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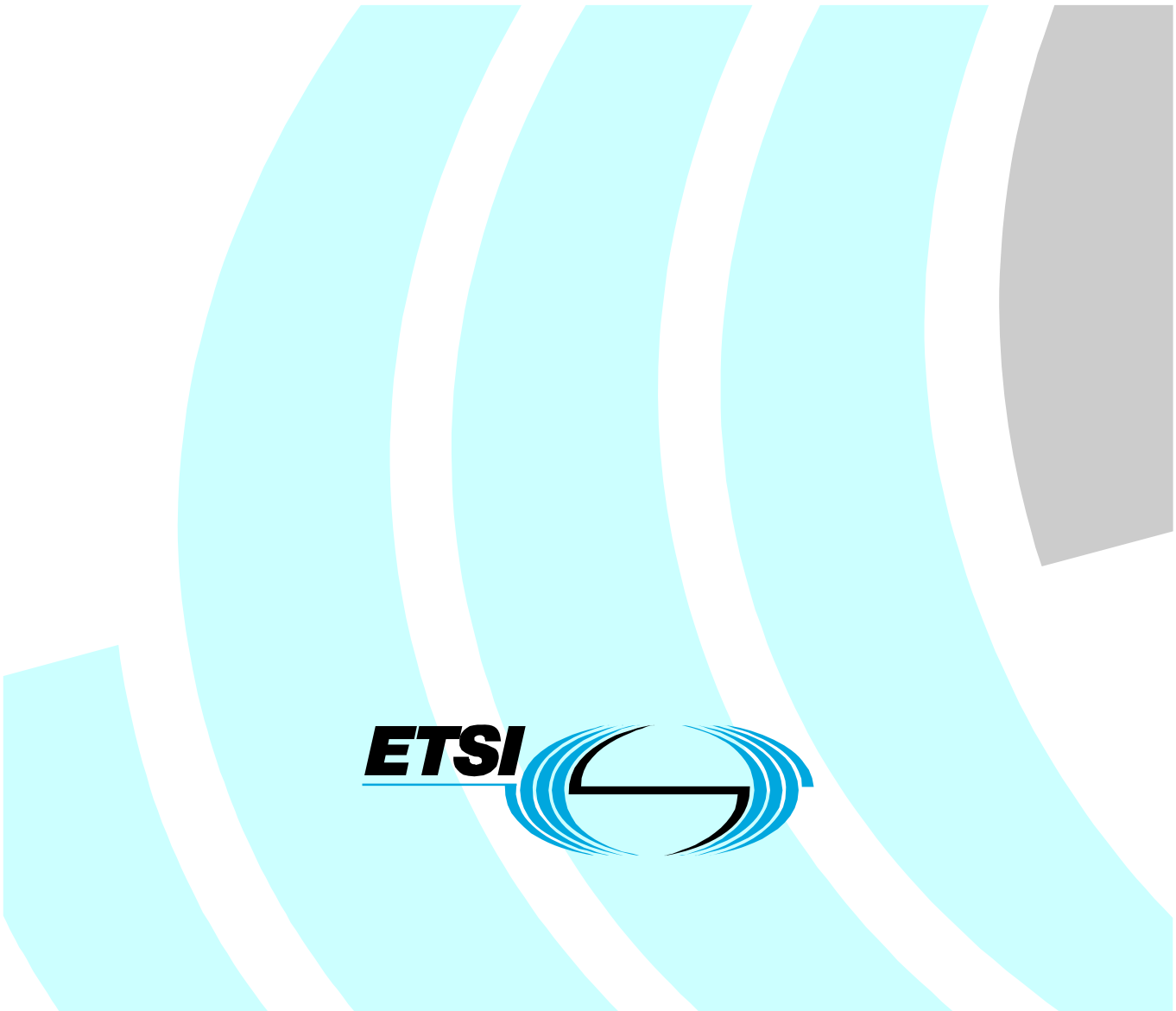
Harmonized European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices; Global Navigation Satellite Systems (GNSS) Repeaters; 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 a mandate from the European Commission issued under Council Directive 98/34/EC (as amended) [i.2] 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.1] 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.1] are given in annex A.

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 [i.1]. The modular structure is shown in EG 201 399 [i.3].

1 Scope

The present document applies to GNSS repeaters. GNSS pseudolites as well as GNSS Receivers are not covered by the present document.

GNSS repeaters are devices designed to re-transmit GNSS signals unchanged inside buildings in order to provide a usable signal for GNSS receivers that are out of sight of the GNSS satellite constellation or that they are unable to connect to GNSS signal simulators. A number of potential uses for such devices have been identified, such as the provision of a signal for test and development purposes and avoiding the need for receivers in emergency vehicles to re-acquire lock upon leaving a garage.

These radio equipment types are capable of operating in all or part of the frequency bands given in table 1.

Table 1: Radiocommunications service frequency bands

	Radiocommunications service frequency bands
Transmit	1 164 MHz to 1 215 MHz
Receive	1 164 MHz to 1 215 MHz
Transmit	1 215 MHz to 1 300 MHz
Receive	1 215 MHz to 1 300 MHz
Transmit	1 559 MHz to 1 610 MHz
Receive	1 559 MHz to 1 610 MHz

The type of equipment covered by the present document is as follows:

- Fixed installed GNSS repeater equipment with a transmit antenna that is for indoor installation. The equipment is fitted with integral or dedicated antenna(s). The GNSS repeater consists of a linear amplifier with a predetermined maximum power output and a maximum gain between in and output channel. The intended use is inside a building with its receiving antenna outside and the transmitting antenna inside the building.

Mobile or portable GNSS repeaters are excluded from the application of the present document.

The present document fulfils the purpose of providing the requirements and associated measurement methods to fulfil the requirements of the R&TTE directive for efficient spectrum use and to protect the primary service and radio services in adjacent frequency bands.

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the R&TTE Directive may apply to equipment within the scope of the present document.

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.

