Draft ETSI EN 303 348 V1.2.0 (2021-02)

Audio frequency induction loop drivers up to 45 A in the frequency range 10 Hz to 9 kHz; Harmonised Standard for access to radio spectrum

Reference
REN/ERM-TG17-161

Keywords
cochlear implant, harmonised standard,
hearing aid, inductive

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.
Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.8] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

Audio Frequency Induction Loop System (AFILS) has been on the market since the middle of the twentieth century, with the first recognizable patents appearing circa 1938. AFILS are primarily used to facilitate improved communication to people with impaired hearing and are an important tool in the reduction of discrimination against disabled people. They are also used in a number of industries including Broadcast and studio.

The present document covers the "drivers" for the loop antenna and represents the performance of equipment which is currently on the market, which has not previously been subjected to compliance to a "radio" directive.

AFILS are installed in places of worship, places of entertainment, places of education, ticket booths and service counters, etc. as well as in domestic situations, providing huge benefits to users with impaired hearing.

AFILS provide an audio frequency magnetic field that couples with a receiving coil (telecoil) fitted in hearing aids, cochlear implants, loop listeners and testing devices. This magnetic field is generated in a wire loop that is fed by an audio frequency driver which is capable of driving current through the "induction loop" which, in turn, is fed from external signals such as those generated by microphones, audio-visual equipment and musical instruments.

AFILS operate below 9 kHz and have a very limited range (some few metres) and there is no known evidence of interference with radio equipment.

AFILS are provided in a range of sizes and can cover areas up to approximately 3 000 m^2. They are also used in vehicles and lifts and interaction with structural metal means that a complete AFILS can only be tested when fitted in their final location. This means that the "Loop" is as an external antenna which is not covered by the Radio Equipment Directive [i.1] and the present document only covers "Drivers".

The market for AFILS is relatively small compared with technologies such as RFID, and is physically separated from most radio systems, so the opportunity for mutual interference problems is reduced compared to other users of the spectrum in this frequency range.

As AFILS drivers use base band audio signals without additional carrier tones, and so when no input signal is present, there will be no output signal and so no magnetic field will be generated, ensuring spectrum efficiency.

The present document has been developed in response to Directive 2014/53/EU [i.1] and is the first radio standard that has been produced for AFILS equipment and has been prepared to allow the assessment of audio frequency induction loop drivers and receivers for compliance with Directive 2014/53/EU [i.1].

1 Scope

The present document specifies technical characteristics and methods of measurements for audio frequency induction loop drivers operating from 10 Hz to 9 kHz used in Audio Frequency Induction Loop System (AFILS) with an upper limit of 45 A_{rms}.

NOTE 1: The object of an AFILS is to transmit an audio signal to people with hearing difficulties. The receiver in this case is normally a hearing aid or cochlear implant with a built in telecoil, both of which are covered by ETSI EN 300 422-4 [i.11].

These radio equipment types are capable of operating in the frequency band within the 10 Hz to 9 kHz range:

- with (an) output connection(s);
- for audio frequency baseband transmission (un-modulated and without the use of a carrier).

The present document covers induction loop drivers with output connectors. Integral antenna systems are covered by ETSI EN 300 422-4 [i.11].

NOTE 2: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] is given in annex A.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced document are necessary for the application of the present document.

[1] Void.

[2] CEPT/ERC/Recommendation 74-01E (Siófok 98, Nice 99, Sesimbra 02, Hradec Kralove 05, Cardiff 11): "Unwanted Emissions in the Spurious Domain".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] Void.

[i.3] Void.

[i.4] IEC 60118-4:2014: "Electroacoustics - Hearing aids - Part 4: Induction loop systems for hearing aid purposes - Magnetic field strength".

[i.5] Void.

[i.6] Void.

[i.7] Void.

[i.8] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.9] Void.

[i.10] Void.

