# ETSI EN 303 348 V1.2.1 (2021-06)


**~~Induction~~Audio frequency induction loop ~~systems intended~~drivers up to ~~assist the hearing impaired~~45 amperes in the frequency range 10 Hz to 9 kHz;**
**Harmonised Standard ~~covering the essential requirements~~for access to radio spectrum**
**~~of article 3.2 of Directive 2014/53/EU~~**

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# Contents

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# Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

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.

| **National transposition dates** | |
|---|---|
| Date of adoption of this EN: | 26 May 2021 |
| Date of latest announcement of this EN (doa): | 31 August 2021 |
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| Date of withdrawal of any conflicting National Standard (dow): | 28 February 2023 |

# 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).

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# Introduction

Audio Frequency Induction Loop ~~Systems~~System (AFILS) ~~have~~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~~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 ~~amplifier~~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~~], which~~] 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 ~~amplifiers~~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 ~~amplifiers and receivers~~drivers operating from 10 Hz to 9 kHz used in ~~audio frequency induction loop systems~~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:

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

The present document covers ~~fixed~~ induction loop ~~amplifiers, mobile induction loop amplifiers and portable induction loop amplifiers.~~ 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 ~~covers the~~and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] ~~under the conditions identified~~ 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~~. Only~~) 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 ~~documents~~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

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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] ~~CEPT/ERC/REC 70-03: "Relating to the use of Short Range Devices (SRD)".~~Void.

[i.3] CISPR 16-2-3: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements".

] Void.

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

[i.5] IEC 62489-1 + Amd 1: "Electroacoustics - Audio-frequency induction loop systems for assisted hearing - Part 1: Methods of measuring and specifying the performance of system components".

] Void.

[i.6] IEC 61672-1: "Electroacoustics. Sound level meters. Specifications".Void.

[i.7] IEC 60268-10: "Sound system equipment. Methods for specifying and measuring the characteristics of peak-programme level meters".

] 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 TR 100 028 (all parts) (V1.EN 300 422-4.1) (12-2001): "Electromagnetic compatibility: "Wireless Microphones; Audio PMSE up to 3 GHz; Part 4: Assistive Listening Devices including personal sound amplifiers and Radio spectrum Matters (ERM); Uncertainties ininductive systems up to 3 GHz; Harmonised Standard covering the measurementessential requirements of mobile radio equipment characteristicsarticle 3.2 of Directive 2014/53/EU".

Definition of terms[i.10]ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

# 43 Definitions, symbols and abbreviations

## 3.1 DefinitionsTerms

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

**artificial loop:** reduced size radiating dummy 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 amplifierdriver(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

**customized loop:** loop built according to manufacturers' loop design rules inside tested limits

~~**dedicated loop:** removable loop supplied and type tested with the AFILS equipment, designed as an indispensable part of the equipment~~

~~NOTE: The loop has been designed or developed for one or more specific types of equipment. It is the combination of dedicated loop and induction loop amplifier that is expected to be compliant with the regulations.~~

**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:** ~~See~~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 ~~occupied~~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 ~~amplifier~~driver:** audio ~~amplifier~~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.

~~**magnetic dipole moment:** product~~**metal compensation:** method of ~~(Number of loop turns) × (loop area) × (loop current)~~

~~NOTE: Air loops only.~~

compensating for amplitude and frequency dependant magnetic field ~~**strength level meter:** instrument designed~~losses due to ~~measure~~ the interaction of the magnetic field ~~strength of~~generated by the loop with nearby metal

**mobile audio frequency** ~~magnetic fields~~

~~NOTE: Two types are in common use; a peak-programme meter (PPM) type having dynamic characteristics similar to those of the Type II meter as specified in IEC 60268-10 [i.7], and a true rms meter type that incorporates a true-rms rectifier, and meets the relevant requirements for a Class 2 sound level meter as specified in IEC 61672-1 [i.6]. Full functional specifications for both types of meter can be found in IEC 60118-4 [i.4].~~

~~**mobile amplifier**~~**induction loop driver:** equipment normally installed in a vehicle (bus, coach, train, etc.)

**out of band emissions:** emissions on a frequency or frequencies ~~which are~~immediately outside the ~~occupied~~necessary bandwidth (10- Hz to 9- kHz), but ~~for which the levels are in transition to a frequency where the level may be reduced without affecting the corresponding transmission of information~~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 ~~amplifier:~~** ~~amplifier~~**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:** ~~the~~ load, stated by the manufacturer, to which the ~~amplifier~~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 ~~occupied~~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].

~~**type designation:** manufacturers' marking of the equipment~~

~~**useful magnetic field volume:** volume within which the AFILS provides a hearing aid user with a signal of acceptable quality~~

~~NOTE: See IEC 60118-4 [i.4].~~

## 3.2 Symbols

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

| | |
|---|---|
| ~~Ω~~ | ~~ohm~~ |
| A | ~~loop area~~ampere |
| 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 ~~baseband~~in band output current |
| $I_S$ | spurious output current |
| λ | wavelength |
| ~~m~~ | ~~magnetic dipole moment~~ |
| 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~~, also known as a Hearing Loop~~ |

NOTE: Also known as a Hearing Loop.

| | |
|---|---|
| AMN | Artificial Mains Network |
| CDN | Coupling/Decoupling Network |
| CEPT | Conférence Européenne des Postes et Télécommunications |
| ~~CISPR~~ | ~~Comité International Spécial des Perturbations Radioélectriques~~ |
| EC | European Community |
| EFTA | European Free Trade ~~Area~~Association |
| ~~EMC~~ | ~~ElectroMagnetic Compatibility~~ |
| ERC | European Radiocommunications Committee |
| EU | European Union |
| EUT | Equipment Under Test |
| ISN | Impedance Stabilization Network |
| LISN | Line Impedance Stabilization Network |
| ~~OOB~~ | ~~Out Of Band~~ |
| RF | Radio Frequency |
| RFID | Radio Frequency Identification Device |
| rms | root mean square |
| SRD | Short Range Device |
| ~~THD~~ | ~~Total Harmonic Distortion~~ |
| ~~TR~~ | ~~Technical Report~~ |

# ~~7~~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 ~~declared by the manufacturer.~~in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document ~~which are identified as applicable in annex A~~ at all times when operating within the boundary limits of the ~~declared~~ operational environmental profile defined by its intended use.

