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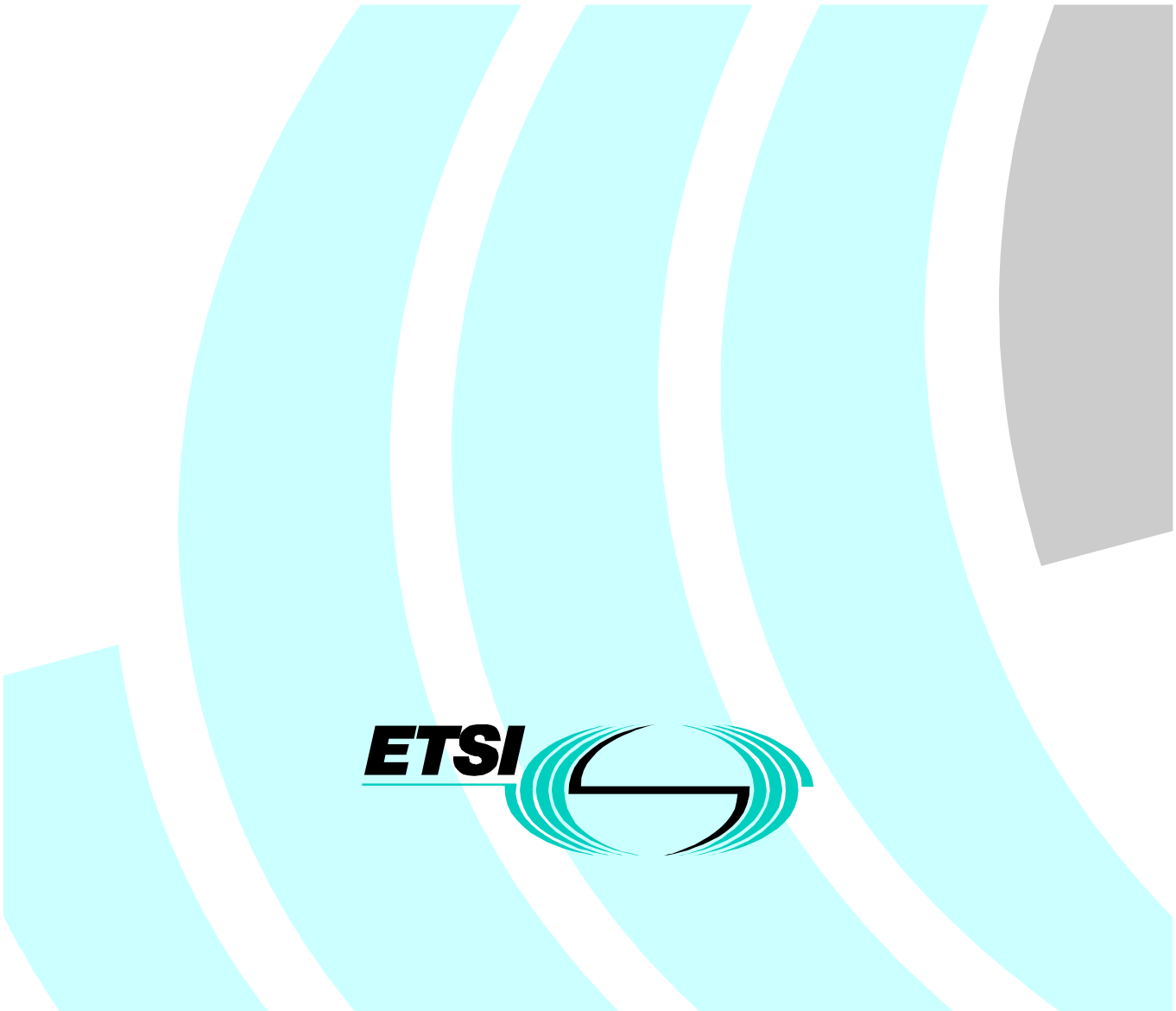
European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment



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Foreword

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

Other ETSI standards cover radio communications equipment not listed in the scope.

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

The present document is based upon the Generic Standards EN 50081-1 [1] and EN 50082-1 [2].

The present document, together with EN 300 198, EN 300 197, ETS 300 636, ETS 300 431, ETS 300 630, ETS 300 633, ETS 300 639, ETS 300 234, ETS 300 407, ETS 300 408, ETS 300 632, ETS 300 638, EN 301 055 and EN 301 021 is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility ("the EMC Directive") (89/336/EEC as amended).

For equipment which can be connected to the Alternating Current (AC) mains supply, the requirements of EN 61000-3-2 and EN 61000-3-3 apply where appropriate from the 1-1-2001.

Technical specifications relevant to the EMC Directive are given in annex A.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	36 months after doa

1 Scope

The present document covers the assessment of Fixed Radio Links and ancillary equipment in respect of ElectroMagnetic Compatibility (EMC). Technical specifications related to the antenna port of the radio equipment are found in the related product standards for the effective use of the radio spectrum. If the relevant product standard does not specify any spurious emission limits for the antenna port, then the default values as specified in subclause 8.4 of the present document apply.

The present document specifies the applicable EMC tests, the test methods, the limits and the minimum performance criteria for Analogue and Digital Fixed Radio Links operating as fixed point to point, and Point to Multipoint systems as defined in annex B, including the associated ancillary equipment.

The processing and protection switch, (de)modulator, transmitter, receiver, RF filters, branching networks, feeders are covered by the present document. The multiplexing and/or de-multiplexing elements are covered if they form part of the transmitter, receiver and/or transceiver.

The environmental classification used in the present document refers to the environment classification used in the Generic Standards EN 50081-1 [1], EN 50082-1 [2] or the telecommunications centre environment ETS 300 386-1 [12].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus at residential, commercial, light industrial or telecommunications centre environment. The levels do not cover extreme cases which may occur in any location but have a low probability of occurrence.

The present document 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 to the requirements of the present document does not signify compliance to any requirements related to the use of the equipment (i.e. licensing requirements).

Compliance to the present document does not signify compliance to any safety requirements. However, it is the responsibility of the assessor of the equipment that any observations regarding apparatus becoming dangerous or unsafe as a result of the application of the tests of the present document, should be recorded in the test report.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] EN 50081-1 (1992): "Electromagnetic compatibility - Generic emission standard - Part 1: Residential, commercial and light industry".

[2] EN 50082-1 (1992): "Electromagnetic compatibility - Generic immunity standard - Part 1: Residential, commercial and light industry".

[3] EN 55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

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

[5] EN 61000-4-3: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test".

[6] EN 61000-4-2: "Electromagnetic compatibility. Part 4, testing and measurement techniques-Section 2: Electrostatic discharge immunity test. Basic EMC publication".

[7] EN 61000-4-4: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC publication".

[8] EN 61000-4-6: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields".

[9] EN 61000-4-11: "Electromagnetic compatibility (EMC) - Part 4: Testing and measuring techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests".

[10] EN 61000-4-5: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity test".

[11] IEC 60050-161: "International Electrotechnical Vocabulary - Chapter 161 Electromagnetic compatibility".

[12] ETS 300 386-1 (1994): "Equipment Engineering (EE); Telecommunication network equipment; Electro-Magnetic Compatibility (EMC) requirements; Part 1: Product family overview, compliance criteria and test levels".

[13] ITU-T Radio Regulations (1994).

[14] EN 301 126-1: "Transmission and multiplexing (TM); Digital Radio Relay Systems (DRRS); Conformance testing for DRRS; part 1: Point-to-point equipment specific parameters".

