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Telephony for hearing impaired people; Inductive coupling of telephone earphones to hearing aids

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Terminal Equipment (TE) Technical Committee, in co-operation with the Human Factors (HF) Technical Committee, of the European Telecommunications Standards Institute (ETSI).

Several administrations and operating agencies have expressed the opinion that it would be acceptable if this ETS were to be made mandatory for public telephones and wherever telephones are installed on the basis of safety, e.g. in lifts. It would not be expected to be mandatory in all countries for all telephone terminals. However, if such a facility is made available, it should conform to the requirements of this ETS, and labels and literature advertising the facility should not be related to a particular product unless it does in fact so comply.

Annexes A and E of this ETS are normative while annexes B to D and annexes F and G are informative.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	31st March 1995
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	30th September 1995
Date of withdrawal of any conflicting National Standard (dow):	30th September 1995

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1 Scope

This ETS applies to all telephones having supra-aural earphones (see ITU-T Recommendation P.57 [4]) that can be connected to the Public Switched Telephone Network (PSTN) or Integrated Services Digital Network (ISDN), which are intended for direct application to the ear (e.g. traditional handsets, operators' headsets) and which provide, at the earphone, a magnetic field for coupling to hearing aids. It specifies the level linearity and frequency dependence of the magnetic field strength produced by the handset and characteristics for the calibrated probe coil.

Handsfree or loudspeaking devices are outside the scope of this ETS.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU-T Recommendation P.37 (1993): "Coupling hearing aids to telephone sets".

[2] ITU-T Recommendation P.64 (1993): "Determination of sensitivity/frequency characteristics of local telephone systems".

[3] CCITT Handbook on Telephonometry, ITU, Geneva (1992).

[4] ITU-T Recommendation P.57 (1993): "Artificial ears".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETS, the following definitions apply:

level of magnetic field strength: The maximum value of the magnetic field strength is given in subclause 5.1 and is measured in accordance with subclause 7.1. The units are Amperes per metre (A/m).

permissible range: The range into which the measured level of the magnetic field strength needs to fall to comply with this ETS.

plane of measurement: A plane parallel to the earcap plane at a distance of 10 mm.

preferred range: The range of magnetic field strength likely to be required for satisfactory performance by hearing aids designed primarily for coupling to magnetic loops often installed in auditoria.

sound pressure level: Acoustic sound pressure level is expressed in decibels relative to 1 Pascal (or dBPa).

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

ISDN	Integrated Services Digital Network
LRGP	Loudness Rating Guard-ring Position
PSTN	Public Switched Telephone Network
TE	Terminal Equipment

4 Introduction

4.1 General

It is recognised that there is a sizeable proportion of telephone users that have difficulty in conversing over a telephone connection due to hearing loss. To alleviate these difficulties special means have been provided in many national systems to enable hearing impaired users to couple their hearing aids inductively to the telephone receiver, and a number of national/international specifications define characteristics for this form of coupling. This ETS addresses the requirements for successful inductive coupling of hearing aids to telephone sets.

Furthermore, it is also recognised that many hearing impaired users are able to have satisfactory telephone conversations while coupling their hearing aids acoustically to the telephone receiver, or even using the telephone handset without a hearing aid. This latter situation is possible due to the fact that, under good conditions, a telephone connection can be louder than a face-to-face conversation over a 1 metre air path by up to 30 dB.

The inclusion of inductive coupling does not reduce or replace existing technical standards that apply to a handset. Inductive coupling can be combined with other additional functionality, such as amplification or extra earpieces, provided specifically for people with special needs.

Provision of additional amplification in the mouth-to-ear path can greatly increase the proportion of telephone conversations involving hearing impaired users that are rated as "good". A separate ETSI Standard is planned to cover this form of coupling and it is also addressed by ITU-T Recommendation P.37 [1]. Certain national standards also exist to enable direct electrical connection of hearing aids to telephone apparatus. It is hoped that this form of coupling will be covered in a future ETSI standard.

4.2 Background

Magnetic induction systems incorporated in telephone handsets generate an alternating magnetic field with special characteristics which make the field detectable by hearing aids equipped with induction pick-up coils.

Reception of an audio-frequency signal via an induction pick-up coil can often allow an acceptable signal-to-noise ratio to be achieved in cases where the acoustical reception would otherwise be degraded by background noise.