## 4.2 General requirements

### 4.2.1 Presentation of induction loop ~~amplifier~~driver equipment for testing purposes

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

~~The manufacturer shall declare the~~The range of operating conditions and power requirements ~~to establish the appropriate test conditions.~~

~~Additionally,~~for tests shall be defined based on the supplied technical documentation and operating manuals ~~sufficient to make the test~~.

Drivers shall be supplied~~.~~

~~For equipment supplied without an internal induction loop, i.e. Product Class 2 defined in clause 5.3.2.2, the manufacturer shall supply~~ with the appropriate test jig incorporating an artificial loop ~~as defined in clause 5.2.2.1~~.

~~In the case of equipment supplied with an internal induction loop, i.e. Product Class 1 equipment as defined in clause 5.3.2.2, it is permissible to supply a sample of the equipment with a temporary connector to facilitate testing. This shall be used to provide a method to monitor the loop current, or at the manufacturer's discretion, to use an artificial loop.~~

~~The means to access and/or implement the internal permanent or temporary loop connector shall be stated by the manufacturer with the aid of a diagram. The fact that use has been made of the internal loop connection, or of a temporary connection to facilitate measurements, shall be recorded in the test report. Such ports shall not affect the performance of the equipment.~~

~~If equipment is designed to operate with different radiated field strengths or power levels, measurement of each parameter shall be performed on samples of equipment as defined in clause 4.2.2.~~

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 ~~declared by the manufacturers~~shown in the manufacturers published technical information.

Equipment offered for test shall provide an output connector for conducted RF measurements. ~~For equipment with an internal loop, this can be a modification for the tests.~~

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 ~~Amplifier~~Driver shut-off facility

If the ~~amplifier~~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 ~~Declarations by~~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 ~~declare any necessary~~provide all information which may be required by an external laboratory.

### 4.2.6 Auxiliary test equipment7 Test jig

All necessary test jig, test signal sources and set-up information shall accompany the equipment when it is 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 declared 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 and/or the internal test power source specified in clause 5.1.3.2. Where equipment can be powered using either external or internal power sources, then the equipment shall be tested using the external power source specified in clause 5.1.3.2 then repeated using the internal power source specified in clause 5.1.3.3.

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 5.1.3.3.2.1 or clause 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.

#### 5.1.3.3 Internal test power source

##### 52.1.3.3.1 General

Where equipment is designed to operate from an internal power source, for conducted measurements or where a test fixture is used, an external power supply at the required voltage may replace the supplied or recommended internal batteries. Use of this shall be stated on the test report.

##### 5.1.3.3.2 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.

#### 5.1.3.3.3 Valve-regulated lead-acid battery power sources

When the equipment is intended for operation from valve-regulated lead-acid battery power source, the normal test voltage shall be 1,1 multiplied by the nominal voltage of the battery (e.g. 6 V, 12 V, etc.).

##### 5.1.3.3.42.2 Other power sources

For operation from other power sources or types of battery (primary or secondary), such as vehicle power supplies, the normal test voltage and tolerance shall be that declaredshown by the manufacturer. Suchmanufacturers technical information. These values shall be stated in the test report.

## 5.2 General conditions

### 5.2.1 Normal test signals

For equipment without a connector for an external audio input (i.e. with only an internal microphone), a connector shall be added to allow testing. This shall be stated in the test report.

#### 5.2.1.0 General

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

- 1 kHz sinusoidal tonesignal

#### 5.2.1.1 Signal input for testing

For the purpose of the measurements with and without an input test signal, there should preferably be a facility to energize the induction loop amplifier with or without an input signal source. The manufacturer shall describe the method of achieving this in the documentation and it shall be recorded in the test report. It may involve temporary internal modifications of the equipment under testdriver.

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 amplifierdriver under test with the normal input device(s) disconnected (e.g. microphone or other audio equipment).

Any 'standby' amplifier"standby" driver modes should be disabled for the duration of test so that the amplifierdriver 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: 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.

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

~~For equipment supplied without an internal loop, i.e. Product Class 2 as defined in clause 5.3.2.2, the~~ The manufacturer shall supply a test jig incorporating an artificial loop ~~(reduced radiating load).~~

~~For equipment supplied with an internal loop, i.e. Product Class 1 equipment as defined in clause 5.3.2.2, the manufacturer may decide to use the existing internal loop and provide a method to monitor the loop current, or use an artificial loop. The actual method used shall be stated within the test report.~~

~~NOTE: Typical loop impedances are described in IEC 62489-1 [i.5], annex B.~~

### 5.2.2.2 Artificial ~~loop~~Loop

For measurements of audio frequency induction loop ~~amplifiers~~drivers (see clause 4.2.1), an artificial loop ~~(reduced radiating load)~~ connected to the loop output connectors, shall be used ~~as agreed with the test laboratory.~~

. The ~~impedance~~component values of the artificial loop shall be selected from table 1. The selection shall be ~~equal to~~based on the ~~nominal load of~~largest current that the ~~equipment~~driver is specified ~~by the manufacturer~~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 $R_{total}$ (Ω) | Inductance $L_{total}$ (µH) | Impedance at 1 kHz (Ω) |
|---|---|---|---|
| 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 ~~amplifier~~driver loop in band currents from 10 Hz to 9 kHz;
- induction loop ~~amplifier~~driver loop out of band currents from > 9 kHz to 20 kHz; and
- induction loop ~~amplifier~~driver spurious loop currents from > 20 kHz to ~~1~~10 MHz.

