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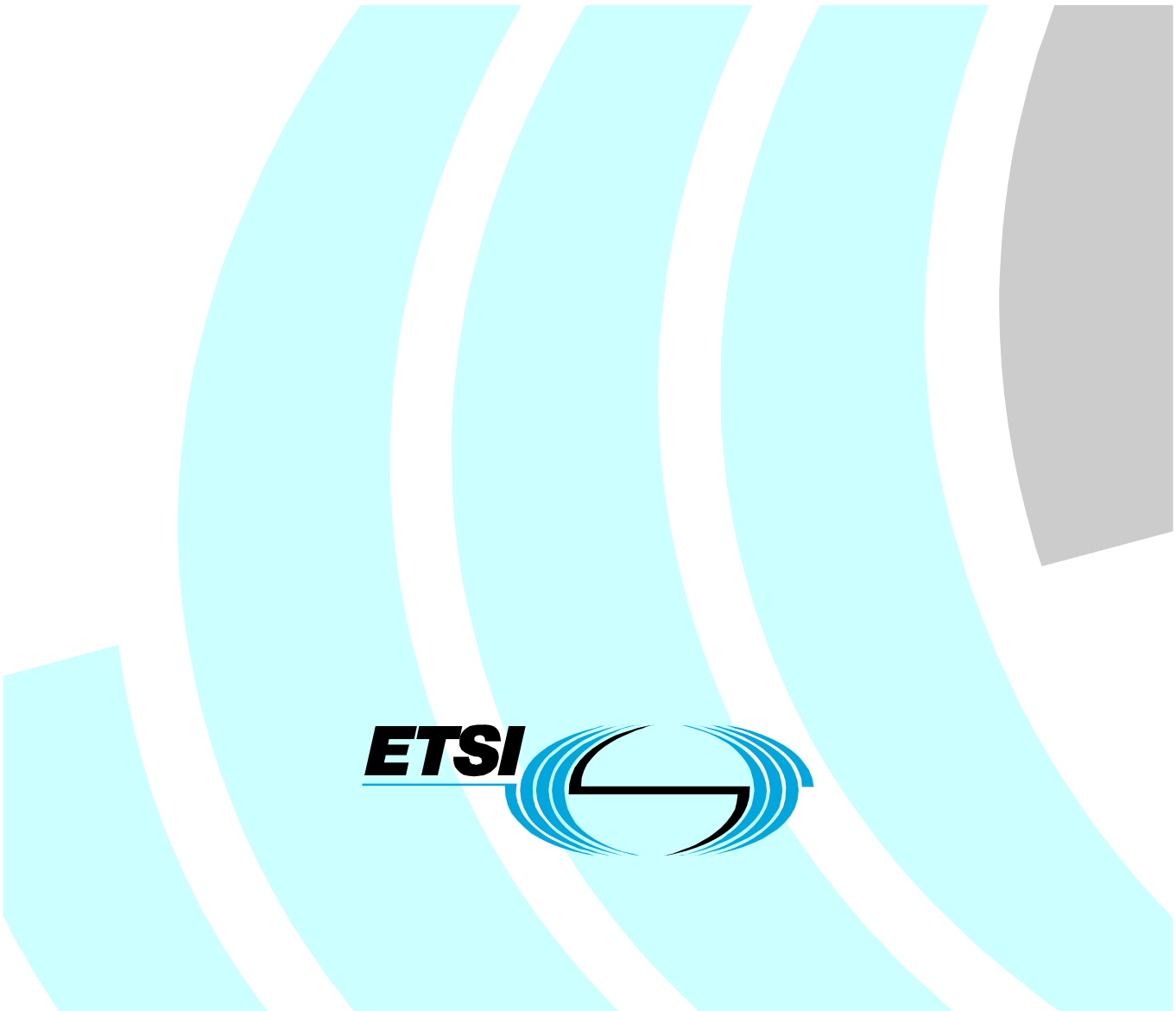
Harmonized European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Active radar target enhancers; 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 [i.4] (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.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").

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

1 Scope

The present document applies to active radar target enhancers which operate in the frequency range 2 900 MHz to 3 100 MHz and/or 9 300 MHz to 9 500 MHz allocated to the radio navigation service as defined in article 5 of the Radio Regulations [i.2].