[i.11] ETSI EN 300 422-4: "Wireless Microphones; Audio PMSE up to 3 GHz; Part 4: Assistive Listening Devices including personal sound amplifiers and inductive systems up to 3 GHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in Directive 2014/53/EU [i.1] and the following apply:

artificial loop: load equal to the nominal resistance and impedance of the loop specified by the manufacturer

audio frequency induction loop driver: audio amplifier designed to drive audio-frequency current in an inductive loop, thus generating an audio-frequency magnetic field

Audio Frequency Induction Loop System (AFILS): system including induction loop driver(s), microphones and/or other signal sources, in which a magnetic field is created by the flow of audio-frequency current in a conductor arranged in the form of a loop or coil

clipping: form of waveform distortion that occurs when an induction loop driver is overdriven and attempts to deliver an output voltage or current beyond its maximum capability

conducted measurements: measurements that are made using a direct connection to the equipment under test

hearing aid: personal amplification system, worn entirely on the listener, which is designed to enable a person with impaired hearing to hear more easily

hearing instrument: hearing aid or cochlear implant

hearing loop system: non-technical name for AFILS used by the hard-of-hearing community

in band emissions: emissions on a frequency or frequencies which are inside the necessary bandwidth (10 Hz to 9 kHz)

induction loop: current carrying loop or coil of an AFILS used to create the magnetic field

NOTE: This is equivalent to the term "antenna" used in other ETSI documents and is used in the present document as it is the term commonly understood by the AFILS industry.

induction loop driver: audio driver designed to drive an induction loop

NOTE: This is equivalent to the term "transmitter" used in other ETSI documents and is used in the present document as it is the term commonly understood by the AFILS industry.

induction loop listener: portable listening device that is designed to give an audible output in response to signals produced by an AFILS

induction loop monitor receiver: equipment designed to verify the performance of an AFILS by audio and visual means:

a) providing visible indication that it is powered and indicating when the strength of the magnetic field produced by the loop falls within a specified range; and

b) providing an audio-frequency output by which the sound quality of the AFILS transmissions can be assessed

induction loop system: See AFILS.

internal loop: loop designed as a fixed part of the equipment, without the use of an external connector and as such which cannot be disconnected from the equipment by the user

loop: See induction loop.

loop listener: See induction loop listener.

metal compensation: method of compensating for amplitude and frequency dependant magnetic field losses due to the interaction of the magnetic field generated by the loop with nearby metal

mobile audio frequency induction loop driver: equipment normally installed in a vehicle (bus, coach, train, etc.)

out of band emissions: emissions on a frequency or frequencies immediately outside the necessary bandwidth (10 Hz to 9 kHz), but excluding spurious emissions

phased loop array: system of overlapping loops in which the currents are out of phase with each other used to provide an even field strength and to limit overspill of the magnetic field

portable audio frequency induction loop driver: driver intended to be carried or attached

radiated measurements: measurements which involve the absolute measurement of a radiated field

rated load: load, stated by the manufacturer, to which the driver output is connected for measurement purposes

reference magnetic field strength level: 0 dB reference for magnetic field strength levels, which is 400 mAm^{-1}

spurious emissions: emissions on a frequency or frequencies which are outside the necessary bandwidth (10 Hz to 9 kHz) and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

telecoil: magnetic pickup coil intended to receive signals from an audio frequency induction loop system

NOTE: A telecoil can be part of a hearing aid, cochlear implant, or of any other device for receiving signals from an audio frequency induction loop system in accordance with IEC 60118-4 [i.4].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

A	loop area
C	correction factor
E	electrical field strength
f	frequency
f_C	centre frequency in Hz
H	magnetic field strength
Hf	H-field-strength limit
H_C	H-field strength at the centre of the frequency of interest
H_S	H-field-strength limit for radiated spurious emissions
I_C	audio frequency in band output current

I_S	spurious output current
λ	wavelength
N	number of turns for a loop
P	power
t	time
Ω	ohm

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AFILS	Audio Frequency Induction Loop System

NOTE: Also known as a Hearing Loop.

AMN	Artificial Mains Network
CDN	Coupling/Decoupling Network
CEPT	Conférence Européenne des Postes et Télécommunications
EC	European Community
EFTA	European Free Trade Association
ERC	European Radiocommunications Committee
EU	European Union
EUT	Equipment Under Test
ISN	Impedance Stabilization Network
LISN	Line Impedance Stabilization Network
RF	Radio Frequency
RFID	Radio Frequency Identification Device
rms	root mean square
SRD	Short Range Device

4 Technical requirements specifications

4.1 Environmental conditions

4.1.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 General requirements

4.2.1 Presentation of induction loop driver equipment for testing purposes

Each equipment submitted for testing shall fulfil the requirements of the present document when operated as intended.

The range of operating conditions and power requirements for tests shall be defined based on the supplied technical documentation and operating manuals.

Drivers shall be supplied with the appropriate test jig incorporating an artificial loop.

Equipment shall be operated at its maximum intended operational current with a duty cycle of 60 s on, 240 s off in order to prevent thermal shutdown.

NOTE: AFILS drivers are designed to deliver long term speech or music signals which are constantly varying in amplitude, they are not designed to deliver sine waves for long periods.