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

~~For equipment supplied with an internal loop, the manufacturer may decide to use the internal loop as the load and provide a suitable method to monitor the loop current, or use an artificial loop. The actual method used shall be stated within the test report.~~

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

### ~~5.2.3 Measuring receiver~~

~~The term "measuring receiver" refers to a selective voltmeter, spectrum analyser or receiver used in the process of testing the equipment under test to the appropriate emission limits. The bandwidth and detector type of the measuring receiver are given in table 1.~~

**~~Table 1~~**

| ~~Frequency~~ | ~~Detector type~~ | ~~Measurement receiver bandwidth~~ | ~~Spectrum analyser bandwidth~~ |
|---|---|---|---|
| ~~9 kHz ≤ f < 150 kHz~~ | ~~rms~~ | ~~200 Hz~~ | ~~300 Hz~~ |
| ~~150 kHz ≤ f < 1 MHz~~ | ~~rms~~ | ~~9 kHz~~ | ~~10 kHz~~ |

~~If different bandwidths are used, follow the guidance in annex G and record this in the test report.~~

## 5.3 Induction loop ~~amplifier~~driver

### 5.3.1 General

To meet the requirements of the present document, the induction loop ~~amplifier~~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 ~~declared by~~ identified in the ~~manufacturer, with any tone controls set to a flat response~~technical documentation.

~~When making tests on~~In order to prevent thermal shutdown, equipment ~~designed for intermittent operation, the duty cycle of the equipment, as declared by the manufacturer,~~ shall ~~not~~ be ~~exceeded. The actual duty cycle used shall be stated on the test report.~~

~~For equipment supplied without a loop, i.e. Product Class 2 as defined in clause 5.3.2.2, the manufacturer shall supply a reduced radiating load (artificial loop) which is to be used for all tests.~~

~~For equipment supplied with an internal loop, i.e. Product Class 1 equipment as defined in clause 5.3.2.2, the manufacturer may decide to use the existing internal loop and provide a method to monitor the loop current, or use an artificial loop for conducted emission measurements below 1 MHz. The actual method used shall be stated within the test report.~~

### ~~5.3.2 Induction loop amplifier definitions~~

#### ~~5.3.2.1 General~~

~~Induction loop amplifiers are divided into Product Classes (see clause 5.3.2.2) depending on the loop type to be used. Class 1 equipment is provided with an internal loop, whereas Class 2 equipment provides an external connection and may allow the customer to use his own loop design based on the manufacturer's design guidelines. AFILS manufacturers will provide written guidance and design tools, or both, to aid with practical and compliant loop design.~~

#### ~~5.3.2.2 Product Classes~~

~~The equipment is divided into Product Classes depending on the induction loop type used.~~

~~The Product Classes according to table 2 are:~~

~~**Product Class 1:**~~

- ~~Induction loop amplifier supplied with an internal loop.~~
- ~~The following restrictions apply to this product class:~~
  - ~~no customization of the internal loop(s) is allowed in the field (or by the end user); and~~
  - ~~the internal loop area shall be < 4 $m^2$.~~

- The audio frequency baseband output and spurious emissions are limited by theoperated at its maximum output loop current multiplied by the loop area, and number of turns as described in annex E and clause 5.3.4.2 and shall comply with the equivalent radiated H-field limits given in clause 5.3.4.2 and clause 5.3.4.3.

- Where a manufacturer provides a range of standard internal loops, the equipment shall be tested as Product Class 1. Either each of the loop(s) shall be fitted in turn with an appropriate monitoring connector attached, or at the manufacturer's discretion, with representative artificial loops used to show compliance when operated with the minimum and maximum expected loads.

- The actual method used shall be stated in the test report.

**Product Class 2:**

This Product Class is intended for use with external loops which may, or may not, be customized. The induction loop amplifier is tested by using an artificial loopoperational current with a maximum duty cycle of 60 s on, 240 s off.

- The audio frequency baseband output and spurious emissions are limited by the maximum output loop current multiplied by the loop area, and number of turns as described in annex E and clause 5.3.4.2, and shall comply with the equivalent radiated H-field limits given in clause 5.3.4.2 and clause 5.3.4.3. The manufacturer shall declare the maximum size of the loop in the user's manual.

Conducted emission measurements below 110 MHz shall be carried out with representative artificial loops used to show compliance when operated with the minimum and maximum expected loadsan artificial loop.

**Table 2: Description of product classes**

| Product Class | Description of induction loop amplifier | Loads to be tested | Loop area | Customization of loop design allowed | Audio frequency baseband, OOB and spurious emission output limits |
|---|---|---|---|---|---|
| 1 | Supplied with Internal Loop(s) | Artificial or internal loop (with test connector) for all conducted measurements below 1 MHz | For internal loop(s) < 4 $m^2$ For equipment with an external connector(s), as per class 2 | For Internal loop(s) no customization is allowed. For equipment with an external connector(s), the external loop(s) may be modified as per class 2 | See clause 5.3.3.3 See clause 5.3.4.3 |
| 2 | Supplied with external Loop connection | Test using an artificial loop | Not Applicable | Yes | See clause 5.3.3.3 See clause 5.3.4.3 |

## 5.3.3 Audio frequency in5.3.2 In band and out of band emission limits

### 5.3.32.1 Definition

Audio frequency in band limits (10- Hz to 9- kHz) are defined as the calculated equivalent emissions produced (see annex D) for the declared loop size(s), measured at the furthest point of the useful magnetic field volume as declared by the manufacturer. The manufacturer shall declare the maximum loop size and the position of the furthest point of the useful magnetic field volume and this shall be stated in the test report.

Outand out of band limits (> 9- kHz to 20- kHz) are defined as the calculated equivalent emissions produced (see annex D) for the declared loop size(s) measured at 10 m from the furthest point of the useful magnetic field volumecurrent measured in the artificial loop.

### 5.3.32.2 Methods of measurement

The equipment shall be set up as follows:

- Class 1 equipment shall be connected either to an appropriatethe supplied artificial loop(s), see clause 5.2.2.2 and annex E, or at the manufacturer's discretion, shall be connected to the internal loop(s), with a suitable method provided to monitor the loop current.

- ~~Class 2 equipment shall be connected to the artificial loop(s), see clause 5.2.2.2 and annex E.~~

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

- ~~a derived output from a calibrated artificial loop connected to a measuring receiver, see annex E; or~~
- a calibrated current probe ~~connected to a measuring receiver~~; 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~~, connected to a measuring receiver~~.

The measuring bandwidth ~~and detector type~~ shall be in accordance with ~~clause 5~~figure B.2.~~3.~~

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

### 5.3.2.~~3.3 Limits~~ Values

The ~~limits~~maximum values for the audio frequency ~~baseband~~in band emission ~~for both Product Classes~~ is given in ~~table 3~~figure B.2 and shall not be exceeded.