The present document does not necessarily include all the characteristics which may be required by a user, nor does it necessarily represent the optimum performance achievable.

The present document is intended to cover the provisions of Directive 1999/5/EC [i.1](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".

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 [i.1] may apply to equipment within the scope of the present document.

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] CENELEC EN 60945 (Edition 4 - 2002): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".

[2] ITU-R Recommendation SM.329-10 (2003): "Unwanted emissions in the spurious domain".

[3] ITU-R Recommendation SM.1541-1 (2002): "Unwanted emissions in the out-of-band domain".

[4] ANSI C63.5 (2006): "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electro Magnetic Interference".

[5] 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".

[6] 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".

[7] IEC 62388: "Maritime navigation and radiocommunication equipment and systems - Shipborne radar - Performance requirements, methods of testing and required test results".

[8] IEC 62252: "Maritime navigation and radiocommunication equipment and systems - Radar for craft not in compliance with IMO SOLAS Chapter V - Performance requirements, methods of test and required test results".

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] ITU Radio Regulations (2008).

[i.3] ITU-R Recommendation M.1176 (1995): "Technical parameters of radar target enhancers".

[i.4] Directive 98/34/EC of the European Parliament and of the Council laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on information society services.

3 Abbreviations

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

CSP	Channel SPacing
e.i.r.p.	equivalent isotropically radiated power
HS	Harmonized Standard
OATS	Open Area Test Site
OoB	Out of Band
RCS	Radar Cross Section
RF	Radio Frequency
RTE	Radar Target Enhancer
VSWR	Voltage Standing Wave Ratio

4 Technical requirements

4.1 Environmental profile

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile which, as a minimum, shall be that specified in the test conditions contained in the present document.

As technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions as specified in the present document to give confidence of compliance for the affected technical requirements (which shall also be within the boundary limits of the declared operational environmental profile).

4.2 Conformance requirements

4.2.1 Radiated emissions

4.2.1.1 Definition

Radiated electromagnetic emissions are to be understood as any signals radiated by the completely assembled and operated radar equipment, other than the operating frequency, with its spectra, which can potentially disturb other equipment on the ship, such as radio receivers or rate of turn indicators.

4.2.1.2 Limits

In the frequency range 150 kHz to 2 GHz, the measured radio frequency field strength at a distance of 3 m caused by the RTE shall not exceed the limits shown in table 1.

Table 1: Radiated electromagnetic emission

Frequency range	Measuring Bandwidth	Limits
150 kHz to 300 kHz	9 kHz	10 mV/m to 316 μV/m (80 dBμV/m to 52 dBμV/m)
300 kHz to 30 MHz	9 kHz	316 μV/m to 50 μV/m (52 dBμV/m to 34 dBμV/m)
30 MHz to 2 GHz	120 kHz	500 μV /m (54 dBμV/m)
156 MHz to 165 MHz	9 kHz	16 μV/m (24 dBμV/m) quasi peak or 32 μV /m (30 dBμV/m) peak

4.2.1.3 Conformance

Conformance tests as defined in clause 5.3.1 shall be carried out.

4.2.2 Operating frequency

4.2.2.1 Definition

Radar target enhancers simply amplify a received signal and then retransmit it at a higher power without any form of frequency translation. The frequency of the input and output signals is always the same (see ITU-R Recommendation M.1176 [i.3]).

4.2.2.2 Limits

The difference in frequency between the input exciting signal and the RTE output signal shall not exceed ±1 MHz.

4.2.2.3 Conformance

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

4.2.3 Radiated output power

4.2.3.1 Definition

The radiated output power of the RTE is the maximum RF output including the transmit antenna gain achievable at the point of saturation of the power amplifier.

4.2.3.2 Limits

The maximum radiated output power of the RTE shall be less than 10 W e.i.r.p.

4.2.3.3 Conformance

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

4.2.4 Stability

4.2.4.1 Definition

This is where the input/output isolation of the RTE equipment is insufficient to prevent parasitic oscillation and should be such that adjacent reflective objects (passing ship or radar reflector on channel bouy) do not induce parasitic oscillation.

