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Harmonized European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment for Eurobalise railway systems; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

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Contents

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Foreword

This Harmonized European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Vote phase of the ETSI standards Two-step Approval Procedure.

The present document has been produced by ETSI in response to mandate M/364 from the European Commission issued under Council Directive 98/34/EC [i.1] (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Directive 1999/5/EC [i.2] of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity ("the R&TTE Directive").

Technical specifications relevant to Directive 1999/5/EC [i.2] are given in annex A.

These specifications are complementary with the system and interoperability requirements for these devices established under Commission Decision 2004/447/EC [i.3].

In addition, relevant parts of EN 50121 [i.4] are applicable for the electromagnetic compatibility of railway applications (part 3-2 for the OBE and part 4 for the Eurobalise equipment).

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

Introduction

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the R&TTE Directive. The modular structure is shown in EG 201 399 [i.5] (see bibliography).

The Eurobalise transmission system is defined by the specifications of the UNISIG consortium (see bibliography).

1 Scope

The present document covers the technical requirements for radio transmitters and receivers used in the Eurobalise transmission system. The system is only used in railway systems.

It applies to the following equipment units:

a) the On-board Equipment (OBE) Tele-powering the Eurobalise; and

b) the Eurobalise that is always installed in between the rails.

The OBE comprises a transmitter (normally un-modulated) and a receiver fitted with an integral or dedicated antenna.

The Eurobalise FSK-modulated transmitter is Tele-powered by the OBE and has an integral antenna.

The Eurobalise transmission system operates in accordance with ERC Recommendation 70-03, annex 4.

These radio equipment types are capable of operating at the following frequencies as given in table 1.

Table 1: Radio communications frequencies

	Radio communications frequencies
OBE transmit centre frequency	27,095 MHz
Eurobalise transmit centre frequency	4,234 MHz

The present document is intended to cover the provisions of Directive 1999/5/EC [i.2] (R&TTE Directive) article 3.2, which states that "… radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference".

NOTE: A list of such ENs is included on the web site http://www.newapproach.org.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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

For online referenced documents, information sufficient to identify and locate the source shall be provided. Preferably, the primary source of the referenced document should be cited, in order to ensure traceability. Furthermore, the reference should, as far as possible, remain valid for the expected life of the document. The reference shall include the method of access to the referenced document and the full network address, with the same punctuation and use of upper case and lower case letters.

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

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI TR 102 273 (V1.2.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

[2] CISPR 16 (2006), (parts 1-1, 1-4 and 1-5): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

[3] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[4] ANSI C63.5 (2006): "American National Standard for Electromagnetic Compatibility - Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas (9 kHz to 40 GHz)".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] 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.

[i.2] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[i.3] Commission Decision 2004/447/EC of 29 April 2004 modifying Annex A to Decision 2002/731/EC of 30 May 2002 and establishing the main characteristics of Class A system (ERTMS) of the control-command and signalling subsystem of the trans-European conventional rail system referred to in Directive 2001/16/EC of the European Parliament and of the Council.

[i.4] CENELEC EN 50121 (all parts): "Railway Applications - Electromagnetic Compatibility".

[i.5] ETSI EG 201 399 (V2.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

dedicated antenna: removable antenna supplied and tested with the radio equipment, designed as an indispensable part of the equipment

down-link: optional binary ASK- modulated transmission link from the OBE to trackside units

duty cycle: defined as the ratio, expressed as a percentage, of the maximum transmitter "on" time monitored over one hour, relative to a one hour period

eurobalise: wayside transmission unit that uses the magnetic transponder technology

NOTE: Its main function is to transmit and/or receive signals through the air gap. The Eurobalise is a single device mounted on the track, which communicates with a train passing over it.

integral antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment

magnetic transponder technology: method that uses magnetic coupling in the air gap between a transmitter and a receiver for conveying data and energy

NOTE: In the Eurobalise transmission system context, it considers systems using the 27,095 MHz for Tele-powering and 4,234 MHz for Up-link transmission.

On-Board Equipment (OBE): consists of antenna unit(s) (for magnetic transponder technology) and the Balise transmission function

NOTE: It functionally matches the air-gap interface and is installed on a train.

RF carrier: fixed radio frequency prior to modulation

Tele-powering: signal transmitted by the OBE, which activates the Eurobalise upon passage

NOTE: The signal is normally an un-modulated RF carrier (CW). However, it may optionally be binary ASK-modulated for the transmission of down-link data.

up-link: transmission link from the Eurobalise to the OBE

3.2 Symbols

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

f	Frequency
S	Power Density
λ	Wavelength

3.3 Abbreviations

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

AC	Alternating Current
ASK	Amplitude Shift Keying
CW	Continuous Wave
EUT	Equipment Under Test
FSK	Frequency Shift Keying
HS	Harmonized Standard
OATS	Open Area Test Site
OBE	On-Board Equipment
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
SRD	Short Range Device
VSWR	Voltage Standing Wave Ratio

4 Technical Requirements Specification

4.1 Technical Requirements

4.1.1 OBE Transmitter Mask

4.1.1.1 Definition

This test only applies to the OBE.

The radiated H-field mask is defined in the direction of maximum field strength under specified conditions of measurement.

4.1.1.2 Test Procedure

This test is performed using a radiated measurement (see clause 7.1).

4.1.1.3 Limit

The limits of figure 1 (expressed in dBµA/m at a distance of 10 m) shall not be exceeded.

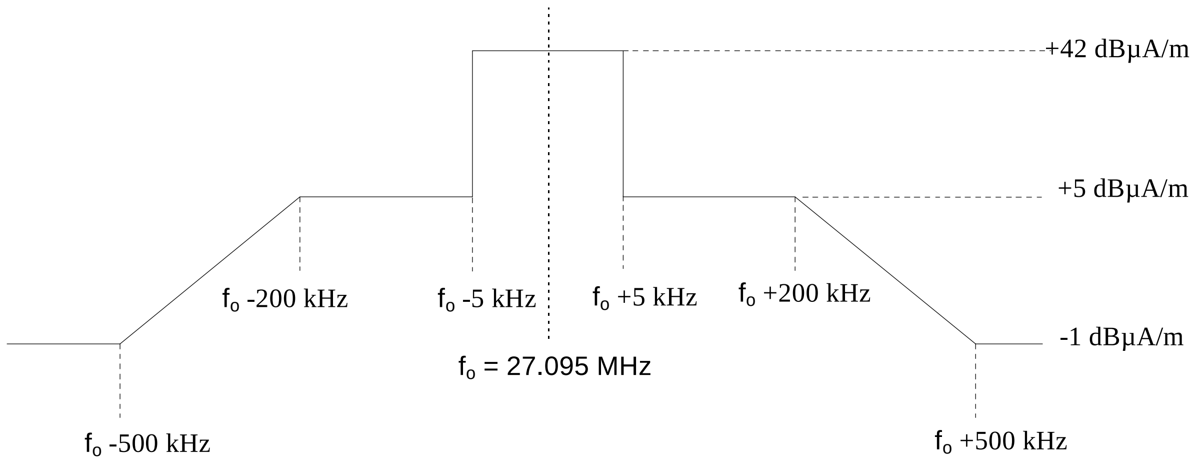

Figure 1: OBE transmitter mask

4.1.1.4 Maximum Allowable Measurement Uncertainty

See table 5 in clause 6.