**~~Table 3: Equivalent H-Field limits for audio frequency in band and out of band emissions~~**

| ~~Frequency range~~ | ~~Audio frequency baseband emission limit ($Am^{-1}$)~~ |
|---|---|
| ~~10 Hz to 9 kHz (In band)~~ | ~~1,005 $Am^{-1}$~~ |
| ~~> 9 kHz to 20 kHz (Out of band)~~ | ~~0,100 $Am^{-1}$ at 9 kHz to 15 $\mu Am^{-1}$ at 20 kHz~~ |
| ~~NOTE 1: The in band limit is the equivalent H-Field limit, when calculated using the equations in annex D, and when measured at the furthest point of the useful magnetic field volume, as declared by the manufacturer. Actual equipment measurements are taken in terms of conducted loop output.~~ | |
| ~~NOTE 2: The out of band limits is the equivalent H-Field limit, when calculated using the equations in annex D, and when measured at 10 m from the furthest point of the useful magnetic field volume, as declared by the manufacturer. Actual equipment measurements are taken in terms of conducted loop output.~~ | |
| ~~NOTE 3: The 9 kHz out of band limit of 0,1 $Am^{-1}$ at 10 m is approximately the field created by a 20 m × 20 m loop when 1 $Am^{-1}$ is generated 0,5 m inside (furthest point of the useful magnetic field volume) the loop using the equations in annex D.~~ | |
| ~~NOTE 4: This is as per the spectrum mask given in annex F.~~ | |

## ~~5.3.4~~5.3.3 Spurious domain emission limits

### 5.3.4~~3~~.1 Definition

Spurious domain emission limits are defined as the ~~calculated equivalent emissions produced (see annex D) for the declared loop size(s) measured at 10 m from the furthest point of the useful magnetic field volume, as declared by the manufacturer. The manufacturer shall declare the maximum loop size, which shall be stated in the test report~~current measured in the artificial loop.

### 5.3.4~~3~~.2 Methods of measurement

~~For Class 1~~The equipment~~, the induction loop amplifier~~ under test shall be connected to ~~an artificial loop or at the discretion of the manufacturer, into the actual loop with a suitable method provided to monitor the loop current (clause 5.2.2.2).~~

~~For Class 2 equipment, the induction loop amplifier shall be connected to an~~the supplied artificial loop ~~(clause 5.2.2.2).~~.

The measuring ~~receiver~~equipment shall be connected to the output of the artificial loop, or a suitable monitoring point ~~in the case of Class 1 equipment~~ and the current for the spurious components shall be measured.

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

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

#### 5.3.~~4~~.3 ~~Limits~~.3Values

The maximum values are shown in annex E.

NOTE: No limits are specified ~~in CEPT/ERC/Recommendation 74-01E [2], annex 2, table 2.1, reference number 2.1.3, up to 1 MHz~~for standby modes because standby modes are disabled for the duration of the test.

~~This relates the output loop current, declared maximum loop area and number of turns, to the maximum equivalent radiated H-Field which may be generated.~~

~~Emission limits are stated in H-Field terms to allow comparison and interpretation with other standards and international agreements.~~

~~NOTE: The out of band limits are considered at 10 m from the furthest point of the useful magnetic field volume, as declared by the manufacturer. Therefore, any current used for testing is based on fields at this distance.~~

## ~~5.4 Induction loop receiver~~

### ~~5.4.1 General~~

~~To meet the requirements of the present document the induction loop receiver shall be measured under various magnetic field strengths with a test signal of 1 kHz, as stated in clause 5.2.1. This confirms adequate sensitivity of the equipment and its capability to operate in the maximum intended field strength without undue overload.~~

### ~~5.4.2 Headphone output~~

~~For AFILS receivers and loop test equipment claiming compliance with the present document and having an output suitable for connection to headphones, a field strength of 400 $mAm^{-1}$ rms at 1 kHz shall be capable of producing an output voltage of 150 mV rms across a 32 Ω resistive load. Furthermore, the equipment shall be able to operate in a field strength of 1 $Am^{-1}$ rms with a THD of less than, or equal to, that stated by the manufacturer. This performance shall be as stated in the manufacturer's documentation and recorded in the test report.~~

### ~~5.4.3 Induction loop receiver definitions~~

~~There are no separate classes of induction loop receiver.~~

### ~~5.4.4 Methods of measurement~~

~~The following tests shall be carried out:~~

~~a) The equipment shall be set up with the headphone port suitably loaded with a 32 Ω resistive load. The actual connection(s) used shall be recorded in the test report.~~

~~The equipment shall be subjected to a field strength of 400 $mAm^{-1}$ rms with a test signal of 1 kHz as stated in clause 5.2.1. Any available volume, gain or sensitivity adjustments shall be set to provide a minimum of 150 mV rms across the 32 Ω resistive load. The actual value shall be recorded in the test report.~~

~~After a minimum of 10 seconds of conditioning, the THD at the headphone output shall be measured and recorded. This shall be less than or equal to that stated by the manufacturer.~~

~~b) Immediately after the tests defined in clause 5.4.4, item a) are carried out, and using the same arrangement, the field strength shall be increased to a level of 1 $Am^{-1}$ rms Any externally available volume, gain or sensitivity adjustments may be adjusted, at the manufacturer's discretion, to provide no less than 150 mV rms across the 32 Ω resistive load. The actual value shall be recorded in the test report.~~

~~After a minimum of 10 seconds of conditioning, the Total Harmonic Distortion at the headphone output shall be measured and recorded. This shall be less than or equal to that stated by the manufacturer.~~

~~Care shall be taken that at each magnetic field strength level, the magnetic field signal, or corresponding generating loop current, shall provide a THD value of less than that declared by the manufacturer for the receiving equipment.~~

### ~~5.4.5 Limits~~

~~AFILS receivers are designed to detect the audio frequency magnetic field from a hearing loop system. There are no oscillators and so they are not capable of radio transmission. Therefore, no limits are specified.~~

## ~~5.5~~5.4 Interpretation of the measurement results

~~The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:~~

- ~~the measured value related to the corresponding limit will be 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 shall be included in the test report;~~
- ~~the recorded value of the measurement uncertainty shall be, for each measurement, equal to or less than the figures in table 4.~~

~~For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.9], in particular in annex D of the ETSI TR 100 028-2 [i.10].~~

~~Table 4 is based on such expansion factors.~~

~~Table 4~~Refer to annex F for more information.

