EUROPEAN TELECOMMUNICATION STANDARD

DRAFT
pr **ETS 300 741**
August 1997

Source: ETSI TC-ERM

Reference: DE/ERM-EMC011

formerly: DE/RES-09011

ICS: 33.020

Key words: EMC, paging, radio

Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for wide-area paging equipment

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Contents

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Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Electromagnetic compatibility and Radio spectrum Matters (ERM) Technical Committee of the European Telecommunications Institute (ETSI), and is now submitted for the One-step Approval Procedure of the ETSI standards approval procedure.

This ETS has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 83/189/EEC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

For equipment within the scope of ETS 300 719-1 [15], this ETS, together with ETS 300 719-1 [15], 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 other equipment, this ETS 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).

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

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

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1 Scope

This European Telecommunication Standard (ETS) covers the assessment of wide-area paging equipment and ancillary equipment, in respect of ElectroMagnetic Compatibility (EMC). Technical specifications related to the antenna port and emissions from the enclosure port of the wide-area paging equipment are not included in this ETS.

This ETS does not cover ERMES paging receiver equipment.

This ETS specifies the applicable EMC tests, the method of measurements, the limits and the minimum performance criteria for wide-area paging equipment.

The environment classification used in this ETS refers to the environment classification used in EN 50081-1 [1], EN 50082-1 [2].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus at residential, commercial and light industrial environments. The levels, however, do not cover extreme cases which may occur in any location but with 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 wide-area paging equipment to the requirements of this ETS, does not signify compliance to any requirements related to spectrum management or any requirement related to the use of the equipment (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 recorded in the test report.

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.

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

[5] CISPR 16-1 (1993): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".

[6] EN 61000-4-3 (1995): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test".

[7] EN 61000-4-2 (1995): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication".

[8] EN 61000-4-4 (1995): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication".

[9] EN 61000-4-6 (1993): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields".

[10] ISO 7637-1 (1990): "Road vehicles - Electrical disturbance by conduction and coupling - Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage - Electrical transient conduction along supply lines only".

[11] ISO 7637-2 (1990): "Road vehicles - Electrical disturbance by conduction and coupling - Part 2: Commercial vehicles with nominal 24 V supply voltage - Electrical transient conduction along supply lines only".

[12] EN 61000-4-11 (1994): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests".

[13] EN 61000-4-5 (1995): "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity test".

[14] ETR 027 (1991): "Radio Equipment and Systems; Methods of measurement for private mobile radio equipment

[15] ETS 300 719-1 (1997): " Radio Equipment and Systems (RES); Private wide area paging service; Part 1: Technical characteristics for private wide-area paging systems".

3 Definitions and abbreviations

3.1 Definitions

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

alignment range: For the purpose of defining the exclusion bands (see subclause 4.7), the alignment range of the wide-area paging equipment is defined as the frequency range over which the receiver or transmitter can be programmed and/or re-aligned to operate without any physical change of components other than programmable read only memories or crystals.

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

- if the equipment is intended for use in conjunction with a receiver or transmitter to provide additional operational and/or control features to the wide-area paging equipment, (e.g. to extend control to another position or location); and

- if the equipment cannot be used on a stand alone basis to provide user functions independently of a receiver or transmitter; and

- if the receiver or transmitter 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 basic functions).

calling function: Transmission of a message via the base transmitter to the pocket receiver in order to alert and/or inform the carrier of the pocket receiver.

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

manufacturer: The legal entity responsible under the terms of the Council Directive 89/336/EEC [3], for placing the product on the market.

mobile equipment: A pocket receiver capable of being powered by the main battery of a vehicle for intended use.

port: A particular interface, of the specified equipment (apparatus), with the electromagnetic environment (see figure 1).

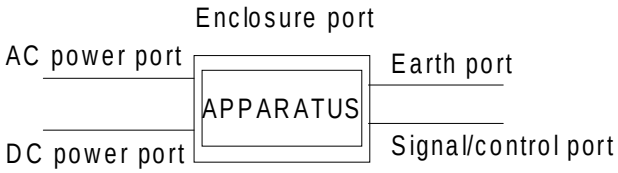


Figure 1

pocket receiver: A stand alone pocket paging receiver.

spot frequency test: A part of the radio-frequency electromagnetic field immunity test (see subclause 9.2.2) which assess the ability of the wide-area paging equipment to transmit and/or receive messages in the presence of radio-frequency electromagnetic field disturbances of defined discrete frequencies.

standby mode (receiver): A mode of operation in which the receiver is capable of receiving calls.

standby mode (transmitter): A mode of operation in which the transmitter is ready to transmit, waiting for a start control signal to actual start transmitting.

wide-area paging equipment: A pocket receiver, a base transmitter or ancillary equipment.

3.2 Abbreviations

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

AC	Alternating Current
CR	Continuous phenomena applied to Receivers
CT	Continuous phenomena applied to Transmitters
DC	Direct Current
EMC	ElectroMagnetic Compatibility
erp	effective radiated power
IF	Intermediate Frequency
LISN	Line Impedance Stabilizing Networks
p.d.	potential difference
RF	Radio Frequency
rms	root mean square
TR	Transient phenomena applied to Receivers
TT	Transient phenomena applied to Transmitters
VSWR	Voltage Standing Wave Ratio

4 Test conditions

4.1 General

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. The test conditions shall be recorded in the test report.

The test configuration and mode of operation shall be as close to normal intended use as possible and shall be recorded in the test report.

For immunity tests the test modulation, test arrangements etc., as specified in this ETS in subclauses 4.2 to 4.8 shall apply and the conditions shall be as follows:

- the base transmitter shall operate in the standby mode, except for the radio frequency immunity test (see subclause 9.2) where the transmitter shall be tested additionally at its maximum rated output power, modulated with normal test modulation (see subclause 4.2);

- for pocket receivers, the message memory of the receiver memory shall be loaded with recognisable messages. The receiver shall operate in the standby mode, except for the spot frequency test of the radio frequency immunity test (see subclause 9.2) where repetitive calls shall be coupled to the input of the receiver.

4.2 Normal test modulation

The test modulation signal to be used for the calling function shall represent selective messages and maybe generated by a signal generator or encoded within the equipment. The signal generator used should be a test signal generator supplied by the manufacturer and capable of generating repetitive calls.

4.3 Arrangements for test signals at the input of the base transmitter

The signal generator to be used for the normal test modulation (see subclause 4.2) shall be located outside the test environment and connected to the modulation input port of the transmitter. Adequate measures shall be taken to protect the measuring equipment from the effect of all of the radiated fields within the test environment.

4.4 Arrangements for test signals at the output of the base transmitter

The output signal shall be delivered from the RF antenna connector by a shielded transmission line, such as a coaxial cable, to the receiving/measuring equipment outside of the test environment.

Adequate measures shall be taken to avoid the effect of unwanted signals on the measuring equipment.

For the spot frequency test of the radio frequency immunity test (see subclause 9.2) repetitive calls shall be transmitted and coupled to the input of the measuring equipment located outside the test environment. The measuring equipment should be a paging receiver.

4.5 Arrangements for test signals at the input of the pocket receiver

The manufacturer shall at the time of submitting the equipment for testing, supply, if necessary, a test fixture and a message generator to generate the wanted input signal.

The source of the wanted input signal, modulated with normal test modulation (see subclause 4.2), shall be located outside the test environment. The signal level used shall be chosen to a value significantly above the threshold sensitivity but below the overload characteristics of the receiver (the signal level should be 60 dB above the threshold sensitivity, if possible). Adequate measures shall be taken to protect the measuring equipment from the effect of all the radiated fields within the test environment.

Where the receiver incorporates an RF antenna connector, the RF signal source shall be coupled to the input of the receiver via a shielded transmission line such as a coaxial cable.

