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**Radio Equipment and Systems (RES);
ElectroMagnetic Compatibility (EMC) standard
for commercially available amateur radio equipment**

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE

Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE

X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI) in response to European Commission mandate [BC-T-353].

This ETS is intended to become a Harmonized EMC Standard, the reference of which is intended to be published in the Official Journal of the European Commission referencing the EMC Directive, 89/336/EEC.

Conformity to the Harmonized Standard will confer presumption of compliance with the essential requirements of the EMC Directive.

The technical specifications, which are relevant to the EMC Directive are listed in annex A.

This ETS is based upon the Generic Standards EN 50081-1 [1] and EN 50082-1 [2], and other standards where appropriate, to meet the essential requirements of the Council Directive 89/336/EEC [3].

Transposition dates	
Date of adoption	20 December 1996
Date of latest announcement of this ETS (doa):	30 April 1997
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 October 1997
Date of withdrawal of any conflicting National Standard (dow):	31 October 1997

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1 Scope

This European Telecommunications Standard (ETS) covers the assessment of radio communication and ancillary equipment in respect of ElectroMagnetic Compatibility (EMC).

This ETS specifies the applicable EMC tests, the methods of measurement, the limits and the minimum performance criteria for radio equipment intended to be used by radio amateurs within the meaning of article 1, definition 53 of the Radio Regulations in the International Telecommunications Convention and which is available commercially.

This ETS applies to amateur radio equipment either manufactured commercially as ready-to-use equipment or as modules or as components having an intrinsic functionality.

The environment classifications used in this ETS refers to the environment classification used in the generic standards EN 50081-1 [1], EN 50082-1 [2], except the vehicular environment class which refers to ISO 7637 [13], [14].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus in residential, commercial, light industrial and vehicular environments. The levels however, do not cover extreme cases which may occur in any location but with a low probability of occurrence.

This ETS may not cover those cases where a potential source of interference which is producing individually repeated transient phenomena or a continuous phenomena is permanently present, e.g. a radar or broadcast site in the near vicinity. In such a case it may be necessary to use special protection applied to either the source of interference or the interfered part or both.

Compliance of radio equipment with the requirements of this ETS does not signify compliance to any requirements related to the use of the equipment (for example, licensing requirements).

Compliance to this ETS does not signify compliance to any safety requirements. However, it is the responsibility of the assessor of the equipment that any observation regarding the equipment becoming dangerous or unsafe as a result of the application of the tests of this ETS, should be properly documented.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

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| [1] | EN 50081-1: "Electromagnetic compatibility - Generic emission standard - Part 1: Residential, commercial and light industry". |
| [2] | EN 50082-1: "Electromagnetic compatibility - Generic immunity standard - Part 1: Residential, commercial and light industry". |
| [3] | 89/336/EEC: "Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility". |
| [4] | ITU Radio Regulations 1 - 18. |
| [5] | EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment". |
| [6] | CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus". |
| [7] | ENV 50140: "Electromagnetic Compatibility - Basic immunity standard - Radiated, radio-frequency electromagnetic field. Immunity test". |

- [8] IEC 1000-4-2: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 2: Electrostatic discharge immunity test. Basic EMC publication".
- [9] IEC 1000-4-4: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC publication".
- [10] EN 61000-4-6: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields".
- [11] EN 61000-4-11: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests - Basic EMC publication".
- [12] ENV 50142: "Electromagnetic Compatibility - Basic immunity standard. Surge immunity test".
- [13] ISO 7637: "Road vehicles - Electrical disturbance by conducting and coupling - Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage - Electrical transient conduction along supply lines only".
- [14] ISO 7637: "Road vehicles - Electrical disturbance by conducting and coupling - Part 2: Commercial vehicles with nominal 24 V supply voltage - Electrical transient conduction along supply lines only".
- [15] EN 50147: "Anechoic chambers - Part 2: Alternative test site suitability with respect to site attenuation".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this ETS, the following definitions apply:

base station equipment: Used to describe amateur radio equipment which is powered from the public AC power network, either directly or indirectly to an AC/DC converter.

integral antenna: An antenna designed to be connected to the equipment without the use of an external connector and considered to be part of the equipment. An integral antenna may be fitted internally or externally to the equipment.

Manufacturer (SUPPLIER): The legal entity responsible under the terms of the Council Directive 89/336/EEC [3], for placing the product on the market in an EU member state.

maximum usable sensitivity: Minimum receiver Radio Frequency (RF) input signal level to produce a specified analogue SINAD ratio or Bit Error Ratio (BER), or other specified output quality measure, which is input signal level related.

mobile equipment: Used to describe all amateur radio equipment powered by a vehicular power supply.

spurious emissions: Emissions 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.

out-of-band emissions: Emissions on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

unwanted emission: Consists of spurious emissions and out-of-band emissions.

port: A particular interface of the specified apparatus with the external electromagnetic environment. Any connection point to an equipment intended for connection of cables to or from that equipment is considered as a port (see figure 1).

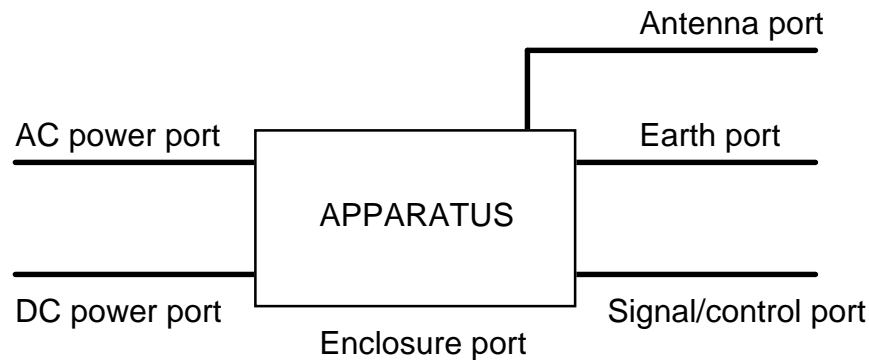


Figure 1: Examples of ports

enclosure port: The physical boundary of the apparatus through which electromagnetic fields may radiate or impinge.

portable equipment: Used to describe all portable amateur radio equipment powered by an internal (and/or) external battery.

NOTE 1: More than one of the equipment classifications may apply to certain equipment as described in subclause 5.2 depending upon the manufacturer's declaration of normal intended use.

ancillary equipment: Equipment (apparatus), used in connection with a receiver, transmitter or transceiver is considered as an ancillary equipment (apparatus) if:

- the equipment is intended for use in conjunction with a receiver, transmitter or transceiver to provide additional operational and/or control features to the radio equipment (e.g. to extend control to another position or location); and
- the equipment cannot be used on a stand alone basis to provide user functions independently of a receiver, transmitter or transceiver; and
- the receiver, transmitter or transceiver to which it is connected, is capable of providing some intended operation such as transmitting and/or receiving without the ancillary equipment. (i.e. it is not a sub unit of the main equipment essential to the main equipment's basic functions).

support equipment: This is equipment that can be used with the EUT, but which has functionality when used alone. Modems and/or PC connections are also to be regarded as support equipment, and not as ancillary equipment.

NOTE 2: The philosophy depends on the manufacturer. It is up to him to declare, for example, his power supply unit as an integral part of his radio equipment or as a stand-alone item which would be declared compliant separately. Typical examples of ancillary equipment include: microphones, loudspeakers, morse keys (manual or automatic/electronic), desktop 'drop-in' battery chargers for hand-held portables. Remote front-panels may be considered as ancillary equipment only if the radio has an integral, permanent front panel as well. Otherwise, demountable front-panels should be considered as an integral part of the EUT. Embedded PCB assemblies sold as options, which increase or change the EUT functionality, are regarded as integral to the EUT and not as ancillary equipment. Snap-on battery packs are also integral parts of the EUT and not ancillary equipment. Plug-in or screw-on whip antennas are regarded as integral parts of the EUT and not ancillary equipment, even if the interface is a 50 Ω connector.

