ETSI EN 302 454-1 V1.1.1 (2007-07)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Meteorological Aids (Met Aids); Radiosondes to be used in the 1 668,4 MHz to 1 690 MHz frequency range; Part 1: Technical characteristics and test methods

Reference
DEN/ERM-TG25-024-1

Keywords
radio, SRD, testing, UHF

ETSI

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

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

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

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Foreword

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

For non-EU countries the present document may be used for regulatory (Type Approval) purposes.

The present document is part 1 of a multi part deliverable, covering digitally modulated Radiosonde transmitters in the Meteorological Aids frequency band from 1 668,4 MHz to 1 690 MHz, as identified below:

Part 1: "Technical characteristics and test methods";

Part 2: "Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive".

Clauses 1, 2 and 3 provide a general description on the types of equipment covered by the present document and the references, definitions and abbreviations used.

Clause 4 provides a guide as to the number of samples required in order that type tests may be carried out, and any markings on the equipment which the manufacturer should provide.

Clauses 5 and 6 give guidance on the test and general conditions for testing of the device. Clause 7 gives the maximum measurement uncertainty values.

Clause 8 specifies the spectrum utilization parameters, which are required to be measured. These are the maximum limits, which have been chosen to minimize harmful interference to other equipment and services. The clause provides details on how the equipment should be tested and the conditions, which should be applied.

Annex A provides specifications concerning radiated measurements.

Annex B provides information on the spectrum analyser specification.

Annex C provides related bibliography information.

National transposition dates	
Date of adoption of this EN:	29 June 2007
Date of latest announcement of this EN (doa):	30 September 2007
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2008
Date of withdrawal of any conflicting National Standard (dow):	31 March 2008

Introduction

Meteorological aids, Radiosondes, are mainly used for *in situ* upper air measurements of meteorological variables (pressure, temperature, relative humidity, wind speed and direction) in the atmosphere up to an altitude of 36 km. The measurements are vital to national weather forecasting capability (and hence severe weather warning services for the public involving protection of life and property). The Radiosonde systems provide simultaneous measurements of the vertical structure of temperature, relative humidity and wind speed and direction over the full height range required. The variation of these meteorological variables in the vertical contains the majority of the critical information for weather forecasting. These systems are the only meteorological observing systems able to regularly provide the vertical resolution that meteorologists need for all four variables.

The Radiosonde observations are produced by Radiosondes carried by ascending balloons launched from land stations or ships. Radiosonde observations are carried out routinely by almost all countries, two to four times a day. The observation data are then circulated immediately to all other countries within a few hours via the WMO (World Meteorological Organization) Global Telecommunications System (GTS). The observing systems and data dissemination are all organized under the framework of the World Weather Watch Programme of WMO.

The observation stations are required, worldwide, at a horizontal spacing of less than or equal to 250 km, during the first decade of the twenty-first century, with a frequency of observation of from one to four times per day.

Remotely sensed measurements from satellites do not have the vertical resolution available from Radiosondes. Successful derivation of vertical temperature structure from these satellite measurements usually requires a computation initialized either directly from Radiosonde statistics or from the numerical weather forecast itself. In the latter case, the Radiosonde measurements ensure that the vertical structure in these forecasts remains accurate and stable with time. In addition, the Radiosonde measurements are used to calibrate satellite observations by a variety of techniques.

Radiosonde observations are thus seen to remain absolutely necessary for meteorological operations for the foreseeable future.

Other applications, independent of the main civilian meteorological organizations include environmental pollution, hydrology, radioactivity in the free atmosphere, significant weather phenomena (e.g. winter storms, thunderstorms, etc.) and investigation of a range of physical and chemical properties of the atmosphere.

The Radiosondes are operated on two frequency bands: 403 MHz band covers primary and co-primary allocations from 400,15 MHz to 406 MHz and 1 680 MHz band from 1668,4 MHz to 1690 MHz. The 403 MHz Radiosonde technology applies RNSS (Radio Navigation Satellite Systems) for wind measurement, whereas the 1 680 MHz systems base the wind measurement on balloon tracking with a RDF (Radio Direction Finding) antenna. Because the 403 MHz wind measurement depends on the availability of the RNSS signals, many operators do not consider this technology secure enough for critical applications (e.g. defence and national security), and consequently prefer 1 680 MHz systems.

About 150 000 Radiosondes are annually used in Europe, about 10 % of them are in 1 680 MHz band. This use is not decreasing with time, since with modern automation it is now much easier to successfully operate systems without highly skilled operators and a large amount of supporting equipment.

1 Scope

The present document applies to digitally modulated Radiosonde transmitters and whole units in the range from 1 668,4 MHz to 1 690 MHz. Because the World Radio Conference WRC-2003, allocated the Mobile Satellite Service (MSS) in the band from 1 670 MHz to 1 675 MHz, and the sub band from 1 683 MHz to 1 690 MHz is used for meteorological satellite, it is encouraged to consolidate the Radiosondes in the sub band from 1 675 MHz to 1 683 MHz.

The present document shall not be applied to the widely used analogue FM Radiosonde transmitter.

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. It is a product family standard, which may be completely or partially superseded by specific standards covering specific applications.

For non-harmonized parameters, national regulatory conditions can apply regarding the type of modulation, channel/frequency separations, and the inclusion of an automatic transmitter shut-off facility as a condition of the issue of an individual or general license, or, as a condition of use under license exemption. The automatic transmitter shut-off facility may be based on elapsed time from the beginning of the sounding or atmospheric pressure measured by the Radiosonde.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

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.

[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).

[2] ETSI TR 100 028 (V1.4.1): "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

[3] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

[4] 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)".

[5] IEC 60489-3: "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

allocated frequency band: as defined by ITU in the Radio Regulations

carrier power: average power delivered to the artificial antenna during one radio frequency cycle in the absence of modulation

NOTE: See clause 8.2.1.

conducted measurements: measurements, which are made using a direct 50 Ω connection to the EUT

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

effective radiated power: power radiated in the direction of the maximum level under specified conditions of measurements in the absence of modulation

NOTE: See clause 8.3.1.

frequency error of the transmitter: difference between the measured unmodulated carrier frequency and the nominal frequency as stated by the manufacturer under normal and extreme conditions

NOTE: See clause 8.1.1.

frequency stability under low voltage conditions: ability of the equipment to remain on the assigned operating frequency band, when the battery voltage falls below the lower extreme voltage level

NOTE: See clause 8.6.1.