**~~: Maximum measurement uncertainty~~**

| ~~Parameter~~ | ~~Uncertainty~~ |
|---|---|
| ~~Frequency~~ | ~~±1 %~~ |
| ~~Loop current~~ | ~~±5 %~~ |
| ~~Temperature~~ | ~~±1 °C~~ |
| ~~Humidity~~ | ~~±5 %~~ |

# 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~~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 | ~~Reference:~~ Clause ~~No~~(s) of the present document | U/C | Condition |
| 1 | Spurious domain emission limits | 3.2 | 5.3.~~4~~3 | U | |
| 2 | ~~Audio frequency in~~In band and out of band emission limits | 3.2 | 5.3.~~3~~2 | U | |
| ~~3~~ | ~~Induction loop receiver~~ | | ~~5.4~~ | ~~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 ~~Number~~(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 ~~amplifiers~~drivers

### B.1.1 General

Induction loop ~~amplifiers~~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~~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~~. Wider frequency responses up to 9 kHz may be required for non-hearing instrument use (e.g. tour guides) and for future developments of hearing instrument technology~~.

### B.1.3 Field strength

A correctly designed and installed AFILS, complying with the requirements of IEC 60118-4 [~~i.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 ~~second~~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 ~~(speech or music).~~ 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 ~~amplifier~~driver performance tests, the ~~amplifier~~driver is expected to be operated as described in clause 5.1~~.~~

~~B.2 Induction loop receivers~~ and ~~test equipment~~clause 5.2.

### ~~B.2.1 General~~

~~AFILS receivers, like hearing instruments, are stand-alone battery-powered devices using a telecoil to convert an AFILS magnetic field into a voltage, which can be processed and amplified to drive an earphone or headphones.~~

~~AFILS field strength meters also sense the magnetic field with a telecoil and often provide a headphone output so that the measured signal can be assessed by listening.~~

~~As there is no heterodyning of signals and no internal intermediate frequency mixer oscillators, etc., the baseband audio frequency magnetic field is transposed directly to an audio frequency baseband output signal. Antenna emissions tests are therefore not required. EMC standards cover any likely emissions from such equipment, including any internal loop(s).~~

~~Receivers and test equipment are non-critical communication devices, whose failure to operate correctly causes loss of function which can be overcome by parallel means. This classification is based upon the impact on persons in case the equipment does not operate above the specified minimum performance level.~~

~~Other hearing instruments (e.g. hearing aids, cochlear implants and loop listeners) that may be used as AFILS receivers are expected to fulfil the standards applicable to that equipment (if any).~~

### ~~B.2.2 Sensitivity~~

~~For AFILS receivers and loop test equipment claiming compliance with the present document and having an output suitable for connection to headphones, a field strength of 400 mAm$^{-1}$ at 1 kHz are expected to be capable of producing an output voltage of 150 mV across a 32 Ω resistive load.~~

~~The receiver's amplifier should not be overloaded by a field strength of 1 Am$^{-1}$.~~

~~The equipment may have a volume or gain control to provide other sensitivities.~~

## 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 from 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 ≤ $f$ ≤ 10 MHz.
- -3,5 dBµA/m, for 10 MHz < $f$ ≤ 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 m × 1 m loop is used. Details of the loop and measurement point at 10 m are shown in figure B.1.

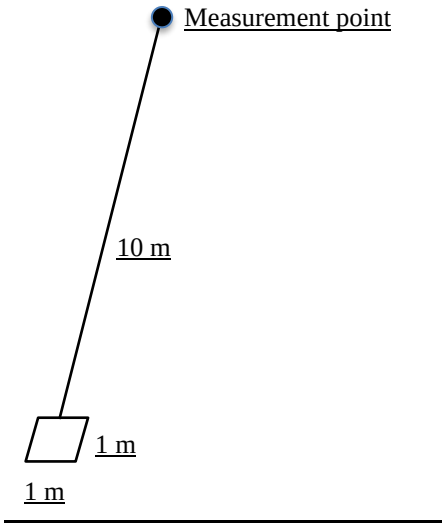



**Figure B.1: 1 m × 1 m loop with measurement point 10 m from the middle of one side**

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.

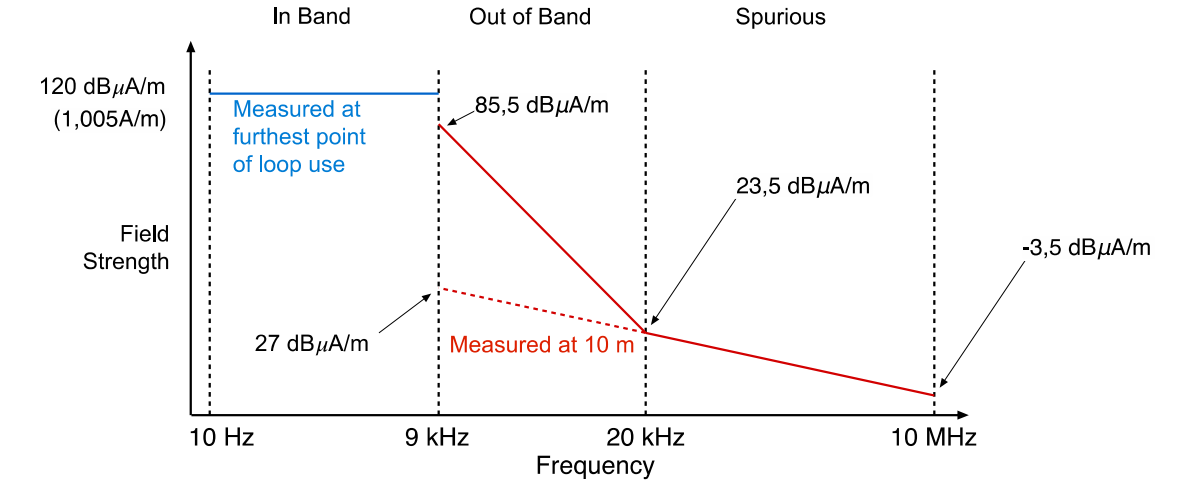



**Figure B.2: Induction loop driver emissions levels and spectrum mask measurements**

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 (normative):~~ ~~Measurement~~