Where the receiver does not incorporate a RF connector, the RF signal source shall be presented to the receiver from another antenna located within the test environment. This antenna shall be coupled to the RF signal source via an adjustable attenuator.

4.6 Arrangements for test signals at the output of the pocket receiver

From the performance check before and after the test it shall be possible to assess the performance of the pocket receiver from the presented messages and/or the call received alert signal(s) of the receiver.

During the spot frequency test of the radio frequency immunity test (see subclause 9.2) the call received alert signal output of the receiver shall be coupled to the outside of the test environment and it shall be possible to assess the performance of the equipment from the call received alert signal(s) of the receiver.

4.7 Exclusion bands

Exclusion bands are determined frequency bands for which the wide-area paging equipment is excluded from RF immunity tests.

4.7.1 Exclusion bands for receivers.

The exclusion band for receivers is the frequency range determined by the alignment range, as declared by the manufacturer, extended as follows:

- for receivers operating in the frequency band of 25 MHz to 80 MHz, the lower frequency of the exclusion band is the lower frequency of the alignment range minus 10 % of the centre frequency of the alignment range or minus 5 MHz, whichever results in the lowest frequency, and the upper frequency of the exclusion band is the upper frequency of the alignment range plus 10 % of the centre frequency of the alignment range or plus 5 MHz whichever results in the higher frequency;

- for receivers operating above 80 MHz, the lower frequency of the exclusion band is the lower frequency of the alignment range minus 5 % of the centre frequency of the alignment range or 10 MHz, whichever results in the lower frequency, and the upper frequency of the exclusion band is the upper frequency of the alignment range plus 5 % of the centre frequency of the alignment range or plus 10 MHz, whichever is greater.

4.7.2 Exclusion band for transmitters

For transmitters operating, or intended to operate, in a channelised frequency band, the exclusion band is three times the channel separation, centred around the nominal operating frequency.

4.8 Narrow band responses on receivers

No immunity tests shall be carried out on frequencies of identified unwanted narrowband responses (spurious responses) of the receiver. These narrowband responses (spurious responses) are identified by the following method.

If during the test the unwanted signal causes a non-acceptable degradation in performance (see subclause 6.3), it is necessary to establish whether this is due to a narrow band response or to a wideband phenomenon. Therefore, the unwanted signal frequency is increased by an amount equal to twice the nominal bandwidth of the receiver pre-demodulation filter, as declared by the manufacturer. The test is repeated with the frequency of the unwanted signal decreased by the same amount.

If the degradation in performance becomes acceptable again (see subclause 6.3), then the response is considered to be a narrow band response.

If the degradation in performance is still not acceptable, 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 procedure is repeated with the increase and decrease of the frequency of the unwanted signal adjusted two and a half times the bandwidth previously referred to. If the degradation in performance remains non acceptable (see subclause 6.3), the phenomenon is considered wide band and therefore an EMC problem and the equipment fails the test.

5 Performance assessment

5.1 General

Each type of equipment shall fulfil the requirements of this ETS on all frequencies over which it is intended to operate. However, the tests shall be performed on one sample for each intended operating band.

The manufacturer shall at the time of submission of the equipment for test, supply information about ancillary equipment intended to be used with the wide-area paging equipment.

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

- 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 AC power, DC power or signal/control including the maximum allowed length of cable connected thereto;

- the bandwidth of the IF filter immediately preceding the demodulator;

- the operating bands over which the equipment is intended to operate;

- the alignment range of the paging receiver;

- the optional features (versions) of the equipment and the actual version of the equipment that is (which are) submitted for test.

5.2 Standard paging equipment

If the equipment is wide-area paging equipment of a non-specialized nature or wide-area paging equipment combined with an ancillary equipment the test modulation, test arrangements, etc. as specified in clause 4 shall apply.

5.3 Special equipment and stand alone tested ancillary equipment

For wide-area paging equipment of a specialized nature and/or ancillary equipment tested on a stand alone basis 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. Under these circumstances the manufacturer also shall provide the following information:

- the primary functions of the equipment to be tested during and after EMC stress;

- the intended functions of the wide-area paging equipment which shall be in accordance with the documentation accompanying the equipment;

- the pass/failure criteria for the equipment;

- the method of observing a degradation of performance of the equipment.

The method of test to determine the performance or the degradation of performance which is be carried out during and/or after the tests, shall be simple, but at the same time give adequate proof that the primary functions of the equipment are operational.

5.4 Equipment classification

Wide-area paging equipment, or combinations of equipment declared as capable of being powered for intended use by the main battery of a vehicle shall additionally be considered as a vehicular mobile equipment.

Wide-area paging equipment or combinations of equipment declared as being capable of being powered for intended use by AC mains shall additionally be considered as base station equipment.

5.5 Conformance of ancillary equipment

At the manufacturer's discretion an ancillary equipment may be:

- assessed separately from a receiver or transmitter against all the applicable immunity and emission clauses of this ETS;

- assessed against another appropriate Harmonized EMC standard;

- assessed with it connected to a receiver or transmitter, in which case compliance shall be demonstrated to the appropriate clauses of this ETS.

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

6 Performance criteria

The equipment shall meet the minimum performance criteria as specified in subclauses 6.1, 6.2, 6.3 and 6.4.

The base transmitter and pocket receiver, for all immunity tests according to this ETS, except the spot frequency test of the radio frequency immunity test (see subclause 9.2), shall be assessed for:

- the transmission of recognisable messages and the storage of these messages in the memory of the paging receiver at the start of the test.

6.1 Performance criteria for Continuous phenomena applied to Transmitters (CT)

For base transmitters:

- during the tests in standby mode, no unintentional transmission shall occur;

- during the radio frequency immunity test (see subclauses 9.2 and 9.5), no loss of functions or stored data shall occur. The transmitter output shall remain on channel and shall be unchanged from its initial power level;

- during the spot frequency test of the radio frequency immunity test (see subclause 9.2), the transmitter shall be capable of transmitting calls to a (paging) receiver or measuring device with a resulting call alert acceptance ratio of 4:5 (four out of five) or better;

- at the conclusion of the test comprising the series of individual exposures the transmitter shall operate as intended with no loss of function or stored data.

6.2 Performance criteria for Transient phenomena applied to Transmitters (TT)

The test shall be performed in standby mode, for all types of transmitters, to ensure that no unintentional transmission or loss of transmission occurs.

At the conclusion of the test the wide-area paging equipment shall operate as intended with no loss of function or stored data.

6.3 Performance criteria for Continuous phenomena applied to Receivers (CR)

For pocket receivers:

- during the test no false call shall occur;

- at the conclusion of the test comprising the series of individual exposures the receiver shall operate as intended with no loss of function or stored data (messages) (as declared by the manufacturer, see subclause 5.1);

- during the spot frequency test of the radio frequency immunity test (see subclause 9.2) the receiver shall provide a call received alert signal acceptance ratio of 4:5 (four out of five) or better.

6.4 Performance criteria for Transient phenomena applied to Receivers (TR)

For pocket receivers no false call shall occur.

At the conclusion of the test comprising the series of individual exposures, the receiver shall operate as intended with no loss of function and/or stored data (messages) as declared by the manufacturer (see subclause 5.1).