4.1.2 OBE Unwanted Emissions

4.1.2.1 Definition

This test only applies to the OBE. Unwanted emissions consist of out-of-band and spurious emissions outside the frequency range 27,095 MHz ± 500 kHz as defined in clause 4.1.1.3.

4.1.2.2 Test Procedure

This test is performed using a radiated measurement (see clause 7.2).

4.1.2.3 Limit

The limits in table 2 (expressed in dBμA/m at a distance of 10 m for frequencies below 30 MHz and expressed in dBμV/m at a distance of 10 m for frequencies equal or greater than 30 MHz) shall not be exceeded.

Table 2: OBE unwanted emissions limits

Frequency: (f)	Limit
9 kHz ≤ f < 150 kHz	44 dBμA/m at 9 kHz decreasing with logarithm of frequency to 19 dBμA/m at 150 kHz
150 kHz ≤ f < 30 MHz	54 dBμA/m at 150 kHz decreasing with logarithm of frequency to 4 dBμA/m at 30 MHz
30 MHz ≤ f ≤ 1 GHz	79 dBμV/m at 30 MHz decreasing with logarithm of frequency to 54 dBμV/m at 1 GHz

4.1.2.4 Maximum Allowable Measurement Uncertainty

See table 5 in clause 6.

4.1.3 Eurobalise Transmitter Mask

4.1.3.1 Definition

This test only applies to Eurobalises.

The radiated H-field uplink mask is defined in the direction of maximum field strength under specified conditions of measurement.

4.1.3.2 Test Procedure

This test is performed using a radiated measurement (see clause 7.3).

4.1.3.3 Limit

The limits of figure 2 (expressed in dBμA/m at a distance of 10 m) shall not be exceeded.

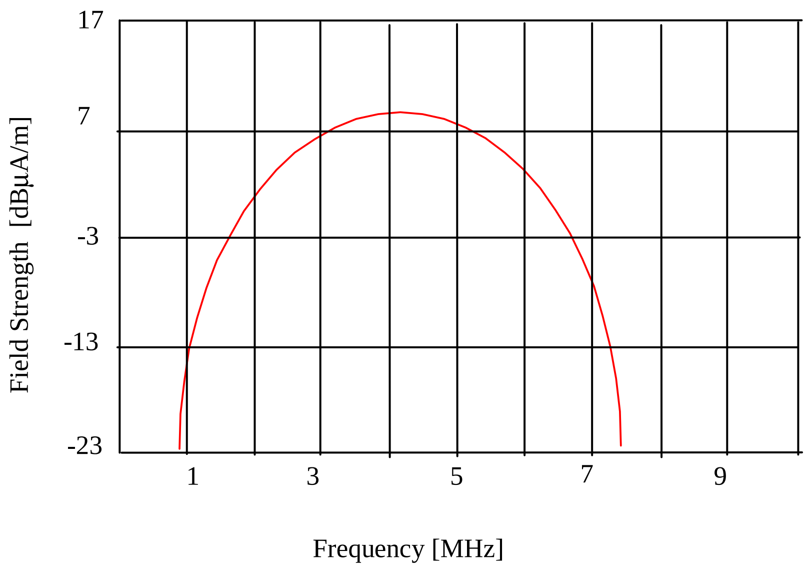

Figure 2: Eurobalise transmitter mask

The defined in-band frequency range is limited to the frequency range 4,234 MHz ± 1 MHz. The maximum value in the graph of figure 2 is 9 dBµA/m.

NOTE: ERC Recommendation 70-03, annex 4 recommends a maximum duty cycle of 1 % for the Eurobalise transmitter. This duty cycle can not be exceeded during normal operation due to the fact that the train never stops above the Eurobalise, i.e. the train only stops after the Eurobalise has been passed. In principle, it is impossible to exceed the duty cycle with moving trains due to the distance between trains versus Eurobalise operating range.

The provider shall declare the maximum duty cycle to not exceed 1 %.

4.1.3.4 Maximum Allowable Measurement Uncertainty

See table 5 in clause 6.

4.1.4 Eurobalise Unwanted Emissions

4.1.4.1 Definition

This test only applies to Eurobalises. Unwanted emissions consist of out-of-band and spurious emissions outside the frequency range 27,095 MHz ± 500 kHz as defined in clause 4.1.1.3 and outside the frequency range 4,234 MHz ± 1 MHz as defined in clause 4.1.3.3.

4.1.4.2 Test Procedure

This test is performed using a radiated measurement (see clause 7.4).

4.1.4.3 Limit

The limits in table 3 (expressed in dBµA/m at a distance of 10 m for frequencies below 30 MHz and expressed in dBµV/m at a distance of 10 m for frequencies equal or greater than 30 MHz) shall not be exceeded.

Table 3: Eurobalise unwanted emissions limits

Frequency: (f)	Limit
9 kHz ≤ f < 150 kHz	44 dBµA/m at 9 kHz decreasing with logarithm of frequency to 19 dBµA/m at 150 kHz
150 kHz ≤ f < 30 MHz	54 dBµA/m at 150 kHz decreasing with logarithm of frequency to 4 dBµA/m at 30 MHz
30 MHz ≤ f ≤ 1 GHz	79 dBµV/m at 30 MHz decreasing with logarithm of frequency to 54 dBµV/m at 1 GHz

4.1.4.4 Maximum allowable measurement uncertainty

See table 5 in clause 6.

5 Test Conditions

5.1 General

Testing shall be made under normal test conditions.

NOTE: The Eurobalise system components (OBE as well as the Eurobalise) are built for interoperability and the UNISIG specifications apply over the full operating temperature range (including the spectrum masks).