4.2.2 Choice of model for testing

Stand-alone equipment shall be supplied by the manufacturer complete with any ancillary equipment needed for testing.

If an equipment has optional features that are considered not to affect the RF parameters, then the tests need only to be performed on the equipment configured with that combination of features considered to be the most complex, as shown in the manufacturers published technical information.

Equipment offered for test shall provide an output connector for conducted RF measurements.

The performance of the equipment submitted for testing shall be representative of the performance of the corresponding production model.

4.2.3 Controls

Controls that may need to be adjusted after installation such as input gain, loop drive, bass, treble, tone or "metal compensation" may be provided. However, any controls that might increase the interfering potential of the equipment, if misadjusted, shall not be easily accessible to the user.

4.2.4 Driver shut-off facility

If the driver is equipped with an automatic shut-off facility (such as a time-out device, over or under temperature, voltage or current, etc.) it should be made inoperative for the duration of the test, or be monitored to ensure that the shut-off facility is not activated during the test.

4.2.5 No input signal, no output signal

The loop driver shall provide no intentional drive to the induction loop when it has no audio input signal.

4.2.6 Information from the manufacturer

When submitting equipment for test, the manufacturer shall provide all information which may be required by an external laboratory.

4.2.7 Test jig

All necessary test jig, test signal sources and set-up information shall accompany the equipment submitted for testing and shall be included in the test report.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

5.1.1 General requirements

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the operational environmental profile defined by its intended use) to give confidence of compliance for the affected technical requirements.

5.1.2 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

- temperature +15 °C to +35 °C;
- relative humidity 20 % to 75 %.

When it is impracticable to carry out tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.1.3 Test power source

5.1.3.1 General requirements

The equipment shall be tested using the external test power source specified in clause 5.1.3.2.

The test power source used shall be stated in the test report.

5.1.3.2 External test power source

5.1.3.2.0 General

During tests, the power source of the equipment shall be replaced by an external test power source capable of producing the test voltage specified in clause 5.1.3.2.1 or 5.1.3.2.2 as applicable. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment. The external test power source shall be suitably de-coupled (including the use of ferrite beads, inductors, chokes, de-coupling capacitors or networks as required by specific test methods e.g. AMN, ISN, LISN, CDN, etc.) and as close to the equipment input power terminals as practicable.

During tests, the test power source voltages shall be within a tolerance of < ±1 % relative to the voltage at the beginning of each test.

Where it can be shown that internal regulation of power supply rails or output regulation is employed (such as in a constant-current output design) in such a way as to negate the effects of such power supply variations or fluctuations, then this tolerance may be relaxed to ±5 % of nominal and RF emission tests shall be performed at the nominal voltage only.

5.1.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage and tolerance, or any of the declared voltages and tolerances for which the equipment was designed.

The frequency of the test power source corresponding to the a.c. mains shall be ±1 Hz of the mains frequency specified by the manufacturer.

5.1.3.2.2 Other power sources

For operation from other power sources, such as vehicle power supplies, the normal test voltage and tolerance shall be that shown by the manufacturers technical information. These values shall be stated in the test report.

5.2 General conditions

5.2.1 Normal test signals

5.2.1.0 General

The normal test signal is specified as follows and may be externally or internally generated:

- 1 kHz sinusoidal signal

5.2.1.1 Signal input for testing

For the purpose of the measurements, there should be a facility to energize the induction loop driver.

For the purpose of testing, the normal test signal, see clause 5.2.1.0, shall be applied to the input of the induction loop driver under test with the normal input device(s) disconnected (e.g. microphone or other audio equipment).

Any "standby" driver modes should be disabled for the duration of test so that the driver is not asleep when no signal is present for long periods.

The induction loop driver should be set to deliver full current with no clipping of the output signal.

NOTE 1: Clipping can be identified by examining the output current waveform with an oscilloscope and comparing it against the source signal or by using a built in "clip" indication if provided by the EUT.

NOTE 2: Audio frequency induction loop drivers are not designed to deliver continuous sine signals for long periods as they are intended to operate with constantly varying signals such as voice or music. Therefore, the tester needs to be aware that internal control circuits may reduce the level and so the test may need to take place in separate tranches. A duty cycle of 60 s on, 240 s off should not be exceeded.

5.2.2 Loop connections

5.2.2.1 General

The manufacturer shall supply a test jig incorporating an artificial loop.