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

BER	Bit Error Ratio
DSB-SC	Double SideBand Suppressed Carrier
EMC	ElectroMagnetic Compatibility
emf	electromotive force
ESD	ElectroStatic Discharge
EUT	Equipment Under Test
LISN	Line Impedance Stabilizing Network
PEP	Peak Envelope Power
RF	Radio Frequency
SSB	Single SideBand

3.3 Symbols

For the purposes of this ETS, the following symbols apply:

F _b	skirt bandwidth
F _c	centre frequency of the transmitter necessary bandwidth
F _n	necessary bandwidth
HF	High Frequency
SINAD	Ratio of Signal + Noise + Distortion to Noise + Distortion
VHF	Very High Frequency
UHF	Ultra High Frequency

4 Test conditions

4.1 Test conditions: general

This subclause defines the requirements for the general test configuration and are as follows:

- the equipment shall be tested under conditions which are within the manufacturer's declared range of humidity, temperature and supply voltage;
- the test configuration shall be as close as possible to normal intended use;
- where portable (handheld) equipment is provided with a detachable integral antenna, it shall be tested with the antenna fitted in a manner typical of normal intended use, unless specified otherwise in this ETS;
- if the equipment with an integral antenna provides an internal antenna connector for testing purposes, the tests can be made via the terminal;
- if the equipment is part of a system, or can be connected to ancillary equipment, then it shall be acceptable to test the equipment while connected to the minimum configuration of ancillary equipment necessary to exercise the ports;
- ports, which in normal operation are connected, shall be connected to an ancillary equipment or to a representative piece of cable correctly terminated to simulate the impedance of the ancillary equipment. RF input/output ports shall be correctly terminated;
- if the equipment has a large number of ports, then a sufficient number shall be selected to simulate the actual operating conditions and to ensure that all different types of termination are tested;
- ports which are not connected to cables during normal intended operation, e.g. service connectors, programming connectors, temporary connectors etc. shall not be connected to any cables for the purpose of EMC testing. Where cables have to be connected to these ports, or interconnecting cables have to be extended in length in order to exercise the EUT, precautions shall be taken to ensure that the evaluation of the EUT is not affected by the addition or extension of these cables;

- the tests shall be carried out at a point within the specified normal operating environmental range at the rated supply voltage for the equipment;
- the test conditions, test configurations modes of operation and the test methods used shall be properly documented.

The manufacturer shall recommend a power supply for use with the equipment under test (EUT), to ensure satisfactory operation of the combination during EMC testing. In the event that a range of power supply units can be used with several of that manufacturer's radios, then each power supply unit shall be tested with the radio having the highest RF output Peak Envelope Power (PEP). These power supply units shall then be listed as preferred items for future generations of that manufacturer's radios.

4.1.1 EUT test frequencies

Testing shall be performed with the EUT set to frequencies as follows:

- single-band equipment: test at the centre of the band;
- double-band equipment: test at the centre of both bands;
- HF multi-band equipment or VHF/UHF multi-band equipment: test at the centre of the lowest, the centre of the middle, and the centre of the highest band;
- HF/VHF, HF/UHF or HF/VHF/UHF combined equipment: test at the centre of the lowest HF band, the centre of the middle HF band, the centre of the highest HF band, the centre of the lowest VHF/UHF band, the centre of the middle VHF/UHF band, and the centre of the highest VHF/UHF band.

4.2 Test conditions: immunity testing

In the case of receivers operating, or capable of operating on a number of frequencies over a wide frequency band, immunity tests shall be made over a selected number of wanted signal test frequencies. For the selected wanted signal test frequencies, see subclause 4.1.1.

A communications link shall be established at the start of the test and maintained during the test. The test modulation, test arrangement etc., as specified in this ETS, subclauses 4.2.1, 4.2.2, 4.2.3, 4.2.4 and 4.2.5 shall apply and the conditions shall be as follows:

- for transmitter immunity testing under active conditions, in the case of transmitters designed to emit transmissions with a non constant envelope, the power setting may be reduced to -6 dB with respect to maximum PEP RF output. In the case of transmitters designed to emit transmissions with a constant envelope, the EUT may be operated at maximum PEP RF output, or at a level up to 6 dB lower than this in the event of declared thermal limitations;
- for stand alone receivers or receivers of transceivers operating in the simplex mode, the wanted RF input signal, coupled to the receiver, shall be modulated with a suitable test signal (see subclause 4.2.3);
- for duplex transceivers, the wanted RF input signal, coupled to the receiver, shall be modulated with a suitable test signal (see subclause 4.2.3). The transmitter shall be operated at its maximum PEP RF output, modulated with the test signal, coupled to the transmitter from the output of the receiver (repeater mode).

4.2.1 Arrangements for wanted signals at the modulation input of the transmitter

The transmitter should be modulated with a suitable signal, from an internal or external signal source. If it is not appropriate to provide a modulated signal from the transmitter, the test may be performed using an unmodulated carrier. It shall be possible to verify that a communications link is established and maintained.

4.2.2 Arrangements for monitoring the RF output of the transmitter

The measuring equipment used to monitor the output signal of the transmitter shall be located outside of the test environment. Adequate measures shall be taken to protect the measuring equipment from the effect of all interference, (e.g. radiated fields and conducted interference).

The output signal of the transmitter shall be coupled to the receiving measuring equipment via a shielded transmission line, such as a coaxial cable, to enable a communications link to be established and maintained.

In the case of an integral antenna equipment not provided with an external RF antenna connector, the output signal of the transmitter shall be coupled to another antenna located within the test environment enabling a communications link to be established and maintained. This antenna shall be coupled to the receiving measuring equipment.

4.2.3 Arrangements for wanted signals at the input of the receiver

The wanted input signal to the receiver should be modulated with a suitable test signal. If it is not appropriate to provide a modulated signal to the receiver, the test may be performed using an unmodulated wanted input signal. It shall be possible to verify that a communications link is established and maintained.

The wanted input signal, to establish a communications link shall be presented to the antenna connector by a coaxial cable. The source of the wanted input signal shall be located outside of the test environment and shall be at a nominal value of 60 dB (or a lower value as declared by the manufacturer) above the maximum usable sensitivity of the EUT as declared by the manufacturer in the product documentation.

4.2.4 Arrangements for monitoring the output of the receiver

The output of the receiver under test shall be coupled via a suitable coupling device in order to demonstrate that the link is maintained.

The equipment used for monitoring the maintenance of the link shall be located outside of the environment.

Adequate measures shall be taken to protect the measuring equipment from the effects of all interference (e.g. radiated fields and conducted interference).

4.2.5 Receiver: exclusion band for immunity testing

Small frequency bands centred around the radio frequency to which the radio is tuned are excluded from immunity tests with either radiated or conducted signals. These RF test exclusions are referred to as "exclusion bands".

The exclusion band for a receiver and the receiver of a transceiver is determined by the characteristics of the equipment.

In the case of receivers operating on a fixed single frequency, the exclusion band extends from minus 5 % to plus 5 % of the fixed single frequency.

In the case of receivers operating, or capable of operating, on a number of spot frequencies in a narrow operating frequency band which is less than 20 % of the centre frequency of the operating band, the exclusion band extends from minus 5 % of the lowest frequency of the narrow operating frequency band to plus 5 % of the highest frequency of that band.

In the case of receivers operating, or capable of operating on a number of spot frequencies over a wide frequency band, the exclusion band for each of the wanted signal test frequencies shall extend from minus 5 % to plus 5 % of each wanted signal test frequency.

4.2.6 Receiver: narrow band responses

Responses on receivers, or receivers of transceivers, occurring during the test at discrete frequencies which are narrow band responses (spurious responses) are identified by the method described in this subclause.

If, during the test, an unwanted signal causes degradation of performance of the output resulting from the wanted signal, it is necessary to establish whether the degradation of performance is due to a narrow band response or to a wide band phenomena. Therefore, the unwanted signal frequency shall be increased by an amount equal to twice the bandwidth of the bandwidth defining filter as declared by the manufacturer. The test shall be repeated with the frequency of the unwanted signal decreased by the same amount.

If the degradation of performance disappears, then the response is considered as a narrow band response.

If the degradation of performance does not disappear, this may be due to the fact that the offset has made the frequency of the unwanted signal correspond to the frequency of another narrow band response. Under these circumstances, the method above is repeated with the increase and decrease of the frequency of the unwanted signal adjusted to two and a half times the bandwidth referred to. If the degradation does not now disappear, the phenomenon is considered wide band and therefore an EMC problem, and the equipment fails the test.

Narrow band responses are disregarded.

4.2.7 Transmitter: exclusion band for immunity testing

The exclusion band for transmitters for immunity testing extends plus and minus twice the maximum occupied bandwidth allowed for the type of service for which the equipment is intended to operate, centred around the occupied bandwidth.

4.3 Test conditions: emissions testing

4.3.1 Transmitter: exclusion band for emissions testing

The exclusion band for transmitters for emission testing shall be determined by the class of emission characteristics of the EUT. For measurement purposes, the exclusion bandwidth shall additionally allow for the skirt bandwidth (Fb) of the measuring instrumentation, as shown in table 1.

Table 1: Transmitter exclusion band for emissions

Necessary bandwidth of emission	Exclusion band	Exclusion band centre
$F_n < 0,05 F_c$	$3 F_n + F_b$	F_c
$F_n > 0,05 F_c$	$1,1 F_n + F_b$	F_c

Where:

- F_n = Necessary bandwidth of the wanted class of emission as defined in ITU RR 1-18 clause 146 [4];
- F_b = 200 kHz in the frequency range below 30 MHz;
- F_b = 2 MHz in the frequency range above 30 MHz;
- F_c = Centre frequency of the transmitter necessary bandwidth.