The magnetic field strength, which enables induction pick up coils in hearing aids to function effectively, shall be high enough to produce an acceptable signal to noise ratio but not so high as to cause overloading of the hearing aid.

The value of the magnetic field strength given in this ETS has been chosen so that these requirements are met as far as possible.

Measurement methods used in this ETS are in accordance with those given in ITU-T Recommendations P.37 [1] and P.64 [2] plus the CCITT Handbook on Telephonometry [3].

NOTE: Care should be taken when designing hearing aids to include sufficient immunity to radio frequency interference to avoid disturbances arising from the detection of radio signals emitted by cordless and mobile telephones.

5 Requirements

The following requirements in respect of magnetic field strength as a function of frequency shall be met at all settings of the volume control, if provided. These requirements concern the sensitivity at 1 000 Hz, the frequency response and the linearity at 1 000 Hz as a function of the earphone sound pressure level measured with an artificial ear conforming to ITU-T Recommendation P.57 [4], Type 1.

NOTE: In respect of low acoustic impedance earphones, when the artificial ear according to ITU-T Recommendation P.57 [4], Type 3.2 is validated then the level definition will need to be reviewed.

5.1 Magnetic field strength level

The level of the magnetic field strength at 1 000 Hz when measured in accordance with subclause 7.2 shall be:

Permissible range: - 17 dB to - 30 dB relative to 1 A/m,

Preferred range: - 17 dB to - 25 dB relative to 1 A/m,

for an electrical drive to the telephone that gives a sound pressure level of - 14 dBPa at the artificial ear.

NOTE: Hearing aids with magnetic pick-up coils primarily intended for coupling to magnetic loops in auditoria in accordance with IEC Publication 118-4, are likely to require a field strength in the preferred range for effective performance.

5.2 Linearity of the magnetic field strength

The linearity of the magnetic field strength as a function of sound pressure level shall deviate by less than $\pm$ 1 dB when measured in accordance with subclause 7.3.

For an increase of sound pressure level of 20 dB the field strength shall increase by 20 dB $\pm$ 1 dB.

5.3 Frequency characteristics

The frequency characteristic of the magnetic field strength shall lie within the template given in table 1 and as shown in figure 1, when measured in accordance with subclause 7.4.

Table 1: Limits for the magnetic field frequency response

Frequency (Hz)	Upper limit (dB)	Lower limit (dB)
300	10	- 10
500	*	- 3
1 000	3	- 3
2 000	*	- 9
3 400	*	- 18
3 400	*	- inf
7 000	7	- inf

NOTE 1: The limit levels at intermediate frequencies marked * in the table lie on a straight line drawn between the given values on a logarithmic (frequency) - linear (dB) scale.

NOTE 2: The preferred frequency characteristic from 300 to 3 400 Hz lies between ± 3 dB.

