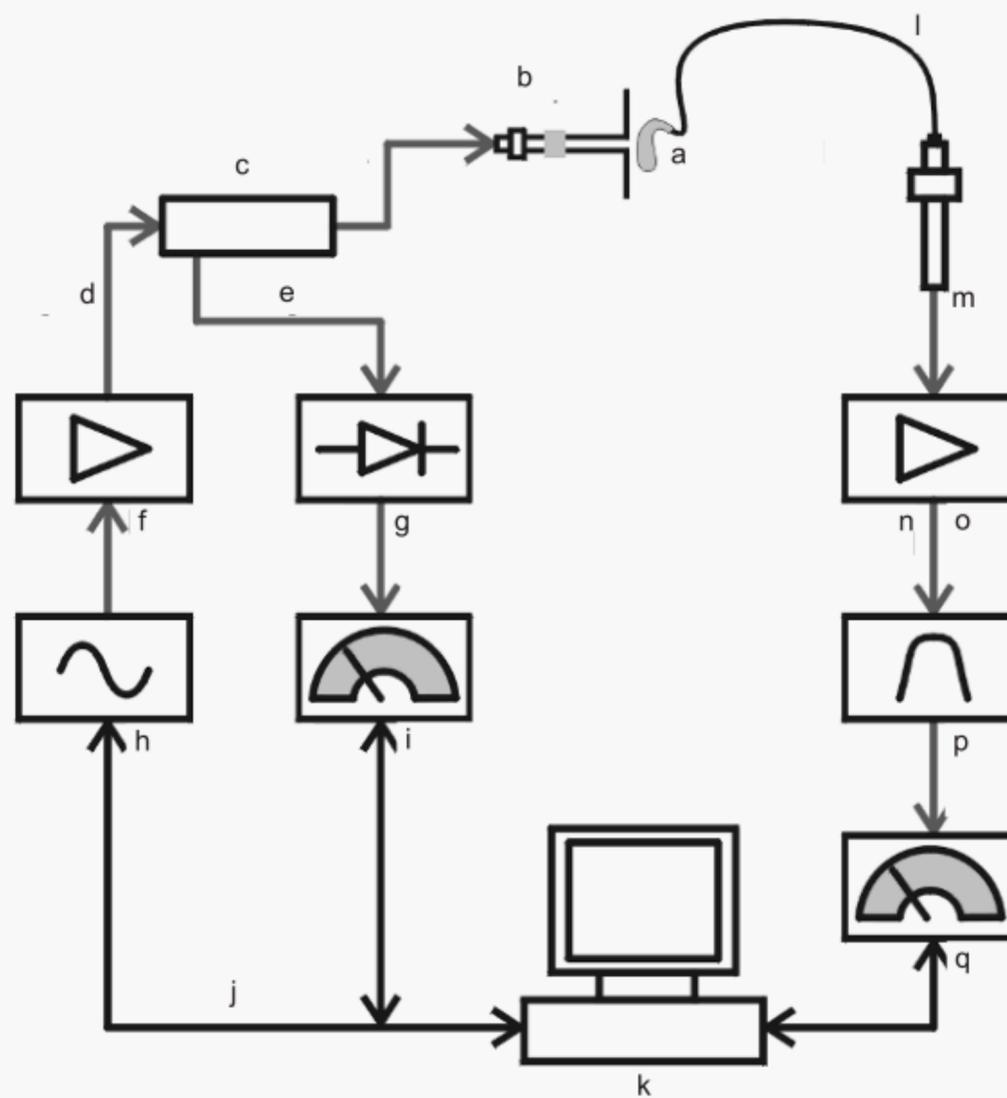
NOTE As the immunity test is performed in a broad frequency band, the frequency with the worst case interference will seldom coincide with an actual carrier frequency.

- The field strength corresponding to maximum transmitting power is used, despite the fact that digital wireless devices only transmit with maximum power in certain situations (battery fully charged, large distance between the digital wireless device and the base station).

Secondly, another practical circumstance should be noted: Users of digital wireless devices will probably tend to obtain as much privacy as possible and thereby increase the distance to nearby persons as much as possible. The field strengths given for bystander compatibility in Table 1 of Clause 4 of the main body of the standard correspond to a theoretical protection distance of approximately 2 m for any digital wireless device.

A.5 Field strengths – User compatibility

As a follow-up on the EHIMA studies concluded in 1995, a project funded by the European Union ISIS programme was conducted in 1999. This project "Hearing aids and mobile phones immunity and interference standards – HAMPIIS " was conducted to establish specifications for a revision of this part of IEC 60118 regarding criteria for hearing aid wearers to use digital wireless devices themselves. A test method proposed in the ANSI C63.19 standard with near-field illumination of hearing aids using a dipole antenna was verified during the project. Near-field illumination of hearing aids using a dipole antenna (or a digital wireless device) was found to be valuable during design and development of new hearing aids, where it can bring valuable information. An example of a suitable test arrangement using a dipole antenna is therefore given in Figure A.2.