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

manufacturer: means the manufacturer, or his authorized representative or the person responsible for placing the equipment on the market

operating frequency range: total range of frequencies covered, either by one type, in which case the tuning range equals operating frequency range, or by a family of equipment, in which case there are different design transmitters involved

NOTE: See clause 4.1.2.2.

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

spurious emissions: emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions

NOTE 1: As defined by ITU.

NOTE 2: See clause 8.5.1.

telemetry: use of radio communication for recording measurement or other data at a distance

transmission power spectral density: spectrum of a transmitter under defined conditions of modulation and output power

NOTE: See clause 8.4.1.

trimming: act by, which the value (in this case relating to frequency) of a component is changed within the circuit

NOTE: This act may include the physical alteration, substitution (by components of similar size and type) or activation/de-activation (via the setting of soldered bridges) of components. See clause 4.1.2.1.

tuning range: maximum frequency range, as specified by the manufacturer, over which the transmitter can be operated without any changes to the circuit, other than the substitution or programming of read only memories or crystals and the trimming of discrete components

NOTE: See clause 4.1.2.1.

3.2 Symbols

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

dB	decibel
E	field strength
FR_L	Lower end of Frequency Range
FR_C	Centre of Frequency Range
FR_H	Higher end of Frequency Range
SND/ND	Signal + Noise + Distortion / Noise + Distortion
°C	Temperature in degrees Celsius
hPa	Atmospheric pressure in hecto Pascal
%RH	Air Relative Humidity in percentage
λ	Wavelength

3.3 Abbreviations

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

EUT	Equipment Under Test
GTS	Global Telecommunications System
ICAO	International Civil Aviation Organization
MSS	Mobile Satellite Service
OATS	Open Area Test Site
OFR	Operating Frequency Range
R&TTE	Radio and Telecommunications Terminal Equipment
RDF	Radio Direction Finding
RF	Radio Frequency
RH	Relative Humidity
RNSS	Radio Navigation Satellite Systems
TR	Tuning Range
VSWR	Voltage Standing Wave Ratio
WMO	World Meteorological Organization

4 Technical requirement specifications

4.1 Presentation of equipment for testing purposes

Each equipment submitted for testing shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

Where appropriate the nominal frequency 1 680 MHz should be used for testing.

If equipment is designed to operate with different carrier powers, measurement of each transmitter parameter shall be performed at the highest power level at which the transmitter is intended to operate.

To simplify and harmonize the testing procedures between the different testing laboratories, measurements shall be performed, according to the present document, on samples of equipment defined in clauses 4.1.1 to 4.1.4.

4.1.1 Choice of model for testing

The manufacturer shall provide one or more samples of the equipment, as appropriate, for testing.

If equipment has several optional features, considered not to affect the RF parameters then tests need only be performed on the equipment configured with that combination of features considered being the most complex, as proposed by the manufacturer and agreed by the test laboratory.

4.1.2 Definitions of Switching Range, Alignment Range and Operational Frequency Range

4.1.2.1 Definition of Tuning Range (TR)

The manufacturer shall state the tuning range of the transmitter.

The TR is the maximum frequency range, as specified by the manufacturer, over which the transmitter can be operated without any changes to the circuit, other than the substitution or programming of read only memories or crystals and the trimming of discrete components, see clause 3.1.

Trimming is an act by, which the value (in this case relating to frequency) of a component is changed within the circuit, see clause 3.1. This act may include the physical alteration, substitution (by components of similar size and type) or activation/de-activation (via the setting of soldered bridges) of components.

Usually Radiosondes are tuned to the used frequency prior to immediate use.

4.1.2.2 Definition of Operating Frequency Range (OFR)

The Operating Frequency Range is the total range of frequencies covered, either by one type, in which case the TR equals OFR, or by a family of equipment, in which case there are different design transmitters involved, see clause 3.1.

4.1.2.3 Allocated Frequency Range

The allocated frequency range for Radiosondes is 21,6 MHz, but the band sharing constraints suggest that only 8 MHz, that is from 1 675 MHz to 1 683 MHz, should be used for Radiosondes. The OFR may be equal to the allocated range.

4.1.2.4 Number of samples for testing

If the TR equals the OFR the tests shall be carried out on 1 680 MHz or on the center frequency of the OFR if better applicable. In this case, only one sample shall be tested.

If a family of equipment covers the OFR, each family member shall be submitted to tests, which shall be carried out on the center frequency of the TR.

4.1.3 Testing of equipment with alternative power levels

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, then each module or add on stage shall be tested in combination with the equipment. The necessary samples and tests can be proposed by the manufacturer and/or test laboratory, based on the requirements of clause 4.1.

4.1.4 Testing of equipment that does not have an external 50 Ω RF connector (integral antenna equipment)

4.1.4.1 Equipment with an internal permanent or temporary antenna connector

The means to access and/or implement the internal permanent or temporary antenna connector shall be stated by the manufacturer with the aid of a diagram. The method shall be recorded in the test report.

No connection shall be made to any internal permanent or temporary antenna connector during the performance of radiated emissions measurements, unless such action forms an essential part of the normal intended operation of the equipment, as declared by the manufacturer.

4.2 Mechanical and electrical design

4.2.1 Controls

Those controls, which, if maladjusted, may increase the interfering potential of the equipment, shall not be easily accessible to the user.

4.2.2 Transmitter shut-off facility

If the transmitter is equipped with an automatic transmitter shut-off facility, it should be made inoperative for the duration of the test.

4.2.3 Marking

The equipment shall be marked in a visible place. This marking shall be legible and durable.

4.2.3.1 Regulatory marking

The equipment shall be marked in accordance with the R&TTE Directive [1].

4.3 Declarations by the manufacturer

The manufacturer shall declare the necessary information of the equipment with respect to all technical requirements set by the present document.

4.4 Auxiliary test equipment

All necessary test signals sources and setting up information shall accompany the equipment, when it is submitted for testing.

5 Test conditions, power sources and ambient conditions

5.1 Normal and extreme test conditions

Testing shall be performed under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in clauses 5.2 to 5.4.

5.2 Test power source

The equipment shall be tested using the appropriate power source. Where equipment can be powered using either external or internal power sources, and then equipment shall be tested using the external test power source as specified in clause 5.2.1 then repeated using the internal power source as specified in clause 5.2.2.

The test power source used shall be recorded and stated.