The test conditions and procedures shall be as specified in clauses 5.2 and 5.3.

5.2 Test Power Source

The OBE equipment shall be tested using the appropriate test power source.

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

The Eurobalise is purely Tele-powered during the test.

During the tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal test voltages as specified in clause 5.3.2. 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. For radiated measurements any external power leads should be so arranged so as not to affect the measurements.

During tests the test power source voltages shall be within a tolerance of < ±1 % relative to the voltage at the beginning of each test. The value of this tolerance can be critical for certain measurements. Using a smaller tolerance will provide a better uncertainty value for these measurements.

5.3 Normal Test Conditions

5.3.1 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 %.

5.3.2 Normal Test Power Source

5.3.2.1 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, or any of the declared voltages, for which the equipment was designed.

The frequency of the test power source corresponding to the AC mains shall be between 49 Hz and 51 Hz.

5.3.2.2 Other Power Sources

For operation from other power sources, the normal test voltage shall be that declared by the equipment provider and agreed by the test laboratory. Such values shall be stated in the test report.

5.4 Requirements for the Test Modulation

The OBE is un-modulated (CW) during testing. If the OBE has implemented the optional down-link modulation (binary ASK), then testing shall occur with a modulated OBE as well. The Eurobalise is Tele-powered and the specified FSK modulation applies. The information content shall be representative of normal use.

The manufacturer shall provide the means to operate the transmitter during the tests.

5.5 Choice of Equipment for Test Suites

The tests shall be carried out on one or more production models or equivalent preliminary models, as appropriate. If testing is performed on (a) preliminary model(s), then the corresponding production models shall be identical to the tested models in all respects relevant for the purposes of the present document.

If equipment has several optional features that are considered to affect directly the RF parameters, then tests need only be performed on the equipment configured with the considered worst case combination of features as declared by the manufacturer.

The test shall be performed as a radiated test using the radiated measurement procedures.

The provider shall provide one or more samples of the equipment, as appropriate for testing. Additionally, technical documentation and operating manuals, sufficient to make the test, shall be supplied.

5.6 Measuring Receiver

The term "measuring receiver" refers to a spectrum analyser. The bandwidth and detector type of the measuring receiver are given in table 4.

Table 4: Measuring receiver

Frequency: (f)	Detector type	Spectrum analyzer bandwidth
9 kHz ≤ f < 150 kHz	Quasi Peak	300 Hz
150 kHz ≤ f < 30 MHz	Quasi Peak	10 kHz
30 MHz ≤ f ≤ 1 GHz	Quasi Peak	100 kHz

6 Measurement Uncertainty

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

- the measured value related to the corresponding limit shall 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 separately included in the test report;
- the value of the measurement uncertainty should be, for each measurement, equal to or lower than the figures in table 5.

Table 5: Absolute measurement uncertainties: maximum values

Parameter	Uncertainty
Radiated field strength	±6 dB
Temperature	±1 °C
Humidity	±10 %

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [3], 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).

Table 5 is based on such expansion factors.

The particular expansion factor used for the evaluation of the measurement uncertainty shall be stated.

TR 102 273 [1] provides further information concerning the usage of test sites.

7 Test Procedures for Essential Radio Test Suites

7.1 OBE Transmitter Mask

See clause 5.1 for the test conditions.

The measurements of the transmitter radiated H-field shall be made on one of the test sites specified in annex B. Any measured values shall be at least 6 dB above the ambient noise level.

The OBE transmitter spectrum within the frequency range 27,095 MHz ± 500 kHz shall be determined and recorded. The OBE Tele-powering signal (CW) is measured as follows.

Step 1 The H-field strength should be measured at 10 m distance by using quasi peak detector and a 10 kHz resolution bandwidth. The result shall be recorded in the test report as the total field strength.

Where a measurement distance of 10 m is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m according to annex D, and these calculations shall be stated in the test report. The H-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with clause 5.6.

The spectrum analyser or equivalent shall be configured as follows unless otherwise stated:

- Resolution bandwidth: 10 kHz.
- Video bandwidth: Not less than the resolution bandwidth.
- Detector mode: Quasi-peak.

For equipment where the optional OBE down-link modulation is implemented (binary ASK modulation), the following measurement shall be conducted:

Step 2 The spectrum of the transmitter is measured also with modulation in the same way as described in step 1 above. The result shall be recorded in the test report.

7.2 OBE Unwanted Emissions

See clause 5.1 for the test conditions.

The measuring receiver shall be tuned over the frequency range 9 kHz to 1 GHz, excluding the frequency range 27,095 MHz ± 500 kHz on which the transmitter is intended to operate.

At each frequency at which a relevant spurious signal is detected, the OBE under test and the test antenna shall be rotated until maximum field strength is indicated on the measuring receiver. This level shall be noted.

For measuring equipment calibrated in dBμV/m, the reading should be reduced by 51,5 dB to be converted to dBμA/m, or vice-versa.

The OBE unwanted emissions are measured as follows.

Step 1 The H-field strength is measured at 10 m distance by using quasi peak detector and the resolution bandwidth as given in table 4 of clause 5.6. The results shall be recorded in the test report as the total field strength.

Where a measurement distance of 10 m is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m according to annex D, and these calculations shall be stated in the test report. The H-field is measured with a shielded loop antenna connected to a measurement receiver below 30 MHz. In the frequency range from 30 MHz to 300 MHz a dipole or bi-conical antenna shall be used. Above 300 MHz a log-periodic antenna shall be used. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with clause 5.6.

The spectrum analyser shall be configured as follows unless otherwise stated:

- Resolution bandwidth: 300 Hz, 10 kHz or 100 kHz in accordance with table 4 in clause 5.6.
- Video bandwidth: Not less than the resolution bandwidth.
- Detector mode: Quasi-peak.

For equipment where the optional OBE down-link modulation is implemented (binary ASK modulation), the following measurement shall be conducted:

Step 2 The spectrum of the transmitter is measured also with modulation in the same way as described in step 1 above. The result shall be recorded in the test report.

7.3 Eurobalise Transmitter Mask

See clause 5.1 for the test conditions.

The measurements of the transmitter radiated H-field shall be made on one of the test sites specified in annex B. Any measured values shall be at least 6 dB above the ambient noise level.

The Eurobalise transmitter spectrum centred at 4,234 MHz shall be measured down to a field strength value of -23 dBμA/m at a distance of 10 m and be recorded. During the measurement, the Eurobalise will be Tele-powered. However, a two step approach as defined below is also allowed.