## ~~C.1 Standard test position to be used with internal loop equipment or equipment having a loop connector~~

~~The standard position for equipment shall be the following:~~

~~a) for equipment with an internal loop, it shall be placed in the position closest to normal use as declared by the manufacturer.~~

~~Equipment which is intended to be worn on a person may be tested using a simulated man as support. The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground.~~

~~The container shall have the following dimensions:~~

- ~~Height: 1,7 m ± 0,1 m.~~
- ~~Inside diameter: 300 mm ± 5 mm.~~
- ~~Sidewall thickness: 5 mm ± 0,5 mm.~~

~~The container shall be filled with a salt (NaCl) solution of 1,5 g per litre of distilled water.~~

~~The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment, as intended in normal use.~~

~~To reduce the weight of the simulated man it may be possible to use an alternative tube which has a hollow centre of 220 mm maximum diameter.~~

# ~~Annex D (normative~~ (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:

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

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 ~~meters~~metres.

*N* = Number of turns of the induction loop.

*I* = Current in Ampere in the induction loop.

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

~~*B*~~*W* = 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 ~~the diagram below~~figure C.1.

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

~~P~~p = $A/2$.

$q$ = $B/2$.

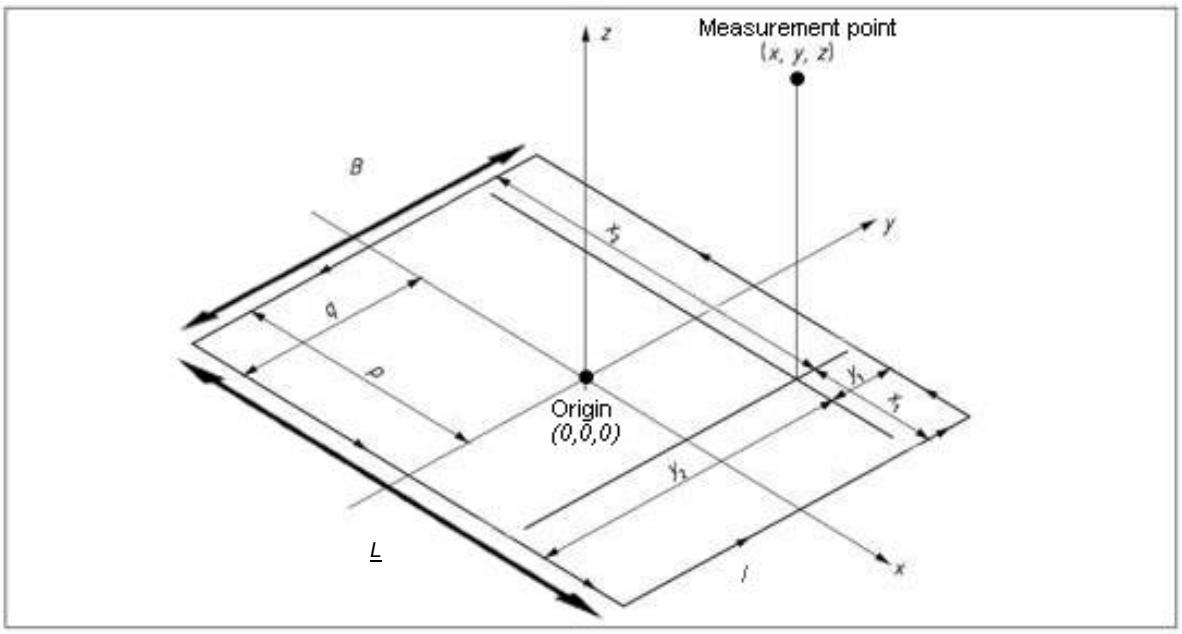



**Figure ~~D~~C.1: Diagram for calculating magnetic field strength at point (x, y, z)**

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:

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

~~Where:~~

W

where:

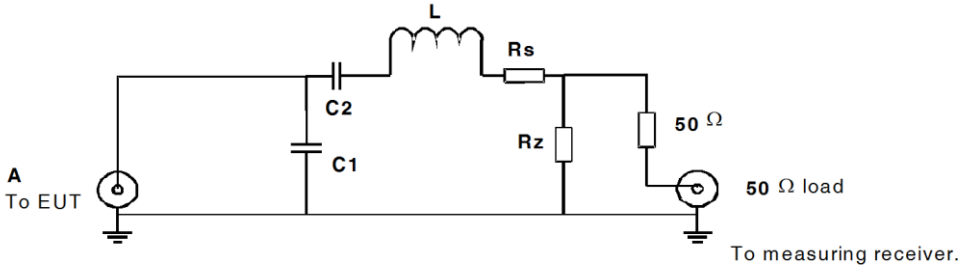
$H_z$ (0,0,z) = H-Field in the Z-axis at, above or below the centre point of the AFILS loop in $Am^{-1}$.

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).

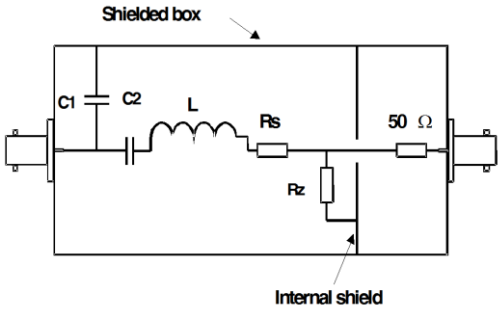
# Annex ~~E~~D (informative): ~~Artificial~~How to construct a test fixture incorporating an artificial loop

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

~~The artificial loop may be used for equipment with a loop connector and submitted for testing without a loop. The radiated fields for the baseband and spurious emissions are proportional to the audio frequency baseband and spurious currents. Therefore, measurements are made to determine the audio frequency baseband and spurious currents in the artificial loop.~~




**~~Figure E.1~~**




**~~Figure E.2~~**

~~An example of the mechanical layout and the~~ 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 ~~are~~is given in figure ~~E.2 and figure E~~D.1 ~~respectively~~.