5 Performance assessment

5.1 General

The manufacturer shall declare, or properly document the following information which shall be in accordance with the information contained in the (user) instructions accompanying the equipment:

- the primary functions of the radio equipment to be evaluated during and after the EMC testing;
- the intended functions of the EUT which shall be in accordance with the documentation accompanying the equipment;
- the ancillary equipment to be combined with the radio equipment for testing;
- the method to be used to verify that a communications link is established and maintained;
- the modulation type to be used including where applicable, the modulating test data sequence and/or the applicable frequency deviation or modulation depth;
- the maximum duty cycle and the maximum transmit time for each mode of transmission where the EUT is incapable of continuous transmission;
- the user-control functions and stored data that are required for normal operation and the method to be used to assess whether these have been lost during and after immunity testing;
- an exhaustive list of ports, classified as either power or signal/control. Power ports shall further be classified as AC or DC power;
- the operating mode which produces the maximum unwanted emission for multimode equipment;
- the bandwidth of the bandwidth-defining filter used in each mode, in the case of multi-mode equipment. The antenna port immunity test (RF immunity, differential mode) shall be performed using the mode with the widest defined bandwidth;
- the nominal antenna load impedance for transmitters and the applicable tolerance;
- the nominal antenna source impedance for receivers and the applicable tolerance.

5.2 Equipment classification

Amateur radio equipment and/or combinations of equipment shall be considered as either base station, and/or mobile equipment and/or portable equipment by declaration of the manufacturer.

Equipment intended for use in more than one EMC environment, shall be tested with each type of declared power source under conditions simulating each declared EMC environment. For example, portable equipment declared as capable of being powered for intended use by the main battery of a vehicle, shall additionally be considered as equipment for vehicular use.

6 Performance criteria

Amateur radio equipment may contain user functions which are of primary relevance from the point of view of conveying information or configure the equipment to allow the exchange of information.

In addition, other user functions may be included in the equipment which do not have a functional relationship with the primary function.

From the perspective of developing intrinsic immunity specifications (minimum performance criteria), the example below illustrates what are considered as primary or secondary functions.

EXAMPLE: A paging receiver also containing an alarm clock:

- primary functions are the reception of a call, the call alert and the storage of a call, if provided;
- secondary functions are all functions related to the alarm clock.

Primary user functions:

- the EUT shall meet the minimum particular performance criteria as specified in subclauses 6.1 and/or 6.2 and/or 6.3, as appropriate.

Secondary user functions:

- for secondary user functions, the equipment shall meet the general performance criteria as specified in subclause 6.4.

6.1 General performance criteria (primary user functions)

Table 2: General performance criteria

Criteria	During test	After test
A	Degradation of performance (note 1) No loss of function Operate as intended (no loss of link) No unintended RF transmission No loss of user control functions or stored configuration data	Operate as intended No degradation of performance (note 2) No loss of function No loss of stored data
B	Loss of function (one or more) No unintended RF transmission No loss of user control functions or stored configuration data	Operate as intended No degradation of performance (note 2) Functions self-recoverable No loss of link after test No loss of stored data
C	Loss of function (one or more) (and/or) user data No unintended RF transmission	Operate as intended No degradation of performance (note 2) Functions recoverable by the operator (i.e. can be reset to normal)
NOTE 1:	Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases, the specified minimum performance level may be replaced by a permissible degradation of performance. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising), and what the user may reasonably expect from the apparatus if used as intended.	
NOTE 2:	No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. After the test no change of actual operating data or user retrievable data is allowed. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising), and what the user may reasonably expect from the apparatus if used as intended.	

In the case of data systems utilizing "Acknowledgement" transmissions, it is recognized that during or after transient phenomena there may be a transmission which although not externally commanded, is a result of performance according to criteria B or C in table 2. Should such transmission take place, this fact shall be noted in the test report but the equipment shall not be deemed to have failed the test as a result of this transmission.

6.2 Particular performance criteria: (primary user functions) transmitters, receivers, transceivers, RF amplifiers and transverters

RF amplifiers and transverters shall be stimulated with signals in accordance with manufacturer's specifications.

6.2.1 Tests with phenomena of a continuous nature

- during and after the test there shall be no unintended transmission;
- at the conclusion of the test, the EUT shall operate as intended with no loss of user control functions or stored data, as declared by the manufacturer;
- during the test the communication link shall not deteriorate below a level of 12 dB SINAD for analogue (speech) communication and the digital throughput shall not drop below 80 % of the nominal throughput;
- after the test, the communications link shall not be lost, and shall not deteriorate below a level specified by the manufacturer, and the digital throughput shall return to its nominal value.

6.2.2 Tests with phenomena of a transient nature

- during and after the test there shall be no unintended transmission;
- after the test there shall be no loss of the communication link;
- it shall be permissible to re-key the transmitter after an ElectroStatic Discharge (ESD) event;
- after the test the speech quality level shall return to a level not below that specified by the manufacturer and the digital throughput shall return to its nominal value;
- after the test there shall be no loss of user control functions and/or stored user data.

6.2.3 Tests with voltage dips

- during and after the test there shall be no unintended transmission;
- after the test there shall be no loss of the communications link;
- after the test the speech quality level shall return to a level not below that specified by the manufacturer and the digital throughput shall return to its nominal value;
- after the test there shall be no loss of user control functions and/or stored user data.

6.2.4 Tests with power interruptions

- during and after the test there shall be no unintended transmission;
- during the test the communications link may be lost and one or more functions and/or stored user data may be lost;
- after the test the communications link shall be recoverable either automatically or by operational user control as declared by the manufacturer;
- after the test the speech quality level shall return to a level not below that specified by the manufacturer and the digital throughput shall return to its nominal value.

6.3 Particular performance criteria: ancillary equipment

In the case of ancillary equipment being tested separately from other equipment, the manufacturer shall declare, for proper documentation, the specification for an acceptable level of performance or degradation of performance during and/or after testing, as required by this ETS in subclause 6.1. The performance specification shall be included in the product description and documentation.

The performance criteria specified by the manufacturer shall provide, as a minimum, the same degree of immunity protection as specified in subclause 6.1.

6.4 General performance criteria (secondary user functions)

The equipment shall meet the performance criteria as given in table 3 including the associated notes 1 and 2.

The performance criteria A, B and C as indicated in table 3 shall be used in the following manner:

- performance criteria A for immunity tests with phenomena of a continuous nature;
- performance criteria B for immunity tests with phenomena of a transient nature;
- performance criteria C for immunity tests with power interruptions exceeding a certain period of time.

Table 3: Performance criteria (secondary user functions)

Criteria	During test	After test
A	Operate as intended Degradation of performance (note 1) No loss of function	Operate as intended No degradation of performance (note 2) No loss of function
B	Loss of function (one or more)	Operate as intended No degradation of performance (note 2) Functions self-recoverable
C	Loss of function (one or more)	Operate as intended No degradation of performance (note 2) Functions recoverable by the operator
<p>NOTE 1: Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance.</p> <p>If the minimum performance level or the permissible performance degradation is not specified by the manufacturer, then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.</p> <p>NOTE 2: No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. After the test no change of actual operating data or user retrievable data is allowed.</p> <p>If the minimum performance level or the permissible performance degradation is not specified by the manufacturer, then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.</p>		

7 Applicability overview tables

7.1 Emissions testing

Table 4: Emission applicability

Equipment test requirement				
Port	Base station, ancillary and other equipment for fixed use	Mobile, ancillary and other equipment for vehicular use	Portable, ancillary and other equipment for portable use	Reference document
Enclosure	applicable	applicable	applicable	
DC power in/out	applicable	applicable	not applicable	EN 55022 [5], CISPR 16-1 [6]
AC mains	applicable	not applicable	not applicable	EN 55022 [5]
Antenna port	applicable	applicable	applicable	

See subclause 5.2 for equipment classification.

7.2 Immunity testing

Table 5: Immunity applicability

Equipment test requirement					
Phenomenon	Port applicability	Base station, ancillary and other equipment for fixed use	Mobile equipment and ancillary and other equipment for vehicular use	Portable, ancillary and other equipment for portable use	Reference document
RF electro-Magnetic field (80 - 1 000 MHz)	Enclosure	applicable	applicable	applicable	ENV 50140 [7]
Electrostatic discharge	Enclosure	applicable	applicable	applicable	IEC 1000-4-2 [8]
Fast transients common mode	Signal and control ports, DC and AC power input ports	applicable	not applicable	not applicable	IEC 1000-4-4 [9]
RF common mode 0,15 - 80 MHz (current clamp injection)	Signal and control ports, DC and AC power input ports	applicable	applicable	applicable	EN 61000-4-6 [10]
Transients and surges, vehicular environment	DC power input ports	not applicable	applicable	not applicable	ISO 7637 Parts 1 and 2 [13, 14]
Voltage dips and interruptions	AC mains power input ports	applicable	not applicable	not applicable	EN 61000-4-11 [11]
Surges, common and differential mode	AC mains power input ports	applicable	not applicable	not applicable	ENV 50142 [12]
RF conducted differential mode	Antenna port	applicable	applicable	applicable	

See subclause 5.2 for equipment classification.