5.2.1 External test power source

During tests, the power source of the equipment shall be replaced by an external test power source capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.6. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured. The external test power source shall be suitably de-coupled and applied as close to the equipment battery as practicable. For radiated measurements any external power, leads should be so arranged so as not to affect the measurements.

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

5.2.2 Internal test power source

For radiated measurements fully charged internal batteries should be used. The batteries used should be as supplied or recommended by the manufacturer. At the end of each test manufacturer shall within the normal operating range specify the voltage.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

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

- temperature: +15°C to +35°C;
- Relative Humidity: 20 % RH to 75 % RH.

5.3.2 Normal test power source

For operation from other power sources or types of battery, the normal test voltage shall be that declared by the manufacturer and where appropriate agreed by the accredited test laboratory. Values shall be recorded and stated.

5.4 Extreme test conditions

5.4.1 General

Tests at extreme conditions simulate the extreme atmospheric conditions, which apply to the Radiosondes in normal operations. The atmospheric model, ICAO Standard Atmosphere, gives -56,5°C as minimum temperature in high atmosphere in low pressure, and it is selected as the first low extreme temperature. The other low temperature, -25°C, corresponds to low extremes conditions close to the earth surface in high pressure.

The test conditions are combined air temperature and air pressure test.

5.4.2 Procedure for tests at extreme conditions

Before measurements are made, the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period.

Usually Radiosondes are designed for continuous operations, however there may be applications where transmit bursts are applicable.

5.4.2.1 Procedure for equipment designed for continuous operation

If the manufacturer states that the equipment is designed for continuous operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature, the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of 30 minutes, after which the equipment shall meet the specified requirements;
- for tests at the lower extreme temperatures, the equipment shall be left in the test chamber until thermal balance is attained, then switched to the on condition for a period of one minute after which the equipment shall meet the specified requirements.

5.4.2.2 Procedure for equipment designed for intermittent operation

If the manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows:

- before tests at the upper extreme temperature, the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then either:
  - transmit for five minutes; or
- if the duty cycle, one period of "on" and "off" exceeds one minute:
  - transmit five periods; or
- if none of these are applicable, the test cycle shall be agreed upon with the accredited test laboratory.

5.4.3 High temperature test

The equipment shall be tested in conditions corresponding to high temperature conditions in the low altitude given in the table 1. The transmitter shall be tested in the high temperature and pressure using a controlled external power source if applicable.

5.4.4 Low temperature tests

The equipment shall be tested in conditions corresponding to low temperature conditions in the high altitude, and low temperature in the low altitude cold climate conditions given in table 1. A heat producing element (e.g. water activated battery) may be included in the normal use configuration, consequently the temperature, where the transmitter stays in normal use conditions may be higher than the ambient temperature given in table 1.

The manufacturer shall state what is the true transmitter temperature when the equipment is stabilized to the ambient conditions given in table 1. Sufficient documents concerning the thermal calculation or test results shall be included in the test documents.

The transmitter shall then be tested in its stated true temperature if a controlled external power source is used.

Table 1: Extreme atmospheric conditions

High Temperature low altitude:	+55°C ±3°C
Pressure: corresponding earth surface conditions	980 hPa ±30 hPa
Relative humidity: Note the reading	Non condensing
Low Temperature high altitude:	-56,5°C ±3°C
Pressure: corresponding to about 16 km altitude	100 hPa ±30 hPa
Relative humidity: Note the reading	Non condensing
Low Temperature low altitude:	-25,0°C ±3°C
Pressure: corresponding earth surface conditions	980 hPa ±30 hPa
Relative humidity: Note the reading	Non condensing

5.4.5 Special Radiosondes

Special Radiosondes, which are used for low altitude profiling (less than 100 hPa), may not be intended to operate in low temperatures given in table 1, consequently only the low altitude extreme conditions for testing shall be used. The manufacturer shall include the commercial brochure to show the intended use, where the altitude constrain is clearly stated. In such a case the Radiosonde may be equipped with a power-off device, which applies when the upper pressure limit is exceeded.

5.4.6 Extreme test source voltages

5.4.6.1 Power sources using batteries

The lower extreme test voltages for equipment with power sources using batteries shall be as follows:

- for equipment with a battery indicator, the end point voltage as indicated;
- for equipment without a battery indicator, the following end point voltage shall be used:
    - for the Leclanché or the lithium type of battery:
        - 0,85 multiplied by the nominal voltage of the battery;
    - for the nickel-cadmium type of battery:
        - 0,9 multiplied by the nominal voltage of the battery;
    - for other types of battery, the equipment manufacturer shall declare the lower extreme test voltage for the discharged condition.

The high end of nominal voltage is considered to be the upper extreme test voltage in this case.

5.4.6.2 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the accredited test laboratory and shall be recorded and stated.

6 General conditions

6.1 Test signals and modulation

The operationally used signal source, which modulates the carrier, and is dependent upon the type of the Radiosonde, shall be used in all tests.

6.2 Artificial antenna

Where applicable, tests shall be carried out using an artificial antenna which shall be a substantially non-reactive non-radiating load with a 50 Ω connected to the antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 Ω connector shall not be greater than 1,2 : 1 over the frequency range of the measurement.

6.3 Test fixture

With equipment intended for use with an integral antenna, and not equipped with a 50 Ω RF output connector, the manufacturer may supply a test fixture (see also clause 4.1.4).

This test fixture is a radio frequency coupling device for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the EUT. This allows certain measurements to be performed using conducted measuring methods, however, only relative measurements may be performed.

In addition, the test fixture shall provide, where applicable:

- a connection to an external power supply;
- a connection to a data interface.

The performance characteristics of the test fixture shall conform to the following basic parameters:

- the circuitry associated with the RF coupling shall contain no active or non-linear devices;
- the coupling loss shall not influence the measuring results;
- the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people;
- the coupling loss shall be substantially reproducible when the equipment under test is removed and replaced;
- the coupling loss shall remain substantially constant when the environmental conditions are varied.

6.4 Test sites and general arrangements for radiated measurements

For guidance on radiation test sites see annex A. Detailed descriptions of the radiated measurement arrangements are included in this annex.

6.5 Modes of operation of the transmitter

For the purpose of the measurements according to the present document, there should be a facility to operate the transmitter in an unmodulated state. The method of achieving an unmodulated carrier frequency shall be agreed upon with the accredited test laboratory. Details shall be described and stated. It may involve suitable temporary internal modifications of the EUT. If it is not possible to provide an unmodulated carrier then this shall be stated.