7 Applicability overview table

7.1 Emission

Table 1

Application	**Equipment test requirement**			**Reference subclause in this ETS**	**Reference document**
	Base station and ancillary equipment for fixed use	**Mobile and ancillary equipment for vehicular use**	**Portable and ancillary equipment for portable use**		
Enclosure	applicable to ancillary equipment	applicable to ancillary equipment	applicable to ancillary equipment	8.2	EN 55022 [4]
DC power in/out	applicable	applicable	not applicable	8.3	EN 55022 [4] CISPR 16-1 [5]
AC mains	applicable	not applicable	not applicable	8.4	EN 55022 [4]

7.2 Immunity

Table 2

Phenomena	Application	Equipment test requirement			Reference subclause in this ETS	Reference document
		Base station and ancillary equipment for fixed use	Mobile and ancillary equipment for vehicular use	Portable and ancillary equipment for portable use		
RF electromagnetic field (80 MHz to 1 000 MHz)	Enclosure	applicable	applicable	applicable	9.2	EN 61000-4-3 [6]
Electrostatic discharge	Enclosure	applicable	applicable	applicable	9.3	EN 61000-4-2 [7]
Fast transients common mode	Signal and control ports, DC and AC power ports	applicable	not applicable	not applicable	9.4	EN 61000-4-4 [8]
RF common mode (current clamp injection) 0,15 MHz to 80 MHz	Signal and control ports, DC and AC power ports	applicable	applicable	not applicable	9.5	EN 61000-4-6 [9]
Transient and surge	DC power input ports	not applicable	applicable	not applicable	9.6	ISO 7637-1 [10] ISO 7637-2 [11]
Voltage dips and interruption	AC mains power input ports	applicable	not applicable	not applicable	9.7	EN 61000-4-11 [12]
Surges, common and differential mode	AC mains power input ports	applicable	not applicable	not applicable	9.8	EN 61000-4-5 [13]

8 Test methods and limits for emission tests

8.1 Test configuration

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

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

- an attempt shall be made to maximize the detected radiated emission, e.g. by moving the cables of the equipment;

- 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 representative configuration of ancillary equipment necessary to exercise the ports;

- 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.

8.2 Enclosure

This test is applicable to ancillary equipment not incorporated in the wide-area paging equipment.

8.2.1 Definition

This test assesses the ability of ancillary equipment to limit their internal noise from being radiated from the enclosure.

8.2.2 Test method

The test method shall be in accordance with EN 55022 [4].

8.2.3 Limits

The wide-area paging equipment shall meet the class B limits according to EN 55022 [4] (10 m measuring distance) shown in table 3.

Table 3: Limits for spurious radiations

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

8.3 DC power input/output ports

This test is applicable for base station and ancillary equipment which may have DC cables longer than 3 m. If the DC power cable of the wide-area paging and/or the ancillary equipment is less than 3 m in length, and intended for direct connection to a dedicated AC/DC power supply, then the measurement shall be performed on the AC power input port of that power supply as specified in subclause 8.4. If the DC power cable may be greater than 3 m in length, then the measurement shall additionally be performed on the DC power port.

8.3.1 Definition

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

8.3.2 Test method

For equipment with a current consumption below 16 A the test method shall be in accordance with EN 55022 [4] and the Line Impedance Stabilizing Networks (LISNs) shall be connected to a DC power source.

For equipment with a current above 16 A the DC power ports shall be connected to 5 μH Line Impedance Stabilizing Networks (LISNs), with 50 Ω characteristic measuring ports. The LISNs shall be in accordance with the requirements of clause 2 of CISPR 16-1 [5].

A measuring receiver shall be connected to each LISN measurement port in turn and the conducted emission shall be 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 [4] subclause 9.3. 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 clause 1 of CISPR 16-1 [5].

8.3.3 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 8.3.2. 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 is unnecessary.

The wide-area paging equipment shall meet the class B limits according to EN 55022 [4], shown in table 4.

Table 4: Limits for conducted RF signals

Frequency range	Quasi-peak	Average
0,15 MHz - 0,5 MHz	66 dBµV - 56 dBµV	56 dBµV - 46 dBµV
> 0,5 MHz - 5 MHz	56 dBµV	46 dBµV
> 5 MHz - 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.		

8.4 AC mains power input/output ports

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

8.4.1 Definition

This test assesses the ability of transmitters, receivers and ancillary equipment to limit its internal noise from being present on the AC mains power input ports.

8.4.2 Test method

The test method shall be in accordance with EN 55022 [4].

8.4.3 Limits

The wide-area paging equipment shall meet the class B limits according to EN 55022 [4] shown in table 4.

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 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 or transmitter coupled to the ancillary equipment, shall be used to judge whether the ancillary equipment passes or fails;

- if 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.

9.2 Radio frequency electromagnetic field (80 MHz - 1 000 MHz)

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

9.2.1 Definition

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

9.2.2 Test method

The test method shall be in accordance with EN 61000-4-3 [6].

The following requirements and evaluation of test results shall apply:

- the test level shall be 3 V/m (measured unmodulated). The test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1 000 Hz;

- for receivers and transmitters, the stepped frequency increments shall be 1 % of the momentary frequency;

- the test shall be performed over the frequency range 80 MHz - 1 000 MHz with the exception of the exclusion band for transmitters (see subclause 4.7.2) or with the exception of the exclusion band for receivers (see subclause 4.7.1) as appropriate;

- the spot frequency test shall be performed at 80, 104, 136, 165, 200, 260, 330, 430, 560, 715 and 920 MHz $\pm$ 1 MHz, excluding those frequencies that fall within the exclusion band. The test shall additionally be performed at the edge frequencies of the exclusion band;

- responses on receivers occurring at discrete frequencies which are narrow band responses, shall be disregarded from the test (see subclause 4.8).

9.2.3 Performance criteria

For transmitters the performance criteria CT (see subclause 6.1) shall apply.

For receivers the performance criteria CR (see subclause 6.3) shall apply.

For ancillary the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

9.3 Electrostatic discharge

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

9.3.1 Definition

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

9.3.2 Test method

The test method shall be in accordance with EN 61000-4-2 [7].

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

The test severity level for contact discharge shall be 4 kV and discharge 8kV. All other details, including intermediate test levels, are contained within EN 61000-4-2 [7].

9.3.3 Performance criteria

For transmitters the performance criteria TT (see subclause 6.2) shall apply.

For receivers the performance criteria TR (see subclause 6.4) shall apply.

For ancillary the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

9.4 Fast transients common mode

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

This test shall be performed on signal ports, control ports and DC power ports if the cables may be longer than 3 m.

This test shall be performed on AC mains ports.

9.4.1 Definition

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

9.4.2 Test method

The test method shall be in accordance with EN 61000-4-4 [8].

For transmitters, receivers and ancillary equipment, which have cables longer than 3 m, or are connected to the AC mains, 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 EN 61000-4-4 [8];

- the test level for DC power input ports shall be 0,5 kV open circuit voltage as given EN 61000-4-4 [8];

- the test level for AC mains power input ports shall be 1 kV open circuit voltage as given EN 61000-4-4 [8].

9.4.3 Performance criteria

For transmitters the performance criteria TT (see subclause 6.2) shall apply.

For receivers the performance criteria TR (see subclause 6.4) shall apply.

For ancillary the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary is tested in connection with a receivers or transmitter in which case the corresponding performance criteria shall apply.

9.5 Radio frequency common mode (current clamp injection)

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

This test shall be performed on signal, control and DC power ports of mobile and their ancillary equipment, which may have cables longer than 2 m.

This test shall be performed on signal, control, and DC power ports of base station and fixed ancillary equipment, which may have cables longer than 1 m.

This test shall be performed on AC mains power ports.

9.5.1 Definition

This test assesses the ability of transmitters, receivers and ancillary equipment to operate as intended in the presence of a radio frequency electromagnetic disturbance on the input/output ports. This test substitutes radiated radio frequency electromagnetic immunity testing in the frequency range 150 kHz to 80 MHz.

9.5.2 Test method

The test method shall be in accordance with EN 61000-4-6 [9].

The following requirements and evaluation of test results shall apply:

- no intrusive or direct connection shall be made to any of the lines of any input/output port. Consequentially the clamp injection method shall be used;

- the test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1 000 Hz;

- for receivers and transmitters the stepped frequency increments shall be 50 kHz in the frequency range 150 kHz - 5 MHz and 1 % frequency increment of the momentary frequency in the frequency range 5 MHz - 80 MHz;

- the test level shall be severity level 2 as defined in EN 61000-4-6 [9], equivalent to 3 V rms unmodulated;

- the test shall be performed over the frequency range 150 kHz - 80 MHz with the exception of an exclusion band for transmitters (see subclause 4.7.2) or with the exception of the exclusion band for receivers (see subclause 4.7.1) as appropriate;

- responses on receivers occurring at discrete frequencies which are narrow band responses, shall be disregarded from the test (see subclause 4.8).