[15] ITU-R Recommendation F 1191-1: "Bandwidths and unwanted emissions of digital radio-relay systems".

[16] ITU-R Recommendation F 746-3: "Radio-frequency channel arrangements for radio-relay systems".

[17] EN 61000-3-2 (1995): "Electromagnetic compatibility (EMC) - Part 3: Limits - Section 2: Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)".

[18] EN 61000-3-3 (1995): "Electromagnetic compatibility (EMC) - Part 3: Limits - Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current up to and including 16 A".

[19] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

3 Definitions and abbreviations

3.1 Definitions

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

ancillary equipment: equipment used in connection with a radio communications equipment is considered as an ancillary equipment if:

- the equipment is intended for use in conjunction with a radio communications equipment to provide additional operational and/or control features, for example 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 radio communications equipment; and
- the radio communications equipment 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).

channel separation: according to ITU-R Recommendation F.1191-1 [20], the CHannel Separation (CHS) is taken as *XS*/2 for alternated frequency channel arrangements and *XS* for co-channel and interleaved frequency channel arrangements as defined by ITU-R Recommendation F.746-3 [21], *XS* is the radio-frequency separation between the centre frequencies of adjacent radio-frequency channels on the same polarization and in the same direction of transmission.

continuous phenomena: electromagnetic disturbance the effects of which on a particular device or equipment cannot be resolved into a succession of distinct effects (IEC 60050-161 [11]).

fixed equipment: equipment intended for installation in a fixed position.

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

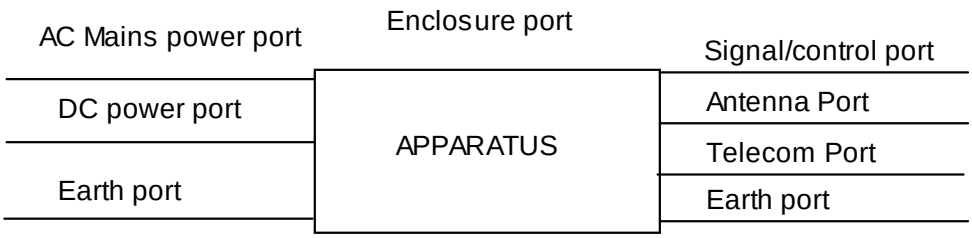


Figure 1: Examples of ports

necessary bandwidth: for digital radio-relay systems the necessary bandwidth is to be considered to have the same value as the occupied bandwidth as defined in (ITU-R Recommendation F 1191-1 [15], subclause 2.2). For application to multi-channel or multi-carrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the necessary bandwidth is taken to be the transmitter or transponder bandwidth.

occupied bandwidth: the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage $\beta/2$ of the total mean power of a given emission. For digital radio-relay systems the value of percentage $\beta/2$ should be taken as 0,5 % (ITU-R Recommendation F 1191-1 [15], subclause 2.1).

telecommunications port: a port intended for direct connection to a telecommunications network.

product standard: functional standard describing frequency management parameters of radio product.

radio communications equipment: telecommunications equipment which includes one or more radio transmitters and/or receivers and/or parts thereof for use in a fixed, mobile or portable application. It can be operated with ancillary equipment but if so, is not dependent on it for basic functionality.

spurios emission: emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out of-band emissions (ITU-T Radio Regulations [13]).

operating frequency range: the range(s) of radio frequencies covered by the Equipment Under Test (EUT) without any change of units.

enclosure port: the physical boundary of the equipment onto which an electromagnetic phenomenon may radiate or impinge. In the case of integral antenna equipment, this port is inseparable from the antenna port.

continuous phenomena (continuous disturbance): electromagnetic disturbance, the effects of which on a particular device or equipment cannot be resolved into a succession of distinct effects (IEC 60050-161 [11]).

transient phenomena: pertaining to or designating a phenomena or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest (IEC 60050-161 [11]).

3.2 Abbreviations

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

AC	Alternating Current
AM	Amplitude Modulation
BER	Bit Error Ratio
CCS	Centarl Controller station
CHS	Channel Separation
CRS	Central Radio Station
CW	Carrier Wave
DC	Direct Current
DRRS	Digital Radio relay Systems
EM	Electromagnetic
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
LISN	Line Impedance Stabilizing Network
RF	Radio Frequency
rms	root mean square
RS	Repeater Stations
TS	Terminal Stations

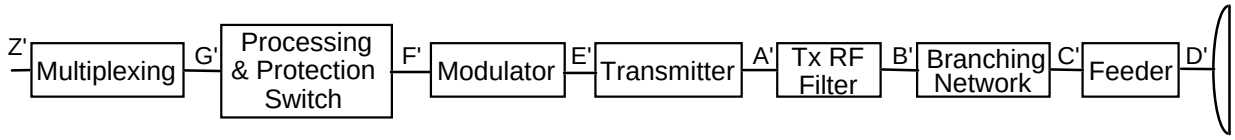
4 General test conditions

This clause defines the general test configuration and is relevant to clauses 8 and 9.

4.1 Test conditions and configurations

This subclause defines the test conditions and configurations for the emission and immunity tests as follows:

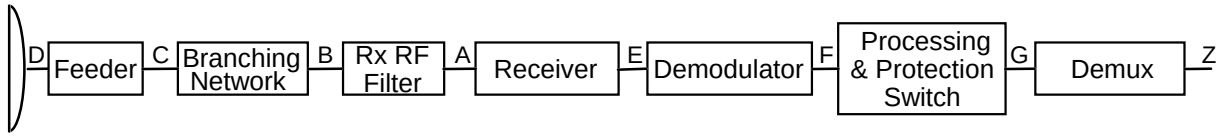
- a transmitter shall, as a minimum, comprise the element between E' and A' of figure 2. Additionally the transmitter may comprise any of the other elements from the transmitter chain shown in figure 2. If these additional elements are part of the transmitter or system they shall also meet the requirements of the present document;



NOTE 1: For the purposes of defining the reference points, the branching network (B' to C') does not include a hybrid.
NOTE 2: Points B' and C' may coincide, dependent on the equipment configuration.

Figure 2: Elements of a transmitter

- a receiver shall, as a minimum, comprise the element between A and E of figure 3. Additionally the receiver may comprise any of the other elements from the receiver chain shown in figure 3. If these additional elements are part of the receiver or system they shall also meet the requirements of the present document;



NOTE 1: For the purposes of defining the reference points, the branching network (B to C) does not include a hybrid.
NOTE 2: Points B and C may coincide, dependent on the equipment configuration.

Figure 3: Elements of a receiver

- a transceiver shall comprise as a minimum the elements E' to A' and A to E shown in figures 1 and 2, and additionally it may comprise any combinations of the other elements. If these additional elements are part of the transceiver they shall also meet the requirements of the present document;

- 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 to normal intended use as possible;

- 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, Radio Frequency (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 actual operation conditions and to ensure that all the 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 Electromagnetic Compatibility (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 test conditions, test configuration and mode of operation shall be recorded in the test report.

4.1.1 Emission tests

This subclause defines the test conditions and configurations for the emission tests as follows:

- the measurement shall be made in the operation mode producing the largest emission in the frequency band being investigated consistent with normal applications;

- for Point to Multipoint systems the minimum configuration shall comprise of the Central Station and a minimum of one Terminal Station. These stations are normally tested separately. See annex B for definition of Central Station and Terminal Station;

- an attempt shall be made to maximize the detected radiated emission for example by moving the cables of the equipment.