6.6 Measuring receiver

The term measuring receiver refers to either a selective voltmeter or a spectrum analyser. The bandwidth of the measuring receiver shall be as given in table 2.

Table 2

Frequency being measured: f	Measuring receiver bandwidth (6 dB)	Spectrum analyser bandwidth (3 dB)
f < 150 kHz	200 Hz or	1 kHz
150 kHz ≤ f < 25 MHz	9 kHz or	10 kHz
25 MHz ≤ f < 1 000 MHz	120 kHz or	100 kHz
1 000 MHz ≤ f	1 MHz	1 MHz

7 Measurement uncertainty

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

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document:
  - the value of the measurement uncertainty for the measurement of each parameter shall be separately included in the test report;
  - the value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 3.

Table 3: Measurement uncertainty

RF frequency	$\pm 1 \times 10^{-7}$
RF power, conducted	±0,75 dB
Transmission spectrum	±3 dB
Conducted emission of transmitter, valid up to 12,75 GHz	±4 dB
Radiated emission of transmitter, valid up to 12,75 GHz	±6 dB

For the test methods, according to the present document the uncertainty figures shall be calculated according to the methods described in the TR 100 028 [2], 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 case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Table 3 is based on such expansion factors.
The particular expansion factor used for the evaluation of the measurement uncertainty shall be stated.

8 Methods of measurement and limits for transmitter parameters

Where the transmitter is designed with an adjustable carrier power, then all transmitter parameters shall be measured using the highest power level, as declared by the manufacturer. The equipment shall then be set to the lowest carrier power setting, as declared by the manufacturer, and the measurements for spurious emissions shall be repeated (see clause 8.5).

If the equipment is supplied with both a permanent external 50 Ω RF connector and a dedicated or integral antenna, then full tests shall be carried out using the external connector. In addition, the following tests shall be carried out with the dedicated or integral antenna:

- effective radiated power (radiated) (see clause 8.3);
- spurious emissions (see clause 8.5).

The submitted equipment shall fulfil the requirements of the stated measurement.

8.1 Frequency error

8.1.1 Definitions

The frequency error of the transmitter is the difference between the measured unmodulated carrier frequency and the nominal frequency as stated by the manufacturer under normal and extreme conditions (see clauses 5.3 and 5.4). The limit is given in the clause 8.1.3.

If the equipment is not capable of producing an unmodulated carrier, then the frequency error shall be measured using the modulated carrier.

8.1.2 Method of measurement

The carrier frequency shall be measured with the transmitter connected to an artificial antenna. A transmitter without a 50 Ω output connector may be placed in the test fixture (see clause 6.3) connected to an artificial antenna. The measurement shall be made under normal test conditions (see clause 5.3) and extreme test conditions (see clause 5.4) (extreme temperature and supply voltage simultaneously).

8.1.3 Limit

The frequency error shall not exceed ±100 kHz (±60 ppm).

8.2 Carrier power (conducted)

This requirement applies to transmitters which may be used without an integral or dedicated antenna.

If the equipment is designed to operate with different carrier powers, the manufacturer shall declare the rated power for each level or range of levels.

These measurements shall be performed at the highest power level at which the transmitter is intended to operate.

8.2.1 Definition

The carrier power is the average power delivered to the artificial antenna (see clause 6.2) during one radio frequency cycle in the absence of modulation, see clause 3.1.

When it is not possible to measure the power in the absence of modulation, this fact shall be stated.

8.2.2 Method of measurement

This method applies only to equipment with a permanent external antenna connector. For equipment with an external antenna connector and supplied with a dedicated antenna, clause 8.3 applies.

The transmitter shall be connected to an artificial antenna (see clause 6.2) and the carrier or average power delivered to this artificial antenna shall be measured under normal test conditions (see clause 5.3).

In the case of pulse modulation equipment where it is not possible to make the measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and peak detector set in accordance with the specification of CISPR 16-1 [3] section one for the bands C and D.

The measurement shall be repeated under extreme test conditions (see clause 5.4).

8.2.3 Limits

Under normal and extreme test conditions, the carrier output power (conducted) shall not exceed 1 500 mW.

8.3 Effective radiated power

This measurement applies to equipment with an integral antenna and to equipment supplied with a dedicated antenna.

If the equipment is designed to operate with different carrier powers, the manufacturer shall declare the rated power for each level or range of levels.

These measurements shall be performed at the highest power level at which the transmitter is intended to operate.

8.3.1 Definition

The effective radiated power is the power radiated in the direction of the maximum level under specified conditions of measurements in the absence of modulation, see clause 3.1.

When it is not possible to measure the power in the absence of modulation, this fact shall be stated.

8.3.2 Methods of measurement

On a test site, selected from annex A, the equipment shall be placed at the specified height on a support, as specified in annex A, and in the position closest to normal use as declared by the manufacturer.

The test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the frequency of the transmitter.

The output of the test antenna shall be connected to the measuring receiver.

The transmitter shall be switched on, if possible, without modulation and the measuring receiver shall be tuned to the frequency of the transmitter under test.

In case of pulse modulation equipment where it is not possible to make the measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and peak detector set in accordance with the specification of CISPR 16-1 [3], section one for the bands C and D.

The test antenna shall be raised and lowered through the specified range of height until the measuring receiver detects a maximum signal level.

The transmitter shall then be rotated through 360° in the horizontal plane, until the measuring receiver detects the maximum signal level.

The test antenna shall be raised and lowered again through the specified range of height until the measuring receiver detects a maximum signal level.

The maximum signal level detected by the measuring receiver shall be noted.

The transmitter shall be replaced by a substitution antenna as defined in clause A.1.5.

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the transmitter.

The substitution antenna shall be connected to a calibrated signal generator.

If necessary, the input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.

The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the transmitter radiated power was measured, corrected for the change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as power level, corrected for any change of input attenuator setting of the measuring receiver.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power is the larger of the two levels recorded at the input to the substitution antenna, corrected for gain of the substitution antenna if necessary.

8.3.3 Limit

The effective radiated power shall not exceed 1 500 mW. The measurement shall be carried out under normal test conditions only.

8.4 Transmission power spectral density

The required transmission spectrum of a Radiosonde shall be defined as the minimum spectral width, which allows two Radiosondes to operate without causing harmful interference to each other. The Radiosonde, which is intended to be received can be 200 km apart from the receiver, when another, alien, Radiosonde can be as close as 20 km to the receiver.