4.2.4.2 Limits

There shall be no observable emissions due to parasitic oscillation.

4.2.4.3 Conformance

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

4.2.5 Radiated spurious emissions

4.2.5.1 Definition

Spurious emissions as described in ITU-R Recommendation SM.329-10 [2] are defined as the entity of all emissions in the frequency range of 70 % of the cut-off frequency of the waveguide to 26 GHz, but outside the OoB-boundaries.

They include:

- harmonic emissions (whole multiples of the operating frequency);
- parasitic emissions (independent, accidentally);
- intermodulation (between oscillator- and operation frequency or between oscillator and harmonics).

4.2.5.2 Limits

Out of band domain emissions do not apply to devices of this power (see ITU-R Recommendation SM.1541-1 [3]) and so only the Spurious domain emission limits will apply to an active reflector. The reflector shall meet the requirements of table 2 of ITU-R Recommendation SM.329-10 [2] with the Category A limits for radiodetermination service equipment.

4.2.5.3 Conformance

Conformance tests as defined in clause 5.3.5 shall be carried out.

5 Testing for compliance with technical requirements

5.1 Test conditions, power supply and ambient temperatures

5.1.1 Standard operating mode of the RTE equipment

Unless otherwise stated the RTE equipment shall be set to the standard operating mode as indicated in the manufacturer's instructions.

5.1.2 Normal test conditions

5.1.2.1 Normal temperature and humidity

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

a) temperature: +15 °C to +35 °C; or within the manufacturers stated operating range and stated in the report.

b) relative humidity: 20 % to 75 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.2.2 Normal test power supply

5.1.2.2.1 AC test power supply

The test voltage for equipment to be connected to an AC supply shall be the nominal mains voltage declared by the manufacturer -10 % to +10 %. 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 is indicated as having been designed. The frequency of the test voltage shall be 50 Hz ± 1 Hz.

5.1.2.2.2 DC test power supply

Where the equipment is designed to operate from a DC source, the normal test voltage shall be the nominal voltage as declared by the manufacturer -10 % to +20 %.

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of testing the power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of ±3 % relative to the voltage level at the beginning of each test.

5.1.3 Extreme test conditions

5.1.3.1 Extreme temperatures

5.1.3.1.1 Indoor unit

The temperature and humidity conditions for extreme tests shall be a combination of nominal temperature and humidity within the following ranges:

a) temperature: 0 °C to +40 °C;

b) relative humidity: 20 % to 75 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.3.1.2 Outdoor unit

The temperature and humidity conditions for extreme tests shall be a combination of nominal temperature and humidity within the following ranges:

a) temperature: -20 °C to +55 °C;

b) relative humidity: 20 % to 93 %.

When the relative humidity is lower than 20 %, it shall be stated in the test report.

5.1.3.2 Extreme power supply voltage test conditions

Extreme values of test power sources are detailed in table 2.

Table 2: Extreme power supply voltage and frequency tolerances

Power supply	Voltage variation %	Frequency variation %
AC	±10	±5
DC	+20 -10	Not applicable

5.1.4 Excitation Signals

A suitable RF signal generator shall be used to simulate the radar signal typical of a modern marine radar conforming to IEC 62388 [7] or IEC 62252 [8].

5.1.4.1 Test Signal for X-Band testing

The signal shall be a pulsed carrier of 9,4 GHz with a repetition frequency of 1 kHz. The rise time and decay time between the 10 % and 90 % values of the pulse amplitude shall be 20 ns ± 5 ns. The duration of the pulses between the 90 % values shall be 500 ns ± 50 ns.

A typical 25 kw X-Band radar will give a power density at 1 nm (typical range at which saturation starts) of some 0,58 W/m² and the signal generator used shall be capable of producing a variable level at the RTE which encompasses this figure.

5.1.4.2 Test Signal for S-Band testing

The signal shall be a pulsed carrier of 3,05 GHz with a repetition frequency of 1 kHz. The rise time and decay time between the 10 % and 90 % values of the pulse amplitude shall be 20 ns ± 5 ns. The duration of the pulses between the 90 % values shall be 500 ns ± 50 ns.