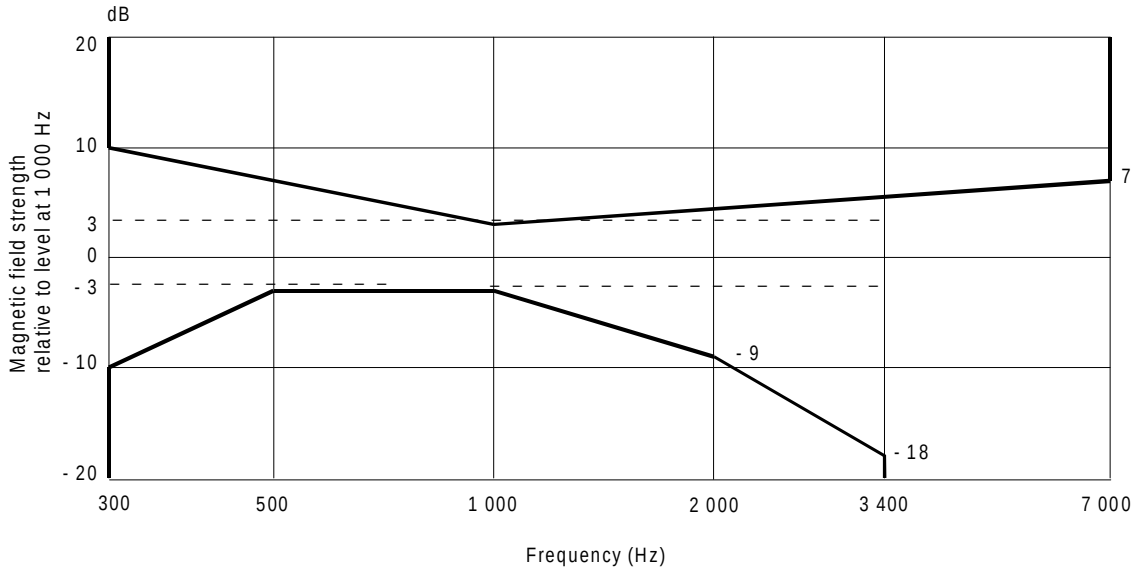


Figure 1: Magnetic field strength frequency characteristics

6 The probe coil

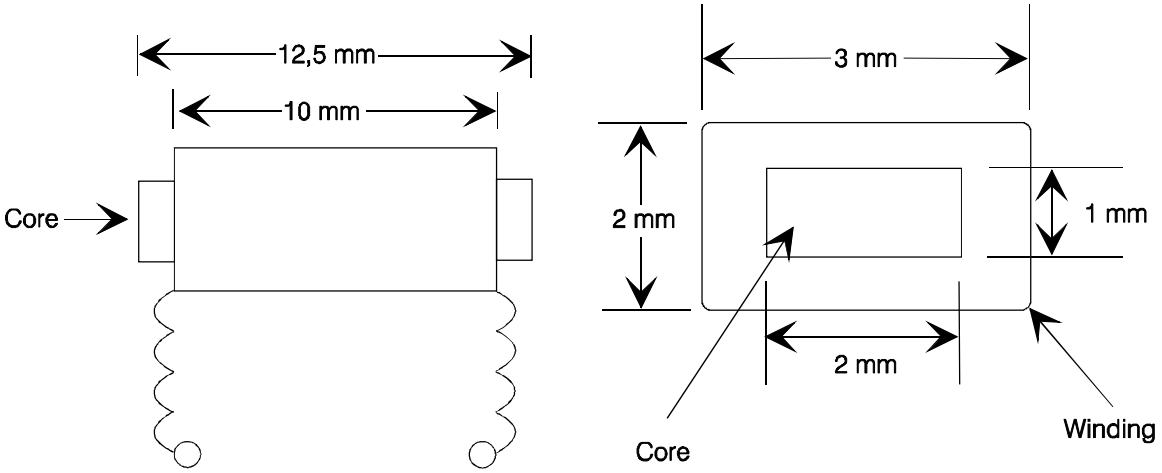
6.1 Dimensions

To minimise the loss of resolution when measuring the magnetic field strength, the following, maximum dimensions are recommended for the calibrated probe coil:

Core:	length 13,5 mm;
cross section:	1,5 mm x 2,5 mm.
Winding:	length 11 mm;
cross section:	2,5 mm x 3,5 mm.

The winding shall be shorter than the core.

An example of a coil is shown diagrammatically in figure 2 (brief details of a commercially available coil used in North America meeting the requirements of this ETS are given in annex D).



NOTE 1: The magnetic field may be non-homogeneous within distances comparable to the length of the probe coil. The introduction of a magnetic core material may also redirect the magnetic field contours. Typically, the sensitivity of the probe coil will increase with frequency at 6 dB/octave.

NOTE 2: The probe coil may be combined with frequency correcting elements to obtain a flat frequency response.

NOTE 3: This figure is not drawn to scale.

Figure 2: The probe coil

6.2 Calibration of probe coil

The probe coil shall be calibrated; a suitable method is given in annex E (normative).

6.3 Distortion

The probe coil shall introduce less than 2 % total harmonic distortion when measuring field strengths up to +2 dB relative to 1 A/m over the frequency range 300 to 3 400 Hz. In assessing the distortion of the probe coil only harmonics up to 8 000 Hz need be considered.`

6.4 Connecting leads for probe coil

To obtain a high sensitivity, the probe coil is likely to possess a relatively high inductive impedance. The connecting leads to the coil, in order to facilitate calibration, shall be of the order of 0,5 metres and their electrical effect on the signal at the measurement point cannot be ignored. Both calibration and measurement should be made using a suitable lead which is permanently attached to the probe coil, and which has stable physical characteristics. Furthermore, to minimise errors arising from different electrical terminations, the voltmeter used for measurements should be the same as that used for calibration.

7 Test procedures

Annex B (informative) gives step-by-step procedures for carrying out these tests.