8.4.1 Definition

Transmission power spectral density is the spectrum of a transmitter under defined conditions of modulation and output power, see clause 3.1.

Radiosondes do not have channel assignments. Table 4 suggests that 1 MHz is required to provide needed protection from interference in the case an alien Radiosonde is in the immediate vicinity of the receiver, and the Radiosonde to be received is at long distance.

8.4.2 Method of measurement

8.4.2.1 Method of measurement using a spectrum analyser

This method applies only to equipment with an external antenna connector.

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a calibrated spectrum analyser. The transmitter shall be switched on with modulation (see clause 6.1).

The following procedure shall be used:

a) the transmitter under test shall be connected via the test load to a spectrum analyzer. The transmitter shall be operated at the maximum operational carrier power level under normal conditions, and tuned to the nominal frequency;

b) observe the relative power in a 1 kHz measurement bandwidth on frequencies apart from the nominal frequency of the carrier. The resolution bandwidth shall be set to 1 kHz, and video bandwidth to 100 Hz. The spectrum analyser shall be put in "Maximum hold" mode. The distance in the frequency domain relative to the nominal frequency is given in the table 4.

8.4.3 Limits

The transmission power spectral density shall not exceed the maximum values given in table 4.

Table 4

Frequency relative to the nominal carrier	Maximum relative power in the 1 kHz bandwidth
±400 kHz to 600 kHz	-30 dBc/1 kHz
±600 kHz to 800 kHz	-40 dBc/1 kHz
±800 kHz to 1 000 kHz	-48 dBc/1 kHz

8.5 Spurious emissions

In the case of pulse modulation equipment where it is not possible to make the measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with bandwidth as stated in clause 6.6 and quasi-peak detector set in accordance with the specification of CISPR 16-1 [3] section one for the bands C and D. For measurements above 1 GHz the peak value shall be measured using a spectrum analyser.

8.5.1 Definition

Spurious emission (as defined by ITU): Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions. The level of spurious emissions shall be measured as:

a) either:

   i) their power level in a specified load (conducted spurious emission); and

   ii) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation);

b) or:

   - their effective radiated power when radiated by the cabinet and the integral antenna, in the case of portable equipment fitted with such an antenna and no external RF connector.

8.5.2 Method of measuring the power level in a specified load, clause 8.5.1 a) i)

This method applies only to equipment with an external antenna connector.

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver. The transmitter shall be switched on with modulation, in the case of pulse modulation, and without modulation, for other types of modulation. If an unmodulated carrier cannot be obtained, then the measurements shall be made with the transmitter modulated by the normal test signal (see clause 6.1) in which case this fact shall be recorded in the test report.

The measuring receiver, (see clause 6.6) shall be tuned over the frequency range 9 kHz to 10 times the carrier frequency. To improve the accuracy of the measurement, a RF pre-selector may be added in order to avoid harmonic components being introduced by the mixer in the receiver.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load. Exception is the band, where the transmitter under test transmits and the band ±1 000 kHz around it, as specified by table 4.

The measurements shall be repeated with the transmitter on stand-by, if applicable.

8.5.3 Method of measuring the effective radiated power, clause 8.5.1 a) ii)

This method applies only to equipment with an external antenna connector.

On a test site, selected from annex A, the equipment shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the manufacturer.

The transmitter antenna connector shall be connected to an artificial antenna (see clause 6.2). The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver. The output of the test antenna shall be connected to a measuring receiver.

The transmitter shall be switched on with modulation, in the case of pulse modulation, and without modulation, for other types of modulation. If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the normal test signal (see clause 6.1) in which case this fact shall be recorded in the test report.

The measuring receiver shall be tuned over the frequency range 25 MHz to 12,75 GHz. At each frequency at which a spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The transmitter shall then be rotated through 360° in the horizontal plane, until the measuring receiver detects the maximum signal level and the test antenna height shall be adjusted again for maximum signal level.

The maximum signal level detected by the measuring receiver shall be noted.

The transmitter shall be replaced by a substitution antenna as defined in clauses A.1.4 and A.1.5.

The substitution antenna shall be orientated for vertical polarization and calibrated for the frequency of the spurious component detected.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected. The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

When a test site according to clauses A.1.1 or A.1.2 is used, the height of the antenna need not be varied.

The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for any change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as a power level, corrected for any change of input attenuator setting of the measuring receiver.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the substitution antenna if necessary.

If applicable, the measurements shall be repeated with the transmitter on standby.

8.5.4 Method of measuring the effective radiated power, clause 8.5.1 b)

This method applies only to equipment without an external antenna connector. The method of measurement shall be performed according to clause 8.5.3, except that the transmitter output shall be connected to the integral antenna or dedicated antenna, and not to an artificial antenna.

8.5.5 Limits

The power of any spurious emission, conducted or radiated, shall not exceed the following values given in table 5.

Table 5

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Operating	200 nW (-37 dBm)	1 µW (-30 dBm)	20 µW (-17 dBm)
Standby	20 nW (-47 dBm)	20 nW (-47 dBm)	20 nW (-47 dBm)

8.6 Frequency stability under low voltage conditions

This test is for battery operated equipment, as Radiosondes are under normal intended use conditions.

8.6.1 Definition

The frequency stability under low voltage condition is the ability of the equipment to remain on the assigned operating frequency band, when the battery voltage falls below the lower extreme voltage level, see clause 3.1.

8.6.2 Method of measurement

The carrier frequency shall be measured, where possible in the absence of modulation, with the transmitter connected to an artificial antenna. A transmitter without a 50 Ω output connector may be placed in a test fixture (see clause 6.3) connected to an artificial antenna. The measurement shall be made under normal conditions (see clause 5.3), the voltage from the test power source shall be reduced below the lower extreme test voltage limit towards zero. Whilst the voltage is reduced the carrier frequency shall be monitored.

8.6.3 Limits

The equipment shall either:

a) remain on operating, whilst the radiated or conducted power is greater than the spurious emission limits; or

b) cease to function below the manufacturers declared operating voltage.

Annex A (normative): Radiated measurement

A.1 Test sites and general arrangements for measurements involving the use of radiated fields

This annex introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in TR 102 273 relevant parts 2, 3 and 4.

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

A.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 A.1.