1) Measure and record the maximum value(s) of the transmitter spectrum at a distance of 10 m.
2) Perform another relative measurement at a shorter distance in order to verify the overall shape of the spectrum.

The H-field strength is measured at 10 m distance (or using the two-step approach above) by using quasi peak detector and a 10 kHz resolution bandwidth. The result is recorded in the test report as the total field strength.

Where a measurement distance of 10 m is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m according to annex D, and these calculations shall be stated in the test report. The H-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with clause 5.6.

The spectrum analyser or equivalent shall be configured as follows unless otherwise stated:

- Resolution bandwidth: 10 kHz.
- Video bandwidth: Not less than the resolution bandwidth.
- Detector mode: Quasi-peak.

7.4 Eurobalise Unwanted Emissions

See clause 5.1 for the test conditions.

The measuring receiver shall be tuned over the frequency range 9 kHz to 1 GHz, except for the in-band frequency ranges as defined in clauses 7.1 and 7.3.

At each frequency at which a relevant spurious signal is detected, the Eurobalise under test and the test antenna shall be rotated until maximum field strength is indicated on the measuring receiver. This level shall be noted.

For measuring equipment calibrated in dBμV/m, the reading should be reduced by 51,5 dB to be converted to dBμA/m, or vice-versa.

The Eurobalise unwanted emissions are measured as follows.

Step 1 The H-field strength is measured at 10 m distance by using quasi peak detector and the resolution bandwidth as given in table 4 of clause 5.6. The results are recorded in the test report as the total field strength.

Where a measurement distance of 10 m is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m according to annex D, and these calculations shall be stated in the test report. The H-field is measured with a shielded loop antenna connected to a measurement receiver below 30 MHz. In the frequency range from 30 MHz to 300 MHz a dipole antenna shall be used. Above 300 MHz a log-periodic antenna shall be used. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with clause 5.6.

The spectrum analyser shall be configured as follows unless otherwise stated:

- Resolution bandwidth: 300 Hz, 10 kHz or 100 kHz in accordance with table 4 in clause 5.6.
- Video bandwidth: Not less than the resolution bandwidth.
- Detector mode: Quasi-peak.

Annex A (normative): HS Requirements and conformance Test specifications Table (HS-RTT)

The HS Requirements and conformance Test specifications Table (HS-RTT) in table A.1 serves a number of purposes, as follows:

- it provides a statement of all the requirements in words and by cross reference to (a) specific clause(s) in the present document or to (a) specific clause(s) in (a) specific referenced document(s);
- it provides a statement of all the test procedures corresponding to those requirements by cross reference to (a) specific clause(s) in the present document or to (a) specific clause(s) in (a) specific referenced document(s);
- it qualifies each requirement to be either:
  - Unconditional: meaning that the requirement applies in all circumstances, or
  - Conditional: meaning that the requirement is dependant on the manufacturer having chosen to support optional functionality defined within the schedule.
- in the case of Conditional requirements, it associates the requirement with the particular optional service or functionality;
- it qualifies each test procedure to be either:
  - Essential: meaning that it is included with the Essential Radio Test Suite and therefore the requirement shall be demonstrated to be met in accordance with the referenced procedures;
  - Other: meaning that the test procedure is illustrative but other means of demonstrating compliance with the requirement are permitted.

Table A 1: HS Requirements and conformance Test specifications Table (HS-RTT)

Harmonized Standard EN 302 608 The following technical requirements and test specifications are relevant to the presumption of conformity under the article 3.2 of the R&TTE Directive						
Requirement			**Requirement Conditionality**		**Test specification**	
No	**Description**	**Reference: clause No**	**U/C**	**Condition**	**E/O**	**Reference: clause No**
1	OBE transmitter mask	4.1.1	C	Applies only to OBE	E	7.1
2	OBE unwanted emissions	4.1.2	C	Applies only to OBE	E	7.2
3	Eurobalise transmitter mask	4.1.3	C	Applies only to Eurobalise	E	7.3
4	Eurobalise unwanted emissions	4.1.4	C	Applies only to Eurobalise	E	7.4
5	Duty cycle	4.1.3	C	Applies only to Eurobalise	X	

Key to columns:

Requirement:

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

Description A textual reference to the requirement.

Clause Number 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 to be *unconditionally* applicable (U) or is *conditional* upon the manufacturers claimed functionality of the equipment (C).

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

Test Specification:

E/O Indicates whether the test specification forms part of the Essential Radio Test Suite (E) or whether it is one of the Other Test Suite (O).

NOTE: All tests whether "E" or "O" are relevant to the requirements. Rows designated "E" collectively make up the Essential Radio Test Suite; those designated "O" make up the Other Test Suite; for those designated "X" there is no test specified corresponding to the requirement. The completion of all tests classified "E" as specified with satisfactory outcomes is a necessary condition for a presumption of conformity. Compliance with requirements associated with tests classified "O" or "X" is a necessary condition for presumption of conformity, although conformance with the requirement may be claimed by an equivalent test or by manufacturer's assertion supported by appropriate entries in the technical construction file.

Clause Number Identification of clause(s) defining the test specification in the present document unless another document is referenced explicitly. Where no test is specified (that is, where the previous field is "X") this field remains blank.

Annex B (normative): Radiated Measurement

B.1 Test sites and General Arrangements for Measurements Involving the use of Radiated Fields

B.1.1 General

This annex introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in TR 102 273 [1].

NOTE: To ensure reproducibility and tractability of radiated measurements only these test sites should be used in measurements in accordance with the present document.

B.1.2 Anechoic Chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure B.1.