NOTE: When measuring sampled systems, it is advisable to avoid measuring at sub-multiples of the sampling frequency. There is a tolerance of ± 2 % on the generated frequencies, which may be used to avoid this problem, except for 4 kHz where only the - 2 % tolerance may be used.

7.1 Calibration of receive sound pressure level

Using the measurement configuration shown in figure 3 for analogue telephones and figure 4 for digital telephones, the earpiece shall be sealed to the knife edge of the type 1 artificial ear (see ITU-T Recommendation P.57 [4]) and the drive level at the oscillator shall be adjusted to produce a sound pressure level, p_e, of -14 dBPa at 1 000 Hz. This drive level shall be used for measuring the level and frequency characteristics of the magnetic field strength.

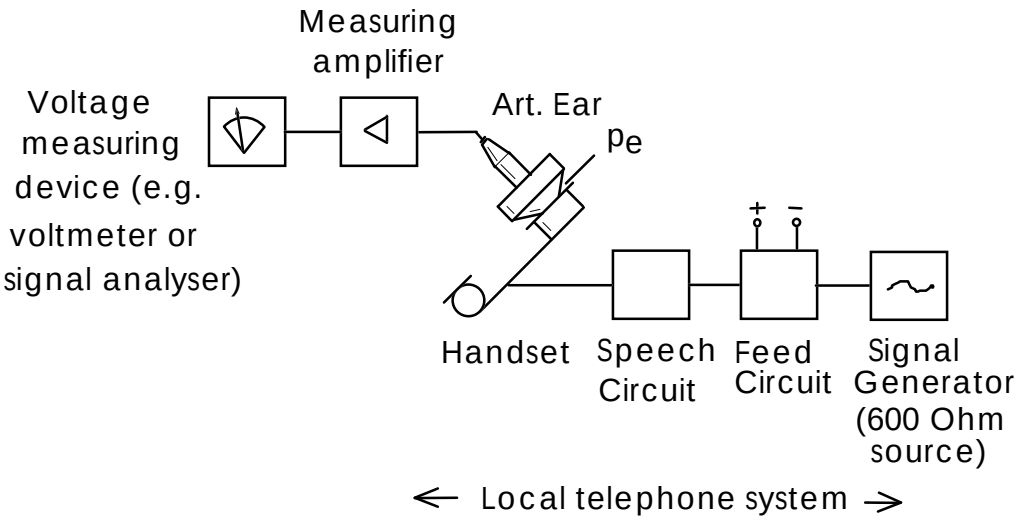


Figure 3: Setting the sound pressure level p_e in the artificial ear for an analogue telephone set

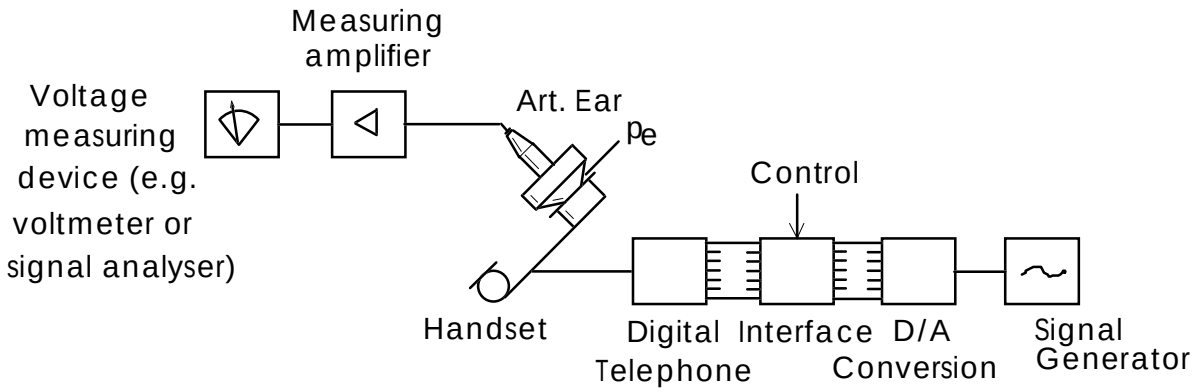


Figure 4: Setting the sound pressure level p_e in the artificial ear for a digital telephone set