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 100 028 (2001) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

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

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 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.2] Council 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.

NOTE: It can be found under www.ero.dk.

[i.3] 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".

[i.4] CEPT ECC Report 129: "Technical and operational provisions required for the use of GNSS repeaters".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in the R&TTE Directive [i.1] and the following apply:

combined equipment: any combination of non-radio equipment that requires a plug-in radio device to offer full functionality

dedicated antenna: antenna external to the equipment, using an antenna connector with a cable and which has been designed or developed for one or more specific types of equipment

NOTE: It is the combination of dedicated antenna and radio equipment that has to be compliant with the regulations.

frequency band: one of the frequency ranges defined in table 1 of the present document

GNSS bands: frequency bands from 1 164 MHz to 1 215 MHz, 1 215 MHz to 1 300 MHz, and from 1 559 MHz to 1 610 MHz

GNSS pseudolites: (pseudo satellites) are ground based radio transmitters that provide an alternative ranging signal, which with other pseudolites signals or satellite signals can give a navigation solution

host equipment: any equipment which has complete user functionality when not connected to the radio equipment part and to which the radio equipment part provides additional functionality and to which connection is necessary for the radio equipment part to offer functionality

integral antenna: antenna 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 with the intent to connect another antenna

NOTE: An integral antenna may be fitted internally or externally. In the case where the antenna is external, a non-detachable cable not exceeding 3 m length is allowed.

plug-in radio device: radio equipment module intended to be used with or within host, combined or multi-radio equipment, using their control functions and power supply

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

stand-alone radio equipment: equipment that is intended primarily as communications equipment and that is normally used on a stand-alone basis

3.2 Symbols

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

dB	decibel
dBi	antenna gain relative to isotropic radiator in decibel
dBr	decibel relative to the maximum power
E	electrical field strength
f	frequency
f_c	nominal centre frequency
G_{total}	GNSS repeater total system gain
G	antenna gain
P	equivalent isotropically radiated power level
R	distance
µs	microsecond

3.3 Abbreviations

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

CEPT	European Conference of Postal and Telecommunications Administrations
e.i.r.p.	equivalent isotropically radiated power
e.r.p.	effective radiated power
EC	European Commission
ECC	Electronic Communications Committee
EM	Electromagnetic
EMC	Electro Magnetic Compatibility
GNSS	Global Navigation Satellite System
HS	Harmonized Standard
IF	Intermediate Frequency
ppm	parts per million = 10^{-6}
PSD	Power Spectral Density
RF	Radio Frequency
rms	root mean square
UUT	Unit Under Test

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be stated by the manufacturer. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the stated operational environmental profile.

4.2 Conformance Requirements

4.2.1 Transmit Frequency Band

4.2.1.1 Definition

The transmit frequency bands are the GNSS frequency bands, or part of these bands, in which the GNSS repeater can re-transmit received signals (see table 1).

4.2.1.2 Limits

The actual transmit frequency band should be maintained within the GNSS bands.

4.2.1.3 Conformance

Conformance tests as defined in clause 5.3.2 shall be carried out.

4.2.2 GNSS Repeater Total Gain

4.2.2.1 Definition

The total gain of the GNSS repeater, G_{total} , is the measured maximum gain of all included radio frequency amplifiers added to the sum of the declared maximum gain of all attached antennas (the declared identified maximum gain of the GNSS repeater receive antenna and the declared maximum gain of the GNSS re-broadcast antenna).

$$G_{total}\ [dB] = \text{GNSS repeater antenna gain(s)} + \text{amplifier gain} - \text{cable losses}$$

4.2.2.2 Limits

The total gain will calculated from the measured amplifier gain and the declared maximum of the antenna gains across the declared transmit frequencies within the GNSS bands. The G_{total} gain limit is 45 dB [i.4]. Installed cable losses of up to 3 dB can be assumed.

4.2.2.3 Conformance

Conformance tests as defined in clause 5.3.3 shall be carried out.

4.2.3 Output power limitation (saturation e.i.r.p.)

4.2.3.1 Definitions

The saturation output power is the maximum equivalent isotropically radiated power (e.i.r.p.) of the equipment for a sinusoidal input signal of any power level. It relates to the maximum output power level of the system when presented with a high level non-GNSS signal such as a radar pulse. It is not related to the level of re-radiated GNSS signal.

Re-radiated GNSS signals would be limited to a significantly lower level by virtue of the limitation on gain given in clause 4.2.2.

4.2.3.2 Limits

The maximum output power shall not exceed -20 dBm for a sinusoidal input signal within any of the frequency bands given in table 1.

The limiting output power capability shall not exceed -27 dBm for a sinusoidal input signal with a frequency of 1 151 MHz or below.

4.2.3.3 Conformance

Conformance tests as defined in clause 5.3.4 shall be carried out.

4.2.4 Transmitter unwanted emissions in the spurious domain

4.2.4.1 Definition

These are radio frequency emissions outside the GNSS bands, other than those of the wanted emissions and associated sidebands.

4.2.4.2 Limits

The level of spurious emissions shall not exceed the limits given in tables 2 and 3.

Table 2: General transmitter spurious emission limits outside the GNSS bands

Frequency range	Maximum power, e.r.p. (above 1 GHz: e.i.r.p.)	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87,5 MHz	-36 dBm	100 kHz
87,5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 1,164 GHz	-30 dBm	1 MHz
1,300 GHz to 1,559 GHz	-30 dBm	1 MHz
1,610 GHz to 12,750 GHz	-30 dBm	1 MHz

Table 3: Specific spurious emissions limits in geographic coverage area of systems operating in other frequency bands

System type operating in the same geographical area	Band for co-existence requirement	Maximum power, e.r.p. (above 1 GHz: e.i.r.p.)	Measurement Bandwidth
Aeronautical systems	960 MHz to 1 151 MHz	-52 dBm	1 MHz
DCS 1 800	1 805 MHz to 1 880 MHz	-47 dBm	100 kHz
	1 710 MHz to 1 785 MHz	-61 dBm	100 kHz
PCS 1 900	1 930 MHz to 1 990 MHz	-47 dBm	100 kHz
	1 850 MHz to 1 910 MHz	-61 dBm	100 kHz
UTRAN TDD	1 900 MHz to 1 920 MHz	-52 dBm	1 MHz

4.2.4.3 Conformance

Conformance tests as defined in clause 5.3.4 shall be carried out.