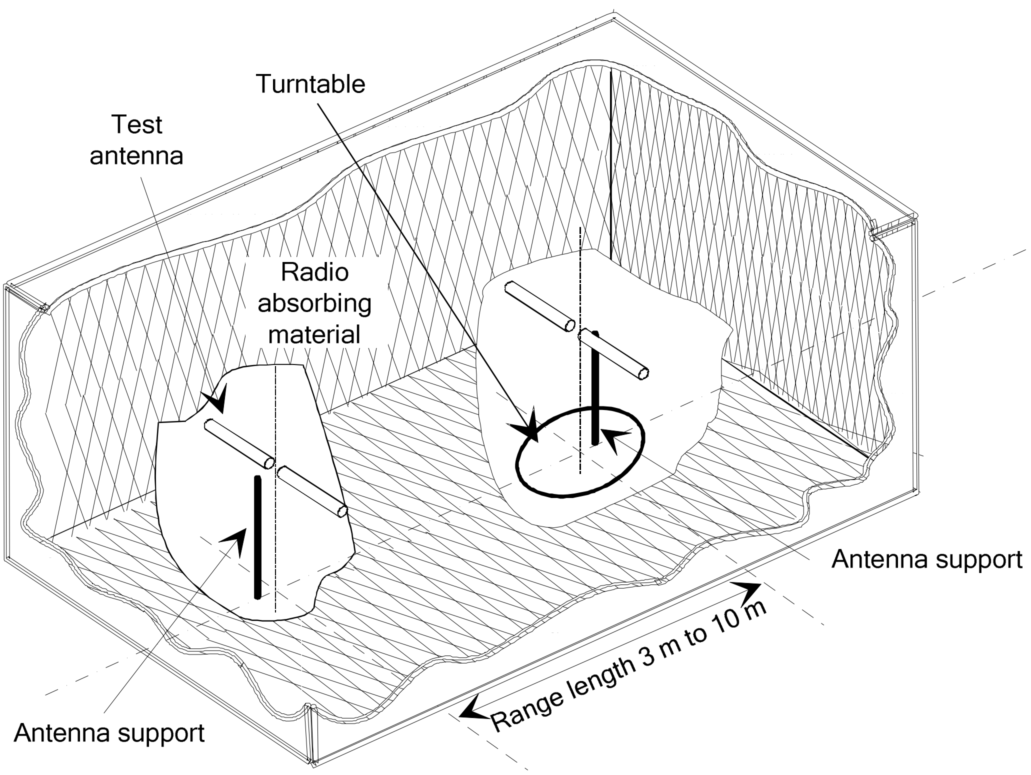

Figure B.1: A typical anechoic chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2 (d_1 + d_2)^2/\lambda$ (m), whichever is greater (see clause B.2.4). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

B.1.3 Anechoic Chamber with a Conductive Ground Plane

An anechoic chamber with a conductive ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a conductive ground plane is shown in figure B.2.

This type of test chamber attempts to simulate an ideal Open Area Test Site whose primary characteristic is a perfectly conducting ground plane of infinite extent.

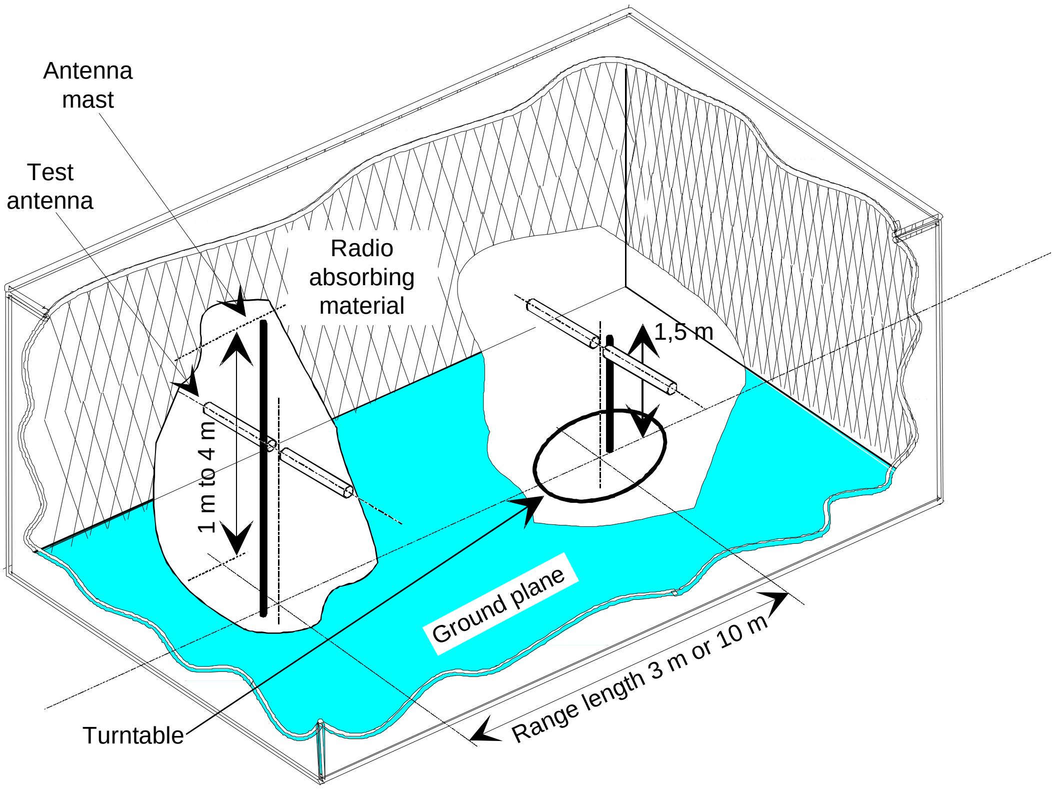

Figure B.2: A typical Anechoic Chamber with a conductive ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2 (d_1 + d_2)^2/\lambda$ (m), whichever is greater (see clause B.2.4). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

B.1.4 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane, which in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical OATS is shown in figure B.3.