7.2 Measurement of the magnetic field strength level

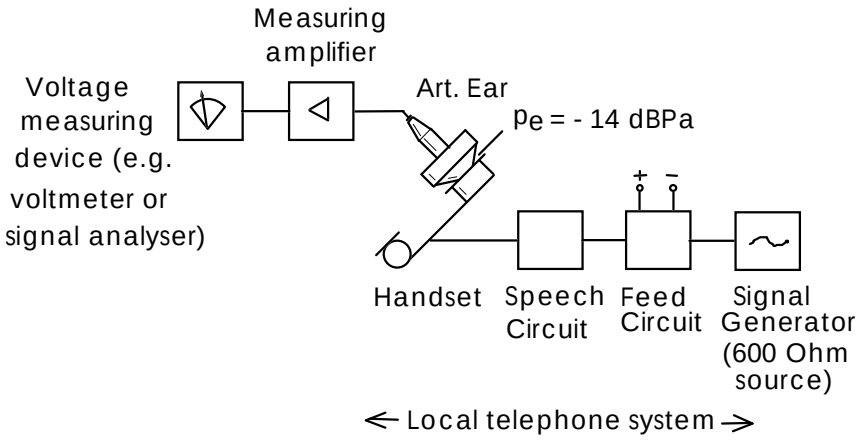
Place the centre of the calibrated probe coil (see clause 6) in the plane of measurement and orientate it in any direction for maximum coupling. Determine the magnetic field strength at 1 000 Hz using the drive level as given in subclause 7.1. Clause 5 gives the requirements for the field strength.

7.3 Measurement of the linearity of the magnetic field strength

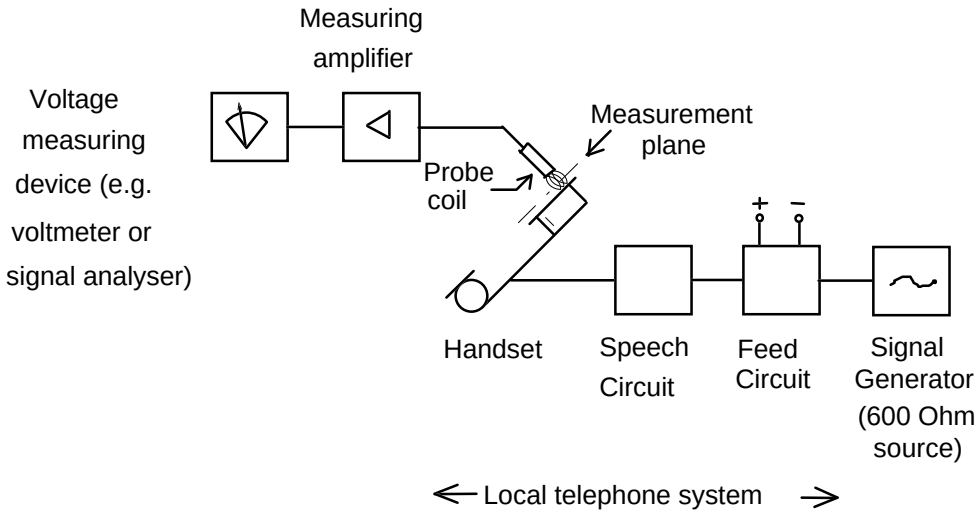
With the probe coil positioned as in subclause 7.2, increase the 1 000 Hz sound pressure level specified in subclause 7.1 by 20 dB and measure the resulting magnetic field strength.

7.4 Measurement of frequency characteristics

With the probe coil positioned as described in subclause 7.2 and the drive level as specified in subclause 7.1, vary the frequency from 300 Hz to 5 000 Hz for analogue telephones and to the upper frequency limit for digital telephones (4 000 Hz or 7 000 Hz as appropriate), and measure the resulting field strength. The magnetic field strength frequency characteristics shall fit within the template shown in figure 1 (subclause 5.3).



5a) Setting the sound pressure level delivered by the earphone



5b) Measuring the magnetic field strength at the earphone

NOTE: The figure shows the test arrangement for analogue sets. For digital sets the test arrangement in figure 4 is used.

Figure 5: Measurement of the magnetic field strength surrounding a telephone earpiece

Annex A (normative): Packaging, labelling and user instructions

A.1 Packaging and labelling

Where the telephone instruments are suitable for use by hearing impaired people, this shall be indicated by the inclusion of an agreed international symbol on the telephone sets themselves, the packaging, brochures and instruction leaflets as public signs that such facilities are available and conform to this ETS. The recommended symbol is shown in annex C, figure C.1.