5.2.2.2 Artificial Loop

For measurements of audio frequency induction loop drivers (see clause 4.2.1), an artificial loop connected to the loop output connectors, shall be used. The component values of the artificial loop shall be selected from table 1. The selection shall be based on the largest current that the driver is specified to deliver at 1 kHz with no clipping of the output signal.

To select the correct set of artificial loop values:

1) Using artificial loop 2 and the 1 kHz sine wave test signal, determine whether full output current can be achieved without clipping, in which case, use artificial loop 2.

2) If clipping does occur, use artificial loop 1.

Table 1: Artificial loop options

Artificial loop	Total resistance R_{total} (ohms)	Inductance L_{total} (µH)	Impedance at 1 kHz (ohms)
1	0,7	75	0,84
2	1,2	150	1,53

This method facilitates conducted measurements to be made of the following:

- induction loop driver loop in band currents from 10 Hz to 9 kHz;
- induction loop driver loop out of band currents from > 9 kHz to 20 kHz; and
- induction loop driver spurious loop currents from > 20 kHz to 10 MHz.

A description of the artificial loop shall be stated in the test report.

Annex D describes a suitable method of assembling an artificial loop.

5.3 Induction loop driver

5.3.1 General

To meet the requirements of the present document, the induction loop driver shall be measured with any tone controls set to a flat response whilst operated at the maximum rated continuous average output level for the load under test, as identified in the technical documentation.

In order to prevent thermal shutdown, equipment shall be operated at its maximum intended operational current with a maximum duty cycle of 60 s on, 240 s off.

Conducted emission measurements below 10 MHz shall be carried out with an artificial loop.

5.3.2 In band and out of band emission limits

5.3.2.1 Definition

Audio frequency in band limits (10 Hz to 9 kHz) and out of band limits (> 9 kHz to 20 kHz) are defined as the current measured in the artificial loop.

5.3.2.2 Methods of measurement

The equipment shall be connected to the supplied artificial loop.

The actual method used shall be stated within the test report, along with details of any modifications to the equipment required to make the measurements possible.

The current delivered to the artificial loop up to 20 kHz. The current shall be measured either by using:

- a calibrated current probe; or
- a calibrated non-inductive resistive current sense element, whose value should not significantly affect the current delivered to the loop, for example, the equipment's own internal current sense.

The measuring bandwidth shall be in accordance with figure B.2.

The measurements shall be made under normal test conditions, see clause 5.1.2.

5.3.2.3 Values

The maximum values for the audio frequency in band emission is given in figure B.2 and shall not be exceeded.

5.3.3 Spurious domain emission limits

5.3.3.1 Definition

Spurious domain emission limits are defined as the current measured in the artificial loop.

5.3.3.2 Methods of measurement

The equipment under test shall be connected to the supplied artificial loop.

The measuring equipment shall be connected to the output of the artificial loop, or a suitable monitoring point and the current for the spurious components shall be measured.

For further details of the artificial loop, see annex D.

The currents shall first be measured with the induction loop driver energized (operational) with the test signal applied (clause 5.2.1) and then repeated with the driver energized (operational) with the test signal removed.

5.3.3.3 Values

The maximum values are shown in annex E.

NOTE: No limits are specified for standby modes because standby modes are disabled for the duration of the test.

5.4 Interpretation of the measurement results

Refer to annex F for more information.

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.8] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 303 348					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of the Directive	Clause(s) of the present document	U/C	Condition
1	Spurious domain emission limits	3.2	5.3.3	U	
2	In band and out of band emission limits	3.2	5.3.2	U	

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative): Technical overview

B.1 Induction loop drivers

B.1.1 General

Induction loop drivers, together with an internal or external induction loop, are used to generate audio-frequency magnetic fields that may be used by a listener's hearing aid, cochlear implant or induction loop listener to provide noise-free and reverberation-free audio directly to the listener. This, therefore, removes the acoustic gap between talker and listener and allows what would otherwise be a difficult or unintelligible message for a hearing-impaired listener to become intelligible.

The majority of hearing instruments are equipped with a small pickup coil (the telecoil) and so no additional equipment is required to use this service. People without hearing instruments wishing to receive the AFILS signal can use dedicated portable stand-alone receivers called loop listeners.

B.1.2 Frequency response

As an audio frequency baseband transmission system, the output of an AFILS system corresponds precisely with the bandwidth of the audio input of the system. There is no carrier frequency or modulation scheme. A correctly designed and installed AFILS complying with the requirements of IEC 60118-4 [i.4] has a frequency response within the range 100 Hz to 5 kHz of ±3 dB with reference to the response at 1 kHz.