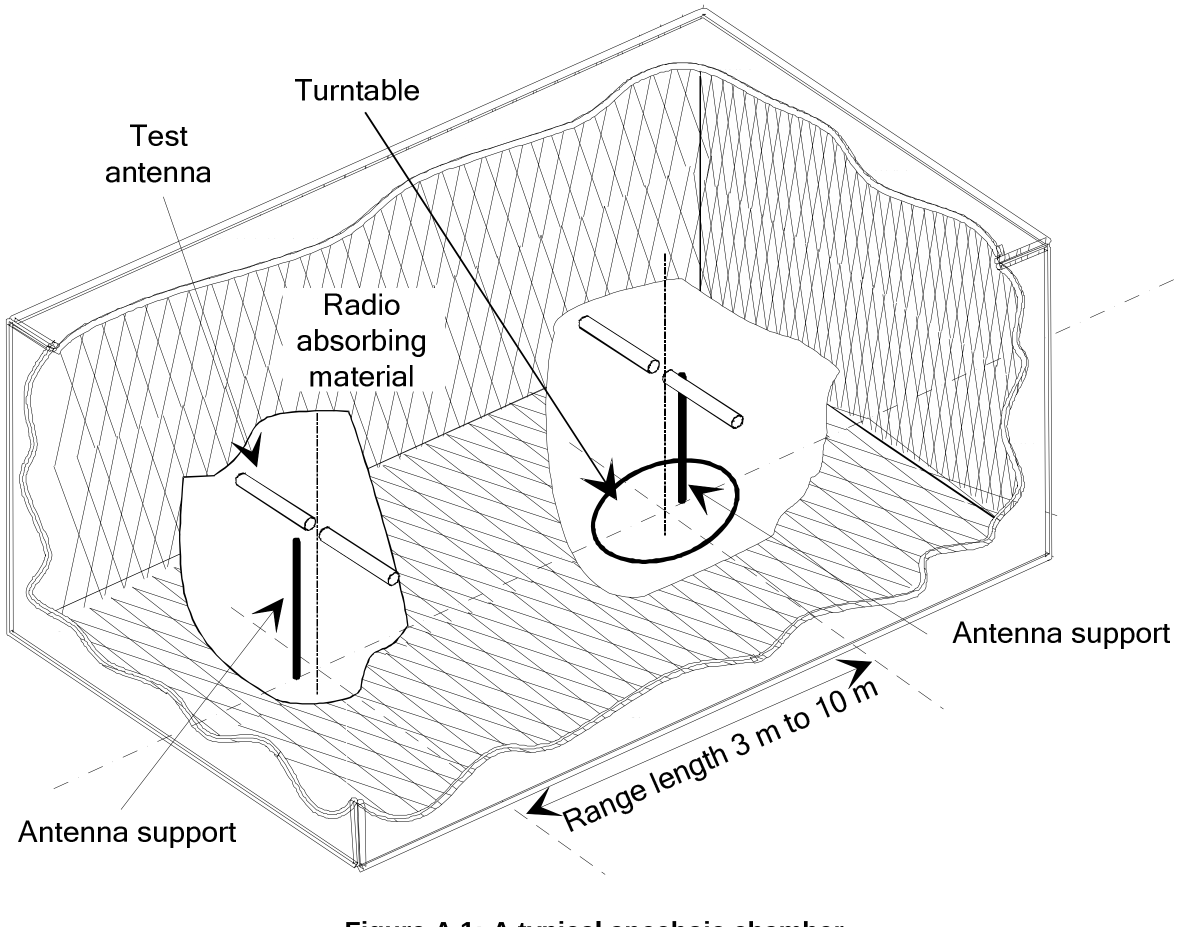


Figure A.1: A typical anechoic chamber

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

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

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see clause A.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. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

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

A.1.2 Anechoic chamber with a conductive ground plane

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

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

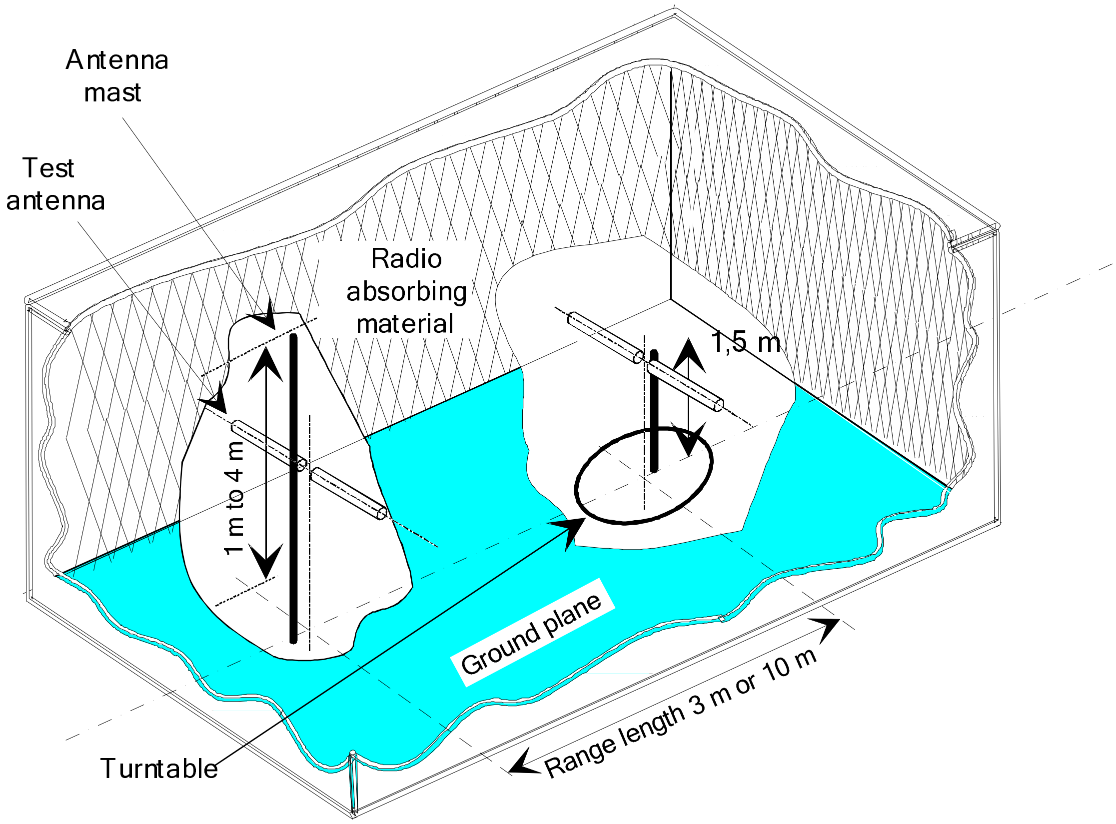


Figure A.2: A typical anechoic chamber with a conductive ground plane

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

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

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1 + d_2)^2 / \lambda$ (m), whichever is greater (see clause A.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 EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