9.5.3 Performance criteria

For transmitters the performance criteria CT (see subclause 6.1) shall apply.

For receivers the performance criteria CR (see subclause 6.3) shall apply.

For ancillary the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary is tested in connection with receivers or transmitters in which case the corresponding performance criteria above shall apply.

9.6 Transients and surges in the vehicular environment

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.

9.6.1 Definition

These tests assess the ability of transmitters, receivers 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.

9.6.2 Test method

The test method shall be in accordance with ISO 7637-1 [10] for 12 V DC powered equipment and ISO 7637-2 [11] for 24 V DC powered equipment.

9.6.2.1 Test requirements for 12 V DC powered equipment

Where the manufacturer in his installation documentation requires the wide-area paging equipment to have a direct connection to the 12 V main vehicle battery the requirements in a) shall apply.

Where the manufacturer does not require the wide-area paging equipment to have a direct connection to the 12 V main vehicle battery the requirements in a) and b) shall apply:

a) Pulse 3a and 3b, level II, with the test time reduced to 5 minutes for each;

Pulse 4, level II, 5 pulses, with the characteristics as follows:

V_s: 5 V; V_a: 2,5 V; t_6: 25 ms; t_8: 5 s; t_f: 5 ms;

b) Pulse 1, level II: t_1: 2,5 s; 10 pulses;

Pulse 2, level II: t_1: 2,5 s; 10 pulses;

Pulse 7, level II: 5 pulses.

Where the manufacturer declares that the wide-area paging equipment requires a direct connection to the vehicular battery, and therefore the tests in accordance with the requirements b) are not carried out, this shall be stated in the test report.

9.6.2.2 Test requirements for 24 V DC powered equipment

Where the manufacturer in his installation documentation requires the wide-area paging equipment to have a direct connection to the 24 V main vehicle battery the requirements in c) shall apply.

Where the manufacturer does not require the wide-area paging equipment to have a direct connection to the 24 V main vehicle battery the requirements in c) and d) shall apply:

c) Pulse 3a and 3b, level II, with the test time reduced to 5 minutes for each;

Pulse 4, level II, 5 pulses, with the characteristics as follows:

- V_s: 10 V; V_a: 5 V; t_6: 25 ms; t_8: 5 s; t_f: 5 ms;

d) Pulse 1a, level II: t_1: 2,5 s; Ri: 25 Ω; 10 pulses;

Pulse 1b, level II: t_1: 2,5 s; Ri: 100 Ω; 10 pulses.

Where the manufacturer declares that the wide-area paging equipment requires a direct connection to the vehicular battery, and therefore the tests in accordance with the requirements d) are not carried out, this shall be stated in the test report.

Radio and ancillary equipment designed to operate at both DC power voltages shall be tested in both configurations.

9.6.3 Performance criteria

For transmitters pulse 3a and 3b the performance criteria CT (see subclause 6.1) shall apply. For pulse 1, 1a, 1b, 2, 4 and 7 the performance criteria TT (see subclause 6.2) shall apply, with the exception that a communication link need not to be maintained during exposure and may have to be re-established.

For receivers pulse 3a and 3b the performance criteria CR (see subclause 6.3) shall apply. For pulse 1, 1a, 1b, 2, 4 and 7 the performance criteria TR (see subclause 6.4) shall apply, with the exception that a communication link need not to be maintained during exposure and may have to be re-established.

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary equipment is tested in connection with receivers, transmitters or transceivers in which case the corresponding performance criteria above shall apply.

9.7 Voltage dips and interruptions

These test are applicable for base station and fixed ancillary equipment, powered by the AC mains.

These test shall be performed on AC mains power input ports.

9.7.1 Definition

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

9.7.2 Test method

The following requirements and evaluation of test results shall apply.

The test method shall be in accordance with EN 61000-4-11 [12].

The test levels shall be:

- a voltage dip corresponding to a reduction of the supply voltage of 30 % for 10 ms; and
- 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 greater than 95 % for 5 000 ms.

9.7.3 Performance criteria

For a voltage dip corresponding to a reduction of the supply voltage of 30 % for 10 ms the following performance criteria apply:

- for transmitters the performance criteria CT (see subclause 6.1);
- for receivers the performance criteria CR (see subclause 6.3);
- for ancillary equipment the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

For a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms the following performance criteria apply:

- for transmitters the performance criteria TT (see subclause 6.2);
- for receivers the performance criteria TR (see subclause 6.4);
- for ancillary equipment the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

For a voltage interruption corresponding to a reduction of the supply voltage of greater than 95 % for 5 000 ms the following performance criteria apply:

- in the case where the equipment is fitted with or connected to a battery back-up, the performance criteria TT (see subclause 6.2) or TR (see subclause 6.4) apply as appropriate;

- in the case where the equipment is powered solely from the AC mains supply (without the use of a parallel battery back-up) volatile user data may have been lost and if applicable the communication link need not to be maintained and lost functions should be recoverable by user or operator;

- no unintentional responses shall occur at the end of the test;

- in the event of loss of function(s) or in the event of loss of user stored data, this fact shall be recorded in the test report, the product description and the user documentation.

9.8 Surges, common and differential mode

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

These test shall be performed on AC mains power input ports.

9.8.1 Definition

These test assesses the ability of transmitters, receivers and ancillary equipment to operate as intended in the event of surges present on the AC mains power input ports.

9.8.2 Test method

The following requirements and evaluation of test results shall apply.

The test method shall be in accordance with EN 61000-4-5 [13]:

- the test level shall be 1 kV open circuit voltage for common mode and 0,5 kV open circuit voltage for differential mode;

- the transients shall be applied (in parallel) to all the wires in the cable with reference to the cabinet reference ground, (true common mode) and the series resistance shall be 10 Ω.

9.8.3 Performance criteria

For transmitters the performance criteria TT (see subclause 6.2) shall apply.

For receivers the performance criteria TR (see subclause 6.4) shall apply.

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see subclause 5.3) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

Annex A (normative): Antenna port phenomena which are relevant for the compliance with the essential requirements of the EC Council Directives

A.1 Scope

This annex covers the EMC phenomena at the antenna port of wide-area paging equipment. These parameters are considered to be: spurious emissions, spurious responses and blocking, and have been derived from consideration of the various National paging specifications used in Europe.

This annex is not valid for private wide-area paging equipment, which have these EMC phenomena specified in the radio product standard ETS 300 719-1 [15].

A.2 Spurious radiations of transmitters

A.2.1 Definition

Spurious radiations are discrete radio frequencies signals other than those of the carrier and sidebands associated with normal modulation.

The level of spurious radiations shall be measured as their power level into a specified load (conducted spurious components) and their effective radiated power when radiated by the cabinet and structure of the equipment (radiated spurious components).

A.2.2 Method of measurement

A.2.2.1 Method of measuring conducted spurious components

Conducted spurious components shall be measured as the power level of any discrete signal delivered into a 50 Ω load. This may be done by connecting the transmitter output through an attenuator to a measuring receiver, or by monitoring the relative levels of the spurious signals delivered to an artificial load.

The transmitter shall be unmodulated if possible, and the measurements shall be made in the frequency range 9 kHz - 4 GHz except for the channel on which the transmitter is intended to operate and its adjacent channels.

If an unmodulated carrier can not be obtained, the measurement shall be made with the transmitter modulated by a paging test signal, in which case this fact shall be recorded in the test report. The measurement shall be made at the highest rated power level to which the transmitter can be set.

The measurement shall be repeated with the transmitter in the stand-by position.