B.1.3 Field strength

A correctly designed and installed AFILS, complying with the requirements of IEC 60118-4 [i.4] and with a 1 kHz sine wave input signal, is capable of producing a magnetic field strength of 400 mAm^{-1} when measured with the true rms meter with 0,125 s averaging time in at least one place within the space where listeners' heads (and therefore hearing instruments) are expected to be and should be no more than 3 dB higher for large area AFILS, and no more than 8 dB higher for small area systems. This is the level also achieved on the highest peaks in the programme material. The average magnetic field strength is much lower and will depend on the programme content.

B.1.4 General performance criteria

For the purpose of the induction loop driver performance tests, the driver is expected to be operated as described in clauses 5.1 and 5.2.

B.2 Translation of H-Field values to loop current values

The present document allows spectrum measurements to be made. The measurements are relevant for AFILS operating between 10 Hz to 9 kHz.

In band emissions are measured at the furthest point of the useful magnetic field volume in accordance with its intended use. Out of band and spurious emissions are measured 10 m from the furthest point of the useful magnetic field volume as defined below.

Spurious H-field limits at 10 m distance, measured by a shielded loop antenna are taken from CEPT/ERC/Recommendation 74-01E [2], table 2.1 reference number 2.1.3:

- 27 dBµA/m, for (at 9 kHz then decaying by 10 dB/decade) 9 kHz $\leq f \leq$ 10 MHz.
- -3,5 dBµA/m, for 10 MHz < $f \leq$ 30 MHz.

For the purposes of deriving a consistent set of current limits for an infinite number of loop layout options, a reference example using a 1 × 1 m loop is used. Details of the loop and measurement point at 10 m are shown in figure B.1.

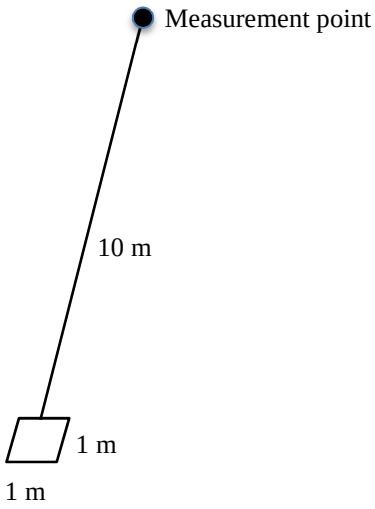

Figure B.1: 1 × 1 m loop with measurement point 10 m from the middle of one side

Using the In-band & Out-of band H-field limits in figure B.2 and spurious H-field emissions in CEPT/ERC/Recommendation 74-01E [2], the overall H-field limit mask is defined as shown in figure B.2. Out-of-band limit at 9 kHz is based on the 45 A_{rms} maximum current as applicable to the present document.

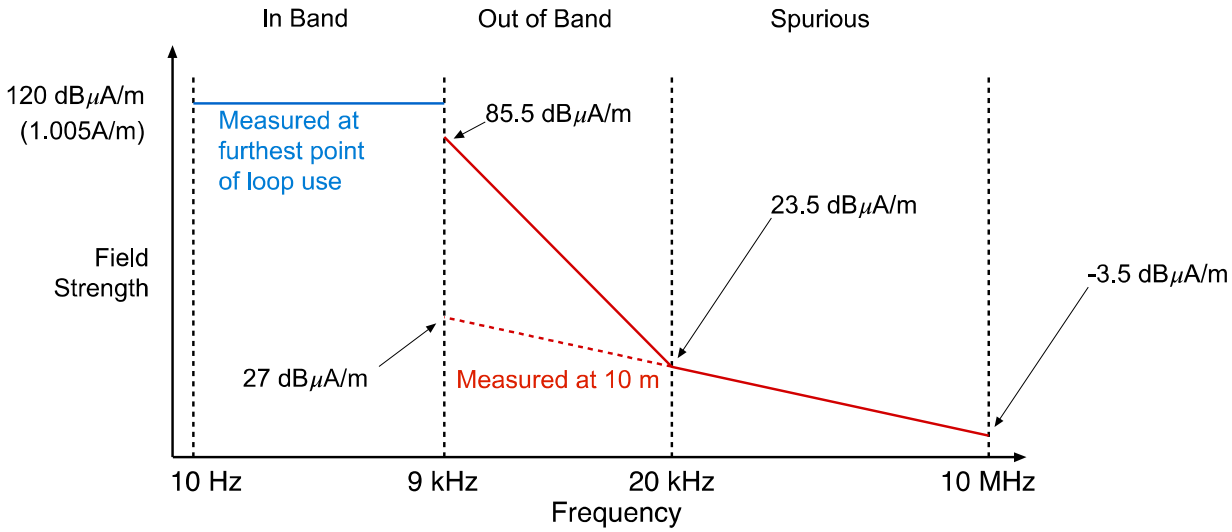

Figure B.2: Induction loop driver emissions levels and spectrum mask measurements

Using the reference loop in figure B.1, and applying the calculations in annex C the current limits can be derived as shown in figure E.1.