4.1.2 Immunity tests

This subclause defines the test conditions and configurations for the immunity tests as follows:

- the test configuration shall for transmitters be in accordance with the principle of one of the figures 4, 6 or 7 and for receivers it shall be in accordance with the principle of one of the figures 5, 6 or 7;

- the measuring equipment shall be located outside the test environment. Adequate measures shall be taken to avoid any effects of the unwanted signals on the measuring equipment.

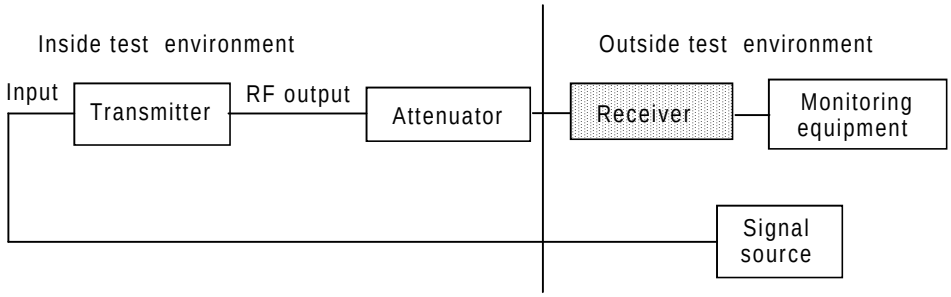


Figure 4: Test configuration for transmitters

During immunity tests the transmitter shall be operated at its rated output power. The input to the transmitter shall be in accordance with subclause 4.1.2.1 (see figure 4). A communication link shall be established at the start of the test and be maintained during the test.

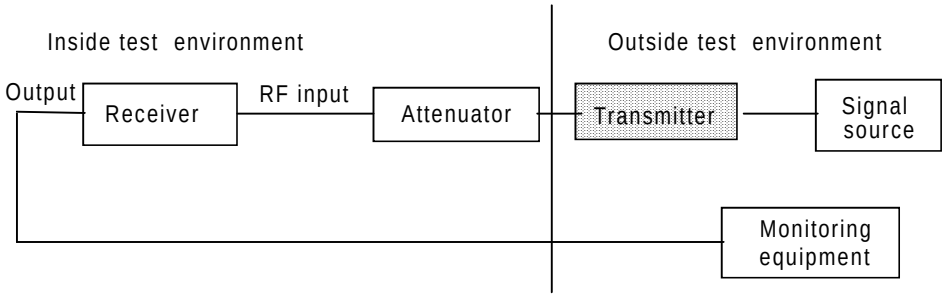


Figure 5: Test configuration for receivers

During immunity tests for receivers, the wanted RF input signal, coupled to the receiver, shall be in accordance with subclause 4.1.2.3 (see figure 5). A communication link shall be established at the start of the test and be maintained during the test.

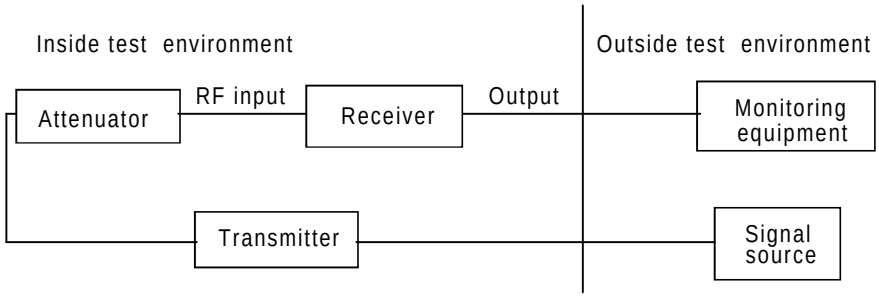


Figure 6: Test configuration of transceiver, operating on the same Rx and Tx frequency

If the transmitter and receiver in the equipment under test can operate on the same radio frequency, the transmitter with an input as in subclause 4.1.2.1 with its RF output suitably attenuated may be used to constitute the wanted RF input

signal to the receiver (see figure 6). A communication link shall be established at the start of the test and be maintained during the test.

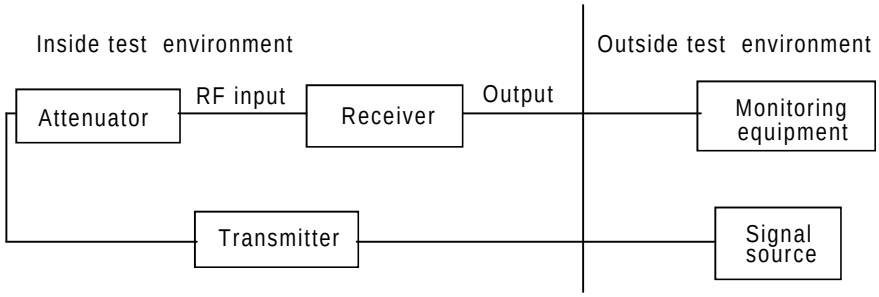


Figure 7: Test configuration of transceiver, operating on different RX and TX frequencies

In the case of duplex transceivers where the transmitter and receiver cannot operate at the same radio frequency, the wanted input signal, coupled to the receiver, shall be in accordance subclause 4.1.2.1. The transmitter shall be operated at its rated output power, and with its input coupled to the output of the receiver (repeater mode) (see figure 7). A communication link shall be established at the start of the test and be maintained during the test.

The measurement shall be made in the mode of operation as required in this subclause.

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.

For Point to Multipoint systems the minimum configuration shall comprise of the Central Station and a minimum of two Terminal Station.

A communication link shall be established at the start of the test and maintained during the test between:

- the Central Station and a Terminal Station;
- one Terminal Station and another Terminal Station.

These stations are normally tested separately.

4.1.2.1 Arrangements for test signals at the input of the transmitter

The input of the transmitter shall be coupled via the normal input connector to the signal source shown in figures 4 to 7.

The wanted signal(s) shall be (a) representative baseband input signal(s) corresponding to normal operation.

4.1.2.2 Arrangements for test signals at the output of the transmitter

To establish a communication link the wanted output signal shall be delivered from the transmitter RF output via suitable attenuation through a coaxial cable or wave guide. Adequate measures shall be taken to minimize the effects of unwanted currents on the external conductor of the coaxial cable or wave guide at the point of entry to the EUT. Mismatch errors may be avoided by placing the attenuators close to the EUT.

If the transmitter RF output cannot be recovered via connection another antenna of the same type may be used to retrieve the wanted output signal from the transmitter.

4.1.2.3 Arrangements for test signals at the input of the receiver

The wanted signal shall be a representative modulated RF input signal corresponding to normal operation.

To establish a communication link the wanted input signal shall be applied to the RF input of the receiver via a coaxial cable or wave guide. Adequate measures shall be taken to minimize the effects of unwanted currents on the external conductor of the coaxial cable or wave guide at the point of entry to the EUT. Mismatch errors may be avoided by placing the attenuators close to the EUT.

If the receiver RF input cannot be applied via connection another antenna of the same type may be used to apply the wanted input signal to the receiver. The source of the wanted input signal shall be located outside of the test environment.

For digital equipment, including point to multipoint equipment, the input signal level shall be at a nominal value of 15 dB above the receiver input level for a Bit Error Ratio (BER) of 1×10^{-5}.