8 Test methods and limits for emission tests

8.1 Emission: antenna port

8.1.1 Definitions

This test assesses the levels of unwanted emission from the antenna port of the EUT.

8.1.2 Method of measurement

The EUT shall be terminated in a non radiating load and power attenuator according to the manufacturer's specifications. The output of the power attenuator shall be connected to a measuring receiver. The measuring receiver (or spectrum analyser) shall comply with the bandwidth and detector requirements as stated below.

The EUT shall be modulated such that the maximum PEP output is achieved, either by single or multiple tones, or by a suitable bit stream, or in the case of transmitters for other than analogue voice or data, by test modulation representative of normal use. Where thermal limitations prevent continuous transmissions under such conditions, the measurements may be made using gated methods. Under these circumstances, the test method shall be documented in the test report.

The manufacturer shall declare the test modulation. In the case of analogue voice modulation for a Single SideBand (SSB) or Double SideBand Suppressed Carrier (DSB-SC) transmitter, the modulation shall consist of two sinusoidal, non-harmonically related frequencies such as to produce signals of equal output power. In the case of an AM transmitter, one such signal shall be used, with a modulation depth of the rated value. In the case of a narrow band FM transmitter, the modulation shall consist of a single audio frequency of such level that the deviation shall be the rated value as declared by the manufacturer.

In the case of equipment intended for data transmission, the manufacturer shall declare a Test Data Sequence with which the transmitter shall be modulated. The Test Data Sequence shall be such that:

- the generated RF signal is the same for each transmission;
- the transmissions occur regularly in time;
- sequences of transmissions can be repeated accurately;
- the format of the signal is such that the transmitted data (as opposed to any preamble or synchronization sequences) is essentially random in nature;
- the modulation depth (or deviation) attained is representative of the normal intended use of the equipment.

The same Test Data Sequence shall be used for all emissions measurements on the same equipment.

For equipment intended for modulation by signals other than those defined above, the modulation shall be representative of that in normal use. In all cases, the details of the modulation shall be documented in the test report.

The measuring receiver shall be tuned over the measurement frequency range and 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. The measurements shall be repeated with the EUT in stand-by-mode and with the EUT in receive mode.

The measurement frequency range extends from 150 kHz to 12,5 GHz or $2 \times F_c$ (table 7) if greater than 12,5 GHz, excluding the transmitter exclusion band for emissions. If spurious emissions are detected within -10 dB of the specified limit between 1,5 and 4 GHz, then the measurement shall continue to 12,75 GHz. If the operating frequency of the EUT is greater than 6,375 GHz, the measurement frequency range shall extend up to and including twice the maximum operating frequency.

Table 6: Bandwidth requirements

Frequency range	6 dB bandwidth
150 kHz - 30 MHz	9 - 10 kHz
30 - 1 000 MHz	100 - 120 kHz
> 1 000 MHz	1 MHz

To improve measurement sensitivity or to avoid spillover from the wanted emission into the measurement receiver bandwidth filters, the measurement bandwidth B may be reduced when measuring close to F_c . Where spectrum analysers or similar instruments are used to perform the measurement, the measurement bandwidth may be reduced in order to improve measurement sensitivity. The total peak power of the all spurious emissions in the bandwidth above shall be used to determine whether the requirements are met. A peak detector complying with CISPR 16-1 [6] shall be used.

NOTE: The tables below are self-contained and do not need supporting text in the main body of this ETS.

Table 7: Transmitter exclusion band for emissions

Necessary bandwidth of emission	Exclusion band	Exclusion band centre
$F_n < 0,05 F_c$	$3 F_n + F_b$	F_c
$F_n > 0,05 F_c$	$1,1 F_n + F_b$	F_c

Where:

- F_n = Necessary bandwidth of the wanted class of emission as defined in ITU RR 1-18 clause 146 [4];
- F_b = 200 kHz in the frequency range below 30 MHz;
- F_b = 2 MHz in the frequency range above 30 MHz;
- F_c = Centre frequency of the transmitter necessary bandwidth.

8.1.3 Limits: antenna port in transmitter-active mode

Table 8: Antenna port limits in active mode

Frequency range	Test Limits	Remarks
0,15 - 1,7 MHz	-36 dBm or -60 dBc whichever is higher	
1,7 - 35 MHz	-36 dBm or -40 dBc whichever is higher	
35 - 50 MHz	-40 to -60 dBc (note 1) or -36 dBm whichever is higher	
50 - 1 000 MHz	-36 dBm or -60 dBc whichever is higher	
> 1 000 MHz	-30 dBm or -50 dBc whichever is higher	(note 2)
NOTE 1: The limit in dBc decreases linearly with the logarithm of frequency in the range 35 MHz to 50 MHz.		
NOTE 2: For measurement at frequencies greater than 40 GHz no test limits are specified.		

8.1.4 Limits: antenna port in standby mode

Table 9: Antenna port limits in standby mode

Frequency Range	Test Limits	Remarks
0,15 - 1 000 MHz	-57 dBm	
> 1 000 MHz	-47 dBm	(note)
NOTE: For measurement at frequencies greater than 40 GHz no test limits are specified.		

8.1.5 Limits: antenna port in receive mode

Table 10: Antenna port limits in receive mode

Frequency Range	Test Limits	Remarks
0,15 - 1000 MHz	-57 dBm	
> 1 000 MHz	-47 dBm	(note)
NOTE: For measurement at frequencies greater than 40 GHz no test limits are specified.		

8.2 Emissions: enclosure port

8.2.1 Definition

This test assesses the levels of unintended emission from the enclosure port of the EUT.

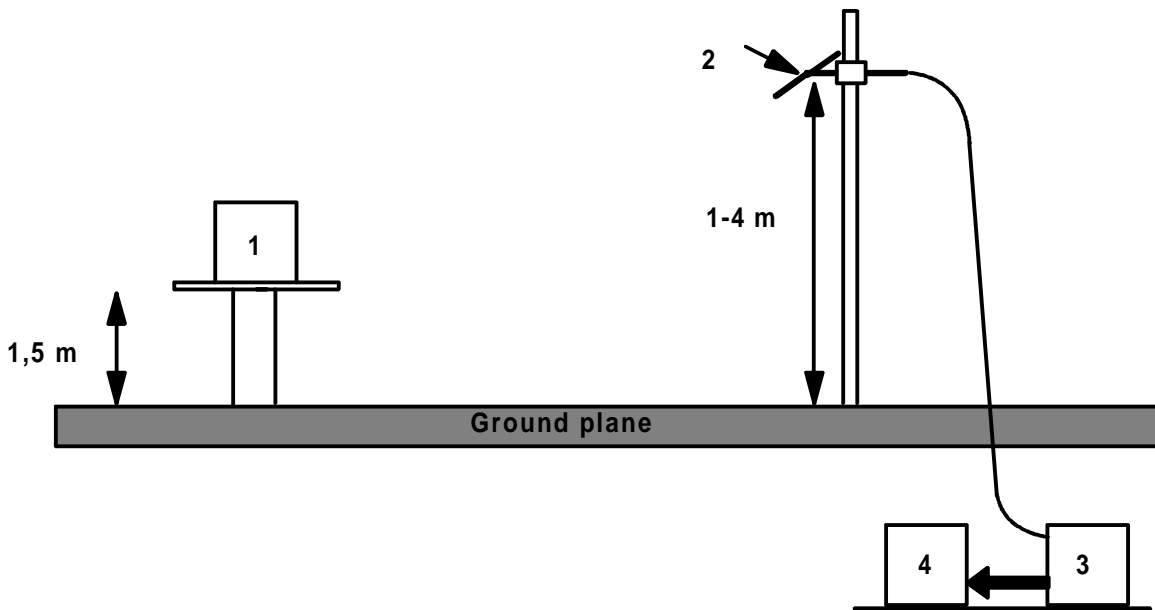
8.2.2 EUT termination

The antenna port of the EUT shall be terminated in a non-radiating load according to the manufacturer's specifications.

8.2.3 Test sites and general arrangements for measurements involving the use of radiated fields

8.2.3.1 Outdoor test site

The outdoor test site shall comply with the requirements of CISPR 16. The standard position for the test sample shall be 1,5 m above the ground plane, supported by a non conductive structure.



- NOTE:
- | | |
|---|---|
| 1 | Equipment under test |
| 2 | Test antenna |
| 3 | High pass filter (may not be necessary) |
| 4 | Spectrum analyser or measuring receiver |

Figure 2

8.2.3.2 Method of measurement

Radiated emission measurements shall be performed using the substitution method.

A test antenna shall be used to detect the radiation from the EUT. This antenna is mounted on a non conducting support such as to allow the antenna to be used in either horizontal or vertical polarization and for the height of its centre above ground to be varied over the range 1 to 4 m. Preferably a test antenna with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

For EUT radiation measurements, the test antenna is connected to a measuring receiver, capable of being tuned to any frequency under investigation and of measuring the levels of signals at its input.