A.2 User instructions

Instructions which clearly describe the manner in which the instrument to be used in conjunction with hearing aids shall be provided with each instrument. The instructions shall show how the telephone is to be placed for maximum coupling efficiency and make reference to the use of the controls on the hearing aid, particularly the switch position necessary for induction pick up (the T position).

Annex B (informative): Step-by-step measurement procedures

Measuring the magnetic field radiating from a telephone earphone.

The required sensitivity is the maximum magnetic field detected at a defined distance from the earpiece as a function of frequency for an input signal level at the exchange that gives, at 1 000 Hz, a sound pressure level in an artificial ear of -14 dBPa.

There are requirements in Clause 5 concerning the sensitivity at 1 000 Hz and as a function of frequency, also the linearity as a function of earphone sound pressure level at 1 000 Hz.

1) Calibrate the artificial ear in accordance with instructions given in the CCITT Handbook on Telephonometry [3], Section 3.2.4.

2) Calibrate the small magnetic probe coil in accordance with instructions given in clause 6.

3) Couple the handset of the telephone set to the artificial ear.

4) Connect the telephone set:

   - for analogue sets, connect the telephone set to the appropriate feed circuits including the 600 ohm source impedance from the signal generator as illustrated in figure 3;

   - for digital sets, connect the telephone set to an appropriate digital interface circuit capable of being driven from a signal generator as illustrated in figure 4.

5) Set the signal generator to give a frequency of 1 000 Hz and at a level which delivers -14 dBPa at the artificial ear.

6) Remove the artificial ear from the handset and with the centre of the probe coil 10 mm from the plane of the earcap, find the position and axis that gives maximum magnetic signal and compare with the recommended range of magnetic field given in subclause 5.1.

7) With the probe coil held in the position as described in 6) above, determine the magnetic field as a function of frequency and compare with the recommended characteristic given in subclause 5.3, figure 1.

8) With the oscillator reset to 1 000 Hz, increase the drive level so that the sound pressure level in the artificial ear increases by 20 dB and check that the magnetic field strength increases by 20 dB $\pm$ 1 dB compared with the measured level under 6) above.

   NOTE: Further useful information may be found in the CCITT Handbook on Telephonometry [3].

Annex C (informative): Symbol indicating facilities for the hearing impaired

The following symbol is recommended for use with telephone apparatus that provide facilities for hearing impaired users.