Annex C (informative): The relationship between loop current and H-Field strength

The H-Field at a given point for an AFILS loop may be calculated directly from the loop current using the following equations.

For an AFILS loop of rectangular dimension, the general equation relating Loop Current to the component of the H-field in the z-axis at an arbitrary point of the loop in free space is given by:

$$H_z\,(x,y,z) = \frac{NI}{4\pi}\sum_{i=1}^{2}\sum_{j=1}^{2}\frac{x_i\,y_j}{\sqrt{x_i^2+y_j^2+z^2}}\left(\frac{1}{x_i^2+z^2}+\frac{1}{y_j^2+z^2}\right)\text{A/m} \qquad \text{(C.1)}$$

where:

$H_z\,(x, y, z)$= H-Field in the Z-axis at an arbitrary point within, above or below the AFILS loop in Am^{-1}.

X, y, z = Arbitrary point relative to the centre of a rectangular loop in metres.

N = Number of turns of the induction loop.

I = Current in Ampere in the induction loop.

A = Length of the rectangular loop in metres in the X axis.

B = Width of the rectangular loop in metres in the Y axis.

X_i = For each element of the sum in turn where: $x_1 = (p-x)$, $x_2 = (p+x)$ according to figure C.1.

Y_j = For each element of the sum in turn where: $y_1 = (q-y)$, $y_2 = (q+y)$ according to figure C.1.

p = $A/2$.

q = $B/2$.

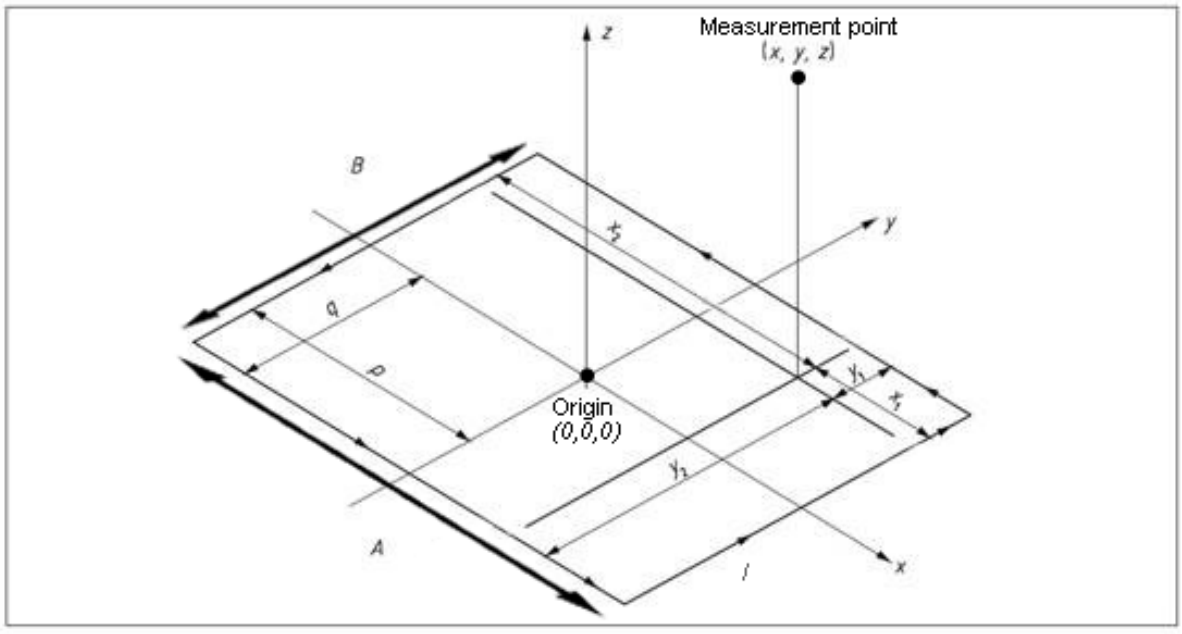

Figure C.1: Diagram for calculating magnetic field strength at point (x, y, z)

However, for ease of calculation, in the case where the measurement position is directly above or below the centre point of the AFILS loop, then the following simplified equation may be used:

$$H_{0,0,z} = \frac{I}{\pi}\left(\frac{pq}{\sqrt{p^2+q^2+z^2}}\right)\left(\frac{1}{p^2+z^2}+\frac{1}{q^2+z^2}\right) A/m \quad \text{(C.2)}$$

where:

$H_z\ (0,0,z)$ = H-Field in the Z-axis at, above or below the centre point of the AFILS loop in Am^{-1}.