5 Testing for compliance with technical requirements

5.1 Conditions for testing

5.1.1 Normal and extreme test conditions

Tests defined in the present document shall be carried out under normal test conditions and where stated, under the extreme test conditions as declared by the manufacturer (see clause 4.1).

5.1.2 Test Frequencies and Operating Modes

The measurements for the RF gain and Output Power Limitation shall be performed at the lowest and highest frequency for each of the stated frequency ranges the GNSS repeater is intended to re-transmit. The measurements for transmitter and receiver spurious emissions shall be performed when operating on one of the frequencies for each of the stated frequency ranges.

If the equipment has different nominal transmit bandwidths, the measurements need to be repeated for each of the repeater transmit bandwidth.

For the purpose of testing of the GNSS repeater for its maximum gain an input signal shall be provided to the receiver front end (either the connector, or in case of an integrated antenna, to the receiving antenna).

Confirmation of the total gain of the system can be measured by sweeping a narrow band 20 kHz signal across the transmit bandwidth, the swept input signal to be set at a value of -80 dBm/20 kHz. The resultant value displayed on a spectrum analyser using peak hold shall not exceed a value of -35 dBm/20 kHz. However, if the measured saturation output power is significantly lower than -20 dBm, this lower value should be used to avoid saturation effects giving an incorrect value of gain, through clause 4.2.2.

For the purpose of testing of the GNSS repeater unwanted emissions, a white-noise input signal shall be provided to the receiver front end (either the connector, or in case of an integrated antenna, to the receiving antenna).

NOTE: Only a relatively small power is needed. Assuming a GNSS signal strength of -160 dBW/24 MHz (approximately -144 dBm/MHz) at the earth surface referenced to an isotropic antenna, and a typical receive antenna gain of 3 dBi, the typical GNSS input signal would by approximately -140 dBm/MHz.

A white-noise signal source from a signal generator shall be applied to the input of the GNSS receiver with a PSD of -105 dBm/MHz for the purpose of testing the transmit frequency range.

5.1.3 Antennas

The equipment can have either integral or dedicated antennas.

Dedicated antennas, further referred to as *dedicated external antennas*, are antennas that are physically external to the equipment and which are assessed in combination with the equipment against the requirements in the present document.

NOTE: It should be noted that assessment does not necessarily lead to testing.

An antenna assembly referred to in the present document is understood as the combination of the antenna (integral or dedicated), its coaxial cable and if applicable, its antenna connector and associated switching components.

Although the measurement methods in the present document allow conducted measurements to be performed, it should be noted that the equipment together with all its intended antenna assemblies shall comply with the applicable technical requirements defined in the present document.

5.1.4 Presentation of equipment

5.1.4.1 Testing of host connected equipment and plug-in radio devices

For combined equipment and for radio parts for which connection to or integration with host equipment is required to offer functionality to the radio, different alternative test approaches are permitted. Where more than one such combination is intended, testing shall not be repeated for combinations of the radio part and various host equipment where the latter are substantially similar.

Where more than one such combination is intended and the combinations are not substantially similar, one combination shall be tested against all requirements of the present document and all other combinations shall be tested separately for radiated spurious emissions only.

5.1.4.1.1 The use of a host or test jig for testing plug-in radio devices

Where the radio part is a plug-in radio device which is intended to be used within a variety of combinations, a suitable test configuration consisting of either a test jig or a typical host equipment shall be used. This shall be representative for the range of combinations in which the device may be used. The test jig shall allow the radio equipment part to be powered and stimulated as if connected to or inserted into host or combined equipment. Measurements shall be made to all requirements of the present document.

5.1.4.1.2 Testing of combinations

5.1.4.1.2.1 Alternative A: General approach for combinations

Combined equipment or a combination of a plug-in radio device and a specific type of host equipment may be used for testing according to the full requirements of the present document.

5.1.4.1.2.2 Alternative B: For host equipment with a plug-in radio device

A combination of a plug-in radio device and a specific type of host equipment may be used for testing according to the full requirements of the present document.

For radiated spurious emission tests the most appropriate standard shall be applied to the host equipment. The plug-in radio device shall meet the radiated spurious emissions requirements as described in the present document.

5.1.4.1.2.3 Alternative C: For combined equipment with a plug-in radio device

Combined equipment may be used for testing according to the full requirements of the present document.

For radiated spurious emissions the requirements of the most appropriate harmonized EMC standard shall be applied to the non-radio equipment. The plug-in radio device shall meet the radiated spurious emissions requirements as described in the present document.

In the case where the plug-in radio device is totally integrated and cannot operate independently, radiated spurious emissions for the combination shall be tested using the most appropriate harmonized standard with the radio part in receive and/or standby mode. If the frequency range is less than the one defined in the present document, additional measurements according to the requirements in the present document shall be performed to cover the remaining parts of the frequency range. With the radio in transmit mode, the radiated spurious emissions requirements of the present document shall be applied.

5.1.4.1.2.4 Alternative D: For equipment with multiple radios

Multi-radio equipment, where at least one of the radio parts is within the scope of the present document, may be used for testing according to the full requirements of the present document. Additional requirements and limits for multi-radio equipment are set out in the relevant harmonized radio product standards applicable to the other radio parts.

When measuring spurious emissions in the receive and/or standby mode, it is essential that none of the transmitters within the combined equipment are transmitting.

5.1.4.1.2.4.1 The spurious emissions from each radio can be identified

Where the spurious emissions from each radio can be identified, then the spurious emissions from each radio are assessed to the relevant harmonized radio standard.