A.2.2.2 Method of measuring radiated spurious components

On a test site, fulfilling the requirements of subclause A.3.4, the sample shall be placed at the specified height on the support. The transmitter shall be operated with maximum carrier output power as specified by the manufacturer, delivered to an artificial load.

The transmitter shall be unmodulated if possible, and the radiation of any spurious component shall be detected by the test antenna and receiver, over the frequency range 30 MHz - 4 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

If an unmodulated carrier cannot be obtained, the measurement shall be made with the transmitter modulated by a paging test signal, in which case this fact shall be recorded in the test report.

At each frequency at which a component is detected, the sample shall be rotated to obtain a maximum response and the effective radiated power (erp) of that component shall be determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarization plane.

The measurements shall be repeated with the transmitter in the stand-by position.

The bandwidth used in this measurement for each spurious radiation shall be sufficiently wide to accept all significant components of the spurious radiation concerned. The conditions used in the relevant measurements shall be recorded in the test report. It is assumed that a -6 dB bandwidth of 120 kHz is sufficiently wide and a correct value for this measurement.

A.2.3 Limits

The power of any spurious component, conducted or radiated, shall not exceed the values given in table A.1.

Table A.1

Transmitter state	Frequencies less than or equal to 1 000 MHz	Frequencies greater than 1 000 MHz
Operating	250 nW	1 µW
Stand by	2 nW	20 nW

A.3 Spurious radiations of paging receivers

A.3.1 Definition

Spurious radiations are discrete radio frequency signals radiated by the receiver.

They are specified as the power level of any discrete signal measured by the measuring device within the specified frequency range.

A.3.2 Method of measurement

On a test site, fulfilling the requirements of subclause A.3.4, the sample shall be placed at the specified height on the support. The receiver shall be switched on.

The radiation of any spurious components shall be detected by the test antenna and receiver over the frequency range of 30 MHz - 4 GHz.

At each frequency at which a component is detected, the sample shall be rotated to obtain the maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal plane.

A.3.3 Limits

The power of any spurious component shall not exceed:

- 2 nW in the range 30 MHz - 1 GHz; and

- 20 nW in the range 1 GHz - 4 GHz.

A.3.4 Test site and general arrangements for the measurement of radiated fields

Test sites shall be open air. The term "open air" should be understood from an electromagnetic point of view. Such a test site may be "outdoor" (really in open air) or alternatively "indoor" with walls and ceiling transparent to the radio waves at the frequencies considered. For these purposes, an anechoic room is considered "open air".

For guidance on test sites see ETR 027 [14], the relevant part of which is reproduced in annex B.

A.4 Spurious response immunity

A.4.1 Definition

The spurious response immunity of the paging receiver is the ability to discriminate between the wanted signal modulated by a paging test signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained. Unwanted signal frequencies shall be tested from 30 MHz to 1 GHz except for frequencies within the wanted frequency channel and the both adjacent channels.

Spurious response immunity is defined as the level of the unwanted signal for which the message acceptance ratio is 80 %.

A.4.2 Method of measurement

The test fixture shall meet the requirements of clause A.7.

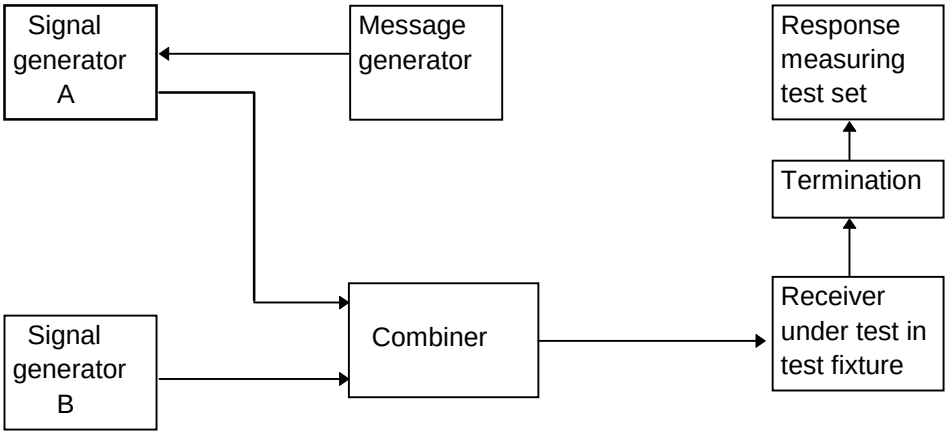


Figure A.1: Measuring arrangement

The method of measurement shall be as follows:

a) two signal generators, A and B shall be connected to the receiver via a combining network (see figure A.1). The wanted signal, produced by the signal generator A, shall be set to the carrier frequency and shall be modulated with normal test modulation (see subclause 4.2). The unwanted signal, produced by signal generator B, shall be modulated with a 400 Hz sinewave signal using a deviation equal to 12 % of the channel separation and shall be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur (see clause A.8);

b) initially, signal generator B shall be switched off. The level of signal generator A shall be adjusted to the reference level (see clause A.6);

c) the wanted signal shall then be transmitted repeatedly and the signal generator B shall be switched on. The input level of the unwanted signal shall be adjusted until a successful message ratio of less than 10 % is obtained;

d) the level of the unwanted signal shall be reduced by 2 dB for each occasion that a successful response is not observed. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall then be recorded;

e) the unwanted input signal shall then be increased by 1 dB and the new value recorded. The wanted signal shall then be continuously repeated. In each case, if a response is not obtained, the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded. No levels of the unwanted signal shall be recorded unless preceded by a change in level. The measurement shall be stopped after a total of 10 values have been recorded;

f) the measurement shall be repeated at each frequency within the specified frequency range at which it is calculated that a spurious response could occur (see clause A.8);

g) the spurious response immunity for messages for the frequency concerned is the ratio in dB of the average of the levels of the unwanted signal recorded in steps d) and e) to the level of the wanted signal, expressed in dB.

A.4.3 Limits

The spurious response immunity ratio shall not be less than 50,0 dB.

A.5 Blocking immunity

A.5.1 Definition

Blocking immunity for paging messages is a measure of the capability of the paging receiver to receive the wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted unmodulated high input signal.

It is defined as the level of the unwanted signal for which the message acceptance ratio is 80 %. The wanted signal level shall correspond to the reference figure (see clause A.6).

A.5.2 Method of measurement

The test fixture shall meet the requirements of clause A.7.

The method of measurement shall be as follows:

a) two signal generators A and B shall be connected to the receiver input via a combining network (see figure A.1). The wanted signal, represented by signal generator A, shall be set to the carrier frequency and shall be modulated with normal test modulation (see subclause 4.2);

b) initially, the unwanted signal, represented by the signal generator B, shall be switched off and the amplitude of signal generator A shall be adjusted to the reference level (see clause A.6);

c) the wanted signal shall then be transmitted repeatedly and the signal generator B shall be switched on. The unwanted signal shall be unmodulated and its frequency shall be selected in the range +1 MHz ± 10 % relative to the nominal frequency of the receiver. This frequency shall be one at which no spurious response has been detected. The level of the unwanted signal shall be adjusted until a successful message ratio of less than 10 % is obtained;

d) the level of the unwanted signal shall be reduced by 2 dB for each occasion that a successful response is not observed. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall then be recorded;

e) the unwanted input signal shall then be increased by 1 dB and the new value recorded. The wanted signal shall then be continuously repeated. In each case, if a response is not obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal shall not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded. No levels of the unwanted signal shall be recorded unless preceded by a change in level. The measurement shall be stopped after a total of 10 values have been recorded;

f) the measurements shall be repeated for frequency of the unwanted signal selected in the range -1 MHz ± 10 %, relative to the nominal frequency of the receiver;

g) the blocking level on either side of the carrier is taken as the average of the levels of the unwanted signal recorded in steps d) and e). The blocking level for messages shall be recorded as the ratio in dB of the lower value to the level of the wanted input signal.