The input signal level for analogue equipment shall be set to 15 dB above the input signal level that produce the reference signal to noise ratio. If the reference signal to noise ratio is not specified in the appropriate product standard, the level specified by the manufacturer shall be used.

These levels are close to normal operation and sufficient to avoid the broad band noise from the power amplifiers, which generate the disturbing EM phenomena, from influencing the measurement.

4.1.2.4 Arrangements for test signals at the output of the receiver

The output of the receiver shall be coupled via the normal output connectors. The test equipment for evaluating the performance of the equipment shall be located outside the test environment.

4.2 Exclusion bands

Frequencies on which radio communications equipment is intended to operate are generally excluded from immunity tests with either conducted or radiated RF test signals. Frequencies on which transmitters are intended to operate, also out-of-band emission frequencies, are additionally excluded from EMC emission measurements.

There shall be no frequency exclusion band applied to EMC emission measurements of receivers, or ancillaries.

4.2.1 Transmitter exclusion bands for EMC emission measurements

Exclusion bands shall not be applied when measuring transmitters in standby mode.

For the purpose of this present document the exclusion band shall extend over the frequencies above and below the fundamental transmitting frequency but separated from the centre frequency of the emission by 250 % of the relevant Channel Separation (CHS) of the radio-frequency channel arrangement where the system is to be placed; in the case when the CHS is not defined the exclusion band shall extend over the frequencies above and below the fundamental transmitting frequency but separated from the centre frequency of the emission by 250 % of the necessary bandwidth.

4.2.2 Transmitter exclusion bands for immunity testing

The exclusion band extends over the frequencies above and below the fundamental transmitting frequency but separated from the centre frequency of the emission by 250 % of the relevant CHS.

4.2.3 Receiver exclusion bands for immunity testing

The exclusion band is the relevant operating frequency band, extended at each end by ± 5 % of the centre frequency.

5 Performance assessment

5.1 General

The manufacturer shall at the time of submission of the equipment for test, supply the following information to be recorded in the test report:

- the primary functions of the radio equipment to be tested during and after the EMC testing;
- the intended functions of the radio equipment which shall be in accordance with the documentation accompanying the equipment;

- the ancillary equipment to be combined with the radio equipment for testing (where applicable);
- 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 after EMC stress;
- an exhaustive list of ports, classified as either power or signal/control. Power ports shall further be classified as ac or dc power;
- the environment(s) in which the equipment is intended to be used This declaration shall be as indicated in the user instructions.

5.2 Equipment which can provide a communications link

The test arrangement and signals given in clause 4 apply to radio equipment or a combination of a radio equipment and ancillary equipment which permits the establishment of a communications link.

5.3 Equipment which does not provide a communications link

If the equipment is of a specialized nature (see clause 6) which does not permit a communications link to be established, such as protection switching equipment, or ancillary equipment tested in isolation, (i.e. not connected to radio equipment), the manufacturer shall define the method of test to determine the acceptable level of performance or degradation of performance during and/or after the test. The manufacturer shall provide the method of observing the degradation of performance of the equipment.

The performance assessment carried out shall be simple, but at the same time give adequate proof that the primary functions of the equipment are operational.

5.4 Ancillary equipment

At the manufacturers discretion an ancillary equipment may be:

- declared compliant separately (in isolation) from a receiver, transmitter or transceiver to all the applicable immunity and emission clauses of the present document;
- declared compliant to another appropriate harmonized EMC standard;
- tested with it connected to a receiver, transmitter or transceiver in which case compliance shall be demonstrated to the appropriate clauses of the present document.

In each case, compliance enables the ancillary equipment to be used with different receivers, transmitters or transceivers.

6 Performance criteria for immunity tests

The general performance criteria apply for those ports for which no specific performance criteria are defined in the present document.

For ancillary equipment the pass/fail criteria supplied by the manufacturer shall apply, unless the ancillary is tested in connection with receivers, transmitters or transceivers in which case the corresponding performance criteria above shall apply.

6.1 General performance criterion A (continuous phenomena)

The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The communication link shall be maintained during and after the test.

6.2 General performance criterion B (transient phenomena)

The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. During the exposure to an electromagnetic phenomenon, degradation of performance is, however, allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.

The communication link shall be maintained after the test.

6.3 General performance criterion C (interruptions)

As defined in clause 6 of EN 50082-1 [2]: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

6.4 Specific performance criteria

6.4.1 Digital signal ports

The performance of the equipment shall be verified for digital signal ports:

- by measuring the number of induced bit errors on the main signal port during all exposures;
- by testing the functionality of the main signal port and the other signal ports after the exposure;
- by verifying that corruption of software and data held in memory has not occurred.

6.4.1.1 Performance criterion A (continuous phenomena)

- For equipment intended for transport applications for which a harmonized grade of service is specified as in ITU-T Recommendations G.826 [19].

  The number of bit errors at the end of each individual exposure shall be zero.

  To allow for background errors which may occur at any time, the test can be repeated up to three times to determine any correlation between eventual errors and the EMC phenomena.

  The equipment will pass the test if:

  - first test - no errors; or
  - first test - errors, second test - no errors; or
  - first test - errors, second test - errors, third test - no errors.

- For equipment intended for applications for which no harmonized grade of service is specified.

  The number of bit errors at the end of each individual exposure shall not exceed the maximum number of errors stated by the manufacturer for intended operation.

  The number of errors is calculated as:

  (the maximum bit error ratio specified by the manufacturer) × (bit rate) × (test time).

  The test time is taken to be the dwell time at each frequency of the exposure.

6.4.1.2 Performance criterion B (transient phenomena)

- For equipment intended for transport applications for which a harmonized grade of service is specified as in ITU-T Recommendations G.826 [19].

  The number of bit errors at the end of each individual exposure shall be zero.

  To allow for background errors which may occur at any time, the test can be repeated up to three times to determine any correlation between eventual errors and the EMC phenomena.

  The equipment will pass the test if:

  - first test - no errors; or
  - **first test - errors, second test - no errors;** or
  - first test - errors, second test - errors, third test - no errors.

- For equipment intended for applications for which no harmonized grade of service is specified.

  Loss of frame alignment or loss of synchronization is not allowed during each individual exposure. No alarms shall be generated as a result of the electromagnetic stress.

  The above does not apply to surge testing where some loss of frame alignment may be expected. For this test, the EUT shall operate as intended following the cessation of the exposure.

6.4.1.3 Performance criterion C (interruptions)

The general performance criteria C apply.

6.4.2 Analogue voice frequency signal ports

The performance of the equipment shall be verified for analogue voice frequency signal ports:

- by measuring the audio signal break-through (demodulated 1 KHz) on the signal port during continuous exposures in both signal path directions covering both analogue to digital conversion and digital to analogue conversion;
- by testing the functionality of the main signal port and the other signal ports after the transient exposures;
- by verifying that corruption of software and data held in memory has not occurred.

6.4.2.1 Performance criterion A (continuous phenomena)

- The noise signal level received from the EUT measured in an impedance of 600 Ω shall not be greater than -40 dBm.

6.4.2.2 Performance criterion B (transient phenomena)

- The EUT shall return automatically to normal performance after the cessation of the exposure.

6.4.3 Ethernet and packet-data interfaces

To interfaces operating in packet mode the criteria below apply.

6.4.3.1 Performance criterion A (continuous phenomena)

For interfaces which are intended for the transmission of third party data traffic, a selected port shall be connected to test equipment (e.g. a data communications analyser) as a single point-to-point data link. This will avoid excessive failed transmission attempts caused by data collisions and bus contention problems.