5.1.4.1.2.4.2 The spurious emissions from each radio cannot be identified

Where the spurious emissions from each radio cannot be identified, then the combined equipment is assessed to the spurious emission requirements contained in all of the relevant harmonized radio standards applicable to the radios contained within the combined product.

Where the applicable harmonized radio standards contain different limits and measuring conditions, then the combined product is assessed to the harmonized radio standard that specifies the least stringent limits for the common part of the frequency measurement ranges. To assess the remaining parts of the frequency measurement ranges the limits from the relevant harmonized radio standard should be used.

5.2 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 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 recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 4.

The measurement uncertainty figures shall be calculated in accordance with TR 100 028 [1] 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 4 is based on such expansion factors.

Table 4: Maximum measurement uncertainty

Parameter	Uncertainty
RF frequency	±1 x 10^{-5}
RF power conducted	±1,5 dB
RF power radiated	±6 dB
Humidity	±5 %
Temperature	±1 °C

5.3 Essential radio test suites

5.3.1 Product information

The following information is necessary in order to carry out the test suites:

- the operating frequency range(s) of the equipment;
- for each of the frequency ranges, the corresponding nominal re-transmission bandwidth(s) of the equipment;
- the type of the antenna: integral or dedicated;
- the intended combination(s) of the radio equipment power settings and one or more antenna assemblies and their corresponding e.i.r.p. spectral density levels;

- the normal and the extreme operating conditions (e.g. voltage and temperature) that apply to the equipment;
- the type of equipment, for example: stand-alone equipment, plug-in radio device, combined equipment, etc.

5.3.2 Transmit Frequency Band

5.3.2.1 Test conditions

These measurements shall be performed under normal test conditions.

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

For a UUT with integral antenna(s) and without a temporary antenna connector, radiated measurements shall be used.

5.3.2.2 Test methods

The transmit frequency bands are the GNSS frequency bands, or part of these bands, in which the GNSS repeater can re-transmit received signals (see table 1).

5.3.2.2.1 Conducted measurement

The UUT shall be connected to the spectrum analyser.

The settings of the spectrum analyser shall be adjusted to optimize the instruments frequency accuracy.

The white- noise input signal from a signal generator shall be applied to the UUT.

In the case of devices with an external antenna, the antenna and device input and output impedance should be investigated. If these impedances are not equal to those of the spectrum analyser and the noise source, the resulting mismatch uncertainty should be added to the total uncertainty of the conducted measurement not exceeding the values in table 4.

The Max Hold function shall be selected and the centre frequency shall be adjusted to the centre re-transmission frequency of the UUT.

The maximum mean value of the power envelope shall be measured and recorded. The frequency span of the spectrum analyser shall be reduced and the marker shall be moved in a positive frequency increment until the upper, (relative to the centre frequency), -10 dBr relative to the maximum of re-transmission is reached. This value shall be noted as f1.

The marker shall then be moved in a negative frequency increment until the lower, (relative to the centre frequency), -10 dBr point is reached. This value shall be noted as f2.

The centre of re-transmission is calculated as (f1 + f2)/2. This value shall be recorded.

5.3.2.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy and sensitivity attached to the test antenna.

NOTE: An open air test site is most likely not usable for this test due to the GNSS signal interfering with the retransmitted signal.

The test procedure is as described under clause 5.3.2.2.1. Mismatch uncertainties do not apply.

5.3.3 GNSS Repeater Total gain

5.3.3.1 Test conditions

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

For a UUT with integral antenna(s) and without a temporary antenna connector, radiated measurements shall be used.

The UUT shall be configured to operate at the highest stated transmitter output power level, i.e. the highest gain step.

5.3.3.2 Test method

5.3.3.2.1 Conducted measurement

These measurements need only to be performed at normal test conditions.

For the purpose of this test, the minimum transmitter on-time from the signal generator shall be 10 seconds.

The transmitter shall be connected to the measuring equipment via a suitable attenuator and the Gain G_{total} as defined shall be measured and recorded.

The Gain G_{total} shall be determined using a spectrum analyser of adequate bandwidth.

The Gain G_{total} to be measured is the highest gain found in any 1 MHz band.

Step 0:

Connect the signal generator transmitter output signal to the spectrum analyser and check that the signal is set at -80 dBm/20 kHz.

Step 1:

Connect the UUT to the spectrum analyser and use the following settings:

- Centre Frequency: The centre frequency of the GNSS re-transmission under test.
- Resolution BW: 20 kHz.
- Video BW: 20 kHz.
- Frequency Span: 2 x Nominal re-transmission bandwidth (e.g. 40 MHz for a 20 MHz re-transmission bandwidth).
- Detector Mode: Average.
- Trace Mode: Max Hold.

Step 2:

Connect signal generator to UUT.

When the trace is complete, record the level against frequency.

NOTE: The detector mode "Average" is often referred to as "RMS Average" but do not use Video Average.

Step 3:

When the trace is complete, capture the trace using the "Hold" or "View" option on the spectrum analyser.

Find the maximum value of the trace and place the analyser marker on this maximum. The difference between this and the -80 dBm/20 kHz level is the amplifier gain. It shall be recorded Gain. This Gain added to the sum of the attached re- broadcast antennas is the Gain $G_{total.}$

In case of conducted measurements on smart antenna systems operating in a mode with multiple transmit chains active simultaneously, the G_{total} of each transmit chain shall be measured separately to calculate the total G_{total} for the UUT.

Step 4:

G_{total} shall be recorded in the test report. The G_{total} gain limit is 45 dB [i.4]. Installed cable losses of up to 3 dB can be assumed.

5.3.3.2.2 Radiated measurement

When performing radiated measurements on a UUT with a directional antenna, the UUT shall be configured/positioned for maximum e.i.r.p. in the horizontal plane.

A test site as described in annex B and using the applicable measurement procedures as described in annex C shall be used.