A typical 30 kw S-Band radar will give a power density at 1 nm (typical range at which saturation starts) of some 0,28 W/m² and the signal generator used shall be capable of producing a variable level at the RTE which encompasses this figure.

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 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 3.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [6] 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 3 is based on such expansion factors.

Table 3: Absolute measurement uncertainties: maximum values

Parameter	Maximum uncertainty
RF frequency	±1 x 10^{-7}
RF power	±1,5 dB
Radiated emissions	±6 dB
Pulse duration time	±10 %

5.3 Essential radio test suites

5.3.1 Radiated emissions

On a test site selected from annex B, the RTE shall be placed on a non-conductive support with a height of 1,5 m.

When the RTE consists of more than one unit, the interconnecting cables shall have the maximum length and type as declared by the manufacturer or 20 m, whichever is shorter.

Available input and output ports of the ancillary equipment under test shall be connected to the maximum length of cable as declared by the manufacturer or 20 m, whichever is shorter. Such cables shall be terminated to simulate the impedance of the relevant ports of the radio equipment. These cables shall be bundled at the approximate centre of the cable with the bundles of 30 cm to 40 cm in length running in the horizontal plane from the port to which it is connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The test antenna shall be placed at a radial distance of 3 m from the edge of the minimum dimension circle, the smallest dimension circle in the horizontal plane that encloses all elements of the indoor- and the outdoor - units, at a height of 1,5 m above the ground plane.

The exciting signal antenna shall be placed at a radial distance of 3 m from the edge of the minimum dimension circle diametrically opposite the test antenna and shall be connected to a suitable RF signal generator. The level of the output of this generator shall be increased until the maximum RF output from the RTE is obtained.

The test method shall be according to EN 60945 [1].

The radiated emission of the RTE shall be measured in the frequency range 150 kHz to 2 GHz.

The results obtained shall be compared to the limits in clause 4.2.1.2 in order to prove compliance with the requirement.

5.3.2 Operating frequency

On a test site selected from annex B, the RTE shall be placed according to the manufacturers installation instructions at a height of 1,5 m.

The measurement antenna shall be placed at a radial distance of 3 m from the edge of the minimum dimension circle, the smallest dimension circle in the horizontal plane that encloses all elements of the indoor- and the outdoor –units, at a height of 1,5 m above the ground plane.

The exciting signal antenna shall be placed at a radial distance of 3 m from the edge of the minimum dimension circle diametrically opposite the test antenna and shall be connected to a suitable RF signal generator. The level of the output of this generator shall be set to the level required to give the maximum RF output from the RTE.

The frequency of the RTE output signal shall be measured and compared to the frequency of the exciting signal generator. Following testing using test signal clause 5.1.4.1 the test shall be repeated using test signal clause 5.1.4.2.

The results obtained shall be compared to the limits in clause 4.2.2.2 in order to prove compliance with the requirement.

5.3.3 Radiated output power

The measurements shall be made under normal test conditions.

On a test site conforming to clause B.1.1, the RTE shall be placed on a non-conductive support with a height of 1,5 m or such that it is completely within the quiet zone.

The test antenna shall be placed at a radial distance calculated according to clause B.2.5 at a height of 1,5 m above the floor absorber.

The exciting signal antenna shall be placed at a radial distance of 3 m from the RTE positioned at 90 ° to the line from the test antenna to the RTE and shall be connected to a suitable RF signal generator. The level of the appropriate test signal (clause 5.1.4) of this generator shall be increased until the maximum RF output from the RTE is obtained.

The RTE shall be rotated through 360 ° around a vertical axis in order to find the direction of the maximum signal.

The RTE shall now be removed and replaced with substitution antenna, in the same position and with the same polarization. The exciting signal RF generator shall be connected to this substitution antenna.

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 maximum carrier 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.

Following testing using test signal clause 5.1.4.1 the test shall be repeated using test signal clause 5.1.4.2.

The results obtained shall be compared to the limits in clause 4.2.3.2 in order to prove compliance with the requirement.