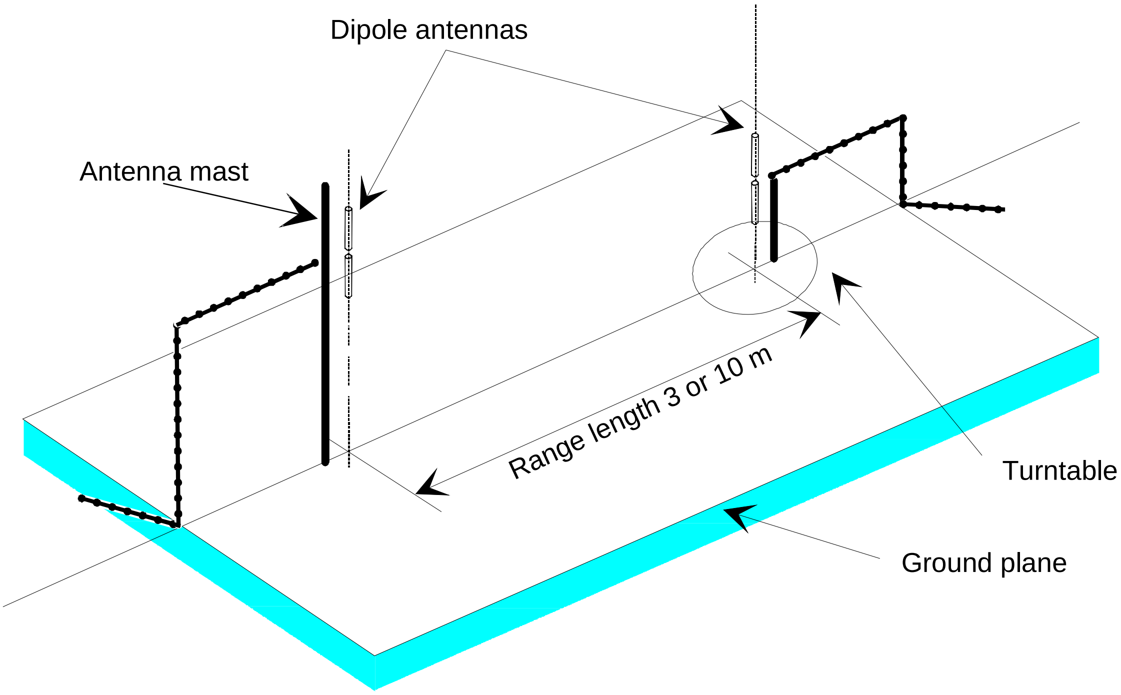

Figure B.3: A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

For measurements below 30 MHz tests may be made according to CISPR 16 [2]. The measurements are made with an inductive shielded loop test antenna, which reads the magnetic field (H-field) only. These measurements are valid for both the far-field and the near-field situations. In this case the OATS shall not have a ground plane using a magnetic conductive material. Therefore, such measurements are normally made without a ground plane.

Typical measuring arrangement common for ground plane test sites is presented in figure B.4.

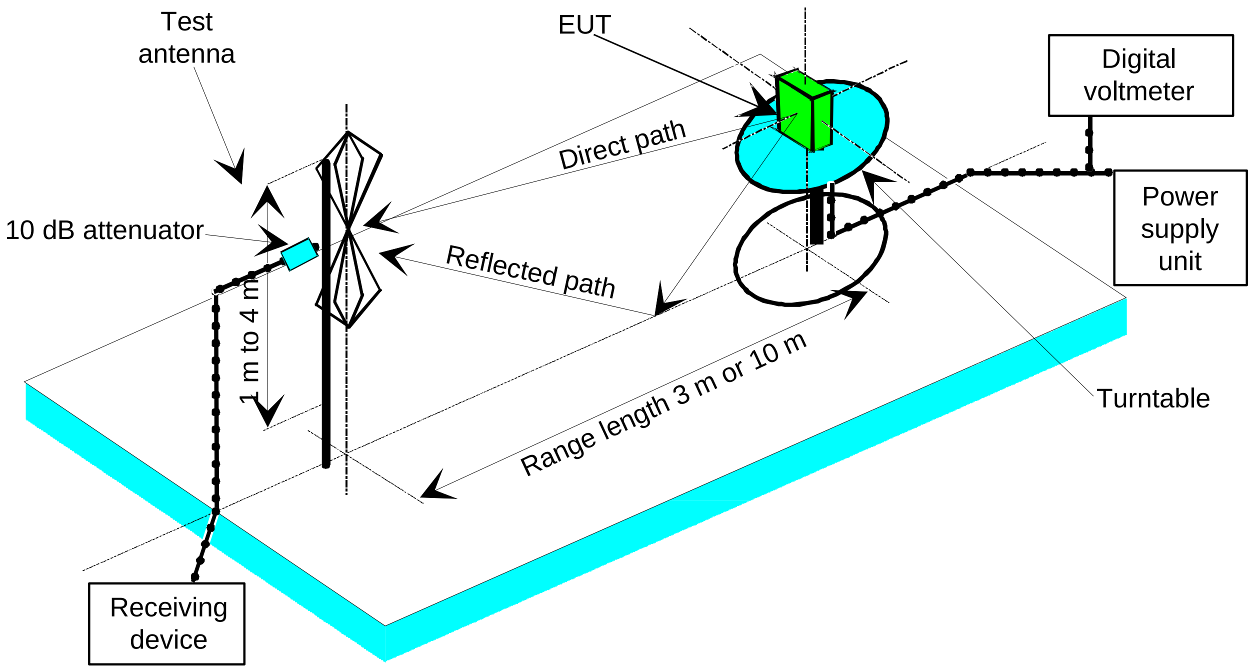

Figure B.4: Measuring arrangement on ground plane test site (OATS set-up for unwanted emission testing)

B.1.5 Test Antenna

A test antenna is always used in radiated test methods. In emission tests the test antenna is used to detect the field from the EUT in one stage of the measurement and from the substitution antenna in the other stage.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency range 9 kHz to 30 MHz, inductive shielded loop antennas according to CISPR 16 [2] are generally recommended. This test antenna method supports measurements in both the far-field and near-field.

In the frequency band 30 MHz to 1 GHz, dipole antennas (constructed in accordance with ANSI C63.5 [4] are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 GHz band.

B.2 Guidance on the Use of Radiation Test Sites

B.2.1 General

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated tests are undertaken. These schemes are common to all types of test sites described in annex B.

B.2.2 Verification of the Test Site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in annex B (i.e. anechoic chamber, anechoic chamber with a ground plane and Open Area Test Site) are given in TR 102 273 [1].

B.2.3 Preparation of the EUT

The provider should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face.

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsa wood, etc.

B.2.4 Range Length

B.2.4.1 Far-field Length Above 30 MHz

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the EUT, i.e. it should be equal to or exceed:

$$\frac{2(d_1 + d_2)^2}{\lambda}$$

where:

d_1 is the largest dimension of the EUT (m);

d_2 is the largest dimension of the test antenna (m);

λ is the test frequency wavelength (m).

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: For the fully anechoic chamber, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: For the anechoic chamber with a ground plane, a full height scanning capability, i.e. 1 m to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of Anechoic Chamber, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: For both the anechoic chamber with a ground plane and the Open Area Test Site, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

B.2.4.2 Near-field and Far-field Length Below 30 MHz

Inductive systems below 30 MHz can be measured both in the near-field and far-field regions at an open test site by means of a shielded loop antenna according to CISPR 16 [2].

The minimum measurement distance, d is determined by:

$$d \geq 3D$$

where D is the maximum dimension in metre of the inductive loop.

B.2.5 Site Preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of anechoic chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (i.e. anechoic chambers with ground planes and Open Area Test Sites) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with. In this case the cable routing is described in the test report.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- Cable loss: ±0,5 dB with a rectangular distribution;
- Measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

B.3 Coupling of Signals

B.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

B.3.2 Data Signals

Isolation can be provided by the use of optical, ultrasonic or infrared means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infrared radiated connections require suitable measures for the minimization of ambient noise.