The test procedure is further as described under clause 5.3.3.2.1.

For measuring the RF output power, it is likely that a radiated measurement would be performed using a spectrum analyser or measurement receiver, rather than a wide band power sensor. If this is the case and if the resolution bandwidth capability of the measurement device is narrower than the occupied bandwidth of the UUT signal measured, then the method of measurement shall be documented in the test report.

Radiated measurements shall be conducted inside an anechoic chamber and a substitution antenna method used to assess the input level to the GNSS repeater against which the gain measurement will be assessed.

The G_{total} gain limit is 45 dB [i.4]. Installed cable losses of up to 3 dB can be assumed.

5.3.4 Maximum output power (saturation e.i.r.p.)

5.3.4.1 Test conditions

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

For a UUT with integral antenna(s) and without a temporary antenna connector, radiated measurements shall be used.

The UUT shall be configured to operate at the highest stated transmitter output power level, i.e. the highest gain step.

5.3.4.2 Test method

5.3.4.2.1 Conducted measurement

These measurements need only to be performed at normal test conditions.

For the purpose of this test, the minimum transmitter on-time from the signal generator shall be 10 seconds.

The transmitter shall be connected to the measuring equipment via a suitable attenuator and the power as defined shall be measured and recorded.

Step 0:

Connect the signal generator transmitter output signal to the spectrum analyser and check that the signal is set at -80 dBm/20 kHz.

Step 1:

Connect the signal generator to the UUT and connect the UUT to the spectrum analyser and use the following settings:

- Centre Frequency: The centre frequency of the GNSS re-transmission under test.
- Resolution BW: 20 kHz.
- Video BW: 20 kHz.
- Frequency Span: 2 x Nominal re-transmission bandwidth (e.g. 40 MHz for a 20 MHz re-transmission bandwidth).
- Detector Mode: Average.
- Trace Mode: Max Hold.

Step 2:

When the trace is complete, record the level against frequency.

NOTE 1: The detector mode "Average" is often referred to as "RMS Average" but do not use Video Average.

Step 3:

When the trace is complete, the trace shall be captured using the "Hold" or "View" option on the spectrum analyser.

Find the maximum value of the trace and place the spectrum analyser marker on this maximum and record its level.

Step 4:

Increase the signal generator output in steps until the recorded value is less than 1 dB greater than the previous value, if this condition is not met continue and repeat steps 1-3 increasing the signal generator output by 2 dB each time until it is. Record this analyser value as the saturation output power. The test is now complete.

Step 5:

The saturation output power shall be recorded in the test report.

NOTE 2: If the recorded value of the saturation e.i.r.p. is less than the recorded output power of the GNSS repeater value identified during the total gain measurement in clause 5.3.3, then clause 5.3.3 is repeated using a signal generator input signal that is lower than that previously used, (-80 dBm/20 kHz). The new signal generator input signal value for the measurement of gain in clause 5.3.3: is 50 dB below the identified saturation output power of clause 5.3.4.

5.3.4.2.2 Radiated measurement

When performing radiated measurements on a UUT with a directional antenna, the UUT shall be configured/positioned for maximum e.i.r.p. in the horizontal plane.

A test site as described in annex B and using the applicable measurement procedures as described in annex C shall be used.

The test procedure is further as described under clause 5.3.4.2.1.

For measuring the RF output power, it is likely that a radiated measurement would be performed using a spectrum analyser or measurement receiver, rather than a wide band power sensor. If this is the case and if the resolution bandwidth capability of the measurement device is narrower than the occupied bandwidth of the UUT signal measured, then the method of measurement shall be documented in the test report.

5.3.5 Transmitter unwanted emissions in the spurious domain

5.3.5.1 Test conditions

The white noise generator shall be applied to the UUT in accordance with clause 5.1.2.

The measurements shall be performed under normal test conditions. The UUT shall be configured to operate at the highest stated power level.

For UUT without an integral antenna and for a UUT with an integral antenna but with a temporary antenna connector, one of the following options shall be used:

a) the level of unwanted emissions shall be measured as their power in a specified load (conducted unwanted emissions) and their radiated power when radiated by the cabinet or structure of the equipment with the antenna connector terminated by a specified load (cabinet radiation); or

b) the level of unwanted emissions shall be measured as their radiated power when radiated by cabinet and antenna.

In the case where the UUT has an integral antenna, but no temporary antenna connector, only radiated measurements shall be used.

5.3.5.2 Test method

5.3.5.2.1 Conducted measurement

The UUT shall be connected to a spectrum analyser capable of RF power measurements.

5.3.5.2.1.1 Pre-scan

The test procedure below shall be used to identify potential unwanted emissions of the UUT.

Step 1:

The sensitivity of the spectrum analyser should be such that the noise floor is at least 6 dB below the limits given in clause 4.2.4.2, tables 2 and 3.

Step 2:

The emissions shall be measured over the range 30 MHz to 1 000 MHz.

Spectrum analyser settings:

- Resolution bandwidth: 100 kHz.
- Video bandwidth: 100 kHz.
- Detector mode: Peak.
- Trace Mode: Max Hold.

Any emissions identified that fall within the 6 dB range below the applicable limit, shall be individually measured using the procedure in clause 5.3.5.2.1.2 and compared to the limits given in clause 4.2.4.2, tables 2 and 3.

Step 3:

The emissions shall now be measured over the ranges:

- 1 GHz to 1,164 GHz.
- 1,300 GHz to 1,559 GHz.
- 1,610 GHz to 12,75 GHz.

however, outside the frequencies measured under clause 5.3.4.

Spectrum analyser settings:

- Resolution bandwidth: 1 MHz.
- Video bandwidth: 1 MHz.
- Detector mode: Peak.
- Trace Mode: Max Hold.

NOTE: For these pre-scan measurements, the bands adjacent to the GNSS bands (20 MHz above and below the respective band) should be monitored for an extended period of time, e.g. by using a sweep time of 30 seconds or more.