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

The distance between the lower extremity of the test antenna and the ground shall not be less than 0,3 m.

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and the precautions described in this clause are observed. Measuring distances of 3, 5, 10 and 30 m are in common use in European test laboratories.

For frequencies above 1 GHz, a smaller measuring distance may be used provided it is greater than five times the maximum dimension of the EUT and five times the maximum dimension of the measurement

antenna and five times the dimension of the substitution antenna and exceeds one half-wavelength at the test frequency.

The position of auxiliary cables (power supply etc.) which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliary equipment should be arranged vertically downwards decoupled to the ground plane.

The EUT shall be placed on the support in its standard position and switched on.

The test antenna shall be oriented initially for vertical polarization. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected.

The EUT shall be rotated through 360° about a vertical axis to maximize the detected signal.

The test antenna shall be raised or lowered again, if necessary, through the specified height range until a maximum is obtained. This level shall be recorded.

This measurement shall be repeated for horizontal polarization.

The substitution antenna shall replace the EUT in the same position and with vertical polarization. The frequency of the signal generator shall be adjusted to the frequency under investigation.

The rotation and height scans to maximize the detected signal shall be repeated.

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 EUT is obtained in the test receiver.

The entire measurement sequence shall be repeated with horizontal positioning of the antennas.

The radiated power is equal to the power supplied by the signal generator, modified 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.

The measurement frequency range extends from 30 MHz to 12,5 GHz or $2 \times F_c$ if greater than 12,5 GHz, excluding the transmitter exclusion band for emissions. If spurious emissions are detected within -10 dB of the specified limit between 1,5 and 4 GHz, then the measurement shall continue to 12,75 GHz. If the operating frequency of the EUT is greater than 6,375 GHz, the measurement frequency range shall extend up to and including twice the maximum operating frequency.

Table 11: Bandwidth requirements

Frequency range	6 dB Bandwidth
30 - 1 000 MHz	100 - 120 kHz
> 1 000 MHz	1 MHz

To improve measurement sensitivity or to avoid spillover from the wanted emission into the measurement receiver bandwidth filters when measuring close to F_c , the measurement of narrow band spurious emissions may be performed with a bandwidth smaller than the above. The total peak power of the all spurious emissions in the bandwidth above shall be used to determine whether the requirements are met. A peak detector complying with CISPR 16-1 [6] shall be used.

Table 12: Transmitter exclusion band for emissions

Necessary bandwidth of emission	Exclusion band	Exclusion band centre
$F_n < 0,05 F_c$	$3 F_n + F_b$	F_c
$F_n > 0,05 F_c$	$1,1 F_n + F_b$	F_c

Where:

- F_n = Necessary bandwidth of the wanted class of emission as defined in ITU RR 1-18 clause 146 [4];
- F_b = 200 kHz in the frequency range below 30 MHz;
- F_b = 2 MHz in the frequency range above 30 MHz;
- F_c = Centre frequency of the transmitter necessary bandwidth.

8.2.3.3 Optional indoor test site

For measurements at frequencies above 80 MHz, use may be made of an indoor test site. If this technique is used, this fact shall be recorded in the test report. Such a test site shall have a minimum area of 6 m by 7 m and be at least 2,7 m in height. The test site shall be as free as possible from reflecting objects.

Reflections from the wall behind the EUT shall be reduced by the placement of a barrier of RF absorbent material in front of it. A corner reflector shall be used around the test antenna to reduce unwanted reflections from other surfaces in the room.

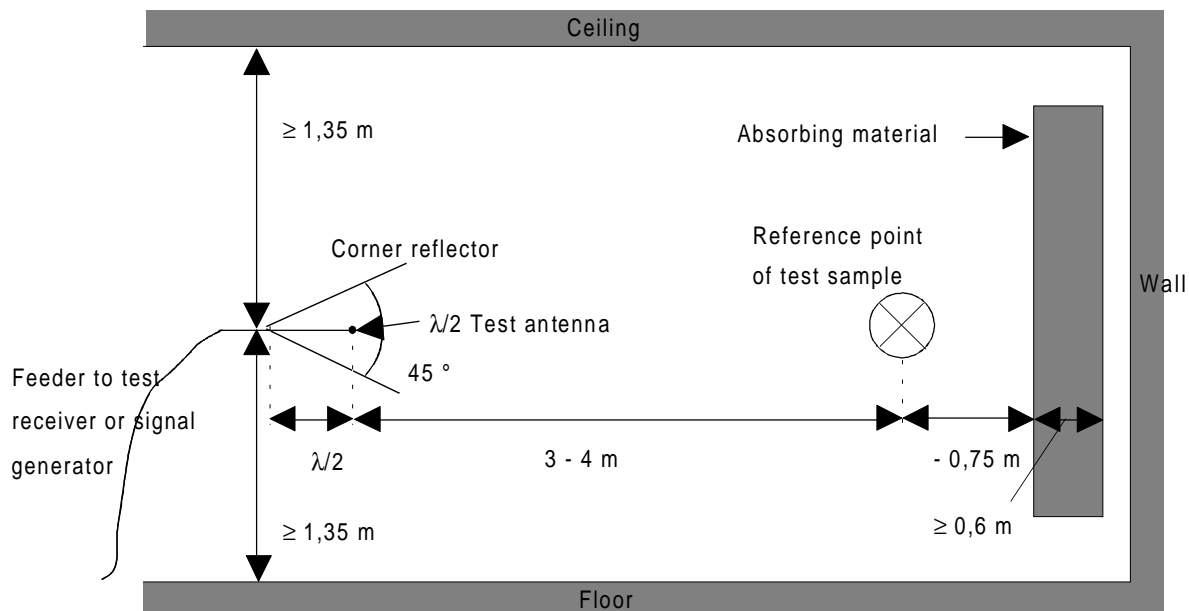


Figure 3: Indoor site arrangement (shown for horizontal polarization)

The test antenna and measuring receiver shall be used in a way similar to subclause 8.2.3.2.

8.2.3.4 Further alternative test site using a fully anechoic RF chamber

Radiated measurements may be performed in a fully anechoic RF chamber simulating a free-space EMC environment. The chamber shall comply with the return loss characteristics of EN 50147 [15]. If such a chamber is used, this fact shall be recorded in the test report.

The test procedure is similar to the method of measurement in subclause 8.2.3.2 but no height search need be performed.

8.2.4 Limits: transmitter active mode

Table 13: Enclosure port limits in active mode

Frequency range	Test limits	Remarks
30 - 35 MHz	-36 dBm or -40 dBc whichever is higher	
35 - 50 MHz	-40 to -60 dBc (note 1) or -36 dBm whichever is higher	
50 - 1 000 MHz	-36 dBm or -60 dBc whichever is higher	
> 1 000 MHz	-30 dBm or -50 dBc whichever is higher	(note 2)
NOTE 1: The limit in dBc decreases linearly with the logarithm of frequency in the range 35 MHz to 50 MHz.		
NOTE 2: For measurement at frequencies greater than 40 GHz no test limits are specified.		

Where limits are stated using dBc, the reference level is the maximum RF output PEP of the transmitter measured at the antenna port.

8.2.5 Limits: standby mode

Table 14: Enclosure port limits in standby mode

Frequency Range	Test Limits	Remarks
30 -1 000 MHz	-57 dBm	
> 1 000 MHz	-47 dBm	(note)
NOTE: For measurement at frequencies greater than 40 GHz no test limits are specified.		

8.2.6 Limits: receive mode

Table 15: Enclosure port limits in receive mode

Frequency Range	Test Limits	Remarks
30 -1 000 MHz	-57 dBm	
> 1 000 MHz	-47 dBm	(note)
NOTE: For measurement at frequencies greater than 40 GHz no test limits are specified.		

8.3 Emission: DC power input/output port

8.3.1 Definition

This test assesses the ability of ancillary equipment, receivers, transmitters or transceivers, transverters, RF amplifiers and modems to limit their internal noise from being present on the DC power input/output ports.

8.3.2 Method of measurement

The test method shall be in accordance with EN 55022 [5].

This test shall be performed on DC power input/output ports, which may have cables longer than 3 m.

Where this test is not carried out because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of DC ports which were not tested shall be properly documented.

For equipment with a current consumption below 16 A, the test method shall be in accordance with EN 55022 [5] and the Line Impedance Stabilizing Networks (LISN) shall be connected to a DC power source.

For equipment with a current consumption above 16 A the DC power ports shall be connected to 5 μ H LISNs provided with 50 Ω measurement ports. The LISNs shall be in accordance with the requirements of section 2 of CISPR 16-1 [6].

A measuring receiver shall be connected to each LISN measurement port in turn and the conducted emission recorded. The LISN measurement ports not being used for the measurement shall be terminated with a 50 Ω load.

The equipment shall be installed with a ground plane as defined in EN 55022 [5]. The reference earth point of the LISNs shall be connected to the reference ground plane with a conductor as short as possible.

The measurement receiver shall be in accordance with the requirements of section 1 of CISPR 16-1 [6].