For calculations of the fields in other axes, and to calculate an overall field strength at any measurement point, use similar equations to equation (C.1).

Annex D (informative): How to construct a test fixture incorporating an artificial loop

This is a test fixture for measuring induction loop driver audio frequency baseband and spurious currents by use of an artificial loop.

The choice of the load and current measurement technique depends on the class and topology of the power amplifier used. Induction loop drivers can be either analogue or switched digital devices and may in either case be configured as a single-sided drive (with one side likely to be connected to the ground via a current sense resistor), or as a bridge-tied drive. In either case, it is likely that connecting one output terminal to ground as shown in figure D.1 will not be possible without providing either galvanic isolation between the equipment under test and the test receiver or elsewhere in order to ensure correct and/or safe operation.

If such isolation can be achieved the equivalent electric circuit of the components is given in figure D.1.

In all other cases, it is advised to use a suitably designed current transformer or current probe that is adequate for both the current level and the bandwidth of the test. A simplified circuit is shown in figure D.2.

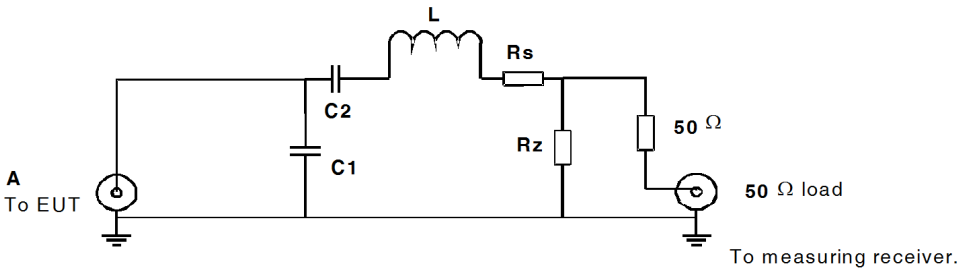

Figure D.1: Non-isolated test circuit

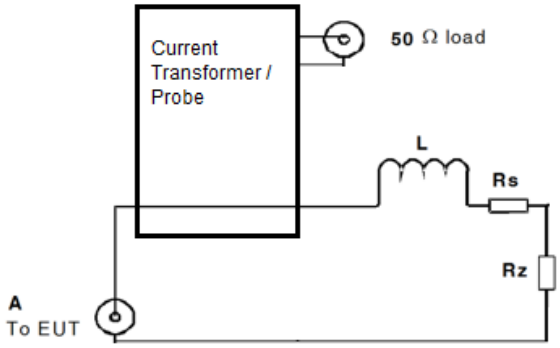

Figure D.2: Isolated test circuit

R_z is a low value non-reactive resistor. The voltage across R_z is proportional to the conducted audio frequency baseband and spurious loop currents. These can be measured at the output connector.

R_s is the series resistance of inductor L. R_s in combination with R_z should be selected to ensure that the total resistance (R_{total}) of the artificial loop matches, within tolerance, the artificial loop chosen from table 1.

If using the isolated test circuit with a terminated current transformer, the in-circuit characteristics (resistance R_t and inductance L_t) also need to be considered with respect to matching the artificial loop specifications, i.e. $R_{total} = R_t + R_s + R_z$ and $L_{total} = L_t + L$. Therefore, the simplest solution is to use a current probe as insertion is usually negligible such that: $R_{total} = R_s + R_z$ and $L_{total} = L$.

In either case, the two artificial loops defined in table 1 can be realized as detailed in table D.1.

Table D.1: Artificial loop options

Artificial Loop	Resistor R_z (Ohms) See note 1	Resistance of Inductor R_s (Ohms) See note 2	Inductance L_{total} (µH) See note 3
1	0,5	≤ 0,2	75
2	1,0	≤ 0,2	150

NOTE 1: Resistor/s should be mounted on a suitable heatsink in order to be capable of dealing with the power delivered by an induction driver safely and without significant change in resistance during the test.