The interface shall be suitably exercised and monitored throughout the test period for errored frames.

No more than 5 % additional errored frames above the quiescent level shall be permitted during the exposure.

6.4.3.2 Performance criterion B (transient phenomena)

The data link connection shall be maintained.

6.4.4 Service and maintenance interfaces

The functional performance of ports of this type not intended to be permanently connected and therefore not subjected to immunity testing shall be verified according to the manufacturer's specification following cessation of the electromagnetic exposure on other ports.

6.4.5 Synchronization interfaces

The performance of slave clock ports shall be checked with the equipment synchronized with an external source.

6.4.5.1 Performance criterion A (continuous phenomena)

During the exposure, synchronization shall not be lost.

6.4.5.2 Performance criteria B (transient phenomena)

No alarm indications shall persist after the exposure.

The functional performance according to the manufacturer's specification shall be verified following cessation of the exposure.

6.4.6 Remote alarm interfaces

These interfaces are defined by the manufacturer.

6.4.6.1 Performance criterion A (continuous phenomena)

No false alarms shall occur during continuous exposures.

6.4.6.2 Performance criterion B (transient phenomena)

No false alarm indications shall persist after the exposure.

7 Applicability overview tables

7.1 Emission

Table 1

Application	Equipment test requirement Fixed links & ancillary for fixed use	Reference subclause in the present document	Reference document
Enclosure port ancillary	applicable	8.1	EN 55022 [3]
Enclosure port radio	applicable	8.1 note 1	EN 55022 [3]
DC power input/output port	applicable	8.2	EN 55022 [3] CISPR 16-1 [4]
AC mains power input/output port	applicable	8.3	EN 55022 [3]
Antenna port	applicable	8.4 notes 1 and 2	EN 301 126-1 [14]
NOTE 1: Exclusion band for transmitter apply see subclause 4.2.1. NOTE 2: Applicable if not specified in the relevant product standard.			

7.2 Immunity

Table 2

Phenomena	Application	Equipment test requirement Fixed links & ancillary for fixed use	Reference clause in this EN	Reference document
RF electromagnetic field 80 to 1 000 MHz	Enclosure port	applicable note 1	9.1	EN 61000-4-3 [5]
Electrostatic discharge	Enclosure port	applicable	9.2	EN 61000-4-2 [6]
Fast transients common mode	Signal & control ports, dc & ac power input ports	applicable	9.3	EN 61000-4-4 [7]
RF common mode 0,15 to 80 MHz	Signal & control ports, dc & ac power input ports	applicable	9.4	EN 61000-4-6 [8]
Voltage dips and interruptions	AC mains power input ports	applicable	9.5	EN 61000-4-11 [9]
Surges common and differential. Mode	Signal & AC mains power input ports	applicable note 2	9.6	EN 61000-4-5 [10]
NOTE 1: Exclusion band apply see 4.2.2 and 4.2.3. NOTE 2: Applicable to AC mains power input ports and signal ports intended to be connected to extensive telecommunications networks.				

8 Test methods and limits for emission tests

8.1 Enclosure port

This test is applicable to radio equipment and ancillary equipment.

Exclusion band shall apply when testing the radio enclosure.

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

8.1.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to limit spurious emissions from the enclosure.

8.1.2 Test method

The test method for spurious emissions from the enclosure shall be in accordance with EN 55022 [3].

8.1.3 Limits

The value of the limits from EN 55022 [3] (see table 3) shall be used. However, the limits in table 4 may be used for equipment in telecommunications centres, ETS 300 386-1 [12], annex B).

Table 3: Limits for unwanted emissions at a measuring distance of 10m

Frequency range	Limit (quasi-peak)
30 to 230 MHz	30 dBµV/m
> 230 to 1 000 MHz	37 dBµV/m

Table 4: Limits for unwanted emissions at a measuring distance of 10m applied in telecommunication centres

Frequency range	Limit (quasi-peak)
30 to 230 MHz	40 dBµV/m
> 230 to 1 000 MHz	47 dBµV/m

8.2 DC power input/output port

This test is applicable to equipment which may have dc cables longer than 3 m.

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

8.2.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to limit their internal noise from the dc power input/output ports.

8.2.2 Test method

The test method shall be in accordance with EN 55022 [3] and the Line Impedance Stabilizing Network (LISN) shall be connected to a dc power source.

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 measurement shall be terminated with a 50 Ω load.

The equipment shall be installed with a ground plane as defined in EN 55022 [3], subclause 9.1.1. 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 one of CISPR 16-1 [4].

8.2.3 Limits

The equipment shall meet the limits below (including the average limit and the quasi-peak limit) when using, respectively, an average detector receiver and a quasi-peak detector receiver and measured in accordance with the method described in subclause 8.2.2 above. If the average limit is met when using a quasi-peak detector, the equipment shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

The following limits shall apply:

Table 5: limits of conducted emissions

Frequency range	Quasi-peak	Average
> 0,15 to 0,5 MHz	79 dBµV	66 dBµV
> 0,5 to 30 MHz	73 dBµV	60 dBµV

Additionally the limits in table 6 shall apply for telecommunication centres (ETS 300 386-1 [12] annex B).

Table 6: limit of conducted emissions for telecommunication centres

Frequency range	Quasi-peak
0,02 to 0,15 MHz	79 dBµV

8.3 AC mains power input/output port

This test is applicable to equipment powered by the ac mains.

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

8.3.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to limit internal noise from the ac mains power input/output ports.

8.3.2 Test method

The test method shall be in accordance with EN 55022 [3].

8.3.3 Limits

The value of the limits from EN 55022 [3] (see table 7) shall be used. However, the limits in table 8 may be used for equipment in telecommunication centres (ETS 300 386-1 [12], annex B).

Table 7: Limits of conducted emission

Frequency range	Quasi-peak	Average
0,15 to 0,5 MHz	66 to 56 dBµV	56 to 46 dBµV
0,5 to 5 MHz	56 dBµV	46 dBµV
5 to 30 MHz	60 dBµV	50 dBµV
NOTE: The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz.		

Table 8: Limits of conducted emission applied in telecommunication centres

Frequency range	Quasi-peak	Average
0,15 to 0,5 MHz	79 dBµV	66 dBµV
> 0,5 to 30 MHz	73 dBµV	60 dBµV

8.4 Antenna port

This test is applicable to the antenna port of a fixed radio communication equipment.

8.4.1 Definition

This test assesses the ability of a fixed radio communication equipment to limit the levels of spurious emission conducted from its antenna port.

8.4.2 Test method

The test method shall be in accordance with EN 301 126-1 [14] subclause 5.2.9 for equipment with an antenna connector or subclause 5.2.10 for equipment with an integral antenna.

8.4.2.1 Frequency limitation for measurement

The exclusion band for transmitters, as specified in subclause 4.2.1, shall apply.