A.5.3 Limits

The blocking level for messages shall not be less than 55,0 dB, except at frequencies on which spurious responses are found (see clause A.4).

A.6 Determination of reference level

The reference level is used as the basis for measurements in the appropriate test fixture. It shall be established according to the following procedure:

a) the receiver shall be placed into the test fixture (see figure A.2 and clause A.7) oriented as specified by the manufacturer;

b) the input signal level to the test fixture required to produce a message acceptance ratio of 80 % shall be determined and shall be noted in dBµV potential difference (p.d.);

c) the reference level for this test fixture is then the value noted for step b), increased by +3 dB.

A.7 Description of test fixture

It is useful to have available a test fixture so that relative measurements can be readily carried out.

The test fixture shall be a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using conducted measurement methods. This calibration may be achieved by the determination of the reference level as described in clause A.6.

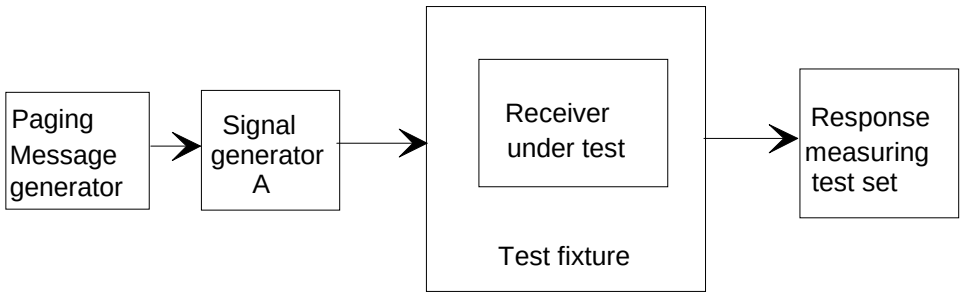


Figure A.2: Receiver in test fixture (see clause A.7)

In addition, the test fixture may provide:

1) a connection to an external power supply; and

2) interfaces to other relevant inputs and outputs.

The test fixture is normally provided by the applicant.

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

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

b) the Voltage Standing Wave Ratio (VSWR) at the 50 Ω socket shall not be greater than 1,5 over the frequency range of the measurements;

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

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

A.8 Calculations of spurious responses frequencies

A.8.1 Introduction to the method

To determine the frequencies at which spurious responses may occur the following calculations shall be made:

a) calculation of the "limited frequency range":

- the limited frequency range is equal to the frequency of the local oscillator signal (f_{lo}) applied to the first mixer of the receiver ± the sum of the intermediate frequencies (if_1..if_n) and half the switching range of the receiver (sr/2);

- hence the limited frequency range is $f_{lo} \pm (if_1 + if_2 + ... + if_n + sr/2)$;

b) calculation of frequencies outside the limited frequency range:

- a calculation of the frequencies at which spurious responses can occur outside the range determined in a) shall be made for the remaining frequency range of interest;

- the frequencies outside the limited frequency range are equal to the harmonics of the frequency of the local oscillator signal (f_{lo}) applied to the first mixer of the receiver ± the numeric value of the first intermediate frequency (if_1) of the receiver;

- hence the frequencies of these spurious responses are $nf_{lo} \pm if_1$ where n is an integer greater than or equal to 2.

For the calculations a) and b) the manufacturer shall state the frequency of the receiver, the frequency of the local oscillator signal (f_{lo}) applied to the first mixer of the receiver, the intermediate frequencies (if_1, if_2, etc.) and the switching range of the receiver.

NOTE: The switching range of the receiver is defined as the maximum frequency range over which the receiver can be operated without re-alignment or re-programming.

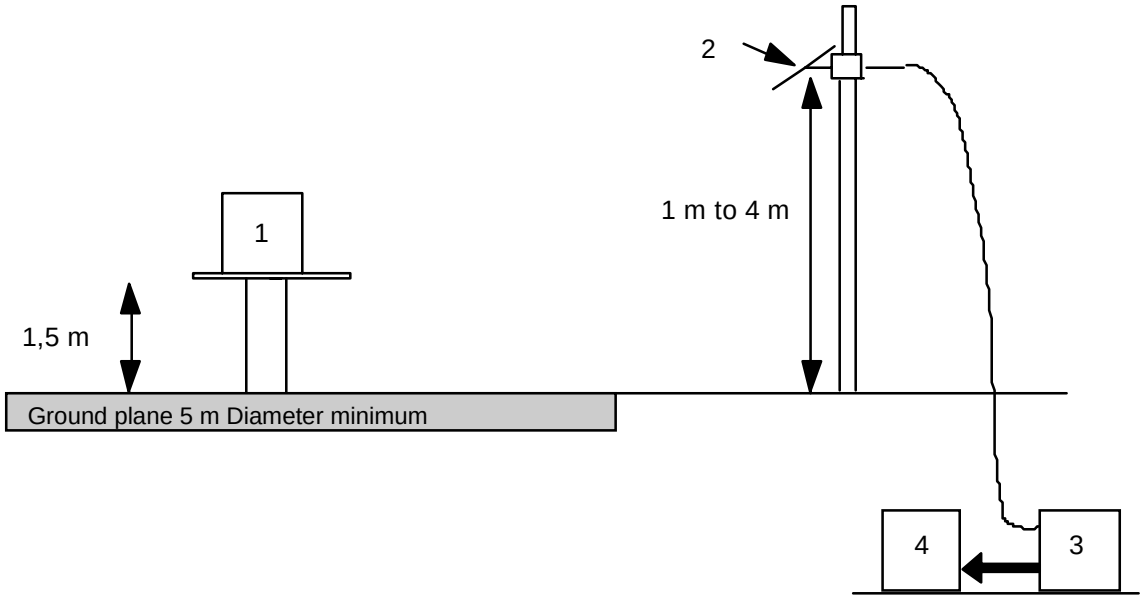
Annex B (normative): Radiated measurements

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

B.1.1 Open air test site

The open air test site (see subclause A.3.4) shall be on a reasonably level surface or ground. At one point on the site, a ground plane of at least 5 m diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample in its standard position, at 1,5 m above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of λ/2 or 3 m whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurements results.



NOTE: 1) Equipment under test

2) Test antenna

3) High pass filter (may be necessary)

4) Spectrum analyser or measuring receiver

Figure B.1: Open air test site

B.1.1.1 Standard position

The standard position on all test sites, except for equipment which is intended to be worn on a person, shall be as follows:

- for equipment with an integral antenna; it shall be placed in the position closest to normal use as declared by the manufacturer;
- for equipment with a rigid external antenna; the antenna shall be vertical;
- for equipment with non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

B.1.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements. Where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics.

This antenna is mounted on a 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 m 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 receiver and transmitter radiation measurements, the test antenna is connected to a measuring receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. For receiver radiated sensitivity measurements the test antenna is connected to a signal generator.

B.1.3 Substitution antenna

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a $\lambda/2$ dipole, resonant at the operating frequency, or a shortened dipole, calibrated to the $\lambda/2$ dipole. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 GHz and 4 GHz either a $\lambda/2$ dipole or a horn radiator may 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 external antenna is connected to the cabinet.