5.3.4 Stability

On a test site conforming to clause B.1.1, the RTE shall be placed on a non-conductive support with a height of 1,5 m or such that it is completely within the quiet zone.

The measurement antenna shall be placed at a radial distance calculated according to clause B.2.5 at a height of 1,5 m above the floor absorber.

The exciting signal antenna shall be placed at a radial distance of 3 m from the RTE positioned at 90 ° to the line from the test antenna to the RTE and shall be connected to a suitable RF signal generator. The level of the appropriate test signal (clause 5.1.4) of this generator shall be increased until the maximum RF output from the RTE is obtained.

A corner reflector of RCS 10 sq m (see note) for a X-Band test and ≈ 1 sq m for S-Band, placed 3 m from the RTE. The corner reflector shall be placed such that it is out of the normal test signal path and oriented so as to return the maximum signal to the active device. The RTE shall be rotated such that its maximum RCS position is aligned with the corner reflector.

The measurement antenna shall be connected to a spectrum analyser set to a span of 100 MHz.

The level of the exciting signal shall be increased by 20 dB and then slowly reduced to zero and then slowly increased back to the original value whilst analysing the emitted spectrum for any signs of auto-oscillation or instability.

Following testing using test signal clause 5.1.4.1 the test shall be repeated using test signal clause 5.1.4.2.

The results obtained shall be compared to the limits in clause 4.2.4.2 in order to prove compliance with the requirement.

NOTE: A suitable reflector would be a well constructed triangular faced single corner reflector with an "a" length of 222 mm. The same corner reflector will present both X and S values required.

5.3.5 Radiated spurious emissions

The measurements shall be made under normal test conditions.

On a test site conforming to clause B.1.1, the RTE shall be placed on a non-conductive support with a height of 1,5 m or such that it is completely within the quiet zone.

The measurement antenna shall be placed at a radial distance calculated according to clause B.2.5 at a height of 1,5 m above the floor absorber.

The exciting signal antenna shall be placed at a radial distance of 3 m from the RTE positioned at 90 ° to the line from the test antenna to the RTE and shall be connected to a suitable RF signal generator. The level of the appropriate test signal (clause 5.1.4) of this generator shall be increased until the maximum RF output from the RTE is obtained.

The spurious emissions are to be measured from 2 GHz to 26 GHz, see ITU-R Recommendation SM.329-10 [2]. Test signals clauses 5.1.4.1 and 5.1.4.2 shall be applied alternately.

5.4 Other test specifications

There are no tests under this clause.

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 302 752 The following 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	Radiated emissions	4.2.1	U		E	5.3.1
2	Operating frequency	4.2.2	U		E	5.3.2
3	Radiated output power	4.2.3	U		E	5.3.3
4	Stability	4.2.4	U		E	5.3.4
5	Radiated spurious emissions	4.2.5	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" 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

This normative 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 [5] relevant parts 2, 3 and 4.

NOTE: To ensure reproducibility and traceability of radiated measurements only these test sites should be used in test measurements.

B.1.1 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. Ferrite lined chambers are unlikely to be suitable for operation at the microwave frequencies needed for the tests in the present document.