B.4 Standard Test Position

The standard position in all test sites for equipment shall be on a non conducting support, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be placed in the position closest to normal use as declared by the provider.

Annex C (informative): E-fields in the Near Field at Low Frequencies

E-field at low frequencies is often in the near field and it is in reality only possible to measure the H-field component with the shielded loop antenna; in this case there is also a relation between the E-field and the H-field by the wave impedance Z. In the near field the wave impedance is highly dependent on the type of radiating antenna (loop or open end wire) and the wavelength. If the power density at a certain distance is the same for an H-field and an E-field generated signal, the following calculation can be made:

In the direction of maximum power in the near field, the power density S is:

$$S = \frac{E^2}{Z_e} = H_e^2 Z_e = H_m^2 Z_m \tag{C.1}$$

where:

- S = power density.
- E = electrical field generated by an E-field antenna at distance d.
- H_e = magnetic field generated by an E-field antenna at distance d.
- H_m = magnetic field generated by an H-field antenna at distance d.
- Z_e = wave impedance of a field generated by an E-field antenna at distance d.
- Z_m = wave impedance of a field generated by an H-field antenna at distance d.

$$Z_m = Z_o 2\pi \frac{d}{\lambda} \; if \; d < \frac{\lambda}{2\pi} \text{ (near field)} \tag{C.2}$$

$$Z_e = Z_0 \frac{\lambda}{2\pi d} \; if \; d < \frac{\lambda}{2\pi} \text{ (near field)} \tag{C.3}$$

Equation (C.1) gives:

$$H_e = H_m \sqrt{\frac{Z_m}{Z_e}} (A/m) \tag{C.4}$$

Equation (C.2) and (C.3) into (C.4) give:

$$H_e = H_m \frac{2\pi d}{\lambda} = H_m \frac{2\pi d \, f_c}{300} \tag{C.5}$$

where fc is the carrier frequency in MHz.

For $2\pi d/\lambda = 1$, d = 10 and f_c = 4,78 MHz, and using equation (C.5), this gives:

$$H_e = H_m \frac{f_c}{4{,}78} \text{ (} f \text{ in MHz)} \tag{C.6}$$

For $2\pi d/\lambda < 1$ if f_c < 4,78 MHz then equation (5) is valid, (i.e. near field).

For $2\pi d/\lambda \geq 1$ if f_c > 4,78 MHz then $H_e = H_m$, (i.e. far field).

The method allows an electric generated E-field to be measured as a magnetic generated H-field by adding a correction factor derived from (C.6).

For a graphical representation of the correction factor, see figure C.1.

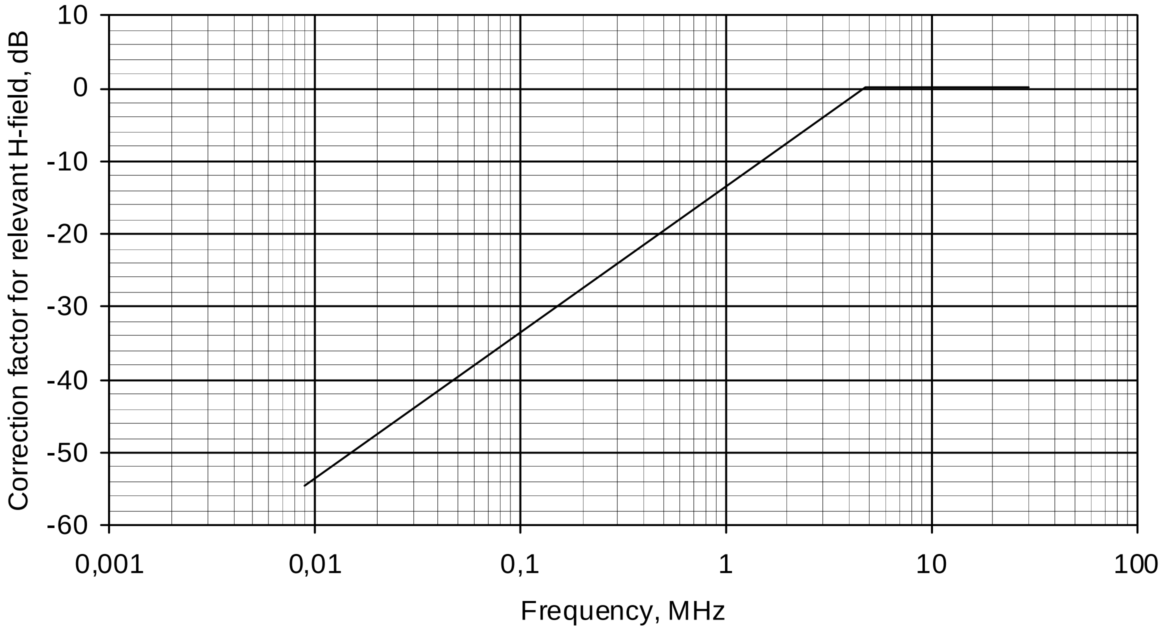

Figure C.1: Correction factor

Annex D (normative): H-field Measurements and Limits at 3 m and 30 m

D.1 General

The present document allows field measurements to be made at other distances than 10 m. In this case, the appropriate H-field limit, H_x, for provider requested measurement distance, d_x, shall be determined by the provider. Both the requested measurement distance and the appropriate limit shall be stated in the Test Report.

The conversion of the H-field limits at 10 m to a new measurements distance is not trivial as the near-field to far-field boundary is changing with both frequency and distance. Different combinations of near/far-field and maximum radiated field strength in either the coaxial or coplanar direction of the loop antenna the conversions of the H-field limits of the present document to 3 m are 30 m (see clauses D.2 and D.3).

The conversion methods of this annex are only applicable if the maximum dimension of the loop coil is small in relation to the measurement distance.

D.2 Limits for Measurements at 30 m Distance

The H-field limit at 30 m, H_{30m}, is determined by the following equation:

$$H_{30m} = H_{10m} + C_{30} \qquad \text{(D.1)}$$

where:

H_{10m} is the H-field limit in dBµA/m at 10m distance according to the present document; and

C_{30} is a conversion factor in dB which is determined from figure D.1.