~~If the manufacturer specifies a range of loop dimensions, two artificial loops having maximum and minimum inductance L should be supplied. This fact should be stated in the test report.~~

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.

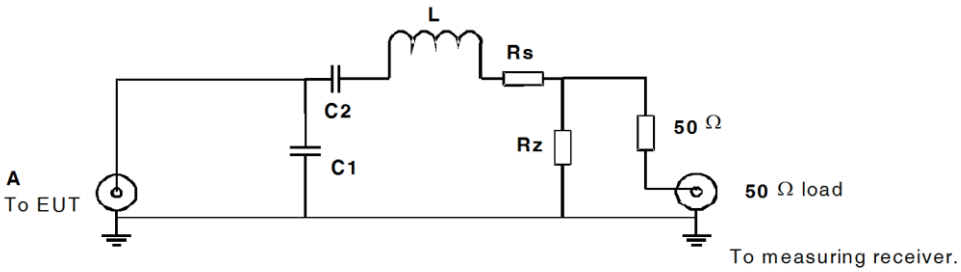



**Figure D.1: Non-isolated test circuit**

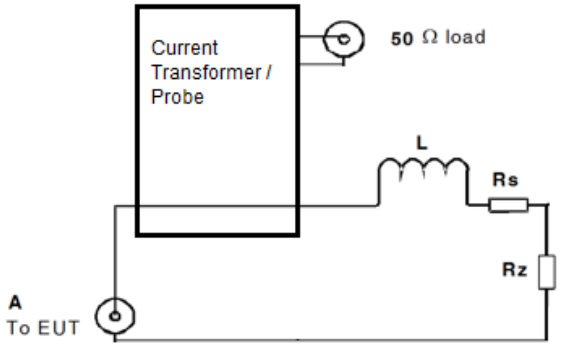


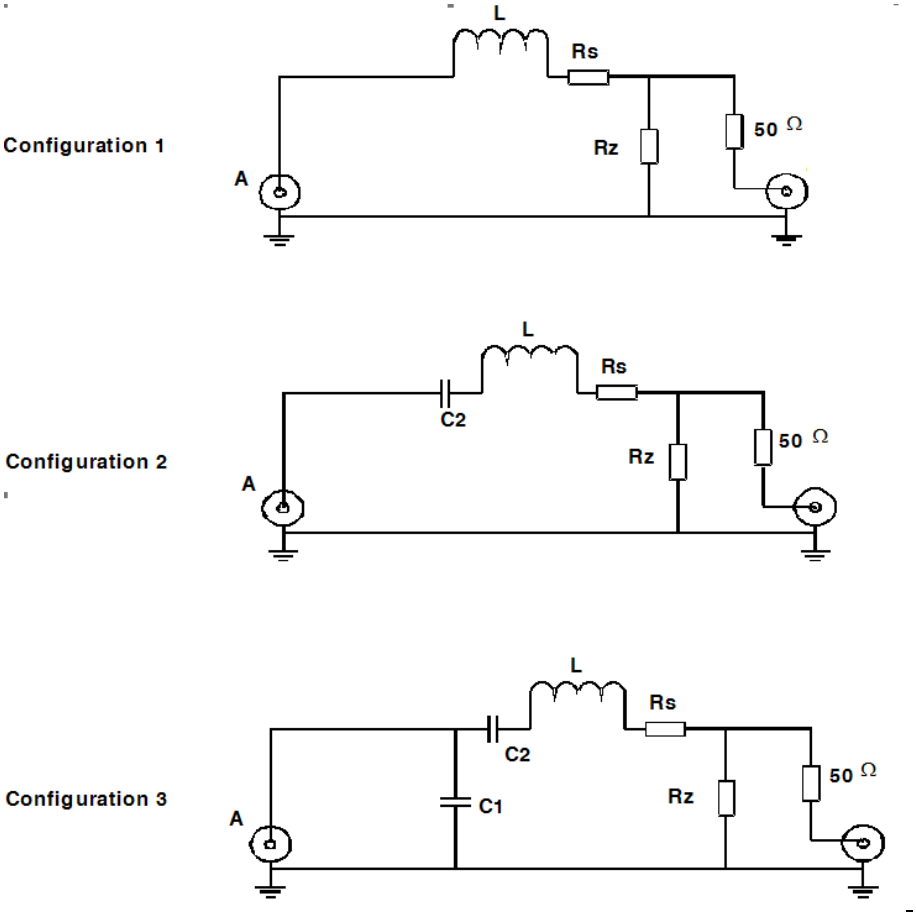

**Figure D.2: Isolated test circuit**

$R_z$ 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 $R_z$ ~~ensures~~should be selected to ensure that the total resistance ($R_{total}$) of the artificial loop ~~has the same Q as the specified loop.~~

~~As~~matches, within tolerance, the artificial loop ~~does not provide galvanic isolation between the equipment under test and the test receiver, isolation may be required elsewhere in order to ensure correct and/ or safe operation~~chosen from table 1.

~~Capacitors C1, C2 are optional components together with L to be used as appropriate by the manufacturer to simulate the actual loop configuration. Other possible configurations are shown in figure E.3.~~