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

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall operate at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

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

B.1.4 Optional additional indoor site

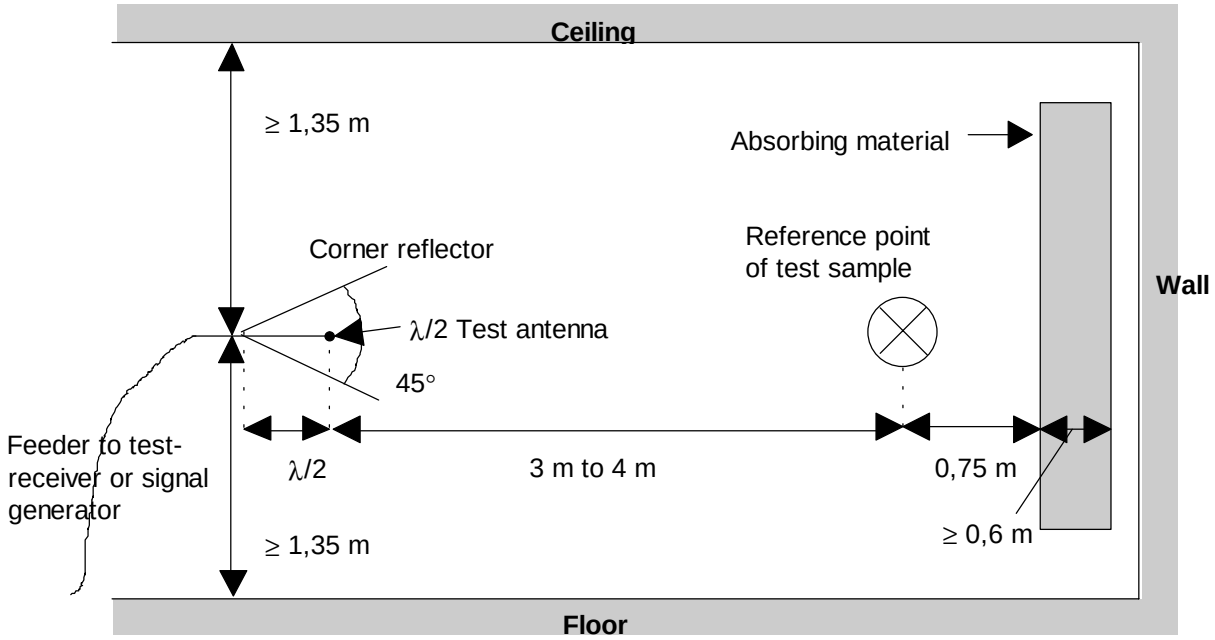


Figure B.2: Indoor test site arrangement (shown horizontal polarization)

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor test site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2,7 m in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling, in the case of horizontally polarized measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements. For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed. For practical reasons, the $\lambda/2$ antenna in figure A.2 may be replaced by an antenna of constant length, provided that this length is between $\lambda/4$ and λ at the frequency of measurement, and the sensitivity of the measuring system is sufficient. In the same way the distance of $\lambda/2$ to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method. To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between the direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ±0,1 m in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-sited until a change of less than 2 dB is obtained.

B.2 Guidance on the use of radiation test sites

For measurements involving the use of radiated fields, use may be made of a test site in conformity with the requirements of clause B.1 of this annex. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

B.2.1 Measuring distance

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 that the precautions described in this annex are observed. Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in European test laboratories.

B.2.2 Test antenna

Different types of test antenna may be used, since performing substitution measurements reduces the effect of the errors on the measuring results.

Height variation of the test antenna over a range of 1 m to 4 m is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at the lower frequencies below approximately 100 MHz.

B.2.3 Substitution antenna

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below approximately 80 MHz. Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the test site. Correction factors shall be taken into account when shortened dipole antennas are used.

B.2.4 Artificial antenna

The dimensions of the artificial antenna used during radiated measurements should be small in relation to the sample under test.

Where possible, a direct connection should be used between the artificial antenna and the test sample. In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores or double screened cables.

B.2.5 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables, etc.) which are not adequately decoupled, may cause variations in the measurement results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non-conducting support).

B.3 Further optional alternative indoor test site using an anechoic chamber

For radiation measurements, when test frequency of the signals being measured is greater than 30 MHz, use may be made of an indoor test site being a well-shielded anechoic chamber simulating a free space environment. If such a chamber is used, this shall be recorded in the test report.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method, clause B.1. In the range 30 MHz to 100 MHz, some additional calibration may be necessary.

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high. Walls and ceiling should be coated with RF absorbers of 1 m height. The base should be covered with absorbing material 1 m thick, and a wooden floor, able to carry test equipment and operators. A measuring distance of 3 m to 5 m in the long middle axis of the chamber can be used for measurements up to 12,75 GHz. The construction of the anechoic chamber is described in the following subclauses.

B.3.1 Example of the construction of a shielded anechoic chamber

Free-field measurements can be simulated in a shielded measuring chamber where the walls are coated with RF absorbers. Figure B.3 shows the requirements for shielding loss and wall return loss of such a room. As dimensions and characteristics of usual absorber materials are critical below 100 MHz (height of absorbers < 1 m, reflection attenuation < 20 dB) such a room is more suitable for measurements above 100 MHz. Figure B.4 shows the construction of an anechoic shielded measuring chamber having a base area of 5 m by 10 m and a height of 5 m.

Ceilings and walls are coated with pyramidal formed RF absorbers approximately 1 m high. The base is covered with absorbers which form a non-conducting sub-floor, or with special ground floor absorbers. The available internal dimensions of the room are $3\ m \times 8\ m \times 3\ m$, so that a maximum measuring distance of 5 m length in the middle axis of this room is available.

At 100 MHz the measuring distance can be extended up to a maximum of 2λ.

The floor absorbers reduce floor reflections so that the antenna height need not be changed and floor reflection influences need not be considered.

All measuring results can, therefore, be checked with simple calculations and the measurement uncertainties have the smallest possible values due to the simple measuring configuration.

B.3.2 Influence of parasitic reflections in anechoic chambers

For free-space propagation in the far field condition the correlation $E = Eo \times (Ro/R)$ is valid for the dependence of the field strength E on the distance R, whereby Eo is the reference field strength in the reference distance Ro.

It is useful to use this correlation for comparison measurements, as all constants are eliminated with the ratio and neither cable attenuation, nor antenna mismatch, or antenna dimensions are of importance.

Deviations from the ideal curve can be seen easily if the logarithm of the above equation is used, because the ideal correlation of field strength and distance can then be shown as a straight line and the deviations occurring in practice are clearly visible. This indirect method shows the disturbances due to reflections more readily and is far less problematical than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions suggested in clause A.3 at low frequencies up to 100 MHz, there are no far field conditions and therefore reflections are stronger so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well. In the frequency range of 1 GHz to 12,75 GHz, because more reflections will occur, the dependence of the field strength on the distance will not correlate so closely.