Any emissions identified during the sweeps above that fall within the 6 dB range below the applicable limit, shall be individually measured using the procedure in clause 5.3.5.2.1.2 and compared to the limits given in clause 4.2.4.2, tables 2 and 3.

For measurements in frequency bands included in table 3 of clause 4.2.4.2, i.e. the DCS 1 800 and PCS 1 900 frequency bands, the resolution bandwidth and video bandwidth shall be narrowed down to 100 kHz instead of using 1 MHz.

5.3.5.2.1.2 Measurement of the emissions identified during the pre-scan

The limits for unwanted emissions in clause 4.2.4.2 refer to average power levels.

The steps below shall be used to accurately measure the individual unwanted emissions identified during the pre-scan measurements above.

A simple measurement using the Video Average detector of the spectrum analyser is permitted. The measured values shall be recorded and compared with the limits in clause 4.2.4.2, tables 2 and 3.

Step 1:

The level of the emissions shall be measured in the time domain, using the following spectrum analyser settings:

- Centre Frequency: Frequency of emission identified during the pre-scan.
- Resolution Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz).
- Video Bandwidth: 100 kHz (< 1 GHz) / 1 MHz (> 1 GHz).
- Frequency Span: 0 Hz.
- Trigger: Video Trigger.
- Detector: Peak.
- Trace Mode: Clear Write.

Adjust the centre frequency (fine tune) to capture the highest level of one burst or sequence of the emission to be measured.

Step 2:

Change the following setting on the spectrum analyser:

- Detector Video Average, minimum of 100 sweeps.

The measured value is the average power of this emission during the on-time of the burst. The value shall be recorded and compared with the limit in clause 4.2.4.2.

5.3.5.2.2 Radiated measurement

The test set up as described in annex B shall be used with a spectrum analyser of sufficient accuracy attached to the test antenna (see clause 5.2).

The test procedure is as described under clause 5.3.5.2.1.

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 dependent 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 302 645 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	Transmit Frequency Band	4.2.1	U		E	5.3.2
2	GNSS Repeater Total Gain	4.2.2	U		E	5.3.3
3	Output Power limitation (saturation e.i.r.p.)	4.2.3	U		E	5.3.4
4	Transmitter unwanted emissions in the spurious domain	4.2.4	U		E	5.3.5

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" 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): Test sites and arrangements for radiated measurements

B.1 Test sites

B.1.1 Open air test sites

The term "open air" should be understood from an electromagnetic point of view. Such a test site may be really in open air or alternatively with walls and ceiling transparent to the radio waves at the frequencies considered.

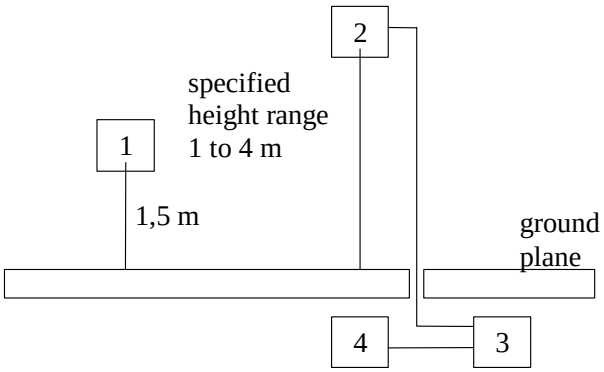
An open air test site may be used to perform the measurements using the radiated measurement methods described in clause 5. Absolute or relative measurements may be performed on transmitters or on receivers; absolute measurements of field strength require a calibration of the test site. Above 1 GHz, measurements should be done in anechoic conditions. This may be met by semi anechoic sites provided reflections are avoided.

For measurements at frequencies below 1 GHz, a measurement distance appropriate to the frequency shall be used. For frequencies above 1 GHz, any suitable measuring distance may be used. The equipment size (excluding the antenna) shall be less than 20 % of the measuring distance. The height of the equipment or of the substitution antenna shall be 1,5 m; the height of the test antenna (transmit or receive) shall vary between 1 m and 4 m.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurement results, in particular:

- no extraneous conducting objects having any dimension in excess of a quarter wavelength of the highest frequency tested shall be in the immediate vicinity of the site according to CISPR 16 [2];
- all cables shall be as short as possible; as much of the cables as possible shall be on the ground plane or preferably below; and the low impedance cables shall be screened.

The general measurement arrangement is shown in figure B.1.



NOTE: 1: Equipment under test.
2: Test antenna.
3: High pass filter (as required).
4: Spectrum analyser or measuring receiver.

Figure B.1: Measuring arrangement

B.1.2 Anechoic chamber

B.1.2.1 General

An anechoic chamber is a well shielded chamber covered inside with radio frequency absorbing material and simulating a free space environment. It is an alternative site on which to perform the measurements using the radiated measurement methods described in clause C.2. Absolute or relative measurements may be performed on transmitters or on receivers. Absolute measurements of field strength require a calibration of the anechoic chamber. The test antenna, equipment under test and substitution antenna are used in a way similar to that at the open air test site, but are all located at the same fixed height above the floor.

B.1.2.2 Description

An anechoic chamber should meet the requirements for shielding loss and wall return loss as shown in figure B.2. Figure B.3 shows an example of the construction of an anechoic chamber having a base area of 5 m by 10 m and a height of 5 m. The ceiling and walls are coated with pyramidically formed absorbers approximately 1 m high. The base is covered with special absorbers which form the floor. The available internal dimensions of the chamber are 3 m × 8 m × 3 m, so that a maximum measuring distance of 5 m in the middle axis of this chamber is available. The floor absorbers reject floor reflections so that the antenna height need not be changed. Anechoic chambers of other dimensions may be used.