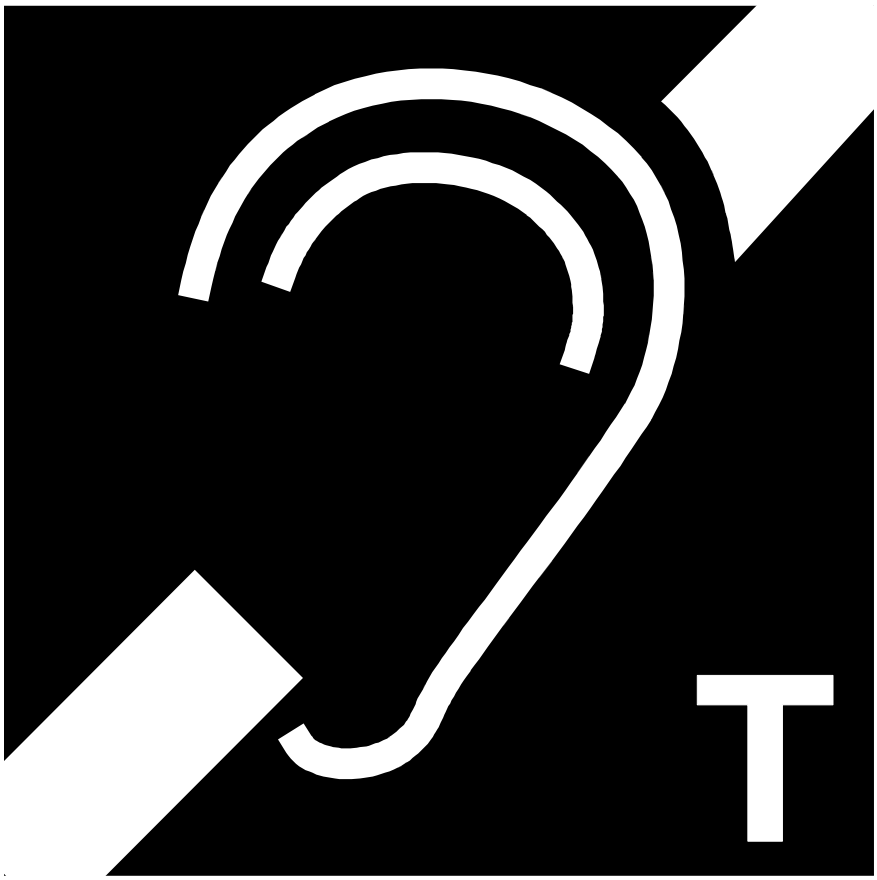


Figure C.1: Internationally agreed symbol to indicate availability of facilities for the hearing impaired

Annex D (informative): Typical characteristics of probe coil

The North American Standard, EIA/TIA RS 504, as included in the FCC Rules Part 68.316 refers to a commercially available probe coil of slightly smaller dimensions to that given above in clause 6 which nevertheless meets the requirements of this ETS. Figure D.1 below gives brief details of this coil.

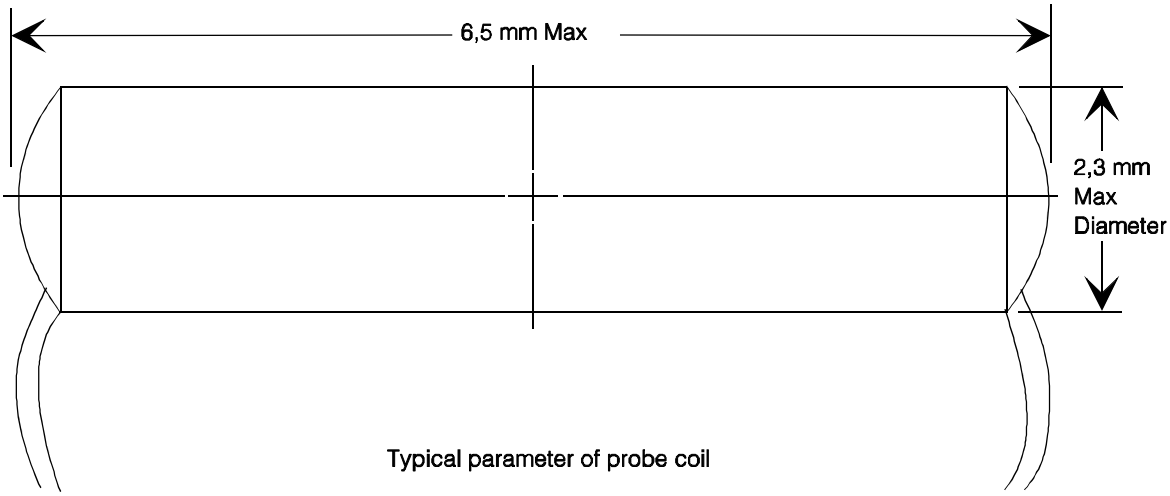


Figure D.1: Typical probe coil characteristics

Annex E (normative): Calibration of the probe coil

In order to calibrate the probe, a homogeneous magnetic field of known intensity shall be available. The magnetic field strength at the centre of a square loop of one turn with a side of "a" metres and carrying a current of "i" amperes is given by:

$$H = \frac{2\sqrt{2}}{\pi} \bullet \frac{i}{a} A/m$$

The dimension "a" should be 0,5 m or more to ensure that the field at the centre is sufficiently well defined in magnitude and direction.

In practice, it may be advantageous to construct the loop having several turns to reduce the current from the source. Essentially, constant current conditions should be maintained over the test frequency range, for example driving the coil from a low impedance generator through a series resistor having at least 100 times the impedance of the coil over the frequency range of interest. If the current drive is monitored during the calibration process any variations can be taken into account when deriving the probe coil sensitivity.

The test space shall be remote from any field disturbing magnetic material or other material in which eddy currents can be induced, so causing a field disturbance.

The sensitivity as a function of frequency of the probe coil shall be measured as the induced voltage over both leads of the probe coil with an accuracy of ± 0,5 dB. This voltage is the standard in relation to the applied current per metre and shall be used for the measurement of the requirements specified in clause 5.

The total harmonic distortion of the magnetic field shall be less than 1%.

NOTE: Further helpful information is given in IEC Publication 118-1.