B.3.3 Calibration of the shielded RF anechoic chamber

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

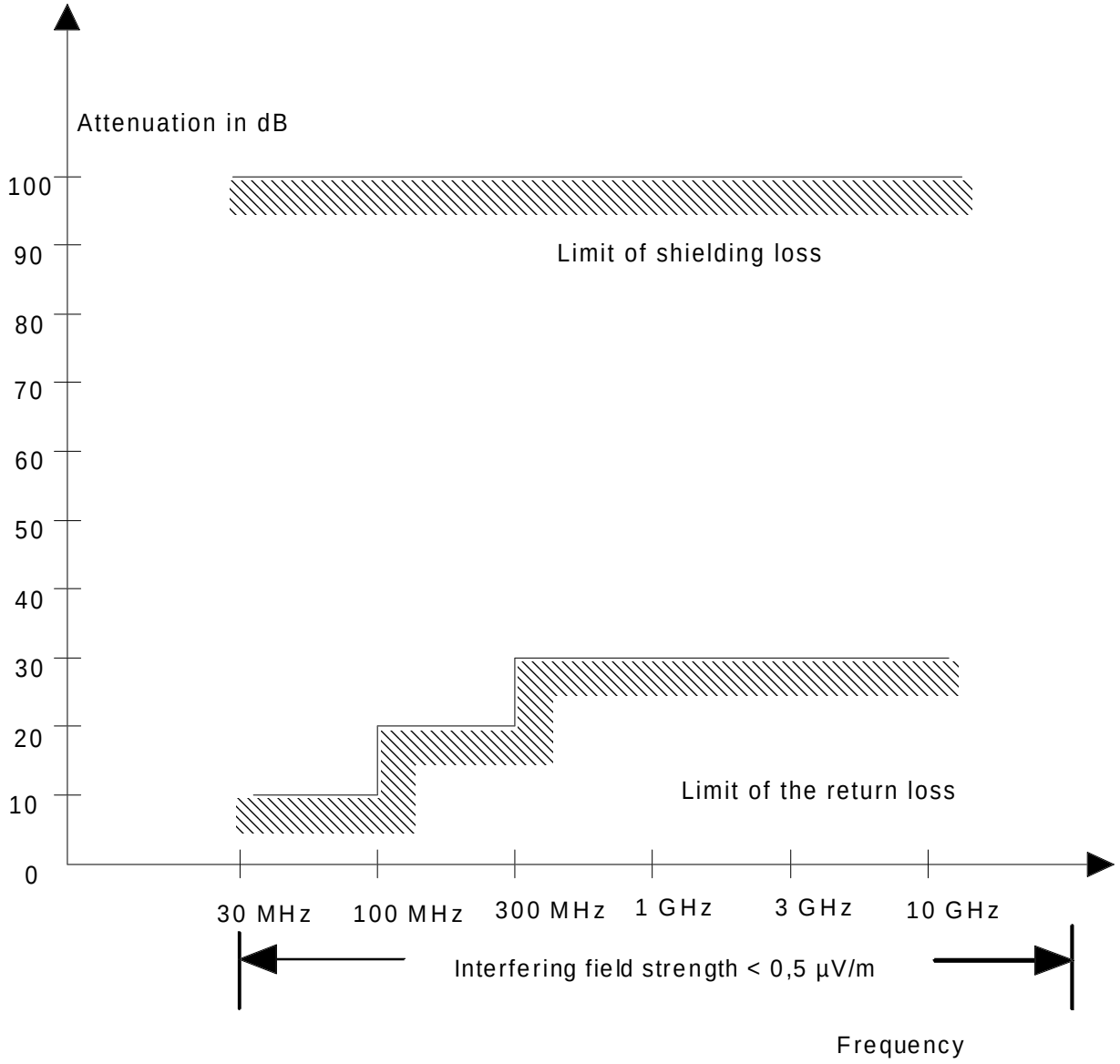

Attenuation in dB
100
90
80
70
60
50
40
30
20
10
0
Limit of shielding loss
Limit of the return loss
30 MHz
100 MHz
300 MHz
1 GHz
3 GHz
10 GHz
Interfering field strength < 0,5 µV/m
Frequency

Figure B.3

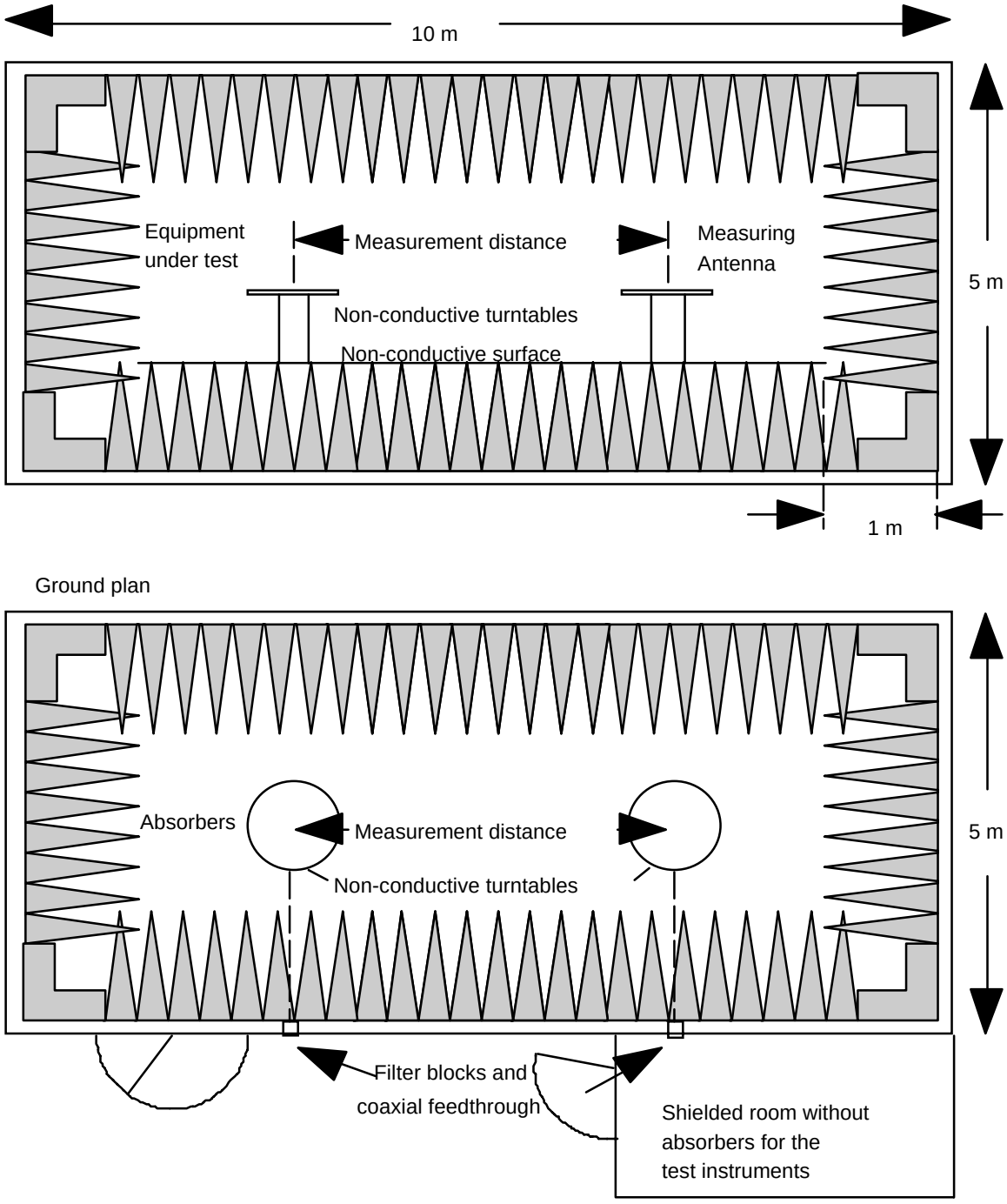


Figure B.4: Example of construction of an anechoic shielded chamber

Annex C (normative): Subclauses of this ETS relevant for compliance with the essential requirements of relevant EC Council Directives

Table C.1: Subclauses of this EN relevant for compliance with the essential requirements of relevant EC Council Directives

Clause/subclause number and title		Corresponding article of Council Directive 89/336/EEC [3]	Qualifying remarks
8.2	Enclosure	4 (a)	
8.3	DC power input/output ports	4 (a)	
8.4	AC mains power input/output ports	4 (a)	
9.2	Radio frequency electromagnetic field (80 MHz - 1 000 MHz)	4 (b)	
9.3	Electrostatic discharge	4 (b)	
9.4	Fast transients common mode	4 (b)	
9.5	Radio frequency common mode (current clamp injection)	4 (b)	
9.6	Transients and surgesin the vehicular environment	4 (b)	
9.7	Voltage dips and interruptions	4 (b)	
9.8	Surges, common and differential mode	4 (b)	
A.2	Spurious radiations of transmitters	4 (a)	
A.3	Spurious radiations of paging receivers	4 (a)	
A.4	Spurious response immunity	4 (b)	
A.5	Blocking immunity	4 (b)	

History

Document history			
May 1996	Public Enquiry	PE 106:	1996-05-20 to 1996-09-13
August 1997	One-step Approval Procedure	OAP 9752:	1997-08-29 to 1997-12-26