B.1.2.3 Influence of parasitic reflections

For free-space propagation in the far field, the relationship of the field strength E and the distance R is given by $E = E_o \times (R_o/R)$, where E_o is the reference field strength and R_o is the reference distance. This relationship allows relative measurements to be made as all constants are eliminated within the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

If the logarithm of the foregoing equation is used, the deviation from the ideal curve may be easily seen because the ideal correlation of field strength and distance appears as a straight line. The deviations occurring in practice are then clearly visible. This indirect method shows quickly and easily any disturbances due to reflections and is far less difficult than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions given above at low frequencies below 100 MHz there are no far field conditions, but the wall reflections are stronger, so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength to the distance meets the expectations very well. Above 1 GHz, because more reflections will occur, the dependence of the field strength to the distance will not correlate so closely.

B.1.2.4 Calibration and mode of use

The calibration and mode of use is the same as for an open air test site, the only difference being that the test antenna does not need to be raised and lowered whilst searching for a maximum, which simplifies the method of measurement.

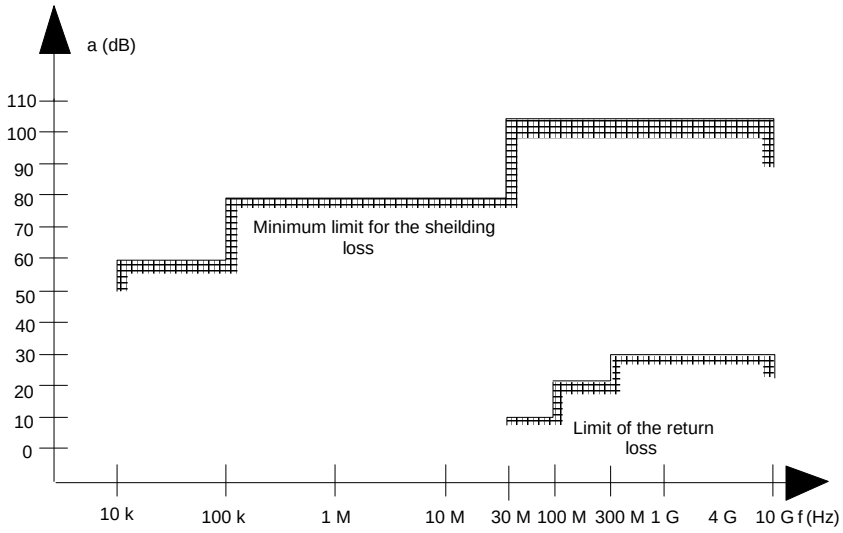


Figure B.2: Specification for shielding and reflections

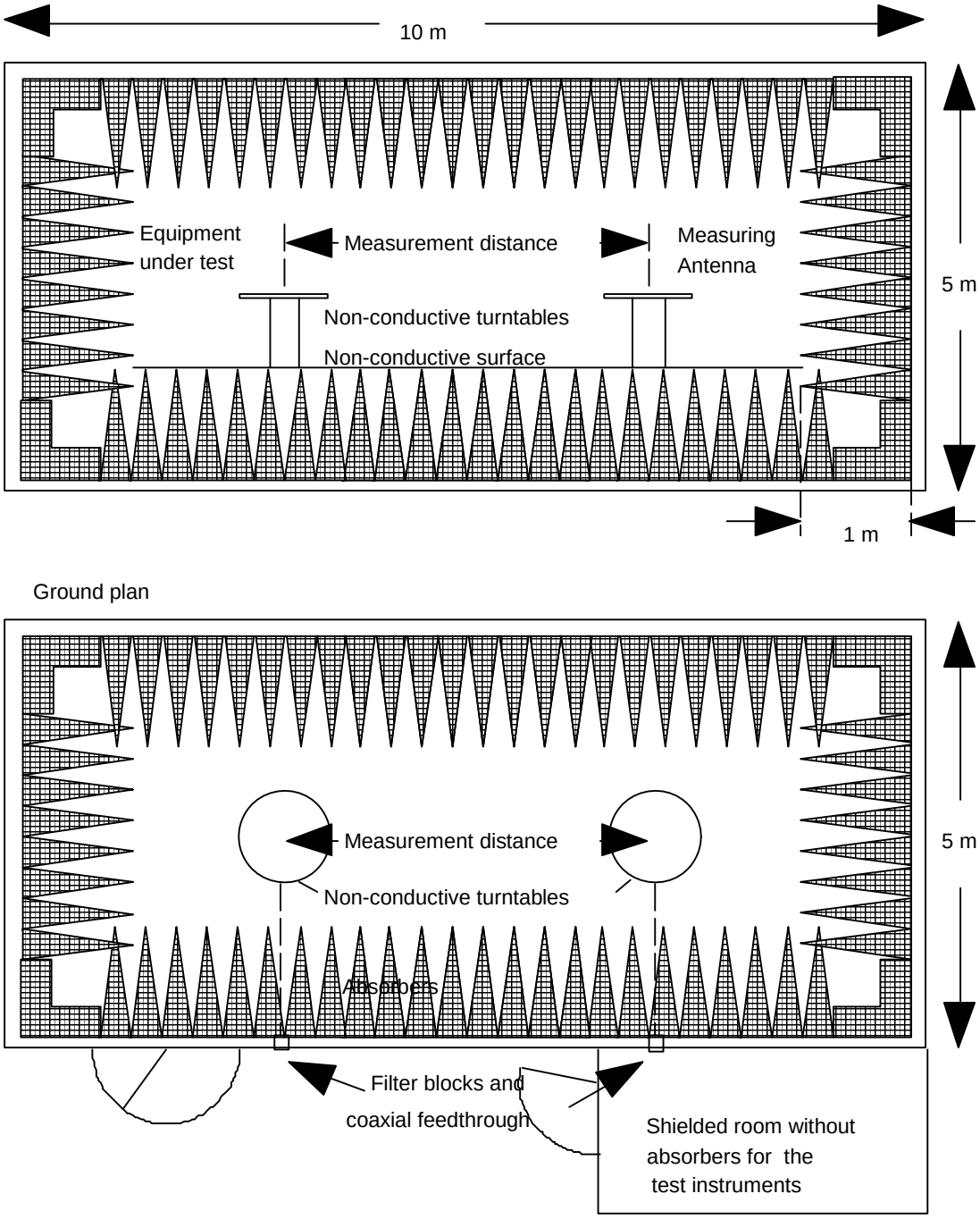


Figure B.3: Anechoic shielded chamber for simulated free space measurements

B.2 Test antenna

When the test site is used for radiation measurements the test antenna shall be used to detect the field from both the test sample and the substitution antenna. When the test site is used for the measurement of receiver characteristics the antenna shall be used as a transmitting antenna. This antenna shall be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and for the height of its centre above the ground to be varied over the specified range. Preferably test antennas with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