The limits of the spurious emissions for radio equipment are considered here to be applicable to the range 9 kHz to 300 GHz. However, for practical measurement purpose only, the frequency range of spurious emissions is restricted. The measurement parameters of table 9 shall apply:

Table 9: Measurement parameters

Fundamental frequency range	Spurious Frequency range	
	Lower frequency	Upper frequency
9 kHz to 100 MHz	9 kHz	1 GHz
100 MHz to 300 MHz	9 kHz	10th harmonic
300 MHz to 5,2 GHz	30 MHz	5th harmonic
5,2 GHz to 13 GHz	30 MHz	26 GHz
13 GHz to 150 GHz	30 MHz	2nd harmonic
150 GHz to 300 GHz	30 MHz	300 GHz

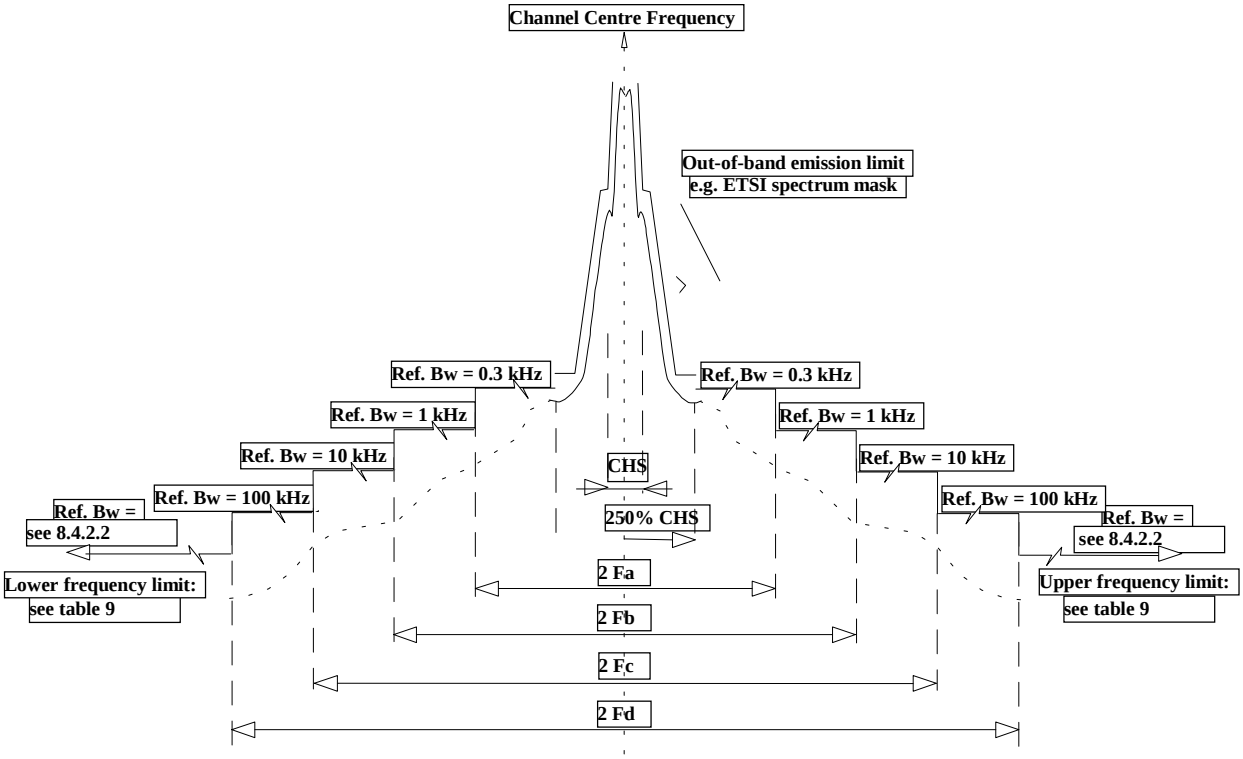
These parameters reflect the increasing difficulty in undertaking practicable tests, especially at frequencies approaching or beyond 110 GHz, taking into account such factors as availability and usability of suitable measurement equipment. In any case, systems having an integral antenna incorporating a waveguide section, or with an antenna connection in such form, and of length equal to at least twice the cut-off wavelength, should not require spurious emissions measurement below 0,7 times the waveguide cut-off frequency.

8.4.2.2 Reference bandwidth

The following measurement bandwidths shall apply:

- 1 kHz between 9 kHz and 150 kHz;
- 10 kHz between 150 kHz and 30 MHz;
- 100 kHz between 30 MHz and 1 GHz;
- 1 MHz above 1 GHz.

For digital systems it is necessary to provide one or more steps of reference bandwidth to produce suitable transition area for the spectral density to manage the required limit because in some frequency bands and/or applications narrow band RF filters are not technically or economically feasible. Consequently, just outside the ± 250 % of the relevant Channel Separation, the limit of spurious emissions are defined with reference bandwidths as detailed by the generic figure 8 and the related table 10.



NOTE: ± Fd frequency steps are not applicable if channel centre frequency +Fd is lower than 1 GHz;
± Fc frequency steps are not applicable if channel centre frequency +Fc is lower than 30 MHz;
± Fb frequency steps are not applicable if channel centre frequency +Fb is lower than 150 kHz.
The breakpoints are defined from the carrier centre frequency.

Figure 8: Spurious emission limit mask (In reference to table 10)

Table 10

VALUES OF Fa, Fb, Fc AND Fd						
Fundamental Emission Frequency	**Channel Separation (CHS) (MHz)**	**Typical Symbol Frequency (~Mbit/s)**	**Ref. BW 0,3 kHz**	**Ref. BW 1 kHz**	**Ref. BW 10 kHz**	**Ref. BW 100 kHz**
			Fa (note) (MHz)	**Fb (note) (MHz)**	**Fc (note) (MHz)**	**Fd (note) (MHz)**
Below 21,2 GHz (Terminal stations)	0,01 ≤ CHS < 1	Fs ≅ 0,006 to 0,8	-	-	14	70
	1 ≤ CHS < 10	Fs ≅ 0,6 to 8	-	-	28	70
	CHS ≥ 10	Fs ~ > 6	-	-	49	70
Below 21,2 GHz (Other stations)	0,01 ≤ CHS < 1	Fs ≅ 0,006 to 0,8	3,5	7	14	70
	1 ≤ CHS < 10	Fs ≅ 0,6 to 8	-	14	28	70
	CHS ≥ 10	Fs ~ > 6	-	-	49	70
Above 21,2 GHz (All stations)	1 ≤ CHS < 10	Fs ≅ 0,6 to 8	-	-	-	70
	CHS ≥ 10	Fs > ~ 6	-	-	-	-
NOTE: The frequency limits are defined from the centre frequency of the emissions. For measurement purposes, the reference bandwidth of this table apply to the frequency range extending from the 250 % CHS point to the first frequency limit indicated, from Fa to Fb, from Fb to Fc, or from Fc to Fd as appropriate.						