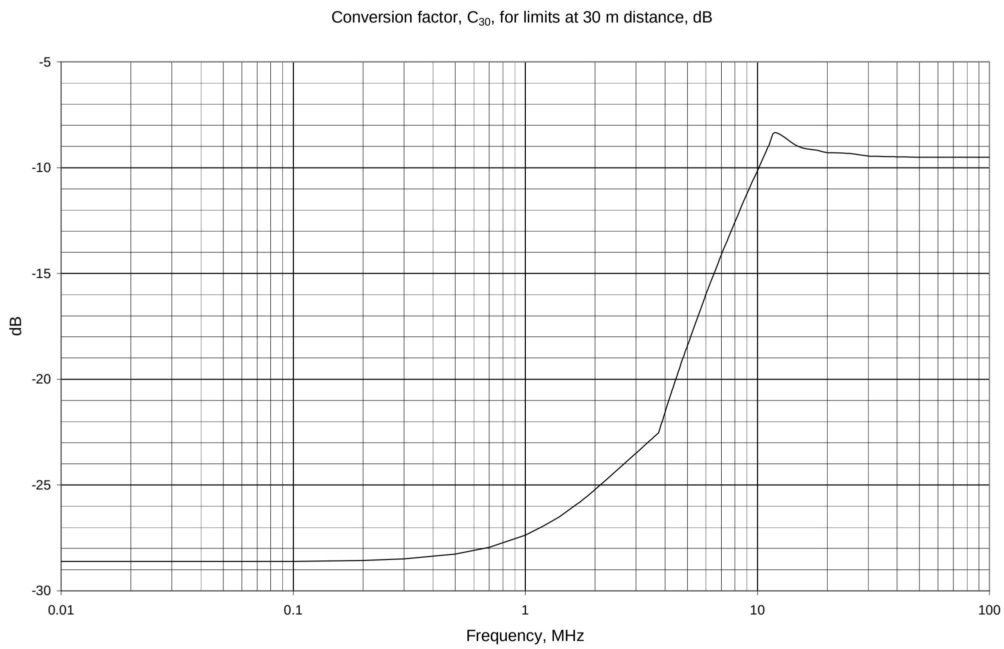

Figure D.1: Conversion factor C_{30} versus frequency

D.3 Limits for Measurements at 3 m Distance

The H-field limit in dBμA/m at 3 m, H_{3m}, is determined by the following equation:

$$H_{3m} = H_{10m} + C_3 \quad \text{(D.2)}$$

where:

H_{10m} is the H-field limit in dBμA/m at 10 m distance according to the present document; and

C_3 is a conversion factor in dB determined from figure D.2.

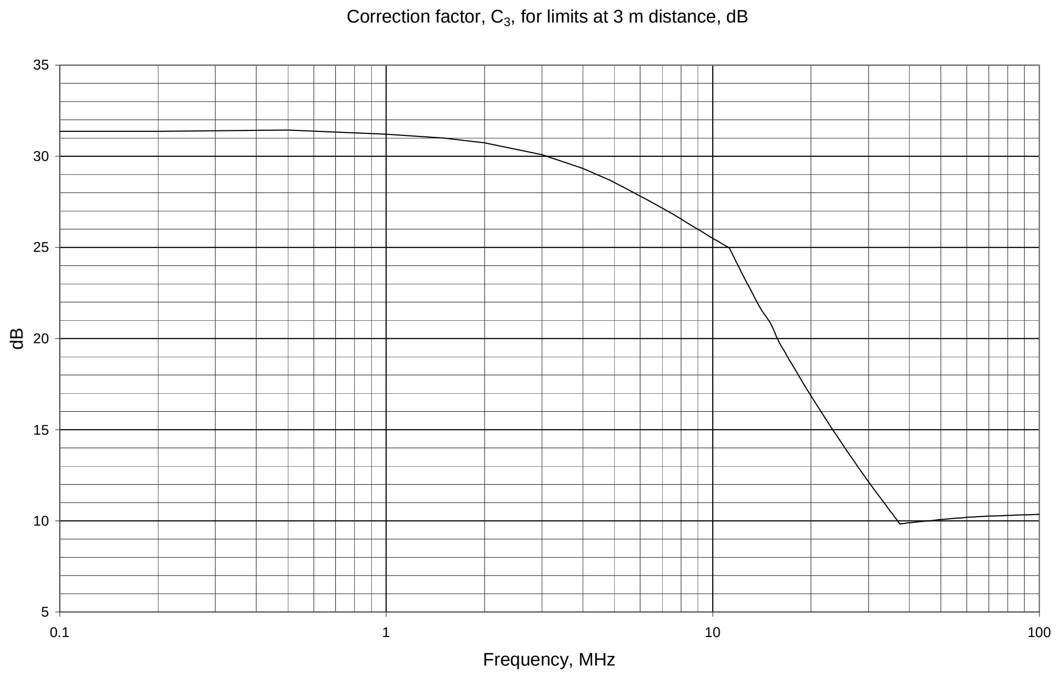

Figure D.2: Conversion factor C_3 versus frequency

Annex E (informative): The EN title in the official languages

The enlargement of the European Union (EU) resulted in a requirement from the EU for a larger number of languages for the translation of the titles of Harmonized Standards and mandated ENs that are to be listed in the Official Journal to support the implementation of this legislation.

For this reason the title translation concerning the present document can be consulted via the e-approval application.

Annex F (informative): Bibliography

- Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).
- Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).
- Ketterling, H-P: "Verification of the performance of fully and semi-anechoic chambers for radiation measurements and susceptibility/immunity testing", 1991, Leatherhead/Surrey.
- Mandate M/364: Standardization mandate to CEN, CENELEC and ETSI in the field of ICT: Harmonized standards for specific short range devices used for Euroloop and Eurobalise applications giving presumption of conformity with the R&TTE Directive (1999/5/EC).
- CEPT/ERC/Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".
- Commission Decision 2002/731/EC of 30 May 2002 concerning the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European high-speed rail system referred to in Article 6(1) of Council Directive 96/48/EC (Text with EEA relevance).
- UNISIG SUBSET-085: "Test Specification for Eurobalise FFFIS".
- UNISIG SUBSET-036: "FFFIS for Eurobalise".

NOTE: The UNISIG Consortium was composed of the following European Companies working in the Railway Signalling area: Alstom, Ansaldo Signal, Bombardier, Invesys Rail, Siemens, and Thales.

History

Document history				
V1.1.1	December 2007	Public Enquiry	PE 20080425:	2007-12-26 to 2008-04-25
V1.1.1	September 2008	Vote	V 20081104	2008-09-05 to 2008-11-04