B.3 Substitution antenna

The substitution antenna shall be used to replace the UUT in substitution measurements. For measurements below 1 GHz the substitution antenna shall be a half wavelength dipole resonant at the frequency under consideration, or a shortened dipole, calibrated to the half wavelength dipole. For measurements between 1 GHz and 4 GHz either a half wavelength dipole or a horn radiator may be used. For measurements above 4 GHz a horn radiator shall be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

Annex C (normative): General description of measurement

This annex gives the general methods of measurements for RF signals using the test sites and arrangements described in annex B.

C.1 Conducted measurements

Conducted measurements may be applied to equipment provided with an antenna connector e.g. by means of a spectrum analyser.

C.2 Radiated measurements

Radiated measurements shall be performed with the aid of a test antenna and measurement instruments as described in annex B. The test antenna and measurement instrument shall be calibrated according to the procedure defined in this annex. The equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted power level. This position shall be recorded in the measurement report. The frequency range shall be measured in this position.

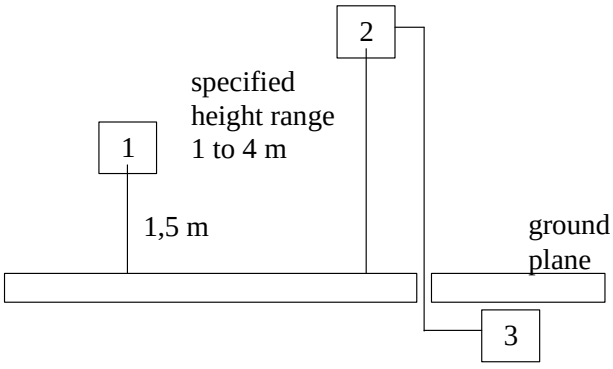
Radiated measurements should be performed in an anechoic chamber. For other test sites corrections may be needed (see annex B). The following test procedure applies:

a) A test site which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be oriented initially for vertical polarization unless otherwise stated and the transmitter under test shall be placed on the support in its standard position (clause B.1.1) and switched on.

b) For average power measurements a non-selective voltmeter or wideband spectrum analyser shall be used. For other measurements a spectrum analyser or selective voltmeter shall be used and tuned to the measurement frequency.

In either case a) or b), the test antenna shall be raised or lowered, if necessary, through the specified height range until the maximum signal level is detected on the spectrum analyser or selective voltmeter.

The test antenna needs not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2.



NOTE: 1: Equipment under test.
2: Test antenna.
3: Spectrum analyser or measuring receiver.

Figure C.1: Measurement arrangement 1

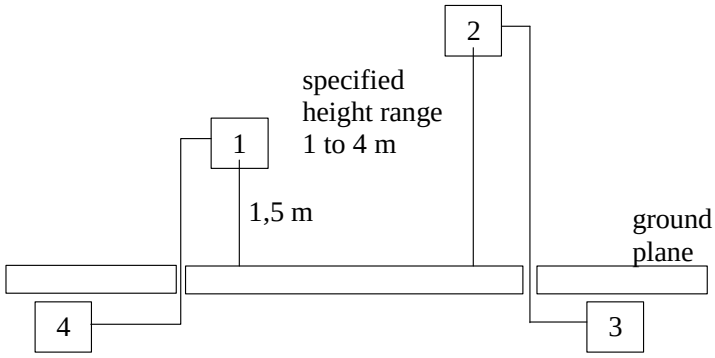
- The transmitter shall be rotated through 360° about a vertical axis until a higher maximum signal is received.
- The test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.

NOTE: This maximum may be a lower value than the value obtainable at heights outside the specified limits.

The test antenna need not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2. This measurement shall be repeated for horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

C.3 Substitution measurement

The actual signal generated by the measured equipment may be determined by means of a substitution measurement in which a known signal source replaces the device to be measured, see figure C.2. This method of measurement should be used in an anechoic chamber. For other test sites corrections may be needed, see annex B.



NOTE: 1: Substitution antenna.
2: Test antenna.
3: Spectrum analyser or selective voltmeter.
4: Signal generator.

Figure C.2: Measurement arrangement 2

Using measurement arrangement 2, figure C.2, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the measurement frequency. The test antenna shall be raised or lowered, if necessary, to ensure that the maximum signal is still received. The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.

The test antenna needs not be raised or lowered if the measurement is carried out on a test site according to clause B.1.2.

The radiated power is equal to the power supplied by the signal generator, increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.

This measurement shall be repeated with horizontal polarization. The result of the measurement is the higher power obtained from the two measurements with the indication of the corresponding polarization.

Annex D (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 E (informative): Bibliography

ETSI TR 102 070-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide to the application of harmonized standards to multi-radio and combined radio and non-radio equipment; Part 2: Effective use of the radio frequency spectrum".

ETSI TR 102 273 (2001) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties".

ANSI C63.5 (2004): "American National Standard for Electromagnetic Compatibility-Radiated Emission Measurements in Electromagnetic Interference (EMI) Control-Calibration of Antennas (9 kHz to 40 GHz)".

History

Document history				
V1.1.1	May 2009	Public Enquiry	PE 20090829:	2009-05-01 to 2009-08-31
V1.1.1	January 2010	Vote	V 20100312:	2010-01-11 to 2010-03-12