The measurement shall be performed with the transmitter in transmit mode as well as in standby mode.

The transmitter shall be operated to obtain its maximum RF output PEP.

The measurement frequency range extends from 150 kHz to 30 MHz, excluding the transmitter exclusion band for emissions measured in the transmit mode.

Table 16: Transmitter exclusion band for emissions

Necessary bandwidth of emission	Exclusion band	Exclusion band centre
$F_n < 0,05 F_c$	$3 F_n + F_b$	F_c
$F_n > 0,05 F_c$	$1,1 F_n + F_b$	F_c

Where:

- F_n = Necessary bandwidth of the wanted class of emission as defined in ITU RR 1-18 clause 146 [4];
- F_b = 200 kHz in the frequency range below 30 MHz;
- F_c = Centre frequency of the transmitter necessary bandwidth.

8.3.3 Limits: transmitter active mode

Table 17: DC power port limits in transmit active mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

8.3.4 Limits: standby mode

Table 18: DC power port limits in standby mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

8.3.5 Limits: receive mode

Table 19: DC power port limits in receive mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

8.4 Emission: AC mains power input/output port

8.4.1 Definition

This test assesses the ability of ancillary equipment, receivers, transmitters or transceivers, transverters, RF amplifiers and modems to limit their internal noise from being present on the AC mains power input/output ports.

8.4.2 Method of measurement:

The conducted measurement method from EN 55022 [5] shall be used.

The measurement shall be performed with the transmitter in transmit mode as well as in standby mode.

The transmitter shall be operated to obtain its maximum RF output PEP.

The measurement frequency range extends from 150 kHz to 30 MHz, excluding the transmitter exclusion band for emissions when measured in the transmit mode.

Table 20: Transmitter exclusion band for emissions

Necessary bandwidth of emission	Exclusion band	Exclusion band-centre
$F_n < 0,05 F_c$	$3 F_n + F_b$	F_c
$F_n > 0,05 F_c$	$1,1 F_n + F_b$	F_c

Where:

- F_n = Necessary bandwidth of the wanted class of emission as defined in ITU RR 1-18 clause 146 [4];
- F_b = 200 kHz in the frequency range below 30 MHz;
- F_c = Centre - frequency of the transmitter necessary bandwidth.

8.4.3 Limits: transmit active mode

Table 21: AC mains port limits in transmit active mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

8.4.4 Limits: standby mode

Table 22: AC mains port limits in standby mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

8.4.5 Limits: receive mode

Table 23: AC mains port limits in receive mode

Environmental phenomena	Frequency range	Test limits	Basic standard
Conducted emission	0,15 - 0,5 MHz	66-56 dB μ V quasi peak 56-46 dB μ V average (note 1)	EN 55022 [5]
Conducted emission	0,5 - 5 MHz	56 dB μ V quasi peak 46 dB μ V average	EN 55022 [5]
Conducted emission	5 - 30 MHz	60 dB μ V quasi peak 50 dB μ V average	EN 55022 [5]
NOTE 1: The limit decreases linearly with the logarithm of frequency in the range 0,15 MHz to 0,50 MHz.			
NOTE 2: Equipment with a DC power input port intended for use with a dedicated AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter as specified by the manufacturer.			

9 Test methods and levels for immunity tests

9.1 Test configuration

This subclause defines the requirements for test configurations for tests in the following subclauses and are as follows:

- the measurement shall be made in the operational mode as required in subclause 4.1;
- if the equipment is part of a system or can be connected to ancillary equipment, then it shall be acceptable to test the equipment connected to the minimum representative configuration of ancillary equipment necessary to exercise the ports;
- for the immunity tests of ancillary equipment, without a separate pass/fail criteria, the receiver, transmitter or transceiver coupled to the ancillary equipment shall be used to judge whether the ancillary equipment passes or fails;
- the configuration and mode(s) of operation during measurements shall be properly recorded;
- if the equipment has a large number of ports, then a sufficient number shall be selected to simulate actual operational conditions and to ensure that all the different types of termination are covered;
- ports which in normal operation are connected, shall be connected to an ancillary equipment or to a representative piece of cable terminated to simulate the impedance of the ancillary equipment. RF input/output ports shall be correctly terminated;
- the tests shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment.

9.1.1 Arrangement for test signals in receive mode

A wanted signal and an unwanted signal shall be combined by a suitable combining network and presented to the antenna connector of the EUT with a level specified in the tables.

The wanted signal shall be at operating frequencies chosen according to subclause 4.1.1.

The wanted signal shall be at levels in accordance with subclause 4.2.3.

Table 24: Test modulation in receive mode

Mode	Units	Modulation
AM	60	% AM (1 kHz)
FM	60	% of the maximum permissible frequency deviation (1 kHz)
SSB	1 kHz offset	None
Other modes	as declared by the manufacturer	as declared by the manufacturer

9.2 Immunity: antenna port, RF conducted

This test is applicable to base station, mobile, portable and ancillary equipment.

This test shall not apply to RF low-noise preamplifiers intended for location directly at the antenna.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.2.1 Definition

This test assesses the ability of receivers, transmitters, transceivers, transverters, RF amplifiers to operate as intended in the presence of a radio frequency conducted disturbance at the antenna port.

9.2.2 Method of measurement: transmitter active mode

In normal use, amateur radio transmitting equipment is not collocated with other radio transmitters operating within 10 % of its own carrier frequency, so that inter-transmitter intermodulation will not occur. Therefore immunity testing of the transmitter antenna port is not justified and is not included in this ETS.

9.2.3 Receive mode

9.2.3.1 Method of measurement

The two input signals shall be connected to the receiver via a combining network.

Test signal sources which are applied to the receiver shall present an impedance of 50 Ω to the receiver input. This requirement shall be met irrespective whether one or more signals using a combining network are applied to the receiver simultaneously.

Receivers which require source impedances other than 50 Ω as specified by the manufacturer, shall be achieved by an impedance transformer placed between the 50 Ω combining network and the receiver input.

The levels of the test signals shall be expressed in terms of the electromotive force (e.m.f.) at the receiver input connector.

The effects of any intermodulation products and noise produced in the test signal sources shall be negligible.

The wanted test signal, at the nominal frequency of the receiver, with normal test modulation, (see table 24), shall be applied to the receiver input connector via one input of the combining network.

For analogue communication (speech):

- where possible, the receiver volume control shall be adjusted to give at least 50 % of the rated output power or, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power;
- the rated audio output power shall be the maximum power, declared by the manufacturer for which all the requirements of this ETS are met. With normal test modulation, the audio output power shall

be measured in a resistive load simulating the load with which the receiver normally operates. The value of this load shall be declared by the manufacturer. The obtained audio output level shall be noted.

For non-speech communication:

- the modulation facilities shall be declared by the manufacturer.

The test shall be performed over the frequency range 150 kHz to 1 GHz using stepped increments of maximum 1 % of the momentary frequency with the exception of the exclusion band defined in subclause 4.2.5.

The test shall be applied to the receiver input connector via the second input of the combining network.

The amplitude of the unwanted test signal shall be adjusted as given in subclause 9.2.3.2.

9.2.3.2 Arrangement for test signals

A wanted signal and a test signal shall be combined by a suitable combining network and presented to the antenna connector of the EUT with the level specified in table 25.

9.2.3.3 Levels: RF conducted differential mode

Table 25: Antenna port levels in receive mode

Environmental phenomena	Operating frequency range of EUT	Characteristics of the unwanted signal	Units	Performance criteria
RF conducted immunity	< 30 MHz	90 80 0,15 - 1 000	dBµV emf % AM (400 Hz) MHz	A and subclause 6.2.1
	> 30 MHz	80 80 0,15 - 1 000	dBµV emf % AM (400 Hz) MHz	A and subclause 6.2.1

If the bandwidth of the bandwidth defining filter of the EUT is greater than 1 % of the momentary frequency, then the frequency increment may be increased to twice the value of the declared bandwidth.

The EUT shall fulfil the general performance criteria A of table 2 and the particular performance criteria of subclause 6.2.1.

Narrow band responses according to subclause 4.2.6 shall be disregarded.

The test system shall be properly documented.

9.3 Immunity: enclosure port

This test is applicable to base station, mobile, portable and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment or a representative configuration of the ancillary equipment tested in isolation.

9.3.1 Definition

This test assesses the ability of transmitters, receivers, transceivers, RF amplifiers, transverters and ancillary equipment to operate as intended in presence of a radio frequency electromagnetic field and electrostatic discharges at the enclosure.

9.3.2 Transmitter active mode

9.3.2.1 Method of measurements: RF immunity

The test method shall be in accordance with ENV 50140 [7] except that the following requirements and evaluation of test results shall apply.

The test shall be performed over the frequency range 80 MHz - 1 GHz with the exception of an exclusion band for transmitters (see subclause 4.2.7).