8.4.3 Limits

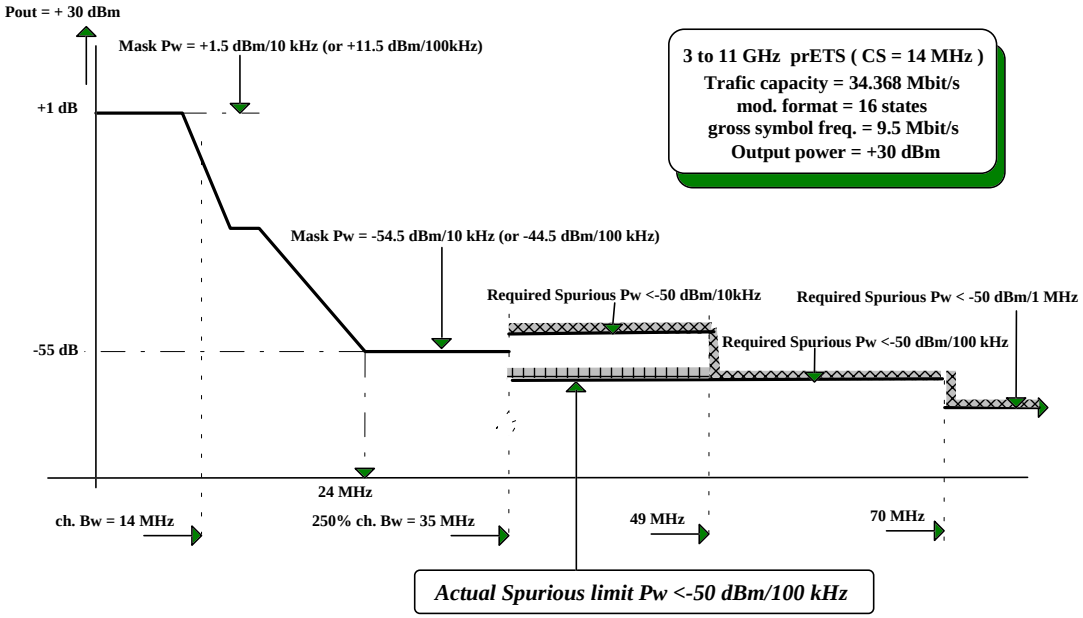
The limit values shown in table 11 shall apply.

Table: 11 Limits

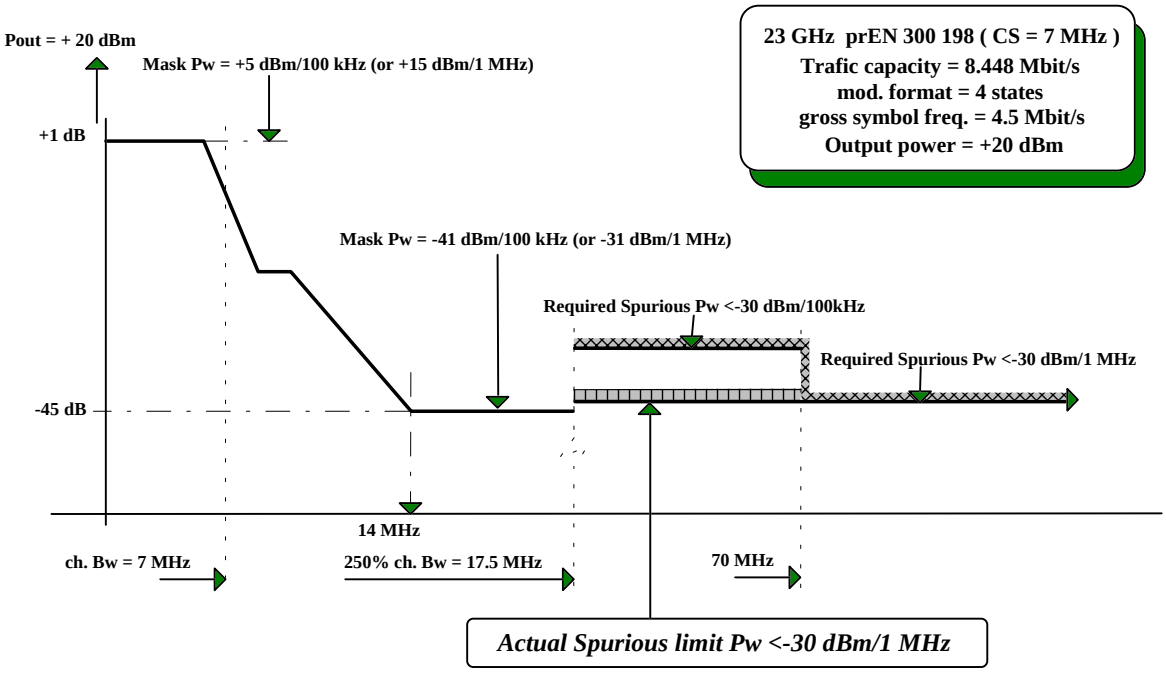
LIMIT FOR FIXED SERVICE RADIO RELAY SYSTEMS	
Type of equipment	**Limits mean power or, when applicable, average power during bursts duration in the reference bandwidth**
Fixed Service (all station except those below)	-50 dBm 9 kHz < *f* < 21,2 GHz -30 dBm 21,2 GHz < *f* (see table 9)
Fixed Service - Terminal station (Terminal Stations of Point to Multipoint systems)	-40 dBm 9 kHz < *f* < 21,2 GHz -30 dBm 21,2 GHz < *f* (see table 9)
Fixed Service – Receivers	The same limits as for the transmitters above apply

In extreme cases, typically above 26 GHz and mostly due to the use of external mixers in the test set-up, it still may not be possible to achieve enough sensitivity to verify that the EUT conforms to the specification requirement under modulated condition. In these cases, the measurement may be carried out in un-modulated (CW) conditions. The spurious emission measurement in the CW condition may be corrected for those emissions that are subject to the modulation process, by an amount equal to the modulation loss of the EUT (i.e. the difference in dB between the power output and the power measured in the reference bandwidth at centre frequency of the carrier).

It is recognized that, depending on the characteristic of the emissions, the actual power density relative to the ETSI mask at the ± 250 % boundary, when evaluated in the reference bandwidth of one or more steps of table 10, may be lower than the spurious emission limit itself. In such cases these steps are not applicable and the first applicable spurious emission reference bandwidth step which corresponds to a power density equal or lower than that evaluated with the ETSI mask in the same reference bandwidth should be extended back to the ± 250 % boundary (examples of this concept are shown in figure 9.



a) ETSI mask power density higher than -50 dBm/1 MHz



b) ETSI mask power density lower than -30 dBm/1 MHz

Figure 9: Examples of ETSI mask more stringent than the spurious emission limits in the reference BW

9 Test methods and levels for immunity tests

9.1 Radio frequency electromagnetic field (80 MHz to 1 000 MHz)

This test is applicable to radio communications equipment and ancillary equipment.

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

9.1.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the presence of a radio frequency electromagnetic field disturbance.

9.1.2 Test method and level

The test method shall be in accordance with EN61000-4-3 [5] except that the following requirements and evaluation of test results shall apply:

- the test level shall be 3 V/m unmodulated. The test signal shall then be amplitude modulated to a depth of 80 % by a sinusoidal audio signal at 1 kHz;
- the stepped frequency increments shall be 1 % of the momentary frequency;
- the test shall be performed over the frequency range 80 MHz to 1 000 MHz. Where appropriate the exclusion band defined in subclause 4.2.2 and subclause 4.2.3 shall apply;
- the test shall be carried out on one surface. The surface selected to face the source of the interference signal shall be the one anticipated by the test house to be the most susceptible;
- the frequencies selected during the test shall be recorded in the test report.

9.1.3 Performance criteria

The performance criteria for continuous phenomena of clause 6 shall apply.

9.2 Electrostatic discharge

This test is applicable to radio communications equipment and ancillary equipment.

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

9.2.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of an electrostatic discharge.

9.2.2 Test method and level

The test method shall be in accordance with EN 60000-4-2 [6].

For transmitters, receivers, transceivers and ancillary equipment the following requirements and evaluation of test results shall apply:

- for contact discharge, the equipment shall be tested at ± 2 kV and ± 4 kV; for air discharge, the equipment shall be tested at ± 2 kV, ± 4 kV and ± 8 kV (EN 61000-4-2 [6] clause 5);
- electrostatic discharges shall be applied to all exposed surfaces of the equipment except where the user documentation specifically indicates a requirement for appropriate protective measures (EN 61000-4-2 [6], subclause 8.3.1).