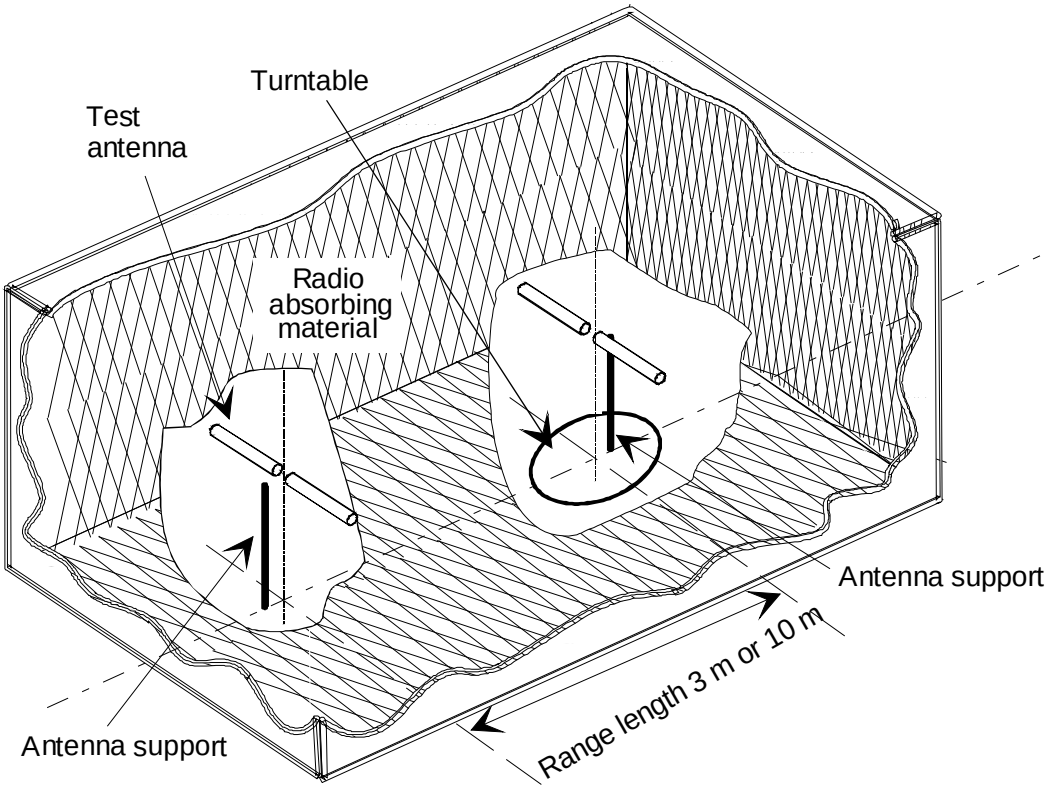

Figure B.1: A typical anechoic chamber

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 (RTE) at a suitable height (e.g. 1 m) above the floor absorbers. 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.2.5). 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. Low frequency performance is only required for test 5.3.1 where a combination structure of ferrite tiles and urethane foam absorbers is may be used to improve performance.

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

B.1.2 Anechoic chamber with a ground plane

An anechoic chamber with a 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 ground plane is shown in figure B.2.

This type of test chamber attempts to simulate an ideal OATS whose primary characteristic is a perfectly conducting ground plane of infinite extent. This type of chamber is only suitable for test 5.3.1.