9.3.2.2 Levels: RF immunity

Table 26: Enclosure port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
RF electromagnetic field	80 - 1 000 3 80	MHz V/m (rms) unmod. % AM (400 Hz)	ENV 50140 [7]	A and subclause 6.2.1

9.3.2.3 Method of measurement: electrostatic discharge

The test method shall be in accordance with IEC 1000-4-2 [8].

9.3.2.4 Levels: electrostatic discharge

Table 27: Enclosure port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Electrostatic discharge	4 (Contact discharge) 8 (Air discharge)	kV (charge voltage)	IEC 1000-4-2 [8]	B and subclause 6.2.2

9.3.3 Standby and receive mode

9.3.3.1 Method of measurement: RF immunity

The test method shall be in accordance with ENV 50140 [7] except that the following requirements and evaluation of test results shall apply.

On receivers the test shall be performed over the frequency range 80 MHz - 1 GHz with the exception of an exclusion band (see subclause 4.2.5).

9.3.3.2 Levels: RF immunity

Table 28: Enclosure port levels in standby or receive mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
RF electromagnetic field	80 - 1 000 3 80	MHz V/m (rms) unmod. % AM (400 Hz)	ENV 50140 [7]	A and subclause 6.2.1

9.3.3.3 Method of measurement: electrostatic discharge

The test method shall be in accordance with IEC 1000-4-2 [8].

9.3.3.4 Levels: electrostatic discharge

Table 29: Enclosure port levels in standby or receive mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Electrostatic discharge	4 (Contact discharge) 8 (Air discharge)	kV (charge voltage)	IEC 1000-4-2 [8]	B and subclause 6.2.2

9.4 Immunity: DC power input/output port

This test is applicable to base station, mobile and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment or a representative configuration of the ancillary equipment tested in isolation.

9.4.1 Definition

This test assesses the ability of transmitters, receivers, transceivers, RF amplifiers, transverters and ancillary equipment to operate as intended in presence of a radio frequency electromagnetic disturbance and in the event of fast transients on the DC power input/output port.

9.4.2 Transmitter active mode

9.4.2.1 Method of measurement: RF immunity, common mode, 0,15 MHz - 80 MHz

The test method shall be in accordance with EN 61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz;
- this test shall be performed on DC power input/output ports, which may have cables longer than 3 m;
- where this test is not carried out on any DC port because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of DC ports which were not tested shall be properly documented;
- this test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.4.2.2 Levels: RF immunity, common mode, 0,15 MHz - 80 MHz

Table 30: DC power port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN 61000-4-6 [10]	(note)	A and subclause 6.2.1

NOTE: The test level can be defined as the equivalent current into a 150 Ω load.

9.4.2.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment, which may have longer cables than 3 m, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on DC power input ports if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment.

9.4.2.4 Levels: fast transients common mode

Table 31: DC power port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transients common mode	0,5 5/50 5	kV (peak) ns (Tr/Th) kHz (rep.freq.)	IEC 1000-4-4 [9]	(note)	B and subclause 6.2.2
NOTE: Not applicable to input ports intended for connection to a battery or a rechargeable battery which shall be removed or disconnected from the equipment for recharging. Equipment with a DC power input port intended for use with an AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter.					

9.4.3 Standby and receive mode

9.4.3.1 Method of measurement: RF immunity, common mode, 0,15 MHz - 80 MHz

The test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz;
- this test shall be performed on DC power input/output ports, which may have cables longer than 3 m;
- where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of the DC ports which were not tested shall be properly documented;
- this test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.4.3.2 Levels: RF immunity, common mode, 0,15 MHz - 80 MHz

Table 32: DC power port levels in standby or receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.4.3.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment, which may have cables longer than 3 m, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on DC power input ports if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment.

9.4.3.4 Levels: fast transients common mode

Table 33: DC power port levels in standby or receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transients common mode	0,5 5/50 5	kV (peak) ns (Tr/Th) kHz (rep.freq.)	IEC 1000-4-4 [9]	(note)	B and subclause 6.2.2
NOTE: Not applicable to input ports intended for connection to a battery or a rechargeable battery which shall be removed or disconnected from the equipment for recharging. Equipment with a DC power input port intended for use with an AC-DC power adapter shall be tested on the AC power input of a typical AC-DC power adapter.					

9.5 Immunity: AC power input/output port

This test is applicable to base station and ancillary equipment for fixed use.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment or a representative configuration of the ancillary equipment tested in isolation.

9.5.1 Definition

This test assesses the ability of transmitters, receivers, transceivers, RF amplifiers, transverters and ancillary equipment to operate as intended in presence of a radio frequency electromagnetic disturbance and in the event of fast transients and surges common and differential mode and voltage dips and interruptions on the AC power input/output port.

9.5.2 Transmitter active mode

9.5.2.1 Method of measurement: RF electromagnetic disturbance common mode, 0,15 - 80 MHz

- the test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:
- the test shall be performed over the frequency range 150 kHz - 80 MHz.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.2.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 34: AC mains port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.5.2.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment intended for connection to the AC mains, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.2.4 Levels: fast transients common mode

Table 35: AC mains port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Fast transients common mode	1 5/50 5	kV (peak) Tr/Th ns kHz rep.fre.	IEC 1000-4-4 [9]	B and subclause 6.2.2

9.5.2.5 Method of measurement: surges common and differential mode

The test method shall be in accordance with ENV 50142 [12].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.2.6 Levels: surges common and differential mode

Table 36: AC mains port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Surges common mode	1,2/50 (8/20) 1	Tr/Th µs kV (peak)	ENV 50142 [12]	B and subclause 6.2.2
Surges differential mode (line to line)	1,2/50 (8/20) 0,5	Tr/Th µs kV (peak)	ENV 50142 [12]	B and subclause 6.2.2

9.5.2.7 Method of measurement: voltage dips and power interruptions

The test method shall be in accordance with EN 61000-4-11 [11].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.2.8 Levels: voltage dips and power interruptions

Table 37: AC mains port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Voltage dips	30 10	% reduction ms	EN 61000-4-11 [11]	B
	60 100	% reduction ms		C and subclause 6.2.4
Power interruptions	> 95 5 000	% reduction ms	EN 61000-4-11 [11]	C and subclause 6.2.4

9.5.3 Standby mode

9.5.3.1 Method of measurement: RF immunity common mode, 0,15 - 80 MHz

The test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz;
- this test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.3.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 38: AC mains port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.5.3.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment intended for connection to the AC mains, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.3.4 Levels: fast transients common mode

Table 39: AC mains port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Fast transients common mode	1 5/50 5	kV (peak) Tr/Th ns kHz rep.fre.	IEC 1000-4-4 [9]	B and subclause 6.2.2

9.5.3.5 Method of measurement: surges common and differential mode

The test method shall be in accordance with ENV 50142 [12].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.3.6 Levels: surges common and differential mode

Table 40: AC mains port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Surges common mode	1,2/50 (8/20) 1	Tr/Th μ s kV (peak)	ENV 50142 [12]	B and subclause 6.2.2
Surges differential mode (line to line)	1,2/50 (8/20) 0,5	Tr/Th μ s kV (peak)	ENV 50142 [12]	B and subclause 6.2.2

9.5.3.7 Method of measurement: voltage dips and power interruptions

The test method shall be in accordance with EN 61000-4-11 [11].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.3.8 Levels: voltage dips and power interruptions

Table 41: AC mains port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Voltage dips	30 10	% reduction ms	EN 61000-4-11 [11]	B
	60 100	% reduction ms		C and subclause 6.2.4
Power interruptions	> 95 5 000	% reduction ms	EN 61000-4-11 [11]	C and subclause 6.2.4

9.5.4 Receive mode

9.5.4.1 Method of measurement: RF immunity common mode, 0,15 - 80 MHz

The test method shall be in accordance with EN 61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.4.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 42: AC mains port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN 61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.5.4.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment intended for connection to the AC mains, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.4.4 Levels: fast transients common mode

Table 43: AC mains port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transients common mode	1 5/50 5	kV (peak) Tr/Th ns Rep.Fre kHz	IEC 1000-4-4 [9]		B and subclause 6.2.2

9.5.4.5 Method of measurement: surges common and differential mode

The test method shall be in accordance with ENV 50142 [12].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.4.6 Levels: surges common and differential mode

Table 44: AC mains port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Surges common mode	1,2/50 (8/20) 1	Tr/Th μ s kV (peak)	ENV 50142 [12]	B and subclause 6.2.2
Surges differential mode (line to line)	1,2/50 (8/20) 0,5	Tr/Th μ s kV (peak)	ENV 50142 [12]	B and subclause 6.2.2

9.5.4.7 Method of measurement: voltage dips and power interruptions

The test method shall be in accordance with EN 61000-4-11 [11].

These tests are applicable to base station and fixed ancillary equipment.

These tests shall be performed on AC mains power input ports only.