9.2.3 Performance criteria

The performance criteria for transient phenomena of clause 6 shall apply.

9.3 Fast transients common mode

This test is applicable to radio communications equipment and ancillary equipment.

This test shall be performed on ac mains power input ports.

This test shall be performed on signal ports, control ports and 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 included in the test report.

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

9.3.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of fast transients on one of the input/output ports.

9.3.2 Test method and level

For transmitters, receivers, transceivers and ancillary equipment, which may have longer cables than 3 m, or are connected to the ac mains, the test method shall be in accordance with EN 61000-4-4 [7] except that the following requirements and evaluation of test results shall apply:

- the test level for signal and control ports shall be 0,5 kV open circuit voltage as given in EN 61000-4-4 [7] clause 5.
- the test level for dc power input ports shall be 1 kV open circuit voltage as given in EN 61000-4-4 [7] clause 5.
- the test level for ac mains power input ports shall be 1 kV open circuit voltage as given in the table of EN 61000-4-4 [7] clause 5.

For ac and dc power input ports the transients shall be applied (in parallel) to all the wires in the cable with reference to the cabinet reference ground (true common mode) the source impedance shall be 50 Ω.

9.3.3 Performance criteria

The performance criteria for transient phenomena of clause 6 shall apply.

9.4 RF common mode, 0,15 MHz to 80 MHz

This test is applicable to radio communications equipment and ancillary equipment.

This test shall be performed on signal, control, dc power and ac mains power input ports of the equipment and ancillary equipment, 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 3 m, a list of ports which were not tested for this reason shall be included in the test report.

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

9.4.1 Definition

This test assesses the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the presence of a radio frequency electromagnetic disturbance on the input/output ports.

9.4.2 Test method and level

The test methods shall be in accordance with EN 61000-4-6 [8], except that the following requirements and evaluation of test results shall apply:

- the test shall be performed over the frequency range 150 kHz to 80 MHz;
- the stepped frequency increments shall be 50 kHz in the frequency range 150 kHz to 5 MHz and 1 % frequency increment of the momentary frequency in the frequency range 5 MHz to 80 MHz;
- the test level shall be severity level 2 as given in EN 61000-4-6 [8] corresponding to 3 V root means of squares (rms);
- the frequencies selected and the test method used during the test shall be recorded in the test report.

9.4.3 Performance criteria

The performance criteria for continuos phenomena as given in clause 6, shall apply.

9.5 Voltage dips and interruptions

These tests are applicable to radio communications equipment and ancillary equipment.

These tests shall be performed on ac mains power input ports.

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

9.5.1 Definition

These tests assesses the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of voltage dips and interruptions on the ac mains power input ports.

9.5.2 Test method and level

The test method shall be in accordance with EN 61000-4-11 [9] except that the following requirements and evaluation of test results shall apply.

The test levels shall be:

- a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms; and

- a voltage interruption corresponding to a reduction of the supply voltage of > 95 % for 5 s.

9.5.3 Performance criteria

The performance criteria B for transient phenomena as given in clause 6, shall apply for a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms.

The following performance criteria shall apply for a voltage interruption corresponding to a reduction of the supply voltage of > 95 % for 5 s:

- the performance criteria B for transient phenomena as given in clause 6, shall apply where the equipment is fitted with or connected to a battery back-up;

- where the equipment is powered solely from the ac mains supply (without parallel battery back-up) the performance criteria for transient phenomena C, as given in clause 6, shall apply.

9.6 Surges common and differential mode

These tests are applicable to radio communications equipment and ancillary equipment.

These tests shall be performed on ac mains power input ports and signal ports intended to be connected to extensive telecommunications networks.

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

9.6.1 Definition

These tests assess the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of surges on the ac mains power input ports and, where applicable, signal ports.

9.6.2 Test method and level

The test method shall be in accordance with EN 61000-4-5 [10] except that the following requirements and evaluation of test results shall apply:

- the test level for signal and control ports shall be 0,5 kV line to ground as given in EN 61000-4-5 [10]. In this case the total output impedance of the surge generator shall be 42 Ω;

- the test level for ac mains power input ports shall be 1 kV line to ground and 0,5 kV line to line with the output impedance of the surge generator as given in the EN 61000-4-5 [10];

- the test generator shall be the 1,2/50 μsec as defined in EN 61000-4-5 [10].

9.6.3 Performance criteria

The performance criteria for transient phenomena as given in clause 6, shall apply.

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

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

Clause/ subclause Number	Title	Corresponding Article of Council Directive 89/336/EEC	Qualifying Remarks
8	Test methods and limits for emission tests		
8.1	Enclosure (ancillary equipment and radio equipment)	4(a)	
8.2	DC power input/output port	4(a)	
8.3	AC mains power input/output port	4(a)	
8.4	Antenna port	4(a)	
9	Test methods and levels for immunity tests		
9.1	Radio frequency electromagnetic field (80 to 1 000 MHz)	4(b)	
9.2	Electrostatic discharge	4(b)	
9.3	Fast transients common mode	4(b)	
9.4	RF common mode, 0,15 MHz to 80 MHz	4(b)	
9.5	Voltage dips and interruptions	4(b)	
9.6	Surges common and differential mode	4(b)	

Annex B (informative): Point to Multipoint fixed radio links general system architecture

A system could consist of physical sub-systems as follows (see figure B.1):

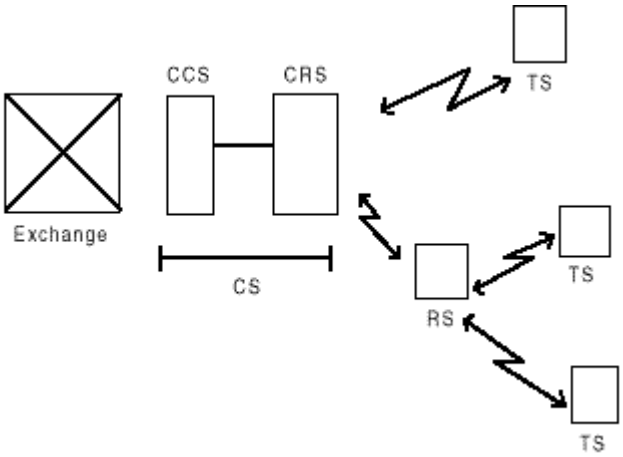


Figure B.1: General system architecture

CS: Central Station which can be subdivided into two units:

- the exchange unit, also called Central Controller Station (CCS) - (interface to the local switch); and
- the radio unit, also called Central Radio Station (CRS) - (central base band/radio transceiver).

TS: Terminal station (outstations with subscriber interfaces).

RS: Repeater Station (radio repeater outstations with or without subscriber interfaces).

The central station performs the interconnection with the local switching exchange, carrying out a concentration function by sharing the total number of available channels in the system. The central station is linked to all remote stations (Repeater Stations (RS) or Terminal Stations (TS)) by radio transmission paths.

Whenever an existing digital transmission link is available, the network implementation can be optimized by separating the CCS installed at the exchange site and the CRS.

Terminal stations are situated as close as possible to the "centre of gravity" of the subscriber locations.

They interface directly with the subscriber loops.

History

Document history			
Edition 1	February 1996	Publication as ETS 300 385	
V1.2.1	December 1998	Public Enquiry	PE 9915: 1998-12-11 to 1999-04-09