NOTE 2: Inductor resistance is kept low as they are difficult to effectively heatsink. E.g. 10 A_{rms} into 0,2 ohms dissipates 20 W.

NOTE 3: Inductors should be air cored, and wound on a suitable material to withstand the heat safely and without significant change in inductance during the test.

The artificial loop used during the test should be stated in the test report.

Annex E (normative): Induction loop driver emission levels and spectrum mask measurements

The present document allows spectrum measurements to be made. The measurements are relevant for AFILS operating between 10 Hz to 9 kHz.

Figure E.1 shows the current levels related to the field limits in clause B.2.

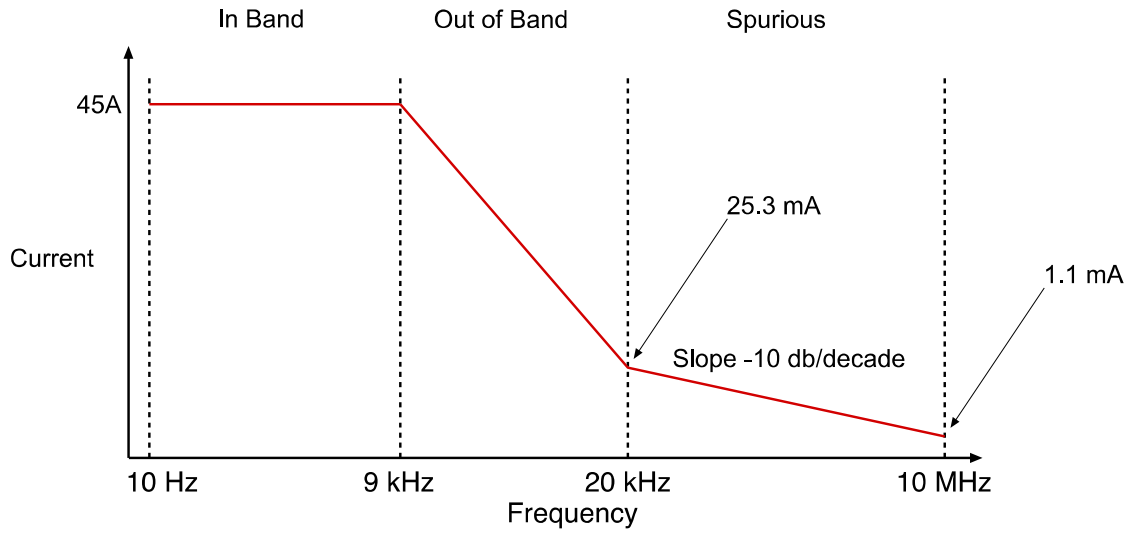

Figure E.1: Induction loop driver emissions levels and spectrum mask measurements

Annex F (informative): Maximum Measurement Uncertainty

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit is used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter is included in the test report.

Table F.1 shows the recommended values for the maximum measurement uncertainty figures.

Table F.1: Maximum measurement uncertainty

Parameter	Uncertainty
Output current	±2 %
Temperature	±1 °C
Humidity	±5 %

Annex G (informative): Bibliography

- ERC Report 044 (1997): "Sharing between inductive systems and radiocommunication systems in the band 9 - 135 kHz".
- ERC Report 069: "Propagation model and interference range calculation for inductive systems 10 kHz - 30 MHz".
- ERC Report 092: "Sharing between inductive SRD systems and radio communication systems operating in the frequency band 10.2 - 11 MHz".
- Council Directive 2004/108/EC of 20 April 2016 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.
- ERC Decision of 12 March 2001 on harmonised frequencies, technical characteristics and exemption from individual licensing of Short Range Devices used for inductive applications operating in the frequency bands 9 - 59.750 kHz, 59.750 - 60.250 kHz, 60.250 - 70 kHz, 70 - 119 kHz, 119 - 135 kHz; (ERC/DEC(01)13).
- Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.
- ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".
- EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" (produced by CENELEC).

Annex H (informative): Change history

Version	Information about changes
1.1.2	First published version July 2017.
1.2.0	Draft March 2018; prepared following discussions with the EC Desk Officer and covers only detachable loop drivers, integral antenna systems and all receivers placed in ETSI EN 300 422-4.

History

Document history		
V1.1.2	July 2017	Publication
V1.2.0	February 2021	EN Approval Procedure AP 20210526: 2021-02-25 to 2021-05-26