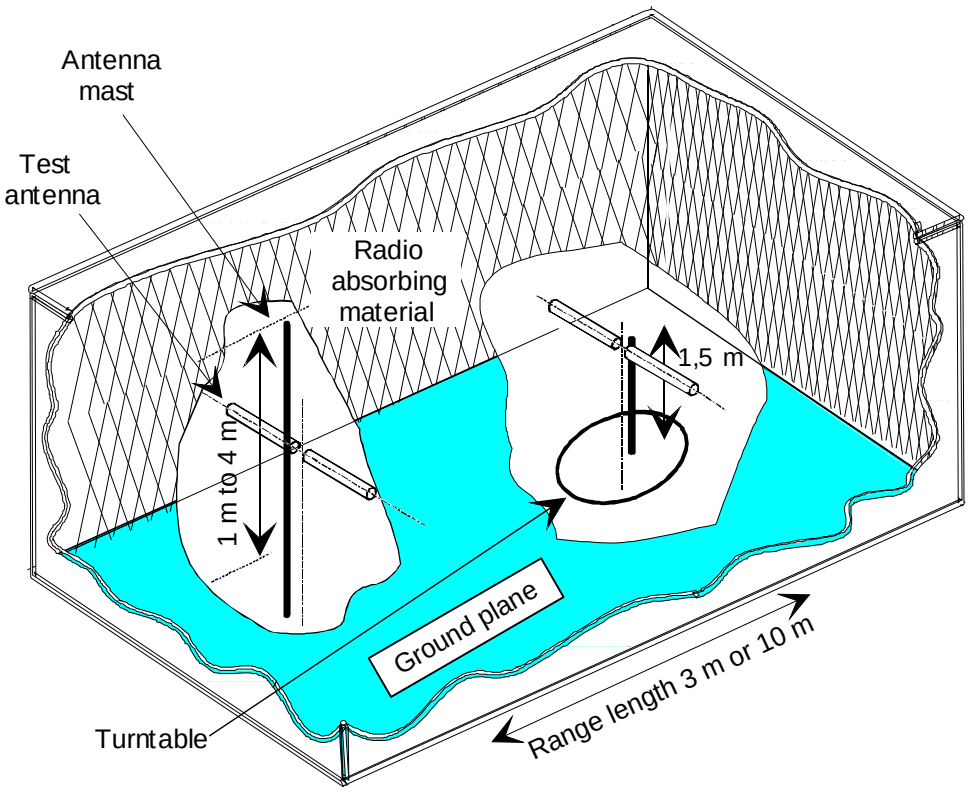

Figure B.2: A typical anechoic chamber with a ground plane

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 RTE) 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 RTE 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 (RTE) 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.2.5). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the RTE by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the RTE) 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 RTE is replaced by a substitution antenna (positioned at the RTE'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.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the RTE will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the RTE. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the RTE.

B.1.3 OATS

An OATS 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.

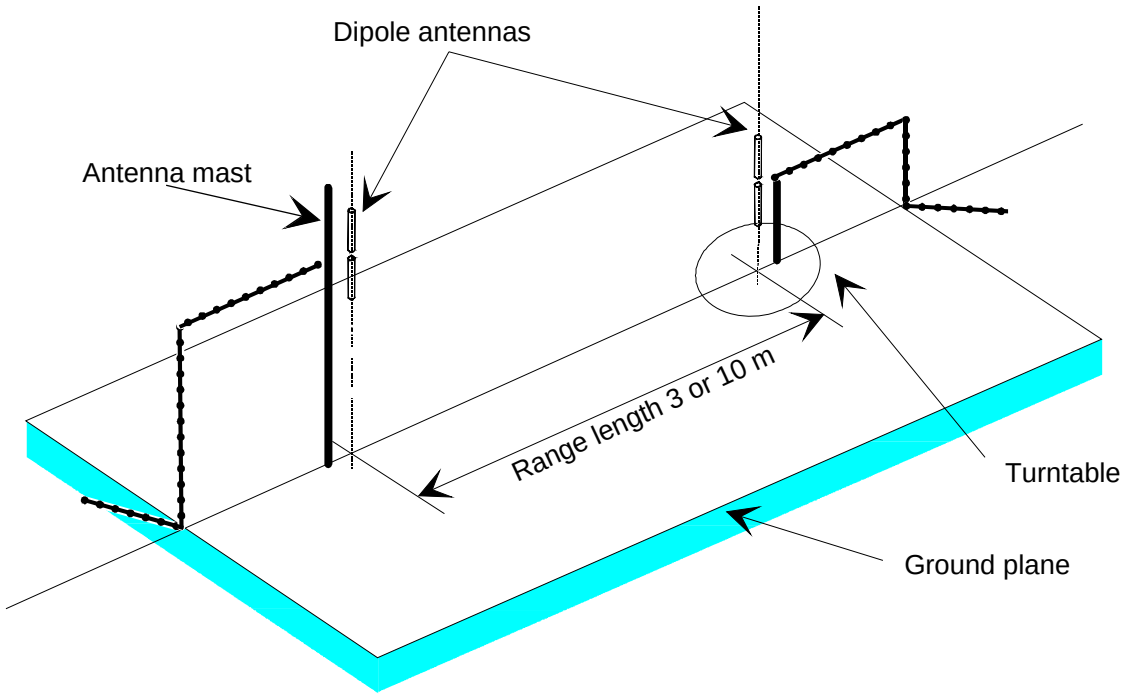

Figure B.3: A typical OATS

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 RTE) 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.