~~**Figure E.3**~~

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**

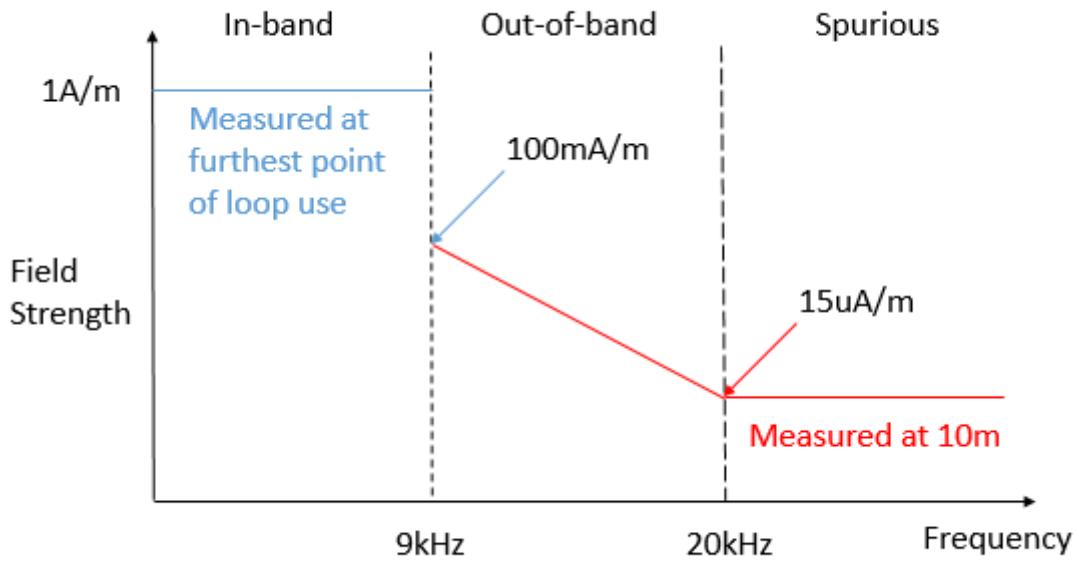
| Artificial Loop | Resistor $R_Z$ (Ω) See note 1 | Resistance of Inductor $R_S$ (Ω) See note 2 | Inductance $L_{total}$ (µH) See note 3 |
|---|---|---|---|
| 1 | 0,5 | ≤ 0,2 | 75 |
| 2 | 1,0 | ≤ 0,2 | 150 |
| NOTE 1: Resistor/s should be mounted on a suitable heatsink in order to be capable of dealing 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 Ω 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 ~~test fixture configuration~~artificial loop used ~~by~~during the ~~manufacturer~~test should be stated in the test report.

# Annex ~~F~~E (normative): Induction loop ~~amplifier~~driver emission levels and spectrum mask measurements

The present document allows spectrum measurements to be made. The measurements are relevant for AFILS operating ~~between 0~~from 10 Hz to 9 kHz.

~~In band emissions are measured at the furthest point of the useful magnetic field volume as declared by the manufacturer. Out of band and spurious emissions are measured 10 m from the furthest point of the useful magnetic field volume as declared by the manufacturer.~~




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

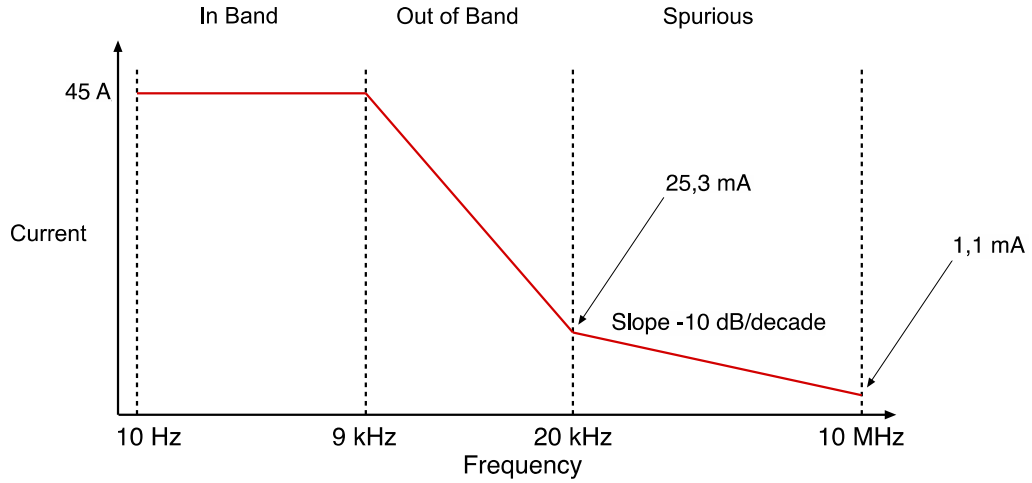



**Figure E.1: Induction loop ~~amplifier~~driver emissions levels and spectrum mask measurements**

# Annex ~~G~~F (informative): ~~Determination and use~~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 ~~bandwidth~~

- ~~CISPR 16-2-3 [i.3] specifies a reference bandwidth~~uncertainty for the measurement of ~~unwanted emissions by~~each parameter is included in the test report.

Table F.1 shows the recommended values for the maximum measurement ~~receivers and spectrum analysers~~uncertainty figures.

**Table F.1: Maximum measurement uncertainty**

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

~~The reference bandwidth ($BW_{REFERENCE}$) cannot always be used as the measurement bandwidth ($BW_{MEASUREMENT}$). This is particularly the case if the measurement is to be made for example on the slope of a spectrum mask or a receiver selectivity curve. In such situations the measurement should be made with a sufficiently low bandwidth in order not to distort the reading.~~

~~The actual measured value, A, should be referred back to the reference bandwidth by:~~

~~Either:~~

~~a) Correcting the measured value, A, for any signal having a flat level spectrum with the following formula:~~

~~$$B = A + 10 \log \frac{BW_{REFERENCE}}{BW_{MEASURED}}$$~~

~~where:~~

~~B is the measured level, A, transferred to the reference bandwidth.~~

~~Or:~~

~~b) Use the measured value, A, directly if the measured spectrum is a discrete spectral line.~~

~~A discrete spectrum line is defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth.~~

# Annex ~~H~~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 ~~harmonization~~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".
- ~~CENELEC~~ EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement~~".~~" (produced by CENELEC).

# Annex ~~I~~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 | | |
|---|---|---|
| ~~V1.1.0~~ | ~~February 2016~~ | ~~EN Approval Procedure AP 20160524: 2016-02-24 to 2016-05-24~~ |
| ~~V1.1.1~~ | ~~May 2017~~ | ~~Vote V 20170715: 2017-05-16 to 2017-07-17~~ |
| V1.1.2 | July 2017 | Publication |
| V1.2.0 | February 2021 | EN Approval Procedure AP 20210526: 2021-02-25 to 2021-05-26 |
| V1.2.1 | June 2021 | Publication |
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