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 EUT 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 EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

A.1.3 Open Area Test Site (OATS)

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

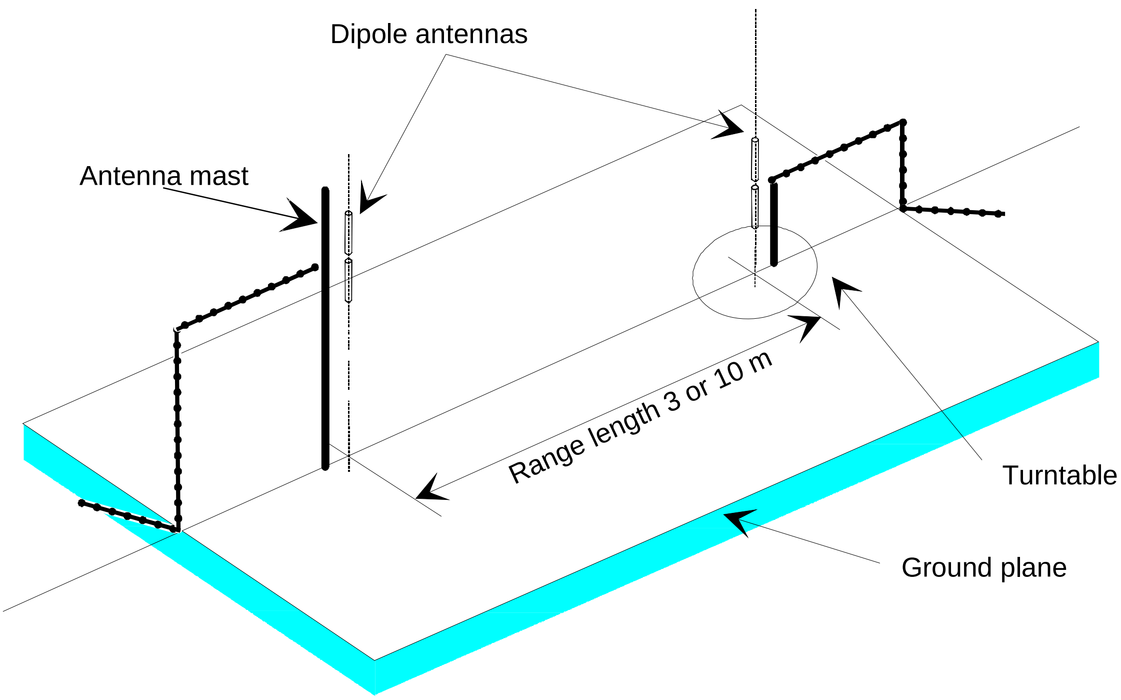


Figure A.3: A typical Open Area Test Site

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

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

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

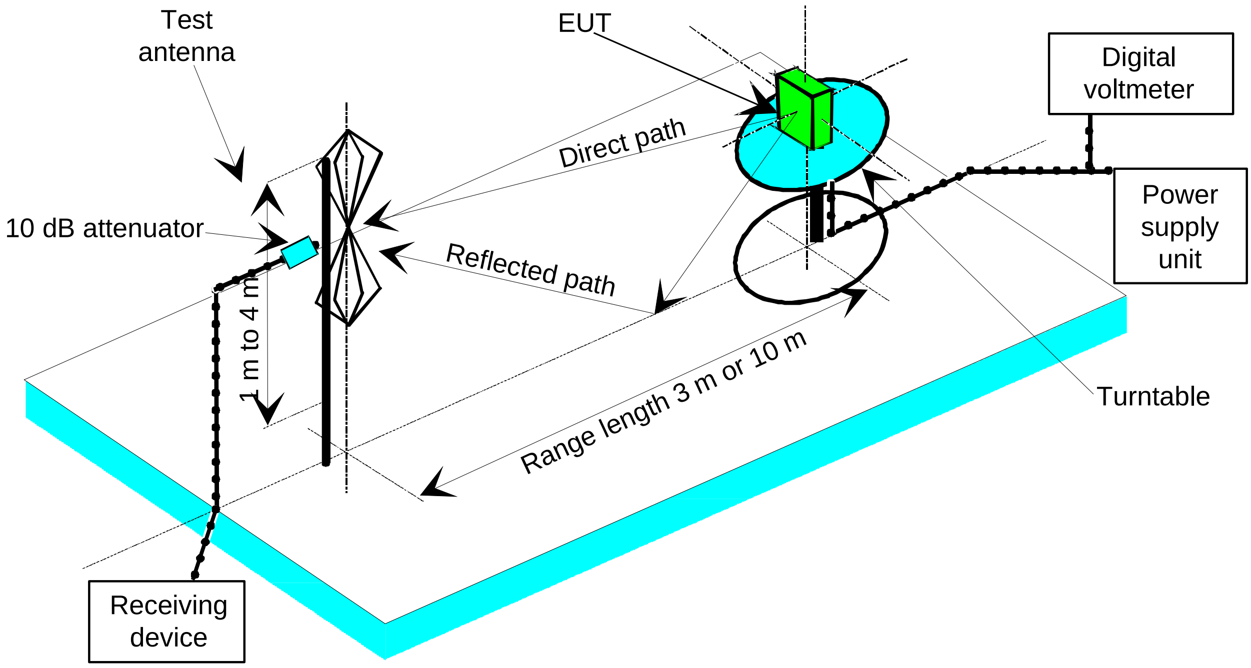


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.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 EUT 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 Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency 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, wave guide 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.

A.1.5 Substitution antenna

The substitution antenna is used to replace the EUT 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 wave guide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre.

A.1.6 Measuring antenna

The measuring antenna is used in tests on an EUT 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 field strength in the vicinity of the EUT. 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 EUT.

A.1.7 Stripline arrangement

A.1.7.1 General

The stripline arrangement is a RF coupling device for coupling the integral antenna of an equipment to a 50 Ω radio frequency terminal. This allows the radiated measurements to be performed without an open air test site but in a restricted frequency range. Absolute or relative measurements can be performed; absolute measurements require a calibration of the stripline arrangement.