Annex F (informative): Components of the inductive field

The inductive field around a telephone earphone associated with the magnetic circuit of a telephone earphone capsule or with an additional coil installed for the purpose of providing an inductive field, may be considered as having 2 components (see figure F.1).

The axial component is perpendicular to the plane of the earcap and usually passes through, or close to, the centre of the earcap plane. The radial component radiates from the centre of the earcap and may be considered for measurement purposes as parallel to the earcap plane.

Hearing aid pick-up coils are usually installed in a vertical orientation to give optimum performance when coupling to room induction loops. It is, therefore, the radial component of the telephone inductive field that most usefully couples with the hearing aid pick-up coil.

It is recommended that the requirements of this ETS should be met by the radial component of the telephone inductive field.

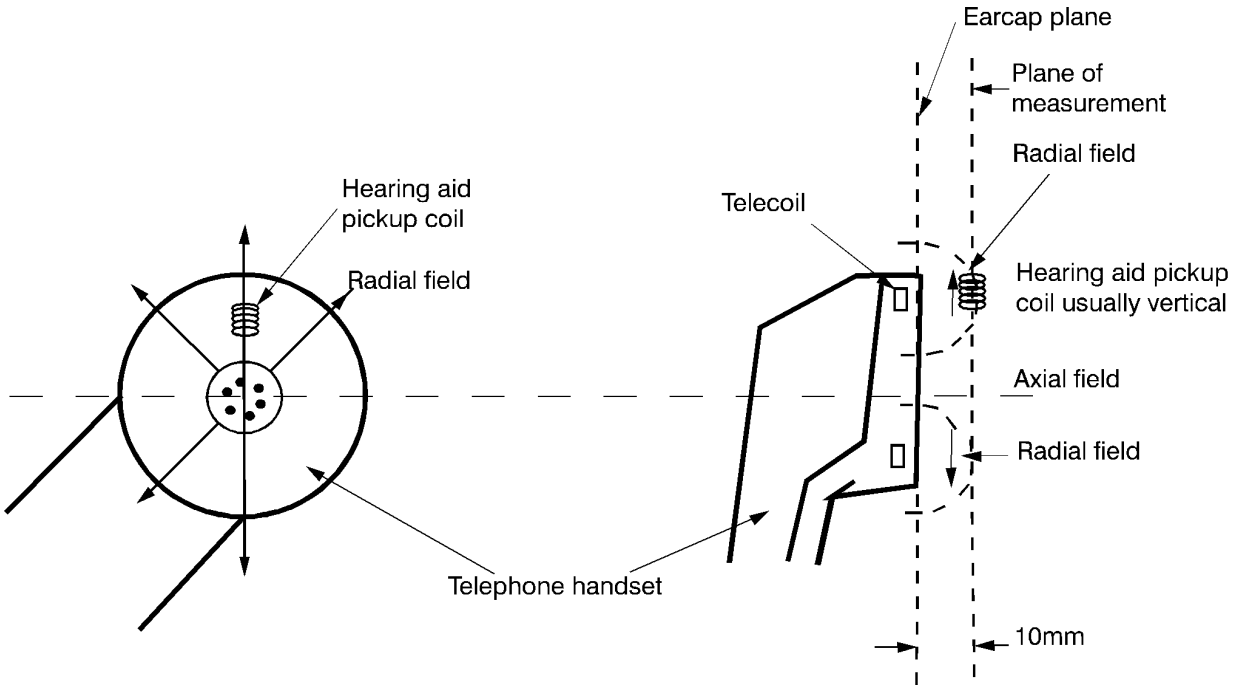


Figure F.1

Annex G (informative): Bibliography

For the purposes of this ETS, the following documents have been referred:

Oftel (UK Office of Telecommunications) WGHI (Working Group for the Hearing Impaired (1985)): "A Code of Practice for the Magnetic Coupling of Telephones to Hearing Aids".

EIA/TIA RS 504: "Magnetic field intensity criteria for telephone compatibility with hearing aids".

EIA/TIA RS 504-1: "Addendum to EIA/TIA RS 504".

IEC Publication 118-1: "Methods of measurement of electroacoustic characteristics of hearing aids; Part 1: Hearing aids with induction pick-up coil input".

IEC Publication 118-4: "Methods of measurement of electroacoustic characteristics of hearing aids; Part 4: Magnetic field strength in audio-frequency induction loops for hearing aid purposes".

History

Document history	
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