These tests shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.5.4.8 Levels: voltage dips and power interruptions

Table 45: AC mains port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Performance criteria
Voltage dips	30 10	% reduction ms	EN 61000-4-11 [11]	B
	60 100	% reduction ms		C and subclause 6.2.4
Power interruptions	> 95 5 000	% reduction ms	EN 61000-4-11 [11]	C and subclause 6.2.4

9.6 Immunity: signal/control input/output port

This test is applicable to base station, mobile, portable and ancillary equipment.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment or a representative configuration of the ancillary equipment tested in isolation.

9.6.1 Definition

This test assesses the ability of transmitters, receivers, transceivers, RF amplifiers, transverters and ancillary equipment to operate as intended in presence of a radio frequency electromagnetic disturbance and in the event of fast transients on the signal/control input/output port.

9.6.2 Transmitter active mode

9.6.2.1 Method of measurement: RF electromagnetic disturbance common mode, 0,15 - 80 MHz

The test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- The test shall be performed over the frequency range 150 kHz - 80 MHz;
- This test shall be performed on signal /control input/output ports, which may have cables longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment.

9.6.2.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 46: Signal/control port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.6.2.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment, which may have longer cables than 3 m, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a signal/control input/output port if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.6.2.4 Levels: fast transients common mode

Table 47: Signal/control port levels in active mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transient common mode	0,5 5/50 5	kV (peak) Tr/Th ns Rep freq kHz	IEC 1000-4-4 [9]	Capacitive clamp to be used	B and subclause 6.2.2

9.6.3 Standby mode

9.6.3.1 Method of measurement: RF immunity common mode, 0,15 - 80 MHz

The test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz;
- this test shall be performed on signal/control input/output ports, which may have cables longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment.

9.6.3.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 48: Signal/control port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1
NOTE: The test level can be defined as the equivalent current into a 150 Ω load.					

9.6.3.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment, which may have longer cables than 3 m, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a signal/control input/output port if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative the combination of radio and ancillary equipment.

9.6.3.4 Levels: fast transients common mode

Table 49: Signal/control port levels in standby mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transient common mode	0,5 5/50 5	kV (peak) Tr/Th ns Rep frq kHz	IEC 1000-4-4 [9]	Capacitive clamp to be used	B and subclause 6.2.2

9.6.4 Receive mode

9.6.4.1 Method of measurement: RF immunity common mode, 0,15 - 80 MHz

The test method shall be in accordance with EN61000-4-6 [10], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz - 80 MHz.

This test shall be performed on signal/control input/output ports, which may have cables longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative configuration of the combination of radio and ancillary equipment.

9.6.4.2 Levels: RF immunity common mode, 0,15 - 80 MHz

Table 50: Signal/control port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Radio frequency common mode	0,15 - 80 3 80	MHz V (rms,unmod) % AM (400 Hz)	EN61000-4-6 [10]	(note)	A and subclause 6.2.1

NOTE: The test level can be defined as the equivalent current into a 150 Ω load.

9.6.4.3 Method of measurement: fast transients common mode

For transmitters, receivers, transceivers and ancillary equipment, which may have longer cables than 3 m, the test method shall be in accordance with IEC 1000-4-4 [9].

This test is applicable to base station equipment and ancillary equipment.

This test shall be performed on a signal/control input/output port if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of signal/control input/output ports which were not tested for this reason shall be properly documented.

This test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

9.6.4.4 Levels: fast transients common mode

Table 51: Signal/control port levels in receive mode

Environmental phenomena	Test levels	Units	Basic standard	Remarks	Performance criteria
Fast transients common mode	0,5 5/50 5	kV (peak) Tr/Th ns Rep.Fre kHz	IEC 1000-4-4 [9]	Capacitive clamp to be used	B and subclause 6.2.2

9.7 Immunity: vehicle DC power interface port

These tests are applicable to mobile and ancillary equipment intended for use in a vehicular environment.

These tests shall be performed on 12 V and 24 V DC power input ports of mobile and ancillary equipment, intended for vehicular use.

These test shall be performed on a representative configuration of the radio equipment or a representative combination of radio and ancillary equipment.

Performance criteria B and subclause 6.2.2 shall be applied for all tests, except for Pulse 7 of table 53 which shall be performed to criteria C.

9.7.1 Definition

These tests assess the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of transients and surges present on the DC power input ports in a vehicular environment.

9.7.2 Method of measurement

The test method shall be in accordance with ISO 7637 part 1 [13] applicable to 12 V DC operated equipment and ISO 7637 part 2 [14] applicable to 24 V DC operated equipment except that the following requirements and evaluation of test results shall apply:

- equipment designed to operate at both 12 V and 24 V DC without component change, module change or adjustment shall be tested according to subclause 9.7.4;
- equipment designed to operate at both 12 V and 24 V DC but with component change, module change or adjustment shall be tested according to subclause 9.7.3 and subclause 9.7.4.

9.7.3 Immunity levels: 12 V DC powered equipment

Where the manufacturer in his installation documentation requires that the equipment shall have a direct connection to the 12 V main vehicle battery, the following pulses apply:

Table 52: 12 V DC power port levels

Pulse	Level	Pulses	Characteristics	Test time
3a	II		see ISO 7637-1 [13]	5 min.
3b	II		see ISO 7637-1 [13]	5 min.
4	II	5	Vs = -5V Va = -2,5V t6 = 25 ms, t8 = 5 s tf = 5 ms	

Where the manufacturer does not require a direct connection to the 12 V main vehicle battery, the pulses in table 53 apply, in addition to those in table 52.

Table 53: Additional levels: 12 V DC power port

Pulse	Level	Pulses	Characteristics	Test time
1	II	10	$t_1 = 2,5 \text{ s}$	
2	II	10	$t_1 = 2,5 \text{ s}$	
7	II	5		

Where the tests for pulses 1, 2 and 7 are not performed because the manufacturer declares that the equipment requires a direct connection to the vehicle battery, this fact shall be properly documented.

9.7.4 Immunity levels: 24 V DC powered equipment

The test shall be carried out in accordance with ISO 7637 part 2 [14] except where stated in this subclause.

Where the manufacturer in his installation documentation requires that the equipment shall have a direct connection to the 24 V main vehicle battery, the following pulses in table 54 apply:

Table 54: 24 V DC power port levels

Pulse	Level	Pulses	Characteristics	Test time
3a	II		see ISO 7637-2 [14]	5 min.
3b	II		see ISO 7637-2 [14]	5 min.
4	II	5	$V_s = -10\text{V}$ $V_a = -5\text{V}$ $t_6 = 25 \text{ ms}$, $t_8 = 5 \text{ s}$ $t_f = 5 \text{ ms}$	

Where the manufacturer does not require a direct connection to the 24 V main vehicle battery, the pulses in table 55 apply, in addition to the pulses in table 54.

Table 55: Additional levels: 24 V DC power port

Pulse	Level	Pulses	Characteristics	Test time
1a	II	10	$t_1 = 2,5 \text{ s}$ $R_i = 25 \Omega$	
1b	II	10	$t_1 = 2,5 \text{ s}$, $R_i = 100 \Omega$	
2	II	10	$t_1 = 2,5 \text{ s}$	

Where the tests for pulses 1a, 1b and 2 are not performed because the manufacturer declares that the equipment requires a direct connection to the vehicle battery, this fact shall be properly documented.

10 Interpretation of the measurement results

The interpretation of the test results recorded in a test report for the measurements described in this ETS shall be:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of this ETS;
- the measurements shall be performed in accordance with the requirements stated in the basic standards.

Annex A (normative): **Clauses and/or subclauses of this ETS relevant for compliance with the essential requirements of EC Council Directives**

Table A.1: Clauses and/or subclauses of this ETS relevant for compliance with the essential requirements of EC Council Directives

Clause/subclause number or annex reference	Title	Corresponding article of Council Directive 89/336/EEC	Qualifying remarks
8	Test methods and limits for emission tests		
8.1	Emission: Antenna port	4 (a)	
8.2	Emission: enclosure port	4 (a)	
8.3	Emission: DC power input/output port	4 (a)	
8.4	Emission: AC mains input/output port	4 (a)	
9	Test methods and levels for immunity tests		
9.2	Immunity: antenna port, RF conducted	4 (b)	
9.3	Immunity: enclosure port	4 (b)	
	RF immunity electrostatic discharge	4 (b)	
9.4	Immunity: DC power input/output port		
	RF immunity, common mode, 0,15 MHz - 80 MHz	4 (b)	
	Fast transients common mode	4 (b)	
9.5	Immunity: AC power input/output port		
	RF immunity common mode, 0,15 - 80 MHz	4 (b)	
	Fast transients common mode	4 (b)	
	Surges common and differential mode	4 (b)	
	Voltage dips and power interruptions	4 (b)	
9.6	Immunity: signal/control input/output port		
	RF immunity common mode, 0,15 - 80 MHz Fast transients common mode	4 (b) 4 (b)	
9.7	Immunity: vehicle DC power interface port		
	12 V DC powered equipment	4 (b)	
	24 V DC powered equipment	4 (b)	

History

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