A.1.7.2 Description

The stripline is made of three highly conductive sheets forming part of a transmission line which allows the equipment under test to be placed within a known electric field. They shall be sufficiently rigid to support the equipment under test.

Two examples of stripline characteristics are given below:

		IEC 60489-3 [5] Appendix J	**FTZ N°512 TB 9**
Useful frequency range	MHz	1 to 200	0,1 to 4 000
Equipment size limits	length	200 mm	1 200 mm
(antenna included):	width	200 mm	1 200 mm
	height	250 mm	400 mm

A.1.7.3 Calibration

The aim of calibration is to establish at any frequency a relationship between the voltage applied by the signal generator and the field strength at the designated test area inside the stripline.

A.1.7.4 Mode of use

The stripline arrangement may be used for all radiated measurements within its calibrated frequency range.

The method of measurement is the same as the method using an open air test site with the following change. The stripline arrangement input socket is used instead of the test antenna.

A.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 annex A.

A.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 annex A (i.e. anechoic chamber, anechoic chamber with a ground plane and Open Area Test Site) are given in TR 102 273 parts 2 to 4, respectively.

A.2.2 Preparation of the EUT

The manufacturer should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, channel separation, 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 min on, 4 min off).

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

A.2.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT'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 EUT. 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 EUT 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).

A.2.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the rated audio output power. In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the rated audio output power. This control should not be readjusted between normal and extreme test conditions in tests.

A.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 EUT i.e. it should be equal to or exceed:

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

where:

d_1 is the largest dimension of the EUT/dipole after substitution (m);

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

λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

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

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

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

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

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

A.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 Open Area Test Sites) 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.

A.3 Coupling of signals

A.3.1 General

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

A.3.2 Signals

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

A.4 Standard test position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand-held equipment, shall be on a non conducting support, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

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

b) for equipment with a rigid external antenna, the antenna shall be vertical;

c) for equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

Equipment which is intended to be worn on a person may be tested using a simulated man as support.

The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

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

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

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

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

In the stripline arrangement the equipment under test or the substitution antenna is placed in the designated test area in the normal operational position, relative to the applied field, on a pedestal made of a low dielectric material (dielectric constant less than 2).

A.5 Test fixture

The test fixture is only needed for the assessment of integral antenna equipment.

A.5.1 Description

The test fixture is a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements may be performed and only those at or near frequencies for which the test fixture has been calibrated.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) in the case of assessment of speech equipment, an audio interface either by direct connection or by an acoustic coupler.

In the case of non-speech equipment, the test fixture can also provide the suitable coupling means e.g. for the data output.

The test fixture shall normally be provided by the manufacturer.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;

c) circuitry associated with the RF coupling shall contain no active or non-linear devices;

d) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced;

f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

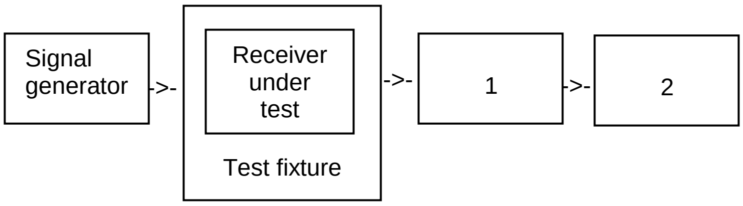
The characteristics and calibration shall be included in the test report.

A.5.2 Calibration

The calibration of the test fixture establishes a relationship between the output of the signal generator and the field strength applied to the equipment placed in the test fixture.

The calibration is valid only at a given frequency and for a given polarization of the reference field.

The actual set-up used depends on the type of the equipment (e.g. data, speech, etc.).



1) Coupling device, e.g. AF load/acoustic coupler (in the case of speech equipment).
2) Device for assessing the performance, e.g. distortion factor/audio level meter, BER measuring device, etc.

Figure A.5: Measuring arrangement for calibration

Method of calibration:

a) Measure the sensitivity expressed as a field strength, as specified in the present document and note the value of this field strength in dBμV/m and the polarization used.

b) Place the receiver in the test fixture which is connected to the signal generator. The level of the signal generator producing:

- a SINAD of 20 dB;
- a bit error ratio of 0,01; or
- a message acceptance ratio of 80 %, as appropriate,

shall be noted.

The calibration of the test fixture is the relationship between the field strength in dBμV/m and the signal generator level in dBμV emf. This relationship is expected to be linear.

A.5.3 Mode of use

The test fixture may be used to facilitate some of the measurements in the case of equipment having an integral antenna.

It is used in particularly for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under the extreme conditions.

For the transmitter measurements calibration is not required as relative measuring methods are used.

To apply the specified wanted signal level expressed in field strength, convert it into the signal generator level (emf) using the calibration of the test fixture. Apply this value to the signal generator.

Annex B (normative): Technical performance of the spectrum analyser

The present document shall include the following requirements:

It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser as displayed on the screen, to an accuracy of ±2 dB in the presence of a signal separated in frequency by:

a) 10 kHz, at a level 90 dB above that of the signal to be measured for 25 kHz and 20 kHz channel separations; and

b) 6,25 kHz, at a level 80 dB above that of the signal to be measured for a 12,5 kHz channel separation; and

c) 5 kHz, at a level 80 dB above that of the signal to be measured for a 10 kHz channel separation.

The reading accuracy of the frequency marker shall be within ±2 % of the channel separation.

The accuracy of relative amplitude measurements shall be within ±1 dB.

It shall be possible to adjust the spectrum analyser to allow the separation, on the display, of two components with a frequency difference of 1 kHz.

Annex C (informative): Bibliography

Technical Report FTZ N°512 TB 9: "Construction of a Stripline".

Ketterling, H-P: "Verification of the performance of fully and semi-anechoic chambers for radiation measurements and susceptibility/immunity testing", 1991, Leatherhead/Surrey.

ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz".

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).

CEPT/ERC/REC 74-01E: " Unwanted emissions in the spurious domain ".

Council Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations.

ETSI EN 300 220-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods".

ETSI EN 302 054 (parts 1 and 2) (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Meteorological Aids (Met Aids); Radiosondes to be used in the 400,15 MHz to 406 MHz frequency range with power levels ranging up to 200 mW".

ETSI TR 102 273 (parts 1 to 7) (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

History

Document history				
V1.1.1	February 2006	Public Enquiry	PE 20060623:	2006-02-22 to 2006-06-23
V1.1.1	April 2007	Vote	V 20070629:	2007-04-30 to 2007-06-29
V1.1.1	July 2007	Publication		