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

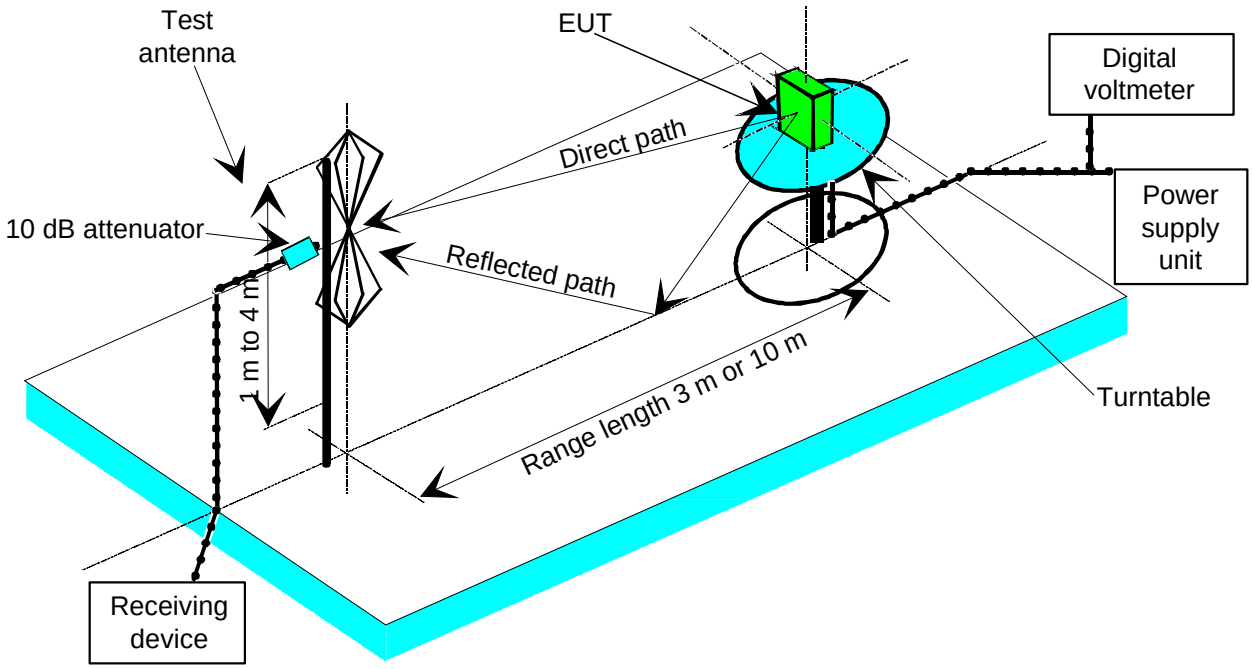

Figure B.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

B.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the RTE in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

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 OATS), 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 band 30 MHz to 1 000 MHz, 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 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

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

B.1.5 Substitution antenna

The substitution antenna is used to replace the RTE for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [4]). 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 measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the RTE it has replaced.

B.1.6 Measuring antenna

The measuring antenna is used in tests on an RTE in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the RTE. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [4]. 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. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the RTE.

B.2 Guidance on the use of radiation test sites

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

B.2.1 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 this annex (i.e. anechoic chamber, anechoic chamber with a ground plane and OATS) are given in TR 102 273 [5] parts 2, 3 and 4, respectively and must cover the frequency ranges 2 900 MHz to 3 100 MHz and 9 300 MHz to 9 500 MHz.

B.2.2 Preparation of the RTE

The manufacturer should supply information about the RTE covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of RTE should include, where relevant, carrier power, CSP, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 m on, 4 m off).

Where necessary, a mounting bracket of minimal size should be available for mounting the RTE 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, balsawood, etc.

B.2.3 Power supplies to the RTE

All tests should be performed using power supplies wherever possible, including tests on RTE designed for battery-only use. In all cases, power leads should be connected to the RTE's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the RTE. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the RTE and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

Details shall be included in the test report.

B.2.4 Void

B.2.5 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the RTE 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 RTE transmit antenna aperture/dipole after substitution (m);
- d_2 is the largest dimension of the test antenna (m);
- λ is the test frequency wavelength (m).

NOTE 1: **For the fully anechoic chamber**, no part of the volume of the RTE 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 OATS**, 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.2.6 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 OATS**) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

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.

Annex C (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 D (informative): Bibliography

ITU-R Recommendation M.1177-3 (2003): "Techniques for measurement of unwanted emissions of radar systems".

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).

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

History

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