IEC 699/11

Key

- | | |
|-----------------------|--------------------------------------|
| a hearing aid | j measurement instrument interface |
| b dipole | k measuring program |
| c directional coupler | l 500 mm Ø2 mm tubing |
| d RF signal | m coupler or ear simulator |
| e RF signal | n audio signal |
| f power amplifier | o microphone power supply |
| g power sensor | p BP filter, 1 kHz, one-third-octave |
| h RF generator | q multimeter |
| i power meter | |

Figure A.2 – Example of test arrangement for hearing aid immunity measurements using dipole antenna

However, as a standardised method for test and classification of hearing aids, the dipole test method was rejected. This was primarily due to the need for a shielded test environment and poor reproducibility from one test arrangement to another. Additionally, an improved correlation between measured performance and real-life performance could not be found, despite the fact that the hearing aid user situation in real-life is a near-field illumination of the hearing aid.

The test field strength for near field use of digital wireless devices with hearing aids was established by a study on hearing aid immunity in user situation. Twelve hearing aids having input related interference levels (IRIL) from below 20 dB to more than 70 dB when tested in a GTEM cell at 900 MHz, 3 V/m and IRIL values from below 20 dB to more than 100 dB at 1 800 MHz, 2 V/m was used for the study. The study was carried out as a listening test where 900 MHz and 1 800 MHz GSM phones were run on maximum power level, controlled by a mobile phone base station simulator. The outcome of the study showed evidence that a hearing aid will be useable in the user situation if IRIL SPL is below 55 dB for a field strength

of 75 V/m or higher at 900 MHz and of 50 V/m or higher at 1 800 MHz when measured in a GTEM cell – a test field strength 25 times higher (approximately 28 dB) than used for verification of the bystander classification.

Test field strengths have been updated for consistency with IEEE C63.19 (see [6] and [7]), and test field strengths for frequencies above 2 GHz have been added. Wireless services like Bluetooth operate in the 2,0 GHz - 2,69 GHz range. Services in this frequency range are typically running at lower power levels compared to services below 1 GHz. TDMA modulation (eg. used in GSM mobile phones and DECT wireless phones) has been shown to generate the most aggressive interference in hearing aids to date, while CDMA and other modulations schemes are less aggressive. The test levels used since the first edition of IEC 60118-13 in 1996 have, through testing of more than 1 000 hearing aid models (ref. European hearing aid manufacturers association – EHIMA), demonstrated to be sufficiently high to ensure well-functioning hearing aids in everyday use, with only a small expectation of complaints regarding interference from digital wireless devices. A test field strength 3 dB below the limit for the 1,4 GHz to 2,0 GHz frequency range is considered sufficient for the 2,0 GHz to 2,48 GHz range because services here are typically running at lower power levels compared to services below 1 GHz.

The performance criteria will not ensure totally interference-free and noise-free use of digital wireless devices but establish limits that will be effective in most situations. In practice a hearing aid user will themselves find a position of the digital wireless device by the ear that gives minimum or no interference in the hearing aid. This could be accomplished by hearing aids fulfilling the user compatibility requirements, especially if a digital wireless device with low radiation at the ear is used – i.e. digital wireless device where the distance between the hearing aid and the antenna exceeds 5 cm in normal use (i.e. Figure A.3, D).

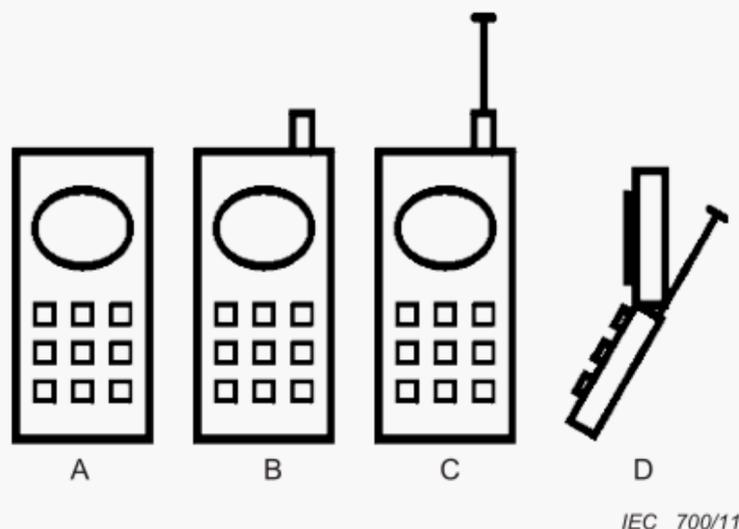


Figure A.3 – Digital wireless devices antenna designs

Bibliography

- [1] IEC 60118-4, *Electroacoustics – Hearing aids – Part 4: Induction loop systems for hearing aid purposes – Magnetic field strength*
 - [2] EHIMA GSM project, final report:1995, *Hearing aids and GSM mobile telephones: Interference problems, methods of measurement and levels of immunity*
 - [3] EU ISIS Programme project:1999, *Hearing Aids and Mobile Phones Immunity and Interference Standards – HAMPIIS*, available from EHIMA, Brussels
 - [4] ANSI C63.19:2001, *American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids*
 - [5] NAL report No. 131:1995, *Interference to Hearing Aids by the Digital Mobile Telephone System, Global System for Mobile Communications (GSM)*, National Acoustic Laboratories, Australia
 - [6] EHIMA, Technical Note 2007, *Comparison of IEC 60118-13 and ANSI C63.19 EMC measurements*
 - [7] IEEE C.63.19:2007, *Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids, Measurements of wireless telephone emissions and hearing aid immunity, with predicted performance based on measures*
 - [8] IEEE 488.2, *IEEE Standard Codes, Formats, Protocols, and Common Commands for Use With IEEE Std 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation*
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